Marda Operations Pty Ltd

ACN: 71 124 374 321

Marda Operations Pty Ltd
PO Box 6070
East Perth WA 6892
Level 1, 130 Royal Street, East Perth WA 6004
Tel: (08) 9202 1127

16/12/2021

Ms Jessica Allen
Senior Environmental Officer
Environmental Impact Assessment South
EPA Services
Department of Water and Environmental Regulation

Dear Ms Allen

DIE HARDY PROJECT – REFERRAL TO THE EPA

Marda Operations Pty Ltd, a wholly-owned subsidiary of Ramelius Resources Ltd (Ramelius), proposes to undertake a small gold mining project at its Die Hardy Project (the Project), north of the town of Southern Cross. The company has recently prepared and submitted a Mining Proposal (MP) and associated Mine Closure Plan (MCP) to the Department of Mines, Industry Regulation and Safety (DMIRS) for this Project.

This letter is in response to a request from the Environmental Protection Authority (EPA) Services of the Department of Water and Environmental Regulation (DWER) to refer the Project under Section 38 of the *Environmental Protection Act 1986* (EP Act) (refer to Attachment 1). This letter introduces the project and discusses key issues. A referral form is included as Attachment 2.

Background

In 2014, Southern Cross Goldfields Ltd referred the Marda East Gold Project under section 38 of the *Environmental Protection Act 1986*. The project comprised two open pits (Red Legs and Fiddleback) and associated infrastructure. While the project was advertised, a level of assessment of Assessment on Proponent Information (API) - Category A was determined by the Environmental Protection Authority. However, the assessment did not proceed.

In 2019, Ramelius acquired the project under tenure held by Marda Operations Pty Ltd. The current proposal for the Die Hardy Project is similar to that referred in 2014 except it excludes the Red Legs deposit, and the Fiddleback open pit has been renamed Die Hardy.

Overview of the Die Hardy Project

Marda Operations Pty Ltd proposes to develop an open pit gold mine and associated infrastructure at the Project site. Mined ore would be hauled to the Edna May Operations mine site (Attachment 3, Figures 1 and 2) for processing along existing roads. No processing of ore will occur at the Project site.

The project will comprise the following components:

- A waste rock landform (WRL);
- The Die Hardy mine void;
- Turkeys nest dam – saline water;
- Mine ore pad (MOP);
- Office and buildings (crib and ablutions);
- Topsoil stockpiles;
- Transport infrastructure corridor (access and haul roads); and
- Water bores and pipelines.

The site layout is shown in Attachment 3, Figure 3.

Workers will be accommodated at the existing Windarling camp under agreement with Mineral Resources Limited.

Environmental factors

A summary of the relevant environmental factors in this proposal is presented in the following table. A more detailed description of the project and the environmental factors is presented in the Mining Proposal document submitted for assessment under the *Mining Act 1978* and included here as Attachment 4.

Table 1: Die Hardy Project – preliminary environmental factors and proposed approach

Factor	Key Information
Flora and Vegetation	• Vegetation clearing of a total of 90 ha. • Located within the boundary of a Priority 1 Ecological Community; Die Hardy Range/Diemels vegetation complex (banded ironstone formation) which encompasses an area of 16,500 ha. The total survey area represents less than 0.1% of the total extent of this Priority Ecological Community (PEC). • No Threatened or Priority Flora have been recorded (three Priority species occur at the Red Legs deposit, excluded from the current proposal). Potential impacts to this environmental factor from the proposed Project are considered not significant. This factor can be managed under an existing approved Native Vegetation Clearing Permit (NVCP) (8931/1) (included as Attachment 5 together with decision report) and under pending Mining Act approvals.
Terrestrial Fauna	• Fauna habitats are widespread. • Desktop surveys have identified a total of 14 species of conservation significance with the potential to occur in the area. Of these, only one,

Factor	Key Information
	the Malleefowl, is known to occur. However, there are no known mounds within the area. Potential impacts to terrestrial fauna as a result of the proposed Project are considered not significant. This factor can be managed under pending Mining Act approvals. There is also a precautionary condition relating to Malleefowl in the existing approved Native Vegetation Clearing Permit (NVCP) (8931/1).
Landforms	The proposed Project footprint occurs in an area of low relief outside of the Die Hardy Range itself. The project area is described as alluvial plains (very gently inclined plains receiving sheet wash from mafic hills, gently undulating calcareous stony upper plains). Landform was a potential environmental factor at the Red Legs deposit, now excluded from the current proposal. Landforms is considered not a relevant factor in this Project.
Terrestrial Environmental Quality	A waste rock landform will be constructed on the eastern side of the mine void. The waste rock has been characterised and the landform designed to provide for permanent encapsulation of material. Impacts to this environmental factor (within the Project footprint and adjacent to) are considered not significant. This factor can be managed under pending Mining Act approvals, including a Mine Closure Plan (MCP).
Social Surroundings	• Archaeological and ethnographic surveys of aboriginal heritage identified one area of ethnographic significance. This area is outside of the Project area and the tenements on which the proposed Project will occur. • There are no known sites of European heritage significance. • There is potential for localised dust generation as a result of mining activities. Management will be by routine dust suppression methods. There are no nearby sensitive receptors. • In terms of visual amenity, the project will be theoretically visible from the Bullfinch-Evanston Road. Views from some locations on the Die Hardy range are also theoretically possible but these areas have no public vehicle access. An assessment included with the previous referral determined the view from public roads would be “negligible at best and ‘blending’ at worst”. (This assessment included the Red Legs deposit, now excluded from the Project). Social Surroundings is considered not a relevant factor in this project. Issues relating to dust management can be managed under pending Mining Act approvals.
Inland Waters	• There are no surface water bodies or drainage lines in the Project area. Sheet flow may occur at times of heavy rainfall. • There are no groundwater dependent ecosystems (GDE) and local groundwater is brackish.

Factor	Key Information
	This factor can be managed under pending Mining Act approvals, including a MCP, as impacts to this environmental factor are considered not significant.

Stakeholder consultation

Ramelius has undertaken consultation regarding this project chiefly with DMIRS (Clearing Permit and Mining Proposal/Mine Closure Plan approvals) and with the Department of Biodiversity, Conservation and Attractions (DBCA) (requirements around Project operational and closure issues on DBCA-managed land). A detailed description of stakeholder consultation is provided in section 5 of the Mining Proposal (Attachment 4).

Assessment under Part IV of the Environmental Protection Act 1986

This referral has been provided at the request of EPA Services (see Attachment 1). While the EPA determined the previous 2014 Project proposal warranted assessment, Ramelius is of the view the current proposal does not warrant assessment under Part IV of the EP Act.

The key rationale behind this view relates to the exclusion of the Red Legs deposit. This deposit occurs on the foot slopes of the Die Hardy Range. Were this deposit to be mined, there would be impacts on three Priority plant species associated with the Priority 1 Ecological Community; Die Hardy Range/Diemels vegetation complex (banded ironstone formation). These species, nor any other Priority species, do not occur at the Die Hardy deposit.

Secondly, given the location of the Red Legs deposit at an elevation above the Bullfinch-Evanston Road, impacts to visual amenity are reduced by its exclusion. Similarly, impacts to significant landforms such as the Die Hardy Range are also reduced by the exclusion of the Red Legs deposit, albeit the deposit only occurred on the foot slopes and is unlikely to have changed the character of the landform in that area.

Ramelius notes the original referral in 2014 identified two environmental factors – Landforms and Amenity – as requiring assessment. This conclusion was reached in consultation with the various regulatory authorities at the time. As discussed above, exclusion of the Red Legs deposit effectively removes these environmental factors as considerations in the current proposal.

The Project area coincides with a section 5(1)h reserve, as defined by the *Conservation and Land Management Act 1984*. This conservation reserve has two permitted land uses; conservation and mining. The proposed Project is compatible with the latter land category.

Conclusion

It is Ramelius' view the current proposal can be managed under an existing NVCP and pending approvals under the Mining Act and does not warrant assessment under Part IV of the EP Act.

Yours sincerely

Glenn Firth
Group Environment Manager
Ramelius Resources Ltd

M: 0448 052 059

E: glennfirth@rameliusresources.com.au

Attachment 1 – EPA Services Correspondence

Attachment 2 – Referral form

Attachment 3 - Figures

Attachment 4 – Mining Proposal

Attachment 5 – NVCP

Attachment 1

EPA Services Correspondence

From: Jessica Allen <Jessica.Allen@dwer.wa.gov.au>
Sent: Friday, 5 November 2021 9:45 AM
To: Glenn Firth <GlennFirth@rameliusresources.com.au>
Subject: Die Hardy Project

Hi Glenn,

EPA Services has been reviewing the Die Hardy Project, that was sent through from Department of Mines, Industry Regulation and Safety for liaison on 26 August 2021. EPA Services has sought internal Department of Water and Environmental Regulation advice on the legal aspects relating to the proposal and met with Ramelius Resources on 18 October to understand more about the proposal.

EPA Services is primarily concerned about the similarities between Ramelius Resources Limited's Die Hardy Project and the Marda East Gold Project, and whether Ramelius Resources Limited is constrained from implementing the Die Hardy Project under section 41A(2) of the *Environmental Protection Act 1986* (EP Act).

In August 2014, the Marda East Gold Project was referred to the Environmental Protection Authority (EPA) under section 38 of the EP Act by the proponent Southern Cross Goldfields Ltd. The proposal was to mine ore from two deposits, Red Legs and Fiddleback (formerly known as Die Hardy), located 140 kilometres north of Southern Cross. The EPA set the level of assessment on the above proposal as Assessment on Proponent Information (API) - Category A. The proponent was required to prepare an Environmental Review document in accordance with a scoping guideline. There were delays with the proponent providing an Environmental Review document and pursuant to section 40A of the EP Act, the EPA terminated the assessment.

Section 41A(1) of the EP Act provides that *'If a decision of the Authority that a proposal is to be assessed has been set out in the public record under section 39, a person who does anything to implement the proposal before a statement is published under section 45(5)(b) or a notification is given under section 45(8) commits an offence'*. Section 41A(2) provides that section 41A(1) *'…applies even if the assessment of the proposal has been terminated under section 40A and applies as if the references to section 45(5)(b) and (8) were references to the application of the those provisions to any revised or further proposal referred to the Authority under section 38 in place of the terminated proposal'.*

There are similarities between the proposals that make it likely the Die Hardy Project is a revised proposal. These include:

- at a fundamental level, the proposals are both for an open pit gold mine at the Fiddleback/Die Hardy deposit with a waste rock landform and associated infrastructure;
- with the exception of the Red Legs ore deposit and the associated haul road to the Red Legs deposit, the development envelopment associated with the Fiddleback deposit is the same in each proposal, with the development being located on the same mining tenements;
- the expected life of the projects are roughly the same (24 months and 20 months), with the Die Hardy Project having a slightly shortly expected operational life; however
- the proposed mining operations at the Fiddleback deposit are not exactly the same in each proposal, with the Die Hardy Project having a larger pit and a different site layout.

As a revised proposal, section 41A(1) and (2) of the EP Act require the proponent to refer the proposal to the EPA under section 38.

<u>EPA Services recommends that Ramelius Resources Limited refer the Die Hardy Project to the EPA.</u>

If you have any queries please let me know.

Kind regards,
Jessica

Jessica Allen
A/Senior Environmental Officer
Environmental Impact Assessment South
EPA Services

Department of Water and Environmental Regulation
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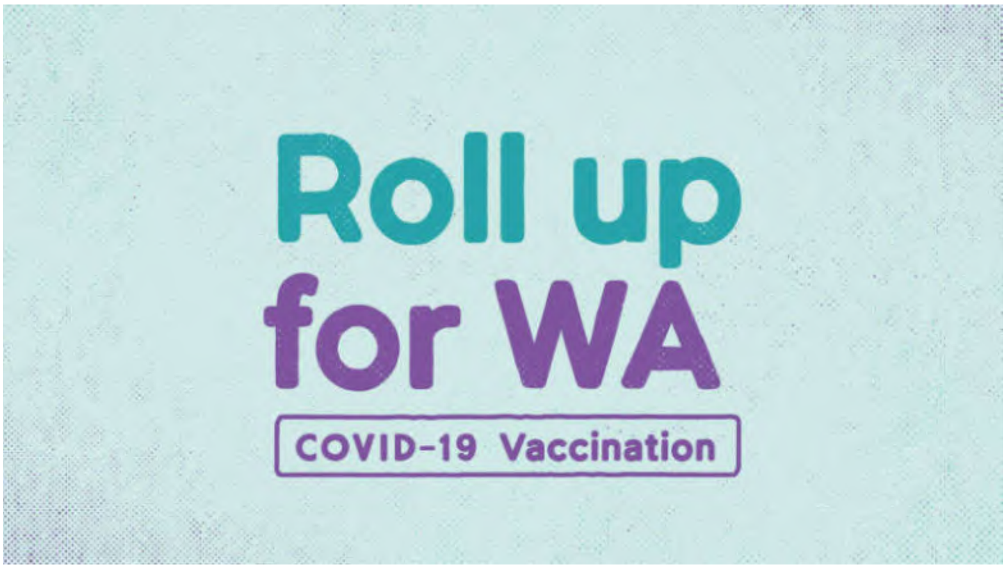


Attachment 2
Referral form

Form

Referral of a proposal under s. 38 of the EP Act

PART A: PROPONENT AND REFERRER INFORMATION AND PROPOSAL DESCRIPTION		
Referrer information		
Who is referring this proposal?	✓ Proponent ☐ Decision-making authority ☐ Community member/third party	
Name of the referrer *Name of the person or organisation referring*	Marda Operations Pty Ltd (a wholly-owned subsidiary of Ramelius Resources Ltd)	
Contact details (for the EPA's assessment of this proposal) *Name, organisation, position, email, phone and address*	Glenn Firth Ramelius Resources Ltd Group Environmental Manager GlennFirth@rameliusresources.com.au	
Does the referrer request that the EPA treat any part of the proposal information in the referral as confidential? *Provide confidential information in a separate attachment.*		☐ Yes ✓ No
Declaration I, …**Glenn Firth**… declare that I am authorised to refer this proposal on behalf of …**Marda Operations Pty Ltd**… and further declare that the information contained in this form is true and not misleading.		
Proponent information		
Name of the proponent/s *Include Trading Name if relevant*	Marda Operations Pty Ltd (a wholly-owned subsidiary of Ramelius Resources Ltd)	
Australian Company Number(s) ☐ Australian Business Number(s) ✓	Marda Operations Pty Ltd – ABN 84 153 608 596 Ramelius Resources Ltd - ABN 51 001 717 540	
Pre-referral discussions		
Have you had pre-referral discussions with the EPA (including the EPA Services of DWER)? *See Cover Letter and Attachment 4*	✓ Yes ☐ No	
Proposal information		
Proposal name	Die Hardy Gold Project	
What is the proposal? (Include general description in the *Instructions and template: How to identify the content of a proposal)*	Refer to attached documentation, including: 1. Cover letter; and 2. Mining Proposal (Attachment 4).	

<table>
<tr><td colspan="2">Have you provided electronic spatial data, maps, and figures in the appropriate format?</td><td>✓ Yes
☐ No
Spatial data for the Development Envelope has been included in this package.</td></tr>
<tr><td>What type of proposal is being referred?

For significant amendment or derived proposal, provide the associated existing Ministerial statement number/s

For a proposal under an assessed planning scheme, provide the scheme number and name</td><td colspan="2">☐ significant proposal. Choose which type of significant proposal
☐ new proposal
☐ significant amendment (proposal only)
☐ significant amendment (conditions only)
☐ significant amendment (proposal and conditions)
☐ strategic proposal
☐ derived proposal
☐ proposals of a prescribed class
☐ proposal under an assessed planning scheme

Ramelius Resources Ltd considers the proposed Project (Proposal) not significant. This form and attachments have been prepared in response to correspondence from the Environmental Protection Authority (EPA) Services of the Department of Water and Environmental Regulation (DWER), dated 5 November 2021 (Attachment 4).</td></tr>
<tr><td colspan="3">Proposal content: Complete the corresponding template (Proposal Content Document) from the Instructions and template: How to identify the content of a proposal for the type of proposal identified above. The completed form must be submitted with the referral.</td></tr>
<tr><td>Alternatives</td><td colspan="2">This referral has been prepared using a covering letter supported by other relevant documentation. Assessment has been undertaken under section 51E of the Environmental Protection Act 1986 (completed and approved) (EP Act) and the Mining Act 1978 (Mining Act) (pending).</td></tr>
</table>

<table>
<tr><td colspan="2">PART B: ASSESSMENT OF ENVIRONMENTAL IMPACTS</td></tr>
<tr><td colspan="2">Environmental factors</td></tr>
<tr><td>What are the likely significant environmental factors for this proposal?

Not Applicable. There are no likely significant environmental factors for this Proposal. See cover letter for a general discussion of environmental factors.</td><td>☐ Benthic Communities and Habitat
☐ Coastal Processes
☐ Marine Environmental Quality
☐ Marine Fauna
☐ Flora and Vegetation
☐ Landforms
☐ Subterranean Fauna
☐ Terrestrial Environmental Quality
☐ Terrestrial Fauna
☐ Inland Waters
☐ Air Quality
☐ Greenhouse Gas Emissions
☐ Social Surroundings
☐ Human Health</td></tr>
<tr><td colspan="2">For each of the environmental factors identified above, complete the following table, or provide the information in a supplementary report</td></tr>
</table>

Potential environmental impacts – for each environmental factor
See cover letter
Holistic impact assessment
Not applicable – no significant impacts are predicted.
Cumulative environmental impact assessment
There are no other mines nearby although mineral exploration activity has occurred locally. The Windarling iron ore mine is about 15 km to the south-west of the proposed Die Hardy Project.
Consultation
Ramelius has undertaken consultation with DMIRS and DBCA in respect of this proposal (see section 5 of the Mining Proposal – Attachment 4).
Supporting documents
Cover letter with the following attachments: • Attachment 1 – EPA Services correspondence • Attachment 2 – This Referral Form • Attachment 3 – Figures • Attachment 4 - Mining Proposal – Die Hardy Project • Attachment 5 – Native Vegetation Clearing Permit (NVCP) 8931/1 Spatial data for the Development Envelope is also attached.

Has the referrer provided survey information according to the *Instructions and Form: IBSA Data Packages* and/or the *Instructions and form: IMSA Data Packages* The project flora and fauna surveys were conducted in 2014 at the time of the original referral. The content was assessed under section 51E of the *Environmental Protection Act 1986* and Clearing Permit 8931/1 was issued in August 2020.	☐ Yes ✓ No

Conclusion
The Proponent considers the Proposal will not have a significant impact on the environment.

PART B: ASSESSMENT OF ENVIRONMENTAL IMPACTS FOR SIGNIFICANT AMENDMENTS ONLY	
Type of significant amendment	☐ significant amendment to the approved proposal ☐ significant amendment to the implementation conditions ☐ significant amendment to both the proposal and the implementation conditions
Information of the approved proposal	Not applicable
Combined effects of the approved proposal and significant amendment	
Analysis of existing implementation conditions	
Previous changes to the Proposal and or implementation conditions	

Compliance	
Environmental Performance	
Control of implementation of significant amendment	

PART B: ASSESSMENT OF ENVIRONMENTAL IMPACTS <u>FOR A PROPOSAL UNDER AN ASSESSED SCHEME ONLY</u>	
What new environmental issues are raised by the proposal that were not assessed during the assessment of the planning scheme?	Not applicable
How does the proposal not comply with the assessed scheme and/or the environmental conditions in the assessed planning scheme?	

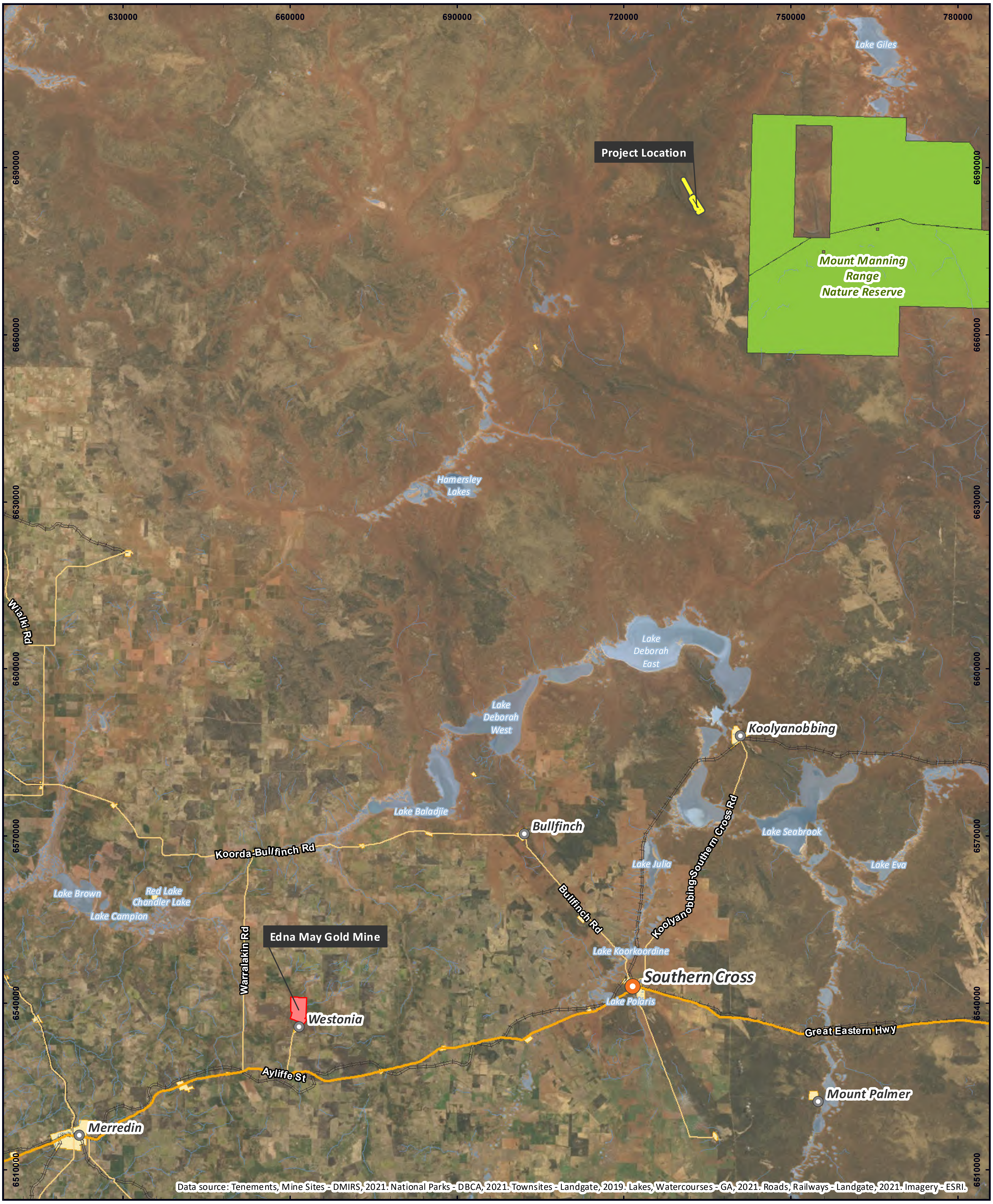
PART B: ASSESSMENT OF ENVIRONMENTAL IMPACTS <u>FOR DERIVED PROPOSALS ONLY</u>	
Demonstrate how the proposal will meet the environmental outcomes defined through the assessment of the strategic proposal	Not applicable
Provide an analysis of the existing implementation conditions of the related strategic proposal in relation to the derived proposal	

PART C: OTHER APPROVALS AND REGULATION	
Decision-making authorities and their approvals	
Provide a table list of the decision-making authorities, associated legislation or agreement regulating the activity and the specific approval required.	See cover letter.
Provide a summary of the statutory decision-making processes you consider can mitigate the potential impacts of the proposal on the environment.	Native Vegetation Clearing Permit (NVCP) (8931/1) conditions (*Environmental Protection Act 1986*). Mining Proposal and Mine Closure Plan (assessment pending) (*Mining Act 1978*).
Tenure and Local Government approvals	
Location of proposal:	M77/1272, L77/261

a) street address, lot number, suburb, and nearest road intersection; or b) if remote, the nearest town and distance and direction from that town to the proposal site.	
Name of the Local Government Authority in which the proposal is located.	Shire of Yilgarn
Is rezoning of any land required before the proposal can be implemented? If yes, please provide details.	☐ Yes ✓ No
What is the current land use on the property, and the extent (area in hectares) of the property?	Former Diemals pastoral station.
Does the proponent have the legal access required for the implementation of all aspects of the proposal? ***If yes**, provide details of legal access authorisations / agreements / tenure.* ***If no**, what authorisations / agreements / tenure is required and from whom?*	✓ Yes ☐ No Ramelius holds the relevant tenure.
Commonwealth Government approvals	
Does the proposal involve an action that may be or is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)?	☐ Yes ✓ No
Has the proposed action been referred? If yes, when was it referred and what is the reference number (EPBC No.)?	☐ Yes ☐ No Date: _________ EPBC No.: __________
If referred, has a decision been made on whether the proposed action is a controlled action? If 'yes', check the appropriate box and provide the decision in an attachment.	☐ Yes ☐ No ☐ Decision – controlled action ☐ Decision – not a controlled action
If the proposal is determined to be a controlled action, do you request that this proposal be assessed under a Bilateral Agreement or as an accredited assessment?	☐ Yes - Bilateral ☐ No ☐ Yes - Accredited
Is approval required from other Commonwealth Government/s for any part of the proposal? *If yes, describe.*	☐ Yes ☐ No Approval:
Decision-making authority referrals <u>ONLY</u>	
What approval/s, under your authority, are required for this proposal? *Please provide details.*	

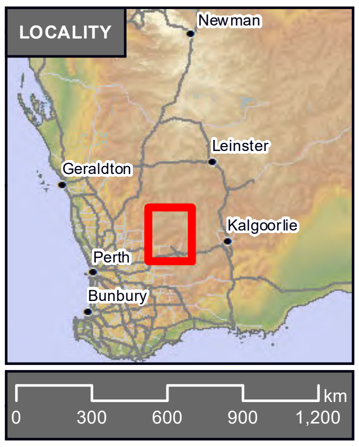
Attachment 3
Figures

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au



LEGEND

- Project Tenements
- Edna May Gold Mine
- Townsites
- National Park
- Lake
- Watercourse
- Freeway / Highway
- Main Road
- Railway Line



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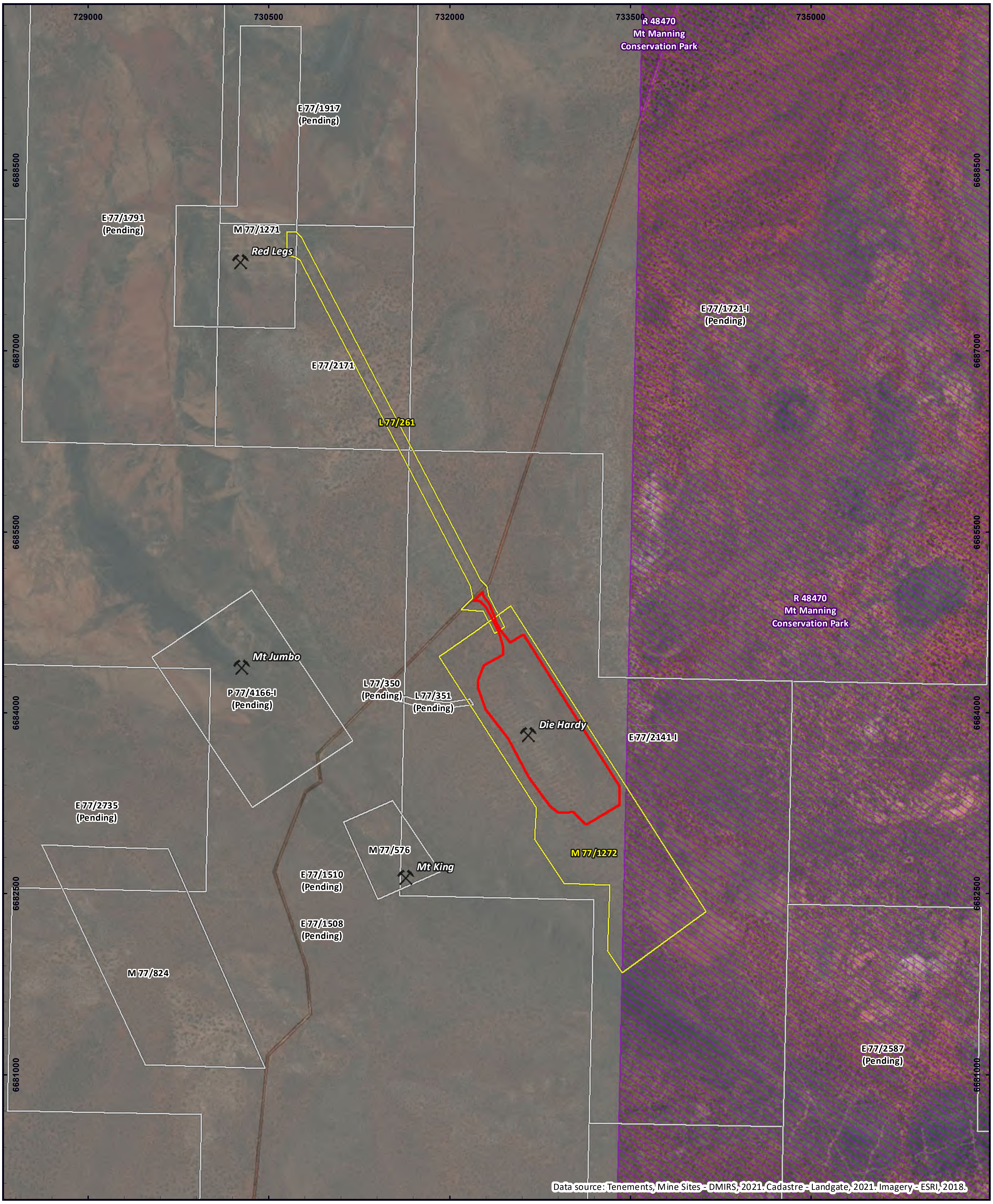
Coordinate System: GDA 1994 MGA Zone 50, Projection: Transverse Mercator, Datum: GDA 1994

LOCALITY
Die Hardy
EPA Referral
Marda Operations Pty Ltd

Prepared:	T Daymond
Reviewed:	T Ball
Project:	TE21120
Revision:	A
Date:	9/12/2021

Figure 1

talis consultants



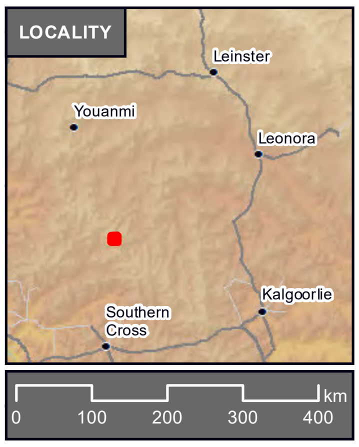
LEGEND

- Development Envelope
- Project Tenements
- Tenements
- Mine Site

Cadastre

- Reserve
- Unallocated Crown Land

LOCALITY



CADASTRE

Die Hardy
EPA Referral
Marda Operations Pty Ltd

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Scale @ A3: 1:30,000
Coordinate System: GDA 1994 MGA Zone 50, Projection: Transverse Mercator, Datum: GDA 1994

Prepared:	T Daymond
Reviewed:	T Ball
Project:	TE21120
Revision:	A
Date:	9/12/2021

Figure 2

talis consultants

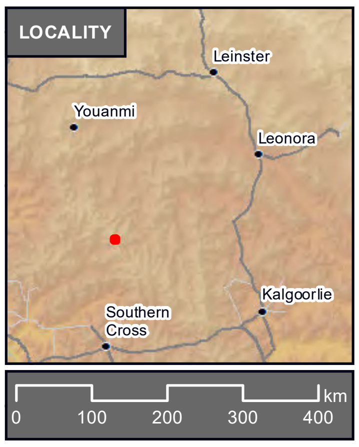
P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au

LEGEND

- Development Envelope
- Project Tenements
- Tenements

Site Layout

- Building (other than workshop) or camp site
- Dam - saline water or process liquor
- Low-grade ore stockpile (class 1)
- Mining void (with a depth of at least 5 metres) - below ground water level
- Topsoil stockpile
- Transport or service infrastructure corridor
- Waste dump or overburden stockpile (class 1)
- Abandonment Bund



SITE LAYOUT
Die Hardy
EPA Referral
Marda Operations Pty Ltd

N
0 100 200 300 m
Scale @ A3: 1:8,000
Coordinate System: GDA 1994 MGA Zone 50, Projection: Transverse Mercator, Datum: GDA 1994

Prepared:	T Daymond
Reviewed:	T Ball
Project:	TE21120
Revision:	A
Date:	9/12/2021

Figure 3

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Attachment 4
Mining Proposal

MINING PROPOSAL
DIE HARDY GOLD PROJECT

Revision 0; Version 2

M77/1272 and L77/261

Environmental Group Site Name:	**Mt Jackson Environmental Group**
Environmental Group Site Code:	**S0232841**
Tenement Holder:	**Marda Operations Pty Ltd**

Contact Details:

Name:	Glenn Firth
Title:	Group Environment Manager
Postal Address:	Level 1, 130 Royal Street East Perth WA 6004
Phone:	0448 052 059
Email:	glennfirth@rameliusresources.com.au
Date of Submission:	22 October 2021 (Revision 0; Version 2)

Document Control

Revision	Date	Author	Initials	Reviewer	Initials
Rev 0; Ver 1	2 August 2021	Glenn Firth	GF	Duncan Coutts	DC
Rev 0; Ver 2	22 October 2021	Glenn Firth	GF	Duncan Coutts	DC

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TABLES

FIGURES

APPENDICES

1. BACKGROUND INFORMATION

1.1 LOCATION

The Die Hardy Gold Project (the Project) is a greenfields gold deposit situated in the Coolgardie Bioregion within the Yilgarn Craton approximately 140 km north of Southern Cross and approximately 350 km east of Perth, Western Australia (Figure 1). The Project is located within the ex-Diemals Station on Unallocated Crown Land Reserve (LR3161/972) which is proposed as a dual-purpose Conservation and Mining Reserve. The land is managed by DBCA (Figure 2).

The Project aims to develop an open pit mining operation to extract gold ore from the deposit, and truck via public roads it to the Edna May Operations for processing. Construction of minimal support infrastructure will be necessary for development and operation of the Project.

1.2 OWNERSHIP AND THIRD-PARTY AUTHORISATION

Ramelius Resources Limited is the ultimate holding company of Marda Operations Pty Ltd (ABN 84 153 608 596); the proponent of the Die Hardy Gold Project.

Details on the Die Hardy project mining tenements held by the Marda Operations are summarised in Table 1 with a tenement plan presented in Figure 2.

Table 1: Project Tenements

Tenement	Area (ha)	Holder	Granted	Expiry
M77/1272	228.2	Marda Operations Pty Ltd	22/08/2014	21/08/2035
L77/261	39.16	Marda Operations Pty Ltd	17/06/2013	16/06/2034

The Project is proposed to occur on mining tenements M77/1272 and L77/261. The proposed project footprint of 90 ha is with native vegetation clearing required.

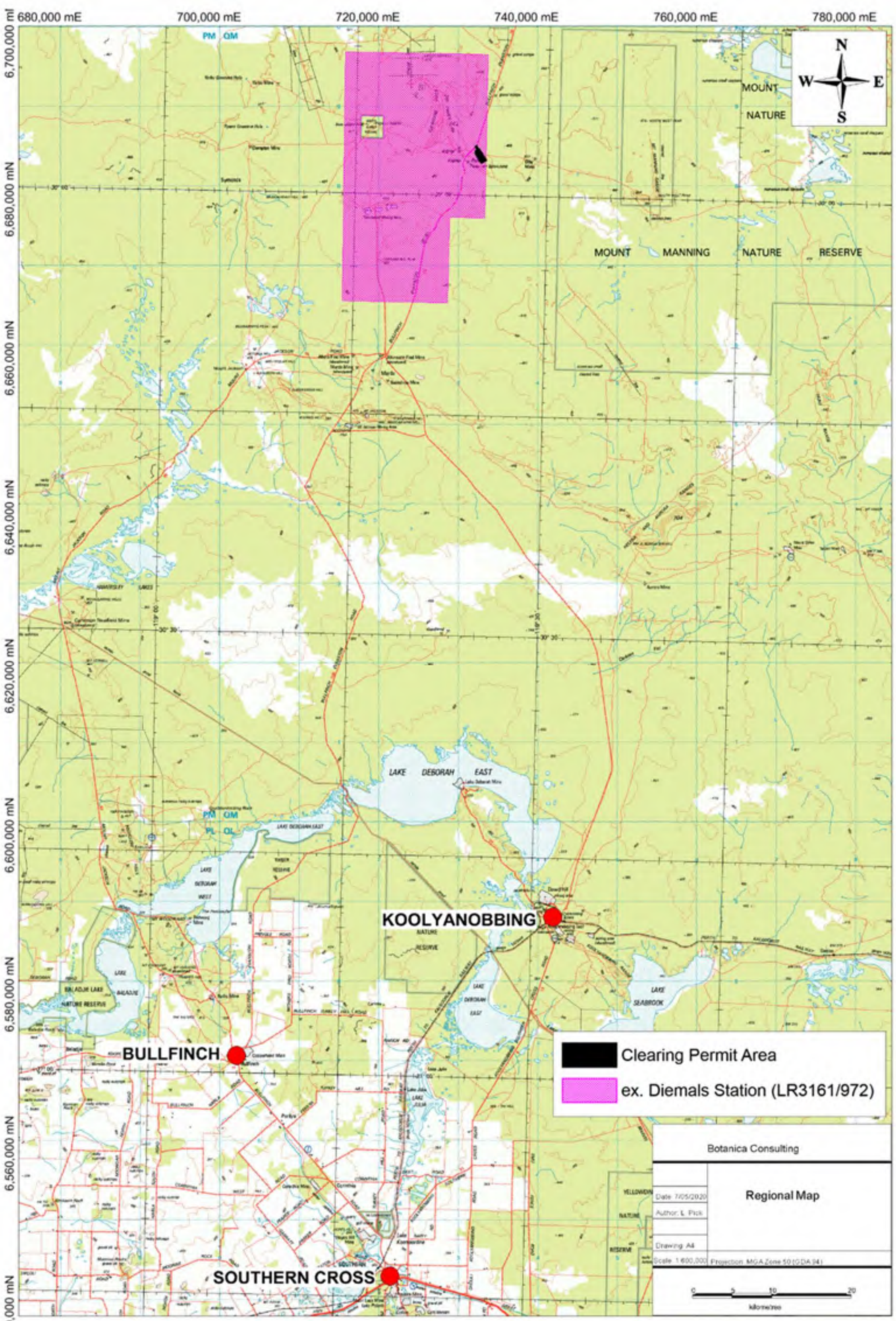

Figure 1: Die Hardy Project Location

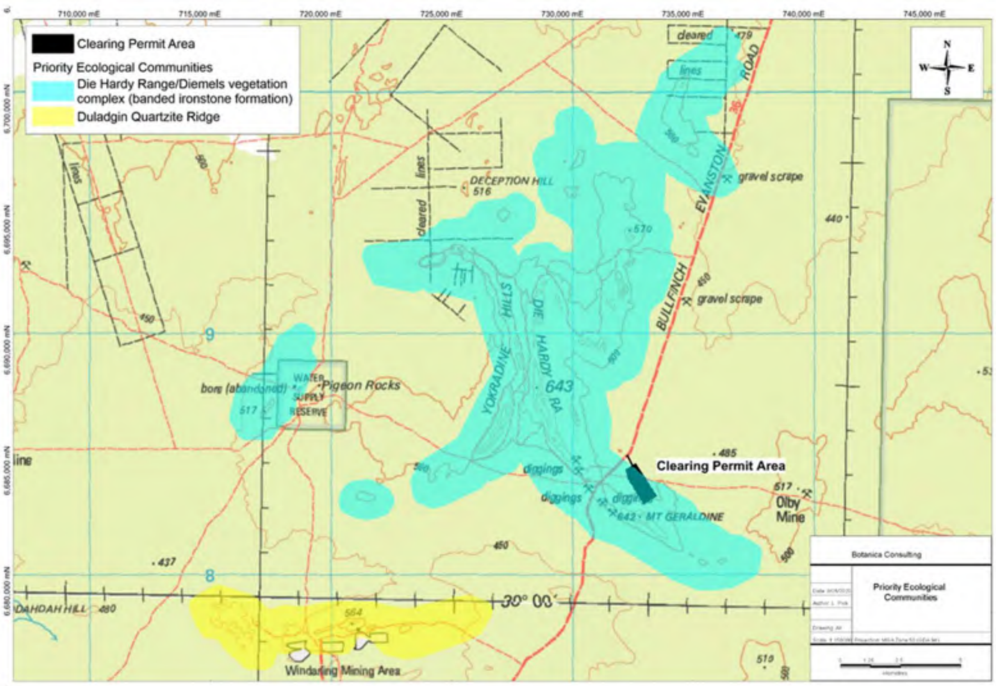

Figure 2: Land Use Plan of the Die Hardy area

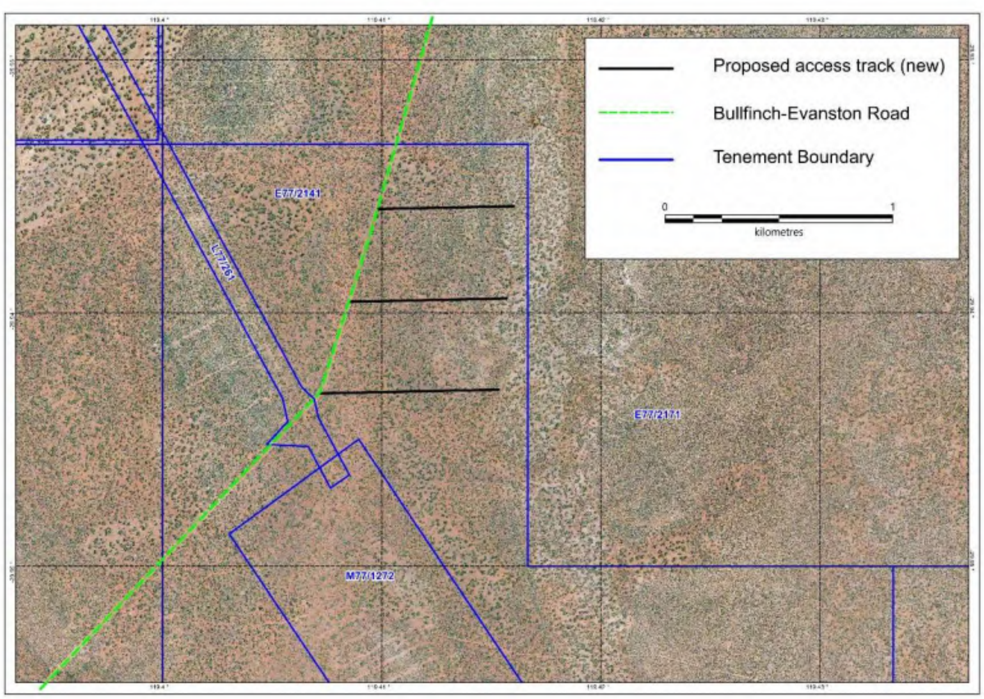

Figure 3: Tenements of Die Hardy

1.3 ENVIRONMENTAL GROUP SITE DETAILS

The Environmental Group Site (EGS) details for the Die Hardy Gold Project are presented in Table 2.

Table 2: Environmental Group Site Details

Environmental Group Site Details		
Site Details		
EGS Name	Mt Jackson Environmental Group	
EGS Code	S0232841	
Description of Operation	Open cut gold mine	
Mine Status	Development	
Commodity Mined	Gold	
Project Commencement Date	Q4 2021	
Estimated Completion Date of the Project	Q2 2023	
Tenement Details	**Tenement**	**Tenement Holder**
	M77/1272	Marda Operations Pty Ltd
	L77/261	Marda Operations Pty Ltd
Proponent Details		
Company or Individual Name:	Marda Operations Pty Ltd	
ABN:	84 153 608 596	
Address:	Level 1, 130 Royal Street, East Perth, 6004	
Postal Address:	PO Box 6070, East Perth, 6892	
Key Contact Representative:	Name:	Glenn Firth
	Position:	Group Environment Manager
	Phone Number:	(08) 9202 1127
	Email:	glennfirth@rameliusresources.com.au

2. PROPOSAL DESCRIPTION

This Mining Proposal has been prepared under the *2020 Statutory Guidelines for Mining Proposals* and fulfils the necessary requirements. Marda Operations Pty Ltd aims to develop an open pit gold mine and associated infrastructure at the Die Hardy project site. Mined ore will be hauled to the Edna May Operations (EMO) mine site (Figure 3) for processing located approximately 200 km by road.

Figure 4: Haul route to EMO

Project construction is scheduled to commence in Q3 2021 with an operational mine life estimated at 18 months; however, exploration is ongoing, and extension of project life is possible. The project will comprise the following components:

- Waste Rock Landform (WRL)
- Mining void
- Turkeys nest – saline water
- Mine ore pad (MOP)
- Office and Buildings (crib and ablutions)
- Topsoil stockpiles
- Transport infrastructure corridor (access and haul roads)
- Water bores and pipelines

Workers will be accommodated at the existing Windarling camp under agreement with Mineral Resources Limited. Minimal infrastructure is required at the Die Hardy project area as the project will be operated as a satellite pit from the Marda Central Project administration offices. Plant and equipment will be serviced at Marda Central. An indicative site plan of the proposed mining activity types for this Mining Proposal is shown in Figure 4.

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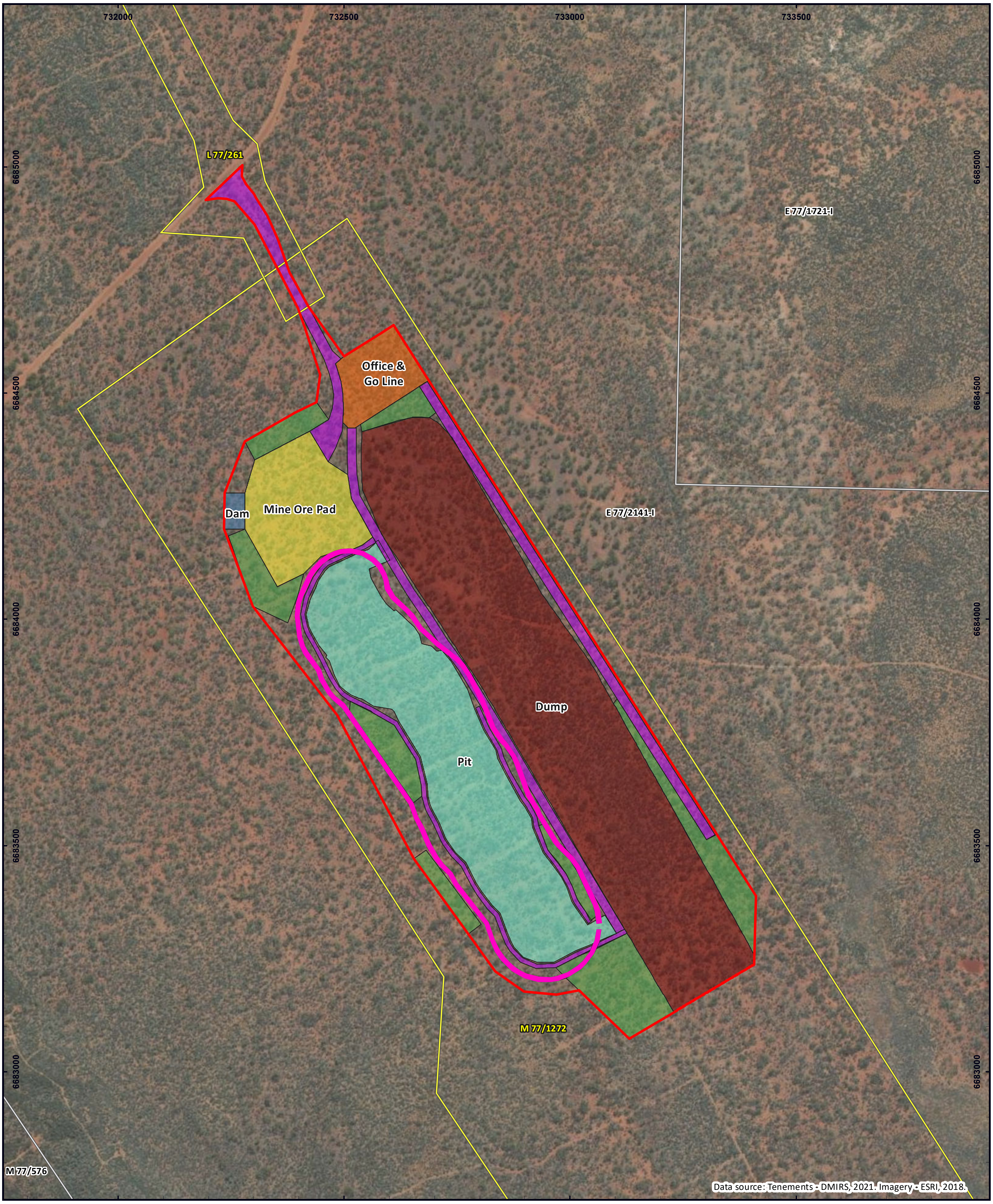


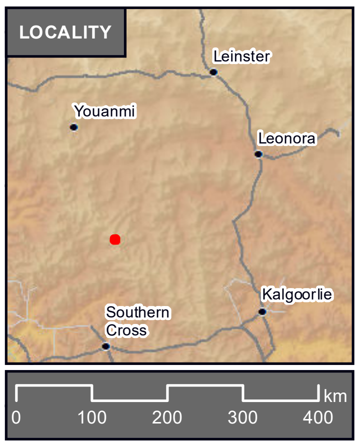
LEGEND

- Development Envelope
- Project Tenements
- Tenements

Site Layout

- Building (other than workshop) or camp site
- Dam - saline water or process liquor
- Low-grade ore stockpile (class 1)
- Mining void (with a depth of at least 5 metres) - below ground water level
- Topsoil stockpile
- Transport or service infrastructure corridor
- Waste dump or overburden stockpile (class 1)
- Abandonment Bund

LOCALITY



SITE LAYOUT
Die Hardy
Mining Proposal
Marda Operations Pty Ltd

N
0 100 200 300 m
Scale @ A3: 1:8,000
Coordinate System: GDA 1994 MGA Zone 50, Projection: Transverse Mercator, Datum: GDA 1994

Prepared:	T Daymond
Reviewed:	J Di Marco
Project:	TE21060
Revision:	A
Date:	29/07/2021

Figure 12

talis consultants

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2.1 ACTIVITY DETAILS

Indicative land disturbance areas for key mining activities and miscellaneous items for the Die Hardy project per tenement are presented in Table 3.

Table 3: Activities for the Die Hardy Gold Project

Tenement	Activity Type	Mine Activity Reference	Proposed Area (ha)
M77/1272	**Key Mining Activity**		
	Mining void (with a depth of at least 5 metres) - below ground water level	Pit	17.5
	Waste dump or overburden stockpile (class 1)	WRL	32.59
	Run-of-mine pad	Mine ore pad (MOP)	5.94
	Dam - saline water or process liquor	Turkeys nest	0.36
		Total Key Mining Activity Area	**56.39**
	Miscellaneous Mine Activities		
	Borefield	Water bores and pipelines	Footprints not required for other activity types
	Building (other than workshop) or camp site	Crib hut and ablutions	
	Fuel storage facility	Small refuelling tank	
	Land (other than land under rehabilitation or rehabilitated land) that is cleared of vegetation	Abandonment bunds	
	Land (other than land under rehabilitation or rehabilitated land) that is cleared of vegetation	Clearing buffer	
	Topsoil stockpile	Topsoil stockpiles	
	Transport or service infrastructure corridor	Haul road	
	Workshop	Small workshop	
		Total Miscellaneous Mine Activity Area	**31.61**
L77/261	**Key Mining Activity**		
	Nil	Nil	0
		Total Key Mining Activity Area	**0.00**
	Miscellaneous Mine Activities		
	Transport or Service Infrastructure Corridor	Haul road	Footprints not required for other activity types
		Total Miscellaneous Mine Activity Area	**2.00**
Total Key Mine Activity Area			**56.39**
Total Miscellaneous Mine Activity Area			**33.61**
Total Project Activity Area			**90.00**

2.2 MINING VOID

2.2.1 Mining Operations

Marda Operations propose to mine gold from the Die Hardy deposit using conventional drill, blast, load and haul open pit mining methods. The final pit design is approximately 1000 m long, up to 180 m wide at the surface, and has a maximum depth of 55 m. The orebody has a 1040 m by 550 m footprint striking approximately 30°, and gold mineralisation remains open to the south-east and at depth.

The Die Hardy deposit will be mined as a single pit with pit ramps exiting at the north and south ends of the void proximal to the WRL and mine ore pad (MOP).

Details relating to the Die Hardy void are presented in Table 4.

Table 4: Details Relating to the Die Hardy Mining Void

Mining Void			
Mine Activity Reference	Die Hardy Mining Void		
Area	17.54 ha		
Area per tenement	M70/816 – 17.54 ha		
Design Description	Type/Design: Open Pit		
	Depth: 55 m		
Material Characteristics	Fibrous minerals	Yes ☐ No☒	See Section 6.2.2
	Radioactive material	Yes ☐ No☒	See Section 6.2.2
	Materials capable of generating acid and metalliferous drainage, including neutral drainage and saline drainage.	Yes ☐ No☒	See Section 6.3
	Dispersive and/ or erosive material that is capable of compromising the structure and stability of the pit or underground workings	Yes ☐ No☒	See Section 6.3
Backfill	Will the mining void be backfilled?	Yes ☐ No☒	

2.2.2 Mining Methods

The total period of mining operations is 20 months. The mine will operate 24 hours a day, seven days a week. Mining equipment will include excavators, haul trucks, surface drill rigs, dozers, water trucks, service trucks and graders. Mining will start by stripping and stockpiling the soil within the final pit design footprint and WRL areas with appropriate physical and chemical characteristics for use in rehabilitation at closure. Reverse Circulation (RC) grade control will be conducted of mineralised zones prior to drilling and blasting on 5 m benches. Ore will be hauled to the MOP stockpiles at Die Hardy, and then relocated to the ROM pad at the Edna May Gold Operation ready for processing. Waste will be excavated and hauled to the WRL. Waste material may also be utilised in the construction of the MOP pad. Low grade ore will also be stockpiled separately during the development of the WRL and transported to and treated at Edna May the end of mine life.

Pit design has been completed by Ramelius technical personnel and external consultants. An independent geotechnical assessment (Appendix A) confirmed the final design parameters for the open pit which are summarised in Table 5. The operational parameters are summarised in Table 6.

Table 5: Die Hardy Open Pit Design Parameters

Parameter	Unit	Measurement
Key Design Parameters		
Surface: North	mRL	505
South	mRL	495
Pit Bottom: North	mRL	450
South	mRL	447.5
Depth: North	m	55
South	m	47.5
Overall Wall Angle for Depth: 0-10 m 10-20 m >20 m	degrees	
Ramp Gradient	ratio	
Berm width on east wall at RL495m, 475m and RL455m	m	5
Berm width on west wall at RL495m, 485m, 465m	m	4
Inter Ramp Angle:	degrees	27-37° (east) 34-37° (west)
Inter Ramp Distance at Depth >20 m	m	NA

Table 6: Overall Mining Operational Parameters

Parameter	Unit	Measurement
Key Operational Parameters		
Ore (>0.9gAu/t) produced:	kt	774.6
Average Ore Grade:	g/t	1.54
Recovered gold	oz	38,261
Low Grade produced	kt	207.3
Waste produced	Mbcm	3.12

The potential for backfilling of open pit has been considered in line with DMIRS and EPA Mine Closure Guidelines (DMP and EPA 2011) and DBCA as a key stakeholder responsible for management of the CALM Act Section 5(1)(h) proposed 'Conservation and Mining Reserve'.

The primary considerations were:

- the extent of potential pit lake formation;
- sterilisation of underlying ore potential; and
- attraction and localised grazing of feral animals.

DMIRS and EPA Mine Closure Guidelines require that, prior to open cut mines being backfilled, a study be conducted to determine the potential for future economic mining from any resource that exists beneath or along strike of the current pit extents. MOPL's resource definition data currently indicates a defined resource extent beyond that which is proposed to be mined. Consequently, there is a risk to sterilising future resources if backfilling was to occur.

During consultation with DBCA on 29 September 2021, DBCA's position is that although backfilling is preferable, it is not mandatory is other factors such as safety or economics reasons preclude backfilling from occurring.

Partial backfilling will occur during the scheduled operational mining phase where possible.

2.2.3 Dewatering and Project Water Balance

Groundwater across the region occurs in basins of weathering and local fracture systems. These vary in both vertical and lateral extent and are controlled by geological structures, which suggest compartmentalisation of groundwater resources where there is little, if any, hydraulic connection between the different compartments. Consequently, groundwater is likely to move or drain very slowly and may be considered stagnant.

Groundwater levels across the region imitate the regional and local topography. Levels at the nearby Marda Central project were found to be greater than 60m below ground surface. It is expected, given the local topography and local data that groundwater in the Die Hardy area will be below the depths of the relatively shallow pit (between 47 and 55m below ground level). Resource drilling and water exploration bores indicated little if any groundwater within holes to 120m which indicates that dewatering will not be required.

Of seven targeted water exploration holes three produced no water, three very small flows and one delivered a potentially useful yield. The results indicate a regolith enhanced possible north-south structurally controlled aquifer of limited lateral extent. The project water demand is around 200kL per day which will be adequately supplied by the onsite water bore (DW004) which has capacity of 3L/sec (260kL/day).

2.2.4 Potential Zone of Instability (PZOI)

The Potential Zone of Instability (PZOI) has been determined as per DMIRS Safety Bund Walls Around Abandoned Open Pit Mines Guideline resulting in an abandonment zone string being generated. Sections have been generated across the Die Hardy deposit (Figure 5). The representative sections of the Die Hardy pit with projected PZOI are shown in Figure 6 (north section of the pit) and Figure 7 (south section of the pit) respectively.

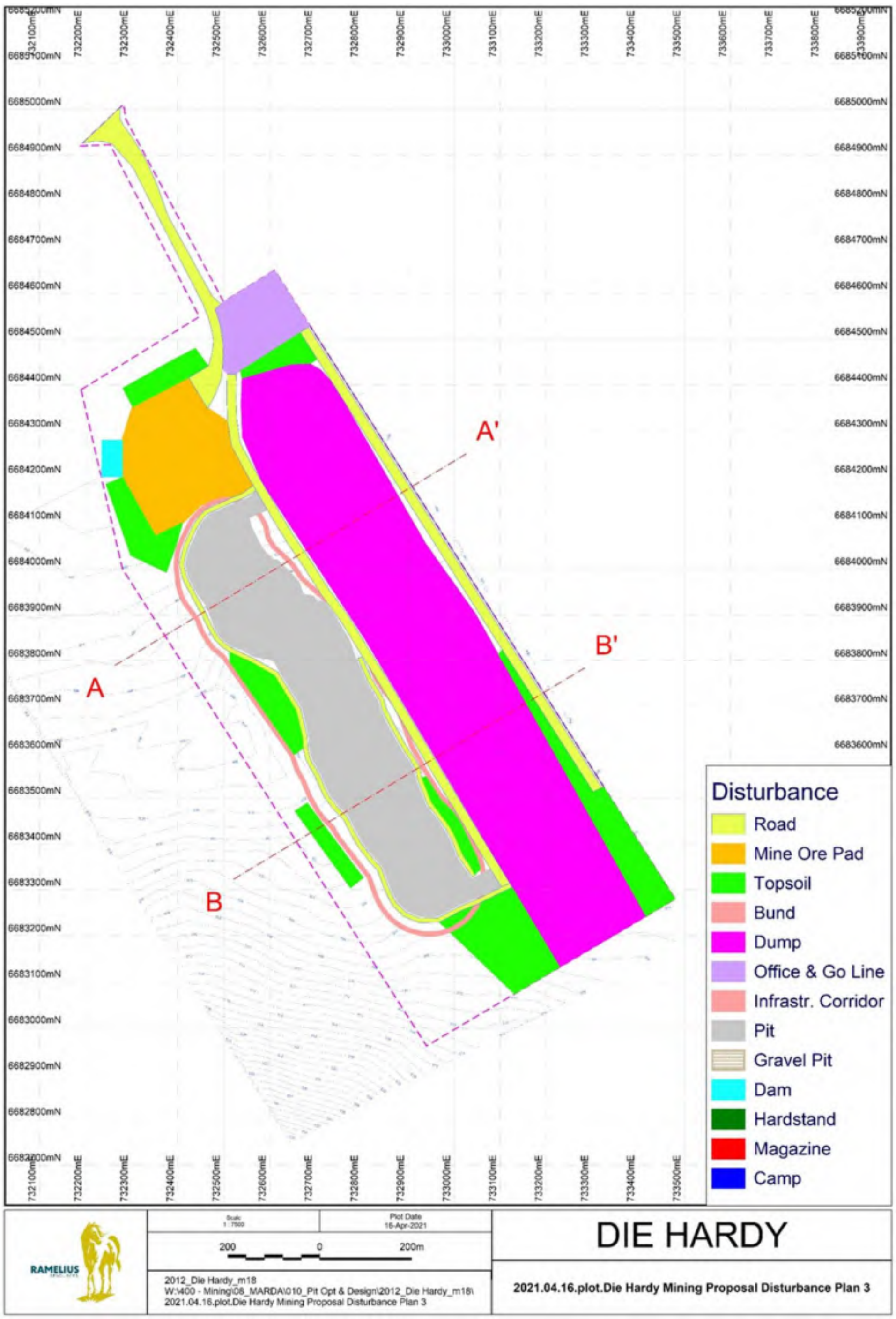

Figure 6: Plan of pit cross-sections

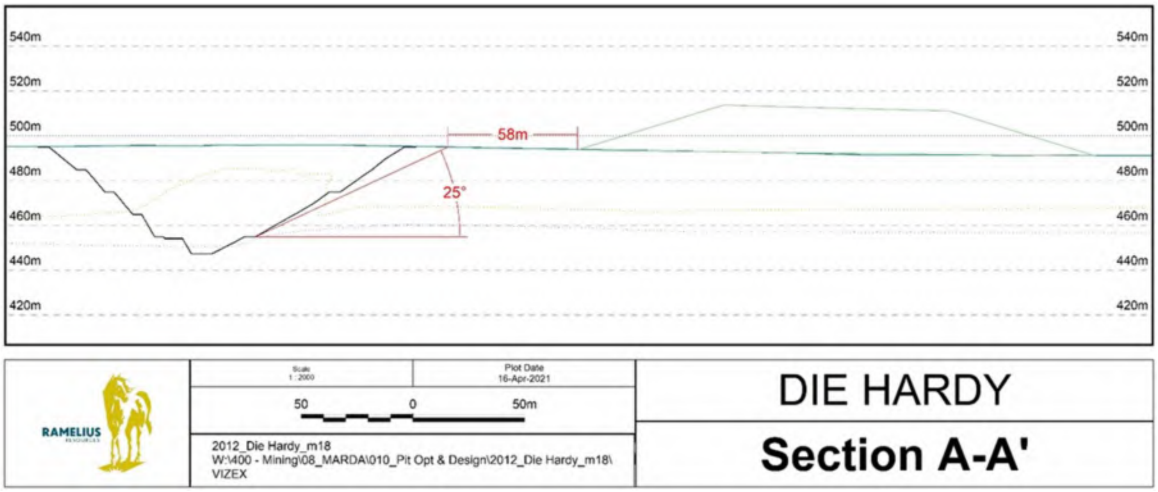

Figure 7: Cross Section of Die Hardy Pit (A-A') with projected PZOI

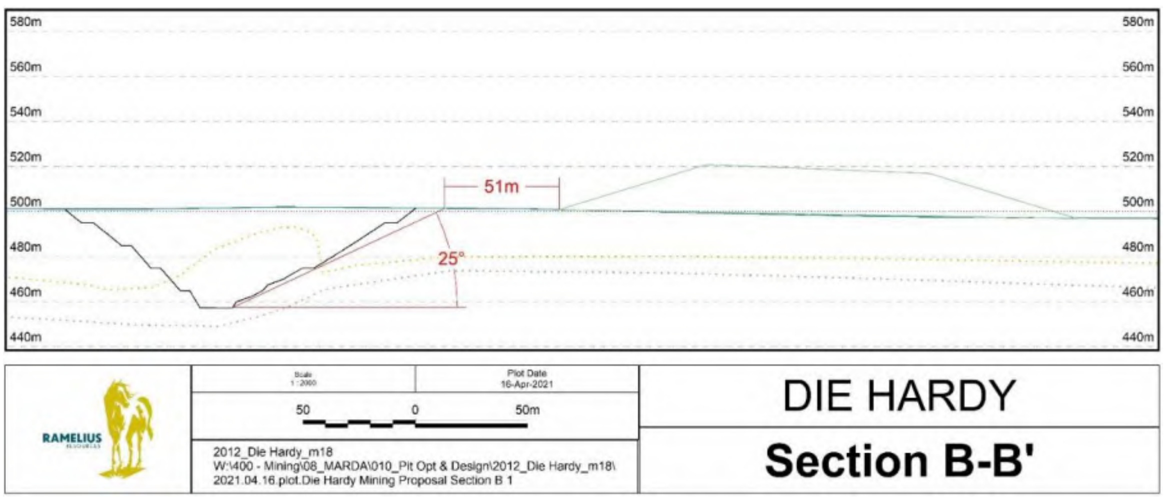

Figure 8: Cross Section of Die Hardy Pit (B-B') with projected PZOI

The Die Hardy depth of oxidation is relatively shallow and consistent (10-20 m) and dictates the adopted wall angles of the pit design. Ground conditions influencing wall stability in the proposed Die Hardy open pit were investigated using current geological interpretations, data contained in geological, structural geological and geotechnical logs for diamond cored, resource/ geotechnical investigation boreholes and laboratory measurement of physical properties of representative samples of country rocks.

A PZOI position has been generated and is shown in Figure 5. Final abandonment bunds and waste rock landforms will be placed outside this position in accordance with DMIRS guidelines.

2.2.5 Abandonment Bund Design

The abandonment bund has been designed to meet the minimum requirements of the DMIRS Guidelines for Safety Bunds Around Abandoned Open Pit Mines. The Die Hardy abandonment bund will run around the outside of the PZOI and will not link into the WRL. The location of the proposed abandonment bund exceeds the minimum distance from the outer wall of the pit as calculated in accordance with the Guidelines.

The Die Hardy abandonment bund will be constructed largely of competent transitional rock from the Die Hardy Open Pit, except for the south section which will be constructed with fresh rock (as recommended from the surface water hydrology studies, as additional long-term flood protection). Further details are provided in section 2.6.4).

2.2.6 Post-closure Pit Lake

The minimum pit crest elevation is about 490m AHD at the north end of the pit. The minimum pit floor elevation is 447.5m AHD. The baseline static water level has been estimated at about 475m AHD based on regional drill data.

Provided surface water is excluded, the pit lake level will stabilise at the point where evaporation from the lake surface balances groundwater inflow. The pit lake evaporation rate is estimated as the product of the annual pan evaporation rate (2.4m per year) and the lake (0.75) and brine factors (0.9), or about 1.6m/year.

For the expected groundwater inflow rate of 1-2L/sec, the final void pit lake level will be in the range 460-465m with a surface area of up to 3.5ha and maximum depth of 15m. The pit will remain a very minor groundwater sink with a post-closure salinity in excess of 20,000mg/L TDS. There is no risk of water discharging from the pit or pit lake as surface or groundwater outflow.

2.3 WASTE ROCK LANDFORM

2.3.1 WRL Detail and Design

Table 7 summarises the details of WRL, with further information provided below.

Table 7: Details Relating to the Waste Rock Landform

Waste Rock Landform			
Mine Activity Reference	Die Hardy WRL		
Area	32.60 ha		
Area per tenement	M77/1272; 32.60 ha		
Design	Max Height: 30 m with the preferrable concave outer slopes. The adopted design is a relatively simple and conservative design consistent with using low batter angles with a concave slope of overall 14° angle, applying gravelly soils with 40% tree debris to the lower third of the final batter.		
Material Characteristics	Fibrous minerals	Yes ☐ No☒	See Section 6.2.2

	Radioactive material	Yes ☐ No☒	See Section 6.2.2
	Materials capable of generating acid and metalliferous drainage, including neutral drainage and saline drainage	Yes ☐ No☒	See Section 6.3
	Highly erodible material that is capable of compromising the structure of the activity	Yes ☒ No☐	See Section 6.3

The adopted WRL design resulted from geotechnical and geochemical testwork undertaken on a range of waste rock samples from the deposit representing each of waste types to be mine, including their weathering state, and supplemented with soil characterisation data. In all, 12 mineral waste samples were tested for water absorption, specific gravity, and hardness using the Schmidt hammer test. A WEPP runoff/erosion simulation model was then constructed on a range of nominal batter shapes and profiles to assist in defining erosion risk. The erodibility component of the WEPP model incorporated particle size distribution and dispersion data, and climate data (Appendix B).

The results of the landform design studies indicated that either linear batters or concave batter slopes could be used on the WRL up to 30m high. The modelled liner slopes of gradients of 12-18° however required a competent resistant surface rock to maintain acceptable rates of erosion and as only minimal amounts of fresh waste rock will be mined (insufficient quantities available for cladding), gravelly soils with 40% tree debris were modelled and found to adequately resist erosion and maintain a stable landform in the long-term. Concave profiles were also modelled for a WRL design up to 30m high. Acceptable rates of erosion were determined from the modelling without the need for any rock cladding or tree debris in this scenario. Regardless, there is 90,000 m^2 of tree clearing required for the project and with only 11,000 m^2 of WRL lower slopes requiring tree debris for stability, amble volumes are available.

The available footprint for a WRL is constrained by the boundaries of the Die Hardy tenement and the vegetation clearing permit area. Despite these constraints, MOPL can still construct the WRL to a maximum height of 30m with the preferrable concave outer slopes. The adopted design remains a relatively simple and conservative design consistent with using low batter angles with a concave slope of overall 14° angle (Figure 9, Figure 10 and Figure 11). The WRL is designed to accommodate 25% swell factor of the *in-situ* waste rock volumes (total design capacity of 3,829,785m^3) that are summarise in Table 8.

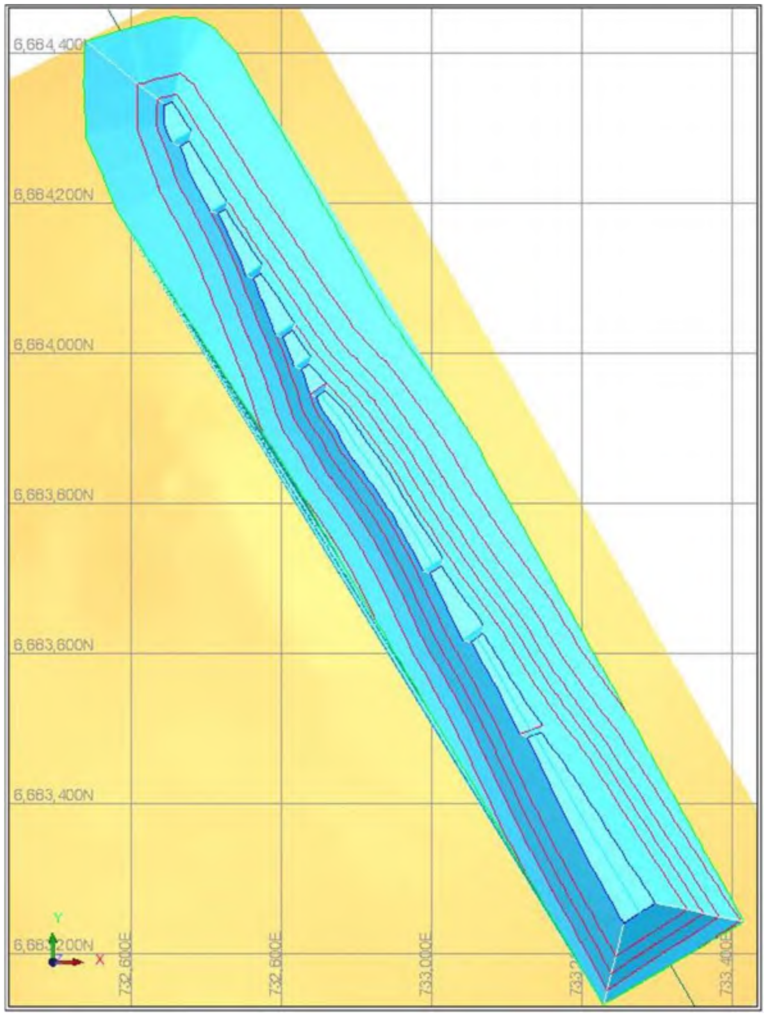

Figure 9: Concave design of the WRL

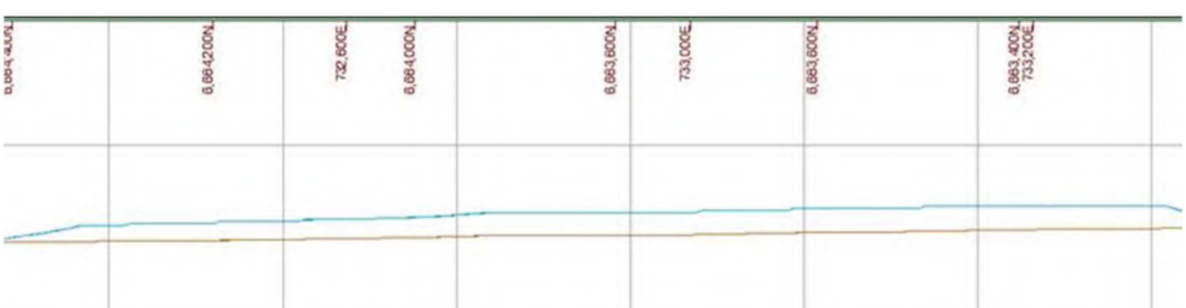

Figure 10: Long section of the WRL (looking north)

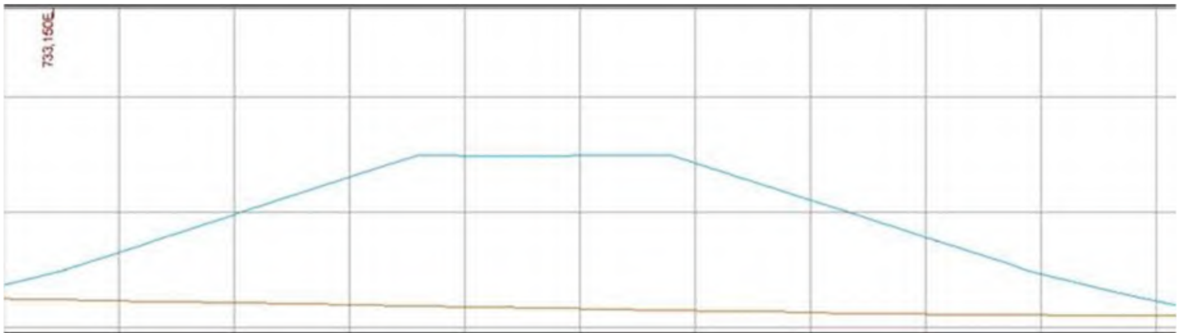

Figure 11: Cross section (looking west) indicating the top of the WRL at 530 RL

Transitional BIF and ultramafic waste which makes up approximately 33% of all waste rock produced will be preferentially stored within the WRL as they exhibit predominantly poor durability, dominated by fines. The oxide and transitional laterite materials with their gravelly fines possess better durability qualities (Appendix B). Mine planning and scheduling will ensure these better materials are placed on the final outer surface of the concave profiled WRL. A summary of the mine waste materials by oxidation state is presented in Table 8.

Table 8: Likely Composition of Mine Waste Material

Waste Type	Depth (m)	Estimated Volume (m^3)	Estimated % of Mine Waste
Oxide (BIF, laterite and ultramafic)	0-45m	2,069,606	66.4
Transitional (BIF, laterite and ultramafic)	25-60m	1,018,695	32.7
Fresh (BIF and ultramafic)	>60m	29,218	0.9
Total	-	**3,117,520**	**100**

The Die Hardy abandonment bund will be constructed of oxidised and transition BIF wastes which have been assessed as being suitable for this purpose (Appendix B), particularly given that there is very little unweathered (Fresh) materials present. These represent the most durable of the weathered materials. The limited quantities of fresh BIF and ultramafic waste rock will be used to clad the eastern toe of the WRL (and extending the southern section of the abandonment bund) to provide long-term stability and erosion-resistant barrier to long-term potential flood waters as modelled. Appendix C contains the results of the modelled 1:1000 year design peak flood height (for post-closure purposes) and recommended the outer (south and east) lower slopes of the WRL be clad with coarse rock armour (d50 = 300mm), to a height of 0.6m AGL 1.0m thick for enhanced erosion protection. A summary of the competent rock requirements is presented in Table 9.

Table 9: Competent Rock Requirements

WRL	Design Volume (m^3)
Die Hardy abandonment bund	35,250
Die Hardy WRL (post-closure scour-resistant cladding of the eastern and southern toes of the WRL)	1000
Total	**36,250**

On completion of the WRL, pre-stripped topsoil will be applied to a depth of 0.2 m to the top and slopes of the landform. Based on the WRL surface area of 325,943m^2, the topsoil coverage requirement is approximately 65,200 m^3.

2.4 RUN OF MINE PAD (MINE ORE PAD)

The Die Hardy project requires a single mine ore pad (MOP) that will consist of land of cleared of topsoil and sheeted with waste rock sourced from the open pit. The MOP will largely remain at ground level and is not a raised landform as such (*i.e.*, not a typical run-of-mine (ROM) ore storage landform and may be slightly raised on the perimeter due to minor undulation in localised topography). Details on the MOP are summarised in Table 15.

Table 10: Details Relating to the Die Hardy MOP

Run of Mine Pad			
Mine Activity Reference	Die Hardy MOP		
Total Area	5.94 ha		
Area per Tenement	M77/1272: 5.94 ha		
Design Description	The MOP will be an area cleared of topsoil and sheeted with low-grade ore or inert waste rock		
Materials Characteristics	Fibrous minerals	Yes ☐ No☒	See Section 6.2.2
	Radioactive material	Yes ☐ No☒	See Section 6.2.2
	Materials capable of generating acid and/ or metalliferous drainage, including neutral drainage and saline drainage	Yes ☐ No☒	See Section 6.3
	Dispersive and/or erosive material that is capable of compromising the structure and stability of the activity	Yes ☐ No☒	See Section 6.3

2.5 DAMS – SALINE WATER

2.5.1 Turkeys Nest Storage

The water supply bore located on the mining tenement will produce around 3L/sec of saline water[1] (EC of 9400 mg/L). A small turkeys nest dam of 0.0.36 ha will be required for dust suppression and road construction. Details on the turkeys nest (saline water dam) are summarised in Table 11.

[1] As per the MRF guidelines, only water with a TDS <2000 mg/L can be considered Fresh Water

Table 11: Details Relating to the Saline Water Dam

Turkeys Nest (Saline water Dam)			
Mine Activity Reference	Die Hardy Turkeys Nest		
Total Area	0.36 ha		
Area per Tenement	M77/1272: 0.36 ha		
Design Description	It will be constructed with suitable oxide material, lined with a HDPE liner and operated with a 600 mm free board. A float valve will be installed in the dam to cut flow once the capacity limit is reached. As this turkeys nest will be an above-ground facility, it will be fenced to restrict access to larger fauna. Fauna egress mats will be installed at water level for small fauna not restricted by the fence.		
Materials Characteristics	Fibrous minerals	Yes ☐ No☒	See Section 6.2.2
	Radioactive material	Yes ☐ No☒	See Section 6.2.2
	Materials capable of generating acid and/ or metalliferous drainage, including neutral drainage and saline drainage	Yes ☐ No☒	See Section 6.3
	Dispersive and/or erosive material that is capable of compromising the structure and stability of the activity	Yes ☐ No☒	See Section 6.3

2.6 MISCELLANEOUS MINE ACTIVITIES

2.6.1 Haulage and Transport Corridors

Minimal internal roads are required for the project. Ore from the proposed Die Hardy operation will be placed on the MOP adjacent to the open pit. It will then be loaded onto road trains and transported off-site along existing public roads to the Edna May Operations at Westonia for processing. Road use agreements with Main Roads WA and local Shires have been agreed in-principle with formal executed agreements remaining in progress.

2.6.2 Workforce and Operations

The project will be operated on a contract mining and contract ore haulage scenario. The workforce will comprise of management personnel, technical personnel, equipment operators and contractors working a combination of 4:3, 8:6, 14:7 and 5:2 rosters. The workforce will consist of fly in-fly out (FIFO) personnel from Perth to Windarling, with a portion of the workforce comprising both local and regional personnel from Southern Cross. The workforce will be accommodated in the existing accommodation village at Windarling under agreement with Mineral Resources Limited (MRL).

2.6.3 Support Facilities

Given the Die Hardy project is a satellite operation to the larger Marda Gold Project to the south, many typical support facilities are not required at Die Hardy (*e.g.*, main administration office, main contractor mine offices, explosive or detonator magazines, bulk explosive storage). All these services will be provided by MOPL. Table 17 lists the specific support facilities required for the Die Hardy project.

Table 12: Die Hardy Facilities

Infrastructure	Description
Crib room/Ablutions, Small Contractor and Technical Office	Transportable buildings
Workshop and washdown bay	Workshop and washdown bay
Fuel Facility	Small refuelling tank
Mobile equipment go line	A small go-line/ hardstand area for the mining fleet and service trucks
Surface water management infrastructure	Any rainfall collected in the pit will be pumped to the turkeys nest dam where it will be utilised for mining and dust suppression.

2.6.4 Surface Water Management Infrastructure

Appendix C summarises a hydrology and hydrogeology study undertaken by MWES (2021) and details the peak flow estimates based on the ARR19 regional flood frequency estimation method for the sub-catchments potentially impacted by the project.

The site is situated on elevated and well-drained ground such that, apart from excluding stormwater from the pit, there are no requirements to contain or divert natural stormwater drainage either during operations or post-closure. There is little potential for impacts on the downstream environment. The main risk is long term dispersal of material eroded from the WRD. Primary controls on this process will be appropriate landform design and construction, with progressive rehabilitation as described in section 2.3.1.

Specific to stormwater impacts is the need for enhanced protection of the eastern toe of the WRL with rock armouring up to the 1:1000 year design peak flood height. The outer (south and east) lower slopes of the WRL will be clad with coarse fresh rock (d50 = 300mm), to a height of 0.6m AGL. Armouring the southern section of the abandonment bund with fresh coarse rock will also be completed to manage the potential hydrological impacts of a 1:1000 year ARI event.

Standard operational site designs will incorporate clean/dirty runoff separation at stockpiles and other industrial facilities, including the following measures:

- After pre-strip stage, a temporary 1m high bund will be installed south of the pit and be removed at closure when the permanent abandonment bund is constructed.

- Waste rock emplacement scheduling to minimise the perimeter length of oxide material until more competent transitional material becomes available.
- Complete the WRL south and east perimeter toe as soon as competent rock is available.
- Until contained by competent rock, areas where oxide or mineralised rock is stored to include downstream stormwater sump with capacity of a 20mm runoff event (~200kL/ha).
- Drainage controls and sediment ponds will be constructed downstream of disturbances to restrict sediment from leaving the Development Envelope. The ponds will be designed to contain 1:100 year events.

3. DISTURBANCE ENVELOPE AND SITE PLAN

The Disturbance Envelope for the Die Hardy Gold Project is approximately 90 ha and is shown in Figure 13. An indicative site plan of the Mining Activities (Key and Miscellaneous) associated with the Die Hardy Gold Project is presented in Figure 4. The total activity area for the Die Hardy Project is 90 ha.

Spatial files (.shp format) of the Disturbance Envelope and the Project activity types within the project tenure have been provided to DMIRS at the date of submission of this proposal.

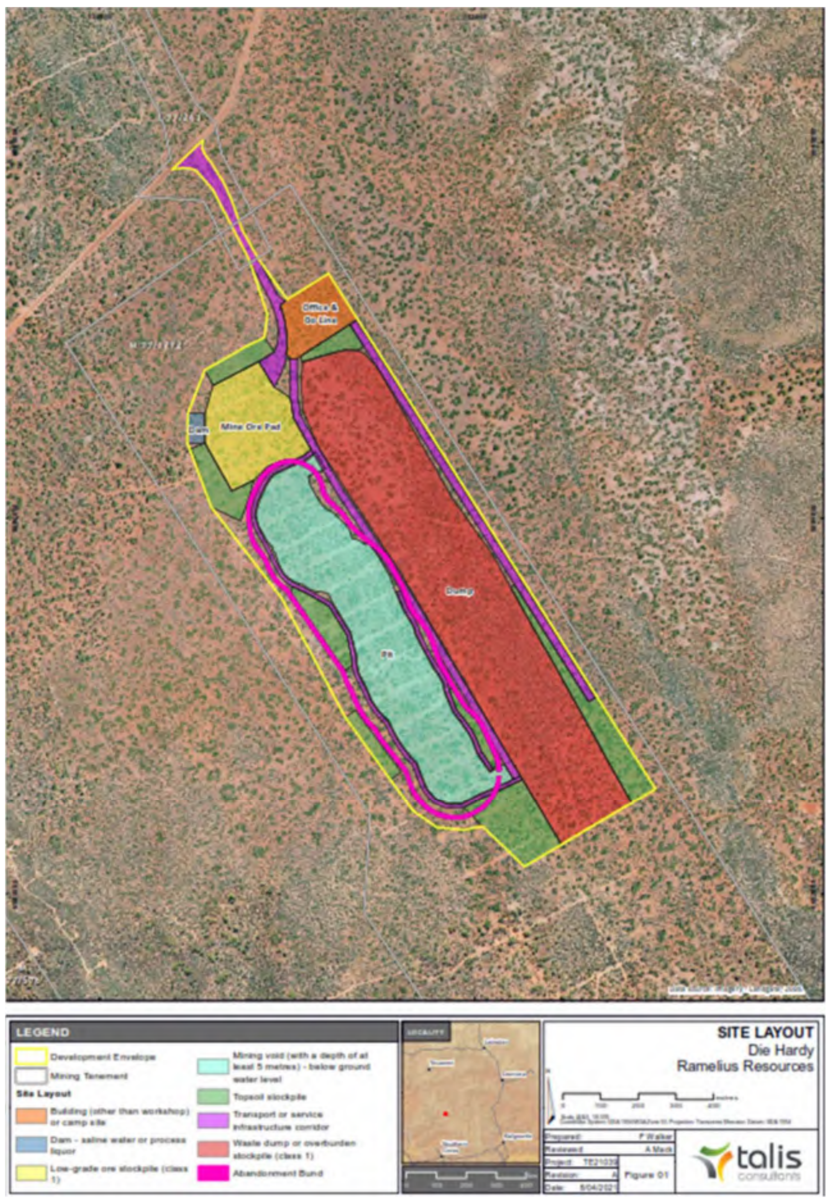

Figure 12: Disturbance Envelope for the Die Hardy Project

4. ENVIRONMENTAL LEGISLATIVE FRAMEWORK

A full list of relevant environmental (and other) approvals and statutory requirements for environmental management of the Die Hardy Project is provided in Table 18.

Table 13: Environmental (and other) Legislative Framework for the Die Hardy Project

Relevant Legislation	Environmental Factor Regulated/Affected	Relevant Approval Requirement
Aboriginal Heritage Act 1972	Aboriginal Heritage	The Project Area has been surveyed and no heritage sites were found
Environmental Protection and Biodiversity Conservation Act 1999	Biodiversity / Flora / Fauna / Ecosystem	Not required. No triggers as a "Controlled Action"
Environmental Protection Act 1986 (Part IV)	Biodiversity / Flora / Fauna /Ecosystem Water Resources	Not Referred. Not a significant proposal
Environmental Protection Act 1986 (Part V)	Water resources Landforms (contamination or pollution)	Not required. No Prescribed Premises
Environmental Protection (Clearing of Native Vegetation) Regulations 2004	Biodiversity / Flora / Fauna / Ecosystem	A Clearing Permit is in place: CPS 8931 covers the Die Hardy project area and will be utilised for clearing
Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974	Septic trench installation	Onsite disposal of wastewater via an Application to Construct or Install an Apparatus for the Treatment of Sewage
Rights in Water and Irrigation Act 1914 (DWER)	Water resources	26D Licence to construct bores and 5C Licence to take groundwater will be applied for and in place prior to the project commencing.
Mining Act 1978 (DMIRS)	Biodiversity, flora, fauna and ecosystem; Water resources; Mine closure	Mining Proposal which details disturbance and operations Mine Closure Plan incorporated into this Mining Proposal
Mine Safety and Inspection Act 1994	Safety and Pollution	A PMP for the Marda Project was approved on 12 July 2019 and will be used for the Die Hardy Project

Part IV of the *Environmental Protection Act 1986* (EP Act) provides for the referral and environmental impact assessment of proposals that are likely, if implemented, to have a significant impact on the environment. A referral can be made by a project proponent, Decision Making Authority (DMA) or any other person aware of the project. With regard to Part IV approvals under the *Environmental Protection*

Act 1986, the Die Hardy tenement was a part of an original proposal by Southern Cross Goldfields (SXG) in 2014 for their Marda East Gold Project which included a significantly more sensitive project (Red Legs) on a tenement unrelated to this Die Hardy Mining Proposal. SXG submitted an Environmental Referral and supporting documentation in accordance with Section 38(1) of the *Environmental Protection Act 1986*. The Environmental Protection Authority (EPA) determined to assess that 2014 proposal at the level of "Assessment on Proponent Information - Category A". MOPL has had discussions with OEPA since this determination and is confident that the Die Hardy project is not the same project that was proposed by SXG in 2014.

A Memorandum of Understanding (MOU) also exists between the DMIRS and the OEPA that establishes a framework for referral of mining proposals under Part IV of the EP Act. Criteria under the MOU that triggers pre-referral consultation with the OEPA for onshore mining proposals is listed below, with an assessment of applicability to the currently proposed Die Hardy Project also provided.

EPA/DMIRS MOU Criteria

Criteria	Applicability to the Project
Located within Environmental Sensitive Areas including:	
• Within 500m of World Heritage Property	Not applicable
• Within 500m of a Bush Forever Property	Not applicable
• Within 500m of a Threatened Ecological Community	Not applicable
• Within 500m of defined wetlands (including Ramsar wetlands, ANCA wetlands, Conservation category wetlands)	Not applicable
• Area containing rare flora	Not applicable
• Area covered by an Environmental protection Policy	Not applicable
• Located within 500m of a declared/proposed State Conservation Estate	The Mt Manning Conservation Park (R48470) intersects tenement M77/1272. A buffer zone of 50m has been set for the Development Envelope, to allow for no ground disturbances or edge effects to occur on the conservation park.
• Within a Public Drinking Water Source Area	Not applicable
• Within 2 km of a declared occupied townsite	Not applicable
• Hydraulic fracturing exploration and development activities	Not applicable
• Within the Strategic Assessment for the Perth Peel Region	Not applicable
• Within areas previously or currently subject to formal assessment by the EPA	Not applicable[2]

[2] As interpreted and discussed above. MOPL has had discussions with OEPA regarding the original proposal Reg Legs project and is confident that the Die Hardy project is not the same project that was proposed by SXG in 2014.

In addition to the MOU, the Statement of Environmental Principles, Factors and Objectives (EPA 2018) is used as a guide by the EPA for assessing whether a proposal's impact on the environment is acceptable. The Statement includes a section on consideration of 'significance', which includes matters as listed below:

Consideration of Significance

Criteria	Applicability to the Die Hardy Project
Values, sensitivity and quality of the environment which is likely to be impacted	The project is on a granted mining lease outside of environmentally sensitive areas. It neighbours a conservation reserve but with the implementation of proposed management measures, impacts outside the Development Envelope are unlikely.
Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts	The Project footprint area is with a short mine life. After successful rehabilitation of the WRL and surface disturbances back to native vegetation, only the final void will remain and be unseen by the general public.
Consequence of the likely impacts (or change)	Impacts have been reduced through understanding of environmental setting and implementation of mitigation strategies as identified in the baseline studies.
Resilience of the environment to cope with the impacts or change	The environment has been historically impacted by exploration activities. Experience with other mining projects in the region suggest that the environment is resilient to change provided environmental impacts are minimised as far as practicable as detailed in the Mining Proposal and baseline studies
Cumulative impact with other existing or reasonably foreseeable activities, developments and land uses connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment	Cumulative impacts associated with clearing, water use and land, degradation is not applicable to the Project impact assessment. Very few mines are in the area.
Level of confidence in the prediction of impacts and the success of proposed mitigation.	The measures listed in the Mining Proposal and baseline studies provide an acceptable level of confidence required to minimise environmental impacts.
Public interest about the likely effect of the proposal, if implemented, on the environment, and public information that informs the EPA's assessment.	The Project is unlikely to gain a high level of public interest given its remote location, short mine life and restricted view from the public road.

Discussions with the OEPA as summarised in the Stakeholder Consultation Register re-affirmed MOPL's position and confidence that the proposed Die Hardy project is not considered significant and the small-scale, temporary impacts can be successfully managed, and permitted and compliance of the Project can be regulated under the Mining Act.

A compliance review of the tenement conditions relevant to the Die Hardy project (M77/1272 and L77/261) was undertaken to ensure the proposal will remain in compliance. No compliance issues exist.

5. STAKEHOLDER ENGAGEMENT

5.1 PRINCIPLES OF STAKEHOLDER ENGAGEMENT

Consultation with stakeholders commenced in 2011 when the previous owners of the project, Southern Cross Goldfields Limited, introduced the main Marda Gold Project and surrounding tenements to State government departments, regulators and advisory bodies. Consultation has more recently been continued throughout the advanced exploration and development phases by Ramelius Resources Limited (and its 100%-owned subsidiary, Marda Operations Pty Ltd) and has formed an integral part of the Project design, operation and closure. Feedback received from local stakeholders during this period indicates that the local pastoralist does not object to the mine development, provided terms agreed to are followed through.

Consultation has involved all parties holding a significant stake in the project (*i.e.*, stakeholders), so that they are properly informed, and their concerns and interests properly addressed. Marda Operation will maintain a list of stakeholders that will be periodically reviewed, to ensure that all relevant parties have been identified, and will consider all reasonable requests from other parties that declare an interest and ask to be consulted.

Table 19 summarises the stakeholders identified for the Die Hardy Gold Project and identifies their key interests associated with the project.

Table 14: Principal Stakeholders and Engagement

Stakeholder Sector	Organisation	Interest
State Government Departments	Department of Planning, Lands and Heritage (DPLH)	Indigenous and native title requirements Heritage, cultural, ethnographic and archaeological sites
	Department of Mines, Industry Regulation and Safety (DMIRS) Mine Safety Inspectorate	Administers (Mining Act) and Regulations. Tenement conditions. Mining proposals, programmes of work. Mining rehabilitation fund. Rehabilitation standards. Safety in resource sector.
	Department of Water and Environmental Regulation (DWER)	Administers EP Act. Part IV (EP Act) Environmental Impact Assessments. Provision of licenses to take and abstract water. Permits to interfere with bed and banks. Groundwater quality and quantity. Administers Part V (EP Act), *Industry Regulation and Licensing and Contaminated Sites Act 2003*.
	Department of Health (DoH)	Environmental health, building and planning compliance

Stakeholder Sector	Organisation	Interest
	Department of Fire and Emergency Services (DFES)	Fire breaks. Provision of emergency services
	Department of Biodiversity, Conservation and Attractions (DBCA)	Administers the *Biodiversity Conservation Act 2016* Interest in Projects that are located on DBCA managed land only. Baseline surveys and licenses to take flora and fauna
	Pastoral Lands Board (PLB)	Pastoral leases, stations, freehold properties
	Main Roads Western Australia (MRWA)	Use of public roads
Local Government Authorities	Shire of Yilgarn Shire of Merredin Shire of Westonia	Use of public roads and infrastructure.
Indigenous Groups	Traditional Owners (Marlinyu Ghoorlie)	Access to and use of Traditional Owner land. Cultural heritage values. Native Title rights
Underlying Land/ Tenement Owners / Pastoralist lease holders		Land access agreement for baseline surveys Mining agreements
Environmental Interest Groups		Potential interest in baseline surveys and significance of data

5.2 STAKEHOLDER ENGAGEMENT STRATEGY

The company aims to build strong stakeholder, social and community support for the Project and to create and maintain a positive foundation for project development, thereby assisting with project approvals, project development, land access, construction and project operations.

This is achieved through development and implementation of stakeholder communication and consultation strategies which ensure that stakeholders are informed and engaged positively about the company and project.

Marda Operations has undertaken extensive engagement with the groups listed in Table 19 and will continue to undertake engagement with those stakeholders who have relevant interests in the project during the operational phase and post-closure:

- Western Australia State Government (State Government).

- Local government authorities (LGA).
- Local pastoralists.

Project messages have related to:

- Technical and commercial viability.
- Timeline and status.
- Metrics and logistics.
- Permitting and approvals.
- Local benefits with respect to local business and employment opportunities.
- Low environmental impacts and sustainability.

The key activity area in the external relations programme has been community consultation programmes to support exploration, environmental approvals and then construction.

5.2.1 Pastoral Lease Holder

Marda Operations is in regular communications with the local pastoralist and meets with him whenever the opportunity presents itself. The company and its representatives will continue to work cooperatively with the pastoralist and will consult with him on all key land access matters relating to the project area throughout the life of the project. There is no pastoralist relevant to the Die Hardy project location as the project itself is situated on DBCA-managed land. The local Mt Jackson pastoralist is aware of project and that the project requires use of the public road for access, which traverses sections of the Mt Jackson station.

5.2.2 Local Government Authorities

Engagement and consultation between the company and LGA's to-date has broadly involved regular meetings to discuss approvals pathways, access to and upgrade of local roads for haulage to Edna May Operations. Road upgrades of local and state roads, and haulage discussions with the Shires have also occurred in concert with State Department MRWA.

5.2.3 DMIRS Environment Minerals Branch

Engagement and consultation between the company and DMIRS to-date has broadly involved:

- Regular meetings to discuss approvals pathways including the proposed works.
- Meetings on the new Mining Proposal Guidelines.
- Meetings to discuss the staging of the Mining Proposal based on tenure.

- A project presentation made to the DMIRS Team Leader and Assessing Officer
- Vegetation clearing requirements

5.2.4 Department of Biodiversity, Conservation and Attractions

Engagement and consultation between the company and DBCA to-date has broadly involved:

- A project presentation provided to the Regional Leader Conservation Office, Kalgoorlie
- Requirements around Project operational and closure issues on DBCA-managed land
- Malleefowl and priority flora on the project area

5.2.5 Department of Water and Environmental Regulation

Engagement and consultation between the company and DWER to-date has broadly involved:

- Regular meetings to discuss approvals pathways including the proposed works.
- Meetings on the Works Approval Application.
- Discussions on licensing of bores

5.3 ONGOING CONSULTATION STRATEGY

Once project construction commences, a more targeted consultation strategy will be implemented to those stakeholders with relevant interest in the project's operations. Table 20 summarises proposed ongoing consultation and how will be conducted including the timing, method and frequency.

Table 15: Strategy for ongoing stakeholder consultation

Stakeholder	Key Points	Strategy	Method	Frequency
Shire of Yilgarn	1. Responsible for assessing the Application to Construct or Install an Apparatus for the Treatment of Sewage	1. Engage during the assessment to ensure no delays in approvals requirements are understood	Phone calls, email	Monthly, or as required
DMIRS	1. Responsible for assessing the Mining Proposal	1. Engage during site establishment and throughout operations 2. Engage on Mining Proposal amendment requirements should the project design change. 3. Obtain feedback leading up to mine closure for input into the MCP	Phone calls, email	Annually, or as required
DBCA	1. Responsible for land management across the tenement	1. Engage during operations 2. Obtain feedback leading up to mine closure for input into the MCP	Phone calls, email	Annually, or as required

5.4 RECORDS OF ENGAGEMENT

Extensive stakeholder engagement on the Die Hardy project has been occurring since 2014 when the previous owners of the project (Southern Cross Goldfields) were looking to develop the resource in conjunction with another resource (Reg Legs). Details of these previous consultation records can be found in SXG (2014). Consultation with the key stakeholders has been undertaken and are summarised in Table 16.

Table 16: Stakeholder Consultation Register

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
210128	Teams Meeting with Felicity Huxtible and Larissa Burnes	DMIRS	Pre-submission (mining proposal) meeting to discuss planned project at Die Hardy	PowerPoint provided	physical (geotech) testwork to be done on waste rock to inform WRL design. Consider economics of backfilling the pit and put problematic material back in. Depth to g/w and implications for pit lake. Do not leave any unknowns. All studies to be completed. All risks and uncertainties to be managed with contingencies included with Risk Assessments and outcomes to meet DMIRS Env. Objectives. Include discussions with DBCA in s/holder register as well as agreements, legal objections and commitments. Tech Reports appended and all uncertainties addressed.
210325	Telephone call with and follow up email to Katherine Hope	DBCA	Pre-submission (mining proposal) meeting to discuss planned project at Die Hardy	PowerPoint provided	No response received
210923	Email to Rebecca Ong and Katherine Hope	DBCA		DMIRS RFI received, and they are asking for evidence that DBCA was consulted with. MOPL referred the communications in March to DBCA seeking their feedback	Rebecca Ong referred the email onto Murray Baker at DBCA to provide feedback to MOPL.
210929	Phone call from Murray Baker	DBCA	Comments from DBCA on consultation	DBCA had not formally responded to a request for feedback on the consultation initiated on 25 March 2021.	DBCA apologised for not having responded. DBCA indica ted they responded to DMIRS as part of the external agency referred for advice. DBCA indicated that the advice provided to DMIRS is relevant to MOPL in revising the Mining Proposal. DBCA make a specific point about the post-closure pit lake in that it is **NOT mandatory that MOPL partially backfill to exclude a permanent pit lake forming; it is just a preference if feasible.** DBCA said they could give MOPL feedback on the March request which was appreciated, but it was decided between DBCA and MOPLY that

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
					this now serves no purpose. Consultation has occurred and if MOPL addresses DBCA comments in the DMIRS RFI, DBCA will be satisfied.
211018	Teams Meeting with Jessica Allen and Helen Butterworth	OEPA	EPA Services would like to meet with Ramelius Resources Limited to get an overview of the proposal and its relationship with the formally assessed Marda East Gold Project.	overview of the DH project and addressed the points summarised in the Pre-referral meeting Form	OEPA interested in the legal definition of the Marda East project proposed by SXG, and if what MOPL is proposing for just the Die Hardy component. OEPA responding with the legal definition outcome by end of the month. Other aspect of interest are discussions had with DBCA regarding final pit lake, access track through the tenement to the conservation park, visual amenity of just the DH project, and justification why it should not be considered under Part IV.
211020	Email to Rebecca Ong and Katherine Hope	DBCA	Updated Malleefowl Management Plan	As DBCA is a stakeholder of the region, and to fulfil MOPL's commitment to consult with DBCA, the updated Malleefowl Management Plan was emailed and with a request for feedback on the mitigation and management actions	no response received
140520	Meeting with Mark Jeffries	OEPA	EPA has a focus on the BIF ranges and is aware of the delay in converting proposed conservation areas into actual conservation areas.	SXG tenure does not infringe on proposed Class A Nature Reserve. The hydrological study completed to determine the potential for runoff into the proposed Class A Nature Reserve confirms that the proposed mine areas will not drain into the proposed Class A Nature Reserve (section 4.3.1 of the Environmental Assessment document).	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
			Edge effect of project on the fringe of conservation reserves - how will SXG ensure that the mine does not impact on the adjacent BIF ranges? In particular, how will SXG ensure that dust and other pollutants from the mine do not impact on the Tetratheca populations on the BIF ranges?	The hydrological study completed to determine the potential for runoff into the proposed Class A Nature Reserve confirms that the proposed mine areas will not drain into the proposed Class A Nature Reserve (section 4.3.1 of the Environmental Assessment document). Management measures will be identified to prevent offsite dust impacts. Monitoring of reference sites will confirm efficacy of management measures.	
			The Landform aspect of the project will require particular attention given the importance of this aspect in BIF regions.	SXG notes the importance of the Landform aspect and has addressed this aspect in section 4.2.2. of the Environmental Assessment document	
			Considerable importance on the impact of the Proposal on conservation reserves and the values being protected in the reserves. • Does the reserve already hold adequate similar vegetation to that described in the Project area? • How will the reserve be afforded with adequate protection?	SXG confirms that there is no DRF within the project area that is typically associated with BIF and could be expected to occur in the proposed Class A Nature reserve (see section 4.2.1. of the Environmental Assessment document). The habitat and vegetation integrity as well as regional significance of flora and vegetation within the Development Envelope has been considered at sections 4.2.1 and 4.2.4. of the Environmental Assessment document	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
			• Can it be assured that the areas outside the reserve are not needed for the integrity of the whole? • How will the Proposal operate without impacting the reserve?		
			The exclusion of the mine tenement R77/001 from the proposed Class A Nature Reserve is on the basis that the tenement was existing at the time of the proposition, not because of differing conservation values. SXG should determine whether the mining tenement includes high conservation values and if it will impact on the adjacent nature reserve.	See sections 4.2.1, 4.2.2 and 4.2.5. of the Environmental Assessment document	
			SXG may choose to review the flora data with a view to refining the PEC boundary with input from the DER. SXG also needs to determine if the proposed mine infrastructure will actually impact on the PEC.	See section 4.2.1. of the Environmental Assessment document. SXG will liaise with the DER during the forward works program to determine whether the PEC boundary may be refined as a result of the data obtained during the surveys for the Proposal.	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
			A (very) detailed closure plan is expected and should focus on restoring values.	The MCP for Marda Central will be updated to reflect the inclusion of the Proposal.	
			How will the possible formation of pit lakes at closure be addressed?	See sections 3.2.4, 4.3.1 and 4.6.2. of the Environmental Assessment document. If groundwater is detected above the base of mining activity during operations, SXG will conduct additional studies to determine whether there is a need for partial backfill to prevent groundwater intrusion in closure. Any backfill considerations will occur in the context of sterilisation implications and in discussions with the DMP and DPaW.	
140522	Meeting Sandra Thomas, Daniel Coffey, Ian Kealley, Julie Futter	DPaW	This area is likely to be subject to intense scrutiny in light of the proximal Banded Ironstone Formation. DPaW refers SXG to the 2007 EPA Annual Report and Bulletin 1256.	See section 4.2.2. of the Environmental Assessment document. SXG has reflected the issues outlined in these documents in its consideration of landform issues.	
			At least a Level 1 fauna study will be required, with some level of field work to verify desktop studies available, given the limited nature of field work conducted off BIF ranges in the area.	A Level 1 fauna study has been completed, and a Level 2 spring fauna study has been included in the forward works section (see section 6.1. of the Environmental Assessment document.)	
			Any presence of malleefowl will require referral under the EPBC Act.	Noted. This is included in the forward works section (see section 6.3 of the Environmental Assessment document).	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
			One of the major issues for consideration is the landform features of the area. There are potential recreation areas in the region and this will be a focus for public engagement. DPaW encourages SXG to follow the DPaW methodology for visual assessment, and if necessary to provide a formal external visual assessment review of the project.	The landform section (see section 4.2.2. of the Environmental Assessment document) addresses this issue and significant stakeholder engagement has been conducted in relation to landform and visual values. Finally, the forward work section 6.1 proposes specialist visual impact modelling to confirm the projected impacts and the efficacy of any proposed rehabilitation strategies.	
			The Species and Communities Branch (Perth) may be consulted in order to review the Priority Ecological Communities boundary, if it is appropriate to use survey information in order to better define the actual boundary.	The forward works section 6.1 includes a proposal to liaise with the Species and Communities Branch in this regard.	
			Impacts to Tetratheca that may occur in the proposed Class A Nature Reserve should be considered, including dust, habitat connectivity and surface water runoff.	These impacts have been considered in sections 4.3.1 and 4.4. of the Environmental Assessment document.	
			DPaW would like the opportunity to review the MCP, with particular	Closure and rehabilitation have been addressed in section 4.6.2. The forward works section includes an updated MCP which will be developed in consultation	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
			reference to the proposed management of any pit lakes.	with stakeholders including DPaW and DMP (see section 6.4 of the Environmental Assessment document).	
			DPaW recommends that SXG consult with relevant Non-Government Organisations prior to referral.	SXG has carried out consultations with a number of NGOs in support of this referral, as further outlined in this table below.	
			The seasonal impacts on flora surveys should be considered. A particularly dry spring may have implications for species observed.	This has been considered in the methodology and reporting for flora and vegetation (see section 4.2.1 of the Environmental Assessment document).	
			DPaW has offered to review scopes of work for any works carried out in support of the assessment.	SXG will liaise with DPaW to obtain feedback regarding the scopes of work for the forward works package.	
			It is important to note in the floristic community types analysis the extent to which local populations will be influenced.	The influence on local populations is limited to Mirbelia Ferricola (P3) populations. While this species occurs prevalently elsewhere, the local population will be reduced by approximately 53% (see section 4.2.1 of the Environmental Assessment document).	
			Aboriginal cultural heritage must be carefully mapped in the context that there is limited agreement on which groups have used the area in the past.	See section 4.5.2. of the Environmental Assessment document. The DAA has been consulted in this regard (see below of the Environmental Assessment document).	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
140610	Letter and Briefing Note to Liz Fox and Nick Dunlop	Bird Life Australia	Briefing note (attached as Appendix C of the Environmental Assessment document) provided to Bird Life Australia outlining the nature of the proposal, the studies completed and planned, the key impacts and requesting to meet with representatives to understand any concerns or issues to be addressed by SXG during the proposal referral process.	Meeting scheduled with Bird Life Australia.	Looking forward to the meeting. See meeting notes of 140630 (30 June 2014)
140610	Letter and Briefing Note	Malleefowl Preservation Group		Briefing note (attached as Appendix C of the Environmental Assessment document) provided to the Malleefowl Preservation Group outlining the nature of the proposal, the studies completed and planned, the key impacts and requesting to meet with representatives to understand any concerns or issues to be addressed by SXG during the proposal referral process.	No response received from Malleefowl Preservation Group.
140610	Letter and Briefing Note to Piers Verstegen	Conservation Council of Western Australia		Briefing note (attached as Appendix C of the Environmental Assessment document) provided to the Conservation Council of WA outlining the nature of the proposal, the studies completed and planned, the key impacts and requesting to meet with representatives to understand any	No response received from Conservation Council of WA

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
				concerns or issues to be addressed by SXG during the proposal referral process.	
140610	Letter and Briefing Note to Sarah Yani Vann-Sander	Wilderness Society (WA)		Briefing note (attached as Appendix C of the Environmental Assessment document) provided to the Wilderness Society of WA outlining the nature of the proposal, the studies completed and planned, the key impacts and requesting to meet with representatives to understand any concerns or issues to be addressed by SXG during the proposal referral process.	No response received from Wilderness Society. Given the Society's interest in the Marda Central Project, follow up phone calls were made in a further attempt to engage with this stakeholder. No response was received.
140610	Letter and Briefing Note to Brian Moyle	Wildflower Society of Western Australia	Briefing note (attached as Appendix C of the Environmental Assessment document) provided to the Wildflower Society of Western Australia outlining the nature of the proposal, the studies completed and planned, the key impacts and requesting to meet with representatives to understand any concerns or issues to be addressed by SXG during the proposal referral process.	Meeting scheduled with Wildflower Society of WA	See meeting note of 140630 (30 June 2014)
140610	Letter and Briefing Note to Cesar Rodriguez	Department of Aboriginal Affairs	Briefing note (attached as Appendix C of the Environmental Assessment document) provided to the Department of Aboriginal	Meeting scheduled with Department of Aboriginal Affairs.	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
			Affairs outlining the nature of the proposal, the studies completed and planned, the key impacts and requesting to meet with representatives to understand any concerns or issues to be addressed by SXG during the proposal referral process.		
140630	Meeting with Brian Moyle	Wildflower Society of WA	The landscape values are likely to be changed forever, for what is a short mine life. Has SXG considered the intergenerational equity of this project?	SXG understands the significance of the Landform factor in this referral and has addressed this issue in sections 4.1 and 4.2.2. of the Environmental Assessment document.	
			The lookout known as Mt Geraldine is the most accessible public access point and campers do frequent this area. Is the mine going to be visible from this point?	SXG has completed a preliminary visual assessment of the proposal (according to the guideline in Visual Landscape Planning in Western Australia (WAPC 2007)). This is referred to in section 4.5.1. Due to the proximity of other range features between Mt Geraldine and the Proposal site, it is not likely that the mine impact area will be visible from the lookout referred to in this conversation. However, the forward work section 6.1 proposes specialist visual impact modelling to confirm the projected impacts and the efficacy of any proposed rehabilitation strategies and will include an assessment of the view from Mt Geraldine.	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
			Historically there have been fewer bushfires on the range areas and as a result there are more mature trees. Can SXG commit to protecting the larger trees?	SXG will align ancillary infrastructure in a manner that minimises impacts to mature trees where it is possible to do so (see section 4.2.1 of the Environmental Assessment document).	
			Has SXG considered the preservation of good topsoil and accurate material characterisation, including basing management practices on different material type?	SXG has committed to carrying out a detailed soil characterisation survey, and will collect and manage topsoil on the basis of values identified during this survey (see sections 4.2.2, 4.6.2 and 6.1 of the Environmental Assessment document). These commitments will be included in the MCP update (see section 6.4 of the Environmental Assessment document).	
			Has SXG considered collecting seed of priority species, and utilising local species that are viable long term (such as pea species) in rehabilitation?	SXG has included these measures in its management commitments (see sections 4.2.1 and 4.6.2. of the Environmental Assessment document).	
			Has SXG considered stockpiling vegetation and timber to use as a resource to create habitats during rehabilitation and closure?	SXG has included these measures in its management commitments (see section 4.6.2 of the Environmental Assessment document).	
			Has SXG designed rehabilitation structures that will be successful over dry and wet seasons?	The WRLs are designed to maximise precipitation infiltration in the context of the material characterisation and soil types, and the regional climate. The MCP will be updated to reflect the Marda East	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
				soil types and waste characterisation (see section 4.6.2. of the Environmental Assessment document).	
			Has SXG considered an education program for site workers in terms of environmental and community values?	SXG has included these measures in its management commitments (see sections 4.2.1 and 4.2.5. of the Environmental Assessment document).	
			The Wildflower Society is focused on the cumulative impacts to the region, and would rather the proposal did not go ahead.	SXG notes this focus and has attempted to address this view point in section 4.2.2. of the Environmental Assessment document.	
140630	Meeting with Liz Fox, Brian Dunlop	Bird Life Australia / Great Western Woodlands (GWW/BLA)	GWW/BLA is concerned with the long term cumulative effects of fragmentation across the landscape, and the impacts to ecosystem values of this fragmentation. The aim of protecting areas is to ensure that the ecosystem remains fully functional.	Section 4.2.1 of the Environmental Assessment document indicates that the disturbance is aligned in such a manner to prevent fragmentation of the vegetation associations and landform units within the region. SXG notes the focus on cumulative impacts and has attempted to address this view point in section 4.2.2. of the Environmental Assessment document	
			GWW/BLA is concerned about the potential impact of stability of landforms in the long term, including open pits, tailings dams and waste dumps.	SXG has addressed this concern in section 4.2.2 of the Environmental Assessment document and will update the MCP to reflect this focus as part of the forward works.	
			GWW/BLA would like to see a higher standard of closure objective set than are	SXG has set closure objectives that are relevant at an ecosystem level. SXG will amend its closure plan as part of the	

Date	Description of Consultation	Stakeholder	Stakeholder Comments/ Issues	Proponent Response and/ or resolution	Stakeholder Response
			currently accepted by regulatory authorities.	forward works and has invited GWW/BLA to be involved in the review of this document before it is finalised.	
			GWW/BLA is concerned about the impact that pit lakes may have on the regional ecosystem following closure.	See sections 3.2.4, 4.3.1 and 4.6.2 of the Environmental Assessment document. If groundwater is detected above the base of mining activity during operations, SXG will conduct additional studies to determine whether there is a need for partial backfill to prevent groundwater intrusion in closure. Any backfill considerations will occur in the context of sterilisation implications and in discussions with the DMP and DPaW.	
			Bird Life Australia have indicated that they have a need for environmental data that is collected by mining companies.	SXG has committed to providing flora and fauna data to Bird Life Australia upon request.	
			GWW/BLA would like to see backfilling of pits.	If groundwater is detected above the base of mining activity during operations, SXG will conduct additional studies to determine whether there is a need for partial backfill to prevent groundwater intrusion in closure. Any backfill considerations will occur in the context of sterilisation implications and in discussions with the DMP and DPaW.	

6. BASELINE ENVIRONMENTAL DATA

A number of baseline surveys of the existing environment have been commissioned for the Die Hardy Project (Table 17). This section of the Mining Proposal describes these surveys and identifies the values and sensitivities and heritage areas that may be affected by the proposed activities.

Table 17: Summary of Baseline Surveys

Environmental Factor	Survey Type	Survey Location	Undertaken By	Date Completed
Flora and Vegetation	Level 2 Flora and Vegetation Survey	Red Legs and Die Hardy Prospects	Western Botanical	2014
	Targeted search for conservation significant flora/vegetation	Die Hardy and Red Legs	Botanica	2019
	Desktop Review of the Flora and Vegetation	Red Legs, Fiddleback and Mt. King Prospects	Western Botanical	2019
Terrestrial Fauna	Level 1 Fauna Assessment	Marda East	APM	2014
Subterranean Fauna	Subterranean Fauna Risk Assessment	Marda	Bennelongia	2013
Hydrology	Marda East Drainage Investigation	Marda East	Palaris	2014
	Hydrology Report	Die Hardy Gold Project	MWES	2021
Soil and Waste Characterisation	Baseline Soil and Waste Rock Characterisation Study	Die Hardy Project Area	Ramelius / Bureau Veritas Minerals	2020
Landform	Rehabilitated Landform Design Guidance	Die Hardy WRL	Landloch	2020
Heritage	Aboriginal Heritage Survey Report Consultations	Die Hardy Range & Red Legs	AHC/Ngalia	2012
	Report on an Archaeological and Ethnographic Site Avoidance Survey	Die Hardy and Red Legs Projects	JCHMC	2020

6.1 CLIMATE

The Southern Cross subregion has an arid non-seasonal to semi-arid Mediterranean climate with an annual rainfall of 200 to 300 mm (Beard 1990). Summers are generally warm, with the highest temperatures recorded in January, while winters are cold with lowest temperatures experienced in July and August. Climate data from the Bureau of Meteorology's (BOM) Southern Cross Airfield (Site Number

12320) are available for the period 1996-2012. Mean rainfall, maximum and minimum temperatures are presented in Figure 13.

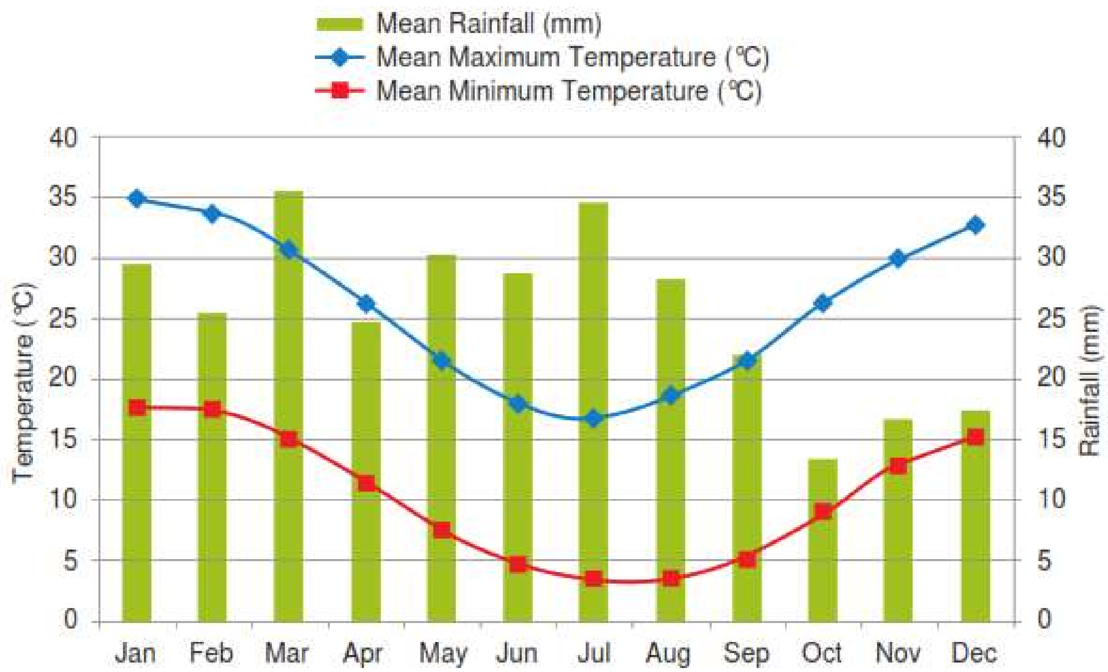

Figure 13: Southern Cross Mean Monthly Climate Data

Rainfall occurs year-round, with yearly totals ranging from 150 to 550 mm with an annual mean of 294mm. Rainfall fluctuates throughout the year and is significantly lower from October to December, with March and July being the wettest months on average. Temperatures vary between an average minimum of 9.2°C and average maximum of 26.6°C (BOM 2013a). Evaporation data in the Project Area were determined using maps of gridded digital evaporation contours created by the BOM. These maps showed that the greatest evaporation in Southern Cross occurs during Summer (900mm) with an estimated annual evaporation of 2,000mm (BOM 2013b). The average annual evaporation rate exceeds rainfall by a factor of 7 (Figure 14).

The Intensity Frequency Duration (IFD) relationship for a particular site can be determined using the BOM Rainfall IFD Data System, and the outputs for Southern Cross can be seen in Figure 15. This indicates that for a 1 in 100 year event that lasts for one hour, approximately 40mm of rain will fall (BOM 2013c).

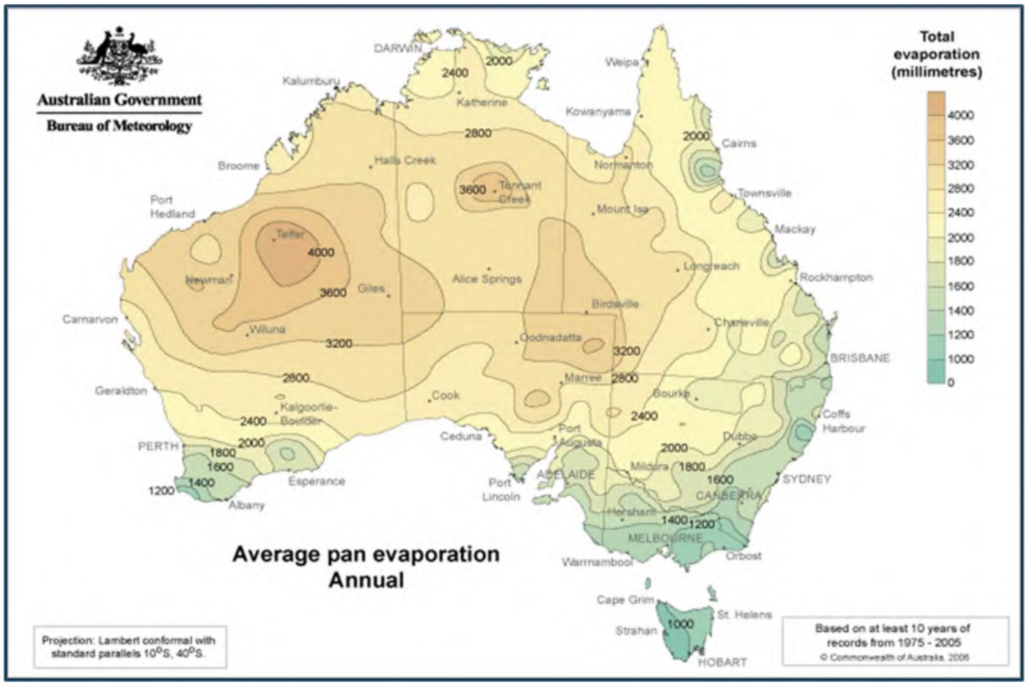

Figure 14: Annual Evaporation Rates Australia

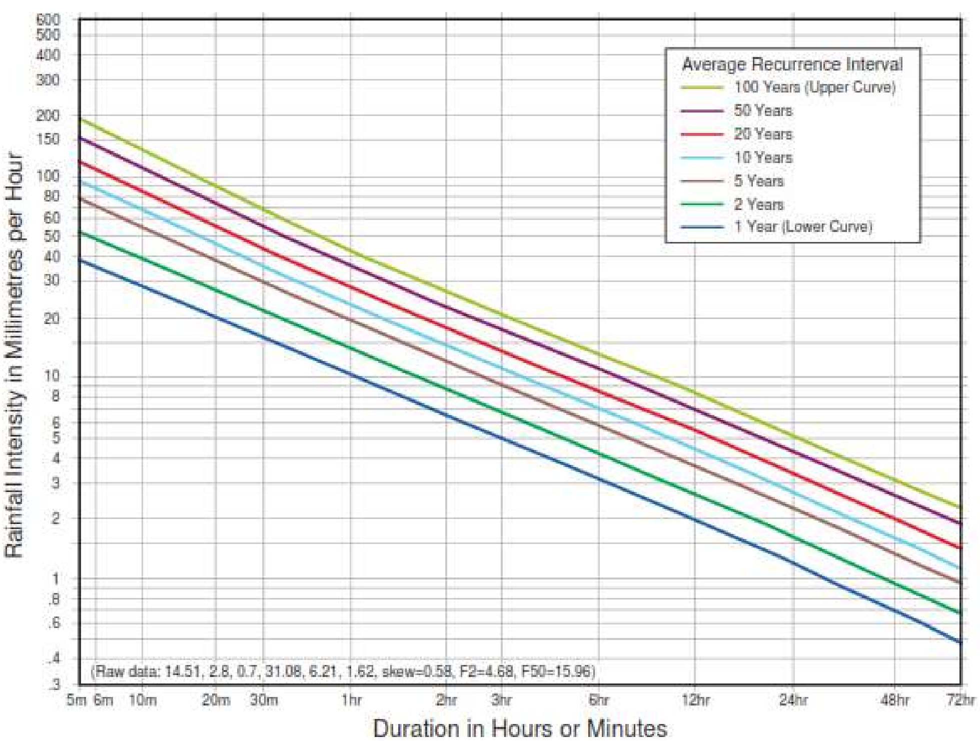

Figure 15: Rainfall Intensity-Frequency-Duration for the Die Hardy Project

6.2 LANDSCAPE

6.2.1 Regional Setting

Die Hardy is located in the Southern Cross IBRA sub-region. The soils and landforms in this region are characterised by gently undulating uplands dissected by broad valleys with bands of low greenstone hills with an occluded drainage system. The valleys have Quaternary duplex and gradational soils and included chains of saline playa –lakes. The upper levels in the landscape are eroded remnants of a lateritic duricrust yielding yellow sandplains, gravelly sandplains and lateritic breakaways (Cowan 2001).

Payne *et al*. (1998) conducted Land Systems (rangelands) mapping at a scale of 1:500,000 encompassing the project area. Land System mapping comprises repeating patterns of topography, soils, and vegetation. Payne *et al*. (1998) describes a single Land Systems that extends over the Die Hardy Project; the Campsite Land Systems, described as consisting of alluvial plains (very gently inclined plains receiving sheet wash from mafic hills, gently undulating calcareous stony upper plains (erosional) and occasional narrow concentrated drainage tracts). It supports eucalypt woodlands with halophytic understoreys and eucalypt-acacia shrublands.

6.2.2 Geology

The Geological survey of Western Australia (GSWA) has completed 1:2,500,000 mapping across the Goldfields region. The project area lies on Archaean metamorphosed basic and ultra basic volcanic and intrusive rocks (GSWA 2014). The area forms part of the Yilgarn Craton, which makes up a significant portion of Western Australia and is one of the oldest, most geologically stable parts of the earth's surface (Gibson *et al*. 2007). The main components of the Yilgarn Craton are granite, interspersed with greenstone and banded iron formation (BIF) ranges.

The project area is located on the eastern flanks of the Die Hardy Range, which is one of the many large BIF ranges within the region. The BIF ranges of the Yilgarn Craton make up a small portion of the land in the region, which is predominantly flat. They are ancient, isolated features, exhibiting different geology, soils, and biological aspects to those found in the surrounding land. The ranges are known for their unique compositions of flora and fauna and for supporting rare and endemic plant species (DEC 2007). Based on survey information to date, each range is distinctly different from the other sampled ranges from an ecological perspective (DEC 2007).

Local Geology & Mineralisation

Mineralisation is hosted within a less significant, sub-parallel BIF unit occurring around 1.5km NE of the Die Hardy Range. The BIF unit sits within a mafic/ultramafic stratigraphy. Stratigraphy strikes NW toward 330° and dips at around 35-40° to the SW. The BIF unit is around 30-40m thick. Mineralisation occurs as a relatively continuous lode zone within the BIF zone. It is essentially stratabound within the BIF unit, generally 2-8m thick and averaging around 5m, and is interpreted as a mineralised shear zone or iron rich sedimentary layer. Mineralisation is defined for around 1,000m of strike and 140m down-dip.

Most resource drilling is RC and is mostly intersects mineralisation within transitionally weathered units. Minor quartz and pyrite is logged in some holes and may relate to the mineralisation. Gold appears depleted near surface in completely oxidised BIF.

A number of recent diamond holes were completed for metallurgical and geotechnical investigations. These holes show that the lode in fresh rock relates to strong Fe sulphide mineralisation occurring as pyrrhotite and pyrite. The sulphides occur as banding, probably replacing iron rich sedimentary layers or brecciated zones. Only minor quartz is seen.

Oxidation logging shows that complete weathering is between 10-35m deep and fresh rock occurs at around 40-50m depth.

No sulphide is seen outside the mineralised lode zone. Fresh sulphidic lode will only form a minor portion of the mined ore as most of the pit is targeting oxide and transitional material.

No fibrous minerals have been reported from the significant drillhole logging campaigns in RC chip or core or RC chip logging.

Likewise, no radioactive minerals or elements are known. This type of sulphide gold mineralisation style is not associated with radioactive elements in the Company's experience.

6.2.3 Mineral Resource Details

The Die Hardy Mineral Resource estimate was generated in December 2020 by Ramelius Resources as part of the project feasibility study and classified and reported in accordance with the JORC Code (2012). The model is a conventional constrained lode type incorporating topcuts and using an ID2 method.

It comprises a Total Resource of 2.0 Mt grading 1.5 g/t gold for 95 koz of contained gold (Table 18). The Die Hardy Gold Project Mineral Resource is inclusive of Mineral Reserves.

Table 18: Die Hardy Gold Project Mineral Resource

Indicated			Inferred			Total Resource		
t	g/t	oz	t	g/t	oz	t	g/t	oz
1,500,000	1.5	72,000	550,000	1.3	23,000	2,000,000	1.5	95,000

By weathering, the resource is around 50% oxide/transitional and 50% fresh. Amounts are: oxide (114kt), transitional (922kt) and fresh (1.004kt). The pit targets the upper 55m and has only very minor fresh ore included.

6.3 MATERIALS CHARACTERISATION

6.3.1 Soils

A soil survey was completed in 2020 by Ramelius personnel with soil samples from 10 soil pits (SCDH001-010) collected from the Die Hardy Project tenements (Figure 16). Samples of topsoil (0 to 200mm) were collected for laboratory analysis with testing undertaken to characterise physical and chemical properties of the soils and to assess their potential as cover materials for rehabilitation. For this reason, the test programme focused on tests measuring physical stability and plant nutrition characteristics.

The following tests were undertaken by Chem Centre (Bentley, Western Australia):

- pH and electrical conductivity (EC).
- Exchangeable cations (calcium, sodium, potassium and magnesium) and relative sodicity.
- Organic carbon and total nitrogen.
- Particle size distribution.
- Potential for dispersion (Emerson Class, AS 1289 C8.1 1980).
- Nutrients and plant available heavy metals (Mehlich extract, Mehlich 1984).

The following sources of information were used to assess the significance of laboratory test results:

- Soil Analysis: An Interpretation Manual (Peverill *et al*., 1999).
- Interpreting Soil Test Results. What do all the numbers mean? (Hazelton and Murphy, 2007).
- Soil Guide. A handbook for understanding and managing agricultural soils. DAFWA Bulletin 4343 (DAFWA 1998).
- Soil-Landscape Mapping in South-Western Australia, Overview of methodology and outputs. Resource Management Technical Report 280 (DAFWA 2004).

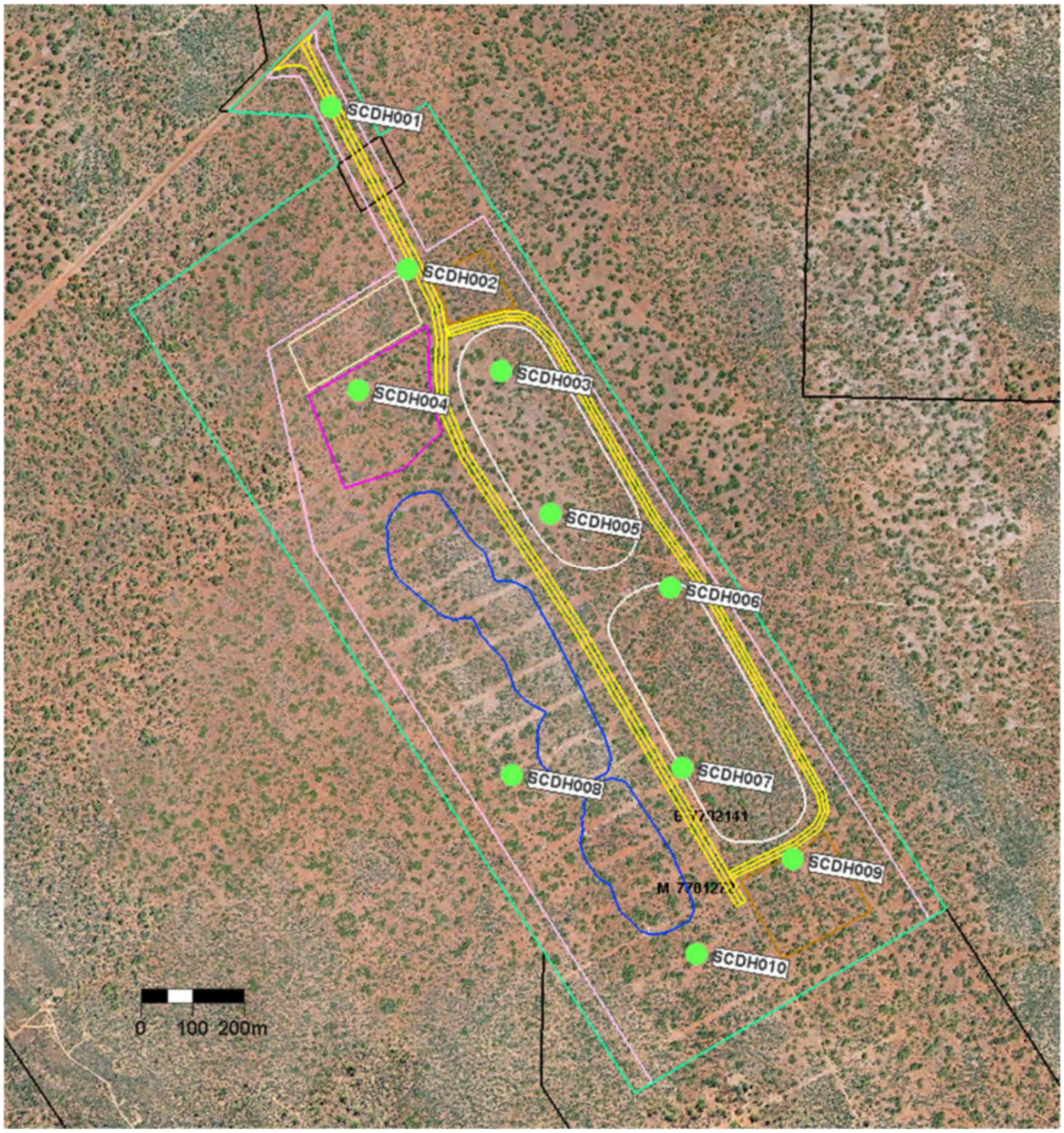

Figure 16: Soil sample locations within the tenements

Chemical Properties

Results of the soil analysis (Table 19 and Table 20, and Appendix D) identified that the soils of the Die Hardy Project area are naturally acidic (average pH 5.4) and classified as non-saline (EC <40 mS/m). The soils are naturally high in nutrients. The exchangeable sodium percentage (ESP) which measures the proportion of cation exchange sites occupied by sodium is favourable which indicates good soil structure that is not dispersive.

Table 19: Topsoil Geochemical Analytical Results

Sample ID	pH	EC (mS/m)	Total P (mg/kg)	Total N (%)	Organic C (%)	Exchangeable cations (cmol(+)/kg)				CEC (cmol(+)/kg)	ESP (%)	BSP (%)
						Ca	K	Mg	Na			
SCDH 001	5.4	3	180	0.035	0.55	3.1	0.22	1.1	0.06	8	0.8	58
SCDH 002	6	2	210	0.034	0.51	5.1	0.86	1.2	0.07	9	0.8	77
SCDH 003	8.1	7	120	0.037	0.47	15	0.49	2.1	0.13	19	0.7	96
SCDH 004	4.2	1	180	0.038	0.66	1.6	0.18	0.48	0.02	6	0.4	37
SCDH 005	7.6	20	110	0.042	0.5	13	0.75	8.2	2.5	28	9	87
SCDH 006	7.7	6	130	0.042	0.5	12	0.48	3.7	0.08	19	0.4	88
SCDH 007	5.1	2	190	0.038	0.62	3.6	0.24	0.82	0.02	7	0.3	66
SCDH 008	5.4	1	190	0.027	0.43	1.8	0.22	0.8	0.04	5	0.7	54
SCDH 009	5.5	2	180	0.037	0.48	2.5	0.45	0.78	0.04	6	0.7	61
SCDH 010	4.1	2	170	0.041	0.58	0.65	0.16	0.29	<0.02	6	0.2	19
Preferred Level	6-8	<40	<20	>0.5	>1	>5	>0.5	>1.6	<1	>10	<6	60-80

Indicates levels outside of preferred values or ranges[3]

Indicated levels within preferred values or ranges

[3] Preferred values or ranges are derived from a combination of reference sources including Peverill *et al*. (1999), Hazelton and Murphy (2007), (DAFWA 1998) and DAFWA (2004)

Table 20: Topsoil Metal Analytical Results

Metal /Metalloid (mg/kg)	Preferred Level (mg/kg)	Sample ID									
		001	002	003	004	005	006	007	008	009	010
Al	<4	>550	>550	>550	>550	>550	>550	>550	>550	>550	>550
As	1-200	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B	0.1-2.0	0.7	1.9	0.1	0.5	1.9	0.8	<0.1	0.9	0.5	<0.3
Ca	50-5000	630	1000	>5500	330	2800	2800	690	370	480	130
Cd	<1	0.06	0.06	0.09	0.04	0.1	0.1	0.06	0.06	0.06	0.05
Co	N/A	1.8	3.6	0.61	0.43	3.2	3.6	1.6	0.89	1.5	0.3
Cu	0.1-5.0	1.5	2.2	1.4	0.8	1.2	1.9	1.7	1	1.3	1.2
Fe	10-200	29	28	25	32	50	45	38	24	26	24
K	10-300	120	300	190	97	320	200	120	110	160	91
Mg	20-2000	140	150	470	61	>1000	690	100	99	96	36
Mn	5-100	91	140	42	25	69	120	160	91	110	21
Mo	0.01-0.05	<0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Na		11	9	11	3	700	11	2	5	6	<1
Ni	1-20	1.1	1.7	1	0.4	3.2	3.3	1.4	0.4	0.6	0.3
P	2-10	5	6	13	3	5	12	10	8	5	4

Metal /Metalloid (mg/kg)	Preferred Level (mg/kg)	Sample ID									
		001	002	003	004	005	006	007	008	009	010
Pb	<20	1	1.2	0.4	1.1	0.5	0.8	0.7	0.8	0.8	1.5
S	5-200	7	4	5	7	3	3	4	3	5	14
Se	0.1-2.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
Zn	10-20	0.9	1.1	0.7	0.3	0.6	1.4	1.3	1.3	0.9	0.6

Indicates levels outside of preferred values or ranges[4]

Indicated levels within preferred values or ranges

[4] Preferred values or ranges are derived from a combination of reference sources including Peverill *et al*. (1999), Hazelton and Murphy (2007), (DAFWA 1998) and DAFWA (2004)

The majority of the metals/metalloids recorded for each of the soil samples were within preferred levels. However, elevated Aluminium (Al) levels were recorded for all samples. This is discussed below.

Acidic soil cations are also undesirable components of a healthy soil, particularly the Al component as soluble Al is phytotoxic to plants. Even though Al is one of the most abundant elements in soil, natural acidification processes result in increasing solubility of aluminium and, as soils become moderately acidic (pH <5.5), Al begins to appear as the exchangeable cation which dominates in the lower mineral horizons. Al toxicity is more important to agricultural cropping rather than the highly adapted native species and vegetation at the Project.

All samples recorded low levels of Zinc (Zn) which may need to correct during rehabilitation depending on species selection.

Bioavailable soil nutrient testing is widely used for diagnosing potential nutrient deficiencies and imbalances in soils used for agriculture; more so than for native vegetation rehabilitation practices at mine sites. The Mehlich 3 multi-element soil test methodology (Mehlich 1984) is an adaption used to test soil nutrient levels to assess mine site soils for potential nutrient deficiencies, toxicity or imbalances that may affect revegetation outcomes. The preferred levels stated in Table 20 indicate a “Low” range rating that corresponds approximately to the lowest fifth percentile of unfertilised WA surface soil types and indicates conditions that may result in deficiency to plants not adapted to very low nutrient concentrations in soils. Values above the “Elevated” range rating corresponds approximately to the 95th percentile of unfertilised WA surface soil types and may indicate conditions resulting in either nutrient imbalances or toxicities to plants not adapted to high nutrient concentrations (especially micronutrients such as boron).

Physical Properties

Texture of the soil samples collected at the Die Hardy Project were characterised as Sandy Loam. The structural stability of sandy loam soils can be assessed by a simple field test referred to as the Emerson aggregate test (AS 1289 C8.1 1980). The test involves observation of the behaviour of natural soil aggregates (peds) and subsamples of soil remoulded at field capacity when placed in deionised water. Poorly structured soils, often containing sodic clays exhibit low strength when wet, resulting in rapid slaking of aggregates and dispersion of fine clays and a cloudy halo when placed in de-ionised water. The Emerson Aggregate Test provides an Emerson class number ranging from 1 to 8, with Emerson class number 1 indicating soils with weak structure and high potential for clay dispersion, while Emerson class number 8 indicating soils that do not slake, swell or disperse when placed in water. Soil aggregates that slake and disperse readily (Emerson Class numbers 1, 2 and 3) indicate weak structure that is easily disrupted by raindrop impact or mechanical disturbance and therefore prone to water erosion, especially on sloping landforms. Soil samples collected from the Project recorded an Emerson Class values predominantly ranging from 1 to 3 which initially indicates medium to high risk of clay dispersion. As stated previously, all of the soils are non-sodic. As these samples contain a high percentage of sand (>75%) which is inert and a low percentage of fine silt, these soils represent a lower dispersion risk (Table 20).

Table 21: Topsoil Physical Characteristic Analytical Results

Sample ID	Stones (%) (>2mm)	Particle Size Distribution (%)			Texture	Emerson Class
		Sand (%) (2mm-20µm)	Silt (%) (20µm-2µm)	Clay (%) (<2µm)		
001	40.6	73.5	9.5	17	Sandy Loam	2
002	7	64	14	22	Sandy Loam	2
003	27.5	75	15	10	Sandy Loam	1
004	11.9	77	6	17	Sandy Loam	3
005	31.5	59	22	19	Sandy Loam	1
006	29.7	72	17	11	Sandy Loam	1
007	37.5	76	8	16	Sandy Loam	3
008	18.6	82.5	6	11.5	Sandy Loam	2
009	17.3	78	9	13	Sandy Loam	2
010	38.4	71	11	18	Sandy Loam	2

As stated above, the soils with weak structure and medium to high risk of clay dispersion also contain a high percentage of sand, thereby lowering their dispersion risk. The topsoil for the Project will be suitably managed to minimise disturbance and erosion to these soil types. Topsoil will be stored in stockpiles of less than three metres and situated away from drainage channels.

Suitability as Growth Media and Topsoil Balance

All surface soils within the proposed project footprint are considered suitable for rehabilitation and will be stripped prior to disturbance. The maximum depth of topsoil stripping will be restricted to the top 200 mm. Stripping to this depth will provide up to 180,000m^3 of topsoil. The site requirement at closure is 145,000m^3 and therefore sufficient volumes of topsoil will be available for rehabilitation.

6.3.2 Mining Waste

Material characterisation was undertaken on samples of waste rock from the Die Hardy project (Figure 17). Fifteen samples were collected from resource drillholes to represent all rock types and weathering states (fresh, transitional and oxidised) of the deposit. Samples consisted of approximately 3-4 kg of cutting from 2 m intervals (Table 21) and samples were subjected to a standard set of static acid-base accounting geochemical tests as well as analysis for elemental and water leachate composition. Bureau Veritas Mineral Testing and Laboratory Services were used to conduct the testwork (Appendix E).

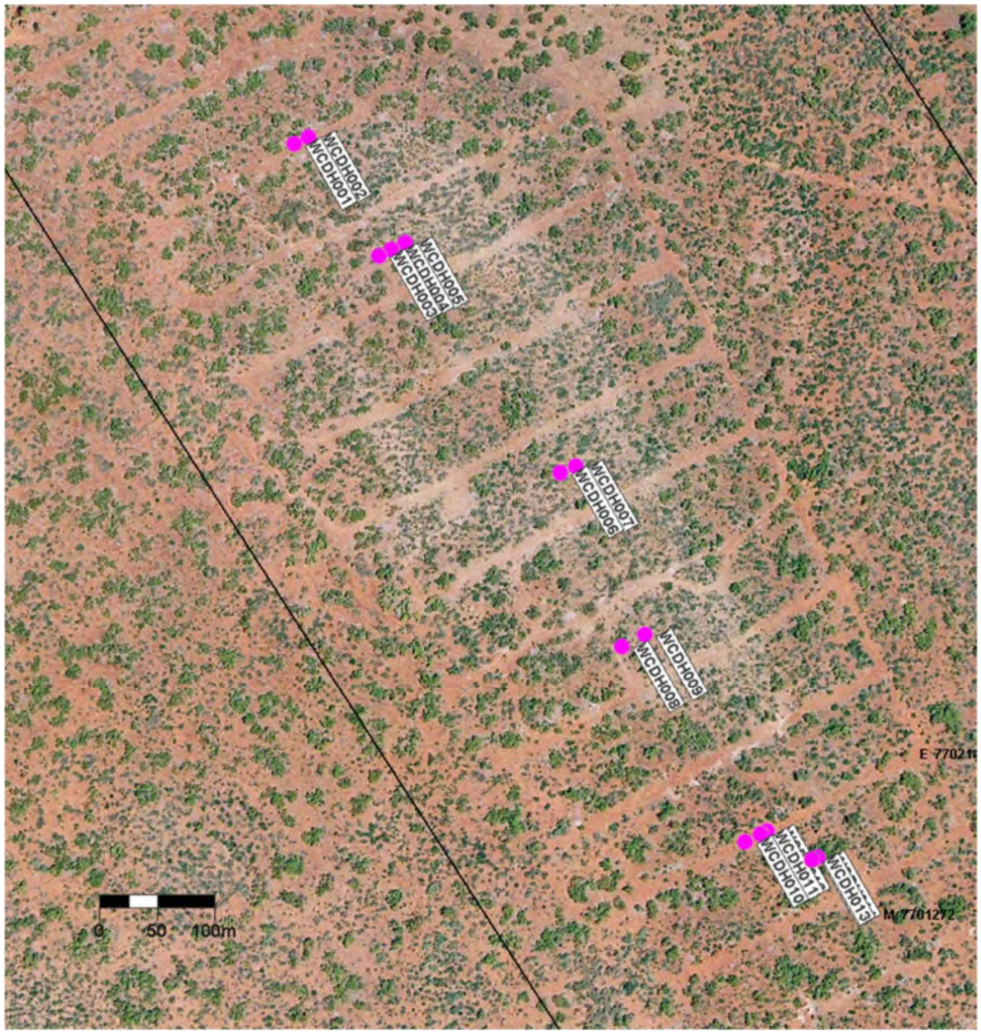

Figure 17: Waste rock sample locations within the proposed pit area

Table 22: Waste rock samples taken from representative geology types

Sample ID	HoleID	From (m)	To (m)	Interval (m)	Zone	Oxidation State
WCDH001	FBRC0070	4	7	3	Laterite	OX
WCDH002	FBRC0070	30	33	3	BIF	TR
WCDH003	FBRC0064	10	13	3	Saprolite (mafic)	OX
WCDH004	FBRC0064	33	36	3	BIF	TR
WCDH005	FBRC0064	60	63	3	mafic	FR
WCDH006	FBRC0039	3	6	3	Laterite	OX
WCDH007	FBRC0039	30	33	3	BIF	TR

Sample ID	HoleID	From (m)	To (m)	Interval (m)	Zone	Oxidation State
WCDH008	FBRC0028	27	30	3	Saprolite (ultramafic)	OX
WCDH009	FBRC0028	67	70	3	BIF	FR
WCDH010	FBRC0015	2	5	3	Laterite	OX
WCDH011	FBRC0015	30	33	3	BIF	OX
WCDH012	FBRC0015	42	45	3	BIF	TR
WCDH013	FBRC0011	5	8	3	Saprolite (mafic)	OX
WCDH014	FBRC0011	15	18	3	BIF	OX
WCDH015	FBRC0013	67	70	3	Ultramafic	FR

Characterisation of Waste Material

Acid Base Accounting (ABA) was conducted on all waste rock samples to assess their potential to generate Acid Mine Drainage (AMD). The following parameters were analysed:

- Total Sulphur (%)
- Maximum Potential Acidity (MPA)
- Net Acid Generation (NAG) – inclusive of NAG4.5 and NAG7.0
- Acid Neutralising Capacity (ANC)
- Net Acid Production Potential (NAPP)
- ANC/MPA Ratio

Classification of wastes uses procedures recommended by AMIRA (2002) based on NAPP and NAGpH results. The AMIRA approach of using NAG testing is particularly useful for PAF-LC materials or where there is very low ANC in the host rock. A combined acid generation classification scheme based on NAPP and NAG determinations is presented in Table 23 is based on the Australian Government's Guidelines on Managing Acidic and Metalliferous Drainage (DTIR 2007) and is in turn based on an earlier classification system included within the AMIRA ARD Test Handbook (AMIRA 2002), which is advocated by the Global Acid Rock Drainage Guidelines (GARD) published by the International Network for Acid Prevention (INAP 2009). This classification system, based on static acid base accounting procedures and used in conjunction with geological, geochemical and mineralogical analysis can still leave materials classified as 'uncertain' where there is conflicting NAGpH and NAPP results. Uncertain materials demonstrating a NAGpH above 4.5 may be tentatively assigned as potentially NAF and those below pH 4.5 as potentially PAF – however in such cases, further assessment, such as the use of kinetic leaching columns may be required to provide a definitive classification.

