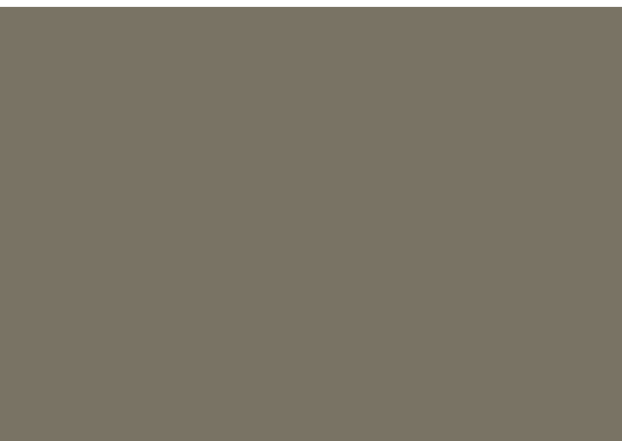


Wonarah Improved Hard Process (IHP) Project

Notice of Intent

December 2012



NOTICE OF INTENT

Wonarah Improved Hard Process (IHP)
Project

December 2012

CR 9014_22_v3



Coffey Environments Australia Pty Ltd ABN 65140765902
Level 7, 80 Mitchell Street Darwin NT 0800
GPO Box 717 Darwin NT 0801
T +61 8 8901 1200 F +61 8 8901 1299
coffey.com

© Coffey Environments Australia Pty Ltd 2012

Project director	Daniel Moriarty		
Project manager	Craig Smith		
Version:	Details:	Approved:	Date:
CR 9014_22_v1	Initial draft to client	CS	07/12/2012
CR 9014_22_v2	Second draft to client	CS	14/12/2012
CR 9014_22_v3	Final to Government	DM	20/12/2012

CONTENTS

1.	INTRODUCTION	1-1
1.1	Overview	1-1
1.2	Project Area and Land Tenure	1-3
1.3	History of the Project	1-3
1.4	Proponent Details	1-5
1.5	Consultant Details	1-5
1.6	Purpose of this Notice of Intent	1-6
1.7	Proposed Environmental Assessment of Project	1-7
1.8	Report Structure	1-7
2.	PROJECT DESCRIPTION	2-1
2.1	Project Overview	2-1
2.2	Differences Between the DSO and IHP Projects	2-2
2.3	Geology and Mineralisation	2-3
2.4	Project Components	2-8
2.5	Mining	2-10
2.5.1	Mining Process	2-10
2.5.2	Mining Schedule	2-13
2.6	Processing	2-15
2.6.1	Beneficiation Process	2-15
2.6.2	Improved Hard Process (IHP)	2-15
2.6.3	Slimes Disposal	2-17
2.7	Transport Infrastructure	2-17
2.7.1	Access Road	2-17
2.7.2	Haul Roads and Other Site Roads	2-19
2.7.3	Aerodrome	2-19
2.7.4	Rail	2-19
2.8	Other Project Infrastructure	2-19
2.8.1	Administration	2-19
2.8.2	Accommodation	2-20
2.8.3	Power	2-20
2.8.4	Port	2-20
2.9	Surface Water Management	2-20
2.10	Groundwater Management	2-21
2.11	Domestic Waste Management	2-22
2.12	Workforce	2-22
2.13	Timing	2-23
2.14	Rehabilitation and Project Closure	2-23
3.	PROJECT PERMITTING	3-1
3.1	History of Project Permitting	3-1
3.2	Northern Territory Compliance Framework	3-2
3.2.1	Mineral Titles Act and Mining Management Act	3-2

3.2.2	Environmental Assessment Act	3-4
3.2.3	Waste Management and Pollution Control Act	3-4
3.2.4	Water Act	3-4
3.2.5	Northern Territory Aboriginal Sacred Sites Act	3-4
3.2.6	Additional Northern Territory Compliance Measures	3-5
3.3	National Compliance Framework	3-6
3.3.1	Environment Protection and Biodiversity Conservation Act	3-6
3.3.2	Native Title Act	3-7
3.3.3	Aboriginal Land Rights (Northern Territory) Act	3-7
3.3.4	Australian Heritage Council Act	3-8
3.3.5	Aboriginal and Torres Strait Islander Heritage Protection Act	3-8
3.3.6	Additional National Compliance Measures	3-8
4.	PUBLIC INVOLVEMENT AND CONSULTATION	4-1
4.1	Consultation Objectives	4-1
4.2	Stakeholders	4-2
4.3	Consultation to Date	4-2
4.4	Ongoing Community Consultation	4-3
4.4.1	Approach	4-4
4.4.2	Mechanisms	4-4
5.	EXISTING ENVIRONMENT, POTENTIAL IMPACTS AND MANAGEMENT	5-1
5.1	Framework	5-1
	Residual Risk Assessment	5-2
5.2	Air Quality	5-4
5.2.1	Existing Environment	5-4
5.2.2	Potential Impacts	5-4
5.2.3	Mitigation and Management Measures	5-7
5.2.4	Residual Risk	5-9
5.2.5	Monitoring	5-10
5.3	Greenhouse Gases	5-11
5.3.1	Existing Environment	5-11
5.3.2	Potential Impacts	5-11
5.3.3	Mitigation and Management Measures	5-12
5.3.4	Residual Risk	5-12
5.3.5	Monitoring	5-12
5.4	Noise and Vibration	5-13
5.4.1	Existing Environment	5-13
5.4.2	Potential Impacts	5-13
5.4.3	Mitigation and Management Measures	5-15
5.4.4	Residual Risk	5-16
5.4.5	Monitoring	5-16
5.5	Landform, Geology and Soils	5-17
5.5.1	Existing Environment	5-17
5.5.2	Potential Impacts	5-20
5.5.3	Mitigation and Management Measures	5-21
5.5.4	Residual Risk	5-22

	5.5.5	Monitoring	5-24
5.6		Land and Resource Use	5-24
	5.6.1	Existing Environment	5-24
	5.6.2	Potential Impacts	5-25
	5.6.3	Mitigation and Management Measures	5-25
	5.6.4	Residual Risk	5-26
	5.6.5	Monitoring	5-27
5.7		Flora and Vegetation Communities	5-27
	5.7.1	Existing Environment	5-27
	5.7.2	Potential Impacts	5-32
	5.7.3	Mitigation and Management Measures	5-33
	5.7.4	Residual Risk	5-35
	5.7.5	Monitoring Program	5-37
5.8		Fauna	5-38
	5.8.1	Existing Environment	5-38
	5.8.2	Potential Impacts	5-42
	5.8.3	Avoidance, Mitigation and Management	5-43
	5.8.4	Residual Impact	5-44
	5.8.5	Monitoring Program	5-47
5.9		Groundwater	5-48
	5.9.1	Existing Environment	5-48
	5.9.2	Potential Impacts	5-51
	5.9.3	Mitigation and Management Measures	5-52
	5.9.4	Residual Risk	5-53
	5.9.5	Monitoring	5-54
5.10		Surface Water	5-54
	5.10.1	Existing Environment	5-54
	5.10.2	Potential Impacts	5-56
	5.10.3	Mitigation and Management Measures	5-58
	5.10.4	Residual Risk	5-60
	5.10.5	Monitoring	5-61
5.11		Socio-economic	5-62
	5.11.1	Existing Environment	5-62
	5.11.2	Potential Impacts	5-62
	5.11.3	Mitigation and Management Measures	5-69
	5.11.4	Residual Risk	5-71
	5.11.5	Monitoring	5-74
5.12		Archaeology and Cultural Heritage	5-75
	5.12.1	Existing Environment	5-75
	5.12.2	Potential Impacts	5-75
	5.12.3	Mitigation and Management Measures	5-76
	5.12.4	Residual Risk	5-77
	5.12.5	Monitoring	5-79
5.13		Infrastructure and Transport	5-79
	5.13.1	Existing Environment	5-79
	5.13.2	Potential Impacts	5-79
	5.13.3	Mitigation and Management Measures	5-80

5.13.4	Residual Risk	5-81
5.13.5	Monitoring	5-82
6.	ENVIRONMENTAL MANAGEMENT	6-1
6.1	Environmental Policy	6-1
6.2	Environmental Management System	6-1
6.2.1	Objectives	6-1
6.2.2	Implementation	6-1
6.3	Responsibility	6-3
6.4	Induction	6-4
6.5	Key Areas of Management	6-4
6.5.1	Compliance with Mineral Lease Conditions	6-4
6.5.2	Audit and Review	6-4
6.5.3	Recording	6-5
6.5.4	Reporting	6-6
6.5.5	Emergency Response	6-6
6.5.6	Communications	6-7
6.6	Environmental Management Plan	6-7
7.	GLOSSARY	7-1
7.1	Units and Symbols	7-1
7.2	Abbreviations	7-2
7.3	Words	7-6
8.	REFERENCES	8-1

Figures

1.1	Location of the Wonarah IHP Project	1-2
1.2	Land tenure	1-4
2.1	Stratigraphic column of the regional geology	2-4
2.2	Long section through Arruwurra deposit	2-5
2.3	Long section through Main Zone deposit	2-7
2.4	Proposed project layout	2-9
2.5	Arruwurra mine layout	2-11
2.6	Main Zone mine layout	2-12
2.7	Strip mining process	2-14
2.8	Improved Hard Process (IHP) for kiln phosphoric acid production	2-16
3.1	Wonarah IHP Project permitting process	3-3
5.1	Morning and afternoon wind direction and speed recorded at the Wonarah BoM station 1957 to 1974	5-5
5.2	Sensitive receptors along the product transport route - air	5-6
5.3	Sensitive receptors along the product transport route - noise	5-14
5.4	Soil classifications in the project area	5-18
5.6	Threatened flora in the project area and surrounds	5-31
5.7	Threatened fauna in the project area and surrounds	5-39
5.8	Location of project production and monitoring bores	5-49
5.9	Catchments and estimated flow paths in the project area	5-55

6.1	Minemakers' corporate environmental policy	6-2
-----	--	-----

Tables

1.1	NOI requirements as addressed by this document	1-6
2.1	Wonarah Total Resource at a 10% P ₂ O ₅ cut-off grade	2-1
2.2	Differences between IHP and DSO projects	2-2
2.3	Project components and approximate footprints	2-10
3.1	Additional relevant Northern Territory regulations	3-5
3.2	Additional relevant federal regulations	3-8
5.1	Descriptors used to classify likelihood and consequence measures of impact	5-3
5.2	Qualitative risk analysis matrix	5-3
5.3	Summary of seasonal wind conditions	5-4
5.4	Summary of residual impacts on air quality	5-9
5.5	Summary of impacts resulting from greenhouse gas emissions	5-12
5.6	Summary of noise and vibration impacts	5-16
5.7	Summary of land resources impacts	5-23
5.8	Summary of land use impacts	5-26
5.9	Summary of impacts and risks to flora	5-35
5.10	Summary of impacts to fauna	5-45
5.11	Third party bores in the project area	5-50
5.12	Summary of impacts to groundwater	5-53
5.13	Groundwater monitoring schedule	5-54
5.14	Summary of surface water impacts	5-60
5.15	Summary of socio-economic impacts	5-71
5.16	Summary of Indigenous cultural heritage impacts	5-77
5.17	Summary of traffic impacts	5-81
6.1	Environmental management responsibilities	6-3
6.2	Indicative timeframes for response and containment of typical complaints	6-5

Plates

2.1	Construction of the IHP demonstration plant	2-18
2.2	Construction of the IHP demonstration plant	2-18
5.1	Typical landform at Wonarah	5-19
5.2	Typical rocky outcrop at Wonarah	5-19
5.3	The project area after fire showing Spinefex regrowth	5-28
5.4	Vegetation in the project area after good wet season rains	5-28
5.5	Main street of Tennant Creek	5-63
5.6	Tennant Creek police station	5-63
5.7	St John Ambulance Barkly Region	5-64
5.8	Tennant Creek primary school	5-64
5.9	Wunara community	5-65
5.10	Houses within the Wunara community	5-65
5.11	Communal area within the Wunara community	5-66
5.12	Barkly Highway	5-66

Attachments

- A Section 46 Cross Reference
- B Summary of impacts, environmental and social outcomes, and residual impacts assessed for the Wonarah DSO project
- C Environmental Management Plans

Appendices

- 1 Wonarah Phosphate Project: Acid Forming Characteristics of Waste Rock Composite Samples from the Arruwurra Prospect and Main Zone and Low Grade Ore
- 2 Surface Water Management
- 3 Baseline Flora and Fauna Report
- 4 Desktop Flora and Fauna Assessment: Proposed Borefield and Water Pipeline
- 5 Hydrogeological and Water Supply Investigations
- 6 Hydrological Baseline Assessment

1. INTRODUCTION

1.1 Overview

Minemakers Australia Pty Ltd (Minemakers) proposes to develop the Wonarah Improved Hard Process (IHP) Project, located approximately 260 km east of Tennant Creek and 960 km southeast of Darwin in the Barkly Tableland of the Northern Territory (Figure 1.1).

The Wonarah IHP Project (hereafter termed 'the project') involves the mining of two phosphate deposits, known as 'Arruwurra' and 'Main Zone'. The project has a total Measured, Indicated and Inferred Joint Ore Reserves Committee (JORC) compliant resource estimate of 842 Mt at 18% phosphorite (P_2O_5) at a 10% P_2O_5 cut-off grade. At a 5% cut-off grade—the grade acceptable as feed for the IHP processing plant—the total resource is 1,406 Mt at 13% P_2O_5 .

Minemakers already holds the Mineral Lease ML27244 for the project area. Based on future resource optimisation studies, applications for additional mineral leases over the resource area may be requested.

Mining will be by conventional open pit mining techniques with pit depths varying from 20 m to approximately 35 m. Beneficiation of the ore will simply entail crushing and scrubbing to remove clays present in the ore. The washed ore will be fed to a fine ore storage stockpile ahead of processing through an IHP plant. In addition to the fine ore stockpile, there will be two other stockpiles, one for petroleum coke and the other for silica sand. The three inputs to the IHP plant will be dried, screened, ground and pelletized before being fed into a ported kiln. Heated air will be blown counter-current to the flow of material in the kiln resulting in the liberation of P_4O_{10} gas, which will then pass through a hydrator where it will be absorbed in water to form phosphoric acid at approximately 70% P_2O_5 . This super phosphoric acid (SPA) product will be cooled, filtered to remove any suspended solids and stored ready for transport.

Gases leaving the hydrator will be scrubbed to recover any product not absorbed, and the vented gases additionally scrubbed and passed through a flue gas desulfurization unit for final cleaning. Inert silica balls produced during the process can be used in local construction (as aggregate in concrete, in the construction of roads and paths, or as drainage aggregate) or returned to the open pits voids. Currently, research and development is being conducted on the physical characteristics of the silica balls. This work suggests that this material may be a useful replacement for cement in the construction of light weight concrete products. Should this be demonstrated during 2013, it is possible that some of this material will be back-loaded in the petroleum coke containers to Tennant Creek or Darwin for concrete product manufacture by third parties. The clay slimes from beneficiation will initially be pumped into a slime storage facility located within a few kilometres of the processing plant. Once discrete open pit areas have been mined, excess silica balls and slimes will be able to be co-deposited back into the open pit voids. The slimes facility will provide for the maximum reclaim of water for re-use as process water.

It is proposed that the project be developed in a staged fashion with a single production module initially, with other modules being added progressively as market demand and availability of financing permits. The long-term goal will be to achieve a production rate of around 1 Mt of contained P_2O_5 per annum, representing five production modules.

The notional life of the project is 20 years; however, given the size of the resource there is the potential for this to be significantly extended and the project become a multi-generational mine.

This Notice of Intent (NOI) provides formal notification to the Northern Territory Government and other interested parties of Minemakers' intention to develop the Wonarah IHP Project.

1.2 Project Area and Land Tenure

The Wunara community is the closest populated area to the project. It is located adjacent to the Barkly Highway and is approximately 10 km to the east of the boundary of ML27244 (see Figure 1.1). The community has four houses and associated buildings and an Indigenous population that fluctuates from 2 to 30 people according to the season.

The project area includes ML27244 to the south of the Barkly Highway, as well as the northern borefield and water supply pipeline located on the Dalmore Downs pastoral lease on the northern side of the Barkly Highway.

The project is located wholly within enhanced freehold portions 3748, 3749 and 3751 to 3754 and the perpetual pastoral lease portion 773 (Figure 1.2). These land portions are declared as Aboriginal community living areas in accordance with the *Miscellaneous Acts Amendment Act* and are part of the Arruwurru Aboriginal land, which is owned by the Arruwurra Aboriginal Corporation.

Minemakers was granted a Mineral Lease for the project area (ML27244) on 18 February 2010 (see Figure 1.2). It is a prerequisite for a Mineral Lease that the applicant holds a Northern Territory Miners Right. Minemakers is the registered holder of Miners Right number 556124. The project area referred to in this NOI reflects the Mineral Lease area, and also encompasses exploration licences EL26055, EL26583, EL26584, EL26585 and EL26586, which are held by Minemakers and parts of which will need to be converted into MLs for this project

1.3 History of the Project

The Wonarah phosphate deposit was originally identified in 1967. Between 1967 and 1970, IMC conducted regional mapping, geophysical drilling and testing activities and described a resource of 307 Mt at 18.98% phosphorite (P_2O_5) (AKD, 2005). During the mid-1980s, CRA Exploration Pty Ltd carried out further exploration activities to the south of the Wonarah deposit, however, it withdrew its interest in the deposit due to low phosphate prices and lack of infrastructure in central Australia at the time.

The project was acquired by AKD Limited (currently Indo Mines Limited) in 1998 from Rare Earths and Minerals Pty Ltd and Pilbara Chemical Corporation NL who had applied for licences over the area in 1997. The exploration leases within which the Wonarah deposit lies were granted to Indo Mines Limited and to a joint venture between Indo Mines Limited and Rio Tinto in 1998 and 2000, respectively. During the joint venture, lasting from March 1999 to December 2002, Rio Tinto continued exploration activities as manager and operator of the tenements (AKD, 2005). The joint venture ended after a prefeasibility study in January 2000 recommended that Rio Tinto not proceed with development of the project (Hackman et al., 2000).

Minemakers purchased exploration licenses EL9976, EL22168, EL24562 and EL26394 from Indo Mines Limited in October 2006 and consolidated them into Substitute Exploration Lease SEL26452, which was registered in September 2007. Following this Minemakers has since applied for and been granted ML27244 covering the project area.

In 2009, Minemakers undertook bulk sampling from the Arruwurra deposit at Wonarah, which involved the mining, crushing and stockpiling of 4,160 t of direct shipping ore (DSO). This bulk sampling program provided DSO samples to potential customers to allow detailed analysis of the ore properties for downstream processing and end use.

Minemakers previously proposed to develop a DSO mine at Wonarah. An EIS for this project was submitted to the Northern Territory Government in November 2009; the project was approved in April 2010. However, as a result of the prevailing economic conditions at the time the project was not constructed. Since 2009 Minemakers, has made a significant investment in the development of the IHP, a recently developed super phosphoric acid production process. The IHP provides the opportunity to produce a high quality super phosphoric acid in Australia that can be used for fluid fertilizer applications throughout the agricultural sector. This represents significant value adding to the project, producing SPA which is a product that currently has to be imported to Australia.

As a result of the increased confidence in IHP gained through bench scale testing and a scoping study, Minemakers is now proposing to develop the Wonarah deposit, including a series of major changes to the DSO project concept and layout. As a result of these proposed changes, a new NOI and subsequent Public Environmental Report (PER) or Environmental Impact Statement (EIS) are required to seek approval for the project from the Northern Territory Government.

1.4 Proponent Details

Minemakers is an Australian company and has been listed on the Australian Stock Exchange since October 2006 (ASX code: MAK). The company is focussed on the development of the Wonarah deposit, and holds a 100% ownership in this project.

Name and Address of Proponent

Minemakers Australia Pty Ltd
Level 2, 34 Colin Street
West Perth WA 6005

Telephone: (08) 9264 7000
Fax: (08) 9264 7099

Contact: Neville Bergin, General Manager - Projects Development.

1.5 Consultant Details

Coffey Environments is an Australian company and has been listed on the Australian Stock Exchange since 1990 (ASX code: COF).

Coffey Environments has been commissioned by Minemakers as the lead environmental consultant for the approvals process to develop the project.

Name and Address of Consultant

Coffey Environments
Level 7, 80 Mitchell Street
Darwin NT 0800

Telephone: (08) 8901 1200
Fax: (08) 8901 1299

Contact: Daniel Moriarty, Project Director.
Craig Smith, Project Manager.

1.6 Purpose of this Notice of Intent

The purpose of this NOI is to:

- Provide formal notification to the Northern Territory Government and other interested parties of Minemakers' intention to develop the project.
- Outline the proposed project, including its potential economic, social and environmental benefits.
- Describe the existing environment and potential environmental impacts of the project.
- Outline high-level management and mitigation measures that are proposed to minimise adverse environmental impacts as a result of the project.
- Provide sufficient information to allow the Department of Mines and Energy (DME) and the Environmental Protection Agency (EPA) of the Department of Lands, Planning and the Environment (DLPE) to determine the appropriate level of environmental assessment for the project.

This NOI has been prepared in accordance with the DLPE Information Guidelines for a Notice of Intent (DNRETAS, 2012), as summarised in Table 1.1, and the DME Environmental Assessment of Mining Proposals Advisory Note (DME, 2012a).

Table 1.1 NOI requirements as addressed by this document

NOI Requirement	Report Section
Name of proponent and consultant	1.4
Address and contact details of proponent	1.4
Location of proposal	1.2
Description of proposal	Chapter 2
Outline of legislative and licensing requirements	Chapter 3
Description of site and related details of existing environment	Chapter 5
Description of marine and land uses in and adjacent to the proposal	5.6
Description of waste management and pollution control on and off site	2.11
Description of existing environment and related environmental aspects	Chapter 5
Identification of the sources and scale of greenhouse gas emissions	5.3
Aboriginal and sacred sites clearance	5.12
Description of project timing, staging and decommissioning	2.13
Description of environmental commitments, safeguards and monitoring	Chapter 6
Description of rehabilitation and decommissioning	2.14

Although the provisions of the *Native Title Act 1993 and Aboriginal Land Rights (Northern Territory) Act 1976* do not apply to the project, at the request of the Central Land Council (CLC), Minemakers will ensure that the environmental permitting process of the project meets the requirements of Section 46 of the *Aboriginal Land Rights (Northern Territory) Act*. Attachment A outlines how this NOI and the subsequent environmental impact assessment document will voluntarily address these Section 46 requirements.

In parallel with the submission of this NOI, a referral will be lodged to the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) for the project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The referral states that the project is not likely to have a significant impact on any matters of national environmental significance as defined by the EPBC Act and therefore that it should be considered 'not a controlled action'. This is consistent with the Wonarah Phosphate Project, which was previously deemed 'not a controlled action'.

1.7 Proposed Environmental Assessment of Project

As a number of fundamental changes between the DSO and IHP projects are being proposed, a new environmental assessment of this project will be required. This report describes the changes to the original project design at the basic level. The preparation of a new PER or EIS will be required to give a more detailed overview of the project and allow the Northern Territory Government to make an informed assessment of the acceptability of the project.

1.8 Report Structure

The NOI comprises eight chapters and a table of contents that outlines figures, tables and plates in relevant chapters. The format of the main report is:

Chapter 1 (this chapter) – introduction, proponent details, project details, project history, project summary, and purpose of the NOI.

Chapter 2 – detailed description of the project.

Chapter 3 – legislative framework (including Commonwealth and Northern Territory legislation, international conventions and national policies and strategies).

Chapter 4 – stakeholder consultation.

Chapter 5 – description of existing environment and identification of potential environmental and social issues, assessment of the impact of those issues identified and an outline of broad management, mitigation and monitoring measures.

Chapter 6 – environmental management.

Chapter 7 – glossary.

Chapter 8 – references.

Attachments – supporting material.

Appendices – reports for baseline specialist study investigations completed to date.

This page intentionally left blank

2. PROJECT DESCRIPTION

2.1 Project Overview

The project involves the mining of two phosphate deposits, known as 'Arruwurra' and 'Main Zone'. The project has a Measured, Indicated and Inferred JORC compliant resource estimate of 842 Mt at 18% phosphorite (P_2O_5) at a P_2O_5 cut-off grade of 10% (Table 2.1). Should the IHP methodology be adopted, then a lower grade feed is likely to be acceptable. At a 5% cut-off, the grade expected to be acceptable as feed for the IHP, the resource is 1,406 Mt at 13% P_2O_5 .

Table 2.1 Wonarah Total Resource at a 10% P_2O_5 cut-off grade

Deposit Description	Tonnage (Mt)	P_2O_5 grade (%)
Main Zone	707	18
Arruwurra	135	16
Total	842	18

Mining will be by conventional open pit mining techniques from a series of open pits within the two principle locations, Arruwurra and Main Zone. Pit depths will vary from 20 m to 35 m with the phosphate ore thickness varying from as little as 1 m to as much as 10 m and an average of approximately 4 m.

Ore mined from the open pits will be stockpiled adjacent to each pit before being hauled to a central processing location and stockpiled on a run of mine (ROM) pad to allow blending of ore sources into the beneficiation plant. Beneficiation of the ore will entail crushing and scrubbing to remove clays present in the ore. The washed ore will be fed to a fine ore storage stockpile ahead of processing through an IHP plant. The clay slimes produced will be pumped to a slime storage facility (SSF) located within a few kilometres of the processing plant. Once initial open pit areas have been mined, the slimes material will be able to be co-deposited with excess silica balls in these pit areas and the existing SSF will be rehabilitated.

The IHP plant will be located immediately adjacent to the beneficiation plant. In addition to the fine ore storage stockpile there will be two other stockpiles, one for petroleum coke and another for silica sand, both used as inputs to the IHP. The product SPA will be cooled, filtered to remove any suspended solids, and stored ready for transport. The IHP produces inert silica balls (J-Rox) as a waste product that will either be used as stand-alone product (see Section 2.6.2) or returned to the open pit voids.

The SPA will be transported by road to Tennant Creek in specially designed isotainers, firstly by roadtrain to Tennant Creek and then by rail to the Port of Darwin for export.

The capital cost of the project, when producing 1 Mt of P_2O_5 per year, is estimated to be \$1.3B.

2.2 Differences Between the DSO and IHP Projects

There are several key differences between the project description of the DSO project and the Wonarah IHP Project; these are described in Table 2.2.

Table 2.2 Differences between IHP and DSO projects

Project component	DSO project	IHP project
Mine grade	Mining a high to medium grade ore.	Mining a lower grade ore.
Pits	Mining up to 23 open pits.	Mining fewer but larger open pits.
Treatment process	Mobile crushing and screening plants located at Arruwurra and Main Zone deposits to reduce ore to 2 mm particle size.	Beneficiation of the ore. Pyrometallurgical processing of the ore to produce SPA. Generation of inert silica balls to be backfilled into pit voids or sold.
Tailings/slimes disposal	No tailings produced.	Production of inert clay slimes and the need to initially store slimes within a slimes storage facility.
Product transport	Haulage of 3 Mtpa of contained P ₂ O ₅ total truck movements of 31,250 per annum. Transport of rock phosphate from the project area.	Reduction on total volume of heavy haulage traffic on the Barkly Highway to 2.2 Mtpa or 23,000 truck movements per annum. Transport of SPA from the project area and the transport of petroleum coke to the mine site.
Storage requirements	Phosphate to be delivered to a multi-user hub north of Tennant Creek and stockpiled at East Arm prior to shipment.	Requirement for SPA isotainer storage at the Tennant Creek rail siding to hold product between road and train transport. Requirement for a storage area at the rail siding to receive full containers of petroleum coke and empty containers for return to Darwin. Requirement for SPA storage at Vopak's facility at the Port of Darwin for export of SPA in bulk and a storage area for petroleum coke delivered in bulk, prior to loading into containers for rail and road transport to the mine site.
Power and water requirements	A power station generating 4 MW. Peak water use of 9.6 ML/d for all purposes including dust suppression and potable water for domestic use.	A power station generating 54 MW. Peak water use of 22 ML/d for all purposes including dust suppression and potable water for domestic use.

Due to the substantial amount of engineering work completed during the definitive feasibility study (DFS) for the DSO project, Minemakers is in a position where it has a base-case for the mining method and the infrastructure required to develop the project (e.g., roads, power, borefield, aerodrome) that is much further advanced compared to other projects at the NOI stage of development. The level of detail provided in this chapter reflects this increased stage of engineering development, but these details may change during the subsequent bankable feasibility study (BFS) for the project.

2.3 Geology and Mineralisation

Regional Geology

The project is located within the Georgina Basin, a sedimentary basin containing lower and middle Palaeozoic sediments. The Georgina Basin is subdivided into several sub-basins that primarily reflect the thickness of Cambrian deposition. Within the region of the Wonarah phosphate deposit two sub-basins occur, the Brunette and the Undilla, which are made up of Middle Cambrian sediments and volcanics.

Within these two sub-basins, two geological sequences (the Ordian and the Late Templetonian) have been identified. The Ordian sequence consists of Thornton Limestone (dolomites, dolomitic siltstones and shales) overlying the basalts, dolerites, and volcanogenic sediments of the Peaker Piker Volcanics. The Late Templetonian sequence includes the phosphate-bearing Upper Gum Ridge Formation which consists of (from bottom to top of formation): the erratically distributed high grade Transitional Phosphorite and overlying Transitional Sediments (clay rich mudstone and siltstone, phosphorite, and minor sandstone); the Chert Breccia Phosphorite, a chert-rich phosphorite; the Mudstone Phosphorite which is comprised of medium to high grade friable and indurated phosphorite; and the weakly-phosphatic Convolute Mudstone. The Upper Gum Ridge Formation is overlain by the Wonarah Beds and these are represented by the non-phosphatic mudstones and siltstones of the Hangingwall Mudstone Unit within the project area. Some dolomitic or calcareous rocks, the Hangingwall Dolostone, are present within the Wonarah Beds in the southwestern part of the project area. A stratigraphic column of the regional geology is shown in Figure 2.1.

Arruwurra Geology

At the Arruwurra deposit the phosphate mineralisation occupies a broad northeast- to southwest-trending shelf that slopes gently to the southwest. The shelf drops away sharply at the western end and along the southeastern edge. Mineralisation outcrops in the northeast before petering out against the basement high to the north.

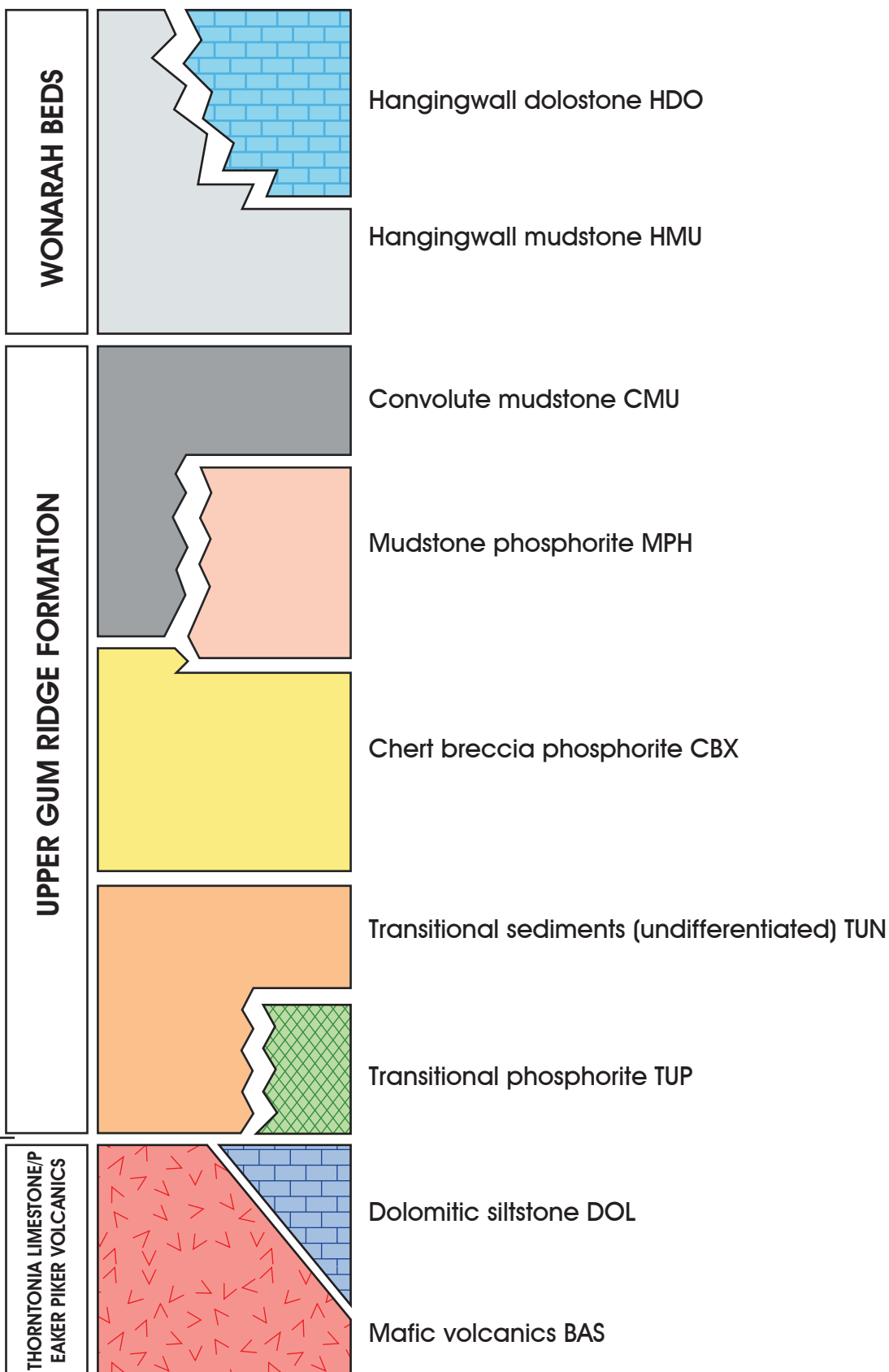
A long section through the Arruwurra deposit is shown in Figure 2.2.

The basement at Arruwurra is a weathered basalt of the Peaker Piker Volcanics. Thornton Limestone equivalent dolomites and dolostones overlay the basalt along the south-eastern and southern margin of the deposit. An abrupt change in lithology and depth to the basalt basement indicates a probable fault which has thrown the deposit side upwards. A karst surface is present on some of the dolomite.

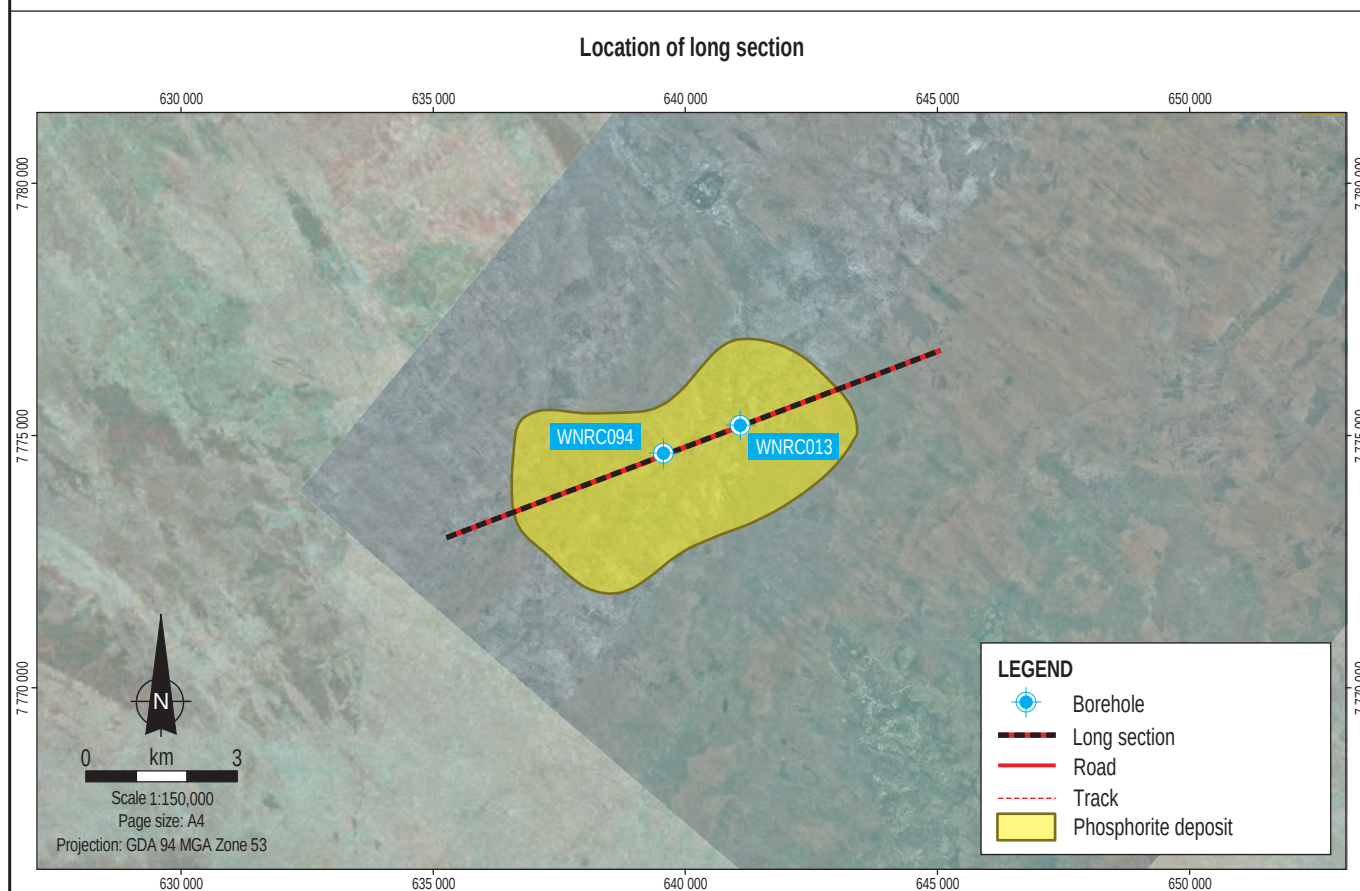
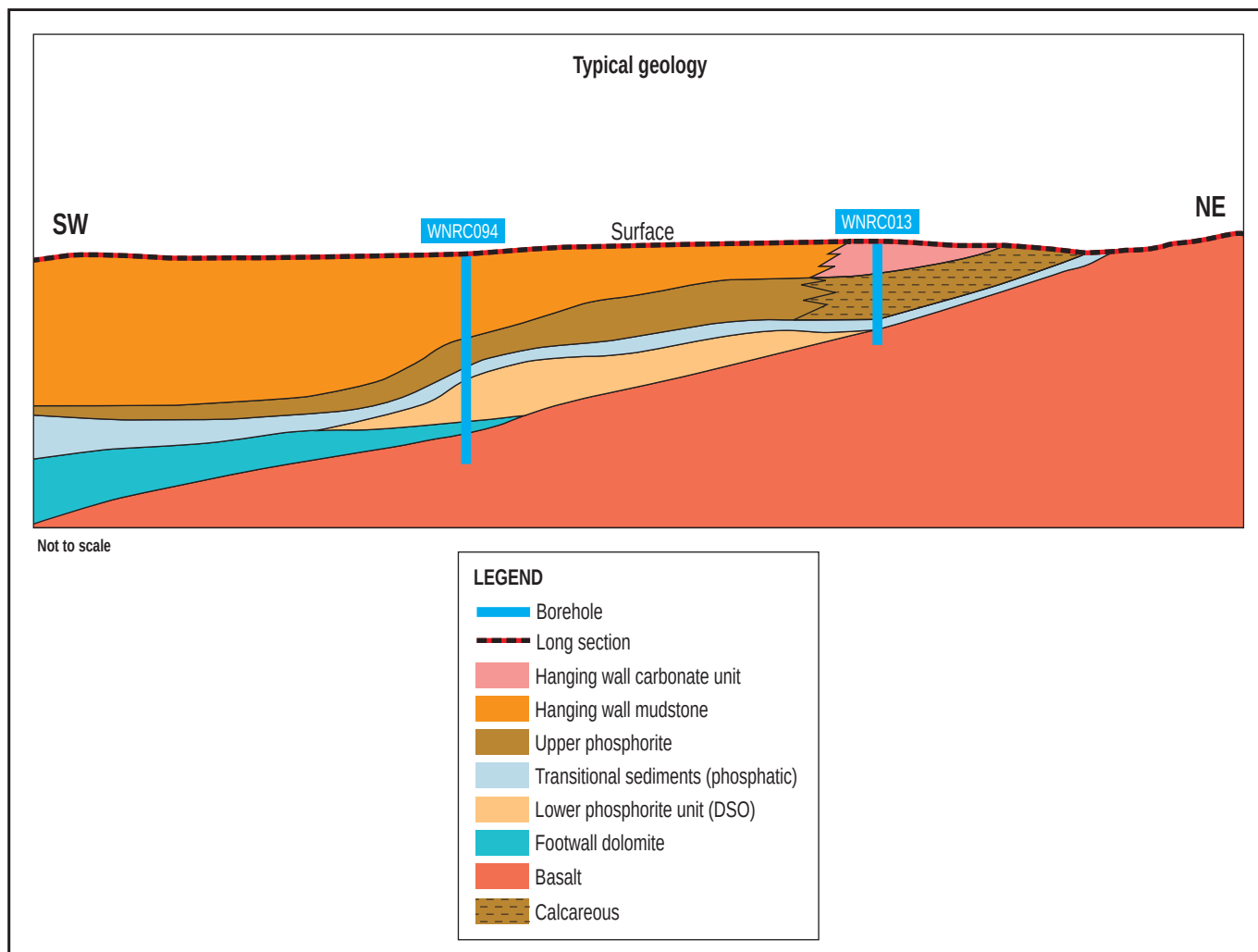
The Upper Gum Ridge Formation at Arruwurra is somewhat attenuated in comparison to the Main Zone. The stratigraphic equivalent of the high grade Transitional Phosphorite is called the Basal Phosphorite at Arruwurra and is the main unit of economic importance. It is a strongly indurated, very high grade brown phosphorite mudstone which averages approximately 2 m in thickness and is developed throughout the northeastern part of Arruwurra. The overlying Transitional Sediments are thinner than in the Main Zone and are comprised of 1 to 3 m of mudstone, siltstone and phosphorite. The Chert Breccia Phosphorite is absent at Arruwurra and the overlying Arruwurra Phosphorite is the stratigraphic equivalent of the Mudstone Phosphorite. The Arruwurra Phosphorite is grey to yellow and is more chert-rich than the Mudstone Phosphorite at the Main Zone. The unit varies in thickness from 1 to 6 m and is thickest along a northeast trending axis through the center of the deposit.

SEQUENCE 2 Late Templetonian

SEQUENCE 1 Ordian



Source: Rio Tinto



The Convolute Mudstone is absent at Arruwurra. The Hangingwall Mudstone unit is similar to the Main Zone except in the far east of Arruwurra where dolomitic and calcareous units, the Hangingwall Dolomite, are present.

Main Zone Geology

The basalt basement in the Main Zone area is also comprised of the Peaker Piker Volcanics. The top of the basalt is extremely weathered and has a ferruginous and manganiferous duricrust. Some dolomitic rocks of the Thornton Limestone equivalent are present above the basalt at the southeastern extremity of the Main Zone. To the east and the south the carbonate rocks are extensively developed.

A long section through the Main Zone deposit is shown in Figure 2.3.

The overlying phosphate-bearing Upper Gum Ridge Formation is divided into four main units: Basal Undifferentiated Transitional Unit sediments, Chert Breccia Phosphorite, Mudstone Phosphorite and Convolute Mudstone.

The basal Transitional Phosphorite is a laterally discontinuous high grade indurated phosphorite up to 3 m thick developed throughout the eastern and southern part of the Main Zone. The Transitional Sediments are laterally continuous, 4 to 8 m thick and comprised of clay-rich mudstone and siltstone with minor phosphorite, dolomite, sandstone and basal epiclastics.

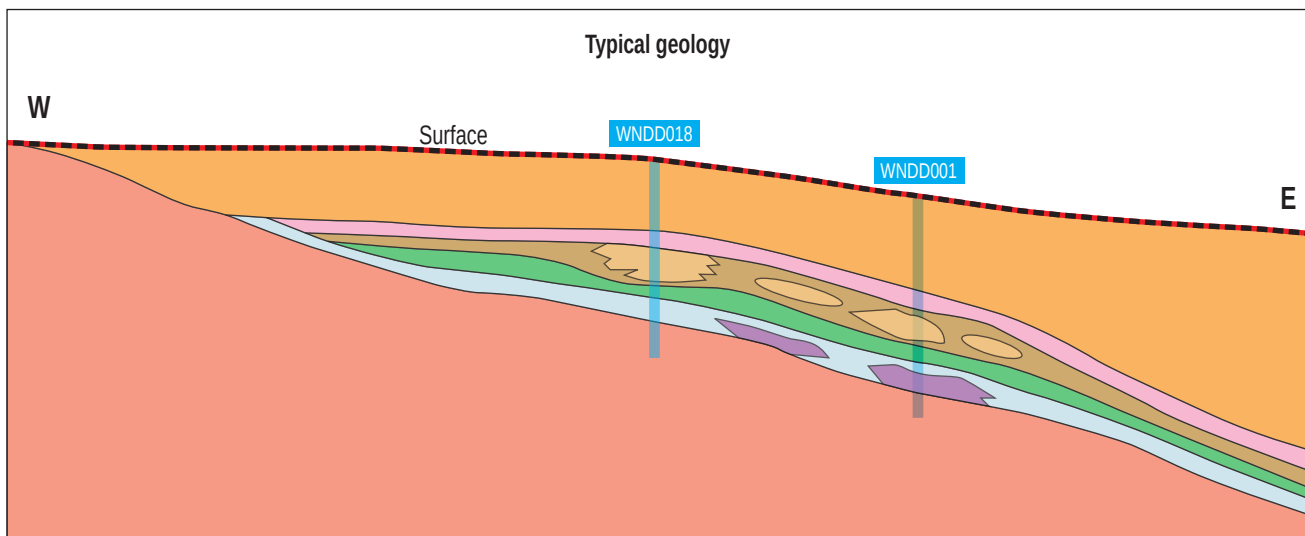
The Chert Breccia Phosphorite is comprised of up to 70% dark grey angular chert within a low to high grade phosphorite matrix which varies from friable to strongly indurated. The unit is present throughout most of the Main Zone, although thinning to the north, and is 2 to 6 m thick. The contact with the overlying Mudstone Phosphorite is mostly sharp and the Mudstone Phosphorite is essentially medium to high grade yellow to pink mudstone phosphorite which varies in texture from friable to strongly indurated. This unit varies in thickness from 1 to 10 m. At the Main Zone, the Mudstone Phosphorite is the economic unit of prime importance. The Mudstone Phosphorite is overlain by the Convolute Mudstone which is comprised of weakly phosphatic clay-rich mudstones.

The Hangingwall Mudstone overlies the Convolute Mudstone and is comprised of mudstone and siltstone with minor chert. This unit thickens towards the east and south away from the basement high that defines the western fringe of the Main Zone. Dolomitic units of the Hangingwall Dolostone are present east and south of the Main Zone.

The phosphatic units thin out towards the basement high which trends in a northeast to southwest direction towards Arruwurra. To the east and south the phosphatic units, although still present with grade and thickness, are too deep to be of economic interest at this time.

2.3.1 Deposit Geochemistry

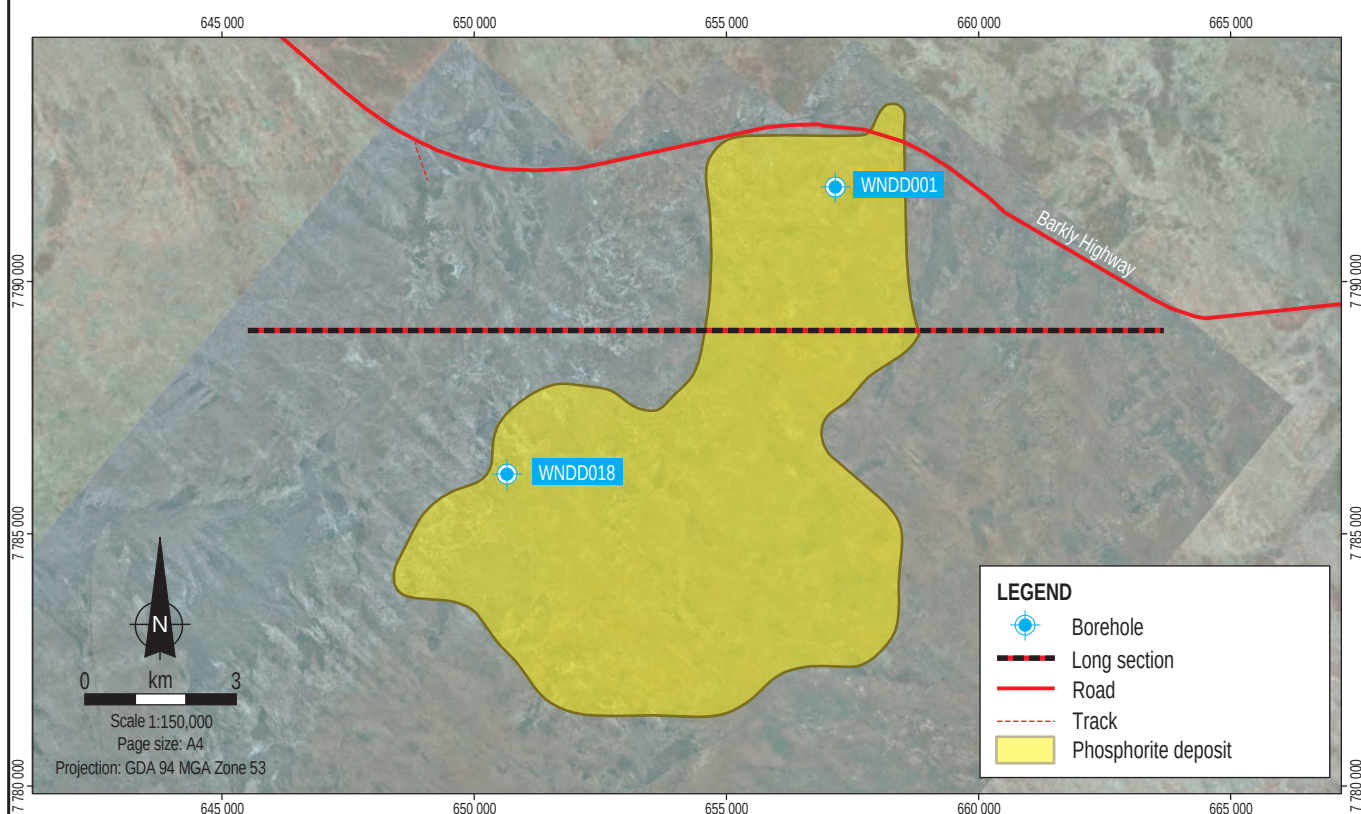
Geochemical characterisation has been carried out on representative samples of the waste rock for both the Arruwurra and Main Zone deposits and the non-DSO by Environmental Geochemistry International Pty Ltd and is provided as Appendix 1. All samples tested were classified as non-acid forming (NAF) and about 40% of the waste rock composites were also barren with respect to sulfur (S) and acid neutralising capacity (ANC), having a total sulfur content of less than or equal to 0.05% and ANC less than or equal to 5 kg sulphuric acid (H₂SO₄) per tonne.



LEGEND

- Borehole
- - - Long section
- Hanging wall carbonate unit
- Convoluted mudstone
- Indurated Phosphorite (DSO)
- Mudstone Phosphorite
- Chert Breccia Phosphorite
- Transitional sediments
- Transitional Phosphorite
- Basalt

Location of long section



LEGEND

- Borehole
- - - Long section
- Road
- - - Track
- Phosphorite deposit

Elemental analysis of selected waste rock composites indicated that phosphorous and beryllium were enriched in most samples from the Arruwurra and Main Zone deposits. Phosphorous enrichment is to be expected given the mineralogy of the deposit and although beryllium was enriched when compared against median soil concentrations, the actual concentrations were not enriched compared to mean crustal abundance. Other elements showing significant enrichment in some samples were silver, calcium, cadmium, copper, magnesium, lead, thallium, uranium and zinc.

Testing showed that all the non-DSO samples were highly enriched in phosphorous and beryllium and half of the samples were also significantly enriched in calcium and uranium. Uranium assays undertaken during the Wonarah DSO EIS show that the actual concentration of uranium in the low grade ore is lower than typically observed in rock phosphate ore. In addition, silver, cobalt, lead and strontium were enriched in some samples.

Water extractions carried out on waste rock and non-DSO samples indicated only low solubility of dissolved constituents and that the majority of the environmentally-significant elements were either at low concentrations or below the detection limit. Phosphorous showed very low solubility. However, there was some solubility of fluorine in the samples. Fluorine is typically associated with phosphate and leaching of fluorine would be expected in these samples.

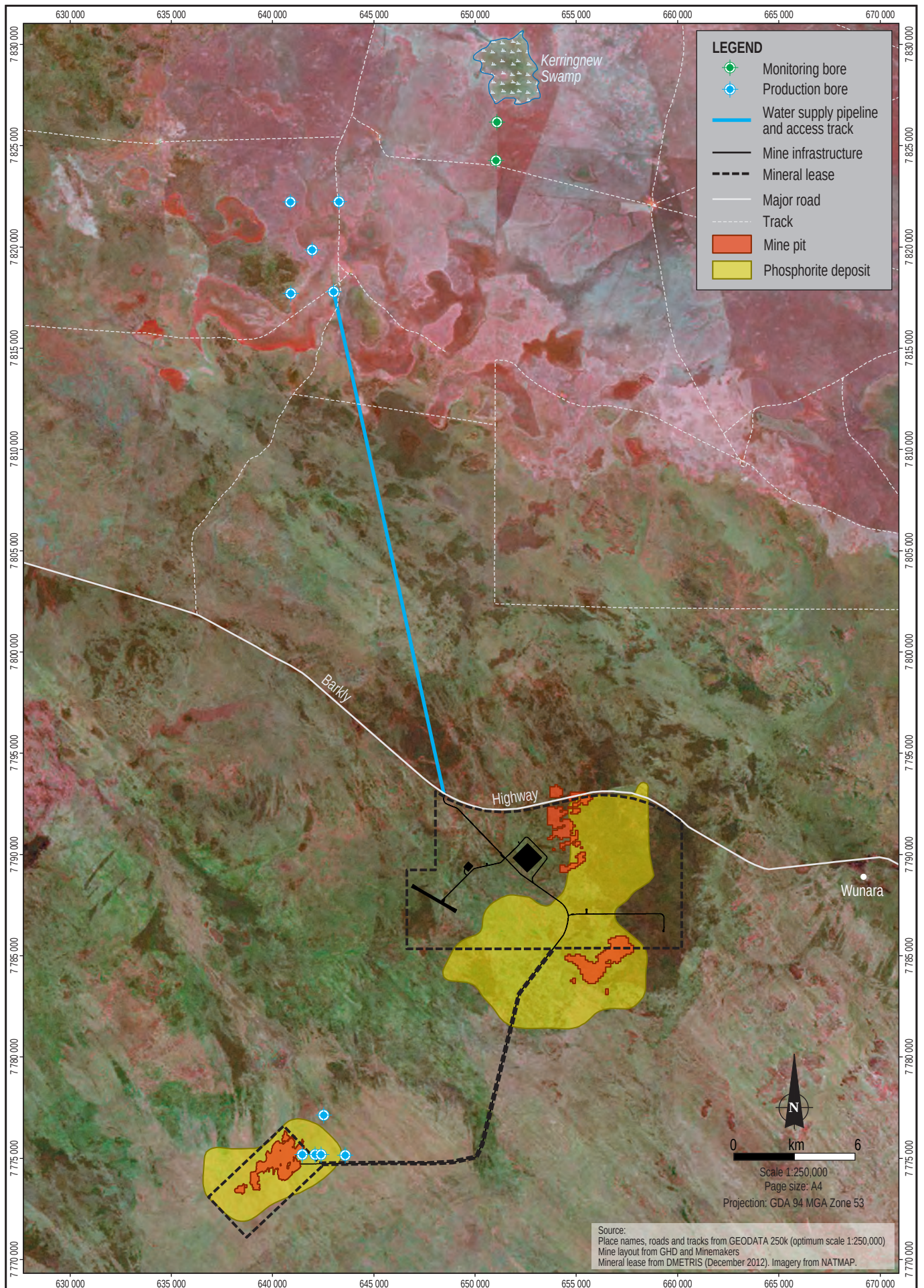
Overall, the geochemical characterisation showed that acid rock drainage (ARD) will not be a concern for the project. However, there are some elements that occur at elevated concentrations in waste rock and non-DSO. Although their solubilities are expected to be low, because of this phosphate, fluorine and beryllium will be included in site water quality monitoring programs.

2.4 Project Components

The major components of the project and their proposed footprints are identified in Table 2.3 and described in detail in the following sections. Planning and design of all project components will incorporate the principles of the Northern Territory government's guidelines for preventing mosquito breeding sites associated with mining sites (Whelan and Warchot, 2005); this includes the design of surface water management structures and drainage to minimise any standing water and breeding sites. The proposed project layout and location of related infrastructure is shown in Figures 2.4.

The general principles guiding the location of project infrastructure have been to:

- Centre infrastructure around the Main Zone deposit, which is a larger deposit than Arruwurra and will produce more ore, to minimise overall haulage distances.
- Build on higher ground where possible to avoid inundation of infrastructure by flood waters.
- Use natural topography where possible to minimise earthworks and pumping requirements (i.e., make use of gravity).
- Place infrastructure such as the aerodrome and village in areas under which drilling to date has indicated that no phosphate is present so as not to sterilise a potential resource.
- Place the accommodation village sufficient distance from the potential mining areas so as to minimise the potential impacts of noise and dust.
- Minimise disturbance by placing infrastructure, such as temporary stockpiles and haul roads in areas that will be disturbed by subsequent mining.



- Ensure access to the site is controlled for safety reasons by locating the office near the site entrance.

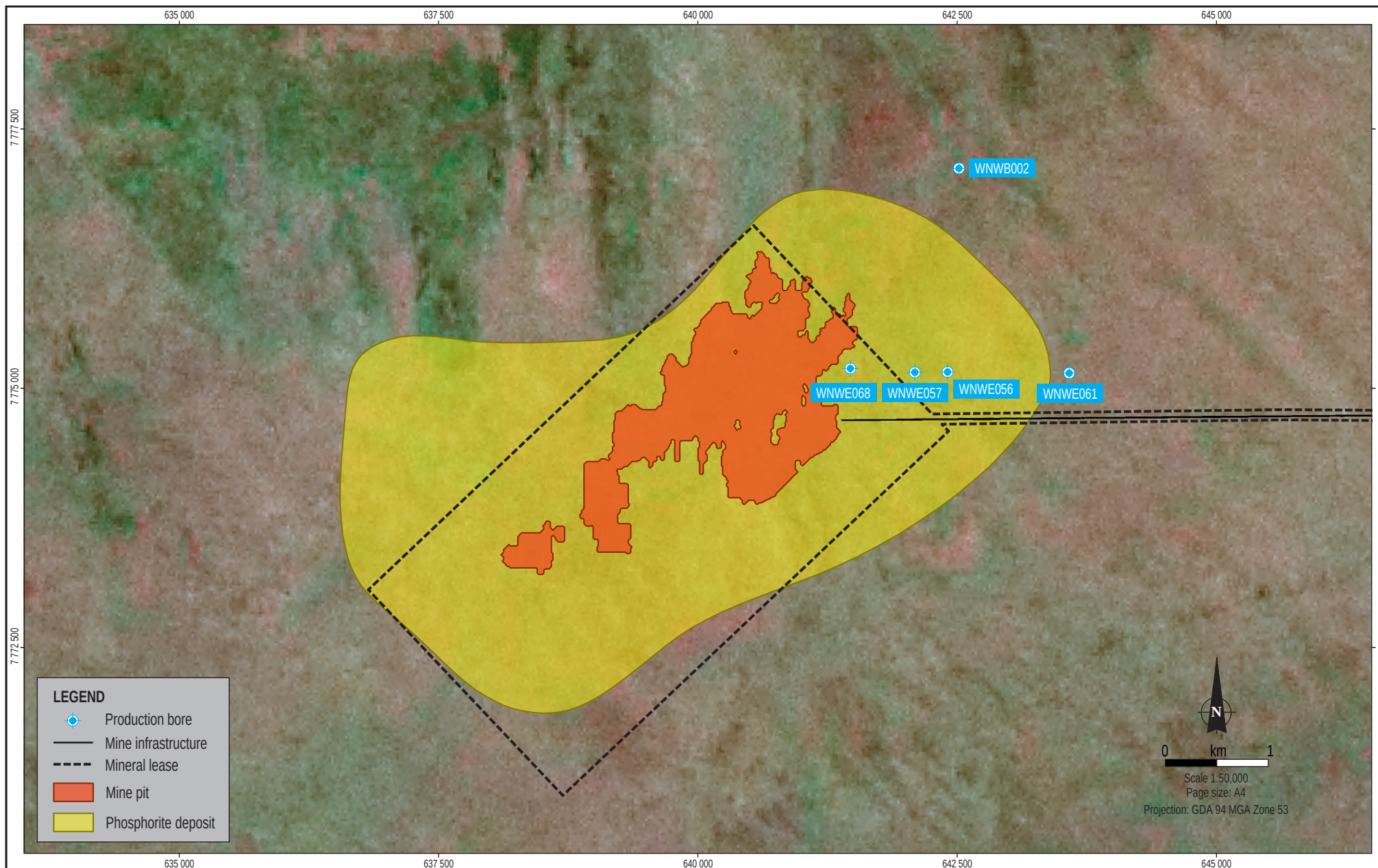
Table 2.3 Project components and approximate footprints

Component	Approximate Total Disturbance Area (ha)
Arruwurra pits	114
Main Zone pits	482
IHP processing plant (including beneficiation plant)	100
Slime Storage Facility	200
Run-of-Mine stockpile	2
Waste rock storage – assuming 0% backfilling (Waste rock storage – assuming 38%backfilling)	1,376 (713)
Access road	32
Mine haul roads (mining area only)	117
Other site roads	44
Aerodrome	28
Borefield	10
Water supply pipeline	75
Offices	4
Explosives magazines	1
Power station	2
Mining contractors area	2
Accommodation village	15
Sewage treatment facility	3
Putrescible waste disposal site	3
Borrow pits	9
Total	2,619

2.5 Mining

2.5.1 Mining Process

The Arruwurra and Main Zone deposits will be developed using conventional shallow open pit and strip mining methods which allow for progressive rehabilitation to occur. A series of open pits will be mined in the Arruwurra deposit (Arruwurra Pits) (Figure 2.5) and in the Main Zone (Main Zone Pits) (Figure 2.6). All pits will be operated concurrently to minimise the potential for downtime and allow blending of ore types to achieve optimum blends for the IHP. The final pit design and positioning will depend on the results of recent pit optimisation and mine planning.



Source:
Mine layout from GHD and Minemakers
Mineral lease from DMETRIS (December 2012).
Imagery from NATMAP

coffey
environment

Date:
17.12.2012
MXD:
9014MM_22_GIS003_v1_1
File Name:
9014_22_F02.05_GIS_HB

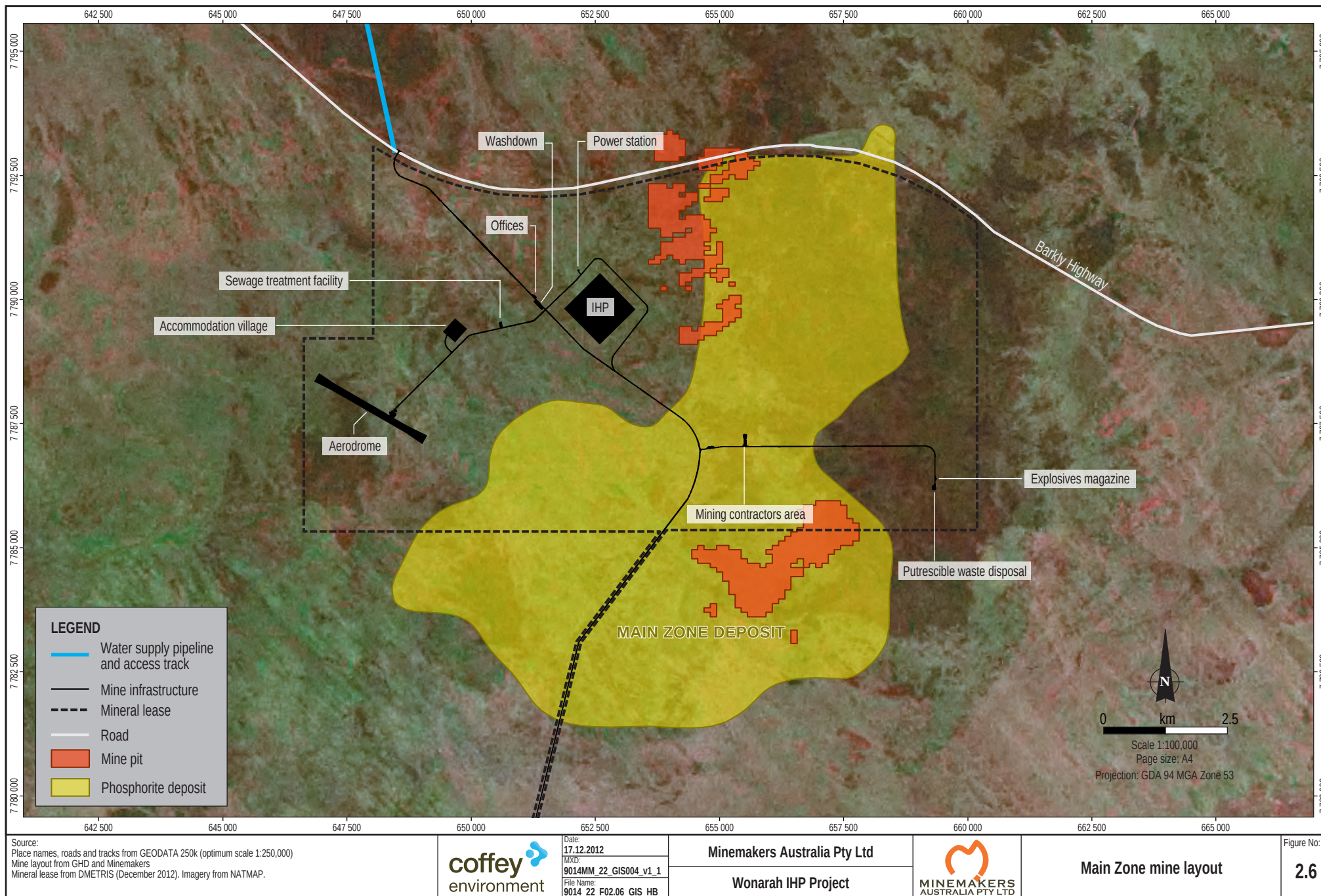
Minemakers Australia Pty Ltd

Wonarah IHP Project

MINEMAKERS
AUSTRALIA PTY LTD

Arruwurra mine layout

Figure No:
2.5



The strip mining process will involve the excavation of waste and ore in progressive strips. After the initial strip or cut has been mined, the waste rock for subsequent strips, together with excess silica ball product from the IHP and clay slimes, will be placed in the void created from the first strip (Figure 2.7). This technique enables areas to be progressively rehabilitated once mining has advanced to the next strip. Contouring of the replaced waste will occur ahead of re-topsoiling and replanting with native species of local provenance.

Typically, the strip mining process will commence with removal of topsoil from all areas to be disturbed for the initial box cut, including the initial waste rock storage. A slot will be opened from the initial wedge-shaped box cut and then extended along the full 500 m strike extent of the pit. The initial box cut will be positioned mid-strike of the ore zone and mining will advance along strike for the full extent of one half of the initial slot before commencing on the other half. The initial pit will have a width of approximately 50 m at the base of the pit.

Waste rock from the initial strip will be stockpiled in waste rock storage areas immediately adjacent to the pits. A proportion of silica sand from this waste material will be mined separately to stockpile ahead of the beneficiation plant. The waste rock storages will be contoured into a low hill with a height above the natural ground level of approximately 15 m and batter slopes of approximately 18°. The waste rock storages will be covered using stockpiled topsoil, and will be ripped and seeded to promote early regrowth of vegetation.

The development and mining of the Main Zone will be deeper than that of the Arruwurra deposit as the depth to the deposits (i.e., or the amount of waste rock overlying the deposits) varies, as does the thickness of the deposits. The depth to the Arruwurra deposit ranges from 10 to 15 m at its shallowest point to 25 to 30 m at its deepest point. The thickness of the Arruwurra phosphorite deposit ranges from 3 to 5 m. For the Main Zone, the depth to the deposit ranges from 20 m at its shallowest point to 50 to 60 m at its deepest point and the thickness of the phosphorite deposit is around 5 m.

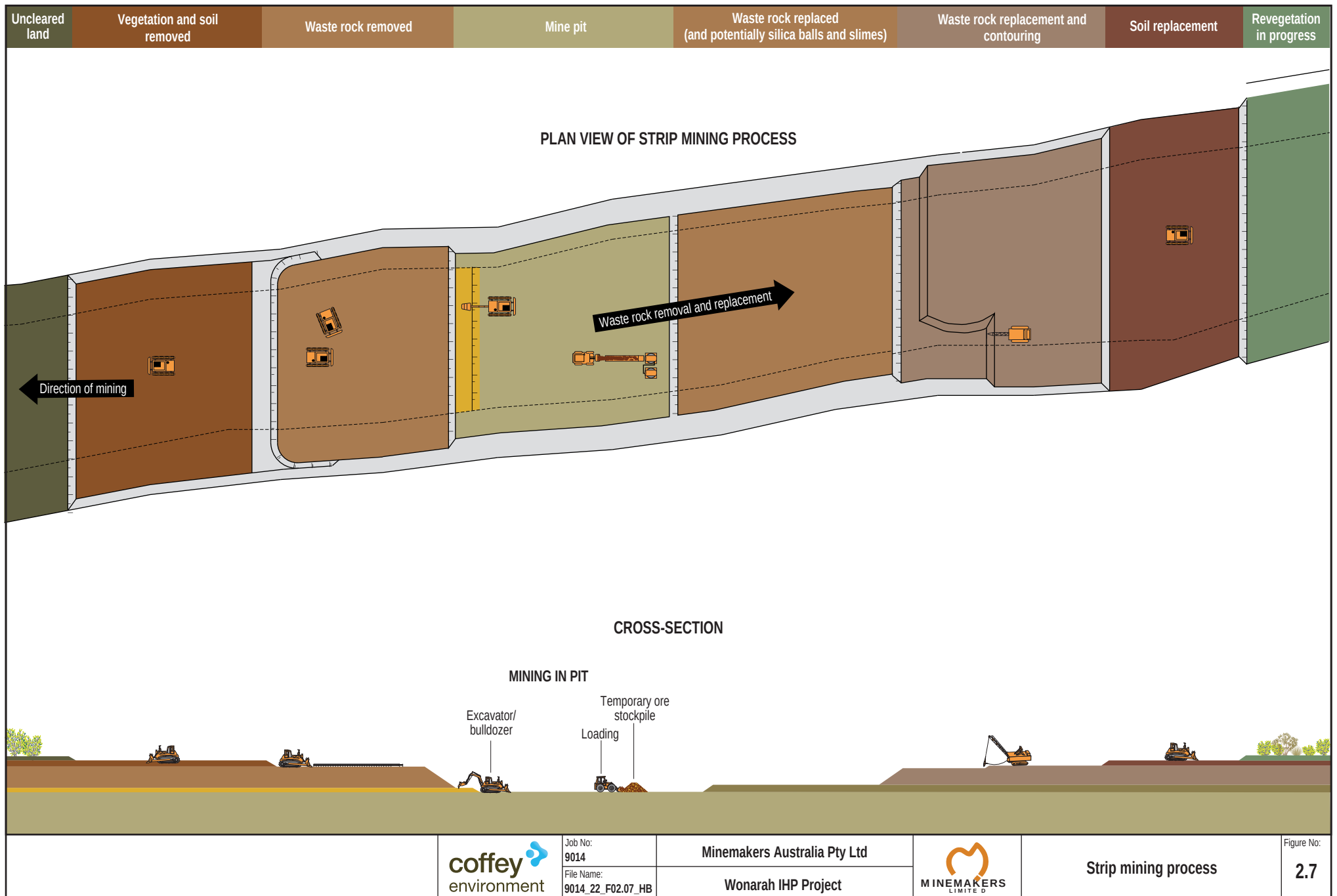
Mining will be undertaken by excavator, face shovel or mobile miner. In some areas blasting may be used to loosen the waste rock ahead of mining. The mined ore will be loaded into haul trucks and transported to a temporary ore stockpile adjacent to each pit. The footprint of each temporary ore stockpile will cover an area of approximately 2 ha. Wherever possible, these stockpiles will be located within the footprint of the final pit and advanced ahead of mining in order to minimise total land disturbance.

During the mining process temporary bunds will be placed at a distance of at least 5 m from the edge of the pits to prevent accidental access to the pit. These bunds will be removed and replaced progressively as the pits advance.

Mined ore will be transported via haul trucks to a central processing location and stockpiled on a run-of-mine (ROM) pad to allow blending of ore sources into the beneficiation plant.

2.5.2 Mining Schedule

Mining will commence at the Main Zone, with pits being mined concurrently to allow blending of ore types to achieve optimum blends for market requirements. The Arruwurra deposit will commence later, possibly not until year 16 of the 20-year schedule. The mining sequence will be confirmed during the feasibility study.



2.6 Processing

2.6.1 Beneficiation Process

Beneficiation will entail crushing and scrubbing to remove clays present in the ore. The washed ore will be fed to a fine ore storage stockpile ahead of processing through an IHP plant. A portion of the silica sand required in the IHP will be sent to the beneficiation plant where it will be scrubbed to remove clay particles before being fed to the silica sand storage stockpile.

2.6.2 Improved Hard Process (IHP)

Details of the IHP are schematically displayed in Figure 2.8. The IHP plant will be located immediately adjacent to the beneficiation plant. In addition to the fine ore storage there will be two other storage areas, one for petroleum coke and another for silica sand. The three inputs, phosphate rock, petroleum coke and silica sand will be fed at accurately controlled flows to a dryer to remove moisture. The solids leaving the dryer will be screened to remove large lumps and the material passing through the screen will be finely ground in a ball mill. The ground material will be formed into balls in a balling drum. Fines and oversize materials will be returned to the balling drum and product-sized balls fed to the ported kiln.

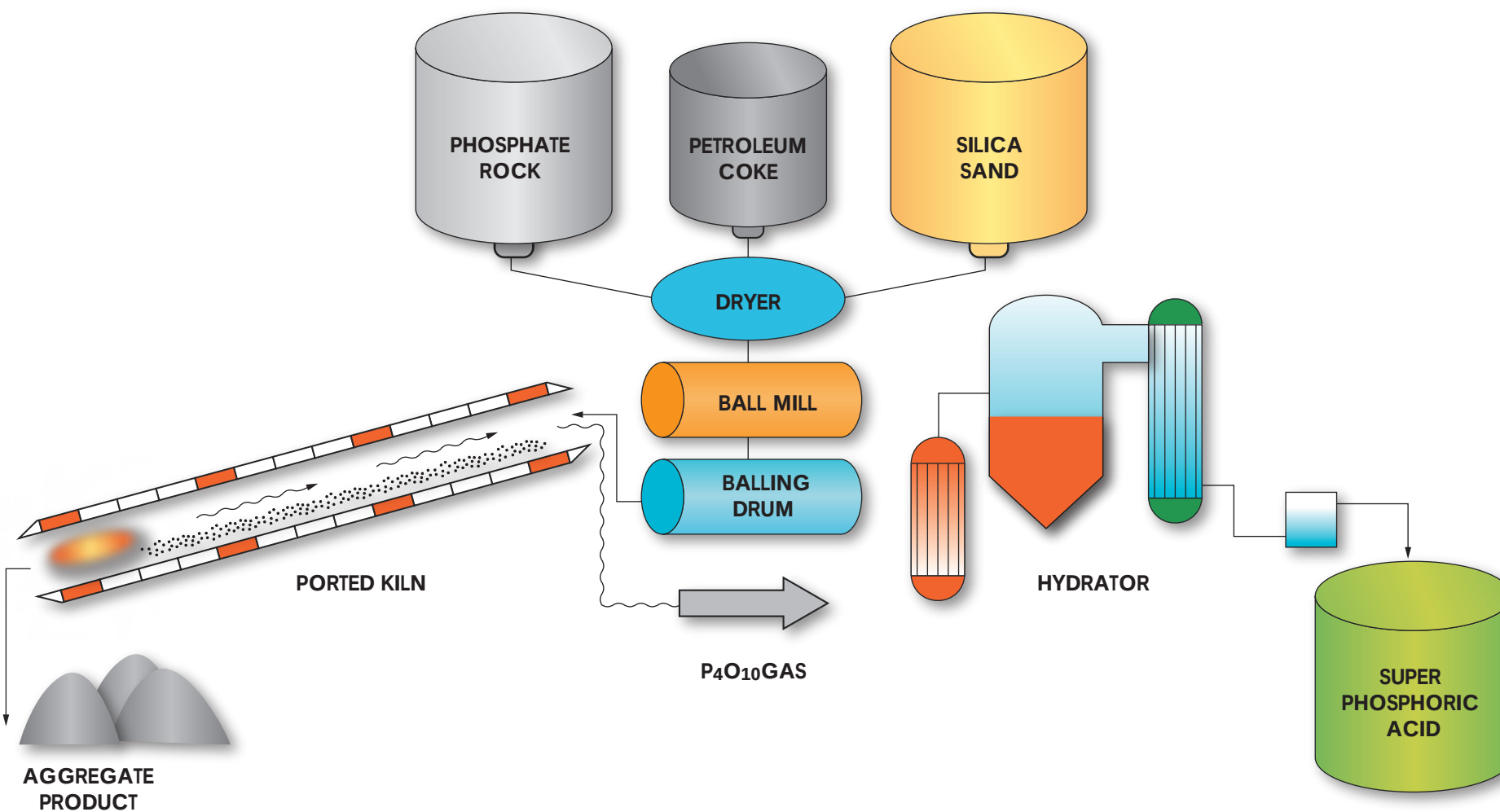
Air will be heated by burning natural gas, which will be blown counter-current to the flow of material in the kiln. The P_4O_{10} gas liberated will pass to the hydrator where it will be absorbed in water to form phosphoric acid at approximately 70% P_2O_5 . Gases leaving the hydrator will be further scrubbed in a venturi scrubber, cyclone/scrubber and mist eliminator to recover product not absorbed in the hydrator. Vent gases will be scrubbed with lime slurry, and then passed to a flue gas desulfurization unit for final cleaning.

The super phosphoric acid (SPA) product will be cooled, filtered to remove any suspended solids, and stored ready for transport. The SPA produced by the process will be pumped into specialised road isotainers for transport to Tennant Creek where these isotainers will be stored at the rail siding. The rail siding will facilitate the transfer of the SPA isotainers onto rail cars for transport to Darwin and for the receipt of petroleum coke in containers from Darwin for transfer by road to Wonarah.

Silica balls produced by IHP will likely be returned to the open pit voids. However, recent research has indicated that this material is suitable as road base, and has potential as a concrete pozzolan, and concrete aggregate additive in the manufacture of light-weight concrete and concrete products such as prefabricated panels and bricks for building construction. This research will continue in 2013. If the research demonstrates the suitability of this material for such products, the material could be back loaded in the empty petroleum coke containers to Tennant Creek or Darwin for commercial production of concrete product.

The silica sand required for the IHP will be mined on site and will be recovered in the course of mining the overburden in each of the open pits. Much of the Wonarah deposit is overlain by several meters of sand. A portion of the sand will be sent to the beneficiation plant where it will be scrubbed to remove clay particles before being fed to the silica sand storage ahead of the IHP plant.

The IHP will be constructed in modular format with each production train capable of producing 200,000 t of contained P_2O_5 equivalent or approximately 290,000t of physical acid. It is proposed that the project be developed in a staged fashion with a single production module initially, with other modules being added progressively as market demand and availability of financing permits.



The long term goal will be to achieve a production rate of around 1 million tonnes of contained P_2O_5 per annum, representing five production modules.

A 1/18th scale demonstration IHP plant is currently being constructed in Florida, USA (Plates 2.1 and 2.2), by JDCPhosphate which holds the patent for the IHP. Minemakers is a cornerstone investor in JDCPhosphate and has the exclusive rights to develop IHP in Australia.

2.6.3 Slimes Disposal

The clay slimes will initially be pumped to a slime storage facility (SSF) located within a few kilometres of the processing plant. The SSF will be constructed as a paddock-style facility, comprising numerous cells constructed as the development of the project proceeds. Slimes will be discharged sub-aerially from spigots around the perimeter of the SSF. A decant tower in each cell will collect decant water for return to the processing plant to supplement the process water and to minimise the raw water make-up requirement of the project.

The design of the SSF will be determined during the BFS, and will be decided on a risk-based approach that considers the geochemical characterisation of the slimes and its potential environmental risk to the underlying groundwater. The characterisation will determine if the slimes is then suitable for co-disposal with excess silica balls in the mined open pit areas. If co-disposal in the pit voids is an option, the existing SSF will be rehabilitated.

2.7 Transport Infrastructure

During the construction phase of the project, materials required for construction and operation will be transported to the site from Tennant Creek, Darwin or Mount Isa via a combination of rail and road. Upgrades to existing transport infrastructure will not be required for construction; however, some upgrades of existing roads and intersections along the transport route from the mine site to the rail siding at Tennant Creek may be required prior to transport of product/petroleum coke during operation.

2.7.1 Access Road

An access road of approximately 8.5 km in length will be constructed from the Barkly Highway to the IHP plant. The area of disturbance for the road will typically be 35 m wide including shoulders and provision for drainage. The access road may be sealed at a later date and the sealed width will be 8 m.

The access road corridor will also host a power line over a distance of 3 km from the power station to the office complex and from the power station to the IHP plant. The corridor will also host water supply and reticulation pipelines.

The total cleared width at any part along the route may be up to 35 m to allow for statutory clearances from overhead power lines. The maximum area of disturbance is anticipated to be approximately 32 ha.



Plate 2.1

Construction of the IHP demonstration plant



Plate 2.2

Construction of the IHP demonstration plant

2.7.2 Haul Roads and Other Site Roads

Approximately 179 km of road network of varying standards will be established to provide access around the site. Roads will provide access to the aerodrome, magazines, accommodation village, northern borefield and putrescible wastes landfill.

The general site roads will typically be formed to a width of approximately 8 m, with a disturbance width up to 35 m to allow for statutory clearances, shoulders and drainage. The total area potentially disturbed by such roads is approximately 161 ha. The road corridor may also host water supply and reticulation pipelines either from the northern borefield or the treatment plant. All pipes will be laid within the disturbed area of the road.

Haul roads will be established to connect each pit to the ROM stockpile as well as to allow mining equipment and other vehicles to travel between pits and back and forth from the workshop and office area. Wherever possible, these haul roads will be formed on areas that will later be disturbed by future mining. Haul roads that cease to be of use and will not be subsequently mined will be rehabilitated.

Water will be sprayed onto unsealed roads to suppress dust using a water cart. Where practicable and economically viable, proven, environmentally benign surfactants may be used on road surfaces to reduce the water demand for dust suppression.

2.7.3 Aerodrome

An aerodrome will be constructed to the southwest of the accommodation and office complex (see Figure 2.6). The aerodrome will be orientated approximately southeast to northwest to accommodate the prevailing wind direction. It will be constructed and marked in accordance with the Civil Aviation Regulations for aircraft landing areas. The runway will be approximately 2 km long with a taxiway to an aircraft parking and refuelling area located at least 50 m from the edge of the runway.

During construction and initial operation, aircraft of 20 to 30 seats will be used for shift changes for workers on a fly-in-fly-out roster. When the project reaches full production, aircraft of up to 100 seats may be required for shift changes.