Table 23: Waste Classifications Criteria

Classification	NAPP Value (kg H_2SO_4/tonne)	NAGpH	Total Sulphur Content	ANC/MPA Ratio
Potentially Acid Forming (PAF)	≥ 10	<4.5	≥ 0.3%	<2
Potentially Acid Forming (PAF) - Low Capacity (PAF-LC)	0 to 10	<4.5	≥ 0.16 - ≤ 0.3%	<2
Uncertain	0 – 5	>4.5	Not important	<2
	-10 – 0	<4.5	Not important	
Non-acid Forming (NAF)	-100 to 0	>4.5	Not important	≥2
Acid Consuming (AC)	< -100	>4.5	Not important	≥2

The criteria from Table 23 were used to assess the potential for waste rock to generate AMD (Table 24). Eleven of the 15 samples recorded a NAPP level between -42 to 0 which indicates they are Non-Acid Forming (NAF). Four samples recorded a NAPP level between 1 to 2, with corresponding NAGpH values >4.5 placing them as Uncertain. The sample from WCDH010 was an oxide laterite from a relatively shallow 2-5m. It is unlikely to be problematic and more of an outlier result with a low sulphur value of only 0.13%. The other three NAPP positive results were represented by BIF oxide and BIF transitional samples all with very low sulphur values (0.01%, 0.04% and 0.06%) but with also very low acid neutralising minerals present. Again, these are considered outliers and not correlating with the other BIF oxide and transitional samples which were all NAPP negative and likely more representative. Fresh BIF is strongly neutralising and NAF.

Table 24: Waste Rock Characterisation Analysis

Sample ID	Depth (m)	Hole ID	Zone	Rock Type	Total Sulphur (%)	ANC (kg H_2SO_4/t)	MPA (kg H_2SO_4/t)	NAG (kg H_2SO_4/t)	NAG pH	NAPP (kg H_2SO_4/t)	Acid Base Accounting (ANC/MPA)	Classification
WCDH001	4-7	FBRC0070	OX	Laterite	0.1	34	3.1	<0.5	7.98	-31	11.1	NAF
WCDH002	30-33	FBRC0070	TR	BIF	0.03	0	0.9	<0.5	7.33	<1	0.0	NAF
WCDH003	10-13	FBRC0064	OX	Saprolite (mafic)	0.04	2	1.2	<0.5	7.68	-1	1.6	NAF
WCDH004	33-36	FBRC0064	TR	BIF	<0.01	-2	0.3	<0.5	7.51	2	-6.5	UC
WCDH005	60-63	FBRC0064	FR	mafic	0.17	47	5.2	<0.5	8.34	-42	9.0	NAF
WCDH006	3-6	FBRC0039	OX	Laterite	0.07	2	2.1	<0.5	7.33	<0	0.9	NAF
WCDH007	30-33	FBRC0039	TR	BIF	0.04	5	1.2	<0.5	7.85	-4	4.1	NAF
WCDH008	27-30	FBRC0028	OX	Saprolite (ultramafic)	0.04	14	1.2	<0.5	7.7	-13	11.4	NAF
WCDH009	67-70	FBRC0028	FR	BIF	0.49	47	15.0	0.5	6.24	-32	3.1	NAF
WCDH010	2-5	FBRC0015	OX	Laterite	0.13	2	4.0	<0.5	7.49	2	0.5	UC
WCDH011	30-33	FBRC0015	OX	BIF	0.06	0	1.8	<0.5	7.6	2	0.0	UC
WCDH012	42-45	FBRC0015	TR	BIF	0.09	10	2.8	<0.5	7.46	-7	3.6	NAF
WCDH013	5-8	FBRC0011	OX	Saprolite (mafic)	0.08	5	2.4	<0.5	7.69	-3	2.0	NAF
WCDH014	15-18	FBRC0011	OX	BIF	0.04	0	1.2	<0.5	7.64	1	0.0	UC
WCDH015	67-70	FBRC0013	FR	Ultramafic	0.02	19	0.6	<0.5	7.92	-18	31.0	NAF

Water Soluble Metals and Metalloids

Results for water soluble metals and metalloids in the 1:5 extracts are given in Appendix E and summarised in Table 25.

ANZECC livestock drinking water guidelines (cattle), ANZECC/DWER freshwater guidelines, and Human Drinking Water Guidelines (NHMRC 2011) were referred to for comparison. When comparing results, it needs to be kept in mind that as the analysis was performed on a 1:5 extract (which is an estimation of pore water quality), the higher solids to water ratio may tend to overestimate the impact on groundwater versus a commonly used comparison ratio of 1:20 extraction (deionised water ASLP).

All metals tested were at low concentrations in the leachates of all sample rock types, with most results below detection limits. In summary, concentrations of soluble metals and metalloids were mostly below detection limit and if compared on a 1:5 extractable ratio, all results fall well below human and livestock health-based drinking water guidelines. These results suggest that water soluble concentrations of metals and metalloids from mine waste material are unlikely to pose any significant risk to the surrounding environment or water usage.

Physical Characteristics

Physical characteristics of the waste rock to be mined from the Die Hardy Project were defined as part of the geotechnical assessment conducted by Peter O'Bryan & Associates (Appendix A). With the use of current geological interpretations, data contained in geological, structural geological and geotechnical logs for diamond cored resource/ geotechnical investigation boreholes, and laboratory measurement of physical properties of representative samples of country rocks, the physical properties were determined. As expected, slightly weathered rock strengths ranged from medium strong to very strong, and fresh rock strengths ranged from strong to very strong. These rock types will be prioritised for cladding, outer WRL slope rehabilitation, erosion control structures, and the abandonment bund. Landloch (2021) with their studies confirmed the materials usefulness in rehabilitation and in the final design of the WRL to maximise its integrity and long-term stability.

6.3.3 Tailings

No tailings are being produced at the Die Hardy project

Table 25: Water Soluble Metals and Metalloids

Sample ID	Zone	Rock Type	EC (µS/cm)	As (mg/L)	Cd (mg/L)	Cr (mg/L)	Hg (µg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Zn (mg/L)
ANZECC Guideline			<10,000	<0.5	<0.01	<1	<0.002	<0.15	<1	<0.1	<20
WCDH001	OX	Laterite	2278	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH002	TR	BIF	395	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH003	OX	Saprolite (mafic)	1428	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH004	TR	BIF	86	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH005	FR	mafic	180	<0.1	<0.1	0.2	<0.1	<0.1	0.1	<0.1	<0.1
WCDH006	OX	Laterite	37	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH007	TR	BIF	101	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH008	OX	Saprolite (ultramafic)	1558	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH009	FR	BIF	752	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.4
WCDH010	OX	Laterite	1186	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH011	OX	BIF	658	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH012	TR	BIF	506	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH013	OX	Saprolite (mafic)	694	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH014	OX	BIF	388	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH015	FR	Ultramafic	120	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.2

6.4 BIODIVERSITY

6.4.1 Flora and Vegetation

Numerous flora and vegetation reviews and surveys for the project area and surrounding district have been conducted over the years by various specialist botanists:

- Biota Environmental Sciences (2014) Southern Koolyanobbing Range Vertebrate Fauna Survey, Cliffs Asia Pacific Iron Ore Pty Ltd
- Woodman Environmental Consulting (2014) Cliffs Asia Pacific Iron Ore Pty Ltd, Southern Koolyanobbing Range, Flora and Vegetation Assessment.
- Rapallo Environmental (2012) Level 2 Flora and Vegetation and of Mt King Central, Golden Orb and King Brown for Southern Cross Goldfields
- Rapallo Environmental (2012) Level 2 Flora and Vegetation Survey of Mt King Tenement (M77/394) and Associated Infrastructure for Southern Cross Goldfields Ltd
- Rapallo Environmental (2011) Reconnaissance Flora Survey of Mt King Tenement – M77/394 for Southern Cross Goldfields Ltd
- Botanica Consulting (2011) Level 2 Flora and Vegetation Survey, Golden Orb Survey Area, Southern Cross Goldfields
- Botanica Consulting (2010) Level 2 Flora and Vegetation Survey, King Brown Survey Area, Southern Cross Goldfields,
- Botanica Consulting (2010) Level 2 Flora and Vegetation Survey, Mt King Survey Area, Southern Cross Goldfields,
- Western Botanical (2009) Flora & Vegetation Survey of Western Jackson Range
- Western Botanical (2005) Flora & Vegetation Assessment for Proposed Exploration in the Evanston Area, Diemals Station
- Western Botanical (2015) Fiddleback Project, Level 2 Flora and Vegetation Survey.
- Western Botanical (2019) Desktop review of the Flora and Vegetation of the Red Legs, Fiddleback and Mt King Prospects.
- Botanica Consulting (2019) Targeted search for conservation significant flora/vegetation-Die Hardy and Red Legs exploration programme.

The recent Botanica Consulting work (Appendix F) is the most relevant report on the Die Hardy tenements. A literature review consisting of a combined search of the Department of Biodiversity, Conservation and Attractions (DBCA) Flora of Conservation Significance databases (DBCA, 2019a), NatureMap search (DBCA, 2019b) and Department of Environment and Energy (DoEE) Protected Matters search (DoEE, 2019) resulted in four Threatened Flora and 35 Priority Flora occurring within a

20km radius of the survey area (Table 1). No Threatened Flora taxa pursuant to the Biodiversity Conservation (BC) Act 2016 and the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 were identified within the survey area. No Priority Flora taxa were identified within the survey.

Three vegetation associations were recorded within the Die Hardy project area:

- CLP-EW1 Low woodland of *Eucalyptus concinna* over mid open shrubland of *Acacia ramulosa* and low sparse shrubland of *Ptilotus obovatus* on clayloam plain
- CLP-EW2 Low woodland of *Eucalyptus salmonophloia/ E. salubris* over mid sparse shrubland of *Acacia tetragonophylla* and low chenopod shrubland of *Atriplex stipitata* on clay-loam plain
- HS-EW1 Low open woodland of *Eucalyptus concinna* over mid shrubland of *Acacia ramulosa* and low sparse shrubland of *Ptilotus obovatus* on hillslope

The Die Hardy project is located within the boundary of a Priority 1 Ecological Community; Die Hardy Range/Diemels vegetation complex (banded ironstone formation) which encompasses an area of 16,500 ha. The total survey area represents less than 0.1% of the total extent of this PEC (Appendix F).

6.4.2 Terrestrial Fauna and Habitat

A Level 1 Fauna Survey was carried out by APM in August 2014 (Appendix G). The fauna survey included a survey of short-range endemic invertebrates (SREs) and was undertaken by identifying fauna habitat and the opportunistic identification of species based on sightings, calls, remains, diggings and other signs.

Based on searches of the Protected Matters and NatureMap databases, 14 species of conservation significance could potentially occur in the Survey area. However, after an analysis of fauna habitats within the Project area it was determined that 4 of the species are unlikely to occur, 3 species have the potential to occur, 6 are likely to occur, and one species (Malleefowl) has been recorded in the Survey area.

Habitat

The small scale of the Survey area was considered and was allocated six habitat types:

- Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain;
- Low Eucalypt Woodland over Acacia Shrubland on Alluvial Plain;
- Low Eucalypt Woodland over Acacia on Rocky Rises;
- Low Eucalypt Woodland over Spinifex on Alluvial Plain; and
- Dense Shrubland on Rocky Rises and Dense Shrubland on Alluvial Plain.

Species of Conservation Significance and Short-range Endemics (SRE's)

An intensive presence/absence search for the Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider at 15 sites over five of the six different habitat types did not locate either spider or evidence of trapdoor burrows. It is considered unlikely that these two spider species are using the Survey area.

Malleefowl mounds and tracks have been recorded in the greater area. This species appears to prefer two particular fauna habitats in the Project area. These habitats were the Dense Shrubland on Alluvial Plain and Dense Shrubland on Rocky Rises. No active mounds existed at the Die Hardy project area during the surveys. Evidence of Malleefowl predation by a fox was found during the survey.

No other species of conservation significance were recorded during the survey however the peregrine Falcon, Australian Bustard, Major Mitchell's Cockatoo, Fork-tailed Swift, Rainbow Bee-eater, Shy Heathwren and the Greater Long-eared Bat have been recorded in the local area and have the potential to occur in the Project area.

6.4.3 Subterranean Fauna

A report by Bennelongia (2013) was produced as a result of investigations undertaken for subterranean fauna at the Marda Gold project; some 30km to the south (Appendix J). This report assessed the potential threats to subterranean fauna (troglofauna and stygofauna) species as a result of the Gold Mine Project at Marda. Marda is analogous to the Die Hardy Project in terms of the local geology, the depth of the proposed gold mining pits and groundwater environments. The main threat to any troglofauna species within the Project was considered to be mine pit excavation, while groundwater drawdown associated with mine pit dewatering was considered to be the principal threat to any stygofauna species present.

An assessment of the likely occurrence of subterranean fauna within the Project was based on records of the Western Australian Museum (WAM) database, previous environmental impact assessments and primary literature. All available data within a 50km by 50 km Search Area surrounding the Project were reviewed, with additional information from nearby mine sites.

The WAM database contained no stygofauna records in the Search Area, reflecting both few stygofauna surveys in the Search Area and the depauperate nature of stygofauna communities present where surveys occurred. Other surveys outside the Search Area, although nearby, also yielded few if any stygofauna.

It was concluded that it is most unlikely a significant stygofauna community inhabits the Die Hardy Project area. The few species collected nearby have wide distributions. Given the small groundwater drawdown cone predicted to be associated with the Project and the depauperate stygofauna community, it was recommended at the time that no subterranean surveys are required for the purpose of environmental impact assessment.

6.5 HYDROLOGY

6.5.1 Surface Water

Regional Hydrology

The project site is located near the northern limit of the Yilgarn Shire and on the ex-Diemals pastoral lease, near its eastern boundary with Crown Land area of the proposed Helena-Aurora national park.

The Department of Primary Industries and Regional Development pastoral land system (https://maps.agric.wa.gov.au/nrm-info/) maps the area as "Campsite Land System" of alluvial plains, eucalypt woodlands, and acacia shrublands.

The nearby local catchment divide formed by the Die Hardy Range is also a continental-scale catchment boundary between the Swan-Avon and Salt Lake Basin catchments. The site is located on the north slope of the strike ridge which forms the boundary and includes Mt Geraldine (elevation 642m AHD), 800m south of the site.

Regional drainage is to the north in a long broad ill-defined swale located east of the Bullfinch-Evanston Rd. This ultimately discharges to a northwest arm of Lake Giles, located 38km north from the site at an elevation of 400m AHD. Lake Giles is practically a southeast arm of Lake Barlee, one of the largest salt lakes in the State (Figure 1).

Natural surface slopes north from the ridge line toward the site exceed 20%, whilst surface gradients north away from the site are about 1%.

Project Area Hydrology

MWES completed a Surface Water Hydrology Study of the Project Area in 2021 (Appendix C). The Die Hardy project is located 800m north of and below the northwest-oriented catchment defining ridgeline (Figure 18); near the continental divide, with very limited upstream catchment. There are no clear or incised natural drainage lines on the northeast side of the Die Hardy Range locally.

Stormwater discharge is assumed to be by overland flow rather than channel flow across the whole project area. The short steeper slopes of the Range transition to nearly flat and sandy surfaces across the site and this area apparently has relatively high infiltration rates and low runoff coefficients.

Drainage northeast from the main ridge is modified by a minor northern spur located east of the WRD. The pit is located on a further, more minor natural spur such that natural drainage flow is either east or west of the site. The two permanent mine landforms will enforce the separation of the two local sub-catchments.

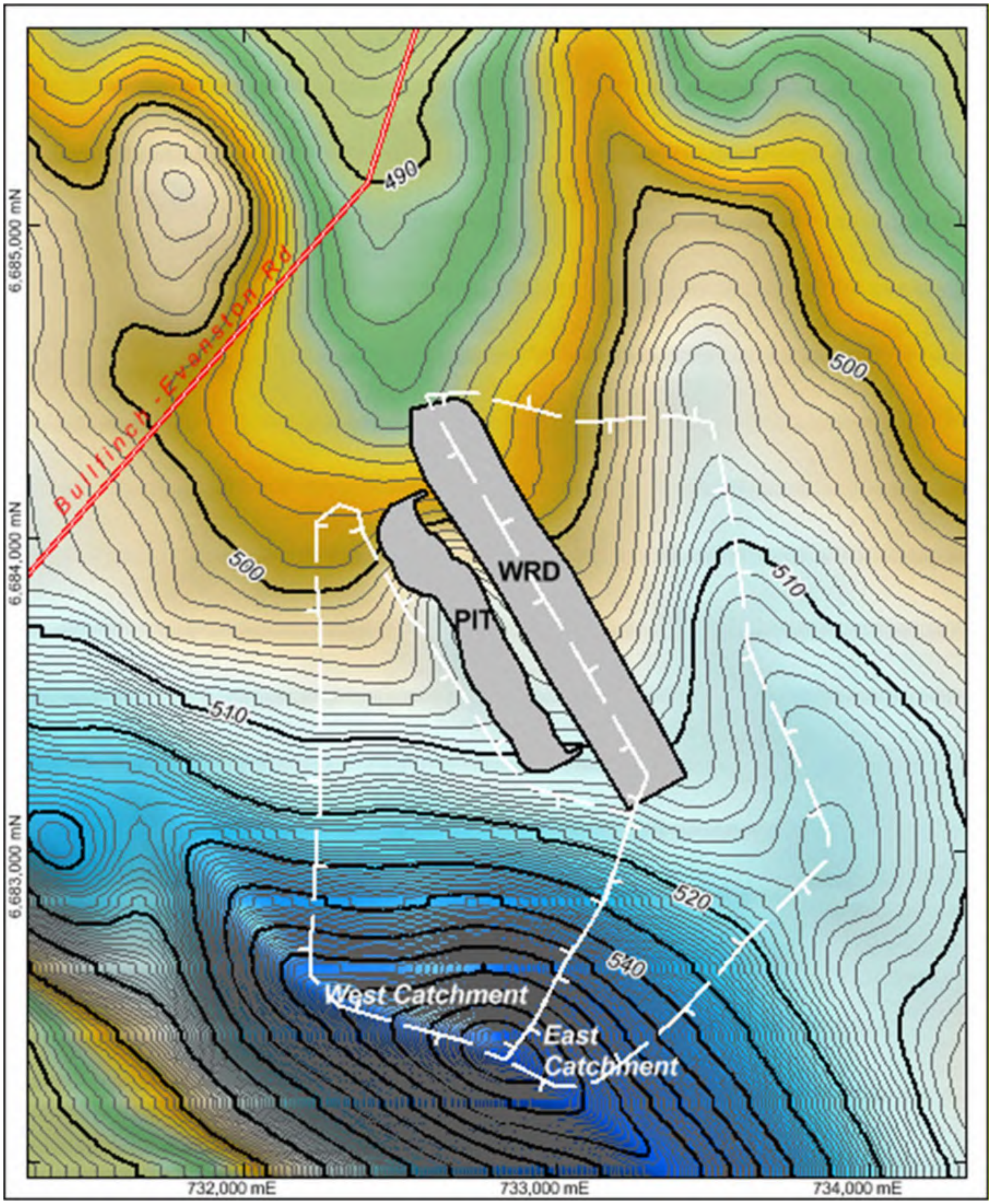

Figure 18: Mining Area, Catchments and Water Reserves

The proposed permanent landforms are oriented nearly parallel to stormwater flow paths down the catchment. Flow in the west sub-catchment will be outside the western pit abandonment bund. At the upstream (south end of the pit) surface gradients are slightly convergent with the structure and at the north end, flowlines are slightly divergent to the northwest. For the eastern sub-catchment flow will be parallel to the WRD toe.

The site is situated on elevated and well-drained ground such that, apart from excluding stormwater from the pit, there are no requirements to contain or divert natural stormwater drainage either during operations or post-closure. Strategically-located sediment retention ponds will be constructed to contain 1:100 year events to restrict sediment loss outside of the Development Envelope. With these measures, there is little potential for impacts on the downstream environment.

6.5.2 Groundwater

Yilgarn groundwater occurrence regionally relates to two main aquifer types. Bedrock groundwater is limited to discrete, typically narrow structures (fractured rock aquifers) set in an otherwise nearly impermeable rock-mass. Such fractured rock aquifers show an extreme range in transmissivity and storage, but typically show limited recharge. The second aquifer type is formed by unconsolidated Cenozoic sediments which infill an ancient more incised bedrock surface. The up-lying country of the Die Hardy site is mostly underlain by outcropping or shallow bedrock, such that only the bedrock aquifer type is relevant.

Groundwater occurrence at Die Hardy is very limited. Most of the exploration drill holes on the deposit did not intersect any groundwater. Mining below the water table is therefore expected to generate very limited groundwater. For project water supplies, groundwater exploration drilling was undertaken on selected targets based on water shows in mineral drilling and on geological structures.

Of seven targeted holes three produced no water, three very small flows and one delivered a potentially useful yield. The results indicate a regolith enhanced possible north-south structurally controlled aquifer of limited lateral extent. As the pit reaches final depth, any remaining groundwater is likely to be depleted by mining-related drawdown.

Groundwater is brackish to saline at a salinity of 9,000-15,000mg/L TDS. Regional drilling results indicate that the background water table is at about 25m depth at the Die Hardy site.

6.6 HERITAGE

6.6.1 Heritage Places

A review of World, Commonwealth, National and State heritage registers showed that the study area does not contain any registered Commonwealth, National or State heritage places.

6.6.2 Aboriginal Heritage Sites

JCHMC was engaged to identify places at the Die Hardy project area that are likely to meet the requirements of the *Aboriginal Heritage Act 1972* by undertaking an archaeological and ethnographic site avoidance field survey in consultation with MG and Kaparn Traditional Owners. The field work and consultation for the Project was undertaken from August 15 to 18, 2020. Methods used and the results are detailed in Appendix H.

In summary, the ethnographic consultation and archaeological field survey resulted in no heritage sites being identified within the Project area. Only one area of ethnographic significance was reported by the Kaparn people. Details of this site are included in Part 2 of Appendix H. Information relating to this site is deemed confidential by the Kaparn traditional owners and Part 2 of this report can only be viewed by Ramelius. The identified site is not in the Project area or on the tenements or will be affected by the proposed Die Hardy project in any way. In conclusion, the MG and Kaparn people consulted approve works within the Project.

6.7 ENVIRONMENTAL THREATS

Environmental threats are identified risks that may further impact environmental factors as a result of proposed mining activities. There are no unmanageable or unacceptable environmental threats for the Die Hardy Project due to the Project's relatively small footprint and short mine life, as well as no requirement to process or on-site. There are very few significant environmental threats based on the results of the baseline surveys. Those potential threats that have been identified for the Die Hardy Project are easily manageable:

- Weeds
- Clearing of native vegetation
- Malleefowl
- Feral animals
- Air quality
- Elevated levels of aluminium in natural soils

6.7.1 Weeds

The existing land use is a proposed dual-purpose Conservation and Mining Reserve managed by DBCA. No introduced (weed) species were encountered during the flora and vegetation surveys of the Project. Subsequently, the key existing environmental threat relevant to the Project is the potential for the introduction and spread of weeds.

Contract mining plant and equipment brought in from other areas have the potential to introduce new weeds, as well as spread existing weeds into and within the disturbance envelope. When undertaking any vegetation clearing, MOPL will take the following steps to minimise the risk of the introduction and spread of weeds:

- clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared;

- ensure that no weed-affected soil, mulch, fill or other material is brought into the area to be cleared;
- restrict the movement of machines and other vehicles to the limits of the areas to be cleared; and
- undertake a weed management programme.

6.7.2 Clearing of Native Vegetation

The Project will require native vegetation clearing of 90ha within the mining tenement for which a Clearing Permit (Purpose Permit) has been granted for 90ha. The Clearing Permit number is 8931/1 which is valid from 22 August 2020 to 21 August 2025. As mentioned, the proposed Project requires vegetation clearing of 90ha, as detailed in the Activity Details (Table 3).

MOPL will avoid, minimise and reduce the impacts and extent of clearing where possible and existing disturbed areas will be utilised. Clearing riparian vegetation will also be avoided where practicable. Where a watercourse or wetland is to be impacted by clearing, existing surface flows will be maintained. All vegetation and topsoil will be recovered and utilised immediately where possible or stored appropriately for further rehabilitation use. Outcomes of the baseline flora and vegetation survey indicate that the area of disturbance will not have a significant impact in a local and regional context.

Where seed is required for rehabilitation, a preference of local provenance seed will be adopted. As the mine operation progresses, further details and knowledge will be accumulated and taken into consideration for rehabilitation planning. The use of seed and rehabilitation methods will be managed through revisions of the MCP.

No Threatened flora species or other significant flora species were recorded within the survey area.

6.7.3 Malleefowl

Malleefowl mounds and tracks have been recorded in the greater area. This species appears to prefer two particular fauna habitats in the Project area. These habitats were the Dense Shrubland on Alluvial Plain and Dense Shrubland on Rocky Rises. No active mounds existed at the Die Hardy project area during the surveys.

As undertaken as part of the nearby Marda project, MOPL will extend the implementation of the approved Malleefowl Management Plan (Reg. ID 45664) at the Die Hardy project to manage any risk associated to this species by the proposed activities. A copy of the Malleefowl Management Plan (updated with reference to the Die Hardy project) is found in Appendix K. MOPL has sought guidance on appropriate predator control options from the Nature Conservation Team (DBCA, Kalgoorlie).

6.7.4 Feral Animals

Evidence of Malleefowl predation by a fox was found during the surveys. Wild dogs have also been recorded in the broader Marda district on the Mt Jackson pastoral station. The introduction of a human population to remote areas like Die Hardy often attracts feral animals. Feral animal numbers can increase with new found access to artificially available sources of potable water and food, particularly at mine sites, accommodation camps and crib huts, and landfill sites. Feral animals will be managed through the following methods:

- Implementation of a feral sighting form to identify feral types and justify relevant feral management measures.
- Expand the routine feral animal baiting programme currently employed at Marda to the Die Hardy project.
- Ensure all external rubbish bins have closed lids that can be locked.
- Limit the accumulation of food wastes and ensure regular disposal of wastes off-site to a secure landfill.

6.7.5 Air Quality

Elevated dust levels are a potential environmental threat identified for the Project that could potentially impacting on adjacent vegetation. Potential fugitive and point-sources of particulate and dust generation can arise from the areas disturbed by blasting activities, exhaust emissions from machinery and movement of vehicles on unsealed roads. Emphasis will be placed on reducing dust generation during high winds.

Products of combustion (oxides of nitrogen, sulphur dioxide, carbon monoxide and carbon dioxide, volatile organic compounds and particulates) from fuel use in vehicles, machinery and fixed plant (including diesel gensets) are unlikely to result in significant air quality impacts, given the short life span and small scale of the mining project.

Common dust suppression measures and management practises used in the mining industry in WA are expected to be sufficient to control environmental impacts to acceptable levels. Pit water collected in sumps are expected to provide sufficient water for effective dust control and can be supplemented with pit dewatering turkeys nest ponds and standpipe. These measures include:

- Water trucks fitted with sprays/dribble bars water unsealed, regularly trafficked, areas such as access tracks, work areas and haul roads.
- Limit vehicle speeds and restrict access to roadways.

6.7.6 Elevated Levels of Aluminium in Natural Soils

Soil baseline surveys identified naturally elevated levels of aluminium in the undisturbed soils of the Project area. Acidic soil cations are undesirable components of a healthy soil, particularly the Al component as soluble Al is phytotoxic to non-native plants and some native plants. Even though Al is one of the most abundant elements in soil, natural acidification processes result in increasing solubility of aluminium and, as soils become moderately acidic (pH <5.5), Al begins to appear as the exchangeable cation which dominates in the lower mineral horizons. The presence of elevated Al is not of concern to the Die Hardy project because Al toxicity is more important to agricultural cropping rather than the highly adapted native species and vegetation at the Project.

7. ENVIRONMENTAL RISK MANAGEMENT

Effective environmental management relies on the ability of those concerned to make informed decisions on risk in planning, construction and operational phases of a project. This requires identification of activities with potential for environmental impact, defining what risk is acceptable, assessment of the risk and what actions can be taken to remediate the risk to an accepted level based on “As Low as Reasonably Possible” (ALARP) principles.

The aim of the environmental risk assessment undertaken for the Die Hardy Project was to ensure the project meets the DMIRS’s principle objective for environmental regulation whereby:

> *“Resource industry activities are designed, operated, closed, decommissioned and rehabilitated in an ecological sustainable manner, consistent with agreed environmental outcomes and end land-uses without unacceptable liability to the State”*

This has been accomplished through ensuring the project meets specific DMIRS environmental objectives for the key environmental factors as presented in Table 26.

Table 26: DMIRS Objectives for Environmental Factors

Environmental Factor	Objective
Biodiversity	To maintain representation, diversity, viability and ecological function at the species, population and community level.
Water Resources	To maintain the hydrological regimes, quality and quantity of groundwater and surface water to the extent that existing and potential uses, including ecosystem maintenance, are protected
Land and Soils	To maintain the quality of land and soils so that environmental values are protected.
Rehabilitation and Mine Closure	Mining activities are rehabilitated and closed in a manner to make them physically safe to humans and animals, geotechnically stable, geochemically non-polluting/ non-contaminating, and capable of sustaining an agreed post-mining land use, and without unacceptable liability to the State.

7.1 METHODOLOGY

A risk assessment was undertaken for the Die Hardy Project for the construction, operational and closure phases of the project and is provided in Section 7.3. The environmental risk rating procedure provides a consistent standard for rating environmental risks across the Die Hardy Project. By applying a consistent environmental risk rating system, the Company has been able to make informed decisions on choosing the most appropriate and adequate risk control measures for the project.

7.2 RISK ASSESSMENT CRITERIA

The risk assessment matrix utilised to determine risks for the Die Hardy Project is consistent with principles set out in *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines* and adopts definitions of likelihood and consequence that have been used to evaluate each risk as it stands and determine whether it is tolerable (requiring no further management) or requires further management.

The definitions for the categories used to determine the likelihood and consequence are provided in Table 27 and Table 28, and the risk matrix utilised for the Die Hardy Gold Project is provided in Table 29.

Table 27: Definitions for Likelihood of Risk Occurring

Category	Definition
Rare	The event may occur in exceptional circumstances (0% to 10% Probability). Remotely possible/occurs in exceptional circumstances only. May occur in exceptional circumstances No known incidents after several years of exposure however is possible an incident could occur.
Unlikely	The event could occur at some time (10% to 20% Probability). Occurs only occasionally - once every 3-5 years About 1 in 1,000 times or could occur once or twice every 10 years.
Possible	The event should occur at some time (20% to 50% Probability). Happens occasionally/might occur at some time. About 1% of the time or about twice a year. Would be unusual but possible.
Likely	The event will occur in most circumstances (50% to 90% Probability). Happens often on almost every day or each time the activity occurs. About 15 % of the time or one or twice per month. Quite possible or not usual.
Almost Certain	The event is expected to occur in most circumstances (90% to 100% probability). Happens all the time on almost every day or every time the activity happens. Greater than 50% of the time or several times or more per month. Almost certain or the most likely and expected result if the selected complete sequence or scenario occurs.

Table 28: Definitions for Consequences of Risk Occurring

Environmental Factor	Insignificant	Minor	Moderate	Major	Extreme
Biodiversity	• Alteration or disturbance to an isolated area with no effect on habitat or ecosystem. • Clearing of significant vegetation communities amounting to no more than 15% of total mapped. • Loss of an individual plant / animal of conservation significance • Manageable, localised weed infestation that does not result in competition with native species. • Manageable increase in pest species numbers, but does not result in impacts to the population viability or abundance of native species	• Alteration or disturbance to <10% of a habitat or ecosystem resulting in a recoverable impact within 2 years. • Clearing of significant vegetation communities amounting to no more than 25% of total mapped. • Loss of multiple plants / animals of conservation significance • Manageable, localised weed infestation that results in minor competition with native species. • Manageable increase in pest species numbers, resulting in localised impacts to the population viability or abundance of native species	• Alteration or disturbance to 10-40% of a habitat or ecosystem resulting in a recoverable impact within 2-5 years. • Clearing of significant vegetation communities amounting to no more than 40% of total mapped. • Loss of <50% known local population of plant / animal of conservation significance. • Localised weed infestation that results in competition with native species requiring considerable management/ control measures • Increase in pest species numbers, resulting in widespread impacts	• Alteration or disturbance to 40-70% of a habitat or ecosystem resulting in a recoverable impact within 5-15 years. • Loss of >50% known local population of plant / animal species with possible loss of entire local population • Clearing of significant vegetation communities amounting to no more than 65% of total mapped. • Regional weed infestation that results in competition with native species requiring extensive management/ control measures. • Pest species introduced and populations expand into the regional area resulting in temporary exclusion of native species that can be controlled by external resources	• Alteration or disturbance to >70% of a habitat or ecosystem resulting in a recoverable impact >15 years. • Clearing of significant vegetation communities amounting to no more than 100% of total mapped. • Local loss of conservation significant or listed species. Extinction of a species • Uncontrollable regional weed infestation that results in competition with native species. • Pest species introduced and populations expand into the regional area resulting in permanent exclusion of native species unable to be controlled by external resources.

Environmental Factor	Insignificant	Minor	Moderate	Major	Extreme
			to the population viability or abundance of native species.		
Water Resources	• Negligible change to surface water quality within the project area that does not change its ability to be used by livestock and fauna. • Short term, minimal changes to local water volumes that do not affect beneficial uses, including livestock and fauna	• Low level change to surface water quality within the project area and minimal change to downstream watercourses that does not affect its use by livestock and fauna. • Medium term, minimal changes to local water volumes that do not affect beneficial uses, including livestock and fauna.	• Moderate (mid-level) change to surface water quality within the project area and low-level change to downstream watercourses that affects its use by livestock and fauna in the short term. • Short term minimal changes to regional water volumes that affect beneficial uses, including livestock and fauna.	• High level decline in surface water quality in the project area and mid-level change to downstream watercourses that prevents medium to long term use by livestock and fauna. • Medium-term low level changes to regional water volumes that affect beneficial uses, including livestock and fauna.	• Mid-level decline in surface water quality on a regional scale that prevents long term use by livestock and fauna. • Project causes permanent, high level loss of surface water resources that affects livelihoods and/or survival of communities.
	• Minimal change to groundwater quality in the project area that does not change its ability to be used by beneficial uses, including livestock, fauna, groundwater dependent ecosystems and subterranean fauna.	• Short term, minimal, localised decline in groundwater quality that affects beneficial uses, including livestock, fauna, groundwater dependent ecosystems and subterranean fauna. • Local, minimal changes to groundwater	• Medium term, low level, localised decline in groundwater quality that affects beneficial uses, including livestock, fauna, groundwater dependent ecosystems and subterranean fauna.	• Short to medium term, low level regional decline in water quality that prevents beneficial uses, including livestock, fauna, groundwater dependent ecosystems and subterranean fauna. • Regional, low level changes to groundwater	• Long term, mid-level regional decline in water quality that prevents beneficial uses, including livestock, fauna, groundwater dependent ecosystems and subterranean fauna. • Regional, mid-level changes to groundwater levels/availability that affect beneficial uses,

Environmental Factor	Insignificant	Minor	Moderate	Major	Extreme
	• Minimal changes to groundwater levels/availability in the project area that do not affect beneficial uses, including livestock, fauna, groundwater dependent ecosystems and subterranean fauna.	levels/availability that do not affect beneficial uses, including livestock, fauna, groundwater dependent ecosystems and subterranean fauna.	• Local, low level changes to groundwater levels/availability that affect beneficial uses, including livestock, fauna, groundwater dependent ecosystems and subterranean fauna in the short to medium-term.	levels/availability that affect beneficial uses including livestock, fauna, groundwater dependent ecosystems and subterranean fauna in the medium term.	including livestock, fauna, groundwater dependent ecosystems and subterranean fauna in the long term.
Land and Soils	• Clean-up by site personnel, rectified immediately. Confined to immediate area around source.	• Clean-up by site personnel, remediation within 1 year. Confined to operational area	• Clean-up by site personnel, remediation within 1-3 years. • Minor impact outside disturbance envelope or minor impact to soil stockpiles.	• Clean-up requiring external specialist, remediation within 3-10 years. • Impact has migrated outside the disturbance envelope or contamination of soil stockpiles	• Clean-up requiring external specialist. Remediation >10 years, or permanent residual impact. • Impact outside the tenement boundary.
Rehabilitation and Mine Closure	• Site is safe, stable a non-polluting. Post mining land use is not adversely affected.	• Site is safe, all major landforms are stable, and any stability or pollution issues are contained and require no residual management. • Post mining land use is not adversely affected.	• Site is safe, and any stability or pollution issues require minor, ongoing maintenance by end land-user. • Post mining land use cannot proceed without some management.	• Site cannot be considered safe, stable or non-polluting without long-term management or intervention. • Post mining land use cannot proceed without ongoing management.	• Site is unsafe, unstable and/or causing pollution or contamination that will cause an ongoing residual affect. • Post mining land use cannot be achieved.

Environmental Factor	Insignificant	Minor	Moderate	Major	Extreme
	• Post mining landforms are consistent with their surroundings. • Post mining landforms are stable	• Post mining landforms are generally consistent with their surroundings with minor variations in elevation, profile and vegetation. • Post mining landforms are stable but may experience minor erosion, such as rilling	• Post mining landforms are generally consistent with their surroundings but show distinguishable variation in elevation, profile and vegetation. • Post mining landforms are generally stable, but may experience moderate erosion, such as limited gullying	• Post mining landforms are inconsistent with their surroundings with notable differences in elevation, profile and vegetation. • Post mining landforms are unstable, with significant erosion, such as tunnelling and gullying, and subsidence	• Post mining landforms are inconsistent with their surroundings, represented by significant differences in elevation, profile and vegetation. • Post mining landforms fail (*e.g.*, TSF embankment failure), with extensive ongoing management issues

Table 29: Risk Assessment Matrix for the Die Hardy Gold Project

Likelihood	Consequences				
	5. Insignificant	4. Minor	3. Moderate	2. Major	1.Catastrophic
A. Almost Certain	Medium 14	High 19	Extreme 22	Extreme 24	Extreme 25
B. Likely	Medium 10	Medium 13	High 18	Extreme 21	Extreme 23
C. Possible	Low 6	Medium 9	Medium 12	High 17	Extreme 20
D. Unlikely	Low 3	Low 5	Medium 8	Medium 11	High 16
E. Rare	Low 1	Low 2	Low 4	Medium 7	High 15

Extreme risk; immediate attention required to actively manage risk and limit exposure.
High risk; attention required to ensure risk exposure is managed effectively, disruptions minimised, and outcomes monitored.
Medium risk; cost benefit analysis to assess extent to which risk should be mitigated. Monitor to ensure risk does not increase over time.
Low risk; effectively manage through routine procedures and appropriate internal controls.

7.3 RISK ASSESSMENT

Table 30 presents the environmental risk assessment undertaken for the Die Hardy Project. It includes a description of environmental and social risks associated with various project activities. The consequence and likelihood of each risk is provided in accordance with the rating system provided in Table 27 and Table 28 respectively, and an overall risk rating has been provided in accordance with the matrix presented in Table 29. Risk ratings have been provided for activities both prior to and after mitigation and management measures have been applied in order to understand the effect of the mitigation and management measures on the risk and to demonstrate that the residual risks are ALARP.

The mitigation and management measures (risk reduction hierarchy) for treating risks were based on the following:

- Eliminate – where reasonably practicable eliminate the risk.
- Substitution – Reduce a risk by substituting a different activity which poses a lower risk.
- Control – control the risk with engineered solutions.
- Mitigate – mitigate the risk using administrative procedures.

Where possible the Company has avoided or eliminated the risk of environmental harm which may have been caused by the Die Hardy Project.

Table 30: Risk Assessment for the Die Hardy Project

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
Water Resources	**Surface Water**	Hydrocarbon spills from mobile equipment resulting in contamination impacts to surface water resources	Construction, Operations	Fuel Store	Possible	Insignificant	c	5	Low	Heavy vehicle maintenance undertaken offsite. Only a small workshop facility required. All spillages occurring as a result of accidents or breakdowns will be addressed by controlling, containing and cleaning up the spill and reported through the incident report procedure. Spill kits will be located at strategic locations throughout the project area and employees trained in their use.	Possible	Insignificant	c	5	Low
		Saline water spills resulting in impacts to downstream water quality	Construction, Operations	Saline pipeline around the turkeys nest	Possible	Insignificant	c	5	Low	Pipelines will be checked regularly to ensure there are no leaks. Pipelines incorporate isolation valves at appropriate intervals.	Possible	Insignificant	c	5	Low
		Increased sediment load in run-off due to ground disturbance and construction of mine	Construction, Operations	Down gradient of mine area	Possible	Minor	c	4	Medium	Clean water interception and diversion. Sediment ponds/traps installed. Progressive rehabilitation when areas become available.	Unlikely	Minor	d	4	Low

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
		infrastructure and landforms.													
	Groundwater	Hydrocarbon spills from mobile equipment resulting in contamination impacts to ground water resources	Construction, Operations	Pit area	Possible	Insignificant	c	5	Low	All spillages occurring as a result of accidents or breakdowns will be addressed and reported through the incident report procedure. Spill kits will be located at strategic locations throughout the project area and employees trained in their use. Vehicles and machinery serviced off-site away from the open pits. Implement DWER water source protection measures for the protection of water quality, as required	Possible	Insignificant	c	5	Low

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
Biodiversity	**Terrestrial Flora and Vegetation**	Dust emissions due to movement of vehicles, stockpiling and transport of ore and waste resulting in reduced vegetation health and condition	Construction, Operations, Closure	Pit area, WRL, Haul roads	Possible	Insignificant	c	5	Low	No conservation-significant vegetation communities or species within the Project footprint. During high winds, topsoil stripping and spreading activities will be restricted if dust cannot be adequately controlled. Vehicle traffic will be confined to defined roads and tracks and be speed limited. Disturbed areas will be rehabilitated upon completion of mining activities or where progressively able to do so. Dust will be managed by watering unsealed roads with a water cart or with fixed sprays.	Possible	Insignificant	c	5	Low
		Loss of significant flora due to land clearing	Construction, operations	Pit, WRL, Supporting infrastructure	Unlikely	Minor	d	4	Low	No significant vegetation being cleared.	Unlikely	Minor	d	5	Low
	Terrestrial Fauna	Increased feral animals as a result of increased access to water resources resulting in increased	Construction, Operations, Care and Maintenance	Turkeys nest, final pit lake	Possible	Minor	c	4	Medium	Foxes and wild dogs to be controlled under the Marda feral animal baiting programme. Operational water resources will be fenced to prevent/	Possible	Minor	C	4	Medium

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
		competition for food and habitat for native fauna								minimise feral animal populations from accessing. Salinity of the post-closure pit lake will be >20,000mg/L and is too saline for animal consumption.					
		Injury or death of terrestrial fauna and birds due to interaction with mobile vehicles and mining equipment.	Construction, Operations	ROM, haul roads	Rare	Insignificant	E	5	Low	Speed limited applied	Rare	Insignificant	E	5	Low
		Dust emissions due to land clearing, earthworks, movement of vehicles, building of the Mine Site areas resulting in impacts to fauna health and behaviour.	Construction, Operations	Site wide	Rare	Insignificant	E	5	Low	No conservation-significant species within the Project footprint. Dust suppression with water on haul roads and the ROM	Rare	Insignificant	E	5	Low

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
		Fauna entrapment in water holding facilities leading to injury or death	Construction, Operations	turkeys nest	Rare	Insignificant	E	5	Low	Egress matting installed	Rare	Insignificant	E	5	Low
		Light and noise pollution disrupting nocturnal activities of native fauna.	Construction, Operations	Open pit, WRL, ROM, haul roads	Rare	Insignificant	E	5	Low	Speed limits applied. Minimal lighting required.	Rare	Insignificant	E	5	Low
		Habitat clearing as a result of construction of the project causing adverse impacts on significant fauna species	Construction	Site wide	Rare	Insignificant	E	5	Low	No conservation-significant species within the Project footprint. Minimal clearing of 90ha and a short mine life, and progressive rehabilitation to restore habitat. Implementation of MOPL's Malleefowl Management Plan at the project site.	Rare	Insignificant	E	5	Low
		Increased predation causing decrease in native fauna populations.	Construction, operations	Site wide	Rare	Insignificant	E	5	Low	Food wastes in lidded bins with regular removal of waste off-site to discourage feral predators	Rare	Insignificant	E	5	Low
		Fragmentation of vertebrate fauna habitat as a result of project implementation resulting in	Construction	Site wide	Rare	Insignificant	E	5	Low	No fragmentation to occur. Clearing of vegetation is a single block of up to 90ha.	Rare	Insignificant	E	5	Low

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
		displacement of fauna.													
		Loss of significant fauna species due to project implementation	Construction, Operations, Closure	Site wide	Rare	Insignificant	E	5	Low	Implementation of MOPL's Malleefowl Management Plan at the project site.	Rare	Insignificant	E	5	Low
	Subterranean Fauna	Direct loss of subterranean fauna habitat due to open pit development	Operations, Closure	Open pit	Rare	Insignificant	e	5	Low	No subterranean fauna likely to occur within the pit area	Rare	Insignificant	e	5	Low
Land and Soils	**Land Disturbance/ Degradation**	Contamination of land from incorrect disposal of dispersive mine waste materials (oxides)	Operations, closure	WRL	Possible	Minor	c	4	Medium	Dispersive materials will not be used as a cover material on slopes for rehabilitation. Final landform design modelled for acceptable erosion rates.	Possible	Minor	c	4	Medium
		Land contamination due to use of brackish water for dust suppression	Construction, Operations	Pit, Roads, MOP	Possible	Minor	C	4	Medium	Use for dust suppression restricted to disturbed areas. Water trucks use dribble bars to minimise external spray drift. Water applied at rates to prevent surface ponding or pooling of water. Sediment/ runoff retention sumps installed along roadway drains to capture first flush runoff events.	Unlikely	Minor	d	4	Low

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
		Contamination of land due to spillage of brackish or saline water	Construction, Operations, Closure	All	Possible	Minor	C	4	Medium	Pipelines will be checked regularly to ensure there are no leaks. Pipelines incorporate isolation valves at appropriate intervals.	Unlikely	Minor	D	4	Low
		Soil saturation from dust suppression or excess water disposal	Operations	All	Possible	Minor	C	4	Medium	Water applied at rates to prevent surface ponding or pooling of water. Water trucks use dribble bars to minimise external spray drift.	Rare	Minor	E	4	Low
		Potential or realised impacts to DBCA managed land neighbouring the Project	Construction, Operations, Closure	All	Possible	Minor	C	4	Medium	Cleared vegetation is only within the approved Clearing Permit boundary. Sediment ponds located downstream of disturbances and sized appropriately to restrict sediment from leaving the Development Envelope. Reporting to DBCA any impacts by notifying DBCA's Kalgoorlie office (Phone 08 9080 5555; or email Kalgoorlie@dbca.wa.gov.au)	Rare	Minor	E	4	Low
Rehabilitation and Mine Closure	**Mine Closure**	Wind and water erosion of landform creating unstable constructed landforms and	Closure	WRL	Possible	Moderate	c	3	Medium	WRL has been designed to create a safe, stable, non-polluting landform constructed and rehabilitated.	Unlikely	Moderate	d	3	Medium

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
		failure to achieve closure criteria								A crest bund will be constructed from well compacted competent material around the top crest of the WRL. Erosion modelling completed for various scenarios and the adopted design to reduce erosion rates to acceptable levels is a max. 30 m high WRL with low batter angles (overall 14°) and a concave slope, applying gravelly soils with 40% tree debris to the lower third of the final batter.					

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
Rehabilitation and Mine Closure	**Mine Closure**	Ineffective establishment of vegetation resulting in failure to achieve physical stability closure criteria	Closure	Die Hardy area	Possible	Minor	c	4	Medium	Progressive rehabilitation will be undertaken where practicable. Disturbed areas will be ripped on the contour where appropriate to remove compaction, improve soil structure and improve infiltration capacity. Local provenance seed will be used where necessary to rehabilitate disturbed areas. Monitoring will be implemented once areas are rehabilitated to ensure progression towards completion criteria. Monitoring will be undertaken of analogue and rehabilitated areas to ensure short, medium and long-term rehabilitation objectives are achieved. Monitoring will be carried out on a regular basis to assess the success of revegetation in rehabilitated areas. Ongoing development of monitoring methodology and rehabilitation techniques will occur during the life of the project.	Unlikely	Minor	d	4	Low

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
		Incorrect placement and management of waste rock on landforms resulting in unstable landforms which will not meet closure criteria	Construction, Operations, Care and Maintenance, Closure	WRL	Possible	Minor	c	4	Medium	Waste dump design incorporates results of materials characterisation studies. Waste movements incorporated into mine plans. Annual review of constructed landforms in terms of geotechnical stability and compliance with design requirements	Unlikely	Minor	d	4	Low
		Post-mining landform is inconsistent with surroundings leading to poor visual amenity	Closure	WRL	Possible	Insignificant	c	5	Low	Continued liaison with stakeholders regarding specific requirements for closure	Possible	Insignificant	c	5	Low
		Poor resource and mine closure planning resulting in known ore reserves or waste materials that may have potential value for future generations or future exportation being sterilised	Operations, Closure	Die Hardy area	Unlikely	Minor	d	4	Low	Mine closure planning is fully integrated with operational mine planning throughout the life of the project ensuring orderly, cost-effective, and timely mine completion. Sterilisation drilling completed	Unlikely	Minor	d	4	Low

DMIRS Objective	Component/ Aspect	Potential Impact and Risk Receptor	Project Phase	Operational Area	Inherent Likelihood on Receptor	Inherent Consequence on Receptor	Array Row	Array Column	Inherent Risk	Controls and/or Management Measures	Residual Likelihood on Receptor	Residual Consequence on Receptor	Array Row	Array Column	Residual Risk
	Landforms	Permanent changes to the landscape as a result of project implementation including development of an open pit and WRL	Construction, Operations, Care and Maintenance, Closure	Die Hardy area	Almost Certain	Minor	a	4	High	Constructed landform designed to complement surrounding hills. Mine Closure Plan developed for the project. Progressive rehabilitation of disturbed areas. Stakeholder consultation will continue to be undertaken.	Almost Certain	Minor	a	4	High
		Wind and water erosion of constructed landform resulting in instability of landforms and landforms not meeting physical stability closure criteria	Construction, Operations, Care and Maintenance, Closure	WRL	Possible	Minor	c	4	Medium	WRL has been designed to create a safe, stable, non-polluting landform. Soil characterisation studies completed. A crest bund will be constructed from well compacted competent material around the top crest of the WRL.	Unlikely	Minor	d	4	Low
		Incorrect placement and management of waste rock on landform resulting in unstable landform which will not meet closure criteria	Construction, Operations, Care and Maintenance, Closure	WRL	Possible	Minor	c	4	Medium	Waste dump design incorporates results of materials characterisation studies. Waste movements incorporated into mine plans. Annual review of constructed landform in terms of geotechnical stability and compliance with design requirements	Unlikely	Minor	d	4	Low

8. ENVIRONMENTAL OUTCOMES, PERFORMANCE CRITERIA AND REPORTING

Environmental outcomes have been set for environmental factors of the Die Hardy Project identified during the risk assessment process that represent a medium to high risk, pre-treatment. These environmental outcomes have been developed to be:

- Proportionate to the potential risk.
- Site specific.
- Realist and achievable.
- Consistent with DMIRS's environmental objects.

Additionally, environmental performance criteria have been defined for the medium to high-risk aspects of the project so that performance in achieving environmental outcomes can be measured and reported upon. Where possible environmental performance criteria for the project have been developed to be outcome-based. This will allow the Company to implement an adaptive and flexible approach to environmental management across the project, managing the risks such that environmental outcomes are met.

Finally, monitoring requirements for each performance criteria have been set in order to measure the performance of the project. Exceedances of performance criteria and/or incidents which cause or have the potential to cause significant environmental harm will be reported to DMIRS in accordance with specified timeframes.

Details of the defined environmental outcomes, performance criteria and proposed monitoring for the project covered under the *Mining Act 1978* administered by DMIRS are provided in Table 31. Rehabilitation and closure are described in the Mine Closure Plan attached as Appendix I.

Environmental factors or objectives directly regulated by an agency or legislation which is not administered by DMIRS are summarised in Table 32. For the Die Hardy Project, the DWER regulates the Environmental Protection Act 1986. Anticipated environmental outcomes, performance criteria and monitoring are summarised in Table 32.

Table 31: Environmental Outcomes, Performance Criteria and Monitoring Regulated by DMIRS

Risk Pathway	Environmental Outcome	Performance Criteria	Monitoring
Environmental Factor: Rehabilitation and Mine Closure **DMIRS Objective: Mining activities are rehabilitated and closed in a manner to make them physically safe to humans and animals, geo-technically stable, geo-chemically non-polluting/non-contaminating, and capable of sustaining an agreed post-mining land use, and without unacceptable liability to the State**			
Wind and water erosion of landforms creating unstable constructed landforms and failure to achieve closure criteria Incorrect placement and management of waste rock on landforms resulting in unstable landforms which will not meet closure criteria Ineffective establishment of vegetation resulting in failure to achieve physical stability closure criteria	Landform is stable in the long term. No sedimentation of the surrounding environment due to erosion of constructed landforms.	See physical stability completion criteria in the MCP (erosion rates at acceptable levels will result from a max. 30 m high WRL with low batter angles (overall 14°) and a concave slope, applying gravelly soils with 40% tree debris to the lower third of the final batter).	At closure - Audit to assess the construction of the WRL against all commitments (including correct placement of waste rock), as specified in Figure 9, and Section 8 of the MCP. Following completion of rehabilitation earthworks – monitor erosion on fixed position erosion transects on outer slopes of WRL (including photo-monitoring), as specified in the MCP. Annual rehabilitation performance monitoring of the rehabilitated landform compared to analogue sites. Assessment by means of a combination of quantitative data sourced via remote sensing and qualitative data sourced during field verification. The assessment relies on the use of unmanned aerial vehicles (drones) and cloud-based data processing to produce high resolution aerial imagery, digital terrain model (DTM), near infrared imagery (NIR) and normalised difference vegetation index (NDM).

Risk Pathway	Environmental Outcome	Performance Criteria	Monitoring
Permanent changes to the landscape as a result of project implementation including development of an open pit and WRL	Landform is geotechnically stable	Permanent landform will be consistent with approved design. Construction and rehabilitation of landform has been completed in accordance with commitments in relevant approvals.	Post closure geotechnical audit of WRL identified within the zone of pit instability to determine appropriate management/ prevention of public access. Annual audit of landform construction and rehabilitation against design criteria (Figure 9, and MCP Section 8).
Environmental Factor: Water Resources **DMIRS Objective: To maintain the hydrological regimes, quality and quantity of groundwater and surface water to the extent that existing and potential uses, including ecosystem maintenance, are protected**			
Increased downstream sediment load in run-off due to ground disturbance and construction of mine infrastructure and landform	Sediment from project activities contained to Disturbance Envelope	No visible sediment fans leaving the Disturbance Envelope as a result of Project activities. Sediment ponds located downstream of disturbances and sized appropriately to restrict sediment from leaving the Development Envelope.	Annual review of aerial photographs to identify project related sediment fans. Integrity inspections of sediment ponds, and maintenance of ponds to remove sediment build-up

Risk Pathway	Environmental Outcome	Performance Criteria	Monitoring
Environmental Factor: Land and Soils **DMIRS Objective: To maintain the quality of land and soils so that environmental values are protected**			
Contamination of land from incorrect disposal of dispersive mine waste materials (oxides)	No land contamination from dispersive mine wastes	Transitional BIF and ultramafic mine waste buried within WRL	Records of transitional BIF and ultramafic mine waste placement within the WRL. Audit of constructed WRL for compliance with WRL design specifications/ required standards (Figure 9, and MCP Section 8).
Contamination of land due to spillage of brackish or saline water	No land contamination from by brackish or saline water	No spillage of brackish or saline waters.	Incident reports. Turkeys nest and pipeline inspections (daily) for freeboard and integrity.
Land contamination due to use of brackish or saline water for dust suppression	No land contamination from use of brackish or saline water	No visible salts in areas where water has been applied for dust suppression. No vegetation death adjacent to application areas.	Water quality data (EC) for turkeys nest and groundwater abstraction bores. Water truck records (usage and locations).
Soil saturation from dust suppression or excess water disposal	No pooling or ponding of water because of water application activities	No pooling, ponding or surface expression of water in application areas	Visual monitoring of land in application areas. Dust suppression activity records.

Table 32: Environmental Outcomes, Performance Criteria and Monitoring Regulated by Others

Risk Pathway	Environmental Outcome	Performance Criteria	Monitoring
Environmental Factor: Terrestrial Fauna **EPA Objective: To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.**			
Increased feral animals as a result of increased access to water resources resulting in increased competition for food and habitat for native fauna	No observation of feral animals on the mining tenements.	Turkeys nest fenced with feral animal proof wire. Post-closure pit lake water salinity >20,000mg/L All rubbish bins have lids fitted. All putrescible waste removed from the tenements for off-site disposal. No goat activity within the pit void	Quarterly feral animal monitoring and baiting programmes. Annual water quality data (EC) for post-mining pit lake
Potential or realised impacts to DBCA managed land neighbouring the Project	No impacts to DBCA managed land neighbouring the Project	Cleared vegetation is only within the approved Clearing Permit boundary. Sediment from disturbed ground remains within the Development Envelope.	Reporting to DBCA any impacts by notifying DBCA's Kalgoorlie office (Phone 08 9080 5555; or email Kalgoorlie@dbca.wa.gov.au)

9. ENVIRONMENTAL MANAGEMENT SYSTEM

9.1 DESCRIPTION OF THE MANAGEMENT SYSTEM

The Die Hardy Project is one of several operations owned by Ramelius Resources Limited. Ramelius Resources has an Environmental Management System (EMS) which is an over-arching structured system designed to help the operational sites (including Die Hardy) manage environmental impacts and improve environmental performance within the workings of their individual Environmental Management Plans (EMP). The system is intended to provide structure to environmental management and covers areas such as training, record management, inspections, objectives and policies. The EMS is based on a continuous improvement cycle of 'Plan, Do, Check, Act' which is aimed at continually improving business and environmental performance. The EMS is a dynamic system that will change over time to meet the evolution of the project.

There are four key elements to the EMS. These are:

- Planning.
- Implementation and Operation
- Checking
- Management review.

9.1.1 Planning

The Die Hardy Project will operate under the Ramelius Resources Limited Health, Safety and Environment Policy. This Policy is a statement by Senior Management of its intentions and principles in relation to its overall environmental performance which provides a framework for action and for the setting of its environmental objectives and targets.

Planning, guided by the Policy requirements, is fundamental to good environmental management. The EMS principle of planning involves formal consideration of:

- The construction, operational and closure phases of the project.
- Environmental risk assessment at all stages.
- Legal and other requirements (including all relevant legislation, mining tenement conditions, and the conditions of other licenses).
- Objectives and targets.
- Environmental management programme

Planning for the Die Hardy Project involves:

- Ensuring compliance with the relevant laws (acts and regulations).
- Ensuring compliance with site-specific conditions imposed by regulatory authorities.
- Identifying potential environmental impacts associated with mining activities.
- Identifying the level of risk of the impact occurring.
- Identifying suitable control measures for reducing the risk of the potential impact to 'As Low As Reasonably Practical' (ALARP).
- Budgeting.

9.1.2 Implementation and Operation

Active implementation of the EMS by all employees is essential to achieve agreed objectives and targets. Implementation ensures that:

- Structure and responsibilities for environmental management are assigned and communicated to all employees.
- Employees are provided with the appropriate training and possess the required competencies and awareness in order to fulfil their environmental responsibilities.
- The aspects of the EMS are communicated to individuals during inductions.
- Documentation and document control are maintained under the EMS.
- Emergency preparedness and response plans are developed and implemented should the need arise.
- Compliance with legal requirements is regularly assessed.
- Continuous environmental improvement is actively encouraged.

9.1.3 Checking

The checking and corrective action steps of the EMS include but are not limited to:

- Monitoring, measuring and reporting.
- Problem and cause identification and evaluation.

- Preventative action implementation.
- Corrective action implementation.
- EMS review.

MOPL management will keep and manage its records effectively in order to amass a reliable source of information on the project and results from the EMS. Periodic internal audits of the EMS will help management verify that the system is designed and operating according to plan.

9.1.4 Management Review

The management review process will be undertaken to assess the ongoing suitability and effectiveness of system and ensure modifications are made as necessary, to ensure compliance is maintained. The management review is designed to ensure continual improvement of the EMS, taking into account results of checking and corrective actions undertaken, correcting performance deficiencies and evaluating required resources and timeframes.

9.2 INTERNAL AND EXTERNAL REPORTING AND COMMUNICATION

9.2.1 Incident Reporting

MOPL will notify DMIRS of any reportable incident within 24 hours of detection. Reportable incidents include:

- An incident that breaches the performance criteria of the approved Mining Proposal.
- An incident arising from any mining activity that has caused, or has the potential to cause, environmental harm.

An incident investigation report outlining the details of the incident, cause, impact on the environment and remedial actions taken will be submitted to DMIRS. The timing for submission of the report will be determined by DMIRS.

9.2.2 Internal Reporting

Environmental incidents that are considered to exceed the performance criteria and/or threaten the environment will be reported using Ramelius' internal system incident reporting system.

Monthly reports will be submitted to the Project or Site Manager. Monthly reports will contain statutory compliance information including environmental reports and current reporting requirements.

9.2.3 External Reporting

Both State and Federal government departments administer compliance conditions required under relevant Acts and Regulations. Reporting conditions are typical of most mining and mining-related activities with the most common external reporting requirements summarised below. The list provided is not exhaustive and is indicative for the most common of reporting conditions. The list will be reviewed and refined as the Project develops.

Department of Mines, Industry Regulation and Safety

DMIRS reporting requirements include:

- An Annual Environmental Report (AER).
- An annual Mine Rehabilitation Fund Report (MRF).
- An Annual Vegetation Clearing Report
- Accident and incident reporting.

Department of Water and Environmental Regulation

DWER reporting requirements include:

- Report of a known or suspected contaminated site.

Department of Agriculture, Water and the Environment (Commonwealth)

DAWE reporting requirements include the National Pollution Inventory Report (NPI) and National Greenhouse and Energy Reporting (NGER).

10. MINE CLOSURE PLAN

Effective closure and rehabilitation planning are required to minimise the ongoing impact to the environment and develop self-sustaining natural ecosystems. A Mine Closure Plan (MCP) for the Project is submitted as part of this Mining Proposal ad aims to ensure that the closure objectives are considered throughout the life of the proposal (Appendix I).

10.1 REHABILITATION

Rehabilitation of the Die Hardy Project will be conducted as per the MCP. Upon cessation of mining operations, all site infrastructure will be removed from the Die Hardy mining area, with any rubbish being collected and deposed of at a licensed landfill facility. Hardstand and compacted areas will be ripped, topsoil spread over the area and contoured ripping undertaken.

The location and alignment of the abandonment bund surrounding the pit was designed to comply with the DMIRS Guideline for Safety Bund Walls Around Abandoned Open Pit Mines 1997 (cross-sections shown in Figure 7 and Figure 8). At closure, MOPL will re-assess the final position of the abandonment bund taking into consideration the final depth of the pit. The Die Hardy pit will have a pit crest safety bund as an extra safeguard inside the proposed final abandonment bund position.

The abandonment bund closure strategy consists of the bund forming a safety barrier to limit vehicle access during operations and restrict vehicle access post-closure. The proposed 2 m high bund separating the pit from the drainage line to the east is also adequate to manage peak flow rates and flood levels (MWES, 2021; Appendix C).

The abandonment bund will be constructed with coarse and/or competent rock. Hydrology studies on the eastern drainage channel modelled the potential hydrological impacts of a 1:1000 year ARI event. Armouring the length of the abandonment bund section south of the pit will adequately manage post-closure events. Similarly, the outer (south and east) lower slopes of the WRD will also be clad with coarse rock to a height of 0.6m AGL to adequately resist potential erosion of 1:1000 year events.

MWES (2021) carried out a post-closure pit lake water and solute balance for both the pit lake. This information formed the basis of the pit lake geochemistry modelling to determine the post-closure pit lake water quality. The resulting equilibrium pit lake water levels are predicted to be lower than the pre-mining groundwater levels, and with the extremely high pit lake evaporation the post-closure pit lake level will remain well-below the surrounding water table and become hydraulic sinks with no outflows to the environment. With the resulting pit lake remaining as a groundwater sink, this situation will pose little risk to groundwater quality.

The pit lake salinity is expected to increase over time because of evapo-concentration reaching about reaching between 10,000 and 20,000 mg/L TDS post-closure and increasing in salinity over time. No extreme pH values are predicted for the pit lake and pH is predicted to be slightly acidic to slightly alkaline. The saline pit water is likely to be unpalatable to most fauna post-closure and should not attract feral animals; goats being the main concern for DBCA. The literature from the WA Department of

Primary Industries and Regional Development (DPIRD) and the Commonwealth Department of Agriculture, Water and Environment (DAWE) indicates that goats may adapt to high salt levels (>5000 mg/L) but generally prefer salinity levels less than 2000 mg/L.

Rehabilitation and mine closure commitments for the Die Hardy Project are provided in Table 33.

Table 33: Rehabilitation and Mine Closure Commitments for the Die Hardy Project

Mine Feature	Rehabilitation/ Closure Commitment
Haul road/ access roads	At final closure, all signage, delineators and culverts will be removed. Topsoil replaced, rip, seed and fertilise (as required).
Go line/ MOP	The MOP will be contoured in regard to surface water management for mine closure. As specified in the MCP, these areas will be re-contoured to restore original drainage paths (where necessary). Replace topsoil, rip, seed and fertilise (as required).
Mobile equipment fuel storage	At final closure (as specified in the MCP) any remaining infrastructure will be removed or buried where appropriate. Assessment for possible soil contamination as per DWER guidelines. Remove and or remediate *in-situ* as per site procedures if necessary. Replace topsoil, rip, seed and fertilise (as required).
Open Pit	Access to the pit will be blocked, the abandonment bund assessed for ongoing integrity, and signage installed
Waste Rock Landform	The final profile of the WRL will be a concave slope with an overall angle of 14 degrees. On completion of the WRL, topsoil will be applied to a depth of 0.2 m. Topsoil coverage requirement approx. 65,200 m^3 to cover the 32.6 ha surface area. The topsoil will ripped and seeded.

The justification for adopting the stated WRL design criteria is based on the results of the landform modelling studies undertaken by Landloch (2021). The adopted design remains a relatively simple and conservative design consistent with using low batter angles with a concave slope of overall 14° angle. The design has also been independently reviewed by geotechnical engineers and it was confirmed that proposed WRL has acceptable geometry and meets requirements for very long-term stability with the slopes being both geotechnically stable and invulnerable to erosion (Appendix A) and will ensure the landform is safe, stable and non-polluting.

10.2 POST-MINING LAND USE

As the mine site is located on DBCA-managed land, ongoing discussion will continue with DBCA to determine the preferred post-mining land use for the surface features of the Die Hardy Project. On completion of closure and rehabilitation, the anticipated post-mining land use for the surface features of the project site will be native vegetation.

10.3 PROVISIONAL CLOSURE TIMEFRAME

MOPL plan to commence mining operations in 2021 with a completion date of around Q2 2023. Rehabilitation will take place progressively throughout the operation where possible.

11. EXPANSION AND/OR ALTERATION TO AN APPROVED MINING PROPOSAL

The *2020 Statutory Guidelines for Mining Proposals* require revised mining proposals for the expansion and/or alteration to approved activities to also include:

- An updated document revision number to indicate that the document is a revision to a previously approved mining proposal; and
- A revision summary table that clearly outlines all changes made in the revised mining proposal.

As this document is the first Mining Proposal for the Die Hardy Project, it has already been structured in accordance with the *2020 Statutory Guidelines for Mining Proposals* and designated as Revision 0 Version 1. A revision summary table that clearly outlines all future changes has been summarised in the Document Control Table on the front cover.

11.1 DMIRS REQUEST FOR ADDITIONAL INFORMATION

Should the Environmental Compliance Branch of DMIRS seek further clarification during their assessment, such clarifications requested will be tabulated in this section of the Mining Proposal, listed with the corresponding responses from MOPL.

A Request for Further Information (RFI) on the Mining Proposal was received from DMIRS on 23 September 2021 which is presented in the table below, along with the corresponding proponent response and updated section of this submission of where additional information has been provided. A separate table with RFI queries relating to the MCP is presented in the updated MCP (Appendix I).

MINING PROPOSAL:

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
1	OVERALL	N/A	The proposed project is adjacent to Mt Manning Conservation Park that is proposed to be upgraded to a National Park and is also adjacent to a proposed Nature Reserve. The area is currently native vegetation with Die Hardy PEC on unallocated crown land. A post mining landuse of pastoral is not acceptable in this setting. A post-mining landuse of return to native vegetation would be more appropriate. The risks posed by the current proposal have not been adequately addressed. DMIRS is particularly concerned about: - A pit lake at closure providing a water source for feral animals leading to impacts in the neighbouring conservation reserve and proposed nature reserve. - Dispersive material eroding from the WRL and impacting on native vegetation outside of the disturbance envelope. - Lack of detail on the proposed rehabilitation of the WRL to return biodiversity values. The partial or complete backfilling of the pit void could negate the identified risks. Please revise both the MP and MCP to demonstrate how Ramelius will manage these risks. The comments below relate to the existing proposal.	Section 10.2 states the anticipated post-mining land use for the surface features of the project site will be native vegetation. No mention was made of returning the site to a pastoral land use. Further discussions with DBCA resulted in them clarifying their preference for partial pit backfilling to negate a pit lake, but they will not mandate this as other factors such as safety in backfilling operations, and financial implications may preclude this management option of being feasible. Sections referring to the post-mining pit lake, material dispersion and WRL rehabilitation have been updated. All of the soils are non-sodic and contain a high percentage of sand (>75%), a low percentage of fine silt and possess	Section 10.2 Section 5.4 Section 6.3.2 Section 6.5.2 Appendix I

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
				a lower dispersion risk. Some soils with weak structure and medium to high risk of clay dispersion also contain a high percentage of sand, thereby lowering their dispersion risk. The Landloch report and Geotech report support the WRL closure design	
2.	Note	N/A	DMIRS geotechnical review is still underway. If additional information is required based on the geotechnical review this will be provided as a separate request.	Noted. A discussion with DMIRS on 18/10/21 indicated that the Geotech review was now complete and no further information is required.	N/A
3.	Note	N/A	Please ensure that all appendices are attached to the MP for resubmission.	All appendices are attached	Appendices
4.	Note	N/A	All relevant sections of the MP/MCP are required to be updated to reflect the new changes.	Updates of both documents in tracked changes	Throughout
5.	Note	N/A	It is noted a miscellaneous licence is pending L77/351. Please note that Mining Act 1978 approval will be required if the licence is to support mining operations. A mining proposal can be submitted whilst a miscellaneous licence is pending.	L77/351 (Pending) is not essential for the operation of the Die Hardy project. When it is granted, MOPL will re-assess the project and its need, and submit an amendment if required.	N/A

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
6.	Table 3 Activity Details	Section 5 Activity Details	Please note there are discrepancies between Table 3 Activities for the Die Hardy Project corresponding Sections 2.4 and 2.5 regarding the proposed area (ha) for the MOP and saline dam. Please ensure the proposed disturbance areas for key mine activities are consistent throughout the MP and MCP.	The discrepancy has been fixed. Table 3 is correct. Sections 2.4 and 2.5 have been edited to reflect Table 3.	Sections 2.4 and 2.5
7.	Table 3 Activity Details	Section 5 Activity Details	Insufficient design description has been provided for the WRL. Please include all design parameters inclusive of cover materials and depth of cover that demonstrate the final landform will be safe, stable, non-polluting and able to be revegetated with native species.	Erosion modelling completed for various WRL design scenarios has resulted in the adopted design demonstrating reduced erosion rates to acceptable levels. The design parameters of max. 30 m high WRL with low batter angles (overall 14°) and a concave slope, applying gravelly soils with 40% tree debris to the lower third of the final batter has been added to the Activity Table. The WRL has been designed to retain water on the top of the WRL, while shedding water on the slopes in a controlled manner to provide stability and prevent erosion. The objective of this design is to capture precipitation	Table 7 Section 2.3.1 Table 30 Table 31 Table 32

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
				and maximise infiltration, which will in turn enhance rehabilitation success.	
8.	Table 3 Activity Details	Section 5.1 Additional Detail for Key Mine Activities (Appendix 2)	The saline water dam is a key mine activity and additional details are required in accordance with Section 5.1 of the Statutory guidelines.	Section 2.5.1 Turkeys Nest Storage has been updated to include a new Table 11 to meet the statutory guidelines.	Section 2.5.1
9.	Section 5 Stakeholder Engagement	Section 7 Stakeholder Engagement	Section 5.2 Stakeholder Engagement Strategy describes the stakeholder engagement that has been undertaken with various stakeholders however, the records within Table 15 Stakeholder Register do not align with the stakeholder consultation described in Sections 5.2.1 to 5.2.5 (inclusive). The MP must demonstrate that stakeholder engagement has occurred with the key stakeholders. Please revise the stakeholder register to accurately capture stakeholder engagement that has occurred for the project.	Table 15 has been updated to be exhaustive with the inclusion of all consultation undertaken. It should be noted that earlier consultation included the Reg Legs mining prospect, which this Mining Proposal is not including.	Table 15
10.	Table 15 Stakeholder Consultation Register	Section 7 Stakeholder Engagement	Please note that the stakeholder response from DBCA is identical to the response from DMIRS. DBCA managed lands are adjacent to the project, it is expected that consultation has occurred with DBCA. The MP must include the record of engagement from DBCA.	The stakeholder consultation section has been updated showing the discussions with DBCA.	Section 5.4
11.	Table 15 Stakeholder	Section 7 Stakeholder Engagement	The date column on Table 15 is uninterpretable, this may be due to a formatting error. Please correct this discrepancy.	The date column is presented as year, month, day. *e.g.,* 200610 (2020, June, 10th)	N/A

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
	Consultation Register				
12.	Section 6.4.3 Subterranean Fauna	Section 8 Baseline Environmental Data	Please attach the Subterranean Fauna survey undertaken by Bennelongia (2013) to verify the stygofauna communities' information.	A new appendix has been added (the Bennelongia report) and reference to this Appendix has been made.	Section 6.4.3 Appendix J
13.	Section 6 Baseline Environmental Data	Section 8 Baseline Environmental Data	Please attach the Malleefowl Management plan to demonstrate that impacts are being managed. Please ensure the management plan incorporates the following: - the relevant tenements for the Die Hardy Project; - Staff training in awareness and management of malleefowl; - Reporting to DBCA on any sightings or disturbance of malleefowl and mounds. Note: relevant documents to support the MP/MCP should be appended and not referred to in another REG ID.	A new appendix has been added (the Malleefowl Management Plan) and reference to this Appendix has been made.	Section 6.7.3 Appendix K
14.	Table 29 Risk Assessment	Section 9 Risk Assessment	Please commit to reporting to DBCA any potential or realised impacts to DBCA managed land neighbouring the project. The notification must be to DBCA's Kalgoorlie office. (Phone 08 9080 5555 or email Kalgoorlie@dbca.wa.gov.au). This should be included as a treatment within the risk assessment to mitigate impacts.	Addition risk added to the relevant tables and commitment made to report.	Table 30 Table 32
15.	Table 29 Risk Assessment	Section 9 Risk Assessment	Ramelius have not clearly demonstrated that the risks from the pit lake and WRL can be managed to achieve DMIRS environmental objectives for Biodiversity, Land and Soils	Advice from DBCA on post-closure pit lake risks and their position not to	Section 10.1

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
			and Rehabilitation and Mine Closure. The management measures proposed both in the MP and MCP risk assessment are to be revised to clearly detail the specific controls that will be implemented to mitigate the risks from the project. For example in relation to the management of dispersive waste materials impacting the surrounding environment, the risk assessment does not demonstrate that residual risks are ALARP and does not adequately apply the hierarchy of control to justify the reduction of consequence to "insignificant". The risk pathway remains even with the acceptable erosion rates proposed. Therefore there should be no change in consequence. DMIRS considers there are potential risks, (erosion and sedimentation of native vegetation) to the surrounding environment that have not been considered from dispersive material from the WRL. For example in relation to the management of dispersive waste materials impacting the surrounding environment, the risk assessment does not demonstrate that residual risks are ALARP and does not adequately apply the hierarchy of control to justify the reduction of consequence to "insignificant". The risk pathway remains even with the acceptable erosion rates proposed. Therefore there should be no change in consequence. DMIRS considers there are potential risks, (erosion and sedimentation of native vegetation) to the surrounding environment that have not been considered from dispersive material from the WRL. DMIRS comments are supported by the following:	insist on partial backfilling if uneconomic has been confirmed and addressed. The pit lake salinity is also too high to attract or sustain goats. A risk analysis has been implemented and a low risk was found. As the salinity concentration of the pit lake would exceed >19000 mg/L TDS over time due to evaporation, this will be insufficient to support a population of feral animals such as goats The risk has been re-assessed based on the science of the modelling and the materials characterisation testwork that has been completed. Likelihood and consequence outcomes have been modified accordingly. Regardless of the majority of waste materials having poor durability with little fresh rock available, erosion modelling completed for various WRL design scenarios has resulted in the	Table 7 Section 2.3.1 Table 30 Table 31 Table 32

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
			- majority of the waste materials having poor durability that are either oxidised or transition wastes, - there is limited fresh rock (1%) available as a mitigation strategy for erosion protection, - Limited physical characterisation data has been provided on the waste types to determine the risks; - the MP does not demonstrate there is sufficient volumes of tree debris to support modelled erosion rates; - The design parameters for the WRL are not clearly defined in the activity table; - There is limited stakeholder engagement with DBCA on the proposed project to identify if the modelled erosion rates impacting surrounding environment are acceptable; - The disturbance envelope proposed sits tightly within the tenure potentially increasing off tenure impacts; - The surrounding Conservation Park, and Proposed Nature Reserve have values that have not been considered; and - Short mine life increasing potential risks. Please explain how impacts to the surrounding environment will be mitigated.	adopted design demonstrating reduced erosion rates to acceptable levels. The design parameters of max. 30 m high WRL with low batter angles (overall 14°) and a concave slope, applying gravelly soils with 40% tree debris to the lower third of the final batter has been added to the Activity Table. Fresh rock is not essential to achieve stability of the final slope. The WRL has been designed to retain water on the top of the WRL, while shedding water on the slopes in a controlled manner to provide stability and prevent erosion. The objective of this design is to capture precipitation and maximise infiltration, which will in turn enhance rehabilitation success. Section 2.3.1 updated to demonstrate there is sufficient volumes of tree debris to support modelled erosion rates	Section 2.3.1

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
16.	Table 29 Risk Assessment	Section 9 Risk Assessment	Sediment ponds/ traps, clean water interception and diversion has been proposed as a measure to mitigate impacts from increased sediment load in run off. Please provide further detail to demonstrate risks will be adequately managed including; locations, size, maintenance regime, and capacity to handle 1:100 year rainfall events for operations and explain sediment management in closure (in the MCP). A figure is a useful way to demonstrate the location of these sediment traps at areas of erosion risk.	Sediment ponds will be sized to accommodate a 1:100 year event and located in areas downstream of disturbances to restrict sediment from leaving the Development Envelope.	Section 2.6.4 Section 6.5.1 Table 30 Table 31 Table 32
17.	Table 29 Risk Assessment	Section 9 Risk Assessment	Backfilling the mine void would negate the risk of dispersive material moving beyond the disturbance envelope at closure. This would be an acceptable option to demonstrate ALARP. Please provide comment on whether backfilling and/or partial backfilling of the pit is considered an option for the project.	The potential for backfilling of open pit has been considered in line with DMIRS and EPA Mine Closure Guidelines (DMP and EPA 2011) and DBCA as a key stakeholder responsible for management of the CALM Act Section 5(1)(h) proposed 'Conservation and Mining Reserve'. The primary considerations were: • the extent of potential pit lake formation; • sterilisation of underlying ore potential; and • attraction and localised grazing of feral animals.	Section 2.2.2

ITEM	SECTION OF SUBMISSION	STATUTORY GUIDELINE SECTION	DMIRS COMMENTS	PROPONENT RESPONSE	UPDATED SECTION OF SUBMISSION
				DMIRS and EPA Mine Closure Guidelines require that, prior to open cut mines being backfilled, a study be conducted to determine the potential for future economic mining from any resource that exists beneath or along strike of the current pit extents. MOPL's resource definition data currently indicates a defined resource extent beyond that which is proposed to be mined. Consequently, there is a risk to sterilising future resources if backfilling was to occur. During consultation with DBCA on 29 September 2021, DBCA's position is that although backfilling is preferable, it is not mandatory is other factors such as safety or economics reasons preclude backfilling from occurring. Partial backfilling will occur during the scheduled operational mining phase where possible.	

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APPENDICES

Appendix A: Geotechnical Report

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RAMELIUS RESOURCES

MARDA GOLD PROJECT

GEOTECHNICAL ASSESSMENT
OPEN PIT MINING
DIE HARDY DEPOSIT

REPORT 20084

Prepared for:

Ramelius Resources Ltd
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Prepared by:

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December 2020

In association with:

GEORGE, ORR and Associates (Australia) Pty Ltd Consulting Engineering Geologists
Peter Clifton & Associates Consulting Hydrogeologists

1.0 EXECUTIVE SUMMARY

Ramelius Resources Ltd plans to develop an open pit on the Die Hardy gold deposit, which lies within Ramelius' Marda Gold Project, Western Australia.

Ground conditions influencing wall stability in proposed open pit mining at Die Hardy have been investigated by Peter O'Bryan & Associates (PBA) using:

- ⇨ Current geological interpretations
- ⇨ Data contained in geological, structural geological and geotechnical logs for diamond cored exploration boreholes FBDD-001, 002 and 003. The logs were compiled by Ramelius Resources and PBA.
- ⇨ Laboratory measurement of physical properties of representative samples of country rocks
- ⇨ Experience in geotechnical assessment and review in similar geological and geotechnical settings.

Assessment and analysis of future open pit wall stability has used:

- ⇨ Current interpretations of geological and geotechnical conditions
- ⇨ Structural geological assessment
- ⇨ Results of laboratory testing of physical properties of country rocks in which future pit walls will be developed
- ⇨ Kinematic stability analysis
- ⇨ Limit equilibrium analysis
- ⇨ Experience-based assessment of expected pit wall conditions.

Ground Conditions

On the basis of core logging data the quality of the *extremely* to *completely weathered* horizon at Die Hardy is classified as *very poor*. The mean Rock Mass Rating (RMR) for observed intervals of *extremely* to *completely weathered* material/ rock was 17 (*very poor* rock).

Highly weathered rocks have an RMR range of 12 to 52 (*very poor* to *fair* rock), with a mean value of ~ 33 (*poor* rock).

Transitional (*moderately weathered*) rocks had RMRs ranging from 47 to 69 (*fair* to *good* rock), with a mean value of ~ 55 (*fair* rock).

Slightly weathered rock had an RMR range of 22 to 75 (*poor* to *good* rock), with a mean of ~ 65 (*good* rock).

Overall, data from *fresh* rock core yielded an RMR range of 56 to 94 (*fair* to *very good* rock), with a mean value of ~ 78 (*good* rock).

Wall Stability Conditions

On the basis of assessed rock mass conditions, it is considered that wall stability within the majority of proposed pit slopes at Die Hardy will be controlled by some combination of the influences of low shear strength of weathered materials and relict geological structures.

Current weathering interpretations indicate that planned mining will intersect limited intervals of *fresh* rock. Where encountered, fresh rocks are expected to generally be *very strong* and wall segment stability will dominantly be controlled by the orientation, persistence and shear strength of geological structures intersected by, or located close behind, pit walls.

Kinematic stability analyses indicate theoretical potential for planar sliding failure from the major eastern wall. It is anticipated that the eastern wall of the proposed pit will follow the orientation of moderately steep south-west dipping lodes within the SIF rock unit; hence batter face and wall Inter Ramp Angles (IRA) would not be expected to exceed the ~ 40° dip of the SIF unit. At modest ≤ 40° face and slope angles, potentials for planar sliding failures, structurally-controlled failures and intact material shear failures are expected to be limited.

Recommended Open Pit *Base Case* Wall Design Parameters

The wall design parameters provided herein may be used for ongoing open pit mining evaluation and planning at Die Hardy.

The preliminary pit design, on which assessment has been based, is shown in Figure ES1; and the recommended *base case* wall profiles are illustrated in Figures ES2 and ES3.

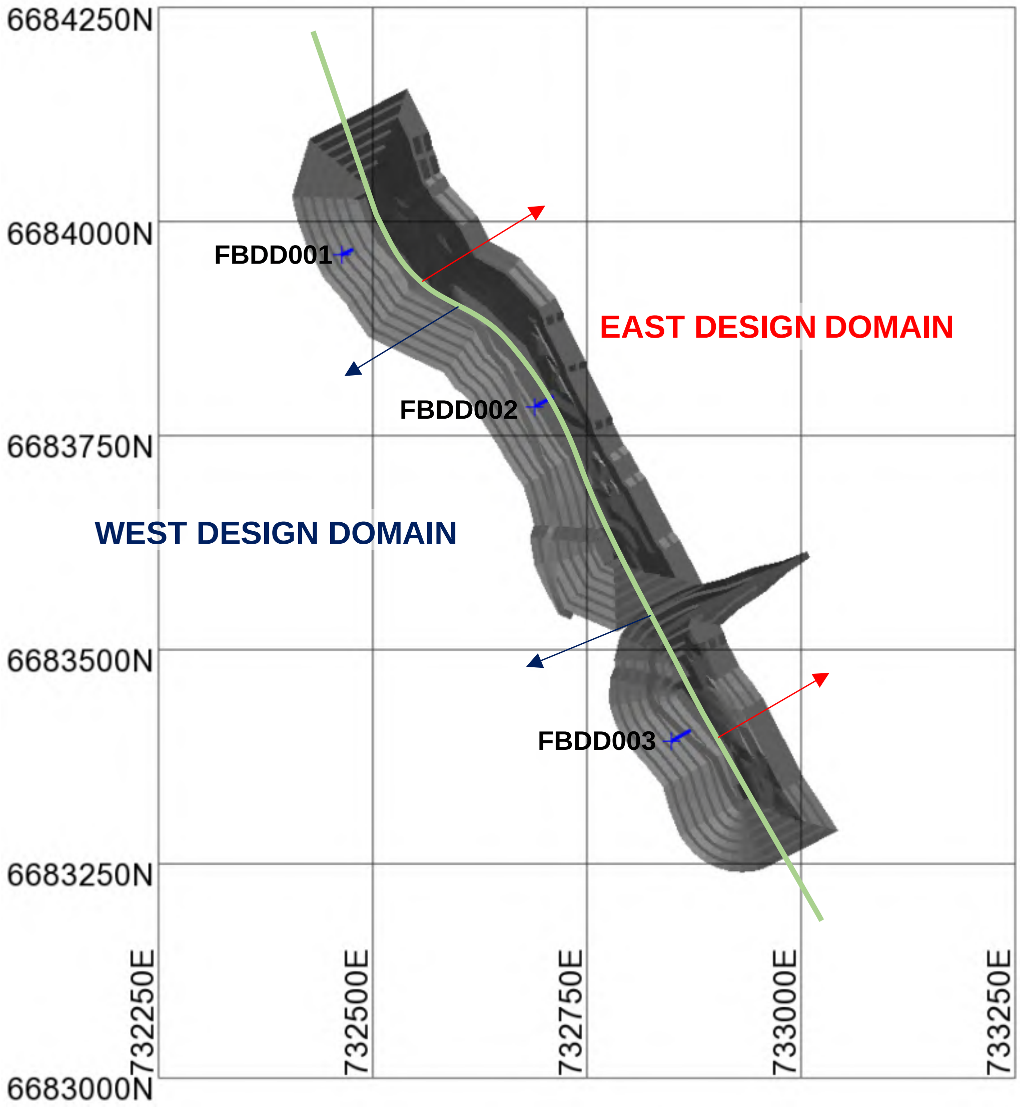

Figure ES1 Preliminary Die Hardy geotechnical design domains

EAST DOMAIN

Figure ES2

From 0 to 10 metres below surface (mbs) (laterite, gravel, transported & *highly* weathered material)

Batter Face Height	**≤ 10m**
Batter Face Angle	**40°**
Berm Width	**5m**
IRA	**30.6°**

From 10 to 50 mbs (*highly* weathered to *fresh* SIF, MDZ & UAC rocks)

Batter Face Height	**≤ 20m***
Batter Face Angle	**40°** (attempting to match bedding/defect angle within wall rocks)
Berm Width	**5m**
IRA	**34.7°**

* *Alternatively, mine as continuous 35° to 40° slope with rock slide arresting bunds or catch fences installed at ≤ 20m vertical intervals.*

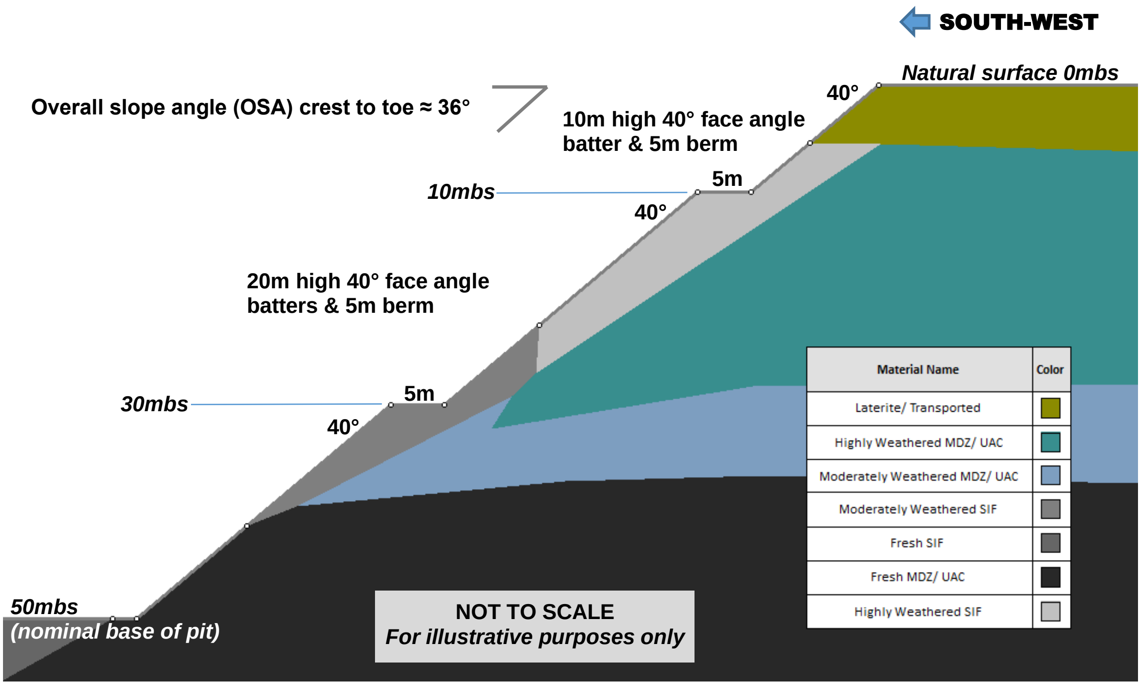

Figure ES2 Die Hardy East Design Domain wall *base case* design parameters

WEST DOMAIN

Figure ES3

From 0 to 10 metres below surface (mbs) (laterite, gravel, transported & *highly* weathered material)

Batter Face Height	**≤ 10m**
Batter Face Angle	**40°**
Berm Width	**5m**
IRA	**30.6°**

From 10 to 40 mbs (*highly* to *moderately* weathered UZZ & SIF rocks)

Batter Face Height	**≤ 10m**
Batter Face Angle	**50°**
Berm Width	**4m**
IRA	**38.9°**

From 40 to 50 mbs (*moderately* weathered to *fresh* SIF rocks)

Batter Face Height	**≤ 10m**
Batter Face Angle	**60°**
IRA	**60°** (single batter)

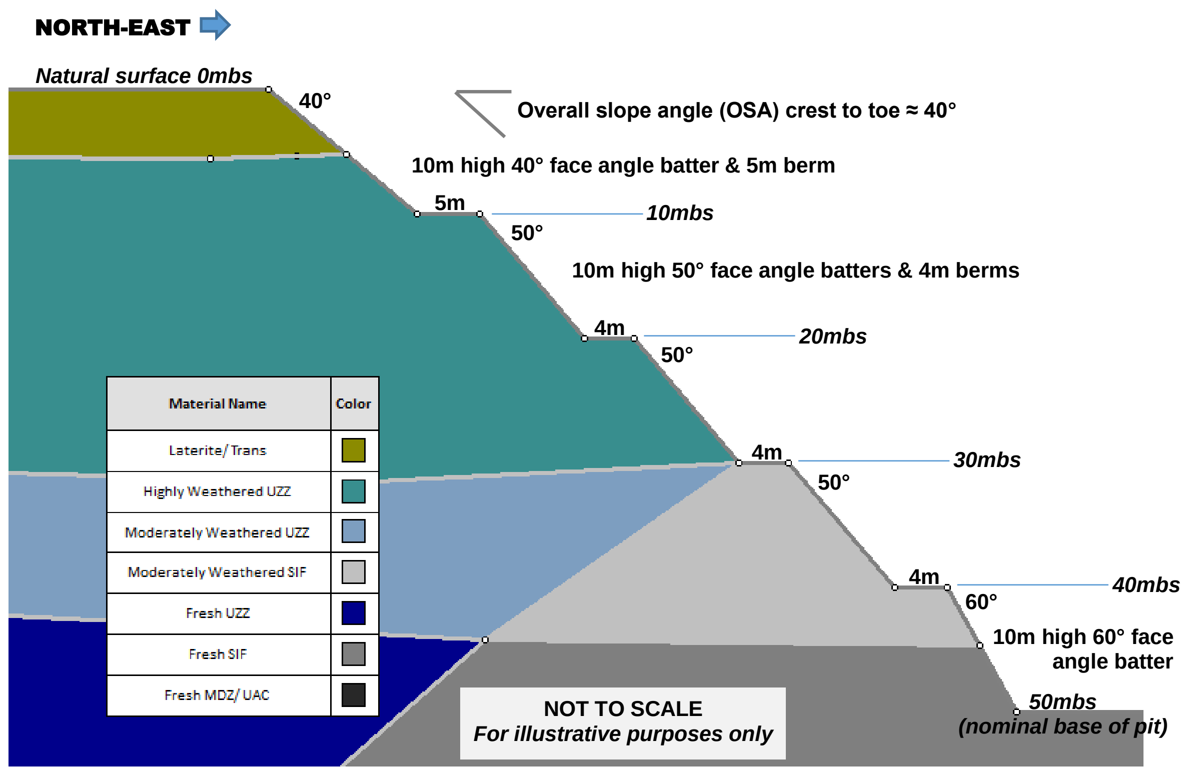

Figure ES3 Die Hardy West Design Domain wall *base case* design parameters

Waste Rock Landform Design

Current proposed Die Hardy waste rock landform (WRL) slopes are of modest height and profile. PBA considers the currently proposed WRL design parameters to be acceptable for construction. The need to manage surface water flows and residence times appropriately is emphasised.

Further Geotechnical Assessment

Pit Wall Mapping & Stability Monitoring

It is considered essential that design re-assessments, and where necessary design adjustments, be made based on *observational techniques* (incorporating ongoing wall mapping and quantitative wall stability monitoring) employed during pit development.

Independent Geotechnical Review

Regular geotechnical review of ground conditions during operations is recommended.

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2.0 Introduction

This report summarises the findings and recommendations of preliminary geotechnical assessment of proposed open pit mining of the Die Hardy gold deposit (Die Hardy), located within the Ramelius Resources Pty Ltd (Ramelius) Marda Gold Project (Marda), Western Australia.

Recommendations are provided for *base case* wall design parameters for ongoing mining evaluation. Requirements for ongoing geotechnical assessment of open pit mining at Die Hardy are also listed.

This report has been prepared at the request of Mr Rob Hutchison, Manager – Mine Geology, Ramelius, made via email on 31 August 2020.

2.1 Scope of Work

The Scope of Work requested by Ramelius was essentially to:

- ⇨ Geotechnically assess rock mass conditions within the limits of proposed Die Hardy open pit excavation:
  - Geotechnically log cores from exploration boreholes.
  - Complete geotechnical investigation work required for the assessment.
  - Complete analysis of data collected through geotechnical investigation work.
- ⇨ Provide recommendations on parameters to be used in design of the open pit.
- ⇨ Provide recommendations on any future geotechnical work deemed to be required.
- ⇨ Summarise the findings and recommendation of the preliminary geotechnical assessment work in a written report.
- ⇨ Assess the geotechnical feasibility of proposed design parameters for a Waste Rock Landform (WRL) planned to be constructed adjacent to the Die Hardy open pit mining area.

2.2 Sources of Information

Ground conditions have been assessed using current Ramelius geological interpretations, data obtained from cores of exploration boreholes and experience in geotechnical assessment and review in similar geological and geotechnical settings.

Findings and recommendations are based on:

- ⇨ Discussions held with Rob Hutchison regarding the Die Hardy geological setting and proposed future mining.
- ⇨ Data contained in geological and geotechnical logs for diamond cored exploration boreholes FBDD-001, 002 and 003 drilled at Die Hardy during October 2020. Geological logging was carried out by Ramelius geologists and geotechnical logging by Peter O'Bryan & Associates (PBA).
- ⇨ Consideration of experience in geotechnical assessment and review of open pit operations in similar geological and geotechnical settings.
- ⇨ Review of site topography, preliminary pit design, interpreted rock weathering and geological interpretation files supplied electronically by Ramelius, as follows:
  - *2020 rh topo_diehardy.dtm*
  - *20_01 Geol_lat.dtm*
  - *dh_pd_nth_ac_0720_SC.dtm*
  - *2011_dh_geol_bif.dtm*
  - *20_01 Geol_boco.dtm*
  - *20_01 Geol_TOFR.dtm*
  - dh_pd_sth_ac_0720_SC*.dtm*

3.0 Background Information

Note that unless stated otherwise, all grid and directions indicated within this report refer to the MGA94_50 grid system.

3.1 Location

The Die Hardy deposit is located ~ 400 km north-east of Perth and ~ 165 km north of the township of Southern Cross, Western Australia (Figure 1). Die Hardy is located ~ 30 km north of the Ramelius Marda Central open pits.

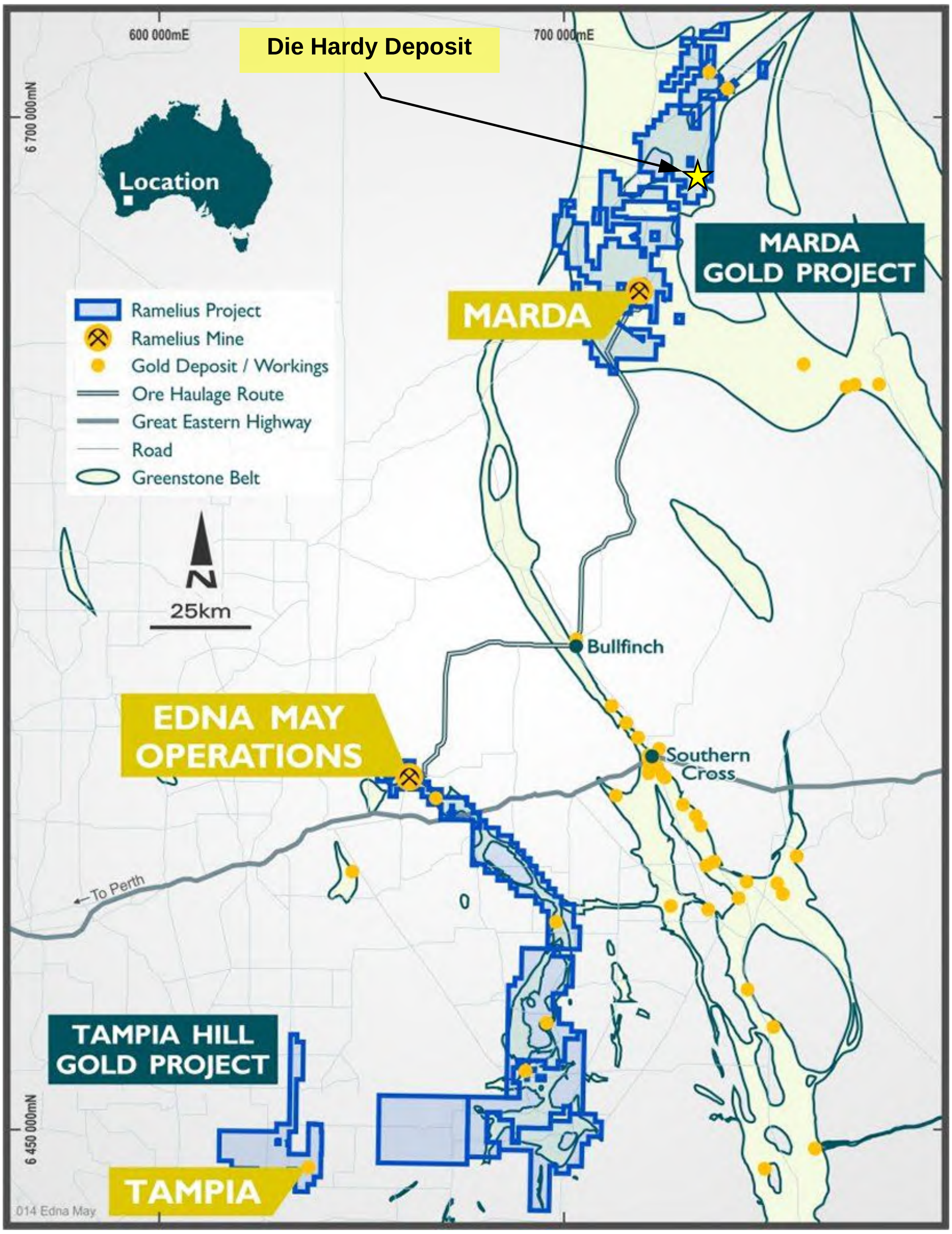


Figure 1 Current Ramelius mines, projects & location of the Die Hardy Deposit
(modified after Ramelius)

3.2 Topography

Natural surface topography within the immediate vicinity of the Die Hardy deposit slopes gently to the north north-west, with a relative difference in elevation of ~ –10m between the southern and northern boundaries of the proposed mining area. Natural surface within the central portion of the deposit rises ~ 5m along a north north-west trending Banded Iron Formation (BIF) unit.

The deposit is aligned parallel to the Die Hardy Range which is located ~ 1.5 km to the south-east.

3.3 Geology

The following descriptions of the geological setting at Die Hardy have been summarised from a background note provided by Ramelius [1].

3.3.1 Local Geology

Mineralisation at Die Hardy is hosted within a BIF unit which is located within mafic and ultramafic stratigraphy. Stratigraphy strikes north north-west toward 330° and dips at around 35° to 40° to the south-west.

The BIF unit is ~ 30m to 40m thick and mineralisation occurs as a relatively continuous lode zone within the unit. Mineralisation is interpreted to occur within a shear zone or iron-rich sedimentary layer which ranges in width from ~ 2m to 8m, with an average width of ~ 5m. Mineralisation is defined for ~ 1,000m along strike and ~ 140m down dip.

Major Logged Lithologies within Die Hardy Exploration Boreholes

Major rock types logged in Die Hardy exploration boreholes FBDD-001 to 003 ranked in order of frequency of occurrence comprise:

- **SIF** – Sedimentary chert and BIF, dominant ferruginous layers
- **UZZ** – Ultramafic undifferentiated
- **UAC** – Ultramafic amphibole chlorite schist
- **TCZ** – Transported clay undifferentiated
- **TGF** – Transported gravel, ferruginous
- **MDZ** – Mafic dolerite undifferentiated
- **TMZ** – Transported mottled clay

3.3.2 Rock Weathering

Interpreted rock weathering surfaces provided by Ramelius (files: *20_01 Geol_lat.dtm*, *20_01 Geol_boco.dtm* and *20_01 Geol_TOFR.dtm*) indicate that weathering extends to variable and considerable depths at Die Hardy.

Current rock weathering interpretations indicate that:

- The depth of transported laterite cover material ranges from ~ 3m to ~ 12m, with an average thickness of ~ 8m.
- The Base of Complete Oxidation (BOCO) is located at significantly shallower depth along the deposit BIF unit compared to that in the bounding mafic and ultramafic rocks. Within the BIF unit BOCO is generally located ~ 10 metres below surface (mbs), with depth locally varying between ~ 7 mbs and ~ 21 mbs.

  Within UZZ and MDZ rocks outside of the BIF, the depth to BOCO is indicated to range from ~ 30 mbs to ~ 40mbs.
- The currently interpreted Top of Fresh Rock (TOFR) shows less variation than the BOCO surface and is relatively uniform across Die Hardy lithologies. Interpreted depths to TOFR are:
  - Western Sector, ~ 45 mbs to ~ 55 mbs, generally ~ 47 mbs.
  - Centre (BIF) Sector, ~ 44 mbs to ~ 61 mbs, generally ~ 47 mbs.
  - Eastern Sector, ~ 37 mbs to ~ 55 mbs, generally ~ 45 mbs.

Sections showing typical interpreted rock weathering profiles across the proposed Die Hardy open pit mining area are shown as Figures 2 and 3.

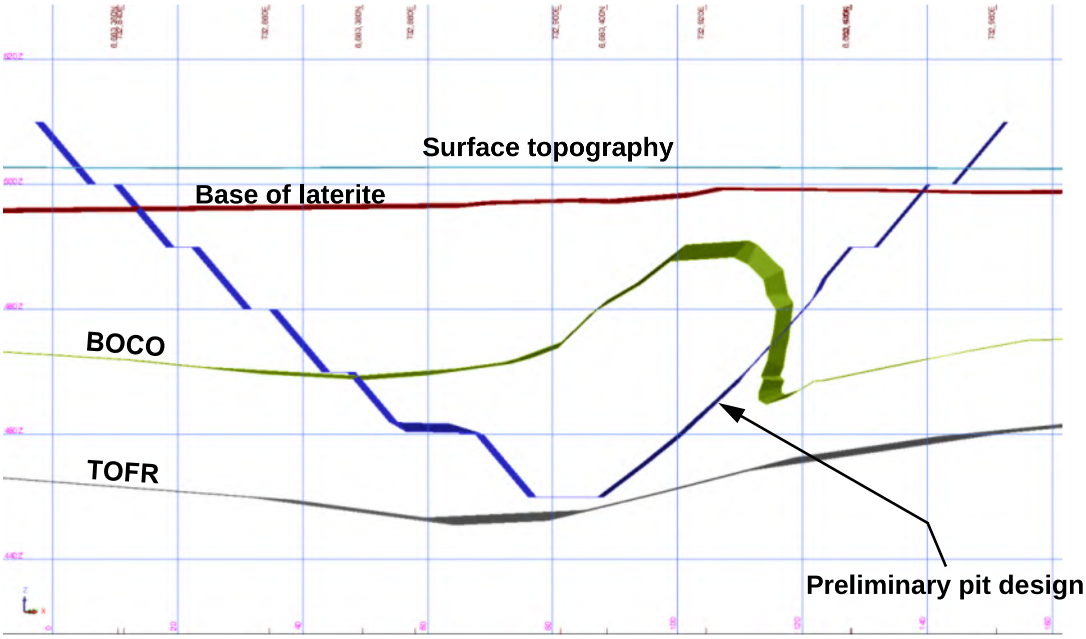


Figure 2 Die Hardy preliminary pit design, surface topography & interpreted weathering surfaces (north-west looking section at ~ 6 683 400mN)

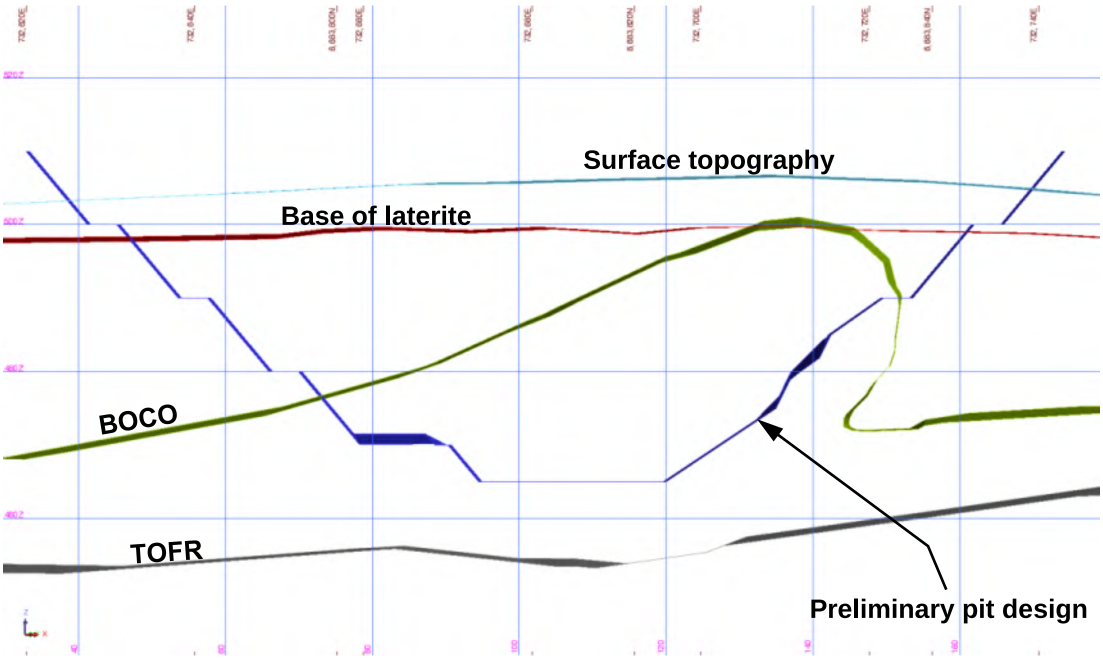


Figure 3 Die Hardy preliminary pit design, surface topography & interpreted weathering surfaces (north-west looking section at ~ 6 683 800mN)

3.3.3 Hydrogeology

Neither Ramelius nor PBA are aware of hydrogeological investigations having been carried out on the Die Hardy mining area.

Ramelius advises (Erik van Noort, personal communication, 19 November, 2020) that reverse circulation exploration holes drilled within the southern portion of the Die Hardy deposit intersected the pre-mining standing groundwater level (PMWL) between 44 mbs and 73 mbs, for an inferred average of 57 mbs.

Ramelius drilled a number of water exploration holes at Die Hardy during 2020. Of the seven (7) holes drilled in the vicinity of the proposed open pit (to between 63m and 124m depth), four (4) intersected groundwater between 40 mbs and 113 mbs. Figure 4 shows the locations of water exploration holes and Table 1 summarises drillhole PMWL intersection depths, and lists yields from basic flow tests carried out by Ramelius.

Based on currently available information, it is inferred that open pit mining at Die Hardy may intersect damp to locally wet conditions at depths greater than ~ 40 mbs. It remains possible that proposed mining may intersect areas of localised inflow; however, it is unknown whether inflow would be short-term or sustained.

Table 1 Ramelius Die Hardy water exploration drill hole and flow test summary
(after Ramelius)

Hole*	Hole Depth (m)	Water Table Depth (m)	Flow Test Depth (m)	Water Flow (L/sec)	Comment
DW001	120	NA	NA	NA	No water
DW002	120	70	120	0.2	90 sec to fill 20 L bucket
DW003	120	NA	NA	NA	No water
DW004	63	40	52	3	Actual water table may lie at between 34 mbs and 40 mbs
DW005	120	113	120	0.24	85 sec to fill 20 L bucket
DW006	120	NA	NA	NA	No water
DW007	124	85	85	0.71	Initial flow of 0.71 L/sec, then slowed significantly
			124	0.016	Weak flow from water table to end of hole

***** All vertical drillholes

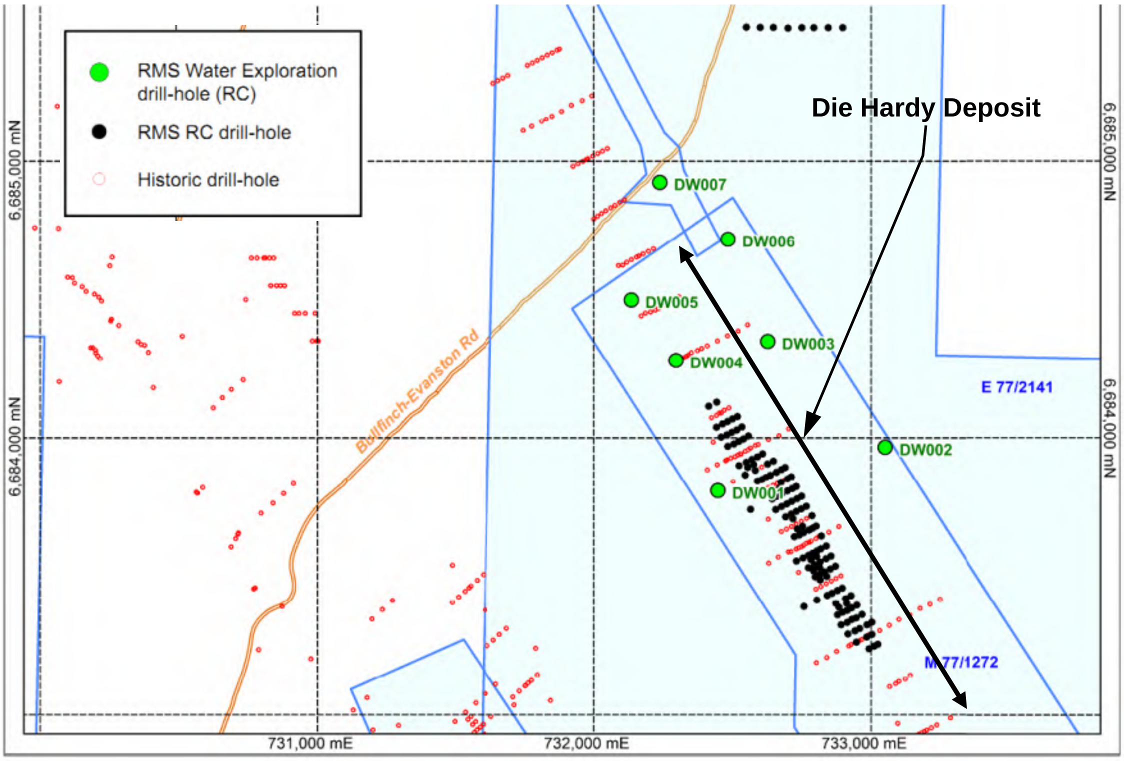


Figure 4 Ramelius Die Hardy water exploration drillhole locations (modified after Ramelius)

3.3.4 Seismicity

The Die Hardy deposit is located within a region of Western Australia judged to be at low risk from future seismic events (earthquakes) taking place within the proposed mining life of the pit. The estimated peak ground acceleration with a 10% chance of being exceeded in a 50-year period is relatively low (at ~ 0.07*g*) [2].

Earthquake-induced ground accelerations of this magnitude (if occurrent) would be expected to have minimal influence on future pit wall stability performance. It is inferred that only marginally stable or metastable zones could be driven to collapse by earthquake shaking.

3.4 Proposed Mining

3.4.1 Open Pit

No previous open pit or underground mining has been carried out at the Die Hardy deposit. Preliminary Die Hardy pit design files (*dh_pd_nth_ac_0720_sc.dtm* and *dh_pd_sth_ac_0720_sc.dtm*) were provided by Ramelius for review.

These preliminary designs indicate Northern and Southern pits separated by a narrow saddle (Figures 5 and 6).

The Southern pit is ~ 325m in length (north north-west to south south-east), ~ 150m in width (east north-east to west south-west) and has a maximum final depth of ~ 60m (floor at ~ 445mRL).

The Northern pit is ~ 660m in length (north north-west to south south-east), between ~ 190m and ~ 120m in width (east north-east to west south-west) and has final depths ranging from ~ 50m (floor elevations ~ 450mRL to ~ 445mRL) in southern and northern sectors to ~ 36m (~ 465mRL) in the central sector.

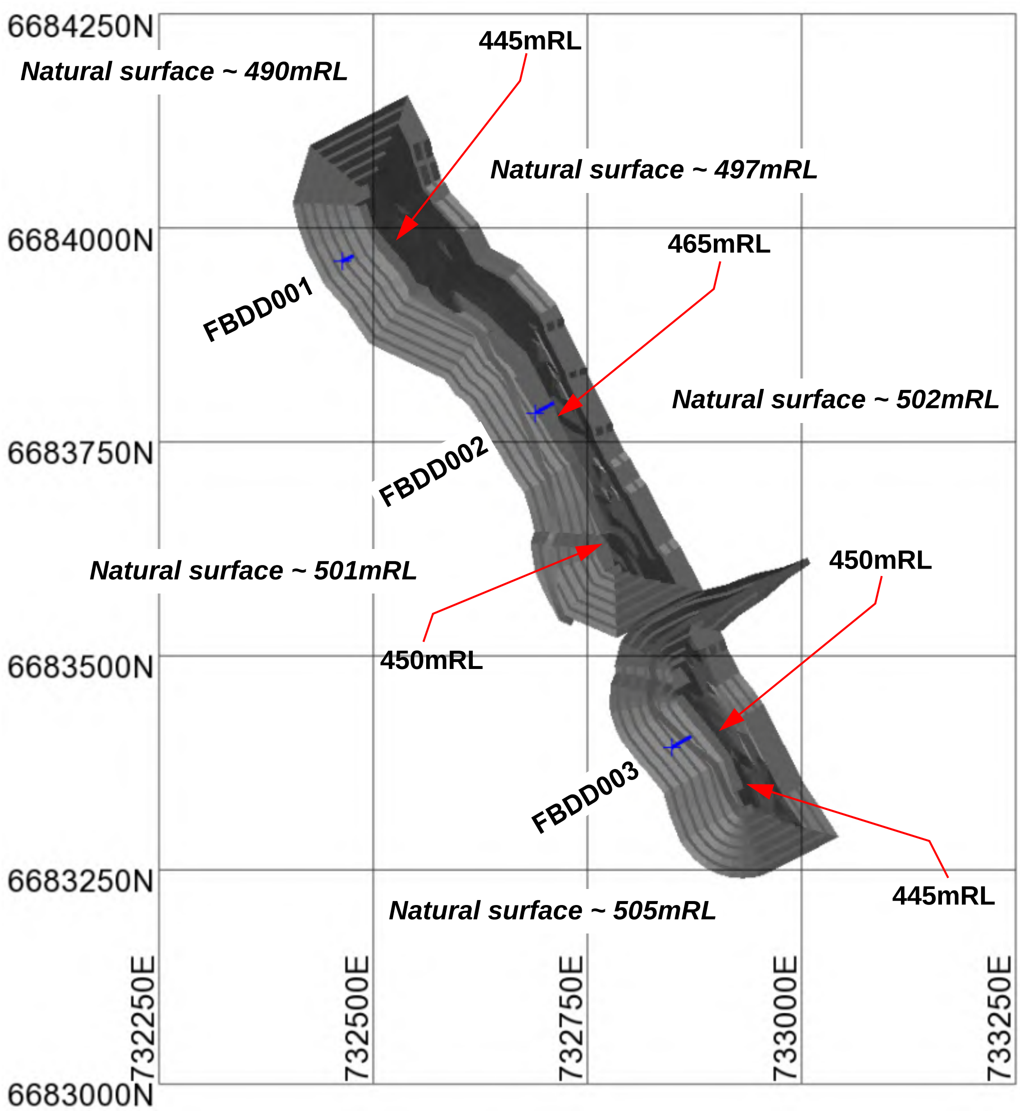


Figure 5 **Die Hardy preliminary pit design & geotechnically logged exploration boreholes** (pits not clipped to surface topography)

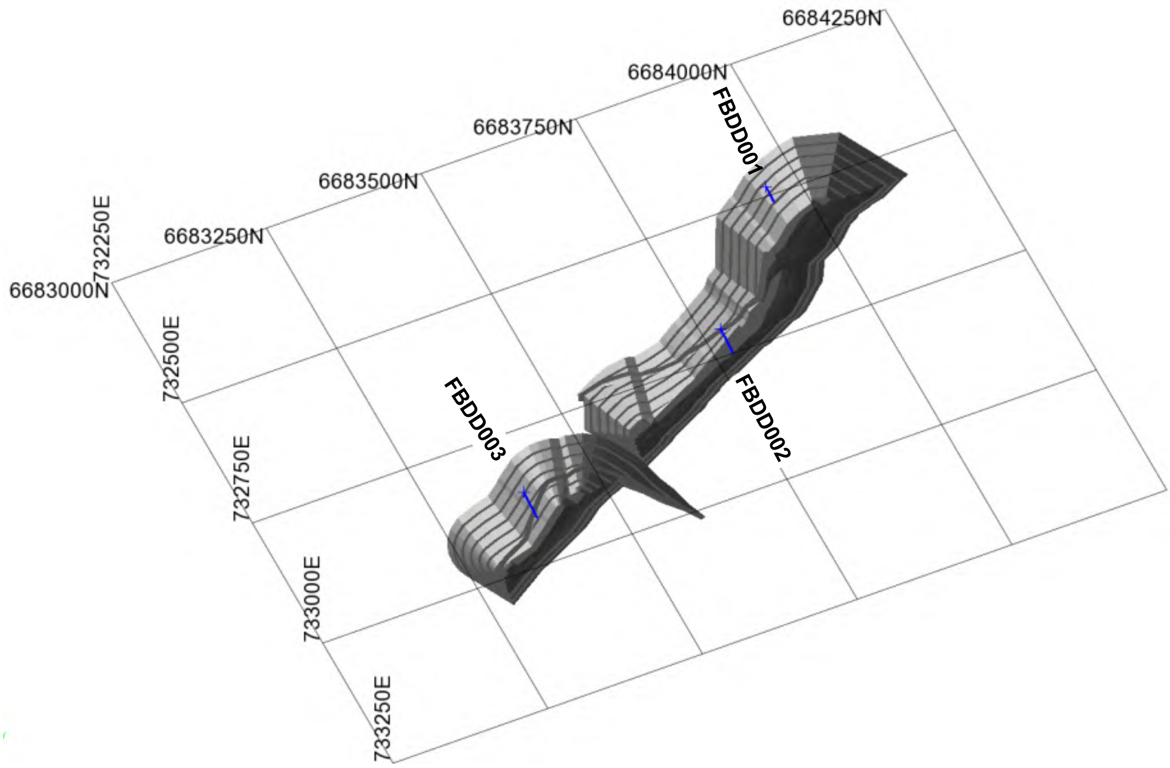


Figure 6 Die Hardy preliminary pit design & geotechnically logged exploration boreholes
(pits not clipped to surface topography)

3.4.2 Waste Rock Landform

Ramelius proposes to construct a WRL on the eastern side of the Die Hardy open pit. Summary details of proposed WRL design as advised by Ramelius are listed below and illustrated in Figure 7:

- Final design height = ≤ 30m
- Slope face angles:
  - Lower 15m at 15^o (unbenched)
  - Upper 15m at 19^o (unbenched)
  - Total slope = 30m at 17^o

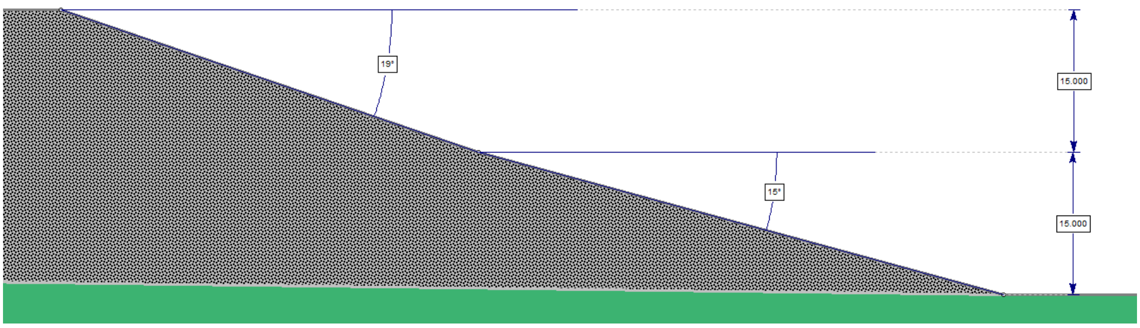


Figure 7 Proposed Die Hardy WRL design parameters

4.0 Investigations

Preliminary geotechnical investigations and assessments for proposed open pit mining of the Die Hardy deposit were based on:

- ⇨ Data contained in geological logs compiled by Ramelius and structural geological and geotechnical logs compiled by PBA from diamond cored exploration boreholes FBDD-001, 002 and 003 drilled in the vicinity of proposed future Die Hardy pit walls during 2020. Exploration boreholes were designed by Ramelius.
- ⇨ Review of core photographs for these boreholes.
- ⇨ Assessment of rock mass conditions and quality using the Geomechanical Classification system (Bieniawski's RMR_{89} system) [3], with values further adjusted to the Mining Rock Mass Rating system (Laubscher's MRMR system) [4].
- ⇨ Results of physical property testing of representative core samples selected by PBA from exploration boreholes. Uniaxial compressive strength (UCS) with elastic property determinations (UCSE) and defect direct shear (DS) tests were performed by E-Precision Laboratory, Perth, Western Australia.

4.1 Geotechnical Core Logging

The exploration boreholes used by PBA for preliminary geotechnical assessment are listed in Table 2. The locations of holes relative to proposed open pit mining are shown in Figures 5 and 6.

Table 2 Die Hardy boreholes & intervals considered as part of open pit geotechnical assessments

Borehole	Collar co-ordinates			Dip (°)	Azimuth (°)	Hole depth (m)	Interval Considered
	mE	mN	mRL				
FBDD001	732463.56	6683960.41	493.89	-60	062	102.2	0.0m to 102.2m
FBDD002	732689.78	6683783.77	506.47	-60	061	70.8	0.0m to 70.8m
FBDD003	732848.96	6683393.32	502.35	-60	060	96.3	0.0m to 96.3m

Geotechnical data collected by PBA from cores of exploration boreholes comprised:

- Degree or weathering
- Estimated intact rock strength (using ISRM ratings)
- Core recovery
- Rock Quality Designation (RQD)
- Fracture Frequency (FF)
- Discontinuity type
- Typical discontinuity planarity, roughness, infill and thickness of infill
- Orientation of discontinuities (Alpha and Beta angles with reference to core axis).

PBA collected geotechnical logging data over 1.0m drill intervals.

Where it was necessary to record "typical" conditions, the chosen data were on the conservative side of average conditions.

Summary geotechnical borehole logs are presented in Appendix A. Original core photographs are held by Ramelius.

4.2 Rock Mass Classification

Rock mass assessment by empirical methods is commonly used to classify weathered and fresh rock masses. Inferences regarding the strength and competence of a particular rock mass, and the likely response of that rock mass to mining, are based on the ratings obtained from these empirical classifications.

The Die Hardy rock mass was classified using both the RMR_{89} system [3] and the MRMR system [4].

4.2.1 RMR_{89} System

The estimations of RMR_{89} classification indices for the intervals were based on the following parameters:

- Field estimated rock strength data were used for calculations.
- Defect spacing has been estimated from fracture frequency.
- Sub-indices are based on the dominant parameter values recorded for the interval or the lower bound where no dominant set exists.
- Intervals containing no defects were assigned parameter values from the adjacent interval.

4.2.2 MRMR System

The estimations of MRMR classification indices for the intervals were based on the following assumptions:

- **Weathering**
  Assumed life for the Die Hardy open pit is ~ 2 years. No individual rock type was assessed to have the potential to weather more readily than any other. The weathering adjustment factor applied for all rocks (assuming slight weathering) was 96%
- **Joint Orientation**
  Three joints defining blocks with two faces inclined away from the vertical, requiring an adjustment of 80%
- **Mining-induced Stresses**
  Negligible induced stress in pit walls, hence a factor of 100%
- **Blasting Effects**
  Assumed good conventional blasting practices, with an associated adjustment of 94%

4.2.3 Rock Properties Testing

In addition to considering estimates of rock strength made using simple index testing in the field during geotechnical logging, a program of laboratory measurement of rock properties was carried out by E-Precision on representative samples selected from Die Hardy boreholes listed in Table 2.

- ⇨ Eight (8) UCSE tests measuring compressive strength and Young’s Modulus and Poisson’s Ratio were performed.
- ⇨ Three (3) multi-stage DS tests were performed.

5.0 Geotechnical Conditions

5.1 Rock Structure

Structural discontinuity orientation data obtained from logged borehole intervals listed in Table 2 were processed and analysed using the Rocscience DIPS program [5]. Only natural occurring defects with measurements able to be referenced to reliable core orientation (agreement up and downhole) were considered in analysis. The current Die Hardy structural data set is limited to 53 data points. In view of that limitation, it is recommended that Ramelius collects structural data to increase this data set and confirm or amend (as the case may be) the following findings.

The present Die Hardy structural data set contains a directional bias, with all boreholes drilled on north-east azimuths at dips of ~ –60°. Moderate to steep north-easterly dipping and north-east striking defects, if present, are expected to be under-represented within the current data set.

Figure 8 is a lower hemisphere equal angle stereoplot showing all defect orientations for the logged intervals.

Structural data analysis identified a single dominant discontinuity grouping and a further four (4) sparsely populated defect clusters which possibly reflect the existence of further defect sets.

The mean orientations and characteristics of each set are listed in Table 3.

The significance of clusters is based on group populations proportionate to the total data set. The identified defect sets are not expected to exist ubiquitously, though it is important to consider all sets in analyses since it is possible that minor sets (as defined within a limited total population) can have a substantial adverse influence on wall stability.

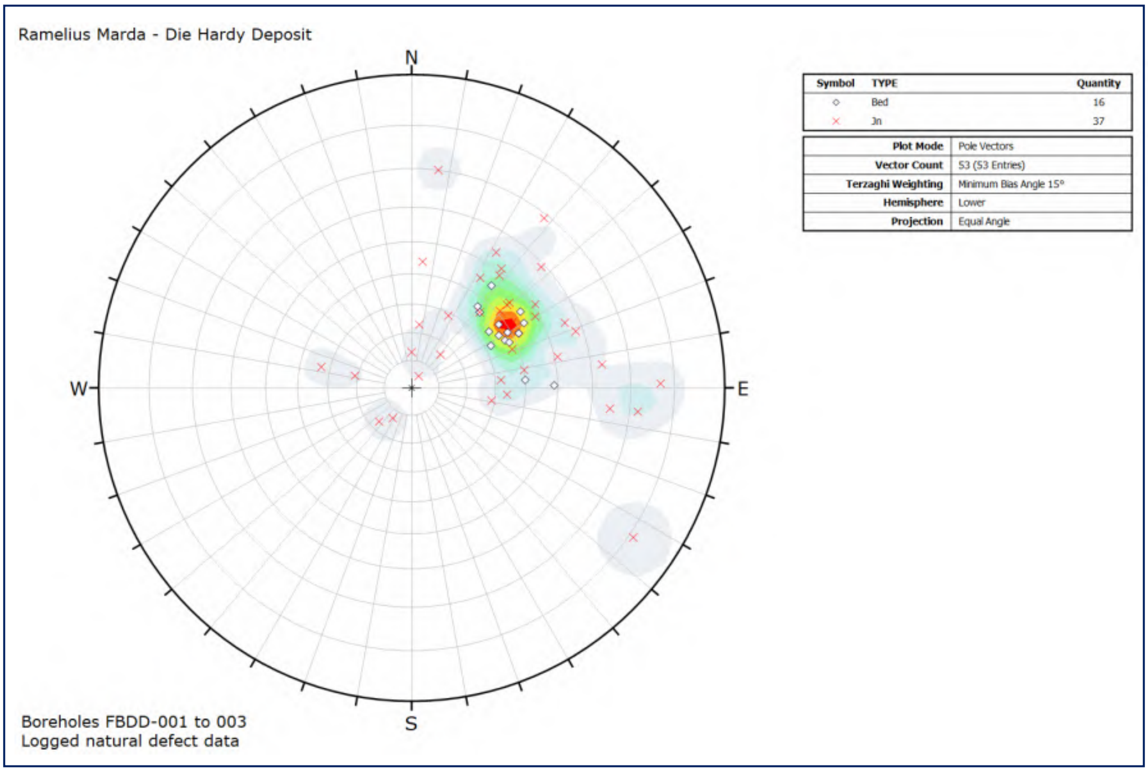


Figure 8 Die Hardy open pit structural data pole plot for Table 2 borehole interval data

Table 3 Defect "Sets" for Die Hardy Table 2 borehole interval data

Defect Set	Defect Description	Dip (°)	Dip Direction (°)
1	Joints and bedding – Moderately steep south-west dipping	41	233
M 2	Joints – Steep west dipping	72	273
M 3	Joints – Flat lying to shallow south dipping	21	194
M 4	Joints – Flat lying to shallow north-east dipping	15	039
M 5	Joints – Flat lying to shallow east dipping	28	103

M = inferred minor defect set

Structural data from Table 2 Die Hardy borehole intervals indicates the following:

- Moderately steep south-west dipping joints and bedding planes, interpreted to be aligned parallel to project stratigraphy, are dominant.
- Minor joint defect clusters at flat lying to shallow south, north-east and east dipping orientations may indicate additional defect sets. These defect clusters are sparsely populated and the existence of defect 'sets' at these orientations is inferred rather than confirmed.

The identified dominant defect set is inferred to reflect the general trend of stratigraphy (including local variations/ inflections). The geneses of remaining defects sets are currently unknown, though it is inferred that these defects may also be related to local variations/ inflections or fault structures.

5.1.1 Notes regarding defect sets & rock structure

As noted, ubiquitous existence of five (5) defect sets at Die Hardy is not inferred. Rather, the variations in defect clustering are considered to reflect local geological variations (for example, faulting and/or folding) and the inherent variability of data obtained from oriented cores. It is inferred to be unlikely that more than 3 (three) defect sets would be present at a given location.

It is not possible to obtain defect persistence data from cores, other than by inference based on the types and characteristics of the defects logged. Logged defect types comprise *joint* and *bedding* features which are usually of limited persistence (typically ≤ 10m).

No *shear*, *fault* or *vein* defect types were recorded in the structural data; however, a small number of these defects were observed in Table 2 borehole cores and recorded in the geotechnical logs.

5.2 Rock Strength

Wall rock strengths are governed by lithology/ mineralogy and rock weathering grades.

Intact rock strengths and defect shear strengths have been assessed by the use of simple index tests during logging and in laboratory testing of representative samples of selected cores.

In summary these sources indicate that at Die Hardy:

- Transported gravels/ laterite material strengths range from ≤ *extremely weak* (UCS 0.25 to 1.0 MPa (ISRM rating R0)) to *medium strong* (UCS 25 to 50 MPa (R3)).
- Extremely to completely weathered material strengths range from ≤ *extremely weak* (R0) to *medium strong* (R3).
- Highly weathered country rock strengths range from *extremely weak* (R0) to *medium strong* (R3).
- Moderately weathered country rock strengths range from *weak* (UCS 5.0 to 25 MPa (R2)) to *medium strong* (R3).
- Slightly weathered rock strengths range from *medium strong* (R3) to *very strong* (UCS 100 to 250 MPa (R5)).
- Fresh rock strengths range from *strong* (UCS 50 to 100 MPa (R4)) to *very strong* (R5).

Table 4 summarises laboratory UCS test results and full test certificates are provided as Appendix B.

Reliable intact rock strength results from laboratory tests are those where failure occurred via rupture of intact material (and not via shear along pre-existing defects). Defect controlled failure occurred as the primary failure mode for a single UAC rock type laboratory tested sample.

Table 4 Results of Die Hardy UCS testing (after E-Precision 2020)

Borehole	Sample	Weathering Grade	Interval (m)	Bulk Density (t/m³)	Lithology	UCS 50 (MPa)
FBDD-001	FB UCS-01	Slight	46.35 - 46.56	3.22	SIF	**126**
FBDD-001	FB UCS-02	Fresh	51.21 - 51.46	3.08	SIF	**78.4**
FBDD-001	FB UCS-03	Fresh	61.75 - 61.97	3.50	SIF	**337**
FBDD-001	FB UCS-04	Fresh	78.32 - 78.59	2.76	MDZ	**189**
FBDD-001	FB UCS-05	Fresh	84.65 - 84.88	2.92	UAC	**174**
FBDD-003	FB UCS-06	Fresh	77.28 - 77.49	2.80	MDZ	**231**
FBDD-003	FB UCS-07	Fresh	88.62 - 88.85	2.91	UAC	**62.9***
FBDD-002	FB UCS-08	Fresh	55.21 - 55.44	2.66	MDZ	**55.3**

* Defect controlled primary failure mode

Sedimentary Chert & BIF (dominant ferruginous layers) - SIF

UCS Results 126 MPa Slightly weathered (shear intact (through intact rock))
78.4 MPa Fresh (shear intact)
337 MPa Fresh (shear intact)

These data indicate that *fresh* **Sedimentary Chert and BIF (dominant ferruginous layers) – SIF** rock substance has a compressive strength of ~ 208 MPa (*very strong* rock).

The single *slightly* weathered SIF rock substance sample tested returned a compressive strength of ~ 126 MPa (*very strong* rock).

Mafic Dolerite Undifferentiated - MDZ

UCS Results 189 MPa Fresh (shear intact)
231 MPa Fresh (shear intact)
55.3 MPa Fresh (shear intact)

These data indicate that *fresh* **Mafic Dolerite Undifferentiated - MDZ** rock substance has a compressive strength of ~ 158 MPa (*very strong* rock).

Ultramafic Amphiboles Chlorite Schist - UAC

UCS Results 174 MPa Fresh (shear intact)
62.9 MPa Fresh (shear on structure)

The single reliable *fresh* **Ultramafic Amphiboles Chlorite Schist – UAC** rock substance sample test result returned a compressive strength of ~ 174 MPa (*very strong* rock).

5.2.1 Laboratory Elastic Property Determinations

Rock elastic properties as determined by laboratory testing are presented in Table 5, with full test certificates provided as Appendix B.

Rock modulus to UCS ratios were reviewed and found to yield reasonable/ reliable data in relation to intact rock strength results.

The single *slightly weathered* SIF sample returned a *high* modulus to UCS ratio and remaining SIF, MDZ and UAC samples returned *average* modulus to UCS ratio. Rocks with high modulus to UCS ratio could exhibit stiff brittle response under high load.

Table 5 Results of Die Hardy core sample deformability test results (after E-Precision 2020)

Borehole	Weathering Grade	Interval (m)	Lithology	Modulus* (GPa)	Poisson's Ratio*	Modulus to UCS Ratio
FBDD-001	Slight	46.35 - 46.56	SIF	**73.70**	**0.220**	**High**
FBDD-001	Fresh	51.21 - 51.46	SIF	**30.91**	**0.166**	**Average**
FBDD-001	Fresh	61.75 - 61.97	SIF	**99.38**	**0.152**	**Average**
FBDD-001	Fresh	78.32 - 78.59	MDZ	**65.58**	**0.157**	**Average**
FBDD-001	Fresh	84.65 - 84.88	UAC	**66.92**	**0.233**	**Average**
FBDD-003	Fresh	77.28 - 77.49	MDZ	**82.65**	**0.250**	**Average**
FBDD-003	Fresh	88.62 - 88.85	UAC	**46.05****	**0.237**	**NA**
FBDD-002	Fresh	55.21 - 55.44	MDZ	**11.11**	**0.235**	**Average**

* Secant (0-50%)
* * Defect controlled primary or secondary failure mode

5.3 Defect Shear Strength

Defect in geotechnically logged core intervals were dominantly *joints* (~ 62% of logged defects) and *bedding* (~ 35% of logged defects).

A small number of *shear* and *vein* defects were also logged (each ~ 1.5% of logged defects).

Defect surface conditions were generally logged as *planar rough* (~ 42% of logged defects) or *undulating rough* (~ 39% of logged defects).

Remaining defects were logged as having *irregular rough* (~ 19% of logged defects), *stepped rough*, *planar smooth* or *undulating smooth* surface conditions (combined ~ 4% of logged defects).

Oxide ≤ 1mm (~ 41% of logged defects) was the most common defect infill recorded, with *nil* (no infill) (~ 21% of logged defects) the second and *quartz/ carbonate ≤ 1mm* (~ 12% of logged defects) the third most common defect infill conditions recorded.

Other infills recorded in minor numbers included *clay 1- 2mm, talc ≤ 1mm, chlorite ≤ 1mm* and *clay ≥ 5mm*.

Based on review of rock defect data from borehole cores and experience in similar rock types, defect shear friction angles are expected to be generally low ($\phi \leq 20°$) within major geological structures/ contacts and clay or soft mineral filled defects. Clean defects in *fresh* rock can reasonably be expected to have frictional characteristics ranging between medium ($\phi \geq 20°$ and $\leq 30°$) and high ($\phi > 30°$).

Direct shear tests were performed on three (3) naturally occurring defects. The test results are summarised in Table 6 and the E-Precision report is included in Appendix B.

The test results indicate peak strength friction angles ranging from ~ 27° to 36°, with cohesion values between ~ 21 kPa and 51 kPa. There were modest reductions in post-failure shear strengths for the tested defects.

Mean peak and residual defect shear strengths for SIF rocks at Die Hardy are inferred to be relatively high a friction angle of ~ 34° was adopted for assessment.

Mean peak and residual defect shear strengths for UAC and UZZ rocks at Die Hardy are inferred to be medium and have been taken to be represented by a friction angle of ~ 26°.

Table 6 Results of Die Hardy defect direct shear testing (after E-Precision 2020)

Borehole	Sample	Depth (m)	Lithology	Peak Strength		Residual Strength	
				Cohesion (kPa)	Friction Angle (°)	Cohesion (kPa)	Friction Angle (°)
FBDD-001	FB DS-01	47.55 – 47.68	SIF [1]	21.3	35.8	0.0	35.0
FBDD-001	FB DS-02	97.84 – 98.00	UAC [2]	37.9	26.6	0.0	25.6
FBDD-002	FB DS-03	29.38 – 29.52	SIF [3]	50.9	33.4	18.2	30.7

[1] Bedding defect, planar rough surface with ≤ 1mm oxide infill
[2] Joint defect, planar smooth surface with ≤ 1mm chlorite/ carbonate infill
[3] Bedding defect, planar rough surface with ≤ 1mm oxide infill

5.4 Rock Quality

Interpretations made from geotechnical review of borehole cores are that:

⇨ Intervals of significant core loss were encountered within *completely* weathered transported materials of the uppermost ~ 10m of boreholes FBDD-001 and 003. Transported gravels were observed to be generally unconsolidated and exhibited limited cohesion (Plate 1).

⇨ Weathering and *very poor* rock quality extends to considerable depths within UZZ rocks in the proposed western wall position, with *highly* weathered, *very poor* quality UZZ observed to depths > 32 mbs (Plate 2).

Plate 1 FBDD003 0.0m - 9.6m, core loss within transported gravel & mottled zone *very poor* quality material

Plate 2 FBDD001 25.9m – 29.5m extremely/ highly weathered UZZ *very poor* quality material

- ⇨ Within boreholes FBDD-001 to 003 the grade of rock weathering was observed to decrease rapidly once SIF rocks were intersected. *Slight* rock weathering, commonly discolouration of material and oxidation along banding defects, was extends to considerable depths within SIF rocks (Plate 3). *Slightly* weathered SIFs have a higher frequency of open bedding/ banding partings than *fresh* SIF intervals.
- ⇨ Discrete (< 0.1m) to significantly wide (> 5.0m) intervals of alteration/ shearing and core loss were observed within SIF rocks (Plates 3 and 4). Where present within Die Hardy wall rocks at unfavourable orientations, such intervals could be problematic to wall stability.

Plate 3 FBDD001 42.9m to 46.3m slightly weathered SIF *fair* quality rock

Plate 4 FBDD002 37.0m to 40.8m altered/ sheared breccia chert/ SIF *poor* quality rock

⇨ Discrete (< 0.4m) intervals of alteration/ shearing were observed at some lithological contacts at and below the lower SIF rock type boundary (Plate 5). Where present within wall rocks and oriented at unfavourable orientations, such intervals could adversely influence wall stability.

Plate 5 FBDD002 52.3m to 55.8m moderately weathered to fresh SIF and dolerite *poor* to *fair* quality rock

5.5 Rock Mass Classification

Summary geotechnical logs and rock mass classification results for boreholes listed in Table 2 are provided in Appendix A.

All geological logs and original files for core photographs are held by Ramelius. Descriptions of logged defect types, surface conditions and infills for Table 2 boreholes are provided in Section 5.3.

On the basis of core logging data collected from Table 2 borehole intervals it is inferred that the *extremely* to *completely weathered* horizon at Die Hardy must be classified as being of *very poor* rock quality. The mean Rock Mass Rating (RMR) for observed intervals of *extremely* to *completely weathered* material/ rock was 17 (*very poor* rock) (Table 7).

Highly weathered rocks were found to have an RMR range of 12 to 52 (*very poor* to *fair* rock), with a mean value of ~ 33 (*poor* rock).

Transitional (*moderately weathered*) rocks RMRs ranged from 47 to 69 (*fair* to *good* rock), with a mean value of ~ 55 (*fair* rock).

Slightly weathered rock RMR ranged from 22 to 75 (*poor* to *good*), with a mean of ~ 65 (*good* rock).

Overall, *fresh* rock core was assessed as having an RMR range of 56 to 94 (*fair* to *very good* rock), with a mean value of ~ 78 (*good* rock).

Assessed RMR range and mean values by rock weathering horizon are provided as Table 7.

Table 7 Summary of RMR rock mass classification values for Table 2 Die Hardy boreholes

Rock Weathering Horizon	RMR Value Range	RMR Class Range	Mean RMR Value	Mean RMR Value Class
Extremely to completely	12 – 51	Very Poor to Fair	17	Very Poor
Highly	12 – 52	Very Poor to Fair	33	Poor
Moderately	47 – 69	Fair to Good	55	Fair
Slightly	22 – 75	Poor to Good	65	Good
Fresh	56 – 94	Fair to Very Good	78	Good

RMR value ranges and mean values for Die Hardy wall rock lithologies are provided in Table 8.