Emergency lighting will be available at the aerodrome to enable the Royal Flying Doctor Service to land and take off at night, should the need arise.

The total cleared area of the aerodrome will be approximately 28 ha.

2.7.4 Rail

A rail siding at Tennant Creek will be developed to facilitate the transfer of SPA isotainers onto rail cars for transport to Darwin and for the receipt of petroleum coke in containers from Darwin. The SPA will be transported to the rail siding by roadtrains with the isotainers being stored in a storage area prior to transfer to the specialised rail cars. The petroleum coke will arrive at the rail siding by rail and be stored on hardstand at the rail siding until transfer to Wonarah by roadtrains.

2.8 Other Project Infrastructure

2.8.1 Administration

An office complex covering approximately 4 ha and comprising site reception, administration, technical services, meeting and training rooms will be located adjacent to the site access road (see Figure 2.6).

Located in the same area will be the occupational health and safety, first aid and rescue centre and a maintenance workshop for both mechanical and electrical work with the site store, laydown area and vehicle parking areas.

2.8.2 Accommodation

An accommodation village covering an area of approximately 15 ha will be constructed approximately 2 km to the southwest of the office (see Figure 2.6).

The village will be a staged development initially accommodating approximately 200 persons during construction and early operations. As subsequent modules of IHP capacity are added to the project, the village will also increase up to a maximum of approximately 550 persons. This maximum of 550 persons will include full-time employees and contractors as well as short-term contractors for construction and visitors.

The accommodation and administration areas will be located as far from standing water bodies as practical and will have appropriate screens installed to prevent mosquito intrusion.

Water storage tanks of approximately 180,000L, sufficient to meet normal use and emergency fire fighting needs, will be located at the village. Power will be supplied via overhead powerlines running from the power station and adjacent to the main access road and village access road. Where possible alternative forms of power will be used, such as solar power.

2.8.3 Power

A power station, ultimately generating approximately 54 MW will be located approximately 4 km from the IHP plant and 1 km from the office complex (see Figure 2.6). This facility will be designed in modular fashion allowing increases in capacity to be built in line with expansion in the number of IHP process trains.

The power station will be dual fuelled (diesel and liquefied natural gas) with fuel storage located immediately adjacent to the power station. A buffer zone of approximately 50 m surrounding the power station will be cleared to minimise fire risk and to allow access for refilling of fuel storage vessels and for heavy vehicle access for removal and replacement of the power generating units.

The power station will be designed to prevent the emission of sparks from the engine exhausts by fitting each with spark arrestors.

2.8.4 Port

A petroleum coke stockpile area will be located at Darwin's East Arm Wharf. This area will facilitate the stockpiling of the petroleum coke and loading of containers for rail transport to the rail siding at Tennant Creek. The stockpile area will be sealed to provide for containment of any run-off contaminated water resulting from rain events. There may be need for the stockpile to be covered. An additional hardstand area will be required for the storage of containers prior to loading and transport. However, there is no need for contamination mitigation as all materials will remain in containers at this location. Management of rain run-off will be required.

2.9 Surface Water Management

The project area is located in a semi-arid climate and there are no significant watercourses or drainage lines present on the site; however, during heavy rainfall the area is prone to flooding. Watercourses that drain the region are ephemeral and only flow after significant rain.

Mine infrastructure will be located to minimise deviation of natural surface water flow paths, to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the project area.

Site surface water management will be based on three broad goals:

- Reduce the potential risk of loss of life, health hazards and property damage.
- Preserve the environment.
- Conserve social and financial resources.

The management of surface water on site will involve minimising the potential changes to natural surface water flows, diverting clean surface water runoff away from disturbed areas, and intercepting runoff from disturbed areas and directing it through sediment control structures prior to discharge to the downstream environment.

A detailed description of the site water management structures for the DSO project is contained within Appendix 2; this will form the base-case for surface water management for the IHP project. These structures will include:

- Flood protection measures (including constructed berms, strategically placed waste rock storages, stockpiles and above-grade haul roads). Flood protection measures will be designed for a 1 in 100 year average recurrence interval (ARI) runoff event and will be located at the Arruwurra mining area.
- Diversion ditches. Diversion ditches will be designed for a 1 in 10 year ARI runoff event. Diversion ditches will be located at:
 - The Arruwurra mining area to divert water from an undisturbed catchment away from the mine services area.
 - Two sections on the northeast side of the aerodrome to divert water from an undisturbed catchment away from the aerodrome.
- Arterial drainage channels and culverts. Arterial drainage channels will be required at both the Arruwurra and Main Zone mining areas to collect runoff from the various mine facilities and convey it to sedimentation ponds and, if suitable, off-site. Arterial drainage channels will be designed for a 1 in 10 year ARI runoff event. Approximately 12 to 15 culvert crossings will be required along the haul road from the Main Zone to Arruwurra.
- Sedimentation ponds. Sedimentation ponds will be located on site to allow treatment of water with potentially high suspended solid concentrations from ore stockpiles and waste rock storages and oily water from the mine services areas. Sedimentation ponds that receive water from mine services areas will have oily water separators (OWS) upstream of their inlets as they will receive runoff from workshops and fuel storages. Sedimentation ponds will be designed for a 1 in 10 year ARI runoff event and all ponds will have emergency spillways/outlets in order to safely pass flow volumes greater than 10 year ARI magnitude around the ponds and off-site.

2.10 Groundwater Management

During the initial construction period the water supply will be developed. This will consist of constructing the northern borefield (see Figure 2.4), approximately 27 km north-northwest of the Mineral Lease. A water supply pipeline will carry the water from the borefield to the Mineral Lease

(a distance of approximately 30 km). From the Mineral Lease boundary, the water supply pipeline will follow the site access road to the water treatment facility.

Previous modelling of the northern borefield suggested that the borefield could readily achieve an overall production rate of 75 L/s over a 10 year mine life. As the IHP project has a nominal 20-year mine life, further groundwater testing will be undertaken to ensure that the aquifer can produce at the potential maximum demand of 22ML per day (for the full 1 Mt of P_2O_5 per year), compared to the previously approved 9.6ML per day for the DSO project. As a result of the staged development of the IHP, starting at 200,000 tonnes P_2O_5 per year, there will be the opportunity to validate the groundwater aquifer modelling over the first stages of project development.

The Arruwurra borefield, adjacent to the Arruwurra pit, will be used to supplement the northern borefield if required.

2.11 Domestic Waste Management

A modular sewage treatment plant, comprising a package membrane bio-reactor process design (as opposed to a pond design) will be located approximately 500 m from the village (see Figure 2.6). It will comprise a number of above ground modules to process sewage waste from the accommodation village and offices. Suitable systems will likely include both aerobic and anaerobic reactors and clarification systems. Processing capacity will be appropriately matched to the number of personnel on site.

All modules or tanks for the plant will be covered to mitigate any potential for entry by mosquitoes. As waste water treatment will be achieved using a membrane bio-reactor, there will be no permanent standing waste water ponds.

A landfill for putrescible and biodegradable waste will be constructed on site in accordance with the Northern Territory Environmental Protection Authority (EPA) landfill guidelines (EPA, 2010). The putrescible waste disposal site will be located in the southeastern corner of the Main Zone Mineral Lease area.

2.12 Workforce

The initial construction phase of the project is expected to employ up to 200 people over a period of approximately 15 months. During initial operations, the mine will accommodate a workforce of approximately 120 positions, including project management, ore treatment staff and contractual mining workforce.

As mining operations increase to 1 Mt/a P_2O_5 , the mine workforce will comprise both construction and operations staff and will be approximately 550 positions once fully operational.

Preference in employment will be given to the Traditional Owners and Tennant Creek residents where they have the appropriate skills, knowledge and experience.

Minemakers has signed a Tripartite Mining Agreement with the Traditional Owners and the Central Land Council that includes a framework for the training of Traditional Owners to enable them to acquire skills, knowledge and experience relevant to the operation and management of the mine and allow them to take up permanent employment positions within the operation.

The mine workforce will be predominantly a fly-in, fly-out workforce and will operate on a two weeks on, one week off (or similar variant) roster. The mine workforce will fly-in and fly-out of the aerodrome located within the Mineral Lease.

2.13 Timing

Pending the regulatory approvals, the initial phase of construction for the project will commence in March 2014 and take approximately 15 months. Once heavy vehicle access is available to the site and sufficient rooms are available for occupation in the accommodation village, work will commence on the IHP plant and other facilities, including workshop, offices and laydown areas. As stated, this project will be staged, with additional IHP trains and infrastructure added as product demand increases. Mining is scheduled to commence in mid-2015, with the first production of SPA planned for the last quarter of 2015.

2.14 Rehabilitation and Project Closure

A mine closure and rehabilitation plan will be prepared for the project that includes specific closure objectives and assessment criteria that will apply to progressive and final rehabilitation and actual closure works. Mine closure planning is a continuous process which commences prior to project development. Closure plans will be progressively refined and adapted throughout the life of the mine. This ensures the planning adapts to further site information that becomes available during construction, and to changes in regulations, stakeholder expectations, technology, knowledge and mine planning.

Mine closure planning will be conducted in consultation with stakeholders to ensure that the final rehabilitation and mine closure objectives incorporate their requirements (e.g., retention of certain infrastructure) and keep them informed of achievements of mine closure criteria.

The mine closure plan will be developed in line with the following objectives:

- Protection of human health and safety.
- Progressive rehabilitation of the site during operations.
- Ecosystem and landscape function after closure is resilient, self-sustaining and comparable to the surrounding areas.
- Project does not compromise the quality and quantity of surface water or groundwater to existing users and water dependent ecosystems.
- Need for long term monitoring and maintenance is reduced through design and construction of mine waste landforms that are physically and chemically stable.
- Landforms are consistent with the surrounding landscape.
- Residual risks and liabilities are identified and can be readily controlled.
- Mine closure process and lease relinquishment occurs in a cost-effective and efficient manner.
- Full cost of decommissioning and rehabilitation is understood and that a mechanism for funding exists.
- Development of an environmental monitoring and reporting program which is focused towards demonstrating the achievement of closure outcomes.

Rehabilitation will be undertaken progressively when areas are no longer required for mining. This will include backfilling of pits where economically feasible, stabilisation of land, and ripping and revegetating of disturbed areas. All infrastructure, excluding any requested by Traditional Owners to remain on-site, will be removed and the areas will be regenerated as per mined areas.

This page intentionally left blank

3. PROJECT PERMITTING

3.1 History of Project Permitting

The previous DSO project underwent assessment under the Environmental Assessment Act in 2009–2010. This process was initiated by lodgement of a Notice of Intent for the project with the Northern Territory Government Department of Resources on 10 March 2009. The project was then referred to the Northern Territory Minister for Natural Resources, Environment and Heritage for consideration under the Environmental Assessment Act. The minister determined that the project required the preparation of an Environmental Impact Statement (EIS) under the Environment Assessment Act on 5 May 2009.

An *Environment Protection and Biodiversity Conservation Act* (EPBC Act) referral for the project was submitted to the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) on 22 April 2009. The project was declared not a controlled action on 21 May 2009 and therefore environmental approval of the project proceeded solely under the Northern Territory legislative process. Due to changes in the location of the proposed water supply, a subsequent EPBC Act referral for the northern borefield and water supply pipeline was submitted to DEWHA in parallel with the EIS. The northern borefield and water supply pipeline was declared not a controlled action on 22 December 2009.

The Draft EIS was prepared by Minemakers and was placed on public exhibition over the period 21 November to 21 December 2009. An EIS Supplement was then produced addressing the submissions received during the public exhibition period and, together with the Draft EIS, forms the final EIS that was assessed by DNRETAS.

Once DNRETAS completed its assessment, the recommendations for approval with conditions were provided to the Northern Territory Minister for Natural Resources, Environment and Heritage for his final decision. The *Wonarah Phosphate Project Assessment Report 64* (DNRETAS, 2010a) stated that:

‘...[The] EIS and EIS Supplement demonstrated a systematic, comprehensive, high quality approach to impact identification, analysis, reduction, mitigation (and in some cases offsets), that generally left stakeholders and government satisfied that potential issues have been appropriately identified and addressed.’

and that the project could proceed without unacceptable environmental impacts provided that:

‘...[T]he project as proposed, including all proposed management mechanisms, environmental commitments and recommendations detailed in the draft EIS, the Supplement, this Assessment Report and in the final management plans, are implemented and managed under the Mining Management Plan for the Project...’

A final recommendation that the DSO project could proceed was provided by the Minister for Natural Resources, Environment and Heritage to the Minister for Primary Industry, Fisheries and Resources on 23 April 2010.

Following the final approval and granting of an authorisation to operate the DSO project, a mining management plan (MMP) was prepared as per Section 40 of the Mining Management Act. The MMP was delivered to the Northern Territory Department of Resources in August 2010.

3.2 Northern Territory Compliance Framework

The initial environmental permitting of mining activities is regulated in the Northern Territory by both the *Mining Management Act* and the *Environmental Assessment Act* (Figure 3.1).

A decision on the appropriate permitting route for new mining proposals in the Northern Territory is initiated by the proponent's submission of a NOI (i.e., this document) to the Northern Territory Government through the Minerals and Energy Referral Assessment branch of the Department of Mines and Energy. If assessment under the Environmental Assessment Act is thought to be required, the NOI is referred to the Minister for Lands, Planning and Environment through DLPE for determination of the appropriate level of assessment.

If DLPE determines that the project requires assessment at the level of PER or EIS, as expected, draft guidelines for the preparation of the PER or EIS will be developed by DLPE based on this NOI. These guidelines will be made available for public comment for a period of 14 days, during which time the public may submit comments to be considered in the development of the final guidelines. Once these guidelines are issued, Minemakers will be required to develop a Draft EIS which addresses the guidelines; once this is submitted the Draft EIS will be placed on public display for at least 28 days to allow for public comment. After this period is complete all comments will be provided to Minemakers and Minemakers will be required to address these comments in the EIS supplement.

Following the completion of the assessment and approval process under the Environmental Assessment Act by the Northern Territory Minister for Lands, Planning and Environment (assisted by the DLPE Environmental Protection Agency) the Department of Mines and Energy proceeds with the approval process under the *Mineral Titles Act* and *Mining Management Act*.

If DLPE determines that the environmental impacts of the project are significant but limited in extent, a PER can be called for. The key points on a PER are:

- A single or limited number of environmental issues.
- A limited magnitude, duration, frequency and extent of impacts.

3.2.1 Mineral Titles Act and Mining Management Act

The principal legislation for the regulation of mining proposals in the Northern Territory is the Mineral Titles Act and the Mining Management Act, both of which are administered by the Department of Mines and Energy.

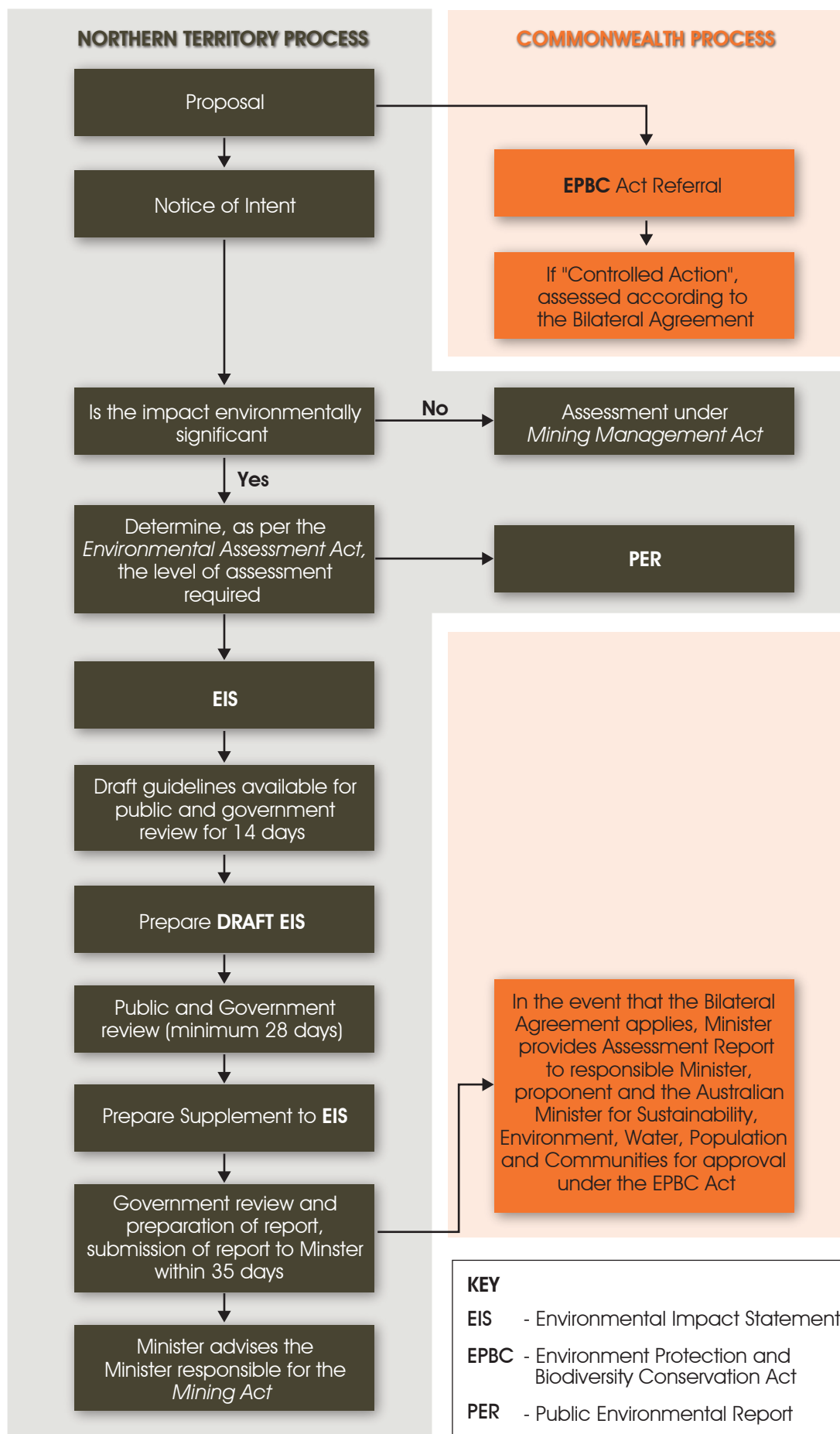
Mineral Titles Act

The Mineral Titles Act establishes the framework within which activities to explore for and mine mineral resources can occur. The act sets out the administrative processes for authorising these activities through the grant of a title.

Prior to any activities taking place on a Mineral Lease granted under the Mineral Titles Act, an authorisation to carry out mining activities under the Mining Management Act must be obtained

Mining Management Act

The objectives of the Mining Management Act are to ensure that the development of mineral resources is in accordance with the best practice standards.



Under the Mining Management Act, an application for an authorisation to carry out mining activities must be accompanied by a mining management plan. A mining management plan includes information relating to the description of mining activities, the management system to be implemented for the management of environmental aspects, costing of closure activities and particulars of organisational structure. Plans of any existing or proposed mine workings and infrastructure must also be included. The mining management plan is required to be reviewed at intervals specified in the authorisation to carry out mining activities.

Under Section 43 of the Mining Management Act a security may be required by the Minister for Mines and Energy for the purpose of securing costs and expenses in relation to the Minister causing an action to be taken to prevent, minimise or rectify environmental harm. Mine operators are expected to calculate rehabilitation costs and present these as part of the MMP. These costs are verified by DME and are reassessed when revised MMPs are submitted.

3.2.2 Environmental Assessment Act

The Environmental Assessment Act and the Environmental Assessment Administrative Procedures establish the framework for the assessment of potential or anticipated environmental impacts of development, and provide for protection of the environment. The Northern Territory Minister for Lands, Planning and the Environment is responsible for administering the act. The minister also determines the appropriate level of assessment for new developments or material changes to existing operations, based on the sensitivity of the local environment, the scale of the proposal and its potential impact upon the environment.

3.2.3 Waste Management and Pollution Control Act

The *Waste Management and Pollution Control Act* provides for the protection of the environment through encouragement of effective waste management and pollution prevention and control practices. The objective of the act is to facilitate the implementation of national environment protection measures made under the *National Environment Protection Council (Northern Territory) Act 2004*.

3.2.4 Water Act

The *Water Act* provides for the investigation, allocation, use, control, protection and management of surface water and groundwater resources, as well as the administrative process for licensing these activities. The act also considers the protection and use of water resources for purposes such as recreational, social and cultural.

Under this act, mining activities (as defined by the *Mining Management Act*) or another activity for a purpose ancillary to that mining activity, including the use of water as drinking water, are exempt from a number of provisions in the Water Act. This includes, but is not limited to, the use of surface water and groundwater as well as the construction of works to allow for the use of water.

If off-lease discharge is required, a waste discharge licence will be sought. Waste is defined in the Water Act as any solids, liquids or gas, which, if added to the water, may pollute the water.

3.2.5 Northern Territory Aboriginal Sacred Sites Act

This act establishes a procedure for the protection and registration of sacred sites, providing for entry onto sacred sites and the conditions to which such entry is subject and establishing a procedure for the avoidance of sacred sites in the development and use of land. Under the act an Authority Certificate can be issued that provides legal indemnity against possible prosecution in relation to damage to sacred sites resulting from the works or uses covered by the certificate as long any conditions imposed are followed.

The Aboriginal Areas Protection Authority (AAPA) administers the issue of Authority Certificates in consultation with the relevant custodians under the act. An application for an Authority Certificate for the project area has been submitted.

3.2.6 Additional Northern Territory Compliance Measures

Additional Northern Territory compliance measures that may be relevant to the project are outlined in Table 3.1.

Table 3.1 Additional relevant Northern Territory regulations

Regulatory or framework element	Description/applicability
<i>Aboriginal Land Act</i>	Provides for access to Aboriginal land and certain roads bordered by Aboriginal land. Transport routes during construction and operation may traverse areas subject to this act. If required, permits will be obtained for access to these areas.
<i>Bushfires Act</i>	Relates to the prevention and suppression of bushfires and outlines when permits are required for controlled burns.
<i>Control of Roads Act</i>	Provides process by which roads can be opened and closed. Any public or gazetted roads that are required to be opened or closed as a result of construction or operation of the mine will follow the provisions of the act. Roads established within the mining lease will not be public roads and will therefore not require approval under this act.
<i>Dangerous Goods Act</i>	This act provides for the safe storage, handling and transport of dangerous goods. Minemakers will obtain licences for storage or transportation of dangerous goods defined under the act.
<i>Dangerous Goods (Road and Rail Transport) Act</i>	This act makes provision for safety in the transport of dangerous goods by road and rail. Involvement in the transport of dangerous goods by road or rail includes, but is not limited to, being the consignee of dangerous goods, loading or unloading dangerous goods that have been transported or the importation or arrangement to import dangerous goods into Australia
<i>Environmental Offences and Penalties Act</i>	This act establishes the penalties for certain offences related to the protection of the environment.
<i>Heritage Act</i>	Provides for the conservation of the Territory's cultural and natural heritage. If any archaeological places or objects are to be disturbed through mining, permission will be required to be sought from the Chief Executive of the Department of Lands, Planning and the Environment to remove, disturb and/or destroy the objects or sites.
<i>Miscellaneous Acts Amendment (Aboriginal Community Living Areas) Act</i>	This act amends certain acts to make provision for the excision of certain areas of land from pastoral leases and for these areas to be granted an estate in fee simple as living areas for the benefit of Aboriginals. The project is located within Northern Territory enhanced freehold parcels issued in accordance with this act.
<i>Planning Act</i>	This act provides for appropriate and orderly planning and control of the use and development of land. The <i>Planning Act</i> will be applicable to any infrastructure constructed at Tennant Creek and East Arm Port.
<i>Soil Conservation and Land Utilisation Act</i>	This act makes provision for the prevention of soil erosion and for the conservation and reclamation of soil. Under this act, Minemakers is considered to be landholders and as such can be in breach of the act if appropriate soil erosion and conservation measures are not adopted and maintained during the life of the project.

Table 3.1 Additional relevant Northern Territory regulations (cont'd)

Regulatory or framework element	Description/applicability
<i>Territory Parks and Wildlife Conservation Act</i>	This act lists those species of plants and animals that are protected within the Northern Territory. Permits issued under this act will be required to take or interfere with protected plants or animals.
<i>Traffic Act</i>	Regulates traffic and includes provisions in relation to the erection and operation of traffic control devices. Consent will be required prior to the erection and operation of traffic control devices.
<i>Weeds Management Act</i>	This act aims to protect the Northern Territory from the adverse impacts of weeds and identifies the responsibilities of all landholders in relation to the management of declared weeds and prevention of their spread.
<i>Workplace Health and Safety Act</i>	This act aims to promote health and safety in the workplace and together with the <i>Dangerous Goods Act</i> requires that a Risk Management Plan be submitted to NT WorkSafe covering the occupational health and safety aspects of the mining operation and complimentary waste storage business.

3.3 National Compliance Framework

3.3.1 Environment Protection and Biodiversity Conservation Act

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), actions that are likely to have a significant impact on a matter of national environmental significance are assessed. The Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) is responsible for administering the act. Matters that are considered to be of national environmental significance include:

- World Heritage properties.
- National Heritage places.
- Ramsar wetlands of international significance.
- Threatened species and ecological communities.
- Migratory species.
- Nuclear actions.
- Commonwealth marine areas.
- Additional matters of national environmental significance ('prescribed actions').

A referral and assessment process has been established to determine the application of the EPBC Act. The first step in this process is referral of the project to the DSEWPaC. The project is then assessed for the potential for impacts upon matters of national significance, and if this is applicable, to establish the significance of these impacts. If it is determined that there will be, or there is likely to be, a significant impact to a matter of national significance the project is declared to be a controlled action.

Should the project be deemed a controlled action under the act and assessment proceed, approval will be contingent on what conditions are imposed, the minister's consideration of the impacts of the proposed action on matters protected by the EPBC Act as well as other economic and social matters. The minister would take into account:

- The principles of ecologically sustainable development.
- The outcomes of the assessment of the impacts of the proposed action.

- Community and stakeholder comment.
- Comments from other government ministers (e.g., social and economic factors).

Environmental offsets can also be used under the EPBC Act to mitigate the environmental effects of a specific project by maintaining or enhancing the health, diversity and productivity of the environment as it relates to matters protected under the act.

Environmental offsets are not applicable to approvals of all proposed projects under the act and each approval is assessed on a case-by-case basis. In circumstances where suitable offsets are not available to adequately compensate for the impacts of a development, the minister is required to make a decision on the overall acceptability of the project.

To gain approval under the EPBC Act, proponents of a mining proposal need to ensure that potentially significant impacts are avoided or reduced by mitigation measures to the extent that they will not be significant. To be considered, any such measures must be concrete and prescriptive, and be clearly effective in avoiding or mitigating any significant impacts.

An EPBC Act referral will be lodged in parallel with this NOI. Due to the disturbance of the site from previous grazing activity and the absence of fauna or fauna species of national significance, it is anticipated that the project will not have significant impacts to matters of national environmental significance.

3.3.2 Native Title Act

The *Native Title Act 1993* establishes a framework for the protection and recognition of native title by Aboriginal people. The act sets up processes to determine where native title exists, how future activity impacting upon native title may be undertaken, and to provide compensation where native title is impaired or extinguished. Native Title is recognised by the Australian legal system in instances where:

- The rights and interests over a portion of land or water are possessed under traditional laws and customs that continue to be acknowledged by the relevant Indigenous Australians.
- By virtue of those laws and customs, the relevant Indigenous Australians have a demonstrable connection with the land or waters.
- The native title rights and interest are recognised by the common law of Australia.

Further, the act gives indigenous Australians who hold native title rights and interests – or who have made a native title claim – the right to be consulted and, in some cases, to participate in decisions about activities proposed to be undertaken on the land.

Another important function of the act is the facilitating of Indigenous Land Use Agreements (ILUA's) between native title parties and other interest holders.

3.3.3 Aboriginal Land Rights (Northern Territory) Act

The *Aboriginal Land Rights (Northern Territory) Act 1976* provides for the granting of inalienable freehold title to traditional Aboriginal owners of land in the Northern Territory, the establishment of Land Councils, and the establishment and management of Land Trusts to hold the Aboriginal land for the benefit of traditional owners of the land. The act also regulates exploration and mining on Aboriginal land and sets out the processes to be followed when negotiating with Traditional Owners for access to and leases over Aboriginal land. An exploration license cannot be granted in relation to Aboriginal land without the consent of the relevant Land Council (for the traditional

owners) and the minister. A mineral lease cannot be granted unless an agreement has been entered into under the act.

As the underlying land tenure of the project is enhanced freehold, the provisions of the Native Title Act and Aboriginal Land Rights (Northern Territory) Act do not apply. However, in recognition that the owners of the underlying land tenure of the Mineral Lease are the Arruwurra Aboriginal Corporation, the Central Land Council (CLC) (on behalf of the Traditional Owners) and Minemakers are working together to address the concerns of the Traditional Owners.

3.3.4 Australian Heritage Council Act

The *Australian Heritage Council Act 2003* provides for the establishment of the Australian Heritage Council. The functions of this council include the provision of advice to Government on issues relating to, including conservation and protection of, places considered of National or Commonwealth Heritage; and making assessments under the EPBC Act relating to areas of National or Commonwealth Heritage.

3.3.5 Aboriginal and Torres Strait Islander Heritage Protection Act

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* provides for the protection of Aboriginal cultural heritage. The act allows the minister and authorised officers to make declaration in respect of Aboriginal heritage which must be complied with. The act is administered by DSEWPaC. Its relevance to mineral exploration and mining is primarily focused on the obligation for companies to report any discovery of Aboriginal remains.

3.3.6 Additional National Compliance Measures

Additional federal compliance measures that may be relevant to the project are outlined in Table 3.2.

Table 3.2 Additional relevant federal regulations

Regulatory or framework element	Description / applicability
National Pollutant Inventory (NPI)	The inventory confers the requirement for companies using over thresholds of listed chemicals to report annual emissions of these chemicals and transfers of waste sewage or stockpiles. This ensures that the annual NPI thresholds for reporting are monitored against and if exceeded an annual report will be required.
Australian Dangerous Goods Code (ADG7)	This code adopts the definitions of the United Nations Recommendations on the Transport of Dangerous Goods Model Regulations, while retaining Australia specific provisions. Like the UN Code, the Australian Code classifies substances based on hazardous properties and also identifies individual dangerous goods (DGs) by type. The Code covers the classification, labelling, packaging and transport requirements of DG transport. The Code is followed for: • Classifications that may require analysis. • Labelling of all containers, packages and bags (each layer) with the appropriate DG label. • Ensuring the correct drum or package which meets the packaging group classification for that DG substance is used. • Ensuring that shipping containers, packages and vehicles are approved for use and placarded correctly. • Ensuring that the correct documentation is carried.

Table 3.2 Additional relevant federal regulations (cont'd)

Regulatory or framework element	Description / applicability
National Transport Commission (Model Amendments: Transport of Dangerous Good by Road or Rail – Package No. 1) Regulations 2009	These regulations cover the transport of dangerous goods in Australia by road or rail, including training, packaging, stowage, driver duties, consigner duties, documentation, placarding, vehicle standards, safety equipment, segregation, bulk transfer and other aspects and must be complied with.
Guidelines for the Preparation of an Emergency Response Plan	These guidelines require that an emergency plan be developed for the transport of dangerous goods.
Model Work Health and Safety Act revised draft 23 June 2011	The current version of the draft legislation is to be adopted across all jurisdictions to provide uniform Occupational Health and Safety laws. The Act required duties to ensure safe working conditions for all in the operation, design and supply of workplace activities including chemicals and substances.
Model Work Health and Safety Regulations	The regulations detail the safe work practices for managing hazardous chemicals.

This page intentionally left blank

4. PUBLIC INVOLVEMENT AND CONSULTATION

Minemakers developed and refined its stakeholder engagement activities during the permitting of the DSO project. This has provided a sound basis on which to develop stakeholder consultation for the IHP project.

Minemakers has adopted an approach to community consultation and stakeholder engagement that is based on the timely and accurate provision of information to stakeholders and listening to stakeholders to understand their views, concerns and aspirations. The approach has included the participation of Minemakers in on-country meetings with the Traditional Owners and the Central Land Council, ongoing consultation with the Northern Territory government and public meetings in Tennant Creek and Alice Springs.

Consultation and engagement strategies have been developed in accordance with best practice standards for community consultation and stakeholder engagement such as the Australian Minerals Council's Enduring Value: The Australian Minerals Industry Framework for Sustainable Development (MCA, 2005) and the International Finance Corporation's Stakeholder Engagement: A good practice handbook for companies doing business in emerging markets (IFC, 2007).

Consultation regarding the IHP project has commenced with key stakeholder groups and will continue during project planning, construction, operations, and mine closure phases in accordance with the stakeholder consultation plan. The stakeholder consultation plan has been designed to ensure that the process is open and transparent for all stakeholders throughout the life of the mine and mine closure process.

4.1 Consultation Objectives

The goal of Minemakers' stakeholder consultation program is to provide a framework that will ensure that stakeholders are provided with accurate information about, and involved to an appropriate degree in, the development of the project.

The specific objectives of Minemakers consultation program are to:

- Achieve mutual understanding between Minemakers and its stakeholders.
- Ensure the smooth and efficient development and operation of the project.
- Provide appropriate opportunities for involving and communicating with relevant stakeholders.
- Provide a process in which project planning and operation can take account of issues raised by stakeholders at the earliest possible stage.
- Reduce the potential for stakeholder disaffection, which can result from a misunderstanding of the project, and, particularly for local communities, either a real or perceived exclusion from the environmental and social impact assessment (i.e., EIS) process.
- Ensure the appropriate regulatory requirements are met.
- Provide a means for recording all initiatives in which consultation is undertaken, issues raised and responses to these issues provided to stakeholders.

These objectives have been met to date by the establishment of a consultation framework and community engagement program that will be supported by relevant technical investigations during project development.

4.2 Stakeholders

Stakeholders are parties with an interest in the project who can potentially influence, or are influenced by, its development. Stakeholders relevant to the project include:

- i) The 'local' community (people associated with the immediate area and who are directly affected by project-related activities), which comprises residents of the Wunara community, pastoralists on surrounding properties, the Central Land Council (CLC) and the Northern Land Council (NLC).
- ii) 'Peripheral' communities (communities that are proximal to the project area and may or may not be affected by the project in some way, e.g., through increased employment opportunities), which comprise the township of Tennant Creek.
- iii) 'Other' communities (communities that are distant from the project area and that may still be affected by the project in some way). These include Darwin and Mt Isa (the localities from which most products, services and people will be sourced), Camooweal and Alice Springs.
- iv) Northern Territory government agencies and relevant Ministers and members of parliament (e.g., Department of Lands, Planning and the Environment (DLPE), Department of Mines and Energy (DME), Department of Chief Minister, NT WorkSafe, NT Emergency Service, Darwin Port Corporation).
- v) Non-government organisations and special interest groups (e.g., Environment Centre Northern Territory, Country Women's Association of Australia (CWAA), Barkly Tourism).
- vi) Media (regional, territory and national).
- vii) General public (particularly within the Northern Territory).
- viii) Minemakers (e.g., board, employees) and its shareholders.
- ix) Contractors/suppliers (including infrastructure providers) and customers to Minemakers.
- x) Financiers (e.g., brokers, bankers and investors) and their advisors.
- xi) Mining industry (e.g., other mineral explorers or producers in the area and the Minerals Council of Australia).

4.3 Consultation to Date

Stakeholder consultation activities were undertaken as part of the permitting of the DSO project. The sections below outline the general consultation topics, activities and the broad stakeholder groups involved with this. Consultation methods included face-to-face, telephone, e-mail and letters. The consultation method undertaken depended on the issues being discussed and the stakeholder being consulted.

4.3.1 Scoping Study Consultation

Consultation activities during the initial planning or scoping stage of the DSO Project (up to February 2009) were focused on introducing the project and the potential options being considered for development and providing detailed information on exploration activities being undertaken. Project information was also posted on Minemakers' website (www.minemakers.com.au).

Stakeholders involved in consultation activities during this scoping study phase were the Traditional Owners, CLC, Northern Territory and Australian government agencies and local pastoralists. Consultation with key Northern Territory and Australian government agencies (such as DME, Department of Chief Minister, DLPE and the Australian Government Department of Sustainability, Environment, Water, Population and Communities) focused on establishing and initiating the assessment and approvals process for the project. Consultation with the Traditional Owners and the CLC and local pastoralists focused on facilitating land access for exploration activities.

4.3.2 Consultation for the DSO EIS

As the DSO project progressed from the scoping study to the feasibility and EIS preparation phase, consultation expanded to include a broader range of organisations and individuals, including residents of Tennant Creek and Alice Springs, local training providers, local businesses, the Northern Territory Mineral Resources Council (formally NT Resources Council), the Northern Territory Industry Capability Network (NTICN) and the Environment Centre Northern Territory (ECNT).

Along with listening to stakeholder concerns and views, topics that were discussed as part of the consultation activities included general updates on the project and its progress; issues specific to the Wunara community; the project approvals process; training, employment and business opportunities; water supply; and access to land.

That comprehensive consultation approach worked well for the DSO project and consequently Minemakers will use the same approach for the IHP project.

A database is being, and will continue to be, kept to record all stakeholder contact.

The broad outcomes of previous consultation activities include:

- Increased government and community awareness and understanding of the project.
- Identification of areas of concern to Traditional Owners and other stakeholders.
- Building relationships with local and peripheral communities.
- Identification of potential employment opportunities for local Indigenous people.
- Opportunities for members of the local community to voice opinions and concerns.

4.4 Ongoing Community Consultation

The community consultation and engagement program will be re-initiated for the Wonarah IHP Project and will continue throughout the life of the project to ensure due consideration of all project-related opportunities and concerns. The ongoing program will involve:

- Maintaining the current good relationships between Minemakers, the Traditional Owners and the CLC, pastoral leaseholders and government (at all levels).
- Establishing contact with other key stakeholders as new issues arise.
- Disseminating information to, and having discussions with, stakeholders on key issues raised during the EIS process.
- Identifying and responding to key issues and concerns of all stakeholders.
- Preparing relevant documents for review by government agencies and other stakeholders.
- Addressing specific concerns of various stakeholders on an ongoing basis.

- Routine reporting.

4.4.1 Approach

Stakeholder consultation will be a participative process, tailored to stakeholder groups to ensure the appropriate levels and types of engagement are undertaken with each stakeholder individual or stakeholder group. Consultation will include, but not be limited to:

- Project briefings for key stakeholders to update them on project progress and issues. Also to provide a forum for Minemakers to listen to, understand and address their concerns and issues.
- Meetings with the Traditional Owners and the CLC and surrounding pastoralists to ensure that landowners and occupiers are kept informed of the project progress and to listen to, understand and address their concerns and issues.
- Community information sessions to gain a broad understanding of the concerns of stakeholders about the project.

The consultation program will ensure the opportune dissemination of project information and enable stakeholders to communicate concerns.

4.4.2 Mechanisms

The ongoing consultation program will involve both formal and informal mechanisms. The PER or EIS assessment process will provide for formal mechanisms for consultation, and informal mechanisms may include:

- Project information bulletins or brochures.
- Information on the Minemakers website.
- Direct consultation with the resident manager.
- An information display and pack containing relevant project and Minemakers contact information.
- Newsletters and fact sheets.
- Presentations, meetings and liaison:
 - Presentations by project personnel to community and other groups.
 - Media releases.
 - Northern Territory Government briefings.
 - Liaison and site inspections with government agencies and regulators.
 - Interviews and articles in local media.
 - Stakeholder information sessions.

5. EXISTING ENVIRONMENT, POTENTIAL IMPACTS AND MANAGEMENT

5.1 Framework

The previous DSO project underwent assessment under the Environmental Assessment Act (DNRETAS, 2010a) and the approval to proceed was provided by the Minister for Natural Resources, Environment and Heritage to the Minister for Primary Industry, Fisheries and Resources in April 2010. As outlined in Section 1.3, the DSO project was not constructed due to Minemakers' subsequent intent to incorporate downstream processing and associated value-adding to the project.

The differences between the IHP and DSO projects are listed in Section 2.2. In summary, they include:

- Mining of a lower grade of phosphate ore, resulting in fewer but larger pits.
- Beneficiation and processing of the ore on site producing super phosphoric acid, rather than production of DSO.
- Production of inert clay slimes that will need to be stored within a SSF.
- Transport of petroleum coke to site and SPA from the project area, rather than haulage of rock phosphate; resulting in a 26% reduction in the truck movements per annum from the DSO project.
- An SPA isotainer storage area and hardstand area for petroleum coke containers at a rail siding in Tennant Creek to facilitate transfer between rail and road transport, rather than transport and stockpiling of the DSO at the Multi-user Hub.
- Increased water and power usage due to the processing requirements on site.

For reference, a summary of the identified impacts, environmental and social outcomes, and residual impacts presented in the EIS and assessed during the permitting of the DSO project are provided in Attachment B.

This chapter presents the environmental and social aspects of the project. Information has been derived from the DSO project EIS as this provides the most current, complete assessment of the aspects relating to the project area. Additional aspects relating to the Wonarah IHP Project have been included. For each aspect the following information is provided:

- Description of the existing environment, based primarily on the findings of studies undertaken as part of the DSO project EIS.
- Description of the potential, credible environmental and social impacts (or issues), both positive and negative, that may be associated with the project. Identification of the potential impacts is based on the findings of the DSO project EIS, knowledge of the existing environment, experience with similar operations elsewhere and issues of concern to key stakeholders. This initial description of impacts does not take into consideration the measures that will be employed by Minemakers during all stages of project development to address these impacts.

- Avoidance, mitigation and/or management measures that will be used to address the newly-identified potential, credible environmental and social impacts. These reflect Minemakers' commitment to good practice mining and environmental management, and are technically and economically feasible within the context of the project's setting.
- The level of residual risk associated with the various impacts, assuming the effective implementation of the proposed control measures.
- A monitoring program that will provide early warning that mitigation and/or management measures are ineffective or failing.

Further detail about the process for determining residual risk and appropriate monitoring measures is provided below.

Residual Risk Assessment

The residual risk assessment identifies the risk associated with the various impacts either known to occur as a result of the project or known to occur at similar mining operations. The residual risk assessment considers what the remaining risk is once the proposed mitigation and/or management measures have been effectively implemented.

The risk assessment was conducted by examining the potential consequences (i.e., a measure of severity of environmental impact) and the likelihood that those impacts will occur. The assessment of 'likelihood' applied specifically to the resulting environmental or social impact. Often a final environmental impact results from a chain of events, each with an associated likelihood. These 'conditional likelihoods' were considered when determining the final likelihood of the environmental impact occurring.

As part of the risk assessment process, a number of risk management assessment processes were considered. These included the Australian/New Zealand Standard Risk Management standard (AS/NZS 4360:2004 (Standards Australia, 2004a)) and the associated guidelines (HB 436:2004 (Standards Australia, 2004b) and HB 158-2006 (Standards Australia, 2006a)), Standards Australia's Environmental risk management – Principles and process (HB 203:2006 (Standards Australia, 2006b)) and the United States Environmental Protection Agency's Guidelines for Ecological Risk Assessment (US Environmental Protection Agency, 1998).

The descriptors used in this assessment are based on those used in the Standards Australia's HB 203:2006 (Standards Australia, 2006b) and the South Australian Guidelines for miners: 'Preparation of a mining lease proposal or mining and rehabilitation program (MARF) in South Australia' (PIRSA, 2009). These descriptors were chosen as they were considered to be most appropriate for the mining project (Table 5.1).

Table 5.1 Descriptors used to classify likelihood and consequence measures of impact

Descriptor	Definition
Likelihood	
Almost certain	Is expected to occur in most circumstances, or is of a continuous nature, or likelihood is unknown.
Likely	Will probably occur during mine lifetime.
Possible	Could occur in most mines.
Unlikely	Could occur in some mines, but not expected to occur.
Rare	Occurs only in exceptional circumstances.
Consequence	
Catastrophic	Health – death or widespread health effects, or toxic release off-site with detrimental effect. Environmental – extreme permanent changes to the natural environment (not able to be practically or significantly rehabilitated or alleviated). Social – major public outrage. Financial – huge financial loss (greater than A\$500 million). Or the consequences are unknown.
Major	Health – extensive injuries. Environmental – substantial and significant changes to the natural environment or only partially able to be rehabilitated or alleviated. Social – will attract public concern in wider community. Financial – major financial loss (A\$100 to 500 million). Or changes will be substantial if cumulative effects are considered.
Moderate	Health – medical treatment required. Environmental – significant local changes, but can be rehabilitated or alleviated with difficulty at significant cost and with outside assistance. Social – will attract concern of adjoining community. Financial – high financial loss (A\$10 to 100 million).
Minor	Health – first aid treatment required. Environmental – on-site release immediately contained very local consequence with no significant long-term changes or may be simply rehabilitated. Social – not of significant concern to wider community. Financial – medium financial loss (A\$1 to 10 million).
Insignificant	Health – no injuries. Environmental – negligible environmental impact. Social – unlikely to be noticed by public. Financial – low financial loss (less than A\$1 million).

The level of risk for each potential impact is then determined by combining consequences and likelihood using the risk matrix shown in Table 5.2.

Table 5.2 Qualitative risk analysis matrix

		Severity of Consequence				
		<i>Catastrophic</i>	<i>Major</i>	<i>Moderate</i>	<i>Minor</i>	<i>Insignificant</i>
Likelihood of Consequence	<i>Almost Certain</i>	Extreme	Extreme	Extreme	High	High
	<i>Likely</i>	Extreme	Extreme	High	High	Moderate
	<i>Possible</i>	Extreme	Extreme	High	Moderate	Low
	<i>Unlikely</i>	Extreme	High	Moderate	Low	Low
	<i>Rare</i>	High	High	Moderate	Low	Low

The evaluation of residual risks is based on the findings from specific investigations carried out in support of the previous DSO project EIS, knowledge of the existing environment likely to be affected, experience at similar operations elsewhere and professional judgement. It is expected that all residual risks will be managed by Minemakers to 'as low as reasonably practicable' (ALARP)

5.2 Air Quality

5.2.1 Existing Environment

The project area is remote from significant pollution sources such as industry. The existing air quality in the vicinity of the project area is relatively pollutant free and is typical of a remote, semi-arid rural environment. Dust generated by wind erosion of exposed surfaces is the main air pollutant present. Other pollutants sources are combustion emissions from bushfires and minor emissions from vehicles travelling along the Barkly Highway.

Wind conditions strongly influence dust generation and transport. In the project area the predominant wind direction is south-easterly and the strength of the wind is usually a fresh breeze (Figure 5.1) (Table 5.3).

Wind data collected at the project area during the DSO Project EIS (May 2008 to October 2009) reflected average data collected at both Brunette Downs and historical Wonarah data (see Figure 5.1). The average winds recorded at Brunette Downs and Wonarah is a gentle breeze (13.5 and 16.3 km/h respectively).

Table 5.3 Summary of seasonal wind conditions

Season	Summary of Wind Condition
Dry season (April – July)	Predominantly calm to moderate southeasterly winds throughout the season.
Build-up to the wet season (September – November)	Predominantly strong southeasterly and moderate southerly winds throughout the season, with calm to mild winds varying in direction from east to northwest.
Wet season (December – March)	Predominantly calm to moderate southeasterly winds with calm winds varying in direction from east to northwest.

Background dust levels were measured by deposition gauges at eight locations within the project area and surrounds over 11 sampling periods, from June 2008 to September 2009. The dust monitoring results indicate that dust deposition ranges in the project area are similar to those in arid regions in general.

5.2.2 Potential Impacts

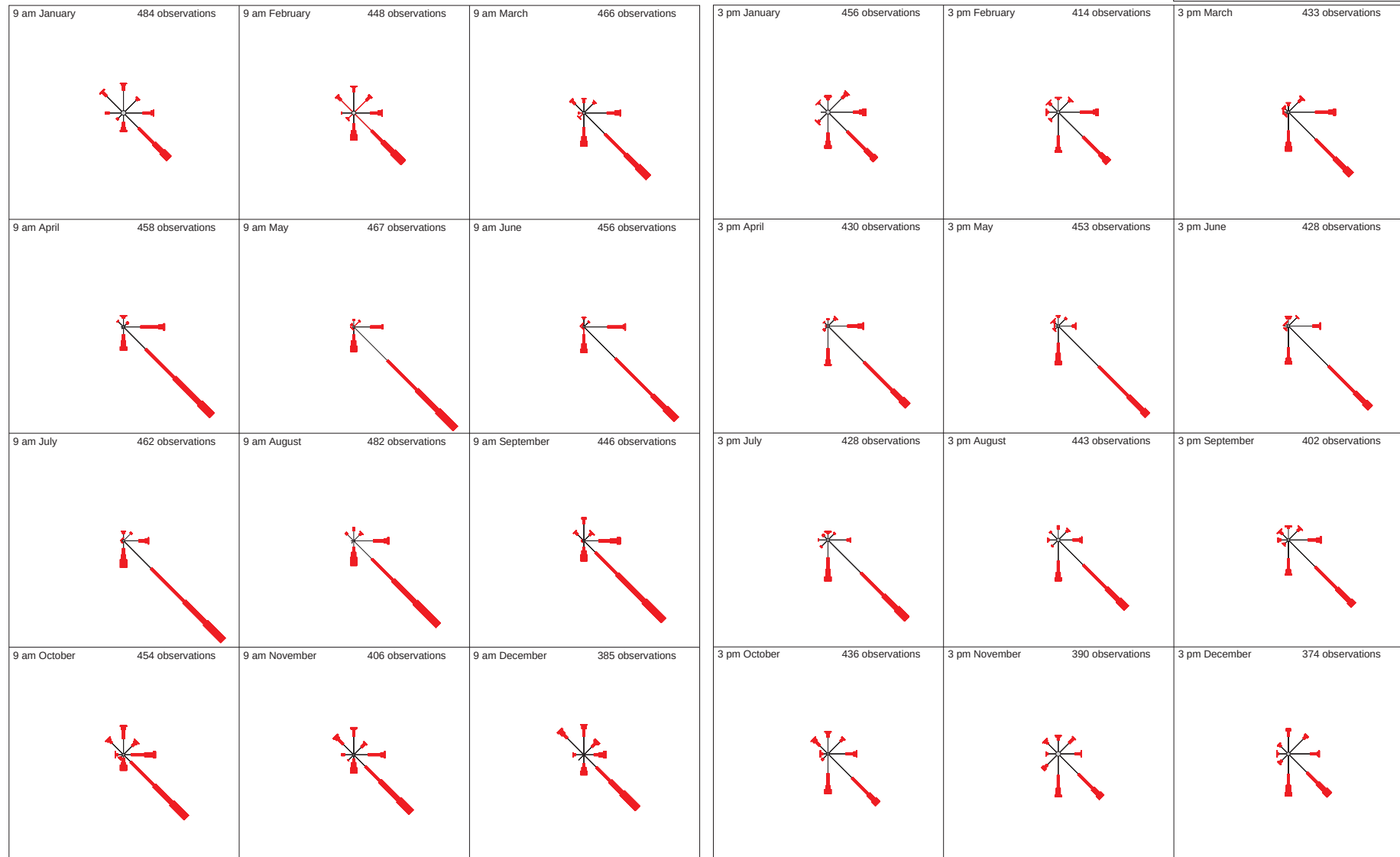
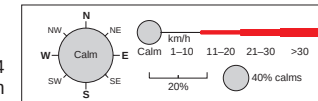
In this section, assessment and discussion of potential impacts to air quality as a result of the construction and operation of the project are from an anthropocentric perspective. Impacts on the natural values of the project area, e.g., flora and fauna, are addressed in their respective sections. The potential impacts are discussed primarily as they relate to potential sensitive receptors (Figure 5.2).

Decrease in Air Quality Due to Dust Emissions Generated within the Mineral Lease

The main potential air quality issue that will result from construction and operation of the project will be the liberation of particulate matter, resulting in airborne dust. The main dust generating activities are likely to be:

Wind Roses using data between Jan 1957 and Aug 1974 for Wonarah

Site Number 015034 • Locality: Ranken • Opened Apr 1946 • Closed 31 Dec 1974
Latitude 19°53'54"S • Longitude 136°20'09"E • Elevation 240m



Prepared by Climate Services Section in the WA Office of the Bureau of Meteorology. Contact us by phone on (08) 9263 2222, by fax on (08) 9263 2233, or by email on climate.wa@bom.gov.au
Copyright © Commonwealth of Australia 2009 Prepared on 24 February 2009
We have taken all due care but cannot provide any warranty nor accept any liability for this information.

coffey
environment

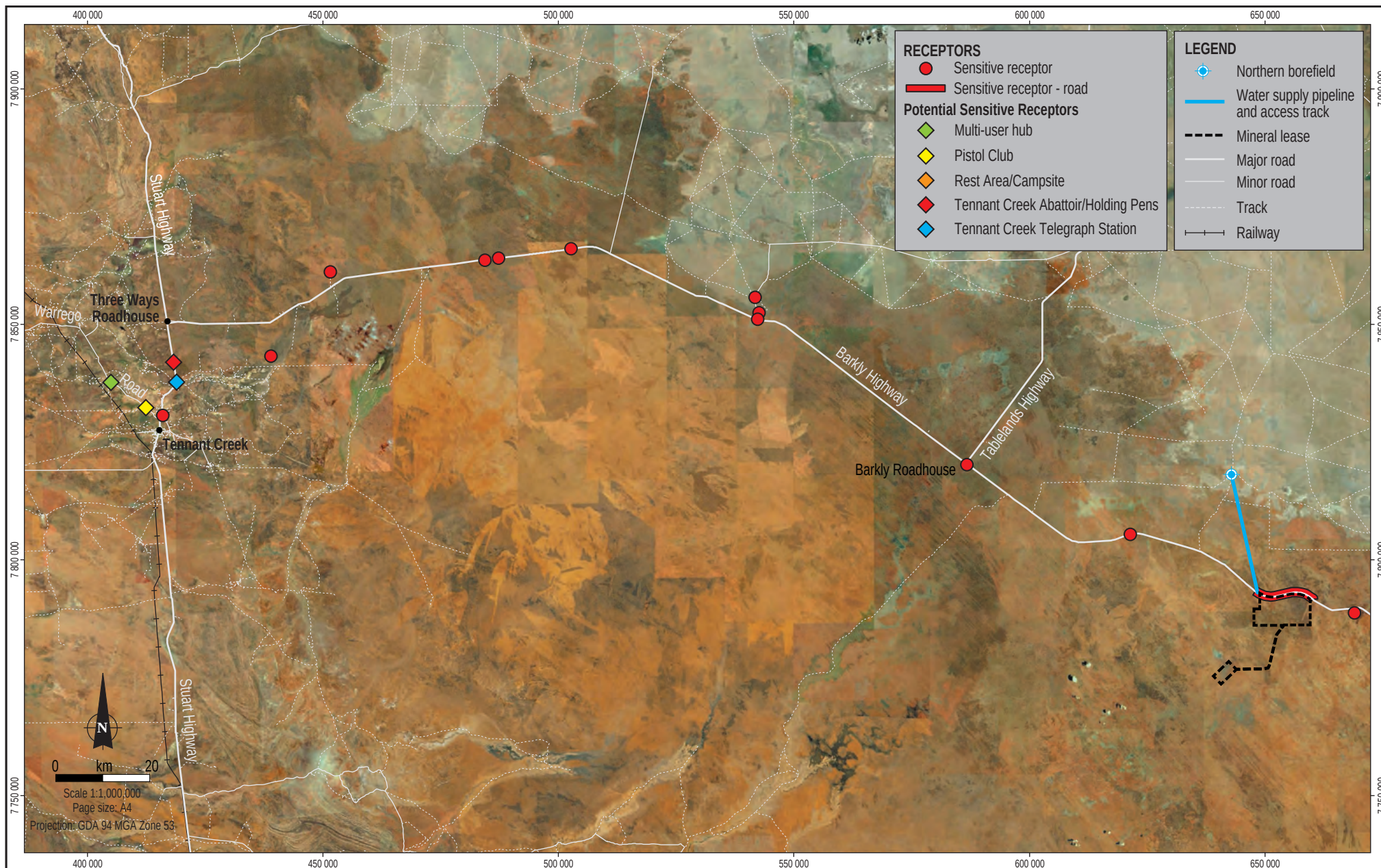
Job No:
9014
File Name:
9014_22_F05.01_FT

Minemakers Australia Pty Ltd
Wonarah IHP Project

MINEMAKERS
AUSTRALIA PTY LTD

Morning and afternoon wind direction and speed recorded at the Wonarah BoM station 1957 to 1974

Figure No:
5.1



Source:
Place names, roadnets and tracks from GEODATA 250k (optimum scale 1:250,000)
Bore locations from GMP.
Mine layout from GHD and MineMakers.
Mineral lease from DMETIS (December 2012).

coffey
environment

Date:
17.12.2012
MXD:
9014MM_22_GIS009_v1_1
File Name:
9014_07_F05.03_GIS_GL

Minemakers Australia Pty Ltd

Wonarah IHP Project

MINEMAKERS
AUSTRALIA PTY LTD

**Sensitive receptors along the
product transport route - air**

Figure No:
5.2

- Clearance of vegetation.
- Drilling and blasting waste rock.
- Loading waste rock to trucks.
- Hauling waste rock to the waste rock stockpiles.
- Drilling and blasting ore.
- Loading ore to trucks.
- Hauling ore to the run of mine (ROM) stockpile.
- Unloading ore at the ROM stockpile.
- General vehicle movements over unsealed roads.
- Wind erosion from exposed surfaces (e.g., soil, stockpiles and dumps).

The sensitive receptors that may be affected by dust emissions from the Mining Lease are the residents of the Wunara community and motorists of the Barkly Highway (see Figure F015). The Wunara community has permanent residents and is located 10 km from the Mineral Lease boundary and may experience dust nuisance and amenity impacts. Motorists that travel on the section of the Barkly Highway that adjoins the Mineral Lease boundary are transient receptors, who would only have short-term exposure to any emissions from the Mineral Lease; however, they may experience temporary dust nuisance and amenity impacts such as reduced driving visibility.

Decrease in Air Quality Due to Combustion Emissions

Project vehicles and equipment will run on hydrocarbon fuels (mostly diesel), which emit products such as carbon monoxide (CO), sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and particulate matter from fuel combustion. These emissions have the potential to adversely impact local air quality and have the potential to cause nuisance or health impacts for the residents of the Wunara community. The impact of the project on greenhouse gases is addressed in Section 5.3.

Decrease in Air Quality Due to Processing Plant Emissions

Vented gases from the IHP plant can potentially have an adverse impact on the air quality in the immediate vicinity of the plant. Sulphur dioxide (SO₂), fluorine (F) and nitrogen oxides (NO_x) generated during the production of the SPA can cause nuisance or health impacts if breathed in. The most at risk will be those working in or near the IHP plant.

Decrease in Air Quality Due to Odour

Odour may be emitted from the sewage treatment plant and putrescible waste landfill, with a potential adverse impact on local air quality and has the potential to cause a nuisance impact for residents at the closest sensitive receptors (i.e., residents of the Wunara community). Some phosphate deposits also have the potential to generate odour, however, no odour has been observed during exploration drilling or laboratory analysis. Additional odours may be produced within the IHP plant during the production of the SPA.

5.2.3 Mitigation and Management Measures

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on air quality. These measures will reflect current good practice at similar mines operating in similar environments and are described below.

Decrease in Air Quality Due to Dust Emissions Generated within the Mineral Lease

To minimise dust emissions and dust nuisance Minemakers will:

- Consider the location of dust and odour generating activities and the prevailing meteorological conditions during the mine planning and design stage, e.g., locate accommodation sufficiently

distant from the sewage treatment plant and mining operations, and locate waste rock storages as far as possible from the Mineral Lease boundary.

- Manage ground disturbance by:
 - Minimising the extent of vegetation cleared to reduce the amount of exposed areas susceptible to wind erosion.
 - Clearing vegetation progressively (i.e., as land is required) to reduce the amount of exposed areas susceptible to wind erosion.
 - Rehabilitating final surfaces progressively during the project to minimise the amount of exposed areas susceptible to wind erosion.
- Manage mine traffic, including such measures as:
 - Using signage, training and markings to ensure traffic is kept to formed site roads where dust suppression techniques are in use.
 - Restricting site access to necessary site vehicles only.
 - Limiting parking of vehicles to designated parking areas to minimise soil disturbance.
 - Speed limits will be imposed on roads used by mine traffic to reduce vehicle dust.
- Manage waste rock, ore and topsoil storage, including such measures as:
 - Watering stockpiles to prevent wind losses when required (e.g., during dry windy weather, when stockpiles have been recently formed, and have surface dust).
 - Maintaining existing screening vegetation along the Mineral Lease boundary adjacent to the Barkly Highway to maximise particle capture on site and minimise dust movement off-site.
- Cease mining and clearing operations during severe meteorological conditions causing extreme levels of dust.
- Spray water and/or dust suppressant on unsealed trafficked areas and other dust generating areas. Minemakers will keep records of the:
 - Operational hours of all water trucks.
 - Amount of water and dust suppressant used.
 - Numbers of water trucks in operation.
 - Time any mining operations are ceased due to severe meteorological conditions.

Decrease in Air Quality Due to Combustion Emissions

Project equipment, machinery and vehicles will meet exhaust air quality standards in the normal manner for all vehicles sold in Australia and will comply with all Northern Territory regulations. Vehicles and machinery will be fitted with the appropriate emission control equipment, and maintained and serviced frequently.

Minemakers will conduct regular general reviews of the mining operations to assess additional measures that can be implemented to minimise impacts on air quality due to combustion emissions. These reviews will incorporate findings from the monitoring program and consider any new technologies that may be available to reduce emissions.

Decrease in Air Quality Due to Processing Plant Emissions

The vented gases from the IHP plant will undergo a series of cleaning stages to ensure safe final exhaust from the plant. The gases are firstly scrubbed with a lime slurry and then passed through a flue gas desulfurization unit for a final cleaning. The IHP demonstration plant described in Section 2.6.2 will refine the engineering requirements for the cleaning stages to ensure that the vented gas meets the required environmental guidelines.

Decrease in Air Quality Due to Odour

The main potential sources of odour on-site will be the sewage treatment plant and the putrescible waste landfill. Location of the sewage treatment plant will comply with Northern Territory's Code of Practice for the small on-site sewage and sullage treatment systems and the disposal or reuse of sewage effluent (DHCS, 1996) and the EPA guidelines that specify a minimum separation distance of 100 m for plants servicing less than 1,000 people.

The putrescible waste landfill will be designed with consideration of, and will be managed in accordance with, the Northern Territory Government's Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory (EPA, 2010).

Selection of the sewage treatment plant to be used on-site will consider the generation of odours among other factors.

Any odours produced during the operations of the IHP plant will be identified during the operation of the IHP demonstration plant described in Section 2.6.2. Management and mitigation measures will be developed if required.

5.2.4 Residual Risk

Assessment of residual air quality impacts was based on the current baseline data for dust deposition and emission rates of similar operations in similar environments. Table 5.4 summarises the residual impacts of the project on air quality after implementation of the management and mitigation measures. These are discussed in more detail below.

Table 5.4 Summary of residual impacts on air quality

Impact	Likelihood	Consequence	Residual Risk
Decrease in air quality due to dust emissions generated within the Mineral Lease.	Rare	Moderate	Moderate
Significant increase in the amount of combustion emissions.	Unlikely	Insignificant	Low
Decrease in air quality due to processing plant emissions	Unlikely	Minor	Low
Decrease in air quality due to odour.	Rare	Minor	Low

Decrease in Air Quality Due to Dust Emissions Generated within the Mineral Lease

Dust will be generated at the mine site and complete dust suppression in this type of operation and setting (which already experiences high levels of dust at times) is not feasible. Based on modelling of other semi-arid mining operations, most dust will be generated by the extraction of waste rock and ore from the open pits.

The potential for dust emissions to impact the nearest sensitive receptor with permanent residents (the Wunara community, located 10 km from the Mineral Lease boundary) is dependent on the

level of dust generated, 'at source' management of the dust generating activities, the separation distance from activities to the receptor and the prevailing wind direction and strengths.

The possibility of movement of dust off the mineral lease in the direction of, and distance to, the Wunara Community, such that it causes nuisance is considered to be **rare**. Based on similar operations in similar environments the consequences of this dust generation in terms of the various assessment criteria if it were to impact the Wunara Community will be **moderate**, giving an overall residual risk ranking of **moderate**.

From an occupational health and safety perspective, air quality at the accommodation camp will only be affected by operational activities at the Main Zone, as the Arruwurra pit will be at least 20 km away and therefore highly unlikely to affect air quality at the accommodation. Air quality on site will be carefully managed and any significant residual risks are unlikely; however, air quality at the accommodation camp will be carefully monitored by Minemakers occupational, health and safety systems.

Significant Increase in the Amount of Combustion Emissions

Even in large mines, the rate of emission of sulfur dioxide, nitrogen dioxide and carbon monoxide from vehicles and equipment are small compared with the emissions from traffic in an urban setting.

A significant increase in the amount of combustion emissions is **unlikely**. Further, impacts will be highly localised and the consequences will be **insignificant**, resulting in a **low** residual risk.

Decrease in Air Quality Due to Processing Plant Emissions

The IHP plant will incorporate a series of cleaning stages to ensure all emission are of sufficient quality from release to the atmosphere. Additionally, safeguards such as emergency backup power will provide for a controlled shutdown of the kiln to control the release of emissions in the event of a power failure at the plant.

A significant decrease in the air quality due to processing plant emissions is **unlikely**. Any impacts will be localised and the consequences will be **minor**, resulting in a **low** residual risk.

Decrease in Air Quality Due to Odour

The likelihood of a decrease in air quality due to odours is **rare** due to the management and mitigation measures that will be adopted; namely, siting of the waste landfill to consider prevailing wind and distance from sensitive receptors, selection of an appropriate sewage treatment plant, and assessment and management of any odours produced during the operation of the IHP demonstration plant.

The consequence of a decrease in air quality due to odour impacting the nearest sensitive receptors would be **minor**, resulting in a **low** residual risk.

5.2.5 Monitoring

Monitoring of dust emissions will incorporate:

- Monthly monitoring of wind speed, wind direction, temperature, humidity and rainfall at Minemakers' Wonarah weather station located within the Mineral Lease.
- Monthly monitoring of total dust deposition at dust deposition gauges located within (or close to) the Mineral Lease and further dust deposition gauges located north of the Barkly Highway.

- Real time dust monitoring gauges will monitor dust deposition until a pattern of dust movement and seasonal variation is established. Monitoring will then occur as required.
- Recording the use of dust suppression techniques in log books in order for Minemakers to gauge the effectiveness of suppression techniques against monitoring data.

Any complaints concerning air quality will be recorded in the Complaints Register. This register will record the complaint and any actions taken to address the complaint and show that no reasonable complaint remains unaddressed.

Monitoring of air quality with respect to the wellbeing of staff and contractors will be conducted where required as part of the project's occupational health and safety system.

Further air quality monitoring measures are outlined in the air quality environmental management plan (Attachment C).

No specific management measures have been designed to address potential odour issues, given the low potential for odour, distances from the nearest sensitive receptor and remoteness of the project area. The need for specific measures will be considered if complaints are received, taking into account frequency of occurrence, intensity, duration, offensiveness and location.

5.3 Greenhouse Gases

5.3.1 Existing Environment

Baseline greenhouse gas emissions in the project area are limited to naturally occurring levels from biogenic sources, i.e., termites, soil, lightning and gut fermentation in animals. Activities which emit greenhouse gas within close vicinity to the project area are limited. The largest sources of anthropogenic greenhouse gas emissions in close vicinity to the project area are likely to be methane emitted from pastoral activities and carbon dioxide from vehicles travelling on the Barkly Highway.

5.3.2 Potential Impacts

The potential impact of the project on greenhouse gas emissions is an increase in the overall greenhouse gas emissions for the project area and the Northern Territory. Greenhouse gases identified under the Kyoto Protocol United Nations Framework Convention on Climate Change are:

- Carbon dioxide (CO₂).
- Methane (CH₄).
- Nitrous oxide (N₂O).
- Hydrofluorocarbons (HFCs).
- Perfluorocarbons (PFCs).
- Sulfur hexafluoride (SF₆).

Of these, CO₂ and N₂O are the most significant for the project as they will be generated through combustion of hydrocarbon fuels (mainly diesel and natural gas), electrical power use and vegetation clearance. Diesel will be used to fuel vehicles, machinery and generators to provide electricity during construction. During operation, power will be generated by a dual fuel power station running on diesel and natural liquefied gas. Other sources of greenhouse gas emissions for the project will be the combustion of natural gas for drying and pyrometallurgical processing of the ore to produce SPA.

5.3.3 Mitigation and Management Measures

Measures that incorporate best practices for greenhouse gas emission reduction will be employed during the construction and operations phases. These measures include:

- Develop and apply policies and procedures for efficient mine operation that will ensure fuel use is minimised.
- Minimise haul distances to minimise diesel use in vehicles and subsequent combustion emissions.
- Monitor energy consumption (e.g., diesel and electricity) and calculate greenhouse gas emissions. This data can then be used to identify and address any key opportunities to reduce greenhouse gas emissions.
- Identify and assess economically viable opportunities for reductions in emission rates, e.g., reducing areas of vegetation clearance and exploring opportunities to use more efficient fuel technology such as natural gas.
- Use renewable energy sources where available and viable (e.g. solar hot water systems, monitoring systems powered by solar energy).
- Ensure that vehicles and equipment are mechanically sound, serviced regularly and fitted with appropriate emission control equipment.
- Use energy efficient lighting in all accommodation and office areas.
- Use 5-star appliances in accommodation and offices where available (e.g., refrigerators, air conditioners and cookers).

5.3.4 Residual Risk

Table 5.5 summarises the residual risk of an increase in net greenhouse gas emissions within the Northern Territory and Australia as a result of the project.

Table 5.5 Summary of impacts resulting from greenhouse gas emissions

Impact	Likelihood	Consequence	Residual Risk
Significant increase in greenhouse gas emissions	Unlikely	Insignificant	Low

In 2010 the total estimated CO₂-equivalent emissions for the Northern Territory was 14.7 Mt, for Australia were 561 Mt and in 2010 total emissions worldwide were 33,500 Mt (DCC, 2012, CDIAC, 2012). When these are compared with the likely emissions from construction and operation of the project (for the DSO project these were estimated at 0.05 Mt/a), the project will represent an increase in CO₂-equivalent emissions of around 0.3% relative to the Northern Territory's total emissions, 0.009% relative to Australia's total emissions and less than 0.0001% relative to global emissions. A significant increase in emission of greenhouse gases in Australia due to project development is therefore **unlikely** to occur, the severity of consequence is **insignificant** and the residual risk is **low**.

5.3.5 Monitoring

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production that requires certain facilities and companies to monitor and report on these factors.

Minemakers will monitor, record and report under the NGER Act reporting guidelines:

- Energy production.
- Energy consumption.
- Greenhouse gas emissions.

No additional outcome and assessment criteria are proposed at this stage.

5.4 Noise and Vibration

5.4.1 Existing Environment

No on-site ambient noise data has been collected. However, no significant, permanent man-made noise sources are located at or near the project area, other than passing vehicles travelling on the Barkly Highway and noise when exploration activities are underway. The only ongoing noise present is caused by wind blowing over vegetation and noises from insects and birds. The background noise levels are therefore likely to be less than 32 dB(A) during the night and in non-windy periods during the day (MMA, 2012).

The nearest sensitive receptors from the mine site, the residents of the Wunara community, are 10 km from the Mineral Lease boundary and approximately 11 km from the nearest source of constant mine-related noise (Figure 5.3). From an occupational health and safety perspective, the sensitive receptor within the Mineral Lease is the accommodation camp, which is located approximately 2.5 km from the nearest source of constant mine-related noise (IHP plant).

Along the product transport route there are a number of potential sensitive receptors to traffic-related noise, including:

- The Barkly Roadhouse.
- Five rest areas, including some with campsites for travellers on the Barkly Highway.
- Tennant Creek Abattoir/Holding Pens (possibly abandoned).
- Tennant Creek Telegraph Station.
- Tennant Creek Pistol Club.
- Five houses between 0.5 km and 7 km from the product transport route.

5.4.2 Potential Impacts

In this section, assessment and discussion of potential impacts to noise and vibration as a result of the construction and operation of the project has an anthropogenic perspective. Impacts on the natural values of the project area as a result of noise and vibration, e.g., flora and fauna, are addressed in their respective sections.

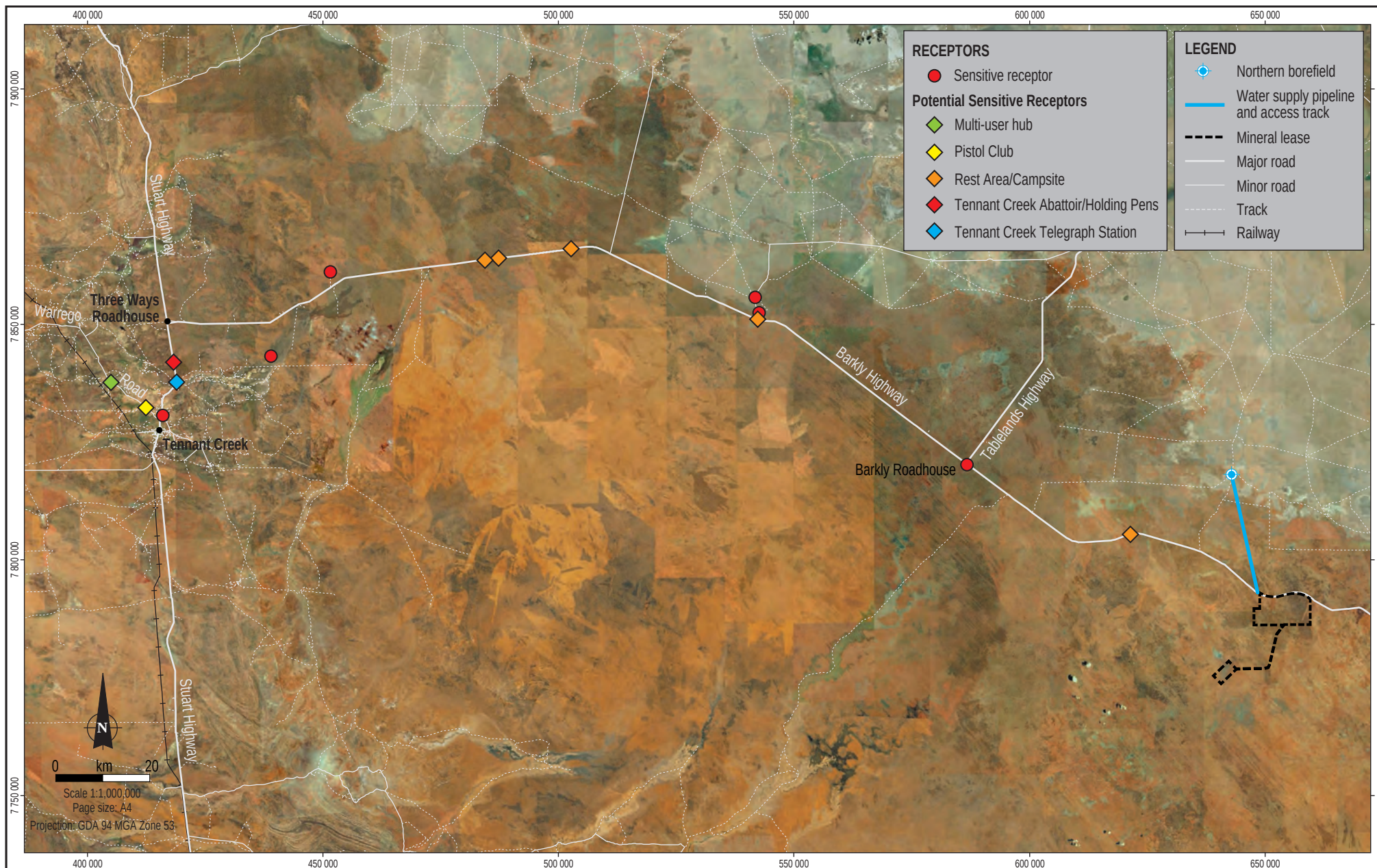
Disturbance to Sensitive Receptors from Noise and Vibration Generated within the Mineral Lease

The project has the potential to cause disturbance to the closest sensitive receptors (i.e., the residents of the Wunara community) from noise and vibration associated with mining activities.

Noise nuisance is generally determined by the noise increment above background noise levels. With noise attenuation by distance travelled over land, this increment above background does not usually extend more than 1 to 2 km from a mine.

The mine construction and operations will produce noise and vibration from both fixed and mobile sources, with the major sources being:

- Vehicles (including reversing alarms).
- Machinery (e.g., drills, loaders, haul trucks, excavators and other ancillary equipment).



Source:
Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000)
Bore locations from GMP. Sensitive receptors from Coffey Environments.
Mine layout from GHD and MineMakers.
Mineral lease from DMETIS (December 2012).

coffey
environment

Date:
17.12.2012
MXD:
9014MM_22_GIS010_v1_1
File Name:
9014_22_F05.03_GIS_GL

Minemakers Australia Pty Ltd

Wonarah IHP Project

MINEMAKERS
AUSTRALIA PTY LTD

**Sensitive receptors along the
product transport route - noise**

Figure No:
5.3

- Ball mill and associated plant.
- IHP kiln and associated equipment.
- Blasting operations.
- Aircraft landing and taking off at the aerodrome.

Disturbance to Sensitive Receptors from Project Related Heavy Vehicle Noise Along the Product Transport Route

The movement of heavy vehicles along the product transport route has the potential to cause disturbance to sensitive receptors (see Figure 5.3) from an increase in noise above existing levels. An assessment of the anticipated increase in noise above existing levels will be conducted when the number of daily product transport movements is confirmed. Due to the nature of the project the level of noise increase above existing levels is expected to be less than that previously approved for the DSO project as there will be considerably fewer transport movements associated with the new project.

5.4.3 Mitigation and Management Measures

Disturbance to Sensitive Receptors from Noise and Vibration Generated within the Mineral Lease

Noise levels at the camp will be managed and monitored by Minemakers occupational health and safety systems.

Although the mine will be located too far from sensitive receptors to cause adverse impacts, Minemakers will implement measures to control noise and vibration to provide a safe working environment. To control noise Minemakers will:

- Service all plant, machinery and vehicles regularly.
- Install and maintain standard noise abatement devices (e.g., mufflers) on machinery and vehicles.
- Monitor noise impacts by complaint, developing additional mitigation measures if necessary.

To ensure there are no impacts from the effects of blasting Minemakers will:

- Strictly manage blasting procedures to ensure the comfort of employees and to protect mine infrastructure.
- Design each blast using a suitably qualified person, with initial blasts being conservatively designed.
- Monitor blasting impacts by complaint, developing additional mitigation measures if necessary.

Disturbance to Sensitive Receptors from Project Related Heavy Vehicle Noise Along the Product Transport Route

Minemakers will implement the following measures to control noise generated by project related heavy vehicles:

- Service all vehicles regularly.
- Install and maintain standard noise abatement devices (e.g., mufflers) on vehicles.
- Impose speed limits on product trucks.
- Monitor noise impacts by complaint, developing additional mitigation measures if necessary.

5.4.4 Residual Risk

Table 5.6 summarises the residual impacts of the project associated with noise and vibration after implementation of the management and mitigation measures.

Table 5.6 Summary of noise and vibration impacts

Impact	Likelihood	Consequence	Residual Risk
Disturbance to sensitive receptors from noise and vibration generated within the Mineral Lease.	Rare	Minor	Low
Disturbance to sensitive receptors from project related heavy vehicle noise along the product transport route.	Unlikely	Minor	Low

Disturbance to Sensitive Receptors from Noise and Vibration Generated within the Mineral Lease

Given the separation distance to the nearest sensitive receptor (approximately 11 km from the nearest source of constant mine-related noise), there is virtually no prospect that noise levels at the closest sensitive receptors would be affected by noise emissions from the project.

Generation of noise and vibration from this type of project is unavoidable. However, due to the distances to the nearest residence, any impacts on sensitive receptors are **rare**. Comparison with relevant criteria shows that the consequences of noise and vibration will be **minor**, giving an overall residual risk ranking of **low**.

Disturbance to Sensitive Receptors from Project Related Heavy Vehicle Noise

Noise attenuation over distance will result in negligible increases above existing traffic noise at most sensitive receptors. However, given the distance of the Barkly Roadhouse to the transport route, complete noise attenuation over distance is not possible at this sensitive receptor.

Generation of noise from project-related heavy vehicle traffic is inevitable; however, the isolated nature of the project and the distance of sensitive receptors from the transport route mean that the likelihood of disturbing sensitive receptors is **unlikely**. In addition, due to noise attenuation any consequences of increased noise are likely to be **minor**, giving an overall residual risk rating of **low**.

5.4.5 Monitoring

Noise Monitoring

No noise monitoring will be conducted unless complaints arise. Minemakers will investigate and act upon any complaints regarding the noise levels of the operations outside of the mine site.

Monitoring of staff and contractor exposure to noise will be conducted as required as part of the project's health and safety system, to ensure that the workplace complies with occupational health and safety noise limits.

Vibration Monitoring

No monitoring will be conducted unless complaints arise. If complaints indicate that agreed control measures are not adequate, Minemakers will assess whether additional mitigation measures are required.

5.5 Landform, Geology and Soils

5.5.1 Existing Environment

Landform

The project is located on the undulating plains of the Barkly Tableland. The landform of the project area has a general low relief, although small rocky outcrops are locally common (Plates 5.1 and 5.2). Across the Barkly Tableland there is generally only a very gentle relief, which varies less than 50 m in elevation from the highest to lowest point (Edgoose, 2003) (Figure 5.4).

Geology

The Barkly Tablelands consist of Tertiary clay deposits overlying calcareous Cambrian deposits. Detailed discussion on the regional geology for this project is discussed in Section 2.3, Geology and Mineralisation.

The proposed mine site consists of two distinct phosphate deposits; the Arruwurra and the Main Zone. The geology of each deposit is discussed in detail in Section 2.3. Notwithstanding the presence of the phosphate deposits, no significant geological formations or features are present within the project area.

Soils

As defined by the Bureau of Rural Sciences (Appendix 3), the soils of the project area fall into three soil classes, lateritic rises and siliceous sands (By4), sand plains and red earths (My80) and grey clays with red earths (CC61).

Lateritic rises and siliceous sands are described as encompassing undulating ridge and slope terrain on lateritic sediments with some rock outcrops. The predominant soils are shallow sands usually containing large amounts of mixed and variable gravels or ironstone gravels, and also soils with some gravels on ridges and upper slopes. Associated soils are shallow to deep varieties of soils on mid and lower slopes. Small areas of other soils are also likely to be found within the lateritic rises and siliceous sands unit. Sand plains and red earths are described as gently undulating plains slightly elevated above the adjoining cracking clay pans with some ridges and hills, and some shallow depressions. The most common soils on long gentle slopes and low rises are neutral red earths with a variable content and surface scatter of ironstone gravels. Associated soils are sands with red and yellow earthy subsoils on slopes and in depressions, loamy soils such as neutral red earths and acid yellow earths marginal to cracking clay plains, and some shallow gravelly and stony soils on ridges and hills.

Grey clays with red earths are described as flat to gently undulating plains of grey clays interspersed with low undulating rises of red earths. The northern borefield is identified in the broadscale Bureau of Rural Sciences mapping as having grey clays with red earths and while the area of the northern borefield was not ground truthed during field investigations, a desktop assessment using the Australian soil classification identified that this is likely to be made up of Epicalcareous Endohypersodic grey Sodosols, Vertosols and red Dermosols (Appendix 3).

The broadscale mapping of the Bureau of Rural Sciences was ground-truthed for the Mineral Lease area during a field investigation conducted by Low Ecological Service Pty Ltd in March 2009 (Appendix 3), using methods based on the Australian Soil and Land Survey Field Handbook (NCST, 2009). Based on the field investigation, soils within the project area were classified into four major soil classifications as per the Australian soil classification system: Kandosols, Vertosols, Calcarosols and Rudosols.