Mean RMR values for *MDZ*, *SIF* and *UAC* wall rocks lie in the *good* rock quality class. Mean RMR values for *UZZ* wall rocks and transported *TGF* and *TCZ* materials lie in the *very poor* rock quality class.

Table 8 Summary of RMR rock mass classification values for Table 2 boreholes major lithologies

Rock Type	1.0m Intervals	RMR Value Range	RMR Class Range	Mean RMR Value	Mean RMR Value Class
MDZ	10	59 - 91	Fair to Very Good	79	Good
TGF (transported)	13	12	Very Poor	12	Very Poor
TCZ (transported)	14	12	Very Poor	12	Very Poor
UZZ	52	13 - 39	Very Poor to Poor	18	Very Poor
SIF	78	22 - 90	Poor to Very Good	67	Good
UAC	49	57 - 94	Fair to Very Good	79	Good

5.6 Geotechnical Design Domains

Preliminary definition of Die Hardy geotechnical design domains has been based on the interpreted location and trend of the SIF rock unit. It is inferred that the eastern wall of the proposed pit will generally follow the orientation of ore lode(s) within the moderately steep south-west dipping SIF rock unit.

Preliminary geotechnical design domains comprise the East and West Domains (Figure 9).

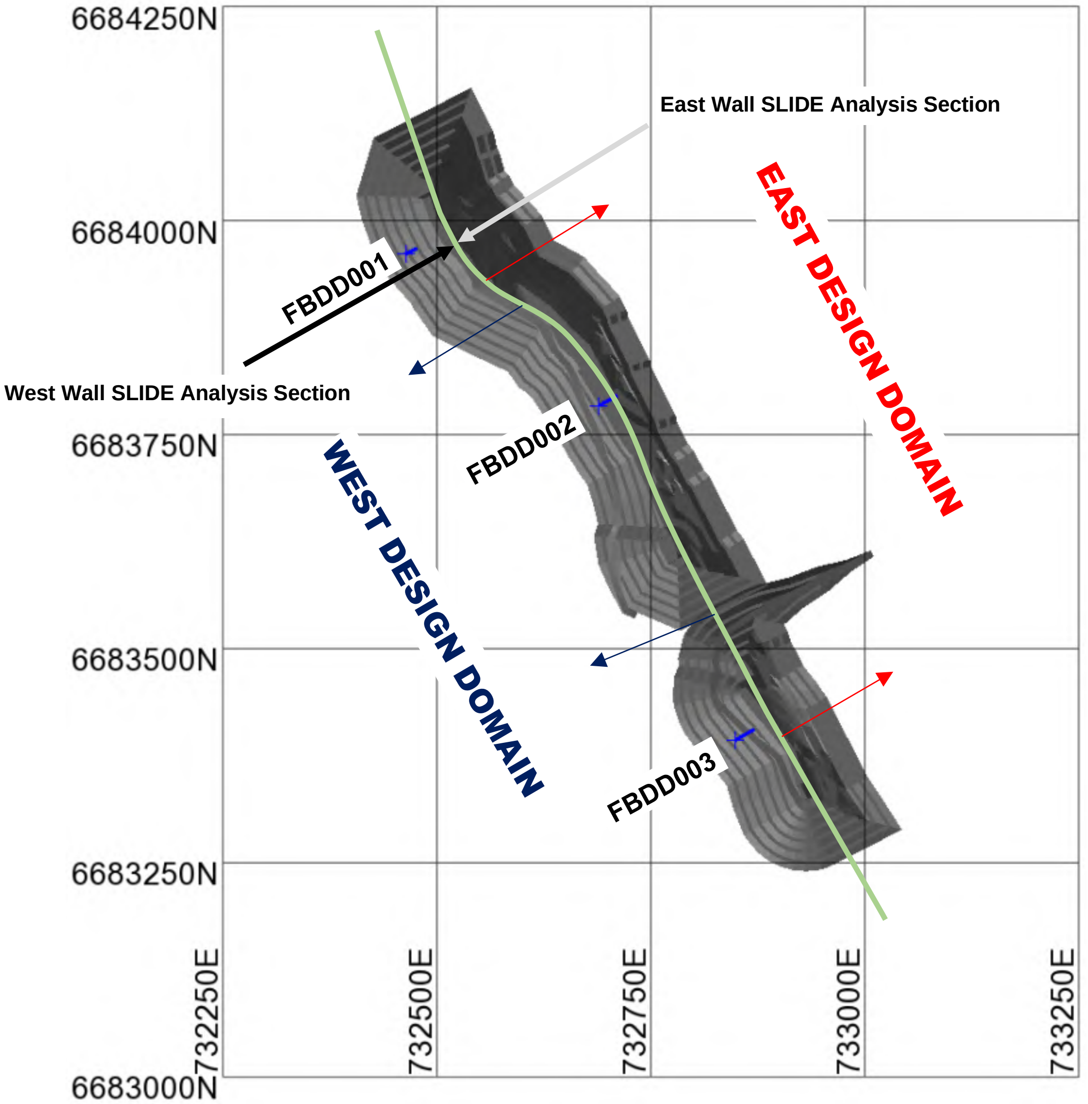


Figure 9 Preliminary Die Hardy geotechnical design domains & locations of *Slide* analysis sections (pit not clipped to surface)

6.0 Stability Analysis

On the basis of assessed rock mass conditions, it is considered that wall stability at Die Hardy will be controlled by some combination of the influences of low shear strength of weathered materials and relict geological structures.

Structural data obtained from geotechnically-logged borehole intervals (Table 2) indicates limited potential for exposure of unfavourably oriented structural defects which could adversely influence wall stability at Die Hardy.

The persistence of such features, where/ if present, and hence the extent of influence (possible scale of instability) will largely remain unknown until excavation provides exposure for mapping.

It is possible that drilling/ logging have not identified all defect sets; hence other unfavourably oriented structures may be encountered during mining.

Wall stability conditions in the proposed Die Hardy pit have been assessed using kinematic methods (to assess potential for structurally-controlled instability) and limit equilibrium analysis (to assess potential for shear failure of weak materials).

Base case wall design parameters have been selected on the basis of aiming to preclude large scale and/ or overall slope failure; limiting the occurrence of bench scale instability; and maintaining adequate catching capacity to contain debris from expected small scale events.

Cross-reference has been made to empirical methods based on the Geomechanical Classification System to check the 'fit' of the recommended wall designs to general open pit experience.

6.1 Kinematic Stability Analysis

Kinematic stability analyses have been carried out for northern, western and southern walls with a 50° face angle and an eastern wall with 40° face angle considering defect orientations as defined by data obtained from the geotechnical logs.

Planar sliding assessments did not apply lateral limits, therefore considered the worst case and most conservative scenario. Lateral limits of 30° were applied to all wedge and toppling assessments.

In summary, kinematic analyses based on available data for Table 2 boreholes show:

East Wall 40°/240° (major wall orientation)

Planar slide	Set 1 (significant potential)
Wedge slide	Not indicated
Topple	Not indicated

West Wall 50°/060° (major wall orientation)

Planar slide	Possible on Minor Set 5 (low potential)
Wedge slide	Not indicated
Topple	Flexural – On Minor Set 2 (low potential) Direct – Not indicated

North Endwall 50°/150° (minor wall orientation)

Planar slide	Possible on Minor Set 5 and outliers of Minor Set 3 (both low potential)
Wedge slide	Combinations of Sets 1 & 2
Topple	Flexural – Possible on single random defect (low potential) Direct – Not indicated

South Endwall 50°/330° (minor wall orientation)

Planar slide	Not indicated
Wedge slide	Not indicated
Topple	Not indicated

In summary, for the proposed Die Hardy open pit:

- ⇨ Potential for *planar sliding* failures exists for the major eastern wall (dipping 40° towards 240°) on bedding and joint defects aligned parallel to project scale stratigraphy.
- ⇨ Potential for *planar sliding* failure is also indicated for the major western wall (50°/060°) and minor northern endwall (50°/150°) on 'minor' defect sets. Within the current data set the quantity of defects within 'minor' set clusters is low; therefore, the corresponding potential for planar sliding to occur within indicated wall sectors is also currently inferred to be low.
- ⇨ Limited theoretical potential for *wedge sliding* is indicated for the minor northern endwall.
- ⇨ Limited theoretical potential for *flexural toppling* failure is indicated for the major western wall (Minor Set 2) and minor northern endwall (random defect).

Kinematic stability analyses indicate theoretical potential for planar sliding on the major eastern wall.

As noted, it is expected that the eastern wall of the proposed pit will follow the orientation of moderately steep south-west dipping ore lodes within the SIF rock unit. Batter face and wall Inter Ramp Angles (IRA) on the eastern wall would therefore generally not be expected to exceed the ~ 40° dip of the SIF unit. At modest ≤ 40° face and slope angles, the potential for planar sliding failures, structurally controlled failures generally and material shear failures is expected to be limited.

6.2 Wedge Assessment

Kinematic stability analysis indicates limited potential for theoretical wedge formation within a Die Hardy open pit minor northern endwall mined with a 50° batter face.

PBA considers that no further Die Hardy wedge sliding assessments are required at present.

6.3 Limit Equilibrium Analysis

Limit Equilibrium Analysis (LEA) of the resistance to development of circular and non-circular (rotational) failures through possible final configurations of Die Hardy pit slopes was performed using the Rocscience code *Slide* [6]. A conventional non-circular global critical failure surface search function was used in analysis of assumed final East Domain south-west dipping and West Domain north-east dipping wall slope configurations.

Potential ultimate Die Hardy pit slopes were modelled comprising *transported* (gravels and clay), *highly weathered* (saprolite material and highly weathered rock), *moderately weathered* (moderately to slightly weathered rock) and *fresh* rock materials. Rock weathering depths and material boundaries applied were derived from digital weathering surfaces and geology solids provided by Ramelius.

Material properties selection for modelling has used published guidelines based on the Geomechanics Classification Rock Mass Rating (RMR) system [3] and experience. Selected material property values are expected to represent likely *median* values and are considered appropriately conservative for the analyses conducted. Material properties selected for modelling the pit slopes are provided in Table 9.

Table 9 Die Hardy estimated material shear strengths

Material	Unit Weight (kN/m^3)		Cohesion (kPa)	Friction Angle (°)
	Unsaturated	Saturated		
Laterite/ Transported	21	22	150	30
Highly weathered SIF	26	27	100	15
Highly weathered UZZ, MDZ & UAC	20	22	60	15
Moderately weathered SIF	29	30	250	30
Moderately weathered UZZ, MDZ & UAC	26	27	150	20
Fresh SIF	32	32	350	35
Fresh UZZ, MDZ & UAC	29	29	250	30

Analyses were conducted for:

- Dry slopes (that is, fully drained and depressurised wall rock conditions) with and without seismic disturbance (pseudo-static analysis with horizontal acceleration to simulate earthquake shaking). A seismic acceleration of 0.07*g* (Section 3.3.4) was applied in all seismic disturbance assessments.
- Saturated to pre-mining groundwater level (PMWL) slopes with and without seismic disturbance. The PMWL was inferred to be located ~ 57m below natural surface (Section 3.3.3).
- Partially saturated slopes with and without seismic disturbance. The partially drained case phreatic surface was estimated to be located ~ 20m below surface at the pit slope crest, grading to the base of the *moderately* weathered zone at the intercept with the pit wall. This theoretical case is inferred to represent possible unfavourable groundwater condition within wall rocks.

The approximate locations of the *Slide* analysis sections with respect to the preliminary Die Hardy pit design are shown in Figure 9. Selected analysis section locations approximate the most extensive potential slopes within the total current preliminary pit design.

Based on guidelines presented within Read and Stacey [7], the following Factor of Safety (FS) acceptance criteria were adopted for limit equilibrium analyses:

- FS of 1.20 considered to be the minimum acceptable value for open pit mining of non-critical walls under static conditions.
- FS of 1.30 considered to be the minimum acceptable value for open pit mining of critical walls under static conditions.
- FS of 1.00 may be acceptable for a transient seismic disturbance, though some slope failure and/ or triggering of rock falls would be expected under such conditions.

Summaries of results obtained from these stability analyses are presented as Table 10, with sample results presented in Figures 10 and 11. Slope parameters for each domain are listed in terms of the Inter Ramp Angles (IRA) and Overall Slope Angles (OSA) applied.

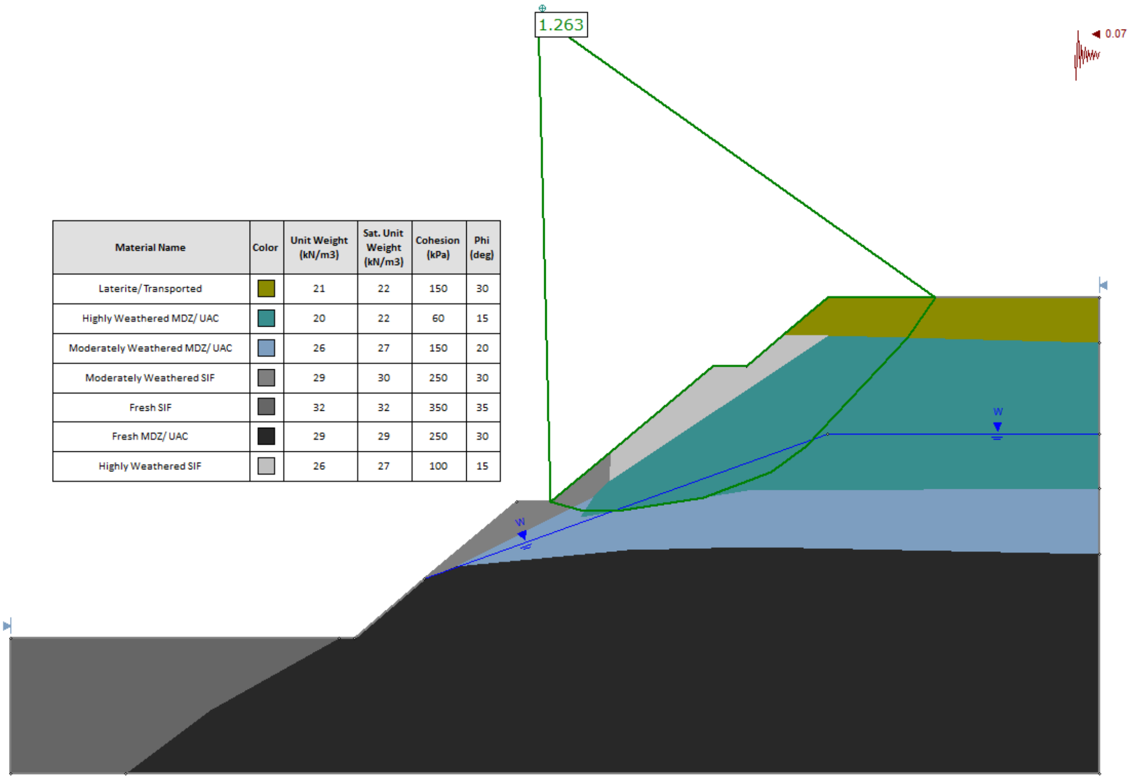
Table 10 Summary of Die Hardy East and West domain LEA stability analyses results

Slope	Slope Condition	Limit Equilibrium Minimum Factor of Safety (FS)** Seismic acceleration = 0.07g***	Probability of Failure (PoF)
West Domain North-East Dipping Wall 10m at IRA 30.6° 30m at IRA 38.9° 10m* at IRA 60.0° OSA ≈ 40°	Dry	1.26	15% ± 5%
	Saturated to PMWL	1.26	15% ± 5%
	Partially Saturated	1.24	15% ± 5%
	Dry with seismic	1.11	> 20%
	Saturated PMWL with seismic	1.11	> 20%
	Partially saturated with seismic	1.09	> 20%
East Domain North-West Dipping Wall 10m at IRA 30.6° 40m at IRA 34.7° OSA ≈ 36°	Dry	1.45	10% ± 5%
	Saturated to PMWL	1.45	10% ± 5%
	Partially Saturated	1.43	10% ± 5%
	Dry with seismic	1.28	15% ± 5%
	Saturated PMWL with seismic	1.28	15% ± 5%
	Partially saturated with seismic	1.26	15% ± 5%

* Single batter only
** Minimum FS from Bishop simplified method reported
*** McCue [2]

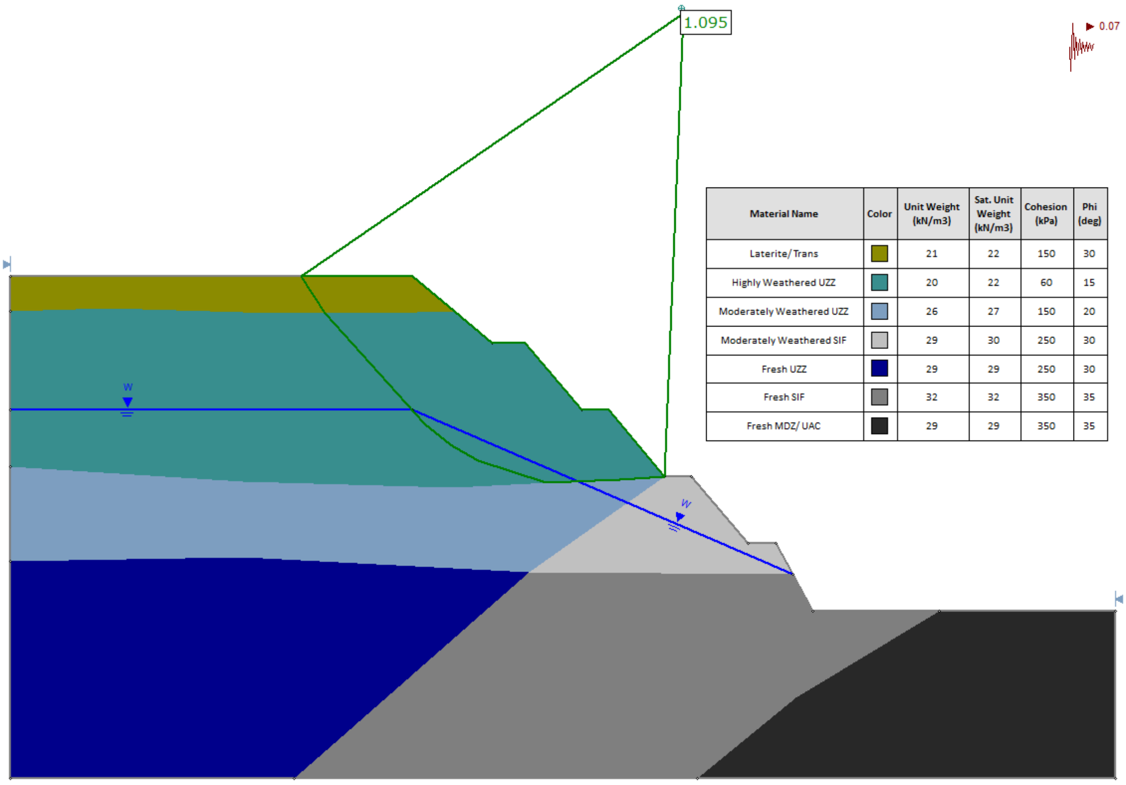
The FS obtained for *dry, saturated to PMWL* and *partially saturated* Die Hardy pit slopes were found to be within acceptable limits, even under the applied seismic disturbance.

Seismic events causing ground accelerations in the deposit area with magnitudes greater than that considered in the analyses would be detrimental to pit wall stability.



Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Laterite/ Transported		21	22	150	30
Highly Weathered MDZ/ UAC		20	22	60	15
Moderately Weathered MDZ/ UAC		26	27	150	20
Moderately Weathered SIF		29	30	250	30
Fresh SIF		32	32	350	35
Fresh MDZ/ UAC		29	29	250	30
Highly Weathered SIF		26	27	100	15

Figure 10 Die Hardy East Domain 50m high 36° OSA partially saturated, seismic loaded slope SLIDE result



Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Laterite/ Trans		21	22	150	30
Highly Weathered UZZ		20	22	60	15
Moderately Weathered UZZ		26	27	150	20
Moderately Weathered SIF		29	30	250	30
Fresh UZZ		29	29	250	30
Fresh SIF		32	32	350	35
Fresh MDZ/ UAC		29	29	350	35

Figure 11 Die Hardy West Domain 50m high 40° OSA partially saturated, seismic loaded slope SLIDE result

6.3.1 Discussion on Limit Equilibrium Analysis Results

Under dry/ fully depressurised conditions all slopes are assessed to be stable against circular and pseudo-circular (rotational) failure. It is inferred that actual FS would be slightly greater than those tabulated due to three-dimensional influences (lateral confinement along the slope) and possible existence of higher shear strengths than those modelled (at least locally).

Calculated minimum FS surfaces for slopes typically span the *transported* and *highly weathered* interval, hence conditions for development of the lowest FS may arise during or at the completion of wall development through the *highly weathered* profile.

Note that while the analysis techniques used could incorporate locally stronger or weaker zones and/ or geological structures (to various levels of reliability), the locations and sizes of such zones are unknown, hence results would be purely illustrative and no practical inferences could be drawn.

Locally poorer zones and/ or zones containing unfavourably oriented geological structures could cause localised instability. Such events could have an adverse impact on stability in a wider sense in that loss of confinement locally could spread progressively to affect overall slope stability. This potential must be monitored closely during open pit operations, as prompt remedial work and/ or local design adjustments may be needed to mitigate their likely adverse influence.

Conversely, locally stronger zones may act to reinforce segments of pit slopes.

6.4 Empirical Assessment

Empirical assessment based on the method devised by Haines and Terbrugge [8] was used to assist in the derivation of, and to check, recommended slope design parameters.

On the basis of MRMR values, the ranges of sustainable overall slope angles at Die Hardy are:

- ⇨ ~ 35° to 64°.

Appropriate wall angles depend on assessed rock mass classification ratings after application of adjustments for expected mining influences and performance after exposure. As noted, there is a strong correlation between rock weathering grades and rock mass classification ratings; hence sustainable wall angles also show a dependence on rock weathering grades.

While this assessment is empirically based, experience has shown that the overall angles derived using this method are generally reliable indicators of practically sustainable slope angles.

7.0 Implications for Mining

7.1 Voids

Neither Ramelius nor PBA are aware of the presence of historic underground voids within the proposed Die Hardy open pit mining area.

7.2 Excavation

Drill and blast methods will be required for development of pit walls at Die Hardy. It is likely that drill and blast will be required from surface in weathered ground in order to maintain required/ suitable productivity levels.

It is essential that appropriate perimeter blast methods are used in the formation of final batters. The recommended wall designs are based on the assumption that suitable methods will be used, and implemented at a consistently high standard, in all wall development blasts. Care must also be taken to ensure that production blasts do not pre-condition/ disturb/ damage wall rocks.

Ideally trim blasting methods would be used to form final batters, and should be included in a Blastmaster sheet for every flitch. The width of trim patterns should be slightly wider than the zone of disturbance of the productions shot(s) fired adjacent to it.

Trim blasts must be fired to a free face, and preferably two free faces. A free face is one where all broken stocks and rill material are removed from the face and toe of the shot. This is critical in allowing good burden relief of the face, thus providing opportunity for burden relief throughout the pattern.

Where there is a good understanding of ground and local geological conditions it is reasonable to consider use of modified production blasting in formation of final batters. Design parameters to be used in modified production patterns must be derived/ confirmed in trials carried out remote from final walls. In our opinion modified production blasting cannot, however, be assumed to be as effective as trim blasting, due primarily to the difficulty in achieving adequate burden relief, particularly at the back of the shot (near the wall).

Without face relief, movement of the body of the pattern is blocked, energy dissipates in all directions, including into the wall. Such conditions are conducive to wall damage, for example via block heave and release of load fracturing, both of which typically result in loss of berm crests.

Kinematic stability analyses identified potential for structurally controlled failures from pit batters. Designed rock catching capacity must be achieved and maintained. To this end control over blast disturbance in limit wall development is critical. Very high-quality practices will thus be essential in establishing berms where blasting is required to develop pit walls. A key performance indicator in this instance will be for $\geq$ 85% of berms to be formed at design width.

Implementation of these practices requires a high level of supervision in the field and stringent application of simple field controls. The return to the operation can be expected via reduced time in wall scaling, retention of berm crests cleaner walls (less loose material) and thus safer pit operating conditions.

All walls must be scaled thoroughly.

7.3 Wall Stability Conditions

On the basis of assessed rock mass conditions, it is considered that wall stability within the majority of proposed pit slopes at Die Hardy will be controlled by some combination of the influences of low shear strength of weathered materials and relict geological structures.

Current weathering interpretations indicate that planned mining will intersect limited intervals of *fresh* rock. Where encountered, fresh rocks are expected to generally be *very strong* and wall segment stability will dominantly be controlled by the orientation, persistence and shear strength of geological structures intersected by, or located close behind, pit batters.

The most obvious potentials for pit wall instability Die Hardy are:

- ⇨ **Slumping failure** within low shear strength materials such as clay, saprolite and saprock material with and without undissipated ground water pressure.
- ⇨ Potential for **planar sliding** instability is indicated for the major eastern wall.
- ⇨ Potential for **wedge instability** is indicated for the minor northern endwall.
- ⇨ **Ravelling failure** which could develop in areas of intense fracturing, for example in/around faults, shears, intrusions, contacts and altered rocks. Instabilities which develop via this mechanism tend to develop progressively, and Ramelius must be aware that loss of confinement in a slope, even within a small area, can have a significant deleterious influence on stability performance.

Widespread wall instability could develop progressively from a localised event, as loss of the integrity and/ or reduction in confinement within the wall can have far reaching effects.

It is pertinent to note that a directional "bias" of geotechnical investigation boreholes and data may not be permitting detection of all defect sets and conditions present in the Die Hardy rock mass.

Ongoing observation of stability performance and data collection will be required to more accurately define the potential(s) for slope instability at Die Hardy. This work should be considered an integral component of mining.

Prompt reaction to, and where necessary, remediation of all instabilities will be a crucial factor in slope management of future mining at the deposit.

Factors which could run counter to successful implementation of ***base case*** parameters are:

- ⇨ Greater than interpreted occurrences of deeply weathered and/ or poor-quality rocks (potentially associated with currently unknown structures).
- ⇨ Failure to control blast disturbance in limit wall development and/ or consistently and comprehensively achieve very high-quality drill and blast practices and design berm width.

8.0 Recommended Base Case Wall Design Parameters

Recommendations for wall design parameters have been derived from:

- ⇨ Review of borehole cores and geotechnical logs
- ⇨ Results of kinematic stability analyses based on defect data obtained from boreholes
- ⇨ Basic rock mass classification using empirical methods
- ⇨ Relevant experience in investigation, assessment, design and operation of open pits of similar scale in similar geotechnical settings.

The following preliminary *base case* wall design parameters may be used for ongoing open pit mining evaluation and planning at Die Hardy (Figures 12 and 13):

EAST DOMAIN

Figure 12

From 0 to 10 metres below surface (mbs) (laterite, gravel, transported & *highly* weathered material)

Batter Face Height	**≤ 10m**
Batter Face Angle	**40°**
Berm Width	**5m**
IRA	**30.6°**

From 10 to 50 mbs (*highly* weathered to *fresh* SIF, MDZ & UAC rocks)

Batter Face Height	**≤ 20m***
Batter Face Angle	**40°** (attempting to match bedding/ defect angle within wall rocks)
Berm Width	**5m**
IRA	**34.7°**

* *Alternatively, mine as continuous 35° to 40° slope with rock slide arresting bunds or catch fences installed at ≤ 20m vertical intervals.*

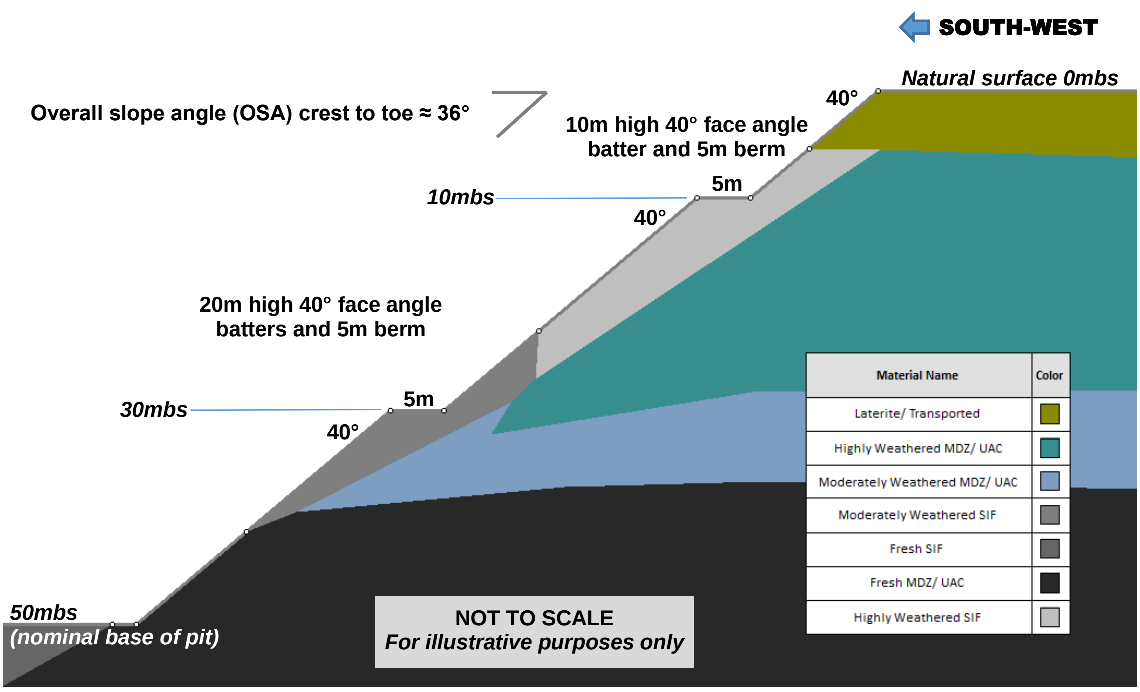


Figure 12 Die Hardy East Design Domain wall *base case* design parameters

WEST DOMAIN

Figure 13

From 0 to 10 metres below surface (mbs) (laterite, gravel, transported & *highly* weathered material)

Batter Face Height	**≤ 10m**
Batter Face Angle	**40°**
Berm Width	**5m**
IRA	**30.6°**

From 10 to 40 mbs (*highly* to *moderately* weathered UZZ & SIF rocks)

Batter Face Height	**≤ 10m**
Batter Face Angle	**50°**
Berm Width	**4m**
IRA	**38.9°**

From 40 to 50 mbs (*moderately* weathered to *fresh* SIF rocks)

Batter Face Height	**≤ 10m**
Batter Face Angle	**60°**
IRA	**60°** (single batter)

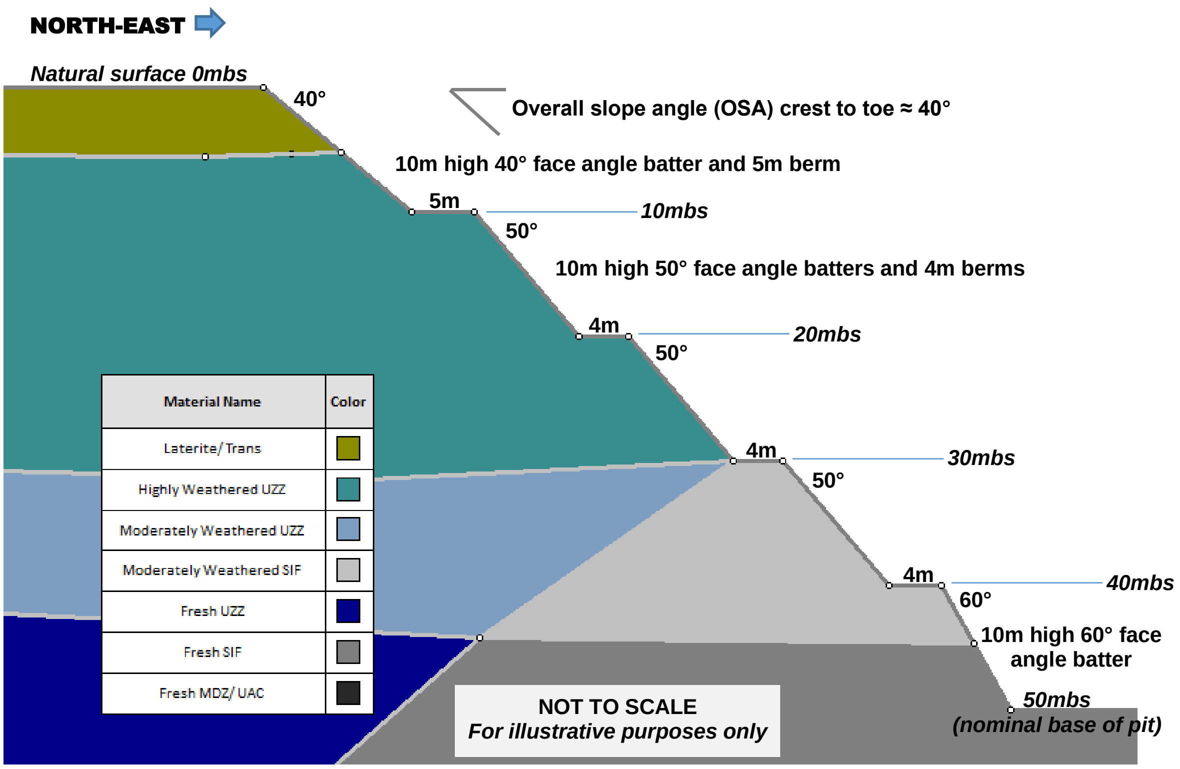


Figure 13 Die Hardy West Design Domain wall *base case* design parameters

8.1 Pit Access Ramp

There is currently no (known) specific geotechnical preference/ requirement for ramp location at Die Hardy.

8.2 Base Case Design Berm Width

Recommendations for minimum berm widths at Die Hardy have been based on a combination of experience and empirical relationships.

The Modified Ritchie Criterion, derived by Call & Nicholas Inc. (Call and Savely, 1990) is well used as a design guide and is included in the *SME Mine Engineering Handbook*.

The Modified Ritchie Criterion defines the preferred catch berm width:

Berm width (m) = 0.2 × bench height + 4.6m

A further relationship, developed by Ryan and Pryor (2000) defines berm width slightly less conservatively as:

Berm width (m) = 0.17 × bench height + 3.5m

The berm widths recommended herein are based on these guidelines and experience.

8.3 Comment on Wall Design Recommendations

The following comments are considered to be applicable to the recommended *base case* design parameters for proposed mining of the Die Hardy pit:

- **The recommended *base case* ‡ parameters are neither overly conservative nor excessively aggressive.**
  Mining to the recommended wall parameters is expected to be accompanied by some local batter scale wall failures. Careful slope monitoring will be required throughout all stages of mining (including stability monitoring of interim slopes).

  The parameters are recommended with an expectation that initial mining will allow use of observational techniques (Section 10) to refine slope parameters for final walls. That is, assessment of staged/ interim slopes will permit confirmation and/or amendment of the parameters.
- The recommended parameters assume that stable wall conditions are required for the medium term (an estimated 2-year life) of the open pit only. Should mine planning for Die Hardy indicate that underground access from the pit will be required in the future, review of pit design parameters for the pit sector in which the portal is located and ramp route to the portal will be required. Similarly, pit design parameters at locations of any planned vertical development breakthroughs into the pit or close to the pit crests should be reviewed. Local or possibly global moderation of pit design parameters may be required.
- The design requires that largely depressurised wall rock conditions are present or can be achieved.
- Inclusion of access ramps and/ or geotechnical berms <u>will</u> be required to moderate the overall angles achieved within the pit.
- A key performance indicator for Die Hardy pit wall development should be for ≥ 85% of berms to be formed at design width.

‡ *Base case* parameters are derived using interpretations based on available data and local experience. Variability of geological/ geotechnical conditions means that adjustment to the design during implementation many be necessary. Ongoing geotechnical re-assessment based on mapping and slope monitoring data is essential to identify such variations and to derive suitable amendments to the design parameters. Required application of such amendments may be local or could be widespread.

- Successful use of appropriate mining techniques, particularly in drilling and blasting and excavation during development of final walls, will be critical to the achievement of the design and maintenance of wall stability.
- Local adjustments to design parameters may be necessary to satisfy stability requirements. Few data are known regarding the persistence of geological structures which could contribute to instability. Flattened batters and/or wider berms may be necessary locally. Conversely, there may be opportunity for local wall steepening.
- Convex, unconfined slope sectors (bullnoses) must be expected to be prone to failure. While it is reasonable to include such shapes in pit plans, (rather than committing directly to remove large "additional" volumes of waste). Ramelius must remain aware of the potential for instability and the possible need to adjust ("smooth out") bullnose areas. Ideally, bullnoses should be avoided as far as practicable during final design.
- No general use of artificial support or reinforcement is anticipated. However, mesh surface support and/ or rock reinforcement could be used locally in *fresh* rocks if required.

9.0 Assessment of Proposed Waste Rock Landform

Two-dimensional limit equilibrium analysis of the resistance to development of circular and non-circular (rotational) failures through a proposed Die Hardy WRL slope was performed using Slide.

A conventional non-circular global critical failure surface search function was used to identify surfaces with minimum Factors of Safety (FS) (as calculated by LEA).

Summary details of proposed WRL design parameters and inferred construction and *in situ* base materials are as listed below. The likely range of intact strengths for *in situ* base and mined waste material were estimated by use of simple index tests during geotechnical core logging.

No obvious indications of dispersive material characteristics were observed within cores of boreholes FBDD-001 to 003.

Die Hardy WRL

- ⇨ Final design height = ≤ 30m
- ⇨ Slope face angles:
  - ▫ Lower 15m at 15° (unbenched)
  - ▫ Upper 15m at 19° (unbenched)
  - ▫ Total slope = 30m at 17°
- ⇨ Material
  - ▫ Transported ferruginous gravel (TGF), transported clay (TCZ) material (estimated strength range ≤ R0 to R3)
  - ▫ *Highly* weathered to *fresh* SIF, MDZ , UAC and UZZ rocks (R0 to R5)
- ⇨ *In Situ* Base material
  - ▫ TGF and TCZ (≤ R0 to R3)

Slope analyses carried out included pseudo-static analysis incorporating a seismic acceleration coefficient of 0.07*g* (Section 3.3.4) and also the influence of a maximum likely earthquake, considering a seismic coefficient of 0.20g, representing an outlier event of greater than expected magnitude at this location. Results obtained are provided as Figures 14 to 16.

Effective surface water management measures that would prevent the potential for build-up of hydrostatic pressures in slopes were assumed in all cases.

Based on guidelines presented within Hawley and Cunning [9], the following Factor of Safety (FS) acceptance criteria were considered for LEA:

- ⇨ FS of 1.30 to 1.40 considered to be the minimum acceptable value for slopes with no critical infrastructure or unrestricted access within the potential run-out shadow.
- ⇨ FS of 1.05 to 1.10 may be acceptable for a transient seismic disturbance, though some slope failure could be expected under such conditions.

The FS obtained for the proposed WRL slope under static and applied seismic disturbance estimated for an event with a 10% probability of exceedance in 50 years (0.07g) conditions were found to be within acceptable limits.

While the FS obtained for the proposed WRL slope under inferred maximum likely earthquake (0.20g) conditions were found to be marginally below acceptable limits, the minimum FS surface for the outlier event is extremely shallow, located either virtually at the slope surface or ≤ 0.2m below it. As such, any slope disturbance that may result from the theoretical outlier event would be expected to be minimal and may not even be visually discernible. On the basis of the location/ limited depth of the minimum surface, the indicated FS is considered to be acceptable for the theoretical outlier event.

The current proposed WRL slope is considered to be of modest height and profile, and as such is assessed to be sufficiently shallow to preclude development of significant rotational sliding instability over the very long term. PBA considers the currently proposed WRL design parameters to be acceptable for construction. The need to manage surface water flows and residence times appropriately is emphasised.

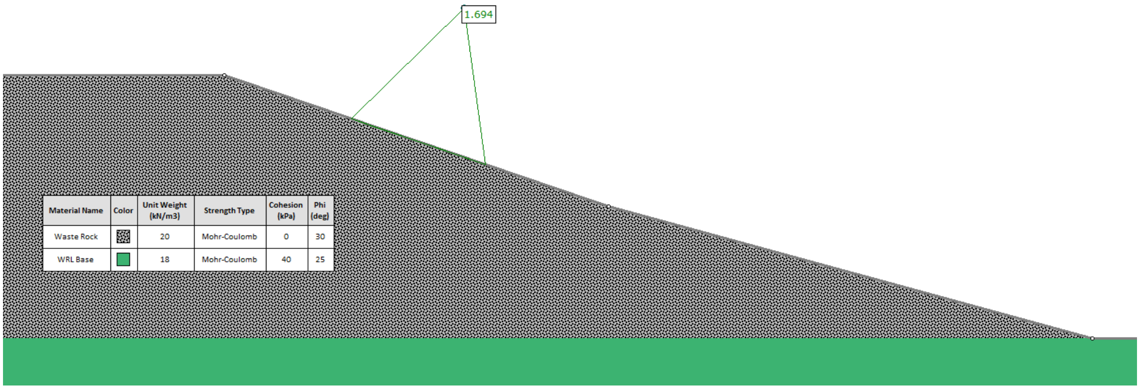


Figure 14 Proposed Die Hardy WRL slope SLIDE analysis result

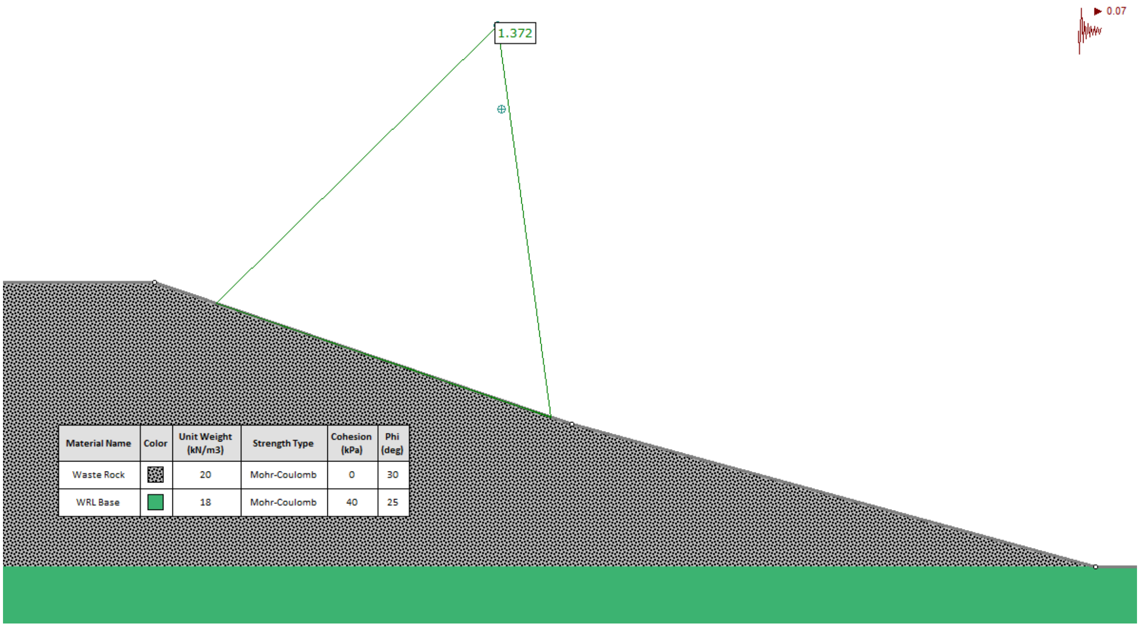


Figure 15 Proposed Die Hardy WRL slope with 0.07g seismic load SLIDE analysis result

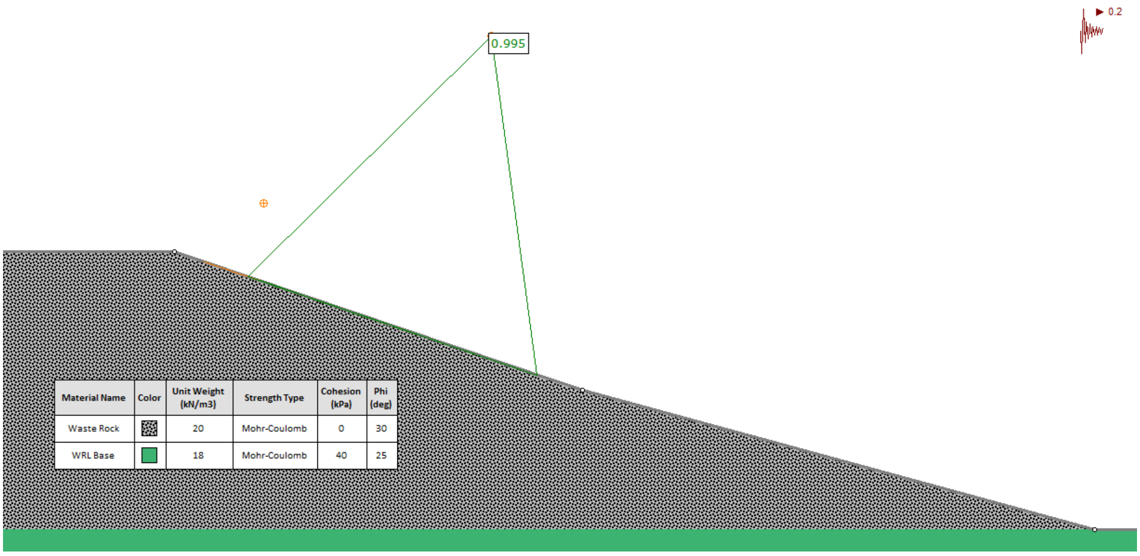


Figure 16 Proposed Die Hardy WRL slope with 0.20g seismic load SLIDE analysis result

10.0 Further Work

This assessment has been based on information derived from data obtained from exploration borehole cores.

10.1 Ongoing Geotechnical Assessment

It is considered essential that ongoing design re-assessments, based on information obtained using *observational techniques* are made during mining. It may be necessary to make local design adjustments during pit development.

Information obtained from mapping and slope stability monitoring should be assessed to confirm, or as the case may be, adjust, pit wall design parameters. As additional data become available, it will become likely that a more "optimal" approach to wall design and development will be derived.

Moderation of slope angles (via shallowing of batter face angles and/ or widening of berms) may be required locally or generally on some or all walls. Conversely, it is possible that local wall steepening may be possible.

10.1.1 Pit Wall Mapping

It is important that wall mapping is carried out to identify/ characterise wall materials and variations thereof. Data to be collected should include:

- ⇨ Basic lithology, degree of weathering and estimated strength (simple index tests)
- ⇨ Information regarding the distribution of material types and strengths
- ⇨ Information related to structural geological features: faults, shears, contacts, foliation fabric, joints *et cetera*, recording location, orientation, persistence, spacing (measured or estimated) shape, roughness, infill, and terminations
- ⇨ Failure descriptions: location, date of (even small localised) failure, features defining the failure, estimated volume, mechanism, break-out mechanism(s)
- ⇨ General observations, for example, occurrence of groundwater or dampness
- ⇨ Review of core in light of exposure in mining faces to determine if it is a useful/ reliable predictor of actual mining conditions.

10.1.2 Pit Wall Stability Monitoring

Slope failures do not occur spontaneously or without warning (provided the pit is being monitored appropriately and adequately). Use of qualitative visual and quantitative electro-optical distance measurement (EDM) stability monitoring methods are recommended for assessment of pit wall slope stability conditions in the Die Hardy pit.

In the first instance, EDM survey methods should be adopted to measure point displacements on all walls. Ideally an automated system would be employed to provide continuous real-time monitoring.

Progressively extended arrays of prisms should be established on all walls as they are developed. Prisms should initially be spaced at ≤ 50m intervals at 20m vertical intervals along the pit crest and alternate berms below. Adjustments to prism locations will be needed to adequately monitor expected local variations in displacement around geological structures and across major cracks. Additional prisms may be required locally.

The frequency of surveying these prisms after identification of movement trends immediately following installation should be based on measured displacement rates, but should not be less frequently than weekly.

Frequent visual inspection of the pit walls, including walking over all safely accessible berms, should be regarded as an integral aspect of open pit mining. Observations should be recorded in a written log, and regularly updated photographic records can provide assistance in qualitative assessment.

The need or otherwise for further action (more intensive monitoring) and/ or design adjustment will be dependent on the results obtained from the proposed monitoring.

10.2 Hydrogeology & Groundwater Monitoring

The presence of groundwater pressures within pit walls is a destabilising influence. The buoyant effects generated by hydrostatic pressures will exacerbate the potential for all possible failure mechanisms. It is crucial therefore, that steps are taken to monitor hydrogeological conditions as open pit mining advances.

10.3 Ground Control Management Plan

It is recommended that a formal operational Ground Control Management Plan (GCMP) be developed for proposed open pit mining at Die Hardy.

The GCMP would describe the ground conditions encountered and/or anticipated in the open pits, and describe/ justify the slope parameters in use or proposed. It would identify likely failure mechanisms and the means by which these would/ could be precluded or avoided to permit safe development and production.

The physical and management procedures to be used to ensure appropriate mine design and use of safe mining practices would also be described.

10.4 Geotechnical Review

Regular geotechnical review of ground conditions during operations is recommended.

For open pits initial review should be conducted relatively early in the life of mining, say, once mining has reached a depth of ~ 20m. The timing of subsequent reviews would depend on the findings of the initial review and/ or according to assessment of actual conditions by Ramelius mining personnel.

10.5 Geotechnical Risk

Die Hardy *base case* pit design parameters have been derived using interpretations based on available data and could require adjustment due to variability of geological/ geotechnical conditions.

It is considered that *base case* design parameters presented maybe subject to the following geotechnical risks:

- The distribution and extent of occurrences of deeply weathered and/ or poor-quality wall rocks (for example, associated with currently unknown structures) may be greater than indicated by current geological interpretations.
- Borehole spatial distribution and direction bias may have resulted in some structural discontinuities being under-represented/ unrepresented in the data sets considered.
- Unknown geological structures/ units, if such exist, may negatively impact *base case* design parameters.
- Rock weathering depths may be locally deeper than current interpretations.
- Unfavourable hydrogeological conditions may result in greater than anticipated destabilisation groundwater pressures in pit wall rocks.

It is expected that Ramelius will gain a better understanding of exposure to geotechnical risks once further project geotechnical investigation work is completed and open pit mining allows geotechnical pit wall mapping/ inspections to be carried out.

11.0 Closure

We trust that the information provided in this report is adequate for your current requirements.

The recommendations presented assume that appropriate techniques will be employed, and performed at consistently high standards, in all aspects of mining and slope stability monitoring activities at Die Hardy.

We stress the need for the use of observational techniques during mining and ongoing re-assessment of the suitability of designs for encountered ground conditions.

Please contact this office if there is any need for clarification or further information.

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per:

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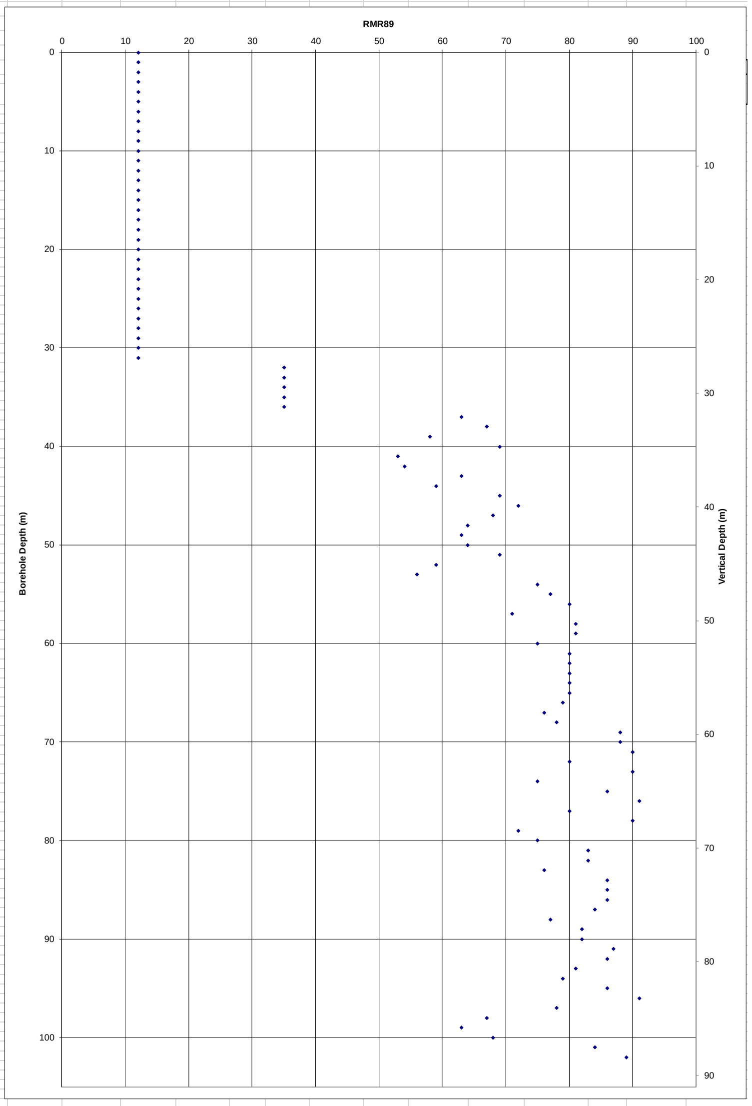
APPENDIX A

SUMMARY GEOTECHNICAL AND ROCK MASS CLASSIFICATION LOGS

BOREHOLES FBDD-001, 002 and 003
RMR and MRMR

Project:	Ramelius Die Hardy			Date:	November 2020			
Hole ID:	FBDD001	Hole Dip	-60°	Ref Table	Ref Table	Jf = Joint filled	S1=Soft<5mm	VR=Very Rough
Northing:	6683960.413	Hole Azi	062°	W1, W2, W3	R0, R1, R2		S2=Soft>5mm	R=Rough
Easting:	732463.564	Bit Size:	HQ3	W4, W5, W6	R3, R4, R5		H1=Hard<5mm	SR=Slightly Rough
Elevation:	493.891				R6	J = Joint	H2=Hard>5mm	SM=Smooth
							Nil=No filling	SL=Slickensided

Drill Record			Recovery	RQD	Fractures	Materials			Structures				
From (m)	To (m)	Drill (m)	m	m	Number of Fractures	Rock Type	Weathering Grade	Strength Grade	Structural Type	Infill (mm)	Infill Hardness & Thickness	Joint Roughness	Comments
0.00	1.00	1.00	0.80	0.00	99	TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	0 to 5m, laterite, gravels, unconsolidated, Very Poor
1.00	2.00	1.00	0.00	0.00	99	TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	
2.00	3.00	1.00	0.30	0.00	99	TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	
3.00	4.00	1.00	0.60	0.00	99	TMZ/ TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	
4.00	5.00	1.00	0.90	0.00	99	TMZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
5.00	6.00	1.00	1.00	0.00	99	TMZ/ TCZ	W5 - W6	R2	NA	NA	NA	NA	
6.00	7.00	1.00	1.00	0.00	99	TCZ	W5 - W6	R2	NA	NA	NA	NA	5 to 15m transported clays, Very Poor
7.00	8.00	1.00	0.20	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
8.00	9.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
9.00	10.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
10.00	11.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
11.00	12.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
12.00	13.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	Swelling clays?
13.00	14.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	Swelling clays?
14.00	15.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	14 to 37m, saprolite, some relict structure visible. Some
15.00	16.00	1.00	1.00	0.00	99	TCZ	W5 - W6	R0	NA	NA	NA	NA	intervals of saprock, generally Very Poor
16.00	17.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
17.00	18.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
18.00	19.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
19.00	20.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
20.00	21.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
21.00	22.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
22.00	23.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
23.00	24.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
24.00	25.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
25.00	26.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
26.00	27.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
27.00	28.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
28.00	29.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
29.00	30.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
30.00	31.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
31.00	32.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
32.00	33.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
33.00	34.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
34.00	35.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
35.00	36.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
36.00	37.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
37.00	38.00	1.00	1.00	0.73	7	SIF/ UZZ	W2	R4	Bed	Surf ox H ≤ 1mm	H1	R	37 to 50m, strongly bedded rock, frequent parting on
38.00	39.00	1.00	1.00	0.87	6	SIF	W2	R4	Bed	Surf ox H ≤ 1mm	H1	R	bedding. 38 to 46m vughy.
39.00	40.00	1.00	1.00	0.59	10	SIF	W3	R3	Bed	Surf ox H ≤ 1mm	H1	R	
40.00	41.00	1.00	1.00	0.54	8	SIF	W3	R2 - R3	Bed	Surf ox H ≤ 1mm	H1	R	
41.00	42.00	1.00	1.00	0.43	15	SIF	W3	R3	Bed	Surf ox H ≤ 1mm	H1	R	
42.00	43.00	1.00	1.00	0.49	8	SIF	W2 - W4	R3 - R0	Shr	Clay 70mm	S2	R	70mm clay interval, shear?
43.00	44.00	1.00	1.00	0.54	11	SIF	W2	R4	Bed	Surf ox H ≤ 1mm	H1	R	
44.00	45.00	1.00	0.90	0.31	14	SIF	W2	R4	Bed	Oxide H ≤ 1mm	H1	VR	
45.00	46.00	1.00	1.00	0.54	8	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	VR	
46.00	47.00	1.00	1.00	0.76	8	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
47.00	48.00	1.00	1.00	0.67	13	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
48.00	49.00	1.00	1.00	0.48	12	SIF	W2	R5	Bed	Oxide H 1mm	H1	VR	
49.00	50.00	1.00	0.90	0.48	12	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
50.00	51.00	1.00	1.00	0.43	7	SIF	W1	R5	Bed	Oxide H ≤ 1mm	H1	R	50 to 54m frequent parting on bedding planes, Fair quality
51.00	52.00	1.00	0.90	0.58	6	SIF	W1	R5	Bed	Oxide H ≤ 1mm	H1	R	
52.00	53.00	1.00	1.00	0.24	9	SIF	W1	R5	Bed	Oxide H ≤ 1mm	H1	R	
53.00	54.00	1.00	1.00	0.00	17	SIF	W1	R5	Bed	Oxide H ≤ 1mm	H1	R	
54.00	55.00	1.00	1.00	0.75	8	SIF	W1	R5	Bed	Nil NA	Nil	R	54 to 74m generally competent BIF rocks, Very Good
55.00	56.00	1.00	1.00	0.87	3	SIF	W1	R5	Bed	Nil NA	Nil	R	
56.00	57.00	1.00	1.00	1.00	3	SIF/ MZZ	W1	R5	Bed	Nil NA	Nil	R	
57.00	58.00	1.00	1.00	0.75	7	SIF	W1	R5	Bed	Oxide S ≤ 1mm	S1	R	
58.00	59.00	1.00	1.00	0.93	2	SIF	W1	R5	Bed	Nil NA	Nil	VR	
59.00	60.00	1.00	1.00	1.00	3	MZZ/ SIF	W1	R5	Jn	Nil NA	Nil	VR	
60.00	61.00	1.00	1.00	0.85	5	SIF/ MZZ	W1	R5	Bed	Nil NA	Nil	R	
61.00	62.00	1.00	1.00	1.00	2	SIF	W1	R5	Bed	Nil NA	Nil	R	
62.00	63.00	1.00	1.00	1.00	3	SIF	W1	R5	Bed	Nil NA	Nil	R	
63.00	64.00	1.00	1.00	0.92	2	SIF	W1	R5	Bed	Nil NA	Nil	R	
64.00	65.00	1.00	1.00	0.92	4	SIF	W1	R5	Bed	Nil NA	Nil	R	
65.00	66.00	1.00	1.00	0.92	3	SIF	W1	R5	Bed	Nil NA	Nil	R	
66.00	67.00	1.00	1.00	1.00	4	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	VR	
67.00	68.00	1.00	1.00	0.83	3	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	VR	
68.00	69.00	1.00	1.00	0.95	2	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	R	
69.00	70.00	1.00	1.00	1.00	0	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	R	
70.00	71.00	1.00	1.00	1.00	0	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	R	
71.00	72.00	1.00	1.00	1.00	0	SIF	W1	R5	Bed	Nil NA	Nil	R	
72.00	73.00	1.00	1.00	0.91	3	SIF	W1	R5	Bed	Nil NA	Nil	R	
73.00	74.00	1.00	1.00	1.00	0	SIF	W1	R5	Bed	Nil NA	Nil	R	
74.00	75.00	1.00	1.00	0.80	5	SIF/ MDZ	W1	R5	Jn	Nil NA	Nil	R	74 to 82m generally competent mafic, Very Good
75.00	76.00	1.00	1.00	1.00	1	MDZ	W1	R5	Jn	Nil NA	Nil	VR	
76.00	77.00	1.00	1.00	1.00	0	MDZ	W1	R5	Jn	Nil NA	Nil	VR	
77.00	78.00	1.00	1.00	1.00	2	MDZ	W1	R5	Jn	Nil NA	Nil	R	
78.00	79.00	1.00	1.00	1.00	0	MDZ	W1	R5	Jn	Nil NA	Nil	R	
79.00	80.00	1.00	1.00	0.66	10	UAC	W1	R5	Jn	Nil NA	Nil	VR	
80.00	81.00	1.00	1.00	0.88	5	UAC/ MDZ	W1	R5	Jn	Nil NA	Nil	R	
81.00	82.00	1.00	1.00	1.00	1	UAC/ MDZ	W1	R5	Jn	Carb H 1mm	H1	R	
82.00	83.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb H 1mm	H1	R	82 to 102m generally Good quality, no significant talc-chlorite
83.00	84.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Nil NA	Nil	SM	alteration
84.00	85.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
85.00	86.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
86.00	87.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
87.00	88.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb H 1mm	H1	VR	
88.00	89.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Carb S 1mm	S1	VR	
89.00	90.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb S 1mm	S1	VR	
90.00	91.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb S 1mm	S1	VR	
91.00	92.00	1.00	1.00	1.00	0	UAC	W1	R5	Jn	Carb S 1mm	S1	VR	
92.00	93.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
93.00	94.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Nil NA	Nil	VR	
94.00	95.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Carb H ≤ 1mm	H1	VR	
95.00	96.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
96.00	97.00	1.00	1.00	1.00	0	UAC	W1	R5	Jn	Nil NA	Nil	VR	
97.00	98.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Carb H ≤ 1mm	H1	R	
98.00	99.00	1.00	1.00	0.75	7	UAC	W1	R5	Jn	Talc ≤ 1mm	S1	SM	
99.00	100.00	1.00	1.00	0.72	6	UAC	W1	R5	Jn	Talc ≤ 1mm	S1	SM	
100.00	101.00	1.00	1.00	0.75	7	UAC	W1	R5	Vn	Carb H 5mm	H2	R	
101.00	102.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb H ≤ 1mm	H1	VR	
102.00	102.20	0.20	0.20	0.20	0	UAC	W1	R5	Jn	Carb H ≤ 1mm	H1	VR	



MRMR Calcs

Drill Record		RMR	MRMR Calcs					
From (m)	To (m)	RMR89	Weathering	Joint Orientation	Induced Stress	Blasting effects	Total Adjustment	MRMR
0.00	1.00	12	0.96	0.80	1.00	0.94	0.72	9
1.00	2.00	12	0.96	0.80	1.00	0.94	0.72	9
2.00	3.00	12	0.96	0.80	1.00	0.94	0.72	9
3.00	4.00	12	0.96	0.80	1.00	0.94	0.72	9
4.00	5.00	12	0.96	0.80	1.00	0.94	0.72	9
5.00	6.00	12	0.96	0.80	1.00	0.94	0.72	9
6.00	7.00	12	0.96	0.80	1.00	0.94	0.72	9
7.00	8.00	12	0.96	0.80	1.00	0.94	0.72	9
8.00	9.00	12	0.96	0.80	1.00	0.94	0.72	9
9.00	10.00	12	0.96	0.80	1.00	0.94	0.72	9
10.00	11.00	12	0.96	0.80	1.00	0.94	0.72	9
11.00	12.00	12	0.96	0.80	1.00	0.94	0.72	9
12.00	13.00	12	0.96	0.80	1.00	0.94	0.72	9
13.00	14.00	12	0.96	0.80	1.00	0.94	0.72	9
14.00	15.00	12	0.96	0.80	1.00	0.94	0.72	9
15.00	16.00	12	0.96	0.80	1.00	0.94	0.72	9
16.00	17.00	12	0.96	0.80	1.00	0.94	0.72	9
17.00	18.00	12	0.96	0.80	1.00	0.94	0.72	9
18.00	19.00	12	0.96	0.80	1.00	0.94	0.72	9
19.00	20.00	12	0.96	0.80	1.00	0.94	0.72	9
20.00	21.00	12	0.96	0.80	1.00	0.94	0.72	9
21.00	22.00	12	0.96	0.80	1.00	0.94	0.72	9
22.00	23.00	12	0.96	0.80	1.00	0.94	0.72	9
23.00	24.00	12	0.96	0.80	1.00	0.94	0.72	9
24.00	25.00	12	0.96	0.80	1.00	0.94	0.72	9
25.00	26.00	12	0.96	0.80	1.00	0.94	0.72	9
26.00	27.00	12	0.96	0.80	1.00	0.94	0.72	9
27.00	28.00	12	0.96	0.80	1.00	0.94	0.72	9
28.00	29.00	12	0.96	0.80	1.00	0.94	0.72	9
29.00	30.00	12	0.96	0.80	1.00	0.94	0.72	9
30.00	31.00	12	0.96	0.80	1.00	0.94	0.72	9
31.00	32.00	12	0.96	0.80	1.00	0.94	0.72	9
32.00	33.00	35	0.96	0.80	1.00	0.94	0.72	25
33.00	34.00	35	0.96	0.80	1.00	0.94	0.72	25
34.00	35.00	35	0.96	0.80	1.00	0.94	0.72	25
35.00	36.00	35	0.96	0.80	1.00	0.94	0.72	25
36.00	37.00	35	0.96	0.80	1.00	0.94	0.72	25
37.00	38.00	63	0.96	0.80	1.00	0.94	0.72	45
38.00	39.00	67	0.96	0.80	1.00	0.94	0.72	48
39.00	40.00	58	0.96	0.80	1.00	0.94	0.72	42
40.00	41.00	69	0.96	0.80	1.00	0.94	0.72	50
41.00	42.00	53	0.96	0.80	1.00	0.94	0.72	38
42.00	43.00	54	0.96	0.80	1.00	0.94	0.72	39
43.00	44.00	63	0.96	0.80	1.00	0.94	0.72	45
44.00	45.00	59	0.96	0.80	1.00	0.94	0.72	43
45.00	46.00	69	0.96	0.80	1.00	0.94	0.72	50
46.00	47.00	72	0.96	0.80	1.00	0.94	0.72	52
47.00	48.00	68	0.96	0.80	1.00	0.94	0.72	49
48.00	49.00	64	0.96	0.80	1.00	0.94	0.72	46
49.00	50.00	63	0.96	0.80	1.00	0.94	0.72	45
50.00	51.00	64	0.96	0.80	1.00	0.94	0.72	46
51.00	52.00	69	0.96	0.80	1.00	0.94	0.72	50
52.00	53.00	59	0.96	0.80	1.00	0.94	0.72	43
53.00	54.00	56	0.96	0.80	1.00	0.94	0.72	40
54.00	55.00	75	0.96	0.80	1.00	0.94	0.72	54
55.00	56.00	77	0.96	0.80	1.00	0.94	0.72	56
56.00	57.00	80	0.96	0.80	1.00	0.94	0.72	58
57.00	58.00	71	0.96	0.80	1.00	0.94	0.72	51
58.00	59.00	81	0.96	0.80	1.00	0.94	0.72	58
59.00	60.00	81	0.96	0.80	1.00	0.94	0.72	58
60.00	61.00	75	0.96	0.80	1.00	0.94	0.72	54
61.00	62.00	80	0.96	0.80	1.00	0.94	0.72	58
62.00	63.00	80	0.96	0.80	1.00	0.94	0.72	58
63.00	64.00	80	0.96	0.80	1.00	0.94	0.72	58
64.00	65.00	80	0.96	0.80	1.00	0.94	0.72	58
65.00	66.00	80	0.96	0.80	1.00	0.94	0.72	58
66.00	67.00	79	0.96	0.80	1.00	0.94	0.72	57
67.00	68.00	76	0.96	0.80	1.00	0.94	0.72	55
68.00	69.00	78	0.96	0.80	1.00	0.94	0.72	56
69.00	70.00	88	0.96	0.80	1.00	0.94	0.72	64
70.00	71.00	88	0.96	0.80	1.00	0.94	0.72	64
71.00	72.00	90	0.96	0.80	1.00	0.94	0.72	65
72.00	73.00	80	0.96	0.80	1.00	0.94	0.72	58
73.00	74.00	90	0.96	0.80	1.00	0.94	0.72	65
74.00	75.00	75	0.96	0.80	1.00	0.94	0.72	54
75.00	76.00	86	0.96	0.80	1.00	0.94	0.72	62
76.00	77.00	91	0.96	0.80	1.00	0.94	0.72	66
77.00	78.00	80	0.96	0.80	1.00	0.94	0.72	58
78.00	79.00	90	0.96	0.80	1.00	0.94	0.72	65
79.00	80.00	72	0.96	0.80	1.00	0.94	0.72	52
80.00	81.00	75	0.96	0.80	1.00	0.94	0.72	54
81.00	82.00	83	0.96	0.80	1.00	0.94	0.72	60
82.00	83.00	83	0.96	0.80	1.00	0.94	0.72	60
83.00	84.00	76	0.96	0.80	1.00	0.94	0.72	55
84.00	85.00	86	0.96	0.80	1.00	0.94	0.72	62
85.00	86.00	86	0.96	0.80	1.00	0.94	0.72	62
86.00	87.00	86	0.96	0.80	1.00	0.94	0.72	62
87.00	88.00	84	0.96	0.80	1.00	0.94	0.72	61
88.00	89.00	77	0.96	0.80	1.00	0.94	0.72	56
89.00	90.00	82	0.96	0.80	1.00	0.94	0.72	59
90.00	91.00	82	0.96	0.80	1.00	0.94	0.72	59
91.00	92.00	87	0.96	0.80	1.00	0.94	0.72	63
92.00	93.00	86	0.96	0.80	1.00	0.94	0.72	62
93.00	94.00	81	0.96	0.80	1.00	0.94	0.72	58
94.00	95.00	79	0.96	0.80	1.00	0.94	0.72	57
95.00	96.00	86	0.96	0.80	1.00	0.94	0.72	62
96.00	97.00	91	0.96	0.80	1.00	0.94	0.72	66
97.00	98.00	78	0.96	0.80	1.00	0.94	0.72	56
98.00	99.00	67	0.96	0.80	1.00	0.94	0.72	48
99.00	100.00	63	0.96	0.80	1.00	0.94	0.72	45
100.00	101.00	68	0.96	0.80	1.00	0.94	0.72	49
101.00	102.00	84	0.96	0.80	1.00	0.94	0.72	61
102.00	102.20	89	0.96	0.80	1.00	0.94	0.72	64

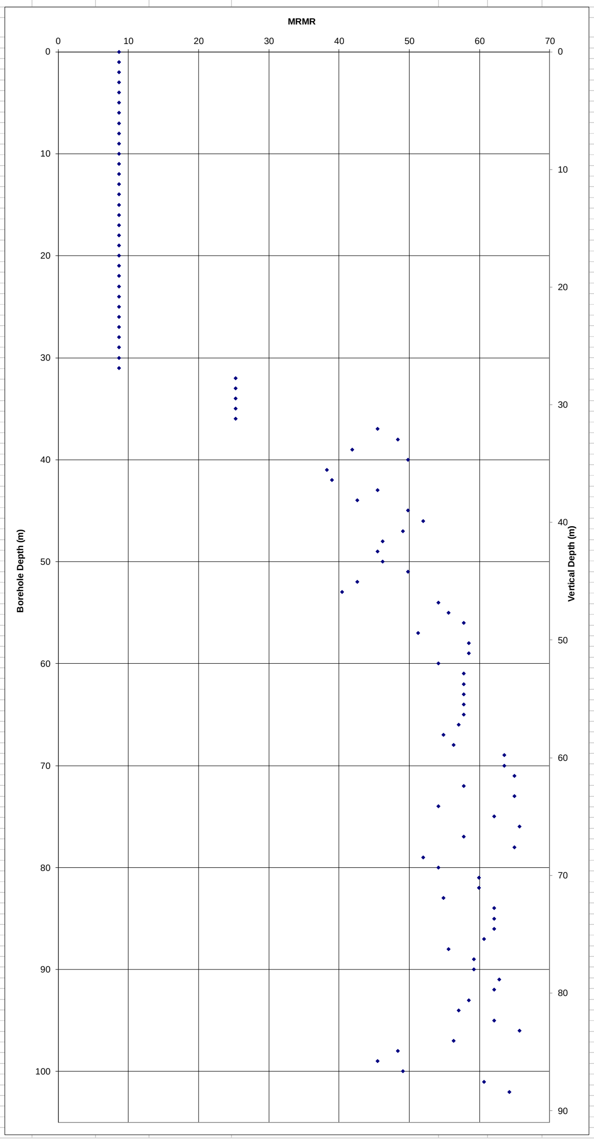
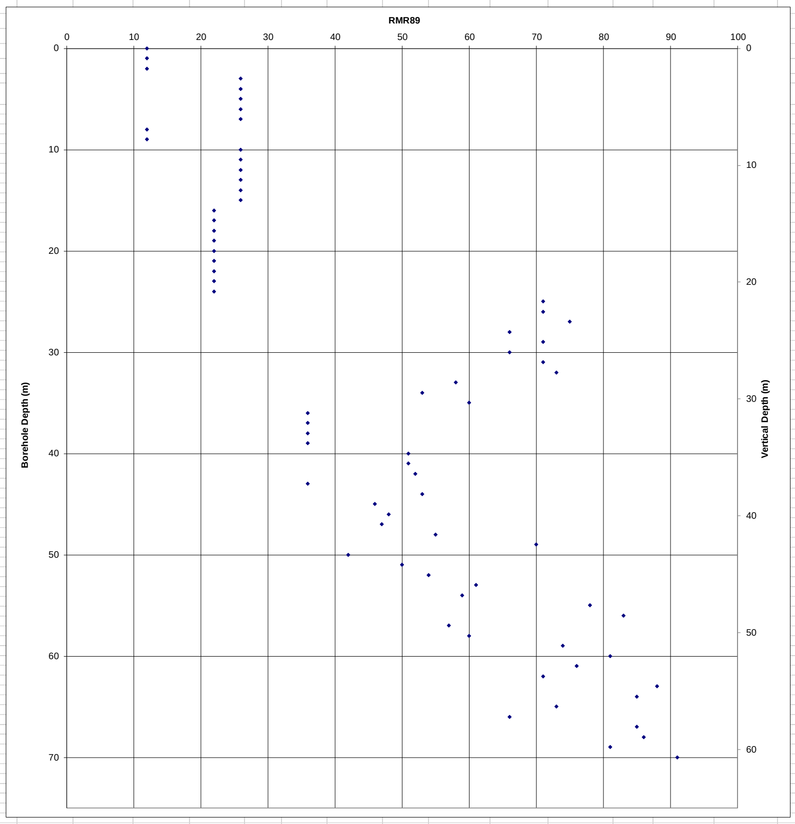


Figure A1 Borehole FBDD-001 summary geotechnical log, RMR and MRMR rock mass classification

Project:	Ramelius Die Hardy				**Date:**	November 2020					
Hole ID:	FBDD002	**Hole Dip**	-60°		**Ref Table**	**Ref Table**	**Jf = Joint filled**	**S1=Soft<5mm**	**VR=Very Rough**		
Northing:	6683783.771	**Hole Azi**	061°		**W1, W2, W3**	**R0, R1, R2**		**S2=Soft>5mm**	**R=Rough**		
Easting:	732689.779	**Bit Size:**	HQ3		**W4, W5, W6**	**R3, R4, R5**		**H1=Hard<5mm**	**SR=Slightly Rough**		
Elevation:	506.469					**R6**	**J = Joint**	**H2=Hard>5mm**	**SM=Smooth**		
								Nil=No filling	**SL=Slickensided**		

Drill Record			**Recovery**	**RQD**	**Fractures**	**Materials**			**Structures**				
From (m)	To (m)	Drill (m)	m	m	Number of Fractures	Rock Type	Weathering Grade	Strength Grade	Structural Type	Infill (mm)	Infill Hardness & Thickness	Joint Roughness	Comments
0.00	1.00	1.00	0.80	0.00	99	TGF	W5 - W6	R3	NA	NA	NA	NA	0 to 3m, laterite, mix of gravel & consolidated material
1.00	2.00	1.00	0.90	0.00	99	TGF	W5 - W6	R3	NA	NA	NA	NA	
2.00	3.00	1.00	0.90	0.00	99	WCZ/ TGF	W5 - W6	R3	NA	NA	NA	NA	
3.00	4.00	1.00	0.90	0.00	99	WCZ/ WCU	W5 - W6	R3	Jn	Clay 1mm	S1	VR	3 to 8m, saprock, some structure, Poor
4.00	5.00	1.00	0.90	0.41	11	WCU	W4	R3	Jn	Clay 1mm	S1	VR	
5.00	6.00	1.00	0.90	0.68	9	WCU	W4	R2 - R3	Jn	Clay 1mm	S1	VR	
6.00	7.00	1.00	0.90	0.27	12	WCU	W4	R2 - R3	Jn	Clay 1mm	S1	VR	
7.00	8.00	1.00	1.00	0.00	20+	WCU/ UZZ	W4	R2 - R3	Jn	Clay 1mm	S1	VR	
8.00	9.00	1.00	0.90	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	8 to 10m saprlolite clay, Very Poor
9.00	10.00	1.00	0.90	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
10.00	11.00	1.00	0.90	0.00	99	UZZ	W5 - W6	R1	Jn	Clay 1-2mm	S1	VR	10 to 16m saprock, consolidated clay, Poor to Fair
11.00	12.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	Jn	Clay 1-2mm	S1	VR	
12.00	13.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R1	Jn	Clay 1-2mm	S1	VR	
13.00	14.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	Jn	Clay 1-2mm	S1	VR	
14.00	15.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	Jn	Clay 1-2mm	S1	VR	
15.00	16.00	1.00	1.00	0.00	99	UZZ/ SIF	W5 - W6	R3	Jn	Clay 1-2mm	S1	VR	
16.00	17.00	1.00	1.00	0.16	15	SIF	W4 - W3	R3	Jn	Clay 1-2mm	S1	VR	16 to 24m saprolite/ saprock, Poor
17.00	18.00	1.00	1.00	0.48	10	SIF	W4 - W3	R3	Jn	Clay 1-2mm	S1	VR	
18.00	19.00	1.00	1.00	0.69	7	SIF/ WCU	W4 - W3	R2 - R3	Jn	Clay 1-2mm	S1	VR	
19.00	20.00	1.00	1.00	0.88	2	UZZ/ OXB/ SIF	W4 - W3	R2	Jn	Clay 1-2mm	S1	VR	
20.00	21.00	1.00	1.00	0.64	7	SIF/ UZZ	W4	R1 - R2	Jn	Clay 1-2mm	S1	VR	
21.00	22.00	1.00	1.00	0.69	6	UZZ/ SIF	W4 - W3	R1 - R2	Jn	Clay 1-2mm	S1	VR	
22.00	23.00	1.00	1.00	0.63	8	SIF/ UZZ	W4 - W3	R2 - R3	Jn	Clay 1-2mm	S1	VR	
23.00	24.00	1.00	1.00	0.72	7	SIF/ UZZ	W4 - W3	R2 - R3	Jn	Clay 1-2mm	S1	VR	
24.00	25.00	1.00	1.00	0.63	8	SIF	W2	R4	Bed	Oxide H ≤ 1mm	H1	R	Weathered BIF, frequent partings on bedding
25.00	26.00	1.00	1.00	0.63	6	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
26.00	27.00	1.00	1.00	0.68	7	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
27.00	28.00	1.00	1.00	0.81	7	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
28.00	29.00	1.00	1.00	0.26	12	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
29.00	30.00	1.00	1.00	0.53	11	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
30.00	31.00	1.00	1.00	0.46	14	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
31.00	32.00	1.00	1.00	0.58	12	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
32.00	33.00	1.00	1.00	0.50	13	SIF	W2	R4 - R5	Bed	Nil	Nil	R	
33.00	34.00	1.00	1.00	0.00	23	SIF	W3	R2 - R3	Bed	Nil	Nil	R	
34.00	35.00	1.00	1.00	0.00	99	SIF/ WCU/ OZZ	W2 - W4	R2 - R0	Bed	Oxide H ≤ 1mm	H1	R	0.2m clay interval R0
35.00	36.00	1.00	1.00	0.58	8	SIF	W2	R3	Bed	Oxide H ≤ 1mm	H1	R	
36.00	37.00	1.00	1.00	0.00	99	SIC/ OZZ	W6	R0	Jn	Clay 2mm	S1	R	37 to 44m Altered/ sheared, very broken, some rubble,
37.00	38.00	1.00	0.50	0.00	99	OZZ	W6	R0	Jn	Clay 2mm	S1	R	Very Poor
38.00	39.00	1.00	0.50	0.00	99	OZZ/ SIC/ SIF	W6	R0	Jn	Clay 2mm	S1	R	
39.00	40.00	1.00	0.50	0.00	99	SIC/ OZZ	W6	R0	Jn	Clay 2mm	S1	R	
40.00	41.00	1.00	0.50	0.00	99	SIC/ OZZ	W6	R2 - R0	Jn	Clay 2mm	S1	R	
41.00	42.00	1.00	0.50	0.00	99	OZZ	W6	R2 - R0	Jn	Clay 2mm	S1	R	
42.00	43.00	1.00	0.50	0.00	99	OZZ/ WCZ/ SIC	W4	R3 - R0	Jn	Clay 2mm	S1	R	
43.00	44.00	1.00	0.50	0.00	99	SIF/ WCZ	W6	R0	Jn	Clay 2mm	S1	R	
44.00	45.00	1.00	1.00	0.23	99	SIF/ UZZ	W2 - W6	R4 - R0	Bed	Oxide H ≤ 1mm	H1	R	0.1m clay interval
45.00	46.00	1.00	1.00	0.00	99	UZZ/ SIF	W6 - W3	R0 - R3	Shr	Clay > 5mm	S2	R	0.5m clay interval
46.00	47.00	1.00	1.00	0.24	16	SIF	W3	R3	Bed	Oxide H ≤ 1mm	H1	R	
47.00	48.00	1.00	1.00	0.33	11	SIF	W3	R3	Bed	Clay 5mm	S2	VR	
48.00	49.00	1.00	1.00	0.42	11	SIF	W3 - W2	R3 - R0	Bed	Clay 5mm	S2	VR	
49.00	50.00	1.00	1.00	0.62	13	SIF	W2	R3 - R0	Bed	Clay 2mm	S1	VR	
50.00	51.00	1.00	1.00	0.21	17	SIF	W3 - W2	R3	Bed	Oxide H ≤ 1mm	H1	R	50 to 52m, frequent partings on bedding
51.00	52.00	1.00	1.00	0.33	15	SIF/ MDZ	W3 - W2	R3	Bed	Oxide H ≤ 1mm	H1	R	
52.00	53.00	1.00	1.00	0.27	7	MDZ/ SIF	W3 - W2	R3 - R0	Shr	Clay > 5mm	S2	R	0.2m clay interval R0
53.00	54.00	1.00	1.00	1.00	5	MDZ	W4 - W3	R3	Jn	Clay ≤ 1mm	S1	VR	
54.00	55.00	1.00	1.00	0.77	14	MDZ	W2 - W3	R3	Jn	Oxide H ≤ 1mm	H1	R	
55.00	56.00	1.00	1.00	1.00	2	MDZ	W1	R5	Jn	Carb H ≤ 1mm	H1	R	55 to 57m Good rock
56.00	57.00	1.00	1.00	1.00	1	MDZ	W1	R5	Jn	Oxide H ≤ 1mm	H1	R	
57.00	58.00	1.00	1.00	0.44	11	UZZ/ MDZ	W2	R4	Jn	Clay ≤ 1mm	S1	VR	57 to 59m, some weathering & breaks, Fair rock
58.00	59.00	1.00	1.00	0.28	13	UZZ/ UAC	W2	R4	Jn	Nil	Nil	R	
59.00	60.00	1.00	1.00	0.85	5	UAC	W1	R5	Jn	Oxide H ≤ 1mm	H1	VR	59 to 70.80m, generally Good rock
60.00	61.00	1.00	1.00	1.00	4	UAC	W1	R5	Jn	Nil	Nil	VR	
61.00	62.00	1.00	1.00	0.92	5	UAC	W1	R5	Jn	Carb H 1mm	H1	R	
62.00	63.00	1.00	1.00	0.63	2	UAC	W1	R5	Jn	Oxide H 1mm	H1	R	
63.00	64.00	1.00	1.00	1.00	0	UAC	W1	R5	Jn	Oxide H 1mm	H1	R	
64.00	65.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	R	
65.00	66.00	1.00	1.00	0.74	3	UAC/ MDZ	W1	R5	Jn	Nil NA	Nil	R	
66.00	67.00	1.00	1.00	0.28	9	UAC/ MDZ	W1	R5	Jn	Nil NA	Nil	R	
67.00	68.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	R	
68.00	69.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
69.00	70.00	1.00	1.00	0.98	3	UAC	W1	R5	Jn	Nil NA	Nil	VR	
70.00	70.80	0.80	0.80	0.80	0	UAC	W1	R5	Jn	Nil NA	Nil	VR	



MRMR Calcs

Drill Record		**RMR**	**MRMR Calcs**					
From (m)	To (m)	RMR89	Weathering	Joint Orientation	Induced Stress	Blasting effects	Total Adjustment	MRMR
0.00	1.00	12	0.96	0.80	1.00	0.94	0.72	9
1.00	2.00	12	0.96	0.80	1.00	0.94	0.72	9
2.00	3.00	12	0.96	0.80	1.00	0.94	0.72	9
3.00	4.00	26	0.96	0.80	1.00	0.94	0.72	19
4.00	5.00	26	0.96	0.80	1.00	0.94	0.72	19
5.00	6.00	26	0.96	0.80	1.00	0.94	0.72	19
6.00	7.00	26	0.96	0.80	1.00	0.94	0.72	19
7.00	8.00	26	0.96	0.80	1.00	0.94	0.72	19
8.00	9.00	12	0.96	0.80	1.00	0.94	0.72	9
9.00	10.00	12	0.96	0.80	1.00	0.94	0.72	9
10.00	11.00	26	0.96	0.80	1.00	0.94	0.72	19
11.00	12.00	26	0.96	0.80	1.00	0.94	0.72	19
12.00	13.00	26	0.96	0.80	1.00	0.94	0.72	19
13.00	14.00	26	0.96	0.80	1.00	0.94	0.72	19
14.00	15.00	26	0.96	0.80	1.00	0.94	0.72	19
15.00	16.00	26	0.96	0.80	1.00	0.94	0.72	19
16.00	17.00	22	0.96	0.80	1.00	0.94	0.72	16
17.00	18.00	22	0.96	0.80	1.00	0.94	0.72	16
18.00	19.00	22	0.96	0.80	1.00	0.94	0.72	16
19.00	20.00	22	0.96	0.80	1.00	0.94	0.72	16
20.00	21.00	22	0.96	0.80	1.00	0.94	0.72	16
21.00	22.00	22	0.96	0.80	1.00	0.94	0.72	16
22.00	23.00	22	0.96	0.80	1.00	0.94	0.72	16
23.00	24.00	22	0.96	0.80	1.00	0.94	0.72	16
24.00	25.00	22	0.96	0.80	1.00	0.94	0.72	16
25.00	26.00	71	0.96	0.80	1.00	0.94	0.72	51
26.00	27.00	71	0.96	0.80	1.00	0.94	0.72	51
27.00	28.00	75	0.96	0.80	1.00	0.94	0.72	54
28.00	29.00	66	0.96	0.80	1.00	0.94	0.72	48
29.00	30.00	71	0.96	0.80	1.00	0.94	0.72	51
30.00	31.00	66	0.96	0.80	1.00	0.94	0.72	48
31.00	32.00	71	0.96	0.80	1.00	0.94	0.72	51
32.00	33.00	73	0.96	0.80	1.00	0.94	0.72	53
33.00	34.00	58	0.96	0.80	1.00	0.94	0.72	42
34.00	35.00	53	0.96	0.80	1.00	0.94	0.72	38
35.00	36.00	60	0.96	0.80	1.00	0.94	0.72	43
36.00	37.00	36	0.96	0.80	1.00	0.94	0.72	26
37.00	38.00	36	0.96	0.80	1.00	0.94	0.72	26
38.00	39.00	36	0.96	0.80	1.00	0.94	0.72	26
39.00	40.00	36	0.96	0.80	1.00	0.94	0.72	26
40.00	41.00	51	0.96	0.80	1.00	0.94	0.72	37
41.00	42.00	51	0.96	0.80	1.00	0.94	0.72	37
42.00	43.00	52	0.96	0.80	1.00	0.94	0.72	38
43.00	44.00	36	0.96	0.80	1.00	0.94	0.72	26
44.00	45.00	53	0.96	0.80	1.00	0.94	0.72	38
45.00	46.00	46	0.96	0.80	1.00	0.94	0.72	33
46.00	47.00	48	0.96	0.80	1.00	0.94	0.72	35
47.00	48.00	47	0.96	0.80	1.00	0.94	0.72	34
48.00	49.00	55	0.96	0.80	1.00	0.94	0.72	40
49.00	50.00	70	0.96	0.80	1.00	0.94	0.72	51
50.00	51.00	42	0.96	0.80	1.00	0.94	0.72	30
51.00	52.00	50	0.96	0.80	1.00	0.94	0.72	36
52.00	53.00	54	0.96	0.80	1.00	0.94	0.72	39
53.00	54.00	61	0.96	0.80	1.00	0.94	0.72	44
54.00	55.00	59	0.96	0.80	1.00	0.94	0.72	43
55.00	56.00	78	0.96	0.80	1.00	0.94	0.72	56
56.00	57.00	83	0.96	0.80	1.00	0.94	0.72	60
57.00	58.00	57	0.96	0.80	1.00	0.94	0.72	41
58.00	59.00	60	0.96	0.80	1.00	0.94	0.72	43
59.00	60.00	74	0.96	0.80	1.00	0.94	0.72	53
60.00	61.00	81	0.96	0.80	1.00	0.94	0.72	58
61.00	62.00	76	0.96	0.80	1.00	0.94	0.72	55
62.00	63.00	71	0.96	0.80	1.00	0.94	0.72	51
63.00	64.00	88	0.96	0.80	1.00	0.94	0.72	64
64.00	65.00	85	0.96	0.80	1.00	0.94	0.72	61
65.00	66.00	73	0.96	0.80	1.00	0.94	0.72	53
66.00	67.00	66	0.96	0.80	1.00	0.94	0.72	48
67.00	68.00	85	0.96	0.80	1.00	0.94	0.72	61
68.00	69.00	86	0.96	0.80	1.00	0.94	0.72	62
69.00	70.00	81	0.96	0.80	1.00	0.94	0.72	58
70.00	70.80	91	0.96	0.80	1.00	0.94	0.72	66

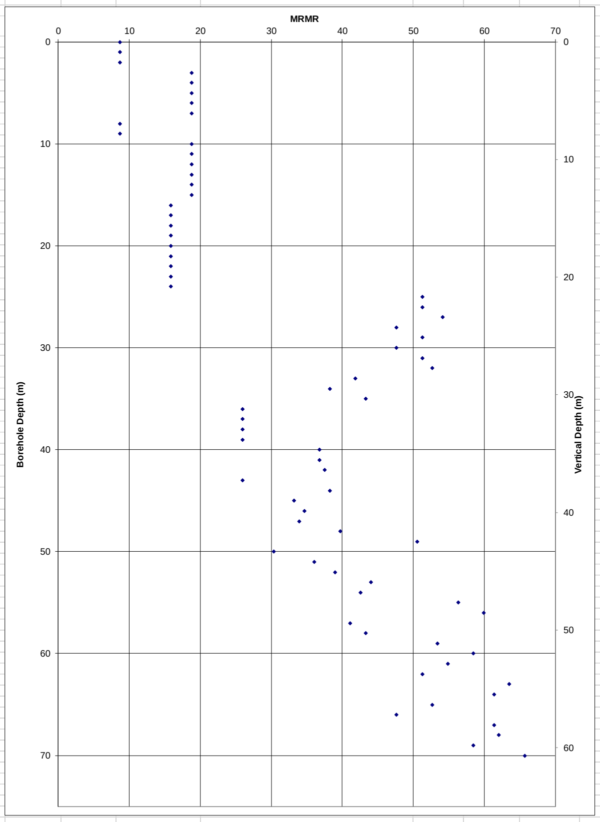
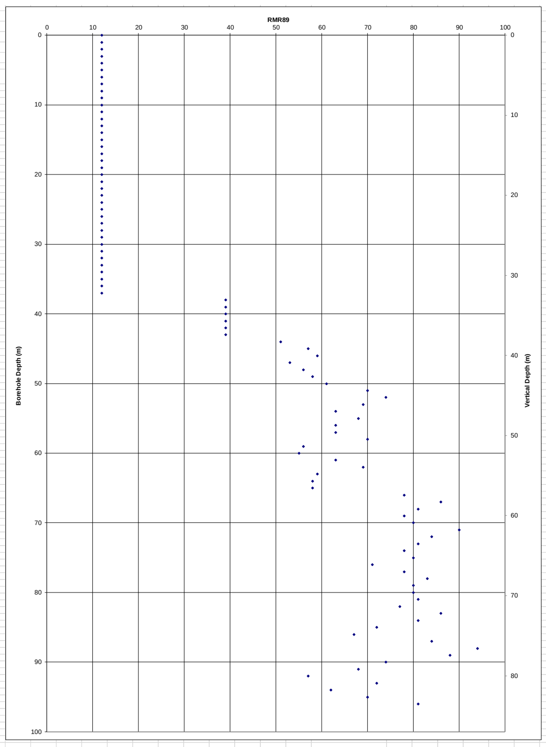


Figure A2 Borehole FBDD-002 summary geotechnical log, RMR and MRMR rock mass classification

Project:	Ramelius - Die Hardy			Date:	November 2020		
Hole ID:	FBDD003	Hole Dip	-60°	Ref Table	Ref Table	Jf = Joint filled	S1=Soft<5mm	VR=Very Rough
Northing:	6683393.319	Hole Azi	060°	W1, W2, W3	R0, R1, R2		S2=Soft>5mm	R=Rough
Easting:	732848.965	Bit Size:	HQ3	W4, W5, W6	R3, R4, R5		H1=Hard<5mm	SR=Slightly Rough
Elevation:	502.352				R6	J = Joint	H2=Hard>5mm	SM=Smooth
							Nil=No filling	SL=Slickensided

Drill Record			Recovery	RQD	Fractures	Materials			Structures				
From (m)	To (m)	Drill (m)	m	m	Number of Fractures	Rock Type	Weathering Grade	Strength Grade	Structural Type	Infill (mm)	Infill Hardness & Thickness	Joint Roughness	Comments
0.00	1.00	1.00	0.00	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	0 to 7m laterite, unconsolidated, gravel/ clay Very Poor
1.00	2.00	1.00	0.80	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
2.00	3.00	1.00	1.00	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
3.00	4.00	1.00	1.00	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
4.00	5.00	1.00	0.40	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
5.00	6.00	1.00	0.20	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
6.00	7.00	1.00	0.40	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
7.00	8.00	1.00	0.10	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	7 to 37m saprolite/ clay, minor saprock, Very Poor
8.00	9.00	1.00	0.70	0.00	99	TMZ/ TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	
9.00	10.00	1.00	0.60	0.00	99	TMZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
10.00	11.00	1.00	0.90	0.00	99	TMZ	W5 - W6	≤ R0	NA	NA	NA	NA	
11.00	12.00	1.00	1.00	0.00	99	TMZ	W5 - W6	≤ R0	NA	NA	NA	NA	
12.00	13.00	1.00	0.60	0.00	99	TMZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
13.00	14.00	1.00	0.60	0.00	99	TMZ/ TCZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
14.00	15.00	1.00	0.60	0.00	99	TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
15.00	16.00	1.00	1.00	0.00	99	TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
16.00	17.00	1.00	1.00	0.00	99	TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
17.00	18.00	1.00	1.00	0.00	99	TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
18.00	19.00	1.00	1.00	0.00	99	UZZ/ TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
19.00	20.00	1.00	0.70	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
20.00	21.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
21.00	22.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
22.00	23.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
23.00	24.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
24.00	25.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
25.00	26.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
26.00	27.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
27.00	28.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
28.00	29.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
29.00	30.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
30.00	31.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
31.00	32.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
32.00	33.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
33.00	34.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
34.00	35.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
35.00	36.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
36.00	37.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
37.00	38.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	37 to 44m saprock, Poor rock
38.00	39.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
39.00	40.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
40.00	41.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
41.00	42.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
42.00	43.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
43.00	44.00	1.00	1.00	0.00	99	UZZ/ SIF	W4	R2	Jn	Oxide S 1mm	S1	R	
44.00	45.00	1.00	1.00	0.62	6	SIF	W2 - W3	R2	Bed	Oxide S 1mm	S1	R	44 to 50m Fair rock
45.00	46.00	1.00	1.00	0.76	7	SIF	W2 - W3	R2	Bed	Oxide H ≤ 1mm	H1	R	
46.00	47.00	1.00	1.00	0.89	4	SIF	W2 - W3	R2	Bed	Oxide H ≤ 1mm	H1	R	
47.00	48.00	1.00	1.00	0.55	8	SIC/ OZZ	W2 - W3	R2	Bed	Oxide H ≤ 1mm	H1	R	
48.00	49.00	1.00	1.00	0.51	8	VQZ/ SIC/ OZZ	W2 - W3	R2	Vn	Nil	Nil	VR	
49.00	50.00	1.00	1.00	0.85	6	VQZ/ SIC	W2 - W3	R2	Vn	Oxide H ≤ 1mm	H1	VR	
50.00	51.00	1.00	1.00	0.45	12	SIF	W2	R5	Bed	Clay 2mm	S1	R	50 to 64m frequent partings on bedding, Fair rock
51.00	52.00	1.00	1.00	0.78	5	SIF	W2	R5	Bed	Clay 2mm	S1	R	
52.00	53.00	1.00	1.00	0.89	3	SIF/ WCU	W2	R5	Jn	Oxide H ≤ 1mm	H1	R	
53.00	54.00	1.00	1.00	0.61	10	SIF	W2	R5	Jn	Oxide H ≤ 1mm	H1	VR	
54.00	55.00	1.00	1.00	0.49	8	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
55.00	56.00	1.00	1.00	0.54	5	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
56.00	57.00	1.00	1.00	0.36	8	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
57.00	58.00	1.00	1.00	0.32	15	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
58.00	59.00	1.00	1.00	0.57	12	SIF	W2	R5	Bed	Nil	Nil	R	
59.00	60.00	1.00	1.00	0.00	20+	SIF	W2	R5	Jn	Oxide H ≤ 1mm	H1	VR	
60.00	61.00	1.00	1.00	0.00	17	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
61.00	62.00	1.00	1.00	0.37	16	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
62.00	63.00	1.00	1.00	0.68	5	SIF	W2	R5	Jn	Oxide H ≤ 1mm	H1	VR	
63.00	64.00	1.00	1.00	0.12	15	SIF	W1	R5	Jn	Carb H 1mm	H1	R	
64.00	65.00	1.00	1.00	0.11	20+	SIF	W1	R5	Bed	Nil	Nil	R	64 to 66m BIF contact, more fractured/ broken Fair to Poor
65.00	66.00	1.00	1.00	0.00	20+	SIF	W1	R5	Bed	Nil	Nil	R	
66.00	67.00	1.00	1.00	0.83	4	SIF	W1	R5	Jn	Nil	Nil	VR	66 to 70m brecciated BIF, Good rock
67.00	68.00	1.00	1.00	1.00	1	SIF	W1	R5	Jn	Nil	Nil	VR	
68.00	69.00	1.00	1.00	0.91	4	SIF	W1	R5	Jn	Nil	Nil	VR	
69.00	70.00	1.00	1.00	0.90	2	SIF	W1	R5	Jn	Nil	Nil	VR	
70.00	71.00	1.00	1.00	0.92	3	SIF	W1	R5	Jn	Nil	Nil	R	70 to 85m BIF & mafic, Good to Very Good rock
71.00	72.00	1.00	1.00	1.00	0	SIF	W1	R5	Jn	Nil	Nil	R	
72.00	73.00	1.00	1.00	1.00	1	SIF	W1	R5	Jn	Oxide H ≤ 1mm	H1	VR	
73.00	74.00	1.00	1.00	1.00	3	SIF	W1	R5	Bed	Nil	Nil	VR	
74.00	75.00	1.00	1.00	1.00	3	SIF	W1	R5	Jn	Oxide H ≤ 1mm	H1	R	
75.00	76.00	1.00	1.00	1.00	3	SIF/ UZZ	W1	R5	Bed	Nil	Nil	R	
76.00	77.00	1.00	1.00	0.55	6	MDZ/ SIF	W1	R5	Jn	Nil	Nil	R	
77.00	78.00	1.00	1.00	1.00	4	MDZ	W1	R5	Jn	Carb H ≤ 1mm	H1	R	
78.00	79.00	1.00	1.00	1.00	1	MDZ	W1	R5	Jn	Carb H ≤ 1mm	H1	R	
79.00	80.00	1.00	1.00	0.92	3	UAC/ MDZ	W1	R5	Jn	Nil	Nil	R	
80.00	81.00	1.00	1.00	1.00	3	UAC	W1	R5	Jn	Nil	Nil	R	
81.00	82.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Nil	Nil	VR	
82.00	83.00	1.00	1.00	0.89	4	UAC	W1	R5	Jn	Nil	Nil	R	
83.00	84.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil	Nil	VR	
84.00	85.00	1.00	1.00	1.00	3	UAC	W1	R5	Jn	Nil	Nil	VR	
85.00	86.00	1.00	1.00	0.51	20+	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	85m to EOH, UM, some broken zones, Fair to Good rock
86.00	87.00	1.00	1.00	0.48	20+	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
87.00	88.00	1.00	1.00	0.92	4	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
88.00	89.00	1.00	1.00	1.00	0	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
89.00	90.00	1.00	1.00	1.00	1	UAC	W1	R4 - R5	Jn	Nil	Nil	R	
90.00	91.00	1.00	1.00	0.53	5	UAC	W1	R4 - R5	Jn	Nil	Nil	R	
91.00	92.00	1.00	1.00	0.38	11	UAC	W1	R4 - R5	Jn	Carb H 1mm	H1	VR	
92.00	93.00	1.00	1.00	0.11	18	UAC	W1	R4 - R5	Jn	Nil	Nil	SM	
93.00	94.00	1.00	1.00	0.58	18	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
94.00	95.00	1.00	1.00	0.00	20+	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
95.00	96.00	1.00	1.00	0.31	11	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
96.00	96.30	0.30	0.30	0.23	1	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	

From (m)	Calculated Parameters				RMR89 Rating									
	Recovery	RQD	Fractures	Spacing					Joint Conditions					
	%	%	FF (p/m)	SP (mm)	IRS (15)	RQD (20)	Spacing (20)	Water (15)	Persistence (6)	Separation (6)	Roughness (6)	Infill (6)	Weathering (6)	RMR89' (100)
0.00	0	0	990000	0	15	3	5	15	3	3	0	6	0	12
1.00	80	0	124	8	15	3	5	15	3	3	0	6	0	12
2.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
3.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
4.00	40	0	248	4	15	3	5	15	3	3	0	6	0	12
5.00	20	0	495	2	15	3	5	15	3	3	0	6	0	12
6.00	40	0	248	4	15	3	5	15	3	3	0	6	0	12
7.00	10	0	990	1	15	3	5	15	3	3	0	6	0	12
8.00	70	0	141	7	15	3	5	15	3	3	0	6	0	12
9.00	60	0	165	6	15	3	5	15	3	3	0	6	0	12
10.00	90	0	110	9	15	3	5	15	3	3	0	6	0	12
11.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
12.00	60	0	165	6	15	3	5	15	3	3	0	6	0	12
13.00	60	0	165	6	15	3	5	15	3	3	0	6	0	12
14.00	60	0	165	6	15	3	5	15	3	3	0	6	0	12
15.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
16.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
17.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
18.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
19.00	70	0	141	7	2	3	5	15	3	3	0	6	0	12
20.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
21.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
22.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
23.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
24.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
25.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
26.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
27.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
28.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
29.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
30.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
31.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
32.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
33.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
34.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
35.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
36.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
37.00	100	0	99	10	2	3	5	15	3	3	5	2	1	12
38.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
39.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
40.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
41.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
42.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
43.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
44.00	100	62	6	167	2	13	8	15	3	3	5	2	0	51
45.00	100	76	7	143	2	17	8	15	3	3	5	4	0	57
46.00	100	89	4	250	2	17	10	15	3	3	5	4	0	59
47.00	100	55	8	125	2	13	8	15	3	3	5	4	0	53
48.00	100	51	8	125	2	13	8	15	3	3	6	6	0	56
49.00	100	85	6	167	2	17	8	15	3	3	6	4	0	58
50.00	100	45	12	83	12	8	8	15	3	3	5	2	5	61
51.00	100	78	5	200	12	17	8	15	3	3	5	2	5	70
52.00	100	89	3	333	12	17	10	15	3	3	5	4	5	74
53.00	100	61	10	100	12	13	8	15	3	3	6	4	5	69
54.00	100	49	8	125	12	8	8	15	3	3	5	4	5	63
55.00	100	54	5	200	12	13	8	15	3	3	5	4	5	68
56.00	100	36	8	125	12	8	8	15	3	3	5	4	5	63
57.00	100	32	15	67	12	8	8	15	3	3	5	4	5	63
58.00	100	57	12	83	12	13	8	15	3	3	5	6	5	70
59.00	100	0	20	50	12	3	5	15	3	3	6	4	5	56
60.00	100	0	17	59	12	3	5	15	3	3	5	4	5	55
61.00	100	37	16	63	12	8	8	15	3	3	5	4	5	63
62.00	100	68	5	200	12	13	8	15	3	3	6	4	5	69
63.00	100	12	15	67	12	3	8	15	3	3	5	4	6	59
64.00	100	11	20	50	12	3	5	15	3	3	5	6	6	58
65.00	100	0	20	50	12	3	5	15	3	3	5	6	6	58
66.00	100	83	4	250	12	17	10	15	3	3	6	6	6	78
67.00	100	100	1	1000	12	20	15	15	3	3	6	6	6	86
68.00	100	91	4	250	12	20	10	15	3	3	6	6	6	81
69.00	100	90	2	500	12	17	10	15	3	3	6	6	6	78
70.00	100	92	3	333	12	20	10	15	3	3	5	6	6	80
71.00	100	100	0	9999	12	20	20	15	3	3	5	6	6	90
72.00	100	100	1	1000	12	20	15	15	3	3	6	4	6	84
73.00	100	100	3	333	12	20	10	15	3	3	6	6	6	81
74.00	100	100	3	333	12	20	10	15	3	3	5	4	6	78
75.00	100	100	3	333	12	20	10	15	3	3	5	6	6	80
76.00	100	55	6	167	12	13	8	15	3	3	5	6	6	71
77.00	100	100	4	250	12	20	10	15	3	3	5	4	6	78
78.00	100	100	1	1000	12	20	15	15	3	3	5	4	6	83
79.00	100	92	3	333	12	20	10	15	3	3	5	6	6	80
80.00	100	100	3	333	12	20	10	15	3	3	5	6	6	80
81.00	100	100	2	500	12	20	10	15	3	3	6	6	6	81
82.00	100	89	4	250	12	17	10	15	3	3	5	6	6	77
83.00	100	100	1	1000	12	20	15	15	3	3	6	6	6	86
84.00	100	100	3	333	12	20	10	15	3	3	6	6	6	81
85.00	100	51	20	50	15	13	5	15	3	3	6	6	6	72
86.00	100	48	20	50	15	8	5	15	3	3	6	6	6	67
87.00	100	92	4	250	15	20	10	15	3	3	6	6	6	84
88.00	100	100	0	9999	15	20	20	15	3	3	6	6	6	94
89.00	100	100	1	1000	15	20	15	15	3	3	5	6	6	88
90.00	100	53	5	200	15	13	8	15	3	3	5	6	6	74
91.00	100	38	11	91	15	8	8	15	3	3	6	4	6	68
92.00	100	11	18	56	15	3	5	15	3	3	1	6	6	57
93.00	100	58	18	56	15	13	5	15	3	3	6	6	6	72
94.00	100	0	20	50	15	3	5	15	3	3	6	6	6	62
95.00	100	31	11	91	15	8	8	15	3	3	6	6	6	70
96.00	100	77	3	300	15	17	10	15	3	3	6	6	6	81



MRMR Calcs

Drill Record		RMR	MRMR Calcs					
From (m)	To (m)	RMR89	Weathering	Joint Orientation	Induced Stress	Blasting effects	Total Adjustment	MRMR
0.00	1.00	12	0.96	0.80	1.00	0.94	0.72	9
1.00	2.00	12	0.96	0.80	1.00	0.94	0.72	9
2.00	3.00	12	0.96	0.80	1.00	0.94	0.72	9
3.00	4.00	12	0.96	0.80	1.00	0.94	0.72	9
4.00	5.00	12	0.96	0.80	1.00	0.94	0.72	9
5.00	6.00	12	0.96	0.80	1.00	0.94	0.72	9
6.00	7.00	12	0.96	0.80	1.00	0.94	0.72	9
7.00	8.00	12	0.96	0.80	1.00	0.94	0.72	9
8.00	9.00	12	0.96	0.80	1.00	0.94	0.72	9
9.00	10.00	12	0.96	0.80	1.00	0.94	0.72	9
10.00	11.00	12	0.96	0.80	1.00	0.94	0.72	9
11.00	12.00	12	0.96	0.80	1.00	0.94	0.72	9
12.00	13.00	12	0.96	0.80	1.00	0.94	0.72	9
13.00	14.00	12	0.96	0.80	1.00	0.94	0.72	9
14.00	15.00	12	0.96	0.80	1.00	0.94	0.72	9
15.00	16.00	12	0.96	0.80	1.00	0.94	0.72	9
16.00	17.00	12	0.96	0.80	1.00	0.94	0.72	9
17.00	18.00	12	0.96	0.80	1.00	0.94	0.72	9
18.00	19.00	12	0.96	0.80	1.00	0.94	0.72	9
19.00	20.00	12	0.96	0.80	1.00	0.94	0.72	9
20.00	21.00	12	0.96	0.80	1.00	0.94	0.72	9
21.00	22.00	12	0.96	0.80	1.00	0.94	0.72	9
22.00	23.00	12	0.96	0.80	1.00	0.94	0.72	9
23.00	24.00	12	0.96	0.80	1.00	0.94	0.72	9
24.00	25.00	12	0.96	0.80	1.00	0.94	0.72	9
25.00	26.00	12	0.96	0.80	1.00	0.94	0.72	9
26.00	27.00	12	0.96	0.80	1.00	0.94	0.72	9
27.00	28.00	12	0.96	0.80	1.00	0.94	0.72	9
28.00	29.00	12	0.96	0.80	1.00	0.94	0.72	9
29.00	30.00	12	0.96	0.80	1.00	0.94	0.72	9
30.00	31.00	12	0.96	0.80	1.00	0.94	0.72	9
31.00	32.00	12	0.96	0.80	1.00	0.94	0.72	9
32.00	33.00	12	0.96	0.80	1.00	0.94	0.72	9
33.00	34.00	12	0.96	0.80	1.00	0.94	0.72	9
34.00	35.00	12	0.96	0.80	1.00	0.94	0.72	9
35.00	36.00	12	0.96	0.80	1.00	0.94	0.72	9
36.00	37.00	12	0.96	0.80	1.00	0.94	0.72	9
37.00	38.00	12	0.96	0.80	1.00	0.94	0.72	9
38.00	39.00	39	0.96	0.80	1.00	0.94	0.72	28
39.00	40.00	39	0.96	0.80	1.00	0.94	0.72	28
40.00	41.00	39	0.96	0.80	1.00	0.94	0.72	28
41.00	42.00	39	0.96	0.80	1.00	0.94	0.72	28
42.00	43.00	39	0.96	0.80	1.00	0.94	0.72	28
43.00	44.00	39	0.96	0.80	1.00	0.94	0.72	28
44.00	45.00	51	0.96	0.80	1.00	0.94	0.72	37
45.00	46.00	57	0.96	0.80	1.00	0.94	0.72	41
46.00	47.00	59	0.96	0.80	1.00	0.94	0.72	43
47.00	48.00	53	0.96	0.80	1.00	0.94	0.72	38
48.00	49.00	56	0.96	0.80	1.00	0.94	0.72	40
49.00	50.00	58	0.96	0.80	1.00	0.94	0.72	42
50.00	51.00	61	0.96	0.80	1.00	0.94	0.72	44
51.00	52.00	70	0.96	0.80	1.00	0.94	0.72	51
52.00	53.00	74	0.96	0.80	1.00	0.94	0.72	53
53.00	54.00	69	0.96	0.80	1.00	0.94	0.72	50
54.00	55.00	63	0.96	0.80	1.00	0.94	0.72	45
55.00	56.00	68	0.96	0.80	1.00	0.94	0.72	49
56.00	57.00	63	0.96	0.80	1.00	0.94	0.72	45
57.00	58.00	63	0.96	0.80	1.00	0.94	0.72	45
58.00	59.00	70	0.96	0.80	1.00	0.94	0.72	51
59.00	60.00	56	0.96	0.80	1.00	0.94	0.72	40
60.00	61.00	55	0.96	0.80	1.00	0.94	0.72	40
61.00	62.00	63	0.96	0.80	1.00	0.94	0.72	45
62.00	63.00	69	0.96	0.80	1.00	0.94	0.72	50
63.00	64.00	59	0.96	0.80	1.00	0.94	0.72	43
64.00	65.00	58	0.96	0.80	1.00	0.94	0.72	42
65.00	66.00	58	0.96	0.80	1.00	0.94	0.72	42
66.00	67.00	78	0.96	0.80	1.00	0.94	0.72	56
67.00	68.00	86	0.96	0.80	1.00	0.94	0.72	62
68.00	69.00	81	0.96	0.80	1.00	0.94	0.72	58
69.00	70.00	78	0.96	0.80	1.00	0.94	0.72	56
70.00	71.00	80	0.96	0.80	1.00	0.94	0.72	58
71.00	72.00	90	0.96	0.80	1.00	0.94	0.72	65
72.00	73.00	84	0.96	0.80	1.00	0.94	0.72	61
73.00	74.00	81	0.96	0.80	1.00	0.94	0.72	58
74.00	75.00	78	0.96	0.80	1.00	0.94	0.72	56
75.00	76.00	80	0.96	0.80	1.00	0.94	0.72	58
76.00	77.00	71	0.96	0.80	1.00	0.94	0.72	51
77.00	78.00	78	0.96	0.80	1.00	0.94	0.72	56
78.00	79.00	83	0.96	0.80	1.00	0.94	0.72	60
79.00	80.00	80	0.96	0.80	1.00	0.94	0.72	58
80.00	81.00	80	0.96	0.80	1.00	0.94	0.72	58
81.00	82.00	81	0.96	0.80	1.00	0.94	0.72	58
82.00	83.00	77	0.96	0.80	1.00	0.94	0.72	56
83.00	84.00	86	0.96	0.80	1.00	0.94	0.72	62
84.00	85.00	81	0.96	0.80	1.00	0.94	0.72	58
85.00	86.00	72	0.96	0.80	1.00	0.94	0.72	52
86.00	87.00	67	0.96	0.80	1.00	0.94	0.72	48
87.00	88.00	84	0.96	0.80	1.00	0.94	0.72	61
88.00	89.00	94	0.96	0.80	1.00	0.94	0.72	68
89.00	90.00	88	0.96	0.80	1.00	0.94	0.72	64
90.00	91.00	74	0.96	0.80	1.00	0.94	0.72	53
91.00	92.00	68	0.96	0.80	1.00	0.94	0.72	49
92.00	93.00	57	0.96	0.80	1.00	0.94	0.72	41
93.00	94.00	72	0.96	0.80	1.00	0.94	0.72	52
94.00	95.00	62	0.96	0.80	1.00	0.94	0.72	45
95.00	96.00	70	0.96	0.80	1.00	0.94	0.72	51
96.00	96.30	81	0.96	0.80	1.00	0.94	0.72	58

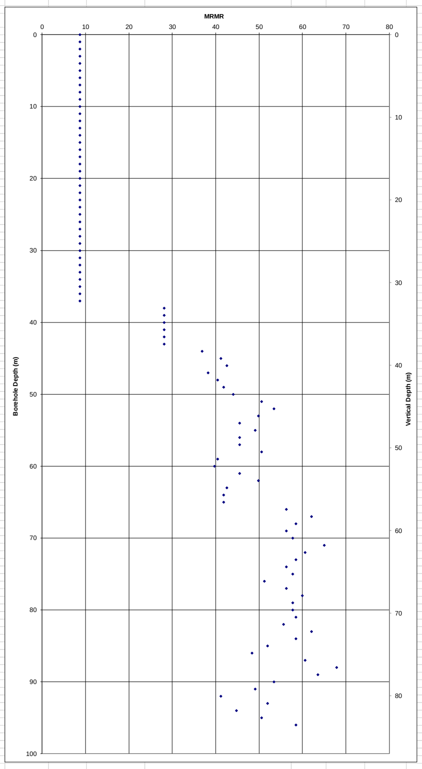


Figure A3 Borehole FBDD-003 summary geotechnical log, RMR and MRMR rock mass classification

APPENDIX B

LABORATORY ROCK PROPERTY TEST RESULTS

UNIAXIAL COMPRESSIVE STRENGTH (UCS)

ELASTIC PROPERTY DETERMINATIONS (UCSE)

MULTI-STAGE DEFECT DIRECT SHEAR

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E-mail: Phillip.li@eprecisionlab.com

E-Precision Laboratory

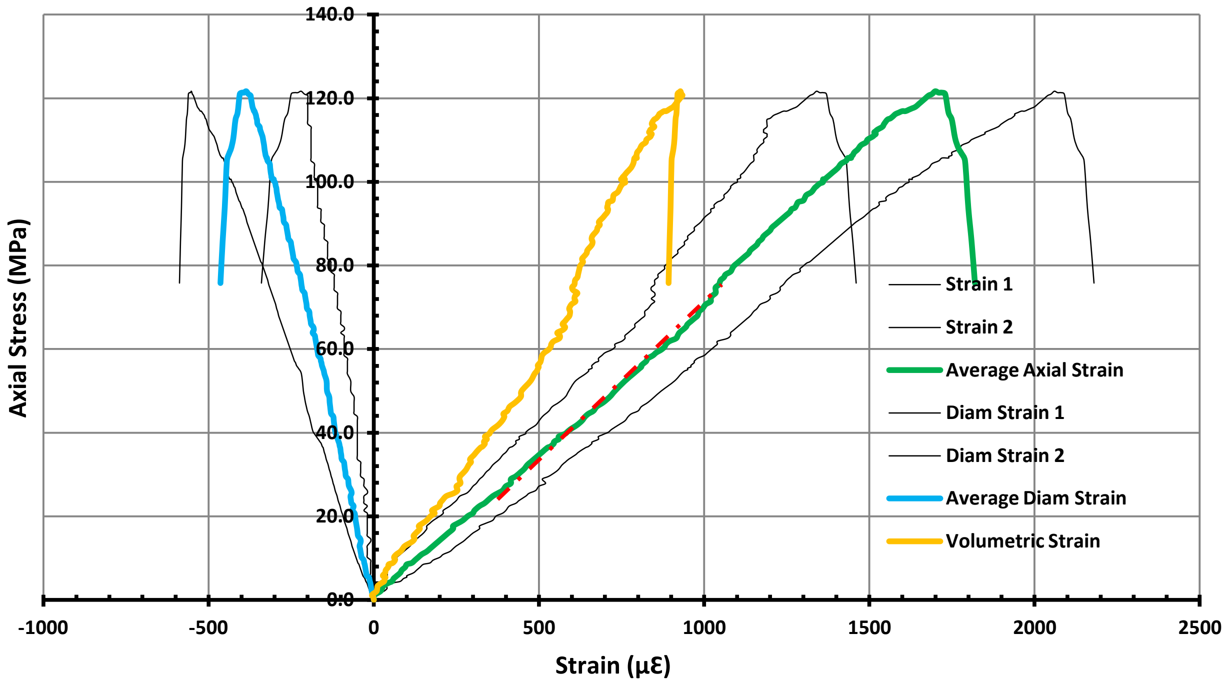
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS01	Lab:	EPLab
Sample ID:	FBDD-001_UCS01_UCSE		
Depth (m):	46.35 - 46.56	Room Temperature at Test:	18°C

Tested by:	Phil	**Geology:**	SIF
Checked by:	Phil		
Length (mm):	152.09	**Length/Diameter Ratio:**	2.49
Diameter (mm):	61.20	**Bulk Density (t/m³):**	3.22
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)		121.70
Young's Modulus (GPa)		**Poisson's Ratio**
Secant (0-50%)	73.70	0.220
Tangent	73.29	0.214

Foliation Angle (°)	**78.2**	**Failure Mode**	**Shear**	**Moisture Content (%)**	**0.00**
				Bulk Density (t/m³)	**3.22**

Integrity Precision Innovation

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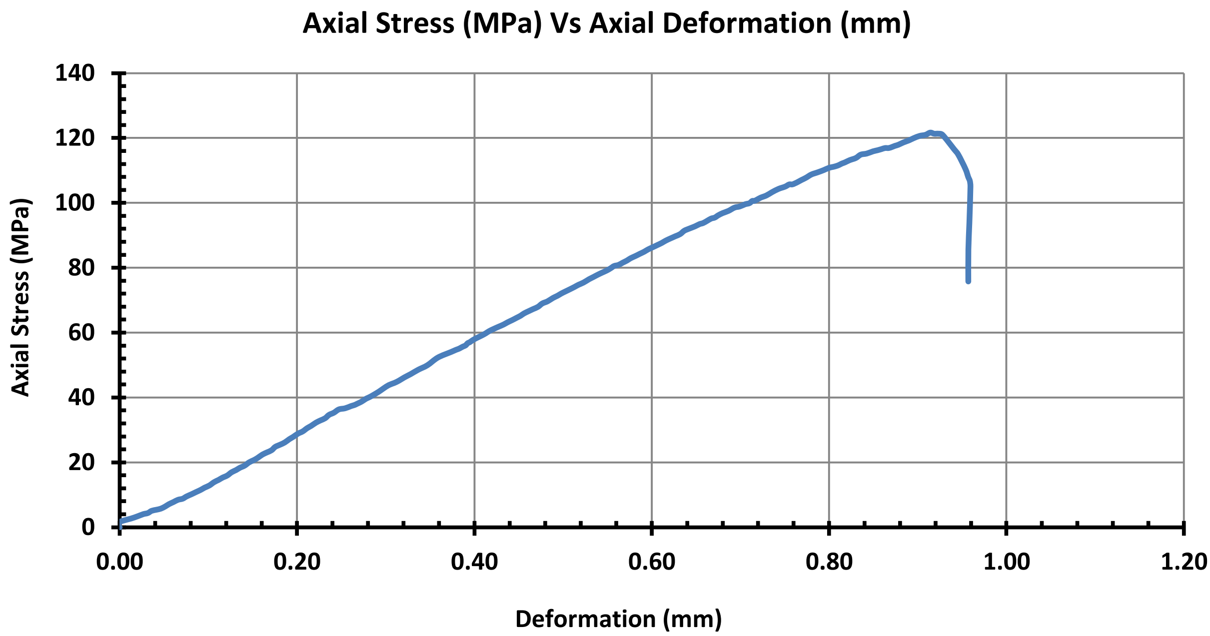
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS01	Lab:	EPLab
Sample ID:	FBDD-001_UCS01_UCSE		
Depth (m):	46.35 - 46.56	Room Temperature at Test:	18°C



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **26.9°** **Intact Shear**

Comments:

Stored and tested the Sample as received, samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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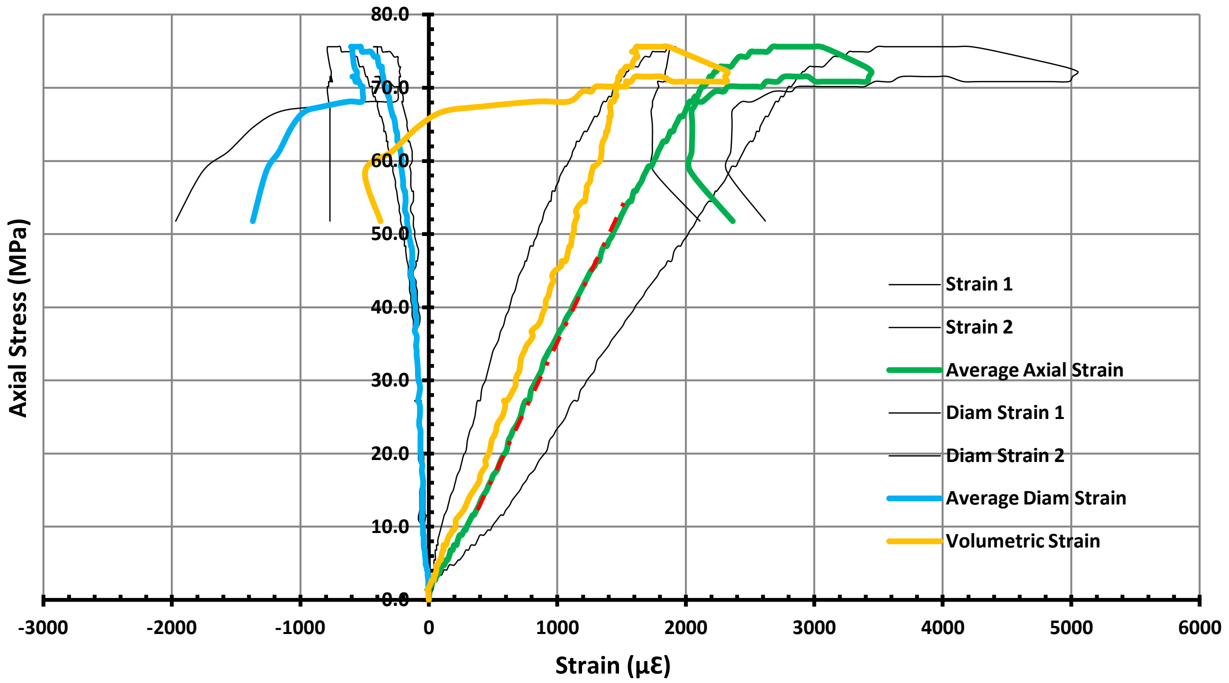
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS02	Lab:	EPLab
Sample ID:	FBDD-001_UCS02_UCSE		
Depth (m):	51.21 - 51.46	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	SIF
Checked by:	Phil		
Length (mm):	15.01	**Length/Diameter Ratio:**	0.25
Diameter (mm):	61.14	**Bulk Density (t/m³):**	30.87
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)				**75.62**	
Young's Modulus (GPa)				**Poisson's Ratio**	
Secant (0-50%)			**30.91**	**0.166**	
Tangent			**33.46**	**0.145**	
Foliation Angle (°)	**69.5**	**Failure Mode**	**Shear**	**Moisture Content (%)**	**0.00**
				Bulk Density (t/m³)	**30.87**

Integrity Precision Innovation

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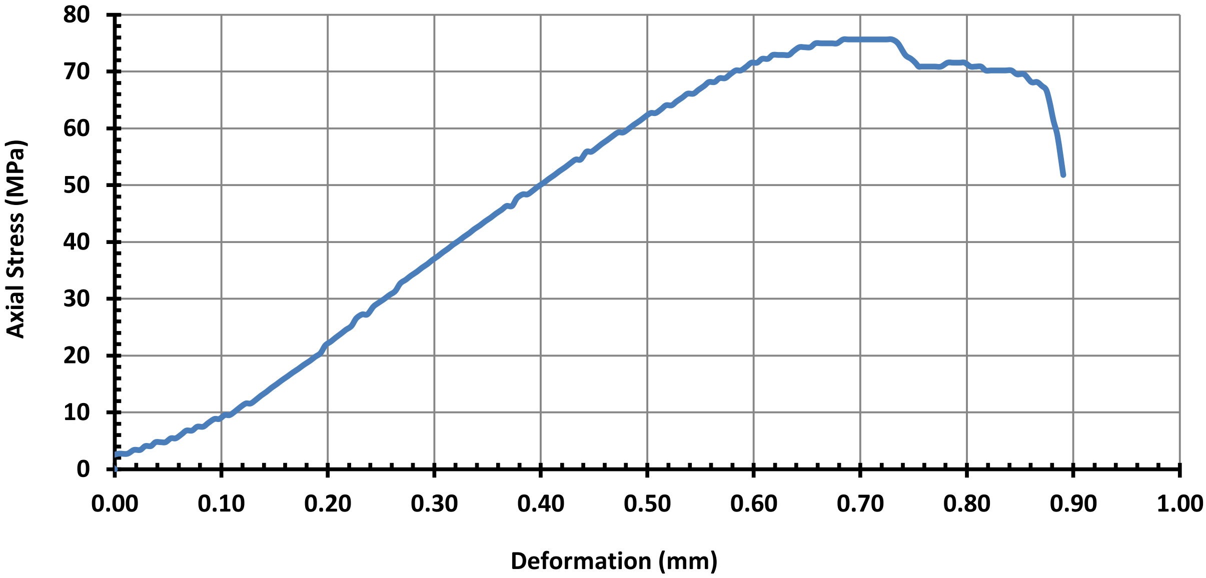
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS02	Lab:	EPLab
Sample ID:	FBDD-001_UCS02_UCSE		
Depth (m):	51.21 - 51.46	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **16.9°** **Intact Shear**

Comments:

Stored and tested the Sample as received, samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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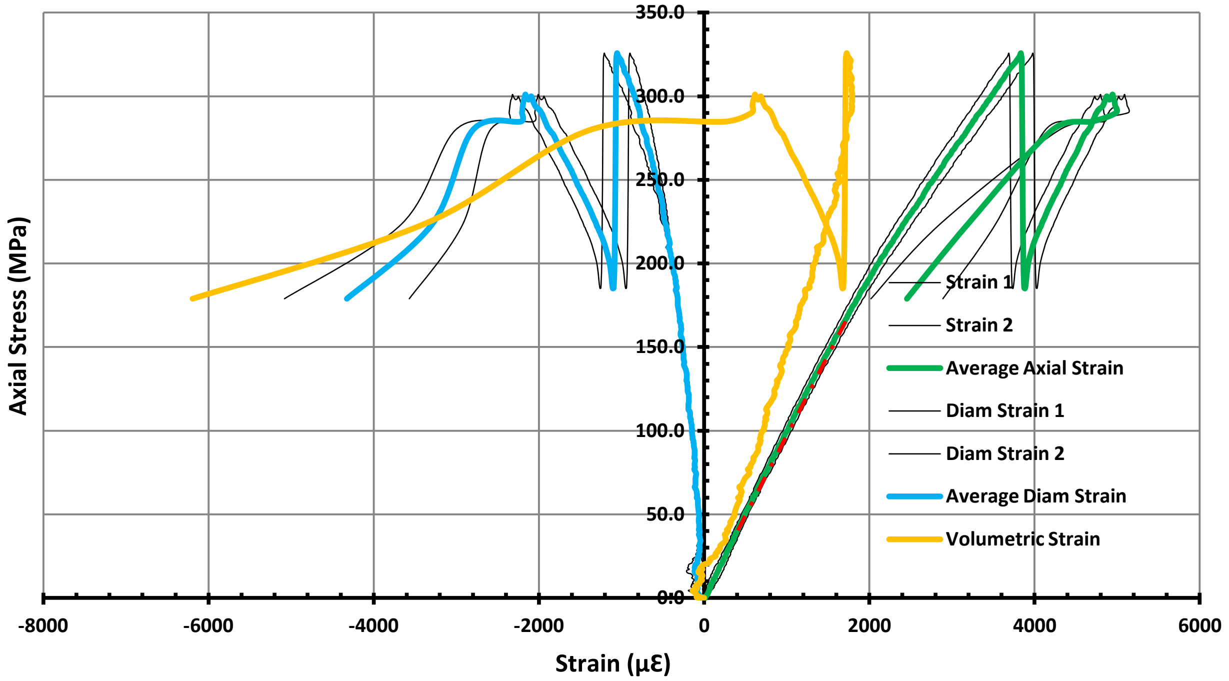
E-Precision Laboratory

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS03	Lab:	EPLab
Sample ID:	FBDD-001_UCS03_UCSE		
Depth (m):	61.75 - 61.97	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	SIF
Checked by:	Phil		
Length (mm):	150.53	**Length/Diameter Ratio:**	2.47
Diameter (mm):	61.01	**Bulk Density (t/m³):**	3.50
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)			**325.65**		
Young's Modulus (GPa)			**Poisson's Ratio**		
Secant (0-50%)		**99.38**	**0.152**		
Tangent		**99.54**	**0.150**		
Foliation Angle (°)	**N/A**	**Failure Mode**	**Shear**	**Moisture Content (%)**	**0.00**
				Bulk Density (t/m³)	**3.50**

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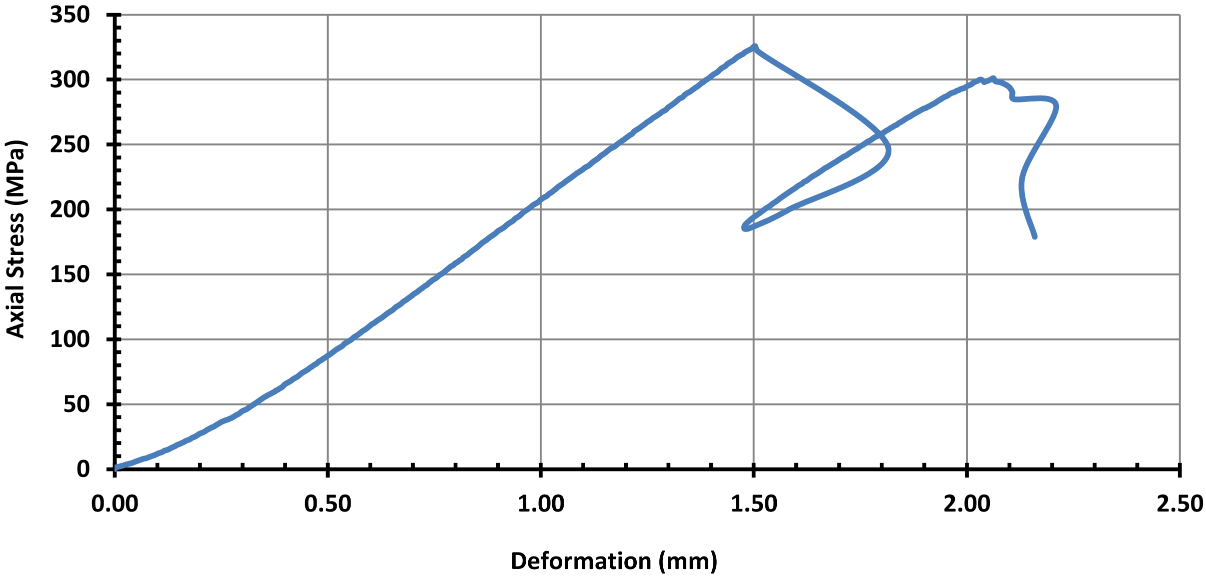
E-Precision Laboratory

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS03	Lab:	EPLab
Sample ID:	FBDD-001_UCS03_UCSE		
Depth (m):	61.75 - 61.97	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo	**Post Test Photo**
	

Failure Angle to Vertical: **33.5°** **Intact Shear**

Comments:

Stored and tested the Sample as received, samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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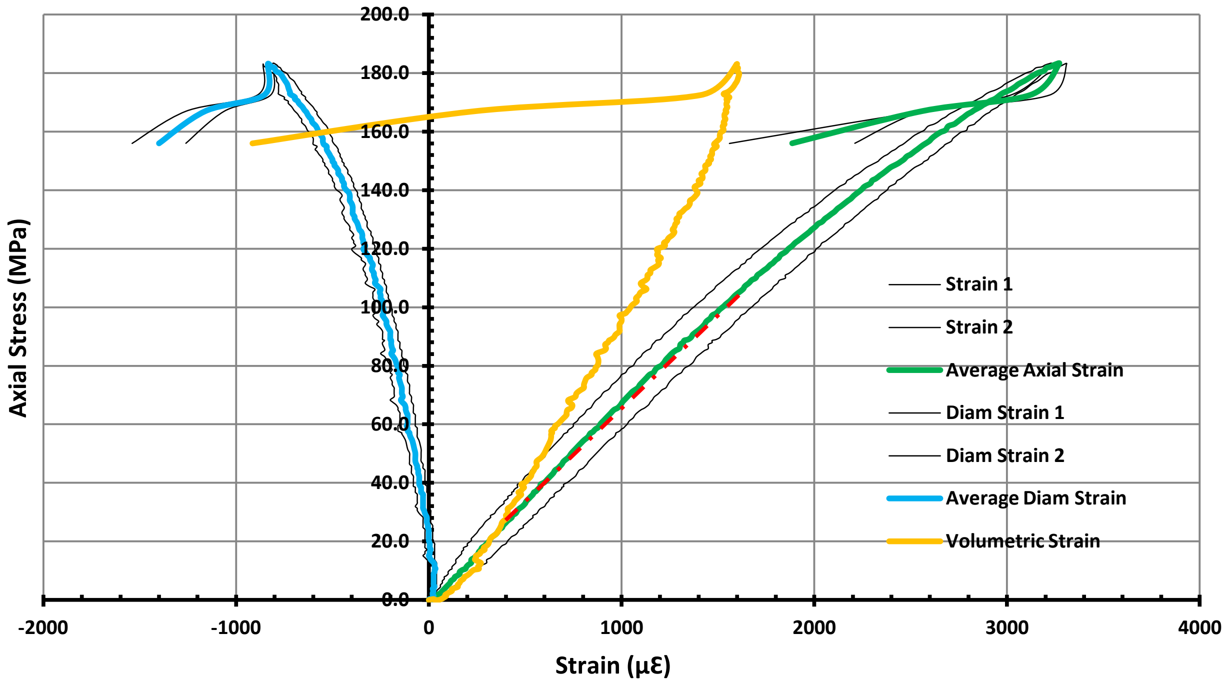
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS04	Lab:	EPLab
Sample ID:	FBDD-001_UCS04_UCSE		
Depth (m):	78.3 - 78.59	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	MDZ
Checked by:	Phil		
Length (mm):	150.41	**Length/Diameter Ratio:**	2.47
Diameter (mm):	60.87	**Bulk Density (t/m³):**	2.76
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)				**183.16**	
Young's Modulus (GPa)				**Poisson's Ratio**	
Secant (0-50%)			65.58	0.157	
Tangent			66.82	0.155	
Foliation Angle (°)	N/A	**Failure Mode**	Shear	**Moisture Content (%)**	0.00
				Bulk Density (t/m³)	2.76

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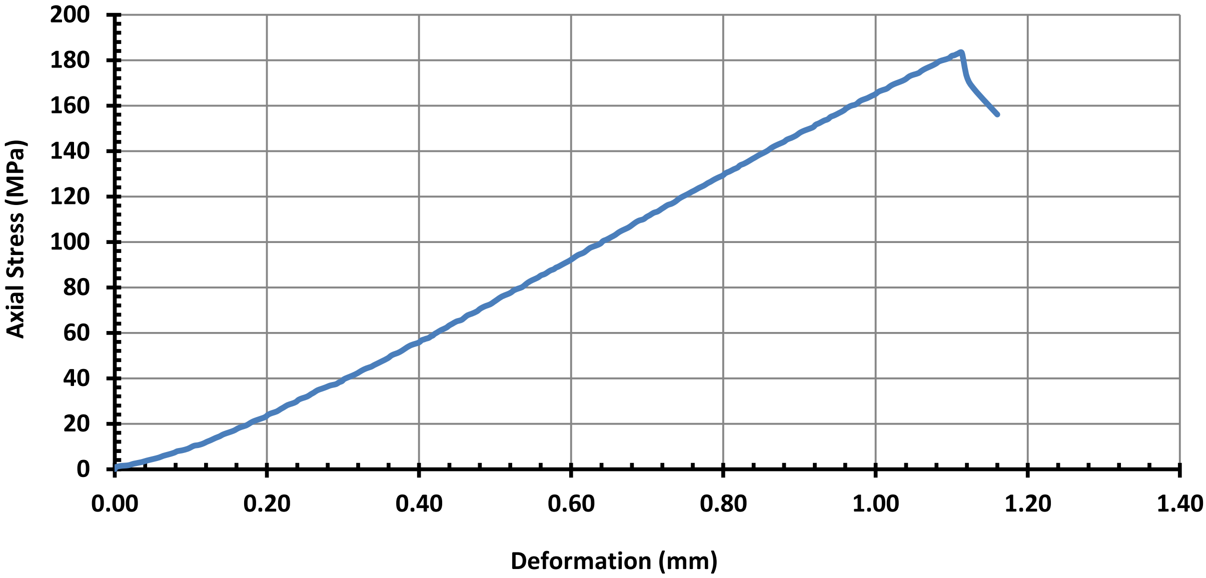
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS04	Lab:	EPLab
Sample ID:	FBDD-001_UCS04_UCSE		
Depth (m):	78.3 - 78.59	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **27.7°** **Intact Shear**

Comments:

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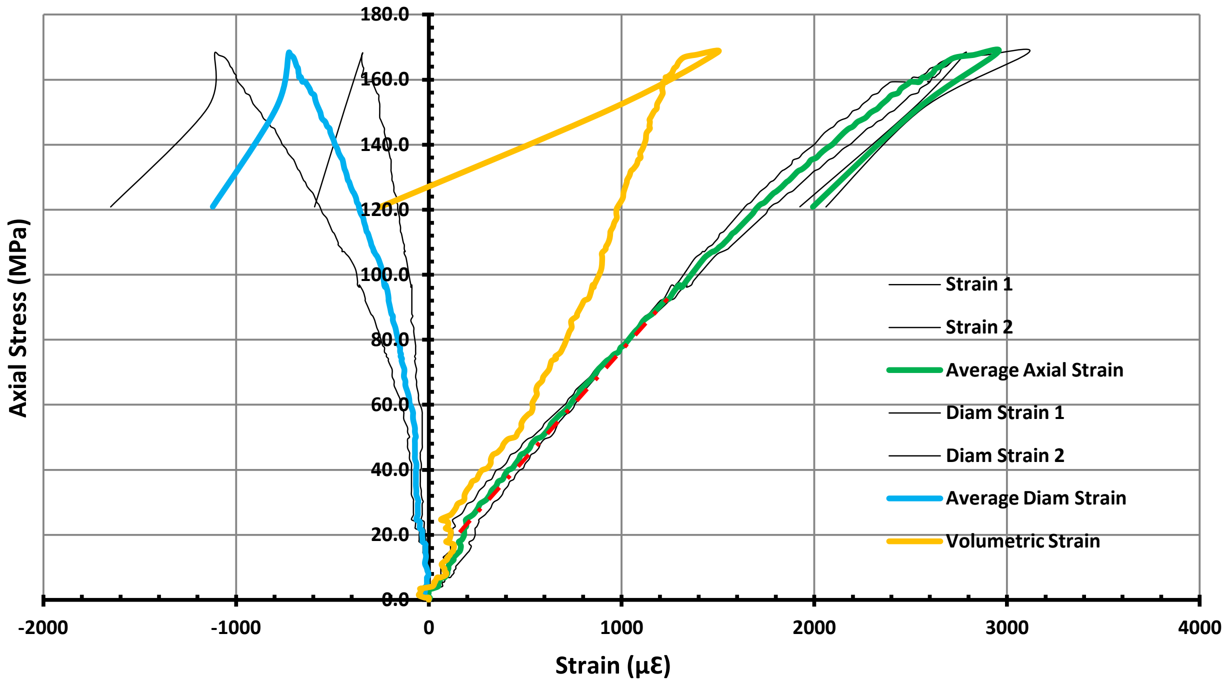
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS05	Lab:	EPLab
Sample ID:	FBDD-001_UCS05_UCSE		
Depth (m):	84.65 - 84.88	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	UAC
Checked by:	Phil		
Length (mm):	150.71	**Length/Diameter Ratio:**	2.48
Diameter (mm):	60.89	**Bulk Density (t/m³):**	2.92
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)		**168.27**	
Young's Modulus (GPa)		**Poisson's Ratio**	
Secant (0-50%)	**66.92**	**0.233**	
Tangent	**70.73**	**0.210**	
Foliation Angle (°)	**N/A**	**Failure Mode**	**Shear**
Moisture Content (%)	**0.00**		
Bulk Density (t/m³)	**2.92**		

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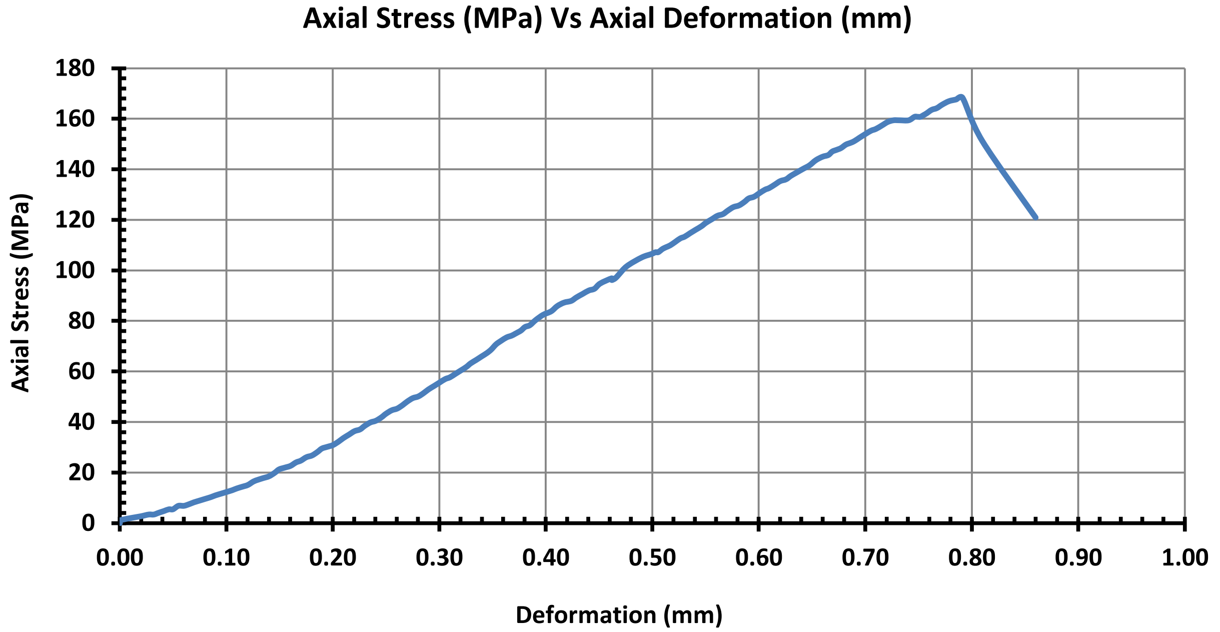
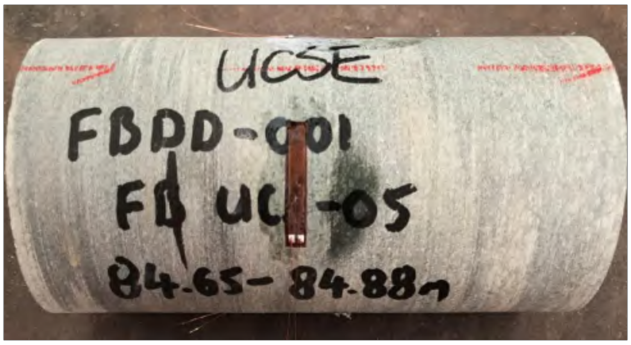
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS05	Lab:	EPLab
Sample ID:	FBDD-001_UCS05_UCSE		
Depth (m):	84.65 - 84.88	Room Temperature at Test:	18°C



Pre-Test Photo



Post Test Photo

Failure Angle to Vertical: **27.7°** **Intact Shear**

Comments:

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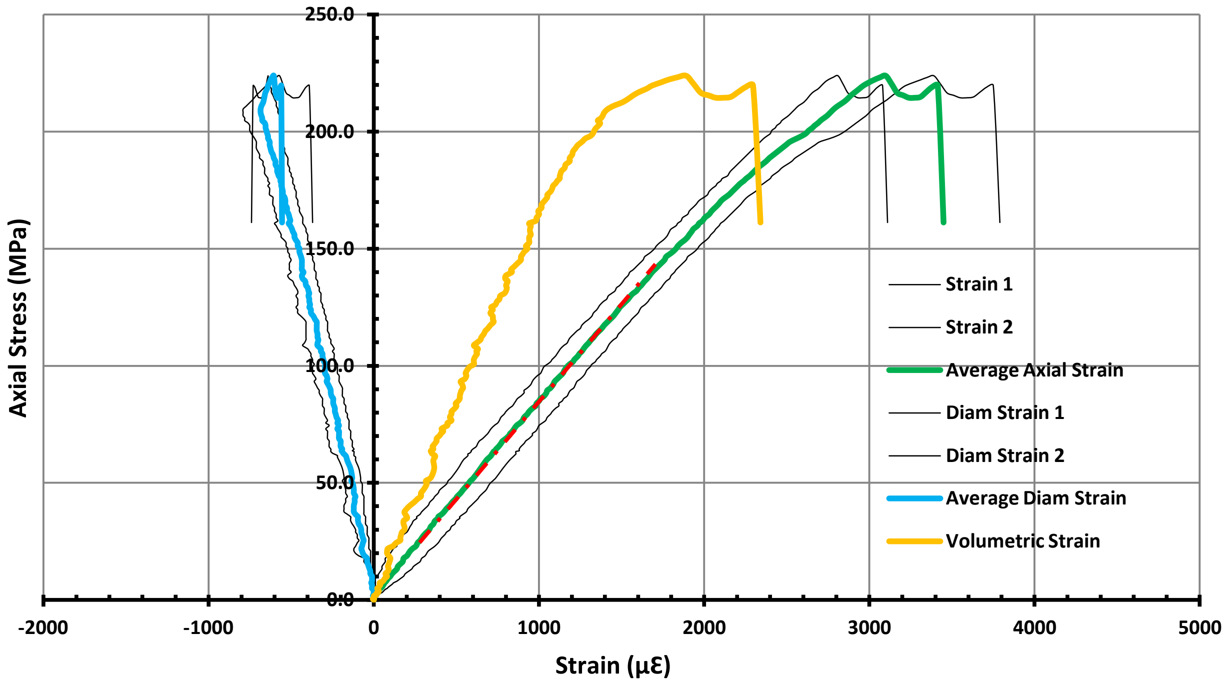
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	15/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-003_UCS06	Lab:	EPLab
Sample ID:	FBDD-003_UCS06_UCSE		
Depth (m):	77.28 - 77.49	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	MDZ
Checked by:	Phil		
Length (mm):	145.63	**Length/Diameter Ratio:**	2.41
Diameter (mm):	60.47	**Bulk Density (t/m³):**	2.80
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)		223.89	
Young's Modulus (GPa)		Poisson's Ratio	
Secant (0-50%)	82.65	0.250	
Tangent	83.57	0.252	
Foliation Angle (°)	N/A	Failure Mode	Shear
Moisture Content (%)	0.00		
Bulk Density (t/m³)	2.80		

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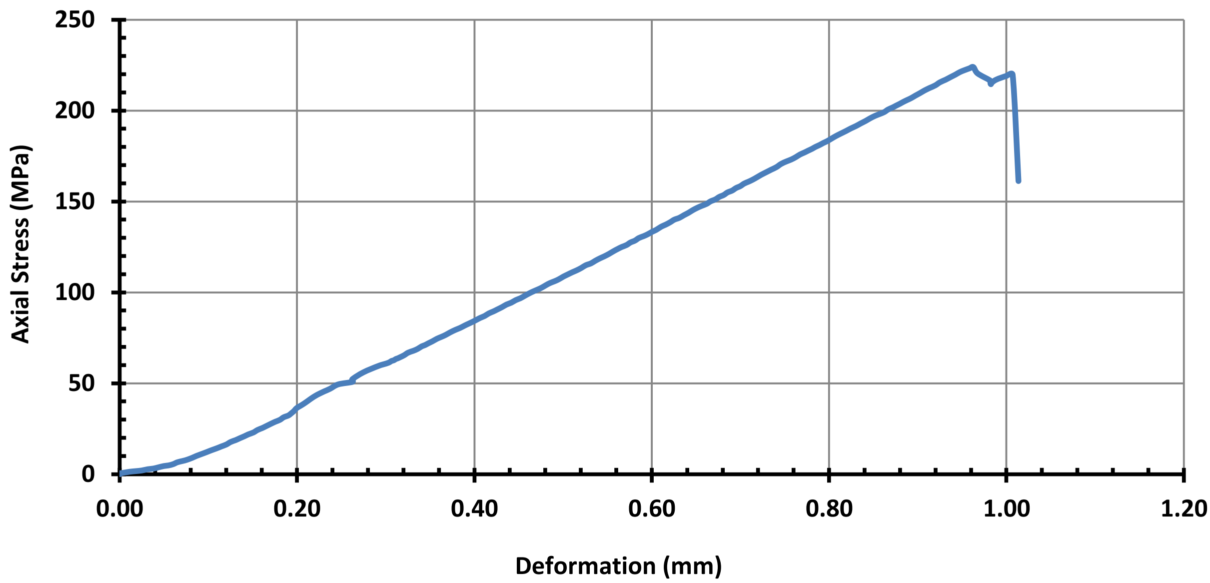
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	15/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-003_UCS06	Lab:	EPLab
Sample ID:	FBDD-003_UCS06_UCSE		
Depth (m):	77.28 - 77.49	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **23.1°** **Intact Shear**

Comments:

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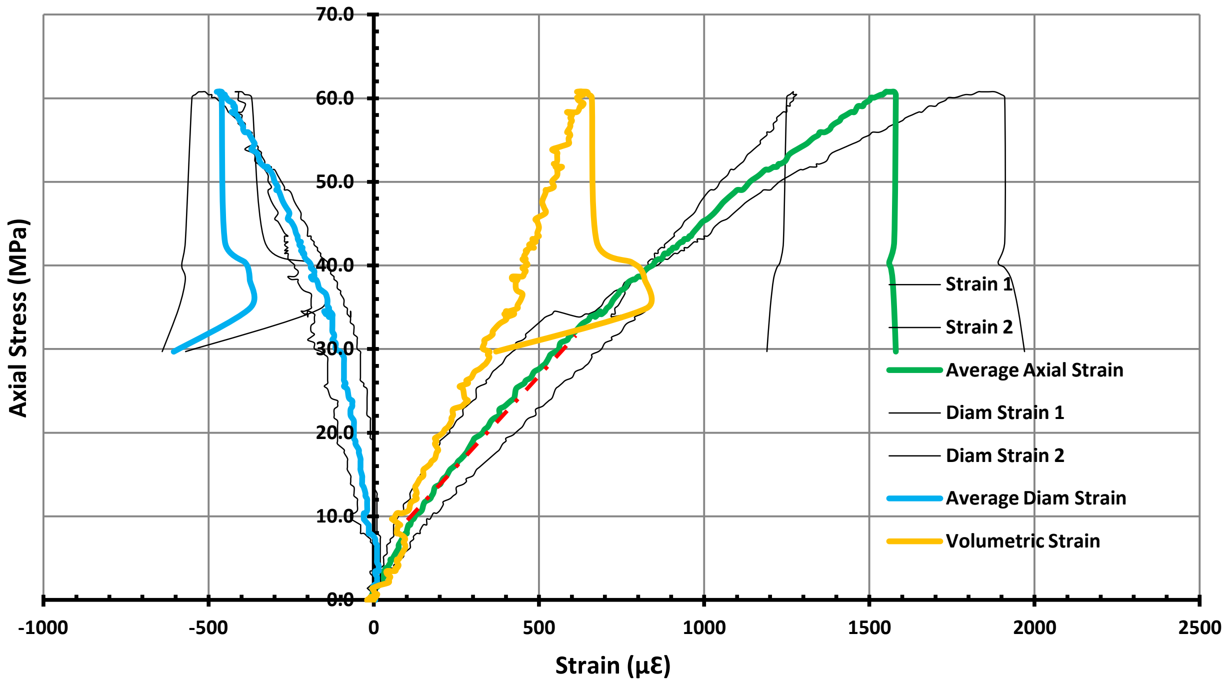
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	15/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-003_UCS07	Lab:	EPLab
Sample ID:	FBDD-003_UCS07_UCSE		
Depth (m):	88.62 - 88.85	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	UAC
Checked by:	Phil		
Length (mm):	148.19	**Length/Diameter Ratio:**	2.44
Diameter (mm):	60.72	**Bulk Density (t/m³):**	2.91
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)				**60.78**	
Young's Modulus (GPa)				**Poisson's Ratio**	
Secant (0-50%)			**46.05**	**0.237**	
Tangent			**48.52**	**0.234**	
Foliation Angle (°)	**N/A**	**Failure Mode**	**Shear**	**Moisture Content (%)** **Bulk Density (t/m³)**	**0.00** **2.91**

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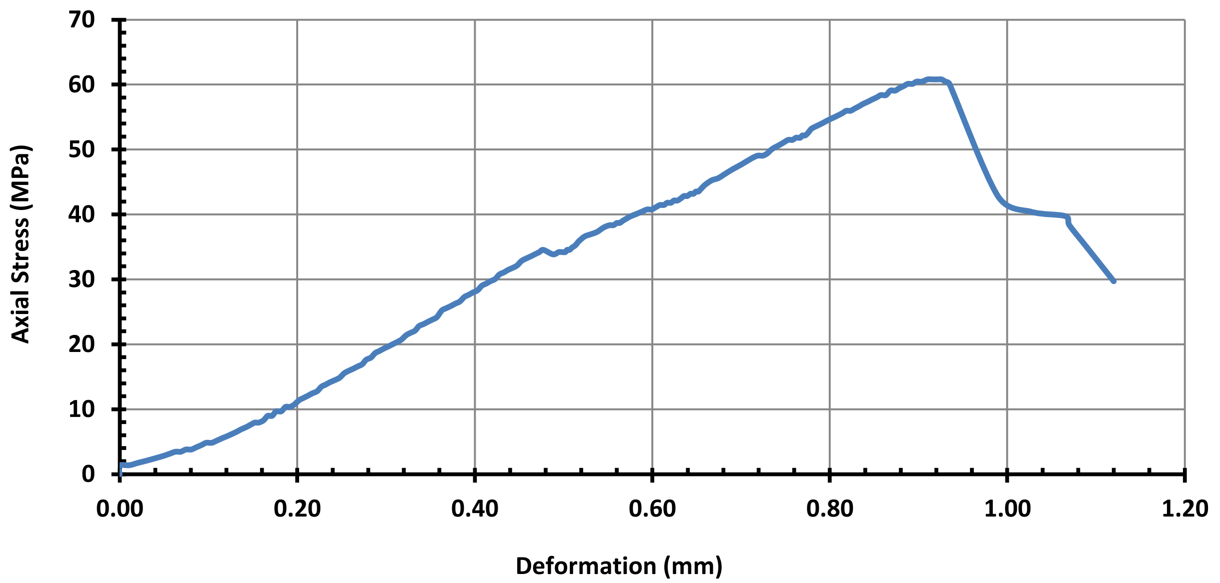
UCS & DEFORMATION TEST REPORT

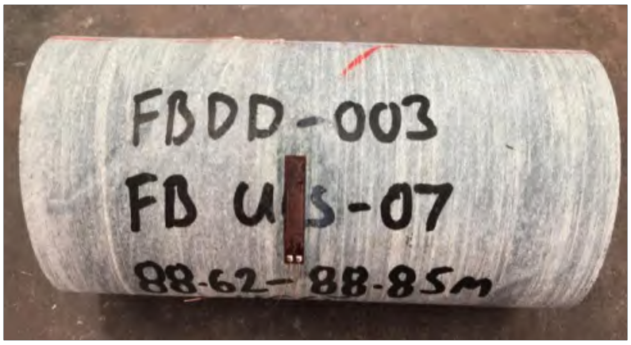
Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	15/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-003_UCS07	Lab:	EPLab
Sample ID:	FBDD-003_UCS07_UCSE		
Depth (m):	88.62 - 88.85	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo



Post Test Photo

Failure Angle to Vertical: **49.6°** **Shear on Structure**

Comments:

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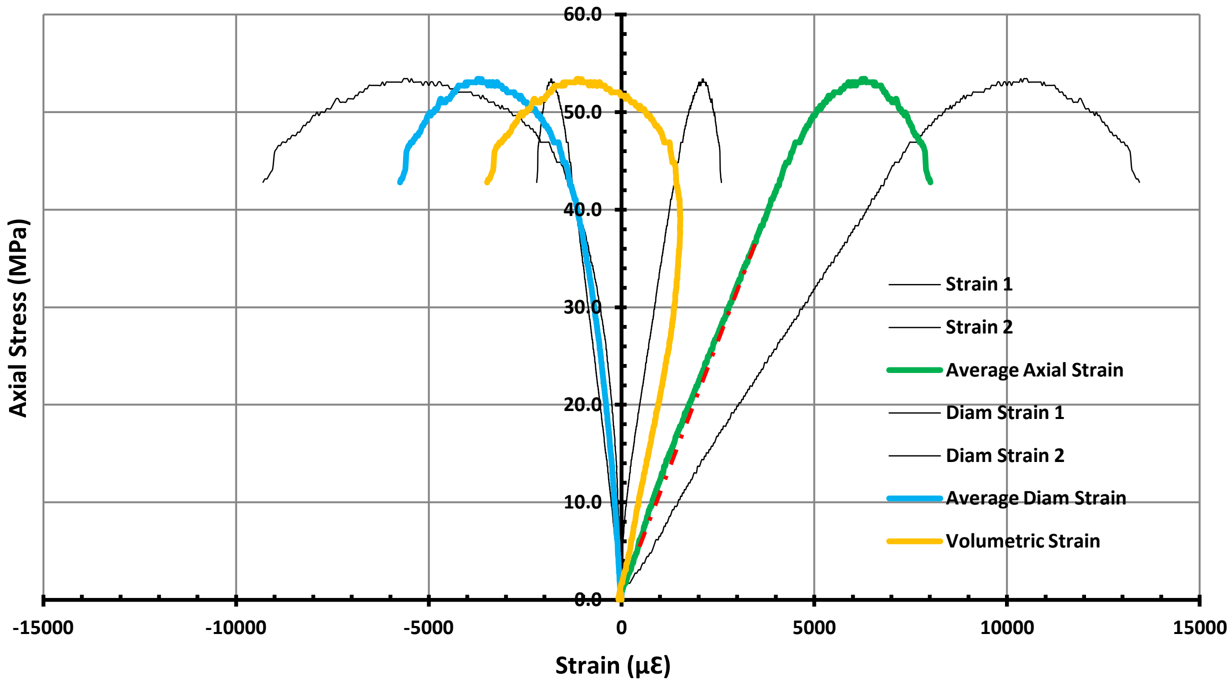
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-002_UCS08	Lab:	EPLab
Sample ID:	FBDD-002_UCS08_UCSE		
Depth (m):	55.21 - 55.44	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	MDZ
Checked by:	Phil		
Length (mm):	152.15	**Length/Diameter Ratio:**	2.50
Diameter (mm):	60.98	**Bulk Density (t/m³):**	2.66
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)			53.41	
Young's Modulus (GPa)			Poisson's Ratio	
Secant (0-50%)		11.11	0.235	
Tangent		11.45	0.230	
Foliation Angle (°)	N/A	Failure Mode: Shear	Moisture Content (%)	0.00
			Bulk Density (t/m³)	2.66

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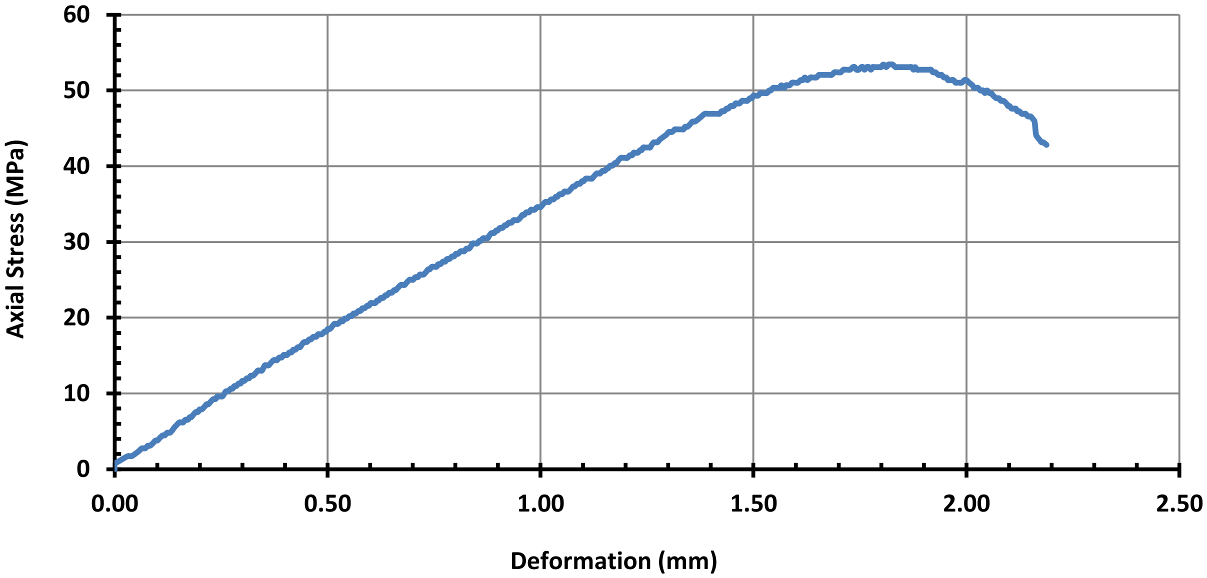
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-002_UCS08	Lab:	EPLab
Sample ID:	FBDD-002_UCS08_UCSE		
Depth (m):	55.21 - 55.44	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **28.7°** **Intact Shear**

Comments:

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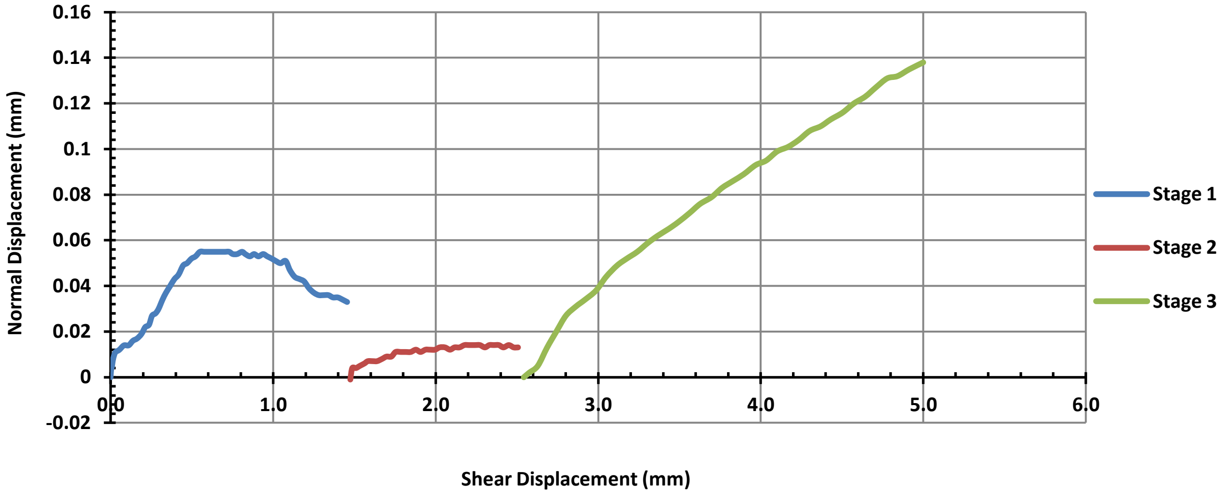
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

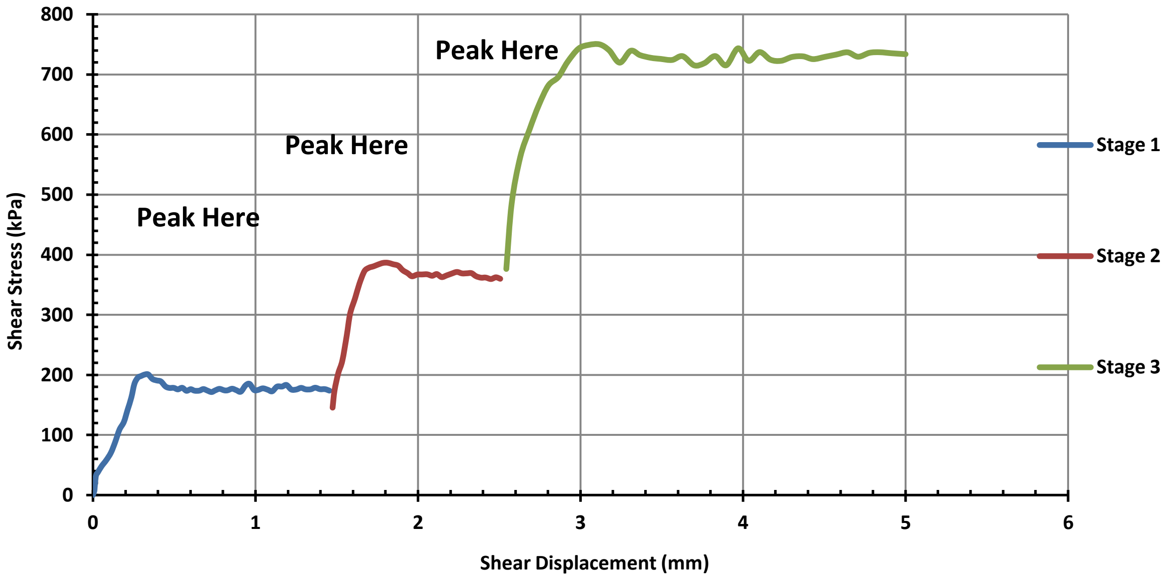
Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS01	Lab:	EPLab
Lab ID:	FBDD-001_DS01_DST3		
Depth (m):	47.55 - 47.68	Room Temperature at Test:	20°

Type of Test:	Natural Defect	**Geology:**	SIF
Dimensions (mm):	82.70 x 60.92	**Shear Plane Dip Angle (°):**	47
Rate of Strain (mm/min):	0.008	**Initial Bulk Density (t/m³):**	2.88
Failure Criteria:	Shear	**Moisture Content (%):**	0.00

Normal Displacement Vs Shear Displacement Plot



Shear Stress Vs Shear Displacement Plot



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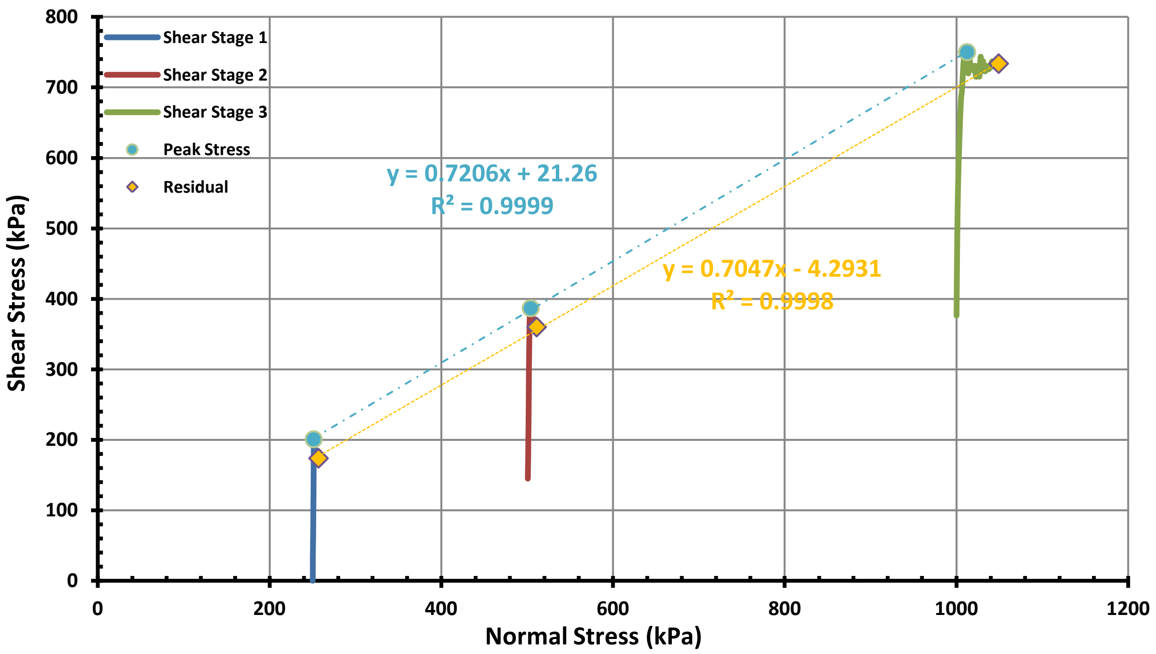
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS01	Lab:	EPLab
Sample ID:	FBDD-001_DS01_DST3		
Depth (m):	47.55 - 47.68	Room Temperature at Test:	20°

(Peak/Residual) Normal Stress Vs Shear Stress



Defect Surface: Undulating Rough Surface with sandy infill

Dip Angle (°): 47

			Normal Stress (kPa)		Shear Stress (kPa)	
Peak	**Shear Angle (°)**	35.79	Stage 1	251	Stage 1	201
	Cohesion (kPa)	21.26	Stage 2	504	Stage 2	387
	R^2	0.9999	Stage 3	1012	Stage 3	750
			Stage 4	-	Stage 4	-

			Normal Stress (kPa)		Shear Stress (kPa)	
Ultimate / Residual	**Shear Angle (°)**	34.99	Stage 1	257	Stage 1	174
	Cohesion (kPa)	0.00	Stage 2	511	Stage 2	360
	R^2	0.9998	Stage 3	1049	Stage 3	734
			Stage 4	-	Stage 4	-

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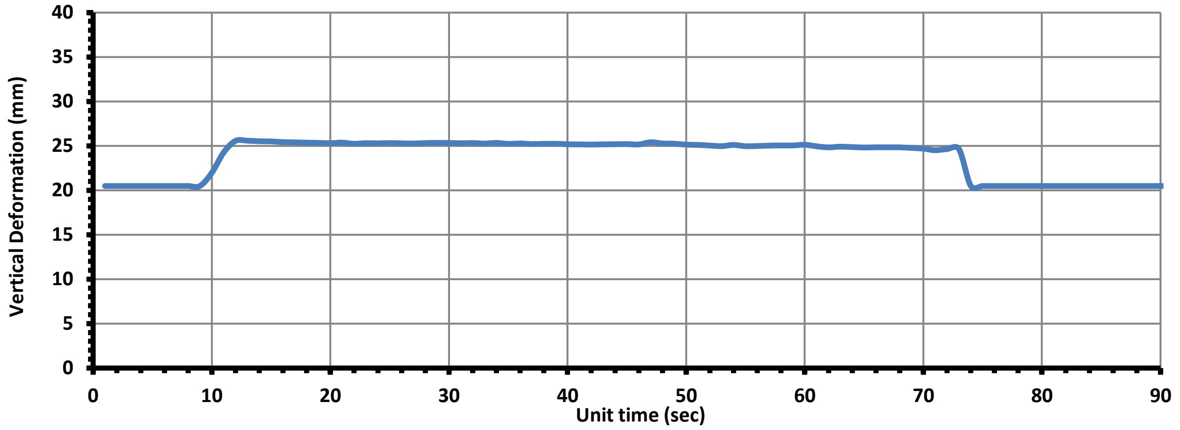
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS01	Lab:	EPLab
Sample ID:	FBDD-001_DS01_DST3		
Depth (m):	47.55 - 47.68	Room Temperature at Test:	20°

Sample Surface Profile Pre and Post Testing (Centre Section)

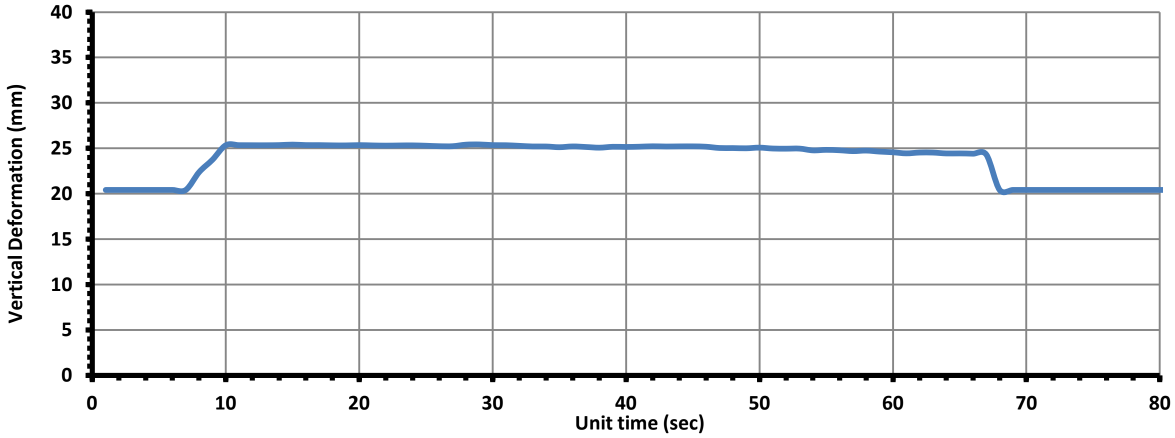
Before Shearing



After Shearing

Direction of Shearing

Y-Y Axis



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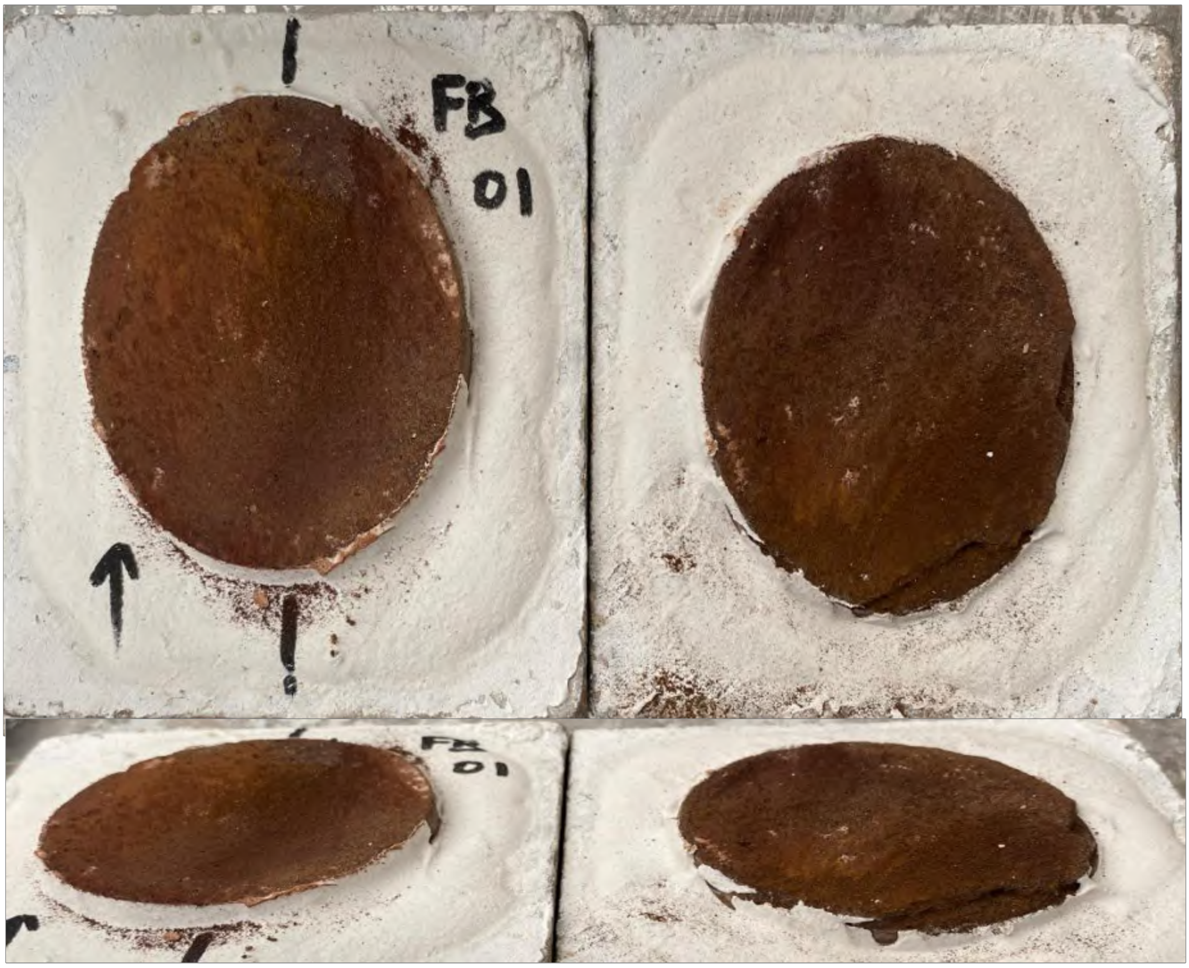
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS01	Lab:	EPLab
Sample ID:	FBDD-001_DS01_DST3		
Depth (m):	47.55 - 47.68	Room Temperature at Test:	20°

Sample Photo Post Testing



Notes: Surface profile drawn using Laser

Stored and Tested the Sample as received
Samples supplied by the Client

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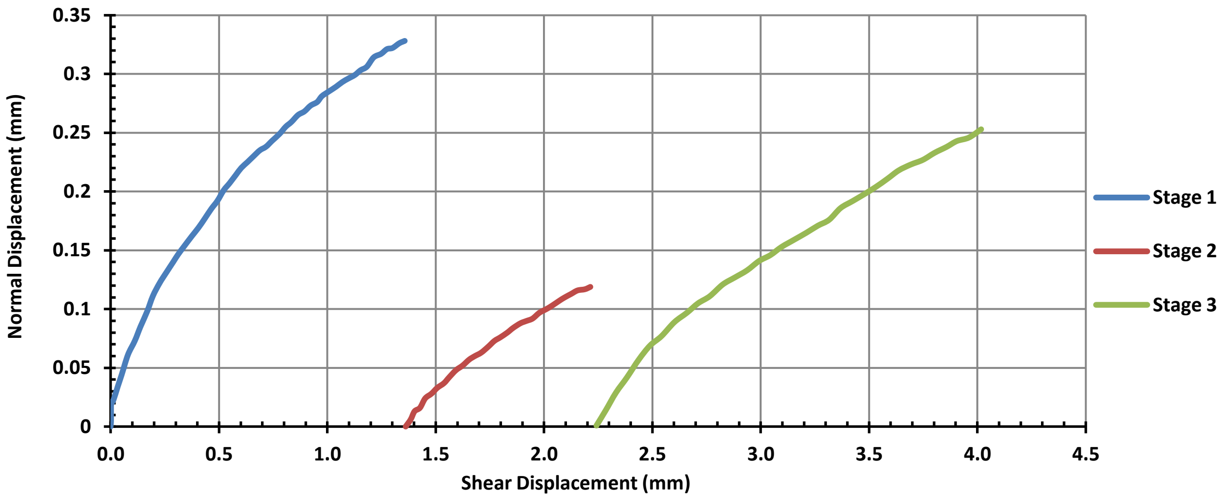
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

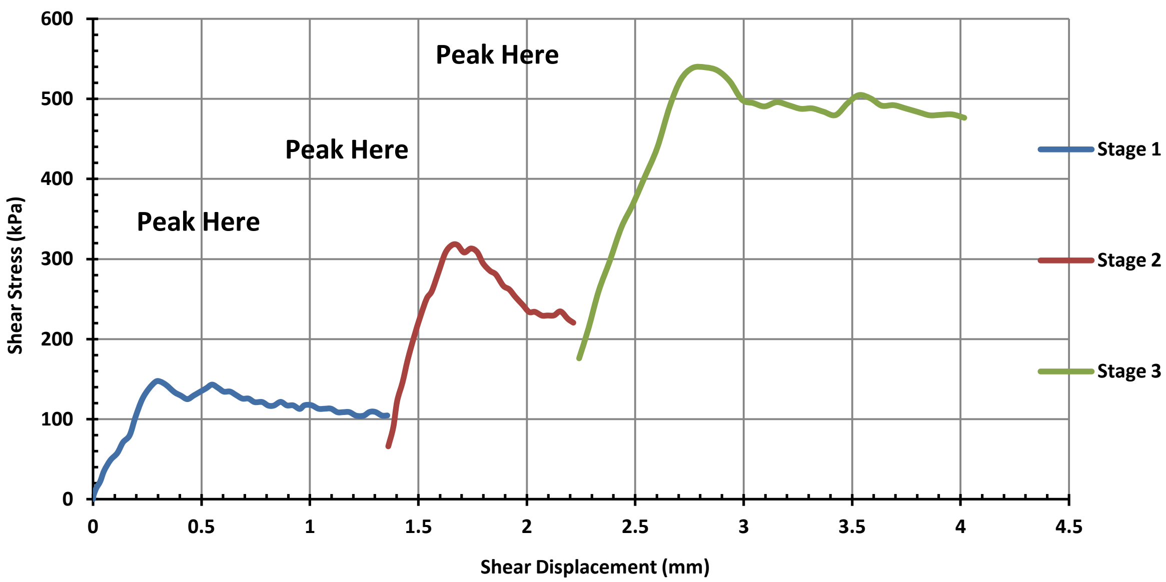
Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS02	Lab:	EPLab
Lab ID:	FBDD-001_DS02_DST3		
Depth (m):	97.84 - 98.00	Room Temperature at Test:	20°

Type of Test:	Natural Defect	**Geology:**	UAC
Dimensions (mm):	66.28 x 60.81	**Shear Plane Dip Angle (°):**	68.9
Rate of Strain (mm/min):	0.008	**Initial Bulk Density (t/m³):**	2.95
Failure Criteria:	Shear	**Moisture Content (%):**	0.00

Normal Displacement Vs Shear Displacement Plot



Shear Stress Vs Shear Displacement Plot



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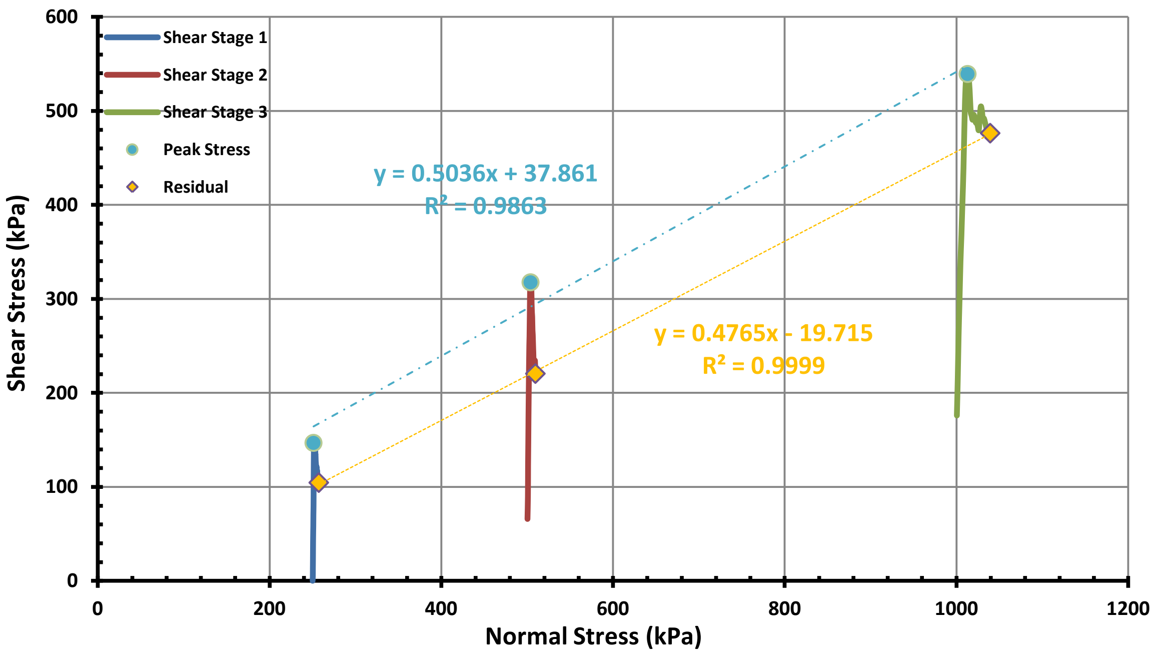
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS02	Lab:	EPLab
Sample ID:	FBDD-001_DS02_DST3		
Depth (m):	97.84 - 98.00	Room Temperature at Test:	20°

(Peak/Residual) Normal Stress Vs Shear Stress



Defect Surface: Undulating Smooth Surface with intrusive infill
Dip Angle (°): 68.9

			Normal Stress (kPa)		Shear Stress (kPa)	
Peak	**Shear Angle (°)**	26.57	Stage 1	251	Stage 1	147
	Cohesion (kPa)	37.86	Stage 2	504	Stage 2	318
	R^2	0.9863	Stage 3	1013	Stage 3	539
			Stage 4	-	Stage 4	-
Ultimate / Residual	**Shear Angle (°)**	25.64	**Normal Stress (kPa)**		**Shear Stress (kPa)**	
	Cohesion (kPa)	0.00	Stage 1	257	Stage 1	105
	R^2	0.9998	Stage 2	510	Stage 2	221
			Stage 3	1039	Stage 3	476
			Stage 4	-	Stage 4	-

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E-PRECISION LABORATORY

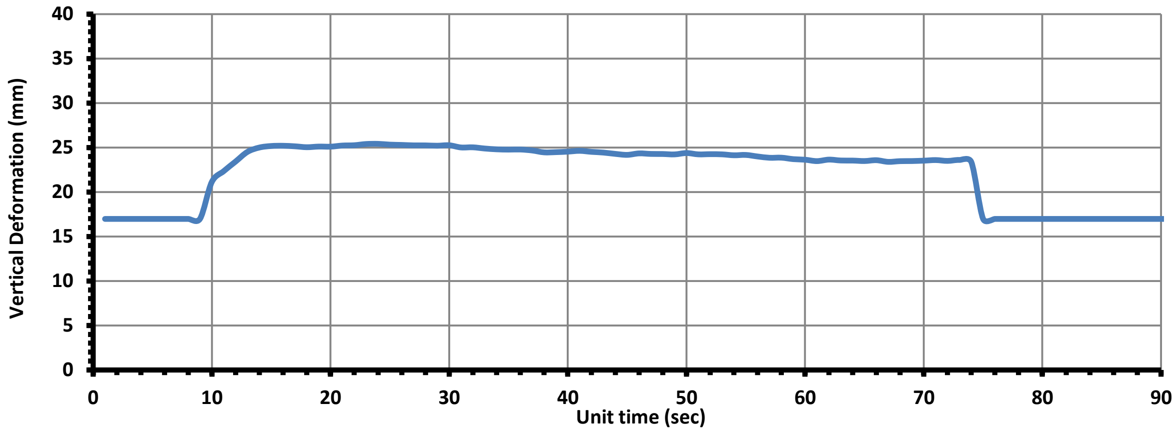
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

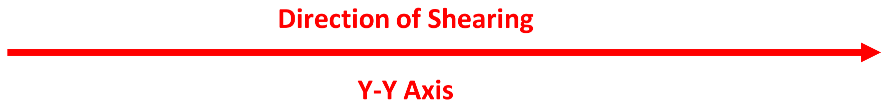
Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS02	Lab:	EPLab
Sample ID:	FBDD-001_DS02_DST3		
Depth (m):	97.84 - 98.00	Room Temperature at Test:	20°

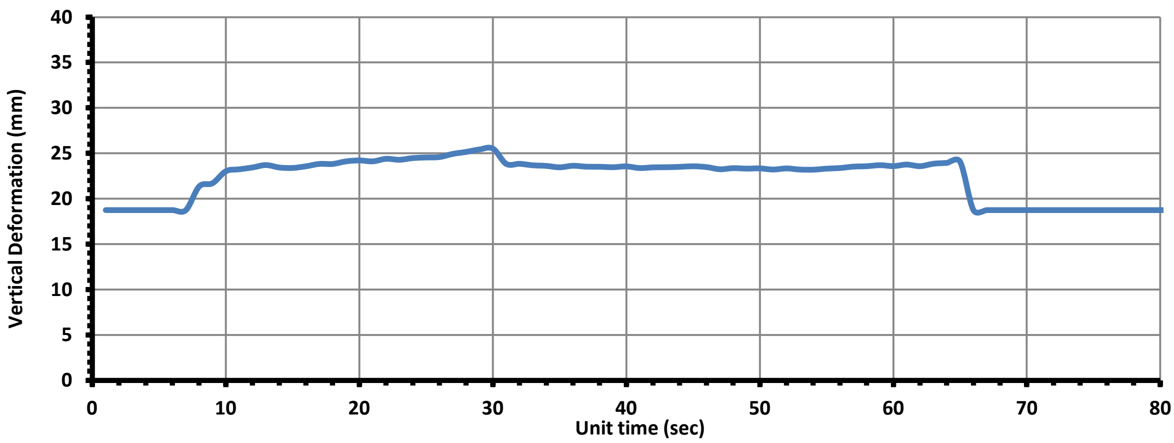
Sample Surface Profile Pre and Post Testing (Centre Section)

Before Shearing



After Shearing





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DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS02	Lab:	EPLab
Sample ID:	FBDD-001_DS02_DST3		
Depth (m):	97.84 - 98.00	Room Temperature at Test:	20°

Sample Photo Post Testing

Notes: Surface profile drawn using Laser

Stored and Tested the Sample as received
Samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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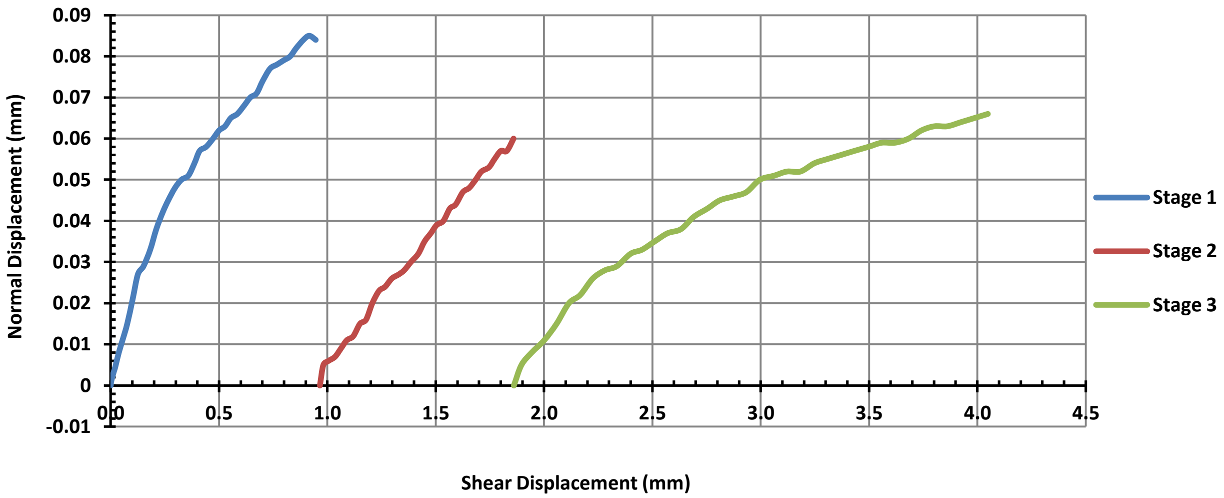
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

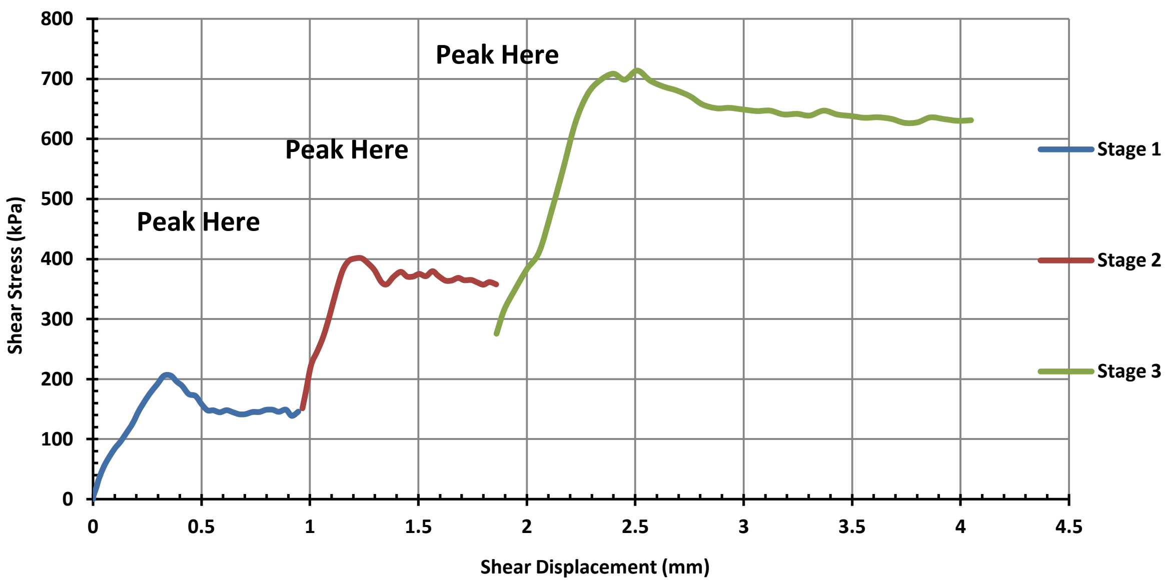
Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-002_DS03	Lab:	EPLab
Lab ID:	FBDD-002_DS03_DST3		
Depth (m):	29.38 - 29.52	Room Temperature at Test:	20°

Type of Test:	Natural Defect	**Geology:**	SIF
Dimensions (mm):	61.53 x 60.87	**Shear Plane Dip Angle (°):**	85.9
Rate of Strain (mm/min):	0.008	**Initial Bulk Density (t/m³):**	2.85
Failure Criteria:	Shear	**Moisture Content (%):**	0.00

Normal Displacement Vs Shear Displacement Plot



Shear Stress Vs Shear Displacement Plot



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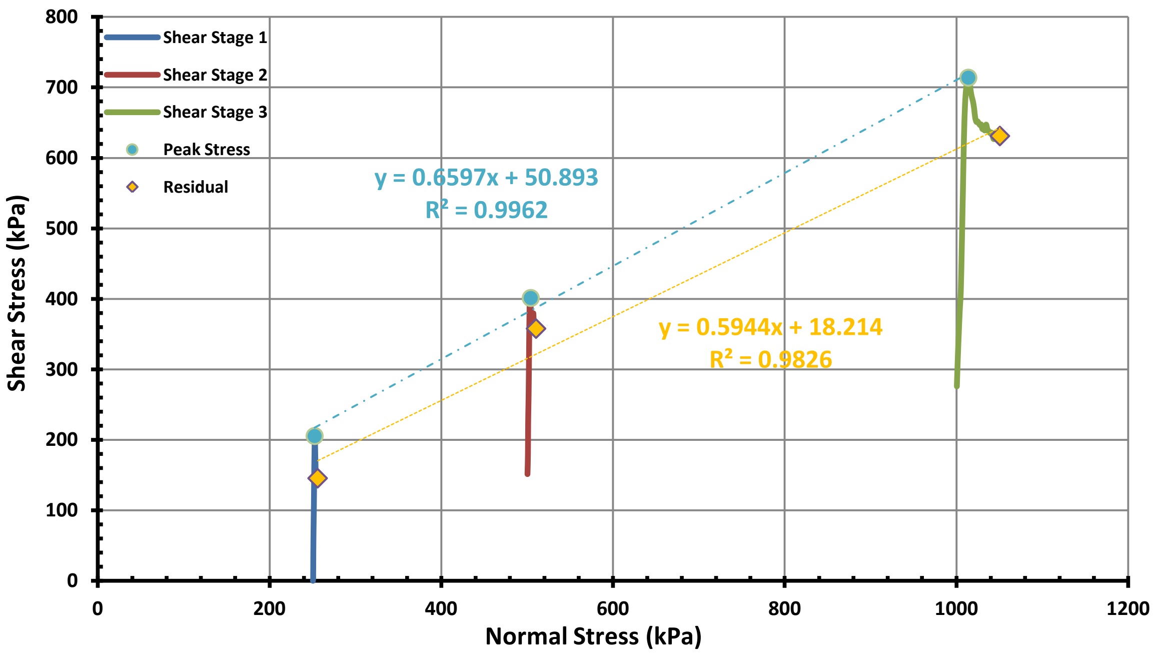
Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-002_DS03	Lab:	EPLab
Sample ID:	FBDD-002_DS03_DST3		
Depth (m):	29.38 - 29.52	Room Temperature at Test:	20°

(Peak/Residual) Normal Stress Vs Shear Stress



Defect Surface: Planar Rough Surface with Sandy Infill
Dip Angle (°): 85.9

			Normal Stress (kPa)		Shear Stress (kPa)	
Peak	**Shear Angle (°)**	33.42	Stage 1	252	Stage 1	206
	Cohesion (kPa)	50.89	Stage 2	504	Stage 2	401
	R^2	0.9962	Stage 3	1014	Stage 3	714
			Stage 4	-	Stage 4	-
Ultimate / Residual	**Shear Angle (°)**	30.71	**Normal Stress (kPa)**		**Shear Stress (kPa)**	
	Cohesion (kPa)	18.21	Stage 1	256	Stage 1	146
	R^2	0.9826	Stage 2	510	Stage 2	358
			Stage 3	1051	Stage 3	631
			Stage 4	-	Stage 4	-

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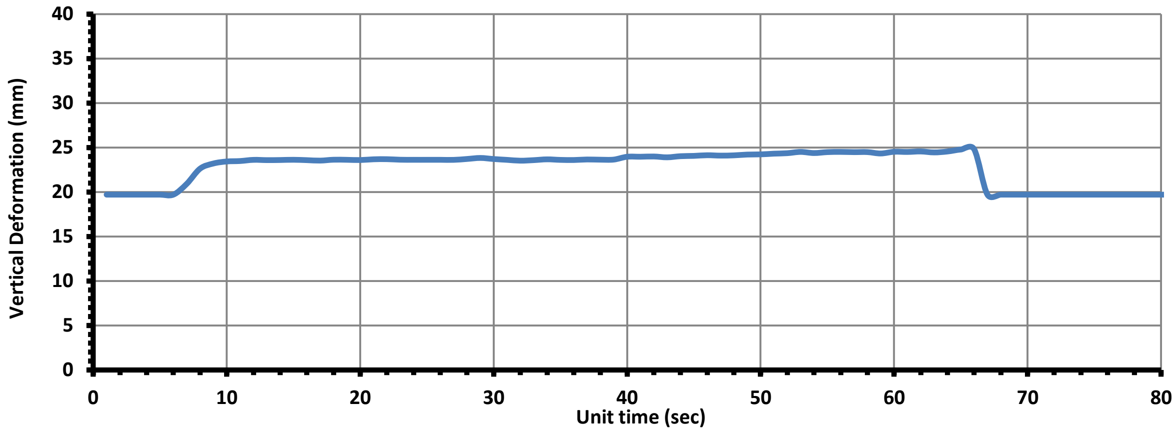
Sample No:	FBDD-002_DS03	Lab:	EPLab
Sample ID:	FBDD-002_DS03_DST3		
Depth (m):	29.38 - 29.52	Room Temperature at Test:	20°

Sample Surface Profile Pre and Post Testing (Centre Section)

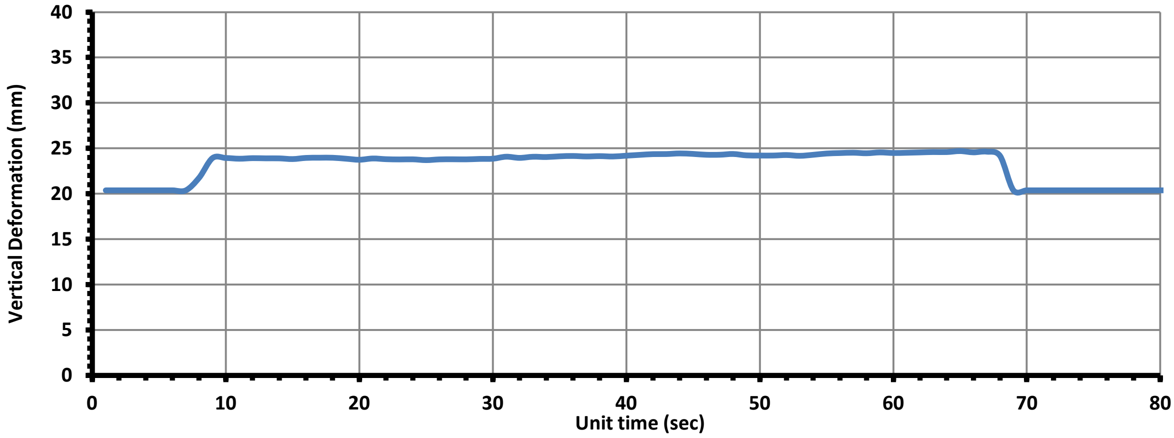
Before Shearing



Direction of Shearing

After Shearing

Y-Y Axis



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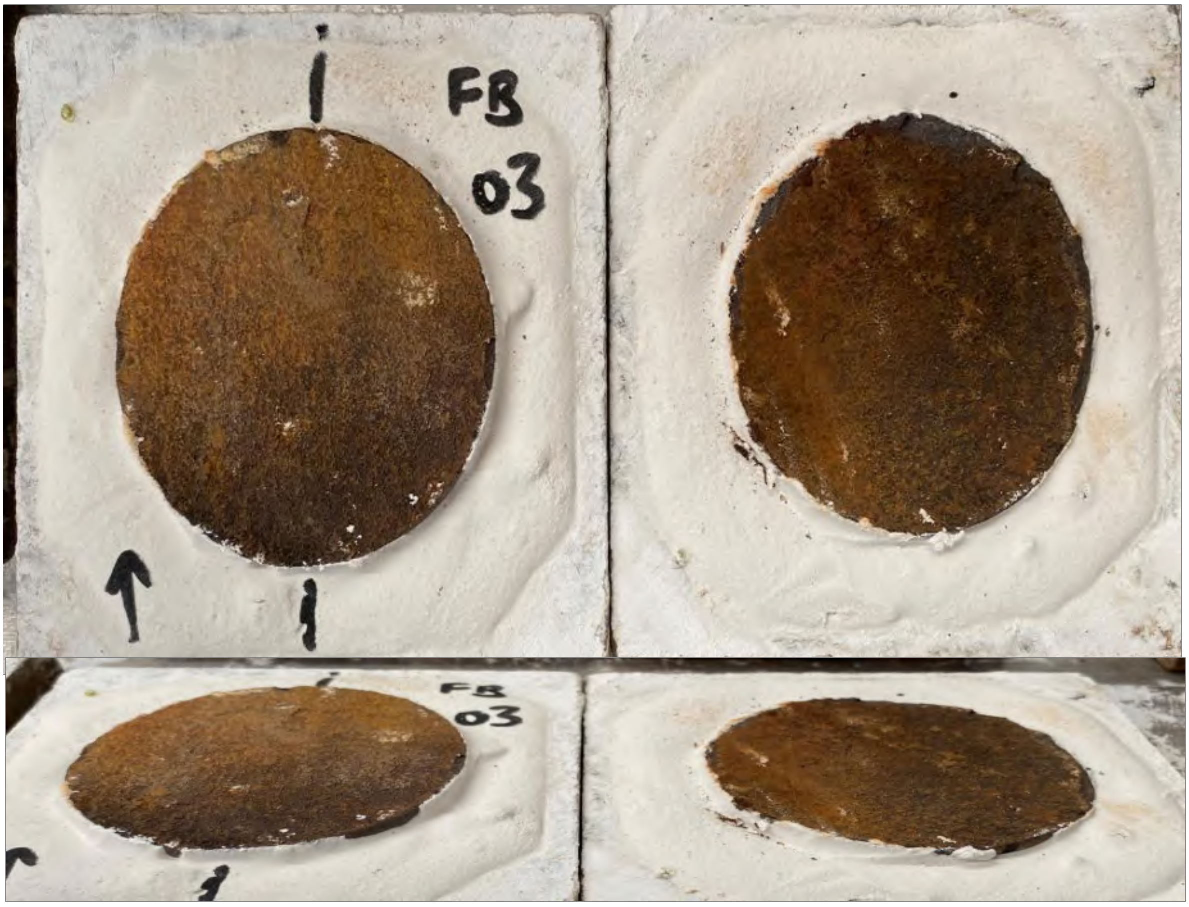
Sample ID:	FBDD-002_DS03_DST3		
Depth (m):	29.38 - 29.52	Room Temperature at Test:	20°

Sample Photo Post Testing



Notes: Surface profile drawn using Laser

Stored and Tested the Sample as received
Samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

Appendix B: Landform Design Report (Landloch 2021)

REHABILITATED LANDFORM DESIGN GUIDANCE: DIE HARDY

Ramelius Resources

June 2021

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A.C.N. 011 032 803
A.B.N. 29011032803

Web site: www.landloch.com.au
Email: admin@landloch.com.au

Project Number: 2415.21b

Report Title: Rehabilitated landform design guidance: Die Hardy

Client: Ramelius Resources

Review History

Version Number	Prepared by:	Reviewed by:	Date
0 (Draft)	E. Howard		10/06/2021
1 (Draft)	E. Howard		21/06/2021
2 (Final)	E. Howard		21/06/2021

Landloch

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1 INTRODUCTION

Ramelius Resources (Ramelius) are seeking approval to mine the Die Hardy gold project (Die Hardy). The project is located within the Mount Jackson goldfield, in the Yilgarn Shire of Western Australia, ~140km north of Southern Cross and 400km north east of Perth (Figure 1). Die Hardy consists of four sites:

- Die Hardy Central, Die Hardy North, and Die Hardy South, all located within mining tenement M77/1272; and
- Red Legs, located within mining tenement M77/1271.

Landloch Pty Ltd (Landloch) has considered issues related to the long-term erosional stability of the mine waste dumps at Die Hardy. The configurations of these facilities are currently not confirmed. Therefore, this document seeks to address erosion and landform stability issues without expressly referencing specific waste geometries.

2 CLOSURE EXPECTATIONS

2.1 Regulator expectations

The primary Western Australian mining regulator involved with waste landforms and closure is the Department of Mines, Industry Regulation and Safety (DMIRS)[1]. DMIRS has provided a range of guidance documents that relate to landform design. In addition, the Australian Government has produced a range of handbooks as part of the Leading Practice Sustainable Development Program (LPSDP) for the Mining Industry. The Mine Closure (LPSDP 2016a) and Mine Rehabilitation (LPSDP 2016b) handbooks are applicable to rehabilitation of waste dumps.

2.1.1 DMIRS

DMIRS takes an objective-based, non-prescriptive approach to assessing the suitability of waste dump closure designs. It is their expectation that mining proponents provide detail about how their project will meet DMIRS' stated broad objectives. These objectives are stated in the completion criteria framework document recently endorsed by DMIRS (Young *et al.* 2019), and in Appendix 2 of the recently updated Mine Closure Plan Guidance (DMIRS 2020):

> *"DMIRS' objective for rehabilitation and mine closure is that mining activities are rehabilitated and closed in a manner to make them (physically) safe to humans and animals, (geo-technically) stable, (geo-chemically) non-polluting/non-contaminating, and capable of sustaining an agreed post-mining land use, and without unacceptable liability to the State."*

[1] Formerly known as the Department of Mines and Petroleum (DMP).

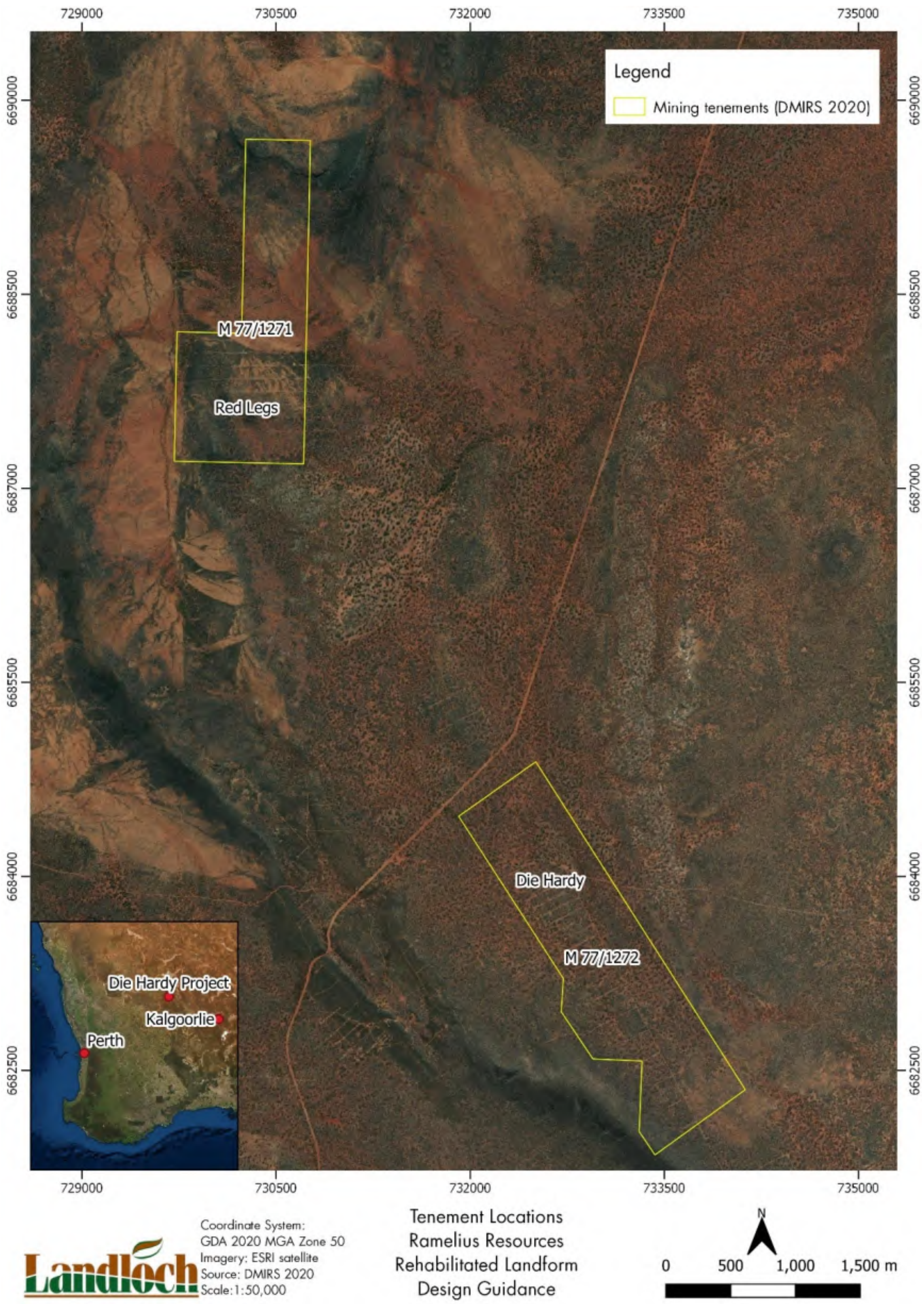


Figure 1: Location of tenements M77/1271 and M77/1272 within which Die Hardy is located.

Based on these broad objectives, land with a post mining land use consistent with 'Conservation and Natural Environments'[2] or 'Production from Relatively Natural Environments'[3] as defined using the Australian Land Use and Management classification (ABARES 2016) would require the development of vegetation consistent with the end land use (e.g., rangeland species) and would need to be non-polluting.

DMIRS' objectives are further detailed on page 27 of DMIRS (2020). Below are some relevant sections[4]:

> *From the project approval stage throughout mine life, the mine closure plan should demonstrate that ecologically sustainable mine closure can be achieved consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State.*
>
> …
>
> *Materials characterisation needs to be carried out prior to project approval to a sufficient level of detail to develop a workable closure plan. This is fundamental to effective closure planning. For existing operations, this work should start as soon as possible. Materials characterisation should include the identification of materials with potential to produce acid, metalliferous or saline drainage, dispersive materials, erosive rock, fibrous and asbestiform materials, and radioactive materials, as well as benign materials intended for use in mine rehabilitation activities. The identification of good quality rehabilitation material (e.g. benign, fresh rock) should also be carried out.*

Specific guidance provided by the DMIRS for waste dumps (DMP 2009) includes:

> *"When selecting the location of any waste rock dump please:*
>
> - *Take into account tenement boundaries and any natural features of the landform;*
> - *Don't interrupt significant drainage lines;*
> - *Blend the dumps into natural hill sides if possible;*
> - *Choose a location that will not be in the way of any possible future pit cut back or any other development;*
> - *Make sure the toe of any waste dump is not closer to the pit than the abandonment bund for that pit;*
> - *Design the pit abandonment bund according to the Department of Mines and Petroleum's guidelines;*
> - *Backfill earlier mined out pits if you can.*
>
> …
>
> *Design the profile of the dump (e.g. height and slope angles) to ensure that the final structure is safe, stable and not prone to significant erosion. Factors that should be considered in the design are material types, proposed vegetation cover, natural*

[2] Conservation purposes based on maintaining the essentially natural ecosystems present.

[3] Primary production with limited change to the native vegetation.

[4] Red underlining is Landloch's emphasis

topography and climate. Generally, more dispersive material, poorer topsoil and high dumps will require flatter outer slopes. Only the best conditions and stable materials would justify slopes approaching 20 degrees.

A major cause of serious erosion on newly created landforms is the lack of adequate drainage control. It is therefore essential to design and construct drainage control measures that will handle expected rainfall events. In arid regions, it is preferable to design the dump profile to be water retaining. This means that the top surface, berms and batters need to be constructed so that they hold the maximum expected rainfall event. The construction of suitably engineered impoundments on the flat surfaces and deep ripping at suitable intervals on the sloping surfaces will generally achieve the necessary control. Minimising slope lengths will help reduce water velocity and therefore reduce erosion potential.

2.1.2 LPSDP handbooks

The Australian Government's Mine Closure handbook (LPSDP 2016a) usefully defines a functional ecosystem (that is implicit in DMIRS' stated closure objectives) as, *"an ecosystem that is stable (not subject to high rates of erosion), is effective in retaining water and nutrients, and is self-sustaining."*

It also provides these useful guiding thoughts:

"The difficulties faced in the restoration of functioning ecosystems on such landforms, often under extreme ranges in temperature and rainfall, are often exacerbated by the properties of the waste material. The physical, chemical and geochemical characterisation of mine waste materials is used to identify potentially problematic waste—for example, potentially acid-forming, sodic or saline waste—or waste units suitable for use as near-surface growth medium, water-holding material or surface armour.

Identification of these characteristics—viewed in conjunction with local climatic conditions, the effects of climate change, the way waste materials are likely to weather and develop over time, and target closure objectives and completion criteria—is paramount to appropriate landform design.

…

The nature of the landform surface directly affects critical long-term objectives, such as resistance to erosion, the integrity of encapsulation of hostile wastes, the capacity to accept and store rainfall, and the ability to support plant growth. Ultimately, slope configuration, and the nature of surface material on those slopes, should be interdependent, with slope angle and length being constrained by the relative capacity of the surface material to resist erosion. Vegetation communities are typically one of the most visible outcomes of mine rehabilitation and thus are a logical focus of rehabilitation planning; however, success in establishing the community depends on creating an appropriate soil environment that forms a stable, functional cover.

The Australian Government's Mine Rehabilitation handbook (LPSDP 2016b) includes landform design as an integral part of rehabilitation. It also defines the characteristics of high and low risk landforms. These are summarised in Table 1 below, are a guide only, and are not absolutely prescriptive. That said, they do highlight the importance of materials, climate, and the shape of the landform when defining landform risk. Considering shape without also factoring in materials and climate is more likely to lead either the failure (and avoidable remediation costs) or to an overly conservative landform (and avoidable construction costs).

Table 1: Summary of high and low risk waste landform batter profiles

Low-risk Landforms	High-risk Landforms
High vegetation cover levels, effective at reducing erosion	Low vegetation cover levels, ineffective at reducing erosion
Low-moderate rainfall erosivity, associated with rain of low intensity and total values.	High rainfall erosivity associated with rain or high intensity and total values.
Low batter slope height (commonly ≤20m)	High batter slope heights (the definition of 'high' varies with climate and materials but in many situations ≥60m would be considered high)
Low erodibility materials, often with significant amounts of competent rock	Highly erodible materials, often with significant amounts of fine-grained materials
Capacity to reduce batter gradients to effective levels during rehabilitation	Limited capacity to reduce batter gradients to effective levels (i.e., footprint constraints)

2.1.3 Summary of regulator expectations

There is an expectation that landform designs meet the broad closure objectives stated by DMIRS. In order to meet these objectives, landform designs must objectively demonstrate that the landform shape (height, gradient, profile shape, footprint) is consistent with the constraints imposed on it by the climate, and the soil and waste material properties. This is achieved through assessment of long-term erosion potential, for which a range of erosion models are available.

There is an expectation in all the guidance documents that rehabilitation of waste landforms include revegetation. This is particularly clear given DMIRS has recently endorsed the closure criteria document in which the post-mining land use options all include vegetation consistent with the post-mining land use (no unvegetated post mining land use is contemplated).

2.2 Landloch's experience

2.2.1 Need for erosion modelling

WA mining regulators (DMIRS specifically) very commonly require that there be a clear link between the waste dump design and the soil and waste material properties. Results of erosion modelling and landform evolution modelling are typically requested, with an increasing expectation for these tasks to have been completed as materials become available and as the site nears the end of mine life.

Early implementation of landform designs underpinned by erosion modelling will increase the likelihood that designs are constructed cost effectively and in line with closure expectations.

2.2.2 Waste landform design life

DMIRS (2020) provides a reference point that is helpful in setting a design life for rehabilitated waste dumps. It states on page 16 that:

> *Development of completion criteria and associated performance indicators should commence upfront in the project approval stage for new projects or as early as possible for existing operations, and be reviewed and refined throughout the development and operation of the project to respond to monitoring, research and trial information and any other information or change as appropriate. The identified completion criteria and associated performance indicators must be able to demonstrate that rehabilitation is progressing as anticipated, particularly where mathematical modelling is utilised to predict long term (usually 300 years or longer) environmental performance (e.g. waste rock landforms).*

Therefore, it seems appropriate to design waste dumps for closure using a design life of ~300 years and adopt an acceptable risk of failure within that period (it is impossible to design a landform that poses zero risk at closure).

2.2.3 Assessing waste dump erosion risk

Assessment of long-term erosion risk of mine waste dump batters commonly does not consider erosion from individual storms. Rather, it defines acceptable erosion based on long-term erosion rates. This is because the available erosion benchmarks against which erosion can be assessed are almost always measures of long-term rates. These benchmarks include naturally occurring erosion rates and rates of soil formation, both of which are measured over decades or centuries and not for individual events.

It is important to note that elevated erosion of a batter during a large rainfall event does not necessarily cause irreversible changes to the batter surface condition such that all subsequent rainfall events yield higher erosion rates. It is the engineered runoff control structures that represent points in the landform design that can irreversibly change (i.e., fail) in a significant rainfall event. These structures include waste dump top crest bunds, mid-batter berms, rock drains, and toe drains. These features introduce a "brittleness" to a rehabilitation design.

For this reason, it is important to determine an appropriate design storm for use in designing engineering control structures for closure (but not for batter shapes). The design storms for closure planning will be much rarer (i.e., larger) than the design storms adopted during construction or operations is it cannot be assumed that ongoing maintenance of control structures will occur after waste dump rehabilitation.

2.2.4 Design storms for design of engineering structures

To inform what is an acceptable design storm for closure, Landloch considered the relationship between design storm events and risk outlined in the Guidelines on Tailings Dams (ANCOLD 2012) for structures with a shorter design life and then applied that risk to closure designs with a 300 year design life. The ANCOLD Guidelines are a commonly used engineering guidance document used to establish appropriate engineering design storms based on risk. These storms are defined by their Annual Exceedance Probabilities (AEP)[5]. Adopting the Guideline's approach for designing a tailings dam's spillway or freeboard in a location where the consequence of failure is minor or medium[6], and the population at direct risk (at closure in this instance) would be less than 10, the resultant risk rating is "very low" to "significant", and the recommended AEP is between 1% and 0.1%. Assuming an operational design life of 50 years, this equates to a 5-39% probability of the design storm being exceeded once in 50 years.

If a probability of failure of 10% is adopted (within the range currently accepted during operations for a TSF but towards the lower end of the range), for a design life of 300 years, this equates to an AEP of 0.04%, equivalent to an Annual Recurrence Interval (ARI) of 2,500 years.

Adoption of a design storm event with an AEP of 0.04% seems reasonable for design of engineered runoff control structures for rehabilitated waste dump at Die Hardy. A design storm with this AEP is considered an 'extreme' design storm event within the Australian Rainfall and Runoff design rainfall classification scheme[7] (Ball *et al.* 2019). Adoption of even more extreme design storms would only be adopted if the risk posed by erosion at Die Hardy can be shown to be greater than outlined above.

---

[5] AEP is the probability that a given event accumulated over a given duration will be exceeded in any one year.

[6] Cost of damage to infrastructure <\$10M; <100 people affected; Social dislocation <100 people or <20 business months; <1km² impacted; impact duration <1 year; damage to the environment limited to items of low conservation value (degraded or cleared land, ephemeral streams, non-endangered flora and fauna), and remediation possible. Cost of damage to infrastructure \$10M-\$100M; 100-1000 people affected; 100-1000 person or 20-2000 business months dislocated; <5km² impacted; impact duration <5 years; significant effects on rural land and local flora and fauna. Limited effects on items of local and state natural heritage, and limited effects on native flora and fauna within forestry, aquatic and conservation reserves, or recognised habitat corridors, wetlands, or fish breeding areas.

[7] AR&R design rainfall classes – Very frequent: 12 to 1 exceedances per year (EY); Frequent: 1 EY to 0.1 AEP; Infrequent: 0.1 to 0.01 AEP; Rare: 0.01 to 0.0005 AEP; Extreme: <0.0005 AEP.

There is currently a trend among WA regulators (that is not yet found in any published guideline) to request that Probable Maximum Precipitation (PMP) events be included in landform designs. The PMP is generally equated to an event with an ARI of 10 million years (AEP of 0.00001%). The likelihood of such an event occurring in 300 years is 0.003%. In other words, there is a 99.997% chance that the PMP would not occur in 300 years.

Inclusion of such extreme events in landform designs is not warranted and stands at odds to standard engineering practice. Such extreme events are only adopted when the consequence of failure is high to extreme, that is where failure has potential to cause loss of thousands of lives and property damage in the order of >$1B. In practice, erosional failure of a waste landform at Die Hardy is very unlikely to result in extreme discharges of runoff or sediment that would cause loss of life or very expensive property damage.

2.2.5 Erosion benchmarks for use in landform design

Assessing the potential erosional stability of rehabilitated landform designs requires the use of erosion and/or landform evolution models to consider long-term erosional performance. Critical to the modelling process is the establishment of an erosion benchmark at or below which landform designs are deemed acceptably stable, and above which design are deemed unacceptable.

A wide range of approaches have been used to define erosion benchmark values, including linking it to:

- rates of soil formation;
- maintenance of soil quality, which may include considerations of plant productivity, effective soil depth, and soil organic matter and nutrient stores;
- rates of natural erosion in adjoining areas;
- potential for gully formation; and
- water quality impacts.

A recent review of data for the Pilbara region (which would be broadly applicable for Die Hardy given the arid climate) (Howard and Loch 2019) found that a mean average annual rate of 6t/ha/y and a peak average annual rate of 12t/ha/y would be suitable for design purposes where the risk is defined as ‘moderate’. A ‘moderate’ risk rating seems appropriate for Die Hardy because there will be significant proportions of fine grained wastes that will not present as durable, blocky rock, and because of the potential for erosion to cause degradation (rather than functional loss) of the wider ecosystem.

2.2.6 Landform shape limitations

Depending on the erodibility of the materials on site, it is possible for the erosion model predictions to indicate that quite steep, high, and/or long slopes would be stable. However, Landloch has observed that very long and/or very steep waste dump batters are quite difficult to construct in practice because of the need for very exacting quality control measures.

Very narrow mid-slope berms (5-10m once the rehabilitation shape has been created) have also been questioned by the regulators because these small widths have been observed to consistently lead to rehabilitation failure. Rather, widths are expected to be set based on their ability to contain a rare rainfall event. For this guidance document these structures are set based on an event with an AEP of 0.04%.

Gradients steeper than 18-20° are typically not readily accepted by the regulators because they:

- Are unsafe to traverse with machinery.
- Have also long been associated with poor vegetation establishment (DME 1996).
- Cannot be ripped and spread with topsoil, reducing vegetation growth potential.

For this guidance document, a maximum batter gradient of 18° was adopted.

3 RAINFALL AND VEGETATION

Erosion potential of waste dumps is strongly influenced by the near-surface materials that are being stored, the shape of the landforms constructed, and the climate. With regards to climate, rainfall is most critical for landform design as rainfall totals and rainfall intensities influence runoff potential which in turn influence erosion potential.

3.1 Rainfall

Die Hardy has an arid, desert climate with distinct summer and winter rainfall patterns. The Bureau of Meteorology (BoM) weather stations located near Die Hardy include Turkey Hill (12079), located ~90km south of Die Hardy. Patched point data for this site was sourced for the period 1 January 1929 to 31 March 2021.

The median annual rainfall is 298mm and the mean annual rainfall is 297mm, indicating that there is little skew in the annual data due to rare large or small annual rainfall totals. This can be seen in the histogram of annual rainfall values for Turkey Hill, shown in Figure 2. Of the 92 years of rainfall data considered, the year 1999 had an annual rainfall of 662mm and 1940 had an annual rainfall of 116mm.

Die Hardy's annual rainfall patterns are temporally highly variable (Figure 3). Although on an annual basis, the long-term average rainfall values are consistent with an arid climate, it is important to note that there are periods of higher rainfall activity, which means that erosion is likely to also be variable from year to year.

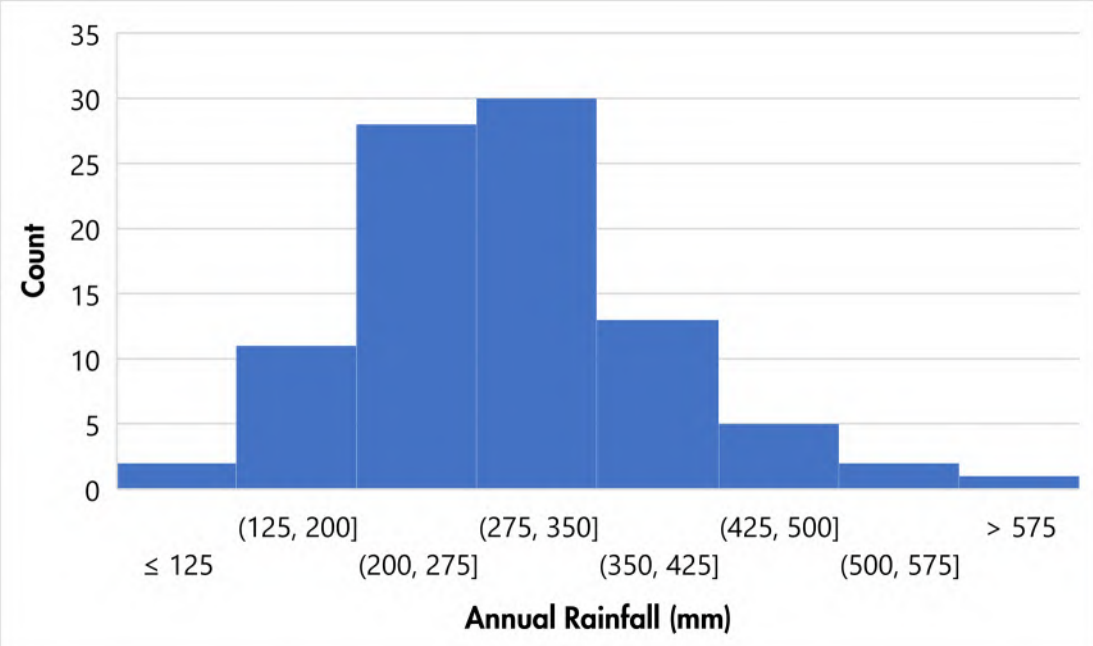


Figure 2: Histogram of annual rainfall totals for Turkey Hill (12079)

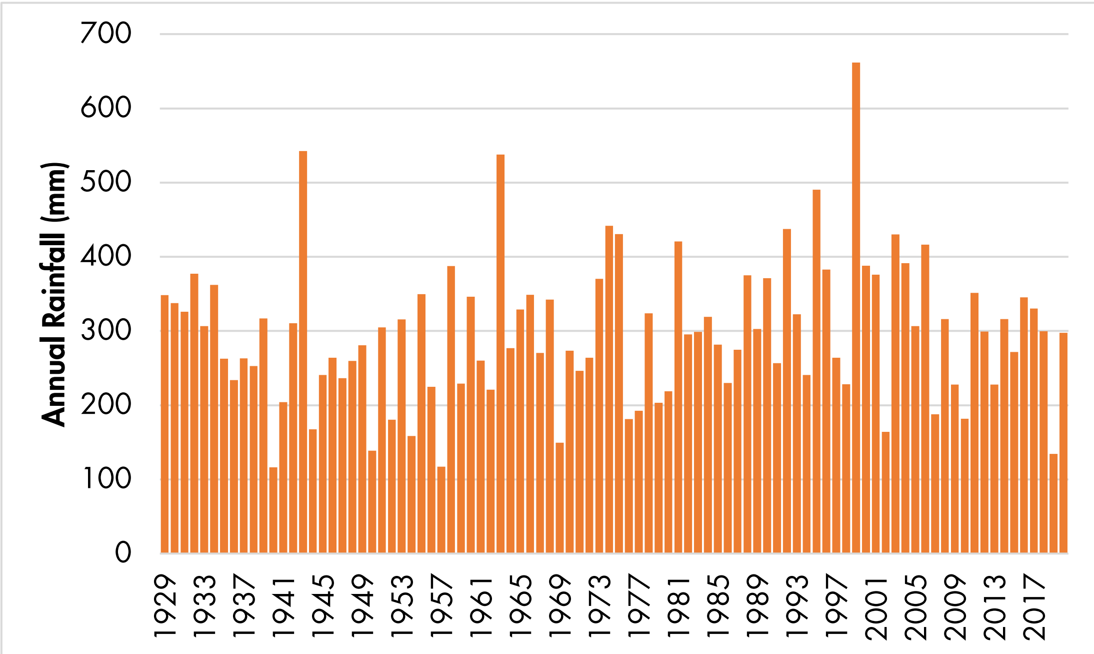


Figure 3: Annual rainfall totals, Turkey Hill (1929-2020).

Average monthly rainfall is highest during the winter months of June to August, and the shoulder month of May. Average rainfall in May to August range from 31-41mm. The remaining months have average rainfalls ranging from 14-26mm (Figure 4).

Annual rainfall values of <300mm will mean that vegetation levels are likely to be low and a high proportion of the land surface will be bare and exposed to the erosive forces of rain and to surface runoff.

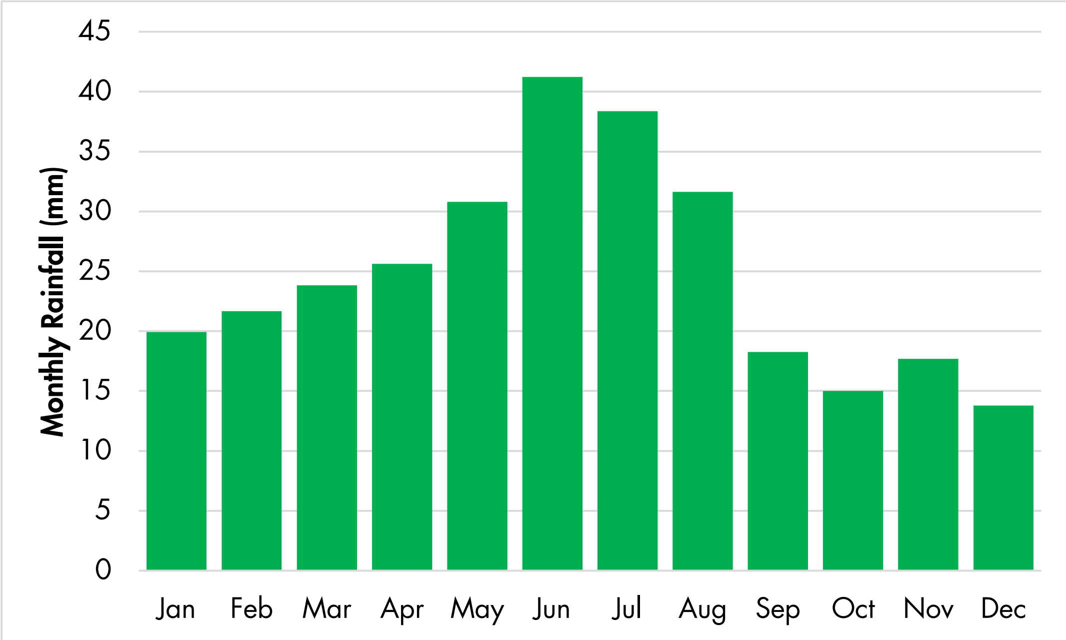


Figure 4: Mean monthly rainfall for Turkey Hill (1929-2020).

3.2 Rainfall erosivity

The erosive force of rain is expressed by rainfall erosivity. Historical rainfall erosivity mapping shows annual erosivity values for the Die Hardy area of 500MJ.mm/(ha.hr.yr) (Rosewell 1993). In terms of waste dump erosional stability, it can be expected that Die Hardy is in a climate that makes erosion by water likely, particularly on steep waste dump batter slopes. Monthly erosivity distributions (based on data from Vrieling et al (2014)) are shown in Figure 5. Monthly erosivity trends closely follow monthly rainfall trends. This indicates that the erosivity is suitably distributed throughout the year.

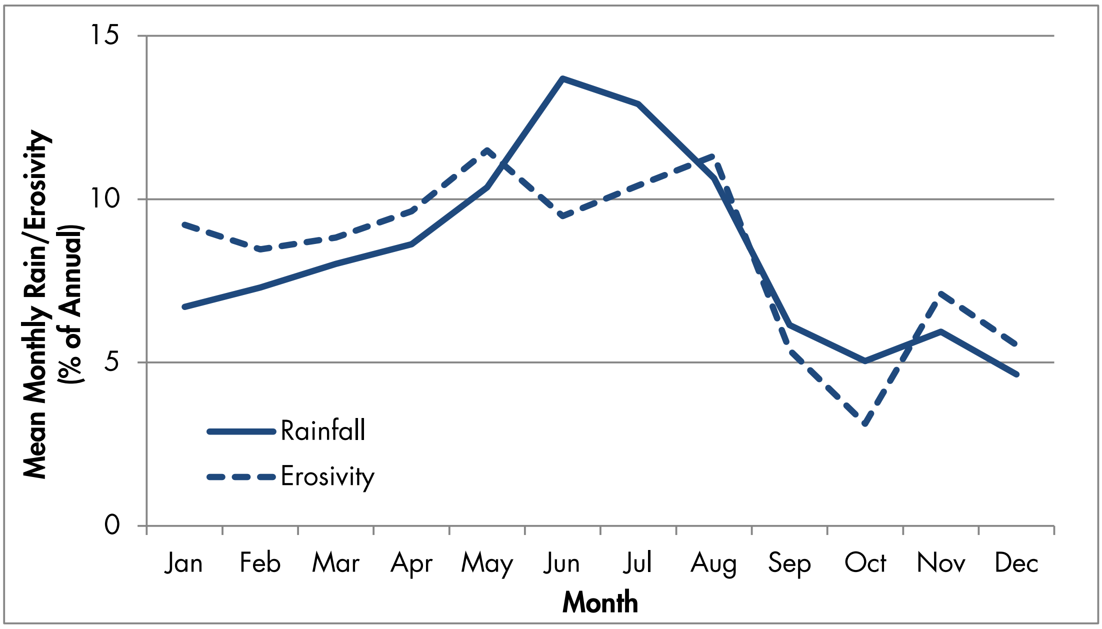


Figure 5: Mean monthly erosivity and rainfall for Die Hardy, expressed as a percentage of the mean annual total values.

3.3 Vegetation impacts on erosion

The WA Department of Agriculture has previously mapped land systems for the rangelands regions of WA. For the Die Hardy area, the land is defined as consisting of[8]:

- Ridges of banded iron formation supporting dense mixed shrublands with emergent native pines, mallees and casuarinas;
- Sandy plains supporting tall shrublands of mulga and bowgada with patchy wanderrie grasses; and
- Alluvial plains supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.

Values for bare ground for the area range from 30-50%[9], meaning canopy cover levels of 50-70%. Shrublands and grasslands with 50-70% canopy cover tend to have surface contact cover levels (grasses in direct contact with the surface) in the order of 2-10% (Payne and Mitchell 2002). Erosion control by vegetation is largely achieved through the presence of grasses that are in direct contact with the soil surface (i.e., surface contact cover). The Revised Universal Soil Loss Equation's (RUSLE) (Renard et al. 1997) cover factor provides a useful benchmark when the effects of vegetation on erosion are being considered. Figure 6 is a typical curve relating erosion by water and surface contact cover for an arid zone. The soil loss ratio is the ratio of erosion from a surface with a certain level of cover to erosion from an unvegetated (bare) soil.

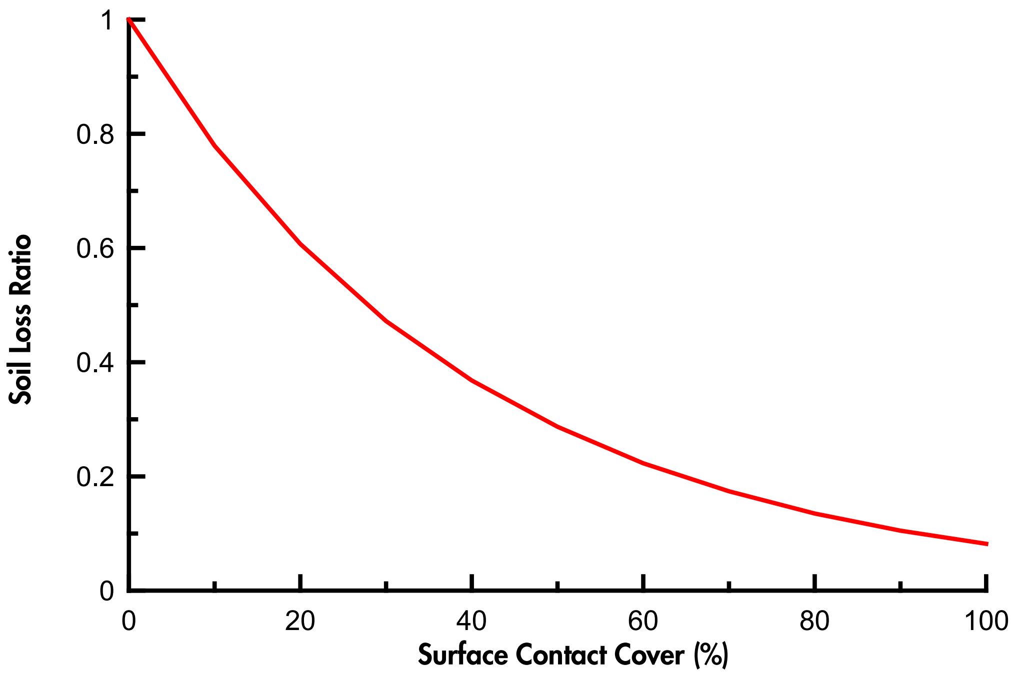


Figure 6: Soil loss ratio for a range of surface contact cover levels.

[8] https://maps.agric.wa.gov.au/nrm-info/
[9] https://maps.tern.org.au

For a 2-10% surface contact cover level, erosion could be expected to be ~90% of the erosion that would occur from an unvegetated surface. Therefore, although vegetation has some impact on soil erosion, it is unlikely to be able to manage erosion risk in the long-term at Die Hardy.

This means that the surface created during rehabilitation must be suitably stable against erosion without the assistance of vegetation. This approach will ensure stability is reached quickly, and that periodic events such as fire or drought, and other pressures such as animal grazing will not adversely impact erosion potential. Further, surfaces that are erosionally stable are also more likely to support the germination and growth of vegetation than surfaces that are mobile and erosion prone.

4 MATERIAL CHARACTERISATION

The key soils and mining wastes at Die Hardy were characterised in order to consider their usefulness in terms of rehabilitation. This section details the material types identified and the characterisation of these materials from a rehabilitation perspective.

4.1 Material types

4.1.1 Soils

Eighteen (18) soil samples were collected from Die Hardy and Red Legs. Two (sites 11 and 12) were located between Die Hardy and Red Legs and were not considered in this study. The coordinates of these soil samples are listed in Table 2 and shown in Figures 7 and 8.

Table 2: Soil sample coordinates (MGA Zone 50)

Deposit	Sample ID	Easting (m)	Northing (m)
Die Hardy	SCDH001	732314	6684863
	SCDH002	732462	6684547
	SCDH003	732645	6684349
	SCDH004	732365	6684312
	SCDH005	732741	6684069
	SCDH006	732975	6683926
	SCDH007	732998	6683574
	SCDH008	732667	6683560
	SCDH009	733214	6683396
	SCDH010	733027	6683212
Red Legs	SCDH013	730719	6687878
	SCDH016	730365	6688058
	SCDH018	730486	6687853
	SCDH014	730012	6687848
	SCDH019	730632	6687640
	SCDH015	730377	6687627
	SCDH017	730174	6687646
	SCDH020	730511	6687445

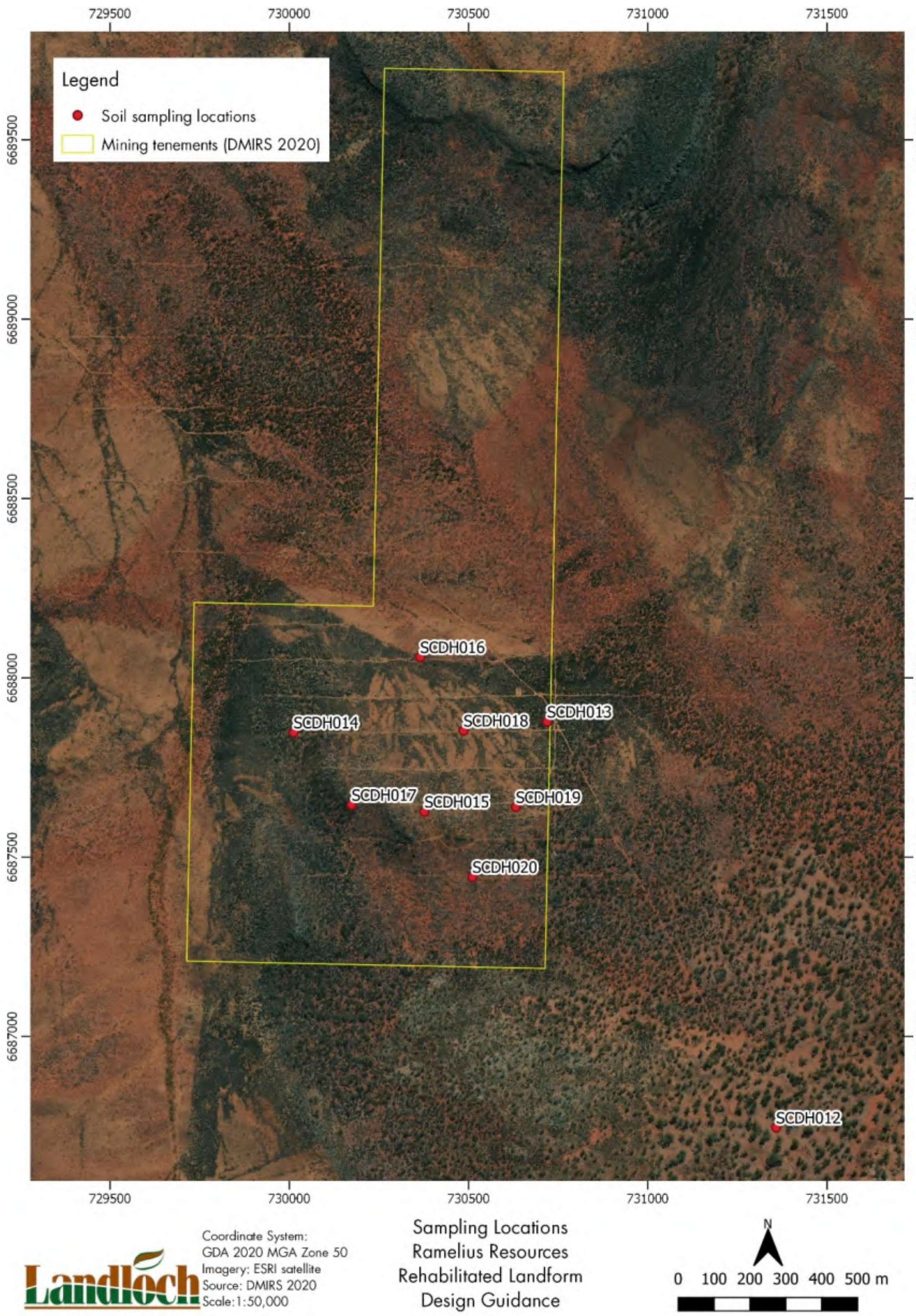


Figure 7: Soil sample locations of Red Legs.

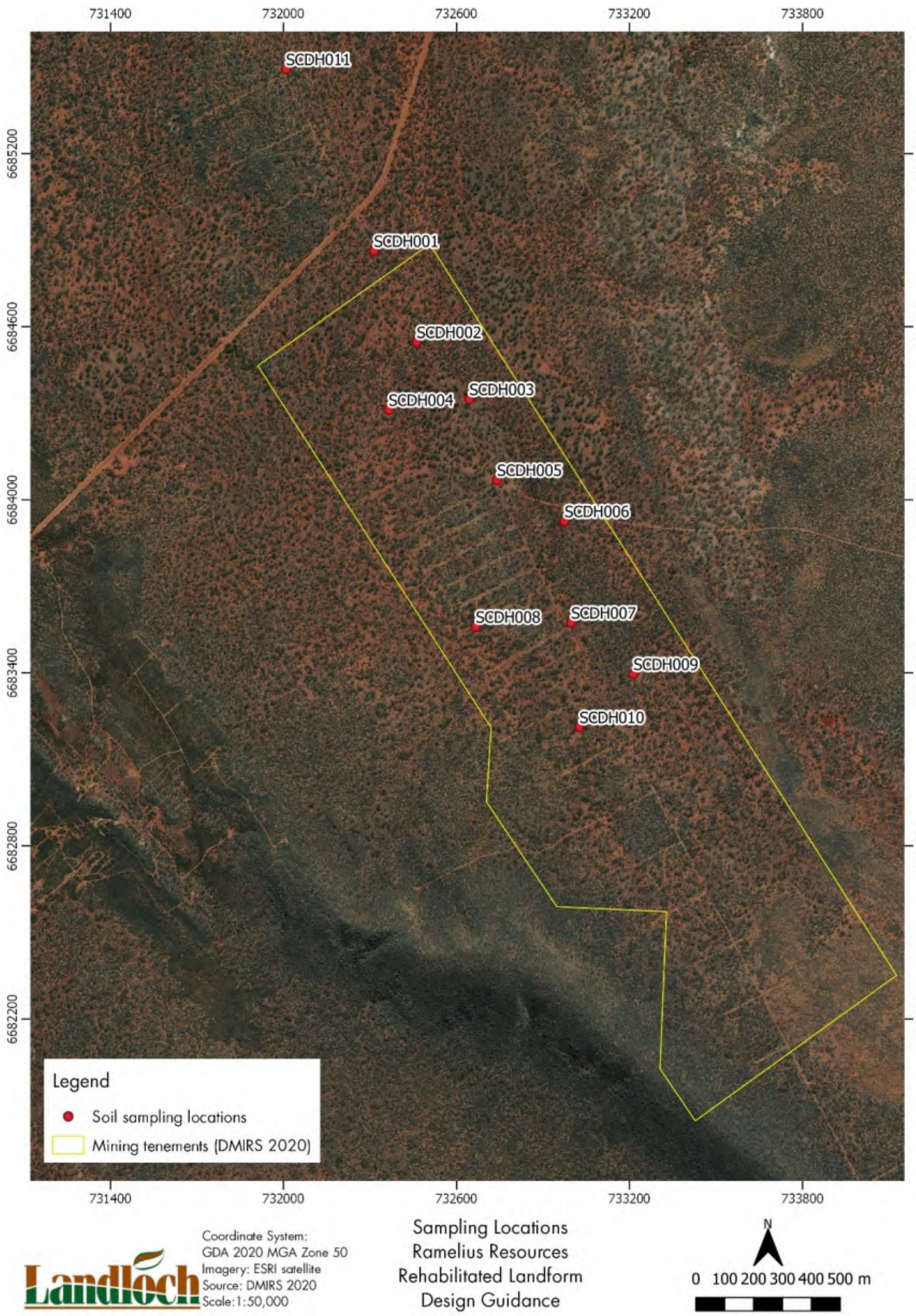


Figure 8: Soil sample locations of Die Hardy.

4.1.2 Wastes

The waste types for Die Hardy include Laterite, BIF (Banded Iron Formation), Mafic, and Ultramafic. Ramelius provided waste volumes[10] to Landloch on 4 March 2021. These volumes are given in Table 3. The volume data indicates that the majority of wastes are oxidised or transition materials. Only 1% of the Die Hardy waste is classed as fresh. The samples included mafic wastes that are not indicated to be present within the proposed pit. Data for these materials are included in the report, but are not used when considering waste dump design risks.

Table 3: Waste volumes

Waste Type	Oxide	Transition	Fresh
Ultramafic	935,610	31,454	23,650
Laterite	673,031	4,000	
BIF	337,050	1,001,956	5,531
Proportion	65%	34%	1%

Fifteen (15) waste samples were collected from Die Hardy. The coordinates and a description of the waste samples are listed in Table 4. The locations of drill hole collars from which the waste samples were taken are shown in Figure 9.

Table 4: Waste sample details (MGA Zone 50)

Sample ID	Hole ID*	Easting (m)	Northing (m)	From (m)	To (m)	Rock Type	Oxidation
WCDH001	0070	732479	6684011	4	7	Laterite	Oxide
WCDH002				30	33	BIF	Transition
WCDH003	0064	732550	6683912	10	13	Mafic	Oxide
WCDH004				33	36	BIF	Transition
WCDH005				60	63	Mafic	Fresh
WCDH006	0039	732712	6683725	3	6	Laterite	Oxide
WCDH007				30	33	BIF	Transition
WCDH008	0028	732754	6683567	27	30	Ultramafic	Oxide
WCDH009				67	70	BIF	Fresh
WCDH010	0015	732873	6683403	2	5	Laterite	Oxide
WCDH011				30	33	BIF	Oxide
WCDH012				42	45	BIF	Transition
WCDH013	0011	732930	6683387	5	8	Mafic	Oxide
WCDH014				15	18	BIF	Oxide
WCDH015	0013	732896	6683370	67	70	Ultramafic	Fresh

* All holes have the prefix FBRC

[10] Based on the CLIPPED_DH_0221_V4.DTM design file

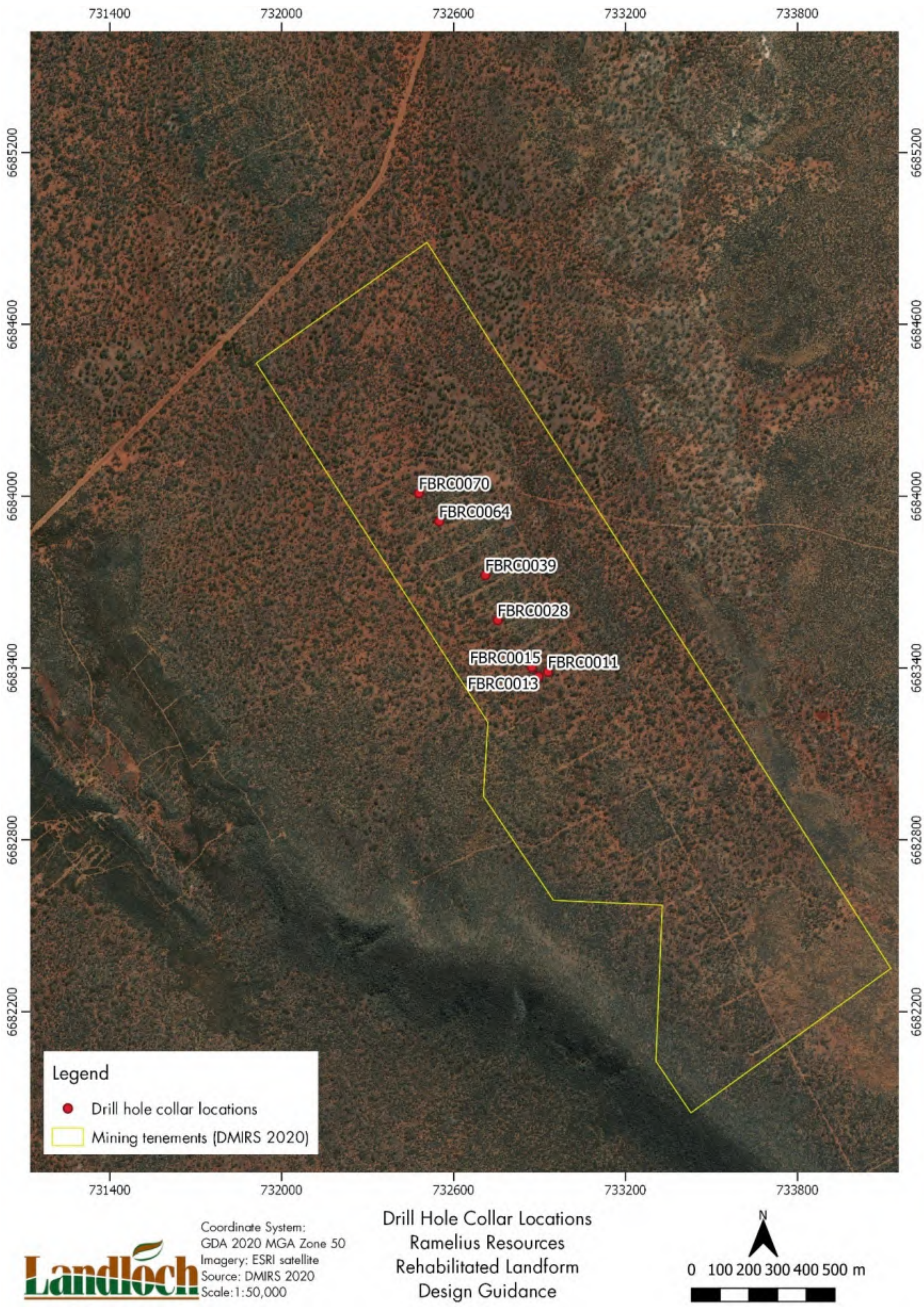


Figure 9: Collar locations of drill holes from which waste samples were sourced.

4.2 Sample testing

4.2.1 Soils

The 20 soil samples were collected and tested by Ramelius. The following basic material properties were considered:

- $pH_{1:5}$ ($CaCl_2$), converted to Ph (water) by adding 0.7 pH units;
- $EC_{1:5}$;
- Total N and P;
- Organic C;
- Exchangeable cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, Al^{3+});
- Effective cation exchange capacity (ECEC);
- Exchangeable sodium percent (ESP);
- Stone content;
- Particle size distribution (sand, silt, clay); and
- Emerson dispersion class.

4.2.2 Wastes

The 15 wastes samples were collected and tested by Ramelius. Issues related to acid and metalliferous drainage are not considered in this report. As such, of the testing completed by Ramelius, only the EC and NAG pH values were considered.

Landloch conducted testing on the available rock chips in the RC drilling material for the following:

- Water absorption;
- Rock density; and
- Rock hardness.

4.3 Data interpretation

The basic material characterisation testing data were interpreted based on Landloch's experience and within the context of available guidelines, such as:

- *Interpreting soil test results – What do all the numbers mean?*, 3rd edition, P. Hazelton & B. Murphy (CSIRO Publishing, Clayton South); and
- *The Rock Manual – The use of rock in hydraulic engineering*, 2nd edition, CIRIA, CUR & CETMEF (CIRIA, London).

4.4 Soils

The results of the soils testing are given in Table 5.

Table 5: Basic characterisation data for the soils.

Sample ID	pH (water)	$EC_{1:5}$ (dS/m)	Exchangeable Cations (meq/100g)						ESP (%)	Emerson Class	N (mg/kg)	Org C (%)	P (mg/kg)	Stones (>2mm) (%)	Particle Size (<2mm)		
			CEC	Ca	K	Mg	Na	Al							Sand. (%)	Silt. (%)	Clay. (%)
Die Hardy																	
SCDH001	6.1	0.03	8	3.1	0.22	1.1	0.06	<0.02	0.8	2	350	0.55	180	40.6	74	10	17
SCDH002	6.7	0.02	9	5.1	0.86	1.2	0.07		0.8	2	340	0.51	210	7.0	64	14	22
SCDH003	8.8	0.07	19	15	0.49	2.1	0.13		0.7	1	370	0.47	120	27.5	75	15	10
SCDH004	4.9	0.01	6	1.6	0.18	0.48	0.02		0.4	3	380	0.66	180	11.9	77	6	17
SCDH005	8.3	0.20	28	13	0.75	8.2	2.5		9	1	420	0.50	110	31.5	59	22	19
SCDH006	8.4	0.06	19	12	0.48	3.7	0.08		0.4	1	420	0.50	130	29.7	72	17	11
SCDH007	5.8	0.02	7	3.6	0.24	0.82	0.02	0.02	0.3	3	380	0.62	190	37.5	76	8	16
SCDH008	6.1	0.01	5	1.8	0.22	0.8	0.04	<0.02	0.7	2	270	0.43	190	18.6	83	6	12
SCDH009	6.2	0.02	6	2.5	0.45	0.78	0.04		0.7	2	370	0.48	180	17.3	78	9	13
SCDH010	4.8	0.02	6	0.65	0.16	0.29	<0.02	0.88	0.2	2	410	0.58	170	38.4	71	11	18
Red Legs																	
SCDH013	4.8	0.02	4	0.09	0.04	0.03	<0.02	0.66	0.2	5	230	0.49	110	43.0	84	8	8
SCDH016	6.8	0.07	7	7.6	0.46	1	0.08		1.2	3	930	1.94	110	30.0	82	8	11
SCDH018	6.1	0.04	8	4.8	0.24	0.46	0.02	0.05	0.3	3	500	1.33	120	38.4	85	8	7
SCDH014	5.0	0.03	5	0.75	0.08	0.3	0.04	0.44	0.8	5	380	0.85	150	51.8	79	8	13
SCDH019	4.9	0.02	4	0.44	0.07	0.1	<0.02	0.64	0.2	5	240	0.37	130	44.8	83	7	11
SCDH015	5.4	0.04	5	1.5	0.13	0.23	<0.02	0.13	0.3	5	420	0.78	200	37.5	77	9	14
SCDH017	5.3	0.08	5	2.4	0.31	1.1	0.08	0.21	1.5	3	800	1.94	220	25.3	67	11	22
SCDH020	4.8	0.02	5	0.55	0.09	0.11	<0.02	0.8	0.2	3	350	0.63	170	25.9	82	5	13

4.4.1 Soil pH

The soils have strongly acid to moderately alkaline pH values. The mean value is 6.1 (slightly acid). All soils at Red Legs were strongly to mildly acidic. Three of the ten samples (3, 5, and 6) from Die Hardy were alkaline and the remainder were acidic.

A difference in pH of strongly acid to slightly acidic at Red Legs is unlikely to impact on the relative availability of the key elements for plants such as Nitrogen, Phosphorus, Potassium, and Sulphur. The alkaline soils at Die Hardy may result in different nutrient availability compared to the acidic soils. As such, there is value in considering vegetation differences between the alkaline and acidic soils and ensuring that future seeding incorporates species that are capable to deal with either (or both) acidic and alkaline soils.

4.4.2 Soil $EC_{1:5}$

The salinity (EC) of all but one of the soil samples are classed as very low or low. Sample SCDH005 was classed as having medium salinity. These values are unlikely to have a negative effect in terms of plant response. Salinity is unlikely to pose a risk to successful plant growth as part of rehabilitation.

4.4.3 Particle size

The soils generally contain appreciable stones (>20%) and would be classed as gravelly or stony soils.

The Die Hardy and Red Legs soils have a loamy sand to loam texture. This is equivalent to clay contents ranging from 7-22%. Soils commonly have sandy loam textures.

The gravelly/stony loam nature of the surface soils will mean that the soils will be prone to water erosion, but that the stone fraction will assist in providing some protection against detachment.

4.4.4 Exchangeable cations and structural decline

Structural decline of the soil fine fraction can be considered from a range of perspectives. Four perspectives are considered in this report.

First, the Exchangeable Sodium Percentage (ESP) is an indicator of structural decline caused by clay dispersion. Typically, ESP values >6% indicate an increased risk of clay dispersion, though clay dispersion is influenced by complex interactions between exchangeable cation types, salt concentrations, and clay content. Second, magnesic soils (those with elevated exchangeable magnesium concentrations relative to the other exchangeable cations) can be dispersive even when the ESP is <6%. Third, very low salinity can also increase the tendency for soil structural decline, even in soils that, by definition, are not otherwise dispersive. The Electrochemical Stability Index (ESI) has recently been developed as a means of considering the relationship between sodicity and salinity. The ESI is defined as the ratio of $EC_{1:5}$ and ESP. A tentative critical ESI value for soils is 0.05. Materials with ESI <0.05 can be considered potentially prone to structural decline caused by clay dispersion. Finally, materials with very high fine sand, silt, and clay fractions (fine sand + silt + clay >70%) are increasingly prone to mobilisation of these fine particles within the macropores of the soil matrix.

To capture these complexities, a material's tendency for structural decline has been defined based on four sets of conditions. If any of these sets of conditions are true, the material is classified as being prone to structural decline:

Condition 1) ESP-based criteria:

- ESP > 6%,
- clay content >10%,
- ECEC >3meq/100g, and
- exchangeable sodium concentration >0.3meq/100g.

Condition 2) Exchangeable Mg-based criteria:

- clay content >10%;
- ECEC >3meq/100g; and
- Ratio of exchangeable Ca to exchangeable Mg <0.5.

Condition 3) ESI-based criteria:

- clay content >10%,
- ECEC >3meq/100g,
- exchangeable sodium concentration >0.3meq/100g, and
- ESI <0.05.

Condition 4) PSD-based criteria:

- Fine sand + silt + clay >70%

Based on these conditions, the soils are generally not prone to structural decline. They typically have low ESP (only one value was greater than 6%), ESI >0.05 on all but two samples, Ca:Mg ratios greater than 0.5, and acceptable fine sand + silt + clay fractions (only one value was greater than 70%).

4.4.5 Fertility

4.4.5.1 Organic C

Soil carbon and the associated biological activity is often the attribute that distinguishes soil from the underlying material (including subsoils). Increasing organic C increases water retention, decreases runoff potential, and reduces erosion potential, although the degree to which it does these varies from soil to soil. Although organic Carbon is likely to have an impact on erosion potential, it should be noted that it is confined to relatively shallow soil depths and its influence on soil physical properties diminishes rapidly with soil depth as a result. Murphy (2015) suggests than the largest influence of organic Carbon is on the surface 0.1m and reduces significantly in soil depths at 0.2m. Similar findings were reported by Loch *et al.* (2008) for more arid zone soils.

This is important in the context of soil use in mine rehabilitation. Often, soil stripping activities will strip and homogenise soils to 0.2-0.3m (or deeper), meaning than the homogenised soil will have Organic C levels ~2 times (or more) lower straight after stripping. Also, during stripping and stockpiling, much of the Organic C that is bound up in the organic matter is disturbed and reduced. This means that soils used in mining quite often have depleted Organic C levels (Spain *et al.* 1995). When subsoils and wastes with little to no Organic C prior to their disturbance are considered, it is clear that their Organic C levels will likely be very low.

A suggested value of low Organic C that could be used to define erosion prone soils would be <0.5%, with values >1.5% being a value for soils that support vegetation[11]. An Organic C value of 0.5% is associated with poor soil structure and very low soil health. Rates >1.5% are associated with moderate to high soil health, improved structural stability, and improved vegetation (Hazelton and Murphy 2016).

The majority of soil (~75%) have Organic C levels (>0.5%). The remaining 25% has low Organic C. This indicates that the organic matter levels are generally acceptable and for most soils would be beneficial to reducing erosion potential.

4.4.5.2 Total N and P

Total N values are very low to low for all samples. That said, the C/N ratio for all except one sample is <25, indicating the decomposition of organic matter will not be slowed by a lack of Nitrogen. Total P values are all low but consistent with arid land soils from the Goldfields area.

4.5 Wastes

The results of the waste testing are given in Table 6.

[11] It is noted that organic Carbon is different to organic matter. Organic matter is a term that is usually used in the broadest sense to describe a wide range of organic components in the soil, including living and non-living organic materials. Organic matter and organic carbon are usually expressed as a percentage of the soil by weight. When results are presented and interpreted, care should be taken to note whether organic matter or organic carbon levels are indicated. Organic matter is calculated from the levels of organic carbon in the soil, by multiplying by ~1.75. This factor assumes that the organic matter in the soil has a constant carbon composition of ~57%. The actual conversion factors of organic carbon to organic matter do vary from 1.72–2.00.

Table 6: Waste testing results

Sample ID	Rock Type	Oxidation	NAG pH (pH Units(	$EC_{1:5}$ dS/m	Average Rock Density (g/cm³)	Average Water Absorption (%)	Rock Durability
WPH45001	Laterite	Oxide	7.98	2.28	2.2	7.2	R2 - Weak
WPH45002	BIF	Transition	7.33	0.40	2.0	18.6	R2 - Weak
WPH45003	Mafic	Oxide	7.68	1.43	Disintegrated	Disintegrated	R1 – Very Weak
WPH45004	BIF	Transition	7.51	0.09	3.0	2.5	R4 - Strong
WPH45005	Mafic	Fresh	8.34	0.18	4.4	0.0	R6 - Extremely Strong
WPH45006	Laterite	Oxide	7.33	0.04	2.3	10.8	R4 - Strong
WPH45007	BIF	Transition	7.85	0.10	1.9	13.8	R1 – Very Weak
WPH45008	Ultramafic	Oxide	7.70	1.56	2.7	4.5	R2 - Weak
WPH45009	BIF	Fresh	6.24	0.75	2.8	3.9	R4 - Strong
WPH45010	Laterite	Oxide	7.49	1.19	3.3	1.6	R3 - Medium Strong
WPH45011	BIF	Oxide	7.60	0.66	2.7	0.2	R4 - Strong
WPH45012	BIF	Transition	7.46	0.51	4.8	1.7	R5 - Very Strong
WPH45013	Mafic	Oxide	7.69	0.69	2.0	15.9	R1 – Very Weak
WPH45014	BIF	Oxide	7.64	0.39	2.1	20.1	R1 – Very Weak
WPH45015	Ultramafic	Fresh	7.92	0.12	3.2	1.7	R5 - Very Strong

4.5.1 Material pH

The pH values of the wastes have not been measured. However, the NAG pH (pH value of the sample after complete oxidation of its sulphide content during the Net Acid Generation test) is available. Based on the NAG pH values the wastes sampled are alkaline. This means that the wastes generally have higher pH values than the soils. The alkaline wastes may result in different nutrient availability compared to the acidic soils. As such, there is value in considering incorporation of species that are adapted to alkaline conditions.

4.5.2 Material EC

The salinity ($EC_{1:5}$) the wastes are variable, ranging from very low (0.04dS/m) to extreme (2.28dS/m). The median value is 0.5dS/m which is classed as high. Salinity values of 0.7-1.4dS/m are likely to impact the growth of salt sensitive and moderately tolerant species, and salinity values of 2.28dS/m are likely to limit the growth of even salt tolerant WA rangeland species (Tanji and Kielen 2002).

The salinity values for the wastes are often higher than those measured for the soils. Their use at or near the surface (i.e., within the active rooting zone) should be avoided. Given that the wastes are also likely to be dominated by fines (see discussion below on rock durability), there is also a risk that salts from the waste may rise into the lower salinity sandy loam surface soils if they are placed over the saline wastes. The likelihood and consequences of this risk should be assessed through solute balance modelling supported by field trials that considers long-term rainfall patterns. For this report, it is considered prudent to assume that the waste dump will likely be moderately saline and capable of supporting only more salt tolerant shrub and tree species. Establishment of species that produce high levels of surface contact cover is unlikely.

4.5.3 Rock durability

An assessment of the durability of the rocky component of the RC drilling material provided was conducted in order to consider the likely character of the wastes that would be extracted and be present within a constructed waste landform. The testing used the available rock chips found within the sample provided.

The assessment of the rock component followed a selection of the quality and durability criteria provided in the Rock Manual. (CIRIA et al 2007). The Schmidt hammer values were used to assess hardness and were those from (ISRM 1978). A summary of the classification scheme used in given in Table 7.

Each of the samples were assessed using these guide values. The 'average' guide value was adopted for each sample as its suitability for use as an armourstone. This is turn was used to consider whether the materials would be and remain rocky once extracted or be fine-grained. Rocky materials can be treated as more erosion resistant than fine grained materials. The results of this assessment are given in Table 8.

Table 7: Rock quality classification system

Criteria	Unit	Quality and Durability Guide			
		Excellent (4)	Good (3)	Marginal (2)	Poor (1)
Lithology	-	Unfoliated igneous and metamorphic rocks, quartzites, and highly cemented sandstones, compact crystalline limestones	Crystalline dolomites, crystalline limestone, moderately well cemented sandstones	Argillaceous limestones, poorly cemented sandstones, dolomite reef rock with void cavities	Shaly limestones, reef breccia, shale, siltstone, slate, schist, chalk, gypsiferous carbonates
Rock density	g/cm^3	>2.7	2.5-2.7	2.3-2.5	<2.3
Water absorption	%	<0.5	0.5-2.0	2.0-6.0	>6.0
Hardness	-	VS, ES	S	MS	W, VW, EW

Table 8: Results of the rock durability assessment

Sample ID	Rock Type	Oxidation	Average Rock Density (g/cm^3)	Average Water Absorption (%)	Hardness	Durability
WPH45001	Laterite	Oxide	2.2	7.2	W	Poor
WPH45002	BIF	Transition	2.0	18.6	W	Poor
WPH45003	Mafic	Oxide	Disintegrated	Disintegrated	VW	Poor
WPH45004	BIF	Transition	3.0	2.5	S	Good
WPH45005	Mafic	Fresh	4.4	0.0	ES	Excellent
WPH45006	Laterite	Oxide	2.3	10.8	S	Poor
WPH45007	BIF	Transition	1.9	13.8	VW	Poor
WPH45008	Ultramafic	Oxide	2.7	4.5	W	Marginal
WPH45009	BIF	Fresh	2.8	3.9	S	Good
WPH45010	Laterite	Oxide	3.3	1.6	MS	Marginal
WPH45011	BIF	Oxide	2.7	0.2	S	Good
WPH45012	BIF	Transition	4.8	1.7	VS	Excellent
WPH45013	Mafic	Oxide	2.0	15.9	VW	Poor
WPH45014	BIF	Oxide	2.1	20.1	VW	Poor
WPH45015	Ultramafic	Fresh	3.2	1.7	VS	Excellent

The laterite materials have poor to marginal durability and are considered to likely present within a waste dump as wastes that are dominated by fines (with some coarse fraction). Oxidised mafic and ultramafic wastes have poor to marginal durability and would present as a waste dominated by fines. Fresh mafic and ultramafic wastes have excellent durability and would likely remain blocky (thought fines would be present).Oxidised and transition BIF wastes have poor to excellent durability, though the majority of the samples were classed as poor. These waste types could be considered likely to be dominated by fines, though with some coarse fraction. Fresh BIF wastes has good to excellent durability and would likely remain blocky (though fines would be present).

The materials have been ranked in terms of erosion resistance as follows (from most resistant to least resistant):

- Fresh BIF, mafic and ultramafic;
- Oxidised and transition BIF; and
- Oxidised laterite mafic, and ultramafic.

5 USING SOILS AND WASTES

5.1 Soils

The soils appear suitable for use as a growth medium. They are generally acidic, though some alkaline soils are present. They have low salinity and are gravelly loamy sand to gravelly loam in texture. They are generally not prone to dispersion and not prone to structural decline. They have low fertility, particularly low Nitrogen levels.

5.2 Wastes

The wastes typically have alkaline pH values. This is in contrast to the soils that are commonly acidic. This may have a negative impact on the quantity and type of vegetation that can establish on a waste dump when the wastes are placed close near the active root zone (i.e., within the surface 0.5-1.0m).

The salinity values for the wastes are often higher than those measured for the soils. Their use at or near the surface (i.e., within the active rooting zone) should be avoided. If used near the surface, there is a risk that capillary rise of salts may occur and increase the salinity of the overlying soils. For this reason, it appear prudent to include salt tolerant species into the rehabilitation seed mix.

The wastes generally have poor rock durability, particularly considering that only 1% of the waste volume is classed as fresh and 99% is either oxidised or transition waste. Therefore, armouring of rehabilitation batters with durable rock is not considered achievable as an erosion mitigation strategy for rehabilitation of waste dumps at Die Hardy. Armouring with tree debris may be possible given the site is located within dense mixed shrublands and grasslands.

5.2.1 Laterite

The laterite materials make up 22% of the waste material. They have poor to marginal durability and are considered to likely present as gravelly fines. They are not suitable for use as a rock armour, but could be used as a material for roads or laydown areas as it will likely compact well. Further geotechnical testing of the laterites should occur as part of engineering design work if they are to be used for this purpose. If placed within the waste dump, these materials should be scheduled so that they are placed nearer the surface than the other oxidised and transitional wastes such as the oxidised and transitional BIF and ultramafics.

5.2.2 BIF wastes

Oxidised and transition BIF wastes make up 44% of the total waste volume. They have poor to excellent durability, though the majority of the samples were classed as poor. These waste types could be considered likely to be dominated by fines, though with some coarse fraction. Although not suitable for use as a rock armour material, these wastes could be considered for use as an abandonment bund material, particularly given that there is very little unweathered materials present. These represent the most durable of the weathered materials. If placed within the waste dump, they should be scheduled such that they are buried within the dump and not located near the surface. If possible, the laterite wastes could be placed closer to the surface than the oxidised or transitional BIF materials.

Fresh BIF wastes make up 0.2% of the waste volume. They have good to excellent durability and would likely remain blocky (though fines would be present). Their small volume means that they are unable to be used as armouring of batters during rehabilitation. But they could be used as rock in high risk erosion zones such as areas prone to flooding, or inlet and outlets of surface water drainage systems. If placed within the waste dump, they should be scheduled such that they are located at the final rehabilitated surface as they will offer some erosion potential.

5.2.3 Ultramafic wastes

Oxidised and transitional mafic and ultramafic wastes make up 32% of the total waste volume. They have poor to marginal durability and would present as a waste dominated by fines. These materials should be placed within the waste dump. If possible, they should be buried under or co-mingled with the oxidised and transitional BIF wastes.

The oxidised BIF and transitional wastes are likely more suitable for using as abandonment bund material than these materials. They should be used for that purpose in preference to weathered materials.

Fresh mafic and ultramafic wastes make up 0.8% of the total waste volume. They have excellent durability and would likely remain blocky (thought fines would be present). Similar to the fresh BIF wastes, their small volume means that they are unable to be used as armouring of batters during rehabilitation. But they could be used as rock in high risk erosion zones such as areas prone to flooding, or inlet and outlets of surface water drainage systems. If placed within the waste dump, the fresh ultramafics should be scheduled such that they are located at the final rehabilitated surface as they will offer some erosion potential.

6 EROSION MODELLING

6.1 Material erodibility

Different surfaces were assessed for erosion potential using the WEPP erosion model. A summary of the WEPP (Water Erosion Prediction Project) erosion model is provided below. The following material types were considered in the sections below:

- Gravelly soil – a fine grained soil with an appreciable amount of gravel and/or stones, a sandy loam texture, moderate permeability, and low tendency for structural decline.
- Gravelly soils with tree debris – the soil as described above, but with addition of 40% tree debris.

Erodibility parameters for the gravelly soil were estimated by comparing the baseline properties (Table 5) to materials with similar baseline properties that Landloch have previously assessed for erodibility using laboratory or field based techniques. A rill spacing of 3m was assumed for modelling of the gravelly soils. These techniques include the application of simulated rain and simulated overland flows. The erodibility parameters are material-specific and were used to predict long-term erosion.

The impact of addition of 40% tree debris cover was assumed to reduce erosion rates by 60% (see Figure 6) while also limiting the ability of surface runoff to accumulate. Therefore, a rill spacing of 1.5m was adopted for modelling of surfaces with tree debris added.

Other site-specific conditions (i.e., climate and landform batter shape) are considered within the erosion model itself.

6.2 Computer simulation of runoff and erosion

6.2.1 The WEPP model

The WEPP model was developed by the United States Department of Agriculture to predict runoff, erosion, and deposition for hillslopes. WEPP is a simulation model with a daily input time step, although shorter time steps are used by internal calculations on days when rainfall occurs. Plant and soil characteristics important to erosion processes are updated every day. When rainfall occurs, those plant and soil characteristics are considered in determining the likelihood of runoff. If runoff is predicted to occur, the model computes sediment detachment, transport, and deposition at points along the slope profile.

The erosion component of the WEPP model uses a steady-state sediment continuity equation as the basis for the erosion computations. Soil detachment in interrill areas is calculated as a function of the effective rainfall intensity and runoff rate. Soil detachment in rills is predicted to occur if the flow hydraulic shear stress is greater than the soil's critical shear stress, and when the sediment load of the flow is below its transport capacity. Deposition in rills is computed when the sediment load is greater than the capacity of the flow to transport it.

6.2.2 Climate file

All WEPP model simulations completed by Landloch use a 100-year stochastic climate sequence for the site developed from observed daily and sub-daily data from nearby weather stations. For each day of simulation, WEPP requires ten daily weather variables:

- Precipitation (mm),
- Precipitation duration (hr),
- Peak storm intensity,
- Time to storm peak,
- Average minimum temperature,
- Average maximum temperature,
- Dew point temperature,
- Solar radiation,
- Wind speed, and
- Wind direction.

Of these, the four rainfall-related variables (underlined in list above) are of particular importance because previous studies have shown that predicted runoff and erosion are most sensitive to these rainfall variables (Nearing et al. 1990; Chaves and Nearing 1991).

For most sites around the world, complete historical weather data on these variables are not available. To use WEPP for runoff and erosion prediction, synthetic weather sequences that statistically preserve the mean and variations in the historical observations are required. CLIGEN is a stochastic weather generator that can be used to provide WEPP climate input files. CLIGEN has been extensively assessed for a wide range of climates, and it was found that CLIGEN was most suitable to provide the required climate input for WEPP to predict runoff and erosion (Yu 2003).

Daily rainfall data were sourced for Die Hardy from Turkey Hill (Bureau of Meteorology station 12079) from January 1929 to March 2021. Turkey Hill is ~90km south of Die Hardy. Patched point data were sourced from SILO (Scientific Information for Land Owners) data service managed by the Queensland Government. Sub-daily (6-minute) rainfall (pluviograph) data were sourced from the Bureau of Meteorology for Merredin. This site contains pluviograph data from January 1966 until March 2011, with an effective record length of approximately 43.1 years.

Using these data sets, the following parameter values were computed and used to develop the synthetic climate sequence for Die Hardy:

- Mean daily rainfall on wet days for each month,
- Standard deviation and skewness coefficient of daily rainfall for each month,
- Probability of a wet day following a dry day for each month,
- Probability of a wet day following a wet day for each month,
- Mean daily max. temperature for each month,
- Standard deviation of daily max. temperature for each month,
- Mean daily min. temperature for each month,
- Standard deviation of daily min. temperature for each month,
- Mean maximum 30-min rainfall intensity for each month, and
- Probability distribution of the dimensionless time to peak storm intensity.

These parameters were used to create a CLIGEN parameter file for the site. Wind data were not synthesised by CLIGEN because Priestley-Taylor's method for estimating the potential evaporation will automatically be used by WEPP. A 100-year climate sequence was generated using CLIGEN version 5.1 (Yu 2002).

The average annual rainfall totals for both the Turkey Hill observed data (1929-2021) and the CLIGEN climate sequence are the same (297mm/y). The average monthly rainfall of the CLIGEN climate sequence is compared with the observed data from Turkey Hill in Figure 10. The absolute error between the CLIGEN sequence and the observed monthly averages is less than 0.01mm/month, equivalent to less than 1mm difference over the entire year. Daily rainfall totals were compared using their Annual Exceedance Probability (AEP) (Figure 11). The data shows that the daily rainfall totals in the CLIGEN sequence closely match the observed data. For example, the observed storm event with an AEP of 1% had a total of 190mm, compared to the CLIGEN value of 194mm. The observed storm event with an AEP of 1.1% had a total of 114mm, compared to the CLIGEN value of 123mm for an AEP of 1%. The observed storm event with an AEP of 2% was 90mm, the same as the CLIGEN value for the event with the same AEP.

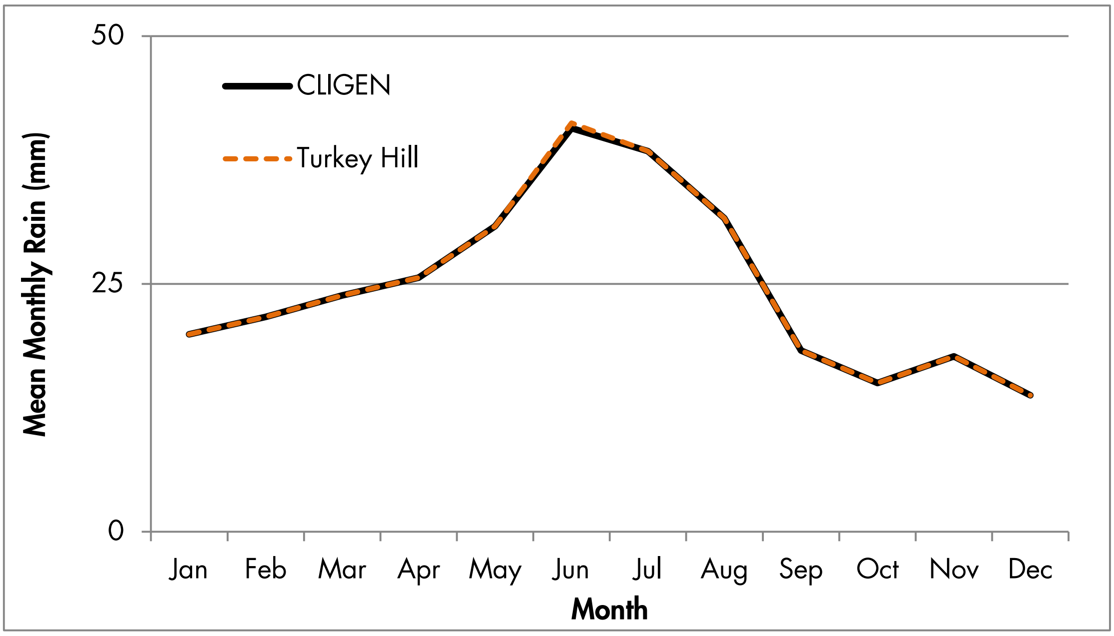


Figure 10: Comparison of CLIGEN mean monthly rainfall with observed data from Turkey Hill (1929-2021).

Based on this analysis it is concluded that the CLIGEN climate sequence:

- reproduces average annual rainfall totals;
- reproduces mean monthly rainfall totals;
- reproduces daily rainfall totals and their AEP;
- has similar average annual erosivity values to those reported in the available literature;
- has a similar amount of annual erosivity to published values and a similar pattern of monthly erosivity to that of mean monthly rainfall; and
- can be used within the WEPP model to predict long-term erosion for Die Hardy.

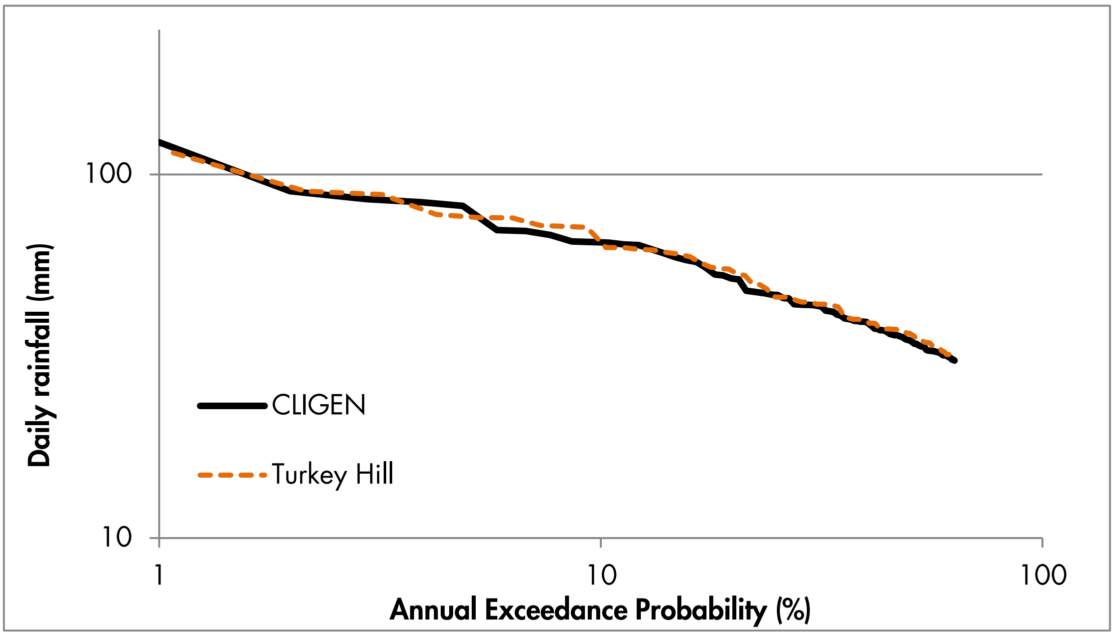
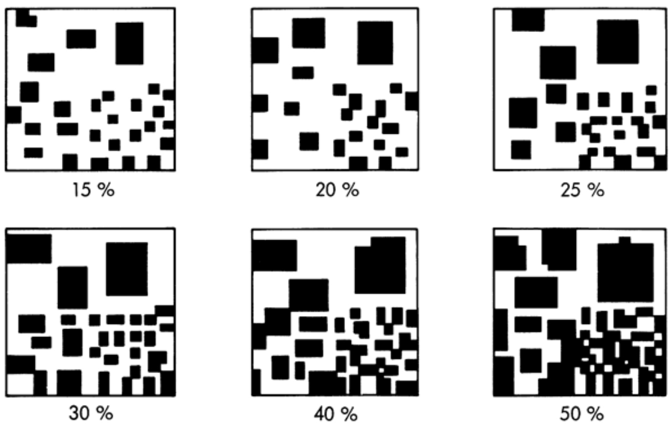


Figure 11: Comparison of daily rainfall totals in the CLIGEN sequence with the daily rainfall totals observed at Turkey Hill (1929-2021).

6.2.3 Other model assumptions

All WEPP models have assumed a minimum cover thickness of 0.5m over any underlying sub-layer. Therefore, surfaces that include soil could assume a soil thickness of 0.5m over any underlying layer. All erosion predictions given below assume that water is controlled on the dump top (i.e., crest bunds are present) and that no cross slope berms were installed. All erosion predictions assume that the underlying wastes are less permeable than the soils. A rill spacing of 4m was assumed for modelling of the gravelly soil, and 1.5m was assumed for the soil when tree debris was applied. When tree debris was applied the WEPP model rate was multiplied by 0.368 (as well as using the reduce rill spacing) to account for application of 40% tree debris. Figure 12 shows graphically what different levels of cover will look like (black squares are representative of the tree debris in this case.)



http://www.kgs.ku.edu/Publications/Bulletins/212/

Figure 12: Graphic for estimating different levels of cover. Each quarter of any one square has the same amount of black but with the black areas having different sizes.

6.3 Proposed Die Hardy landform

Ramelius plan to adopt a rehabilitation waste landform at Die Hardy with the following characteristics:

- Number of lifts: 1
- Batter shape: Uniform (single gradient)
- Maximum landform height: 20m
- Batter gradient: 18° (32.5%)

Details of the landform as supplied by Ramelius are given in Figures 13 and 14.

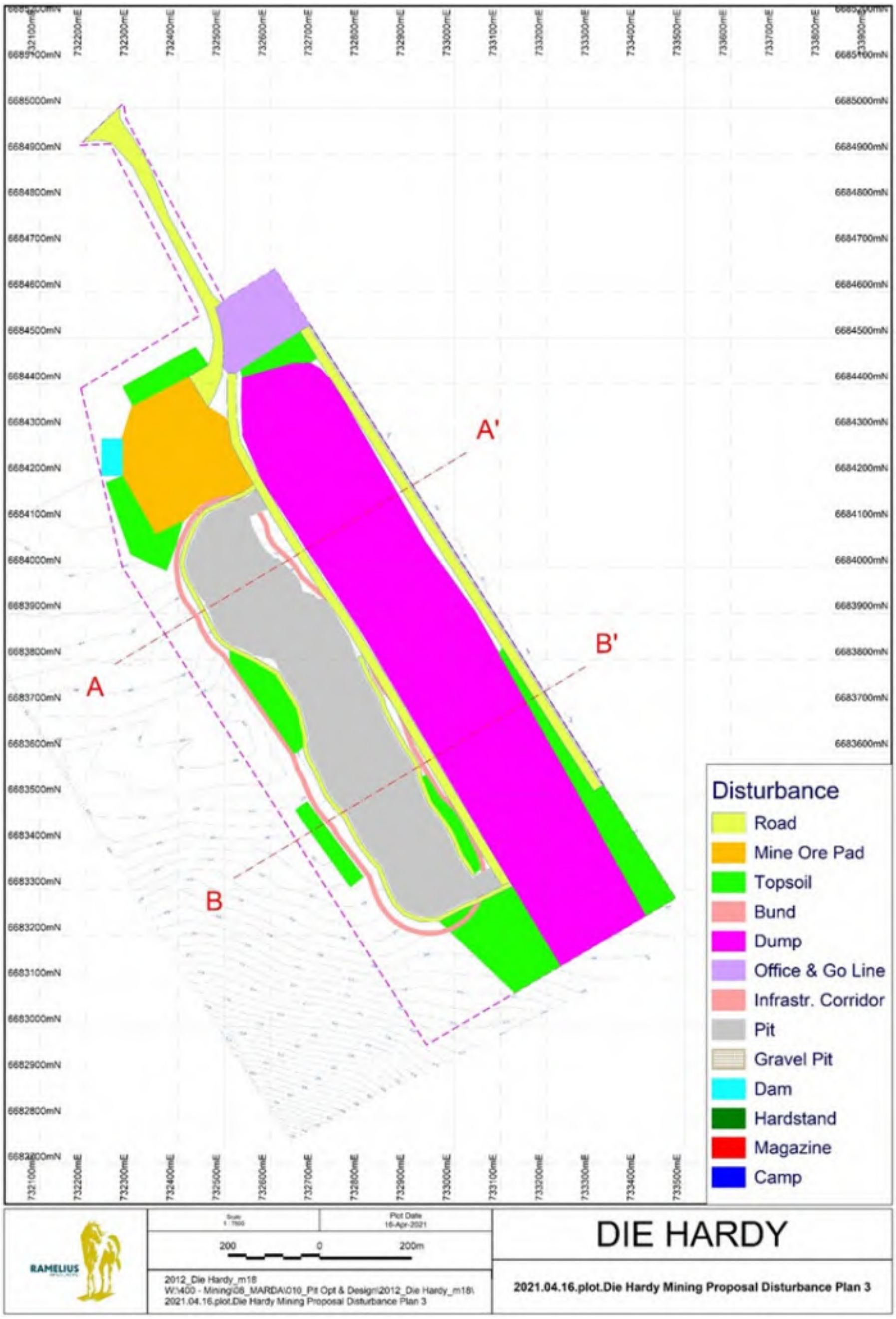


Figure 13: Waste dump (pink) in plan view showing location od sections A-A′ and B-B′

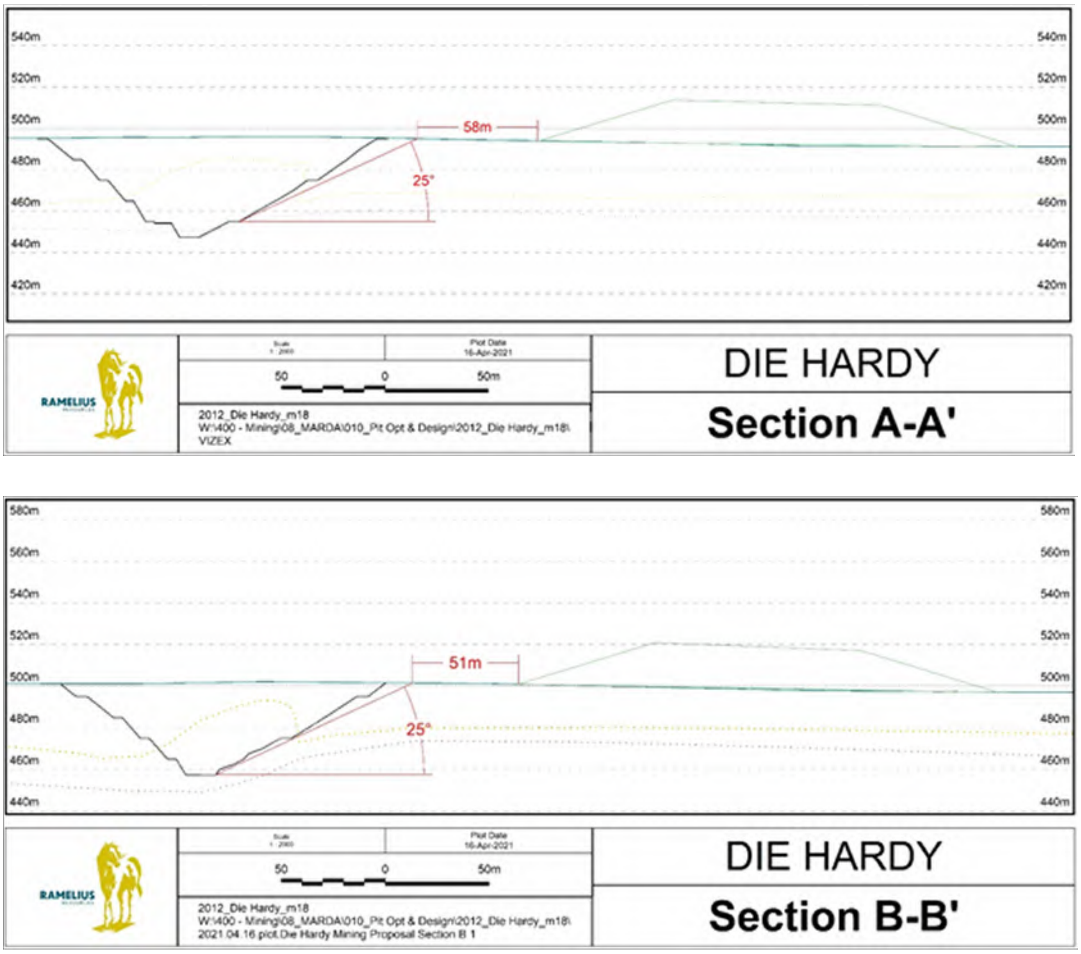


Figure 14: Cross section A-A′ (top) and B-B′ of the Die Hardy waste dump

7 WATER EROSION PREDICTIONS

For all erosion predictions presented in tables in this section, the cells shaded green represent batter geometries that produce acceptable erosion rates[12]. Cells shaded orange represent batter geometries that produce unacceptable erosion rates.