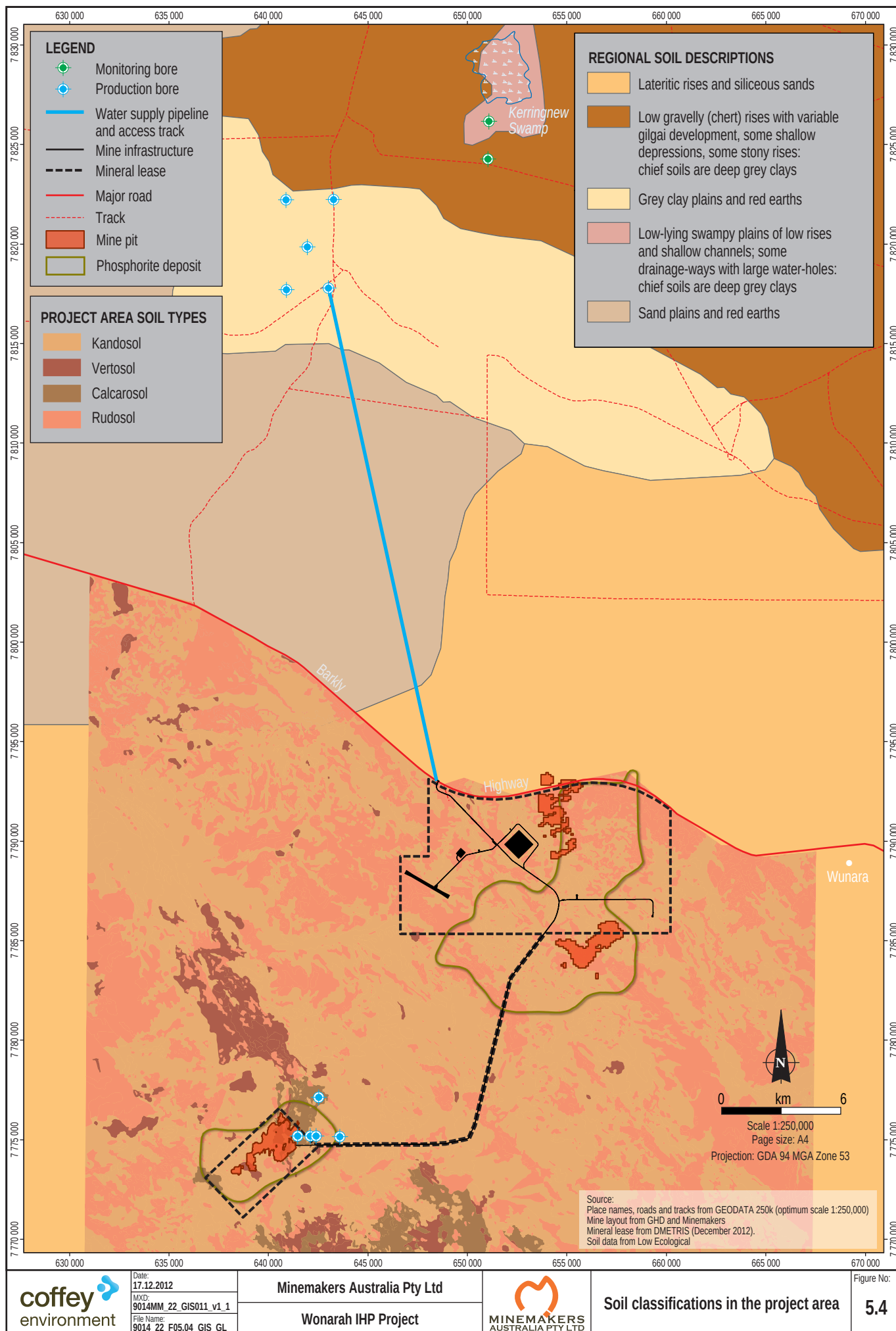


Plate 5.1
Typical landform at Wonarah



Plate 5.2
Typical rocky outcrop at Wonarah



Kandosols and Rudosols dominate the sand plains within the project area, while Vertosols and Calcarosols are restricted to areas subject to inundation (e.g., ephemeral lakes) and two localities in the southern end of the project area, respectively (see Figure 5.4).

Soil Erosion

Low Ecological Services Pty Ltd assessed the erodibility of soils in the project area during the field investigation in March 2009 (Appendix 3), with most soils assessed to have a low potential for erosion. Deep soils (mostly Rudosols with loose rock aggregations) on sloping terrains overlain by deep clayey sands, e.g., such as those found in the northeast corner of the Mineral Lease, were assessed as being susceptible to erosion. Minor gully erosion has occurred within the project area along existing exploration tracks.

5.5.2 Potential Impacts

Construction and operation of the project will involve the excavation and movement of large volumes of material within the project's proposed footprint. Specifically, activities that will involve the excavation and movement of soil on site will include removal and storage of topsoil and waste rock, construction of roads, and excavation of the phosphorite deposit. These activities could significantly affect the landform and quality of soil in the project area if not managed correctly.

Potential impacts to landform and soils due to the project include:

- Unstable landforms.
- Significant reduction in soil quality.

These are discussed in more detail below.

Unstable Landforms

Mining will be by conventional open pit mining techniques. Therefore, waste rock will be stockpiled adjacent to the pits. Where pits are not backfilled, a final void and waste rock stockpile will remain.

This change in landform, through the creation of waste rock storages and voids, will result in a change to the landform from pre-mining to post-mining. The stability of this post-mining landform will be dependent upon the landform design. Mass failure of the landform could result in substantial increases in sediment entering the surface water system.

Significant Reduction in Soil Quality

Reduction in soil quality may be due to a number of factors, including an altered soil profile, compaction, contamination and erosion. A significant reduction in the quality of soil in the project area will present problems for the successful rehabilitation and revegetation of the site, and consequent compliance with agreed closure completion criteria, i.e., that the project area is returned to as close to pre-mining condition as possible. The potential causes and effects of this are discussed below.

Due to altered profile—as part of the construction and operation of the project, topsoil and subsoil will be removed and stockpiled. If this topsoil and subsoil is not stored in appropriately segregated areas (i.e., the topsoil and subsoil is allowed to mix), and not replaced in accordance with the profile in which it was removed, there will be a reduction in the quality of the soil in mined out areas to be rehabilitated.

Due to compaction—heavy machinery used during construction and operation of the project will compact the soil. This compaction will reduce the permeability of the soil, leading to increased

surface runoff of water from disturbed areas and subsequent increased rates of erosion during and after rainfall, ultimately reducing the quality of soil in the project area. This soil may require treatment (e.g., ripping) before rehabilitation activities can take place.

Due to contamination—the soil in the project area may be contaminated during construction and operation activities due to spills from chemical storage and fuel storage areas, or seepage from putrescible waste. Geochemical analysis conducted during the DSO EIS studies classified the waste rock as non-acid forming and with low solubility; therefore, contamination from waste rock storages is not a concern for this project (Appendix 1).

Due to erosion—all disturbed soils and stockpiled soils in the project area may be subject to erosion by wind and water. This erosion has the potential to remove soil from the project area, with consequent reduction in the quality of soil in the project area able to be used during rehabilitation. Analysis of the erodibility of soils present in the project area (Appendix 3) determined that most soils had low potential for erosion, except for deep soils on slopes.

5.5.3 Mitigation and Management Measures

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on landform and soils. These measures will reflect current good practice at similar mines operating in similar environments.

Unstable Landforms

Successful rehabilitation of disturbed areas will increase the stability of post-mining land forms and minimise the potential for long term changes to the landform and landscape as a result of the project. Rehabilitation will be designed to achieve the agreed post-mining landform described in the mine closure and rehabilitation plan which will be developed as part of the PER/EIS process.

While rehabilitation and mine closure planning will continue to be refined during the life of the mine, generally the landform aspect of the project will be rehabilitated as follows:

- Open pits will be progressively backfilled with waste rock where practicable and economic during mining. The areas will be contoured, topsoil will be spread and they will be revegetated with native species. At the completion of mining some final voids may be left unfilled. Bunds will be formed around any of these final voids at a distance of at least 25 m to prevent accidental access to the edge of the void.
- Waste rock storages will remain at completion of mining and these will be contoured to low hills not exceeding 20 m above the natural ground level, spread with topsoil (if necessary for successful rehabilitation) and revegetated with native species.
- No slopes of waste rock storages will exceed 18° to maximise the stability of these landforms.
- Other disturbed areas will be rehabilitated.

Significant Reduction in Soil Quality

To maximise the potential for successful rehabilitation of disturbed areas soil quality will be maintained as close to baseline levels as possible. To ensure the integrity of the soil quality, the following mitigation measures will be implemented during the mining process:

Due to altered profile—prior to development of any site infrastructure, including the pits, the topsoil layer will be stripped. Where possible stripped topsoil will be immediately reused elsewhere to preserve the seed store and nutrients. When immediate reuse is not possible, topsoil will be stored in stockpiles no higher than 2 m and adjacent to the area of clearance in

readiness for reuse in rehabilitation. Where possible, stockpiles will be respread within three to six months of removal.

Due to compaction—to reduce the effects of compaction, all areas where the soil has been compacted during construction and operation (other than those with infrastructure to remain after closure) will be ripped, spread with topsoil and revegetated with native species.

Due to contamination—if mining works result in contamination of the soil, then the soil will be appropriately remediated and site contamination assessment will be carried out before Minemakers is released from its closure obligations. Measures to manage waste and minimise the potential for contamination due to spills are described in Attachment C.

Due to erosion—sediment and erosion control measures will be incorporated in the erosion and sediment control management plan. These sediment and erosion control measures will be developed to control and mitigate the soil erosion that may occur. They will include general measures to maintain soil quality such as:

- Restricting clearing to essential areas and minimising the area of exposed cleared land.
- Watering unsealed roads and other dust sources during windy conditions.
- Minimising the period of time subsoil is exposed and topsoil is stored.
- Minimising disturbance to the ground layer by restricting machinery access from areas not required for project works, and through selection of equipment that will minimise disturbance (e.g., track type, weight, weight to track size ratio).
- Undertaking progressive rehabilitation and revegetation.

Measures specific to controlling sediment, and therefore maintaining the local quality of soil, include:

- Installing sediment traps downslope of stockpiles (including topsoil, subsoil and waste rock) to prevent eroded sediment entering drainage lines.
- Controlling drainage and diverting it away from infrastructure.
- Diverting clean water away from disturbed areas through diversion channels.
- Directing runoff from exposed subsoil to sedimentation ponds.

5.5.4 Residual Risk

The physical effects on land from excavation and mining will be evident. In the case of mining, the impact will involve some permanent landform changes, in the form of remnant waste rock storages and final pit voids.

Management measures will be adopted to stabilise disturbed areas and contain erosion, followed by rehabilitation, monitoring and remedial works as required. These measures are intended to confine impacts to the vicinity of active work areas and promote recovery from the short-term impacts of construction and operation.

Table 5.7 summarises the residual impacts of the project on the landform, geology and soils, considering the likelihood and consequence of the predicted impacts after the successful implementation of control and mitigation measures. The assessments of these are described in further detail below.

Table 5.7 Summary of land resources impacts

Impact	Likelihood	Consequence	Residual Risk
Unstable landforms	Unlikely	Minor	Low
Significant reduction in soil quality due to:			
Altered profile	Unlikely	Minor	Low
Compaction	Unlikely	Minor	Low
Contamination	Unlikely	Minor	Low
Erosion	Possible	Moderate	High

Unstable Landforms

The setting of the mine and its associated infrastructure in the gently undulating plains of the Barkly Tablelands means that there will be a change to the landform as a result of the project. This will include final disturbance areas including final voids and waste rock storages. The waste rock storages will also result in a change to the pre-mining landform by providing localised topographic highs in otherwise gentle relief areas. However, the design of the post-mining landform will be based on best practice and existing landform design used in similar mining operations and will provide for a stable landform. The likelihood of mass failure or unstable landforms is therefore **unlikely**.

This changed landform, be it pit voids or material stockpiles, will result in a change to the visual landscape of the project area. Successful rehabilitation of disturbed areas and compliance with agreed closure completion criteria will ensure that any long term visual impact is minimal.

The approximate area of portions of land subject to the Mineral Lease is 10,846 ha. Mining and associated infrastructure will disturb approximately 2,619 ha, with a residual disturbance area following rehabilitation post-mining of approximately 1,509 ha. Therefore, the consequence of these changes to landform will be **minor**, as the area disturbed from mining activities will be contained to a small local area. The resulting residual risk is therefore **low**.

Significant Reduction in Soil Quality

The successful rehabilitation of disturbed areas within the mining lease will be reliant on the resulting soil quality at the completion of mining. Failure to maintain soil quality may result in a diminished capacity to establish vegetation due a poor growth medium. The risk of this occurring is discussed below.

Due to altered profile—by following the management and mitigation measures to handle, store and replace excavated topsoil and subsoil described above, it is **unlikely** that the project will result in a significant long term reduction in soil quality due to an altered profile. Should it occur, the impacts of this altered profile will be **minor** as the re-handling of soil can occur prior to machinery being moved off-site at the completion of mining; the resulting in a residual risk is therefore **low**.

Due to compaction—soil will be compacted during construction and operation of the project. However, management and mitigation measures will be used to minimise the potential for this and to rehabilitate compacted soil. These measures are readily available and standard practice in earthworks activities. Therefore, it is **unlikely** that there will be a significant long term reduction in soil quality due to compaction. Should it occur, the consequence of this impact will be **minor**, as it will be relatively straightforward to rehabilitate. The residual risk is therefore **low**.

Due to contamination—soil may be locally contaminated by project activities (e.g., spill of fuel or chemicals, discharge of hydraulic fluid); however, spill response measures will be followed to ensure that the impacts of the spill are minimised. With these measures in place, it is **unlikely** that this project will cause a significant long term reduction in soil quality due to contamination. The consequence of any reduction in soil quality due to contamination is **minor**. Given the unlikely possibility this will occur and its minor consequence, the residual risk is **low**.

Due to erosion—given the large volumes of ground to be disturbed during construction and operation of the project, erosion will affect the quality of soil in the project area. However, management and mitigation measures will be used to minimise the spatial and temporal extent of this erosion. These measures are common to the mining and earthworks industries and will be adapted as site conditions demand. Implementation of surface water management measures outlined in Section 5.10 will also assist in managing erosion due to water (e.g., direction of sediment-laden water to sediment ponds). However, it is **possible** that the project will result in a long term reduction in soil quality due to erosion. The consequence of a long term reduction in soil quality due to erosion, should it occur, will be **moderate**, as there may be direct or indirect environmental impacts as a result. The residual risk is therefore **high**.

5.5.5 Monitoring

Landform

The stability of the landform in the project area (e.g., pit walls, batters, waste rock storages) will be routinely monitored as part of construction and operation activities. Landform changes will be monitored through the mine closure and rehabilitation plan to ensure that progressive rehabilitation is meeting closure criteria.

Photo monitoring points will be established adjacent to proposed pit locations and photographic data will be collected on an annual basis once mining of the pit commences. Once rehabilitation commences, photographic data will be collected on a six monthly basis to ensure seasonal variation is captured.

Soils

Monitoring of soils will be addressed through an Erosion and Sediment Control Management Plan, the monitoring programs for dust (see Section 5.2.5) and the treatment of waste should contaminated soil be disturbed.

5.6 Land and Resource Use

5.6.1 Existing Environment

The Traditional Owners use the project area and surrounds for hunting and gathering and for accessing culturally significant sites. Broad-scale land use mapping identifies the project area as having grazing, natural vegetation and traditional Indigenous use (Owen and Meakin, 2003). Surrounding pastoral properties are grazed with beef cattle and pastoral activities are currently only carried out in the northern borefield section of the project area. The project area and surrounds has also been used for mineral exploration, including drilling, periodically over the past 40 years.

There is little development in the area, with the closest populated area being the Wunara community, located approximately 10 km east of the northeast corner of the Mineral Lease boundary. The project area lies within the Arruwurra portions of Aboriginal Land.

5.6.2 Potential Impacts

Potential, credible project-related impacts to land use are described below. These do not take into consideration the proposed avoidance, mitigation and management measures that will be implemented by Minemakers during all stages of project development and which will result in the residual impacts discussed in Section 5.6.4.

Potential impacts to land use as a result of the project include:

- Reduced availability of land for traditional hunting and gathering.
- Restriction of Traditional Owner access to sites of cultural significance.
- Significant reduction in land for potential pastoral use.

Reduced Availability of Land for Traditional Hunting and Gathering

The project area currently provides some value to the Traditional Owners as an area in which they practice traditional hunting and gathering. Project-related land clearance will result in a temporary reduction in the area available for hunting and gathering; Traditional Owners will also be restricted from entering the Mineral Lease during the life of the mine.

Restriction of Traditional Owner Access to Sites of Cultural Significance

Several culturally significant sites occur near, but outside, the Mineral Lease. The historical development of exploration tracks has provided easy access to these sites by Traditional Owners. Access to these sites via the exploration tracks to the east of the Mineral Lease will not be permitted during the life of the mine, as they either directly intercept the mine site or will be converted to haul roads. For the safety of the Traditional Owners and mine staff, the means of access to some culturally significant sites will therefore change and may require indirect routes.

Significant Reduction in Land for Potential Pastoral Use

Cattle grazing is the predominant land use of the Barkly Tablelands, with approximately 35% of the Northern Territory herd raised on the Barkly Tablelands (EnviroNorth, 2012). The project area to the north of the highway, that incorporates the northern borefield and water supply pipeline, is currently used for pastoral purposes; however, the mine site area, to the south of the highway, is not currently being used for this purpose but is suitable for cattle grazing.

There will be some loss of actual grazing land during the life of the mine at the northern borefield as the bores will be fenced to prevent access by grazing animals. There will also be a loss of potential grazing area in areas of the Mineral Lease to be used by the project.

5.6.3 Mitigation and Management Measures

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on land use. These measures will reflect current good practice at similar mines operating in similar environments and are described below.

Reduced Availability of Land for Traditional Hunting and Gathering

The immediate loss of land for traditional hunting and gathering will be compensated for, as agreed during discussions and negotiations with the Traditional Owners and the Central Land Council (CLC) and Minemakers and will be formalised in a Mining Agreement between the parties. Rehabilitation and revegetation of the project area and the implementation of safety features (bunds) post mining will assist in the project area being suitable for hunting and gathering use after mining has finished.

Restriction of Traditional Owner Access to Sites of Cultural Significance

Prior to construction of the project Minemakers will develop alternative access routes to the sacred sites in consultation with the Traditional Owners and the CLC. These access routes will be designed to ensure safe access to the sites and the safe operation of the mine; it is likely that access routes will be restricted to the western side of the Mineral Lease boundary and not allow for unauthorised crossing of haul roads.

Significant Reduction in Land for Potential Pastoral Use

The Mine Closure and Rehabilitation Plan will outline strategies to enable large areas of the mine site to be rehabilitated to a function similar to the surrounding land use and could therefore be used for grazing if desired; however, it is recognised that the mine site is not currently used for pastoral purposes and not part of a pastoral lease. The northern borefield and associated water supply pipeline is located on a pastoral lease. To minimise any permanent disturbance to the pastoral lease, the water supply pipeline will be buried and the borefield disturbance area restricted to the immediate area of the bore.

5.6.4 Residual Risk

Table 5.8 summarises the residual impacts of the project on land use, considering the likelihood and consequence of the predicted impacts after the successful implementation of control and mitigation measures. The assessments of these are described in further detail below.

Table 5.8 Summary of land use impacts

Impact	Likelihood	Consequence	Residual Risk
Reduced availability of land for traditional hunting and gathering.	Almost Certain	Insignificant	Low
Restriction of Traditional Owner access to sites of cultural significance.	Rare	Minor	Low
Significant reduction in land for potential pastoral use.	Unlikely	Insignificant	Low

Reduced Availability of Land for Traditional Hunting and Gathering

It is **almost certain** that the amount of land available for traditional hunting and gathering by Traditional Owners will be reduced in the project area. However, the consequence of this will be **insignificant**. The loss of land available for hunting and gathering will be temporary, i.e., during the life of the mine, and comprise only a small percentage of the amount subject to the Mineral Lease. Minemakers will consult with the Traditional Owners and the CLC to determine appropriate compensation prior to the project proceeding. The residual risk is therefore **low**.

Restriction of Traditional Owners Access to Sites of Cultural Significance

It is almost certain that the Traditional Owners residing in, or accessing the culturally significant sites from, the Wunara Community will have a reduction in their ease of access to these sites as a result of the project; however, access to the sites will not be restricted as a result of the mining activities. Safe, alternative access routes will be developed in consultation with the Traditional Owners. As a result, the **rare** likelihood and **minor** consequence of the impact presents a **low** residual risk.

Significant Reduction in Land for Potential Pastoral Use

The Barkly Tableland is approximately 100,000 km² in area (Edgoose, 2003) and is used predominantly for pastoral purposes. The disturbance area of the project is estimated to be

2,619 ha, with this disturbance area being reduced to approximately 1,509 ha once rehabilitation has been completed post-mining.

The approximate disturbance area that will be excluded from grazing in the bore field to the north of the highway amounts to approximately 6.0 ha. The likelihood of a significant reduction in land for potential pastoral use is therefore **unlikely**. Minemakers will revegetate disturbed areas, which will result in the project area being suitable for grazing in the future, should this be desired. The consequence is therefore **insignificant**, giving an overall risk ranking of **low**.

5.6.5 Monitoring

No formal monitoring of impacts on land use is proposed, except by complaint.

5.7 Flora and Vegetation Communities

5.7.1 Existing Environment

The baseline characterisation of the composition, structure and diversity of flora species in the project area is based on database searches and vegetation surveys completed by Low Ecological Services Pty Ltd in March 2009 (Appendix 3). This work builds upon previous similar work completed by Low Ecological Associates Pty Ltd in June 2008. The June 2008 survey followed a bushfire, which burnt much of the vegetation within the project area and reduced the possibility of species identification (Plate 5.3). The March 2009 survey followed favourable summer rains and regrowth was extensive with the area showing good signs of regeneration (Plate 5.4). A further desktop survey of the northern borefield and associated water supply pipeline route was carried out by Low Ecological Services Pty Ltd in October 2009 (Appendix 4).

Further surveys will be completed during the EIS for the project, targeting the presence/absence of the plant species of conservation significance discussed in this section.

At a broad scale the project area is dominated by the Yelverloft land system and characterised by skeletal soils and gravelly lateritic earth with *Eucalyptus brevifolia* or *E. dichromophora* woodlands. The Arruwurra mine area and a section of the water supply pipeline is on the Wonarah land system and is characterised by gently undulating land with lateritic red earths with *Eucalyptus brevifolia* woodland or *Eucalyptus* spp. (low mallees) – *Acacia* spp. shrubland. Part of the northern borefield lies within the Wonarah/Barkly land system, described as gently undulating to nearly flat with *Astrebla pectinata* (Mitchell grass) plains.

Searches of the NT Parks and Wildlife Flora Atlas (Appendices 3 and 4) and field surveys identified no vegetation communities or flora species listed under the EPBC Act in the project area. No vegetation communities listed under the *Territory Parks and Wildlife Conservation Act* (TPWC Act) were recorded in the project area. However, thirteen species listed under the TPWC Act have been recorded in the region, with four species being recorded in the project area. Two near threatened species, *Bergia barklyana* and *Hibiscus brachychlaenus*, and two data deficient species, *Distichostem barklyanus* and *Heliotropium pulvinum*, listed under the TPWC Act were identified during the March 2009 survey.

No *Sporobolus latzi* specimens were identified during surveys in March 2009 specifically targeted to detect its presence.

Plate 5.3
The project area after fire
showing Spinefex regrowth



Plate 5.4
Vegetation in the project area
after good wet season rains



Vegetation Communities

The distribution and composition of vegetation is influenced by soil types. Field surveys identified five vegetation communities within the Mineral Lease (Figure 5.5):

1. Sand plains supporting *Eucalyptus* and *Acacia* open woodland over hummock grassland.
2. Black soil and clay pan supporting coolibah low open woodland over grassland.
3. Calcareous plains supporting supplejack low open woodland over open grassland.
4. Ephemeral lakes supporting coolibah low open woodland over grassland.
5. Rocky rises supporting *Acacia* and mallee shrubland over hummock grassland.

Three vegetation communities were identified by desktop review in the northern borefield and associated water supply pipeline:

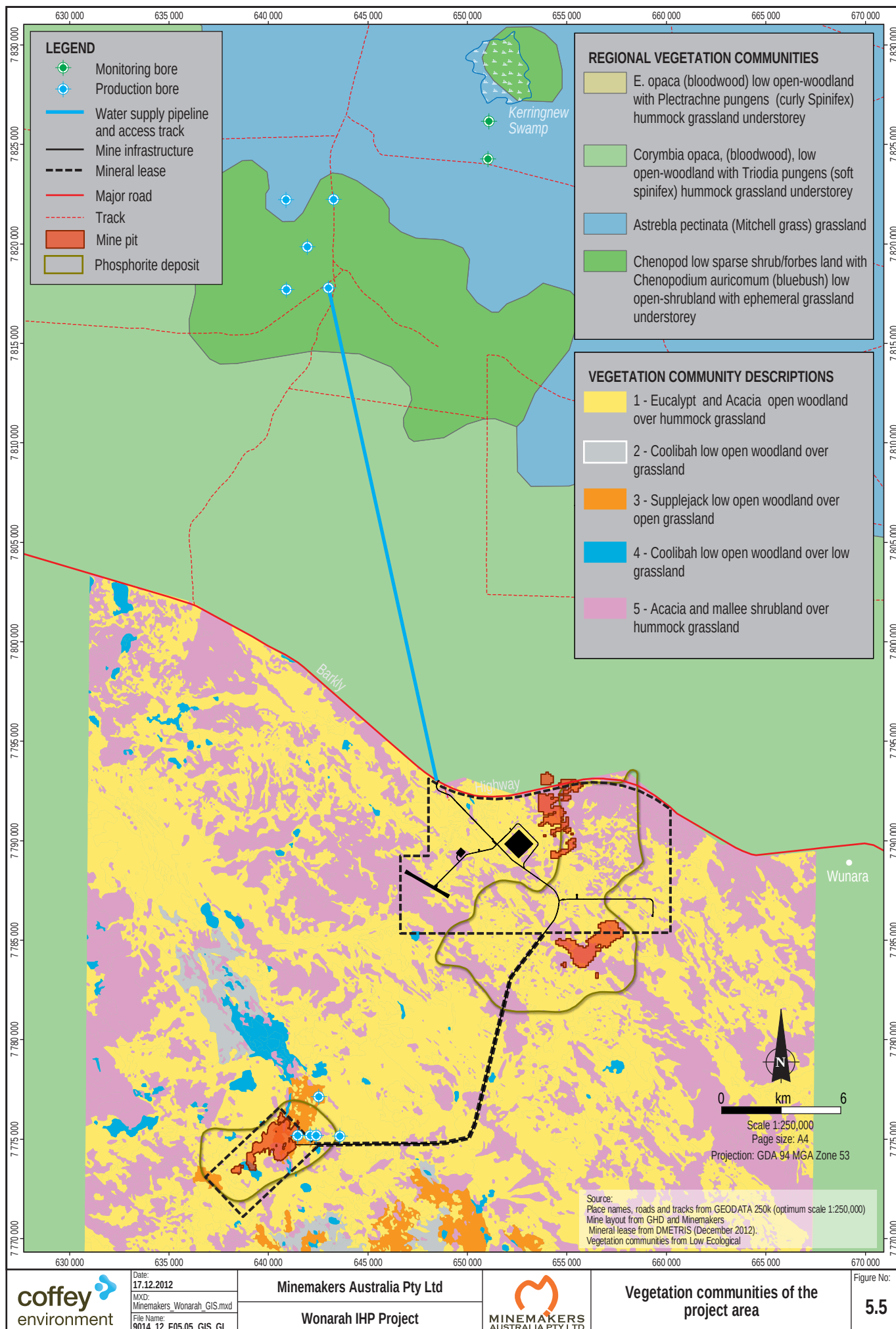
1. Low open woodland supporting *Corymbia opaca*, (bloodwood) with *Triodia pungens* (soft spinifex) hummock grassland understorey.
2. Low open shrubland supporting Chenopod with *Chenopodium auricomum* (bluebush) with ephemeral grassland understorey.
3. *Astrebla pectinata* (Mitchell grass) grassland.

These vegetation communities are widespread and common across the Davenport Murchinson Ranges bioregion.

Plant Species of Conservation Significance

No flora species of conservation significance listed under the EPBC Act were recorded in the project area, and none are considered likely to be present. A search of the NT Parks and Wildlife Flora Atlas (Appendices 3 and 4) identified six species listed as data deficient under the TPWC Act in the project area. One data deficient species was recorded during the field surveys that has not previously been recorded in the area, with a further two near threatened species recorded (Figure 5.6). These were:

- *Bergia barklyana*. Listed as near threatened. *B. barklyana* plants were recorded at one survey site within low lying alluvial sand plain supporting open eucalypt woodland over hummock grassland. Dominant species were coolibah and bloodwood over spinifex. This area is within an Indigenous cultural exclusion zone.
- *Bonomia alatisemina*. Listed as data deficient. A single plant has been recorded in the NT Parks and Wildlife Flora Atlas within Arruwurra deposit. No specimens were recorded during site surveys.
- *Distichostemon barklyanus*. Listed as data deficient. A single specimen of *D. barklyanus* has been recorded 10 km southeast of the Arruwurra deposit prior to the current surveys. No specimens were recorded during site surveys.
- *Heliotropium ballii*. Listed as data deficient. A search of the NT Parks and Wildlife Flora Atlas identified one record of *H. ballii* just inside of the main zone deposit, alongside the Barkly Highway. No specimens were recorded during site surveys.
- *Heliotropium pulvinum*. Listed as data deficient. The NT Parks and Wildlife Flora Atlas records eight specimens of *H. pulvinum* in the project area surrounds. Records are scattered around the area with the closest record along the Barkly Highway. The March 2009 survey identified specimens within the Acacia shrubland.



- *Hibiscus brachychlaenus*. Listed as near threatened. The March 2009 survey identified *H. brachychlaenus* plants within the Arruwurra deposit. Specimens were found within the Acacia shrubland vegetation community. This species has not been recorded in the area before.
- *Sporobolus latzii*. Listed as data deficient. One record of *S. latzii* is listed in the NT Parks and Wildlife Flora Atlas and this record is within an Indigenous cultural exclusion zone. This is the only known collection site of this species in Australia. Although targeted searches were performed as part of the surveys no specimens were identified.
- *Triumfetta deserticola*. Listed as data deficient. A single record of *T. deserticola* has been recorded within the proposed Arruwurra pit; however, no plants were recorded as part of the June 2008 or March 2009 surveys.

Weed Species

A baseline flora and fauna study conducted in 2009 identified five introduced flora species within the surrounding region and some of these could potentially occur in the project area.

An additional 10 introduced species that are of concern were identified in the bioregion. Many other introduced species could potentially occur, particularly as the project area is in close proximity to a major highway where vehicles are a major vector for weeds.

5.7.2 Potential Impacts

Vegetation will be cleared to accommodate project components such as access roads, aerodrome, pits, beneficiation and IHP plants and administration facilities. Potential, credible project-related impacts to flora are described below.

Reduced Species Abundance (Density and Diversity of Species)

Vegetation clearing will remove individual plants from the broader population of plants in and around areas affected by the project. Grazing by animals attracted to increased levels of surface water and vegetation growth may also reduce the distribution and density of preferentially grazed plants in the project area. This may reduce the number of species present, and reduce the distribution, dispersal and genetic diversity of species, in the region. This may also fragment and reduce the area of habitat available for dependent fauna species (the potential impacts of this are discussed in Section 5.8.2).

Significant Impacts to Threatened Species

Vegetation clearing may reduce the abundance of threatened species in the area of disturbance with consequent impacts to populations of threatened species at local, territory or national levels.

Reduced Conditions Favourable for Plant Growth

Health and growth of flora communities and species may be reduced by deposition of dust generated during construction and operation of the project. Physical effects include blockage and damage to stomata, and shading or abrasion of the leaf surface or cuticle. Vegetation clearing will result in soil previously covered by vegetation being no longer bound by roots and protected by vegetative matter, and therefore more prone to wind (and water) erosion. Disturbance of areas that are not naturally vegetated can also lead to increased erosion, as the protective surface crust or stones will be removed. Vehicle movements and day-to-day operational activities will also generate dust. Increased erosion and dust generation has the potential to reduce conditions favourable for plant growth, with subsequent reduced plant health. Compaction of disturbed ground, minor contamination of soil and physical damage to vegetation in the project area may

reduce the ability of plants to become established, and limit the potential for regeneration and revegetation of disturbed areas.

Increased Weed Density and Distribution

Vegetation clearing and movement of project-related vehicles, machinery and equipment (especially earth-moving equipment) has the potential to increase weed density and distribution by creating conditions favourable for the establishment of weed species and exclusion of native species.

Introduction of New Weed Species

Vegetation clearing and project-related vehicles, machinery and equipment (especially earth-moving equipment) have the potential to introduce and/or spread weed species within the project area, particularly via the import of seeds or vegetative matter from outside the project area. This may result in reduced flora species diversity and habitat in areas where weeds become established.

5.7.3 Mitigation and Management Measures

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on flora communities and species. These measures will reflect current good practice at similar mines operating in similar environments and are described below.

Reduced Species Abundance (Density and Diversity of Species)

Land clearing is recognised as a principal cause of biodiversity loss (DNRETAS, 2010b). Land clearing will be required as a result of the project; however, during the design phase Minemakers will minimise, where practical, the area of vegetation required to be cleared.

Other measures to avoid, mitigate and manage the risks associated with reduced species abundance include:

- Minimising the area of direct land clearing, and only clearing areas immediately prior to their development.
- Minimising the area of direct land clearing in areas sensitive to disturbance, such as erosion-sensitive soils and drainage lines.
- Ensuring the development and implementation of relevant clearance protocols.
- Restricting clearing activities to existing disturbed areas, where possible.
- Progressively rehabilitating disturbed areas, including mine pits, and avoiding unnecessary future disturbance of these areas.
- Ensuring vegetation debris (e.g., wood) on areas that do not require clearing is left in situ and not collected for firewood or other purposes.
- Minimising the potential for water to pool in areas where it is applied as a dust suppressant (e.g., along unsealed access roads) to reduce the attraction of grazing animals.
- Carrying out regular inspections and maintenance of water containers and pipes to reduce the attraction of grazing animals to the project area from leaks and subsequent vegetation growth.

Significant Impacts to Threatened Species

Along with measures to mitigate and manage the risks associated with reduced species abundance outlined above, measures specifically designed to avoid, minimise and manage significant impacts to threatened species include:

- Conducting walkovers of land to be cleared to identify plant species of conservation significance. If individuals are found, protocols will be followed to minimise the impacts to these plants.
- Continually monitoring low lying areas subject to inundation for the plant species *S. latzii*. If found, protocols will be followed to avoid and/or minimise the impacts to this species.
- Erecting flagging tape to mark 'no-go' zones to ensure areas to be protected are clearly defined, identified and avoided and that clearing and ground disturbance only occur within designated areas.
- Investigating the opportunities to use TWPC Act listed species known to occur in the region in rehabilitation.
- Avoiding the clearance of vegetation communities associated with ephemerals lakes, with such areas classified as 'no-go' areas and flagged accordingly.

Reduced Conditions Favourable for Plant Growth

Measures designed to avoid, minimise and manage the risks associated with increased rates of erosion and dust generation are outlined in Sections 5.5.3 and 5.2.3, respectively.

Increased Weed Density and Distribution

Measures designed to avoid, minimise and manage the risks associated with weed infestation as a result of the project include:

- Minimising the area of vegetation to be cleared.
- Using targeted weed control measures for any observed significant increase in the distribution or density of existing weeds, particularly buffel grass.
- Regularly monitoring areas with a high potential for, or susceptibility to, weed invasion, such as along roadsides and recently cleared areas.
- Controlling and/or preventing weed infestations in topsoil stockpiles to minimise the likelihood of weed introduction during respreading of topsoil.
- Instigating the ongoing rehabilitation of disturbed areas to reduce the potential for weed species to become established.
- Liaising with government agencies on appropriate measures to eradicate or control weed outbreaks, should they occur.

Introduction of New Weed Species

Along with the management measures to reduce the density and distribution of weed species outlined above, measures designed to avoid, minimise and manage the risks associated with the introduction of new weed species to the project area include:

- Ensuring that vehicles and project equipment arrive on site clean and free of vegetative matter, seeds and mud.

- Focussing on the control of declared weed species present in and around the project area, and preventing their spread during the life of the project.
- Using targeted weed control measures for new populations of weeds identified in previously uninfested areas.

5.7.4 Residual Risk

Table 5.9 summarises the residual impacts of the project to flora, considers the likelihood and consequences of the impacts (taking into account proposed management measures) and provides an overall risk rating for each potential impact. These are discussed in detail below.

Table 5.9 Summary of impacts and risks to flora

Impact	Likelihood	Consequence	Residual risk
Reduced species abundance.	Unlikely	Insignificant	Low
Significant impacts to threatened species.	Unlikely	Moderate	Moderate
Reduced conditions favourable for plant growth due to dust.	Likely	Insignificant	Moderate
Reduced conditions favourable for plant growth due to disturbance.	Unlikely	Insignificant	Low
Increased weed density and distribution.	Unlikely	Moderate	Moderate
Introduction of new weed species.	Unlikely	Moderate	Moderate

Reduced Species Abundance

Locating some project components in areas that are currently vegetated and must be cleared is unavoidable, with the area to be cleared totalling approximately 2,619 ha (see Section 2.4).

While the diversity of species may remain the same following vegetation clearing, the density of individual plants will reduce in the short term. However, progressive rehabilitation will enable Minemakers to identify and refine successful rehabilitation techniques throughout the life of the mine, making the likelihood of a long term reduction in species diversity **unlikely**.

The attraction of grazing animals to the project area will be prevented wherever possible and undertaken in accordance with the mitigation and management measures outlined above. The area will be actively managed to prevent overgrazing from native and introduced fauna (e.g., kangaroos or camels). Increased grazing impacts as a result of the project are therefore expected to be **unlikely**.

Long term consequences of reduced species abundance in the project area are **unlikely**; impacts will be relatively restricted, both spatially and temporally. The composition of flora species in these areas comprises species common across the region. Natural regeneration of vegetation, and progressive rehabilitation, will at least partially compensate for vegetation lost during clearing.

At a vegetation community level, vegetation clearing is expected to have an **insignificant** effect on the abundance, diversity, geographic distribution and productivity of flora in the region. No long-term changes in habitat are expected as a result of the project. The removal and/or fragmentation of vegetation communities associated with the ephemeral lakes (community 4) will be avoided. The vegetation groups and habitat present in the project area are widespread, and are known to be present in surrounding areas of the region with similar topography to that of the project area (Appendices 3 and 4).

The residual risk is therefore **low**.

Significant Impacts to Threatened Species

The approximate 2,619 ha of land to be cleared to accommodate project components has been found to support near threatened species listed under the TPWC Act. The area may potentially contain further threatened species that have not yet been located; however, it is unlikely that, were these species found to be present, project-related disturbance will result in significant impacts at a local level. Any impacts that did result would be insignificant at a regional, territory and national scale.

No flora species of high conservation value have been identified in the project area and most plants and communities are widespread in the region. The near threatened (TPWC Act) *Hibiscus brachychlaenus* was identified in the Arruwurra deposit, and *Bergia barklyana* in an Indigenous cultural exclusion zone (community 4). No vegetation from community 4 will be cleared for the project as it is located within an Indigenous cultural exclusion zone. All habitat types to be disturbed by the project are common in the region and any impact to threatened species will be limited, therefore the likelihood of significant impacts is **unlikely**.

One threatened species (*S. latzii*) could potentially be impacted by the project and is known to occur in a very specific habitat which covers a small area adjoining the Mineral Lease. A single record of *S. latzii* exists within an Indigenous cultural exclusion zone, although on-site surveys were unable to confirm its presence despite targeted searches for this species. All cultural exclusion areas are outside the project area and no project-related disturbance will occur within the Indigenous cultural exclusion areas. However, Minemakers will continue to monitor low lying inundated areas within the project area for the presence of *S. latzii*. As a result, there is little potential for the project to result in a significant change to the presence or abundance of this species.

Natural regeneration of vegetation, and progressive rehabilitation targeted to provide conditions favourable for the regeneration of threatened species, will compensate for any threatened species that may be inadvertently cleared.

Should it occur the consequence of significant impacts to threatened species is considered **moderate**. The provision of environmental benefits measures will provide compensation for any reduced abundance of threatened species in the project area, and will further mitigate the likelihood of significant impacts to threatened species occurring.

Given this moderate consequence and unlikely likelihood, the residual risk is **moderate**.

Reduced Conditions Favourable for Plant Growth Due to Dust

Dust suppression measures, such as water trucks, will be used throughout the life of the mine to minimise dust emissions (see Section 2.2). However, given the nature of construction and operations activities and the semi-arid environment, some dust generation is **likely**, which is likely to contribute to reduced conditions for plant growth.

The effect of reduced conditions favourable for plant growth is **insignificant**, although there is variation in the ability of different species to withstand dust deposition. Increased wind erosion and dust is not likely to lead to long term changes in flora composition, as impacts are likely to be localised in nature and able to be rehabilitated.

The residual risk is therefore **moderate**.

Reduced Conditions Favourable for Plant Growth Due to Disturbance

Given the design of the project and the nature of construction and operations activities and management and mitigation measures, it is **unlikely** that disturbance will reduce conditions favourable for plant growth beyond the immediate footprint. The effect of reduced conditions favourable for plant growth is **insignificant**. Impacts will be localised in nature, and able to be rehabilitated both progressively and following project completion. The residual risk is therefore **low**.

Increased Weed Density and Distribution Due to Disturbance

Weed management measures outlined in Section 5.7.3, such as minimising the area of vegetation disturbed, and regularly monitoring and promptly controlling any outbreaks of weed infestation, will reduce the likelihood for significant increases in the density and distribution of weeds. As a result, it is **unlikely** that the project will result in increased densities and distribution of weed species.

However, should it occur, the potential consequence of increased weed density and distribution as a result of the project is **moderate**. Weeds have the potential to change the composition and abundance of native vegetation communities, and rehabilitation of areas infested by weeds can be difficult. The residual risk is therefore **moderate**.

Introduction of New Weed Species

Measures to prevent the introduction of new weed species, and limit their potential to become established if present, will ensure that it is **unlikely** that new weed species will present a threat to the native flora of the region. However, if new weed species do become established as a result of the project, then the potential consequence is **moderate**. The residual risk is therefore **moderate**.

5.7.5 Monitoring Program

Ongoing vegetation monitoring will be conducted to allow identification of any impacts of mine construction and operations on flora. Monitoring will be conducted in vegetation communities identified during the baseline survey and any new areas as considered appropriate.

Monitoring sites will be visually inspected and photographed to allow assessment of:

- Changes in the abundance, composition or condition of vegetation communities, particularly threatened vegetation communities.
- Ongoing impacts to flora as a result of project-related activities.
- Increases in the density and distribution of known weed infestations.
- Introduction of new weed species.
- Accumulation of litter.

Transects will be used to allow the comparison of quantitative data on shrub numbers in the different vegetation communities, and between near-mine and control sites.

Vegetation monitoring will be timed as follows:

- Biennially during construction and operations. To ensure that the maximum number of species is recorded, vegetation monitoring will occur during both the wet and dry season.
- Post-closure of the operations until completion criteria are met.

Weed Monitoring

Minemakers will ensure that all vehicles and plant brought to the mine or transferred between properties are visually inspected to check they are free of mud, seeds and other plant material. Areas with a high potential for, or susceptibility to, invasion by pest plants, such as along roadsides and recently cleared areas, will be monitored biannually (with a focus on after rain events) or after disturbance events such as clearing.

Monitoring for pest plants will include:

- Inspecting for pest plant outbreaks after the wet season and opportunistically after rain events and recording the size of infestations and the control treatment applied.
- Inspecting for pest plants after significant germination events and recording of level of pest plant invasion.

Vegetation Clearance Monitoring

All areas to be cleared for project purposes will be documented recording the area and nature of the vegetation cleared. Each area cleared will be inspected to ensure that clearance is conducted in accordance with the conditions of the Mineral Lease and Mining Management Plan.

5.8 Fauna

5.8.1 Existing Environment

The characterisation of fauna species and habitat types in the project area and surrounds is based on fauna surveys completed by Low Ecological Services Pty Ltd in June 2008 and March 2009 (Appendix 3). The site surveys build on a desktop survey completed before on-site visits. Records of previously observed fauna within a 20 km radius of the project area (hereafter referred to as the 'project surrounds') were obtained from a protected matters report generated from the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) website and the NT Parks and Wildlife Fauna Atlas. A further desktop survey of the northern borefield and associated water supply pipeline route was carried out by Low Ecological Services Pty Ltd in October 2009 (Appendix 4).

Further surveys will be completed during the EIS for the project, targeting the presence/absence of the fauna species of conservation significance discussed in this section.

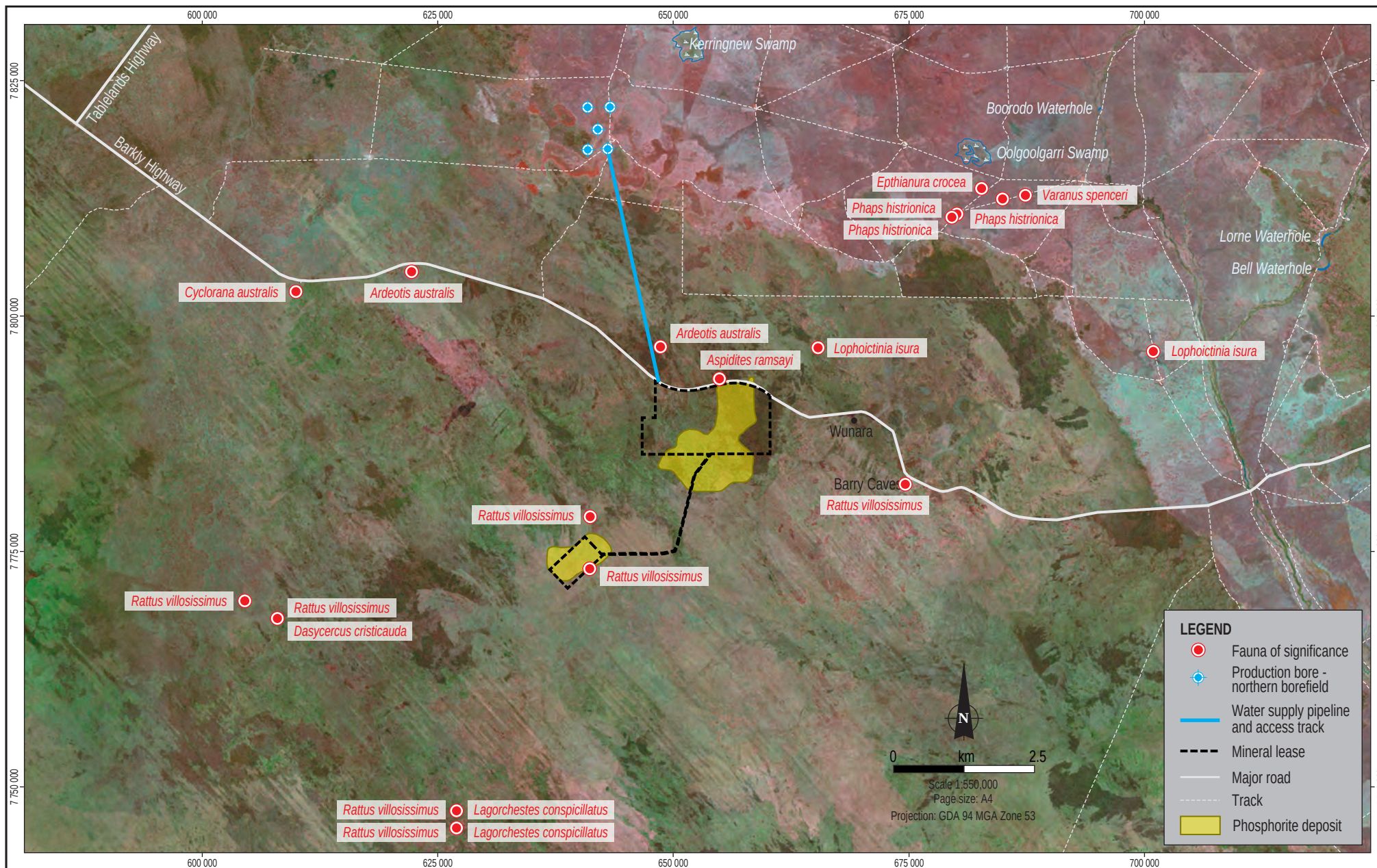
Eight species listed under the TPWC Act have been recorded within the project surrounds; two species (both listed as near threatened) have been recorded in the project area, *Rattus villosissimus* (long haired rat) and *Aspidites ramsayi* (woma) (Figure 5.7).

Field surveys identified no habitats of ecological importance.

Two species of conservation significance were recorded during the field surveys, *Ardeotis Australia* (Australian bustard) (listed as vulnerable under the TPWC Act) and *Onychogalea unguifera* (northern nail-tailed wallaby) (listed as near threatened under the TPWC Act).

Birds

A total of 31 bird species were identified during the field surveys (see Appendix A003 for a complete description). One species, *Ardeotis australis* (Australian bustard), listed as vulnerable under the TPWC Act, was recorded within the low lying sand plain characterised by low open woodland vegetation.



Source:
Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000).
Bore locations from GMP.
Fauna data from Low Ecological.
Mine layout from GHD and Minemakers.
Mineral lease from DMETIS (December 2012).

coffey
environment

Date:
17.12.2012
MXD:
9014MM_22_GIS006_v1_1
File Name:
9014_22_F05.07_GIS_HB

Minemakers Australia Pty Ltd
Wonarah IHP Project

MINEMAKERS
AUSTRALIA PTY LTD

**Threatened fauna in the project area
and surrounds**

Figure No:
5.7

Ninety species have previously been recorded in the project surrounds and it is expected that these species would be present in the project area from time to time. The sand plain vegetation communities (see Figure 5.5) are likely to support the highest avian diversity in the project area due to the diverse and dense nature of the habitat.

In general, ephemeral areas are likely to be important to migratory species listed under the EPBC Act during the wet season. An ephemeral swamp is located approximately 15 km to the northwest of the Arruwurra deposit, and may offer suitable habitat during periods of high rainfall. However, the lake is situated within a cultural exclusion zone and will not be disturbed during project operations. Another ephemeral swamp, Kerringnew Swamp, is located approximately 10 km northeast of the northern borefield. The habitat requirements of migratory species and lack of suitable ephemeral water bodies within the project area makes the ongoing presence of these migratory species unlikely.

Reptiles and Amphibians

No amphibian species were recorded during field surveys. One species, listed as data deficient under the TPWC Act, *Cyclorana australis* (northern snapping frog), has previously been recorded approximately 40 km northwest of the Main Zone deposit. A further two species, not of listed conservation significance; have been recorded in the project area.

A total of 11 reptile species were identified during the field surveys (see Appendix A003 for a complete description). No species of conservation significance listed under the EPBC Act or TPWC Act were recorded during the survey period; however, many tracks were unable to be identified to a species level. Within the surrounding region 50 species have previously been recorded and habitat within the project area is suitable for many, and their presence in the project area is possible.

A search of the NT Parks and Wildlife Fauna Atlas identified two reptile species of conservation significance within the project area and surrounds:

- *Aspidites ramsayi* (woma). Listed as near threatened under the TPWC Act. Previously recorded on the northern side of the Barkly Highway, just north of the Main Zone deposit. The woma is large python which inhabits subtropical to temperate deserts, sand plains and dunefields and cracking clays in semi-arid environments. Habitat includes woodlands, shrublands and grasslands, feeding on lizards, snakes, birds and small mammals (DEH, 2012).
- *Varanus spenceri* (Spencers monitor). Listed as data deficient under the TPWC Act. Previously recorded 40 km northeast of the Main Zone deposit.

One amphibian species listed as data deficient, *Cyclorana australis* (northern snapping frog), has previously been recorded approximately 40 km northwest of the Main Zone deposit. This burrowing frog lives in coastal floodplains, woodlands and grasslands.

Mammals

No bats were recorded as part of the surveys due to equipment failure. Microchiropteran bats were observed in flight at dusk during the survey; however, no species of conservation significance have been recorded in the project area or surrounds. One species of bat, *Saccolaimus flaviventris* (yellow bellied sheath tailed bat), has previously been recorded in the project surrounds.

A total of 10 native mammal species were recorded during the field surveys (see Appendix 3 for a complete description). One species, *Onycholagea unguifera* (northern nail-tailed wallaby), listed

as near threatened under the TPWC Act, was recorded during the March 2009 survey. No species listed under the EPBC Act were recorded during the fauna surveys.

An additional seven mammal species were identified in the NT Parks and Wildlife Fauna Atlas as being previously recorded in the project surrounds:

- *Dasyercus cristicauda* (mulgara).
- *Largorcheses conspicillatus* (spectacled hare wallaby).
- *Leggadina forresti* (Forrest's mouse).
- *Macrotis lagotis* (bilby).
- *Planigale ingrami* (long-tailed planigale).
- *Sminthopsis macroura* (striped face dunnart).

All these species are classified as of least concern in the Northern Territory.

The TPWC Act listed species *Onycholeale ungifera* (northern nail-tailed wallaby) was recorded during the March 2009 survey. Listed as near threatened, the northern nail-tailed wallaby is generally scarce and patchily distributed over the northern Australian coast, extending several hundred kilometres. The preferred habitat of this species is open woodlands, grasslands, shrubby savannah and usually near water. It particularly favours the blacksoil plains with tussock grasslands such as those found in the Barkley Tablelands. Within central Northern Territory it is also found in coolibah open woodlands and tall shrublands. These habitats are widespread and common throughout the Barkly Tablelands.

Four species of conservation significance have been previously recorded in the project surrounds. Of these, two species, *Dasyercus cristicauda* (mulgara) and *Macrotis lagotis* (bilby) are listed as vulnerable under the EPBC Act. A further two species are listed as near threatened under the TPWC Act, *Largorcheses conspicillatus* (spectacled hair wallaby) and *Rattus villosissimus* (long-haired rat).

Rattus villosissimus was previously recorded a number of times in the project surrounds and there are two records within the project area, on the boundary of the Mineral Lease at the Arruwurra deposit, and within the ephemeral lake in the cultural exclusion zone.

Habitat for *Dasyercus cristicauda*, *Macrotis lagotis* and *Largorcheses conspicillatus* exists within the project area:

- *Dasyercus cristicauda*. Suitable habitat for this species is present within and surrounding the project area. Mulgaras have not been recorded in the project area and there is no evidence (i.e., burrows) of a population being present despite targeted searches for this species. Mulgara were recorded 40 km west-southwest of the project area in 1993.
- *Macrotis lagotis*. The bilby previously occupied a large area of arid and semi-arid Australia; however, the distribution has declined significantly since European settlement and now occupies 20% of its former range. Broad-scale surveys of bilbies in the Northern Territory in the 1990s indicated that laterite and drainage line land systems were occupied more frequently than sand plain and dune systems, which is the dominant system of the project area.
- *Largorcheses conspicillatus*. Although considered widespread in the Northern Territory, the spectacled hare wallaby has disappeared from the southern part of its range, contracting 200 km northward. The species inhabits a variety of habitats including open forests and woodlands, tall shrublands, and hummock and tussock grasslands, these habitats are widespread throughout the Barkly Tablelands.

Fauna of Indigenous Conservation Significance

Traditional Owners identified local fauna of cultural significance for their utilitarian values. Larger fauna species such as kangaroo, Australian bustard, sand goanna and other large dragons are still hunted by the Traditional Owners. The ephemeral lakes within the cultural exclusion zones are considered as an important hunting ground as they provide seasonal refuge to larger species. The Traditional Owners consulted during the March 2009 survey identified no species of mythical significance.

Introduced Fauna

Five introduced fauna were recorded within the project area during on-site surveys. Three herbivore species were recorded, *Camelus dromedarius* (camel), *Bos taurus* (cow), and *Equus asinus* (donkey). Two carnivorous species were recorded in the project area, *Felis catus* (cat) and *Vulpes vulpes* (fox). Traces of cats and foxes were recorded along exploration tracks, and it is not uncommon for these species to use tracks for access into new areas. Numbers of records of this species were low, indicating they are in low abundance in the area.

5.8.2 Potential Impacts

Native bird, reptile and mammal species, including some species of conservation significance, may be affected by the project. Vegetation clearing and ground disturbance during construction has the potential to reduce areas of habitat and resources within the project area. Potential, credible project-related impacts to fauna are described below.

Reduced Species Abundance (Density and Diversity of Species)

There is potential for species abundance to be reduced as a result of:

- *Vegetation clearing and ground disturbance.* Vegetation clearing and ground disturbance will remove fauna habitat, reduce resources for fauna species resident within the project area and increase inter- and intra-specific competition for food and habitat, with potential changes in the abundance of native fauna species in the fauna area.
- *Noise, light and vibration.* Project construction and operations will create noise, light and vibration emissions, typically generated by vehicle traffic, excavations, blasting and ore processing.
- *Surface water contamination.* Waterbodies established as part of the project (e.g., sediment ponds) may attract waterbirds to the area. There is the potential for adverse impacts to visiting waterbirds if these waterbodies are contaminated.

Significant Impacts to Threatened Species

Ground disturbance (including mining) and vegetation clearing, in particular the clearing of particularly high quality habitat, may reduce the abundance of threatened animal species in the project area. This may result in significant impacts to resident threatened species at a local, regional, territory or national level, if there is a lack of other suitable habitat surrounding the project area or if the project area supports a significant population of a threatened species.

Increased Abundance of Introduced Species

Project construction and operations have the potential to create conditions favourable for increased abundances of introduced species such as foxes, cats, camels, donkeys and camels that are currently present in low densities across the project area.

The construction of waterbodies and presence of domestic waste near the administration and accommodation facilities may provide food and shelter for these species. If not properly controlled, there is the potential for the populations of introduced species to increase as a result of these additional resources.

Increased abundance of introduced foxes and cats is likely to increase predation pressure on native bird, reptile and mammal species, leading to a reduction in their population size.

5.8.3 Avoidance, Mitigation and Management

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on fauna. These measures will reflect current good practice at similar mines operating in similar environments and include site and species specific measures. These measures are described below.

Reduced Species Abundance

During the design phase the project footprint has been minimised and located to avoid disturbance to significant habitats where practical. Other measures to avoid, mitigate and manage the risks associated with habitat removal or change include (see also Section 5.7.3):

- Minimising and consolidating areas of vegetation to be cleared for access tracks and infrastructure pathways so that large blocks of habitat, rather than small fragments, are preserved.
- Rehabilitating cleared land both progressively during the life of the project and following project completion.
- Regularly inspecting potential 'fauna traps' such as temporary trenches required during construction.

Measures designed to avoid, mitigate and manage the risks associated with increased levels of noise and vibration are outlined in Section 5.4. Those measures specific to fauna include:

- Locating noisy and illuminated infrastructure (e.g., crushing and scrubbing plant) close together to localise areas affected by noise and light from equipment.
- Where possible, locating vehicle and machinery access roads outside high-quality habitat to minimise the potential for disturbance to resident fauna.
- Limiting the number of roads constructed in the project area.
- Blasting during the day to minimise the potential for disturbance to nocturnal species such as the dunnarts which forage at night and bird and mammal species particularly active at dawn and dusk.

Following significant rainfall, surface runoff may contain sediment and metal concentrations that have the potential to be toxic to wildlife. However, geochemical analysis has revealed high levels of metals or toxins in sedimentation is unlikely (Appendix 1). Surface water management measures are detailed in Section 5.10; however, management and mitigation measures specific to fauna include:

- Sediment release and erosion control measures to minimise the release of sediment to the receiving surface water environment.

- Rehabilitation of disturbed areas progressively once areas are no longer required for mining, where possible.
- Containment and reuse of all potentially contaminated waters in the project area (except during extreme rainfall events), thereby minimising the potential for discharge of contaminated water to surrounding surface water.

Other measures such as netting of the water storages or the use of passive deterrent devices will be considered if the water storages are shown to contain toxic levels of contaminants and are attracting fauna.

Threatened Species

A fauna management plan, which incorporates mitigation measures such as relocation of resident species from areas to be disturbed, is provided in Attachment C. To mitigate impacts to significant fauna the following techniques will be implemented:

- Undertaking a walk over survey of all areas to be disturbed prior to commencement of works to locate the presence of any significant species. Rescue and relocation protocols will be developed in consultation with NT National Parks and Wildlife Service and/or Department of Land Resource Management (DLRM).
- Monitoring programs to establish the presence of any significant species and any impacts upon them.
- Training of key staff in the identification of significant species and any traces left by them.
- Managing pest species and native predators (i.e., dingo).

Management protocols will be reviewed if any additional significant species or known locations are identified so that any impacts upon them can be assessed and minimised.

Increased Abundance of Introduced Species

Measures designed to manage and mitigate the risks associated with an increased abundance of introduced species include:

- Controlling existing feral animal populations outlined in the flora and fauna management plan.
- Targeting new populations, or significant increases in the current population, of foxes and/or feral cats.
- Ensuring that waste management procedures (see Attachment C) are diligently followed to reduce potential resources for these species.
- Regularly monitoring areas with a high potential for, or susceptibility to, increases in abundance of introduced species (e.g., administration and plant facilities, waste storage areas and around water sources).

5.8.4 Residual Impact

Table 5.10 summarises the residual impacts of the project to fauna, considers the likelihood and consequences of the impacts (taking into account proposed management measures), and provides an overall risk rating for each potential impact. These are discussed in detail below.

Table 5.10 Summary of impacts to fauna

Impact	Likelihood	Consequence	Residual Risk
Reduced species abundance in the long term.	Unlikely	Minor	Low
Significant impacts to threatened species.	Unlikely	Minor	Low
Increased abundance of introduced species.	Unlikely	Moderate	Moderate

Reduced Species Abundance

The project's footprint is approximately 2,619 ha, with some of the project components being unavoidably located in areas that currently provide habitat for a range of bird, reptile and mammal species. As a result of vegetation clearing, that habitat will be lost during the life of the project and fauna may be forced out of the area or die. Fauna may also move out of the immediate vicinity of the mine due to noise, light, dust and vibration emissions. Therefore, it is almost certain that the abundance of fauna species present in the project area and surrounds will be reduced for the life of the project. However, due to the abundance of similar flora communities and habitat surrounding the project area (see Section 5.7.4) and the progressive rehabilitation of some mining pits, these impacts are **unlikely** to impact on fauna communities in the long term.

At a community level, the loss of habitat is expected to have a **minor** effect on the abundance, diversity, geographic distribution and viability of native fauna populations. All reptile and mammal species and the majority of bird species recorded during the surveys are relatively common in the Barkly Tableland. Animals able to relocate prior to clearing will not be significantly affected by project activities, and none of the project infrastructure will encircle habitats and prevent fauna from moving between habitat areas.

The location of project infrastructure away from areas of high quality habitat will minimise the potential for impacts to fauna due to disturbance, although some disturbance is inevitable. Noise, vibration and dust due to vehicle traffic, blasting, excavations and ore crushing and screening in the project area are likely to disturb fauna. The louder and longer the duration of the noise and vibration, the greater the impact will be on species present. Species sensitive to disturbance by noise, vibration and light are likely to relocate to other suitable habitat in the project area or surrounds. There is the potential that in time, fauna in the project area may become tolerant to disturbance and re-colonise habitat previously vacated. This is likely to occur after construction of the project is complete. Should this occur, the residual risk to fauna may decrease.

The consequence of reduced species abundance in the project area is **minor**. Impacts are not expected to result in significant long-term changes to fauna composition in the region. Natural regeneration of vegetation, and ultimately rehabilitation, will at least partially compensate for habitat removed during clearing. The environmental benefits for the project such as control of introduced species and increased habitat complexity will also assist in the mitigation of impacts associated with native vegetation clearing. The regeneration of habitat will allow for the re-colonisation of disturbed areas by native fauna species following project closure. It is expected that, if carefully managed over time, the rehabilitated areas will provide similar and/or better habitat to that present prior to clearing.

Given the unlikely likelihood that this impact will occur over the long term, and the minor consequence of such an impact, the residual risk is **low**.

Significant Impacts to Threatened Species

Species Known to be Present

The project is **unlikely** to significantly impact on the two TPWC Act listed species known to be present in the project area:

- Australian bustard (*Ardeotis australis*). While the species is relatively scarce in the Northern Territory it is known to occur within the project area. Numbers of the species are likely to fluctuate depending on seasons, and due to the highly mobile nature of the species and widespread availability of habitat, small, localised disturbance is not likely to affect its conservation status.
- Northern nail-tailed wallaby (*Onycholalea ungifera*). This species is unlikely to be impacted by the project due to its ability to move into other suitable surrounding habitat.

Species Potentially Present

Ten EPBC Act listed species have the potential to exist in the project area; however, significant long term impacts upon those species are **unlikely**. The predicted residual risk to two of them, the mulgara and the bilby, are discussed below.

Mulgara (Dasycercus cristicauda)

Suitable habitat for this species is present within and surrounding the project area; however, mulgara have not been recorded in the project area and there is no evidence (i.e., burrows) of a population being present. The mulgara may be present within suitable habitat in the project area, and could be disturbed during construction and operation activities. However, any impacts to this species, should they occur, are not predicted to be significant given:

- Critical habitat and populations of the mulgara are yet to be investigated but there is no evidence of the species being present within the project area, indicating that significant populations are unlikely to be present. As such it is unlikely that any mining activities will affect a significant habitat or significant population of this species.
- Any habitat disturbed during construction and operation of the project will be minor in the context of the extensive areas of similar suitable habitat across the Barkly Tablelands. Further, the proposed method of backfilling, where possible, lends itself to progressive rehabilitation of disturbed areas, minimising the period of time between ground disturbance and re-establishment of habitat.
- Predation of the mulgara by foxes and cats and competition pressure by introduced grazers are suspected of significantly impacting on mulgara populations. Foxes, cats and dingoes, rabbits and cattle have been recorded in the project area. This project is unlikely to see the introduction of any further pest species that could potentially impact on mulgara, if present. Conversely, control of feral animals in the project area and surrounds may reduce local hunting pressure on this species.

Bilby (Macrotis lagotis)

Broadscale surveys of bilbies in the Northern Territory in the 1990s indicated that laterite and drainage line land systems were occupied more frequently than sand plain and dune systems. It is unlikely that the project will have any significant impacts on the bilby because:

- The project area does not cover any critical habitat for the bilby identified in the Bilby Recovery Plan (Pavey, 2006) and it is unlikely that an important population falls within the project area. Although there is suitable habitat within the project area, the Bilby Recovery Plan considers

the Tanami desert bioregion (west of the Stuart Highway) and the northern Great Sandy Desert bioregion as containing critical habitat and populations of the bilby. The project area does not encompass and will have no effect on these bioregions.

- It is unlikely that the project will in any way adversely affect the availability or quality of habitat to the extent that it will cause a further decline of the bilby. The habitat is not critical and the proposed method of backfilling pits, where possible, lends itself to progressive rehabilitation of disturbed areas.
- The project is unlikely to result in the introduction of invasive species. The major threats to the bilby across the Northern Territory are predation by foxes, cats and dingoes and competition with introduced grazers for food resources. All of these introduced pests are already present in the project area and this project will not introduce any new invasive species harmful to the bilby. All existing feral populations will be controlled through pest management measures.

Increased Abundance of Introduced Species

Introduced species are already present in the project area in relatively low densities. The fox and cat are listed as key threatening processes under Section 3 of the EPBC Act, with the impact to bird, reptile and mammal species as a result of predation by foxes and cats being of particular concern. Management and mitigation measures outlined in Section 5.8.3 will provide for the control of introduced species and it is **unlikely** that the density and distribution of these species in the project area will increase as a result of project activities.

The consequence of an increased abundance of introduced species, and in particular foxes and cats, is **moderate** given numbers are currently low and both the fox and cat are considered to be a key threatening process to Australia's biodiversity. As a result of this, and the possible likelihood of it occurring, the residual risk is **moderate**.

The strict implementation of control measures outlined in Section 5.8.3 during construction and operation of the project may lower populations of introduced animals in the project area and surrounds.

5.8.5 Monitoring Program

Fauna monitoring will involve fauna surveys and targeted counts for threatened species at selected sites to allow assessment of:

- Changes in the abundance, composition or condition of fauna species, particularly threatened species.
- Ongoing impacts to fauna as a result of project-related activities.
- Success of rehabilitation activities for threatened species.
- Increases in the density and distribution of pest animal infestations.
- Introduction of new pest animal species.
- Diversity and health of any waterbirds present in the project area.

Survey methods may include visual observations, spotlighting, bird census transects, trapping and active searching.

5.9 Groundwater

5.9.1 Existing Environment

The project occurs within the central portion of the Georgina Basin and the Barkly Tablelands. The Georgina Basin is a large sedimentary basin covering most of the central-eastern Northern Territory and extends into western Queensland (DME, 2012b). A number of water resource studies have been undertaken within the Georgina Basin to identify suitable groundwater resources for domestic and agricultural use. The main aquifers on the Barkly Tableland have been used to provide domestic and stock water across the tableland for nearly a century.

Groundwater recharge is predominantly from rainfall infiltration. Recharge from surface water will occur locally in the vicinity of the major rivers and, after rainfall events, from minor watercourses and marshy areas.

Groundwater levels in the region are extremely variable, ranging from about 25 to over 100 m below ground level (bgl). While the regional groundwater flow regime is poorly understood, it is thought that there may be a north-south groundwater divide along latitude 20°S, with groundwater south of this parallel flowing to the southeast and groundwater north of the parallel flowing to the northeast and discharging to the Gregory River.

In 2009 and 2010, Minemakers undertook a drilling program encompassing the construction of four production bores and six monitoring bores (Figure 5.8). In the area north of the Mineral Lease groundwater levels are reasonably consistent, lying between 49 to 51 m bgl, and falling to about 65 m bgl towards the north of the Mineral Lease. This consistency indicates the presence of a well-connected aquifer system within the cavernous and weathered dolomite.

Groundwater levels in the Mineral Lease are more variable and range from around 3 m to 103 m. This variability in groundwater level suggests a heterogeneous groundwater system, with poor hydraulic connections between aquifers. Watertable levels are below the base of the ore across the deposits, with the exception of a few isolated locations that show evidence of minor or perched waterbodies. Within the Main Zone, groundwater levels varied from about 3 to 63 m bgl. Two of the areas surveyed had groundwater levels above the average pit depth (50 m bgl), which were found to be blocked just below the measured water level. It is therefore almost certain the elevated levels in these holes are atypical and probably reflect a shallow, isolated and perched groundwater body. Similarly at Arruwurra, four holes where groundwater was encountered were blocked just below the recorded groundwater level. The depth of the ore zone in one of the remaining three wet holes was found to lie well below the measured water level. The reason for the anomalous levels is not known, but it is expected to be localised.

Groundwater Users

Ten existing boreholes lie within the vicinity of the Mineral Lease, all located along the Barkly Highway. Seven of these boreholes were installed by the Northern Territory Government for construction and maintenance of the highway. An additional six existing boreholes lie within a 10 km radius of the northern borefield; these bores were installed by Dalmore Downs Station for stock watering purposes. Table 5.11 details all third party bores within or surrounding the project area.

The majority of the existing bores have not been test pumped, preventing reliable estimates of aquifer yields. However, historical airlift testing suggests rates of over 5 L/s are common and in some instances rates over 100 L/s have been reported.

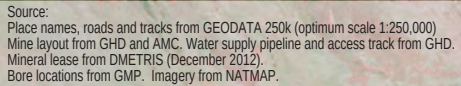


Table 5.11 Third party bores in the project area

Registered Bore Number (RN number)	Bore name	Location MGA Zone 53		Depth (m)	Date Installed	Status	Yield (L/s)
		(mE)	(mN)				
RN000031	4A-132 Barkly Highway	636,226	7,801,919	92.9	ND	ND	0.39
RN000301	3A-128 Mile Barkly Highway	641,726	7,798,919	60.9	ND	Not in use	ND
RN000302	2A-128 Mile Barkly Highway	641,726	7,798,919	ND	ND	Not in use	ND
RN000370	1A-124 Mile Barkly Highway	646,126	7,794,869	ND	ND	Not in use	ND
RN001237	No 2 Eagles Nest, Dalmore Downs Station	643,850	7,818,572	81.7	1950	ND	2.6
RN001238	No 3 Blue Bush, Dalmore Downs Station	634,207	7,815,614	88	1951	ND	2.6
RN001778	Wonarah repeater station, Barkly Highway	640,212	7,799,448	111.5	1958	ND	0.68
RN004087	No 11 Alroy Downs Station	634,526	7,825,369	71	1963	ND	2.86
RN006751	No 11 Dalmore Downs Station	634,571	7,825,132	94.5	1970	ND	3
RN020997	81/1 Barry Caves West, Dalmore Downs Station	648,937	7,792,271	ND	1981	ND	0.4
RN020998	81/2 Barry Caves West, Dalmore Downs Station	646,026	7,794,669	125	1981	ND	0.25
RN021238	81/3 Barkly Highway Barry Caves West	653,526	7,792,769	145	1981	ND	0.38
RN021239	81/4 Barkly Highway Barry Caves West	652,227	7,795,886	76	1981	Not in use	ND
RN021245	81/5 Barkly Highway Barry Caves West	640,230	7,799,600	134	1981	ND	1.9
RN025678	No 10A 88/37 Dalmore	645,306	7,825,367	140	1988	ND	5
RN025874	No 10 Dalmore Downs Station	645,320	7,825,391	135.6	1971	ND	1.4

Note: ND = Not determined

Groundwater Quality

Groundwater quality over the Barkly Tableland is generally fresh to brackish (Appendix 5), ranging from 500 to 4,000 mg/L total dissolved solids (TDS). Groundwater pH ranged from neutral to slightly alkaline. Total suspended solids (TSS) and turbidity were between either below detection limits or slightly elevated. The dominant ions were sodium, bicarbonate and chloride. High silica was measured in the Arruwurra bores, while those bores in the north were moderate to high in silica.

Environmentally Sensitive Areas

There are two environmentally sensitive areas in the vicinity of the project area that have the potential to be impacted by the extraction of groundwater for the project; Kerringnew Swamp and Oolgoolgarri Swamp. These areas have been identified as environmentally sensitive areas due to their potential to provide seasonal habitat for migratory bird species.

The Kerringnew Swamp is located 10 km northeast of the northern borefield (see Figure 5.8). During the hydrogeological and water supply investigations the swamp was inspected, at that time there was no evidence of recent surface water, although the vegetation suggested inundation might occur after rainfall events. An environmental monitoring bore was installed during the field program. The bore was dry to a completed depth of 18 m depth suggesting the swamp is an ephemeral surface water feature and not related to groundwater. It is therefore not expected to be influenced by changes in the underlying groundwater level.

The Oolgoolgarri Swamp is located 37 km east of the northern borefield and is not expected to have a groundwater connection with the borefield.

5.9.2 Potential Impacts

Groundwater quality and quantity has the potential to be affected by the project. Potential, credible project-related groundwater impacts are described below.

Decrease in the Availability of Groundwater for Third Party Users

Groundwater naturally recharges or replenishes through infiltration of surface water. During groundwater extraction (for project water supply) there is potential for the extraction rate to exceed the recharge rate, causing a local cone of depression or drawdown of the groundwater table. This depression may affect the available water within the cone of depression, decreasing the availability of groundwater for existing third party users within the cone of depression.

Where the mine pit depth is equal to or below the depth of the groundwater, inundation of groundwater will occur. To enable mining of the ore, any groundwater inflow will be required to be intercepted before it enters the pit and/or removed from the pit, which can also reduce the availability of groundwater for third party users.

Reduced Groundwater Quality

The continued and/or potential future use of groundwater by third parties may be dependent upon the quality of the groundwater. A reduction in the quality may result in a change or restriction in the use of this resource.

Potential impacts to groundwater quality may result through:

- Seepage from slime storage facilities.
- Increasing salinity due to reductions in dilution of salts in the aquifer system due to over-extraction of groundwater.

- Spillage or seepage of hazardous materials stored on-site such as chemicals or hydrocarbons.

Reduced Availability of Groundwater for Environmentally Sensitive Areas

Groundwater dependent ecosystems are ecosystems that use groundwater as part of their survival and can include wetlands, vegetation and mound springs. Changes to the flow, level and quality of groundwater may affect the survival of groundwater dependent ecosystems.

If groundwater dependent ecosystems exist within the zone of influence of the borefield and mine pits ecological habitats may potentially be impacted. Two environmentally sensitive areas have been identified as potentially groundwater dependent, Kerringnew Swamp (10 km northeast of the borefield) and Oolgoogarri Swamp (37 km east of borefield). Groundwater modelling results indicate drawdown of less than 3 m at Kerringnew Swamp and 0.2 m at Oolgoogarri Swamp after 10 years of pumping, which is considered to be negligible considering the ambient groundwater depth of around 50 m. In addition, hydrogeological investigations of the Kerringnew Swamp indicate the swamp is fed through surface water flow and is not dependent on groundwater (see Section 5.9.1).

Potential impacts to the environmentally significant areas due to reduced groundwater availability are not considered to be credible impacts and are not assessed further in this report.

5.9.3 Mitigation and Management Measures

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on groundwater. These measures will reflect current good practice at similar mines operating in similar environments and include site and species specific measures. These measures are described below.

Decrease in the Availability of Groundwater for Third Party Users

Minemakers' groundwater monitoring program will monitor groundwater levels. Minemakers will deepen existing bores or provide a suitable alternative water supply for users of these third party bores if a reduction in water supply occurs as a result of Minemakers' extraction activities.

Reduced Groundwater Quality

Measures to avoid, mitigate and manage the risks associated with reduced groundwater quality include:

- Ensuring appropriate design of slime storage facility.
- Ensuring appropriate pad design and construction for stockpiles to prevent runoff or seepage interaction with groundwater.
- Appropriately storing and managing hazardous substances on-site.
- Implementing the surface water management plan.
- Ensuring the extraction of groundwater does not exceed sustainable yield limits.

If a reduction in groundwater quality does occur, it will be detected by the groundwater monitoring program (see Section 5.9.5) and the necessary remedial measures will be put in place.

Reduced Availability of Groundwater for Environmentally Sensitive Areas

Impacts to groundwater dependent ecosystems have been avoided by locating the borefield in an area with no such ecosystems. Therefore, no specific measures are proposed to minimise or mitigate impacts to groundwater dependent ecosystems. However, to confirm that there is no

linkage between the Kerringnew Swamp and the underlying groundwater table Minemakers will continue to monitor the environmental bore during construction and operation of the project. This will identify any fluctuations in groundwater level at this location and any unexpected linkage between it and the ecosystem. Should this monitoring detect linkage, ecological survey sites will be established at the swamp to determine the nature of impacts to the ecosystem as a result of drawdown due to the project.

5.9.4 Residual Risk

Table 5.12 summarises the residual impacts of the project to groundwater, considers the likelihood and consequences of the impacts (taking into account proposed management measures), and provides an overall risk rating for each potential impact. These are discussed in detail below.

Table 5.12 Summary of impacts to groundwater

Impact	Likelihood	Consequence	Residual Risk
Decrease in the availability of groundwater for third party users.	Possible	Minor	Moderate
Reduced groundwater quality.	Unlikely	Minor	Low

Decrease in the Availability of Groundwater for Third Party Users

Water during the construction phase will be required for road construction, dust suppression for the roads, construction water for the beneficiation and IHP plant and village, and potable water demand. The total water demand during construction is estimated to peak at 30 L/s during the final phase of construction.

Water during the operational phase of the project will be required for the beneficiation process, cooling within the IHP, dust suppression for the roads and mining areas, accommodation areas and potable water demand. Demand for water will increase as more IHP trains become operational. The peak water demand during full operation is estimated to be 22 ML/day.

The staged approach to the project will enable staging of the required water supply. New bores will come online as required for the project. Validation of the groundwater modelling will continue during the staged approach allowing for adequate aquifer yields.

The likelihood of a decrease in the availability of groundwater for third party users is considered **possible**. Due to Minemakers commitment to maintaining existing third party user supplies, the consequence is **minor**, resulting in a **moderate** residual risk.

Reduced Groundwater Quality

Detailed geochemical investigations of slimes produced in the proposed project will be conducted as part of future studies. The location and design of the slime storage facility will take the findings of these studies into consideration. Storage bins for product such as petroleum coke will also require design considerations to ensure mitigation of interaction of run-off seepage with surrounding groundwater. Hazardous materials and chemicals stored on site will be minimal, with notable items being fuel, and sundry lubricants and cleaning chemicals. All hazardous materials stored on site will be contained within bunded areas and will be managed to minimise spillage. The implementation of the spill management procedures in the waste management plan will also minimise any risk of contamination of groundwater aquifers as a result any spills.

With the planned groundwater quality monitoring program and the appropriate management of hazardous materials stored on-site is considered **unlikely** that there would be an unacceptable

reduction in groundwater quality. The monitoring program will enable early detection of changes in groundwater quality and allow for mitigation measures to be implemented; the consequence is therefore **minor**, giving a risk rating of **low**.

5.9.5 Monitoring

Regular monitoring will be implemented for the potential groundwater impacts identified. The proposed groundwater monitoring schedule is presented in Table 5.13.

Table 5.13 Groundwater monitoring schedule

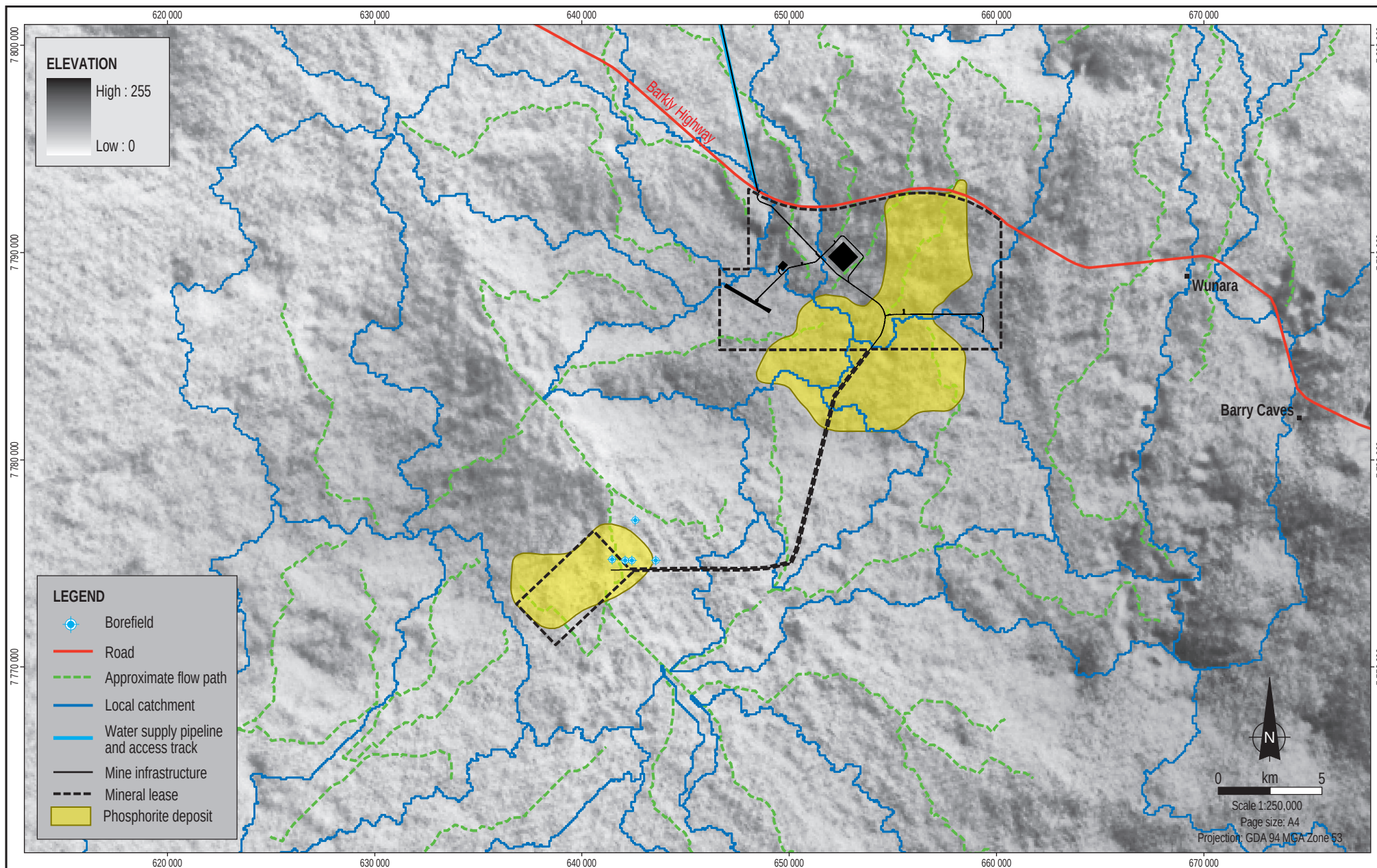
Monitoring Site	Parameter	Frequency
Arruwurra and camp area production bores	Groundwater level depth.	Monthly
	Cumulative pumping volume.	Monthly
	Electrical conductivity (EC), temperature and pH.	Monthly
Northern borefield - production bores	Groundwater level depth.	Monthly
	Cumulative pumping volume.	Monthly
	EC, temperature and pH.	Monthly
	Water quality (pH, TDS, EC, major ions, NO ₃ and Fe).	Annual
Northern borefield - monitoring bores	Groundwater level depth	Monthly
Operational pits	Quantity of groundwater inflow removed from pits. Period of time during which pumps are operating to remove groundwater inflow.	As necessary
Regional sites		
Environmental monitoring bore (WNEM001)	Groundwater level depth.	Monthly
Nearby stock bores	Groundwater level depth.	Monthly

5.10 Surface Water

5.10.1 Existing Environment

The project area is located within the internally-draining Barkly surface water management area (SWMA), which covers an area of 123,000 km² and has an annual mean runoff volume of 600,000 ML/year (Appendix 6). The project area incorporates nine local catchment areas (Figure 5.9). No discernible watercourse or drainage channels are located within the project area; and all of the watercourses and drainage lines in vicinity of the project area are relatively minor and ephemeral in nature and are likely to only carry runoff for short periods following significant rainfall events. Occasionally, flows will be significant enough to cause flooding.