7.1 Linear profiles

2-D batter slope geometries consistent with the planned dump geometry were considered for long-term erosion, with the results tabulated in Table 7. A batter heights of 20m and uniform gradient of 18° was considered. Results are given for the case where 40% tree debris is added, and when tree debris is not added.

[12] Acceptable erosion rates are mean average annual erosion rates <=6t/ha/y and peak average annual erosion rates <=12/t/ha/y.

Table 7: Long-term erosion predictions for gravelly soil

Linear Batter Gradient (°)	Linear Batter Gradient (%)	Batter Height (m)	Batter Footprint (m)	WEPP-Predicted Average Annual Erosion (t/ha/y)			
				0% Tree Debris		40% Tree Debris	
				Mean	Peak	Mean	Peak
18	32.5	20	62	8.4	22	1.1	4.8

Batter heights of 20 are predicted to erode at unacceptable rates for gradients of 18° (Table 7). Lowering gradients to as low as 12° was also shown to yield unacceptable rates.

The impact of the application of tree debris was considered. It is assumed that addition of durable fresh rock is not possible given it is in short supply on site. Application of tree debris in order to achieve 40% cover is predicted to reduce erosion rates to acceptable levels for batters of up to 30m and gradients of 18° (Table 7). Tree debris should be applied to the lower third of the batter; it is not required to be spread over the entire batter, only on the lower section where erosion rates are predicted to exceed acceptable peak erosion rates.

7.2 Concave profiles

Concave profiles were developed for total waste dump heights of 20m and 30m. A height of 20m was consistent with the current design height. However, if a concave profile was adopted, it is likely that the total storage volume for the dump would be reduced. Given that it seems unlikely that the footprint can be increased (Figure 13 shows that the dump is quite footprint constrained), the option is to maintain the storage capacity are to increase the dump height. This could be done by either:

1. Adopting a single concave options with a larger total height (hence modelling 30m); or
2. Adoption of a single 20m high concave, with the remaining waste stored in a small lift built on the top of the waste, but with its toe well away from the crest of the concave.

The case where no tree debris was applied was modelled. However, if it is available, it should be placed at the points where the gradients change as a means of further reducing erosion risk and encouraging vegetation establishment. The erosion modelling results are shown in Table 8 and given graphically in Figures 15 and 16.

7.3 A note of vegetation and erosion control

All of the WEPP erosion predictions assume no impact of standing vegetation on erosion control. If vegetation were to establish, erosional stability would improve. However, the potential benefit (assuming ~5% surface contact cover is achieved) would be in the order of 10% reduction in erosion rates.

Table 8: WEPP predicted erosion rates for the gravelly soil applied on variable concave batter profiles at 20m and 30m batter heights. 0% tree debris cover is assumed.

Horizontal Distance from Crest (m)	Vertical Distance from Crest (m)	Gradient (°)	Gradient (%)	Average annual erosion (t/ha/y)	
				Mean	Peak
20m High – 3 Stage Concave					
0 – 30.8	20 - 10	18	32.5	4.3	11
30.8 – 50.9	10 – 5	14	24.9		
50.9 – 76.6	5 - 0	11	19.4		
30m High – 4 Stage Concave					
0 – 30.8	30 - 20	18	32.5	4.7	11
30.8 – 50.9	20 – 15	14	24.9		
50.9 – 76.6	15 - 10	11	19.4		
76.6 – 140	10 – 0	9	15.8		

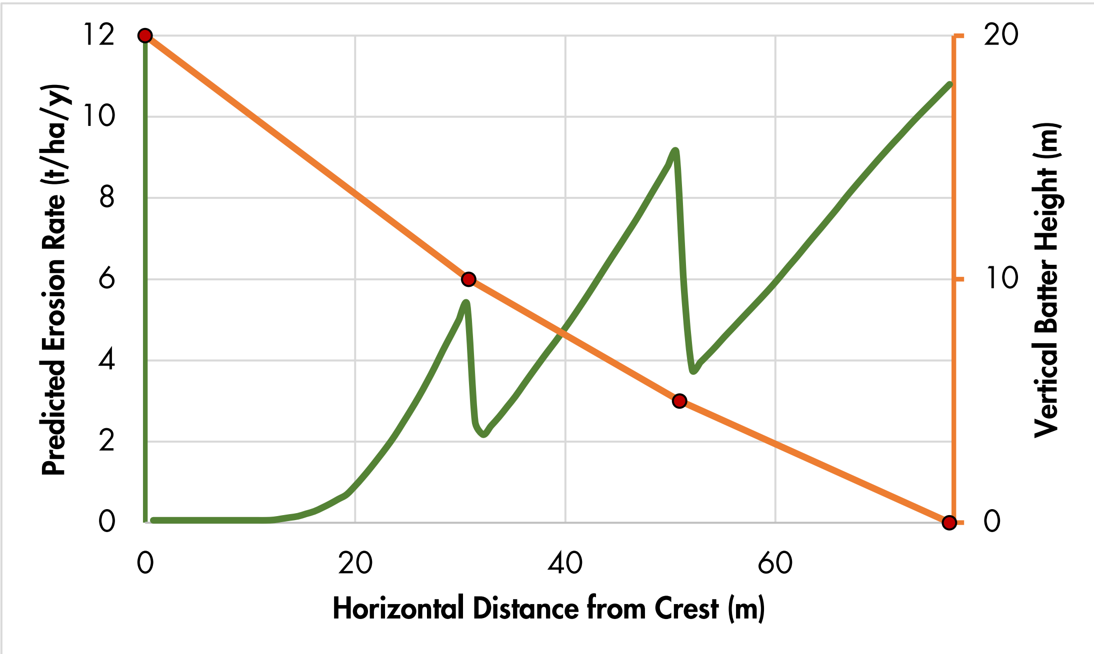


Figure 15: Predicted erosion along a 20m high concave slope with gravelly soil applied. The concave profile is described in Table 8.

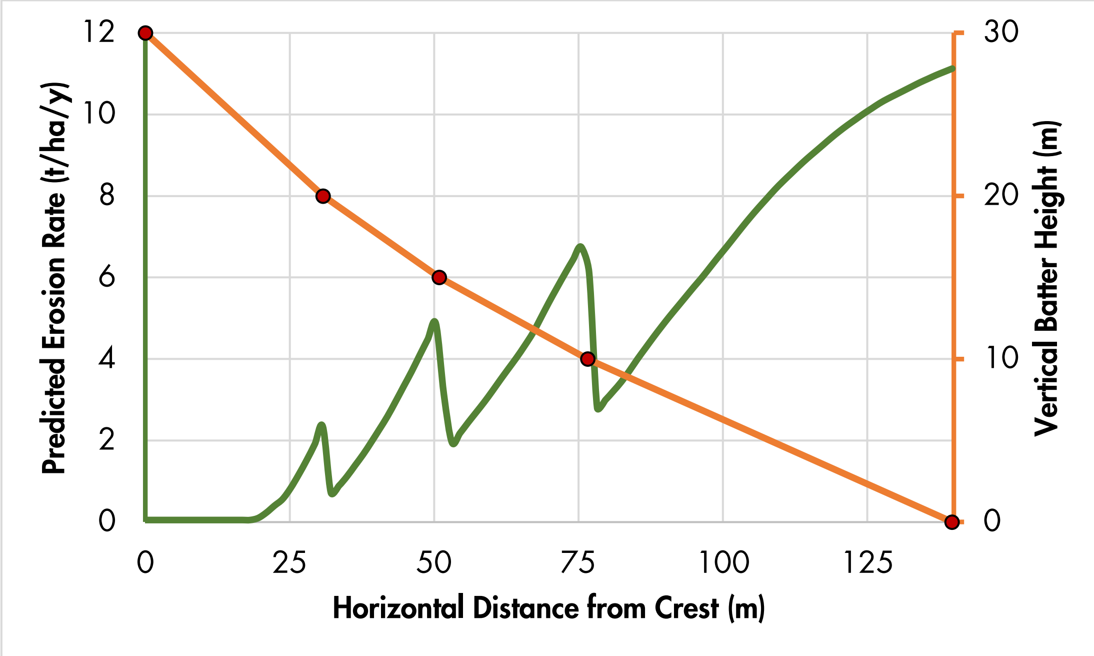


Figure 16: Predicted erosion along a 30m high concave slope with gravelly soil applied. The concave profile is described in Table 8.

8 ENGINEERED RUNOFF CONTROL STRUCTURES

8.1 Cross-slope berms

The erosion predictions indicate that cross-slope berms are not required for landforms with uniform gradient (18°) profiles up to 20m high if tree debris is applied. For the concave options, cross slope berms are not predicted to be necessary.

It is recommended that cross-slope berms be avoided (at present they are not required in any case). This is because the underlying oxidised waste is likely to have low permeability, meaning that when runoff occurs, berms will experience prolonged ponding. Although it cannot be shown from the available data, many oxidised wastes in the arid regions of Western Australia are prone to dispersion. Prolonged ponding of runoff over dispersive oxidised waste increases the risk of tunnel erosion and landform failure. If berms are contemplated in the future (e.g. if the design changes), the berm design must consider this risk and also be able to manage runoff and sediment from extreme runoff events.

If a concave option with a small additional lift on the dump top to store the required waste volume is adopted, there would be a need to use a berm. The berms should be at least 20m wide, and have a backslope of at least 5° in order to manage future runoff and sediment in the long term.

8.2 Crest bunds

Crest bunds are often placed on the very edge of the flat waste dump. They are placed in order to mitigate the risk posed by uncontrolled discharge from the landform top to the steep-gradient outer batter slopes. They are essential when designing a water retaining landform.

When used, crest bunds should be constructed from stable materials that are not prone to structural decline. They should be constructed such that their outer face has the same gradient as the outer slope of the landform. Their inner face should be sloped at an angle of 10% so that water (if it ponds) does not pond near the outer face of the landform. The top of the bund should be at least 2m wide. The height is set so that an extreme rainfall event can be stored, while allowing for some lateral movement of water and some freeboard. A minimum height of 1m is recommended for Die Hardy.

8.3 Cross bunds

For larger waste dumps, it is recommended that the top of the dump be separated into 2-3ha segment by installation of cross bunds. These are small (0.5m high) bunds that run across the top of the waste dump and mesh into the crest bunds.

8.4 Toe drains/bunds

In the instance where the risk of off-site impact of sediment movement is low, and where landforms are designed to erode at acceptable rates, there is no need for a toe drain or bund to contain eroded sediment. This is because the erosion rates are similar to those that occur naturally in the surrounding environment.

9 GENERAL LANDFORM GUIDANCE

9.1 Waste dump top

The top of the rehabilitated waste dump must be level (i.e., at a fixed RL). It must not be sloping such that water can flow laterally and accumulate on one side of the dump top. If this were to occur, uncontrolled discharge of runoff could occur and cause erosion failure of the batter slopes.

9.2 Flood protection

If waste dump batters are located within the 100-year flood line, rock armour protection is recommended for the impacts batter areas. This armouring should be sized according to a surface water flow study that calculates the potential flow velocities that will be experienced. The fresh BIF waste rock will likely be a suitable source of rock armour for flood protection works, assuming the correct rock sizes can be sourced either from the run of mine waste, or from crushing to reduce the size or utilising special blasting patterns to produce the large size required. The required rock size will depend on the final placement of the waste dumps relative to the flood flows. If the fresh BIF waste is to be used for this purpose it must be segregated and stockpiled because it is in very limited supply (1% of the total waste volume is fresh BIF).

Alternately, flood bunds are also used in some cases to divert water away from the waste landforms rather than allowing the water to interact with the landform batter.

9.3 Ramps

Ramps are a consistent source of failure in rehabilitated landforms. Where possible, ramps should be removed as part of the rehabilitation of the landform. Where they are left, their erosion potential must be assessed using a 3-D landform evolution model.

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Appendix C: MWES (2021) Die Hardy Gold Project Mining Proposal Hydrology Report

Die Hardy Gold Project
Hydrology Report

Prepared for

Marda Operations Pty Ltd

PO Box 6070
East Perth WA 6892

June 2021

MWES
Hydrological Services

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Version:

Rev0 – 6 April 2021

Rev1 – 8 April 2021

Rev2 – 24 June 2021

EXECUTIVE SUMMARY

This report presents the results of a hydrological assessment of the Die Hardy Gold Project. The main permanent surface disturbances include an open pit and the associated waste rock.

The proposed development site is elevated and well-drained. It is located within hundreds of metres of the regional catchment divide, such that operational and post-closure surface water management and flooding considerations are minor.

Groundwater occurrence is limited on the deposit. A mining water supply will need to be met by developing the limited local groundwater and augmenting that by development of supplies from neighbouring tenements.

There are no groundwater licensees or water reserves in the region. There is no potential for water-related impacts to any known water resource or ecological receptor.

Following closure, a small shallow final pit lake will form with a stable water level well below the pit crest, and at a modelled lake depth of around 15m. The lake will become a local groundwater sink and there is no risk of groundwater or surface water discharge. Salinity will gradually increase over time due to evaporative concentration of discharging groundwater solute. Salinity will remain the major feature of the water and the major constraint on any beneficial use.

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CONTENTS

TABLES

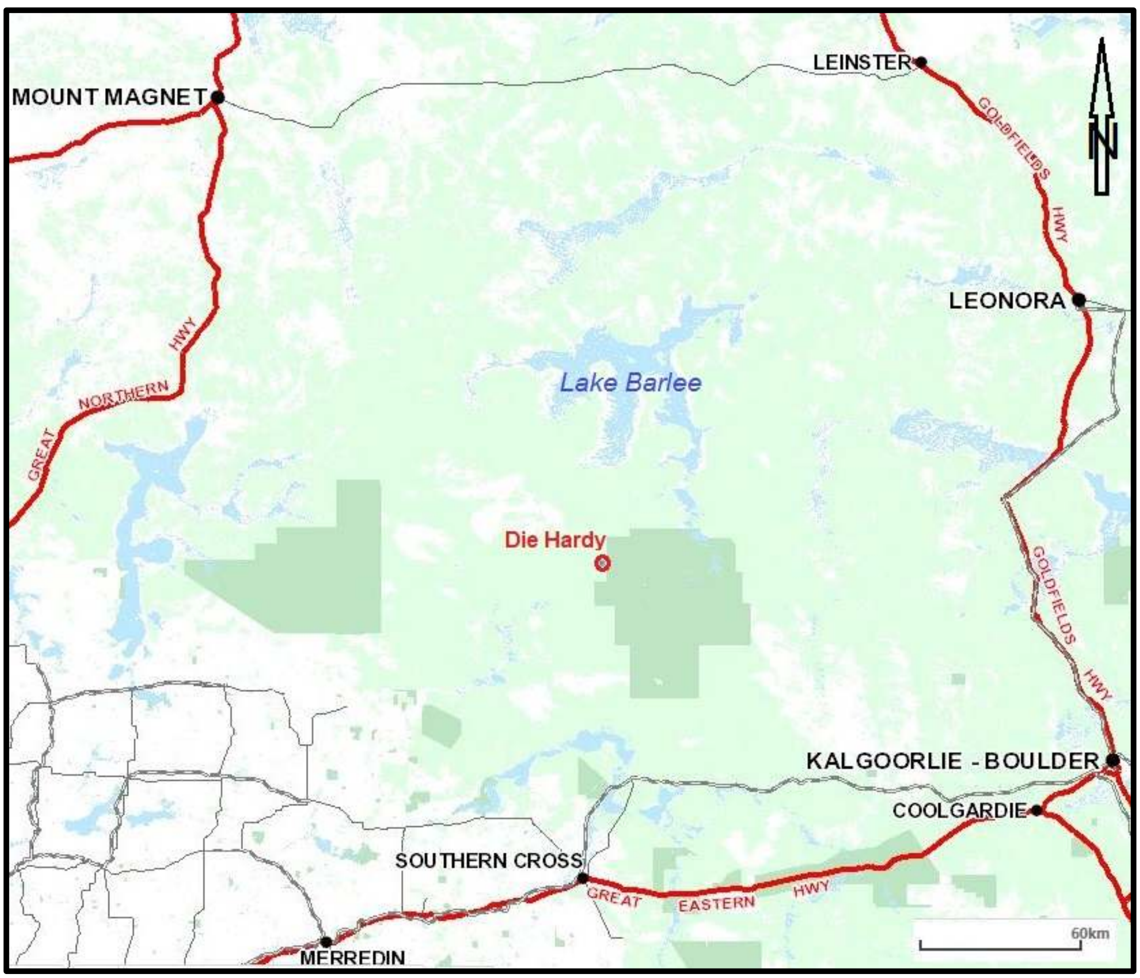
FIGURES

1. INTRODUCTION

Marda Operations Pty Ltd (MOPL), a wholly-owned subsidiary of Ramelius Resources Limited, owns the tenements for its Die Hardy gold project north of the existing Marda Central gold mine. MOPL is seeking approval for mining development at this satellite deposit (Figure 1). The site is located on M77/1272, near the Bullfinch-Evanston Rd, 30 km north of the Marda Central mining area. This report covers surface and groundwater-related matters in support of a mining proposal to the Department of Mines, Industry Regulation and Safety (DMIRS), as well as dewatering and hydrological information that will support a Works Approval application to the Department of Water and Environmental Regulation (DWER), if required.

There is a brief history of underground mining on the nearby Die Hardy Range from the 1930's. The only prior work at the current deposit site is exploration drilling. The proposed project surface works include an open pit, waste rock landform (WRL), Run-of-mine (RoM) ore storage pad and supporting infrastructure. Run-of-mine ore will be trucked south from the site for processing at Ramelius' Edna May Operation, near Westonia.

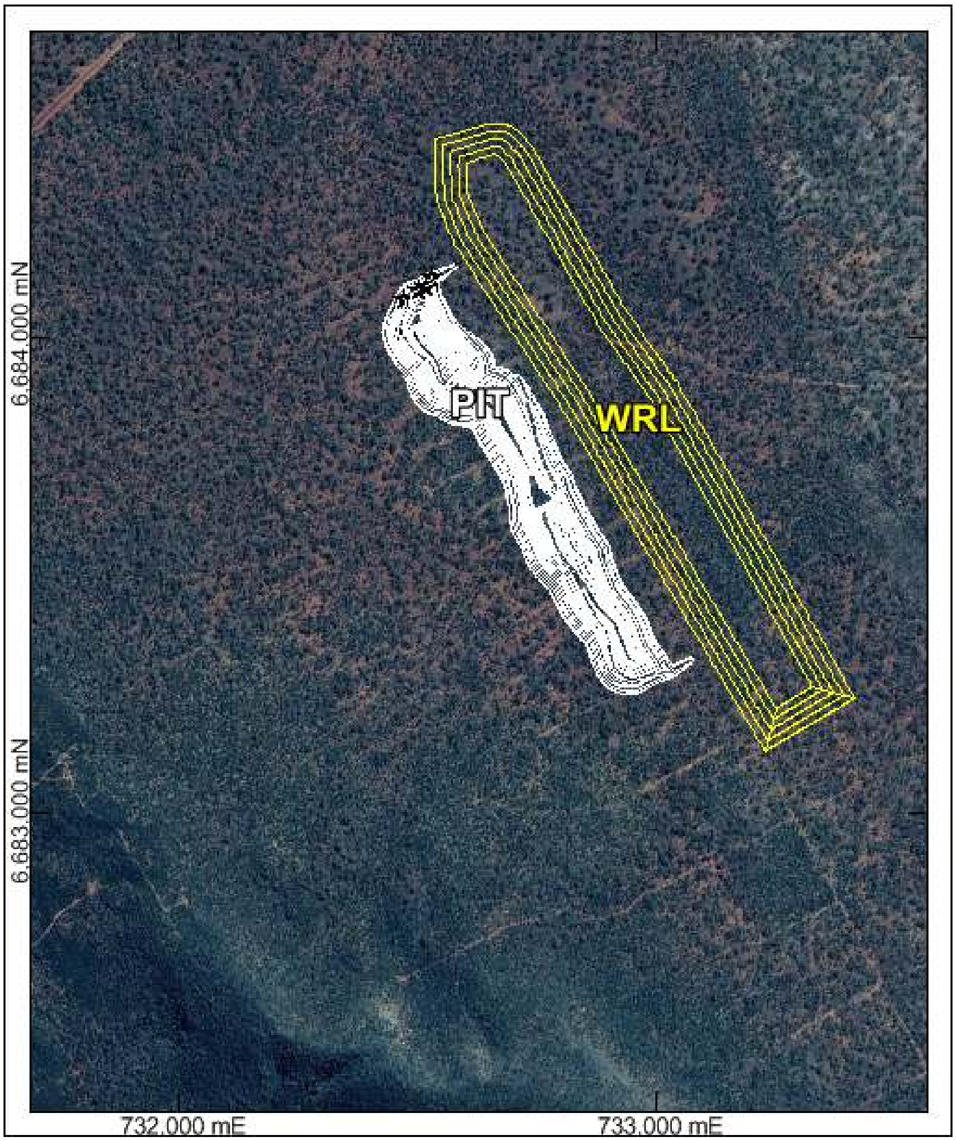
Figure 1 – Die Hardy Regional Location Plan



2. PROJECT LAYOUT

Project components are shown in Figure 2. The permanent landforms include the open pit and Waste Rock Landform (WRL). The pit is 980 x 150 metres with a surface area of 15 hectares, and up to 52 m deep. The WRL has a maximum elevation of 519 m AHD, or 29 m high. Dimensions are 1500 m x 240 m and footprint is 33 hectares.

Figure 2 – Project Layout



3. BASELINE CONDITIONS

3.1. Climate

The climate is warm semi-arid with hot dry summers and cold winters. Rainfall statistics can be summarised as the average of those recorded at BoM stations at Paynes Find and Sandstone. The long term annual average is 267 mm and average monthly totals range from 10mm (October) to 25-35 mm in January-July. Pan evaporation data from Paynes Find show a seasonal range averaging between 2.5 and 11.9 mm per day with an average annual total of 2480 mm. This is in agreement with the BoM continentwide pan evaporation grid value of 2440 mm.

Shorter duration rainfall intensity is described by the intensity-frequency-duration (IFD) statistics downloaded from the Bureau of Meteorology (BoM) Design Rainfall Data System, 2016. These are summarised in Table 1 and shown graphically in Figures 3 and 4.

Table 1 – Rainfall IFD Statistics

Duration	Units	Annual Exceedance Probability				Return Period (years)	
		50%	10%	5%	1% = 100	500	1000
10	min	7.08	14	17.3	26.1	36.2	41.5
15	min	8.62	17.1	21.1	31.8	44.1	50.6
20	min	9.75	19.3	23.8	35.8	49.8	57.1
30	min	10.6	21	25.9	39	54.3	62.2
45	min	11.4	22.4	27.6	41.5	57.9	66.4
1	hour	13.1	25.6	31.4	47.2	65.9	75.7
1.5	hour	14.4	27.9	34.2	51.3	71.7	82.4
2	hour	16.5	31.5	38.5	57.6	80.5	92.6
3	hour	18.1	34.4	41.9	62.6	87.4	100
4.5	hour	20.8	39	47.5	70.8	98.6	113
6	hour	23.9	44.6	54.3	80.8	112	128
9	hour	26.4	49.1	59.9	89.1	123	141
12	hour	30.2	56.5	69	103	142	162
18	hour	33.1	62.3	76.4	114	157	180
24	hour	37.3	71.1	87.5	131	182	208
30	hour	40.2	77.4	95.7	144	201	231
36	hour	42.3	82.1	102	154	218	251
2	day	43.9	85.8	107	162	231	266
3	day	46.1	91	114	174	250	289
4	day	48.6	96.8	122	186	271	316
5	day	50.2	99.9	125	192	282	329
7	day	51.4	102	128	195	287	335

Considering the up-lying location of the site, short duration events (up to 30 minutes) are most relevant to stormwater water responses. Such events may be unpredictable and can potentially occur at any time of year.

As shown in Table 1, rainfall totals tend to asymptote over periods of 7 days or longer and these greater totals may be relevant to site water storage management. Such extreme weekly/monthly totals are likely to relate to seasonally controlled cyclonic events which for this location typically arrive after a 2-3 day warning period.

Figure 3 - Rainfall Intensity Curves for Die Hardy (29.9625 S, 119.4125 E)

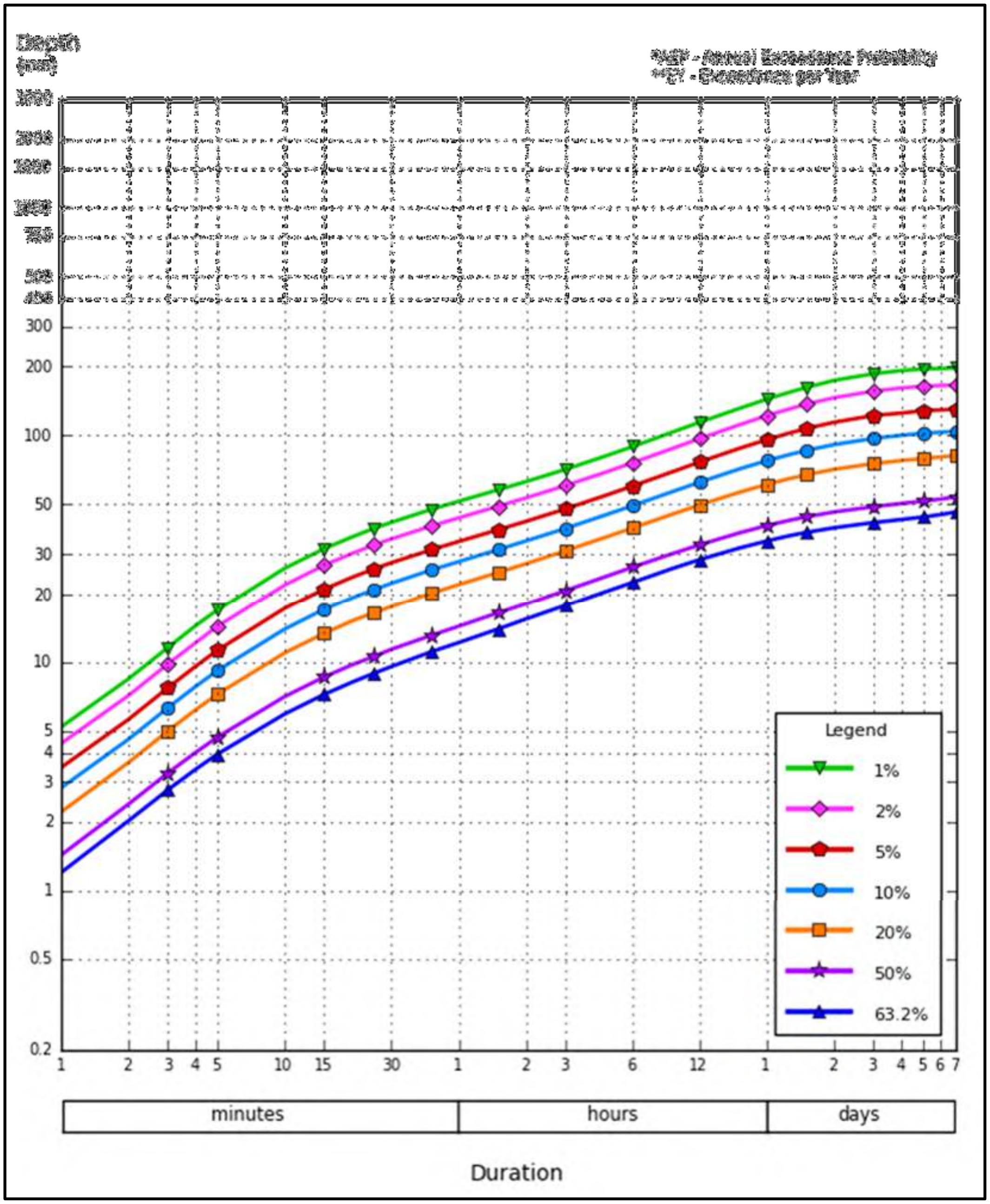
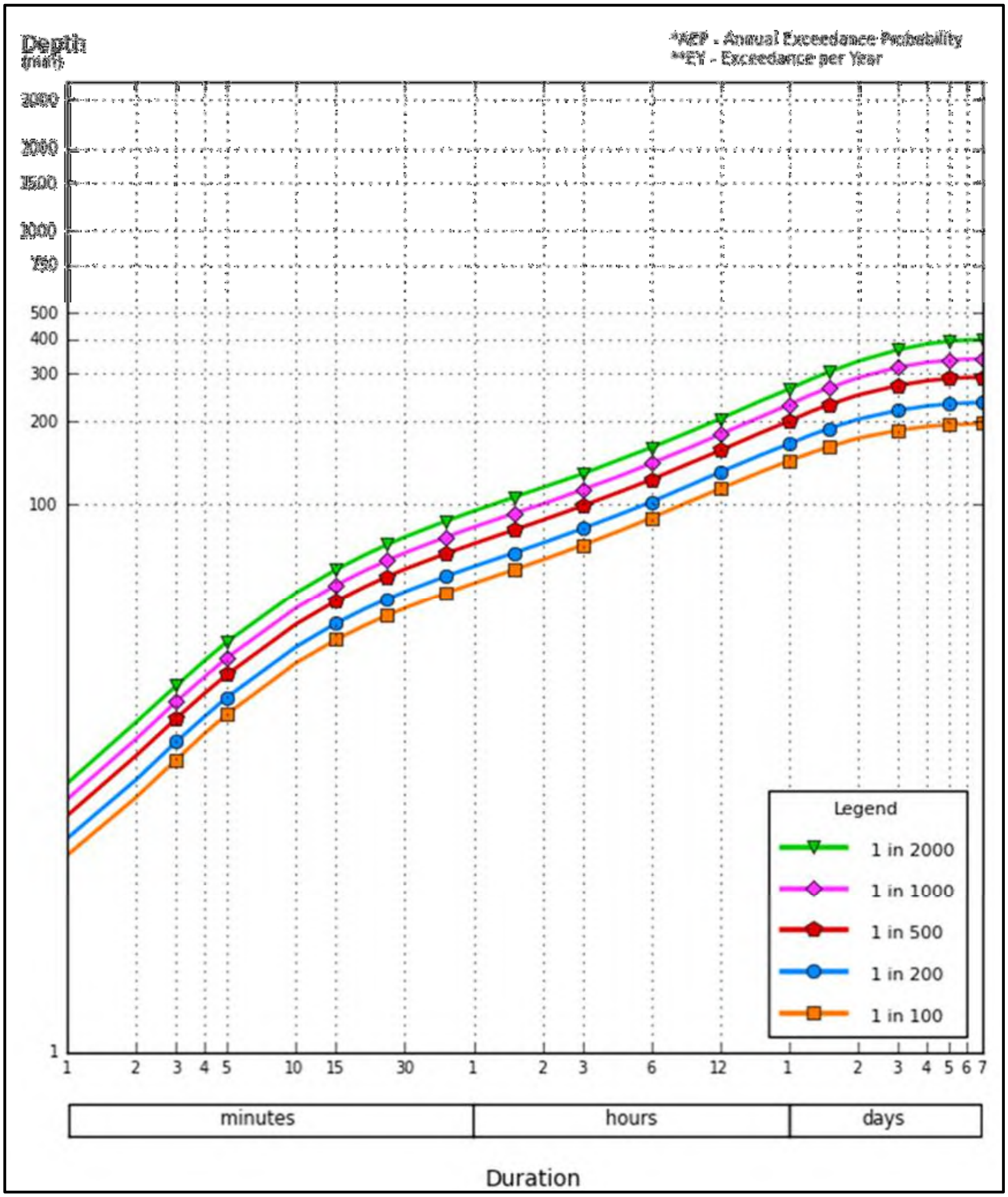


Figure 4 - Rainfall Intensity Curves for Rare Events



3.2. Regional Physiography and Land Use

The project site is located near the northern limit of the Yilgarn Shire and on the Diemals pastoral lease, near its eastern boundary with Crown Land area of the proposed Helena-Aurora national park.

The Department of Primary Industries and Regional Development pastoral land system (https://maps.agric.wa.gov.au/nrm-info/) maps the area as "Campsite Land System" of alluvial plains, eucalypt woodlands, and acacia shrublands.

The nearby local catchment divide formed by the Die Hardy Range is also a continental-scale catchment boundary between the Swan-Avon and Salt Lake Basin catchments. The site is located on the north slope of the strike ridge which forms the boundary and includes Mt Geraldine (elevation 642 m AHD), 800 m south of the site.

Regional drainage is to the north in a long broad ill-defined swale located east of the Bullfinch-Evanston Rd. This ultimately discharges to a northwest arm of Lake Giles, located 38 km north from the site at an elevation of 400 m AHD. Lake Giles is practically a southeast arm of Lake Barlee, one of the largest salt lakes in the State (Figure 1).

Natural surface slopes north from the ridge line toward the site exceed 20%, whilst surface gradients north away from the site are about 1%.

3.3. Other Water Users and Environmental Receptors

The DWER Water Information Reporting (WIR) database includes no records in the vicinity of the project. The nearest WIR sites are dewatering bores in the Windarling mining area located 17 km to the southeast and associated with GWL154459 (Yilgarn Iron P/L). That licence includes a large tenement package on a north-south zone 15 km east of Die Hardy.

Topographic maps show a water supply reserve including an abandoned bore at Pigeon Rocks 13 km east of the site, being Lot 1596 an excision from the Diemals pastoral lease. The reserve area includes extensive granite outcrop and was clearly preserved for its surface or shallow groundwater harvesting potential.

There is a water supply reserve 22 km north from the site near the historic Evanston Mine (Lot 22 and Reserve 22066).

Inspection of mapping and aerial imagery did not disclose any natural surface drainage features or topographically controlled vegetation zones indicative of sensitivity to surface water flow patterns at the scale of the project.

3.4. Site Catchments

The site is located 800 m north of and below the northwest-oriented catchment defining ridgeline (Figure 5). Drainage northeast from the main ridge is modified by a minor northern spur located east of the WRD. The pit is located on a further, more minor natural spur such that natural drainage flow is either east or west of the site. The two permanent mine landforms will enforce the separation of the two local sub-catchments.

The elevations shown in Figure 5 used for catchment delineation are from the SRTM 1-second digital elevation model (DEM: sourced from https://elevation.fsdf.org.au/). The regional elevation data set data is typically accurate to within several metres and correctly describes surface gradients, however around the ridge-line near the southern extent of Figure 5, elevation and slopes are erroneously large and the data set is uncharacteristically inaccurate.

Quantitative hydrology presented in subsequent sections is further constrained by locally acquired spot height data.

3.5. Hydrology

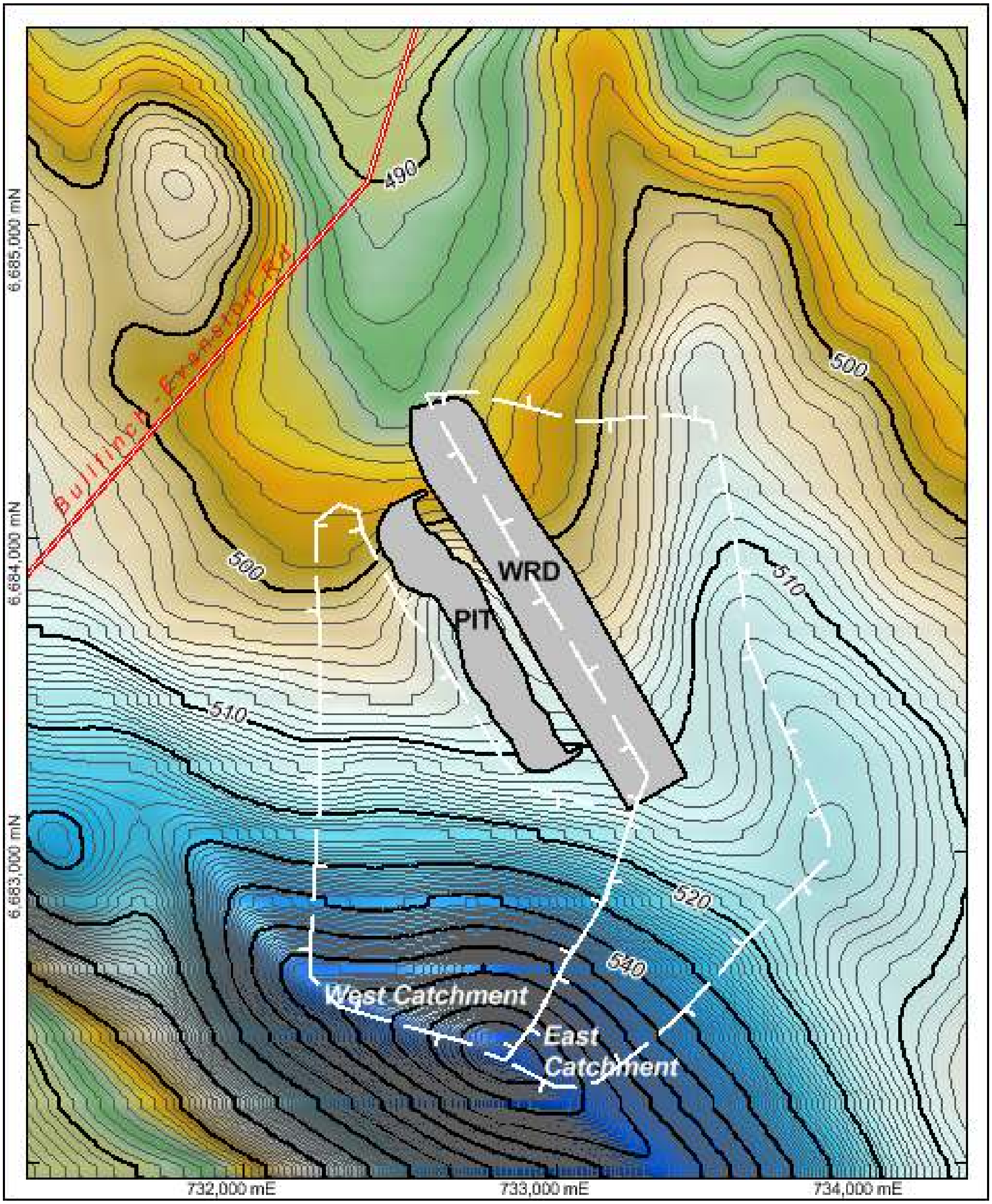
The site is located near the continental divide, with very limited upstream catchment. There are no clear or incised natural drainage lines on the northeast side of the Die Hardy Range locally.

Stormwater discharge is assumed to be by overland flow rather than channel flow across the whole project area. The short steeper slopes of the Range transition to nearly flat and sandy surfaces across the site and this area apparently has relatively high infiltration rates and low runoff coefficients.

For purposes of peak flood level estimation, rainfall losses (runoff coefficients) used at Ramelius' Mt Magnet Gold Mine site can be considered conservative (higher peak flows) for the Die Hardy site. That assumption being based on a qualitative comparison, IFD statistics, ground slope, catchment geometry, soils, vegetation and natural drainage network features. The adopted runoff coefficients (Cn, where n = average recurrence interval in years) for the peak flow calculation are :

C10 = 30%
C100 = 51%
C1000 = 70%

Figure 5 – Catchment Boundaries and Ground Elevation (Regional DEM)



3.6. Groundwater

Yilgarn groundwater occurrence regionally relates to two main aquifer types. Bedrock groundwater is limited to discrete, typically narrow structures (fractured rock aquifers) set in an otherwise nearly impermeable rock-mass. Such fractured rock aquifers show an extreme range in transmissivity and storage, but typically show limited recharge. The second aquifer type is formed by unconsolidated Cenozoic sediments which infill an ancient more incised bedrock surface. The up-lying country of the Die Hardy site is mostly underlain by outcropping or shallow bedrock, such that only the bedrock aquifer type is relevant.

Groundwater occurrence at Die Hardy is very limited. Most of the exploration drill holes on the deposit did not intersect any groundwater. Mining below the water table is therefore expected to generate very limited groundwater. For project water supplies, groundwater exploration drilling was undertaken on selected targets based on water shows in mineral drilling and on geological structures. Groundwater exploration drill sites near the project site are shown in Figure 6 and drill results summarised in Table 2.

Of seven targeted holes three produced no water, three very small flows and one delivered a potentially useful yield. The results indicate a regolith enhanced possible north-south structurally controlled aquifer of limited lateral extent. A water bore at the DW004 may provide part of the project water supply requirements for much of the project operational period. As the pit reaches final depth, any remaining groundwater is likely to be depleted by mining-related drawdown.

Groundwater is brackish to saline at a salinity of 9,000-15,000 mg/L TDS. Regional drilling results indicate that the background water table is at about 25 metres depth at the Die Hardy site.

Figure 6 – Groundwater Exploration Drill Sites

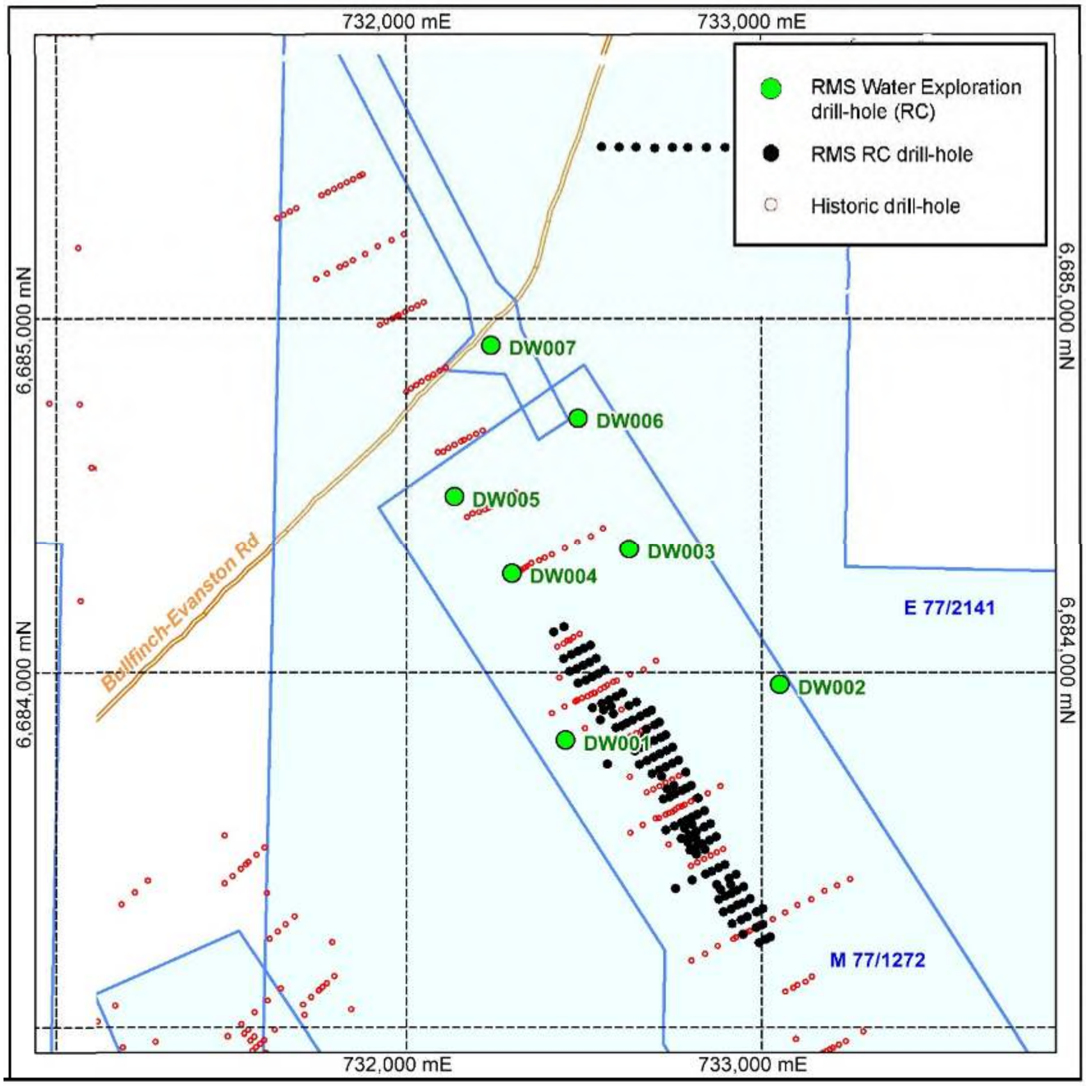


Table 2 – Groundwater Exploration Drilling Results

Hole	Depth	Water Strike	Flow (L/sec)	Comments
DW001	120			No water
DW002	120	70	0.2	Max. 0.2 L/sec at 120 m, EC = 15000 ppm
DW003	120			No water
DW004	63	40	3.0	Yield depth 40-50 m. EC = 9400ppm.
DW005	120	113	0.2	Yield near EoH
DW006	120			No water
DW007	124	85	0.7	Initial flow 0.71 l/s, dropped to 0.02 at EoH

4. STORMWATER RUNOFF

4.1 Peak Flood Depths

The proposed permanent landforms are oriented nearly parallel to stormwater flow paths down the catchment. Flow in the west sub-catchment will be outside the western pit abandonment bund. At the upstream (south end of the pit) surface gradients are slightly convergent with the structure and at the north end, flowlines are slightly divergent to the northwest. For the eastern sub-catchment flow will be parallel to the WRD toe.

The peak flood level (depth) was estimated for a selected drainage line cross sections as follows:

- The time of concentration was calculated using the Bransby-Williams Equation. This was found to be in the range 15 minutes for the two sub-catchments
- The rainfall depth (Pn where n = average recurrence interval in years, units mm) for the appropriate duration was selected from the IFD data (Table 1)
- The peak runoff rate (Qn where n = average recurrence interval in years, units cubic metres per second) was calculated using the rational method and the applicable runoff coefficient
- Flood water depth (dn where n = average recurrence interval in years, units metres) were determined for flow path widths of 100 metres using the Manning Equation and assuming a Manning Coefficient of 0.1

The equations and assumptions are based on material presented in Maidment (1993) and from similar regional settings. Results are summarised in Table 3. Note that the extent of inundation shown has a duration of the order of 15 minutes.

Table 3 - Peak Flow Rates and Depths

Catchment	West	East
Area (sq km)	0.99	1.29
Length (km)	1.86	2.54
Slope (m/km)	43.0	31.0
P10 (mm)	17	17
P100 (mm)	32	32
P100 (mm)	51	51
Q10 (cumecs)	6	7
Q100 (cumecs)	18	23
Q1000 (cumecs)	39	51
d10 (metres)	0.17	0.18
d100 (metres)	0.32	0.37
d1000 (metres)	0.52	0.6

The results show that stormwater overland flow at depths of up to 0.6 m could occur briefly at 1:1000 year frequency. Under such conditions, practically the whole site would be subject to some degree of inundation.

4.2 Stormwater Impacts and Controls

The site is situated on elevated and well drained ground such that, apart from excluding stormwater from the pit, there are no requirements to contain or divert natural stormwater drainage either during operations or post-closure. There is little potential for impacts on the downstream environment. The main risk is long term dispersal of material eroded from the WRD. Primary controls on this process will be appropriate landform design and construction, with progressive rehabilitation.

Specific to stormwater impacts is the need for enhanced protection with rock armouring up to the 1:1000 year design peak flood height. The outer (south and east) lower slopes of the WRD should be clad with coarse rock (d50 = 300 mm), to a height of 0.6 m AGL, rather than fine-grained growth media.

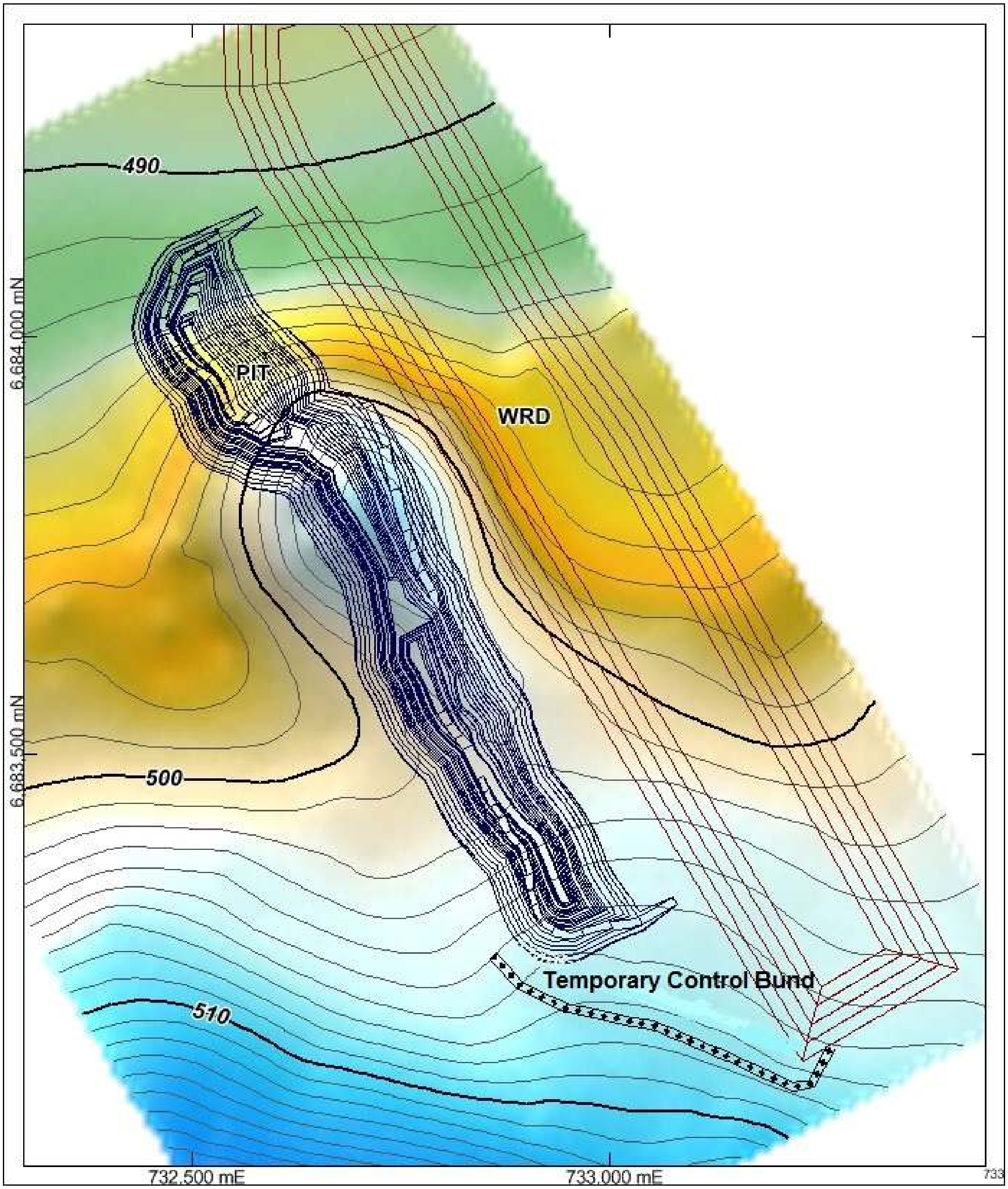
During operations the western bund should be extended south to tie into the southwest corner of the WRD (Figure 7).

Armouring the length of the WRL toe and extending the abandonment bund will adequately manage the potential hydrological impacts of a 1:1000 year ARI event.

Detailed operational site design and layout will incorporate clean/dirty runoff separation at stockpiles and other industrial facilities, including the following measures:

- After pre-strip stage, install preliminary 1 metre high bund on the alignment shown in Figure 7 as temporary diversion structure until coarse competent rock is available for the permanent structure
- WRD emplacement scheduling to minimise the perimeter length of oxide material until competent material is available
- Complete the WRD south and east perimeter toe as soon as competent rock is available
- Until contained by competent rock, areas where oxide or mineralised rock is stored to include downstream stormwater sump with capacity of 20 mm runoff (200 kL/hectare)

Figure 7 – Stormwater Control Bund and Ground Elevation (Local DEM)



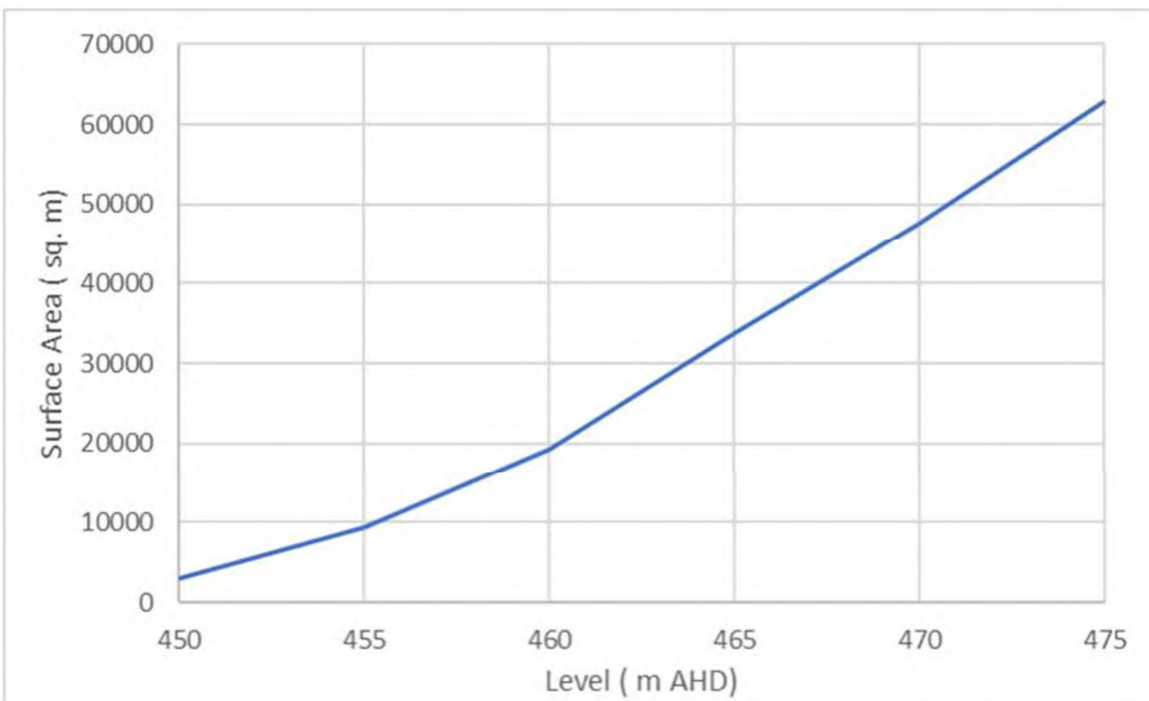
5. POST - CLOSURE PIT LAKE

The minimum pit crest elevation is about 490 m AHD at the north end of the pit. The minimum pit floor elevation is 447.5 m AHD. The baseline static water level has been estimated at about 475 m AHD based on regional drill data. The surface area of the pit void at the range of possible pit lake levels is shown in Figure 8.

Provided surface water is excluded, the pit lake level will stabilise at the point where evaporation from the lake surface balances groundwater inflow. The pit lake evaporation rate is be estimated as the product of the annual pan evaporation rate (2.4 m per year) and the lake (0.75) and brine factors (0.9), or about 1.6 metres/year.

For the expected groundwater inflow rate of 1-2 L/sec, the final void pit lake level will be in the range 460-465 m with a surface area of up to 3.5 hectares and maximum depth of 15 metres. The pit will remain a very minor groundwater sink. There is no risk of water discharging the pit or pit lake as surface or groundwater outflow.

Figure 8 – Die Hardy Pit Surface Area Curve



6. WATER MANAGEMENT

6.1 Mine Water Balance

The pit will generate no groundwater until the water table is intersected at about 475 m AHD. From this time maximum pit groundwater inflows are expected to be very limited, *i.e.*, of the order of 1-2 L/sec.

During normal dry weather, mining water requirements for drilling and dust suppression will be obtained from the local water bores and augmented from bores on surrounding tenements as required.

6.2 Water Monitoring

Monitoring requirements will be aligned with the requirements of the Groundwater Abstraction Licence (Section 5c, *Rights in Water and Irrigation Act 1914*). It is anticipated that such monitoring requirements may include monitoring of monthly abstraction volumes from each source and appropriate water level and water quality monitoring as approved by DWER.

6.3 Closure Considerations

The water-related priorities for closure include:

1. Permanent complete bunding to exclude stormwater ingress to the pit voids
2. Mechanical integrity of WRD against stormwater erosion and dispersal

As is typical of Yilgarn mining pits, provided external stormwater is excluded, the post-closure pits will become a groundwater sink and there is no risk of groundwater or surface water discharge. A small shallow pit lake will form and stabilise well below the pit crest. Salinity of the pit lake will gradually increase over time due to evaporative concentration of discharging groundwater solute. Salinity will remain the major feature of the pit lake water and the major constraint on any possible beneficial use.

7. REFERENCES

Maidment, 1993. Handbook of Hydrology. McGraw Hill

MWES, 2021. Mt Magnet Gold. Stormwater Management Plan. Revision 3 – February 2021.

Pilgrim, 1987. Australian Rainfall and Runoff, Book IV

Report Limitations

MWES Consulting (MWES) have prepared this report in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty expresses or implied, is made as to the professional advice included in this report. This report should be read in full. No responsibility is accepted for use of any part of this report in any context.

MWES has made no independent verification of this information beyond the agreed scope of works and MWES assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information reviewed at the time of our investigations that information contained in this report as provided to MWES was false. Whilst to the best of our knowledge information contained in this report is accurate, subsurface and groundwater conditions are subject to inherent unpredictability which may limit the ultimate accuracy of estimations presented in this report.

This report was prepared April 2021 and is based on the conditions encountered and information reviewed at the time of preparation. MWES disclaims responsibility for any changes that may have occurred after this time.

Appendix D: Die Hardy Soils Characterisation Results

ChemCentre

Scientific Services Division

Report of Examination

Resources and Chemistry Precinct
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WA 6102
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F +61 8 9422 9801
www.chemcentre.wa.gov.au
ABN 40 991 885 705

Purchase Order: 51180
Your Reference:
ChemCentre Reference: 19S4306 R0

Ramelius Marda Gold Project
1/130 Royal St
East Perth 6004

Attention: Glenn Firth

Final Report on 20 samples of soil received on 03/04/2020

LAB ID	Client ID and Description
19S4306 / 001	SCDH 001
19S4306 / 002	SCDH 002
19S4306 / 003	SCDH 003
19S4306 / 004	SCDH 004
19S4306 / 005	SCDH 005
19S4306 / 006	SCDH 006
19S4306 / 007	SCDH 007
19S4306 / 008	SCDH 008
19S4306 / 009	SCDH 009
19S4306 / 010	SCDH 010
19S4306 / 011	SCDH 011
19S4306 / 012	SCDH 012
19S4306 / 013	SCDH 013
19S4306 / 014	SCDH 014
19S4306 / 015	SCDH 015
19S4306 / 016	SCDH 016
19S4306 / 017	SCDH 017
19S4306 / 018	SCDH 018
19S4306 / 019	SCDH 019
19S4306 / 020	SCDH 020

Analyte Method Unit Lab ID	Client ID	Stones (>2mm) %	EC (1:5) mS/m	pH (CaCl2)	Sand. fraction %	Silt. fraction %	Clay. fraction %
19S4306/001	SCDH 001	40.6	3	5.4	73.5	9.5	17.0
19S4306/002	SCDH 002	7.0	2	6.0	64.0	14.0	22.0
19S4306/003	SCDH 003	27.5	7	8.1	75.0	15.0	10.0
19S4306/004	SCDH 004	11.9	1	4.2	77.0	6.0	17.0
19S4306/005	SCDH 005	31.5	20	7.6	59.0	22.0	19.0
19S4306/006	SCDH 006	29.7	6	7.7	72.0	17.0	11.0
19S4306/007	SCDH 007	37.5	2	5.1	76.0	8.0	16.0
19S4306/008	SCDH 008	18.6	1	5.4	82.5	6.0	11.5
19S4306/009	SCDH 009	17.3	2	5.5	78.0	9.0	13.0
19S4306/010	SCDH 010	38.4	2	4.1	71.0	11.0	18.0
19S4306/011	SCDH 011	36.4	2	3.9	81.0	6.0	13.0
19S4306/012	SCDH 012	25.2	13	8.2	72.0	16.0	12.0
19S4306/013	SCDH 013	43.0	2	4.1	84.0	8.0	8.0
19S4306/014	SCDH 014	30.0	7	6.1	81.5	8.0	10.5
19S4306/015	SCDH 015	38.4	4	5.4	85.0	8.0	7.0
19S4306/016	SCDH 016	51.8	3	4.3	79.0	8.0	13.0
19S4306/017	SCDH 017	44.8	2	4.2	83.0	6.5	10.5
19S4306/018	SCDH 018	37.5	4	4.7	77.0	9.0	14.0
19S4306/019	SCDH 019	25.3	8	4.6	67.0	11.0	22.0
19S4306/020	SCDH 020	25.9	2	4.1	82.0	5.0	13.0

Analyte Method Unit Lab ID	Client ID	OrgC (W/B) %	BSP% (calc) %	Emerson Class	ESP (calc) %	N (total) %	P (totals) mg/kg
19S4306/001	SCDH 001	0.55	58	2	0.8	0.035	180
19S4306/002	SCDH 002	0.51	77	2	0.8	0.034	210
19S4306/003	SCDH 003	0.47	96	1	0.7	0.037	120
19S4306/004	SCDH 004	0.66	37	3	0.4	0.038	180
19S4306/005	SCDH 005	0.50	87	1	9.0	0.042	110
19S4306/006	SCDH 006	0.50	88	1	0.4	0.042	130
19S4306/007	SCDH 007	0.62	66	3	0.3	0.038	190
19S4306/008	SCDH 008	0.43	54	2	0.7	0.027	190
19S4306/009	SCDH 009	0.48	61	2	0.7	0.037	180
19S4306/010	SCDH 010	0.58	19	2	0.2	0.041	170
19S4306/011	SCDH 011	0.43	7	5	0.1	0.026	130
19S4306/012	SCDH 012	0.89	96	1	4.8	0.071	130
19S4306/013	SCDH 013	0.49	5	5	0.2	0.023	110
19S4306/014	SCDH 014	1.94	>110	3	1.2	0.093	110
19S4306/015	SCDH 015	1.33	70	3	0.3	0.050	120
19S4306/016	SCDH 016	0.85	24	5	0.8	0.038	150
19S4306/017	SCDH 017	0.37	15	5	0.2	0.024	130
19S4306/018	SCDH 018	0.78	35	5	0.3	0.042	200
19S4306/019	SCDH 019	1.94	74	3	1.5	0.080	220
19S4306/020	SCDH 020	0.63	16	3	0.2	0.035	170

Analyte		CEC	Ca	K	Mg	Na	Al
Method		(NH4Cl)	(exch)	(exch)	(exch)	(exch)	(exch)
Unit		cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg
Lab ID	Client ID						
19S4306/001	SCDH 001	8	3.1	0.22	1.1	0.06	<0.02
19S4306/002	SCDH 002	9	5.1	0.86	1.2	0.07	
19S4306/003	SCDH 003	19	15	0.49	2.1	0.13	
19S4306/004	SCDH 004	6	1.6	0.18	0.48	0.02	
19S4306/005A	SCDH 005	28	13	0.75	8.2	2.5	
19S4306/006	SCDH 006	19	12	0.48	3.7	0.08	
19S4306/007	SCDH 007	7	3.6	0.24	0.82	0.02	0.02
19S4306/008	SCDH 008	5	1.8	0.22	0.80	0.04	<0.02
19S4306/009	SCDH 009	6	2.5	0.45	0.78	0.04	
19S4306/010A	SCDH 010	6	0.65	0.16	0.29	<0.02	0.88
19S4306/011	SCDH 011	4	0.16	0.09	0.06	<0.02	1.2
19S4306/012	SCDH 012	18	12	1.0	3.3	0.84	
19S4306/013	SCDH 013	4	0.09	0.04	0.03	<0.02	0.66
19S4306/014	SCDH 014	7	7.6	0.46	1.0	0.08	
19S4306/015	SCDH 015	8	4.8	0.24	0.46	0.02	0.05
19S4306/016	SCDH 016	5	0.75	0.08	0.30	0.04	0.44
19S4306/017	SCDH 017	4	0.44	0.07	0.10	<0.02	0.64
19S4306/018	SCDH 018	5	1.5	0.13	0.23	<0.02	0.13
19S4306/019	SCDH 019	5	2.4	0.31	1.1	0.08	0.21
19S4306/020A	SCDH 020	5	0.55	0.09	0.11	<0.02	0.80

Analyte		Mn	Al	B	Ca	Cd	Co
Method		(exch)	(M3)	(M3)	(M3)	(M3)	(M3)
Unit		cmol(+)/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Lab ID	Client ID						
19S4306/001	SCDH 001	0.04	>550	0.7	630	0.06	1.8
19S4306/002	SCDH 002		>550	1.9	1000	0.06	3.6
19S4306/003	SCDH 003		>550	<0.1	>5500	0.09	0.61
19S4306/004	SCDH 004		>550	0.5	330	0.04	0.43
19S4306/005A	SCDH 005		>550	1.9	2800	0.10	3.2
19S4306/006	SCDH 006		>550	0.8	2800	0.10	3.6
19S4306/007	SCDH 007	0.11	>550	<0.1	690	0.06	1.6
19S4306/008	SCDH 008	0.04	>550	0.9	370	0.06	0.89
19S4306/009	SCDH 009		>550	0.5	480	0.06	1.5
19S4306/010A	SCDH 010	0.06	>550	<0.3	130	0.05	0.30
19S4306/011	SCDH 011	<0.02	>550	0.2	34	0.03	0.02
19S4306/012	SCDH 012		>550	2.8	>5500	0.13	0.70
19S4306/013	SCDH 013	<0.02	>550	<0.1	27	0.04	0.04
19S4306/014	SCDH 014		>550	1.1	1500	0.06	0.45
19S4306/015	SCDH 015	0.05	>550	<0.1	810	0.06	0.17
19S4306/016	SCDH 016	0.07	>550	<0.1	160	0.04	0.27
19S4306/017	SCDH 017	0.02	>550	<0.1	95	0.03	0.02
19S4306/018	SCDH 018	0.05	>550	<0.1	310	0.04	0.11
19S4306/019	SCDH 019	0.12	>550	0.2	460	0.04	0.09
19S4306/020A	SCDH 020	0.03	>550	<0.1	110	0.04	0.15

Analyte Method Unit Lab ID	 Client ID	Cu (M3) mg/kg	Fe (M3) mg/kg	K (M3) mg/kg	Mg (M3) mg/kg	Mn (M3) mg/kg	Mo (M3) mg/kg
19S4306/001	SCDH 001	1.5	29	120	140	91	<0.01
19S4306/002	SCDH 002	2.2	28	300	150	140	0.01
19S4306/003	SCDH 003	1.4	25	190	470	42	<0.01
19S4306/004	SCDH 004	0.8	32	97	61	25	0.01
19S4306/005	SCDH 005	1.2	50	320	>1000	69	<0.01
19S4306/006	SCDH 006	1.9	45	200	690	120	<0.01
19S4306/007	SCDH 007	1.7	38	120	100	160	<0.01
19S4306/008	SCDH 008	1.0	24	110	99	91	<0.01
19S4306/009	SCDH 009	1.3	26	160	96	110	<0.01
19S4306/010A	SCDH 010	1.2	24	91	36	21	<0.01
19S4306/011	SCDH 011	0.8	31	56	<10	2.2	<0.01
19S4306/012	SCDH 012	1.3	38	440	950	64	<0.01
19S4306/013	SCDH 013	0.5	34	28	<10	2.3	<0.01
19S4306/014	SCDH 014	1.0	50	160	130	76	<0.01
19S4306/015	SCDH 015	0.8	56	120	54	51	<0.01
19S4306/016	SCDH 016	1.6	51	52	38	41	<0.01
19S4306/017	SCDH 017	0.5	27	47	13	9.3	<0.01
19S4306/018	SCDH 018	1.0	37	76	31	39	<0.01
19S4306/019	SCDH 019	4.4	62	140	130	58	<0.01
19S4306/020A	SCDH 020	1.1	32	57	15	12	<0.01

Analyte Method Unit Lab ID	 Client ID	Na (M3) mg/kg	Ni (M3) mg/kg	P (M3) mg/kg	S (M3) mg/kg	Zn (M3) mg/kg	As (M3) mg/kg
19S4306/001A	SCDH 001	11	1.1	5	7	0.9	<0.1
19S4306/002	SCDH 002	9	1.7	6	4	1.1	<0.1
19S4306/003	SCDH 003	11	1.0	13	5	0.7	0.1
19S4306/004	SCDH 004	3	0.4	3	7	0.3	<0.1
19S4306/005A	SCDH 005	700	3.2	5	3	0.6	<0.1
19S4306/006	SCDH 006	11	3.3	12	3	1.4	<0.1
19S4306/007	SCDH 007	2	1.4	10	4	1.3	<0.1
19S4306/008	SCDH 008	5	0.4	8	3	1.3	<0.1
19S4306/009	SCDH 009	6	0.6	5	5	0.9	<0.1
19S4306/010A	SCDH 010	<1	0.3	4	14	0.6	<0.1
19S4306/011	SCDH 011	<1	0.1	2	28	0.2	<0.1
19S4306/012	SCDH 012	180	2.7	13	12	1.0	0.1
19S4306/013	SCDH 013	<1	0.1	2	40	0.6	<0.1
19S4306/014	SCDH 014	12	0.4	4	9	0.7	<0.1
19S4306/015	SCDH 015	2	0.2	4	11	0.5	<0.1
19S4306/016	SCDH 016	5	0.5	3	20	0.7	<0.1
19S4306/017	SCDH 017	<1	<0.1	2	45	0.3	<0.1
19S4306/018	SCDH 018	<1	0.1	2	23	0.5	<0.1
19S4306/019	SCDH 019	13	0.3	2	25	1.1	<0.1
19S4306/020A	SCDH 020	<1	0.3	3	16	0.3	<0.1

Analyte		Pb	Se
Method		(M3)	(M3)
Unit		mg/kg	mg/kg
Lab ID	Client ID		
19S4306/001A	SCDH 001	1.0	<0.1
19S4306/002	SCDH 002	1.2	<0.1
19S4306/003	SCDH 003	0.4	<0.1
19S4306/004	SCDH 004	1.1	<0.1
19S4306/005A	SCDH 005	0.5	<0.1
19S4306/006	SCDH 006	0.8	<0.1
19S4306/007	SCDH 007	0.7	<0.1
19S4306/008	SCDH 008	0.8	0.2
19S4306/009	SCDH 009	0.8	<0.1
19S4306/010A	SCDH 010	1.5	<0.1
19S4306/011	SCDH 011	1.0	<0.1
19S4306/012	SCDH 012	0.5	<0.1
19S4306/013	SCDH 013	0.9	<0.1
19S4306/014	SCDH 014	0.6	0.1
19S4306/015	SCDH 015	0.7	<0.1
19S4306/016	SCDH 016	0.9	<0.1
19S4306/017	SCDH 017	0.9	<0.1
19S4306/018	SCDH 018	0.8	<0.1
19S4306/019	SCDH 019	0.8	<0.1
19S4306/020A	SCDH 020	0.9	<0.1

Analyte	Method	Description
Stones	(>2mm)	Stones - sieved particles greater than 2 mm (sample preparation method manual 3.3.2)
EC	(1:5)	Electrical conductivity of 1:5 soil extract at 25 C by in-house method S02
pH	(CaCl2)	pH of 1:5 soil extract in 0.01M CaCl2 by in-house method S03
BSP%	(calc)	BSP%, Base Saturation Percenatge (calculated)
ESP	(calc)	Exchangeable Sodium Percentage (calculated)
K	(exch)	Potassium, K exchangeable (ref. Rayment & Lyons 2011)
Mg	(exch)	Magnesium, Mg exchangeable (ref. Rayment & Lyons 2011)
Mn	(exch)	Manganese, Mn exchangeable (ref. Rayment & Lyons 2011)
Na	(exch)	Sodium, Na exchangeable (ref. Rayment & Lyons 2011)
Ca	(exch)	Calcium, Ca exchangeable (ref. Rayment & Lyons 2011)
Al	(exch)	Aluminium, Al exchangeable (ref. Rayment & Lyons 2011)
Al	(M3)	Aluminium,Al extracted by Mehlich No 3 - method S42
As	(M3)	Arsenic, As extracted by Mehlich No 3 - method S42
B	(M3)	Boron,B extracted by Mehlich No 3 - method S42
Ca	(M3)	Calcium,Ca extracted by Mehlich No 3 - method S42
Cd	(M3)	Cadmium,Cd extracted by Mehlich No 3 - method S42
Co	(M3)	Cobalt,Co extracted by Mehlich No 3 - method S42
Cu	(M3)	Copper,Cu extracted by Mehlich No 3 - method S42
Fe	(M3)	Iron, Fe extracted by Mehlich No 3 - method S42
Na	(M3)	Sodium, Na extracted by Mehlich No 3 - method S42
Ni	(M3)	Nickel, Ni extracted by Mehlich No 3 - method S42
P	(M3)	Phosphorus, P extracted by Mehlich No 3 - method S42
Pb	(M3)	Lead, Pb extracted by Mehlich No 3 - method S42
Mn	(M3)	Manganese, Mn extracted by Mehlich No 3 - method S42
Mo	(M3)	Molybdenum, Mo extracted by Mehlich No 3 - method S42
Mg	(M3)	Magnesium, Mg extracted by Mehlich No 3 - method S42
K	(M3)	Potassium, K extracted by Mehlich No 3 - method S42
S	(M3)	Sulphur, S extracted by Mehlich No 3 - method S42
Se	(M3)	Selenium, Se extracted by Mehlich No 3 - method S42
Zn	(M3)	Zinc, Zn extracted by Mehlich No 3 - method S42
CEC	(NH4Cl)	Cation Exchange Capacity, 1M NH4Cl method S22.0
N	(total)	Nitrogen N, total by method S10
P	(totals)	Phosphorus,P Total by method S14
OrgC	(W/B)	Organic Carbon C, Walkley and Black method S09.
Emerson	Class	Emerson class number by AS 1289 C.8.1
Clay.	fraction	Clay, less than 0.002mm by method S06. ref. Australian Standard AS1289.C6.3
Silt.	fraction	Silt, 0.02 to 0.002mm by method S06. ref. Australian Standard AS1289.C6.3
Sand.	fraction	Sand, 0.02 to 2.0mm by method S06. ref. Australian Standard AS1289.C6.3

Results are based on a air-dry (40C) , < 2 mm basis. Stones (>2mm) if present are reported on an air dry whole sample basis.

EMERSON CLASS CLASSIFICATION

The swelling and dispersive properties of the soils were tested by placing natural peds and samples re-moulded at or near field capacity moisture content in deionised water. Based on their slaking and dispersive behaviour, the samples were classified into one of 8 classes according to the Emerson Classification scheme as described in Australian Standard AS 1289.C8.1-1980.

Summary of classification scheme:

Class 1   Soil slakes, air-dried crumbs are strongly dispersive
Class 2   Soil slakes, air-dried crumbs show slight to moderate dispersion
Class 3   Soil slakes, air-dried crumbs do not disperse, re-moulded soil disperses
Class 4   Soil slakes, air-dried crumbs do not disperse, calcium carbonate or calcium sulphate are present.
Class 5   Soil slakes, air-dried and re-moulded soil do not disperse, 1:5 soil:water extract remains dispersed after 5 minutes.
Class 6   Soil slakes, air-dried and re-moulded soil do not disperse, 1:5 soil:water extract begins to flocculate within 5 minutes
Class 7   Soil does not slake, air-dried crumbs remain coherent and swell.
Class 8   Soil does not slake, air-dried crumbs remain coherent, but do not swell.

A sample with a result of 0, indicates the sample was not suitable for the test, i.e air-dried sample did not conatin soil peds between 4.75 - 2.36mm diameter.

Exchangeable Sodium Percentage (ESP)

The ESP is a measure of sodicity (i.e exchangeable Na+) based on a soils exchange complex . High levels of sodium can adversley effect plant growth and soil structure.
The table below (categorised by Northcote and Skene, 1972) relates % ESP to soil sodicity. This table should only be used as a guide as it tolerance can vary on soil type and plant species.

ESP<6   non-sodic
ESP6-15   sodic
ESP>15   strongly sodic

Multi-Element Soil Extraction Universal Extractants (Mehlich No.3)

The Mehlich No.3 Test is an alternate soil test using universal extractants for multi-elemental analysis. Results obtained using the Mehlich 3 extractant are highly correlated with the standard "single element" soil tests currently used for a wide range of Western Australian soil types.   The test provides information on the amount of plant-available nutrients including phosphorus, potassium, sulphur, calcium, magnesium, sodium, boron, copper, iron, manganese and zinc, in the soil . It can be used as a "screening*" tool (see note below) to measure concentrations of cobalt, aluminium, molybdenum and toxic metals such as cadmium, lead, arsenic, selenium and nickel in soil. It is ideally suited to acid and neutral soils, the amounts of nutrients extracted being similar to those of other soil tests used in WA .

*Results that are reported as ">" are outside the linear range of the calibration and outside the scope of the method. This results should only be used as a guide and consideration should be given to a more specific test method if the actual "value" need to be determined, hence these results should only be used as a guide.
Bolland, Allen & Walton. Aust J Soil Research 2002.
Soil Chemical Methods, Australasia (Rayment & Lyons) 2010Particle size analysis data of these soils, in the form of an Excel spreadsheet, are attached. The silt and clay components were determined by sedimentation using Stokes' Law principles whereas the sand fractions were determined by dry sieving the >0.075 mm fraction.
Note: the fraction in the "Diff." column is 100 - (sum of all other fractions). This fraction will include any soluble salts and most of the organic matter in the sample.

B. Price

Barry Price
Snr Chemist & Research Officer
Scientific Services Division
27-May-2020

Appendix E: Die Hardy Gold Project Waste Rock Characterisation

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802

35 Cormack Road
Wingfield SA 5013

Telephone (08) 8416 5200
Facsimile (08) 8234 0355

Reference: **aa044924**
Date Finished: 09/04/2020
Order: 100721
Project: Die Hardy
Date Received: 20/03/2020
Type of Sample: RAB\RC
Samples Analysed: **15**

FINAL ANALYSIS REPORT

Analysis of Mineral Samples

for

Mt Magnet Gold

PO Box 83 Mt Magnet WA 6638

Attention: Mr Rob Hutchison

Authorised By:

Vaughn Noble	Fabian Gregus	Michael Grieger	Jenet Hwende
Senior Chemist	Chemist	Chemist	Laboratory Manager

Bureau Veritas Minerals Pty Ltd
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Telephone (08) 8416 5200
Facsimile (08) 8234 0355

Reference: aa044924 **Order Number:** 100721 Page 1 of 4

Method	**TC003**	**GC009**	**SIE5**	**SIE5**	**SIE5**	**SIE5**	**SIE5**	**SIE5**
Result Name	**S**	**SO4**	**ANC**	**NAG**	**NAG pH**	**NAG 4.5**	**NAG 7.0**	**NAPP**
Units	**%**	**%**	**KgH2SO4 /tonne**	**KgH2SO4 /tonne**	**pH_unit**	**KgH2SO4 /tonne**	**KgH2SO4 /tonne**	**KgH2SO4 /tonne**
Detection Limit	0.01	0.01	1	0.5	0.01	0.5	0.5	1
WCDH001	0.10	0.27	34	<0.5	7.98	<0.5	<0.5	-31
WCDH002	0.03	0.09	0	<0.5	7.33	<0.5	<0.5	1
WCDH003	0.04	0.12	2	<0.5	7.68	<0.5	<0.5	-1
WCDH004	<0.01	<0.01	-2	<0.5	7.51	<0.5	<0.5	2
WCDH005	0.17	0.05	47	<0.5	8.34	<0.5	<0.5	-42
WCDH006	0.07	0.11	2	<0.5	7.33	<0.5	<0.5	0
WCDH007	0.04	0.07	5	<0.5	7.85	<0.5	<0.5	-4
WCDH008	0.04	0.12	14	<0.5	7.70	<0.5	<0.5	-13
WCDH009	0.49	0.32	47	0.5	6.24	<0.5	0.5	-32
WCDH010	0.13	0.38	2	<0.5	7.49	<0.5	<0.5	2
WCDH011	0.06	0.15	0	<0.5	7.60	<0.5	<0.5	2
WCDH012	0.09	0.11	10	<0.5	7.46	<0.5	<0.5	-7
WCDH013	0.08	0.21	5	<0.5	7.69	<0.5	<0.5	-3
WCDH014	0.04	0.11	0	<0.5	7.64	<0.5	<0.5	1
WCDH015	0.02	<0.01	19	<0.5	7.92	<0.5	<0.5	-18

****

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Method	**SIE6**	**IND7**	**IND7**	**IND7**	**IND7**	**IND7**	**IND7**	**IND7**
Result Name	**EC**	**As**	**Cd**	**Cr**	**Hg**	**Mo**	**Ni**	**Pb**
Units	**uS/cm**	**mg/L**	**mg/L**	**mg/L**	**ug/L**	**mg/L**	**mg/L**	**mg/L**
Detection Limit	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
WCDH001	2278	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH002	395	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH003	1428	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH004	86	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH005	180	<0.1	<0.1	0.2	<0.1	<0.1	0.1	<0.1
WCDH006	37	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH007	101	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH008	1558	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH009	752	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
WCDH010	1186	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH011	658	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH012	506	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH013	694	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH014	388	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
WCDH015	120	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1

****

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ABN: 30 008 127 802
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Method	**IND7**
Result Name	**Zn**
Units	**mg/L**
Detection Limit	0.1
WCDH001	<0.1
WCDH002	<0.1
WCDH003	<0.1
WCDH004	<0.1
WCDH005	<0.1
WCDH006	<0.1
WCDH007	<0.1
WCDH008	<0.1
WCDH009	0.4
WCDH010	<0.1
WCDH011	<0.1
WCDH012	<0.1
WCDH013	<0.1
WCDH014	<0.1
WCDH015	0.2

****

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****

These results pertain to the samples as received at this laboratory.
Where standards are reported, the nominal value for the element is reported above the result found.

"NR" Implies result is not required for this determination

Sample Storage
****

The excess material (Residue) will be held after 30 days

The pulp samples (Pulp) will be held after 60 days as per instructions.

Sample Preparation
****

Digest and Analysis:
****

The samples have been digested with hot concentrated hydrochloric acid. All soluble sulphates (except for some barium and strontium sulphates that occur in reasonably high concentrations) remain in solution.

SO4
have been determined by Inductively Coupled Plasma (ICP) Optical Emission Spectrometry.

Total Combustion S & C

S
have been determined by Total Combustion Analysis.

Total dissolved salts (TDS) have been calculated from conductivity measurements.

EC
have been determined using a conductivity meter.

A test portion is extracted in a buffer then leached by a rotating extraction for at least 16 hours. The TCLP extract is then filtered, concentrated by evaporation, acidified with nitric acid for the determination of the elements of interest. (AS4439)

Cr
have been determined by Inductively Coupled Plasma (ICP) Optical Emission Spectrometry.
Hg
have been Analysed by AAS Cold Vapour
As,Cd,Mo,Ni,Pb,Zn
have been determined by Inductively Coupled Plasma (ICP) Mass Spectrometry.

Acid Neutralizing Capacity (ANC), Net Acid Generation (NAG) and Net Acid Production Potential (NAPP)

NAG,NAG,4.5,NAG,7.0,NAG,pH,NAPP
have been NAG Titration

ANC
have been determined volumetrically.

Appendix F: Targeted Flora Report

Phone: (08) 9093 0024
Mobile: 0419 916 034
Email: jim@botanicaconsulting.com.au
52 to 56 Oroya St, Boulder
PO Box 2027 Boulder WA 6432
ABN 47141175297

Glenn Firth
Group Environmental Manager
Ramelius Resources Limited
glenfirth@rameliusresources.com.au

20th December 2019

RE: Targeted search for conservation significant flora/vegetation-Die Hardy and Red Legs exploration program

Dear Glenn,

Botanica Consulting (BC) was commissioned by Ramelius Resources Limited (Ramelius) to undertake a targeted search for conservation significant flora/ vegetation and Malleefowl of the Die Hardy (previously referred to as the Fiddleback prospect) and Red Legs exploration programme (referred to as the survey area), located within tenements E77/2141, E77/2171, M77/1271 and M77/1272. A map of the survey area is provided in Figure 1. The survey area is located approximately 140 km north of Southern Cross and approximately 350 km east of Perth, Western Australia, within the ex Diemals Station which is managed by DBCA (Figure 2). The survey area covers an area of approximately 23.4 ha and included surveying approximately 6.7km of proposed drill lines (majority of which were located along existing drill lines) and 5.3km of existing access tracks. Each drill line was accessed via existing cleared tracks. The fieldwork was conducted on the 11th and 28th November 2019 by two BC staff members (Jim Williams and Matthew Newlands). A handheld GPS was used to record the locations of tracks traversed and locations of any conservation significant flora/vegetation (recorded in GDA 94 format). The survey area was traversed on foot and by Four Wheel Drive.

Figure 1: Survey Area Map

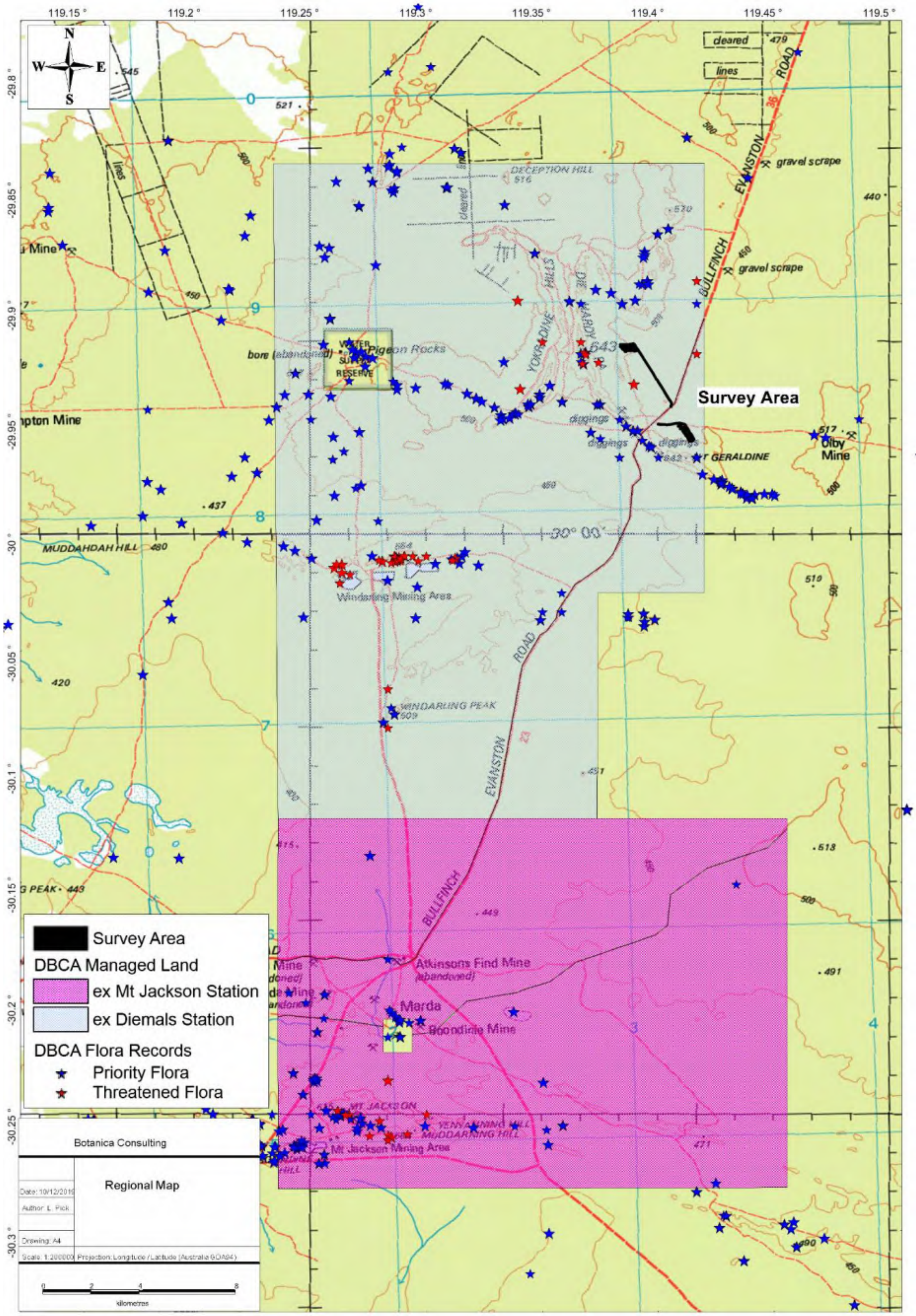

Figure 2: Regional Map including DBCA Managed Land

Background Information

Previous flora/vegetation surveys within the local area were reviewed prior to undertaking the priority searches:

- Biota Environmental Sciences (2014) Southern Koolyanobbing Range Vertebrate Fauna Survey, Cliffs Asia Pacific Iron Ore Pty Ltd
- Woodman Environmental Consulting (2014) Cliffs Asia Pacific Iron Ore Pty Ltd, Southern Koolyanobbing Range, Flora and Vegetation Assessment.
- Rapallo Environmental (2012) Level 2 Flora and Vegetation and of Mt King Central, Golden Orb and King Brown for Southern Cross Goldfields
- Rapallo Environmental (2012) Level 2 Flora and Vegetation Survey of Mt King Tenement (M77/394) and Associated Infrastructure for Southern Cross Goldfields Ltd
- Rapallo Environmental (2011) Reconnaissance Flora Survey of Mt King Tenement – M77/394 for Southern Cross Goldfields Ltd
- Botanica Consulting (2011) Level 2 Flora and Vegetation Survey, Golden Orb Survey Area, Southern Cross Goldfields
- Botanica Consulting (2010) Level 2 Flora and Vegetation Survey, King Brown Survey Area, Southern Cross Goldfields,
- Botanica Consulting (2010) Level 2 Flora and Vegetation Survey, Mt King Survey Area, Southern Cross Goldfields,
- Western Botanical (2009) Flora & Vegetation Survey of Western Jackson Range
- Western Botanical (2005) Flora & Vegetation Assessment for Proposed Exploration in the Evanston Area, Diemals Station
- Western Botanical (2015) Fiddleback Project, Level 2 Flora and Vegetation Survey.
- Western Botanical (2019) Desktop review of the Flora and Vegetation of the Red Legs, Fiddleback and Mt King Prospects.

A literature review consisting of a combined search of the Department of Biodiversity, Conservation and Attractions (DBCA) Flora of Conservation Significance databases (DBCA, 2019a), NatureMap search (DBCA, 2019b) and Department of Environment and Energy (DoEE) Protected Matters search (DoEE, 2019) resulted in four Threatened Flora and 35 Priority Flora occurring within a 20km radius of the survey area (Table 1). No Threatened or Priority Flora were listed on the DBCA Flora of Conservation Significance databases as occurring within the survey area (Figure 2).

Table 1: Threatened/Priority Flora within 20km of the survey area

Taxon	EPBC Act	BC Act	DBCA Priority	Description (WAHERB, 2019)
Acacia adinophylla			P1	Prostrate or erect tangled shrub, 0.15-1.6 m high, to 3 m wide. Fl. yellow, Sep to Nov. Stony loamy or sandy soils, clay. Ironstone ridges, undulating plains (WAHERB 2019)
Austrostipa blackii			P3	Tufted perennial, grass-like or herb, 1 m high. Fl. Sep to Nov. (WAHERB 2019)
Banksia arborea			P4	Tree or shrub (large), 2-8 m high. Fl. yellow, Mar to May or Sep to Oct. Stony loam. Ironstone hills. (WAHERB 2019)
Banksia rufa subsp. *chelomacarpa*			P3	Prostrate shrub, to 0.45 m high. Fl. yellow, Jul to Oct. Sandy loam over gravel. (WAHERB 2019)
Beyeria rostellata			P1	Spindly resinous or viscid shrub to 1.8 high, bark grey and fibrous, young shoots pale green, recurved leaves. Fl green-yellow (Woodman 2014)
Bossiaea sp. Jackson Range (G. Cockerton & S. McNee LCS 13614)			P3	Dense, spinescent shrub to 1.4 m. Flowers yellow and red, July. (Woodman 2014)
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)			P3	No description available

Taxon	EPBC Act	BC Act	DBCA Priority	Description (WAHERB, 2019)
Calytrix paucicostata			P2	Shrub, 0.5-1(-2) m high. Fl. pink & yellow, Sep to Oct. Yellow or grey sand. Sand dunes. (WAHERB 2019)
Calytrix viscida			P1	No description available
Cyathostemon verrucous			P3	No description available
Eucalyptus formanii			P4	Tree or (occasionally mallee), 3-11 m high, bark flaky & fibrous on the trunk. Fl. white, Dec or Jan to Apr. Red sand. Ironstone slopes. (WAHERB 2019)
Frankenia georgei			P1	Small shrub. Fl. pink, Dec. Rocky slopes. (WAHERB 2019)
Grevillea erectiloba			P4	Shrub, 1-3 m high. Fl. red, Sep to Oct. Gravelly loam. Lateritic ridges. (WAHERB 2019)
Grevillea georgeana			P3	Erect to widely spreading shrub, 1-3 m high, up to 4 m wide. Fl. red/red & pink & cream, Jan or Mar or Sep to Nov. Stony loam/clay. Ironstone hilltops & slopes. (WAHERB 2019)
Hysterobaeckea ochropetala subsp. *ochropetala*			P1	*Distribution and habitat.* Extends from the Diemals Station area south-west to Mt Moore and south-east to Jaurdi Station (Figure 4). Occurs in yellow sand or other sandy habitats, some records being of sand over laterite. (Rye 2018)
Hysterobaeckea cornuta			P3	No description available
Jacksonia Jackson			P1	Erect, spreading shrub, 0.25-0.3 m high, to 0.45 m wide. Fl. yellow-orange, Jul to Sep. Stony loam, clay, ironstone gravel. Hill. (WAHERB 2019)
Lepidosperma ferricola			P3	Tufted rhizomatous, perennial, herb (sedge), leaves 0.32-1.05 m high, culms and leaves spirodistichous. Well-drained stony loam, silty clay, banded ironstone. On rocky ledges, scree slopes, crevices and ravines. (Barret 2007)
Lepidosperma jacksonense			P1	Tufted rhizomatous, perennial, herb (sedge), leaves 0.23-0.67 m high, culms and leaves distichous. Silty, sandy loam with chert outcrops. Mod-slopes. (Barret 2007)
Lepidosperma sp. Pigeon Rocks (H. Pringle 30237)			P3	No description available
Leptospermum macgillivrayi			P3	Divaricate shrub, to 1 m high. Fl. probably Aug to Sep. Loam. Decaying granite outcrops (WAHERB 2019)
Leucopogon sp. Yanneymooning (F. Mollemans 3797)			P3	Compact shrub, to 0.6 m high. Fl. white, May. White-grey sandy clay, brown gritty loam over granite, skeletal soils. Tops of valleys, hills and breakaways. (WAHERB 2019)
Malleostemon sp. Adelong (G.J. Keighery 11825)			P2	No description available
Melichrus sp. Bungalbin Hill (F.H. & M.P. Mollemans 3069)			P3	No description available
Mirbelia ferricola			P3	Shrub to 3 m tall and 2 m wide, appearing leafless (leaves reduced to scales), flowers yellow with red, Jun-Nov. (Woodman 2014)
Neurachne annularis			P3	Tussock-forming perennial, grass-like or herb, to 0.75 m high. Shallow red-brown sandy loam, yellowish-red loam, sometimes with ironstone gravel or stones. Among rocks on tops, sides and bases of banded ironstone ranges. (WAHERB 2019)
Notisia intonsa			P3	No description available

Taxon	EPBC Act	BC Act	DBCA Priority	Description (WAHERB, 2019)
Philotheca coateana			P3	Shrub, 0.3-0.5 m high, branchlets glabrous; leaf blades 3-4 mm long; flowers terminal, solitary; petals 7-9 mm long. Fl. white & pink, Aug to Sep. Red sand. (WAHERB 2019)
Philotheca deserti subsp. *brevifolia*			P3	Erect shrub, ca 1 m high, leaves fusiform to narrowly obovoid, 3-5 mm long. Fl. white, Sep. Red sandy clay. (WAHERB 2019)
Psammomoya grandiflora			P3	Erect, spreading shrub, to 0.8 m high. Fl. white, Aug to Oct. Red loam, sand, jasperlite. Sandplains, rocky country. (WAHERB 2019)
Ricinocarpos brevis	EN	EN		Shrub, to 1.8 m high. Fl. white, Jun to Jul. Rocky hillslopes, rock outcrops. (WAHERB 2019)
Rinzia triplex			P3	No description available
Sowerbaea multicaulis			P4	Tufted perennial, herb, 0.075-0.25 m high. Fl. purple-violet, Oct to Dec or Jan. Yellow-brown sand. (WAHERB 2019)
Stenanthemum newbeyi			P3	Erect or spreading shrub, 1-1.6 m high. Fl. yellow, Aug to Sep or Dec or Jan. Clayey sand, clay or loam over laterite or ironstone. Hillslopes. (WAHERB 2019)
Styphelia sp. Bullfinch (M. Hislop 3574)			P3	Compact shrub to 1 m high x 0.7 m wide, intricately but openly branched. Flowers cream, bud apex pink, anthers purple, Apr to July. (WAHERB 2019)
Stylidium choreanthum			P3	Creeping perennial, herb, 0.01-0.03 m high, to 0.3 m wide. Fl. pink/white, Sep to Nov. White/yellow or red sand. Plains. (WAHERB 2019)
Tetratheca paynterae subsp. *cremnobata*	EN	VU		Clumped, multistemmed, leafless shrub, to 1 m high. Fl. purple, Jun. Shallow red-brown loam, clayey silt, ironstone. Outcrops, ridges, breakaways, rocky slopes. (WAHERB 2019)
Tetratheca harperi	VU	VU		Multi-stemmed, leafless shrub, 0.2-0.4 m high. Fl. pink, May or Sep to Nov. Stony loam. Rocky outcrops, rock crevices. a harperi. (WAHERB 2019)
Tetratheca paynterae subsp. *paynterae*	EN	CR		Dwarf, leafless shrub, to 0.5 m high. Fl. pink. Brown clay loam, silty sandy or clayey loam, ironstone, jasperite. Mid-upper slopes, rock crevices, ridges and cliffs. (WAHERB 2019)

Results

Flora

No Threatened Flora taxa pursuant to the *Biodiversity Conservation* (BC) *Act 2016* and the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* were identified within the survey area. Three Priority Flora taxa were identified within the survey area as shown in Figure 3:

1. *Banksia arborea* (P3);
2. *Eucalyptus formanii* (P4); and
3. *Grevillea georgeana* (P3).

GPS records of each taxon are provided in Attachment 1.

The DBCA lists and manages 'Priority' species which are under consideration for declaration as Threatened Flora. These priority species have no formal legal protection until they are endorsed by the Minister as being Threatened under the BC Act. Clearing of any locations of Priority Flora should be avoided. Should disturbance to these plant locations not be able to be avoided, DBCA recommends consulting with the DBCA Species and Communities Program. Details on the newly identified records of each taxon will be reported to DBCA for their records.

Banksia arborea **(P3)**
Botanica recorded three locations of this taxon (total of three plants) during the survey (Figure 3a). Based on DBCA records, this taxon has been previously recorded approximately 1.6km west of the Red Legs survey area. One record of this taxon was recorded at one drill hole. The remaining two records were recorded on one drill line (existing cleared line) as shown in Figure 3a.

Plate 1: *Banksia arborea* (P3)

Eucalyptus formanii **(P4)**
Botanica recorded 106 locations of this taxon (total of 106 plants) during the survey. Based on DBCA records, the closest DBCA record of this taxon is located approximately 1.6km west of the Red Legs survey area. 24 locations of this taxon were recorded at eight proposed drill holes as shown in Figure 3a. All other records of this taxon are located along proposed drill lines/ existing access tracks (Figure 3a).

Plate 2: *Eucalyptus formanii* (P4)

***Grevillea georgeana* (P3)**
Botanica recorded 66 locations of this taxon (total of 66 plants) during the survey. Based on DBCA records, the closest DBCA record of this taxon is located approximately 1.6km west of the Red Legs survey area. 13 locations of this taxon were recorded at five proposed drill holes as shown in Figure 3a. All other records of this taxon are located along proposed drill lines/ existing access tracks (Figure 3a).

Plate 3: *Grevillea georgeana* (P3)

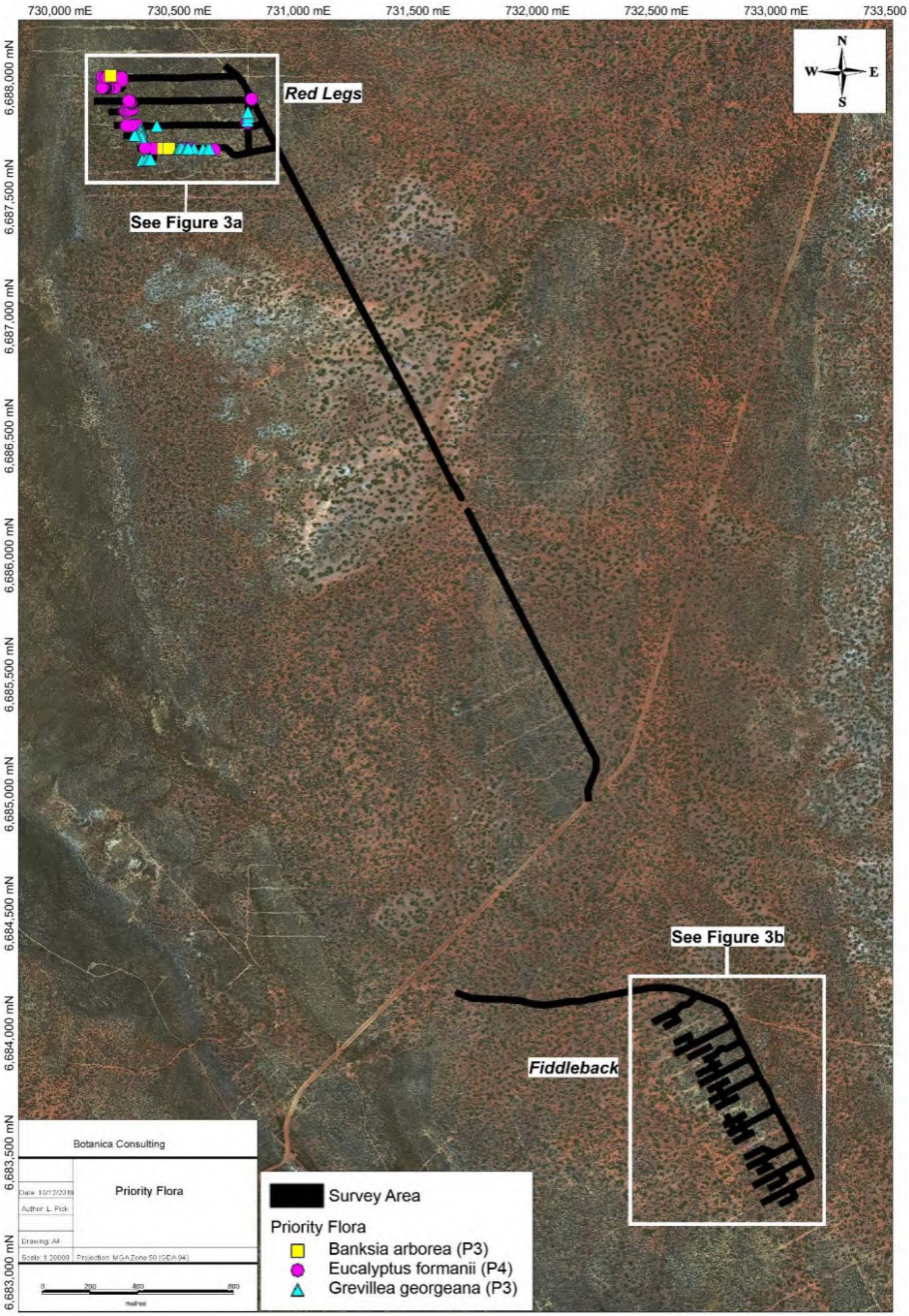

Figure 3: Priority Flora records within the survey area

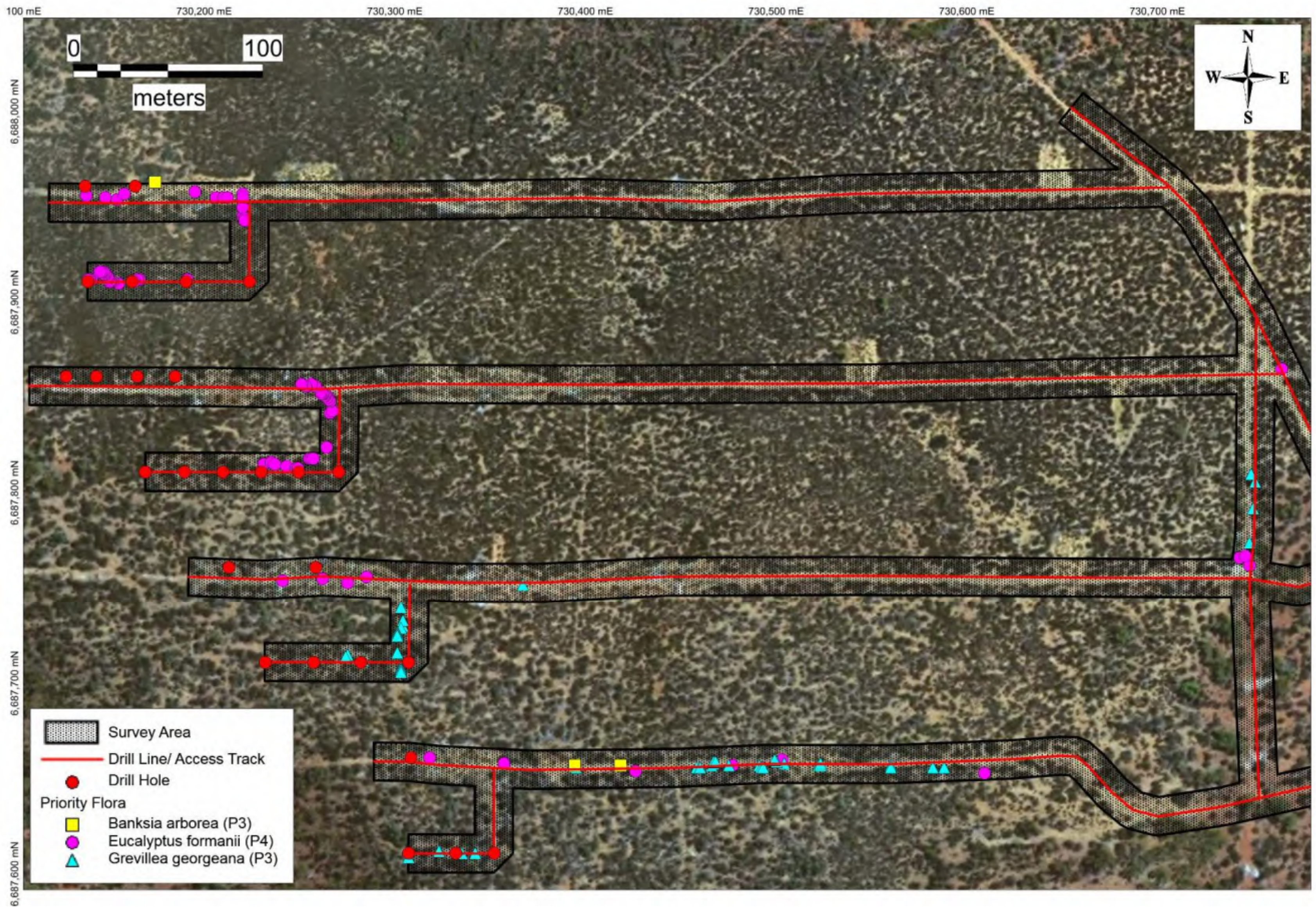

Figure 3a: Priority Flora records in relation to the Red Legs exploration program

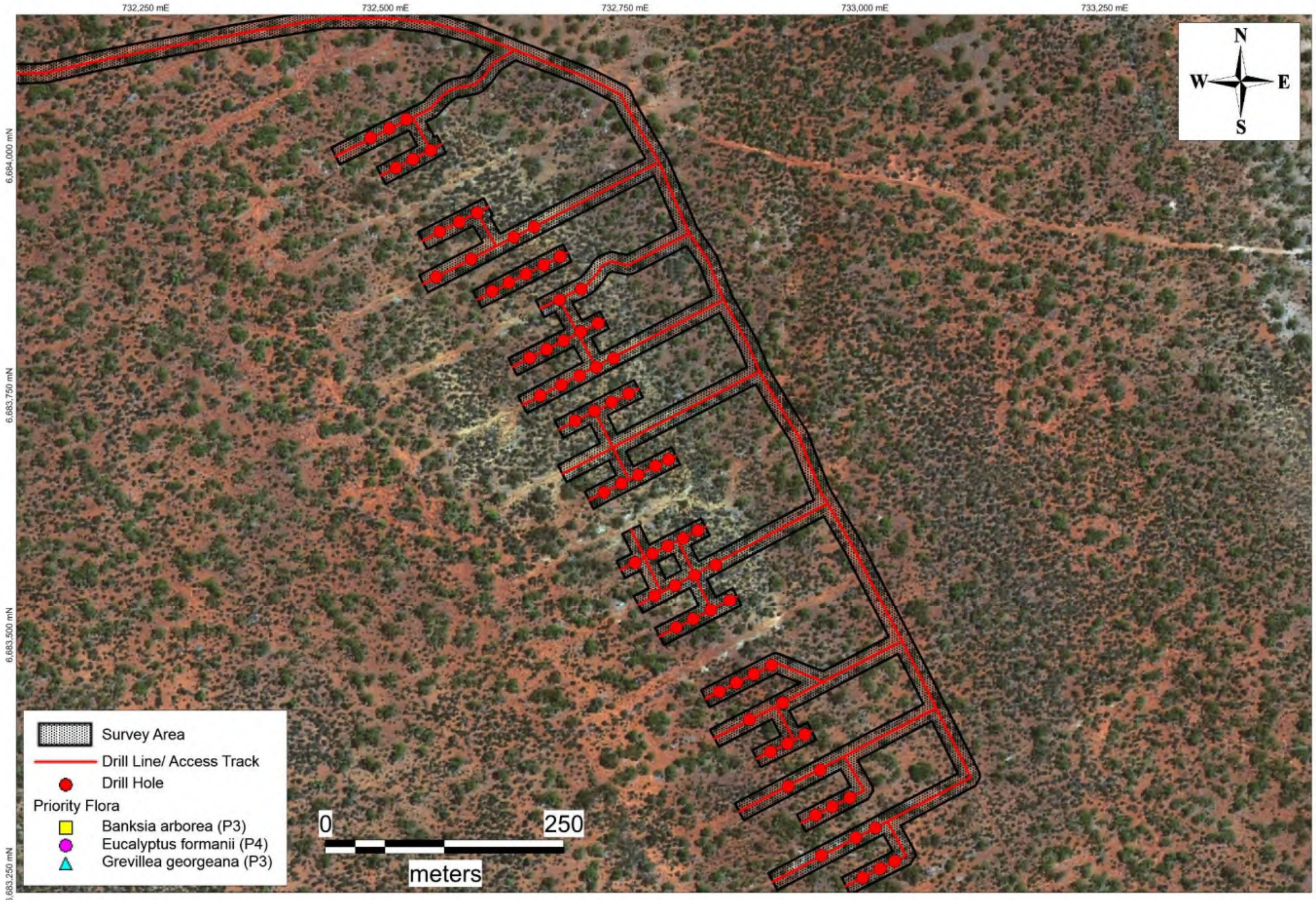

Figure 3b: Priority Flora records in relation to the Die Hardy exploration program

Vegetation

Four vegetation associations were recorded within the survey area as listed in Table 2 and shown in Figure 4. Approximately 20.5 ha of the survey area (~88% of the total survey area) is located within the boundary (including 500m buffer) of a Priority 1 Ecological Community; Die Hardy Range/Diemels vegetation complex (banded ironstone formation) which encompasses an area of 16,500 ha. The total survey area (23.4 ha) represents 0.14% of the total extent of this PEC. A map showing Priority Ecological Communities in relation to the survey area is provided in Figure 5.

Table 2: Vegetation Associations recorded within the survey area

Vegetation Code	Vegetation Association	Area (ha)	Area (%)	Photo
CLP-EW1	Low woodland of *Eucalyptus concinna* over mid open shrubland of *Acacia ramulosa* and low sparse shrubland of *Ptilotus obovatus* on clay-loam plain	2.6	11.1	
CLP-EW2	Low woodland of *Eucalyptus salmonophloia/ E. salubris* over mid sparse shrubland of *Acacia tetragonophylla* and low chenopod shrubland of *Atriplex stipitata* on clay-loam plain	11.5	49.1	

Vegetation Code	Vegetation Association	Area (ha)	Area (%)	Photo
HS-CFW1	Mid shrubland of *Allocasuarina campestris* over low sparse shrubland of *Goodenia* spp. on hillslope	6.3	26.9	
HS-EW1	Low open woodland of *Eucalyptus concinna* over mid shrubland of *Acacia ramulosa* and low sparse shrubland of *Ptilotus obovatus* on hillslope	3	12.8	
TOTAL		**23.4**	**100**	

Figure 4: Vegetation Associations within the survey area

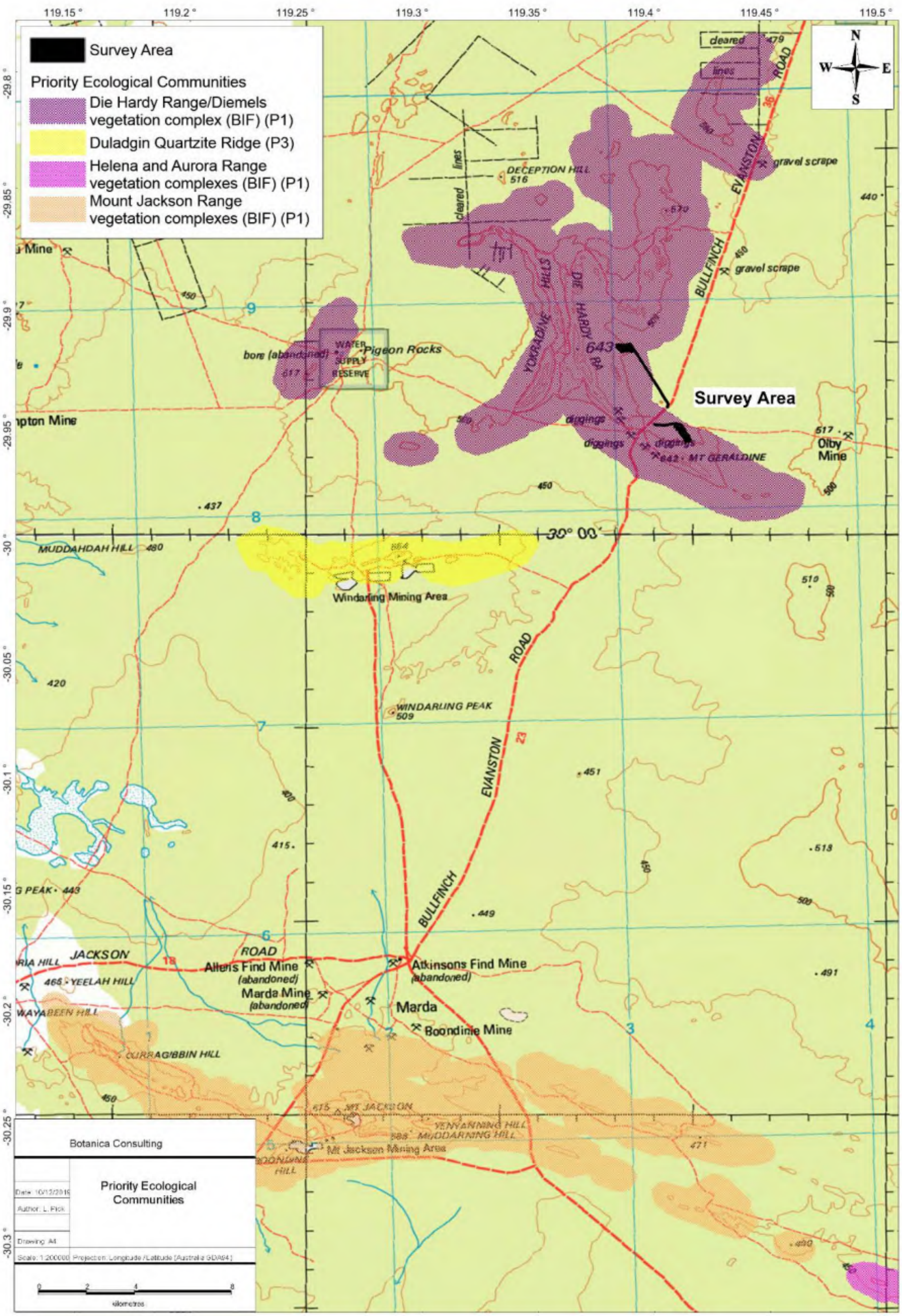

Figure 5: Priority Ecological Communities in relation to the survey area

Fauna

There was no evidence of Malleefowl mounds or other evidence of Malleefowl activity (tracks, feathers or bird observations etc.) observed during the survey.

Conclusion

Majority of the proposed drilling is located within areas of existing disturbance (as shown in Figure 3a and 3b), therefore clearing of mature Eucalypts will be avoided and disturbance to native vegetation will be minimised. Clearing of any locations of Priority Flora should be avoided. Should disturbance to these plant locations not be able to be avoided, DBCA recommends consulting with the DBCA Species and Communities Program.

Should you have any questions, please do not hesitate to contact me.

Regards,

Jim Williams

Director

Attachment 1: GPS coordinates of Priority Flora recorded by Botanica (GDA94)

Taxon	Zone	Easting	Northing	Elevation
Banksia arborea (P3)	50 J	730167	6687952	519 m
Banksia arborea (P3)	50 J	730387	6687646	528 m
Banksia arborea (P3)	50 J	730411	6687646	527 m
Eucalyptus formanii (P4)	50 J	730758	6687854	501 m
Eucalyptus formanii (P4)	50 J	730741	6687751	502 m
Eucalyptus formanii (P4)	50 J	730736	6687755	503 m
Eucalyptus formanii (P4)	50 J	730739	6687756	503 m
Eucalyptus formanii (P4)	50 J	730278	6687745	527 m
Eucalyptus formanii (P4)	50 J	730268	6687742	528 m
Eucalyptus formanii (P4)	50 J	730255	6687744	530 m
Eucalyptus formanii (P4)	50 J	730234	6687743	530 m
Eucalyptus formanii (P4)	50 J	730311	6687650	533 m
Eucalyptus formanii (P4)	50 J	730350	6687647	531 m
Eucalyptus formanii (P4)	50 J	730419	6687643	523 m
Eucalyptus formanii (P4)	50 J	730470	6687646	525 m
Eucalyptus formanii (P4)	50 J	730496	6687649	525 m
Eucalyptus formanii (P4)	50 J	730602	6687642	516 m
Eucalyptus formanii (P4)	50 J	730224	6687804	522 m
Eucalyptus formanii (P4)	50 J	730228	6687805	523 m
Eucalyptus formanii (P4)	50 J	730230	6687804	523 m
Eucalyptus formanii (P4)	50 J	730236	6687803	523 m
Eucalyptus formanii (P4)	50 J	730241	6687802	523 m
Eucalyptus formanii (P4)	50 J	730242	6687802	523 m
Eucalyptus formanii (P4)	50 J	730248	6687807	522 m
Eucalyptus formanii (P4)	50 J	730248	6687807	522 m
Eucalyptus formanii (P4)	50 J	730248	6687807	522 m
Eucalyptus formanii (P4)	50 J	730249	6687807	522 m
Eucalyptus formanii (P4)	50 J	730249	6687807	522 m
Eucalyptus formanii (P4)	50 J	730249	6687807	522 m
Eucalyptus formanii (P4)	50 J	730249	6687807	522 m
Eucalyptus formanii (P4)	50 J	730250	6687807	522 m
Eucalyptus formanii (P4)	50 J	730257	6687813	521 m
Eucalyptus formanii (P4)	50 J	730259	6687831	520 m
Eucalyptus formanii (P4)	50 J	730259	6687831	520 m
Eucalyptus formanii (P4)	50 J	730260	6687832	520 m
Eucalyptus formanii (P4)	50 J	730259	6687837	519 m
Eucalyptus formanii (P4)	50 J	730258	6687838	519 m
Eucalyptus formanii (P4)	50 J	730258	6687838	519 m
Eucalyptus formanii (P4)	50 J	730258	6687838	519 m
Eucalyptus formanii (P4)	50 J	730258	6687839	519 m
Eucalyptus formanii (P4)	50 J	730257	6687839	519 m
Eucalyptus formanii (P4)	50 J	730257	6687839	519 m

Taxon	Zone	Easting	Northing	Elevation
Eucalyptus formanii (P4)	50 J	730257	6687839	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730254	6687841	519 m
Eucalyptus formanii (P4)	50 J	730254	6687842	519 m
Eucalyptus formanii (P4)	50 J	730254	6687842	519 m
Eucalyptus formanii (P4)	50 J	730254	6687842	519 m
Eucalyptus formanii (P4)	50 J	730251	6687845	519 m
Eucalyptus formanii (P4)	50 J	730249	6687846	519 m
Eucalyptus formanii (P4)	50 J	730247	6687845	518 m
Eucalyptus formanii (P4)	50 J	730246	6687845	518 m
Eucalyptus formanii (P4)	50 J	730244	6687846	518 m
Eucalyptus formanii (P4)	50 J	730213	6687946	516 m
Eucalyptus formanii (P4)	50 J	730213	6687939	517 m
Eucalyptus formanii (P4)	50 J	730213	6687934	517 m
Eucalyptus formanii (P4)	50 J	730214	6687933	517 m
Eucalyptus formanii (P4)	50 J	730214	6687933	517 m
Eucalyptus formanii (P4)	50 J	730214	6687932	517 m
Eucalyptus formanii (P4)	50 J	730184	6687901	518 m
Eucalyptus formanii (P4)	50 J	730159	6687901	521 m
Eucalyptus formanii (P4)	50 J	730158	6687901	521 m
Eucalyptus formanii (P4)	50 J	730156	6687900	521 m
Eucalyptus formanii (P4)	50 J	730148	6687899	522 m
Eucalyptus formanii (P4)	50 J	730148	6687899	522 m
Eucalyptus formanii (P4)	50 J	730145	6687900	522 m
Eucalyptus formanii (P4)	50 J	730144	6687900	522 m
Eucalyptus formanii (P4)	50 J	730144	6687900	522 m
Eucalyptus formanii (P4)	50 J	730144	6687900	522 m
Eucalyptus formanii (P4)	50 J	730143	6687900	522 m
Eucalyptus formanii (P4)	50 J	730143	6687900	522 m
Eucalyptus formanii (P4)	50 J	730143	6687900	522 m
Eucalyptus formanii (P4)	50 J	730142	6687901	522 m

Taxon	Zone	Easting	Northing	Elevation
Eucalyptus formanii (P4)	50 J	730142	6687901	522 m
Eucalyptus formanii (P4)	50 J	730142	6687902	522 m
Eucalyptus formanii (P4)	50 J	730142	6687903	522 m
Eucalyptus formanii (P4)	50 J	730141	6687904	522 m
Eucalyptus formanii (P4)	50 J	730141	6687904	523 m
Eucalyptus formanii (P4)	50 J	730140	6687904	523 m
Eucalyptus formanii (P4)	50 J	730140	6687905	523 m
Eucalyptus formanii (P4)	50 J	730139	6687905	523 m
Eucalyptus formanii (P4)	50 J	730139	6687905	523 m
Eucalyptus formanii (P4)	50 J	730139	6687905	523 m
Eucalyptus formanii (P4)	50 J	730138	6687905	523 m
Eucalyptus formanii (P4)	50 J	730134	6687901	523 m
Eucalyptus formanii (P4)	50 J	730133	6687901	523 m
Eucalyptus formanii (P4)	50 J	730133	6687901	523 m
Eucalyptus formanii (P4)	50 J	730132	6687901	523 m
Eucalyptus formanii (P4)	50 J	730132	6687901	523 m
Eucalyptus formanii (P4)	50 J	730131	6687945	524 m
Eucalyptus formanii (P4)	50 J	730141	6687944	522 m
Eucalyptus formanii (P4)	50 J	730147	6687943	521 m
Eucalyptus formanii (P4)	50 J	730151	6687946	521 m
Eucalyptus formanii (P4)	50 J	730188	6687947	519 m
Eucalyptus formanii (P4)	50 J	730199	6687944	518 m
Eucalyptus formanii (P4)	50 J	730203	6687944	517 m
Eucalyptus formanii (P4)	50 J	730205	6687944	517 m
Eucalyptus formanii (P4)	50 J	730213	6687944	517 m
Grevillea georgeana (P3)	50 J	730360	6687741	517 m
Grevillea georgeana (P3)	50 J	730296	6687729	524 m
Grevillea georgeana (P3)	50 J	730297	6687722	525 m
Grevillea georgeana (P3)	50 J	730297	6687722	525 m
Grevillea georgeana (P3)	50 J	730297	6687719	525 m
Grevillea georgeana (P3)	50 J	730297	6687719	525 m
Grevillea georgeana (P3)	50 J	730296	6687718	526 m
Grevillea georgeana (P3)	50 J	730294	6687716	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687714	526 m
Grevillea georgeana (P3)	50 J	730294	6687714	526 m
Grevillea georgeana (P3)	50 J	730294	6687714	526 m

Taxon	Zone	Easting	Northing	Elevation
Grevillea georgeana (P3)	50 J	730294	6687714	526 m
Grevillea georgeana (P3)	50 J	730294	6687705	527 m
Grevillea georgeana (P3)	50 J	730296	6687698	528 m
Grevillea georgeana (P3)	50 J	730296	6687698	528 m
Grevillea georgeana (P3)	50 J	730296	6687697	528 m
Grevillea georgeana (P3)	50 J	730296	6687697	528 m
Grevillea georgeana (P3)	50 J	730296	6687697	528 m
Grevillea georgeana (P3)	50 J	730296	6687697	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687695	528 m
Grevillea georgeana (P3)	50 J	730276	6687701	529 m
Grevillea georgeana (P3)	50 J	730268	6687704	529 m
Grevillea georgeana (P3)	50 J	730268	6687704	529 m
Grevillea georgeana (P3)	50 J	730267	6687703	530 m
Grevillea georgeana (P3)	50 J	730267	6687703	530 m
Grevillea georgeana (P3)	50 J	730300	6687598	537 m
Grevillea georgeana (P3)	50 J	730316	6687601	537 m
Grevillea georgeana (P3)	50 J	730327	6687600	537 m
Grevillea georgeana (P3)	50 J	730328	6687600	537 m
Grevillea georgeana (P3)	50 J	730335	6687600	536 m
Grevillea georgeana (P3)	50 J	730388	6687645	528 m
Grevillea georgeana (P3)	50 J	730451	6687645	526 m
Grevillea georgeana (P3)	50 J	730453	6687645	526 m
Grevillea georgeana (P3)	50 J	730459	6687646	527 m
Grevillea georgeana (P3)	50 J	730460	6687647	527 m
Grevillea georgeana (P3)	50 J	730460	6687648	527 m
Grevillea georgeana (P3)	50 J	730461	6687648	527 m
Grevillea georgeana (P3)	50 J	730468	6687646	527 m
Grevillea georgeana (P3)	50 J	730484	6687646	527 m
Grevillea georgeana (P3)	50 J	730485	6687645	527 m
Grevillea georgeana (P3)	50 J	730486	6687645	527 m
Grevillea georgeana (P3)	50 J	730493	6687648	526 m
Grevillea georgeana (P3)	50 J	730492	6687649	526 m
Grevillea georgeana (P3)	50 J	730497	6687647	526 m
Grevillea georgeana (P3)	50 J	730515	6687646	525 m
Grevillea georgeana (P3)	50 J	730516	6687646	525 m
Grevillea georgeana (P3)	50 J	730516	6687647	525 m
Grevillea georgeana (P3)	50 J	730553	6687646	523 m

Taxon	Zone	Easting	Northing	Elevation
Grevillea georgeana (P3)	50 J	730553	6687645	523 m
Grevillea georgeana (P3)	50 J	730575	6687645	521 m
Grevillea georgeana (P3)	50 J	730581	6687645	519 m
Grevillea georgeana (P3)	50 J	730741	6687763	506 m
Grevillea georgeana (P3)	50 J	730743	6687781	506 m
Grevillea georgeana (P3)	50 J	730744	6687795	504 m
Grevillea georgeana (P3)	50 J	730742	6687799	504 m

Appendix G: Level 1 Fauna Assessment

SOUTHERN CROSS GOLDFIELDS LTD

LEVEL 1 FAUNA ASSESSMENT

August 2014

Level 1 Fauna Assessment

FOR THE MARDA EAST PROJECT

Tenements R 77/1, R 77/2, L 77/261

animal plant mineral

SXG001 – Southern Cross Goldfields Limited - Level 1 Fauna Assessment of the Marda East Project

This report was completed by:

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Disclaimer

EXECUTIVE SUMMARY

Southern Cross Goldfields Limited is developing the Marda East Project, located approximately 140 km north of Southern Cross. The Project includes two ore deposits, Red Legs and Fiddleback which are approximately 3.5 km apart and joined by a proposed haul route which crosses the Bulfinch-Evanstone Road. These areas are approximately 12 ha and 33 ha in size, respectively, and are located within a Survey area of approximately 245 ha.

Animal Plant Mineral Pty Ltd was engaged in June 2014 to undertake a Level 1 fauna assessment in order to provide sufficient information for SXG to accurately assess the likely impact of mining activities on biodiversity, fauna and habitat values of conservation significance in a local and regional context.

The Survey area is located in a semi-arid Mediterranean climate in the Coolgardie Bioregion and encompasses four land systems; Campsite, Dryandra, Moriarty and Yowie, with the majority of the Survey area falling within the Campsite land system.

The Project resides within the Department of Parks and Wildlife Act Section 5(1)(h) proposed 'Conservation and Mining Reserve' and borders the Mount Manning - Helena and Aurora Ranges Conservation Park at the south eastern corner of the Fiddleback prospect. Additionally, the north western boundary of the Red Legs prospect abuts a proposed 'Class A' Nature Reserve which encompasses the Priority 1 Die Hardy Range Banded Ironstone Formation. The south eastern corner of the Fiddleback prospect borders the Mount Manning - Helena and Aurora Ranges Conservation Park and the Mount Manning Range Nature Reserve and Mount Manning Range Conservation Park are located toward the east and within 20 km.

A desktop survey of the EPBC Act Protected Matters, NatureMap and DPaw databases was conducted to develop a list of conservation significant fauna.

A field survey was conducted to assess fauna habitat and conduct targeted searches for Shield-backed Trapdoor Spiders and Tree-stem Trapdoor Spiders whilst also ground truthing Malleefowl mound activity of mounds located during the flora and vegetation survey conducted in 2012 by Western Botanical.

Based on searches of the Protected Matters and NatureMap databases, 14 species of conservation significance could potentially occur in the Survey area. However, after an analysis of fauna habitats within the Project area it was determined that 4 of the species are unlikely to occur, 3 species have the potential to occur, 6 are likely to occur, and one species (Malleefowl) has been recorded in the Survey area.

The small scale of the Survey area was considered and was allocated six habitat types; Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain; Low Eucalypt Woodland over Acacia Shrubland on Alluvial Plain; Low Eucalypt Woodland over Acacia on Rocky Rises; Low Eucalypt Woodland over Spinifex on Alluvial Plain; Dense Shrubland on Rocky Rises and Dense Shrubland on Alluvial Plain.

Fauna habitat of greatest value to fauna species occurring within the Survey area was Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain.

An intensive presence/absence search for the Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider at 15 sites over five of the six different habitat types did not locate either spider or evidence of trapdoor burrows. It is considered unlikely that these two spider species are using the Survey area.

Malleefowl mounds and tracks have been recorded in the Survey area and this species appears to prefer two particular fauna habitats in the Project area that, together, account for 15.71 ha of the area surveyed. These

habitats were the Dense Shrubland on Alluvial Plain and Dense Shrubland on Rocky Rises. Two of the 11 mounds were classified as active during the 2013 and again during the current survey (site number 1 and site number 11). Remains of a Malleefowl suspected to be predated on by a fox were found at site 11. Nine recommendations for future Malleefowl management have been proposed.

No other species of conservation significance were recorded during the survey however the peregrine Falcon, Australian Bustard, Major Mitchell's Cockatoo, Fork-tailed Swift, Rainbow Bee-eater, Shy Heathwren and the Greater Long-eared Bat have been recorded in the local area and have the potential to occur in the Project area.

APM recommends that, rather than investing resources into another baseline fauna survey of the Project area in Spring 2014, the Client should focus any further survey effort on a subset of the fauna species of conservation significance that may occur, but have not yet been located in the Project area. APM proposes a nest hollow assessment and trapping program be undertaken in Spring 2014 targeting populations of Numbat, Major Mitchell's Cockatoo and the Greater Long-eared Bat.

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LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviation	Meaning
APM	Animal Plant Mineral Proprietary Limited
BIF	Banded Ironstone Formation
BoM	Bureau of Meteorology
DoE	Department of the Environment
DPaW	Department of Parks and Wildlife
EPA	Environmental Protection Authority
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
MNES	Matters of National Environmental Significance
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities (now the Department of the Environment)
SRE	Short Range Endemic
SXG	Southern Cross Goldfields Limited
WA	Western Australia
WC Act	*Wildlife Conservation Act 1950*

Symbols and Units	Meaning
^{o}C	Degrees Celsius
cm	Centimetres
ha	Hectares
km	Kilometres
mm	Millimetres

1 INTRODUCTION

1.1 PROJECT AND LOCATION

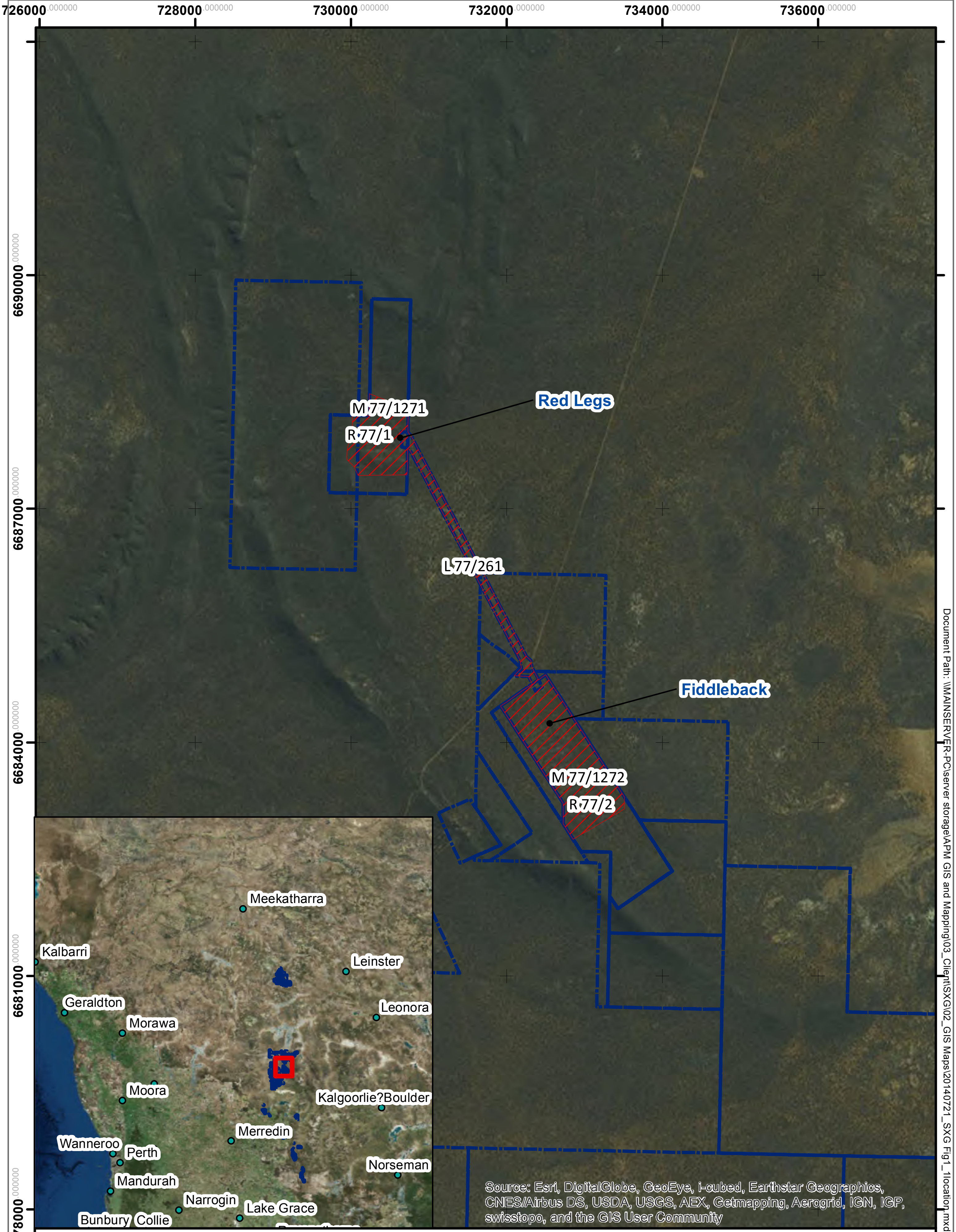
Southern Cross Goldfields Limited (SXG) is an ASX-listed company which is developing a long-term gold business based on a portfolio of production and exploration assets in Western Australia (WA) and New South Wales.

SXG completed a positive Feasibility Study in 2012 on the Marda Project in WA; this was based on the development of a greenfields gold project with open pit mines, processing facility and associated support infrastructure located at Marda Central.

SXG is now looking to progress approvals for the ore bodies 35 km north-east of the Marda Central pits, known as the Marda East Project (the Project), which includes two ore deposits, Red Legs and Fiddleback (previously named Die Hardy). These two deposits are approximately 3.5 km apart and joined by a proposed haul route which crosses the Bulfinch-Evanstone Road. These areas are approximately 12 ha and 33 ha in size, respectively, and are located within a Survey area of approximately 245 ha.

The Project is located approximately 140 km north of Southern Cross (Figure 1-1), comes under the jurisdiction of the Menzies Shire and is part of the Yilgarn Mineral Field. The Project is on the former Diemals Pastoral Station lease that is currently destocked and now a Department of Parks and Wildlife (DPaW) Act Section 5(1)(h) proposed ‘Conservation and Mining Reserve’. A proposed ‘Class A’ Nature Reserve in the Die Hardy Range occurs immediately adjacent to the north-western boundary of the Red Legs prospect. Additionally the project area borders The Mount Manning - Helena and Aurora Ranges Conservation Park at the south eastern corner of the Fiddleback prospect.

The Project is located within 20 km of the Mount Manning Range Nature Reserve and the Mount Manning Range Conservation Park and a portion of the Project is located on the south eastern flanks of the Die Hardy Range, a Banded Ironstone Formation (BIF) and classified as a Priority 1 (P1) Priority Ecological Community (PEC).



Legend

Figure 1.1: Location of the Marda East Project, WA

Date: 21/07/2014

Marda East Project Survey Area

Southern Cross Goldfield Ltd Tenements

Coordinate System: GDA 1994 MGA Zone 50

Author: T Smith

Document Name: 20140721_SXG Fig1_1location

1.2 Scope of Work

Animal Plant Mineral Pty Ltd (APM) was engaged by SXG in June 2014 to undertake a Level 1 fauna assessment in an area of approximately 245 hectares (ha), defined by SXG (Survey area) (Figure 1-1), encompassing the Red Legs and Fiddleback deposits which are located approximately 3.5 km apart and linked by a haul road corridor 100 metres (m) wide.

The assessment was designed in accordance with a Level 1 fauna survey (Reconnaissance survey) as defined in Environmental Protection Authority Position Statement 3 (Environment Protection Authority (EPA) 2002), Guidance Statement 56 (EPA 2004) and Guidance Statement 20 (EPA 2009).

The objectives of the survey were to:

- Enhance the level of knowledge regarding vertebrate fauna and short range endemic invertebrates (SREs) at a local scale and place it in a regional context.
- Provide sufficient information for SXG to accurately assess the likely impact of mining activities on biodiversity, fauna and habitat values of conservation significance in a local and regional context.

2 EXISTING ENVIRONMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 Climate

The Survey area is located in a semi-arid Mediterranean climate. Temperatures are strongly seasonal with hot summers (December – February) and cooler winters (June – August); rainfall predominantly occurs in late summer, autumn and winter.

Data was sourced from two different locations in order to compile the most relevant climate information for the Survey area. The Bureau of Meteorology (BoM) have been recording rainfall data from the Windarling station (BoM Site Number 012141), approximately 12 km south west of the Survey area, since 2004. Temperature data was sourced from the Southern Cross Airfield station (BoM Site Number 12320; opened in 1996), approximately 140 km south of the Survey area.

Average monthly temperature and rainfall data is presented in Table 2-1. Recorded data suggests that the Survey area is likely to receive approximately 277 mm of rain on an annual basis and experience temperatures ranging between 3 °C and 35 °C. Although rainfall and daily temperatures in the Project area may vary slightly, data from the above mentioned Research Stations provides a good indication of climatic conditions within the region.

Table 2-1: Southern Cross Airfield Station Temperature Data and Windarling Station Rainfall Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Max Temp (°C) (Southern Cross Airfield)	34.7	33.7	30.5	26.4	21.5	17.9	16.6	18.5	21.5	26.3	29.9	32.7	25.8
Mean Min Temp (°C) (Southern Cross Airfield)	17.7	17.6	15.0	11.6	7.6	4.6	3.4	3.4	5.1	9.1	12.9	15.3	10.2
Mean Rainfall (mm) (Windarling)	49.9	32.6	24.9	26.1	22.4	22.8	28.8	17.0	19.0	10.7	14.6	12.0	276.5
2014 Rainfall (mm) (Windarling)	162.4	2.5	10.2	60.2	44.0	8.8	Not yet reported by BoM						

Source: http://www.bom.gov.au

2.1.2 Bioregions and Systems

Mapping for the Interim Biogeographic Regionalisation for Australia (IBRA version 6.1) programme placed the Project area in the Southern Cross subregion of the Coolgardie Bioregion (SEWPaC, undated). The subregion and bioregion, respectively, is described in McKenzie et al. 2002 as follows:

"The Southern Cross subregion comprises gently undulating uplands on granite strata and broad valleys with bands of low greenstone hills."

"The Coolgardie Bioregion is within the Yilgarn Craton. Its granite basement includes Archaean Greenstone intrusions in parallel belts. Drainage is occluded. The climate is arid to semi-arid warm Mediterranean with 250-300mm of mainly winter rainfall. Diverse woodlands, rich in endemic eucalypts, occur on low greenstone

hills, on alluvial soils on the valley floors, around the saline playas of the region's occluded drainage system, and on broad plains of calcareous earths.

The granite basement outcrops at mid-level in the landscape. It supports swards of 'granite grass', wattle shrublands and York Gum. The playa lakes support dwarf shrublands of samphire. Sand lunettes are associated with playas along the broad valley floors, and sand sheets surround the granite outcrops.

Upper levels in the landscape are the eroded remnants of a Tertiary lateritic duricrust, with yellow (in the Southern Cross subregion) or red (in the Eastern Goldfields subregion) sandplains, gravel plains and laterite breakaways. These support scrubs and mallees. In the west, these scrubs are rich in endemic Proteaceae; in the east they are rich in endemic acacias."

The Project lies adjacent to the Die Hardy Range, which is one of many Banded Ironstone Formations (BIFs) in the region. These BIF ranges have been recognised for the unique compositions of flora and fauna and for supporting rare and endemic plant species (DEC 2007).

The Priority One (P1) Die Hardy Range / Diemels vegetation complex (banded ironstone formation), Priority Ecological Community (PEC) covers an area of 10,547.54 ha and occurs around the Banded Ironstone Formation geology of the Die Hardy Ranges and the adjacent Yokradine Hills, inclusive of the midslopes, lower slopes and portions of the adjacent plains. The Marda East Project area intersects this PEC with 107.18 ha of the project area mapped by Western Botanical (2014) occurring within the PEC (representing 1.02 % of the total PEC). Ten of the 12 vegetation associations mapped by Western Botanical in the Project area form part of the Priority 1 PEC vegetation complex (banded ironstone formation).

2.1.3 Land Systems Mapping

The Rangeland Land System Mapping for Western Australia dataset (Department of Agriculture and Food, 2009) was consulted to further facilitate a broad assessment of the regional representation of vegetation that occurs in the Survey area. A land system is defined as 'an area or group of areas, throughout which there is a recurring pattern of topography, soils and vegetation'. Four land systems were mapped within the Survey area by Payne *et al.* (1998):

- **Campsite:** Alluvial plains; very gently inclined plains receiving sheet wash from mafic hills, gently undulating calcareous stony upper plains (erosional) and occasional narrow concentrated drainage tracts. Supports eucalypt woodlands with halophytic understoreys and eucalypt-acacia shrublands.
- **Dryandra:** Conspicuous banded ironstone and jaspilite ridges and hills with hill slopes of variable country rock, relief up to 150 m or more. Supports dense mixed shrublands with emergent native pines, mallees and casuarinas.
- **Moriarty:** Low greenstone rises and stony plains, with local pockets of lateritic duricrust on weathered greenstone, very gently undulating plains with stony lag and alluvial plains with texture contrast soils. Supports chenopod, halophytic and acacia shrublands with patchy eucalypt over storeys.
- **Yowie:** Sandy plains with negligible surface drainage features. Supports shrublands of mulga and bowgada with common mallee eucalypts and patchy wanderrie grasses.

The majority of the Survey area is within the Campsite land system (171.02 ha) followed by the Dryandra land system (61.19 ha); these two land systems represent 94.6% of the Survey area (245 ha).