The only notable surface water feature within close proximity to the project area is the seasonally flooded ephemeral swamps to the north of the Arruwurra section of the Mineral Lease and northeast of the northern borefield. These ephemeral lakes are not permanently inundated; however, some ephemeral lakes in the region are known to retain water for extended periods after rain (Edgoose, 2003).



Source:
Place names, roads and tracks from GEODATA 250k (optimum scale 1:250,000).
Mine plan from AMC & GHD.
Catchments and flow paths from Carrick Consulting.
DEM from Northern Territory Geological Survey.
Mineral lease from DMETIS (December 2012).

coffey
environment

Date:
17.12.2012
MXD:
9014MM_22_GIS013_v1_1
File Name:
9014_22_F05.09_GIS_GL

Minemakers Australia Pty Ltd
Wonarah IHP Project

MINEMAKERS
AUSTRALIA PTY LTD

**Catchments and estimated flow paths
in the project area**

Figure No:
5.9

The closest significant watercourses are the ephemeral Ranken River approximately 60 km to the east of the project area (in the Georgina River catchment) and the ephemeral Playford River (in the Playford River catchment) to the north. Although there is no flow data for the Playford River, there is highly variable annual flow data for the Ranken and Georgina rivers, which are representative of the effects of climatic variations on surface water flows in the region. Maximum flow rates in these rivers can also be very high reflecting heavy rain periods.

Rainfall

Rainfall in the region tends to be seasonal and although the mean annual rainfall values are relatively low (around 300 mm), high intensity rainfall events can be significant. Rainfall intensity data shows that short duration rainfall intensities in excess of 150 mm/hr have been recorded at the local Bureau of Meteorology (BoM) stations of Brunette Downs and Wonarah and a 180 mm rainfall event was recorded at the project area in January 2009.

Evaporation

Mean daily evaporation rates are approximately 8 mm per day, ranging from a high of approximately 10 mm per day during October and November to a low of approximately 6 mm during June and July. Evaporation is highest during the build-up to the wet season and the early wet season (October, November and December) with mean monthly evaporation in the range of 317 to 347 mm, reducing by half over the dry season (June to September) period. During the 2008 to 2009 survey period evaporation at Wonarah exceeded rainfall.

Water Uses

There is no major water storage, diversion or supply infrastructure within the Barkly SWMA and the volume of surface water used is less than 0.1% of the mean annual runoff. There are no current surface water licences within the Barkly SWMA and any water use is for stock watering, with groundwater resources providing the main water source in the region (see Section 5.9).

Grazing of stock occurs to the north of the Barkly Highway, but relies predominantly on groundwater. Water (predominately groundwater) is sometimes used for maintenance of the Barkly Highway.

There are also ephemeral lakes adjoining the project area that are culturally significant sites and have been classified as exclusion zones by the Traditional Owners and CLC (see Section 5.12). Large ephemeral lakes, which act as seasonal refuges for populations of larger fauna, are important hunting grounds for Traditional Owners.

5.10.2 Potential Impacts

Construction and operation of the project will involve the excavation and dumping of spoil and overburden, construction of roads, construction of the water supply pipeline and excavation of the phosphorite deposit. These activities could significantly affect the movement of surface waters in the project area and surrounding local environment if not managed correctly.

Given the nature of the project, i.e., relatively unreactive ores and processing of ore on site, the key issues are related to:

- Adverse effects on downstream ecosystems due to fugitive sediment.
- Adverse effects on downstream fauna and riparian vegetation due to altered flow regimes.
- Adverse Effects on beneficial users due to surface water contamination.

These are discussed in further detail below.

Adverse Effects on Downstream Ecosystems due to Fugitive Sediment

As heavy seasonal rains are common in the Barkly SWMA, flows in the area are likely to carry high sediment loads regardless of the source (see Section 5.10.1). However, given the type of disturbance associated with the project (e.g., clearance of a large area of vegetation, excavation of soil and exposure of subsoil), storm water runoff from the project area may result in an increase in sediment delivery to downstream ecosystems.

Increases in sediment-laden storm water runoff could be associated with erosion and subsequent damage to downstream ecosystems. This could include physically altering watercourse habitat – through in-stream deposition and erosion effects – leading to unfavourable conditions for flora and fauna survival and changed ecosystem composition to species more tolerant of these conditions.

Adverse Effects on Downstream Fauna and Riparian Vegetation Due to Altered Flow Regimes

Data has shown that local maximum rainfall records are generally associated with cyclone events and can result in flooding, road closures and operational interruptions. Construction of infrastructure for the mine and mining-related alteration of the landform will change the movement of surface flows in the project area. This could result in the development of new drainage channels or decrease or increase flows to existing watercourses, drainage lines and wetland habitats.

Depending on the relative changes in flow regimes related to these areas, riparian vegetation and aquatic fauna in these watercourses could be adversely impacted due to reduction of water supply or change in water quality conditions at downstream locations.

There are cultural exclusion zones in the vicinity of the project area, which include wetland areas of importance to the Traditional Owners. The exclusion zone to the northeast of the Arruwurra deposit also contains historical record of the plant *Sporobolus latzii* (see Section 5.7), which is recognised as significant at a national level (White et al., 2000); however, it is not listed for protection under the Commonwealth *Environment Protection, Biodiversity and Conservation Act 1999* (EPBC Act). If flow regimes were altered in these areas it could result in adverse impacts to these cultural sites and threaten the survival of *Sporobolus latzii* in this area.

The Arruwurra pits will be susceptible to flooding if appropriate measures are not put in place. This is due to the local watercourse that flows in a northwesterly direction towards the Arruwurra deposit. It is possible that flood water from this watercourse could report to some of the Arruwurra pits, thereby affecting flows to downstream environments. No such threat exists for the Main Zone deposit.

Adverse Effects on Beneficial Users Due to Surface Water Contamination

The main chemicals stored on-site that will be potential sources of contamination will include super phosphoric acid, fuels, lubricants and other liquid chemicals for machinery maintenance. Additionally, water with potentially high TSS from the beneficiation process may be a source of downstream contamination, either from the beneficiation plant or from the SSF.

The potential exists for spillage of chemicals reporting to downstream surface watercourses (and possibly infiltrating groundwater sources) during flood events, resulting in a toxic effect to flora and fauna and impacts to users of groundwater in the region. Areas where such spillage could originate are:

- Arruwurra fuel storage and workshops.
- Central fuel storage and workshops.

- Aerodrome fuel storage.
- Vehicle washdown and tyre wash areas.
- Beneficiation plant.
- IHP plant.

Waterbodies that are part of the project infrastructure (e.g., sediment ponds) may attract waterbirds to the area. These migratory birds could be harmed if these waterbodies are contaminated due to project activities.

5.10.3 Mitigation and Management Measures

Minemakers' surface water management objectives for the project include:

- Minimise the potential project impacts such as changes in the streamflow regime, alteration of habitat, pollution or increased erosion and sedimentation.
- Where feasible, maintain the shape and composition of the natural watercourse geometry, natural biological indicator conditions and flow conditions.
- Employ protection measures to prevent adverse hydrological and water quality impacts, for all recognised watercourses within the project area.
- Rehabilitate any watercourses that are unacceptably impacted as soon as practicable after detecting the impact.

The following high-level avoidance, mitigation and management measures have been developed to reduce the risk of the potential impacts to surface water in the project area described in Section 5.10.2:

- Site surface water management will be based on the principle of diverting clean surface water runoff away from disturbed areas and into existing natural watercourses and drainage lines, and intercepting runoff from disturbed areas and directing it through sediment control structures prior to discharge to the downstream environment.
- Mine infrastructure will be located to minimise deviation of natural surface water flow paths to avoid inundation of the open pits and to prevent erosion and siltation and adverse impacts on water quality downstream of the Mineral Lease.

Adverse Effects on Downstream Ecosystems due to Fugitive Sediment

To minimise the risk of sediment runoff adversely affecting receiving water environments and downstream ecosystems, the following measures will be implemented:

- Sediment and erosion control plan for the project.
- Disturbed areas will be rehabilitated progressively once areas are no longer required for mining, so that the potential for erosion and siltation of watercourses is minimised.
- Runoff from non-process areas (e.g., roads, roofs, yards, run of mine (ROM) area) will be captured in open drains. The drains will report to a sedimentation pond, before either being reused or, if suitable, released off-site.
- Waste rock stockpiles will be bunded around their full perimeter to contain water and to separate it from clean runoff from the surrounding catchment. The runoff from the stockpiles will be collected in diversion channels and directed through sediment ponds prior to discharging to the natural environment.

- The quality of water in sedimentation ponds will be routinely monitored. Water that is considered unsuitable for release to the environment, based on the potential for adverse impacts on environmental values of downstream watercourses, will be recycled for reuse on-site. Sediment accumulated in sedimentation traps will be removed periodically and disposed of to one of the active waste rock stockpiles.
- Sedimentation ponds will be constructed at the Main Zone, Arruwurra and crushing and scrubbing plant to allow separate treatment of potentially high sediment runoff from ore and waste rock stockpiles.

Adverse Effects on Downstream Fauna and Riparian Vegetation Due to Altered Flow Regimes

Impacts to the local surface water flow regime will be managed by the placement of project components, where possible, to minimise changes to the flow regime. Runoff from undisturbed areas surrounding the project will be diverted around project facilities into existing natural watercourses or drainage lines by providing diversion drains typically sized for the 10 year ARI event with a minimum 500 mm freeboard. Flow velocities along all diversion drains will be limited to minimise erosion and the generation of sediment.

Flood diversion measures such as berms and flow diversion ditches will be used at the southeastern perimeter of the Arruwurra pits to minimise the risk of infiltration of these pits during stormwater runoff (and subsequent alteration of surface water flow in this vicinity) and will be designed to withstand a 100-year ARI event.

To avoid flooding of the Arruwurra pits and infrastructure near Main Zone (and subsequent alteration of surface flow regimes in these areas), two upstream catchment diversion ditches will be constructed.

Adverse Effects on Beneficial Users Due to Surface Water Contamination

Storage areas for the SPA, chemicals, oils and hazardous material will be bunded in accordance with the relevant codes and standards. Water collected within the bunds will be assessed prior to release. If the water quality is suitable, the area will be drained to the closest non-process drain that reports to a sedimentation pond. Water that does not meet relevant water quality criteria will be returned to the process or disposed of appropriately.

The IHP plant will be situated in a bunded area so that all surface water drains to one or more collection points to allow for the capture of contaminated water prior to discharge to the environment.

To minimise the potential for oil leaks into watercourses during operation, oily water separators will be installed at four facilities as a minimum. These are:

- Arruwurra fuel storage and workshops.
- Central fuel storage and workshops.
- Airstrip fuel storage.
- Vehicle washdown and tyre wash areas.

The slimes storage facility will be constructed to contain and manage slimes production. Detailed engineering designs will be produced during the definitive feasibility study to ensure long-term containment of the slimes and protection of ground and surface waters. Existing geochemical studies undertaken during the previously approved EIS indicated that the slimes material would be neutralising in nature and essentially benign. Although it is expected that the slimes produced from the proposed process will also have these characteristics, a detailed geochemical

assessment will be provided in the EIS to support the proposal and inform the design of the SSF and the approvals process for the project.

A suitable ongoing water quality monitoring program will be adopted to identify any alterations to water quality as a result of project-related activities (Section 5.10.5). Procedures for management, monitoring and mitigation measures will be presented in the EIS document and supporting environmental management plans including spill response, waste management and emergency response to ensure that, in the unlikely event of adverse impact to ground or surface water occurred impact will be minimised and reporting and remediation measures clearly defined.

5.10.4 Residual Risk

Table 5.14 summarises the residual impacts of the project on surface waters, considering the likelihood and consequence of the predicted impacts after the successful implementation of management and mitigation measures. These assessments are described in further detail below and are considered with respect to the environmental value 'maintenance of aquatic ecosystems'.

Table 5.14 Summary of surface water impacts

Impact	Likelihood	Consequence	Residual Risk
Adverse effects on downstream ecosystems due to fugitive sediment.	Possible	Minor	Moderate
Adverse effects on downstream fauna and riparian vegetation due to altered flow regimes.	Unlikely	Insignificant	Low
Adverse effects on fauna and riparian vegetation and groundwater users due to surface water contamination.	Unlikely	Moderate	Moderate

Adverse Effects on Downstream Ecosystems due to Fugitive Sediment

Release of fugitive sediment from the project area will be minimised by rehabilitation of the water supply pipeline from the northern borefield and implementation of on-site sediment control measures within the Mineral Lease.

Implementation of onsite sediment control measures, which include diversion drains to separate clean and dirty water and appropriately designing sediment control structures will minimise the release of fugitive sediment off the Mineral Lease. High sediment loads are likely to occur only during high flow periods following long dry periods in semi-arid environments; therefore any sediment impacts in the overall context are likely to be minimal.

Notwithstanding the sediment control measures to be implemented, it is **possible** that some fugitive sediment will report to surface drainage lines in the vicinity of the project area due to project activities. However, the extent to which this occurs will depend to a large degree on the nature of rainfall events during project development. Drainage lines in the project area are dry unless significant rainfall events occur, and as noted earlier sediment loads in such semi-arid watercourses are naturally high. Fugitive sediment is therefore likely to be localised to the vicinity near the project area due to the infrequent nature of such rainfall events.

Downstream habitats are common and widespread, and likely to support organisms that are tolerant of episodic high sediment loads.

The consequence of fugitive sediment on the environmental values of regional downstream waterbodies is therefore considered to be **minor** over the longer term, and the risk is accordingly assessed to be **moderate**.

Adverse Effects on Downstream Fauna and Riparian Vegetation Due to Altered Flow Regimes

It is **unlikely** that flood flow regimes will be altered so runoff from the catchment upstream of the Arruwurra Zone mining area will be diverted around the infrastructure in this area. The establishment of flood protection measures (including flood protection berms, strategically placed and armoured waste rock storages and above-grade haulage routes) will divert the flood flows to the east. However, modelling shows flood flows from this watercourse could be well in excess of 1 km wide, therefore the consequence of the altered flood flow regimes for downstream habitats will be **insignificant** due to the large volumes of water that are likely to be received by downstream environments in such a rainfall event. The residual risk is therefore **low**.

Adverse Effects on Beneficial Users Due to Surface Water Contamination

Due to the high evaporation rate over rainfall experienced in the region the potential for water containment infrastructure such as the SSF and sediment ponds etc. to discharge into the receiving environment is unlikely except during or after extreme weather events. During such events dilution would likely be rapid due to the high volumes of water involved and the relatively inert nature of the slimes. This will be confirmed during further geochemical studies to be conducted in the next stage of investigations.

With the combination of management measures, including bunding, oily water separators, measures to minimise the risk of flooding and the implementation of emergency response management plans, it is **unlikely** that surface water contaminants will report to downstream environments.

In the event that this did occur the long-term consequences for aquatic fauna and downstream riparian vegetation and ecosystems will be **moderate** since the sources and volumes of contamination associated with the project are limited and such a release will probably be associated with an intense rainfall event when dilution would be greatest. The residual risk is accordingly assessed to be **moderate**.

5.10.5 Monitoring

Ongoing surface water quality monitoring will be conducted to allow identification of any impacts of mine construction and operations on downstream ecosystems. All surface waters will be sampled for major anions and cations, total and dissolved metals and pH, total dissolved solids (TDS) and electrical conductivity (EC).

The integrity of flow diversion and bunding infrastructure will be inspected twice a year (before and after the wet season); and downstream environments (flora and fauna) will be monitored at regular intervals (see Sections 5.7 and 5.8 for further detail).

The integrity of the SSF and slimes delivery lines will be monitored daily as part of routine mine operations.

Ongoing monitoring will include:

- Event-driven water quality sampling and monitoring of project water storages (i.e., sedimentation ponds) and downstream ephemeral streams, with a focus on locally-defined water quality objectives.
- Inspection of flow diversion and flood protection infrastructure, with particular attention given to those protecting the susceptible Arruwurra mining area.

5.11 Socio-economic

5.11.1 Existing Environment

Information contained in the following socio-economic profiles has been sourced mainly from the Australian Bureau of Statistics 2006 and 2011 census data.

The project is located on the Barkly Tableland region, which covers a large area of the central eastern part of the Northern Territory. The major service centre for the region is the town of Tennant Creek (population 3,061; Plates 5.5, 5.6, 5.7 and 5.8). The region is sparsely populated with the major sources of income for the region generated from grazing. Pastoral production within the Barkly Tableland region accounts for 39% of the Northern Territory cattle industry (DoT, 2012). Other sources of regional income include mining and tourism.

Indigenous people comprise 49% of the total population of Tennant Creek and 60% for the region. The region has a long history of occupation by Aboriginal people with many Aboriginal people maintaining a strong association with the land and water in the region. The Traditional Owners for Tennant Creek are the Warumungu people. Other Traditional Owners of the Barkly Tableland include the Kaiditch, Alyawarr and Arruwurra people. Three Aboriginal language groups exist; in the area covered by the project and ore road transport route, these are the Warumungu, Kaytej and Wakaya.

Unemployment in Tennant Creek at the 2011 census was 7.1% and a similar unemployment rate exists throughout the non-urban areas of the Barkly Tablelands. Employment in Tennant Creek is predominantly in the areas of public administration, health care and social assistance, trade, sales and labouring. Mining accounts for approximately 2% of employment in Tennant Creek.

Indigenous unemployment in Tennant Creek is 12% higher than the overall unemployment rate for the Northern Territory (4.4%). Tennant Creek residents earned a higher share of the region's average wages and salaries. The lower population and higher percentage of residents employed in agricultural activities may contribute to the lower regional earnings.

Wunara Community

Wunara is the closest populated area to the project and is a small Aboriginal settlement located approximately 10 km from the Mineral Lease boundary (Plates 5.9, 5.10 and 5.11), adjacent to the Barkly Highway (Plate 5.12). The population residing in the community fluctuates from 2 to 30 people according to the season. Employment opportunities within the community are extremely limited; however, Minemakers has employed some Wunara residents to assist with exploration and trial mining activities.

5.11.2 Potential Impacts

The project has the potential to result in positive impacts such as:

- Economic benefits.
- Employment.
- Training.
- Education.

However, there is the potential for negative impacts, such as:

- Social disruption due to changes in population and demographics.
- Increased competition for skilled labour.



Plate 5.5
Main street of Tennant Creek



Plate 5.6
Tennant Creek police station



Plate 5.7
St John Ambulance Barkly Region



Plate 5.8
Tennant Creek primary school



Plate 5.9
Wunara community



Plate 5.10
Houses within the Wunara community



Plate 5.11
Communal area within the Wunara community



Plate 5.12
Barkly Highway

- Pressure on existing infrastructure and community services.
- Reduced availability and affordability of housing.
- Increased traffic on roads, with a consequent safety risk and reduced amenity for road users.
- Increased availability and affordability of drugs and alcohol, with consequent negative social impacts.

Demographic and Economic Profile

Development of the project has the potential to boost the local economy of Tennant Creek and create employment opportunities and training incentives and through associated business creation, economic stimulus in the region. It may also change the demographic and economic profile within the region. This is discussed further below.

Population and Demographics

Potential positive population impacts may be the increase in the number of people living in Tennant Creek as local businesses develop and expand to service the requirements of the project. There is also the chance that people/families may relocate to Tennant Creek, particularly if the heavy haulage for the project is based there. Traditional owners may also return to Wunara community to work on the project.

A change in regional demographics may result an influx of mine workers who are typically male and in their 20s to 40s; this could contribute to social disruption in Tennant Creek and Wunara due to increased law and order issues, tension between newcomers and existing residents and increases in drug and alcohol use.

The fly-in fly-out (FIFO) workforce will increase the temporary population of the Barkly Tableland region. Given the insular nature of FIFO operations, this population increase may not translate into population benefits for this region (i.e., disposable incomes of the mine workers is spent in their home localities and not within the region of their employment), but will have positive benefits for other communities (e.g., those hosting the FIFO employees).

Employment

The project will increase the number and variety of employment opportunities at the local, peripheral and Northern Territory level. Unemployment in the region is consistently above the Northern Territory average and employment as a result of the proposed mine may reduce the unemployment rate.

Local businesses and pastoralists sometimes have difficulty in finding suitable employees and this may be exacerbated if the mine is seen as an attractive place to work. Jobs within the mining industry may offer higher wages than other business or agricultural enterprises. They also provide a similar number of work hours as other industries; however, with mine rosters they will have two weeks off every four or six weeks. Therefore, there is potential for increased competition for skilled labour in Tennant Creek and across the Barkly Tableland.

However, the opportunity to source local labour will depend on the available skill base within Tennant Creek and Wunara. While Minemakers has a preference to employ from the local area, it is recognised that appropriately skilled personnel (particularly for highly skilled people with previous mining experience) may need to be sourced from the other areas and that this will not translate into a positive impacts on employment within Tennant Creek or Wunara.

Local Economy

A significant positive economic impact may boost the territory and national economies due to the project, primarily from:

- Direct financial contributions through the payment of taxes and royalties.
- Increased gross state product (and gross domestic product) from sales revenue.
- Indirect financial contributions through the payment of taxes by people employed either directly or indirectly by the mine, and also by companies that service the project directly or indirectly.
- Decreased unemployment levels.

No potential negative impacts to the local economy have been identified.

Community Services and Infrastructure

Potential positive impacts to community services and infrastructure may be an increase in government funding and economies of scale for local service providers.

Potential negative impacts to community services and infrastructure include:

- Increased strain on health services due to a major incident at the mine site, during the transport of SPA or at the rail siding, requiring the attendance or assistance from local emergency services from Tennant Creek.
- Increased pressure on existing infrastructure and community services, particularly in terms of the capacity of local infrastructure to meet demands from the increased number of households, including health, waste, water, power, and education services.

Housing and Accommodation

The nature, extent, quality and availability of housing and accommodation in the region are limited. While an accommodation village will be constructed for the FIFO mine workforce, there is likely to be an increase in demand for housing (particularly in Tennant Creek) for people employed by businesses associated with the mine (e.g., transport companies) and Traditional Owners attracted back to the Wunara community. The potential negative impacts of increased housing demand include:

- Increase in property prices in the town that may drive out existing residents from the property market or cause financial hardship for existing residents who may not be able to afford the 'mine prices' for accommodation. This has been evidenced in a number of mining towns such as Kalgoorlie in Western Australia and Emerald, Moranbah in Queensland. Inadequate housing may also cause issues with overcrowding and the establishment of sub-standard accommodation in the region (i.e., long-term caravan dwellers, shed dwellers).
- A lack of available housing in the Wunara community. The NT Planning Scheme identifies the Wunara community as an unzoned area. Therefore, development within the community is not subject to land use controls under the *Planning Act* or the NT Planning Scheme; development would be driven by the desire and financial capacity of the Traditional Owners.

Tennant Creek, however, is subject to the planning control provisions of the NT Planning Scheme and any development within Tennant Creek will require development approval. Development of land in Tennant Creek is currently constrained by the land available for development. Suitable parcels of land for future residential development exist within Tennant Creek; however, they are

currently Crown land and require the Northern Territory government to release them for development.

Roads and Traffic

Road traffic will increase along the product transport route from the Mineral Lease to the rail siding in Tennant Creek. This includes the Barkly Highway, Stuart Highway and Warrego Road. Potential impacts associated with roads and traffic are addressed in Section 5.13.2, see also Section 5.4.2, which discusses the potential impacts of increased traffic to noise.

Drug and Alcohol Issues

Minemakers may request the Wunara community and CLC give consideration to the operation of a wet mess (bar) within the accommodation village within the Mineral Lease solely for the purposes of the employees and contractors. The community has previously indicated a willingness to consider this proposal; however, Minemakers appreciates the concern of the Wunara community as to the potential for the development of drug and alcohol issues associated with the provision of a wet mess at the mine site. Traditional Owners have raised concerns that this may increase the level of alcohol abuse among their people, and potentially result in employees losing their job due to problems with alcohol. There is also potential for an increase in drug and alcohol use in Tennant Creek due to the increased amount of money available in the community due to the economic flow on from the project.

5.11.3 Mitigation and Management Measures

Minemakers will implement avoidance, mitigation and management measures to address the potential socio-economic impacts. These measures will reflect current good practice at similar mines operating in similar environments and include site specific measures. These measures are described below.

Economy

To optimise the socio-economic benefits of the project, Minemakers will:

- Develop and implement an Industry Participation Plan in accordance with the requirements of the Northern Territory Government for major projects. This plan that will be based on preferentially sourcing people, goods and services from within the Barkly Tableland region and the Northern Territory to build business, industry and community capability through capacity building, education and training.
- Aim to use local (Barkly Tableland region or Northern Territory) businesses to fill contract positions (e.g., catering, cleaning, fuel supply, light vehicle maintenance) provided the contractors are competitive and appropriately skilled.
- Consider how the contractors have considered or incorporated social and economic opportunities for the Traditional Owners when assessing and granting contracts.
- Develop the project as quickly as practicable, having regard for the necessary regulatory approvals and prevailing economic conditions.
- Seek premium prices for the sale of the SPA.
- Continue to work with the Northern Territory government agencies, Barkly Shire Council and local businesses to build community capacity by working with schools and training providers to develop curricula and pathways to employment in the resource sector. Also establish

relationships with other mining and exploration operators in the region to determine skill requirements and potential traineeship and apprenticeship programs.

- Place a high emphasis on stakeholder consultation to foster and maintain good relationships.
- Develop guiding principles for determining how the Company selects which causes to support. These principles will aim to ensure support is targeted and focuses on those causes that contribute to sustainable benefits for the community. Any support provided by Minemakers will be given through an open and transparent process.
- Where possible, assist in community-driven development initiatives, which may involve donation of people's time, skills and knowledge.

The Traditional Owners and the Wunara community will receive income in the form of royalties from the project. The Traditional Owners and the CLC are currently working together to establish a trust fund system where a percentage of royalties can be invested to establish a long-term, sustainable economic return from the project. Any profits from the trust fund can then be re-invested in to the community in the form of scholarships for Traditional Owners or infrastructure.

Employment and Training

Minemakers recognises the opportunity that accessing a workforce pool in Tennant Creek and the Wunara community represents. Minemakers will work with existing training providers to ensure that programs they deliver will give previously unskilled people the necessary skills to gain employment with the project. As part of the stakeholder consultation plan, Minemakers will also make the local community aware of the types of jobs that will be required and the skills and qualifications people will require to fill them, as well as when opportunities for tender will be available.

Indigenous Employment and Training

Minemakers does not intend to provide any specific training and employment programs prior to the commencement of mining. However, Minemakers will work with local training providers to ensure programs are focused on maximising skill development and employment opportunities for members of the Indigenous community. Minemakers, as member of the Northern Territory Division of the minerals Council of Australia (MCA), will also participate in the recently announced initiative to improve Indigenous employment opportunities in the mining industry.

Minemakers' strategy for training local Indigenous community members prior to mining commencing will require ongoing communication with local training providers and government agencies. Ongoing communication with the local Indigenous community will also provide guidance in the types of employment and business opportunities available.

It is expected that civil, mining and logistics contractors will run programs to recruit and train members of the local Indigenous community.

Community Services and Infrastructure

The project will be managed in accordance with Minemakers' workplace health and safety processes and procedures throughout all phases of the project. These processes and procedures ensure risks to the health and safety of both workers and the general public are minimised. Above and beyond these processes and procedures Minemakers will:

- Consult with local emergency services as part of the stakeholder consultation plan to ensure that any issues identified regarding additional strain on health services are identified and resolved.

- Provide first aid and facilities for emergency medical treatment at the mine site.

Minemakers will continue to liaise with the Barkly Shire Council and the Northern Territory Government to assist with future planning and development activities. Any necessary expansion or new facilities required to address increased demand will need to be built into town planning processes.

Housing and Accommodation

The construction of the accommodation village at the mine site will reduce the pressure on existing housing in Tennant Creek. Sufficient accommodation in the village will be available to house the entire workforce.

Minemakers will have sufficient capacity within the accommodation village to accommodate additional personnel, contractors or consultants as required. From time to time local temporary accommodation, such as the Barkly Roadhouse and Tennant Creek motels, may be required if the project's accommodation villages are full. Minemakers will work with providers of temporary accommodation to ensure that they can adequately meet this demand as required.

Drug and Alcohol Management

Minemakers will develop and implement a drug and alcohol management plan for the project, which will apply to all employees and contractors and will induct people in the implementation of the management plan and their responsibilities under the plan. Minemakers will also implement substance abuse testing and management in all aspects of the operation. While a zero tolerance approach will be taken, the drug and alcohol management plan will also ensure details of relevant contacts and support services are provided for those people that have significant drug or alcohol problems.

5.11.4 Residual Risk

Table 5.15 summarises the potential residual negative socio-economic impacts of the project, considers the likelihood and consequences of the impacts (taking into account proposed management measures), and provides an overall risk rating for each potential impact. These are discussed in detail below. The risks associated with the potential positive impacts have not been assessed using the risk matrix; they are also discussed in the relevant sections below.

Table 5.15 Summary of socio-economic impacts

Impact	Likelihood	Consequence	Residual Risk
Social disruption caused by population and demographics	Unlikely	Moderate	Moderate
Increased competition for skilled labour, particularly for highly skilled people with previous mining experience	Possible	Minor	Moderate
Significant pressure placed on existing emergency services	Unlikely	Minor	Low
Inadequate existing infrastructure and community services	Unlikely	Moderate	Moderate
Reduced availability and affordability of housing and accommodation in Tennant Creek	Unlikely	Moderate	Moderate
Lack of accommodation for Traditional Owners in Wunara community	Possible	Minor	Moderate
Social problems due to drugs and alcohol	Unlikely	Moderate	Moderate

Population and Demographics

It is **unlikely** that the project will result in social disruption due to an increased population in either the Wunara community or Tennant Creek due to changes in demography associated with the project. If impacts were to occur they would be of **moderate** consequence and the residual risk of this impact is therefore **moderate**.

Employment

Workforce

The project is expected to employ 150 to 200 people during the ten month construction phase. During 1 Mt/a P₂O₅ operations, the mine will accommodate a predominately fly-in-fly-out mine workforce of approximately 550 people, including project management, processing staff and contract mining workforce. It is expected that local people will be employed during the operation of the accommodation village in positions such as catering, cleaning and maintenance.

The Australian Bureau of Statistics estimates that the employment flow-on from mining operations is generally a multiple of 1.588 for each position directly related to the running of the operations (Madden, 1994). Considering Minemakers expects to directly employ a total of 550 people, then the flow on employment benefits would be in the order of 870 people locally and regionally.

Sources of Labour

The workforce will be preferentially sourced from the local, regional, territory and then national level. Providing employment opportunities for the local community will be a priority and will be determined by the skills of people living in Wunara and Tennant Creek.

Sourcing labour from within the existing, local, labour market will increase local employment opportunities and may provide incentives for more skilled workers to move to the area and for skilled workers who have left the area to return to country. This type of structural adaptation in the workforce is common to the entry of any new industry into an area and is likely to create opportunities for both the existing and future workforce.

Minemakers will preferentially source labour from Wunara and Tennant Creek; the secondary sources will be Mount Isa and Darwin.

It is **possible** that the project will increase competition for skilled labour, particularly for highly skilled people with previous mining experience. The negative consequence of competition for skilled labour occurring is **minor**. Overall, the residual risk associated with the negative impact of increased competition for skilled labour is considered to be **moderate**.

Training and Education

Once employed, Minemakers' employees and contractors will receive job-related training and education. This will provide those trained with skills, experience and knowledge that should be able to be applied elsewhere after closure of the mine. Training opportunities offered directly by Minemakers will include occupational health and safety training and other associated on-site training and external accredited qualifications as required.

Minemakers is currently consulting with local training providers in Tennant Creek and Darwin about the training needs for the required workforce. It is anticipated that local training providers will tailor courses they offer to allow local residents seeking employment with the project to gain the required skills and qualifications prior to the project commencing.

Local Economy

The project will result in increased revenue for local and Northern Territory economies.

The local community, i.e., the residents of Wunara located 10 km east of the project, will receive direct financial benefit from the project. There is the provision for the payment of royalties to the residents of Wunara (Traditional Owners of the project area) within the mining exploration agreement and the mining land use agreement. The payment of royalties has been negotiated with and through the CLC.

There will also be some indirect employment benefits to the Wunara community as part of clearance programs where Traditional Owners and the CLC are paid for their role in the land clearance procedures outlined in the mining land use agreement.

Peripheral Communities

Tennant Creek

Minemakers will preferentially employ local people. Further indirect benefits including the provision of goods and services and sponsorships are expected. The goods and services required for the operation of the workforce camps will be sourced locally where these are available at commercially competitive prices.

Minemakers will contribute financially to local sporting communities and clubs, community based training providers and service groups in Tennant Creek.

Mount Isa

Although Minemakers will preferentially source labour and goods from Tennant Creek and the Northern Territory, where this is not possible or the goods are not available in Tennant Creek, Mount Isa will be the secondary source as it is the next closest regional centre to the project. The Mount Isa economy is likely to consequently benefit from this.

Community Services and Infrastructure

The provision of site-based emergency response teams and medical assistance, combined with the strong safety culture, operational and management systems implemented through all phases of operation, make it **unlikely** that significant pressure will be placed on existing emergency services. If externally provided emergency medical evacuation was required, the Royal Flying Doctor Service would be used. The expected infrequent reliance on external emergency and medical services results in this impact having a **minor** consequence. Minemakers will liaise with local emergency services to ensure they have capacity to deal with any credible mine-related emergencies that may occur. The residual risk is therefore **low**.

Employment of local people will not place additional strain on existing infrastructure services such as power, water and schooling as they are already using these services. The fly-in-fly-out workforce will be workers only (i.e., not families) and will not be located in Tennant Creek, so it should not place significant pressure on existing infrastructure services. Given this, it is **unlikely** that the project will result in existing infrastructure and community services being inadequate. The consequence of this, should it happen, consequence will be **moderate**. The residual risk is therefore **moderate**.

Housing and Accommodation

The provision of the accommodation village at the mine site makes it **unlikely** that the project workforce will impact the availability and affordability of housing and accommodation. It is recognised that there may be pressure on housing associated with the flow-on effects of the mine (i.e., the increased business development in Tennant Creek); however, the direct project workforce will be accommodated within the villages. The consequence of this impact, should it

occur, will be **moderate**, and is likely to require government planning to address. The residual risk is therefore **moderate**.

Traditional Owners who return to the area to work at the mine may wish to live in the community. With a total of four houses, the Wunara community does not have the housing to provide for a significant influx of such people, although it is not known how many people this is likely to be. Therefore, it is **possible** that there will be a lack of accommodation for Traditional Owners who return to country. This may require them to construct additional houses. However, Traditional Owners interviewed have highlighted the return to country of these people as a major potential positive benefit of the project. Accommodation for employed Traditional Owners will be available at the workers camp for these people until suitable additional housing can be constructed. Given this, the consequence of the current lack of accommodation for Traditional Owners is considered **minor**. The residual risk is therefore **moderate**.

Drug and Alcohol Issues

Minemakers believes that with responsible management and implementation of the drug and alcohol management plan, impacts to the residents of the Wunara Community will be prevented. The availability of self-testing facilities at the mine site accommodation village will allow the opportunity to prevent a person from presenting for work in an unfit condition and thereby risk losing their employment.

The reality is that wherever there is money there is the potential for drugs to be brought into the community. Minemakers believes a zero tolerance approach to drugs, supported by a random testing regime, will deter most people from risking possessing or using drugs while on-site.

Through the strict management of the consumption and supply of alcohol in the accommodation villages, the likelihood of increased social problems due to drug and alcohol use as a result of the project is **unlikely**. Given the concern of the Traditional Owners, the consequence of inappropriate management of drugs and alcohol across the project, were it to occur, will be **moderate**. The residual risk therefore is **moderate**.

5.11.5 Monitoring

Ongoing monitoring will be conducted to allow identification of any impacts from the project on stakeholders and socio-economic conditions in the local and peripheral communities. This will involve monitoring of stakeholder and community sentiment and socio-economic impacts as part of Minemakers' ongoing stakeholder consultation program.

Monitoring of stakeholder consultation will include ongoing monitoring of:

- Records of attendance at public events and community meetings to gauge the success of stakeholder consultation and to improve ongoing stakeholder consultation.
- Records of feedback including the person's name and contact details, method of consultation, information communicated, responses and outcomes of the consultation in the stakeholder database.
- Articles that appear in the media, particularly local newspapers in the peripheral communities.

Monitoring of the socio-economic impacts will include ongoing monitoring of the following indicators:

- Workforce statistics, including number of 'local' and Northern Territory people employed by the project.

- Number and nature of complaints documented in the Complaints Register, including the person's name and contact details, communication, action taken to resolve the complaint, outcomes and feedback from complainant.
- Service and goods supply statistics. These will include details regarding:
 - Type and quantity of goods/service.
 - Value.
 - Location of supplier.
- Contributions made by Minemakers to local communities, such as sponsorship of local events.

5.12 Archaeology and Cultural Heritage

5.12.1 Existing Environment

Indigenous Cultural Heritage

Sites of Indigenous and non-Indigenous cultural or archaeological significance have the potential to occur within the project area.

Through the CLC, consultation with Traditional Owners identified six sacred sites close to the project area. These sites have consequently been incorporated into cultural exclusion zones. No infrastructure or activities related to the project is to occur in these cultural exclusion zones. All of these cultural exclusion zones are located outside of the Mineral Lease.

A search of the Aboriginal Areas Protection Authority (AAPA) Heritage Database did not identify any sites within the northern borefield or associated water supply pipeline to the north of the Barkly Highway. The closest registered or recorded sites are approximately 40 km to the north west of the northern borefield.

A search of the Australian Heritage Database and the NT Heritage Register identified no sites of non-Indigenous cultural heritage within the project area. In addition, there is no reason to suspect that non-Indigenous sites of cultural heritage significance are present within the project area. As such, non-Indigenous cultural heritage is not considered further in this impact assessment.

5.12.2 Potential Impacts

Construction and operation of the project will involve the excavation and movement of large volumes of material within the project's proposed footprint; specifically, removal and storage of topsoil, excavation and dumping of spoil, construction of roads, and excavation of the phosphorite deposit. These activities could significantly affect the sacred sites or sites of archaeological significance, by either disturbing or destroying them.

Disturbance to Cultural Exclusion Zones

There is potential for project related activities to disturb sacred sites contained within the cultural exclusion zones.

Disturbance to Identified Archaeological Site of Moderate Significance

There is potential for project related activities to disturb the archaeological site of moderate significance identified during the archaeological survey.

Disturbance to, or Destruction of, Identified Archaeological Sites of Low Significance

There is potential for project related activities to disturb and/or destroy archaeological sites of low significance identified during the archaeological survey, especially those within the footprint of project infrastructure or proposed pits.

Disturbance to, or Destruction of, Unidentified Archaeological Sites of Significance

Survey work suggests that sites of archaeological significance may exist within close proximity to all silcrete outcrops within the project area. However, the survey did not identify these sites and as such there is potential for the project to disturb sites that are as yet unidentified and unassessed in terms of significance.

5.12.3 Mitigation and Management Measures

Minemakers will implement avoidance, mitigation and management measures to address the potential impacts on archaeology and cultural heritage. These measures will reflect current good practice at similar mines operating in similar environments.

One of the primary measures implemented by Minemakers to avoid, mitigate and manage all potential impacts to cultural heritage will be to implement a cultural heritage management plan that will:

- Maintain an Indigenous sacred site and archaeological site inventory.
- Record all sacred and archaeological sites in the project's geographic information system (GIS) throughout construction and operations.
- Ensure regular monitoring of implementation of the cultural heritage management plan and relevant legislation.
- Induct and train all employees and contractors in the cultural heritage management plan to ensure that employees and contractors are aware of their obligations under the *Heritage Conservation Act* and the *Northern Territory Aboriginal Sacred Sites Act*.
- Ensure site inductions and training provides sufficient information that employees are well aware of the restriction to enter or disturb the cultural exclusion zones.
- Establish procedures to be followed should probable archaeological sites be unearthed that are not associated with silcrete outcroppings during site development, i.e., cease work and contact the mine site environmental officer for further assessment.

Disturbance to Cultural Exclusion Zones

Minemakers has applied to the AAPA for an Authority Certificate over the proposed Mineral Lease; this document will identify sacred sites and provide legal indemnity for work carried out in accordance certificate conditions, one of which will be that sacred sites are not disturbed without prior approval or consent under the Northern Territory Aboriginal Sacred Sites Act. In addition, the CLC, in conjunction with the Traditional Owners, has identified sacred sites within Minemakers' Substitute Exploration Licence 26452. These sacred sites are incorporated into the cultural exclusion areas, which also include a buffer to ensure impacts do not occur. Activities and infrastructure planned within the proposed Mineral Lease have been designed so that the cultural exclusion areas are not affected.

Disturbance to Identified Archaeological Site of Moderate Significance

The identified site of moderate significance is outside the Mineral Lease and due to the proximity of the site of moderate significance to a cultural exclusion zone, the management and mitigation measures will be the same as those detailed above for disturbance to cultural exclusion zones.

Disturbance to, or Destruction of, Identified Archaeological Sites of Low Significance

Physical disturbance of the land as a result of project activity will most likely result in the disturbance to or destruction of identified archaeological sites of low significance. Minemakers proposes to apply to the Department of Lands, Planning and Environment, for consent to disturb the area of the proposed mineral lease under the *Heritage Act*. In this way removal of artefacts from these areas will be undertaken in accordance with Heritage Act.

Disturbance to, or Destruction of, Unidentified Archaeological Sites of Significance

Minemakers proposes to apply to the Department of Lands, Planning and Environment for consent to disturb the area of the Mineral Lease under the Heritage Act. In this way removal of artefacts from these unidentified sites will be undertaken in accordance with Heritage Act.

Minemakers' implementation of the cultural heritage management plan will also ensure that any sites uncovered, that are considered to be a potential site of archaeological significance, will be subject to some level of assessment by the mine site environmental officer, who will determine whether further, formal assessment of significance is required.

5.12.4 Residual Risk

Table 5.16 summarises the residual impacts of the project on Indigenous cultural heritage and archaeological sites, considering the likelihood and consequence of the predicted impacts after the successful implementation of control and mitigation measures. The assessments of these are described in further detail below.

Table 5.16 Summary of Indigenous cultural heritage impacts

Impact	Likelihood	Consequence	Residual Risk/Benefit
Disturbance to cultural exclusion zones	Rare	Major	High
Disturbance to identified archaeological site of moderate significance	Rare	Moderate	Moderate
Disturbance to identified archaeological sites of low significance	Likely	Insignificant	Moderate
Disturbance to unidentified archaeological sites of significance	Possible	Insignificant	Low

Disturbance to Indigenous Cultural Exclusion Zones

Minemakers has consulted with the AAPA, CLC and Traditional Owners to identify sacred sites and have identified cultural exclusion zones. These cultural exclusion zones include a buffer area around the site of concern to provide further protection from any potential disturbance. The proposed Mineral Lease and project infrastructure have been designed to avoid these zones. All Minemakers' employees will be made aware of the location of these cultural exclusion zones through project inductions and access (and therefore disturbance) to these areas will be prohibited. Therefore, the likelihood is **rare** that the Indigenous cultural exclusion zones will be disturbed.

If the Indigenous cultural exclusion zones are disturbed, it is likely that the disturbance would attract the concern of the adjacent Wunara community and associated parties within the wider community, such as the CLC and AAPA; as such the consequence is **major**.

The overall risk is therefore **high**.

Disturbance to Identified Archaeological Site of Moderate Significance

The identified site of moderate archaeological significance is close to a cultural exclusion zone and is not within the Mineral Lease and as such will not be disturbed by mining related activities. During project inductions, all Minemakers' employees will be made aware of the location of areas that have restrictions on access and this archaeological site will be included in these restricted areas. Therefore it is **rare** that the identified archaeological site of moderate significance will be disturbed.

Should the identified site of moderate significance be disturbed, Minemakers will have to notify the Minister responsible for the Heritage Act that an archaeological site had been disturbed without prior consent. The Traditional Owners will be notified and as such it is likely it will attract the concern of the adjacent Wunara community, CLC and the Heritage Branch of DNRETAS. Therefore, any consequence of disturbance will be **moderate**.

The overall risk is therefore **moderate**.

Disturbance to, or Destruction of, Identified Archaeological Sites of Low Significance

It is **likely** that sites of low significance will be disturbed during the mine life.

Minemakers proposes to apply to the Department of Lands, Planning and Environment, for consent to disturb the archaeological sites within the Mineral Lease under the Heritage Act. In this way removal of artefacts from these areas will be undertaken in accordance with Heritage Act. Due to the likelihood of their widespread occurrence across the region, the disturbance and/or destruction of these four sites of low significance will result in no loss of unique or rare archaeological artefacts. Therefore, the consequence of disturbance to these would be **insignificant**.

The overall risk is therefore **moderate**.

Disturbance to, or Destruction of, Unidentified Archaeological Sites of Significance

During construction and operation of the project, some disturbance to unidentified sites of low significance associated with silcrete outcroppings could occur. However, if material is discovered away from silcrete outcroppings, it may be a site of greater significance than those catalogued during the survey; and as such stop work procedures will be implemented and the mine site environmental officer contacted to determine whether further, formal, assessment is required. Overall, it is **possible** that disturbance or destruction of unidentified archaeological sites of significance could occur.

Minemakers proposes to apply to the Department of Lands, Planning and Environment, for consent to disturb the area of the project area (Mineral Lease, northern borefield and water supply pipeline) under the Heritage Act. In this way removal of artefacts from these unidentified sites will be undertaken in accordance with Heritage Act. In addition, the archaeological survey suggests that similar sites occur at all silcrete outcroppings in the area, and due to the likelihood of their widespread occurrence across the area, the loss of these sites would result in no loss of unique

or rare archaeological artefacts. Therefore, the consequence of disturbance to these would be **insignificant**.

The overall risk is therefore **low**.

5.12.5 Monitoring

Monitoring of Indigenous cultural heritage and archaeological sites will primarily involve auditing of the cultural heritage management plan to ensure that all of the commitments therein are being met.

5.13 Infrastructure and Transport

5.13.1 Existing Environment

Road Transport

The Barkly Highway is the major transport link between Northern Territory and Queensland, and the Stuart Highway connects South Australia from the south to Darwin in the north. Tourists and freight transport frequently use both highways; an average of 248 vehicles use the Barkly Highway and 415 use the Stuart Highway south of Three Ways each day (DLP, 2010).

All public roads along the product transport route from the mine to Tennant Creek are sealed, dual carriage way. The speed limit within Tennant Creek is 50 km/hr. Outside of the built-up areas, the default speed limit is 100 km/hr; however, a speed limit of 130 km/hr applies on some parts of the Barkly and Stuart highways.

Current road usage incorporates three groups; local traffic, tourist traffic and freight transport vehicle traffic. According to the 2006 census data, there are approximately 1,659 registered motor vehicles within the Tennant Creek region, consisting mostly of passenger vehicles (915) and light commercial vehicles (538) (ABS, 2009). On average, the Barkly region receives 100,000 holiday makers each year (Travel NT, 2012).

Rail Transport

The Adelaide-Darwin railway line runs through Tennant Creek and is a standard gauge, single-track, open access railway. Access to the Adelaide-Darwin railway is supplied by Genesee and Wyoming Inc., the owner and operator of the infrastructure. The current weekly rail traffic on the line is made up of 34 trains consisting of:

- Intermodal freight.
- Bulk freight.
- Passenger trains.

5.13.2 Potential Impacts

Construction and operation of the project will involve transport of up to 1 Mt/a of P_2O_5 from the project to the East Arm in Darwin and 700,000 t/a of petroleum coke from East Arm to Wonarah. Transport will be a combination of road and rail. The transport of the product has the potential to increase the users of the existing road and rail infrastructure.

The key issues related to increased traffic and the transport of the product is:

- Adverse effects on safety due to increased road traffic.
- Decreasing road and rail capacity due to increased traffic.

- Adverse effects on air quality due to increased traffic related emissions (this is addressed in Section 5.2).
- Adverse effects on amenity due to increased traffic related noise (this is addressed in Section 5.4).

Potential impacts due to increased road and rail traffic are discussed in further detail below.

Increased Risk of Accident

The increased number of vehicles on the road, largely heavy vehicles, may increase the likelihood of road accidents by:

- Reducing average headway between successive vehicles.
- Increasing the rate of road degradation through increased traffic, particularly heavy vehicles.

The degree to which the project increases road traffic levels will depend upon the annual product production rate, i.e., there will be significantly less traffic associated with the project when it is operating at 200,000 t/a of P_2O_5 than when it is operating at 1 Mt/a.

Decreasing Road and Rail Capacity Due to Increased Increment in Traffic

Increases in road and rail traffic as a result of the project could adversely affect the available capacity of this infrastructure.

The 1 Mt/a P_2O_5 production rate equates to 48 round trips by isotainer road trains per day, plus 22 round trips by petroleum coke road trains per day. The current traffic counts for the Barkly Highway show it is not heavily trafficked and when the mine generated traffic is added, the additional traffic volumes do not unduly impact on the Barkly Highway road capacity. The Stuart Highway to the north of Tennant Creek carries more traffic than the Barkly Highway and again, this additional traffic does not severely impact the capacity of the Stuart Highway.

The current road network has an existing capacity of 6,000 annualised average daily traffic (AADT). The peak transport demand projected for the DSO project was 400 AADT, less than 10% of the available capacity. Projected transport demand for the IHP project is anticipated to be less than this. At no stage of the project do predicted volumes approach the lane capacity. Therefore, the proposed traffic increases on the road system are negligible in this regard.

While some upgrades will be required to the existing rail network (i.e., the rail siding at Tennant Creek), Minemakers is consulting with Genesee and Wyoming Inc. to ensure that upgrades to the existing rail infrastructure will be in place prior to the project commencing transport of the product. Therefore, the rail network will have the available capacity to accommodate Minemakers' product transport.

A significant decrease in road and rail capacity is therefore not anticipated as a result of the project. This is therefore not considered to be an impact associated with the project and is not considered further in the residual risk assessment.

5.13.3 Mitigation and Management Measures

Minemakers will implement a traffic management plan, which will include such things as:

- All vehicle operators will be trained and licensed appropriately for the vehicles they are operating.
- A requirement for all vehicle operators to be inducted in the procedures of the plan.

The plan will also cover how to manage project-related road transport issues such as incident hotspots, river crossings, how spills will be handled and the emergency response procedures for this, as well as general aspects such as driver fatigue. Contractors will be required to comply with Minemakers' procedures and the relevant codes and standards for transport, storage and handling of hazardous materials, including emergency response.

Contractors will be required to adhere to Northern Territory road rules at all times.

Future road upgrades will be subject to government funding arrangements and Minemakers will contribute to the maintenance of roads through licence fees, fuel excise, taxes and royalties paid. The proposed traffic increases will conform to all Northern Territory registration controls and will contribute to taxes and other legislative requirements for road maintenance.

Genesee and Wyoming Inc. will be required to maintain the rail tracks to a safe standard at all times and complete any upgrades needed to meet that standard.

5.13.4 Residual Risk

Table 5.17 summarises the residual impacts of the project on road and rail traffic, considering the likelihood and consequence of the predicted impacts after the successful implementation of management and mitigation measures.

Table 5.17 Summary of traffic impacts

Impact	Likelihood	Consequence	Residual Risk
Increased risk of accident due to reduced headway	Possible	Moderate	High
Increased risk of accident due to increased rate of road degradation	Possible	Minor	Low

Increased Risk of Accident due to Reduced Headway

The SPA will be transported using isotainers mounted on roadtrains, petroleum coke will be transported using specially designed containers. The total haul distance from the project to the rail siding is 306.5 km (one way). The operation will be carried out 24 hours/day for 365 days/year, however, an allowance for two weeks of road closures due to flooding or other reasons has been made when calculating the expected product transport requirements.

It is **possible** that there will be an increased risk of accident on a public road due to mine related traffic. The implementation of a traffic management plan will ensure that road transport of the product will be conducted in a responsible and legal manner with minimal disruption to other road users. The consequence of an increased risk of accident is **moderate** as it will attract the concern of the community. The residual risk is therefore **high**. However, when the risk of traffic accidents is placed into context of normal day-to-day driving undertaken by the general public, the risk will most likely be lower.

Increased Rate of Road Degradation

It is **possible** the significant increase in heavy vehicles on the road due to project related activities may result in faster degradation of road infrastructure. Traffic investigations indicate that the design and condition of the roads to be used for the project (and particularly the route for the transport of the product from the mine site to rail siding) is suitable for the increased level of traffic that will result from the project. Maintenance for the road will be the responsibility of government and through royalties, taxes, licence fees and fuel excises Minemakers will make a financial contribution to this. The consequence of a reduced road condition, were it to occur, will be **minor**

as road maintenance will return the road to its current condition. Therefore, the residual risk is **low**.

5.13.5 Monitoring

Minemakers will undertake monitoring of infrastructure and transport facilities associated with the project.

6. ENVIRONMENTAL MANAGEMENT

6.1 Environmental Policy

Minemakers' corporate environmental policy is provided in Figure 6.1. The environmental performance of the company is measured and reported against this policy.

Minemakers' environmental policy is based on the recognition that all activities, including resource development and processing, impact on the environment. Since it is not possible to eliminate this impact, Minemakers' policy is to engineer and conduct operations with the objective of achieving best practice so that adverse effects on the environment are either avoided or managed to an acceptable level.

6.2 Environmental Management System

6.2.1 Objectives

Under the environmental policy, Minemakers is committed to developing an environmental management system (EMS). The system provides a framework that coordinates emergency response, occupational health and hygiene, safety, environment and social responsibility management activities.

The objectives of Minemakers EMS will be to:

- Achieve compliance with regulatory requirements.
- Achieve performance levels/control requirements specified in during the environmental assessment and approvals process.
- Achieve best practice to minimise any adverse effects on the environment.
- Minimise waste generation and emissions and usage of resources.
- Satisfy the public with the company's responses to concerns or enquiries.

The immediate target to achieve these objectives is to develop and implement the various EMS components, including issues-based management plans. Specific objectives and performance standards for various environmental aspects are contained within these issues-based management plans (Attachment C).

6.2.2 Implementation

Minemakers will implement the EMS to reflect the environmental, social and regulatory settings specific to the project. Minemakers will adopt a range of site-specific procedures and documentation to support the EMS. These will include protocols outlining:

- The responsibility of Minemakers management, personnel and contractors.
- Legislative requirements and compliance with Mineral Lease conditions.
- Auditing and review of environmental management procedures.
- Recording and reporting of environmental procedures.
- Emergency response.
- Communications with stakeholders.



ENVIRONMENTAL POLICY

Minemakers Limited regards sound environmental management and protection as an integral part of its business and of playing its part in the community, and is committed to excellence in this area of activity.

Minemakers aims to minimise environmental impacts at every stage of work, from planning, exploration, development, mining, production and through to decommissioning.

To achieve this goal, the Company will:

- seek to identify, monitor and manage all environmental impacts arising from its operations;
- integrate environmental considerations into project planning and operations;
- develop, implement and enforce a comprehensive Environmental Management System;
- provide information and training to our workforce, contractors, suppliers and customers to provide a greater understanding of environmental issues and responsibilities in relation to our business;
- undertake consultation with appropriate community and government groups to ensure that community interests are addressed;
- comply with applicable laws, regulations and standards as a minimum;
- monitor, report and be accountable for our performance and provide safeguards and contingency plans for all activities to detect and prevent any potential impacts;
- review the Company's operations in the context of technological advances to seek improvements in production processes, waste management and the efficient use of resources.

As with all areas of its operations, Minemakers will be a responsible corporate citizen in respect to the environment. All employees and contractors are responsible for upholding the Company's standards of environmental management and care.

Andrew Drummond
Executive Chairman

Approved by the MAK Board on 27 February 2012.

6.3 Responsibility

The Resident Manager will be responsible for ensuring that all activities associated with the project are undertaken in full compliance with statutory regulations and non-statutory obligations, and are consistent with Minemakers' environmental policy.

Minemakers will ensure that the environmental approval conditions are accessible to senior management and other personnel on request at all times. All personnel are responsible for ensuring that their work complies with these conditions and the described environmental management measures. Individual accountability will be defined through conditions of contracts of employment.

Responsibilities of the various personnel involved in the project are outlined in Table 6.1.

Table 6.1 Environmental management responsibilities

Personnel	Responsibilities
Resident Manager	Overall responsibility for the project. Overall responsibility for site-specific implementation of the accepted EIS, including: environment policy, systems and management measures.
Environmental Officer	Reports to the Resident Manager. Ensures EMS is implemented uniformly, revised and maintained. Assesses the suitability and effectiveness of the EMS. Ensures that contractors fulfil their contractual obligations. Implements induction procedures and appropriate training. Ensures compliance with licence conditions and company policy via the establishment and maintenance of appropriate reporting systems and databases. Participates with personnel to improve work practices on site. Undertakes internal site environmental audits. Provides advice as required to other project personnel. Liaison with Northern Territory regulatory authorities. Liaises with stakeholders. Ensures implementation and regular review of environmental management measures.
Contractors	Fulfil contractual obligations.
Archaeologist on call	Provides advice and assessment on call in the event that archaeological material is uncovered during exploration activities undertaken outside the Mineral Lease. Liaises with the relevant community groups and government agencies.
Independent Environmental Auditor	Conducts regular independent environmental audits of the operations to ensure compliance with EIS and statutory regulations.

6.4 Induction

Following appointment, each employee and contractor will undergo a formal comprehensive site induction to ensure that personnel have the appropriate knowledge concerning health and safety, environmental and community relations policies, objectives and targets. The induction will address such areas as:

- Organisational structure and responsibilities for environment and community relations
- Legal and other requirements.
- Site environmental management policies and procedures, including Standard Operating Procedures.
- Cultural heritage and archaeology.
- Site safety and occupational health policies, procedures and employee obligations.
- Hazard and incident reporting and management.
- Emergency services and procedures.
- Site security.
- Employment policies and conditions of employment.

6.5 Key Areas of Management

6.5.1 Compliance with Mineral Lease Conditions

A register of legal and other regulatory requirements will be maintained and updated regularly. This register will capture the requirements of the Mineral Titles Act, other relevant legislation, Mineral Lease conditions and commitments/environmental objectives contained within the environmental approval conditions such that site-specific procedures are developed to ensure that compliance is achieved.

6.5.2 Audit and Review

Minemakers' success in achieving the objectives and targets of its environmental management will be reviewed annually during operation. The EMS, its component environmental management plans (EMP) (see Section 6.6) and the procedures outlined within them will be regularly reviewed during construction and operation of the project to ensure that:

- All project activities are undertaken in compliance with statutory obligations.
- Environmental objectives of the project are achieved.
- A system of continuous improvement is established.
- As further information is obtained, this is incorporated into the plan.

Environmental Audits and Inspections

Supervision and Inspection

The Resident Manager (or their delegate) will undertake regular supervision and inspections of activities to ensure that environmental management procedures are being implemented satisfactorily. The frequency of inspection will depend on the magnitude of risk associated with the particular hazard. Inspection results will be reported to Minemakers periodically.

Compliance Audits

Audits will be undertaken by the Environmental Officer (or their delegate) on a regular basis to ensure compliance with the environmental management procedures and approval conditions.

Complaints

Minemakers will aim to resolve complaints received from stakeholders as soon as possible, although the nature of the complaint will determine the timeframe and actions taken. Table 6.2 sets out indicative timeframes for resolving typical complaints that might be received. Response time is the time taken to secure initial attendance by the Resident Manager (or their delegate) at site after first being made aware of an incident or complaint. Containment time is the time taken to contain the incident after first being made aware of its occurrence.

Table 6.2 Indicative timeframes for response and containment of typical complaints

Type of Complaint	Initial Response Time	Containment Time
Chemical, petrol or oil spill	Within 2 hours of notification	Within 24 hours of notification
Inappropriate vegetation clearing	Within 2 hours of notification	During initial response
Weed/pathogen hygiene not observed	Within 2 hours of notification	During initial response
Dust nuisance	Within 2 hours of notification	Within 24 hours of notification
Noise nuisance	Within 2 hours of notification	Within 24 hours of notification
Damage to land or property not in Mineral Lease	Within 24 hours of notification	Depends on nature of damage
Unacceptable behaviour or abuse of personnel	Within 24 hours of notification	N/A
Request for further information	Initial acknowledgement letter within 24 hours with further follow-up within 5 working days	N/A

The concept of 'response time' will also apply to requests for further information, but in this case it will allow for an initial acknowledgment letter and subsequent investigation of the issue, with a final response in writing.

6.5.3 Recording

The EMS and EMP will become part of an auditable record system maintained by Minemakers. The record system will also include the following:

- PER/EIS and associated documents.
- Approval documents.
- Mining Management Plan (MMP).
- Compliance inspection and audit reports.
- Incidents register.
- Complaints register.
- Consultation records including meeting notes.

In accordance with the principles of AS/NZS ISO 14001:2004, the above EMS documentation will be:

- Easily located and logically filed in hard copy and electronic copy form, including date of issue.
- Available for all Minemakers personnel, contractors and consultants.
- Periodically reviewed and revised as necessary (and clearly dated) by authorised personnel.
- Removed from all points of issue when obsolete.

The Resident Manager will be responsible for ensuring that feedback is assessed and implications for the EMS are acted upon.

6.5.4 Reporting

Routine Reporting Systems

Minemakers will employ the following environmental and social reporting systems:

- Results from environmental monitoring and investigation programs will be reported formally to Department of Mines and Energy (DME) on an annual basis as part of the MMP.
- An annual report dealing specifically with environmental issues will be included in Minemakers internal reports. This will include a summary of non-compliances, corrective actions, and major issues arising from daily supervision and inspection and audits.

Databases

Minemakers will maintain a computerised database for monitoring data and other relevant information. The primary functions of the system will include:

- Recording relevant regulatory documents, e.g., acts of parliament, government policies, permits and dangerous goods or other licences.
- Recording additional information such as training records and the results of environmental audits and reviews.
- Providing other information.
- Recording hydrocarbon usage.

Management Review

Continual improvement is the implicit aim of any EMS and EMP. The EMS and EMP will therefore be subject to review and modification to reflect issues that arise as the project is developed.

6.5.5 Emergency Response

An emergency response plan will be developed that establishes specific actions to manage significant events such as fires, car accidents, chemical or oil spills or product spillage. Particular attention will be paid to the emergency response in the result of a spill of SPA during transport by road to Tennant Creek; Minemakers will also work with Genesee Wyoming regarding emergency response procedures in the event of a spill of SPA during transport by rail to Darwin.

All incidents, both minor and major, will be recorded in an incident register that will form part of the environmental management system documentation. In the event of a major incident the procedure will be to:

- Ensure that the area is safe.
- Take immediate action to contain the incident.
- Report emergencies to the relevant emergency service.
- Notify the relevant regulatory authority.
- Remediate the site.
- Investigate and prepare a report detailing the findings of the environmental incident investigation.

- Review environmental management procedures.

The project will have an emergency response team that is trained to respond to emergencies, lead evacuations and administer first aid.

6.5.6 Communications

The Resident Manager (or their delegate) will maintain consultation with stakeholders, including:

- Department of Mines and Energy.
- Department of Lands, Planning and environment.
- NT Worksafe.
- Central and Northern Land Councils.
- Wunara community.
- Project personnel.
- Other stakeholders as relevant.

Matters for consultation will include operational issues, potential impacts of the project on other parties and their management, and safety or environmental incidents. Consultation may be required on an ad-hoc basis for some stakeholders (in terms of issues to be covered and timing of communications); while for others a structured program may be required. Depending on the stakeholder involved, consultation may take the form of telephone communications, formal written correspondence, one-on-one informal meetings or formal gatherings. Significant stakeholder consultation will be recorded in a stakeholder database and kept in the site office.

A Complaints Register will be established to:

- Record complaints received from stakeholders.
- Identify the party/person responsible for dealing with the complaint.
- Record the action(s) taken to resolve the complaint.
- Record communication with the complainant (including feedback).

Further detail on stakeholder consultation is provided in Chapter 4.

6.6 Environmental Management Plan

A risk-based EMP will be developed for the project to:

- Document project commitments and impact mitigation requirements.
- Document conditions of approval resulting from the environmental approval process.
- Provide the basis for the development of environmental guidelines and work procedures to be prepared by the construction contractor.

The following issue-based management plans will be developed to manage risks for the main environmental impacts of the IHP project discussed in Chapter 5:

- Air Quality Management Plan.
- Waste Management Plan (which includes both hazardous and non-hazardous wastes).
- Fire Management Plan.
- Emergency Response Plan.
- Groundwater Management Plan.
- Cultural Heritage Management Plan.
- Flora Management Plan

- Fauna management Plan
- Mosquito Management Plan.
- Sediment and Erosion Control Plan.
- Stakeholder Consultation Plan.

The EMPs are strategic documents that describe the framework for environmental management for construction, operation and decommissioning phases of the project. The EMPs will be drafted during and finalised after the PER/EIS assessment is complete and will take into account comments received during the public display period. The EMPs will also incorporate recommendations and conclusions contained in the PER/EIS Assessment Report and approval conditions. The plans will be used directly in the Mining Management Plan for the project.

7. GLOSSARY

7.1 Units and Symbols

%	Percent
/a	Per annum
/cm	Per centimetre
/d	Per day
/h	Per hour
/L	Per litre
/s	Per second
/wk	Per week
/yr	Per year
A\$	Australian dollars
dB(A)	Decibels (A-weighted)
dB L	Decibels linear
°C	Degrees Celsius
cm	Centimetres
g/m²/month	Grams per square metre per month
GL	Gigalitres
ha	Hectare
kg	Kilogram
kL	Kilolitre
km	Kilometre
km²	Square kilometre
kt	Kilo tonne
kWh	Kilowatt hour

L	Litre
µm	Micrometre
µg/m³	Microgram per cubic metre
m	Metre
m²	Square metre
m³	Cubic metre
M	Million
mg	Milligram
ML	Mega litres
mm	Millimetre
Mt	Million tonnes
Mtpa	Million tonnes per annum
MW	Megawatt
ppm	Parts per million
t	Metric tonne
t/a	Tonnes per annum
TJ	Tera joule
US\$	United States dollar
W	Watt

7.2 Abbreviations

AADT	Annualised average daily traffic
AAPA	Aboriginal Areas Protection Authority
ABS	Australian Bureau of Statistics
AKD	Australian Kimberley Diamonds Ltd
ALARP	As low as reasonably practicable

ANC	Acid neutralising capacity
ANZECC	Australian and New Zealand Environment Conservation Council
ARD	Acid rock drainage
ARMCANZ 2000	Agriculture and Resource Management Council of Australia and New Zealand 2000
ARI	Average recurrence interval
AS/NZS	Australian standard/New Zealand standard
ASX	Australian Stock Exchange
bgl	Below ground level
BFS	Bankable feasibility study
BoM	Bureau of Meteorology
CCTV	Closed circuit television
CFC	Chlorofluorocarbon
CH₄	Methane
CLC	Central Land Council
CO	Carbon monoxide
CO₂	Carbon dioxide
COF	Coffey International, ASX code
CWAA	Country Woman's Association of Australia
DEC	New South Wales Government Department of Environment and Conservation
DERM	Queensland Government Department of Environment and Resource Management
DEWHA	Australian Government Department of the Environment, Water, Heritage and the Arts
DFS	Definitive feasibility study
DG	Dangerous good

DLPE	Northern Territory Government Department of Lands, Planning and the Environment
DLRM	Northern Territory Government Department of Land Resource Management
DME	Northern Territory Government Department of Mines and Energy
DNRETAS	Northern Territory Government Department of Natural Resources, Environment, the Arts and Sport
DSEWPaC	Australian Government Department of Sustainability, Environment, Water, Population and Communities
DSO	Direct shipping ore
EC	Electrical conductivity
ECNT	Environment Centre Northern Territory
EIS	Environmental Impact Statement
EL	Exploration Licence
EMP	Environmental management plan
EMS	Environmental management system
EPA	Northern Territory Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERP	Emergency response plan
F	Fluorine
Fe	Iron
FIFO	Fly-in, fly-out
GIS	Geographic information system
GRM	Groundwater Resource Management Pty Ltd
H₂SO₄	Sulfuric acid

HFCs	Hydrofluorocarbons
IHP	Improved hard process
ILUA	Indigenous Land Use Agreement
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
JDCP	JDCPhosphate Incorporated
JORC	Joint Ore Reserves Committee
MAK	Minemakers Australia Pty Ltd, ASX code
MARP	Mining and rehabilitation program
MCA	Minerals Council of Australia
MMP	Mining Management Plan
N₂O	Nitrous oxide
NAF	Non-acid forming
NEPC	National Environment Protection Council
NEPM	National Environmental Protection Measure
NGA	National greenhouse accounts
NGER Act	<i>National Greenhouse and Energy Reporting Act 2007</i>
NLC	Northern Land Council
NO₂	Nitrogen dioxide
NOI	Notice of Intent
NO_x	Nitrogen oxides
NPI	National Pollutant Inventory
NT	Northern Territory
NTICN	Northern Territory Industry Capability Network
OWS	Oily water separator

P₂O₅	Phosphorite
PER	Public Environmental Report
PFCs	Perfluorocarbon
PPE	Personal protective equipment
RFDS	Royal Flying Doctor Service
ROM	Run of mine
SEL	Substitute Exploration Lease
SF₆	Sulfur hexafluoride
SO₂	Sulfur dioxide
SPA	Super phosphoric acid
SSF	Slime storage facility
SWMA	Surface water management area
TDS	Total dissolved solids
TPWC Act	<i>Territory Parks and Wildlife Conservation Act</i>
TSP	Total suspended particulate
TSS	Total suspended solids
USA	United States of America

7.3 Words

A

Aboriginal: Of or pertaining to members of the Indigenous people of Australia.

Anthropocentric: Interpreting or regarding the world in terms of human values and experiences.

Anthropogenic: Relating to or resulting from the influence that humans have on the natural world.

Aquifer: A water-bearing layer of sediment or rock.

Archaeological site: Cultural heritage site with physical evidence of past cultural activity visible on or in the ground.

Artefact: Anything made by human workmanship, particularly by previous cultures.

B

Backfill: 1. *v.* To refill an excavation with the material previously removed from that excavation. 2. *n.* The material used in that backfilling.

Best practice: A process, technique, or use of technology, equipment or resource that has a proven record of success.

Bore: A well, usually less than 20 cm diameter, sunk into the ground and from which water is pumped.

Bund: An embankment constructed around an area to prevent the inflow or outflow of liquids.

C

Calcareous: Resembling or containing calcium carbonate or limestone.

Calcarosols: Soils with calcium carbonate often formed on limestone. Restricted to small pockets in Central Australia, Victoria River District including Gregory National Park and Katherine and Mataranka Districts.

Cambrian: The first geological period of the Paleozoic era, lasting from 542 ± 0.3 million years ago to 488.3 ± 1.7 million years ago

Catchment: The entire land area from which water (e.g., rainfall) drains to a specific water course or waterbody.

CO₂-equivalent: The concentration of CO₂ that would cause the same level of radiative forcing as a given type and concentration of greenhouse gas.

Cultural heritage: The cultural history of a region or of a people; the engagement of people with their customary practices (particularly through specific sites) in the past and in the present.

D

dB(A): decibels, A-weighted scale; unit used for most measurements of environmental noise; the scale is based upon typical responses of the human ear to sounds of different frequencies.

Dewater: To remove water from (e.g., a mine pit or an aquifer).

Disturbed ground: An area of ground that has been disturbed by construction or operations activities for the project.

E

Emission: A discharge of a substance (e.g., dust) into the environment.

Ephemeral: Having an intermittent flow, especially said of a watercourse.

Erosion: The wearing away of the land surface (whether natural or artificial).

F

G

Ground disturbance: Any activity that causes ground to be disturbed, i.e., excavating, trenching, traversing, or clearing ground to provide access for construction or operation of the project.

Groundwater: Water naturally stored beneath the surface of the earth, which saturates the pores and fractures of sand, gravel and rock formations.

H

Hazard: An agent or situation capable of potentially injuring or compromising the health and safety of a person or causing damage to plant or premises.

Hydraulic conductivity: The volume of water that will flow in a unit time under a unit hydraulic gradient through a unit area.

I

Incident: An event on site that has the potential to cause an adverse effect on:

- The safety or health of a person.
- The environment on a mining site.
- The plant or equipment on a mining site.

Indigenous: Persons of Australian Aboriginal and Torres Strait Islander origin.

IUCN Red List: The 1994 International Union for Conservation of Nature (IUCN) Red List, compiled by the World Conservation Monitoring Centre, includes more than 6,000 animal species known to be at risk and threatened with extinction.

J

K

Kandosols: Soils that are massive and earthy (formerly red, yellow and brown earths). Throughout the Northern Territory; widespread across the Top End, Sturt plateau, Tennant Creek regions and Central Australia.

Karst: The characteristic landform of limestone regions, typically including underground streams, sinkholes, and steep-sided gorges.

L

M

Monitoring: Systematic sampling and, if appropriate, sample analysis to record changes over time caused by impacts associated with development such as mining.

N

O

Ore: a mineral or mixture of minerals containing an element or compound in sufficient amounts for its extraction to be profitable.

P

Palaeozoic: The earliest of three geologic eras of the Phanerozoic eon. The Paleozoic spanned from roughly 542 to 251 million years ago, and is subdivided into six geologic periods; from oldest to youngest they are: the Cambrian, Ordovician, Silurian, Devonian, Carboniferous and Permian.

Particulate matter: Material 10 microns or less in size and capable of being breathed deep into the lungs, the amount of particulate matter in the air is used as an indicator of health risk.

PM₁₀: The fraction of dust with a particle size of 10 µm or less; a health indicator for the fine particles of respirable dust capable of being inhaled into the lungs.

PM_{2.5}: The fraction of dust with a particle size of 2.5 µm or less; a health indicator for the very fine particles of respirable dust capable of deep penetration into the lungs and alveoli.

Q

R

Rehabilitation: The measures taken to stabilise disturbed land, such as recontouring, drainage and topsoil respreading.

Revegetation: The natural or active re-establishment and development of plant cover; natural revegetation (also called passive revegetation) takes place without intervention and active revegetation takes place with intervention using artificial means, such as ground preparation, fertilisation, seeding or seedling planting.

Reverse osmosis: The filtration process in which pressure is used to force a solution through a membrane, retaining the solute on one side and allowing the pure solvent to pass to the other. Commonly used to purify drinking water.

Right of Way: The prepared surface from which the pipeline construction crew can carry out the pipeline installation work.

Rudosols: Very shallow soils or those with minimal soil development. Includes very shallow rocky and gravelly soils across rugged terrain such as the Arnhem Plateau and also the sands of the Simpson Desert.

Runoff: That portion of precipitation (rain, hail and snow) that flows from a specific area as water.

S

Seepage: Subsurface movement of water.

Stockpile: A pile used to store material (such as low-grade ore) for future use.

Surface water: All water flowing over, or contained on, a landscape (e.g., runoff, streams, lakes).

T

Total suspended solids (TSS): A common measure used to determine suspended solids concentrations in a waterbody and expressed in terms of mass per unit of volume (e.g., milligrams per litre).

Traditional Owner: A descendent of the tribe or ethnic group that occupied a particular region before European settlement.

U

V

Vegetation clearing: The removal, destruction or lopping of vegetation.

Vertosols: Cracking clay soils which may or may not be poorly drained. Common across coastal floodplains of the Top End, the Barkly Tableland and alluvial plains of the Victoria River District.

W

Notice of Intent
Wonarah IHP Project

X

Y

Z

8. REFERENCES

- AKD. 2005. Wonarah phosphate deposit Northern Territory. February. Report prepared by AKD Ltd, West Perth, Western Australia.
- ABS. 2009. National Regional Profile: Tennant Creek (T) (Local Government Area). Australian Bureau of Statistics. A WWW publication accessed on 14 September 2009 at <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/>.
- CDIAC. 2012. Carbon Dioxide Information Analysis Centre. A WWW publication accessed on 3 December 2012 at http://cdiac.ornl.gov/trends/emis/meth_reg.html.
- DCC. 2012. National greenhouse accounts (NGA) factors. A WWW publication accessed on 20 November 2012 at <http://www.climatechange.gov.au/~media/publications/nga/NGA-Factors-20120829-PDF.pdf>. Department of Climate Change. July.
- DEH. 2012. Woma profile. A www publication accessed 20 November 2012 at <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10069>. Fact sheet released by Department of Environment and Heritage, NSW.
- DHCS. 1996. Code of Practice for the small on-site sewage and sullage treatment systems and the disposal or reuse of sewage effluent. Department of Health and Community Services. November.
- DLP. 2010. Annual Traffic Report 2010. A report prepared by Territory Asset Management Services. Department of Lands and Planning, Road Network Division. Darwin, Northern Territory.
- DME. 2012a. Environmental Assessment of Mining Proposals. Department of Mines and Energy Advisory Note, AA7-009. Northern Territory. November.
- DME. 2012b. Georgina Basin. A WWW publication accessed on 5 December 2012 at http://www.nt.gov.au/d/Minerals_Energy/Geoscience/index.cfm?header=Georgina%20Basin. Department of Mines and Energy. Darwin, Northern Territory.
- DNRETAS. 2010a. Wonarah phosphate project: environmental assessment reports and recommendations. Assessment report 64. Report prepared by Environment, Heritage and Arts Division. Department of Natural Resources, Environment, the Arts and Sport. Darwin, Northern Territory.
- DNRETAS. 2010b. Land Clearing Guidelines, Northern Territory Planning Scheme. Department of Natural Resources, Environment, The Arts and Sport, Darwin. Northern Territory.
- DNRETAS. 2012. Information guidelines for a notice of intent (NOI). A WWW publication accessed on 3 December 2012 at <http://www.nretas.nt.gov.au/environment-protection/assessment/page5>. Northern Territory.
- DoT. 2012. Policy - Road traffic noise on NT Government controlled roads. A WWW publication accessed on 10 December 2012 at <http://www.transport.nt.gov.au/ntroads/nt-roads-policies/traffic-noise>. Department of Planning and Infrastructure, Road Networks Division, Darwin, Northern Territory.
- Edgoose, C. J. 2003. Barkly Tableland region, Northern Territory. Department of Lands, Planning and Environment, Alice Springs, Northern Territory.
- EnviroNorth. 2012. Grazing in the Barkly Tablelands. A WWW publication accessed on 3 December 2012 at http://www.environorth.org.au/windows/mg/mg_grazing_barkly_tablelands.html. Australia.

- EPA. 2010. Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory. Environment Protection Agency, Department of Natural Resources, Environment, the Arts and Sport. Northern Territory.
- Hackman, D., Teh, M., Chouzadjan, K., and Watkins, R. 2000. Wonarah phosphate project prefeasibility study. January. Internal report prepared by Rio Tinto Technical Services, South Melbourne, Victoria.
- IFC. 2007. Stakeholder Engagement: A good practice handbook for companies doing business in emerging markets. International Finance Corporation. USA.
- Madden, R. 1994. Australian National Accounts Input-Output Multipliers 1989-1990. Report prepared for the Australian Bureau of Statistics, Canberra.
- MCA. 2005. Enduring Value: The Australian Minerals Industry Framework for Sustainable Development, Guidance for Implementation. A www publication accessed on 16 November 2012 at http://www.minerals.org.au/file_upload/files/resources/enduring_value/EV_GuidanceForImplementation_July2005.pdf. Minerals Council of Australia.
- MMA. 2012. Traffic noise background information. A WWW publication accessed on 20 November 2012 at <http://www.drnoise.com/projects/traffic.asp> Michael Minor and Associates. Portland, Oregon, USA.
- NCST. 2009. Australian Soil and Land Survey Field Handbook. 3rd ed. The National Committee on Soil and Terrain. CSIRO Publishing. Victoria.
- Owen, G. and Meakin, C. 2003. Land Use Mapping of the Northern Territory. Prepared for the Northern Territory Department of Infrastructure, Planning and Environment, Northern Territory.
- Pavey, C. 2006. National Recovery Plan for the Greater Bilby *Macrotis lagotis*. Report prepared for Northern Territory Department of Natural Resources, Environment and the Arts.
- PIRSA. 2009. Guidelines for miners: preparation of a mining lease proposal or mining and rehabilitation program (MARF) in South Australia. Version 4.9. Prepared by the Mineral Resources Group, Primary Industries and Resources South Australia.
- Standards Australia. 2004a. Risk Management AS/NZS 4360:2004. Report prepared by Standards Australia and Standards New Zealand, Sydney, New South Wales.
- Standards Australia. 2004b. Handbook Risk Management Guidelines Companion to AS/NZS 4360:2004. Report prepared by Standards Australia and Standards New Zealand, Sydney, New South Wales.
- Standards Australia. 2006a. Handbook Delivering assurance based on AS/NZS 4360:2004 Risk Management. Report prepared by Standards Australia, Sydney, New South Wales.
- Standards Australia. 2006b. HB 203:2006 Environmental risk management – Principles and process. Report prepared by Standards Australia, Sydney, New South Wales.
- Travel NT. 2012. Destinations/Tennant Creek and surrounds. A WWW publication accessed on 10 December 2012 at <http://www.travelnt.com/tennant-creek-and-barkly-region.aspx>.
- US Environmental Protection Agency. 1998. Guidelines for Ecological Risk Assessment. US Environmental Protection Agency, Washington, DC, United States of America.
- Whelan, P. and Warchot, A. 2005. Guidelines for preventing mosquito breeding sites associated with mining sites. A report for the Department of Health and Families, Northern Territory.
- White, M., Albrecht, D., Duguid, A., Latz, P., and Hamilton, M. 2000. Plant Species and Sites of Botanical Significance in the Southern Bioregions of the Northern Territory. Volume 1: Significant Vascular Plants. A report to the Australian Heritage Commission from the Arid Lands Environment Centre. Alice Springs, Northern Territory of Australia.