2.1 PREVIOUS SURVEYS

No fauna surveys have been undertaken in the specific Project area however, previous work has been done at Marda Central:

- Bamford Consulting Ecologists, Level 1 Fauna Assessment of Proposed haul Roads, Camps and Airstrips, 2013.
- Bamford Consulting Ecologists, Targeted Fauna (Malleefowl), Marda Gold Project, 2013.
- Rapallo Environmental, Short Range Endemic Fauna Desktop and Risk Assessment of the Marda Gold Project, 2012.

Additionally biological surveys have been undertaken in nearby areas:

- Ecologia, Terrestrial and Subterranean Fauna Assessment, J4 Mine and Haul Road, 2013.
- Cliffs, Koolyanobbing Iron Ore Project, Biodiversity and Research Management Plan, 2009.
- Ninox Wildlife Consulting, Fauna Survey of the Carina Prospect, 2009.
- Terrestrial Ecosystems, Tree Hollow Assessment for Cockatoos at Battler, King Brown Marda and Golden Orb, 2011.

Level 1 flora and vegetation studies of portions of the Red Legs and Fiddleback deposits have been undertaken for exploration Programme of Work purposes and a Level 2 flora and vegetation survey was completed by Western Botanical in spring 2013 (reported in 2014).

The Western Botanical report provides a detailed summary of previous local and regional botanical surveys in addition to their own comprehensive reporting on the Project area specifically. This report should be considered with reference to the Western Botanical report.

3 METHODOLOGY

3.1 LEGISLATION

Species considered to be of national conservation significance (MNES) are protected under the *Environmental Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). Under this Act, activities that may have a significant impact on a species of national conservation significance must be referred to the Department of the Environment (DoE), formerly the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), for assessment.

In WA, all native fauna species are protected under the *Wildlife Conservation Act 1950* (*WC Act*). Fauna species that are considered rare, threatened with extinction or have high conservation value are specially protected by four schedules in this Act (Appendix 1). The DPaW also classifies some other fauna under five different Priority codes (Appendix 1).

In addition, some species of fauna are covered under the 1991 Australian and New Zealand Environment Conservation Council (ANZECC) Convention (Commonwealth (Cth)), while certain birds are listed under the 1974 Japan and Australian Migratory Bird Agreement (JAMBA) (Cth) and the 1986 China and Australian Migratory Bird Agreement (CAMBA) (Cth). More recently Australia and the Republic of Korea agreed to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA. The Republic of Korea-Australian Migratory Bird Agreement (ROKAMBA) was entered into force in 2007. All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as MNES under the *EPBC Act*.

3.2 DESKTOP METHODOLOGY

A comprehensive list of conservation significant fauna known to occur in the area was assimilated using online database searches:

- A search of the *EPBC Act* list of protected species was undertaken using the Protected Matters Search Tool to identify fauna considered to be a MNES (Appendix 2). This search was conducted using a polygon that covered the Project area and included a 10 km buffer area. The coordinates for the polygon were as follows: -29.8382E, 118.47619S; -29.8382, 119382202 S; -30.70872E, 119.82202; -30.70872E, 118.47619S; -29.8382 E, 118.47619S.

- A search for fauna previously recorded within 40 km using a centre point at (119°16'50''E, 30°01'00''S) was undertaken using NatureMap (Appendix 3). The records include historical data on specimens held in the WA Museum and the DPaW Fauna Database.

- A request was made for a search of the DPaW databases for threatened and priority fauna. This search was conducted using a spot location (119°16'50''E, 30°01'00''S) with a 40km buffer area to adequately encompass the Survey area.

3.3 TAXONOMY AND NOMENCLATURE

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum's *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (2012) with alternative bird taxonomy from Christidis and Boles (2008) given in parentheses. Common names of species were used throughout the text where possible and scientific names were used in the tables and appendices with the corresponding common names.

3.4 Fieldwork Methodology

The Level 1 targeted field survey was conducted between June 20th and June 22nd 2014. The survey was designed to assess fauna habitat of the Survey area and the presence of three target species; Malleefowl *Leipoa ocellata* (protected under the *EPBC Act*), Shield-backed Trapdoor Spider *Idiosoma nigrum* (protected under the *EPBC Act*) and Tree-stem Trapdoor Spider *Aganippe castellum* (protected under the *WC Act*). Additionally, opportunistic observations of other species were recorded at all times.

3.4.1 Fauna Habitat

To produce a fauna habitat map of the Survey area, the types of fauna habitat present were assessed and cross-referenced with the vegetation map produced by Western Botanical in 2014.

Vegetation condition is an important aspect of fauna habitat; higher quality of vegetation condition results in higher value fauna habitat. Vegetation condition at the Project was assessed by Western Botanical (2014) and was considered to be in Excellent to Very Good condition. The vegetation structure was considered to be intact with the exception of historic drill lines, drill pads and access tracks previously cleared during exploration drilling; however these areas were observed to be regenerating and recovering well.

The areas and percentages of potential impact on the fauna habitats were calculated using the boundaries and extents of the vegetation associations mapped by Western Botanical (2014). Western Botanical (2014) mapped vegetation over 245.29 ha within the Marda East tenements. Presently the total proposed impact footprint of the Marda East project is expected to be 67.18 ha.

3.4.2 Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider

Spider search sites were located in different habitats across the Survey area and outside of the defined Survey area; a total of 15 sites were searched, of these 12 were within the Survey area.

Search sites comprised minimum 10 x 10 metre quadrats which were searched for a minimum of 15 minutes each for signs of the spiders’ burrows. Any burrows found were to be measured, photographed and logged in the GPS.

3.4.3 Malleefowl

Western Botanical recorded Malleefowl mounds that were opportunistically encountered within the Marda East Project area during their Level 2 Flora and Vegetation Assessment; a total of 11 mounds were recorded. These mounds were revisited and assessed during the current survey; the mounds were re-classified by zoologists as Active or Inactive.

Active mounds would show signs of fresh scratching or loose soil and Malleefowl footprints may be observed; active mounds would likely contain abundant plant material and shell fragments may be evident. Inactive mounds would likely have compacted soil, limited or no plant material and show signs of weathering, erosion and/or colonisation by plants.

3.5 Contributing Authors

The strategy for the fauna assessment was developed and managed by APM Principal Biologist Dr Mitch Ladyman.

The field component of this survey was undertaken by Dr Mitch Ladyman and Mr Shane McAdam.

The subsequent reporting was completed by Dr Mitch Ladyman and Mr Shane McAdam with assistance from Ms Corinne Chambers.

4 RESULTS

4.1 DESKTOP SURVEY

Based on searches of the Protected Matters and NatureMap databases, 14 species of conservation significance could potentially occur in the Survey area. These species comprise 10 birds, two mammals and two reptiles (Table 4-1).

A likelihood of occurrence analysis revealed that 4 of the species are unlikely to occur, 6 are likely to occur, 3 species have the potential to occur and one species (Malleefowl) has been recorded in the Survey area. The total list of conservation significant species and the likelihood of their occurrence in the Survey area is presented in Table 4-1.

Table 4-1: List of Conservation Significant Species potentially occurring in the Survey area

Species	Conservation Status			Habitat Description	Likelihood of Occurrence
	Commonwealth (*EPBC Act*)	State (*WC Act*)	DPaW (Priority Status)		
BIRDS					
Malleefowl *Leipoa ocellata*	Vulnerable	Schedule 1 Division 2		Malleefowl occurs in semi-arid and arid zones in temperate Australia. It mainly occupies shrubland and low woodland dominated by multi-stemmed Eucalypt species on sandy or loamy soils with an abundance of leaf litter (DoE SPRAT 2014).	**Occurs** Active mounds recorded in the Survey area. Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally
Cattle Egret *Ardea ibis*	Migratory Wetland Species			The Cattle Egret is classed as a migrant, as it was originally from Asia. The species often feeds with cattle, eating insects disturbed by the cattle as they graze. The Cattle Egret can also be seen feeding in fresh water environments if conditions are favourable and frogs and tadpoles are abundant. This species can be present at all times of the year and roosts in colonies (DoE SPRAT 2014).	**Unlikely to occur** Suitable habitat is unavailable.
Great Egret *Ardea alba*	Migratory Wetland Species			This species is classified as migratory but there is little evidence to support this. The Great Egret is present at all times of year in fresh and saltwater environments. Great Egrets are widespread in Australia. They occur in all states and territories of mainland Australia and in Tasmania. They often occur solitarily, or in small groups when feeding. They roost in large flocks that may consist of hundreds of birds. They live in a wide variety of habitats ranging from inland to coastal. The species usually frequents shallow waters. They mainly forage by wading through water consuming a diet of fish, molluscs, crustaceans, lizards, snakes, frogs and small mammals and birds (DoE SPRAT 2014).	**Unlikely to occur** Suitable habitat is unavailable.

Species	Conservation Status			Habitat Description	Likelihood of Occurrence
	Commonwealth (*EPBC Act*)	State (*WC Act*)	DPaW (Priority Status)		
Peregrine Falcon *Falco peregrinus (inc.* subsp. *macropus)*		Schedule 4 Division 2		The Peregrine Falcon is found in most habitats and altitudes throughout Australia. This species requires abundant avian prey and secure nest sites. The Peregrine Falcon prefers coastal and inland cliffs or open woodlands near water, but can even be found nesting on tall city buildings (DoE SPRAT 2014).	**Potential to occur** This species may nest in the BIF ranges and forage over the Survey area. However it would not be dependent on habitats within the Survey area.
Australian Bustard *Ardeotis australis*			Priority 4	Australian Bustards are found in tussock grassland, *Triodia* hummock grassland, grassy woodland, low shrublands and structurally similar artificial habitats such as croplands and golf-courses. They will also use denser vegetation when this has been opened up by recent burning (Garnett and Crowley 2000).	**Likely to occur** Species has been recorded in the local area (DPaW 2013). Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally
Major Mitchell's Cockatoo *Cacatua leadbeateri*		Schedule 4 Division 2		Major Mitchell's Cockatoos occur in sparsely timbered grasslands, scrublands, stands of Casuarinas along sand ridges and covering rocky outcrops, and mallee. They are always found in the vicinity of water and they require large, old, hollow-bearing Eucalypts for breeding (Johnstone and Storr 1998).	**Likely to occur** Species has been recorded in the local area (DPaW 2013). Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally
Fork-tailed Swift *Apus pacificus*	Migratory Marine Species			The Fork-tailed Swift is a migratory species. Individuals are almost exclusively aerial and feed at high altitudes. During thunderstorms and cyclones birds forage lower to the ground, and emergent termites are one source of food that brings this species down to lower altitudes (DoE SPRAT 2014).	**Potential to occur** May utilise the local area while hawking for insects. Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally

Species	Conservation Status			Habitat Description	Likelihood of Occurrence
	Commonwealth (*EPBC Act*)	State (*WC Act*)	DPaW (Priority Status)		
Rainbow Bee-eater *Merops ornatus*	Migratory Terrestrial Species			This species is moderately common to common in open woodland and near water. Though the Rainbow Bee-eater is classified as a migratory, not all individuals of the species migrate. It is most commonly observed in ones and twos but is occasionally seen in small flocks of up to 100 individuals (DoE SPRAT 2014).	**Likely to occur** Species has been recorded in the local area (DPaW 2013). Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally
Hooded (Dotterel) Plover *Thinornis (Charadrius) rubricollis*			Priority 4	The Hooded Dotterel is medium in size for a plover, stocky, and pale in colour with a distinct black hood, white collar, red bill and red legs. In Western Australia, Hooded Plovers are generally recorded on ocean beaches and salt lakes where they feed on insects, sandhoppers (*Orchestia* sp.), small bivalves, and soldier crabs (*Mictyris platycheles*). The species also nests on the beaches or in adjacent dunes.	**Unlikely to occur** Suitable habitat is unavailable.
Shy Heathwren *Hylacloa cauta* subsp. *whitlocki*			Priority 4	The Shy Heathwren (Grasswren, Hylacola) is a small passerine (perching bird) that inhabits shrublands and eucalypt woodlands, but will also utilise post fire regeneration and uncleared road verges. It prefers stony hills and is distributed across the south west of Western Australia, east and north of the Darling Scarp. Nesting close to the ground or on the ground amongst vegetation this species is especially vulnerable to feral predators.	**Likely to Occur** Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally.
MAMMALS					
Numbat *Myrmecobius fasciatus*	Vulnerable			Falling within the Critical Weight Range (35 – 5500 grms), populations of this small marsupial have been decimated by feral predators across its range. A highly specialised diet of termites also determines that this species has very specific habitat requirements. Eucalypt woodlands are the primary habitat of this species as they provide hollows for refuge and nesting, and an abundance of termites on which to feed.	**Potential to Occur** There is potential for this species to occur based on the availability of habitat. However, the likelihood of occurrence is low due to the rarity of the species.

Species	Conservation Status			Habitat Description	Likelihood of Occurrence
	Commonwealth (*EPBC Act*)	State (*WC Act*)	DPaW (Priority Status)		
Greater Long-eared Bat *Nyctophilus major*			Priority 4	Known to be wide-spread in the arid Coolgardie Bioregions, the taxonomy of this species is presently unclear. It is common but patchily distributed through eucalypt woodlands with well-defined shrub strata. It feeds by gleaning invertebrates from the surfaces of vegetation and can be found feeding from the ground. Secure populations are known to occur in the Mount Manning Nature Reserve.	**Likely to Occur** Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally.
INVERTEBRATES					
Shield-backed Trapdoor Spider *Idiosoma nigrum*	Vulnerable	Schedule 1 Division 7		Burrows tend to be located in soil dominated by clay/loam and rock or by sandy clay/loam and rock. This environment is necessary to provide a microhabitat that supports tubular burrows that are 20-30 cm deep with a trapdoor diameter of >2.0 cm (Main 1992) that provide stable temperature and humidity conditions which perpetuate when they close their burrow during the late summer months and aestivate (Main 1985).	**Unlikely to occur** Though habitat is present the Naturemap search does not indicate the species has been recorded near the Survey area. The larger area of the MNES search indicates a presence regionally.
Tree-stem Trapdoor Spider *Aganippe castellium*			Priority 4	The Tree-stem Trapdoor inhabits areas that are prone to localised flooding and, as such, construct burrows with elevated palisades around the entrance, comprising leaves and twigs that deflect water. As for most mygalomorph spiders individuals are long lived and invest significant time in burrow construction. Thus, trampling and habitat destruction from fire have a significant impact on local populations. This contributes to the species conservation significance.	**Likely to Occur** Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally.

4.2 FIELD SURVEY

4.2.1 Fauna Habitat

Fauna assemblages are closely aligned with available habitats. The habitat types chosen represent a scale relevant to the small size of the Survey area in relation to the surrounding landscape and largely reflect landform, soil type and vegetation communities.

The Survey area covers six habitat types (Figure 4-1):

- Tall *Eucalypt* Woodland over Halophytic understorey on Alluvial Plain.
- Low *Eucalypt* Woodland over Acacia Shrubland on Alluvial Plain.
- Low *Eucalypt* Woodland over Acacia on Rocky Rises.
- Low *Eucalypt* Woodland over Spinifex on Alluvial Plain.
- Dense Shrubland on Rocky Rises.
- Dense Shrubland on Alluvial Plain.

A summary of these six habitats are provided in Table 4-2.

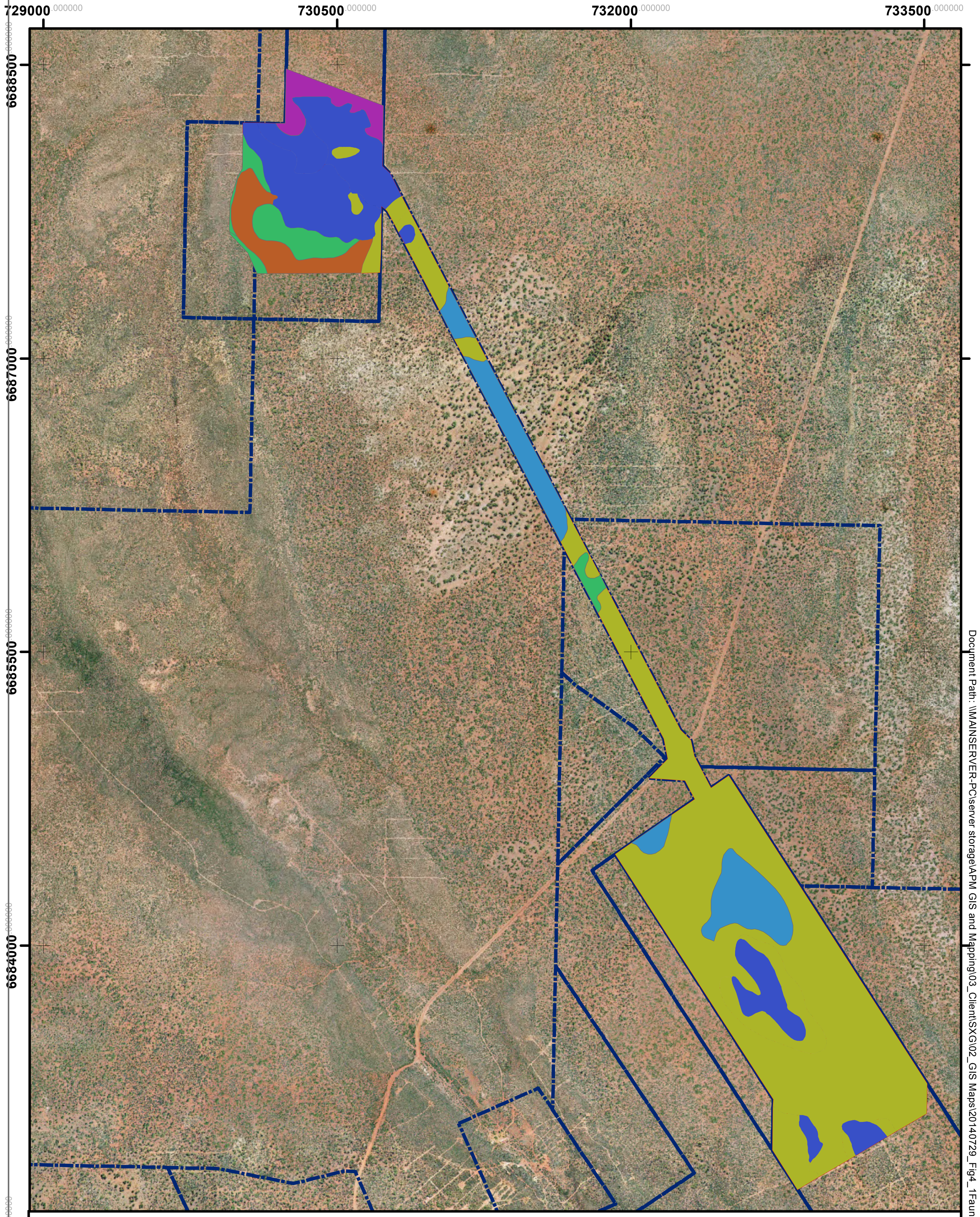


Figure 4.1: Fauna Habitat of the Marda East Survey Area

Legend

Marda East Project Survey Area

Southern Cross Goldfield Ltd Tenements

Fauna Habitat Descriptions

- Dense shrubland on alluvial plain
- Dense shrubland on rocky rises
- Low eucalypt woodland over acacia shrubland on alluvial plain
- Low eucalypt woodland over acacia shrubland on rocky rises
- Low eucalypt woodland over spinifex on alluvial plain
- Tall eucalypt woodland over halophytic understory on alluvial plains

N

Date: 29/07/2014

530 265 0 530 Meters

Coordinate System: GDA 1994 MGA Zone 50

Document Name: 20140729_Fig4_1FaunaHabitat

Author: ems@animalplantmineral.com.au

Table 4-2: Summary of Habitat Types identified in the Survey area

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Tall *Eucalypt* Woodland over Halophytic understorey on Alluvial Plain	Alluvial plain prone to flooding; gravelly clay substrate supporting tall, moderately large, hollow bearing *Eucalypts*, a variety of mid-level shrubs, surface herbs and low level halophytes.  	• Hollow bearing *Eucalypts* with a range of hollow diameters on living trees and deadfall timber. • Exfoliating bark. • Detritus around the base of larger trees. • Range of vegetation strata suitable to a variety of passerine and non-passerine birds. • Relatively dense shrubs providing cover for cryptic small geckonids. • Termitaria in standing and fallen dead timber. • Ground not especially suited to burrowing species. • Halophytes may attract a small subset of the fauna assemblage that may not occur elsewhere in the Survey area.	• Tree-stem Trapdoor Spider (Priority 4) – patches of substrate suitable for burrow construction. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging and nesting. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging and nesting where suitable hollows can be sourced. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over and roosting within upper vegetation strata. • Shy Heathwren (western) (Priority 4) – foraging but not likely nesting. • Rainbow Bee-eater (International Agreement) – foraging only. • Greater Long-eared Bat (Priority 4) – foraging and roosting in hollows. • Numbat (Vulnerable) – foraging and refuging in suitable hollows.

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Low *Eucalypt* Woodland over Acacia shrubland on Alluvial Plain	Gravelly clay loam substrate; this habitat is situated on an alluvial plain however a slight gradient means the habitat is subject to surface water flow but not flooding. *Eucalypt* woodland and open *Acacia* shrubland.  	• Hollow bearing *Eucalypts* with a range of hollow diameters on living trees and deadfall timber. • Exfoliating bark. • Detritus around the base of larger trees. • Range of vegetation strata suitable to a variety of passerine and non-passerine birds. • Relatively dense shrubs providing cover for cryptic small geckonids. • Termitaria in standing and fallen dead timber. • Gravelly clay loam ideal for burrowing.	• Tree-stem Trapdoor Spider (Priority 4) – patches of substrate suitable for burrow construction. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging and nesting. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging and nesting where suitable hollows can be sourced. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over and roosting within upper vegetation strata. • Shy Heathwren (western) (Priority 4) – foraging but not likely nesting. • Rainbow Bee-eater (International Agreement) – foraging only. • Greater Long-eared Bat (Priority 4) – foraging and roosting in hollows. • Numbat (Vulnerable) – primarily foraging and possible temporary refuge in marginally suitable hollows.

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Low *Eucalypt* Woodland over Acacia shrubland on Rocky Rises	Similar to the Low Eucalypt Woodland over Acacia shrubland on Alluvial Plain habitat in terms of vegetation and detritus however this habitat comprises steeper slopes with more variable and rocky substrate.  	• Fewer and smaller hollow bearing *Eucalypts* with a limited diameter hollows suitable for bats, some reptiles and smaller hollow nesting birds. • Limited exfoliating bark. • Limited detritus due to the presence of smaller trees. • Limited vegetation strata due to the presence of smaller trees. • Relatively dense shrubs providing cover for cryptic small geckonids. • Patches of gravelly loam suitable for burrowing but dominated by rocky areas less suitable.	• Tree-stem Trapdoor Spider (Priority 4) – patches of substrate suitable for burrow construction. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging and nesting. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging and nesting where suitable hollows can be sourced. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over and roosting within upper vegetation strata. • Shy Heathwren (western) (Priority 4) – foraging but not likely nesting. • Rainbow Bee-eater (International Agreement) – foraging only. • Greater Long-eared Bat (Priority 4) – foraging and roosting in hollows. • Numbat (Vulnerable) – primarily foraging and possible temporary refuge in marginally suitable hollows.

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Low *Eucalypt* Woodland over Spinifex on Alluvial Plain	Similar to Low *Eucalypt* Woodland habitats in terms of vegetation structure with the addition of *Triodia* hummocks (± 30cm in height). Fallen logs are present however gravel and rocks are absent and the alluvial plain substrate consists of sandy loam.  	• Valuable and less well-represented habitat. • A significant number of hollow bearing *Eucalypts*, both standing and deadfall. • Exfoliating bark. • Substrate very well suited to a variety of burrowing invertebrates, small mammals and reptiles. • Valuable patches of detritus comprising rotting timber and leaf litter. • Less diverse vegetation strata supporting a less diverse avifauna assemblage. • Unique habitat due to the presence of spinifex which, alone, can support a unique fauna assemblage.	• Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging. Not likely to nest due to substrate. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging, with nesting possible in larger eucalypts. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over canopy and roosting within canopy but not nesting. • Shy Heathwren (western) (Priority 4) – potentially foraging but unlikely nesting. • Rainbow Bee-eater (International Agreement) – foraging and nesting. • Greater Long-eared Bat (Priority 4) – foraging and roosting. • Numbat (Vulnerable) – foraging only.

<table>
<tr><th>Habitat Type</th><th>Description of Habitat</th><th>Representative Faunal Habitat Attributes</th><th>Conservation Significant Species that may Potentially Occur in Habitat</th></tr>
<tr><td>Dense Shrubland on Rocky Rises</td><td>Slightly elevated heath land with a stony substrate; subject to dendritic drainage.

</td><td>Dendritic drainage creates incisions in the landscape that provides some crevice habitat used as refuge by small reptiles.
Small rocky breakaways also provide rocks of suitable size for refuge for dragons and geckonids.
Dense shrubs provide abundant habitat for small passerine birds.
Shrubs also drop significant detritus around the base providing habitat resources for trapdoor spiders.
Detritus and soil, combined, provides foraging and nesting habitat resources for malleefowl.</td><td>Tree-stem Trapdoor Spider (Priority 4) – patchy substrate suitable for burrowing.
Fork-tailed Swift (International Agreement) – foraging over the canopy.
Australian Bustard (Priority 4) – foraging only.
Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging only.
Peregrine Falcon (Other Specially Protected Fauna) – foraging over the canopy.
Shy Heathwren (western) (Priority 4) – foraging and nesting in the low dense shrubland vegetation.
Mallefowl (Threatened) – foraging and nesting.
Greater Long-eared Bat (Priority 4) – foraging only.</td></tr>
</table>

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Dense Shrubland on Alluvial Plain	Similar to the Dense Shrubland on Rocky Rises habitat in terms of vegetation however this habitat is not elevated and has a less rocky substrate which is more comparable to the Low *Eucalypt* Woodland on Alluvial Plain habitats.  	• Dense shrubs provide abundant habitat for small passerine birds. • Shrubs also drop significant detritus around the base providing habitat resources for trapdoor spiders. • Detritus and soil, combined, provides foraging and nesting habitat resources for malleefowl. • Gravelly clay loam ideal for burrowing.	• Tree-stem Trapdoor Spider (Priority 4) – suitable for burrow construction. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – predominantly foraging. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging within shrub strata. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over the canopy. • Shy Heathwren (western) (Priority 4) – foraging and nesting in the dense base of shrubland vegetation. • Mallefowl (Threatened) – foraging and nesting. • Greater Long-eared Bat (Priority 4) – foraging only.

4.2.2 Habitat Impact

The potential impact on the habitats considered most valuable to fauna species of conservation significance are outlined in Table 4-3. The total proposed impact footprint of the Marda East project is expected to be 67.18 ha. Western Botanical mapped vegetation associations over 245.29 ha and the boundaries and extents of these vegetation associations have been used to calculate the boundaries and extents of the fauna habitats.

Impacts to integral components of the fauna habitat that are limited in their availability are of most concern. These include nesting hollows or nesting sites for birds and refuge sites for other animals. It is the impacts on these limited resources that have been calculated and presented in Table 4-3.

All of the conservation significant fauna listed in Tables 4-2 and 4-3 are expected to forage broadly across their requisite habitats within and outside of the Project area. Those species that forage widely over all habitat within the project area will lose a total of 67.18 ha of foraging habitat once clearing has been completed. As these species are not specifically dependent on habitats within the Project area for feeding the loss of feeding habitat associated with the development of the Project is insignificant in a Regional context.

Approximately 61 ha of the Dryandra and 171 ha of the Campsite land systems occurs within the Marda East project area. The area of Dryandra and Campsite land systems that intersects or occurs adjacent to the Project area spans some 5387 ha and 1421 ha, respectively. Therefore the impact to areas of these two land systems is insignificant (Table 4-4).

4.2.3 Impact to Banded Iron Formations and Conservation Reserves

The proposed 'Class A' Nature Reserve in the Die Hardy Range occurs immediately adjacent the north-western boundary of the Red Legs prospect. The proposed mine impact footprint for the Red Legs deposit spans two conical hills less than 1km east of the Die Hardy Range ridgeline. Though part of the Banded Ironstone Formation geology of the Die Hardy Ranges and the adjacent Yokradine Hills, which includes midslopes and lower slopes, these conical hills do not support any fauna habitats that are of particular value to fauna species normally associated with banded ironstone formations. For instance, there are no south-facing vertical cliffs that confer the benefits of lower temperatures and higher humidity to many BIF short range endemic invertebrate species. There are also no cliffs to be used by nesting Peregrine Falcons. Disturbance to these conical hills is unlikely to isolate or fragment any populations of fauna inhabiting these slope habitats.

Proximity to the Die Hardy Range also places the Red Legs deposit within, and parts of the Haul Road and Fiddleback deposit partially within the Priority One (P1) Die Hardy Range / Diemels vegetation complex (banded ironstone formation) Priority Ecological Community (PEC). The boundary of this PEC also follows the Banded Ironstone Formation geology of the Die Hardy Ranges and the adjacent Yokradine Hills, inclusive of the mid and low slopes. Western Botanical (2014) report that 107.18 ha of the Marda East Project intersects this PEC and, thus, has the potential to cause impact to 1.02% of the PEC.

However, the fauna habitat of greatest value to fauna species occurring within the Project area was Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain (mapped as Vegetation Association 2.7 in Western Botanical (2014)) and this vegetation association is not included vegetation of conservation significance associated with this PEC. Therefore, impacts to the PEC are not likely to significantly impact the fauna habitat values of the region.

Table 4-3: List of Conservation Significant Species and the Potential for Impact on Habitat

		Presence/Absence	Resource Specific Dependency	Area Mapped (ha)	Proposed Impact (ha)	% Impact on Total Area Mapped	% of Total Impact Area
Malleefowl	*Leipoa ocellata*	Occurs	Nesting habitat	59.42	15.71	26.44	23.38
Cattle Egret	*Ardea ibis*	Not present based on habitat	n/a	n/a	n/a	n/a	n/a
Great Egret	*Ardea alba*	Not Present based on habitat	n/a	n/a	n/a	n/a	n/a
Peregrine Falcon	*Falco peregrinus (inc. subsp. macropus)*	Potential	Project area wide foraging only	245.29	67.18	27.39	100.00
Australian Bustard	*Ardeotis australis*	Likely	Project area wide foraging only	245.29	67.18	27.39	100.00
Major Mitchell's Cockatoo	*Cacatua leadbeateri*	Likely	Nesting habitat	26.32	7.17	27.24	10.67
Fork-tailed Swift	*Apus pacificus*	Potential	Project area wide foraging only	245.29	67.18	27.39	100.00
Rainbow Bee-eater	*Merops ornatus*	Likely	Nesting habitat	26.32	7.17	27.24	10.67
Hooded (Dotterel) Plover	*Thinornis (Charadrius) rubricollis*	Not Present	n/a	n/a	n/a	n/a	n/a
Shy Heathwren	*Hylacloa cauta subsp. whitlocki*	Likely	Nesting habitat	22.31	2.83	12.68	4.21
Numbat	*Myrmecobius fasciatus*	Potential	Denning habitat	26.32	7.17	27.24	10.67
Greater Long-eared Bat	*Nyctophilus major*	Likely	Roosting habitat	185.87	32.86	17.68	48.91
Shield-backed Trapdoor Spider	*Idiosoma nigrum*	Not present based on survey	n/a	n/a	n/a	n/a	n/a
Tree-stem Trapdoor Spider	*Aganippe castellium*	Not present based on survey	n/a	n/a	n/a	n/a	n/a

Table 4-4: Percentage Areas of Impact Relative to Land Systems.

	Area of Land System Within Project Area (ha)	Area of Land System Within or Immediately Adjacent Project Area (ha)	% Impact of Project on Land System Within or Immediately Adjacent Project Area (ha)	Total Area of Land System in the Region	% of Project Area in the Context of Regional Land System
Dryandra	61	5387	1.13	35301	0.1728
Campsite	171	1421	12.03	148931	0.1148
Moriaty	6	93	6.45	259563	0.0023
Yowie	7	2980	0.23	1622816	0.0004

4.2.4 Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider

An intensive presence/absence search for the Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider at 15 sites over five of the six different habitat types did not locate either spider or evidence of trapdoor burrows.

The Low *Eucalypt* Woodland over Spinifex on Alluvial Plain was not searched due to lack of suitable habitat.

The search effort totalled 7 person hours and search locations are presented in Figure 4-2.

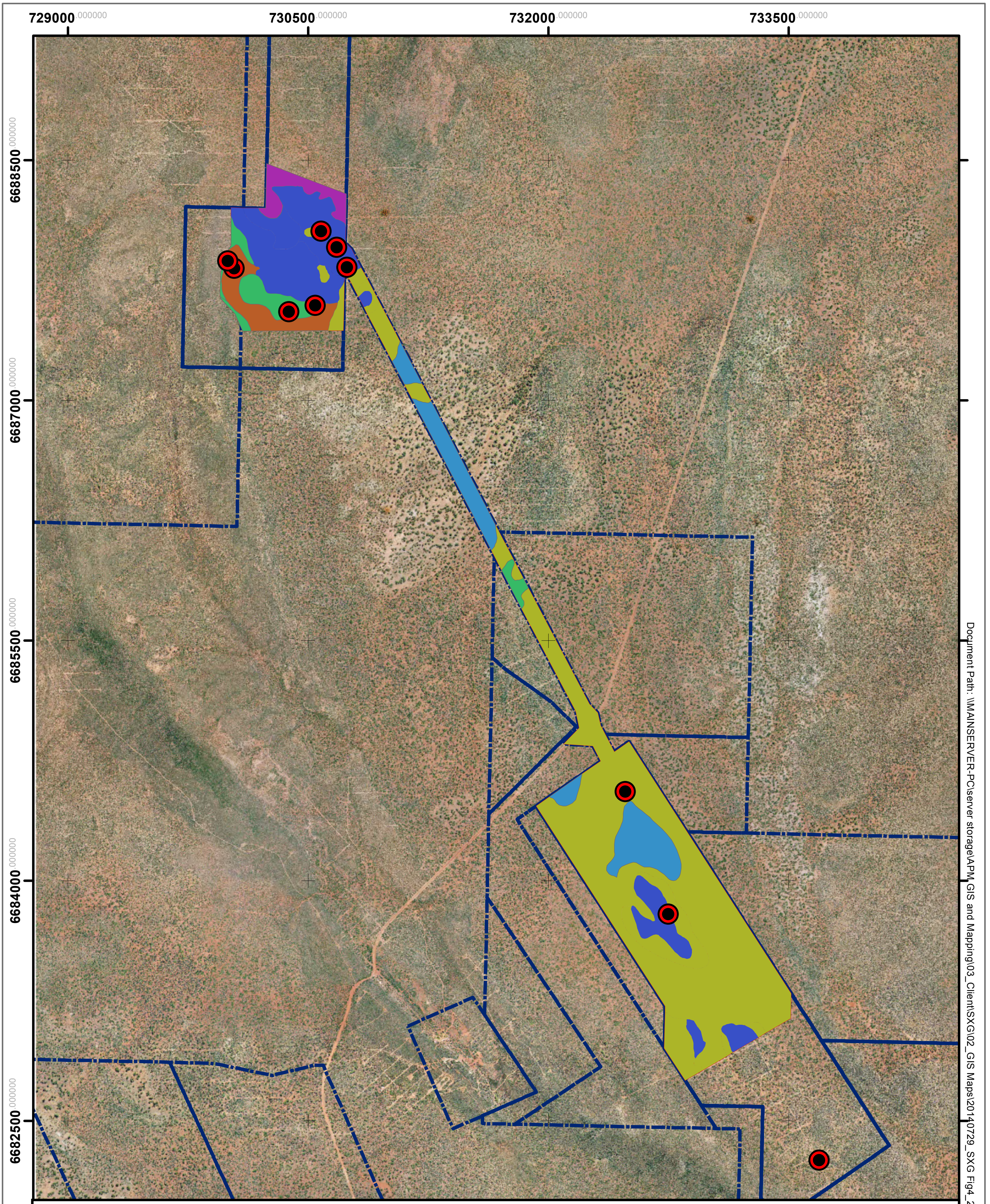


Figure 4.2: Shield-backed and Tree-stem Trapdoor Spider Search Locations

Legend

Spider Search Locations

Marda East Project Survey Area

Southern Cross Goldfield Ltd Tenements

Fauna Habitat Descriptions

- Dense shrubland on alluvial plain
- Dense shrubland on rocky rises
- Low eucalypt woodland over acacia shrubland on alluvial plain
- Low eucalypt woodland over acacia shrubland on rocky rises
- Low eucalypt woodland over spinifex on alluvial plain
- Tall eucalypt woodland over halophytic understory on alluvial plains

N

Date: 29/07/2014

640 320 0 640 Meters

Coordinate System: GDA 1994 MGA Zone 50

Document Name: 20140729_SXG Fig4_2Spidersearches

Author: ems@animalplantmineral.com.au

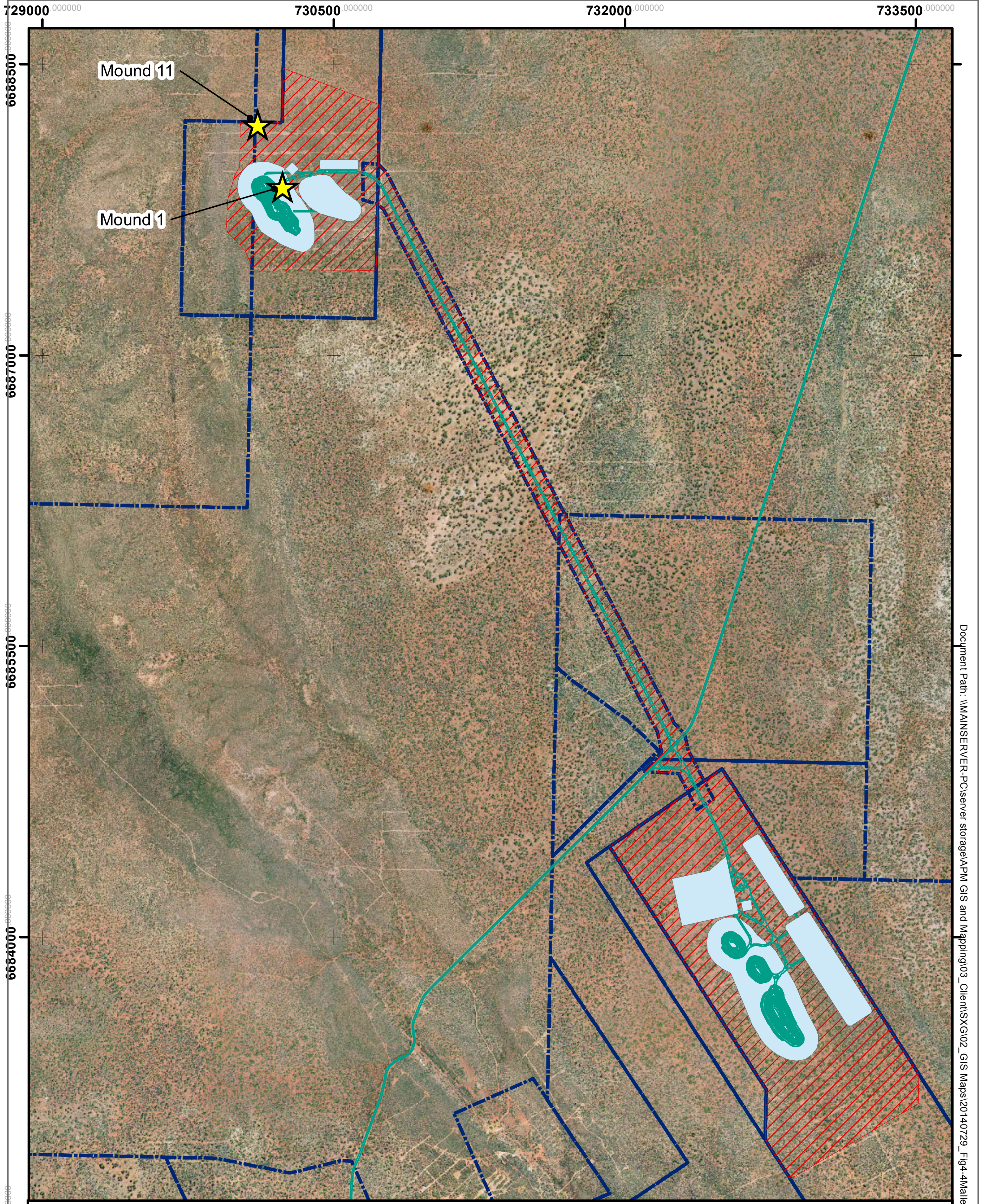
4.2.5 Malleefowl

In 2013 Western Botanical searched the Survey area utilising an intensive foot transect methodology intent on visually covering the entire site. During this search they located 11 Malleefowl mounds.

Of the 11 mounds previously recorded eight were within the Red Legs prospect, two within the Haul Road alignment and one at the Fiddleback prospect. Only two of the 11 mounds were classified as active during the 2013 survey; these were at site number 1 and site number 11. The current survey confirmed that only these same two mounds are presently active. Photographs of the active mounds are provided in Figure 4-3 and the locations are provided in Figure 4-4.

Figure 4-3: Active Malleefowl Mounds

The remains of a predated (potentially by a fox) Malleefowl were located in close proximity (approximately 2m away) to the mound at site number 11.



Legend

Figure 4.4: Active Malleefowl Mound Locations

Active Malleefowl Mounds 2014

Marda East Project Survey Area

Proposed Infrastructure

Proposed Infrastructure Disturbance Area

Southern Cross Goldfield Ltd Tenements

N

Date: 29/07/2014

530 265 0 530 Meters

Coordinate System: GDA 1994 MGA Zone 50

Document Name: 20140729_Fig4-4MalleeFowlMounds

Author: ems@animalplantmineral.com.au

4.2.6 Feral Animals

There were many signs of the presence of rabbits throughout the Survey area and it is suspected that the predated Malleefowl had been killed by a fox. Both of these species are listed as potentially occurring within the area by the Protected Matters search.

5 DISCUSSION

5.1 PREVIOUSLY RECORDED FAUNA OF CONSERVATION SIGNIFICANCE

Based on searches of the Protected Matters and NatureMap databases, 14 species of conservation significance had previously been recorded in the search radius around the Project area. Four of these were immediately discounted due to a lack of requisite habitat. Only one species, the Malleefowl, was recorded during the present survey and one species, the Tree-stem Spider, was discounted after intensive searching failed to record any evidence of this species.

Of the remaining eight remaining species, five were determined likely to occur and three have the potential to occur based on the presence of suitable habitat and the frequency at which these species are normally encountered.

Prior to the field survey a formal request was made to DPAW WA for data contained within the Department's Threatened Fauna database, which includes species which are declared as 'Rare or likely to become extinct (Schedule 1)', 'Birds protected under an international agreement (Schedule 3)', and 'Other specially protected fauna (Schedule 4)'. These data are the most accurate and reliable in determining historical presence/absence.

Of the eight remaining species likely to occur or having the potential to occur in the Project area the DPAW WA Threatened Fauna database search revealed the following:

- The Peregrine Falcon was recorded most recently in the Yokradine Hills and Diemels area in 2000.
- The Australian Bustard was observed on the Mount Jackson Road and at the Golden Orb mine site in 2012 and 2011, respectively.
- The Major Mitchell’s Cockatoo was recorded at the Golden Orb mine site in 2011.
- The Fork-tailed Swift was recorded over Lake Deborah (46km SSW) in 2012.
- The Rainbow Bee-eater has been formerly reported on 22 occasions within the search radius since 2000.
- The Shy Heathwren was recorded once at Mount Jackson in 2000.
- The Greater Long-eared Bat was recorded on two occasions at Mount Jackson in 2012 and 2013.

The DPAW Threatened Fauna database search returned records of the Priority 4 Crested Bellbird (Southern) *Oreoica gutturalis gutturalis* (Vigors & Horsfield, 1827). These records did not appear on the Naturemap search which returned records only for the Crested Bellbird. The Project area occurs on the boundary of the distribution of the two variants of this species. Therefore, it is likely that the Threatened Fauna data base records, one of which is more southerly in Lake Deborah have detected the Southern variant where the Naturemap record (the lower extent of which was north of Lake Deborah) did not.

The Numbat was not recorded in either the DPAW Threatened Fauna search or the Naturemap search. This species was included in the fauna assessment as it appeared in the broader MNES search. Moreover, suitable habitat for this species was shown to be present within the Project area. It should be clearly stated that this species has not been recorded in the local area around the Marda East project and its consideration in this fauna assessment is purely precautionary as this species is so rarely recorded that exact habitat preferences and extents are not known with certainty.

5.2 MALLEEFOWL

Malleefowl are sedentary and most individuals establish pairs and remain in the same area throughout the year (see Frith, 1962b; Marchant & Higgins, 1993; Benshemesh, 2000; Garnett & Crowley, 2000). Over the course of a year, adult pairs may roam over an area of one to several kilometres. During the breeding season, males remain close to the nest most of the time. Individuals may display local shifts in home range between seasons or years.

Egg-laying usually starts in September until mid- to late-summer or sometimes early autumn. Chicks usually begin hatching and emerging from the mound in November. Most usually emerge before January but in some seasons hatching may continue until March. Young birds disperse long distances after leaving the nest without any assistance or parental care from the adults.

The Malleefowl occupies semi-arid to arid shrublands and low woodlands dominated by mallee and associated habitats, such as broombush Melaleuca uncinata and native pine Callitris spp. scrub (Frith 1962a, b; Marchant & Higgins, 1993; Benshemish, 1999; Garnett & Crowley, 2000). Malleefowl favour mallee that is long unburnt and ungrazed. In the Project area Malleefowl have been recorded in, or are very likely to utilise two of the fauna habitats Dense Shrubland on Alluvial Plain and Dense Shrubland on Rocky Rises. These two fauna habitats are analogous with Vegetation Associations 1.1, 1.2, 1.4, 2.6, 3.1, 3.2 and 3.3 which collectively account for 15.71 ha, or 23.38 % of the total proposed impact footprint (67.18 ha).

The loss of habitat equates to 26.44 % of the total suitable Malleefowl habitat mapped in the Project Area. However, significant areas of suitable Malleefowl habitat occurs outside of proposed disturbance areas within the tenements. Areas of the Dryandra, Yowie and Moriarty land systems that directly intersect or occur adjacent to the Project area cover 4,494 ha and each of these land systems contain vegetation and land form features that provide both feeding and nesting habitat for this species. Therefore, the impact associated with this Project is not considered significant in a local context. Regionally, these land systems cover 2, 031, 310 ha.

The active mound recorded as Site 11 occurs adjacent the boundary of the Red Legs survey area and is approximately 300m away from the proposed Red Legs abandonment bund and any other proposed disturbance. The active mound recorded as Site 1 is located between the abandonment bund and the pit at the Red Legs deposit and will likely be impacted should the Project proceed.

- Recommendation 1 – Monitor mound Site 1 quarterly in the 12 months prior to clearing and construction to determine if the mound being used by Malleefowl; and
- Recommendation 2 – If evidence of use is observed and disturbance of a Malleefowl mound is unavoidable, undertake development with regard to advice from the Commonwealth Department of Sustainability Environment Water People and Communities and the WA DPaW.

Any other active Mallefowl mounds not presently within the direct impact footprint, or those that may be used in the future, should be buffered and management actions put in place to prevent disturbance where possible.

In order to prevent potential fatalities to Malleefowl the following management strategies are recommended for implementation:

- Recommendation 3 – Lower traffic speeds in the vicinity of historic mounds;
- Recommendation 4 – Monitoring existing mounds annually for evidence of use;
- Recommendation 5 – Avoid disturbance of any actively used mound with a buffer of 250m or as advised under Recommendation 2;

- Recommendation 6 – Where practical, avoid disturbance to existing (historical or inactive) mounds with a buffer of 50m;
- Recommendation 7 – Include Malleefowl identification training in Site induction;
- Recommendation 8 – Ensure all personnel record sightings of Malleefowl and report these to the Manager Environment; and
- Recommendation 9 – ensure all personnel record newly discovered Malleefowl mounds and report these to the Manager Environment

5.3 MAJOR MITCHELL'S COCKATOO

Major Mitchell's Cockatoos occur in sparsely timbered grasslands, scrublands, stands of Casuarinas along sand ridges and covering rocky outcrops, and mallee. They are always found in the vicinity of water and they require large, old, hollow-bearing Eucalypts for breeding (Johnstone and Storr 1998). The nesting hollows required for breeding are the major limiting factor in the persistence of this species across its range.

This species is moderately common in in the north-eastern interior and northern wheat belt. Generally rare and patchily distributed flocks of only up to 40 birds are typically recorded. The Major Mitchell's Cockatoo has only been recorded as breeding in the wheat belt and is specifically dependant on the hollows of larger trees. In the Project area valuable habitat for this species would occur in Tall Eucalypt Woodland over Halophytic Understory (mapped as Vegetation Association 2.7 in Western Botanical (2014)).

The current mine and infrastructure plan indicates that only 27.24% of the total of this habitat mapped by Western Botanical (2014) would be disturbed by the Project. The area proposed to be impacted is 10.67% of the total proposed impact area.

Tall Eucalypt Woodland over Halophytic Understory (analogous with Vegetation Association 2.7 (Western Botanical, 2014)) is the key indicator of the Campsite land system. The area of this land system that directly intersects or occurs adjacent to the Project area covers 5,387 ha and provides nesting habitat to local populations of this species. The 7.17 ha proposed to be disturbed represents only 0.013% of this land system locally. Therefore, the impact associated with this Project is not considered significant in a local context. Regionally, this land systems covers 35, 301 ha.

Efforts to reduce the disturbance of this habitat through reduced clearing or consideration to the impact footprint of the haul road would contribute significantly to the conservation of this species. Additionally, fire management and feral predator control would lead to net positive impacts of mining on this species.

- Recommendation 1 – Undertake a nest hollow assessment in the Tall Eucalypt Woodland over Halophytic Understory habitat that occurs across the Project area. The methodology should be consistent with that used previously in the Marda Central project;
- Recommendation 2 – Where practical, re-align the Haul Road to avoid impact to mature hollow-bearing eucalypt species;
- Recommendation 3 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 4 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.4 Rainbow Bee-eater

The Rainbow Bee-eater is a migratory species that is common and broadly distributed across Australia. Threats to this species centre around burrow invasion and predation of nestlings, as the species nests in hollows on the ground. Nests are made in vertical banks in loamy plains, and optimal nesting habitat occurs with Tall Eucalypt over Halophytic Understory fauna habitat, due primarily to the dominant alluvial soil profile.

The current mine and infrastructure plan indicates that only 27.24% of the total of this habitat mapped by Western Botanical (2014) would be disturbed by the Project. The area proposed to be impacted is 10.67% of the total proposed impact area.

The Campsite land system soil structure is described as very gently inclined alluvial plains receiving sheet wash from mafic hills, gently undulating calcareous stony upper plains (erosional) and occasional narrow concentrated drainage tracts), all components of which are favoured by the Rainbow Bee-eater for nesting. The area of this land system that directly intersects or occurs adjacent to the Project area covers 5,387 ha and provides nesting habitat to local populations of this species. The 7.17 ha proposed to be disturbed represents only 0.013% of this land system locally. Therefore, the impact associated with this Project is not considered significant in a local context. Regionally, this land systems covers 35, 301 ha.

Mining can actually have a net positive impact on this species as Rainbow bee-eaters often nest in the soft loamy spoil heaps left during road construction (wind rows) (Ladyman pers. obs) or in disused mine pit walls. Feral fauna control can also greatly enhance fledgling success of populations that occur locally around mine sites.

- Recommendation 1 – Undertake a nest hollow assessment in the Tall Eucalypt Woodland over Halophytic Understory habitat that occurs across the Project area. The methodology should be consistent with that used previously in the Marda Central project;
- Recommendation 2 – Following road construction, schedule road maintenance (grading) during the period between February and July to avoid impacts on breeding birds ;
- Recommendation 3 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 4 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.5 Shy Heathwren

The Shy Heathwren (Grasswren, Hylacola) is a small passerine (perching bird) that inhabits shrublands and eucalypt woodlands, but will also utilise post fire regeneration and uncleared road verges. It prefers stony hills and is distributed across the south west of Western Australia, east and north of the Darling Scarp.

This species is most likely to occur in Dense Shrubland on Rocky Rise and Low Eucalyptus Woodland over Acacia Shrubland on Rocky Rise fauna habitats. These are analogous to Vegetation Associations 1.4, 1.2,2.3 and 3.1 mapped by Western Botanical (2014) which collectively account for 2.83 ha, or 4.21 % of the total proposed impact footprint (67.18 ha).

The loss of habitat equates to 12.68 % of the total suitable Shy Heathwren habitat mapped in the Project Area. However, significant areas of suitable habitat occur outside of proposed disturbance areas within the tenements. Areas of the Dryandra and Moriarty land systems that directly intersect or occur adjacent to the Project area cover 5,480 ha and each of these land systems contain vegetation and land form features that provide both feeding and nesting habitat for this species. Therefore, the impact associated with this Project is not considered significant in a local context. Regionally, these land systems cover 294,864 ha.

Nesting close to the ground or on the ground amongst vegetation, this species is especially vulnerable to feral predators and fire is a continuous threat to nestlings and also food availability. Common management practices associated with mining, such as fire mitigation and feral control, could positively influence the habitat value and availability of habitat to this species.

- Recommendation 1 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 2 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.6 NUMBAT

It is unlikely that this species occurs in the project area. However, as suitable habitat is available and the project area is within the historical range of this species (Van Dyck and Strahan, 2008) its potential presence cannot be ignored. In the Project area valuable habitat for this species would occur in Tall Eucalypt Woodland over Halophytic Understory (mapped as Vegetation Association 2.7 in Western Botanical (2014)).

The current mine and infrastructure plan indicates that only 27.24% of the total of this habitat mapped by Western Botanical (2014) would be disturbed by the Project. The area proposed to be impacted is 10.67% of the total proposed impact area.

As described in Section 5.3 this fauna habitat also defines the major elements of the Campsite land system. Therefore, habitat suitable for refuging Numbats is present locally over an area of 5,387 and 35, 301 ha regionally.

Predation is the single greatest threat to this species as it is able to occupy any and all habitats that have hollows suitable for refuge and termites available for feeding. Wildfires destroy the fallen timber within which the Numbats regularly retreat. In turn, this leaves them far more vulnerable to predation.

If clearing can be minimised in Fauna Habitat Tall eucalypt woodland over halophytic understory then valuable refuge habitat will be immediately preserved. Ongoing fire control and feral management over the life of the project will contribute significantly to the preservation of this species.

- Recommendation 1 – Undertake an intensive trapping program in early October to determine if the species is present in the area;
- Recommendation 2 – Where practical, re-align the Haul Road to avoid impact to mature hollow-bearing eucalypt species;
- Recommendation 3 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 4 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.7 GREATER LONG-EARED BAT

Local populations of Greater Long-eared Bat have the potential to be impacted by the Project. This species can roost in hollow limbs with only a small diameter, making four of the fauna habitats supporting eucalypt woodland available for roosting.

The current mine and infrastructure plan indicates that only 17.68% of the total of this habitat mapped by Western Botanical (2014) would be disturbed by the Project. The area of suitable habitat proposed to be impacted is 48.91% of the total proposed impact area. Therefore, the Project has the potential to have the greatest impact on this species within the actual impact footprint. However, roosting habitat for this species is broadly available; more so than for any of the other species reported. Habitat requirements are met in a range of vegetation associations on a range of land forms across all four of the Land Systems intersected by the project area. Thus there is a total of 9,881 ha of habitat available for this species in the areas of the land systems that intersect or lie adjacent to the Project area and 2,066,611 regionally. Finally, the most secure populations of this species are known to occur within the Mount Manning Nature Reserve.

As described in Section 5.3 this fauna habitat also defines the major elements of the Campsite land system. Therefore, habitat suitable for refuging Numbats is present locally over an area of 5,387 and 35, 301 ha regionally.

- Recommendation 1 – Where practical, re-align the Haul Road to avoid impact to mature hollow-bearing eucalypt species;
- Recommendation 2 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 3 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.8 Tree-stem Trapdoor Spider

The Tree-stem Trapdoor Spider has been previously recorded from the lower slopes to the top of the ridges of the Koolyanobbing Range, in a range of vegetation types (Bamford Consulting Ecologists, 2009). They have also been recorded at Mount Jackson, Helena and Aurora Range and the Die Hardy Range (Cliffs Natural Resources 2009). These ranges surround the Survey area in relatively close proximity. However, as landforms, they are very dissimilar to the Survey area. The Threatened Fauna database search returned 48 records in the search area.

This species is able to burrow in gravelly loam and rocky soils and its absence from heavy loam or clay soil supporting eucalypt over saltbush discounts the potential presence from a number of the fauna habitat types.

Where the species was known to occur at Koolyanobbing Range, individuals were estimated at a density of 74 spiders per hectare. As the burrows are elevated from the ground surface and constructed abutting the base of shrubs they are relatively easy to find. Despite vigorous searching not a single individual or burrow was located during the current survey.

Unlike many mygalomorphs, recent work has revealed that broadly disjunct populations of Tree-stem Trapdoor Spiders are not genetically distinct and therefore cannot be defined as Short Range Endemics. Moreover, the Survey area represents common landforms that are broadly distributed in the region with a high degree of connectivity.

The lack of burrows present in the survey area and the connectivity of landforms and habitats ensure that the Project is unlikely to impact this species.

5.9 Other Protected Species

The seven remaining protected species have the potential to be present in the Survey area, but are not specifically dependent upon it. Moreover, these species are not actually dependent upon any of the fauna habitats represented within the Survey area.

The Fork-tailed Swift, Peregrine Falcon and Australian Bustard may all be transient visitors to the Survey area but all four species forage over a wide variety of habitats across the landscape. The Fork-tailed Swift is almost exclusively aerial, even roosting on the wing. Thus disturbances associated with mining have little or no impact on this species. The major resource limitation for the Peregrine Falcon is suitable nest sites which are typically on vertical cliffs. Any peregrine falcons observed in future surveys would likely be nesting in the nearby ranges. Thus mining related disturbances will not impact nesting and, as the species feeds predominantly on birds, the potential for mining impacts on prey is reduced. Mining can actually have a net positive impact as Peregrine Falcons are frequently observed nesting in the walls of disused mine pits (Ladyman pers. obs). Australian Bustards are nomadic, wandering broadly across the plains and showing no specific habitat or territory affinities. Destocking, fire management and feral fauna control associated with mining can often lead to better security for local populations of this species.

The Shield-backed Trapdoor Spider is generally found from the lower to upper slopes of ironstone ridges; not on the very low slopes or surrounding plains. Burrows are generally constructed in cobble soils with gravel and loam. There is most often an association with rock outcrops and Acacia shrubs, particularly *Acacia ramulosa*.

In suitable habitat, and where known to be present, Shield-backed Trapdoor Spiders occur at densities of 250 – 300 burrows per hectare or three burrows in a 10 x 10 m sampling quadrat. Though cryptic, once one burrow is located they become progressively easier to find as local clusters of individuals tend to construct very similar burrows.

Despite the intensive searching, not a single burrow was located in the Survey area. It may be that the topography is too low. Generally this species show a preference for burrowing at the base of south-facing slopes which have a lower average annual temperature and higher humidity which contributes to water conservation. The flatter topography of the Survey area would not confer any such advantages, particularly in comparison to the surrounding ranges where the species is known to occur.

5.10 Feral Animals

Though the only direct evidence of feral fauna was the ubiquitous presence of rabbit middens across the Project area, secondary evidence of either cats or foxes was present in the form of the predated Malleefowl. There is no question that both of these species would be common to the Project area. Active control of ferals is the best management strategy and, in remote areas such as this, operation mines are able to commit to and undertake such control.

5.11 Impact to Banded Iron Formations and Conservation Reserves

The conical hills that will be directly impacted by the Red Legs mine occur within the midslopes and lower slopes of the Die Hardy Ranges and the adjacent Yokradine Hills. Outside of the R77/1, these mid slopes and lower slopes are generally considered as landscapes worthy of conservation and, as such, are included in the proposed 'Class A' Nature Reserve. However, these conical hills are outside of the proposed nature reserve and do not support any fauna habitats that are of particular value to fauna species normally associated with banded ironstone formations.

Western Botanical (2014) report that 107.18 ha of the Marda East Project intersects the Priority One (P1) Die Hardy Range / Diemels vegetation complex (banded ironstone formation) Priority Ecological Community (PEC), with potential to cause impact to 1.02% of the PEC.

However, the fauna habitat of greatest value to fauna species occurring within the Project area was Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain (mapped as Vegetation Association 2.7 in Western Botanical (2014)) and this vegetation association is not included vegetation of conservation significance associated with this PEC. Therefore, impacts to the PEC are not likely to significantly impact the fauna habitat values of the region.

5.12 Further Studies

Due to the proximity of the Project area to a number of conservation reserves and proposed nature reserves, and due to the number of proposed and operational mines in the local area the region has been subjected to a number of baseline biological surveys.

With a total disturbance area of only 67.18 ha occurring within vegetation associations, fauna habitats and land forms that are broadly distributed it is unlikely that the Project will have a significant impact on the common fauna assemblages.

APM recommends that, rather than investing resources into another baseline fauna survey of the Project area in Spring 2014, the Client should focus any further survey effort on a subset of the fauna species of conservation significance likely to occur in the Project area.

APM recommends that a nest hollow assessment and trapping program be undertaken in Spring 2014 targeting populations of Numbat, Major Mitchell's Cockatoo and the Greater Long-eared Bat.

6 REFERENCES

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7 APPENDICES

Appendix 1: Fauna Conservation Codes

DEFINITIONS OF FAUNA CONSERVATION CODES

Definitions used in the *EPBC Act* and *WC Act*.

Extinct: Taxa not definitely located in the wild during the past 50 years.

Extinct in the wild: Taxa known to survive only in captivity.

Critically Endangered: Taxa facing an extremely high risk of extinction in the wild in the immediate future.

Endangered: Taxa facing a very high risk of extinction in the wild in the near future.

Vulnerable: Taxa facing a very high risk of extinction in the wild in the medium-term future.

Near Threatened: Taxa that risk becoming Vulnerable in the wild.

Conservation Dependent: Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

Data Deficient: Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Least Concern: Taxa that are not Threatened.

Schedules used in the *WC Act*.

Schedule 1: Fauna that are rare or likely to become extinct.

Schedule 2: Fauna presumed to be extinct.

Schedule 3: Migratory birds that are listed under international treaties.

Schedule 4: Other specially protected fauna.

DEC recognises five levels of priority fauna:

Priority 1: Taxa with few, poorly known populations on threatened lands.
Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority 2: Taxa with few, poorly known populations on conservation lands.
Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority 3: Taxa with several, poorly known populations, some on conservation lands.
Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority 4: Taxa in need of monitoring.
Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.

Priority 5: Taxa in need of monitoring.
Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix 2: Protected Matters Database Search Results

Australian Government
Department of the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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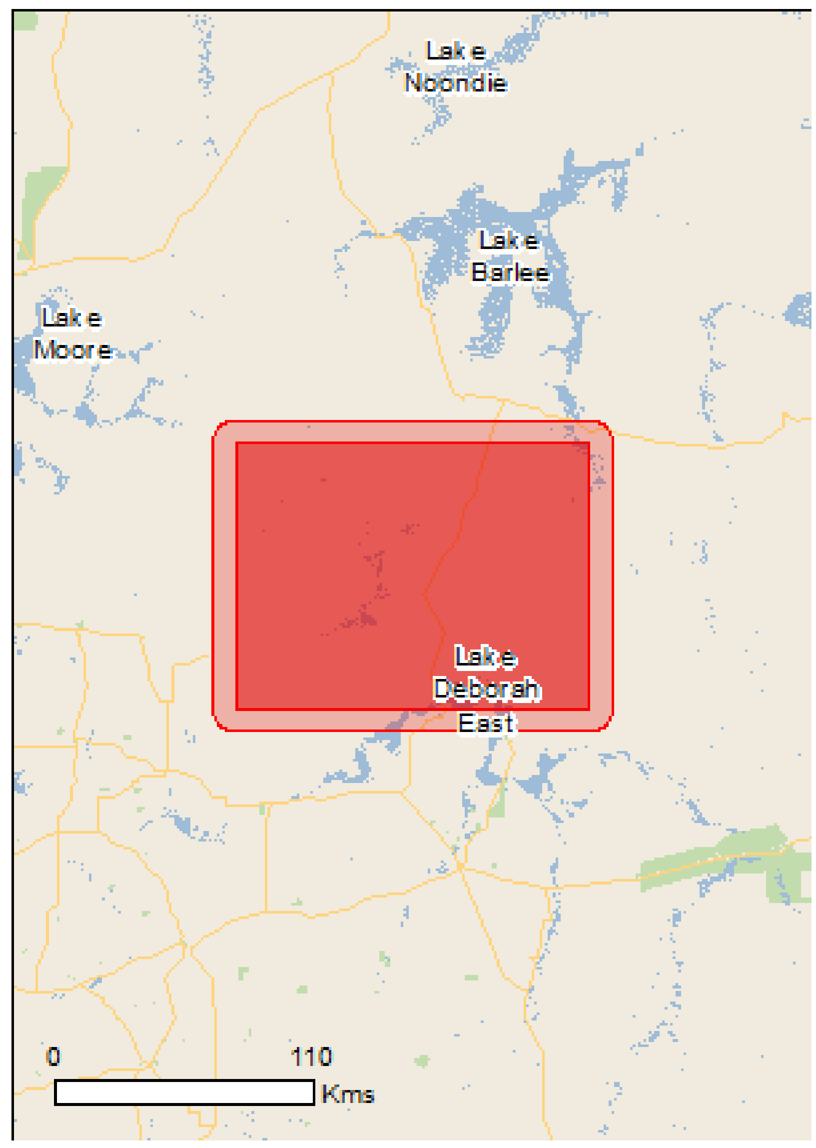

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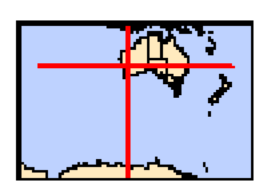

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	23
Listed Migratory Species:	4

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	4
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	3
State and Territory Reserves:	14
Regional Forest Agreements:	None
Invasive Species:	14
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Myrmecobius fasciatus Numbat [294]	Vulnerable	Species or species habitat likely to occur within area
Other		
Idiosoma nigrum Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Acacia denticulosa Sandpaper Wattle [20600]	Vulnerable	Species or species habitat likely to occur within area
Acacia lobulata Chiddarcooping Wattle [55567]	Endangered	Species or species habitat known to occur within area
Acacia sciophanes Wundowlin Wattle, Ghost Wattle [17877]	Endangered	Species or species habitat may occur within area
Boronia adamsiana Barbalin Boronia [16935]	Vulnerable	Species or species habitat likely to occur within area
Eremophila resinosa Resinous Eremophila [11735]	Endangered	Species or species habitat likely to occur within area
Eremophila virens Campion Eremophila, Green-flowered Emu bush	Endangered	Species or species

Name	Status	Type of Presence
[21433]		habitat known to occur within area
Eremophila viscida Varnish Bush [2394]	Endangered	Species or species habitat likely to occur within area
Eucalyptus brevipes Mukinbudin Mallee [7495]	Endangered	Species or species habitat likely to occur within area
Eucalyptus recta Silver Mallet [56430]	Endangered	Species or species habitat likely to occur within area
Gastrolobium diabolophyllum Bodallin Poison [78384]	Critically Endangered	Species or species habitat likely to occur within area
Grevillea pythara Pythara Grevillea [64525]	Endangered	Species or species habitat may occur within area
Leucopogon spectabilis Ironstone Beard-heath [83012]	Critically Endangered	Species or species habitat known to occur within area
Melaleuca sciotostyla Wongan Melaleuca [24324]	Endangered	Species or species habitat known to occur within area
Myriophyllum lapidicola Chiddarcooping myriophyllum [55940]	Endangered	Species or species habitat known to occur within area
Pityrodia axillaris Native Foxglove, Woolly Foxglove [17376]	Critically Endangered	Species or species habitat may occur within area
Ricinocarpos brevis [82879]	Endangered	Species or species habitat known to occur within area
Roycea pycnophylloides Saltmat [21161]	Endangered	Species or species habitat likely to occur within area
Tetratheca aphylla Bungalbin Tetratheca [2915]	Vulnerable	Species or species habitat likely to occur within area
Tetratheca harperi Jackson Tetratheca [6251]	Vulnerable	Species or species habitat likely to occur within area
Tetratheca paynterae Paynter's Tetratheca [66451]	Endangered	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Lake Moore Area	WA	Registered
Mount Manning Nature Reserve	WA	Registered
Walyahmoning Rock Nature Reserve	WA	Registered

State and Territory Reserves [Resource Information]

Name	State
Geeraning	WA
Jouerdine	WA
Karroun Hill	WA
Mount Manning Range	WA
Mount Manning Range	WA
Unnamed WA23991	WA
Unnamed WA32864	WA
Unnamed WA32865	WA
Unnamed WA32993	WA
Unnamed WA36918	WA
Unnamed WA38800	WA
Unnamed WA44446	WA
Walyahmoning	WA
Yanneymooning	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa		
Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Carrichtera annua		
Ward's Weed [9511]		Species or species habitat likely to occur within area
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera		
Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area

Coordinates

-29.8382 118.47619,-29.8382 119.82202,-30.70872 119.82202,-30.70872 118.47619,-29.8382 118.47619

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Department of Environment, Climate Change and Water, New South Wales
- -Department of Sustainability and Environment, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment and Natural Resources, South Australia
- -Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
- -Environmental and Resource Management, Queensland
- -Department of Environment and Conservation, Western Australia
- -Department of the Environment, Climate Change, Energy and Water
- -Birds Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -SA Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Atherton and Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- -State Forests of NSW
- -Geoscience Australia
- -CSIRO
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix 3: NatureMap Database Search Results

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 06/05/2014

Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	119°16' 50" E,30°01' 00" S
Buffer	40km
Group By	Kingdom

Kingdom	Species	Records
Animalia	271	3245
Fungi	6	8
Plantae	601	4212
TOTAL	**878**	**7465**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Animalia					
1.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
2.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
3.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
4.	24264	*Acanthiza robustirostris (Slaty-backed Thornbill)*			
5.	24265	*Acanthiza uropygialis (Chestnut-rumped Thornbill)*			
6.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
7.	25536	*Accipiter fasciatus (Brown Goshawk)*			
8.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
9.	33902	*Aganippe castellum (Tree-stem Trapdoor Spider)*		P4	
10.	-11966	*Aname tepperi*			
11.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
12.	24561	*Anthochaera carunculata (Red Wattlebird)*			
13.	25670	*Anthus australis (Australian Pipit)*			
14.	25528	*Aphelocephala leucopsis (Southern Whiteface)*			
15.	24266	*Aphelocephala leucopsis subsp. castaneiventris (Southern Whiteface)*			
16.	25554	*Apus pacificus (Fork-tailed Swift)*		IA	
17.	24285	*Aquila audax (Wedge-tailed Eagle)*			
18.	24610	*Ardeotis australis (Australian Bustard)*		P4	
19.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
20.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
21.	24355	*Artamus minor (Little Woodswallow)*			
22.	24356	*Artamus personatus (Masked Woodswallow)*			
23.	-1794	*Arthrorhabdus paucispinus*			
24.	-12070	*Atelomastix bamfordi*			
25.	-11973	*Badumna insignis*			
26.	24251	*Bos taurus (European Cattle)*	Y		
27.	42381	*Brachyurophis semifasciatus (Southern Shovel-nosed Snake)*			
28.	24722	*Cacatua leadbeateri (Major Mitchell's Cockatoo)*		S	
29.	25715	*Cacatua roseicapilla (Galah)*			
30.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
31.	24269	*Calamanthus campestris (Rufous Fieldwren)*			
32.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
33.	24732	*Calyptorhynchus banksii subsp. samueli (Red-tailed Black-Cockatoo)*			
34.	24039	*Canis lupus subsp. dingo (Dingo)*	Y		
35.	24086	*Cercartetus concinnus (Western Pygmy-possum, Mundarda)*			
36.	-12508	*Cercophonius michaelseni*			
37.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
38.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
39.	24187	*Chalinolobus morio (Chocolate Wattled Bat)*			
40.	24376	*Charadrius rubricollis (Hooded Plover)*		P4	
41.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
42.	24434	*Chrysococcyx osculans (Black-eared Cuckoo)*			
43.	24834	*Cincloramphus mathewsi (Rufous Songlark)*			

	Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area[1]
44.	25580	*Cinclosoma castaneothorax (Chestnut-breasted Quail-thrush)*			
45.	30956	*Cinclosoma castanotus (Chestnut Quail-thrush)*			
46.	25581	*Climacteris affinis (White-browed Treecreeper)*			
47.	24393	*Climacteris affinis subsp. superciliosa (White-browed Treecreeper)*			
48.	24396	*Climacteris rufa (Rufous Treecreeper)*			
49.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
50.	24613	*Colluricincla harmonica subsp. rufiventris (Grey Shrike-thrush)*			
51.	24361	*Coracina maxima (Ground Cuckoo-shrike)*			
52.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
53.	-1732	*Cormocephalus strigosus*			
54.	-1739	*Cormocephalus turneri*			
55.	24416	*Corvus bennetti (Little Crow)*			
56.	25592	*Corvus coronoides (Australian Raven)*			
57.	24417	*Corvus coronoides subsp. perplexus (Australian Raven)*			
58.	25593	*Corvus orru (Torresian Crow)*			
59.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
60.	25595	*Cracticus tibicen (Australian Magpie)*			
61.	24422	*Cracticus tibicen subsp. dorsalis (White-backed Magpie)*			
62.	25596	*Cracticus torquatus (Grey Butcherbird)*			
63.	24424	*Cracticus torquatus subsp. torquatus (Grey Butcherbird)*			
64.	25456	*Crenadactylus ocellatus (Clawless Gecko)*			
65.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
66.	30893	*Cryptoblepharus buchananii*			
67.	25020	*Cryptoblepharus plagiocephalus*			
68.	24871	*Ctenophorus cristatus (Bicycle Dragon)*			
69.	24873	*Ctenophorus fordi (Mallee Sand Dragon)*			
70.	25459	*Ctenophorus isolepis (Crested Dragon, Military Dragon)*			
71.	24879	*Ctenophorus maculatus subsp. griseus (Spotted Military Dragon)*			
72.	24883	*Ctenophorus ornatus (Ornate Crevice-Dragon)*			
73.	24886	*Ctenophorus reticulatus (Western Netted Dragon)*			
74.	24889	*Ctenophorus scutulatus (Lozenge-marked Dragon)*			
75.	25026	*Ctenotus atlas*			
76.	25052	*Ctenotus leonhardii*			
77.	25054	*Ctenotus mimetes*			
78.	25074	*Ctenotus schomburgkii*			
79.	25075	*Ctenotus severus*			
80.	25465	*Ctenotus uber (Spotted Ctenotus)*			
81.	25080	*Ctenotus uber subsp. uber (Spotted Ctenotus)*			
82.	25089	*Cyclodomorphus melanops subsp. elongatus (Slender Blue-tongue)*			
83.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
84.	24606	*Daphoenositta chrysoptera subsp. pileata (Varied Sittella, Black-capped Sitella)*			
85.	24995	*Delma australis*			
86.	24997	*Delma butleri*			
87.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
88.	25295	*Demansia psammophis subsp. cupreiceps (Yellow-faced Whipsnake)*			
89.	25247	*Demansia psammophis subsp. psammophis (Yellow-faced Whipsnake)*			
90.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
91.	24441	*Dicaeum hirundinaceum subsp. hirundinaceum (Mistletoebird)*			
92.	25469	*Diplodactylus granariensis*			
93.	24929	*Diplodactylus granariensis subsp. granariensis*			
94.	24940	*Diplodactylus pulcher*			
95.	24470	*Dromaius novaehollandiae (Emu)*			
96.	24650	*Drymodes brunneopygia (Southern Scrub-robin)*			
97.	25092	*Egernia depressa (Southern Pygmy Spiny-tailed Skink)*			
98.	25094	*Egernia formosa*			
99.	24651	*Eopsaltria australis subsp. griseogularis (Western Yellow Robin)*			
100.	24567	*Epthianura albifrons (White-fronted Chat)*			
101.	24570	*Epthianura tricolor (Crimson Chat)*			
102.	24258	*Equus caballus (Horse)*	Y		
103.	25109	*Eremiascincus richardsonii (Broad-banded Sand Swimmer)*			
104.	-1804	*Ethmostigmus curtipes*			
105.	-1667	*Ethmostigmus rubripes*			
106.	24368	*Eurostopodus argus (Spotted Nightjar)*			
107.	25621	*Falco berigora (Brown Falcon)*			
108.	24471	*Falco berigora subsp. berigora (Brown Falcon)*			
109.	25622	*Falco cenchroides (Australian Kestrel)*			
110.	24472	*Falco cenchroides subsp. cenchroides (Australian Kestrel)*			
111.	25623	*Falco longipennis (Australian Hobby)*			
112.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
113.	24475	*Falco peregrinus subsp. macropus (Australian Peregrine Falcon)*		S	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
114.	24041	*Felis catus (Cat)*	Y		
115.	24957	*Gehyra purpurascens*			
116.	24959	*Gehyra variegata*			
117.	-13016	*Geogarypus taylori*			
118.	25530	*Gerygone fusca (Western Gerygone)*			
119.	24735	*Glossopsitta porphyrocephala (Purple-crowned Lorikeet)*			
120.	24443	*Grallina cyanoleuca (Magpie-lark)*			
121.	25408	*Heleioporus albopunctatus (Western Spotted Frog)*			
122.	25474	*Hemiergis initialis*			
123.	25115	*Hemiergis initialis subsp. initialis*			
124.	42408	*Hesperoedura reticulata*			
125.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
126.	24491	*Hirundo neoxena (Welcome Swallow)*			
127.	25629	*Hirundo nigricans (Tree Martin)*			
128.	24492	*Hirundo nigricans subsp. nigricans (Tree Martin)*			
129.	-12894	*Hoggicosa forresti*			
130.	-13410	*Hoggicosa storri*			
131.	-12660	*Hogna pexa*			
132.	-11716	*Holconia westralia*			
133.	34001	*Hylacola cauta subsp. whitlocki (Shy Heathwren (western))*		P4	
134.	-1695	*Isometroides vescus*			
135.	-11972	*Isopeda magna*			
136.	24367	*Lalage tricolor (White-winged Triller)*			
137.	24557	*Leipoa ocellata (Malleefowl)*		T	
138.	25137	*Lerista gerrardii*			
139.	30927	*Lerista kingi*			
140.	-18207	*Lerista kingi*			
141.	25482	*Lerista macropisthopus*			
142.	25149	*Lerista macropisthopus subsp. macropisthopus*			
143.	25155	*Lerista muelleri*			
144.	42411	*Lerista timida*			
145.	25005	*Lialis burtonis*			
146.	25659	*Lichenostomus leucotis (White-eared Honeyeater)*			
147.	24576	*Lichenostomus leucotis subsp. novaenorciae (White-eared Honeyeater)*			
148.	25661	*Lichmera indistincta (Brown Honeyeater)*			
149.	24582	*Lichmera indistincta subsp. indistincta (Brown Honeyeater)*			
150.	41411	*Liopholis inornata (Desert Skink)*			
151.	30935	*Lucasium maini*			
152.	25489	*Macropus robustus (Euro)*			
153.	24135	*Macropus robustus subsp. erubescens (Euro, Biggada)*			
154.	24136	*Macropus rufus (Red Kangaroo, Marlu)*			
155.	-12475	*Mainosa longipes*			
156.	24544	*Malurus lamberti subsp. assimilis (Variegated Fairy-wren)*			
157.	24551	*Malurus pulcherrimus (Blue-breasted Fairy-wren)*			
158.	25654	*Malurus splendens (Splendid Fairy-wren)*			
159.	24552	*Malurus splendens subsp. splendens (Splendid Fairy-wren)*			
160.	24583	*Manorina flavigula (Yellow-throated Miner)*			
161.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
162.	24586	*Melithreptus brevirostris subsp. leucogenys (Brown-headed Honeyeater)*			
163.	25184	*Menetia greyii*			
164.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	
165.	25693	*Microeca fascinans (Jacky Winter)*			
166.	24654	*Microeca fascinans subsp. assimilis (Jacky Winter)*			
167.	-11748	*Missulena occatoria*			
168.	24904	*Moloch horridus (Thorny Devil)*			
169.	25190	*Morethia butleri*			
170.	24184	*Mormopterus planiceps (Southern Freetail-bat)*			
171.	24223	*Mus musculus (House Mouse)*	Y		
172.	25425	*Neobatrachus kunapalari (Kunapalari Frog)*			
173.	25426	*Neobatrachus pelobatoides (Humming Frog)*			
174.	24737	*Neophema bourkii (Bourke's Parrot)*			
175.	24740	*Neophema splendida (Scarlet-chested Parrot)*			
176.	24094	*Ningaui ridei (Wongai Ningaui)*			
177.	24096	*Ningaui yvonneae (Southern Ningaui)*			
178.	25748	*Ninox novaeseelandiae (Boobook Owl)*			
179.	24224	*Notomys alexis (Spinifex Hopping-mouse)*			
180.	24229	*Notomys mitchellii (Mitchell's Hopping-mouse)*			
181.	-18081	*Notomys sp.*			
182.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
183.	41424	*Nyctophilus major (Greater Long-eared Bat)*		P4	

NatureMap
Mapping Western Australia's biodiversity

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
184.	43367	*Nyctophilus major subsp. tor (Southern Long-eared Bat)*			
185.	24742	*Nymphicus hollandicus (Cockatiel)*			
186.	24618	*Oreoica gutturalis (Crested Bellbird)*			
187.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
188.	24619	*Pachycephala inornata (Gilbert's Whistler)*			
189.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
190.	24624	*Pachycephala rufiventris subsp. rufiventris (Rufous Whistler)*			
191.	25254	*Parasuta monachus*			
192.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
193.	25682	*Pardalotus striatus (Striated Pardalote)*			
194.	24630	*Pardalotus striatus subsp. westraliensis (Striated Pardalote)*			
195.	24658	*Petroica cucullata (Hooded Robin)*			
196.	24659	*Petroica goodenovii (Red-capped Robin)*			
197.	24409	*Phaps chalcoptera (Common Bronzewing)*			
198.	-11765	*Phryssonotus novaehollandiae*			
199.	24748	*Platycercus varius (Mulga Parrot)*			
200.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
201.	24750	*Platycercus zonarius subsp. semitorquatus (Twenty-eight Parrot)*			
202.	24751	*Platycercus zonarius subsp. zonarius (Port Lincoln Parrot)*			
203.	25703	*Podargus strigoides (Tawny Frogmouth)*			
204.	24679	*Podargus strigoides subsp. brachypterus (Tawny Frogmouth)*			
205.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
206.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
207.	25722	*Polytelis anthopeplus (Regent Parrot)*			
208.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
209.	24106	*Pseudantechinus woolleyae (Woolley's Pseudantechinus)*			
210.	25261	*Pseudechis australis (Mulga Snake)*			
211.	24230	*Pseudomys albocinereus (Ash-grey Mouse)*			
212.	24232	*Pseudomys bolami (Bolam's Mouse)*			
213.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
214.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
215.	25434	*Pseudophryne occidentalis (Western Toadlet)*			
216.	42340	*Ptilotula ornatus (Yellow-plumed Honeyeater)*			
217.	42344	*Purnella albifrons (White-fronted Honeyeater)*			
218.	25008	*Pygopus lepidopodus (Common Scaly Foot)*			
219.	25009	*Pygopus nigriceps*			
220.	24278	*Pyrrholaemus brunneus (Redthroat)*			
221.	25271	*Ramphotyphlops australis*			
222.	30824	*Ramphotyphlops bicolor*			
223.	25273	*Ramphotyphlops bituberculatus*			
224.	25285	*Ramphotyphlops pinguis*			
225.	-13795	*Rhipidura albicauda*			
226.	25613	*Rhipidura fuliginosa (Grey Fantail)*			
227.	24452	*Rhipidura fuliginosa subsp. preissi (Grey Fantail)*			
228.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
229.	24454	*Rhipidura leucophrys subsp. leucophrys (Willie Wagtail)*			
230.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
231.	-1709	*Scolopendra laeta*			
232.	-1847	*Scolopendra morsitans*			
233.	24199	*Scotorepens balstoni (Inland Broad-nosed Bat)*			
234.	-11998	*Selenotholus foelschei*			
235.	25266	*Simoselaps bertholdi (Jan's Banded Snake)*			
236.	30948	*Smicrornis brevirostris (Weebill)*			
237.	24108	*Sminthopsis crassicaudata (Fat-tailed Dunnart)*			
238.	24109	*Sminthopsis dolichura (Little long-tailed Dunnart)*			
239.	25515	*Sminthopsis griseoventer (Grey-bellied Dunnart)*			
240.	24114	*Sminthopsis hirtipes (Hairy-footed Dunnart)*			
241.	24116	*Sminthopsis macroura (Stripe-faced Dunnart)*			
242.	-18122	*Sminthopsis murina*			
243.	25597	*Strepera versicolor (Grey Currawong)*			
244.	24426	*Strepera versicolor subsp. plumbea (Grey Currawong)*			
245.	24923	*Strophurus assimilis (Goldfields Spiny-tailed Gecko)*			
246.	24927	*Strophurus elderi*			
247.	42310	*Sugomel niger (Black Honeyeater)*			
248.	25269	*Suta fasciata (Rosen's Snake)*			
249.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
250.	24185	*Tadarida australis (White-striped Freetail-bat)*			
251.	30870	*Taeniopygia guttata (Zebra Finch)*			
252.	30871	*Taeniopygia guttata subsp. castanotis (Zebra Finch)*			
253.	-11995	*Tamopsis transiens*			Y

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
254.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
255.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			
256.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
257.	24851	*Turnix velox (Little Button-quail)*			
258.	30814	*Tympanocryptis cephalus (Pebble Dragon)*			
259.	24983	*Underwoodisaurus milii (Barking Gecko)*			
260.	-11701	*Urodacus novaehollandiae*			
261.	-13359	*Urodacus similis*			
262.	24386	*Vanellus tricolor (Banded Lapwing)*			
263.	25211	*Varanus caudolineatus*			
264.	25216	*Varanus giganteus (Perentie)*			
265.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
266.	25222	*Varanus panoptes subsp. panoptes*			
267.	25526	*Varanus tristis (Racehorse Monitor)*			
268.	25227	*Varanus tristis subsp. tristis (Racehorse Monitor)*			
269.	24202	*Vespadelus baverstocki (Inland Forest Bat)*			
270.	24206	*Vespadelus regulus (Southern Forest Bat)*			
271.	-12194	*Wesmaldra talgomine*			

Fungi

272.	42104	*Buellia albula*			
273.	27722	*Diploschistes ocellatus*			
274.	27763	*Haematomma eremaeum*			
275.	27999	*Psora crystallifera*			
276.	28356	*Xanthoparmelia verrucella*			
277.	28186	*Xanthoparmelia versicolor*			

Plantae

278.	4889	*Abutilon cryptopetalum*			
279.	4902	*Abutilon oxycarpum (Flannel Weed)*			
280.	16159	*Acacia acanthoclada subsp. acanthoclada*			
281.	14613	*Acacia acanthoclada subsp. glaucescens*			
282.	3199	*Acacia acuaria*			
283.	3200	*Acacia acuminata (Jam, Mangard)*			
284.	14044	*Acacia adinophylla*		P1	
285.	3216	*Acacia andrewsii*			
286.	3217	*Acacia aneura (Mulga, Wanari)*			
287.	3226	*Acacia assimilis*			
288.	15467	*Acacia assimilis subsp. assimilis*			
289.	3248	*Acacia burkittii (Sandhill Wattle)*			
290.	36417	*Acacia caesaneura*			
291.	23977	*Acacia cockertoniana*			
292.	3269	*Acacia coolgardiensis (Spinifex Wattle)*			
293.	3285	*Acacia daviesioides*			
294.	3301	*Acacia dielsii*			
295.	32118	*Acacia effusifolia*			
296.	12257	*Acacia enervia subsp. explicata*			
297.	3324	*Acacia erinacea*			
298.	3366	*Acacia hemiteles*			
299.	36418	*Acacia incurvaneura*			
300.	3393	*Acacia jennerae*			
301.	3395	*Acacia jibberdingensis*			
302.	3399	*Acacia kempeana (Witchetty Bush, Ilykuwara)*			
303.	3419	*Acacia ligulata (Umbrella Bush, Watarka)*			
304.	3426	*Acacia longispinea*			
305.	36416	*Acacia mulganeura*			
306.	15290	*Acacia neurophylla subsp. erugata*			
307.	3495	*Acacia prainii (Prain's Wattle)*			
308.	3507	*Acacia quadrimarginea*			
309.	3510	*Acacia ramulosa (Horse Mulga)*			
310.	19499	*Acacia ramulosa var. ramulosa*			
311.	3513	*Acacia resinimarginea*			
312.	16145	*Acacia resinosa*			
313.	3545	*Acacia sibina*			
314.	30717	*Acacia sp. Mt Jackson (B. Ryan 176)*			
315.	3555	*Acacia steedmanii*			
316.	23525	*Acacia steedmanii subsp. steedmanii*			
317.	3577	*Acacia tetragonophylla (Kurara, Wakalpuka)*			
318.	7817	*Actinobole uliginosum (Flannel Cudweed)*			
319.	184	*Aira caryophyllea (Silvery Hairgrass)*	Y		
320.	1720	*Allocasuarina acutivalvis*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
321.	13904	*Allocasuarina acutivalvis subsp. acutivalvis*			
322.	13905	*Allocasuarina acutivalvis subsp. prinsepiana*			
323.	1721	*Allocasuarina campestris*			
324.	1722	*Allocasuarina corniculata*			
325.	1725	*Allocasuarina dielsiana (Northern Sheoak)*			
326.	12657	*Allocasuarina eriochlamys*			
327.	13906	*Allocasuarina eriochlamys subsp. eriochlamys*			
328.	1730	*Allocasuarina helmsii*			
329.	12655	*Allocasuarina spinosissima*			
330.	1738	*Allocasuarina tessellata*		P1	
331.	19467	*Aluta appressa*			
332.	19466	*Aluta aspera subsp. aspera*			
333.	6565	*Alyxia buxifolia (Dysentery Bush)*			
334.	14636	*Alyxia tetanifolia*		P3	
335.	12025	*Amphipogon caricinus var. caricinus*			
336.	199	*Amphipogon strictus (Greybeard Grass)*			
337.	2369	*Amyema benthamii*			
338.	13267	*Amyema linophylla subsp. linophylla*			
339.	2380	*Amyema miquelii (Stalked Mistletoe)*			
340.	2382	*Amyema nestor*			
341.	40910	*Androcalva luteiflora (Yellow-flowered Rulingia)*			
342.	7836	*Angianthus tomentosus (Camel-grass)*			
343.	207	*Aristida contorta (Bunched Kerosene Grass)*			
344.	210	*Aristida holathera*			
345.	1265	*Arthropodium curvipes*			
346.	17039	*Astartea sp. Mt Dimer (C. McChesney TRL4/72)*		P1	Y
347.	7846	*Asteridea athrixioides*			
348.	7847	*Asteridea chaetopoda*			
349.	2469	*Atriplex nummularia (Old Man Saltbush)*			
350.	11516	*Atriplex nummularia subsp. spathulata (Old Man Saltbush)*			
351.	11525	*Atriplex paludosa subsp. baudinii*			
352.	11791	*Atriplex quadrivalvata var. quadrivalvata*			
353.	2481	*Atriplex vesicaria (Bladder Saltbush)*			
354.	17232	*Austrostipa blackii*		P3	
355.	17237	*Austrostipa elegantissima*			
356.	17246	*Austrostipa nitida*			
357.	19588	*Austrostipa nodosa*			
358.	17247	*Austrostipa platychaeta*			
359.	17251	*Austrostipa scabra*			
360.	17255	*Austrostipa trichophylla*			
361.	5341	*Baeckea crispiflora*			
362.	5344	*Baeckea elderiana*			
363.	5356	*Baeckea muricata*			
364.	5357	*Baeckea ochropetala*		P1	
365.	16737	*Baeckea sp. Bencubbin-Koorda (M.E. Trudgen 5421)*			
366.	20617	*Baeckea sp. Bungalbin Hill (B.J. Lepschi & L.A. Craven 4586)*		P3	
367.	20616	*Baeckea sp. Die Hardy Range (E. Mattiske J91)*		P1	Y
368.	20690	*Baeckea sp. Mt Jackson (G.J. Keighery 4362)*		P1	Y
369.	20804	*Baeckea sp. Parker Range (M. Hislop & F. Hort MH 2968)*		P3	
370.	20681	*Baeckea sp. Pigeon Rocks (D. Grace DJP 281)*		P1	Y
371.	32685	*Banksia arborea (Yilgarn Dryandra)*		P4	
372.	1815	*Banksia elderiana (Swordfish Banksia)*			
373.	7852	*Bellida graminea (Rosy Bellida)*			
374.	34259	*Beyeria rostellata*		P1	
375.	7856	*Blennospora drummondii*			
376.	4409	*Boronia coerulescens*			
377.	1267	*Borya constricta*			
378.	33023	*Bossiaea sp. Jackson Range (G. Cockerton & S. McNee LCS 13614)*		P3	
379.	3722	*Bossiaea walkeri*			
380.	4999	*Brachychiton gregorii (Desert Kurrajong, Ngalta)*			
381.	7871	*Brachyscome ciliaris*			
382.	18431	*Brachyscome ciliaris var. ciliaris*			
383.	11884	*Brachyscome ciliaris var. lanuginosa*			
384.	7872	*Brachyscome ciliocarpa*			
385.	7880	*Brachyscome lineariloba*			
386.	7882	*Brachyscome perpusilla*			
387.	7883	*Brachyscome pusilla*			
388.	247	*Bromus arenarius (Sand Brome)*			
389.	249	*Bromus diandrus (Great Brome)*	Y		
390.	253	*Bromus rubens (Red Brome)*	Y		

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
391.	7413	*Brunonia australis (Native Cornflower)*			
392.	3167	*Bursaria occidentalis*			
393.	15355	*Caladenia hirta subsp. rosea*			
394.	15357	*Caladenia incrassata*			
395.	19219	*Caladenia mesocera*			
396.	1614	*Caladenia roei (Ant Orchid)*			
397.	30797	*Caladenia saxicola*			
398.	1617	*Caladenia sigmoidea*			
399.	18594	*Caladenia sp. Muddarning Hill (S.D. Hopper 4013)*			
400.	2853	*Calandrinia eremaea (Twining Purslane)*			
401.	20478	*Calandrinia sp. Blackberry (D.M. Porter 171)*			
402.	19455	*Calandrinia sp. Bungalbin (G.J. Keighery & N. Gibson 1656)*			
403.	92	*Callitris canescens*			
404.	8466	*Callitris columellaris (White Cypress Pine)*			
405.	96	*Callitris preissii (Rottnest Island Pine, Maro)*			
406.	8637	*Callitris verrucosa*			
407.	5408	*Calothamnus gilesii*			
408.	13232	*Calothamnus superbus*		P1	
409.	7903	*Calotis hispidula (Bindy Eye)*			
410.	7905	*Calotis multicaulis (Many-stemmed Burr-daisy)*			
411.	16492	*Calycopeplus paucifolius*			
412.	5442	*Calytrix birdii*			
413.	5452	*Calytrix divergens*			
414.	5470	*Calytrix paucicostata*		P2	
415.	28241	*Calytrix sp. Paynes Find (F. & J. Hort 1188)*			
416.	43545	*Calytrix viscida*		P1	Y
417.	3008	*Carrichtera annua (Ward's Weed)*	Y		
418.	7911	*Carthamus lanatus (Saffron Thistle)*	Y		
419.	2955	*Cassytha nodiflora*			
420.	12658	*Casuarina pauper (Black Oak)*			
421.	7916	*Centaurea melitensis (Maltese Cockspur)*	Y		
422.	7922	*Cephalipterum drummondii (Pompom Head)*			
423.	7924	*Ceratogyne obionoides (Wingwort)*			
424.	1215	*Chamaexeros fimbriata*			
425.	1216	*Chamaexeros macranthera*			
426.	12796	*Cheilanthes adiantoides*			
427.	31	*Cheilanthes austrotenuifolia*			
428.	32	*Cheilanthes brownii*			
429.	37	*Cheilanthes lasiophylla (Woolly Cloak Fern)*			
430.	12818	*Cheilanthes sieberi subsp. sieberi*			
431.	3168	*Cheiranthera filifolia*			
432.	7933	*Chthonocephalus pseudevax (Woolly Groundheads)*			
433.	4555	*Comesperma integerrimum*			
434.	7943	*Cotula australis (Common Cotula)*			
435.	3137	*Crassula colorata (Dense Stonecrop)*			
436.	11709	*Crassula colorata var. acuminata*			
437.	11563	*Crassula colorata var. colorata*			
438.	11349	*Crassula decumbens var. decumbens*			
439.	3139	*Crassula exserta*			
440.	20268	*Crassula tetramera*			
441.	7951	*Cratystylis subspinescens (Australian Sage, Spiny Grey Bush)*			
442.	4791	*Cryptandra apetala*			
443.	13471	*Cryptandra connata*			
444.	16185	*Cryptandra graniticola*			
445.	6663	*Cuscuta epithymum (Lesser Dodder, Greater Dodder)*	Y		
446.	15400	*Cyanicula amplexans*			
447.	6747	*Cyanostegia angustifolia (Tinsel-flower)*			
448.	7438	*Dampiera eriocephala (Woolly-headed Dampiera)*			
449.	7469	*Dampiera roycei*			
450.	6218	*Daucus glochidiatus (Australian Carrot)*			
451.	15505	*Daviesia incrassata subsp. incrassata*			
452.	3836	*Daviesia purpurascens (Purple-leaved Daviesia)*			
453.	1259	*Dianella revoluta (Blueberry Lily)*			
454.	11636	*Dianella revoluta var. divaricata*			
455.	6771	*Dicrastylis parvifolia*			
456.	29315	*Dicrastylis rugosifolia*			
457.	15436	*Diuris porrifolia*			
458.	4752	*Dodonaea adenophora*			
459.	4766	*Dodonaea inaequifolia*			
460.	4769	*Dodonaea lobulata (Bead Hopbush)*			

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461.	12034	*Dodonaea microzyga var. acrolobata*			
462.	4775	*Dodonaea pinifolia*			
463.	4779	*Dodonaea rigida*			
464.	4780	*Dodonaea stenozyga*			
465.	4782	*Dodonaea viscosa (Sticky Hopbush)*			
466.	11674	*Dodonaea viscosa subsp. mucronata*			
467.	11202	*Dodonaea viscosa subsp. spatulata (Sticky Hop-bush)*			
468.	3106	*Drosera macrantha (Bridal Rainbow)*			
469.	14298	*Drosera macrantha subsp. macrantha*			
470.	3109	*Drosera menziesii (Pink Rainbow)*			
471.	33479	*Dysphania melanocarpa (Black Crumbweed)*			
472.	33597	*Dysphania melanocarpa forma melanocarpa (Black Goosefoot)*			
473.	2510	*Enchylaena lanata*			
474.	2511	*Enchylaena tomentosa (Barrier Saltbush)*			
475.	12064	*Enchylaena tomentosa var. tomentosa (Barrier Saltbush)*			
476.	357	*Enneapogon caerulescens (Limestone Grass)*			
477.	32353	*Entosthodon apophysatus*			
478.	378	*Eragrostis dielsii (Mallee Lovegrass)*			
479.	7180	*Eremophila alternifolia (Poverty Bush)*			
480.	13807	*Eremophila caperata*			
481.	7189	*Eremophila clarkei (Turpentine Bush)*			
482.	7193	*Eremophila decipiens (Slender Fuchsia)*			
483.	14895	*Eremophila decipiens subsp. decipiens*			
484.	7204	*Eremophila eriocalyx (Desert Pride)*			
485.	7206	*Eremophila falcata*			
486.	7208	*Eremophila forrestii (Wilcox Bush)*			
487.	15052	*Eremophila forrestii subsp. forrestii*			
488.	7211	*Eremophila georgei*			
489.	7215	*Eremophila glabra (Tar Bush)*			
490.	14340	*Eremophila glabra subsp. glabra*			
491.	14191	*Eremophila glabra subsp. tomentosa*			
492.	7216	*Eremophila glutinosa*			
493.	7219	*Eremophila granitica (Thin-leaved Poverty Bush)*			
494.	7225	*Eremophila interstans*			
495.	7226	*Eremophila ionantha (Violet-flowered Eremophila)*			
496.	7230	*Eremophila latrobei (Warty Fuchsia Bush, Mintjingka)*			
497.	17576	*Eremophila latrobei subsp. latrobei*			
498.	7240	*Eremophila metallicorum*			
499.	7246	*Eremophila oldfieldii (Pixie Bush)*			
500.	15003	*Eremophila oldfieldii subsp. angustifolia*			
501.	7247	*Eremophila oppositifolia (Weeooka)*			
502.	18570	*Eremophila oppositifolia subsp. angustifolia*			
503.	7250	*Eremophila pantonii*			
504.	7267	*Eremophila scoparia (Broom Bush ()*			
505.	7269	*Eremophila serrulata (Serrate-leaved Eremophila)*			
506.	19528	*Eremophila sp. Mt Jackson (G.J. Keighery 4372)*			
507.	417	*Eriachne pulchella (Pretty Wanderrie)*			
508.	16486	*Eriachne pulchella subsp. pulchella*			
509.	20718	*Ericksonella saccharata*			
510.	2514	*Eriochiton sclerolaenoides (Woolly Bindii)*			
511.	4331	*Erodium aureum*	Y		
512.	4333	*Erodium cicutarium (Common Storksbill)*	Y		
513.	4334	*Erodium crinitum (Corkscrew)*			
514.	4335	*Erodium cygnorum (Blue Heronsbill)*			
515.	14377	*Erymophyllum ramosum subsp. ramosum*			
516.	13516	*Eucalyptus aequioperta*			
517.	5565	*Eucalyptus brachycorys (Cowcowing Mallee)*			
518.	12904	*Eucalyptus capillosa*			
519.	12903	*Eucalyptus capillosa subsp. capillosa (Wheatbelt Wandoo)*			
520.	5592	*Eucalyptus clelandii (Cleland's Blackbutt)*			
521.	5595	*Eucalyptus comitae-vallis (Comet Vale Mallee)*			
522.	5596	*Eucalyptus concinna (Victoria Desert Mallee)*			
523.	5605	*Eucalyptus cornuta (Yate, Yeid)*			
524.	5607	*Eucalyptus corrugata (Rough-fruited Mallee)*			
525.	5632	*Eucalyptus ebbanoensis (Sandplain Mallee)*			
526.	13549	*Eucalyptus ebbanoensis subsp. ebbanoensis*			
527.	18349	*Eucalyptus ebbanoensis subsp. glauciramula*			
528.	5641	*Eucalyptus ewartiana (Ewart's Mallee)*			
529.	5651	*Eucalyptus formanii*		P4	
530.	5665	*Eucalyptus griffithsii (Griffith's Grey Gum)*			

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531.	5673	*Eucalyptus horistes*			
532.	19523	*Eucalyptus kochii subsp. amaryssia*			
533.	15670	*Eucalyptus kochii subsp. plenissima*			
534.	5696	*Eucalyptus leptopoda (Tammin Mallee)*			
535.	13059	*Eucalyptus leptopoda subsp. leptopoda*			
536.	13056	*Eucalyptus leptopoda subsp. subluta*			
537.	20802	*Eucalyptus longissima*			
538.	5702	*Eucalyptus loxophleba (York Gum, Dwoda)*			
539.	13037	*Eucalyptus loxophleba subsp. lissophloia*			
540.	13038	*Eucalyptus loxophleba subsp. supralaevis*			
541.	19323	*Eucalyptus moderata*			
542.	5725	*Eucalyptus oldfieldii (Oldfield's Mallee)*			
543.	5726	*Eucalyptus oleosa (Giant Mallee)*			
544.	20091	*Eucalyptus oleosa subsp. oleosa*			
545.	5731	*Eucalyptus orbifolia (Round-leaved Mallee)*			
546.	5742	*Eucalyptus petraea (Granite Rock Box)*			
547.	13520	*Eucalyptus polita*			
548.	12380	*Eucalyptus ravida (Silver-topped Gimlet)*			
549.	5761	*Eucalyptus rigidula (Stiff-leaved Mallee)*			
550.	5766	*Eucalyptus salmonophloia (Salmon Gum, Wurak)*			
551.	5767	*Eucalyptus salubris (Gimlet)*			
552.	5772	*Eucalyptus sheathiana (Ribbon-barked Gum)*			
553.	12883	*Eucalyptus subangusta subsp. subangusta*			
554.	5793	*Eucalyptus transcontinentalis (Redwood, Pungul)*			
555.	15799	*Eucalyptus trichopoda*			
556.	5802	*Eucalyptus yilgarnensis (Yorrell)*			
557.	4617	*Euphorbia australis (Namana)*			
558.	16722	*Euryomyrtus maidenii*			
559.	19723	*Euryomyrtus patrickiae*			
560.	20711	*Eutaxia leptophylla*			
561.	10977	*Exocarpos aphyllus (Leafless Ballart)*			
562.	5197	*Frankenia desertorum*			
563.	5204	*Frankenia interioris*			
564.	17348	*Galium aparine (Goosegrass)*	Y		
565.	7323	*Galium murale (Small Goosegrass)*	Y		
566.	25797	*Galium spurium*	Y		
567.	12780	*Gilberta tenuifolia*			
568.	7977	*Gilruthia osbornei*			
569.	6144	*Glischrocaryon flavescens*			
570.	7061	*Glossostigma drummondii (Mudmat)*			
571.	19925	*Glycine peratosa*			
572.	7988	*Gnephosis arachnoidea (Cobwebby-headed Gnephosis)*			
573.	7996	*Gnephosis intonsa (Shaggy Gnephosis)*		P3	
574.	17721	*Gnephosis sp. Norseman (K.R. Newbey 8096)*		P3	
575.	8002	*Gnephosis tenuissima*			
576.	6159	*Gonocarpus nodulosus*			
577.	7495	*Goodenia berardiana*			
578.	7514	*Goodenia havilandii*			
579.	12523	*Goodenia helmsii*			
580.	7531	*Goodenia occidentalis*			
581.	1949	*Grevillea acuaria*			
582.	8830	*Grevillea ceratocarpa*			
583.	1998	*Grevillea erectiloba*		P4	
584.	2000	*Grevillea eriobotrya (Woolly Cluster Grevillea)*			
585.	2004	*Grevillea extorris*			
586.	2009	*Grevillea georgeana*		P3	
587.	2047	*Grevillea nematophylla*			
588.	19541	*Grevillea nematophylla subsp. nematophylla*			
589.	2051	*Grevillea obliquistigma*			
590.	15981	*Grevillea obliquistigma subsp. obliquistigma*			
591.	2057	*Grevillea paradoxa (Bottlebrush Grevillea)*			
592.	15766	*Grevillea shuttleworthiana subsp. obovata*			
593.	2106	*Grevillea tetrapleura*		P4	
594.	15982	*Grevillea zygoloba*			
595.	32386	*Grimmia laevigata*			
596.	2182	*Hakea minyma*			
597.	17557	*Hakea recurva subsp. recurva*			
598.	29840	*Halgania cyanea var. Allambi Stn (B.W. Strong 676)*			
599.	31117	*Halgania cyanea var. Charleville (R.W. Purdie +111)*			
600.	17491	*Halgania cyanea var. cyanea*			

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601.	6691	*Halgania integerrima*			
602.	6174	*Haloragis gossei*			
603.	6180	*Haloragis trigonocarpa*			
604.	17725	*Hannafordia bissillii subsp. latifolia*			
605.	3016	*Heliophila pusilla*	Y		
606.	6843	*Hemigenia brachyphylla*			
607.	6862	*Hemigenia pedunculata*			
608.	5122	*Hibbertia eatoniae*			
609.	5124	*Hibbertia exasperata*			
610.	5165	*Hibbertia rostellata*			
611.	5166	*Hibbertia rupicola*			
612.	5171	*Hibbertia spicata*			
613.	5815	*Homalocalyx thryptomenoides*			
614.	12742	*Hyalosperma demissum*			
615.	11973	*Hybanthus floribundus subsp. curvifolius*			
616.	6239	*Hydrocotyle rugulosa*			
617.	8086	*Hypochaeris glabra (Smooth Catsear)*	Y		
618.	7	*Isoetes australis*			
619.	8087	*Isoetopsis graminifolia (Cushion Grass)*			
620.	7397	*Isotoma petraea (Rock Isotome, Tundiwari)*			
621.	14746	*Jacksonia jackson*		P1	Y
622.	4044	*Kennedia prostrata (Scarlet Runner)*			
623.	13729	*Keraudrenia velutina*			
624.	19892	*Keraudrenia velutina subsp. velutina*			
625.	5840	*Kunzea pulchella (Granite Kunzea)*			
626.	6779	*Lachnostachys coolgardiensis*			
627.	13284	*Lawrencella rosea*			
628.	19726	*Leiocarpa semicalva*			
629.	19727	*Leiocarpa semicalva subsp. semicalva*			
630.	12628	*Lemooria burkittii*			
631.	3033	*Lepidium oxytrichum*			
632.	31770	*Lepidosperma ferricola*		P3	
633.	31766	*Lepidosperma jacksonense*		P1	Y
634.	29138	*Lepidosperma sp. Pigeon Rocks (H. Pringle 30237)*		P3	
635.	12687	*Leptospermum macgillivrayi*		P1	
636.	13260	*Leucochrysum fitzgibbonii*			
637.	16049	*Leucopogon sp. Clyde Hill (M.A. Burgman 1207)*			
638.	20371	*Leucopogon sp. Salt Lake (G.F. Craig 3069)*			
639.	7670	*Levenhookia dubia (Hairy Stylewort)*			
640.	7676	*Levenhookia pusilla (Midget Stylewort)*			
641.	7403	*Lobelia heterophylla (Wing-seeded Lobelia)*			
642.	2533	*Maireana amoena*			
643.	2538	*Maireana carnosa (Cottony Bluebush)*			
644.	2543	*Maireana eriosphaera*			
645.	2544	*Maireana georgei (Satiny Bluebush)*			
646.	2555	*Maireana pentatropis*			
647.	2556	*Maireana planifolia (Low Bluebush)*			
648.	2561	*Maireana radiata*			
649.	2567	*Maireana tomentosa (Felty Bluebush)*			
650.	11662	*Maireana tomentosa subsp. tomentosa*			
651.	2568	*Maireana trichoptera (Downy Bluebush)*			
652.	5865	*Malleostemon roseus*			
653.	16295	*Malleostemon sp. Adelong (G.J. Keighery 11825)*		P2	
654.	5866	*Malleostemon tuberculatus*			
655.	12949	*Marsdenia australis*			
656.	74	*Marsilea drummondii (Common Nardoo)*			
657.	4077	*Medicago minima (Small Burr Medic)*	Y		
658.	4079	*Medicago polymorpha (Burr Medic)*	Y		
659.	5869	*Melaleuca acuminata*			
660.	20284	*Melaleuca atroviridis*			
661.	5896	*Melaleuca cordata*			
662.	5908	*Melaleuca eleuterostachya*			
663.	5912	*Melaleuca fulgens (Scarlet Honeymyrtle)*			
664.	19486	*Melaleuca hamata*			
665.	5929	*Melaleuca leiocarpa*			
666.	9183	*Melaleuca nematophylla (Wiry Honey-myrtle)*			
667.	5958	*Melaleuca radula (Graceful Honeymyrtle)*			
668.	41785	*Melichrus sp. Bungalbin Hill (F.H. & M.P. Mollemans 3069)*		P3	
669.	17643	*Microcorys sp. Mt Gibson (S. Patrick 2098)*			
670.	19787	*Micromyrtus monotaxis*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
671.	6000	*Micromyrtus racemosa*			
672.	8105	*Millotia myosotidifolia*			
673.	12631	*Millotia perpusilla*			
674.	8107	*Minuria cunninghamii (Bush Minuria)*			
675.	4089	*Mirbelia depressa*			
676.	41443	*Mirbelia ferricola*		P3	
677.	4094	*Mirbelia microphylla*			
678.	490	*Monachather paradoxus*			
679.	29418	*Monoculus monstrosus*	Y		
680.	31791	*Neurachne annularis*		P3	
681.	6976	*Nicotiana occidentalis (Native Tobacco)*			
682.	6978	*Nicotiana rotundifolia (Round-leaved Tobacco)*			
683.	8134	*Olearia exiguifolia (Small-leaved Daisy Bush)*			
684.	12734	*Olearia humilis*			
685.	8140	*Olearia muelleri (Goldfields Daisy)*			
686.	8145	*Olearia pimeleoides (Pimelea Daisybush, Burrobunga)*			
687.	8151	*Olearia stuartii*			
688.	8152	*Olearia subspicata (Spiked Daisy Bush)*			
689.	12670	*Parietaria cardiostegia*			
690.	10975	*Paspalidium basicladum*			
691.	518	*Paspalidium clementii (Clements Paspalidium)*			
692.	2259	*Persoonia coriacea (Leathery-leaf Persoonia)*			
693.	3674	*Petalostylis cassioides*			
694.	4497	*Phebalium canaliculatum*			
695.	4500	*Phebalium filifolium (Slender Phebalium)*			
696.	4504	*Phebalium tuberculosum*			
697.	18539	*Philotheca brucei*			
698.	18537	*Philotheca brucei subsp. brucei*			
699.	16833	*Philotheca coateana*		P3	
700.	18519	*Philotheca coccinea*			
701.	18386	*Philotheca deserti subsp. brevifolia*		P3	
702.	18385	*Philotheca deserti subsp. deserti*			
703.	18506	*Philotheca tomentella*			
704.	16177	*Phyllangium paradoxum*			
705.	4142	*Phyllota luehmannii*			
706.	5245	*Pimelea forrestiana*			
707.	5256	*Pimelea microcephala (Shrubby Riceflower, Banjine)*			
708.	11185	*Pimelea microcephala subsp. microcephala*			
709.	12104	*Pimelea spiculigera var. thesioides*			
710.	19744	*Pittosporum angustifolium*			
711.	7299	*Plantago debilis*			
712.	65	*Pleurosorus rutifolius (Blanket Fern)*			
713.	573	*Poa drummondiana (Knotted Poa)*			
714.	8172	*Podolepis canescens (Bright Podolepis, Grey Podolepis)*			
715.	8173	*Podolepis capillaris (Wiry Podolepis)*			
716.	8177	*Podolepis lessonii*			
717.	8181	*Podolepis tepperi*			
718.	8182	*Podotheca angustifolia (Sticky Longheads)*			
719.	8184	*Podotheca gnaphalioides (Golden Long-heads)*			
720.	12706	*Prostanthera althoferi*			
721.	15822	*Prostanthera althoferi subsp. althoferi*			
722.	6912	*Prostanthera campbellii*			
723.	6916	*Prostanthera grylloana*			
724.	6919	*Prostanthera magnifica (Magnificent Prostanthera)*			
725.	41650	*Prostanthera prostantheroides*			
726.	11986	*Prostanthera semiteres subsp. intricata*			
727.	4725	*Psammomoya choretroides*			
728.	16370	*Psammomoya grandiflora*			
729.	18155	*Psydrax suaveolens*			
730.	10778	*Pterostylis picta*			
731.	19327	*Pterostylis sp. dainty brown (N. Gibson & M. Lyons 3690)*			
732.	18657	*Pterostylis sp. inland (A.C. Beauglehole 11880)*			
733.	10897	*Pterostylis spathulata*			
734.	2690	*Ptilotus aervoides*			
735.	2707	*Ptilotus carlsonii*			
736.	2717	*Ptilotus divaricatus (Climbing Mulla Mulla)*			
737.	2718	*Ptilotus drummondii (Narrowleaf Mulla Mulla)*			
738.	41246	*Ptilotus exiliflorus*			
739.	2727	*Ptilotus gaudichaudii*			
740.	41506	*Ptilotus gaudichaudii subsp. gaudichaudii*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
741.	2730	*Ptilotus helichrysoides*			
742.	2732	*Ptilotus holosericeus*			
743.	2746	*Ptilotus nobilis (Tall Mulla Mulla)*			
744.	2747	*Ptilotus obovatus (Cotton Bush)*			
745.	15855	*Ptilotus schwartzii var. schwartzii*			
746.	41000	*Ptilotus sp. Goldfields (R. Davis 10796)*			
747.	2581	*Rhagodia drummondii*			
748.	11254	*Rhagodia preissii subsp. preissii*			
749.	13306	*Rhodanthe battii*			
750.	13241	*Rhodanthe chlorocephala subsp. rosea*			
751.	13300	*Rhodanthe citrina*			
752.	13305	*Rhodanthe heterantha*			
753.	13294	*Rhodanthe laevis*			
754.	13234	*Rhodanthe manglesii*			
755.	13238	*Rhodanthe maryonii*			
756.	13248	*Rhodanthe oppositifolia*			
757.	13249	*Rhodanthe oppositifolia subsp. oppositifolia*			
758.	13296	*Rhodanthe polycephala*			
759.	13252	*Rhodanthe pygmaea*			
760.	13253	*Rhodanthe rubella*			
761.	13254	*Rhodanthe stricta*			
762.	6599	*Rhyncharrhena linearis (Bush Bean, Wintjulanypa)*			
763.	14225	*Ricinocarpos brevis*		T	
764.	11151	*Rostraria pumila*	Y		
765.	30434	*Salsola australis*			
766.	2356	*Santalum acuminatum (Quandong, Warnga)*			
767.	2359	*Santalum spicatum (Sandalwood, Wilarak)*			
768.	13008	*Sarcostemma viminale*			
769.	7639	*Scaevola restiacea*			
770.	12586	*Scaevola spicigera*			
771.	7644	*Scaevola spinescens (Currant Bush, Maroon)*			
772.	8200	*Schoenia cassiniana (Schoenia)*			
773.	2606	*Sclerolaena cuneata (Yellow Bindii)*			
774.	2607	*Sclerolaena densiflora*			
775.	2609	*Sclerolaena diacantha (Grey Copperburr)*			
776.	2610	*Sclerolaena drummondii*			
777.	2615	*Sclerolaena fusiformis*			
778.	8877	*Sclerolaena gardneri*			
779.	2619	*Sclerolaena lanicuspis (Spinach Burr)*			
780.	2627	*Sclerolaena patenticuspis (Spear-fruit Saltbush)*			
781.	8206	*Senecio glomeratus (Cluster-headed Fireweed)*			
782.	8207	*Senecio glossanthus (Slender Groundsel)*			
783.	25881	*Senecio lacustrinus*			
784.	20161	*Senecio pinnatifolius*			
785.	8217	*Senecio quadridentatus*			
786.	17645	*Senna artemisioides*			
787.	12276	*Senna artemisioides subsp. filifolia*			
788.	17558	*Senna artemisioides subsp. x artemisioides*			
789.	16378	*Senna pleurocarpa*			
790.	12315	*Senna pleurocarpa var. angustifolia*			
791.	12314	*Senna pleurocarpa var. pleurocarpa*			
792.	4970	*Sida calyxhymenia (Tall Sida)*			
793.	31759	*Sida ectogama*			
794.	31854	*Sida sp. Excedentifolia (J.L. Egan 1925)*			
795.	31857	*Sida sp. Golden calyces glabrous (H.N. Foote 32)*			
796.	19712	*Sida sp. dark green fruits (S. van Leeuwen 2260)*			
797.	2909	*Silene gallica (French Catchfly)*	Y		
798.	7013	*Solanum hoplopetalum (Thorny Solanum)*			
799.	7018	*Solanum lasiophyllum (Flannel Bush, Mindjulu)*			
800.	7023	*Solanum nummularium (Money-leaved Solanum)*			
801.	7026	*Solanum orbiculatum (Wild Tomato)*			
802.	7028	*Solanum petrophilum (Rock Nightshade)*			
803.	7038	*Solanum terraneum*			
804.	8230	*Sonchus asper (Rough Sowthistle)*	Y		
805.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		
806.	12647	*Sondottia connata*			
807.	20767	*Spartothamnella sp. Helena & Aurora Range (P.G. Armstrong 155-109)*		P3	
808.	6827	*Spartothamnella teucriiflora*			
809.	19555	*Stackhousia muricata subsp. annual (W.R. Barker 2172)*			
810.	43541	*Stackhousia sp. Hairy fruited (E.N.S. Jackson 1387)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
811.	2917	*Stellaria filiformis (Thread Spurry)*			
812.	14797	*Stenanthemum newbeyi*		P3	
813.	16200	*Stenanthemum stipulosum*			
814.	3076	*Stenopetalum filifolium*			
815.	3077	*Stenopetalum lineare (Narrow Thread Petal)*			
816.	30212	*Stenopetalum lineare var. lineare*			
817.	3079	*Stenopetalum pedicellare*			
818.	8236	*Streptoglossa cylindriceps*			
819.	8238	*Streptoglossa liatroides*			
820.	7714	*Stylidium dielsianum (Tangle Triggerplant)*			
821.	7719	*Stylidium ecorne (Foot Triggerplant)*			
822.	7740	*Stylidium induratum (Desert Triggerplant)*			
823.	7810	*Stylidium yilgarnense (Yilgarn Triggerplant)*			
824.	33018	*Styphelia sp. Bullfinch (M. Hislop 3574)*		P3	
825.	4221	*Swainsona colutoides (Bladder Vetch)*			
826.	4231	*Swainsona kingii*			
827.	31918	*Tecticornia doleiformis (Samphire)*			
828.	33216	*Tecticornia sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)*			
829.	31717	*Tecticornia undulata*			
830.	2822	*Tetragonia eremaea*			
831.	16287	*Tetragonia moorei*			
832.	4534	*Tetratheca harperi (Jackson Tetratheca)*		T	Y
833.	13649	*Tetratheca paynterae*			Y
834.	23987	*Tetratheca paynterae subsp. cremnobata*		T	Y
835.	23988	*Tetratheca paynterae subsp. paynterae*		T	Y
836.	20732	*Thelymitra petrophila*			
837.	6050	*Thryptomene australis (Hook-leaf Thryptomene)*			
838.	19698	*Thryptomene australis subsp. australis*			
839.	6058	*Thryptomene kochii*			
840.	6068	*Thryptomene urceolaris*			
841.	674	*Thyridolepis mitchelliana (Mulga Grass)*			
842.	1338	*Thysanotus manglesianus (Fringed Lily)*			
843.	1343	*Thysanotus patersonii*			
844.	1352	*Thysanotus speckii*			
845.	19253	*Trachymene ceratocarpa*			
846.	6268	*Trachymene cyanopetala*			
847.	6279	*Trachymene ornata (Spongefruit)*			
848.	6280	*Trachymene pilosa (Native Parsnip)*			
849.	12652	*Trichanthodium skirrophorum*			
850.	17874	*Triodia rigidissima*			
851.	699	*Triodia scariosa*			
852.	13041	*Triodia tomentosa*			
853.	705	*Tripogon loliiformis (Five Minute Grass)*			
854.	8253	*Triptilodiscus pygmaeus*			
855.	16986	*Trymalium myrtillus subsp. myrtillus*			
856.	7656	*Velleia cycnopotamica*			
857.	7661	*Velleia hispida (Hispid Velleia)*			
858.	7664	*Velleia rosea (Pink Velleia)*			
859.	6087	*Verticordia helmsii*			
860.	8268	*Vittadinia humerata*			
861.	11018	*Vulpia muralis*	Y		
862.	724	*Vulpia myuros (Rat's Tail Fescue)*	Y		
863.	33101	*Vulpia myuros forma myuros*	Y		
864.	7386	*Wahlenbergia gracilenta (Annual Bluebell)*			
865.	7393	*Wahlenbergia tumidifructa*			
866.	8275	*Waitzia acuminata (Orange Immortelle)*			
867.	13331	*Waitzia acuminata var. acuminata*			
868.	6938	*Westringia cephalantha*			
869.	34602	*Westringia cephalantha var. cephalantha*			
870.	9247	*Westringia rigida (Stiff Westringia)*			
871.	1391	*Wurmbea densiflora*			
872.	1248	*Xerolirion divaricata (Basil's Asparagus)*			
873.	4386	*Zygophyllum aurantiacum (Shrubby Twinleaf)*			
874.	18140	*Zygophyllum eichleri*			
875.	4389	*Zygophyllum eremaeum*			
876.	4390	*Zygophyllum fruticulosum (Shrubby Twinleaf)*			
877.	4392	*Zygophyllum iodocarpum*			
878.	4394	*Zygophyllum ovatum (Dwarf Twinleaf)*			

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix H: Heritage Report

JCHMC

REPORT ON AN ARCHAEOLOGICAL AND ETHNOGRAPHIC SITE AVOIDANCE SURVEY OF RAMELIUS DIE HARDY AND RED LEGS PROJECT

Prepared for Ramelius Resources

SEPTEMBER 2020

Part 2 of this Report is Confidential and can be viewed by Ramelius only.

Part 2 of this report contains names of deceased Aboriginal people.

ACKNOWLEDGEMENTS

JCHMC Pty Ltd would like to acknowledge and thank Ramelius Project Geologist Erik Van Noort and the Traditional Owners who participated in the survey.

DATUM

All spatial references for heritage places in this report are in GDA 94 (MGA Zone 50) and are accurate to 3m.

AUTHORSHIP

This report was prepared by John Cecchi.

REFERENCE

J. Cecchi 2020. Report On an Archaeological and Ethnographic Site Avoidance Survey of Ramelius Die Hardy and Red Legs Project. Unpublished Report prepared for Ramelius Resources. Closed Access/Confidential Report.

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ABBREVIATIONS

ABBREVIATION	DEFINITION
ACMC	Aboriginal Cultural Material Committee
Act	The Aboriginal Heritage Act 1972 (WA)
AHIS	Aboriginal Heritage Inquiry System
AHS	Aboriginal Heritage Survey
A/S	Artefact Scatter
BIF	Banded Iron Formation
BoM	Bureau of Meteorology
BP	Before Present (BP) before 1 January 1950
14C	Radiocarbon. Carbon 14 isotope
cal BP	calibrated years or calendar years before 1 January 1950
DPLH	Western Australian Department of Planning, Lands and Heritage
GPS	Global Positioning System
HIS	Heritage Information Submission Form
ICOMOS	International Council on Monuments and Sites
LGM	Last Glacial Maximum
MG	Marlinyu Ghoorlie
PAD	Potential Archaeological Deposit
Project	Ramelius drilling exploration at Die Hardy, 140km north of Southern Cross.
Register	The Register of Aboriginal Sites, Western Australia
Registrar	The Registrar of Sites, Department of Planning, Lands and Heritage
R/S	Rock shelter
s5	Section 5 of the Aboriginal Heritage Act 1972 (WA)
s16	Section 16 of the Aboriginal Heritage Act 1972 (WA)
s18	Section 18 of the Aboriginal Heritage Act 1972 (WA)
TO	Traditional Owners

EXECUTIVE SUMMARY

i. Author: John Cecchi

ii. Project Name: Die Hardy and Red Legs

iii. Project Brief: Identify places that are likely to meet the requirements of the *Aboriginal Heritage Act 1972* (WA) (the Act) by undertaking an archaeological and ethnographic site avoidance field survey in consultation with MG and Kaparn Traditional Owners.

iv. Survey Area Location and Extent: Ramelius is planning exploratory mining operations at its Die Hardy and Red Legs tenements, approximately 140 kilometers north of Southern Cross, in Western Australia. The survey area consists of approximately 2.6km² of land on either side of the Bullfinch-Evanston Road, north of Mt Geraldine and a connecting haul road.

v. Traditional Owners Consulted/Field Participants: The following stakeholders were consulted with regards to the Project and participated in an ethnographic and archaeological field survey:

Marlinyu Ghoorlie	**Kaparn**
George A. Champion	Elizabeth Sambo
George R. Champion	Gina Sambo
Charlie Champion	Lonnie Coleman
Sariah Champion	Leith Sambo
Kyron Tucker	Si-Anne Sambo
Malcom Champion	Daniel Lewis
Kristy Forrest	
Kylie Champion	
Jonelle Champion	
Danielle Champion	
Jodi Walley	

Table 1. Traditional owners consulted.

John Cecchi, Finn Mickle and Liam Hotinski of JCHMC Pty Ltd were engaged as heritage consultants.

vi. Field Survey Dates: The field work and consultation for the Project was undertaken from August 15 to 18, 2020.

vii. Methods: A search for previous surveys and recorded sites in the region was undertaken prior to the field survey in order to identify any known sites and relevant previous heritage surveys. No Registered sites are listed on the DPLH Site Register near or within the Project. Prior to the commencement of the field inspection, the survey team members discussed the general cultural landscape and Aboriginal ethnographic values that it may contain. To ensure systematic coverage for sites pedestrian transects were aligned east-west, north-south or along the proposed haul road route, with participants spaced 20m apart.

viii. Results: As a result of the ethnographic consultation and archaeological field survey:

- all the defined survey areas were assessed;
- no heritage sites were identified within the Project;
- one area of ethnographic significance was reported by the Kaparn people. Details of this site are included in Part 2 of this report. Information relating to this site is deemed confidential by the Kaparn traditional owners and Part 2 of this report can only be viewed by Ramelius; and
- the MG and Kaparn people consulted approve works within the Project (Appendix E).

ix. Discussion: It is postulated that given the ethnographic consultation and field survey any major Aboriginal heritage site/s within the survey area would have been recorded. Given the results the MG and Kaparn stakeholders consulted approve the Project. Sites are protected under the Act whether Registered or yet unrecorded. The proponent should formulate and implement a plan to manage potential disturbances to sites of Aboriginal heritage and skeletal remains during ground works. Should ground works encounter buried Aboriginal cultural material or human skeletal remains the DPLH Site Registrar should be contacted, additionally for the latter the WA Police should be notified and works ceased until a proper inspection of the find/s has taken place.

x. Conclusion: The Project should proceed as planned. A plan should be formulated to manage potential cultural material/skeletal finds during ground works.

xi. Recommendations

- **RECOMMENDATION 1- Earthworks Planning**

Sites are protected under the Act whether Registered or yet unrecorded. Ramelius should have a plan to mitigate potential disturbances to sites of Aboriginal heritage/skeletal material during ground works.

- **RECOMMENDATION 2- Project Approval**

An ethnographic consultation and systematic archaeological field survey have been undertaken over the Project and as a result no new sites of Aboriginal heritage were identified within the proposed work areas. Given the results the Aboriginal stakeholders recommend that the Project may proceed as planned.

- **RECOMMENDATION 3- Future Works Planning**

Any future plans for works in the area should consider the location of the heritage place reported under Part 2 of this report. Ramelius should aim to keep access to this place open to Kaparn members and it is recommended that future plans consider the site's location in order to avoid any unwarranted disturbances there.

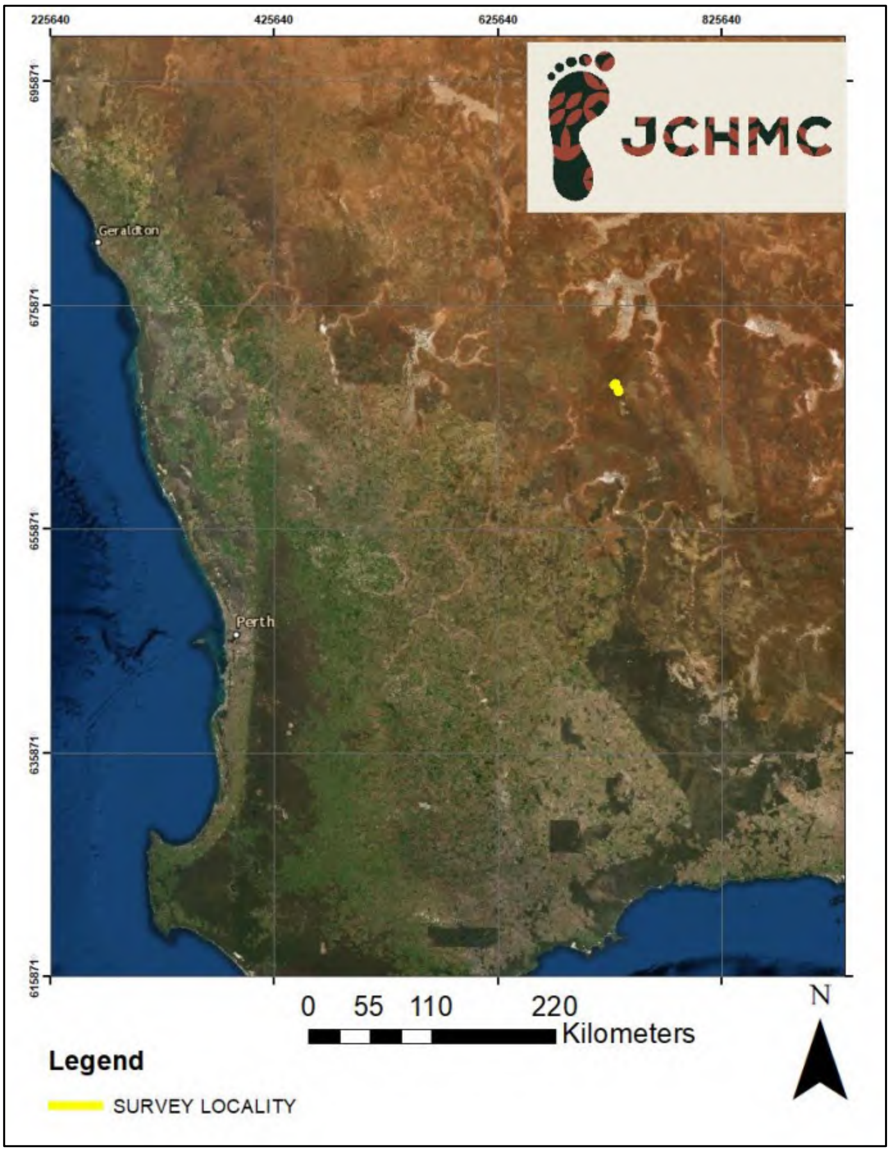
CONTENTS

PART 1 – REPORT

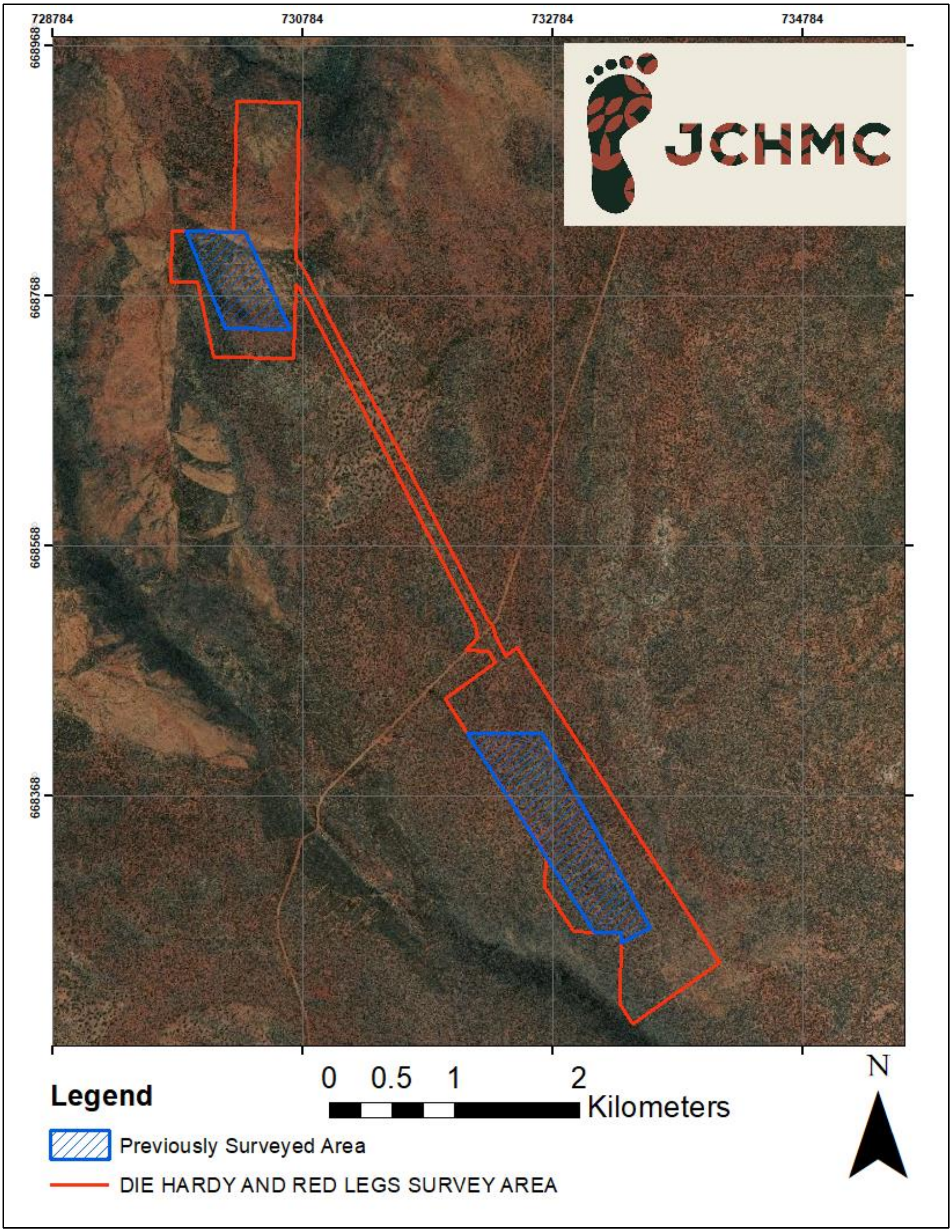
1. INTRODUCTION

JCHMC Pty Ltd was commissioned to undertake an ethnographic and archaeological Aboriginal site avoidance survey of the Project. The Project is located approximately 140 kilometres north of Southern Cross (Map 1) and consists of land within the following areas (Map 2):

- Red Legs and connecting haulage road (1.3km²); and
- Die Hardy (1.3km²).



Map 1. Survey Locality Map.



Map 2. Aerial Map of Die Hardy and Red Legs Survey Area.

1.1. PROJECT BRIEF

The purpose of the ethnographic and archaeological Aboriginal heritage site avoidance survey was to locate Aboriginal sites that are likely to meet the requirements of the Act.

The survey areas include:

- the Die Hardy and Red Legs mining tenements and a proposed haulage road connecting both tenements to the Bullfinch-Evanston Road.

To complete the brief JCHMC Pty Ltd was engaged to:

- undertake an ethnographic field survey with members of the MG and Kaparn Group;
- identify sites of archaeological and, or ethnographic significance and assess whether an identified site meets the criteria of the Act; and
- record the location and extent, and describe any Aboriginal heritage site that is identified using a systematic method of recording.

1.2. FIELD WORK DATES

The field work and consultation for the Project was undertaken from August 15 to 18, 2020.

1.3. FIELD WORK PARTICIPANTS

The following people participated in field work for the project.

Table 2. Field Participants.

MG MEMBERS	KAPARN	JCHMC	RAMELIUS
George A. Champion	Elizabeth Sambo	John Cecchi	Erik Van Noort
George R. Champion	Gina Sambo	Finn Mickle	
Charlie Champion	Lonnie Coleman	Liam Hotinski	
Sariah Champion	Leith Sambo		
Kyron Tucker	Si-Anne Sambo		
Malcom Champion	Daniel Lewis		
Kristy Forrest			
Kylie Champion			
Jonelle Champion			
Danielle Champion			
Jodi Walley			

The relevant background information regarding this Aboriginal heritage site avoidance survey can be found in the following appendices.

- Appendix A. - Environmental Background.
- Appendix B. - Archaeological Background.
- Appendix C. - Ethnographic Background.
- Appendix D. - Legislative Context.
- Appendix E. - Signed Statements of Aboriginal Consultation and Conditional Project Approval.
- Appendix F. - References.

Plate 1. Kaparn survey participants (L-R): John Cecchi, Gina Sambo, Si-Anne Sambo, Lonnie Coleman, Elizabeth Sambo, Daniel Lewis and Leith Sambo.

Plate 2. MG Survey Participants (L-R): Finn Mickle, George R. Champion, Charlie Champion, Malcom Champion, Sariah Champion, Kyron Tucker, George A. Champion and Liam Hotinski.

Plate 3. MG Survey Participants (L-R): George A. Champion, Jonelle Champion, Kylie Champion, Kristy Forrest, Danielle Champion and Jodi Walley.

Plate 4. View northwest from southwest corner of survey area.

Plate 5. View south of survey area.

Plate 6. Survey participants undertaking transects at the survey area.

2. METHODS

2.1 PRE-DESK TOP REVIEW

Prior to the commencement of fieldwork JCHMC undertook a desktop review of the Survey Area. The purpose of desktop review was to address the following components of the project:

- identify any potential safety management and environmental issues;
- undertake appropriate GIS terrain (slope) analysis and mapping to inform a suitable survey strategy;
- identify any landscapes or other areas with higher ethnographic/archaeological potential or interest; and
- propose a specific survey strategy for the project with reference to the components identified through the review.

2.1.1 AHIS SEARCH

As part of the desktop study for this project, JCHMC undertook a search of the DPLH Register of Places and Objects through the online Aboriginal Heritage Inquiry System (AHIS) and a review of relevant previous heritage reports held by JCHMC and the DPLH.

No known heritage sites were identified within the survey area.

The author's private library contained five relevant reports that are summarized below (Table 3).

Table 3. Relevant Heritage Survey Reports

SURVEY REPORT ID	SURVEY TYPE	REPORT AUTHORS	REPORT TITLE	AREA DESCRIPTION
N/A	Cecchi, J.	Archaeological and Ethnographic	Aboriginal Site Avoidance Survey of Ramelius Resources Limited Marda Project, near Windarling, Goldfields, WA	Three proposed drill lines were surveyed to the north of the Die Hardy project on the western side of Bullfinch-Evanston road in consultation with members of the Marlinyu Ghoorlie and former Central West Goldfields people (currently Kaparn group). No sites were identified near the current survey area.
N/A	Cecchi, J.	Archaeological and Ethnographic	Report on an Aboriginal Heritage Survey of Radar Iron Limited's Johnston Range, Evanston and Die Hardy Project Areas. Yilgarn Region, Western Australia. Report prepared for Radar Iron Ltd.	Nine previously reported sites were identified via a desktop study and the survey newly recorded seven sites, including rockshelter, artefact scatter, rockhole and quarry sites. Recommendations included avoidance of breakaway/granite outcrop areas and avoidance of recorded sites. An artefact scatter/reduction area site (named Die Hardy 1) was also recorded within the Die Hardy Project Area, south of Mt Geraldine and outside the current survey area.

N/A	Cecchi, J.	Archaeological and Ethnographic	Report On An Archaeological Survey Of Radar Iron Ltd Die Hardy Project	One quarry site was identified comprising approximately 300 chert artefacts. The survey was undertaken in consultation with members of the former Kelemaia Kubu(d)n group, now MG and former Central West Goldfields, now Kaparn group.
N/A	Cecchi, J.	Archaeological and Ethnographic	Report on an Archaeological Survey of Southern Cross Goldfields Ltd Die Hardy and Red Legs Project. Report prepared for Southern Cross Goldfields Ltd.	This survey event surveyed the areas within the current Project. Members of the Sambo and Champion family were consulted and participated in a field survey. No sites were located within the survey area.
N/A	Cecchi, J.	Archaeological and Ethnographic	Report On An Aboriginal Heritage Survey Of Southern Cross Goldfields Ltd Marda Gold Project Additional Areas And Die Hardy Road Widening	Members of the Sambo and Champion family were consulted and participated in a field survey. No sites were located within or near the current Project.

2.3 INFIELD BRIEFING

The Survey team undertook a project briefing prior to the commencement of field work. The purpose was to brief the members present about the survey scope and the proposed works and to discuss the proposed survey strategy for the Project, identify any landscapes with higher ethnographic/archaeological potential and identify any potential safety management and environmental issues.

3.0 SURVEY METHODS

The heritage site avoidance survey aimed to identify all Aboriginal heritage sites within the Project that may meet the requirements of the Act. To meet this objective, a consultation and field survey was undertaken over the survey area.

Prior to the commencement of the field inspection, the survey team members discussed the general cultural landscape and Aboriginal ethnographic values that it may contain. To ensure systematic coverage for sites, transects were aligned north-south, east-west or along the proposed haul road route with pedestrians spaced 20m apart.

3.1 SIGNIFICANCE ASSESSMENT

The Australia ICOMOS Charter for Places of Cultural Significance, The Burra Charter, 2013 (Burra Charter) and the associated series of Practice Notes provide a best practice standard for managing cultural heritage places in Australia (Australia ICOMOS 2020). The values assessed are aesthetic, historic, scientific, social and spiritual values.

Further assessment is applied for archaeological significance. The standard applied is based on a site's representativeness and research potential (Bowdler 1984). Site significance is therefore assessed on the basis of present knowledge of sites within the area, archaeological techniques, theory and method, all of which will invariably vary with time.

During the survey, the significance of archaeological sites was analysed in regards to its potential to answer the following research questions:

-When was the region initially occupied by Aboriginal people? What cultural shifts occurred in response to differing sea levels in the past?

-How did economies adapt to environmental and climate changes?

-How do occupational patterns reflect this?

-What stone tool technologies and reduction practices were employed in the area?

-What are the characteristics and what accounts for variables in stone tool production within assemblages and over time?

Overall these questions can generate knowledge on pre-historic human economies and environmental adaptation by exploring the relationships between certain areas and processes within the archaeological record.

4.0 RESULTS

4.1 SURVEY AREA

The Survey Area was assessed in its entirety.

4.2 SURVEY RESULTS

No new sites of Aboriginal heritage were identified within the survey area.

One site of ethnographic significance was reported by the Kaparn group, proximal and outside of the current survey area. Information relating to this place are included under Part 2 of this report. This information was deemed confidential by the Kaparn traditional owners and can only be viewed by Ramelius.

5. DISCUSSION AND CONCLUSION

Given the survey methodology and Aboriginal consultation and field work it is postulated that any major site of archaeological and, or ethnographic significance within the Project would have been identified. Given the survey results the Traditional owners consulted approve the Project.

A site of ethnographic significance was deemed to be relevant to the Project by members of the Kaparn group. This site is situated outside of the current survey area, however the survey participants requested that information regarding this site be included in the report to inform Ramelius of the site's location and significance in order to ensure Kaparn people's continued access to the place, and prevent any unwarranted disturbances to this place. Information with regards to this site was deemed confidential by the Kaparn members consulted and details under Part 2 of this report can only be viewed by Ramelius.

Sites are protected under the Act whether Registered or yet unrecorded. The proponent should formulate and implement a plan to manage potential disturbances to sites of Aboriginal heritage and skeletal remains during ground works. Should ground works encounter buried Aboriginal cultural material or human skeletal remains the DPLH Site Registrar should be contacted, additionally for the latter the WA Police should be notified and works ceased until a proper inspection of the find/s has taken place.

6. RECOMMENDATIONS

6.1 RECOMMENDATION 1- Earthworks Planning

Sites are protected under the Act whether Registered or yet unrecorded. Ramelius should have a plan to mitigate potential disturbances to sites of Aboriginal heritage/skeletal material during ground works.

6.2 RECOMMENDATION 2-Project Approval

An ethnographic consultation and systematic archaeological field survey have been undertaken over the Project and as a result no new sites of Aboriginal heritage were identified within the proposed work areas. The Aboriginal stakeholders recommend that the Project may proceed as planned.

6.3 RECOMMENDATION 2-Future Works

Any future plans for works in the area should consider the location of the heritage place reported under Part 2 of this report. Ramelius should aim to keep access to this place open to Kaparn members and it is recommended that future plans consider the site's location in order to avoid any unwarranted disturbances there.

APPENDIX A-ENVIRONMENTAL BACKGROUND

A.1 CLIMATE

The study area experiences a semi-arid climate with 9 to 11 months of the year being dry and is characterised hot summers and mild winters. Mean maximum temperature for the hottest month occur in January at 36 °C with a mean minimum of 20.9 °C. Maximum temperatures exceeding 45 °C have been recorded for the region. Temperatures in July reach a mean maximum of 17.4 °C and a mean minimum of 6 °C. The area receives on average of 253mm of rain annually, fairly evenly distributed throughout the year, with slightly higher fall in the between February and July. Winter rainfall is usually associated with cold fronts, whilst summer thunderstorms provide the area with localised and variable rainfall during the summer months. Flooding is not uncommon during thunderstorms with one 24hr period event recording nearly 150mm of rain. Lowest rainfall for the area has been recorded at 0mm for nearly all the months of the year and the area is subject to droughts due to high temperatures and high evaporation rates (Beard 1981).

A.2 PALEOCLIMATE

Throughout the Quaternary period studies have shown evidence for an expansion and contraction of the arid zone in response to changing climatic conditions with a peak in arid conditions during the Last Glacial Maximum (Smith 1987, 1989, Veth 1989, 1993a, 1995, O'Connor and Veth 2006).

The Pleistocene period lasting 50k BP to 35k BP would likely have presented warmer and wetter conditions than at present. Studies have shown that both tropical trade winds and westerlies in the period prior to 50k BP would have resulted in greater Indo-Australian monsoon activity (Cohen et al. 2012; Johnson et al. 1999). During this time it is postulated that mega-lakes would have formed in the interior with surface water widely available (Cohen et al 2011, De Dekker et al 2011).

A shift in climate has been proposed for the period after 25k BP to 17kBP (Hiscock 2008) with peaks in glacial conditions occurring from 18k to 14k BP (Veth 1993b and Marwick 2002). The last glacial period and LGM is postulated to be characterised by lower sea-surface temperatures (Burroughs and Juggins 2005) and as being colder, windier and drier than today. These conditions and the resulting reduction of surface water and higher evaporation rates is postulated to have led to drying of great inland lakes, reduced faunal resources and expansion of the arid zone (O'Connor and Veth 2006). At this stage sea-levels are estimated to have been over 100m lower than at present rising to their current levels 4k to 6k BP (Chappel and Thom 1977).

The climate began to warm post LGM for a period of about 6k years before a shift of conditions. Sea levels began to rise and inundate then coastal areas to form islands such as the Dampier Archipelago and Barrow Island (Copp 2005) in the Pilbara and Rottnest Island off the Perth metropolitan area. A relative temporary reversal of conditions occurred during the Antarctic Cold Reversal, followed by a continued period of warmer and wetter climate coinciding with the re-appearance of the northern summer monsoon cycle and an increase in vegetation cover and mega-lake formation in central Australia (Wyroll & Miller 2001). A shift in climate has been noted between 5k to 4k BP with drier conditions prevailing and a cessation of the northwest monsoon at this period (Nott 2011, Dimitriades & Cranston 2001).

A wetter climate is postulated from between 4k to 2k BP, with arid conditions trending over the last 2k years to present.

APPENDIX B- ARCHAEOLOGICAL BACKGROUND

B.1 REGIONAL RESEARCH

The survey region has not been the subject of much in-depth archaeological investigation. Current research trends focus on the initial occupation of the region, as well as human settlement patterns, in terms of Australia's arid zone (Smith 1986, Veth 1989, 1993a, 1995) and climatic and environmental changes over time, with special attention to the adaptation to climatic conditions of the LGM and the effects of sea level changes (Veth 1989).

Some of the earliest dated sites in WA come from Barrow Island, some 64km offshore from Mardie Station in WA Pilbara Region, where at Boodie Cave cultural material has been dated to 53±5.4 KA (Veth et al. 2017, Ward et al 2017). Several rockshelters in the Hamersley and Chichester region have yielded cultural material dated to around 40,000 BP (Morse et al 2014, Dias & Rapley 2014).

Aboriginal colonisation theories for arid and semi-arid ecosystems have been widely debated. Smith (1988) has suggested that availability of water during an earlier lacustral phase would have allowed Aboriginal occupation of the interior of Australia by 12,000 BP. Occupation of desert lowlands before and during the last glacial maximum would have been abandoned until the amelioration in climate c.15,000 to 7,000 BP. Veth (2000) postulated a different model whereby the initial colonisation of the arid regions occurred during the more favorable climatic period of the late Pleistocene, from approximately 25,000 BP, with a retreat to less arid areas during the 22,000 to 13,000 BP period, and a re-occupation of marginal lands between 13,000 to 5,000 BP. From 5,000 to 1,500 BP all desert ecosystems are thought to have been inhabited due to a re-establishment of regional networks and an intensification of site occupation, ceremonial gatherings and long distance exchange (Veth 2000).

Both the Pleistocene and Holocene occupation of the arid region are not well understood with most of the information stemming from rockshelter sites, 80% of which are dated to the Holocene (Morse et al 2009). Whilst this has been seen as an intensification of site occupation it can be argued that this may be an overrepresentation of younger deposits caused by lack of preservation of older deposits and or higher probability of their destruction by subsequent occupations.

Several dated rockshelter sites within the survey region have yielded Holocene dates in the range of 2,000 BP near Leinster (Liberman et al 1977) and near Deception Hill (Cecchi 2017), and 1,570 BP at Windimurra (Harris 2002) to 500 BP near Hyden (Bowdler 1989 at Carina Rockshelter dated to c.500BP (Artefaxion 2009a) and at Windarling Rockshelter dated to 927 + 37BP (Artefaxion 2009b).

According to previous research, the archaeological mark of a rain-chasing model of occupation includes a higher number of low-density artefact scatters around ephemeral water sources and larger sites associated with more permanent water bodies.

B.2 REGIONAL ARCHAEOLOGICAL EXCAVATION

Several rockshelters have been subject to archaeological excavation in the region indicating a sparse occupation over the last 2,000 years, including Mulka's Cave southwest of the Project. The results of that excavation concluded that the site was occupied minimally, on few occasions, over the last 500 years (Bowdler et. al. 1989). Recent excavations surrounding Mulka's Cave have yielded two dates of 6,000 BP and 8,000 BP respectively (Rossi 2013) indicating a much earlier occupation of the area.

North of the Project, at Windimurra, Harris excavated a test pit to bedrock ending at a depth of 53cm. A hearth identified between 15 and 20cm below the surface was dated to 468±43 BP, whit the oldest occupation for the rockshelter was dated to 1572 + 45 BP (Harris 2002). Fifty-one artefacts were recovered, most of which comprised debitage, with only one utilised flake and one core fragment recovered. The main artefact lithology comprised quartz with a minor percentage of ironstone, chalcedony and chert artefacts.

Liberman et al. (1977) excavated a rockshelter near Leinster, with stratified cultural deposits including a hearth between 5-10cm below the surface and hundreds of artefacts, including backed blades. Charcoal from the hearth was dated to 2160±105 BP.

Previously, excavations at a rockshelter near Windarling Peak recovered eleven stone artefacts dated to 900 BP (Artefaxion 2009a). The paucity of artefacts was interpreted as indicating an ephemeral or transitory occupation of the rockshelter.

Another rockshelter at Curragibbin Hill, was excavated via a 1m² test pit dug to a depth of 48cm. Two lithic artefacts were recovered just below the surface and no other Aboriginal cultural material was identified (Artefaxion 2009b).

The Carina Rockshelter was excavated to a maximum depth of 23 cm (Artefaxion 2009c). Seventy stone artefacts were excavated from three test pits totaling a surface area of 1m². Charcoal dating, although problematic given that samples gathered from the lowest layer were dated 100 years younger than those above, were assessed as evidencing Aboriginal occupation over the last 500 years. Given the number of artefacts identified and the absence of any cores, formal tools or Aboriginal cultural material, the rockshelter was assessed as having been utilized in an ephemeral or transitory manner.

A rockshelter near Deception Hill was excavated by the author (Cecchi 2017) via three test pits covering a combined surface area of 1m² and recovered a total of 302 artefacts from surface to bedrock. The excavated material indicated that the rockshelter was utilised repeatedly and a variety of activities associated with hunter gatherer tasks were undertaken at the site. Faunal remains recovered from the test pits indicate a heavy reliance on medium sized marsupials and mammals such as wallabies, possums and bettongs and a minor reliance on larger game such as kangaroo with some evidence for consumption of lizards and other small marsupials. The assemblage as a whole was assessed as typical of the region, indicating that tool making, artefact reduction, tool usage and tool discard were occurring at the site. Initial occupation of the rockshelter was dated via radiocarbon samples to 1872±36 BP with an increase in activity until about 1051 ±19 BP and intermitted occupation until recent times. Both surface and excavated assemblages at the site showed similar compositions that are characterised by a high proportion of debitage and include retouched artefacts and cores. The retouched tool category indicates that a variety of scrapers were in use since 1872±36 BP and backing techniques employed from 1759 ±24 BP. No grinding material was identified at the site.

APPENDIX C- ETHNOGRAPHIC BACKGROUND

C.1 ETHNO-HISTORICAL BACKGROUND

Pre-European settlement the general area in which the Project is located was a transition zone between the Bibbulmun people of the Southwest and the tribal groups who inhabited the Desert regions of Australia's interior (collectively known nowadays as "Wangkayis" or "Wongis"). Thus, Bates (1944) notes that:

"...Southern Cross was the eastern border of Bibbulmun country. In 1909 all remaining members of its group had been drawn into the circumcised tribes on their eastern boundary, the last natives of Merredin and Burracoppin also having being circumcised before they died out."

Tindale (1974) refers to these intermediate people as the *Kelamaia*, but his field notes reveal that this was the name for the language spoken in that region, whereas *Kubrun* was the name of the people which he collected. In her field notes, published in 1985 by the National Library of Australia, Bates gives more detail in their regard, collected during a visit to that region in the early years of the century:

*"...the name Karratjibbin has been applied to this nation as it was the term supplied by my Southern Cross informants, for their chief camping ground in that locality...the area over which this group extended ran from Mount Jackson in the north (about Lat. 30*20') through the Southern Cross district towards the Dundas area...The peculiar organisation existing amongst these people differentiates them from every other known tribe in the West. They possess a two-moiety system, which in this respect links them with their south-western neighbours, but with the important difference amongst the Karratjibbin people of each moiety marrying within itself and producing the other moiety...Whether the area of these people extends further than the limits mentioned, could not be ascertained in the short time allowed for investigation...I found the system among the Norseman district natives and in the Mount Jackson group. Their social organisation, customs, laws, initiation, etc., coincide with those of their eastern, north-eastern and south-eastern neighbours, with whom*

they have traded their local products...The various groups composing the "nation" held rights of possession to certain water-holes, hills, soaks, springs, etc., the chief of which appeared to be Karratjibbin, Wilgauin (Mt. Jackson), Yogguragain (west of Karratjibbin), Kammining (north-west of Karratjibbin), Malyorning (?), Juwardain (near Mt. Jackson)...The Karratjibbin Nation borders the Bibbulmun on the north-east, and several of the latter were adopted into and circumcised by the Karratjibbin people."

To the east of the above groups the country was occupied by the most westerly groups who inhabited the desert interior. In that area, social and linguistic similarity stretched in a wide arc from Oodnadatta in present-day South Australia, through the Great Victoria and Great Sandy Deserts, to the Fitzroy River in the northwest and the vicinity of Purnululu National Park in the northeast, extending partially into the present-day Northern Territory. To the south, and centered upon Norseman, Balladonia and Frasers Range, were located the Ngadju people.

Cultural practices and religious stories in the general Goldfields region were shared between neighbouring groups, although names of spiritual entities tended to be changed with transition from one culture-group to another. Aboriginal traditional religion is based on the land; its shrines, hymns and religious objects refer to topographic and other natural features. In such a religion, a degree of permanence and stability exists, which would not be the case were the religion based in man-made structures. In the general region in which the present study was carried out, the hymns and stories which are the link which binds the human to the natural (viewed, from an emic perspective, as supernatural) have been retained by a pivotal generation of elderly Aboriginal people. The existence and location of religious sites is therefore still known to the Aboriginal people. These sites, in the Kalgoorlie/Coolgardie/Menzies area are related mainly to four mythic sagas, which are commemorated in song and story, namely:

(i) the Yina Kutjarra, two mythic human ancestors, carriers of Law and religion (known to neighbouring Wangkayi groups as *Wati Kutjarra*), who pursued an emu ancestor through the Kalgoorlie region;

(ii) the Tjilkamarta or echidna ancestor, a creative being;

(iii) the Nganamarra or mallee fowl ancestor, a creative being;

(iv) the Milyura or Pleiades, creative women ancestors (known to neighbouring Wangkayi groups as *Kungkarangkara*).

Generally, sites associated with these mythic sagas are either prominent rocky outcrops or water-sources.

C.2 NATIVE TITLE

Paragraph 2.18 of the *Due Diligence Guidelines* (DPLH 2020) issued by DPLH are relevant to deciding which persons or groups should be included in Aboriginal heritage surveys and consultations, as follows:

Information about the Aboriginal heritage of a particular area is best obtained in consultation with the relevant Aboriginal people for that area. Whilst there is no definitive list of Aboriginal people who should be consulted for an area, the Aboriginal Cultural Material Committee suggests that the following people at least should be consulted:

- *a. those who are determined native title holders;*
- *b. those who are registered native title claimants;*
- *c. persons named as informants on Aboriginal site recording forms held in the Register at DPLH;*
- *d. any other Aboriginal persons who can demonstrate relevant cultural knowledge in a particular area.*

APPENDIX D- LEGISLATIVE CONTEXT

D.1 DEFINITION OF ABORIGINAL SITE

The applicability of the Act depends on whether a place falls within the definition of 'Aboriginal site' (**Site**). A Site is defined in section 4 of the Act to mean *'a place to which the Act applies, by operation of section 5'*.

Section 5 of the Act defines a Site as:

(a) *any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present;*

(b) any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;

(c) any place which, in the opinion of the Committee, is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the State;

(d) any place where objects to which this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed.

Section 28(1) of the Act establishes an Aboriginal Cultural Materials Committee (**ACMC**), the functions of which are set out in section 39 of the Act. One of the functions as stated in section 39(1)(a) of the Act is 'to evaluate on behalf of the community the importance of place and objects alleged to be associated with Aboriginal persons'. Section 39(3) of the Act states that '*associated sacred beliefs, and ritual or ceremonial usage, in so far as such matters can be ascertained, shall be regarded as the primary considerations to be taken into account in the evaluation of any place or object for the purposes of the Act"*. The construction of the definition of Site and the applicability of the Act to a place, therefore largely rests on the ACMC's evaluation.

In evaluating the importance of places and objects, the ACMC must take into consideration the factors set out in section 39(2) of the Act, namely:

(a*)* *any existing use or significance attributed under relevant Aboriginal custom;*

(b) *any former or reputed use or significance which may be attributed upon the basis of tradition, historical association, or Aboriginal sentiment;*

(c) *any potential anthropological, archaeological or ethnographical interest; and*

(d) *aesthetic values.*

The information provided by a recorder on a given area is central to the ACMC's evaluation.

Procedurally, once the ACMC has assessed and advised that a place is a Site for the purposes of the Act, the place is to be Registered. The DPLH has the responsibility to uphold a Register of sites for public access. Areas of Aboriginal heritage may fall within the definition of a Site even though they do not appear on the Register because they are yet unknown, unreported or unassessed.

From an archaeological perspective, a site has been defined as a place that represents particular focus of past human activity (Pearson and Sullivan 1999) or as *'any place that contains physical evidence of past human activity'* (Burke and Smith 2004: 63). In archaeology, research questions may determine what is referred to as a site.

In practical terms, with regards to artefact scatters, consultancy agencies have often formulated paradigms to define a Site based on artefact concentrations/numbers (i.e. defining artefact scatter sites as background scatter density x 3, or in certain instances employing arbitrary definitions such as six or more artefacts in relative close proximity). In the past it was not uncommon in Western Australia for single artefacts to be deemed a Site.

D.2 OFFENCES UNDER THE ACT

Under s15 of the Act it is obligatory to report to the Registrar of Aboriginal Sites all Aboriginal heritage places and or objects that may reasonably be suspected to apply.

Under s17 of the Act it is an offence to excavate, destroy, damage, conceal or in any way alter any Aboriginal site, unless with the authorization of the Registrar of Aboriginal Sites under s16 or the consent of the Minister of Aboriginal Affairs under s18 of the Act.

APPENDIX E- SIGNED STATEMENTS OF ABORIGINAL CONSULTATION AND PROJECT APPROVAL

TRADITIONAL OWNER CONSULTATION FORM

DATE 22 / 08 / 2020

We, the undersigned, members of the Marlinyu Ghoorlie have been consulted with regards to DIE HARDY & RED LEGS PROJECT (the Project) and have participated in a field survey.

- [x] We approve the Project.
- [ ] We approve the Project subject to:
- [ ] We do not approve the project given the reasons below:

SIGNED

Name GEORGE CHAMPION SNR Signature

Name MALCOLM Champion Signature

Name CHARLES CHAMPION JNR Signature

Name George champion Signature

Name Saviah Champion Signature

Name Kyran Tucker Signature

JCHMC

TRADITIONAL OWNER CONSULTATION FORM

DATE 22/08/2020

We, the undersigned, members of the KAPARN GROUP have been consulted with regards to DIE HARDY & RED LEGS PROJECT (the Project) and have participated in a field survey.

- [x] We approve the Project.
- [ ] We approve the Project subject to:
- [ ] We do not approve the project given the reasons below:

SIGNED

Name ELIZABETH SAMBO Signature

Name SI-ANNE SAMBO Signature

Name LEITH SAMBO Signature

Name DANIEL LEWIS Signature

Name LONNIE COLEMAN Signature

Name GINA SAMBO Signature

Name Signature

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Appendix I: Mine Closure Plan

Die Hardy Gold Project: Mine Closure Plan

Tenements: M77/1272 and L77/261

Mt Jackson Environmental Group S0232841

Version 1.1

Prepared for Ramelius Resources (WA) Ltd

22 October 2021

Project Number: TE21060

Assets | Engineering | Environment | Noise | Spatial | Waste

Proponent Information

The proponent of the project is:

Ramelius Resources Limited (Marda Operations Pty Ltd)

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DOCUMENT CONTROL					
Version	**Description**	**Date**	**Author**	**Reviewer**	**Approver**
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Approval for Release

Name	**Position**	**File Reference**
Greg Barrett	Principal Environmental Consultant	TE21060_Die Hardy MCP_1.1
Signature		

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Appendix G	Fauna assessment (APM)

1 Introduction

Ramelius Resources (WA) Limited (**Ramelius**) has developed this Mine Closure Plan (**MCP**) for the Die Hardy Mining Operation (the **Project**) in accordance with the Government of Western Australia's (WA) *Statutory Guidance for Mine Closure Plans* (the Guidelines) (March 2020).

This MCP is required to ensure that all Project operations are closed, decommissioned and rehabilitated in an ecologically sustainable manner and leave no unacceptable liability on the State of WA. This document identifies all issues relating to Project closure and adopts a risk-based approach to their management. The MCP has considered all applicable and available regulatory requirements, guidelines, tenement conditions, and closure and rehabilitation commitments made by Ramelius, Ramelius company standards and external stakeholder expectations (**section 4**).

The MCP will be reviewed throughout the life of the project to consider changes in final land uses, the addition of future infrastructure (if required), changing site conditions and stakeholder expectations.

2 Project Summary

2.1 Ownership

The Project is located within two tenements held by Marda Operations Pty Ltd, a subsidiary Ramelius. These leases collectively occupy a total of 267.36 hectares (ha) of land (**Table 2-1**).

Table 2-1: Site tenement details

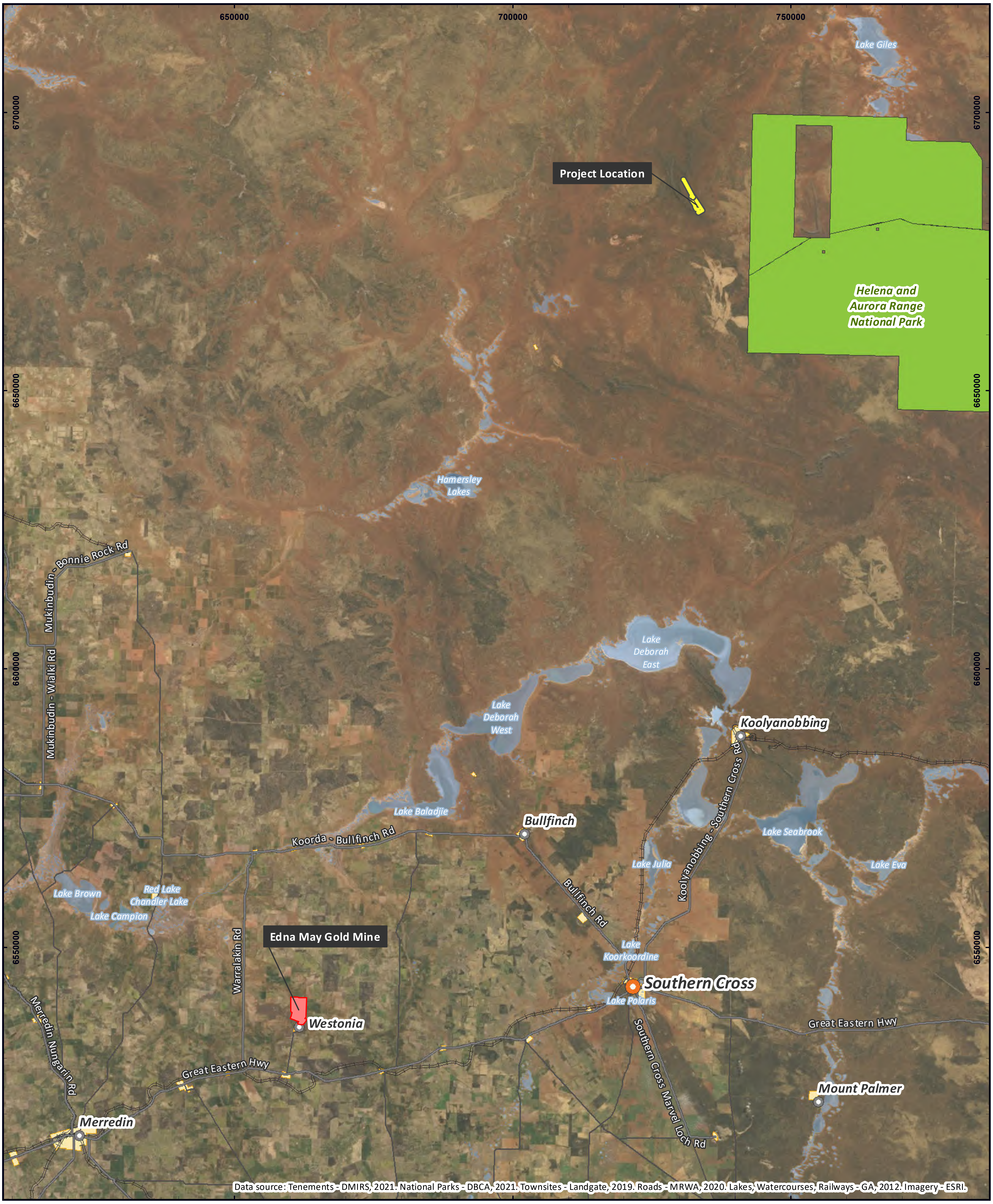
Tenement	Holder	Granted	Expiry	Area (ha)[1]
M77/1272	Marda Operations Pty Ltd	22/08/2014	21/08/2035	228.2
L77/261	Marda Operations Pty Ltd	17/06/2013	16/06/2034	39.16
Total				**267.36**

2.2 Location

The Project is a greenfields gold deposit situated in the Coolgardie Bioregion within the Yilgarn Craton, approximately 140 km north of Southern Cross and 160 km northeast of Ramelius' Edna May mine (**Figure 2-1**). The Project is located within the ex-Diemals Station on Unallocated Crown Land Reserve (LR3161/972), some of which is proposed as a dual-purpose Conservation and Mining Reserve.

The Mt Manning Conservation Park (R48470) intersects tenement M 77/1272 (**Figure 2-2**). A buffer zone of 50 m has been set for the development envelope, to allow for no ground disturbances or edge effects to occur on the conservation park.

[1] Area shown in Mineral Titles Online database.



LEGEND

- Project Tenements
- Edna May Gold Mine
- Townsites
- National Park
- Lake
- Watercourse
- Railway Line

LOCALITY
Die Hardy
Mine Closure Plan
Marda Operations Pty Ltd

N
0 5 10 15 20 km
Scale @ A3: 1:650,000
Coordinate System: GDA 1994 MGA Zone 50, Projection: Transverse Mercator, Datum: GDA 1994

Prepared:	T Daymond
Reviewed:	J Di Marco
Project:	TE21060
Revision:	A
Date:	16/07/2021

Figure 2-1

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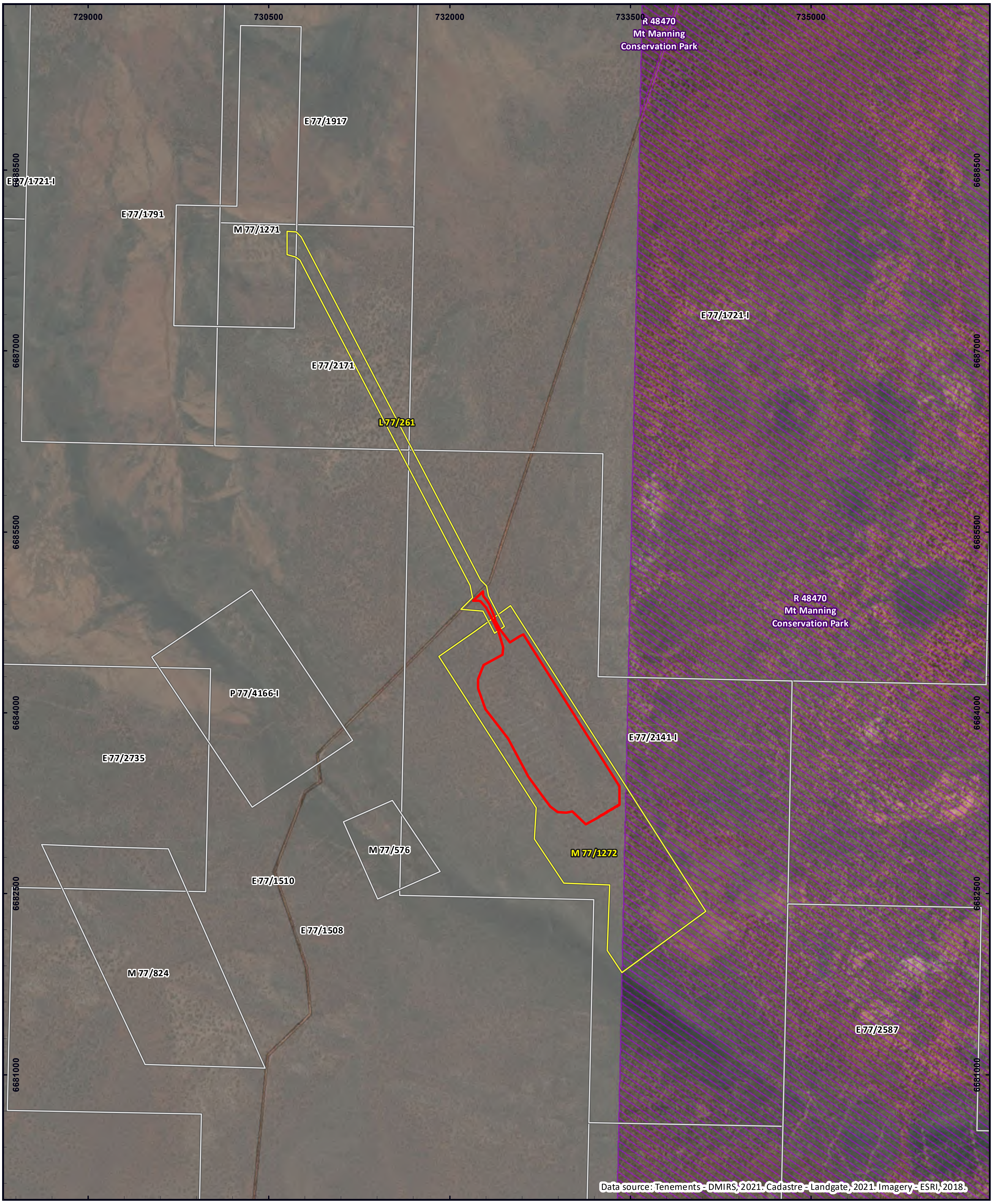


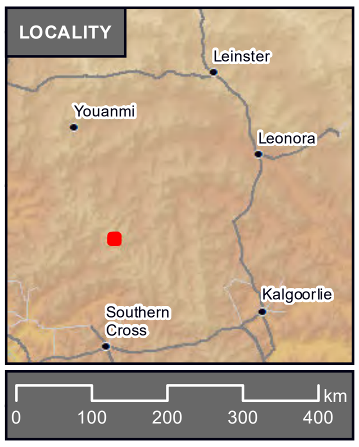
LEGEND

- Development Envelope
- Project Tenements
- Tenements

Cadastre

- Reserve
- Unallocated Crown Land

LOCALITY



CADASTRE

Die Hardy
Mine Closure Plan
Marda Operations Pty Ltd

N

0 0.2 0.4 0.6 0.8 1 km

Scale @ A3: 1:30,000
Coordinate System: GDA 1994 MGA Zone 50, Projection: Transverse Mercator, Datum: GDA 1994

Prepared:	T Daymond
Reviewed:	J Di Marco
Project:	TE21060
Revision:	A
Date:	21/07/2021

Figure 2-2

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2.3 Project Overview

Ramelius aims to develop an open pit gold mine and associated infrastructure at the Project site (**Figure 2-3**). Mined ore will be hauled to the Edna May Operations (EMO) mine site for processing located approximately 200 km via road. The Project construction is scheduled to commence in Q3 2021 with an operational life of mine estimated at 20 months or Q1 2023. However, exploration is ongoing, and extension of project life is possible.

Workers will be accommodated at the existing Windarling camp under agreement with Mineral Resources Limited. Minimal infrastructure is required, as the Project will be operated as a satellite pit from the Marda Central Project administration offices. Plant and equipment will be serviced at Marda Central.

The project will have a footprint of approximately 90 ha, comprising of the following components:

- Key mining activities:
  - Mining void (depth of at least 5 metres) – below groundwater;
  - Waste dump or overburden stockpile (class 1);
  - Run-of-mine pad (Mine Operations Pad – MOP); and
  - Dam – saline (turkey nest).
- Miscellaneous mining activities:
  - Water bore;
  - Building (other than workshop or camp);
  - Fuel storage facility;
  - Topsoil stockpiles;
  - Transport or service infrastructure corridor (haul and access roads); and
  - Workshop.

2.4 Mining Operations

Ramelius propose to mine gold from the Die Hardy deposit using conventional drill, blast, load and haul open pit mining methods. The final pit design is approximately 1000 m long, up to 180 m wide at the surface, and has a maximum depth of 55 m. The orebody has a 1040 m by 550 m footprint striking approximately 30°, and gold mineralisation remains open to the south-east and at depth. The Die Hardy deposit will be mined as a single pit with pit ramps exiting at the north and south ends of the void proximal to the WRL and mine ore pad (MOP).

Dewatering will not be required for the Project as groundwater levels were found to be greater than 60 m below ground surface. Resource drilling and water exploration bores further indicated little if any groundwater within holes to 120 m.

Mining will start by stripping and stockpiling the soil within the final pit design footprint and WRL areas with appropriate physical and chemical characteristics for use in rehabilitation at closure. Reverse Circulation (RC) grade control will be conducted of mineralised zones prior to drilling and blasting on 5 m benches. Ore will be hauled to the MOP stockpiles at Die Hardy, and then relocated to the ROM pad at the EMO ready for processing. Waste rock will be excavated and hauled to the WRL. Waste rock may also be utilised in the construction of the MOP pad.

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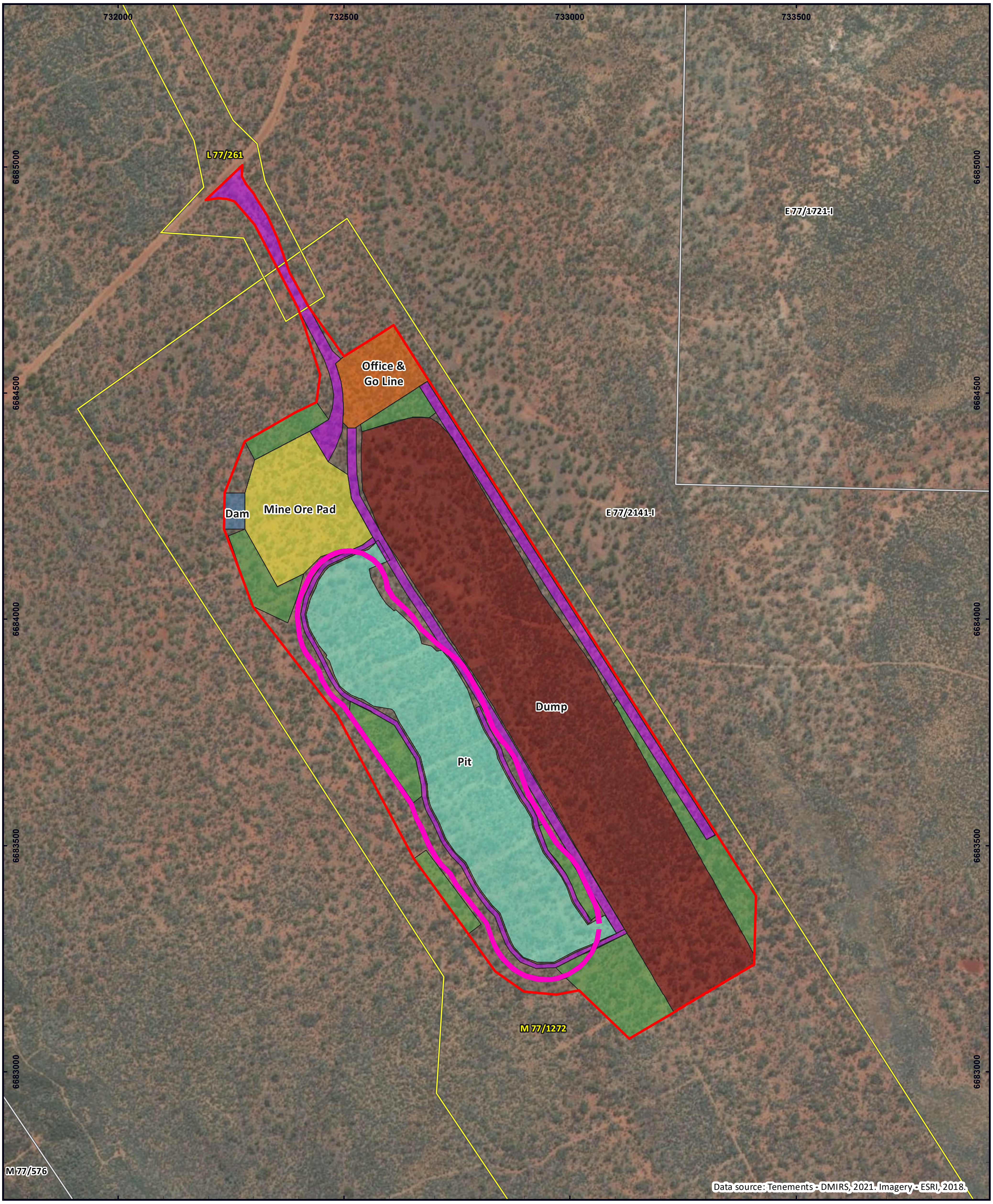


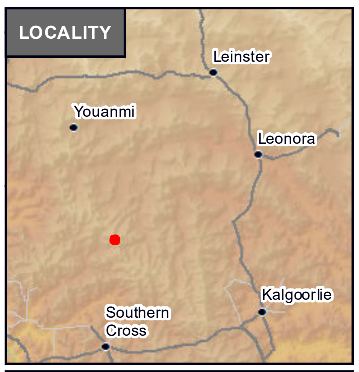
LEGEND

- Development Envelope
- Project Tenements
- Tenements

Site Layout

- Building (other than workshop) or camp site
- Dam - saline water or process liquor
- Low-grade ore stockpile (class 1)
- Mining void (with a depth of at least 5 metres) - below ground water level
- Topsoil stockpile
- Transport or service infrastructure corridor
- Waste dump or overburden stockpile (class 1)
- Abandonment Bund

LOCALITY



N

0 100 200 300 m

Scale @ A3: 1:8,000
Coordinate System: GDA 1994 MGA Zone 50, Projection: Transverse Mercator, Datum: GDA 1994

SITE LAYOUT

Die Hardy
Mining Proposal
Marda Operations Pty Ltd

Prepared:	T Daymond
Reviewed:	J Di Marco
Project:	TE21060
Revision:	A
Date:	29/07/2021

Figure 2-3

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3 Identification of Closure Obligations and Commitments

The legal obligations and commitments relevant to closure have been identified and provided in a legal obligation register (**LOR**) in **Appendix A**. The LOR includes all tenement conditions, endorsements and commitments made in previous Mining Proposals (**MP**)/Mine Closure Plans (**MCP**), Notices of Intent (**NOI's**), licences and other documents or agreements relevant to the Project (**Appendix A**).

Ramelius notes that the prior written consent of the Minister responsible for the *Mining Act 1978* being obtained before commencing any mining activities on Conservation Park CR 48470. The current proposal does not include any disturbance to CR 48470.

4 Stakeholder Engagement

4.1 Communication Process

Consultation with stakeholders commenced in 2011 when the previous owners of the project, Southern Cross Goldfields Limited, introduced the main Marda Gold Project and surrounding tenements to State government departments, regulators and advisory bodies. More recently, consultation has been continued throughout the advanced exploration and development phases by Ramelius and has formed an integral part of the Project design, operation and closure. Feedback received from local stakeholders during this period indicates that the local pastoralist does not object to the mine development, provided the terms agreed to be followed through.

Consultation has involved all parties holding a significant stake in the project (*i.e.*, stakeholders), so that they are properly informed, and their concerns and interests properly addressed. A list of stakeholders that will be periodically reviewed, to ensure that all relevant parties have been identified, and will consider all reasonable requests from other parties that declare an interest and ask to be consulted.

4.2 Stakeholders

The key stakeholders and interested parties that have been identified are listed in the following table.

Table 4-1: Die Hardy Project stakeholders - primary areas of interest

Stakeholder	Primary area of interest
Department of Mines Industry Regulation and Safety (DMIRS)	Public safety; standard and timing of rehabilitation; compliance with *Mining Act 1978* and *Mine Safety and Inspection Act 1994.*
Department of Water and Environmental Regulation (DWER)	Potential for contaminated sites including Acid Mine Drainage Water quality (pit and local waterways); dust generation.
Department of Fire and Emergency Services (DFES)	Fire breaks. Provision of emergency services
Main Roads WA (MRWA)	Use of public roads.
Local government Authorities (Yilgarn, Merredin and Westonia shires)	Commercial activities (Including contractor mobilisation for site works); environmental concerns

Stakeholder	Primary area of interest
Department of Planning, Lands and heritage (DPLH)	Any ground disturbing works (clearing/topsoil stripping) Listed heritage sites.
Department of Biodiversity, Conservation and Attractions (DBCA)	Administers the *Biodiversity Conservation* Act 2016 Surveys and licenses to take flora and fauna. Malleefowl and Priority Flora. Mt Manning Conservation Park (R48470). Post-mining land use.
Native Title Groups (Marlinyu Ghoorlie, Kalparn)	Native title rights.
Pastoral Lands Board (PLB)	Pastoral leases, stations, freehold properties

4.3 Stakeholder Engagement Records

Extensive stakeholder engagement on Project has been occurring since 2014 when the previous owners of the project (Southern Cross Goldfields) were looking to develop the resource in conjunction with another resource. Details of these previous consultation records can be found in SXG (2014). More recently, consultation with the key stakeholders has been undertaken and are summarised in (**Table 4-2**).

Table 4-2: Stakeholder consultation register

Date	Description of consultation	Purpose of consultation	Proponent response	Stakeholder response
28/02/21	Teams meeting with Felicity Huxtable and Larissa Burnes (DMIRS)	Pre-submission (mining proposal) meeting to discuss planned project at Die Hardy.	PowerPoint provided	• Physical (geotech) testwork to be done on waste rock to inform WRL design. • Consider economics of backfilling the pit and put problematic material back in. • Depth to groundwater and implications for pit lake. • Do not leave any unknowns. • All studies to be completed. • All risks and uncertainties to be managed with contingencies included with Risk Assessments and outcomes to meet DMIRS Env. Objectives. • Include discussions with DBCA in stakeholder register as well as agreements, legal objections and commitments. • Tech Reports appended and all uncertainties addressed.
25/03/21	Telephone call with and follow up email to Katherine Hope (DBCA)	Pre-submission meeting to discuss planned project at Die Hardy.	PowerPoint provided	No formal response was received.

5 Baseline and Closure Data and Analysis

5.1 Climate

The Southern Cross subregion has an arid non-seasonal to semi-arid Mediterranean climate with an annual rainfall of 200 to 300 mm (Beard 1990). Summers are generally warm, with the highest temperatures recorded in January, while winters are cold with lowest temperatures experienced in July and August (**Figure 5-1**). The nearest climatic data is situated at Southern Cross Airfield Station (BoM station ID: 123320), approximately 145 km of the Project site.

Rainfall occurs year-round, with yearly totals ranging from 150 to 550 mm with an annual mean of 294 mm (**Figure 5-1**). Rainfall fluctuates throughout the year and is significantly lower from October to December, with March and July being the wettest months on average. Temperatures vary between an average minimum of 9.2°C and average maximum of 26.6°C. Evaporation data in the Project Area were determined using maps of gridded digital evaporation contours. These maps showed that the greatest evaporation in Southern Cross occurs during summer (900 mm) with an estimated annual evaporation of 2,000 mm (BOM 2013b). The average annual evaporation rate exceeds rainfall by a factor of 7 (**Figure 5-2**).

The Intensity Frequency Duration (IFD) relationship for a particular site can be determined using the BOM Rainfall IFD Data System, and the outputs for Southern Cross can be seen in (**Figure 5-3**). This indicates that for a 1 in 100-year event that lasts for one hour, approximately 40mm of rain will fall (BOM 2013c). The highest recorded rainfall events occurred in 1942, with a total of 84 mm of rain during a 24-hr period (**Figure 5-1**).

Wind speed and direction ranges throughout the year with the average morning winds ranging from 14-22 km/h from the east to northeast direction (**Figure 5-4, Figure 5-5**). The Afternoon winds tend to have a higher average ranging from 16-33 km/h from a westerly direction (**Figure 5-4, Figure 5-6**).

Figure 5-1: Rainfall at Southern Cross Airfield station (site No: 123320) Monthly mean temperature and rainfall

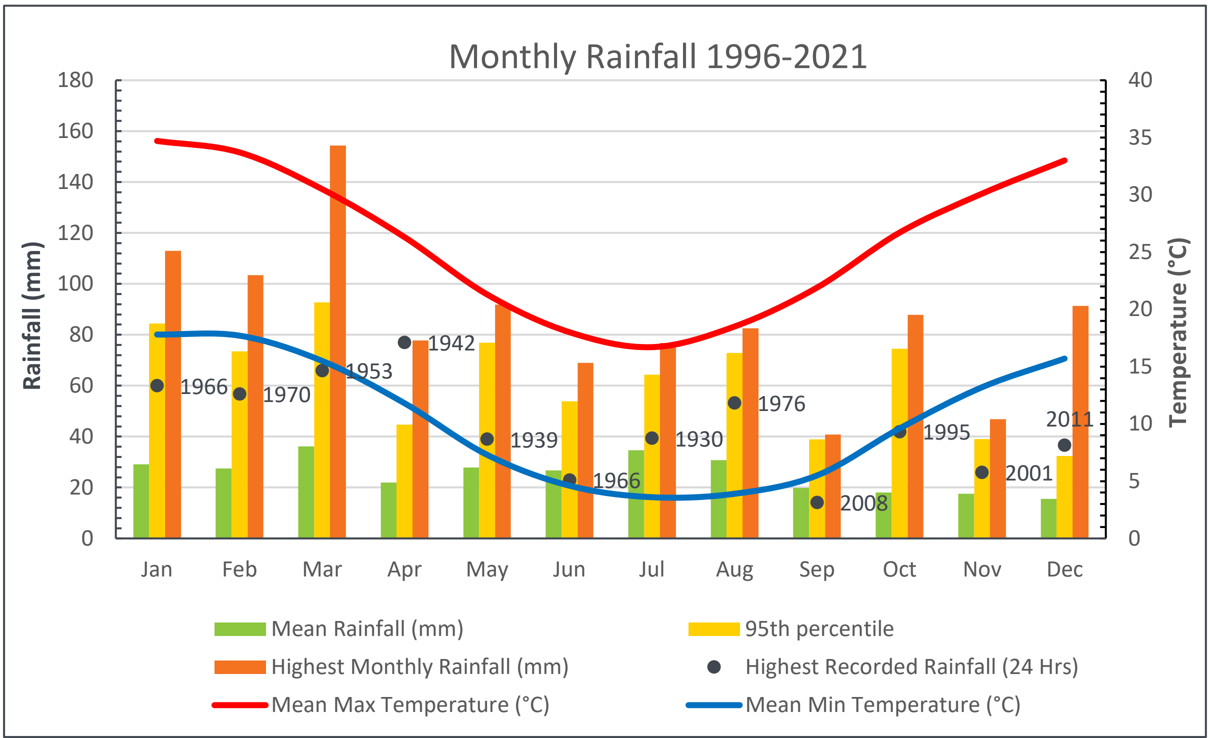


Figure 5-2: Annual evaporation rates Australia

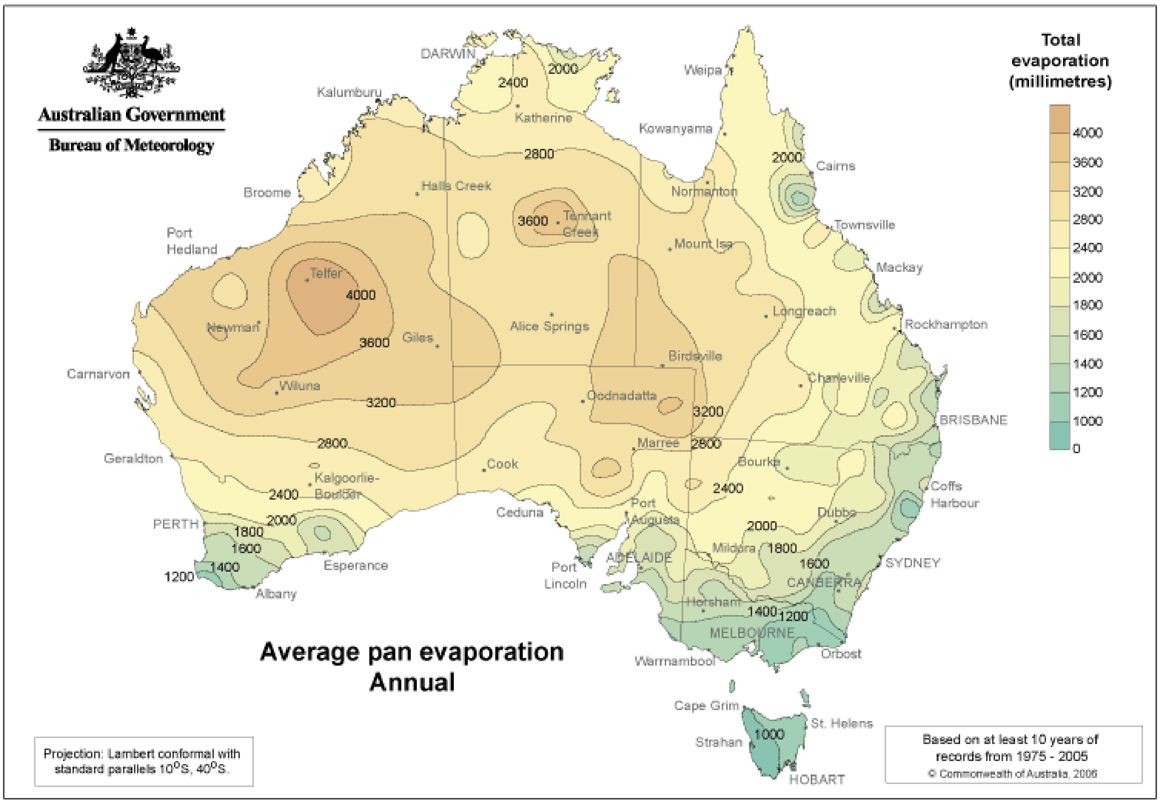


Figure 5-3: Rainfall Intensity-Frequency-Duration for the Project

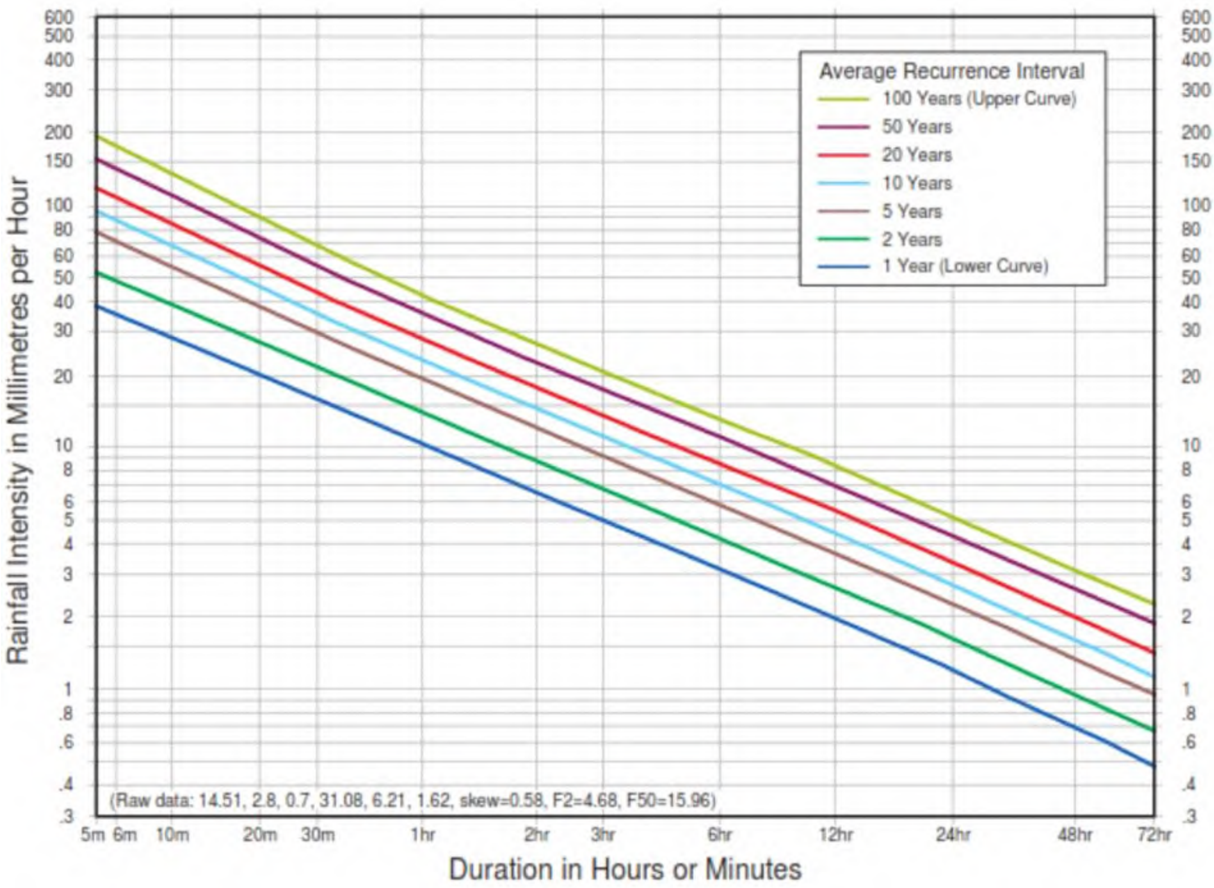


Figure 5-4: 1996-2021 mean wind speed at Southern Cross Airport (Site No: 12320) (BOM,2021)

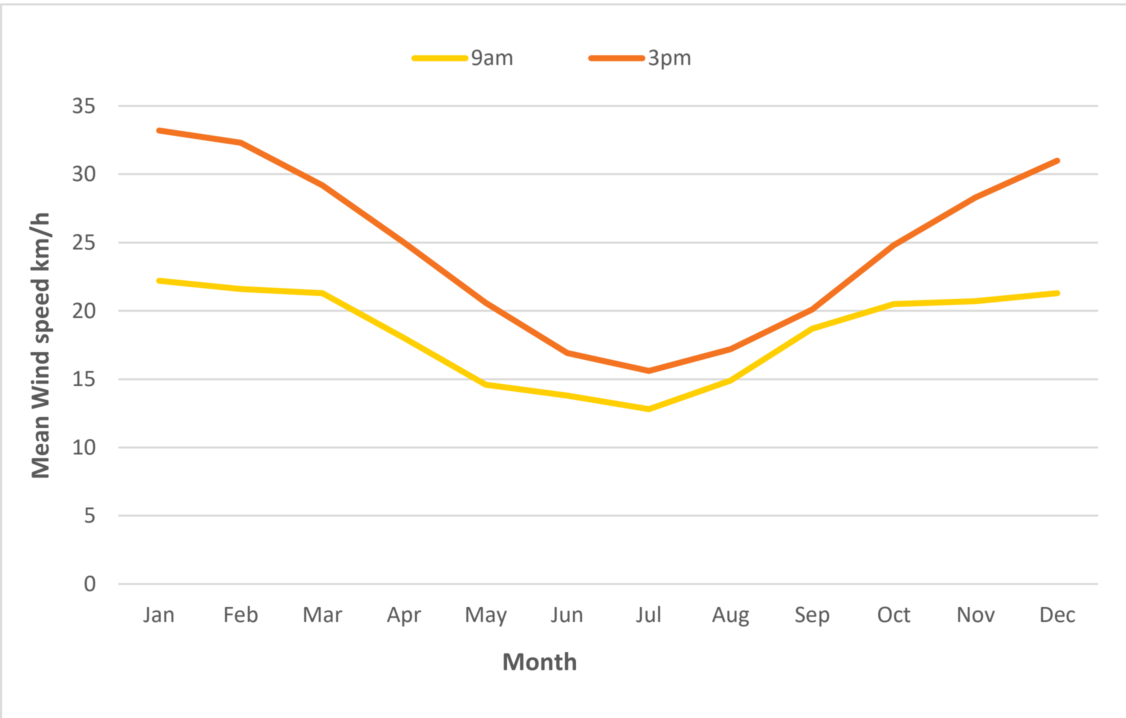


Figure 5-5: Southern Cross Airport (Site No: 12320) 9 am Rose of Wind direction versus Wind speed in km/h during May 1970- August 2020 (BOM, 2021).

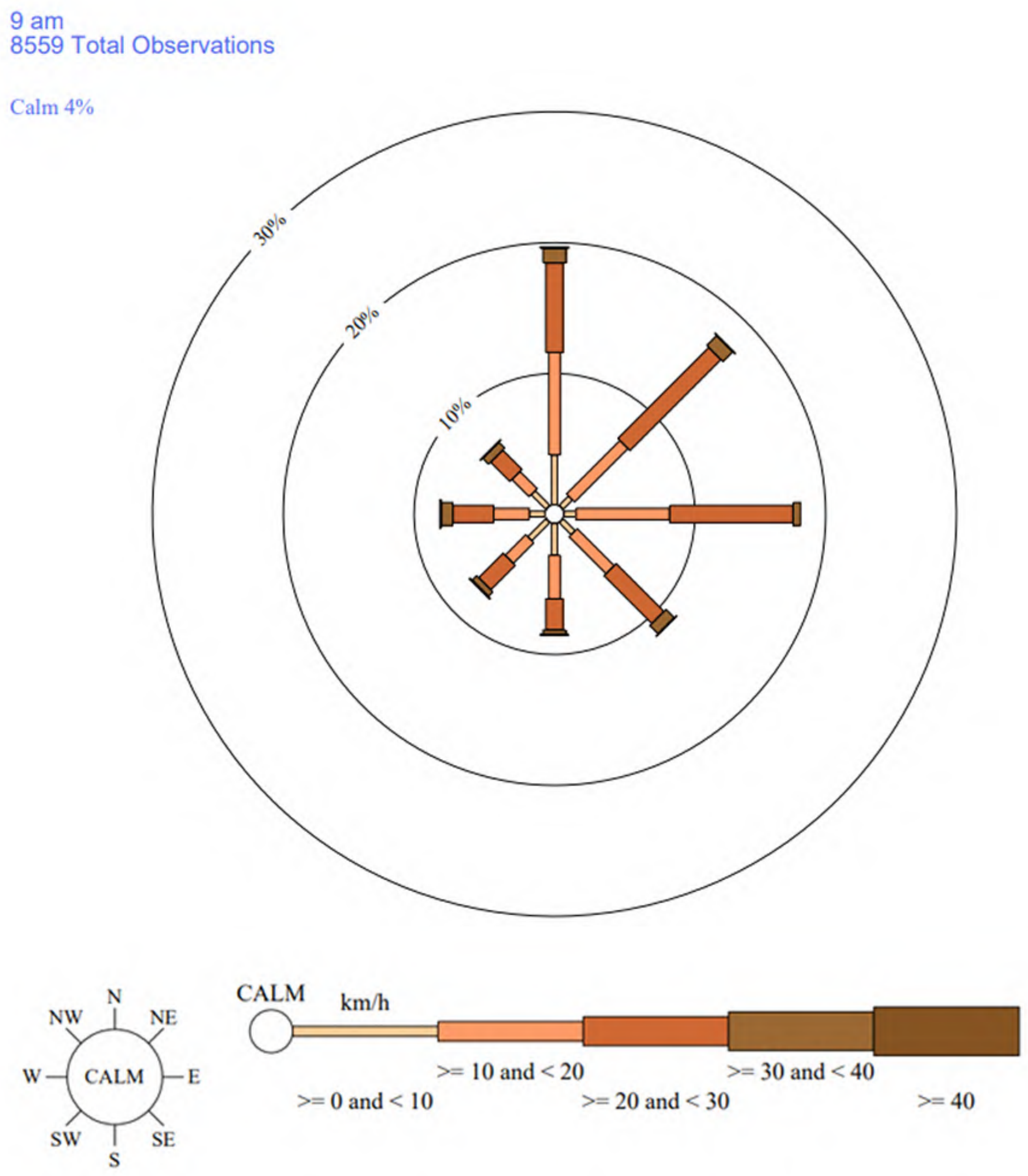
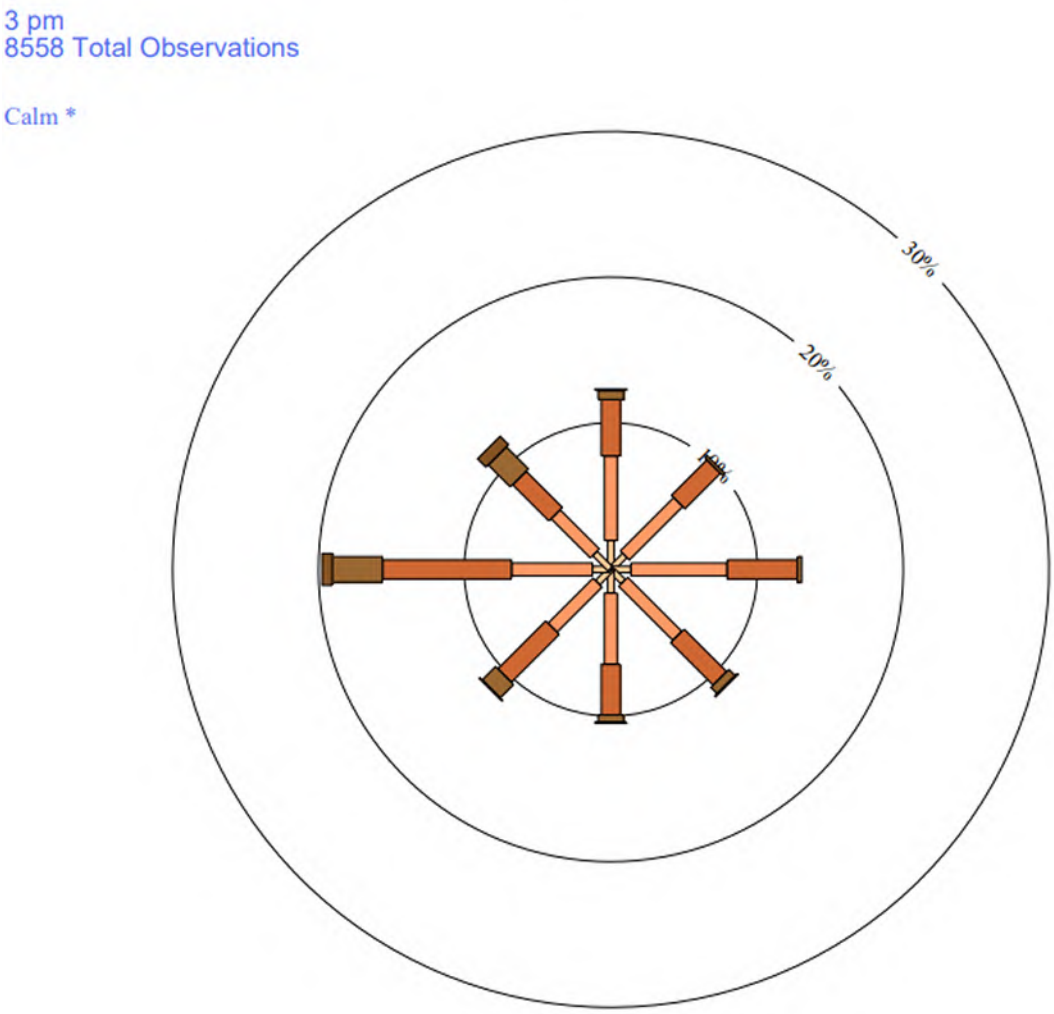


Figure 5-6: Southern Cross Airport (Site No: 12320) 3 pm Rose of Wind direction versus Wind speed in km/h during May 1970- August 2020 (BOM, 2021).



5.2 Biogeography

The landscape across the project site varies and can be described by the Interim Biogeographic Regionalisation for Australia (IBRA) (**Table 5-1**). The sites fall within the **COO2** (Coolgardie 2 - Southern Cross subregion).

Table 5-1: Description of IBRA sub-region for the Project (DAWE, 2021)

IBRA Subregion	Subregion description
COO2	The landscape comprises of gently undulating uplands with broad valleys and bands of low greenstone hills. Eucalyptus woodlands occur around salt lakes, on low greenstone hills, and broad plans of calcareous earth. Mallees and scrub-heaths occur in the uplands, broad valley floor, and sand sheets around the granite outcrops.

5.3 Geology

The Geological survey of Western Australia (GSWA) has completed 1:2,500,000 mapping across the Goldfield's region. The project area lies on Archaean metamorphosed basic and ultra-basic volcanic and intrusive rocks (GSWA 2014). The area forms part of the Yilgarn Craton, which makes up a significant portion of Western Australia and is one of the oldest, most geologically stable parts of the earth's surface (Gibson et al. 2007). The main components of the Yilgarn Craton are granite, interspersed with greenstone and banded iron formation (BIF) ranges. The project area is located on the south-eastern flanks of the Die Hardy Range, which is one of the many large BIF ranges within the region. The BIF ranges of the Yilgarn Craton make up a small portion of the land in the region, which is predominantly flat. They are ancient, isolated features, exhibiting different geology, soils, and biological aspects to those found in the surrounding land. The ranges are known for their unique compositions of flora and fauna and for supporting rare and endemic plant species (DEC 2007). Based on survey information to date, each range is distinctly different from the other sampled ranges from an ecological perspective (DEC 2007).

5.4 Seismicity

The project is located within a region of Western Australia judged to be at low risk from future seismic events. The estimated peak ground acceleration with a 10% chance of being exceeded in a 50-year period is relatively low (**Appendix B**).

Earthquake-induced ground accelerations of this magnitude (if occurring) would be expected to have minimal influence on future pit wall stability performance. It is inferred that only marginally stable or metastable zones could be driven to collapse by earthquake shaking.

5.5 Soils

A soil survey was completed in 2021 by Landloch to characterise physical and chemical properties of the solids and to assess their potential as cover materials for rehabilitation (**Appendix C**). Chemical properties of the soil were naturally acidic and non-saline with an average pH of 6.6 and electrical conductivity of <40 mS/m.

Texture of the soil were characterised as sandy loam. Samples had an Emerson class value between 1 and 3, majority of the samples have a low ESP < 0.9 %, Ca:Mg ratios greater than 0.5. Based on these conditions, soils are generally not prone to structural decline.

5.6 Waste rock characterisation

Testing undertaken by Ramelius has shown that waste rock materials are not acid-forming (**Appendix D**). However, some waste materials are saline, and there is a median salinity value of 0.5 dS/m. This is likely to restrict vegetation establishment when rehabilitation is undertaken. There is a further discussion of this issue in **Appendix C**.

5.7 Groundwater

Yilgarn groundwater occurrence regionally relates to two main aquifer types.

Bedrock groundwater is limited to discrete, typically narrow structures (fractured rock aquifers) set in an otherwise nearly impermeable rock-mass. Such fractured rock aquifers show an extreme range in transmissivity and storage, but typically show limited recharge. The second aquifer type is formed by unconsolidated Cenozoic sediments which infill an ancient more incised bedrock surface. The up-lying country of the Die Hardy site is mostly underlain by outcropping or shallow bedrock, such that only the bedrock aquifer type is relevant.

Groundwater occurrence at Die Hardy is very limited. Most of the exploration drill holes on the deposit did not intersect any groundwater. Mining below the water table is therefore expected to generate very limited groundwater. For project water supplies, groundwater exploration drilling was undertaken on selected targets based on water shows in mineral drilling and on geological structures.

Of seven targeted holes three produced no water, three very small flows and one delivered a potentially useful yield. Water strike was found at a depth of 40 m with a flow of 3.0 L/sec. The results indicate a regolith enhanced possible north-south structurally controlled aquifer of limited lateral extent. As the pit reaches final depth, any remaining groundwater is likely to be depleted by mining-related drawdown. Groundwater is brackish to saline at a salinity of 9,000-15,000 mg/L TDS.

Post-mining, some small groundwater inflows into the pit are anticipated. MWES (2021) (**Appendix E**) concluded the following about the post-mining situation:

> *As is typical of Yilgarn mining pits, provided external stormwater is excluded, the post-closure pits will become a groundwater sink and there is no risk of groundwater or surface water discharge. A small shallow pit lake will form and stabilise well below the pit crest. Salinity of the pit lake will gradually increase over time due to evaporative concentration of discharging groundwater solute. Salinity will remain the major feature of the pit lake water and the major constraint on any possible beneficial use.*

5.8 Surface water

The Project is located 800m north of and below the northwest-oriented catchment defining ridgeline near the continental divide, with very limited upstream catchment. There are no clear or incised natural drainage lines on the northeast side of the Die Hardy Range locally. Stormwater discharge is assumed to be by overland flow rather than channel flow across the whole project area. The short steeper slopes of the Range transition to nearly flat and sandy surfaces across the site and this area apparently has relatively high infiltration rates and low runoff coefficients. Drainage northeast from the main ridge is modified by a minor northern spur located east of the WRD. The pit is located on a further, more minor natural spur such that natural drainage flow is either east or west of the site. The two permanent mine landforms will enforce the separation of the two local sub catchments.

The permanent landforms are oriented nearly parallel to stormwater flow paths down the catchment. Flow in the west sub-catchment will be outside the western pit abandonment bund. At the upstream (south end of the pit) surface gradients are slightly convergent with the structure and at the north end, flowlines are slightly divergent to the northwest. For the eastern sub-catchment flow will be parallel to the WRD toe. The site is situated on elevated and well-drained ground such that, apart from excluding stormwater from the pit, there are no requirements to contain or divert natural stormwater drainage either during operations or post-closure. There is little potential for impacts on the downstream environment (see **Appendix E** for further discussion).

5.9 Flora and Vegetation

5.10 Flora and vegetation

5.10.1 Flora

A literature review consisting of a combined search of the Department of Biodiversity, Conservation and Attractions (DBCA) Flora of Conservation Significance databases (DBCA, 2019a), Nature Map search (DBCA, 2019b) and Department of Environment and Energy (DoEE) Protected Matter's search (DoEE, 2019) resulted in four Threatened Flora and 35 Priority Flora occurring within a 20km radius of the survey area. A subsequent field survey (**Appendix F**) did not record any Threatened or Priority species within the project area.

5.10.2 Vegetation and Ecological Communities

Three vegetation associations were recorded within the project area (**Table 5-2**).

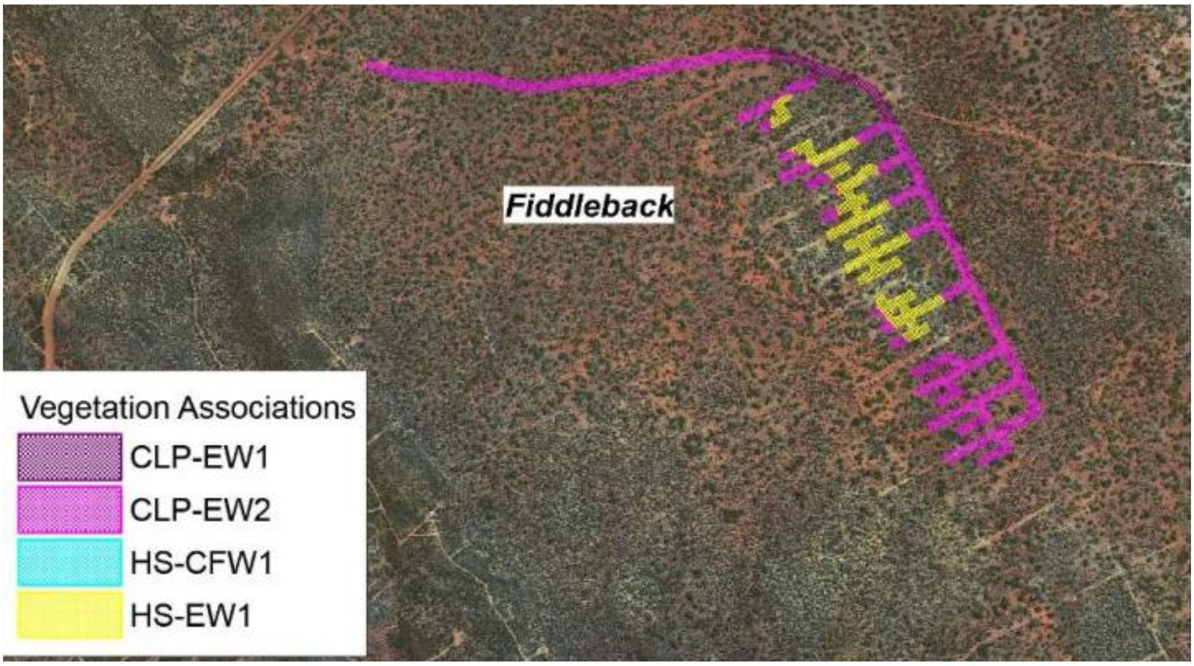
Table 5-2: Vegetation association occurring within the project area

Code	Description
CLP-EW1	Low woodland of Eucalyptus concinna over mid open shrubland of Acacia ramulosa and low sparse shrubland of Ptilotus obovatus on clay loam plain
CLP-EW2	Low woodland of Eucalyptus salmonophloia/ E. salubris over mid sparse shrubland of Acacia tetragonophylla and low chenopod shrubland of Atriplex stipitata on clay-loam plain
HS-EW1	Low open woodland of Eucalyptus concinna over mid shrubland of Acacia ramulosa and low sparse shrubland of Ptilotus obovatus on hillslope

The Project is located within the boundary of a Priority 1 Ecological Community; Die Hardy Range/Diemals vegetation complex (banded ironstone formation) which encompasses an area of 16,500 ha. The total survey area represents less than 0.1% of the total extent of this PEC.

Figure 5-7: Vegetation associations recorded at Die Hardy (formerly known as Fiddleback)

From Botanica Consulting 2019 (Appendix F)



5.11 Fauna

5.11.1 Terrestrial Fauna

A level 1 Fauna Survey was carried out by APM 2014 (**Appendix G**) which included a survey of short-range invertebrates (SREs).

Malleefowl mounds and tracks have been recorded in the greater area. This species appears to prefer two particular fauna habitats in the Project area. These habitats were the Dense Shrubland on Alluvial Plain and Dense Shrubland on Rocky Rises (**Table 5-4**). No active mounds existed at the Die Hardy project area during the surveys. Evidence of Malleefowl predation by a fox was found during the survey, no other species of conservation significance were recorded during the survey.

An intensive presence/absence search did not locate either species of Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider or evidence of trapdoor burrows. It is considered unlikely that these two spider species are using the Project area.

A desktop survey using the Protected Matters and NatureMap databases found 14 species of conservation significance that could potentially occur in the Project area (**Table 5-3**). Further analysis of fauna habitats (**Table 5-4**) within the Project area concluded that four of the species are unlikely to occur, three species have the potential to occur, six are likely to occur, and one species (Malleefowl) has been recorded.

5.11.2 Fauna habitats

The Project area consists of three habitat types which have been described in term of their attributes in **Table 5-4.** A map showing areas of the different habitat types in relation to the Project area is provided in **Appendix G**.

Table 5-3: Conservation significant fauna (Threatened or Priority) potentially present at the operation

From APM 2014 (Appendix G)

Species	Occurrence
Birds	
Malleefowl (*Leipoa ocellata*)	One inactive mound. Tracks recorded in greater area.
Cattle Egret (*Ardea ibis*)	Unlikely to occur.
Great Egret (*Ardea alba*)	Unlikely to occur.
Peregrine Falcon (*Falco peregrinus*)	Potential to occur.
Australian Bustard (*Ardeotis australis*)	Potential to occur.
Major Mitchell's Cockatoo (*Cacatua leadbeateri*)	Likely to occur.
Fork-tailed Swift (*Apus pacificus*)	Potential to occur.
Rainbow Bee-eater (*Merops ornatus*)	Likely to occur.
Hooded Plover (*Thinornis rubricollis*)	Unlikely to occur.
Shy Heathwren (*Hylacola cauta*)	Likely to occur.
Mammals	
Greater Long-eared Bat (*Nyctophilus major*)	Likely to occur.
Invertebrates	
Shield-backed Trap door spider (*Idiosoma Nigrum*)	Unlikely to occur.
Tree-stem Trapdoor spider (*Aganippe castellum*)	Likely to occur.

Table 5-4: Fauna habitat within the project area

Habitat type	Suitability
Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain	• Range of vegetation suitable to a variety of passerine and non-passerine birds; • Relatively dense shrubs providing cover for cryptic small geckonids; • Termitaria in standing and fallen dead timber; • Ground not specifically suited to burrowing species; and • Halophytes may attract a small subset of the fauna assemblages.
Low Eucalypt Woodland over Acacia Shrubland on Alluvial Plain	• Range of vegetation suitable to a variety of passerine and non-passerine birds; • Relatively dense shrubs providing cover for cryptic small geckonids; and • Gravelly clay loam ideal for borrowing.
Dense shrubland on alluvial plain	• Dense shrubs provide abundant habitat for small passerine birds; and • Gravelly clay loam ideal for borrowing

5.11.3 Subterranean fauna

An assessment of the likely occurrence of subterranean fauna within the Project was based on records of the Western Australian Museum (WAM) database, previous environmental impact assessments and primary literature. All available data within a 50km by 50 km Search Area surrounding the Project were reviewed, with additional information from nearby mine sites.

The WAM database contained no stygofauna records in the Search Area, reflecting both few stygofauna surveys in the Search Area and the depauperate nature of stygofauna communities present where surveys occurred. Other surveys outside the Search Area, although nearby, also yielded few if any stygofauna.

5.11.4 Introduced species

While not recorded in surveys, it is possible feral goats could occur in the local environment. It is unlikely, however, that the mine area would support a population, even if a pit lake established post-mining. The salinity of the groundwater, further increased through evaporation, is higher than goats are able to tolerate. Goats may adapt to high salt levels (> 5,000 mg/L TDS) but generally prefer saline levels less than 2,000 mg/L TDS (Department of Local Government and Regional Development, 2003). Wild animals may survive on higher salinities (McGregor 2004) but pit lake salinities are likely to be too high (≈20,000 mg/L) to sustain a local population. Over time, pit lake salinity will further increase due to evaporation.

5.12 Heritage

5.12.1 Aboriginal Heritage

An archaeological field and desktop survey resulted in no heritage sites of archaeological significance occurring on the Project area. Two sites of archaeological significance exist outside the Project area. One site, ID 31477, is listed in **Table 5-5**. The other site is deemed confidential by the Kaparn traditional owners and its precise location has not been disclosed. The report by JCHMC Pty Ltd is not attached but is available to DMIRS upon request.

Table 5-5: Registered Aboriginal Site outside of tenement (DPLH, 2021)

Site Name	Site ID	Type	Distance
Die Hardy 1	31477	Registered site Artefacts/Scatter	1.3 km from M77/1272

Ramelius will ensure the site is not disturbed during any closure activities that occur. Consultation with Native Title Groups is ongoing to ensure that mining operations do not disturb any significant sites and that the final land use on the mining areas and associated objectives are achievable.

5.12.2 European Heritage

A review the world, Commonwealth, National and State heritage registers showed that the project area does not contain any registered Commonwealth, National or state heritage places.

5.13 Other Closure Related Data

5.13.1 Geotechnical assessment – pit walls

The Potential Zone of Instability (PZOI) has been determined as per DMIRS Safety Bund Walls Around Abandoned Open Pit Mines Guideline resulting in an abandonment zone string being generated. Sections have been generated across the Die Hardy deposit (**Figure 5-8**). The representative sections of the Die Hardy pit with projected PZOI (see **Appendix B**) are shown in **Figure 5-9** (north section of the pit) and **Figure 5-10** (south section of the pit) respectively. Final abandonment bunds and waste rock landforms will be placed outside this position in accordance with DMIRS guidelines.

The Die Hardy depth of oxidation is relatively shallow and consistent (10-20 m) and dictates the adopted wall angles of the pit design. Ground conditions influencing wall stability in the proposed Die Hardy open pit were investigated using current geological interpretations, data contained in geological, structural geological and geotechnical logs for diamond cored, resource/ geotechnical investigation boreholes and laboratory measurement of physical properties of representative samples of country rocks.

Figure 5-8: Plan of Pit cross-sections

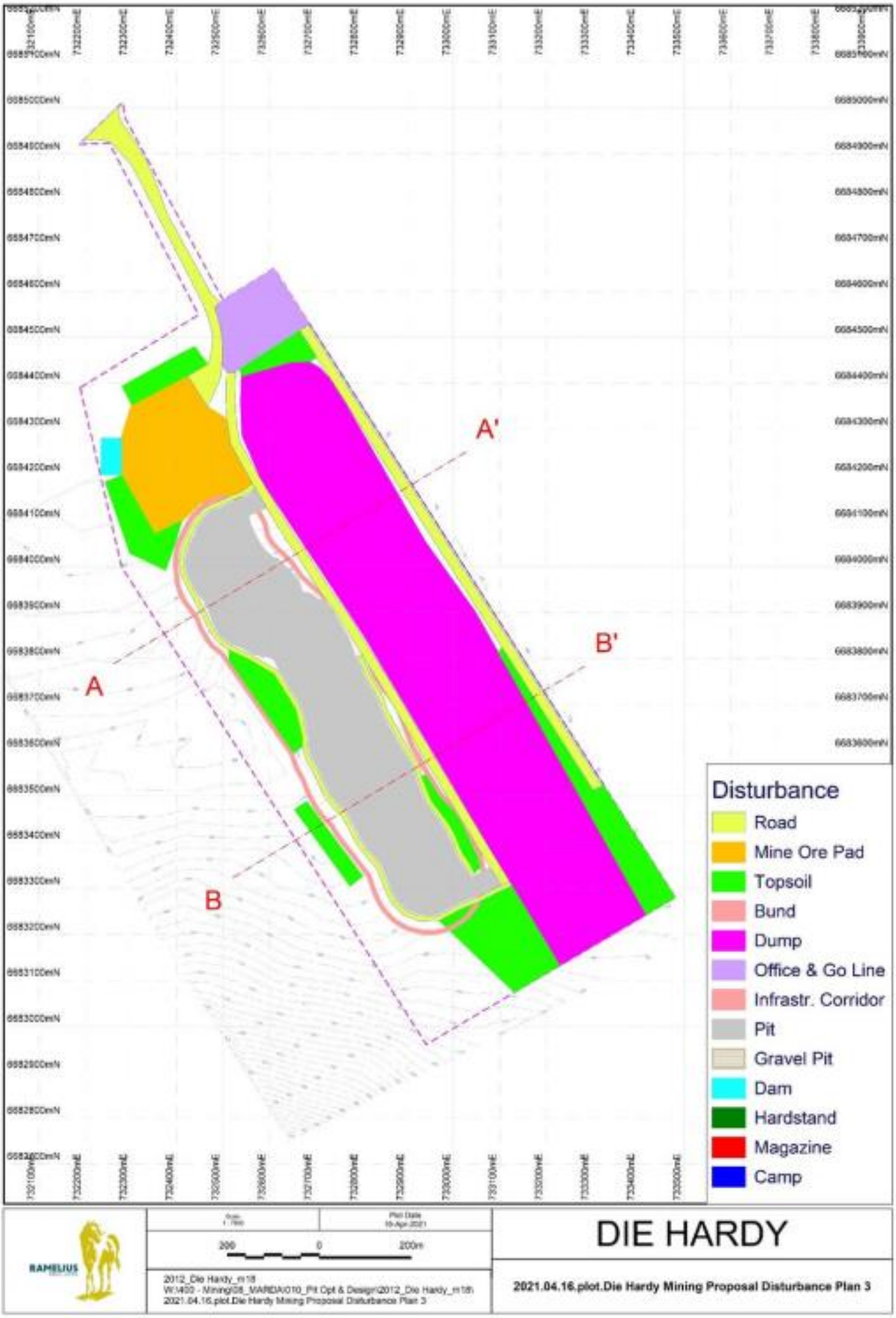


Figure 5-9: Cross Section of Die Hardy Pit (A-A') with projected PZOI

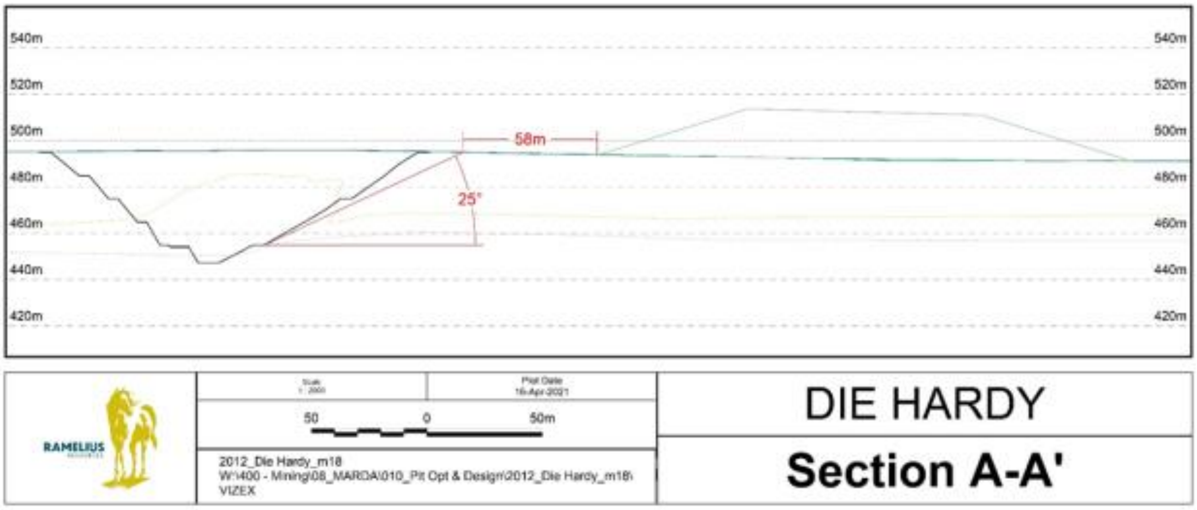
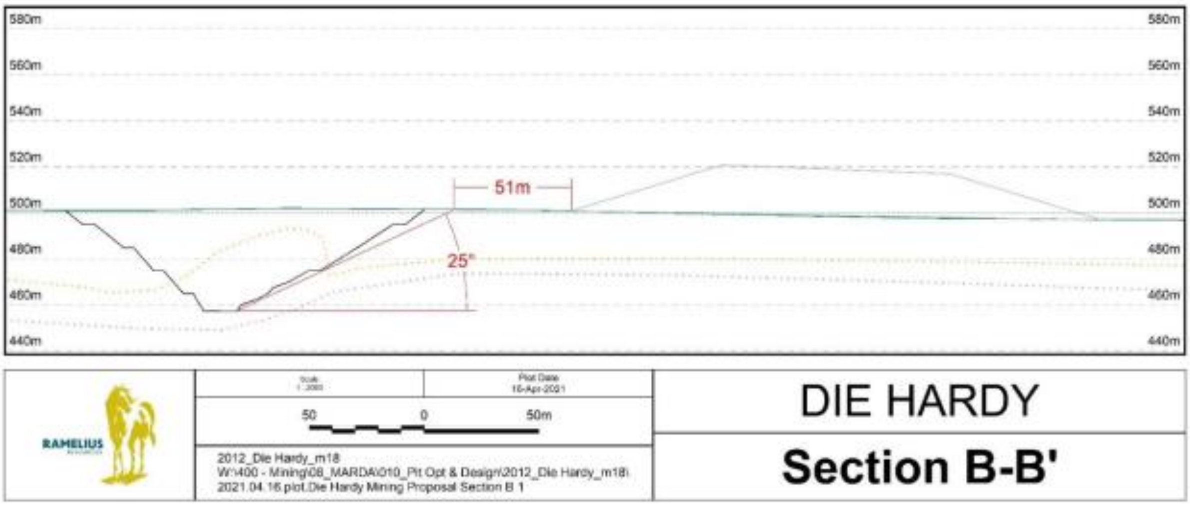


Figure 5-10 Cross Section of Die Hardy Pit (B-B') with projected PZOI



5.13.2 Landform design

The available footprint for a WRL is constrained by the boundaries of the Die Hardy tenement and the vegetation clearing permit area. Despite these constraints, Ramelius can still construct the WRL to a maximum height of 30 m with the preferrable concave outer slopes. The adopted design consistent with using low batter angles with a concave slope of overall 14° angle with 40% tree debris to adequately resist erosion and maintain a stable long-term landform (**Figure 5-11, Figure 5-12, Figure 5-13**). The WRL is designed to accommodate 25% swell factor of the in-situ waste rock volumes (total design capacity of 3,829,785 m^3) that are summarised in **Table 5-6.**

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Transitional BIF and ultramafic waste which makes up approximately 33% of all waste rock produced will be preferentially stored within the WRL as they exhibit predominantly poor durability, dominated by fines. The oxide and transitional laterite materials with their gravelly fines possess better durability qualities, these materials will be placed on the final outer surface of the concave profiled WRL.

The abandonment bund will be constructed of oxidised and transitional BIF as there is very little unweathered (fresh) material present. The limited quantities of fresh BIF and ultramafic waste rock will be used to clad the eastern toe of the WRL (and extending the southern section of the abandonment bund) to provide long-term stability and erosion-resistant barrier to long-term potential flood waters. The results of the modelled 1:1000 year design peak flood height (for post-closure purposes) and recommended the outer (south and east) lower slopes of the WRL be clad with coarse rock armour (d50=300mm), to a height of 0.6m AGL 1.0m thick for enhanced erosion protection. On completion of the WRL, topsoil will be applied to a depth of 0.2 m to the top of the slopes of the landform. As the WRL surface area is 325,943 m^2, the coverage requirement of topsoil is approximately 65,200 m^3. A summary of the competent rock requirements is presented in **Table 5-7**.

Design considerations for the waste rock landform were considered by Landloch (**Appendix C**). These design considerations were driven by the nature of the waste rock and topsoil materials. Key findings included:

- Addition of tree debris to the lower third of the batter will significantly reduce erosion.
- A concave profile will increase stability but an increase in height may be required to compensate as the footprint of the WRL cannot be expanded.
- If a concave slope is adopted for a 20 m high WRL, cross slope berms are not necessary. An exception is where additional height is required.
- Crest bunds of 1 m were recommended.
- The upper surface must be level to avoid accumulation of rainfall in any one location. This issue can also be addressed by breaking the upper surface into 2-3 ha segments separated by cross bunds.

These recommendations will be adopted.

Figure 5-11: WRL concave design

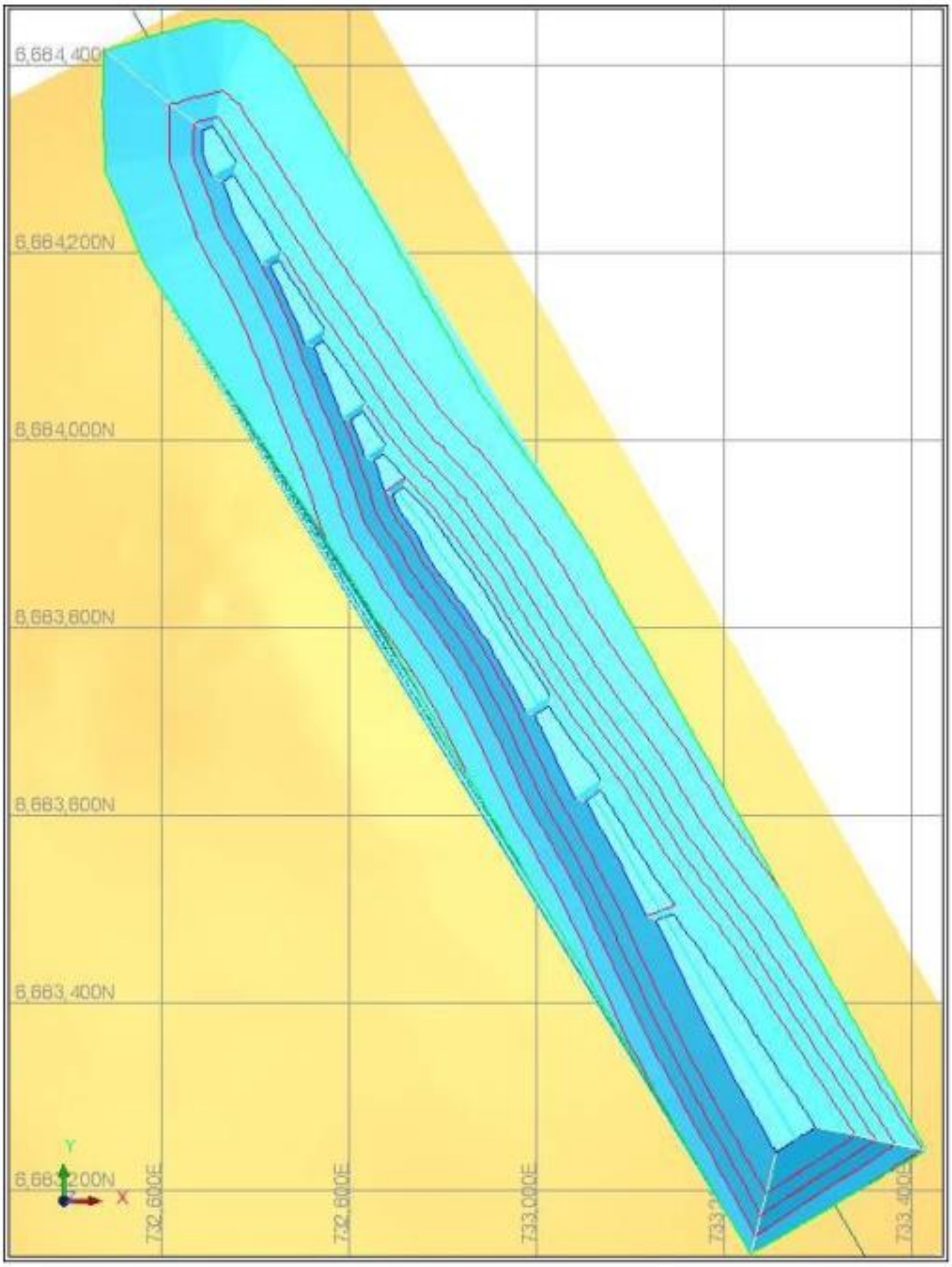

Figure 5-12: Long section of the WRL looking north

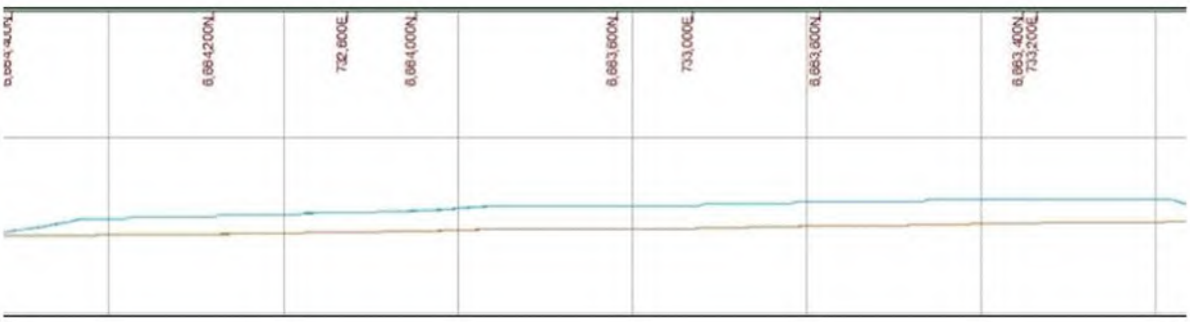

Figure 5-13: WRL cross section of looking west, top of the WRL at 530 RL

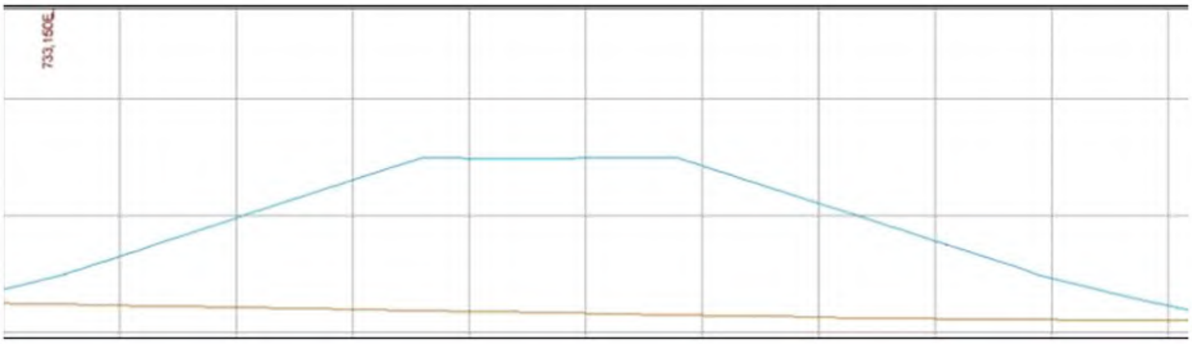

Table 5-6: Expected composition of mine waste material

Waste Type	Depth (m)	Estimated Volume (m^3)	Estimated % of Mine Waste
Oxide (BIF, laterite and ultramafic)	0-45	2,069,606	66.4
Transitional (BIF, laterite and ultramafic)	25-60	1,018,695	32.7
Fresh (BIF and ultramafic)	>60	29,218	0.9
Total	-	**3,117,520**	**100**

Table 5-7: Competent rock requirements

Structures	Design Volume (m^3)
Die Hardy abandonment bund	35,250
Die Hardy WRL (post-closure scour-resistant cladding of the eastern and southern toes of the WRL)	1,000
Total	**36,250**

5.14 Data Analysis and Implications for Closure

Key considerations for closure design include:

- Relatively low rainfall, on average distributed evenly through the year, and high evaporation rates are the main climatic drivers.
- There is potential for a small pit lake to form when mining operations are complete.
- Waste rock materials are saline and potentially unstable. Incorporation of tree debris into the waste rock landform has been recommended.
- A PZOI has been assessed and will be adhered to.
- No specific surface water concerns due to position in catchment.
- No acid-forming materials.

5.15 Knowledge Gaps

No specific knowledge gaps at this stage.

6 Post-Mining Land Use(s)

The Project is located on Unallocated Crown Land (LR3161/972), the land was formerly a pastoral lease and was forfeited to DBCA in 2011 and have been managing the land since.

The Mt Manning Conservation Park (R48470) intersects tenement M 77/1272 (**Figure 2-2**). A buffer zone of 50 m has been set for the development envelope, to allow for no ground disturbances or edge effects to occur on the conservation park.

Given the relatively intact nature of the environment in the vicinity of the Project area, and the vegetation, flora and fauna values that have been identified in the general area, the proposed post-mining land use for the Project is native vegetation.

In general terms, the Project Area will require rehabilitation of disturbed areas with native vegetation. In practical terms this means that rehabilitated areas need to be sufficiently safe, stable and non-erodible to allow for the re-establishment of native vegetation appropriate to the soils and landforms of the area as well as retention or replacement of pastoral and other related infrastructure.

7 Environmental Risk Management

7.1 Identification of closure risks

7.1.1 Risk assessment process

A standard risk matrix (AS/NZS ISO 31000:2009) was utilised to evaluate the likelihood and consequence of potential risks:

- Likelihood - The likelihood of an impact on the surrounding environment or other receptors; and
- Consequence - The scale or magnitude of the potential impact (i.e., severity/extent) if it were to occur.

The levels for likelihood and consequence used to inform the risk assessment are detailed in **Table 7-1** and **Table 7-2** below.

Table 7-1: Likelihood of Risk Summary

Likelihood	Description
Almost Certain	The event is expected to occur in most circumstances.
Likely	The event will probably occur in most circumstances.
Possible	The event may occur at some time.
Unlikely	The event has not occurred in our company, but has occurred within the industry as a whole on a number of occasions.
Rare	Event has not been known to occur in our company, but has been known to occur infrequently within the industry and is only likely to occur in exceptional circumstances.

Table 7-2: Consequence of a Risk Summary

Insignificant	Minor	Moderate	Major	Catastrophic
Environment				
No or very low environmental impact. Insignificant fauna/flora, habitat, soil, aquatic & land ecosystems, atmosphere, or water resources affected e.g. oil spill < 5Lt within a contained area.	Low environmental impact. Minor impact on fauna/flora, habitat, and soil, aquatic & land ecosystems, atmosphere, or water resources e.g. wildlife death.	Moderate environmental impact. Moderate impact on fauna/flora, habitat, and soil, aquatic & land ecosystems, atmosphere, or water resources e.g. machinery tramming on uncleared bush land without an internal permit to clear.	Major environmental impact. Major impact on fauna/flora, habitat, soil, aquatic & land ecosystems, atmosphere, or water resources.	Severe impact on fauna/flora, habitat, soil, aquatic & land ecosystems, atmosphere, or water resources.

The risk matrix in **Table 7-3** combines the level of likelihood and consequence to determine the level of associated risk. The following levels of risk are used and are based on a qualitative assessment.

- Low indicating no discernible risk (green);
- Moderate presenting a limited level of risk, but should not require any substantive measures to maintain this level of risk (yellow);
- High indicating the potential for impacts to the environment and may require mitigation measures to be introduced (orange); and
- Extreme signifies that there is potential for serious impacts and if confirmed would require mitigation measures to be implemented (red).

Table 7-3: Risk Matrix

	Consequence				
Likelihood	Incidental	Minor	Moderate	Major	Severe
Almost Certain	M	H	E	E	E
Likely	M	M	H	E	E
Possible	L	M	H	H	E
Unlikely	L	L	M	H	H
Rare	L	L	L	M	M

7.2 Risk management process

Management controls applied to the identified risks were determined using the hierarchy structure outlined in **Table 7-4** below. This hierarchy assigns a control method to the identified risk, based on the nature of the hazard.

Table 7-4: Hierarchy of Controls

Control	Example or Description
1. Elimination	Is there a need to use the plant, process, product or substance that created the risk?
2. Substitution	Can the hazardous item or product be substituted with another item that has less risk?
3. Isolation	Can the hazard or product be isolated from the person?
4. Engineering	Can the risk be minimised by redesigning the plant, substance, product or process?
5. Administrative	Examples include job rotation, SOP, training, signs, housekeeping inspections.
6. Personal Protective Equipment (PPE)	This is the least desirable method, which must only be used in combination with other controls or if other controls are not suitable. Employees issued

Control	Example or Description
	with PPE must have it fitted correctly and be trained in its use and maintenance.

Based on the consequence levels of the identified risks, management actions for each risk were determined based on the tolerability of the risk, as outlined in (**Table 7-5**).

7.3 Closure Risk Assessment

Using the risk assessment process outlined in **Section 7.1.1**, Ramelius undertook a comprehensive risk assessment of the Project which is provided as **Table 7-7**. The table describes each identified risk, the associated risk pathways, and the potential impacts of these risks on the surrounding environment. It also identifies both the initial and residual risk levels, and determines the relevant controls and actions based on these levels.

Table 7-5: Closure risk assessment

Phase	Activity/Point source	Risk Pathway	Likelihood	Consequence	Raw Risk	Treatment	Likelihood	Consequence	Treated Risk
Operation/ Closure	Waste rock landform/ Low Grade Stockpile	PAF material leaching into environment. Uncertainty of content in stockpile with regard to geochemical considerations	Unlikely	Moderate	M	Majority of the samples taken from the WRD indicate a NAPP level between -42 to 0, which are Non-Acid Forming. Some samples were considered uncertain. Uncertain material should be placed accordingly, to minimise exposure to oxygen and water.	Rare	Moderate	L
Operation/ Closure	Waste rock landform/ Low Grade Stockpile	Erosion/surface water runoff of WRL caused by rainfall, poor design, inadequate rehabilitation material.	Unlikely	Moderate	M	Specific design considerations have been recommended and will be implemented.	Rare	Moderate	L
Closure	Mine void	Inadvertent access to the pit voids by the public/fauna. Lack of abandonment bunds and poor signage.	Possible	Severe	E	Safety bund/abandonment bund constructed as per DMIRS standards. Ensure abandonment bunds are located outside the zone of instability, and abandonment bund constructed with competent material. Periodic site inspections/audits to check integrity of abandonment	Rare	Severe	M

Phase	Activity/Point source	Risk Pathway	Likelihood	Consequence	Raw Risk	Treatment	Likelihood	Consequence	Treated Risk
Closure	Mine void	Flooding event causes erosion and collapse of the walls of the pit Lack of abandonment bunds/flood berms. WRL located within the pit zone of instability.	Possible	Major	H	Final pit designs based on geological characteristics of pit Ensure abandonment bunds are located outside the zone of instability, and abandonment bund constructed with competent material Abandonment bunds/flood berms constructed around all mine voids, Constructed to withstand a 1:100 ARI.	Rare	Major	M
Closure	Mine void	Formation of a pit lake post-closure is used as a source of water by feral animals, in particular goats, and helps sustain a local population., potentially impacting local vegetation.	Possible	Moderate	H	Groundwater is expected to be in the salinity range of 9,000-15,000 mg/L TDS. Salinity of the pit lake will gradually increase over time due to evaporative concentration of discharging groundwater solute to be > 19,000 mg/L. Goats prefer salinity levels < 2000 mg/L but can adapt to levels > 5000 mg/L (DAWA, 2021). Pit water salinity will be well above this level and will increase over time.	Rare	Moderate	L
Construction/ Closure	Rehabilitation	Insufficient topsoil for rehabilitation purposes	Possible	Moderate	H	Ensure appropriate amount of topsoil is allocated for rehabilitation of all areas	Unlikely	Moderate	M

Phase	Activity/Point source	Risk Pathway	Likelihood	Consequence	Raw Risk	Treatment	Likelihood	Consequence	Treated Risk
Construction/ Closure	Rehabilitation	Failure in vegetation to establish and weed proliferation in topsoil	Possible	Moderate	H	Use of provenance-sourced seed Ensure topsoil stockpiles are free of weeds, implement weed management during operations	Rare	Moderate	L
Construction/ Closure	Rehabilitation	Soil contamination from site operations	Possible	Minor	M	At closure, test soil for contamination and remediate as necessary	Rare	Minor	L
Construction/ Closure	Impact to Mt Manning Conservation Park (R48470)	Generation of dust from WRL and mine void by wind erosion.	Possible	Minor	M	Complete all proposed rehabilitation works	Unlikely	Minor	L
Construction/ Closure	Impact to Mt Manning Conservation Park (R48470)	Water flow alterations from WRL	Possible	Moderate	H	There are no significant water bodies, drainage lines, creeks or rivers within the Project area. Ensure water flow and run off is naturally maintained to the terrain.	Rare	Moderate	L
Construction/ Closure	Impact to Mt Manning Conservation Park (R48470)	Failure of WRL	Likely	Moderate	H	Appropriate design and engineering of WRD to minimise failure.	Rare	Moderate	L

8 Closure Outcomes and Completion Criteria

The Project's closure outcomes and indicative completion criteria are listed in **Table 8-1**. The outcomes are primarily drawn from the risk assessment where treated risks were adjudged to be Moderate or higher. Other lower risks have been added to ensure broader expectations of the site's closure are also met, even if these issues do not represent a significant risk.

Table 8-1: Summary of closure outcomes and indicative completion criteria

Aspect	Closure Outcome	Indicative Completion Criteria	Measurement Tool
Compliance	All legally binding conditions and commitments relevant to rehabilitation and closure will be met.	All tenement conditions and Notice of Intent/Mining Proposal commitments have been met.	Audit (degree of compliance).
Landforms	All constructed waste rock landforms and low grade stockpiles will be stable, resistant to erosion and will be non-polluting with substances potentially harmful to people or the environment permanently encapsulated or removed from site.	All landforms constructed in accordance with approved design and parameters (including application of 40% tree debris cover) All landforms must be stable and erosion resistant. No visible sediment discharge beyond the immediate footprint of landforms.	Audit (degree of compliance). Undertake erosion and vegetation monitoring either via LFA or comparable method. Visual monitoring will include inspection of toe drain to determine erosion levels
	The site will be safe for people and animals.	Abandonment bund prevents inadvertent access to mine void.	Inspection (degree of compliance).
Revegetation	All rehabilitated areas have an established cover of native vegetation. Weeds are an insignificant component of revegetation.	An average native vegetation foliar cover of ≥ 50%. All weeds listed as an environmental weed[2] are eradicated. All weeds not listed as an environmental weed but forming a contiguous cover of ≥ 1 m^2 are controlled.	Cover assessment using standard vegetation/landscape monitoring techniques. Records of site inspections for weeds, noting species and extent of weed occurrences. Records of weed treatment (if required).

[2] Environmental weeds can be defined as any other plant that causes or has the potential to cause negative environmental, social or economic impact.

Aspect	Closure Outcome	Indicative Completion Criteria	Measurement Tool
		Monitoring results for vegetation cover (total percentage cover of live perennial vegetation) and plant density (total no. perennial plants) are within the reference range of representative analogue sites for three consecutive post closure monitoring periods.	
Pit lake	Pit lake does not support feral animals.	Pit lake exceeds or trending to exceed 20,000 mg/L Total Dissolved Solids.	Undertake salinity concentration monitoring and visual monitoring of feral animals at and around pit lake.
Infrastructure	Some access roads and saline water dam embankment to remain. All other infrastructure is to be removed.	All infrastructure removed unless otherwise agreed.	Decommissioning report (compliance with this MCP).

9 Closure Implementation

Closure will be implemented by incorporating the closure obligations, completion criteria, risk assessment and identified tasks into the overall operational and environmental management of the site. The MCP will be internally reviewed and checked periodically to ensure suitable progress is being made towards achieving the closure criteria and commitments.

9.1 Closure Task Register

The following tasks have been identified to bring the Project to full closure (**Table 9-1**).

Table 9-1: Closure task register summary

Domain	Tasks	Timing
General Closure	Restrict access to all areas of the site through the installation of fences, bunding and alternative access restraints where appropriate. Install signage stating that access is restricted, including appropriate warning signage. Site will be cleared of any non-mineral wastes. Any remaining exploration drill holes will be capped.	Within three months of the cessation of mining.
Waste rock landforms	Batter final slopes to concave form; incorporate tree debris into lower third of batter. Contour rip and seed; construct a crest bund and form upper surface such that ponding does not occur in a single area. WRL will be retained with signage to inform and help prevent unauthorised access. Safety audits and inspections of bunding, fences and signage of this area will continue.	Progressive rehabilitation will occur during operations and will be monitored every year for a period of a minimum of 3 years post closure or until revegetation meets completion criteria. Final WRL design works will be completed prior to the cessation of mining.
Mining void	Complete abandonment bund and to DMIRS specifications, ensuring it is outside the PZOI. Install signage and install fencing where appropriate to restrict unauthorised access. Safety audits and inspections of bunding, fences and signage of this area will continue.	Abandonment bund, signage, safety audits and inspections will be completed within three months of the cessation of mining.
ROM pad	Batter and contour rip and seed.	Progressive rehabilitation will occur during operations and will be monitored every year for a period of a minimum of
Workshop	Infrastructure will be decommissioned, dismantled and removed off-site. Break up concrete and bury locally.	

Domain	Tasks	Timing
	Rip and seed.	3 years post closure or until revegetation meets completion criteria
Saline water dam	Push in walls and liner, cap with local soils. Rip and seed.	
Laydown or hardstand areas	Rip and seed.	
Access roads	Retain access around site. Rip and seed access roads in excess of site access requirements.	
Other areas	Rip and seed.	

10 Closure Monitoring and Maintenance

10.1 Monitoring

Measurement of the progress and performance of rehabilitation at Die Hardy will be monitored in late summer against closure objectives and criteria. Rehabilitated areas will be monitored **every year** for a period of **a minimum of** 3 years **post closure or until** revegetation meets completion criteria.

10.1.1 Vegetation

Photo points will be set up to capture evidence of rehabilitation progress. Monitoring will include the capture of quantitative data to compare against the completion criteria. The following will be assessed during each monitoring event:

- Vegetation health (based on observation), cover and composition;
- Species richness; and
- Weed cover.

Analogue sites from undisturbed areas will be used to gain reference data for vegetation cover, composition and species richness.

10.1.2 Surface Water Drainage

Monitoring of surface water drainage within rehabilitation areas (including visual inspection for rills and scours) will occur for 3 years post-closure.

10.1.3 Infrastructure

Visual inspection will be undertaken to confirm all infrastructure removed (unless required by a third party taking a controlling interest in the leases).

10.1.4 Waste Rock Landform

The closure outcome for the WRL's is a geotechnically safe, stable landform with minimal erosion. The closure design details to achieve this outcome are as follows:

- Bunds constructed at the top perimeter crest and on berms of the landforms to prevent pooled water from cascading onto lower levels;
- Final landforms to have low angle of relief for external batters (less than 18 degrees);
- Protection from erosion by ripping final surfaces on the contour, application of 40% tree debris;
- Seeding with local provenance seeds. This process will be facilitated by the close proximity of established vegetation communities to the WRL enabling the capture of wind-borne seed from the surrounding dominant vegetation communities;
- Batters to have rock topsoil mulch applied to a depth of 100 mm, all rock applied on the batters will be NAF (no oxide material to be placed on outer batters);
- Construction of cells on the top of the landforms to prevent flow from concentrating on the top surface
- All access ramps onto the landforms will be re-profiled to blend in with the final closure batter design

These design parameters will ensure that the landform is water-retaining, reduces surface runoff down the slopes and encourages vegetation establishment. Visual assessment and aerial imagery of surface stability and erosion with targeted sampling and testing of any areas of concern.

10.2 Closure Maintenance

Maintenance works will be undertaken on rehabilitated areas and may include the following activities:

- Activities to correct erosion (such as filling in of rills and scours) within rehabilitation areas;
- Weed control within rehabilitation areas; and
- Additional seeding of rehabilitation areas.

11 Financial Provisioning for Closure

11.1 Objective

Under Ramelius' policy, closure costs are reviewed on an annual basis or if there are major changes to the project which will significantly affect the closure liability. The estimate has considered all rehabilitation requirements (as per legal obligations and standards within WA) and specified within the updated closure plan.

Additional costs have been considered for pre- and post-closure activities to be undertaken to satisfy the DMIRS and other regulatory requirements and as specified within the closure plan.

The equipment costed is considered appropriate for the likely proposed closure works include a range of mining equipment and other relevant and typical equipment used in mine closure and rehabilitation activities by earthmoving and civil contractors. Unit costs and production schedules have been developed based on earthmoving "bottom-up first principles" and have been calibrated against actual rehabilitation and mining activities, to ensure currency and consistency with expected contractor rates for the type of closure activities likely to be undertaken at closure and used in the estimates.

11.2 Financial Costing Methodology and Assumptions

The financial provision for the Project includes all direct closure execution costs included in a Life of Mine (LOM) total closure cost estimate, as they relate to the disturbance footprint at the time of reporting. The following costs have been included:

- All earthworks costs associated with rehabilitating all disturbed footprints including waste rock dumps (WRD), open pits, ore stockpiles, run of mine (ROM) and product pads, all associated milling and support infrastructure footprints including workshops, administration, laydowns, water containment facilities, drainage infrastructure, water supply facilities, pipelines, storage sheds etc. Costs also include the post closure monitoring period as the rehabilitated site stabilises;
- All decommissioning and demolition costs for dismantling and removing of all infrastructure off the site, breakup and burial of demolition rubble, and disposal of hazardous material and rubbish;
- All mobilisation and demobilisation of necessary closure and rehabilitation equipment and personnel required during the closure period;
- All costs associated with contamination investigation, removal and reporting;
- All consultant costs associated with the active and post closure periods (note that consultant costs required during operations are accounted for and included in operating budgets as a part of the closure planning function of the mine owner); and
- All environmental compliance, monitoring and reporting obligations during the active and passive (post) closure periods.

The costing has allowed for additional costs that may be incurred during both operations and closure activity periods and include:

- Owner's management costs during the closure activities and include for management and supervision, quality assurance and quality control (QA/QC) activities, social licence activities, consultant services, and rehabilitation earthmoving contractor mobilisation and demobilisation costs;

- Contingency to allow for the uncertainty in estimation and costs untested with current market conditions;
- Sudden closure care and maintenance costing; and
- Other closure costs expected to be incurred during operations and include for closure related technical and social studies as well as closure plan reviews and updates as required by the DMIRS.

For the purposes of the closure cost estimate the following assumptions have been made:

- The mine closure schedule is as per the current life of operations as described in the current Mine Closure Plans or as per the revised closure. All demolition and rehabilitation works are assumed to be undertaken every year for a period of a minimum of 3 years post closure or until revegetation meets completion criteria.
- Demolition costs are based on industry averages factored for similar sized plants and assumed mill and associated infrastructure schedules of quantities of concrete and steel required during the construction of the facilities;
- All rehabilitation earthworks and revegetation costs have been estimated on a first principles, bottom up, task and activity basis;
- Demolition rubble collected during the decommissioning of all infrastructure is to be disposed of within nearby disposal sites (raw water ponds) prior to their closure and rehabilitation. Scrap steel and hazardous materials (if any) are assumed to be removed from the sites for disposal at appropriate recycling and landfill locations respectively;
- Topsoil materials are assumed to be placed in an average 100 mm thick layer over all disturbed areas;
- Haulage distances for transport of rehabilitation materials are assumed to range from 500 m (adjacent to rehabilitation works) to 3,000 m;
- All closure works are assumed to be undertaken on a single (day) shift, twelve-hour, seven days per week basis, with equipment efficiencies (availability and utilisation of available hours) based on operational experience; and
- An assumed fuel price delivered to site, ex the diesel fuel excise rebate has been used.

In relation to uncertainties, there are few due to the lack of infrastructure at site and absence of processing activity (crushing, CIL etc). There is uncertainty attached to revegetation as the ability to recruit native plants from topsoil is assumed but uncertain. Additional costs may be incurred if re-seeding and reworking of rehabilitated surfaces is required. Significant rainfall events prior to the establishment of a substantial plant cover may also lead to a requirement for remedial work.

12 Management of Information and Data

Data management and storage, document filing, review history, correspondence, registers, and archiving, will be managed via the Ramelius' Document Control Procedures, and a specific Data Management Procedure designed for the management of environmental data at the Die Hardy Operations. An electronic library of documents has been established and will be maintained over the LoM. Ramelius will retain the following information relating to closure and rehabilitation:

- Historical mine closure plans and reports;
- Monitoring databases and analytical reports;
- Regulatory reports, for example, annual audit compliance reports and AERs;
- Rehabilitation trials, studies and reports;
- Information regarding areas of disturbance;
- Availability and volumes of materials required for rehabilitation;
- LoM plans and production scheduling information;
- Layout diagrams/maps of infrastructure and landforms;
- Design, construction and waste characterisation details of landforms;
- Significant spills and regulatory reportable incident records;
- Suspected or actual contaminated sites investigations and reports (if any occur);
- Correspondence with regulators and other stakeholders; and
- Lessons learned at similar mine sites.

All documents associated with operation and closure of the Project shall be stored in accordance with the Ramelius Document Control Procedure and other legal requirements. The full list of relevant documentation will be provided in the final Decommissioning Report that will be submitted to DMIRS at closure.

Spatial data will be stored in an ArcGIS database by Environmental staff on the Ramelius server. This server will be backed up on a daily basis and is used to store all relevant environmental spatial data.

13 Changes from previous Mine Closure Plan

The first version of this MCP submitted was version 1.0. The following table shows comments from DMIRS on this version and outlines how these comments were addressed in this revised version (1.1).

Table 13-1: Comments and responses on version 1.0 of this MCP

Item	Section of submission	Statutory guideline section	DMIRS comments	Proponent comments	Updated section of submission
1.	Section 4 Stakeholder Engagement	Section 7 Stakeholder Engagement	Limited stakeholder engagement has been provided in relation to PMLU, closure and rehabilitation and its acceptability to the key stakeholders. Consultation with DBCA regarding PMLU, closure and rehabilitation is required.	The land is a former pastoral station (Diemals) but is now Unallocated Crown Land under the management of DBCA (R48470). Acknowledgement of DBCA's interest in post-mining land use has been included. See also item 4.	Section 4
2.	Section 5.13.2	Section 5 Baseline and Closure Data Analysis	If the revised proposal includes a WRL please provide the WRL final landform design including cover material, depth of cover, percentage of tree debris etc.	WRL design, material balance and other parameters have been included.	Section 5.13.2
3.	Section 5.13.2	Section 5 Baseline and Closure Data Analysis	If the revised proposal includes a WRL please support the final landform design with a material balance indicating the required and available material to support the proposed design.	WRL material balance sheet and design has been added.	Section 5.13.2 (Tables 5-6 and 5-14)
4.	Section 6 Post Mining Land Use	Section 6 Post Mining Land Use	Pastoral Lands proposed as a PMLU is not relevant to the environment in which the mine will operate; it is not demonstrated to be acceptable to key stakeholders, and is not ecologically sustainable in the context of the local and regional environment. Please revise the PMLU in accordance with the Statutory Guidelines.	Post-mining land use has been changed from pastoral use to native vegetation.	Section 6
5.	Section 7.3 Closure Risk Assessment	Section 7 Closure Risk Assessment	The number of feral animals may increase due to increased water supply from the post mining pit lake. Backfilling the mine void would negate the risk to native fauna and increased risk of feral animal impacts	The potential for backfilling of open pit has been considered in line with DMIRS and EPA Mine Closure Guidelines (DMP and EPA 2011) and DBCA as a key stakeholder responsible for management of the CALM	Section 5.11.4 (new) Section 7.3 Table 7-5

Item	Section of submission	Statutory guideline section	DMIRS comments	Proponent comments	Updated section of submission
			in closure. How will potential impacts to the proposed Nature Reserve and adjacent Conservation Park be mitigated during closure?	Act Section 5(1)(h) proposed 'Conservation and Mining Reserve'. The primary considerations were: the extent of potential pit lake formation; sterilisation of underlying ore potential; and attraction and localised grazing of feral animals. DMIRS and EPA Mine Closure Guidelines require that, prior to open cut mines being backfilled, a study be conducted to determine the potential for future economic mining from any resource that exists beneath or along strike of the current pit extents. MOPL's resource definition data currently indicates a defined resource extent beyond that which is proposed to be mined. Consequently, there is a risk to sterilising future resources if backfilling was to occur. During consultation with DBCA on 29 September 2021, DBCA's position is that although backfilling is preferable, it is not mandatory as other factors such as safety or economics reasons preclude backfilling from occurring. A risk analysis has been implemented and a low risk was found. As the salinity concentration of the pit lake would exceed >19000 mg/L TDS over time due to evaporation, this will be insufficient to support a population of feral animals such as goats	
6.	Table 8-1 Summary of Closure outcomes and completion criteria	Section 8 Closure outcomes and completion criteria	If the revised proposal includes a WRL please revise the completion criteria for the landform to include the acceptable erosion rates and include the percentage of tree debris cover as modelled in	Section has been amended to include either visual or LFA monitoring to determine acceptable erosion rates.	Section 8 (Table 8-1)

Item	Section of submission	Statutory guideline section	DMIRS comments	Proponent comments	Updated section of submission
			Appendix B Landform Design Guidance Document.		
7.	Table 8-1 Summary of Closure outcomes and completion criteria	Section 8 Closure outcomes and completion criteria	If the revised proposal includes a pit lake, please provide an outcome to mitigate feral animal activity post closure.	Salinity levels are likely to be too high to provide support for local populations of feral animals. Some information has been included in the MCP about salinity tolerances in goats. Also addressed in the risk assessment. Monitoring of pit lake salinity levels and visual monitoring post-closure will be undertaken.	Section 5.11.4Table 8-1
8.	Table 8-1 Summary of Closure outcomes and completion criteria	Section 8 Closure outcomes and completion criteria	In relation to the completion criteria for revegetation please define the foliar cover as native vegetation and please include an additional completion criteria for species richness.	Foliar cover has been amended to be defined as native vegetation Species richness completion criteria amended to 25 % of the site baseline.	Section 8 (Table 8-1)
9.	Section 9 Closure Implementation	Section 9 Closure Implementation	Due to the short mine life of the project the closure implementation tasks proposed in Table 9-1 require to more detailed to describe the prescribed rehabilitation for the project to demonstrate it is consistent with the revised PMLU and DMIRS environmental objectives. Please also include timeframes for closure of each domain.	More detail on the proposed tasks for closure has been incorporated. Detail on timeframes for each domain has been added.	Section 9 (Table 9-1)
10.	Section 10 Closure Monitoring and Maintenance	Section 10 Closure Monitoring and Maintenance	If the revised proposal includes a WRL specific monitoring is required for landform stability to ensure the landform has been designed in accordance with proposed parameters and acceptable erosion rates are being achieved.	Information regarding WRL monitoring and design have been incorporated.	Section 10.

Item	Section of submission	Statutory guideline section	DMIRS comments	Proponent comments	Updated section of submission
11.	Table 8-1 Summary of Closure outcomes and completion criteria	Section 10 Closure Monitoring and Maintenance	Please ensure the monitoring within the measurement tool column in Table 8-1 is consistent with the monitoring proposed in Section 10 Closure Monitoring and Maintenance.	Updated section to ensure Table 8-1 monitoring and measurement tool is consistent with closure monitoring and maintenance in Section 10	Table 8-1
12.	Section 11 Financial Provisioning for Closure	Section 11 Financial Provisioning for Closure	This section is to be revised to detail the closure costing methodology, assumption and uncertainties.	Section has been revised and costing methodology has been incorporated -see Table 11-1.	Section 11 and Table 11-1

14 References

Cowan, M., Graham, G. and McKenzie, N. (2001). Coolgardie 2 (COO2 – Southern Cross subregion). Pp 143-155 In May, J.E and McKenzie, N.L. (2003). A Biodiversity Audit of Western Australia's Biogeographical Subregions in 2002. Department of Conservation and Land Management.

Department of Local Government and Regional Development (2003). Code of Practice for Goats in Western Australia.

McGregor, B.A.(2004). Water quality and provision for goats. Rural industries Research and Development Corporation, March 2004.

Payne, A.L., Van Vreeswyk, A.M.E., Pringle, H.J.R., Leighton, K.A. & Hennig, P. (1998). An inventory and condition survey of the Sandstone-Yalgoo-Paynes Find area, Western Australia, Technical Bulletin no. 90, Agriculture Western Australia, South Perth.

APPENDIX A
Legal Obligations Register

Table A1: Tenement conditions (closure-related conditions in bold)

Tenement	No.	Version	Condition	Start Date
M77/1272	1	1	Survey.	22/08/2014
M77/1272	2	1	**All surface holes drilled for the purpose of exploration are to be capped, filled or otherwise made safe immediately after completion.**	22/08/2014
M77/1272	3	1	**All disturbances to the surface of the land made as a result of exploration, including costeans, drill pads, grid lines and access tracks, being backfilled and rehabilitated to the satisfaction of the Environmental Officer, Department of Mines and Petroleum (DMP). Backfilling and rehabilitation being required no later than 6 months after excavation unless otherwise approved in writing by the Environmental Officer, DMP.**	22/08/2014
M77/1272	4	1	**All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.**	22/08/2014
M77/1272	5	1	Unless the written approval of the Environmental Officer, DMP is first obtained, the use of drilling rigs, scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.	22/08/2014
M77/1272	6	1	The lessee submitting a plan of proposed operations and measures to safeguard the environment to the Executive Director, Environment Division, DMP for his assessment and written approval prior to commencing any developmental or productive mining or construction activity.	22/08/2014
M77/1272	7	1	The rights of ingress to and egress from Miscellaneous Licence 77/261 being at all times preserved to the licensee and no interference with the purpose or installations connected to the licence.	22/08/2014
M77/1272	8	1	**The prior written consent of the Minister responsible for the Mining Act 1978 being obtained before commencing any mining activities on CONSERVATION PARK CR 48470.**	22/08/2014

Tenement	No.	Version	Condition	Start Date
M77/1272	9	2	**The construction and operation of the project and measures to protect the environment to be carried out in accordance with the document titled:** • **(PoW Reg ID 82095) "Marda Project Conservation Management Plan for Exploration within former leasehold-ex Diemals Station (LR3161/972) and ex Mt Jackson Station (LR3141/662" dated 30 May 2019, Version 1, and retained on Department of Mines, Industry Regulation and Safety File No. EARS-POW-82095 as Doc ID 6891285;** • **(PoW Reg ID 89029) "Marda Project Conservation Management Plan for Exploration within former leasehold-ex Diemals Station (LR3161/972) and ex Mt Jackson Station (LR3141/662)" submitted 19 November 2020 by Erik Van Noort and retained on Department of Mines, Industry Regulation and Safety File No. EARS-POW-89029 as Doc ID 7872060**	14/07/2020
L77/261	1	1	The Licensee submitting a plan of proposed operations and measures to safeguard the environment to the Executive Director, Environment Division, DMP for assessment and written approval prior to commencing any development or construction.	17/06/2013
L77/261	2	1	Where surface disturbance activities are proposed on the licence which are not associated with development or construction proposals, the prior written approval of the Environmental Officer, DMP must be obtained before the use of drilling rigs, scrapers, graders, bulldozers, backhoes or other mechanised equipment for the proposed surface disturbance activities. Following approval, all topsoil being removed ahead of operations and separately stockpiled for replacement after backfilling and/or completion of operations.	17/06/2013
L77/261	3	1	To properly maintain the installations as directed by the Environmental Officer, Department of Mines and Petroleum.	17/06/2013
L77/261	4	1	**All topsoil that may be removed ahead of pipelaying operations to be stockpiled for replacement in accordance with the directions of the Environmental Officer, Department of Mines and Petroleum.**	17/06/2013

Tenement	No.	Version	Condition	Start Date
L77/261	5	1	Ingress and egress of pastoralists and tenement holders to be preserved by the construction of vehicular access crossings over any pipeline constructed pursuant to this licence.	17/06/2013
L77/261	6	1	Wherever any part of a road intersects an existing fence, the holder shall where necessary construct a gate or livestock grid having such dimensions and be constructed of such materials and be of such standard as agreed with the pastoralist or as determined by the Environmental Officer, DMP.	17/06/2013
L77/261	7	1	At the direction of the Special Inspector of Mines - Electrical, DMP the holder shall clear such area about any powerline as determined by the Inspector of any dry or other growth considered by the Inspector to be a potential risk for fire or for any other reason the Inspector may deem is necessary.	17/06/2013
L77/261	8	1	The road to be constructed using proper materials to suit the purpose for which it is being constructed, and further that it be constructed in a workman like manner and further that it be constructed to the satisfaction of the Environmental Officer, DMP.	17/06/2013
L77/261	9	1	The holder shall maintain the road from time to time as shall be required to ensure that it is safe for the purpose that it is constructed.	17/06/2013
L77/261	10	1	**On the completion of the life of mining operations in connection with this licence the holder shall:** **remove all installations constructed pursuant to this licence; and** **on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Environmental Officer, Department of Mines and Petroleum and properly maintain same until the Environmental Officer advises regrowth is self-supporting;** **unless the Minister responsible for the Mining Act 1978 orders or consents otherwise.**	17/06/2013
L77/261	11	1	The road is to be clearly signposted as a private road and the signposting is to be regularly maintained at the licence holder's expense.	17/06/2013

Tenement	No.	Version	Condition	Start Date
L77/261	12	1	All traffic on the road must give way to traffic on public roads	17/06/2013
L77/261	13	1	All intersections with public roads should be at 90 degrees or as close as possible to maintain visibility and such intersections are to be maintained at the licence holder's expense.	17/06/2013
L77/261	14	1	The electrical installation shall meet the requirements of relevant on-site conditions and be carried out to the satisfaction of the Special Inspector of Mines - Electrical, DMP.	17/06/2013
L77/261	15	1	The licensee is to obtain the written approval of the Shire of Yilgarn or Main Roads WA or both where applicable and lodge a copy of that approval with the Mining Registrar prior to the construction of that part of the road that will intersect with any existing road. Where a difference exists between DMP conditions and the requirements of either authority, the requirements of the authority prevail.	17/06/2013
L77/261	16	1	In respect to DEC - Managed Lands P5H/35, Proposed 5(1)(H) Reserve Conservation and Mining the following conditions apply:	17/06/2013
L77/261	16	1	Prior to lodgement of a Programme of Work (PoW), the Licensee preparing a Conservation Management Plan (CMP) to address the conservation impacts of the proposed activities and submitting the CMP to the relevant Regional Manager of the Department of Environment and Conservation (DEC). This CMP shall be prepared pursuant to DEC-prepared "Guidelines for Conservation Management Plans Relating to Mineral Exploration on Lands Managed by the Department of Environment and Conservation" to meet the requirements of the Minister for Environment for acceptable impacts to conservation estate. A copy of the CMP and of DEC's decision on its acceptability under the guidelines is to accompany the lodgement of the PoW application with the Department of Mines and Petroleum.	17/06/2013

Tenement	No.	Version	Condition	Start Date
L77/261	17	1	At least five working days prior to accessing the reserve or proposed reserve area, unless otherwise agreed with the relevant Regional Manager of the Department of the Environment and Conservation (DEC-R), the holder providing the DEC-R with an itinerary and programme of the locations of operations on the Licence area and informed at least five days in advance of any changes to that itinerary. All activities and movements shall comply with reasonable access and travel requirements of the DEC-R regarding seasonal/ground conditions	17/06/2013
L77/261	18	1	The Licensee submitting to the Director of Environment, Department of Mines and Petroleum (DMP), and to the relevant Regional Manager, Department of the Environment and Conservation (DEC-R) a project completion report outlining the project operations and rehabilitation work undertaken in the programme. This report is to be submitted within six months of completion of the exploration activities.	17/06/2013

Table A2: Tenement endorsements (closure-related conditions in bold)

Tenement	No.	Version	Endorsements	Start date
M77/1272	1	1	The Lessee's attention is drawn to the provisions of the Aboriginal Heritage Act 1972 and any Regulations thereunder.	22/08/2014
M77/1272	2	1	The Lessee's attention is drawn to the Environmental Protection Act 1986 and the Environmental Protection (Clearing of Native Vegetation) Regulations 2004, which provides for the protection of all native vegetation from damage unless prior permission is obtained.	22/08/2014
M77/1272		1	In respect to Proclaimed Ground Water Areas GWA/21 Goldfields, the following endorsement applies:	22/08/2014

Tenement	No.	Version	Endorsements	Start date
M77/1272	3	1	The abstraction of groundwater is prohibited unless a current licence to construct/alter a well and a licence to take groundwater has been issued by the DoW.	22/08/2014
M77/1272		1	In respect to Water Resource Management Areas (WRMA) the following endorsements apply:	22/08/2014
M77/1272	4	1	The Lessee attention is drawn to the provisions of the: • Waterways Conservation Act, 1976 • Rights in Water and Irrigation Act, 1914 • Metropolitan Water Supply, Sewerage and Drainage Act, 1909 • Country Areas Water Supply Act, 1947 • Water Agencies (Powers) Act 1984 Water Resources Legislation Amendment Act 2007	22/08/2014
M77/1272	5	1	The rights of ingress to and egress from the mining tenement being at all reasonable times preserved to officers of Department of Water (DoW) for inspection and investigation purposes.	22/08/2014
M77/1272	6	1	The storage and disposal of petroleum hydrocarbons, chemicals and potentially hazardous substances being in accordance with the current published version of the DoWs relevant Water Quality Protection Notes and Guidelines for mining and mineral processing.	22/08/2014

Tenement	No.	Version	Endorsements	Start date
M77/1272	7	1	The abstraction of groundwater from an artesian well and the construction, enlargement, deepening or altering of any artesian well is prohibited unless a current licence for these activities has been issued by the DoW.	22/08/2014
M77/1272	8	1	In respect to Waterways the following endorsements apply: Advice shall be sought from the DoW if proposing any mining/activity in respect to mining operations within a defined waterway and within a lateral distance of: • 50 metres from the outer-most water dependent vegetation of any perennial waterway, and • 30 metres from the outer-most water dependent vegetation of any seasonal waterway	22/08/2014
M77/1272	9	1	Measures such as effective drainage controls, sediment traps and stormwater retention facilities being implemented to minimise erosion and sedimentation of receiving catchments and adjacent areas.	22/08/2014
L77/261	1	1	The Licensee's attention is drawn to the provisions of the Aboriginal Heritage Act 1972 and any Regulations thereunder.	17/06/2013
L77/261	2	1	The Licensee's attention is drawn to the Environmental Protection Act 1986 and the Environmental Protection (Clearing of Native Vegetation) Regulations 2004, which provides for the protection of all native vegetation from damage unless prior permission is obtained.	17/06/2013
L77/261	3	1	The Licensee's attention is drawn to the provisions of: • the Conservation and Land Management Act 1984 and any Regulations there under; • the Bushfires Act 1954 and any regulations thereunder, and the Wildlife Conservation Act 1950 and any Regulations thereunder.	17/06/2013

Tenement	No.	Version	Endorsements	Start date
L77/261	4	1	In respect to Proclaimed Ground Water Areas GWA/21 Goldfields, the following endorsement applies:	17/06/2013
L77/261	5	1	In respect to Water Resource Management Areas (WRMA) the following endorsements apply: The Licensee attention is drawn to the provisions of the: • Waterways Conservation Act, 1976 • Rights in Water and Irrigation Act, 1914 • Metropolitan Water Supply, Sewerage and Drainage Act, 1909 • Country Areas Water Supply Act, 1947 • Water Agencies (Powers) Act 1984 • Water Resources Legislation Amendment Act 2007	17/06/2013
L77/261	6	1	The rights of ingress to and egress from the mining tenement being at all reasonable times preserved to officers of Department of Water (DoW) for inspection and investigation purposes.	17/06/2013
L77/261	7	1	The storage and disposal of petroleum hydrocarbons, chemicals and potentially hazardous substances being in accordance with the current published version of the DoWs relevant Water Quality Protection Notes and Guidelines for mining and mineral processing.	17/06/2013
L77/261	8	1	In respect to Artesian (confined) Aquifers and Wells the following endorsement applies:	17/06/2013

Tenement	No.	Version	Endorsements	Start date
			The abstraction of groundwater from an artesian well and the construction, enlargement, deepening or altering of any artesian well is prohibited unless a current licence for these activities has been issued by the DoW.	
L77/261	9	1	In respect to Waterways the following endorsement applies: Advice shall be sought from the DoW if proposing any activity in respect to licence purpose within a defined waterway and within a lateral distance of: • 50 metres from the outer-most water dependent vegetation of any perennial waterway, and • 30 metres from the outer-most water dependent vegetation of any seasonal waterway.	17/06/2013

APPENDIX B

Geotechnical Report (Peter O'Bryan and Associates)

PETER O'BRYAN *& Associates*

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A division of WBG *Pty Ltd* ABN 94 082 091 236

MARDA GOLD PROJECT

GEOTECHNICAL ASSESSMENT
OPEN PIT MINING
DIE HARDY DEPOSIT

REPORT 20084

Prepared for:

Ramelius Resources Ltd
1/130 Royal Street
EAST PERTH WA 6004

Prepared by:

Scott Campbell
Peter O'Bryan
December 2020

In association with:

GEORGE, ORR and Associates (Australia) Pty Ltd Consulting Engineering Geologists
Peter Clifton & Associates Consulting Hydrogeologists

1.0 EXECUTIVE SUMMARY

Ramelius Resources Ltd plans to develop an open pit on the Die Hardy gold deposit, which lies within Ramelius' Marda Gold Project, Western Australia.

Ground conditions influencing wall stability in proposed open pit mining at Die Hardy have been investigated by Peter O'Bryan & Associates (PBA) using:

- ⇨ Current geological interpretations
- ⇨ Data contained in geological, structural geological and geotechnical logs for diamond cored exploration boreholes FBDD-001, 002 and 003. The logs were compiled by Ramelius Resources and PBA.
- ⇨ Laboratory measurement of physical properties of representative samples of country rocks
- ⇨ Experience in geotechnical assessment and review in similar geological and geotechnical settings.

Assessment and analysis of future open pit wall stability has used:

- ⇨ Current interpretations of geological and geotechnical conditions
- ⇨ Structural geological assessment
- ⇨ Results of laboratory testing of physical properties of country rocks in which future pit walls will be developed
- ⇨ Kinematic stability analysis
- ⇨ Limit equilibrium analysis
- ⇨ Experience-based assessment of expected pit wall conditions.

Ground Conditions

On the basis of core logging data the quality of the *extremely* to *completely weathered* horizon at Die Hardy is classified as *very poor*. The mean Rock Mass Rating (RMR) for observed intervals of *extremely* to *completely weathered* material/ rock was 17 (*very poor* rock).

Highly weathered rocks have an RMR range of 12 to 52 (*very poor* to *fair* rock), with a mean value of ~ 33 (*poor* rock).

Transitional (*moderately weathered*) rocks had RMRs ranging from 47 to 69 (*fair* to *good* rock), with a mean value of ~ 55 (*fair* rock).

Slightly weathered rock had an RMR range of 22 to 75 (*poor* to *good* rock), with a mean of ~ 65 (*good* rock).

Overall, data from *fresh* rock core yielded an RMR range of 56 to 94 (*fair* to *very good* rock), with a mean value of ~ 78 (*good* rock).

Wall Stability Conditions

On the basis of assessed rock mass conditions, it is considered that wall stability within the majority of proposed pit slopes at Die Hardy will be controlled by some combination of the influences of low shear strength of weathered materials and relict geological structures.

Current weathering interpretations indicate that planned mining will intersect limited intervals of *fresh* rock. Where encountered, fresh rocks are expected to generally be *very strong* and wall segment stability will dominantly be controlled by the orientation, persistence and shear strength of geological structures intersected by, or located close behind, pit walls.

Kinematic stability analyses indicate theoretical potential for planar sliding failure from the major eastern wall. It is anticipated that the eastern wall of the proposed pit will follow the orientation of moderately steep south-west dipping lodes within the SIF rock unit; hence batter face and wall Inter Ramp Angles (IRA) would not be expected to exceed the ~ 40° dip of the SIF unit. At modest ≤ 40° face and slope angles, potentials for planar sliding failures, structurally-controlled failures and intact material shear failures are expected to be limited.

Recommended Open Pit *Base Case* Wall Design Parameters

The wall design parameters provided herein may be used for ongoing open pit mining evaluation and planning at Die Hardy.

The preliminary pit design, on which assessment has been based, is shown in Figure ES1; and the recommended *base case* wall profiles are illustrated in Figures ES2 and ES3.

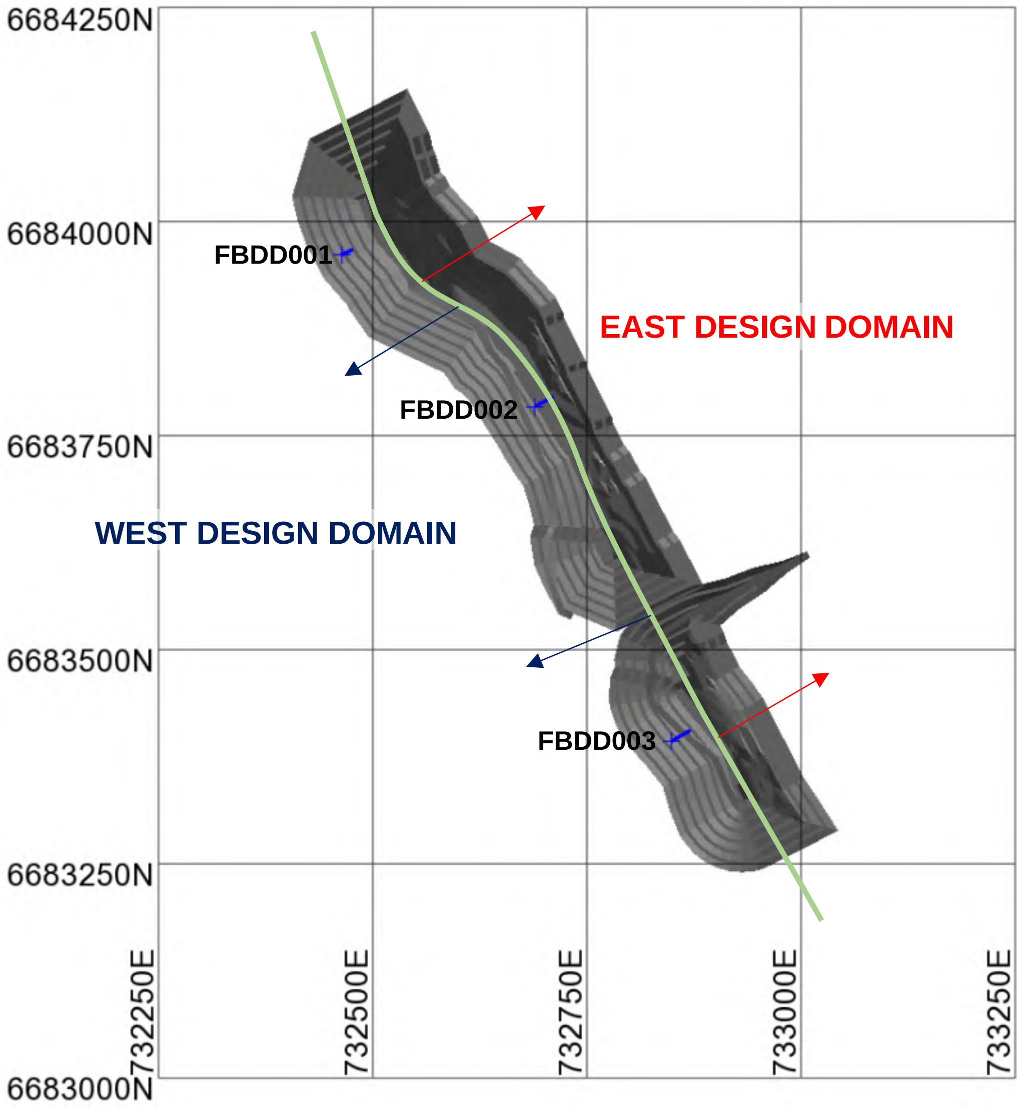

Figure ES1 Preliminary Die Hardy geotechnical design domains

EAST DOMAIN

Figure ES2

From 0 to 10 metres below surface (mbs) (laterite, gravel, transported & *highly* weathered material)

Batter Face Height	**≤ 10m**
Batter Face Angle	**40°**
Berm Width	**5m**
IRA	**30.6°**

From 10 to 50 mbs (*highly* weathered to *fresh* SIF, MDZ & UAC rocks)

Batter Face Height	**≤ 20m***
Batter Face Angle	**40°** (attempting to match bedding/defect angle within wall rocks)
Berm Width	**5m**
IRA	**34.7°**

* *Alternatively, mine as continuous 35° to 40° slope with rock slide arresting bunds or catch fences installed at ≤ 20m vertical intervals.*

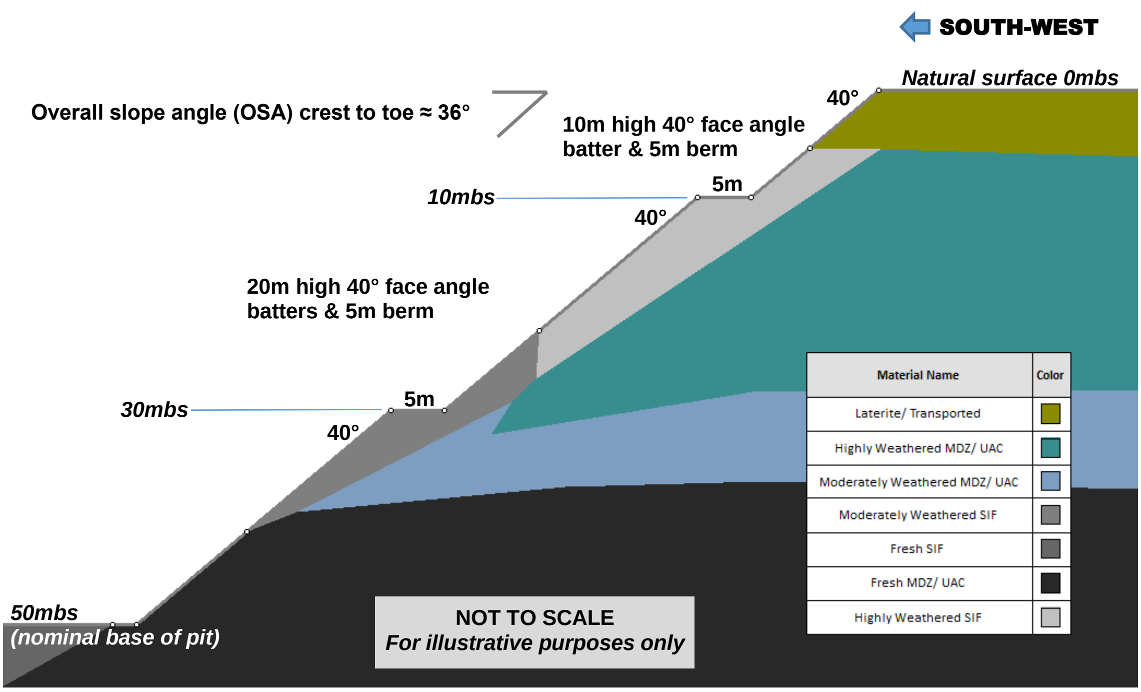

Figure ES2 **Die Hardy East Design Domain wall *base case* design parameters**

WEST DOMAIN

Figure ES3

From 0 to 10 metres below surface (mbs) (laterite, gravel, transported & *highly* weathered material)

Batter Face Height	**≤ 10m**
Batter Face Angle	**40°**
Berm Width	**5m**
IRA	**30.6°**

From 10 to 40 mbs (*highly* to *moderately* weathered UZZ & SIF rocks)

Batter Face Height	**≤ 10m**
Batter Face Angle	**50°**
Berm Width	**4m**
IRA	**38.9°**

From 40 to 50 mbs (*moderately* weathered to *fresh* SIF rocks)

Batter Face Height	**≤ 10m**
Batter Face Angle	**60°**
IRA	**60°** (single batter)

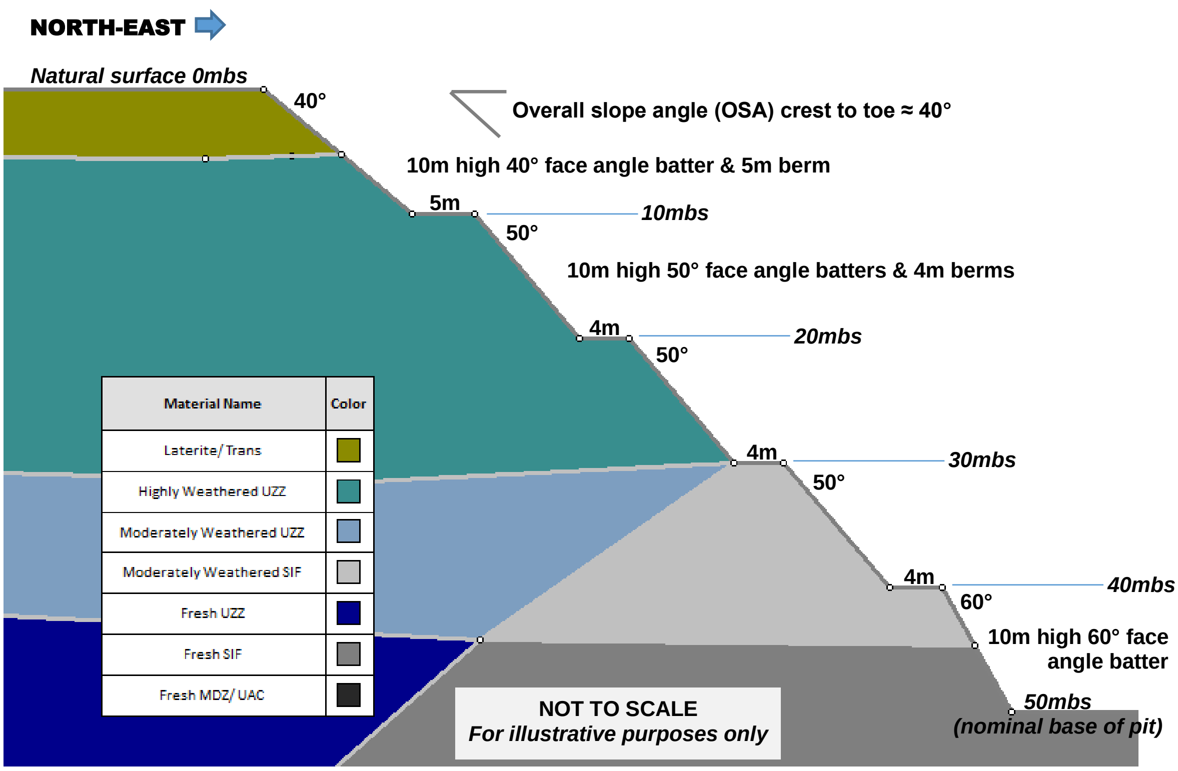

Figure ES3 Die Hardy West Design Domain wall *base case* design parameters

Waste Rock Landform Design

Current proposed Die Hardy waste rock landform (WRL) slopes are of modest height and profile. PBA considers the currently proposed WRL design parameters to be acceptable for construction. The need to manage surface water flows and residence times appropriately is emphasised.

Further Geotechnical Assessment

Pit Wall Mapping & Stability Monitoring

It is considered essential that design re-assessments, and where necessary design adjustments, be made based on *observational techniques* (incorporating ongoing wall mapping and quantitative wall stability monitoring) employed during pit development.

Independent Geotechnical Review

Regular geotechnical review of ground conditions during operations is recommended.

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2.0 Introduction

This report summarises the findings and recommendations of preliminary geotechnical assessment of proposed open pit mining of the Die Hardy gold deposit (Die Hardy), located within the Ramelius Resources Pty Ltd (Ramelius) Marda Gold Project (Marda), Western Australia.

Recommendations are provided for *base case* wall design parameters for ongoing mining evaluation. Requirements for ongoing geotechnical assessment of open pit mining at Die Hardy are also listed.

This report has been prepared at the request of Mr Rob Hutchison, Manager – Mine Geology, Ramelius, made via email on 31 August 2020.

2.1 Scope of Work

The Scope of Work requested by Ramelius was essentially to:

- Geotechnically assess rock mass conditions within the limits of proposed Die Hardy open pit excavation:
  - Geotechnically log cores from exploration boreholes.
  - Complete geotechnical investigation work required for the assessment.
  - Complete analysis of data collected through geotechnical investigation work.
- Provide recommendations on parameters to be used in design of the open pit.
- Provide recommendations on any future geotechnical work deemed to be required.
- Summarise the findings and recommendation of the preliminary geotechnical assessment work in a written report.
- Assess the geotechnical feasibility of proposed design parameters for a Waste Rock Landform (WRL) planned to be constructed adjacent to the Die Hardy open pit mining area.

2.2 Sources of Information

Ground conditions have been assessed using current Ramelius geological interpretations, data obtained from cores of exploration boreholes and experience in geotechnical assessment and review in similar geological and geotechnical settings.

Findings and recommendations are based on:

- Discussions held with Rob Hutchison regarding the Die Hardy geological setting and proposed future mining.
- Data contained in geological and geotechnical logs for diamond cored exploration boreholes FBDD-001, 002 and 003 drilled at Die Hardy during October 2020. Geological logging was carried out by Ramelius geologists and geotechnical logging by Peter O'Bryan & Associates (PBA).
- Consideration of experience in geotechnical assessment and review of open pit operations in similar geological and geotechnical settings.
- Review of site topography, preliminary pit design, interpreted rock weathering and geological interpretation files supplied electronically by Ramelius, as follows:
  - *2020 rh topo_diehardy.dtm*
  - *20_01 Geol_lat.dtm*
  - *dh_pd_nth_ac_0720_SC.dtm*
  - *2011_dh_geol_bif.dtm*
  - *20_01 Geol_boco.dtm*
  - *20_01 Geol_TOFR.dtm*
  - dh_pd_sth_ac_0720_SC*.dtm*

3.0 Background Information

Note that unless stated otherwise, all grid and directions indicated within this report refer to the MGA94_50 grid system.

3.1 Location

The Die Hardy deposit is located ~ 400 km north-east of Perth and ~ 165 km north of the township of Southern Cross, Western Australia (Figure 1). Die Hardy is located ~ 30 km north of the Ramelius Marda Central open pits.

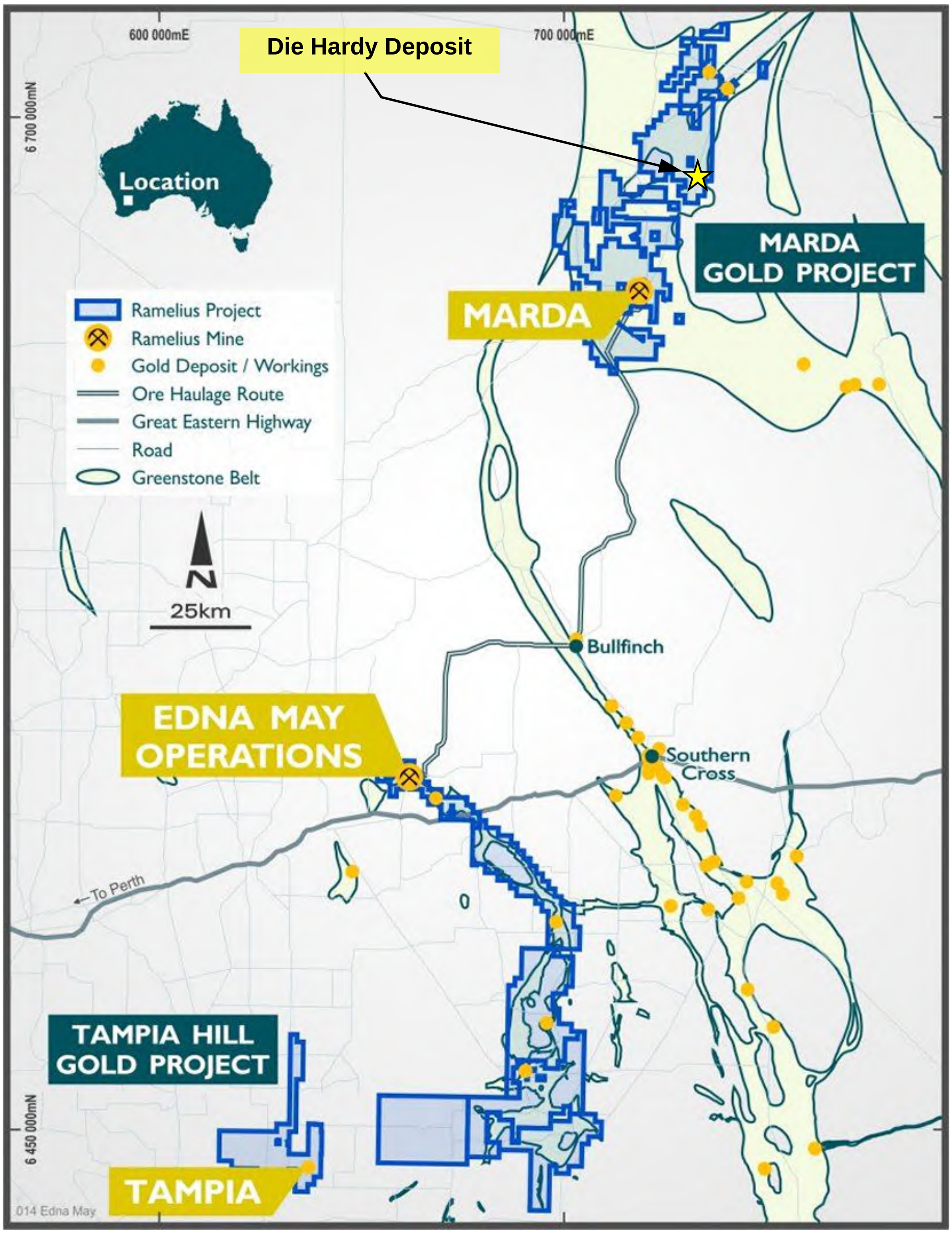

Figure 1 Current Ramelius mines, projects & location of the Die Hardy Deposit
(modified after Ramelius)

3.2 Topography

Natural surface topography within the immediate vicinity of the Die Hardy deposit slopes gently to the north north-west, with a relative difference in elevation of ~ –10m between the southern and northern boundaries of the proposed mining area. Natural surface within the central portion of the deposit rises ~ 5m along a north north-west trending Banded Iron Formation (BIF) unit.

The deposit is aligned parallel to the Die Hardy Range which is located ~ 1.5 km to the south-east.

3.3 Geology

The following descriptions of the geological setting at Die Hardy have been summarised from a background note provided by Ramelius [1].

3.3.1 Local Geology

Mineralisation at Die Hardy is hosted within a BIF unit which is located within mafic and ultramafic stratigraphy. Stratigraphy strikes north north-west toward 330° and dips at around 35° to 40° to the south-west.

The BIF unit is ~ 30m to 40m thick and mineralisation occurs as a relatively continuous lode zone within the unit. Mineralisation is interpreted to occur within a shear zone or iron-rich sedimentary layer which ranges in width from ~ 2m to 8m, with an average width of ~ 5m. Mineralisation is defined for ~ 1,000m along strike and ~ 140m down dip.

Major Logged Lithologies within Die Hardy Exploration Boreholes

Major rock types logged in Die Hardy exploration boreholes FBDD-001 to 003 ranked in order of frequency of occurrence comprise:

- ⇨ **SIF** – Sedimentary chert and BIF, dominant ferruginous layers
- ⇨ **UZZ** – Ultramafic undifferentiated
- ⇨ **UAC** – Ultramafic amphibole chlorite schist
- ⇨ **TCZ** – Transported clay undifferentiated
- ⇨ **TGF** – Transported gravel, ferruginous
- ⇨ **MDZ** – Mafic dolerite undifferentiated
- ⇨ **TMZ** – Transported mottled clay

3.3.2 Rock Weathering

Interpreted rock weathering surfaces provided by Ramelius (files: *20_01 Geol_lat.dtm*, *20_01 Geol_boco.dtm* and *20_01 Geol_TOFR.dtm*) indicate that weathering extends to variable and considerable depths at Die Hardy.

Current rock weathering interpretations indicate that:

- ⇨ The depth of transported laterite cover material ranges from ~ 3m to ~ 12m, with an average thickness of ~ 8m.
- ⇨ The Base of Complete Oxidation (BOCO) is located at significantly shallower depth along the deposit BIF unit compared to that in the bounding mafic and ultramafic rocks. Within the BIF unit BOCO is generally located ~ 10 metres below surface (mbs), with depth locally varying between ~ 7 mbs and ~ 21 mbs.

  Within UZZ and MDZ rocks outside of the BIF, the depth to BOCO is indicated to range from ~ 30 mbs to ~ 40mbs.
- ⇨ The currently interpreted Top of Fresh Rock (TOFR) shows less variation than the BOCO surface and is relatively uniform across Die Hardy lithologies. Interpreted depths to TOFR are:
  - ▫ Western Sector, ~ 45 mbs to ~ 55 mbs, generally ~ 47 mbs.
  - ▫ Centre (BIF) Sector, ~ 44 mbs to ~ 61 mbs, generally ~ 47 mbs.
  - ▫ Eastern Sector, ~ 37 mbs to ~ 55 mbs, generally ~ 45 mbs.

Sections showing typical interpreted rock weathering profiles across the proposed Die Hardy open pit mining area are shown as Figures 2 and 3.

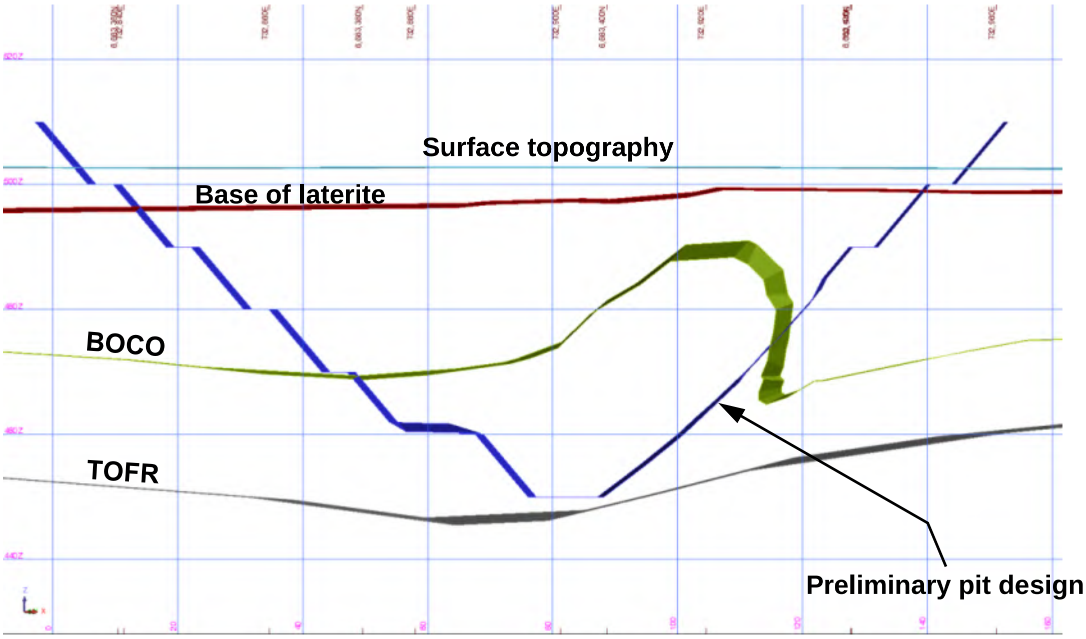

Figure 2 Die Hardy preliminary pit design, surface topography & interpreted weathering surfaces (north-west looking section at ~ 6 683 400mN)

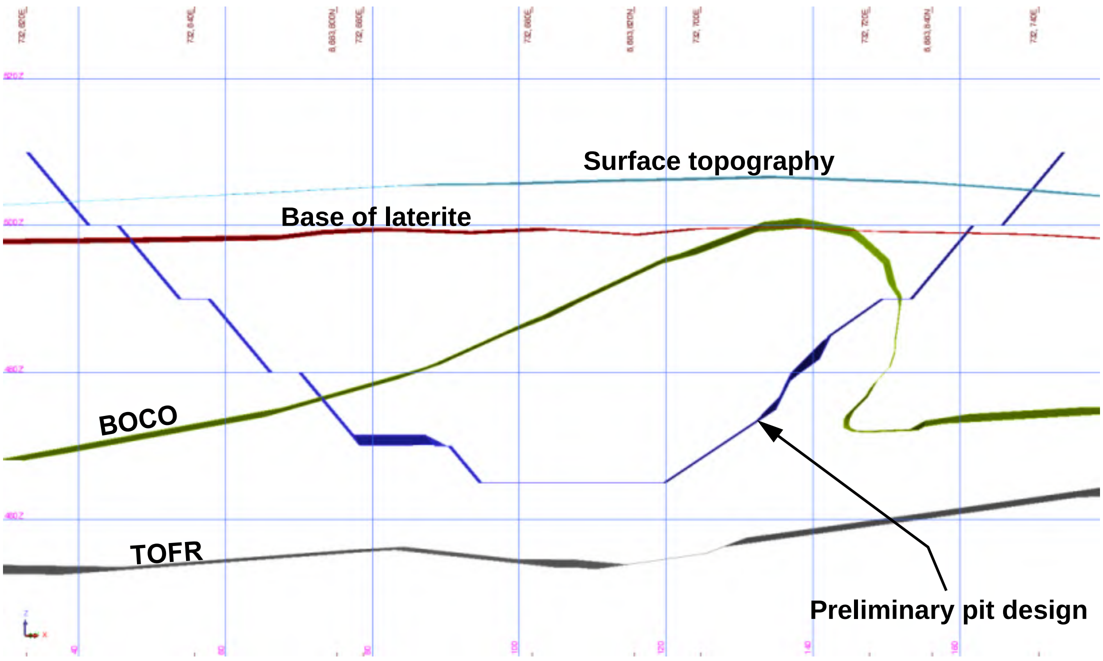

Figure 3 Die Hardy preliminary pit design, surface topography & interpreted weathering surfaces (north-west looking section at ~ 6 683 800mN)

3.3.3 Hydrogeology

Neither Ramelius nor PBA are aware of hydrogeological investigations having been carried out on the Die Hardy mining area.

Ramelius advises (Erik van Noort, personal communication, 19 November, 2020) that reverse circulation exploration holes drilled within the southern portion of the Die Hardy deposit intersected the pre-mining standing groundwater level (PMWL) between 44 mbs and 73 mbs, for an inferred average of 57 mbs.

Ramelius drilled a number of water exploration holes at Die Hardy during 2020. Of the seven (7) holes drilled in the vicinity of the proposed open pit (to between 63m and 124m depth), four (4) intersected groundwater between 40 mbs and 113 mbs. Figure 4 shows the locations of water exploration holes and Table 1 summarises drillhole PMWL intersection depths, and lists yields from basic flow tests carried out by Ramelius.

Based on currently available information, it is inferred that open pit mining at Die Hardy may intersect damp to locally wet conditions at depths greater than ~ 40 mbs. It remains possible that proposed mining may intersect areas of localised inflow; however, it is unknown whether inflow would be short-term or sustained.

Table 1 Ramelius Die Hardy water exploration drill hole and flow test summary
(after Ramelius)

Hole*	Hole Depth (m)	Water Table Depth (m)	Flow Test Depth (m)	Water Flow (L/sec)	Comment
DW001	120	NA	NA	NA	No water
DW002	120	70	120	0.2	90 sec to fill 20 L bucket
DW003	120	NA	NA	NA	No water
DW004	63	40	52	3	Actual water table may lie at between 34 mbs and 40 mbs
DW005	120	113	120	0.24	85 sec to fill 20 L bucket
DW006	120	NA	NA	NA	No water
DW007	124	85	85	0.71	Initial flow of 0.71 L/sec, then slowed significantly
			124	0.016	Weak flow from water table to end of hole

***** All vertical drillholes

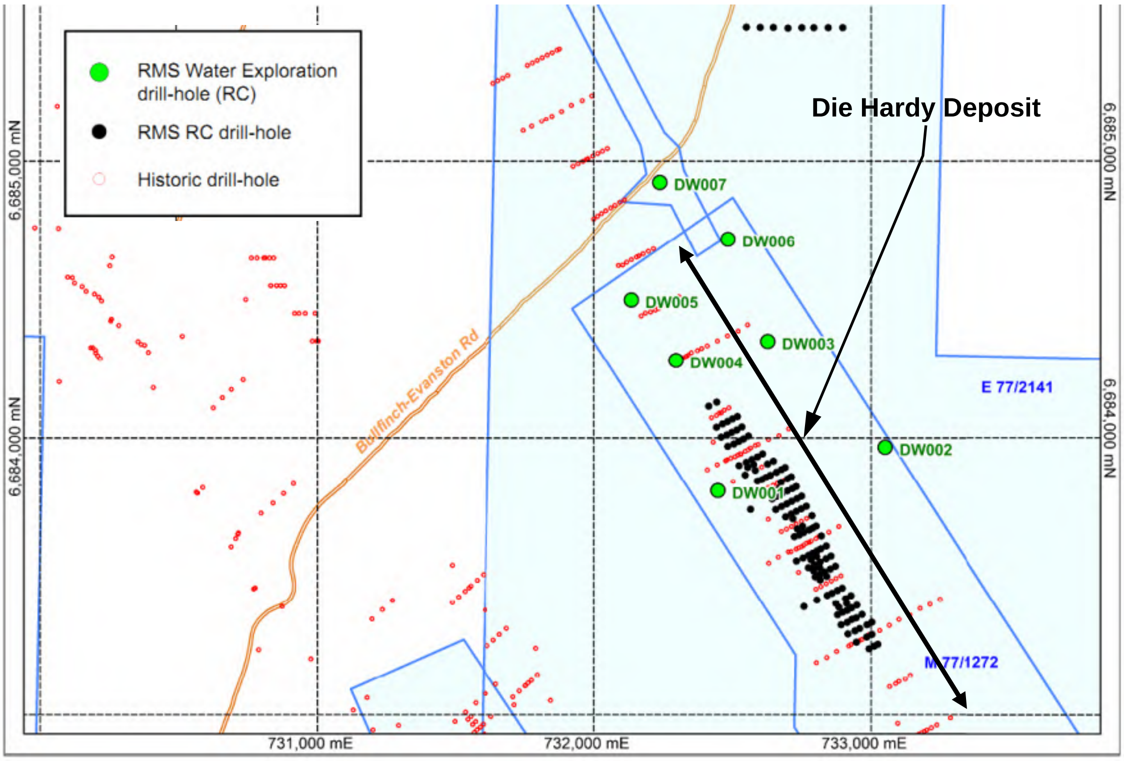

Figure 4 Ramelius Die Hardy water exploration drillhole locations (modified after Ramelius)

3.3.4 Seismicity

The Die Hardy deposit is located within a region of Western Australia judged to be at low risk from future seismic events (earthquakes) taking place within the proposed mining life of the pit. The estimated peak ground acceleration with a 10% chance of being exceeded in a 50-year period is relatively low (at ~ 0.07*g*) [2].

Earthquake-induced ground accelerations of this magnitude (if occurrent) would be expected to have minimal influence on future pit wall stability performance. It is inferred that only marginally stable or metastable zones could be driven to collapse by earthquake shaking.

3.4 Proposed Mining

3.4.1 Open Pit

No previous open pit or underground mining has been carried out at the Die Hardy deposit. Preliminary Die Hardy pit design files (*dh_pd_nth_ac_0720_sc.dtm* and *dh_pd_sth_ac_0720_sc.dtm*) were provided by Ramelius for review.

These preliminary designs indicate Northern and Southern pits separated by a narrow saddle (Figures 5 and 6).

The Southern pit is ~ 325m in length (north north-west to south south-east), ~ 150m in width (east north-east to west south-west) and has a maximum final depth of ~ 60m (floor at ~ 445mRL).

The Northern pit is ~ 660m in length (north north-west to south south-east), between ~ 190m and ~ 120m in width (east north-east to west south-west) and has final depths ranging from ~ 50m (floor elevations ~ 450mRL to ~ 445mRL) in southern and northern sectors to ~ 36m (~ 465mRL) in the central sector.

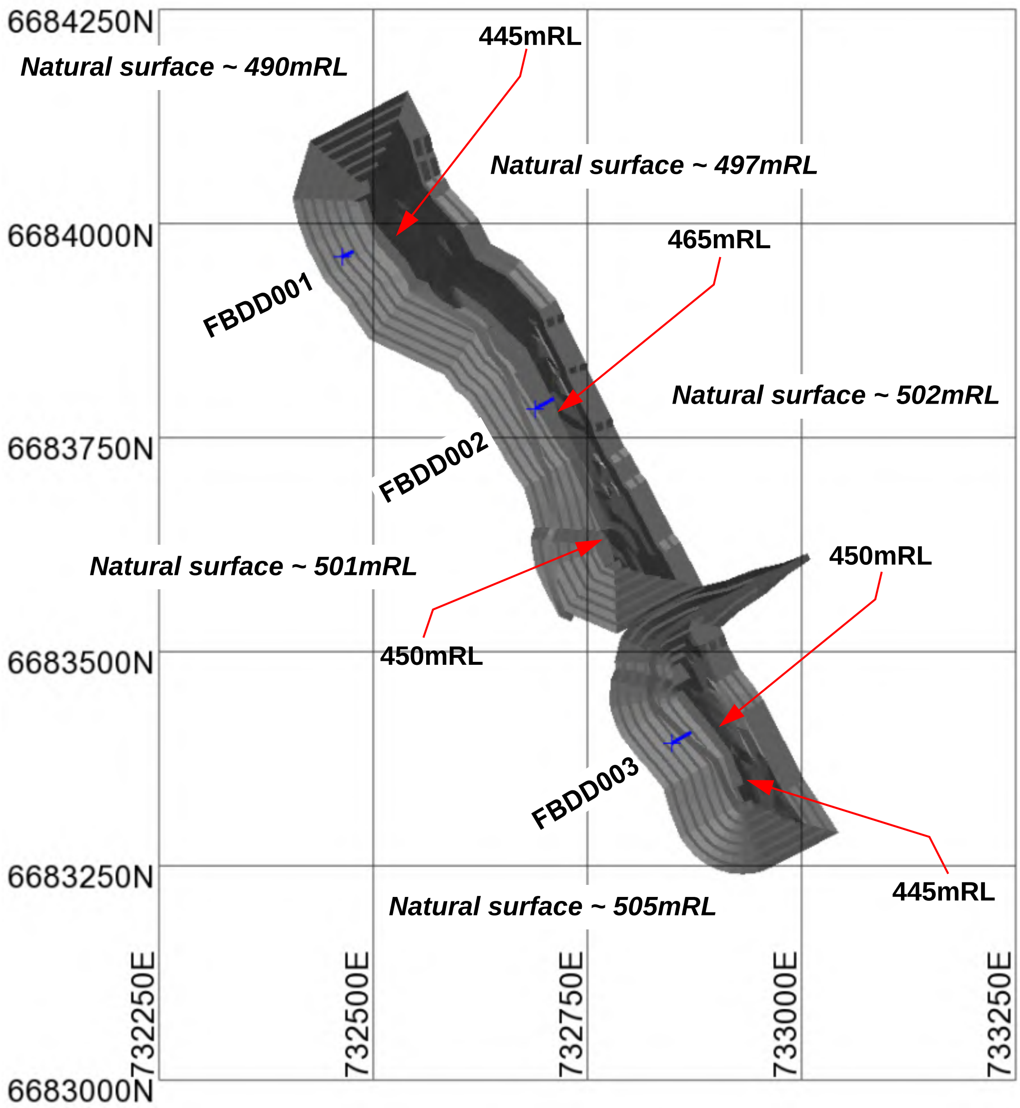

Figure 5 Die Hardy preliminary pit design & geotechnically logged exploration boreholes
(pits not clipped to surface topography)

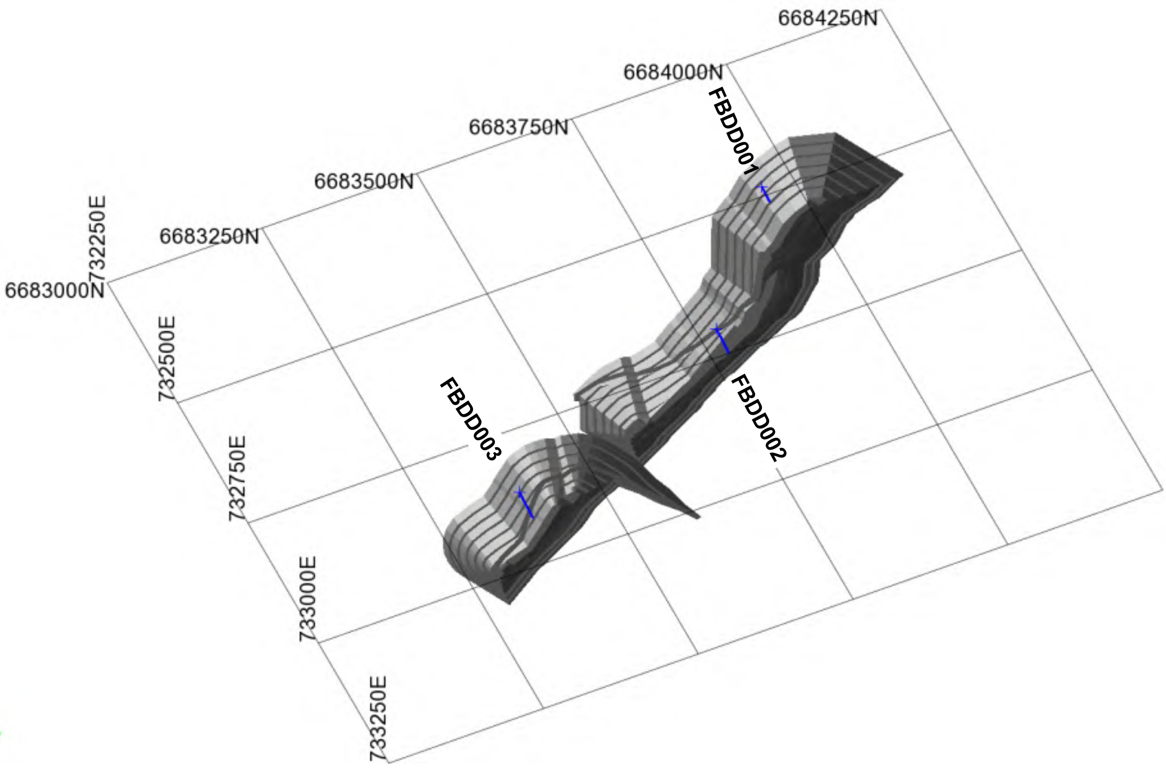

Figure 6 Die Hardy preliminary pit design & geotechnically logged exploration boreholes
(pits not clipped to surface topography)

3.4.2 Waste Rock Landform

Ramelius proposes to construct a WRL on the eastern side of the Die Hardy open pit. Summary details of proposed WRL design as advised by Ramelius are listed below and illustrated in Figure 7:

- Final design height = ≤ 30m
- Slope face angles:
  - Lower 15m at 15° (unbenched)
  - Upper 15m at 19° (unbenched)
  - Total slope = 30m at 17°

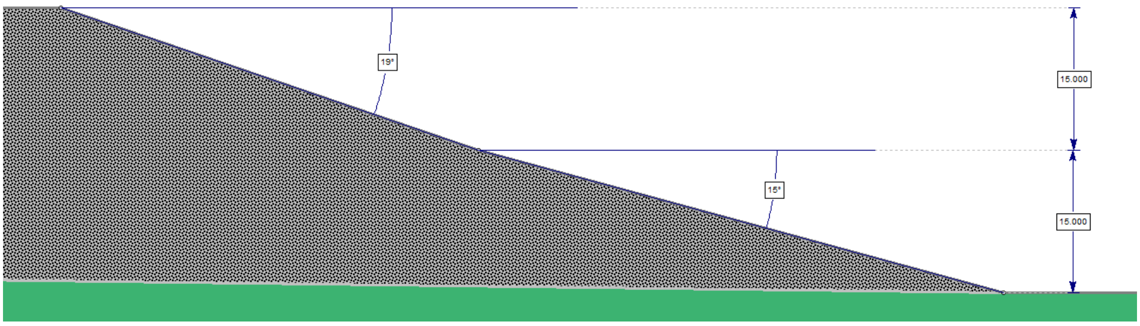

Figure 7 Proposed Die Hardy WRL design parameters

4.0 Investigations

Preliminary geotechnical investigations and assessments for proposed open pit mining of the Die Hardy deposit were based on:

- ⇨ Data contained in geological logs compiled by Ramelius and structural geological and geotechnical logs compiled by PBA from diamond cored exploration boreholes FBDD-001, 002 and 003 drilled in the vicinity of proposed future Die Hardy pit walls during 2020. Exploration boreholes were designed by Ramelius.
- ⇨ Review of core photographs for these boreholes.
- ⇨ Assessment of rock mass conditions and quality using the Geomechanical Classification system (Bieniawski's RMR_{89} system) [3], with values further adjusted to the Mining Rock Mass Rating system (Laubscher's MRMR system) [4].
- ⇨ Results of physical property testing of representative core samples selected by PBA from exploration boreholes. Uniaxial compressive strength (UCS) with elastic property determinations (UCSE) and defect direct shear (DS) tests were performed by E-Precision Laboratory, Perth, Western Australia.

4.1 Geotechnical Core Logging

The exploration boreholes used by PBA for preliminary geotechnical assessment are listed in Table 2. The locations of holes relative to proposed open pit mining are shown in Figures 5 and 6.

Table 2 Die Hardy boreholes & intervals considered as part of open pit geotechnical assessments

Borehole	Collar co-ordinates			Dip (°)	Azimuth (°)	Hole depth (m)	Interval Considered
	mE	mN	mRL				
FBDD001	732463.56	6683960.41	493.89	-60	062	102.2	0.0m to 102.2m
FBDD002	732689.78	6683783.77	506.47	-60	061	70.8	0.0m to 70.8m
FBDD003	732848.96	6683393.32	502.35	-60	060	96.3	0.0m to 96.3m

Geotechnical data collected by PBA from cores of exploration boreholes comprised:

- Degree or weathering
- Estimated intact rock strength (using ISRM ratings)
- Core recovery
- Rock Quality Designation (RQD)
- Fracture Frequency (FF)
- Discontinuity type
- Typical discontinuity planarity, roughness, infill and thickness of infill
- Orientation of discontinuities (Alpha and Beta angles with reference to core axis).

PBA collected geotechnical logging data over 1.0m drill intervals.

Where it was necessary to record "typical" conditions, the chosen data were on the conservative side of average conditions.

Summary geotechnical borehole logs are presented in Appendix A. Original core photographs are held by Ramelius.

4.2 Rock Mass Classification

Rock mass assessment by empirical methods is commonly used to classify weathered and fresh rock masses. Inferences regarding the strength and competence of a particular rock mass, and the likely response of that rock mass to mining, are based on the ratings obtained from these empirical classifications.

The Die Hardy rock mass was classified using both the RMR_{89} system [3] and the MRMR system [4].

4.2.1 RMR_{89} System

The estimations of RMR_{89} classification indices for the intervals were based on the following parameters:

- Field estimated rock strength data were used for calculations.
- Defect spacing has been estimated from fracture frequency.
- Sub-indices are based on the dominant parameter values recorded for the interval or the lower bound where no dominant set exists.
- Intervals containing no defects were assigned parameter values from the adjacent interval.

4.2.2 MRMR System

The estimations of MRMR classification indices for the intervals were based on the following assumptions:

- **Weathering**
  Assumed life for the Die Hardy open pit is ~ 2 years. No individual rock type was assessed to have the potential to weather more readily than any other. The weathering adjustment factor applied for all rocks (assuming slight weathering) was 96%
- **Joint Orientation**
  Three joints defining blocks with two faces inclined away from the vertical, requiring an adjustment of 80%
- **Mining-induced Stresses**
  Negligible induced stress in pit walls, hence a factor of 100%
- **Blasting Effects**
  Assumed good conventional blasting practices, with an associated adjustment of 94%

4.2.3 Rock Properties Testing

In addition to considering estimates of rock strength made using simple index testing in the field during geotechnical logging, a program of laboratory measurement of rock properties was carried out by E-Precision on representative samples selected from Die Hardy boreholes listed in Table 2.

- ⇨ Eight (8) UCSE tests measuring compressive strength and Young's Modulus and Poisson's Ratio were performed.
- ⇨ Three (3) multi-stage DS tests were performed.

5.0 Geotechnical Conditions

5.1 Rock Structure

Structural discontinuity orientation data obtained from logged borehole intervals listed in Table 2 were processed and analysed using the Rocscience DIPS program [5]. Only natural occurring defects with measurements able to be referenced to reliable core orientation (agreement up and downhole) were considered in analysis. The current Die Hardy structural data set is limited to 53 data points. In view of that limitation, it is recommended that Ramelius collects structural data to increase this data set and confirm or amend (as the case may be) the following findings.

The present Die Hardy structural data set contains a directional bias, with all boreholes drilled on north-east azimuths at dips of ~ –60°. Moderate to steep north-easterly dipping and north-east striking defects, if present, are expected to be under-represented within the current data set.

Figure 8 is a lower hemisphere equal angle stereoplot showing all defect orientations for the logged intervals.

Structural data analysis identified a single dominant discontinuity grouping and a further four (4) sparsely populated defect clusters which possibly reflect the existence of further defect sets.

The mean orientations and characteristics of each set are listed in Table 3.

The significance of clusters is based on group populations proportionate to the total data set. The identified defect sets are not expected to exist ubiquitously, though it is important to consider all sets in analyses since it is possible that minor sets (as defined within a limited total population) can have a substantial adverse influence on wall stability.

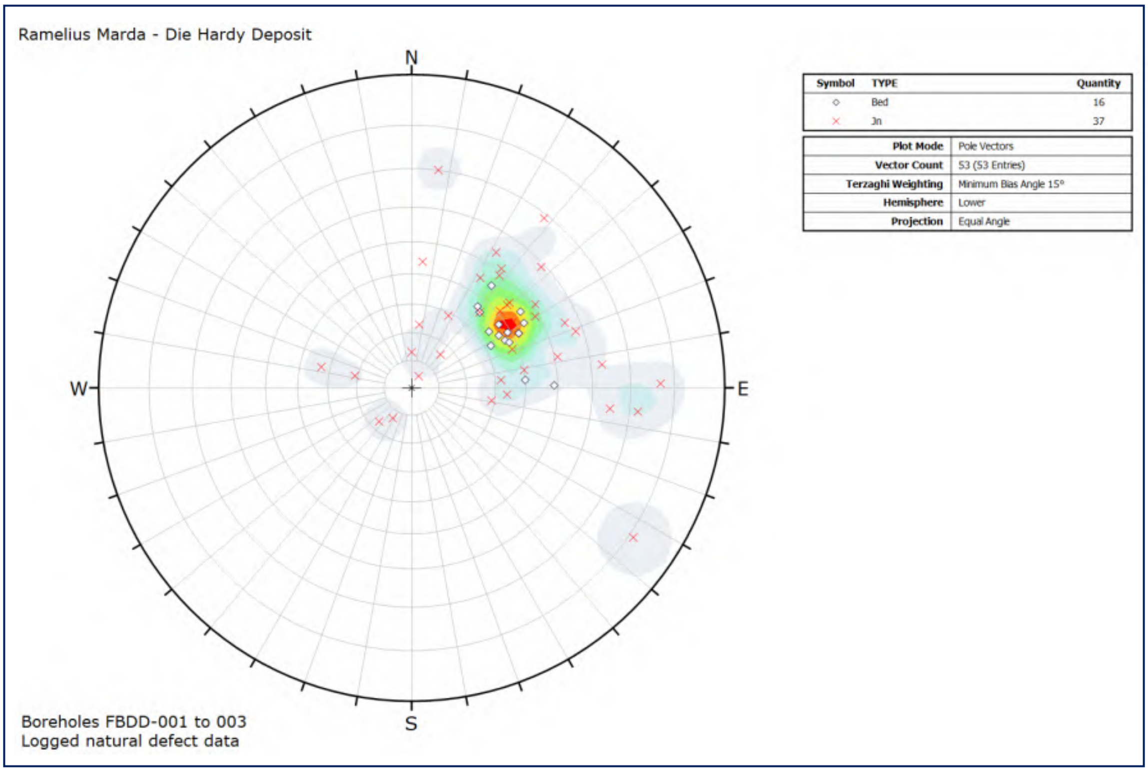

Figure 8 Die Hardy open pit structural data pole plot for Table 2 borehole interval data

Table 3 Defect "Sets" for Die Hardy Table 2 borehole interval data

Defect Set	Defect Description	Dip (°)	Dip Direction (°)
1	Joints and bedding – Moderately steep south-west dipping	41	233
M 2	Joints – Steep west dipping	72	273
M 3	Joints – Flat lying to shallow south dipping	21	194
M 4	Joints – Flat lying to shallow north-east dipping	15	039
M 5	Joints – Flat lying to shallow east dipping	28	103

M = inferred minor defect set

Structural data from Table 2 Die Hardy borehole intervals indicates the following:

- Moderately steep south-west dipping joints and bedding planes, interpreted to be aligned parallel to project stratigraphy, are dominant.
- Minor joint defect clusters at flat lying to shallow south, north-east and east dipping orientations may indicate additional defect sets. These defect clusters are sparsely populated and the existence of defect 'sets' at these orientations is inferred rather than confirmed.

The identified dominant defect set is inferred to reflect the general trend of stratigraphy (including local variations/ inflections). The geneses of remaining defects sets are currently unknown, though it is inferred that these defects may also be related to local variations/ inflections or fault structures.

5.1.1 Notes regarding defect sets & rock structure

As noted, ubiquitous existence of five (5) defect sets at Die Hardy is not inferred. Rather, the variations in defect clustering are considered to reflect local geological variations (for example, faulting and/or folding) and the inherent variability of data obtained from oriented cores. It is inferred to be unlikely that more than 3 (three) defect sets would be present at a given location.

It is not possible to obtain defect persistence data from cores, other than by inference based on the types and characteristics of the defects logged. Logged defect types comprise *joint* and *bedding* features which are usually of limited persistence (typically ≤ 10m).

No *shear*, *fault* or *vein* defect types were recorded in the structural data; however, a small number of these defects were observed in Table 2 borehole cores and recorded in the geotechnical logs.

5.2 Rock Strength

Wall rock strengths are governed by lithology/ mineralogy and rock weathering grades.

Intact rock strengths and defect shear strengths have been assessed by the use of simple index tests during logging and in laboratory testing of representative samples of selected cores.

In summary these sources indicate that at Die Hardy:

- ⇨ Transported gravels/ laterite material strengths range from ≤ *extremely weak* (UCS 0.25 to 1.0 MPa (ISRM rating R0)) to *medium strong* (UCS 25 to 50 MPa (R3)).
- ⇨ Extremely to completely weathered material strengths range from ≤ *extremely weak* (R0) to *medium strong* (R3).
- ⇨ Highly weathered country rock strengths range from *extremely weak* (R0) to *medium strong* (R3).
- ⇨ Moderately weathered country rock strengths range from *weak* (UCS 5.0 to 25 MPa (R2)) to *medium strong* (R3).
- ⇨ Slightly weathered rock strengths range from *medium strong* (R3) to *very strong* (UCS 100 to 250 MPa (R5)).
- ⇨ Fresh rock strengths range from *strong* (UCS 50 to 100 MPa (R4)) to *very strong* (R5).

Table 4 summarises laboratory UCS test results and full test certificates are provided as Appendix B.

Reliable intact rock strength results from laboratory tests are those where failure occurred via rupture of intact material (and not via shear along pre-existing defects). Defect controlled failure occurred as the primary failure mode for a single UAC rock type laboratory tested sample.

Table 4 Results of Die Hardy UCS testing (after E-Precision 2020)

Borehole	Sample	Weathering Grade	Interval (m)	Bulk Density (t/m^3)	Lithology	UCS_{50} (MPa)
FBDD-001	FB UCS-01	Slight	46.35 - 46.56	3.22	SIF	**126**
FBDD-001	FB UCS-02	Fresh	51.21 - 51.46	3.08	SIF	**78.4**
FBDD-001	FB UCS-03	Fresh	61.75 - 61.97	3.50	SIF	**337**
FBDD-001	FB UCS-04	Fresh	78.32 - 78.59	2.76	MDZ	**189**
FBDD-001	FB UCS-05	Fresh	84.65 - 84.88	2.92	UAC	**174**
FBDD-003	FB UCS-06	Fresh	77.28 - 77.49	2.80	MDZ	**231**
FBDD-003	FB UCS-07	Fresh	88.62 - 88.85	2.91	UAC	**62.9***
FBDD-002	FB UCS-08	Fresh	55.21 - 55.44	2.66	MDZ	**55.3**

* Defect controlled primary failure mode

Sedimentary Chert & BIF (dominant ferruginous layers) - SIF

UCS Results 126 MPa Slightly weathered (shear intact (through intact rock))
78.4 MPa Fresh (shear intact)
337 MPa Fresh (shear intact)

These data indicate that *fresh* **Sedimentary Chert and BIF (dominant ferruginous layers) – SIF** rock substance has a compressive strength of ~ 208 MPa (*very strong* rock).

The single *slightly* weathered SIF rock substance sample tested returned a compressive strength of ~ 126 MPa (*very strong* rock).

Mafic Dolerite Undifferentiated - MDZ

UCS Results 189 MPa Fresh (shear intact)
231 MPa Fresh (shear intact)
55.3 MPa Fresh (shear intact)

These data indicate that *fresh* **Mafic Dolerite Undifferentiated - MDZ** rock substance has a compressive strength of ~ 158 MPa (*very strong* rock).

Ultramafic Amphiboles Chlorite Schist - UAC

UCS Results 174 MPa Fresh (shear intact)
62.9 MPa Fresh (shear on structure)

The single reliable *fresh* **Ultramafic Amphiboles Chlorite Schist – UAC** rock substance sample test result returned a compressive strength of ~ 174 MPa (*very strong* rock).

5.2.1 Laboratory Elastic Property Determinations

Rock elastic properties as determined by laboratory testing are presented in Table 5, with full test certificates provided as Appendix B.

Rock modulus to UCS ratios were reviewed and found to yield reasonable/ reliable data in relation to intact rock strength results.

The single *slightly weathered* SIF sample returned a *high* modulus to UCS ratio and remaining SIF, MDZ and UAC samples returned *average* modulus to UCS ratio. Rocks with high modulus to UCS ratio could exhibit stiff brittle response under high load.

Table 5 Results of Die Hardy core sample deformability test results (after E-Precision 2020)

Borehole	Weathering Grade	Interval (m)	Lithology	Modulus* (GPa)	Poisson's Ratio*	Modulus to UCS Ratio
FBDD-001	Slight	46.35 - 46.56	SIF	**73.70**	**0.220**	**High**
FBDD-001	Fresh	51.21 - 51.46	SIF	**30.91**	**0.166**	**Average**
FBDD-001	Fresh	61.75 - 61.97	SIF	**99.38**	**0.152**	**Average**
FBDD-001	Fresh	78.32 - 78.59	MDZ	**65.58**	**0.157**	**Average**
FBDD-001	Fresh	84.65 - 84.88	UAC	**66.92**	**0.233**	**Average**
FBDD-003	Fresh	77.28 - 77.49	MDZ	**82.65**	**0.250**	**Average**
FBDD-003	Fresh	88.62 - 88.85	UAC	**46.05****	**0.237**	**NA**
FBDD-002	Fresh	55.21 - 55.44	MDZ	**11.11**	**0.235**	**Average**

* Secant (0-50%)
* * Defect controlled primary or secondary failure mode

5.3 Defect Shear Strength

Defect in geotechnically logged core intervals were dominantly *joints* (~ 62% of logged defects) and *bedding* (~ 35% of logged defects).

A small number of *shear* and *vein* defects were also logged (each ~ 1.5% of logged defects).

Defect surface conditions were generally logged as *planar rough* (~ 42% of logged defects) or *undulating rough* (~ 39% of logged defects).

Remaining defects were logged as having *irregular rough* (~ 19% of logged defects), *stepped rough*, *planar smooth* or *undulating smooth* surface conditions (combined ~ 4% of logged defects).

Oxide ≤ 1mm (~ 41% of logged defects) was the most common defect infill recorded, with *nil* (no infill) (~ 21% of logged defects) the second and *quartz/ carbonate ≤ 1mm* (~ 12% of logged defects) the third most common defect infill conditions recorded.

Other infills recorded in minor numbers included *clay 1- 2mm*, *talc ≤ 1mm*, *chlorite ≤ 1mm* and *clay ≥ 5mm*.

Based on review of rock defect data from borehole cores and experience in similar rock types, defect shear friction angles are expected to be generally low ($\phi \leq 20°$) within major geological structures/ contacts and clay or soft mineral filled defects. Clean defects in *fresh* rock can reasonably be expected to have frictional characteristics ranging between medium ($\phi \geq 20°$ and $\leq 30°$) and high ($\phi > 30°$).

Direct shear tests were performed on three (3) naturally occurring defects. The test results are summarised in Table 6 and the E-Precision report is included in Appendix B.

The test results indicate peak strength friction angles ranging from ~ 27° to 36°, with cohesion values between ~ 21 kPa and 51 kPa. There were modest reductions in post-failure shear strengths for the tested defects.

Mean peak and residual defect shear strengths for SIF rocks at Die Hardy are inferred to be relatively high a friction angle of ~ 34° was adopted for assessment.

Mean peak and residual defect shear strengths for UAC and UZZ rocks at Die Hardy are inferred to be medium and have been taken to be represented by a friction angle of ~ 26°.

Table 6 Results of Die Hardy defect direct shear testing (after E-Precision 2020)

Borehole	Sample	Depth (m)	Lithology	Peak Strength		Residual Strength	
				Cohesion (kPa)	Friction Angle (°)	Cohesion (kPa)	Friction Angle (°)
FBDD-001	FB DS-01	47.55 – 47.68	SIF [1]	21.3	35.8	0.0	35.0
FBDD-001	FB DS-02	97.84 – 98.00	UAC [2]	37.9	26.6	0.0	25.6
FBDD-002	FB DS-03	29.38 – 29.52	SIF [3]	50.9	33.4	18.2	30.7

[1] Bedding defect, planar rough surface with ≤ 1mm oxide infill

[2] Joint defect, planar smooth surface with ≤ 1mm chlorite/ carbonate infill

[3] Bedding defect, planar rough surface with ≤ 1mm oxide infill

5.4 Rock Quality

Interpretations made from geotechnical review of borehole cores are that:

- ⇨ Intervals of significant core loss were encountered within *completely* weathered transported materials of the uppermost ~ 10m of boreholes FBDD-001 and 003. Transported gravels were observed to be generally unconsolidated and exhibited limited cohesion (Plate 1).
- ⇨ Weathering and *very poor* rock quality extends to considerable depths within UZZ rocks in the proposed western wall position, with *highly* weathered, *very poor* quality UZZ observed to depths > 32 mbs (Plate 2).

Plate 1 **FBDD003 0.0m - 9.6m, core loss within transported gravel & mottled zone *very poor* quality material**

Plate 2 **FBDD001 25.9m – 29.5m extremely/ highly weathered UZZ *very poor* quality material**

- Within boreholes FBDD-001 to 003 the grade of rock weathering was observed to decrease rapidly once SIF rocks were intersected. *Slight* rock weathering, commonly discolouration of material and oxidation along banding defects, was extends to considerable depths within SIF rocks (Plate 3). *Slightly* weathered SIFs have a higher frequency of open bedding/ banding partings than *fresh* SIF intervals.
- Discrete (< 0.1m) to significantly wide (> 5.0m) intervals of alteration/ shearing and core loss were observed within SIF rocks (Plates 3 and 4). Where present within Die Hardy wall rocks at unfavourable orientations, such intervals could be problematic to wall stability.

Plate 3 FBDD001 42.9m to 46.3m slightly weathered SIF *fair* quality rock

Plate 4 FBDD002 37.0m to 40.8m altered/ sheared breccia chert/ SIF *poor* quality rock

⇨ Discrete (< 0.4m) intervals of alteration/ shearing were observed at some lithological contacts at and below the lower SIF rock type boundary (Plate 5). Where present within wall rocks and oriented at unfavourable orientations, such intervals could adversely influence wall stability.

Plate 5 **FBDD002 52.3m to 55.8m moderately weathered to fresh SIF and dolerite *poor* to *fair* quality rock**

5.5 Rock Mass Classification

Summary geotechnical logs and rock mass classification results for boreholes listed in Table 2 are provided in Appendix A.

All geological logs and original files for core photographs are held by Ramelius. Descriptions of logged defect types, surface conditions and infills for Table 2 boreholes are provided in Section 5.3.

On the basis of core logging data collected from Table 2 borehole intervals it is inferred that the *extremely* to *completely weathered* horizon at Die Hardy must be classified as being of *very poor* rock quality. The mean Rock Mass Rating (RMR) for observed intervals of *extremely* to *completely weathered* material/ rock was 17 (*very poor* rock) (Table 7).

Highly weathered rocks were found to have an RMR range of 12 to 52 (*very poor* to *fair* rock), with a mean value of ~ 33 (*poor* rock).

Transitional (*moderately weathered*) rocks RMRs ranged from 47 to 69 (*fair* to *good* rock), with a mean value of ~ 55 (*fair* rock).

Slightly weathered rock RMR ranged from 22 to 75 (*poor* to *good*), with a mean of ~ 65 (*good* rock).

Overall, *fresh* rock core was assessed as having an RMR range of 56 to 94 (*fair* to *very good* rock), with a mean value of ~ 78 (*good* rock).

Assessed RMR range and mean values by rock weathering horizon are provided as Table 7.

Table 7 Summary of RMR rock mass classification values for Table 2 Die Hardy boreholes

Rock Weathering Horizon	RMR Value Range	RMR Class Range	Mean RMR Value	Mean RMR Value Class
Extremely to completely	12 – 51	Very Poor to Fair	17	Very Poor
Highly	12 – 52	Very Poor to Fair	33	Poor
Moderately	47 – 69	Fair to Good	55	Fair
Slightly	22 – 75	Poor to Good	65	Good
Fresh	56 – 94	Fair to Very Good	78	Good

RMR value ranges and mean values for Die Hardy wall rock lithologies are provided in Table 8.

Mean RMR values for *MDZ*, *SIF* and *UAC* wall rocks lie in the *good* rock quality class. Mean RMR values for *UZZ* wall rocks and transported *TGF* and *TCZ* materials lie in the *very poor* rock quality class.

Table 8 Summary of RMR rock mass classification values for Table 2 boreholes major lithologies

Rock Type	1.0m Intervals	RMR Value Range	RMR Class Range	Mean RMR Value	Mean RMR Value Class
MDZ	10	59 - 91	Fair to Very Good	79	Good
TGF (transported)	13	12	Very Poor	12	Very Poor
TCZ (transported)	14	12	Very Poor	12	Very Poor
UZZ	52	13 - 39	Very Poor to Poor	18	Very Poor
SIF	78	22 - 90	Poor to Very Good	67	Good
UAC	49	57 - 94	Fair to Very Good	79	Good

5.6 Geotechnical Design Domains

Preliminary definition of Die Hardy geotechnical design domains has been based on the interpreted location and trend of the SIF rock unit. It is inferred that the eastern wall of the proposed pit will generally follow the orientation of ore lode(s) within the moderately steep south-west dipping SIF rock unit.

Preliminary geotechnical design domains comprise the East and West Domains (Figure 9).

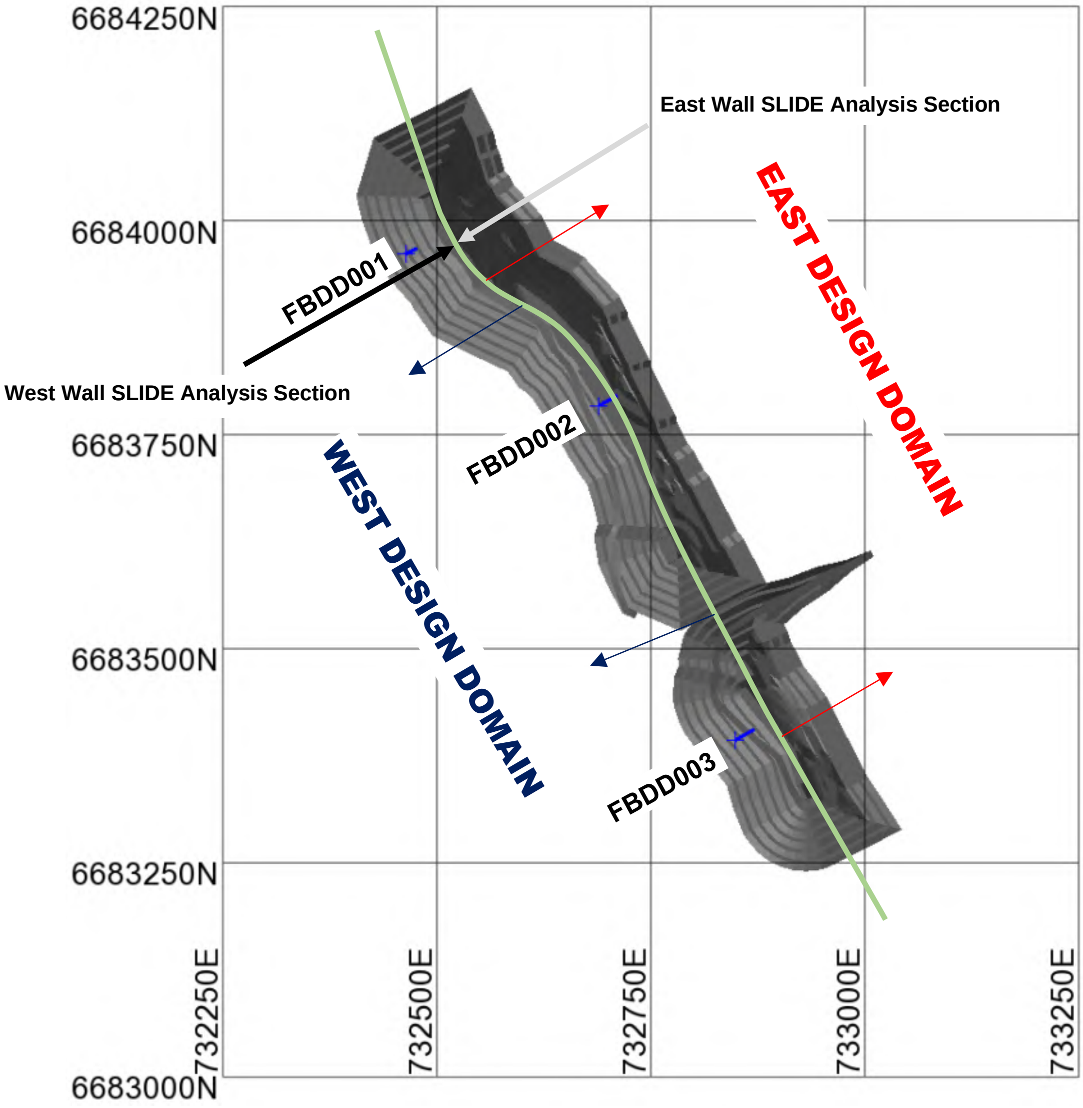

Figure 9 Preliminary Die Hardy geotechnical design domains & locations of *Slide* analysis sections (pit not clipped to surface)

6.0 Stability Analysis

On the basis of assessed rock mass conditions, it is considered that wall stability at Die Hardy will be controlled by some combination of the influences of low shear strength of weathered materials and relict geological structures.

Structural data obtained from geotechnically-logged borehole intervals (Table 2) indicates limited potential for exposure of unfavourably oriented structural defects which could adversely influence wall stability at Die Hardy.

The persistence of such features, where/ if present, and hence the extent of influence (possible scale of instability) will largely remain unknown until excavation provides exposure for mapping.

It is possible that drilling/ logging have not identified all defect sets; hence other unfavourably oriented structures may be encountered during mining.

Wall stability conditions in the proposed Die Hardy pit have been assessed using kinematic methods (to assess potential for structurally-controlled instability) and limit equilibrium analysis (to assess potential for shear failure of weak materials).

Base case wall design parameters have been selected on the basis of aiming to preclude large scale and/ or overall slope failure; limiting the occurrence of bench scale instability; and maintaining adequate catching capacity to contain debris from expected small scale events.

Cross-reference has been made to empirical methods based on the Geomechanical Classification System to check the 'fit' of the recommended wall designs to general open pit experience.

6.1 Kinematic Stability Analysis

Kinematic stability analyses have been carried out for northern, western and southern walls with a 50° face angle and an eastern wall with 40° face angle considering defect orientations as defined by data obtained from the geotechnical logs.

Planar sliding assessments did not apply lateral limits, therefore considered the worst case and most conservative scenario. Lateral limits of 30° were applied to all wedge and toppling assessments.

In summary, kinematic analyses based on available data for Table 2 boreholes show:

East Wall 40°/240° (major wall orientation)

Planar slide	Set 1 (significant potential)
Wedge slide	Not indicated
Topple	Not indicated

West Wall 50°/060° (major wall orientation)

Planar slide	Possible on Minor Set 5 (low potential)
Wedge slide	Not indicated
Topple	Flexural – On Minor Set 2 (low potential) Direct – Not indicated

North Endwall 50°/150° (minor wall orientation)

Planar slide	Possible on Minor Set 5 and outliers of Minor Set 3 (both low potential)
Wedge slide	Combinations of Sets 1 & 2
Topple	Flexural – Possible on single random defect (low potential) Direct – Not indicated

South Endwall 50°/330° (minor wall orientation)

Planar slide	Not indicated
Wedge slide	Not indicated
Topple	Not indicated

In summary, for the proposed Die Hardy open pit:

- ⇨ Potential for *planar sliding* failures exists for the major eastern wall (dipping 40° towards 240°) on bedding and joint defects aligned parallel to project scale stratigraphy.
- ⇨ Potential for *planar sliding* failure is also indicated for the major western wall (50°/060°) and minor northern endwall (50°/150°) on 'minor' defect sets. Within the current data set the quantity of defects within 'minor' set clusters is low; therefore, the corresponding potential for planar sliding to occur within indicated wall sectors is also currently inferred to be low.
- ⇨ Limited theoretical potential for *wedge sliding* is indicated for the minor northern endwall.
- ⇨ Limited theoretical potential for *flexural toppling* failure is indicated for the major western wall (Minor Set 2) and minor northern endwall (random defect).

Kinematic stability analyses indicate theoretical potential for planar sliding on the major eastern wall.

As noted, it is expected that the eastern wall of the proposed pit will follow the orientation of moderately steep south-west dipping ore lodes within the SIF rock unit. Batter face and wall Inter Ramp Angles (IRA) on the eastern wall would therefore generally not be expected to exceed the ~ 40° dip of the SIF unit. At modest ≤ 40° face and slope angles, the potential for planar sliding failures, structurally controlled failures generally and material shear failures is expected to be limited.

6.2 Wedge Assessment

Kinematic stability analysis indicates limited potential for theoretical wedge formation within a Die Hardy open pit minor northern endwall mined with a 50° batter face.

PBA considers that no further Die Hardy wedge sliding assessments are required at present.

6.3 Limit Equilibrium Analysis

Limit Equilibrium Analysis (LEA) of the resistance to development of circular and non-circular (rotational) failures through possible final configurations of Die Hardy pit slopes was performed using the Rocscience code *Slide* [6]. A conventional non-circular global critical failure surface search function was used in analysis of assumed final East Domain south-west dipping and West Domain north-east dipping wall slope configurations.

Potential ultimate Die Hardy pit slopes were modelled comprising *transported* (gravels and clay), *highly weathered* (saprolite material and highly weathered rock), *moderately weathered* (moderately to slightly weathered rock) and *fresh* rock materials. Rock weathering depths and material boundaries applied were derived from digital weathering surfaces and geology solids provided by Ramelius.

Material properties selection for modelling has used published guidelines based on the Geomechanics Classification Rock Mass Rating (RMR) system [3] and experience. Selected material property values are expected to represent likely *median* values and are considered appropriately conservative for the analyses conducted. Material properties selected for modelling the pit slopes are provided in Table 9.

Table 9 Die Hardy estimated material shear strengths

Material	Unit Weight (kN/m³)		Cohesion (kPa)	Friction Angle (°)
	Unsaturated	Saturated		
Laterite/ Transported	21	22	150	30
Highly weathered SIF	26	27	100	15
Highly weathered UZZ, MDZ & UAC	20	22	60	15
Moderately weathered SIF	29	30	250	30
Moderately weathered UZZ, MDZ & UAC	26	27	150	20
Fresh SIF	32	32	350	35
Fresh UZZ, MDZ & UAC	29	29	250	30

Analyses were conducted for:

- Dry slopes (that is, fully drained and depressurised wall rock conditions) with and without seismic disturbance (pseudo-static analysis with horizontal acceleration to simulate earthquake shaking). A seismic acceleration of 0.07*g* (Section 3.3.4) was applied in all seismic disturbance assessments.
- Saturated to pre-mining groundwater level (PMWL) slopes with and without seismic disturbance. The PMWL was inferred to be located ~ 57m below natural surface (Section 3.3.3).
- Partially saturated slopes with and without seismic disturbance. The partially drained case phreatic surface was estimated to be located ~ 20m below surface at the pit slope crest, grading to the base of the *moderately* weathered zone at the intercept with the pit wall. This theoretical case is inferred to represent possible unfavourable groundwater condition within wall rocks.

The approximate locations of the *Slide* analysis sections with respect to the preliminary Die Hardy pit design are shown in Figure 9. Selected analysis section locations approximate the most extensive potential slopes within the total current preliminary pit design.

Based on guidelines presented within Read and Stacey [7], the following Factor of Safety (FS) acceptance criteria were adopted for limit equilibrium analyses:

- FS of 1.20 considered to be the minimum acceptable value for open pit mining of non-critical walls under static conditions.
- FS of 1.30 considered to be the minimum acceptable value for open pit mining of critical walls under static conditions.
- FS of 1.00 may be acceptable for a transient seismic disturbance, though some slope failure and/ or triggering of rock falls would be expected under such conditions.

Summaries of results obtained from these stability analyses are presented as Table 10, with sample results presented in Figures 10 and 11. Slope parameters for each domain are listed in terms of the Inter Ramp Angles (IRA) and Overall Slope Angles (OSA) applied.

Table 10 Summary of Die Hardy East and West domain LEA stability analyses results

Slope	Slope Condition	Limit Equilibrium Minimum Factor of Safety (FS)** Seismic acceleration = 0.07g***	Probability of Failure (PoF)
West Domain North-East Dipping Wall 10m at IRA 30.6° 30m at IRA 38.9° 10m* at IRA 60.0° OSA ≈ 40°	Dry	1.26	15% ± 5%
	Saturated to PMWL	1.26	15% ± 5%
	Partially Saturated	1.24	15% ± 5%
	Dry with seismic	1.11	> 20%
	Saturated PMWL with seismic	1.11	> 20%
	Partially saturated with seismic	1.09	> 20%
East Domain North-West Dipping Wall 10m at IRA 30.6° 40m at IRA 34.7° OSA ≈ 36°	Dry	1.45	10% ± 5%
	Saturated to PMWL	1.45	10% ± 5%
	Partially Saturated	1.43	10% ± 5%
	Dry with seismic	1.28	15% ± 5%
	Saturated PMWL with seismic	1.28	15% ± 5%
	Partially saturated with seismic	1.26	15% ± 5%

* Single batter only
** Minimum FS from Bishop simplified method reported
*** McCue [2]

The FS obtained for *dry, saturated to PMWL* and *partially saturated* Die Hardy pit slopes were found to be within acceptable limits, even under the applied seismic disturbance.

Seismic events causing ground accelerations in the deposit area with magnitudes greater than that considered in the analyses would be detrimental to pit wall stability.

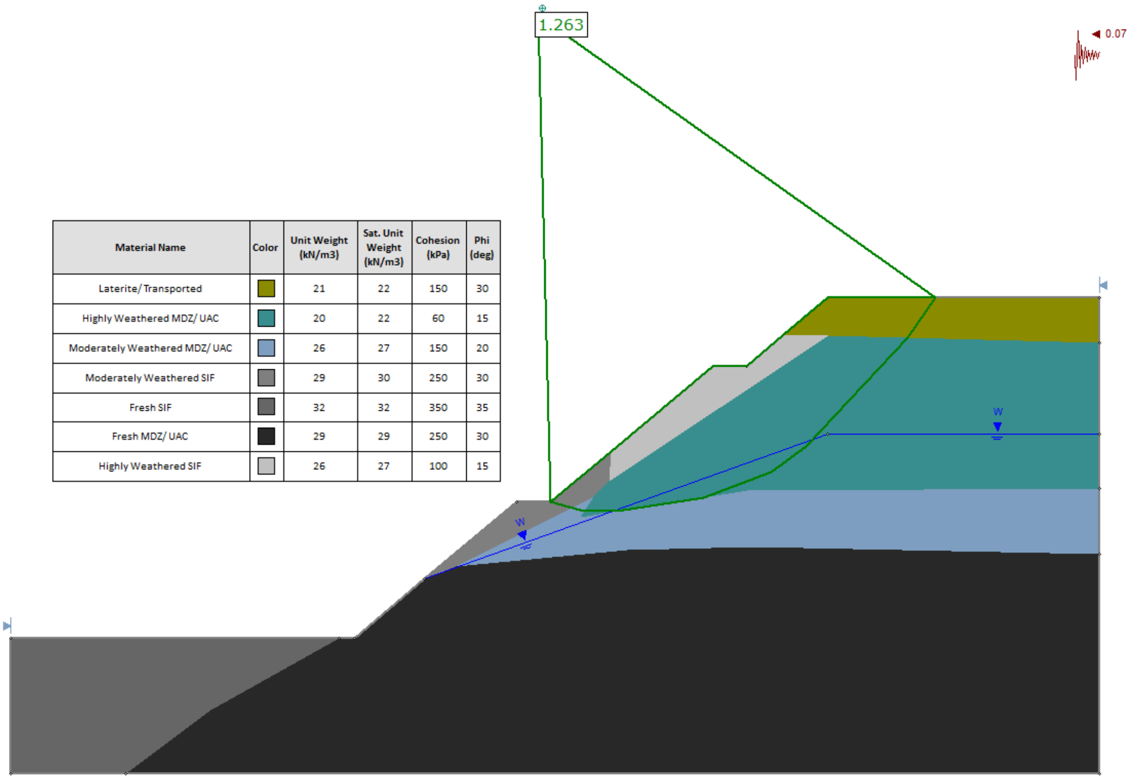

Figure 10 **Die Hardy East Domain 50m high 36° OSA partially saturated, seismic loaded slope SLIDE result**

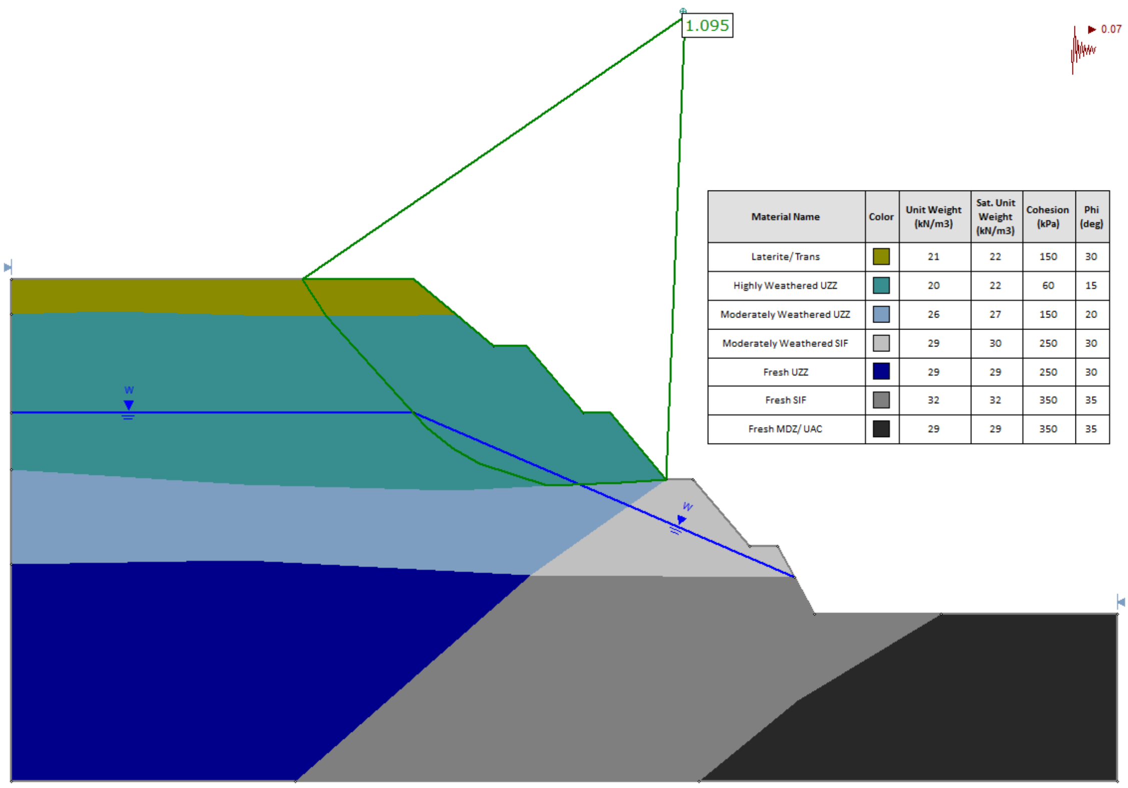

Figure 11 **Die Hardy West Domain 50m high 40° OSA partially saturated, seismic loaded slope SLIDE result**

6.3.1 Discussion on Limit Equilibrium Analysis Results

Under dry/ fully depressurised conditions all slopes are assessed to be stable against circular and pseudo-circular (rotational) failure. It is inferred that actual FS would be slightly greater than those tabulated due to three-dimensional influences (lateral confinement along the slope) and possible existence of higher shear strengths than those modelled (at least locally).

Calculated minimum FS surfaces for slopes typically span the *transported* and *highly weathered* interval, hence conditions for development of the lowest FS may arise during or at the completion of wall development through the *highly weathered* profile.

Note that while the analysis techniques used could incorporate locally stronger or weaker zones and/ or geological structures (to various levels of reliability), the locations and sizes of such zones are unknown, hence results would be purely illustrative and no practical inferences could be drawn.

Locally poorer zones and/ or zones containing unfavourably oriented geological structures could cause localised instability. Such events could have an adverse impact on stability in a wider sense in that loss of confinement locally could spread progressively to affect overall slope stability. This potential must be monitored closely during open pit operations, as prompt remedial work and/ or local design adjustments may be needed to mitigate their likely adverse influence.

Conversely, locally stronger zones may act to reinforce segments of pit slopes.

6.4 Empirical Assessment

Empirical assessment based on the method devised by Haines and Terbrugge [8] was used to assist in the derivation of, and to check, recommended slope design parameters.

On the basis of MRMR values, the ranges of sustainable overall slope angles at Die Hardy are:

- ⇨ ~ 35° to 64°.

Appropriate wall angles depend on assessed rock mass classification ratings after application of adjustments for expected mining influences and performance after exposure. As noted, there is a strong correlation between rock weathering grades and rock mass classification ratings; hence sustainable wall angles also show a dependence on rock weathering grades.

While this assessment is empirically based, experience has shown that the overall angles derived using this method are generally reliable indicators of practically sustainable slope angles.

7.0 Implications for Mining

7.1 Voids

Neither Ramelius nor PBA are aware of the presence of historic underground voids within the proposed Die Hardy open pit mining area.

7.2 Excavation

Drill and blast methods will be required for development of pit walls at Die Hardy. It is likely that drill and blast will be required from surface in weathered ground in order to maintain required/ suitable productivity levels.

It is essential that appropriate perimeter blast methods are used in the formation of final batters. The recommended wall designs are based on the assumption that suitable methods will be used, and implemented at a consistently high standard, in all wall development blasts. Care must also be taken to ensure that production blasts do not pre-condition/ disturb/ damage wall rocks.

Ideally trim blasting methods would be used to form final batters, and should be included in a Blastmaster sheet for every flitch. The width of trim patterns should be slightly wider than the zone of disturbance of the productions shot(s) fired adjacent to it.

Trim blasts must be fired to a free face, and preferably two free faces. A free face is one where all broken stocks and rill material are removed from the face and toe of the shot. This is critical in allowing good burden relief of the face, thus providing opportunity for burden relief throughout the pattern.

Where there is a good understanding of ground and local geological conditions it is reasonable to consider use of modified production blasting in formation of final batters. Design parameters to be used in modified production patterns must be derived/ confirmed in trials carried out remote from final walls. In our opinion modified production blasting cannot, however, be assumed to be as effective as trim blasting, due primarily to the difficulty in achieving adequate burden relief, particularly at the back of the shot (near the wall).

Without face relief, movement of the body of the pattern is blocked, energy dissipates in all directions, including into the wall. Such conditions are conducive to wall damage, for example via block heave and release of load fracturing, both of which typically result in loss of berm crests.

Kinematic stability analyses identified potential for structurally controlled failures from pit batters. Designed rock catching capacity must be achieved and maintained. To this end control over blast disturbance in limit wall development is critical. Very high-quality practices will thus be essential in establishing berms where blasting is required to develop pit walls. A key performance indicator in this instance will be for $\geq$ 85% of berms to be formed at design width.

Implementation of these practices requires a high level of supervision in the field and stringent application of simple field controls. The return to the operation can be expected via reduced time in wall scaling, retention of berm crests cleaner walls (less loose material) and thus safer pit operating conditions.

All walls must be scaled thoroughly.

7.3 Wall Stability Conditions

On the basis of assessed rock mass conditions, it is considered that wall stability within the majority of proposed pit slopes at Die Hardy will be controlled by some combination of the influences of low shear strength of weathered materials and relict geological structures.

Current weathering interpretations indicate that planned mining will intersect limited intervals of *fresh* rock. Where encountered, fresh rocks are expected to generally be *very strong* and wall segment stability will dominantly be controlled by the orientation, persistence and shear strength of geological structures intersected by, or located close behind, pit batters.

The most obvious potentials for pit wall instability Die Hardy are:

- ⇨ **Slumping failure** within low shear strength materials such as clay, saprolite and saprock material with and without undissipated ground water pressure.
- ⇨ Potential for **planar sliding** instability is indicated for the major eastern wall.
- ⇨ Potential for **wedge instability** is indicated for the minor northern endwall.
- ⇨ **Ravelling failure** which could develop in areas of intense fracturing, for example in/around faults, shears, intrusions, contacts and altered rocks. Instabilities which develop via this mechanism tend to develop progressively, and Ramelius must be aware that loss of confinement in a slope, even within a small area, can have a significant deleterious influence on stability performance.

Widespread wall instability could develop progressively from a localised event, as loss of the integrity and/ or reduction in confinement within the wall can have far reaching effects.

It is pertinent to note that a directional “bias” of geotechnical investigation boreholes and data may not be permitting detection of all defect sets and conditions present in the Die Hardy rock mass.

Ongoing observation of stability performance and data collection will be required to more accurately define the potential(s) for slope instability at Die Hardy. This work should be considered an integral component of mining.

Prompt reaction to, and where necessary, remediation of all instabilities will be a crucial factor in slope management of future mining at the deposit.

Factors which could run counter to successful implementation of ***base case*** parameters are:

- ⇨ Greater than interpreted occurrences of deeply weathered and/ or poor-quality rocks (potentially associated with currently unknown structures).
- ⇨ Failure to control blast disturbance in limit wall development and/ or consistently and comprehensively achieve very high-quality drill and blast practices and design berm width.

8.0 Recommended Base Case Wall Design Parameters

Recommendations for wall design parameters have been derived from:

- ⇨ Review of borehole cores and geotechnical logs
- ⇨ Results of kinematic stability analyses based on defect data obtained from boreholes
- ⇨ Basic rock mass classification using empirical methods
- ⇨ Relevant experience in investigation, assessment, design and operation of open pits of similar scale in similar geotechnical settings.

The following preliminary *base case* wall design parameters may be used for ongoing open pit mining evaluation and planning at Die Hardy (Figures 12 and 13):

EAST DOMAIN

Figure 12

From 0 to 10 metres below surface (mbs) (laterite, gravel, transported & *highly* weathered material)

Batter Face Height	**≤ 10m**
Batter Face Angle	**40°**
Berm Width	**5m**
IRA	**30.6°**

From 10 to 50 mbs (*highly* weathered to *fresh* SIF, MDZ & UAC rocks)

Batter Face Height	**≤ 20m***
Batter Face Angle	**40°** (attempting to match bedding/ defect angle within wall rocks)
Berm Width	**5m**
IRA	**34.7°**

* *Alternatively, mine as continuous 35° to 40° slope with rock slide arresting bunds or catch fences installed at ≤ 20m vertical intervals.*

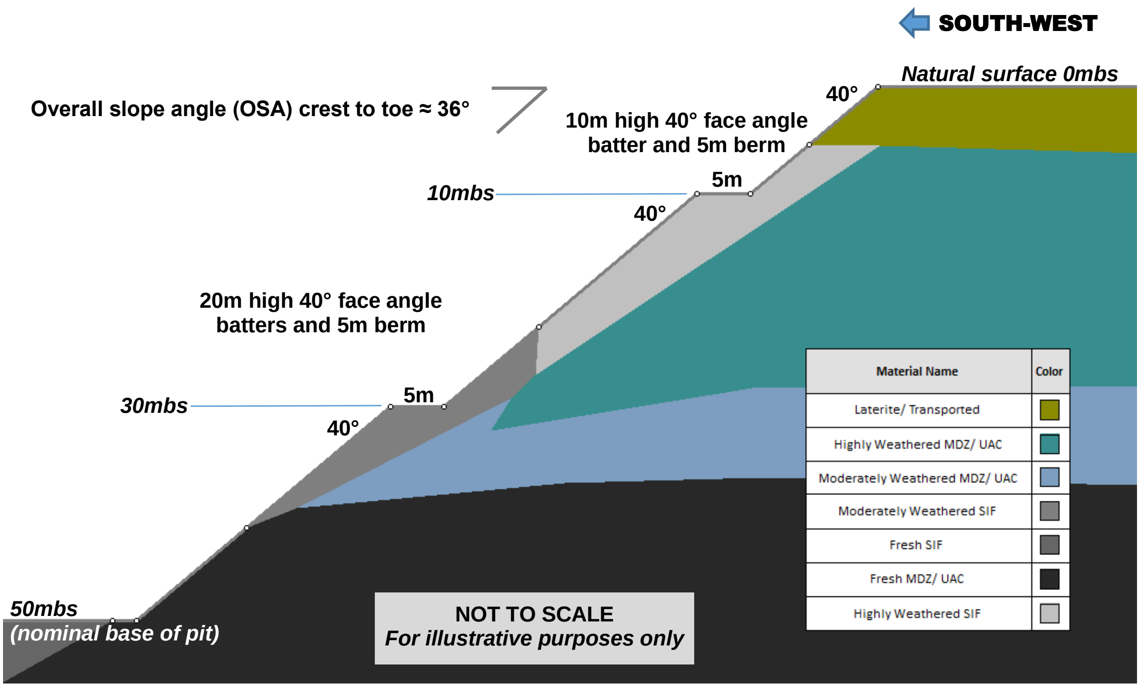

Figure 12 Die Hardy East Design Domain wall *base case* design parameters

WEST DOMAIN

Figure 13

From 0 to 10 metres below surface (mbs) (laterite, gravel, transported & *highly* weathered material)

Batter Face Height	**≤ 10m**
Batter Face Angle	**40°**
Berm Width	**5m**
IRA	**30.6°**

From 10 to 40 mbs (*highly* to *moderately* weathered UZZ & SIF rocks)

Batter Face Height	**≤ 10m**
Batter Face Angle	**50°**
Berm Width	**4m**
IRA	**38.9°**

From 40 to 50 mbs (*moderately* weathered to *fresh* SIF rocks)

Batter Face Height	**≤ 10m**
Batter Face Angle	**60°**
IRA	**60°** (single batter)

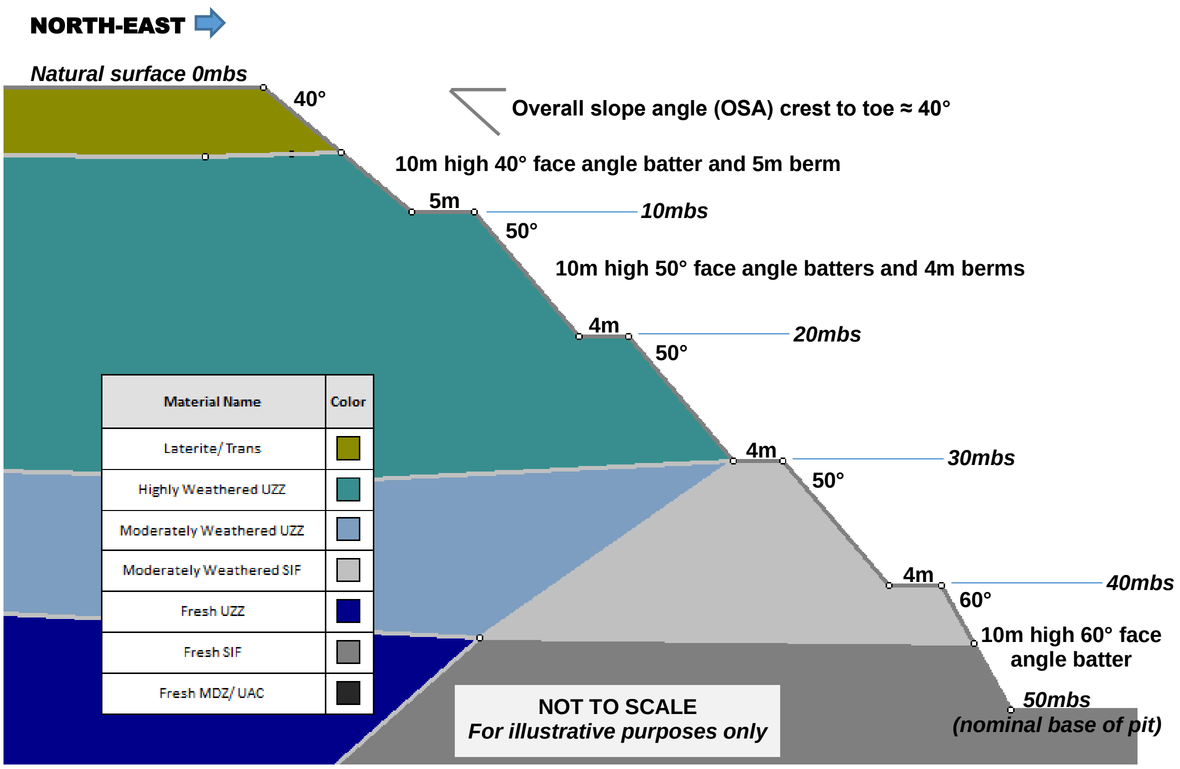

Figure 13 Die Hardy West Design Domain wall *base case* design parameters

8.1 Pit Access Ramp

There is currently no (known) specific geotechnical preference/ requirement for ramp location at Die Hardy.

8.2 Base Case Design Berm Width

Recommendations for minimum berm widths at Die Hardy have been based on a combination of experience and empirical relationships.

The Modified Ritchie Criterion, derived by Call & Nicholas Inc. (Call and Savely, 1990) is well used as a design guide and is included in the *SME Mine Engineering Handbook*.

The Modified Ritchie Criterion defines the preferred catch berm width:

Berm width (m) = 0.2 × bench height + 4.6m

A further relationship, developed by Ryan and Pryor (2000) defines berm width slightly less conservatively as:

Berm width (m) = 0.17 × bench height + 3.5m

The berm widths recommended herein are based on these guidelines and experience.

8.3 Comment on Wall Design Recommendations

The following comments are considered to be applicable to the recommended *base case* design parameters for proposed mining of the Die Hardy pit:

- **The recommended *base case* ‡ parameters are neither overly conservative nor excessively aggressive.**

  Mining to the recommended wall parameters is expected to be accompanied by some local batter scale wall failures. Careful slope monitoring will be required throughout all stages of mining (including stability monitoring of interim slopes).

  The parameters are recommended with an expectation that initial mining will allow use of observational techniques (Section 10) to refine slope parameters for final walls. That is, assessment of staged/ interim slopes will permit confirmation and/or amendment of the parameters.
- The recommended parameters assume that stable wall conditions are required for the medium term (an estimated 2-year life) of the open pit only. Should mine planning for Die Hardy indicate that underground access from the pit will be required in the future, review of pit design parameters for the pit sector in which the portal is located and ramp route to the portal will be required. Similarly, pit design parameters at locations of any planned vertical development breakthroughs into the pit or close to the pit crests should be reviewed. Local or possibly global moderation of pit design parameters may be required.
- The design requires that largely depressurised wall rock conditions are present or can be achieved.
- Inclusion of access ramps and/ or geotechnical berms <u>will</u> be required to moderate the overall angles achieved within the pit.
- A key performance indicator for Die Hardy pit wall development should be for ≥ 85% of berms to be formed at design width.

‡ *Base case* parameters are derived using interpretations based on available data and local experience. Variability of geological/ geotechnical conditions means that adjustment to the design during implementation many be necessary. Ongoing geotechnical re-assessment based on mapping and slope monitoring data is essential to identify such variations and to derive suitable amendments to the design parameters. Required application of such amendments may be local or could be widespread.

- Successful use of appropriate mining techniques, particularly in drilling and blasting and excavation during development of final walls, will be critical to the achievement of the design and maintenance of wall stability.
- Local adjustments to design parameters may be necessary to satisfy stability requirements. Few data are known regarding the persistence of geological structures which could contribute to instability. Flattened batters and/or wider berms may be necessary locally. Conversely, there may be opportunity for local wall steepening.
- Convex, unconfined slope sectors (bullnoses) must be expected to be prone to failure. While it is reasonable to include such shapes in pit plans, (rather than committing directly to remove large “additional” volumes of waste). Ramelius must remain aware of the potential for instability and the possible need to adjust (“smooth out”) bullnose areas. Ideally, bullnoses should be avoided as far as practicable during final design.
- No general use of artificial support or reinforcement is anticipated. However, mesh surface support and/ or rock reinforcement could be used locally in *fresh* rocks if required.

9.0 Assessment of Proposed Waste Rock Landform

Two-dimensional limit equilibrium analysis of the resistance to development of circular and non-circular (rotational) failures through a proposed Die Hardy WRL slope was performed using Slide.

A conventional non-circular global critical failure surface search function was used to identify surfaces with minimum Factors of Safety (FS) (as calculated by LEA).

Summary details of proposed WRL design parameters and inferred construction and *in situ* base materials are as listed below. The likely range of intact strengths for *in situ* base and mined waste material were estimated by use of simple index tests during geotechnical core logging.

No obvious indications of dispersive material characteristics were observed within cores of boreholes FBDD-001 to 003.

Die Hardy WRL

- ⇨ Final design height = ≤ 30m
- ⇨ Slope face angles:
  - ▫ Lower 15m at 15° (unbenched)
  - ▫ Upper 15m at 19° (unbenched)
  - ▫ Total slope = 30m at 17°
- ⇨ Material
  - ▫ Transported ferruginous gravel (TGF), transported clay (TCZ) material (estimated strength range ≤ R0 to R3)
  - ▫ *Highly* weathered to *fresh* SIF, MDZ , UAC and UZZ rocks (R0 to R5)
- ⇨ *In Situ* Base material
  - ▫ TGF and TCZ (≤ R0 to R3)

Slope analyses carried out included pseudo-static analysis incorporating a seismic acceleration coefficient of 0.07*g* (Section 3.3.4) and also the influence of a maximum likely earthquake, considering a seismic coefficient of 0.20g, representing an outlier event of greater than expected magnitude at this location. Results obtained are provided as Figures 14 to 16.

Effective surface water management measures that would prevent the potential for build-up of hydrostatic pressures in slopes were assumed in all cases.

Based on guidelines presented within Hawley and Cunning [9], the following Factor of Safety (FS) acceptance criteria were considered for LEA:

- ⇨ FS of 1.30 to 1.40 considered to be the minimum acceptable value for slopes with no critical infrastructure or unrestricted access within the potential run-out shadow.
- ⇨ FS of 1.05 to 1.10 may be acceptable for a transient seismic disturbance, though some slope failure could be expected under such conditions.

The FS obtained for the proposed WRL slope under static and applied seismic disturbance estimated for an event with a 10% probability of exceedance in 50 years (0.07g) conditions were found to be within acceptable limits.

While the FS obtained for the proposed WRL slope under inferred maximum likely earthquake (0.20g) conditions were found to be marginally below acceptable limits, the minimum FS surface for the outlier event is extremely shallow, located either virtually at the slope surface or ≤ 0.2m below it. As such, any slope disturbance that may result from the theoretical outlier event would be expected to be minimal and may not even be visually discernible. On the basis of the location/ limited depth of the minimum surface, the indicated FS is considered to be acceptable for the theoretical outlier event.

The current proposed WRL slope is considered to be of modest height and profile, and as such is assessed to be sufficiently shallow to preclude development of significant rotational sliding instability over the very long term. PBA considers the currently proposed WRL design parameters to be acceptable for construction. The need to manage surface water flows and residence times appropriately is emphasised.

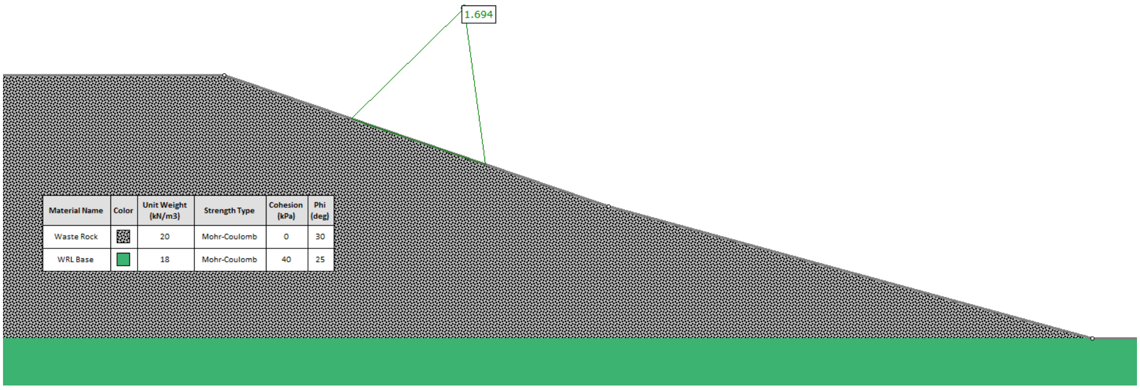

Figure 14 Proposed Die Hardy WRL slope SLIDE analysis result

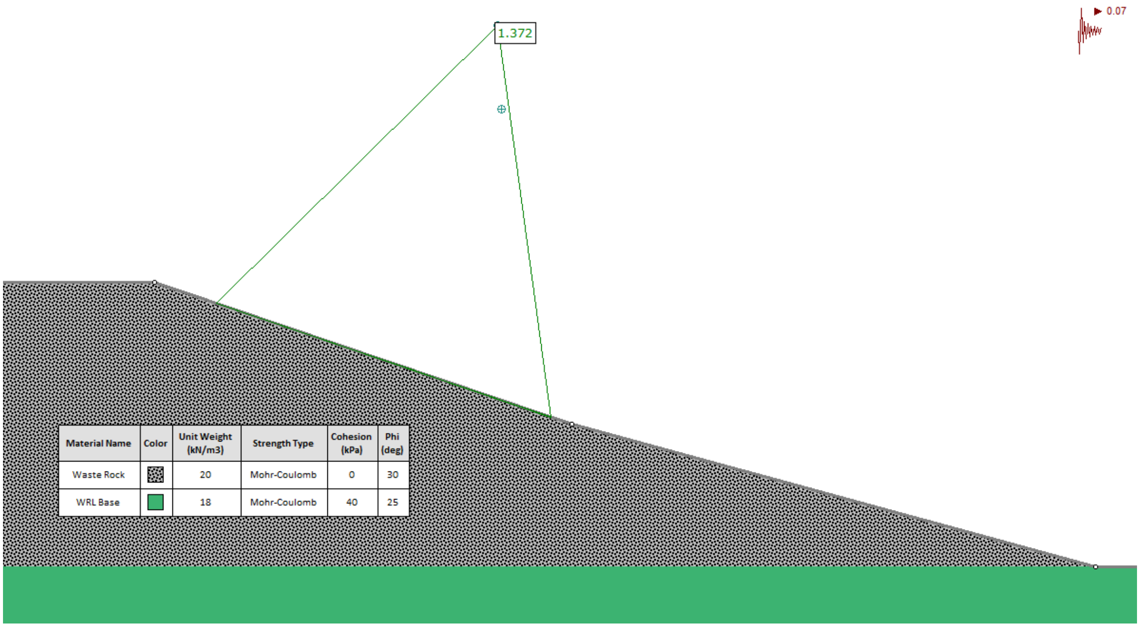

Figure 15 Proposed Die Hardy WRL slope with 0.07g seismic load SLIDE analysis result

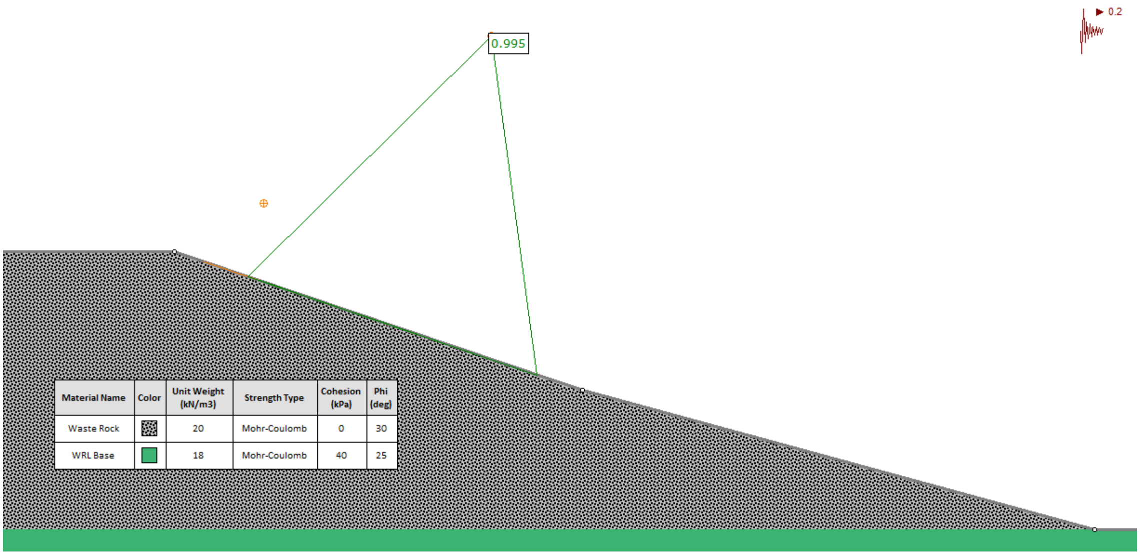

Figure 16 Proposed Die Hardy WRL slope with 0.20g seismic load SLIDE analysis result

10.0 Further Work

This assessment has been based on information derived from data obtained from exploration borehole cores.

10.1 Ongoing Geotechnical Assessment

It is considered essential that ongoing design re-assessments, based on information obtained using *observational techniques* are made during mining. It may be necessary to make local design adjustments during pit development.

Information obtained from mapping and slope stability monitoring should be assessed to confirm, or as the case may be, adjust, pit wall design parameters. As additional data become available, it will become likely that a more “optimal” approach to wall design and development will be derived.

Moderation of slope angles (via shallowing of batter face angles and/ or widening of berms) may be required locally or generally on some or all walls. Conversely, it is possible that local wall steepening may be possible.

10.1.1 Pit Wall Mapping

It is important that wall mapping is carried out to identify/ characterise wall materials and variations thereof. Data to be collected should include:

- ⇨ Basic lithology, degree of weathering and estimated strength (simple index tests)
- ⇨ Information regarding the distribution of material types and strengths
- ⇨ Information related to structural geological features: faults, shears, contacts, foliation fabric, joints *et cetera*, recording location, orientation, persistence, spacing (measured or estimated) shape, roughness, infill, and terminations
- ⇨ Failure descriptions: location, date of (even small localised) failure, features defining the failure, estimated volume, mechanism, break-out mechanism(s)
- ⇨ General observations, for example, occurrence of groundwater or dampness
- ⇨ Review of core in light of exposure in mining faces to determine if it is a useful/ reliable predictor of actual mining conditions.

10.1.2 Pit Wall Stability Monitoring

Slope failures do not occur spontaneously or without warning (provided the pit is being monitored appropriately and adequately). Use of qualitative visual and quantitative electro-optical distance measurement (EDM) stability monitoring methods are recommended for assessment of pit wall slope stability conditions in the Die Hardy pit.

In the first instance, EDM survey methods should be adopted to measure point displacements on all walls. Ideally an automated system would be employed to provide continuous real-time monitoring.

Progressively extended arrays of prisms should be established on all walls as they are developed. Prisms should initially be spaced at ≤ 50m intervals at 20m vertical intervals along the pit crest and alternate berms below. Adjustments to prism locations will be needed to adequately monitor expected local variations in displacement around geological structures and across major cracks. Additional prisms may be required locally.

The frequency of surveying these prisms after identification of movement trends immediately following installation should be based on measured displacement rates, but should not be less frequently than weekly.

Frequent visual inspection of the pit walls, including walking over all safely accessible berms, should be regarded as an integral aspect of open pit mining. Observations should be recorded in a written log, and regularly updated photographic records can provide assistance in qualitative assessment.

The need or otherwise for further action (more intensive monitoring) and/ or design adjustment will be dependent on the results obtained from the proposed monitoring.

10.2 Hydrogeology & Groundwater Monitoring

The presence of groundwater pressures within pit walls is a destabilising influence. The buoyant effects generated by hydrostatic pressures will exacerbate the potential for all possible failure mechanisms. It is crucial therefore, that steps are taken to monitor hydrogeological conditions as open pit mining advances.

10.3 Ground Control Management Plan

It is recommended that a formal operational Ground Control Management Plan (GCMP) be developed for proposed open pit mining at Die Hardy.

The GCMP would describe the ground conditions encountered and/or anticipated in the open pits, and describe/ justify the slope parameters in use or proposed. It would identify likely failure mechanisms and the means by which these would/ could be precluded or avoided to permit safe development and production.

The physical and management procedures to be used to ensure appropriate mine design and use of safe mining practices would also be described.

10.4 Geotechnical Review

Regular geotechnical review of ground conditions during operations is recommended.

For open pits initial review should be conducted relatively early in the life of mining, say, once mining has reached a depth of ~ 20m. The timing of subsequent reviews would depend on the findings of the initial review and/ or according to assessment of actual conditions by Ramelius mining personnel.

10.5 Geotechnical Risk

Die Hardy *base case* pit design parameters have been derived using interpretations based on available data and could require adjustment due to variability of geological/ geotechnical conditions.

It is considered that *base case* design parameters presented maybe subject to the following geotechnical risks:

- The distribution and extent of occurrences of deeply weathered and/ or poor-quality wall rocks (for example, associated with currently unknown structures) may be greater than indicated by current geological interpretations.
- Borehole spatial distribution and direction bias may have resulted in some structural discontinuities being under-represented/ unrepresented in the data sets considered.
- Unknown geological structures/ units, if such exist, may negatively impact *base case* design parameters.
- Rock weathering depths may be locally deeper than current interpretations.
- Unfavourable hydrogeological conditions may result in greater than anticipated destabilisation groundwater pressures in pit wall rocks.

It is expected that Ramelius will gain a better understanding of exposure to geotechnical risks once further project geotechnical investigation work is completed and open pit mining allows geotechnical pit wall mapping/ inspections to be carried out.

11.0 Closure

We trust that the information provided in this report is adequate for your current requirements.

The recommendations presented assume that appropriate techniques will be employed, and performed at consistently high standards, in all aspects of mining and slope stability monitoring activities at Die Hardy.

We stress the need for the use of observational techniques during mining and ongoing re-assessment of the suitability of designs for encountered ground conditions.

Please contact this office if there is any need for clarification or further information.

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per:

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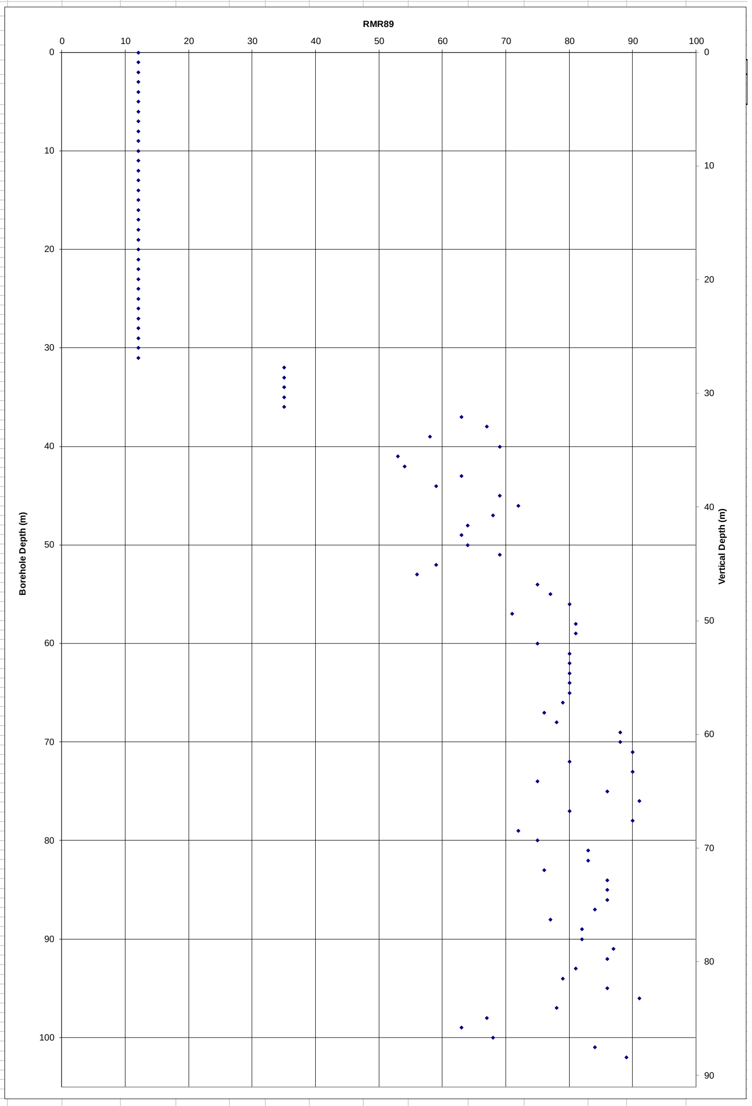
APPENDIX A

SUMMARY GEOTECHNICAL AND ROCK MASS CLASSIFICATION LOGS

BOREHOLES FBDD-001, 002 and 003
RMR and MRMR

Project:	Ramelius Die Hardy						**Date:**	November 2020				
Hole ID:	FBDD001		**Hole Dip**	-60°			**Ref Table**	**Ref Table**	**Jf = Joint filled**	**S1=Soft<5mm**	**VR=Very Rough**	
Northing:	6683960.413		**Hole Azi**	062°			**W1, W2, W3**	**R0, R1, R2**		**S2=Soft>5mm**	**R=Rough**	
Easting:	732463.564		**Bit Size:**	HQ3			**W4, W5, W6**	**R3, R4, R5**		**H1=Hard<5mm**	**SR=Slightly Rough**	
Elevation:	493.891							**R6**	**J = Joint**	**H2=Hard>5mm**	**SM=Smooth**	
										Nil=No filling	**SL=Slickensided**	

Drill Record			**Recovery**	**RQD**	**Fractures**	**Materials**			**Structures**				
From (m)	To (m)	Drill (m)	m	m	Number of Fractures	Rock Type	Weathering Grade	Strength Grade	Structural Type	Infill (mm)	Infill Hardness & Thickness	Joint Roughness	Comments
0.00	1.00	1.00	0.80	0.00	99	TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	0 to 5m, laterite, gravels, unconsolidated, Very Poor
1.00	2.00	1.00	0.00	0.00	99	TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	
2.00	3.00	1.00	0.30	0.00	99	TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	
3.00	4.00	1.00	0.60	0.00	99	TMZ/ TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	
4.00	5.00	1.00	0.90	0.00	99	TMZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
5.00	6.00	1.00	1.00	0.00	99	TMZ/ TCZ	W5 - W6	R2	NA	NA	NA	NA	
6.00	7.00	1.00	1.00	0.00	99	TCZ	W5 - W6	R2	NA	NA	NA	NA	5 to 15m transported clays, Very Poor
7.00	8.00	1.00	0.20	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
8.00	9.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
9.00	10.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
10.00	11.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
11.00	12.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	
12.00	13.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	Swelling clays?
13.00	14.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	Swelling clays?
14.00	15.00	1.00	1.00	0.00	99	TCZ	W5 - W6	>R0	NA	NA	NA	NA	14 to 37m, saprolite, some relict structure visible. Some
15.00	16.00	1.00	1.00	0.00	99	TCZ	W5 - W6	R0	NA	NA	NA	NA	intervals of saprock, generally Very Poor
16.00	17.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
17.00	18.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
18.00	19.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
19.00	20.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
20.00	21.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
21.00	22.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
22.00	23.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
23.00	24.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
24.00	25.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
25.00	26.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
26.00	27.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
27.00	28.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
28.00	29.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
29.00	30.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
30.00	31.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
31.00	32.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
32.00	33.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
33.00	34.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
34.00	35.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
35.00	36.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
36.00	37.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
37.00	38.00	1.00	1.00	0.73	7	SIF/ UZZ	W2	R4	Bed	Surf ox H ≤ 1mm	H1	R	37 to 50m, strongly bedded rock, frequent parting on
38.00	39.00	1.00	1.00	0.87	6	SIF	W2	R4	Bed	Surf ox H ≤ 1mm	H1	R	bedding. 38 to 46m vughy.
39.00	40.00	1.00	1.00	0.59	10	SIF	W3	R3	Bed	Surf ox H ≤ 1mm	H1	R	
40.00	41.00	1.00	1.00	0.54	8	SIF	W3	R2 - R3	Bed	Surf ox H ≤ 1mm	H1	R	
41.00	42.00	1.00	1.00	0.43	15	SIF	W3	R3	Bed	Surf ox H ≤ 1mm	H1	R	
42.00	43.00	1.00	1.00	0.49	8	SIF	W2 - W4	R3 - R0	Shr	Clay 70mm	S2	R	70mm clay interval, shear?
43.00	44.00	1.00	1.00	0.54	11	SIF	W2	R4	Bed	Surf ox H ≤ 1mm	H1	R	
44.00	45.00	1.00	0.90	0.31	14	SIF	W2	R4	Bed	Oxide H ≤ 1mm	H1	VR	
45.00	46.00	1.00	1.00	0.54	8	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	VR	
46.00	47.00	1.00	1.00	0.76	8	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
47.00	48.00	1.00	1.00	0.67	13	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
48.00	49.00	1.00	1.00	0.48	12	SIF	W2	R5	Bed	Oxide H 1mm	H1	VR	
49.00	50.00	1.00	0.90	0.48	12	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
50.00	51.00	1.00	1.00	0.43	7	SIF	W1	R5	Bed	Oxide H ≤ 1mm	H1	R	50 to 54m frequent parting on bedding planes, Fair quality
51.00	52.00	1.00	0.90	0.58	6	SIF	W1	R5	Bed	Oxide H ≤ 1mm	H1	R	
52.00	53.00	1.00	1.00	0.24	9	SIF	W1	R5	Bed	Oxide H ≤ 1mm	H1	R	
53.00	54.00	1.00	1.00	0.00	17	SIF	W1	R5	Bed	Oxide H ≤ 1mm	H1	R	
54.00	55.00	1.00	1.00	0.75	8	SIF	W1	R5	Bed	Nil NA	Nil	R	54 to 74m generally competent BIF rocks, Very Good
55.00	56.00	1.00	1.00	0.87	3	SIF	W1	R5	Bed	Nil NA	Nil	R	
56.00	57.00	1.00	1.00	1.00	3	SIF/ MZZ	W1	R5	Bed	Nil NA	Nil	R	
57.00	58.00	1.00	1.00	0.75	7	SIF	W1	R5	Bed	Oxide S ≤ 1mm	S1	R	
58.00	59.00	1.00	1.00	0.93	2	SIF	W1	R5	Bed	Nil NA	Nil	VR	
59.00	60.00	1.00	1.00	1.00	3	MZZ/ SIF	W1	R5	Jn	Nil NA	Nil	VR	
60.00	61.00	1.00	1.00	0.85	5	SIF/ MZZ	W1	R5	Bed	Nil NA	Nil	R	
61.00	62.00	1.00	1.00	1.00	2	SIF	W1	R5	Bed	Nil NA	Nil	R	
62.00	63.00	1.00	1.00	1.00	3	SIF	W1	R5	Bed	Nil NA	Nil	R	
63.00	64.00	1.00	1.00	0.92	2	SIF	W1	R5	Bed	Nil NA	Nil	R	
64.00	65.00	1.00	1.00	0.92	4	SIF	W1	R5	Bed	Nil NA	Nil	R	
65.00	66.00	1.00	1.00	0.92	3	SIF	W1	R5	Bed	Nil NA	Nil	R	
66.00	67.00	1.00	1.00	1.00	4	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	VR	
67.00	68.00	1.00	1.00	0.83	3	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	VR	
68.00	69.00	1.00	1.00	0.95	2	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	R	
69.00	70.00	1.00	1.00	1.00	0	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	R	
70.00	71.00	1.00	1.00	1.00	0	SIF	W1	R5	Jn	Surf ox H ≤ 1mm	H1	R	
71.00	72.00	1.00	1.00	1.00	0	SIF	W1	R5	Bed	Nil NA	Nil	R	
72.00	73.00	1.00	1.00	0.91	3	SIF	W1	R5	Bed	Nil NA	Nil	R	
73.00	74.00	1.00	1.00	1.00	0	SIF	W1	R5	Bed	Nil NA	Nil	R	
74.00	75.00	1.00	1.00	0.80	5	SIF/ MDZ	W1	R5	Jn	Nil NA	Nil	R	74 to 82m generally competent mafic, Very Good
75.00	76.00	1.00	1.00	1.00	1	MDZ	W1	R5	Jn	Nil NA	Nil	VR	
76.00	77.00	1.00	1.00	1.00	0	MDZ	W1	R5	Jn	Nil NA	Nil	VR	
77.00	78.00	1.00	1.00	1.00	2	MDZ	W1	R5	Jn	Nil NA	Nil	R	
78.00	79.00	1.00	1.00	1.00	0	MDZ	W1	R5	Jn	Nil NA	Nil	R	
79.00	80.00	1.00	1.00	0.66	10	UAC	W1	R5	Jn	Nil NA	Nil	VR	
80.00	81.00	1.00	1.00	0.88	5	UAC/ MDZ	W1	R5	Jn	Nil NA	Nil	R	
81.00	82.00	1.00	1.00	1.00	1	UAC/ MDZ	W1	R5	Jn	Carb H 1mm	H1	R	
82.00	83.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb H 1mm	H1	R	82 to 102m generally Good quality, no significant talc-chlorite
83.00	84.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Nil NA	Nil	SM	alteration
84.00	85.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
85.00	86.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
86.00	87.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
87.00	88.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb H 1mm	H1	VR	
88.00	89.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Carb S 1mm	S1	VR	
89.00	90.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb S 1mm	S1	VR	
90.00	91.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb S 1mm	S1	VR	
91.00	92.00	1.00	1.00	1.00	0	UAC	W1	R5	Jn	Carb S 1mm	S1	VR	
92.00	93.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
93.00	94.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Nil NA	Nil	VR	
94.00	95.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Carb H ≤ 1mm	H1	VR	
95.00	96.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
96.00	97.00	1.00	1.00	1.00	0	UAC	W1	R5	Jn	Nil NA	Nil	VR	
97.00	98.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Carb H ≤ 1mm	H1	R	
98.00	99.00	1.00	1.00	0.75	7	UAC	W1	R5	Jn	Talc ≤ 1mm	S1	SM	
99.00	100.00	1.00	1.00	0.72	6	UAC	W1	R5	Jn	Talc ≤ 1mm	S1	SM	
100.00	101.00	1.00	1.00	0.75	7	UAC	W1	R5	Vn	Carb H 5mm	H2	R	
101.00	102.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Carb H ≤ 1mm	H1	VR	
102.00	102.20	0.20	0.20	0.20	0	UAC	W1	R5	Jn	Carb H ≤ 1mm	H1	VR	



MRMR Calcs

Drill Record		**RMR**	**MRMR Calcs**					
From (m)	To (m)	RMR89	Weathering	Joint Orientation	Induced Stress	Blasting effects	Total Adjustment	MRMR
0.00	1.00	12	0.96	0.80	1.00	0.94	0.72	9
1.00	2.00	12	0.96	0.80	1.00	0.94	0.72	9
2.00	3.00	12	0.96	0.80	1.00	0.94	0.72	9
3.00	4.00	12	0.96	0.80	1.00	0.94	0.72	9
4.00	5.00	12	0.96	0.80	1.00	0.94	0.72	9
5.00	6.00	12	0.96	0.80	1.00	0.94	0.72	9
6.00	7.00	12	0.96	0.80	1.00	0.94	0.72	9
7.00	8.00	12	0.96	0.80	1.00	0.94	0.72	9
8.00	9.00	12	0.96	0.80	1.00	0.94	0.72	9
9.00	10.00	12	0.96	0.80	1.00	0.94	0.72	9
10.00	11.00	12	0.96	0.80	1.00	0.94	0.72	9
11.00	12.00	12	0.96	0.80	1.00	0.94	0.72	9
12.00	13.00	12	0.96	0.80	1.00	0.94	0.72	9
13.00	14.00	12	0.96	0.80	1.00	0.94	0.72	9
14.00	15.00	12	0.96	0.80	1.00	0.94	0.72	9
15.00	16.00	12	0.96	0.80	1.00	0.94	0.72	9
16.00	17.00	12	0.96	0.80	1.00	0.94	0.72	9
17.00	18.00	12	0.96	0.80	1.00	0.94	0.72	9
18.00	19.00	12	0.96	0.80	1.00	0.94	0.72	9
19.00	20.00	12	0.96	0.80	1.00	0.94	0.72	9
20.00	21.00	12	0.96	0.80	1.00	0.94	0.72	9
21.00	22.00	12	0.96	0.80	1.00	0.94	0.72	9
22.00	23.00	12	0.96	0.80	1.00	0.94	0.72	9
23.00	24.00	12	0.96	0.80	1.00	0.94	0.72	9
24.00	25.00	12	0.96	0.80	1.00	0.94	0.72	9
25.00	26.00	12	0.96	0.80	1.00	0.94	0.72	9
26.00	27.00	12	0.96	0.80	1.00	0.94	0.72	9
27.00	28.00	12	0.96	0.80	1.00	0.94	0.72	9
28.00	29.00	12	0.96	0.80	1.00	0.94	0.72	9
29.00	30.00	12	0.96	0.80	1.00	0.94	0.72	9
30.00	31.00	12	0.96	0.80	1.00	0.94	0.72	9
31.00	32.00	12	0.96	0.80	1.00	0.94	0.72	9
32.00	33.00	35	0.96	0.80	1.00	0.94	0.72	25
33.00	34.00	35	0.96	0.80	1.00	0.94	0.72	25
34.00	35.00	35	0.96	0.80	1.00	0.94	0.72	25
35.00	36.00	35	0.96	0.80	1.00	0.94	0.72	25
36.00	37.00	35	0.96	0.80	1.00	0.94	0.72	25
37.00	38.00	63	0.96	0.80	1.00	0.94	0.72	45
38.00	39.00	67	0.96	0.80	1.00	0.94	0.72	48
39.00	40.00	58	0.96	0.80	1.00	0.94	0.72	42
40.00	41.00	69	0.96	0.80	1.00	0.94	0.72	50
41.00	42.00	53	0.96	0.80	1.00	0.94	0.72	38
42.00	43.00	54	0.96	0.80	1.00	0.94	0.72	39
43.00	44.00	63	0.96	0.80	1.00	0.94	0.72	45
44.00	45.00	59	0.96	0.80	1.00	0.94	0.72	43
45.00	46.00	69	0.96	0.80	1.00	0.94	0.72	50
46.00	47.00	72	0.96	0.80	1.00	0.94	0.72	52
47.00	48.00	68	0.96	0.80	1.00	0.94	0.72	49
48.00	49.00	64	0.96	0.80	1.00	0.94	0.72	46
49.00	50.00	63	0.96	0.80	1.00	0.94	0.72	45
50.00	51.00	64	0.96	0.80	1.00	0.94	0.72	46
51.00	52.00	69	0.96	0.80	1.00	0.94	0.72	50
52.00	53.00	59	0.96	0.80	1.00	0.94	0.72	43
53.00	54.00	56	0.96	0.80	1.00	0.94	0.72	40
54.00	55.00	75	0.96	0.80	1.00	0.94	0.72	54
55.00	56.00	77	0.96	0.80	1.00	0.94	0.72	56
56.00	57.00	80	0.96	0.80	1.00	0.94	0.72	58
57.00	58.00	71	0.96	0.80	1.00	0.94	0.72	51
58.00	59.00	81	0.96	0.80	1.00	0.94	0.72	58
59.00	60.00	81	0.96	0.80	1.00	0.94	0.72	58
60.00	61.00	75	0.96	0.80	1.00	0.94	0.72	54
61.00	62.00	80	0.96	0.80	1.00	0.94	0.72	58
62.00	63.00	80	0.96	0.80	1.00	0.94	0.72	58
63.00	64.00	80	0.96	0.80	1.00	0.94	0.72	58
64.00	65.00	80	0.96	0.80	1.00	0.94	0.72	58
65.00	66.00	80	0.96	0.80	1.00	0.94	0.72	58
66.00	67.00	79	0.96	0.80	1.00	0.94	0.72	57
67.00	68.00	76	0.96	0.80	1.00	0.94	0.72	55
68.00	69.00	78	0.96	0.80	1.00	0.94	0.72	56
69.00	70.00	88	0.96	0.80	1.00	0.94	0.72	64
70.00	71.00	88	0.96	0.80	1.00	0.94	0.72	64
71.00	72.00	90	0.96	0.80	1.00	0.94	0.72	65
72.00	73.00	80	0.96	0.80	1.00	0.94	0.72	58
73.00	74.00	90	0.96	0.80	1.00	0.94	0.72	65
74.00	75.00	75	0.96	0.80	1.00	0.94	0.72	54
75.00	76.00	86	0.96	0.80	1.00	0.94	0.72	62
76.00	77.00	91	0.96	0.80	1.00	0.94	0.72	66
77.00	78.00	80	0.96	0.80	1.00	0.94	0.72	58
78.00	79.00	90	0.96	0.80	1.00	0.94	0.72	65
79.00	80.00	72	0.96	0.80	1.00	0.94	0.72	52
80.00	81.00	75	0.96	0.80	1.00	0.94	0.72	54
81.00	82.00	83	0.96	0.80	1.00	0.94	0.72	60
82.00	83.00	83	0.96	0.80	1.00	0.94	0.72	60
83.00	84.00	76	0.96	0.80	1.00	0.94	0.72	55
84.00	85.00	86	0.96	0.80	1.00	0.94	0.72	62
85.00	86.00	86	0.96	0.80	1.00	0.94	0.72	62
86.00	87.00	86	0.96	0.80	1.00	0.94	0.72	62
87.00	88.00	84	0.96	0.80	1.00	0.94	0.72	61
88.00	89.00	77	0.96	0.80	1.00	0.94	0.72	56
89.00	90.00	82	0.96	0.80	1.00	0.94	0.72	59
90.00	91.00	82	0.96	0.80	1.00	0.94	0.72	59
91.00	92.00	87	0.96	0.80	1.00	0.94	0.72	63
92.00	93.00	86	0.96	0.80	1.00	0.94	0.72	62
93.00	94.00	81	0.96	0.80	1.00	0.94	0.72	58
94.00	95.00	79	0.96	0.80	1.00	0.94	0.72	57
95.00	96.00	86	0.96	0.80	1.00	0.94	0.72	62
96.00	97.00	91	0.96	0.80	1.00	0.94	0.72	66
97.00	98.00	78	0.96	0.80	1.00	0.94	0.72	56
98.00	99.00	67	0.96	0.80	1.00	0.94	0.72	48
99.00	100.00	63	0.96	0.80	1.00	0.94	0.72	45
100.00	101.00	68	0.96	0.80	1.00	0.94	0.72	49
101.00	102.00	84	0.96	0.80	1.00	0.94	0.72	61
102.00	102.20	89	0.96	0.80	1.00	0.94	0.72	64

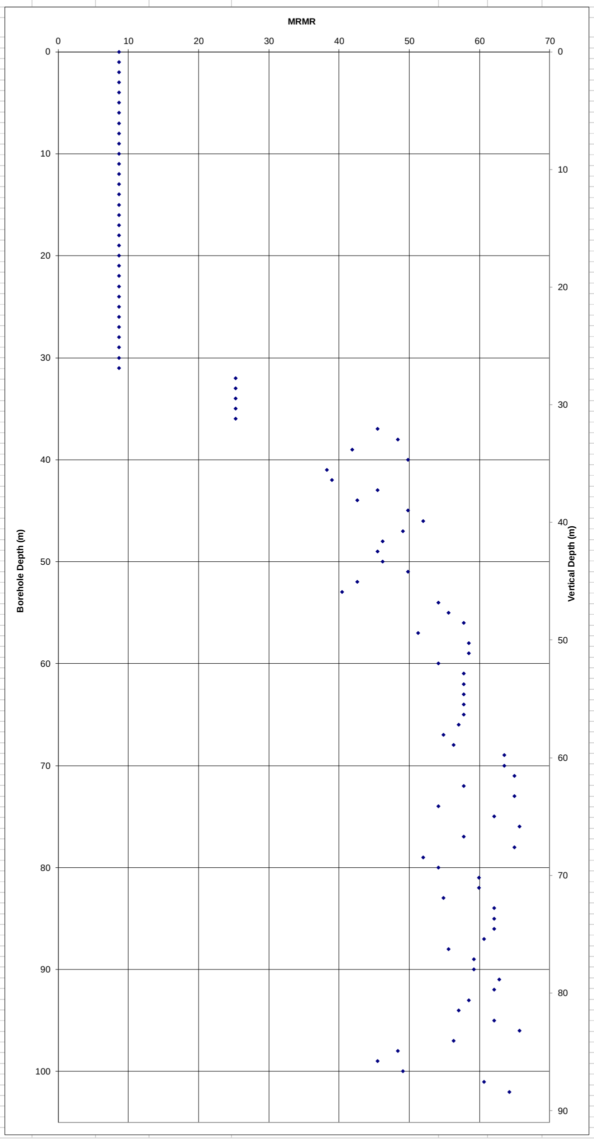
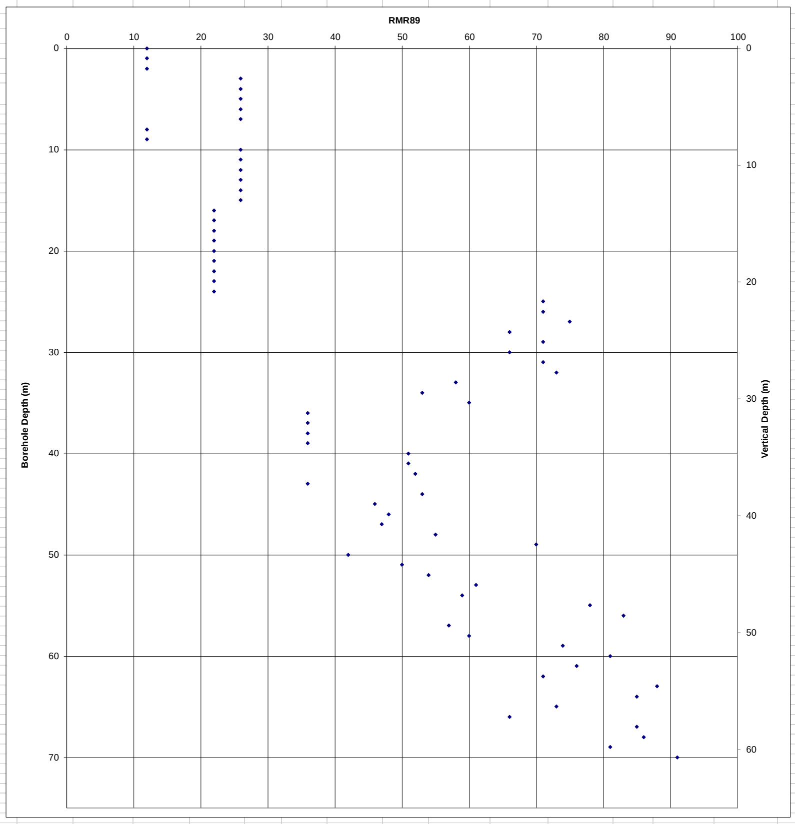


Figure A1 Borehole FBDD-001 summary geotechnical log, RMR and MRMR rock mass classification

Project:	Ramelius Die Hardy			**Date:**	November 2020		
Hole ID:	FBDD002	**Hole Dip**	-60°	**Ref Table**	**Ref Table**	**Jf = Joint filled**	**S1=Soft<5mm**
Northing:	6683783.771	**Hole Azi**	061°	**W1, W2, W3**	**R0, R1, R2**		**S2=Soft>5mm**
Easting:	732689.779	**Bit Size:**	HQ3	**W4, W5, W6**	**R3, R4, R5**		**H1=Hard<5mm**
Elevation:	506.469				**R6**	**J = Joint**	**H2=Hard>5mm**
							Nil=No filling

VR=Very Rough; **R=Rough**; **SR=Slightly Rough**; **SM=Smooth**; **SL=Slickensided**

Drill Record			Recovery	RQD	Fractures	Materials			Structures				
From (m)	To (m)	Drill (m)	m	m	Number of Fractures	Rock Type	Weathering Grade	Strength Grade	Structural Type	Infill (mm)	Infill Hardness & Thickness	Joint Roughness	Comments
0.00	1.00	1.00	0.80	0.00	99	TGF	W5 - W6	R3	NA	NA	NA	NA	0 to 3m, laterite, mix of gravel & consolidated material
1.00	2.00	1.00	0.90	0.00	99	TGF	W5 - W6	R3	NA	NA	NA	NA	
2.00	3.00	1.00	0.90	0.00	99	WCZ/ TGF	W5 - W6	R3	NA	NA	NA	NA	
3.00	4.00	1.00	0.90	0.00	99	WCZ/ WCU	W5 - W6	R3	Jn	Clay 1mm	S1	VR	3 to 8m, saprock, some structure, Poor
4.00	5.00	1.00	0.90	0.41	11	WCU	W4	R3	Jn	Clay 1mm	S1	VR	
5.00	6.00	1.00	0.90	0.68	9	WCU	W4	R2 - R3	Jn	Clay 1mm	S1	VR	
6.00	7.00	1.00	0.90	0.27	12	WCU	W4	R2 - R3	Jn	Clay 1mm	S1	VR	
7.00	8.00	1.00	1.00	0.00	20+	WCU/ UZZ	W4	R2 - R3	Jn	Clay 1mm	S1	VR	
8.00	9.00	1.00	0.90	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	8 to 10m saprlolite clay, Very Poor
9.00	10.00	1.00	0.90	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
10.00	11.00	1.00	0.90	0.00	99	UZZ	W5 - W6	R1	Jn	Clay 1-2mm	S1	VR	10 to 16m saprock, consolidated clay, Poor to Fair
11.00	12.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	Jn	Clay 1-2mm	S1	VR	
12.00	13.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R1	Jn	Clay 1-2mm	S1	VR	
13.00	14.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	Jn	Clay 1-2mm	S1	VR	
14.00	15.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	Jn	Clay 1-2mm	S1	VR	
15.00	16.00	1.00	1.00	0.00	99	UZZ/ SIF	W5 - W6	R3	Jn	Clay 1-2mm	S1	VR	
16.00	17.00	1.00	1.00	0.16	15	SIF	W4 - W3	R3	Jn	Clay 1-2mm	S1	VR	16 to 24m saprolite/ saprock, Poor
17.00	18.00	1.00	1.00	0.48	10	SIF	W4 - W3	R3	Jn	Clay 1-2mm	S1	VR	
18.00	19.00	1.00	1.00	0.69	7	SIF/ WCU	W4 - W3	R2 - R3	Jn	Clay 1-2mm	S1	VR	
19.00	20.00	1.00	1.00	0.88	2	UZZ/ OXB/ SIF	W4 - W3	R2	Jn	Clay 1-2mm	S1	VR	
20.00	21.00	1.00	1.00	0.64	7	SIF/ UZZ	W4	R1 - R2	Jn	Clay 1-2mm	S1	VR	
21.00	22.00	1.00	1.00	0.69	6	UZZ/ SIF	W4 - W3	R1 - R2	Jn	Clay 1-2mm	S1	VR	
22.00	23.00	1.00	1.00	0.63	8	SIF/ UZZ	W4 - W3	R2 - R3	Jn	Clay 1-2mm	S1	VR	
23.00	24.00	1.00	1.00	0.72	7	SIF/ UZZ	W4 - W3	R2 - R3	Jn	Clay 1-2mm	S1	VR	
24.00	25.00	1.00	1.00	0.63	8	SIF	W2	R4	Bed	Oxide H ≤ 1mm	H1	R	Weathered BIF, frequent partings on bedding
25.00	26.00	1.00	1.00	0.63	6	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
26.00	27.00	1.00	1.00	0.68	7	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
27.00	28.00	1.00	1.00	0.81	7	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
28.00	29.00	1.00	1.00	0.26	12	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
29.00	30.00	1.00	1.00	0.53	11	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
30.00	31.00	1.00	1.00	0.46	14	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
31.00	32.00	1.00	1.00	0.58	12	SIF	W2	R4 - R5	Bed	Oxide H ≤ 1mm	H1	R	
32.00	33.00	1.00	1.00	0.50	13	SIF	W2	R4 - R5	Bed	Nil	Nil	R	
33.00	34.00	1.00	1.00	0.00	23	SIF	W3	R2 - R3	Bed	Nil	Nil	R	
34.00	35.00	1.00	1.00	0.00	99	SIF/ WCU/ OZZ	W2 - W4	R2 - R0	Bed	Oxide H ≤ 1mm	H1	R	0.2m clay interval R0
35.00	36.00	1.00	1.00	0.58	8	SIF	W2	R3	Bed	Oxide H ≤ 1mm	H1	R	
36.00	37.00	1.00	1.00	0.00	99	SIC/ OZZ	W6	R0	Jn	Clay 2mm	S1	R	37 to 44m Altered/ sheared, very broken, some rubble,
37.00	38.00	1.00	0.50	0.00	99	OZZ	W6	R0	Jn	Clay 2mm	S1	R	Very Poor
38.00	39.00	1.00	0.50	0.00	99	OZZ/ SIC/ SIF	W6	R0	Jn	Clay 2mm	S1	R	
39.00	40.00	1.00	0.50	0.00	99	SIC/ OZZ	W6	R0	Jn	Clay 2mm	S1	R	
40.00	41.00	1.00	0.50	0.00	99	SIC/ OZZ	W6	R2 - R0	Jn	Clay 2mm	S1	R	
41.00	42.00	1.00	0.50	0.00	99	OZZ	W6	R2 - R0	Jn	Clay 2mm	S1	R	
42.00	43.00	1.00	0.50	0.00	99	OZZ/ WCZ/ SIC	W4	R3 - R0	Jn	Clay 2mm	S1	R	
43.00	44.00	1.00	0.50	0.00	99	SIF/ WCZ	W6	R0	Jn	Clay 2mm	S1	R	
44.00	45.00	1.00	1.00	0.23	99	SIF/ UZZ	W2 - W6	R4 - R0	Bed	Oxide H ≤ 1mm	H1	R	0.1m clay interval
45.00	46.00	1.00	1.00	0.00	99	UZZ/ SIF	W6 - W3	R0 - R3	Shr	Clay > 5mm	S2	R	0.5m clay interval
46.00	47.00	1.00	1.00	0.24	16	SIF	W3	R3	Bed	Oxide H ≤ 1mm	H1	R	
47.00	48.00	1.00	1.00	0.33	11	SIF	W3	R3	Bed	Clay 5mm	S2	VR	
48.00	49.00	1.00	1.00	0.42	11	SIF	W3 - W2	R3 - R0	Bed	Clay 5mm	S2	VR	
49.00	50.00	1.00	1.00	0.62	13	SIF	W2	R3 - R0	Bed	Clay 2mm	S1	VR	
50.00	51.00	1.00	1.00	0.21	17	SIF	W3 - W2	R3	Bed	Oxide H ≤ 1mm	H1	R	50 to 52m, frequent partings on bedding
51.00	52.00	1.00	1.00	0.33	15	SIF/ MDZ	W3 - W2	R3	Bed	Oxide H ≤ 1mm	H1	R	
52.00	53.00	1.00	1.00	0.27	7	MDZ/ SIF	W3 - W2	R3 - R0	Shr	Clay > 5mm	S2	R	0.2m clay interval R0
53.00	54.00	1.00	1.00	1.00	5	MDZ	W4 - W3	R3	Jn	Clay ≤ 1mm	S1	VR	
54.00	55.00	1.00	1.00	0.77	14	MDZ	W2 - W3	R3	Jn	Oxide H ≤ 1mm	H1	R	
55.00	56.00	1.00	1.00	1.00	2	MDZ	W1	R5	Jn	Carb H ≤ 1mm	H1	R	55 to 57m Good rock
56.00	57.00	1.00	1.00	1.00	1	MDZ	W1	R5	Jn	Oxide H ≤ 1mm	H1	R	
57.00	58.00	1.00	1.00	0.44	11	UZZ/ MDZ	W2	R4	Jn	Clay ≤ 1mm	S1	VR	57 to 59m, some weathering & breaks, Fair rock
58.00	59.00	1.00	1.00	0.28	13	UZZ/ UAC	W2	R4	Jn	Nil	Nil	R	
59.00	60.00	1.00	1.00	0.85	5	UAC	W1	R5	Jn	Oxide H ≤ 1mm	H1	VR	59 to 70.80m, generally Good rock
60.00	61.00	1.00	1.00	1.00	4	UAC	W1	R5	Jn	Nil	Nil	VR	
61.00	62.00	1.00	1.00	0.92	5	UAC	W1	R5	Jn	Carb H 1mm	H1	R	
62.00	63.00	1.00	1.00	0.63	2	UAC	W1	R5	Jn	Oxide H 1mm	H1	R	
63.00	64.00	1.00	1.00	1.00	0	UAC	W1	R5	Jn	Oxide H 1mm	H1	R	
64.00	65.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	R	
65.00	66.00	1.00	1.00	0.74	3	UAC/ MDZ	W1	R5	Jn	Nil NA	Nil	R	
66.00	67.00	1.00	1.00	0.28	9	UAC/ MDZ	W1	R5	Jn	Nil NA	Nil	R	
67.00	68.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	R	
68.00	69.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil NA	Nil	VR	
69.00	70.00	1.00	1.00	0.98	3	UAC	W1	R5	Jn	Nil NA	Nil	VR	
70.00	70.80	0.80	0.80	0.80	0	UAC	W1	R5	Jn	Nil NA	Nil	VR	



MRMR Calcs

Drill Record		RMR	MRMR Calcs					
From (m)	To (m)	RMR89	Weathering	Joint Orientation	Induced Stress	Blasting effects	Total Adjustment	MRMR
0.00	1.00	12	0.96	0.80	1.00	0.94	0.72	9
1.00	2.00	12	0.96	0.80	1.00	0.94	0.72	9
2.00	3.00	12	0.96	0.80	1.00	0.94	0.72	9
3.00	4.00	26	0.96	0.80	1.00	0.94	0.72	19
4.00	5.00	26	0.96	0.80	1.00	0.94	0.72	19
5.00	6.00	26	0.96	0.80	1.00	0.94	0.72	19
6.00	7.00	26	0.96	0.80	1.00	0.94	0.72	19
7.00	8.00	26	0.96	0.80	1.00	0.94	0.72	19
8.00	9.00	12	0.96	0.80	1.00	0.94	0.72	9
9.00	10.00	12	0.96	0.80	1.00	0.94	0.72	9
10.00	11.00	26	0.96	0.80	1.00	0.94	0.72	19
11.00	12.00	26	0.96	0.80	1.00	0.94	0.72	19
12.00	13.00	26	0.96	0.80	1.00	0.94	0.72	19
13.00	14.00	26	0.96	0.80	1.00	0.94	0.72	19
14.00	15.00	26	0.96	0.80	1.00	0.94	0.72	19
15.00	16.00	26	0.96	0.80	1.00	0.94	0.72	19
16.00	17.00	22	0.96	0.80	1.00	0.94	0.72	16
17.00	18.00	22	0.96	0.80	1.00	0.94	0.72	16
18.00	19.00	22	0.96	0.80	1.00	0.94	0.72	16
19.00	20.00	22	0.96	0.80	1.00	0.94	0.72	16
20.00	21.00	22	0.96	0.80	1.00	0.94	0.72	16
21.00	22.00	22	0.96	0.80	1.00	0.94	0.72	16
22.00	23.00	22	0.96	0.80	1.00	0.94	0.72	16
23.00	24.00	22	0.96	0.80	1.00	0.94	0.72	16
24.00	25.00	22	0.96	0.80	1.00	0.94	0.72	16
25.00	26.00	71	0.96	0.80	1.00	0.94	0.72	51
26.00	27.00	71	0.96	0.80	1.00	0.94	0.72	51
27.00	28.00	75	0.96	0.80	1.00	0.94	0.72	54
28.00	29.00	66	0.96	0.80	1.00	0.94	0.72	48
29.00	30.00	71	0.96	0.80	1.00	0.94	0.72	51
30.00	31.00	66	0.96	0.80	1.00	0.94	0.72	48
31.00	32.00	71	0.96	0.80	1.00	0.94	0.72	51
32.00	33.00	73	0.96	0.80	1.00	0.94	0.72	53
33.00	34.00	58	0.96	0.80	1.00	0.94	0.72	42
34.00	35.00	53	0.96	0.80	1.00	0.94	0.72	38
35.00	36.00	60	0.96	0.80	1.00	0.94	0.72	43
36.00	37.00	36	0.96	0.80	1.00	0.94	0.72	26
37.00	38.00	36	0.96	0.80	1.00	0.94	0.72	26
38.00	39.00	36	0.96	0.80	1.00	0.94	0.72	26
39.00	40.00	36	0.96	0.80	1.00	0.94	0.72	26
40.00	41.00	51	0.96	0.80	1.00	0.94	0.72	37
41.00	42.00	51	0.96	0.80	1.00	0.94	0.72	37
42.00	43.00	52	0.96	0.80	1.00	0.94	0.72	38
43.00	44.00	36	0.96	0.80	1.00	0.94	0.72	26
44.00	45.00	53	0.96	0.80	1.00	0.94	0.72	38
45.00	46.00	46	0.96	0.80	1.00	0.94	0.72	33
46.00	47.00	48	0.96	0.80	1.00	0.94	0.72	35
47.00	48.00	47	0.96	0.80	1.00	0.94	0.72	34
48.00	49.00	55	0.96	0.80	1.00	0.94	0.72	40
49.00	50.00	70	0.96	0.80	1.00	0.94	0.72	51
50.00	51.00	42	0.96	0.80	1.00	0.94	0.72	30
51.00	52.00	50	0.96	0.80	1.00	0.94	0.72	36
52.00	53.00	54	0.96	0.80	1.00	0.94	0.72	39
53.00	54.00	61	0.96	0.80	1.00	0.94	0.72	44
54.00	55.00	59	0.96	0.80	1.00	0.94	0.72	43
55.00	56.00	78	0.96	0.80	1.00	0.94	0.72	56
56.00	57.00	83	0.96	0.80	1.00	0.94	0.72	60
57.00	58.00	57	0.96	0.80	1.00	0.94	0.72	41
58.00	59.00	60	0.96	0.80	1.00	0.94	0.72	43
59.00	60.00	74	0.96	0.80	1.00	0.94	0.72	53
60.00	61.00	81	0.96	0.80	1.00	0.94	0.72	58
61.00	62.00	76	0.96	0.80	1.00	0.94	0.72	55
62.00	63.00	71	0.96	0.80	1.00	0.94	0.72	51
63.00	64.00	88	0.96	0.80	1.00	0.94	0.72	64
64.00	65.00	85	0.96	0.80	1.00	0.94	0.72	61
65.00	66.00	73	0.96	0.80	1.00	0.94	0.72	53
66.00	67.00	66	0.96	0.80	1.00	0.94	0.72	48
67.00	68.00	85	0.96	0.80	1.00	0.94	0.72	61
68.00	69.00	86	0.96	0.80	1.00	0.94	0.72	62
69.00	70.00	81	0.96	0.80	1.00	0.94	0.72	58
70.00	70.80	91	0.96	0.80	1.00	0.94	0.72	66

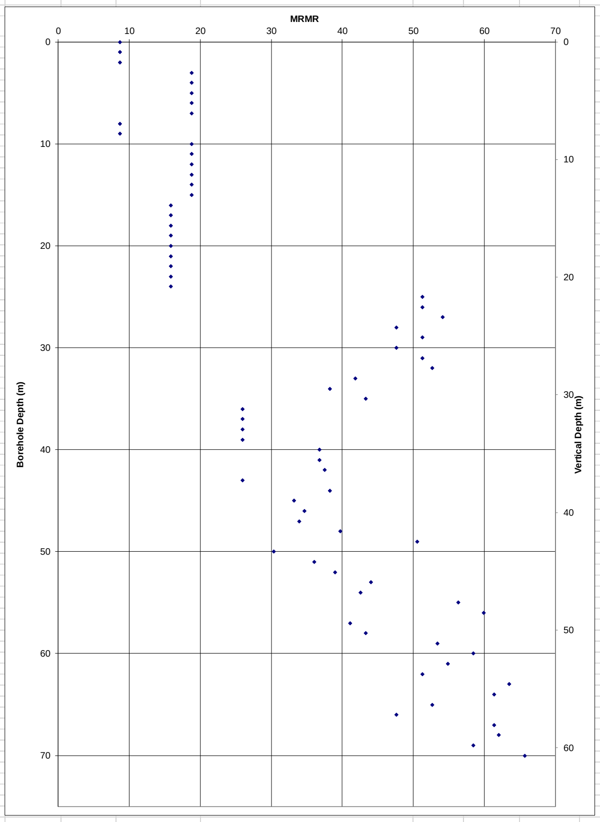
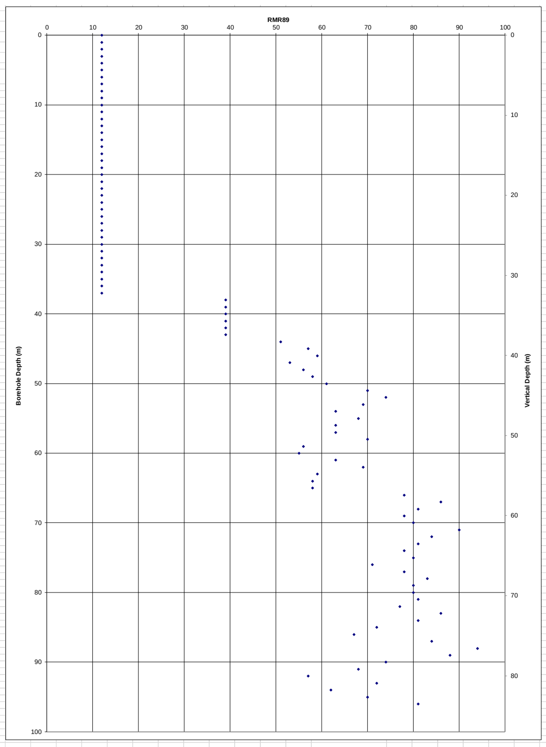


Figure A2 Borehole FBDD-002 summary geotechnical log, RMR and MRMR rock mass classification

Project:	Ramelius - Die Hardy			**Date:**	November 2020
Hole ID:	FBDD003	**Hole Dip**	-60°	**Ref Table** W1, W2, W3 / W4, W5, W6	**Ref Table** R0, R1, R2 / R3, R4, R5 / R6
Northing:	6683393.319	**Hole Azi**	060°	**Jf = Joint filled** / **J = Joint**	**S1=Soft<5mm** / **S2=Soft>5mm** / **H1=Hard<5mm** / **H2=Hard>5mm** / **Nil=No filling**
Easting:	732848.965	**Bit Size:**	HQ3		**VR=Very Rough** / **R=Rough** / **SR=Slightly Rough** / **SM=Smooth** / **SL=Slickensided**
Elevation:	502.352				

Drill Record			Recovery	RQD	Fractures	Materials			Structures				
From (m)	To (m)	Drill (m)	m	m	Number of Fractures	Rock Type	Weathering Grade	Strength Grade	Structural Type	Infill (mm)	Infill Hardness & Thickness	Joint Roughness	Comments
0.00	1.00	1.00	0.00	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	0 to 7m laterite, unconsolidated, gravel/ clay Very Poor
1.00	2.00	1.00	0.80	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
2.00	3.00	1.00	1.00	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
3.00	4.00	1.00	1.00	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
4.00	5.00	1.00	0.40	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
5.00	6.00	1.00	0.20	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
6.00	7.00	1.00	0.40	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	
7.00	8.00	1.00	0.10	0.00	99	TGF	W5 - W6	≤ R0	NA	NA	NA	NA	7 to 37m saprolite/ clay, minor saprock, Very Poor
8.00	9.00	1.00	0.70	0.00	99	TMZ/ TGF	W5 - W6	R2 - R3	NA	NA	NA	NA	
9.00	10.00	1.00	0.60	0.00	99	TMZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
10.00	11.00	1.00	0.90	0.00	99	TMZ	W5 - W6	≤ R0	NA	NA	NA	NA	
11.00	12.00	1.00	1.00	0.00	99	TMZ	W5 - W6	≤ R0	NA	NA	NA	NA	
12.00	13.00	1.00	0.60	0.00	99	TMZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
13.00	14.00	1.00	0.60	0.00	99	TMZ/ TCZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
14.00	15.00	1.00	0.60	0.00	99	TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
15.00	16.00	1.00	1.00	0.00	99	TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
16.00	17.00	1.00	1.00	0.00	99	TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
17.00	18.00	1.00	1.00	0.00	99	TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
18.00	19.00	1.00	1.00	0.00	99	UZZ/ TCZ	W5 - W6	≤ R0	NA	NA	NA	NA	
19.00	20.00	1.00	0.70	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
20.00	21.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
21.00	22.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
22.00	23.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
23.00	24.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
24.00	25.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
25.00	26.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
26.00	27.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
27.00	28.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
28.00	29.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
29.00	30.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2 - R3	NA	NA	NA	NA	
30.00	31.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R0	NA	NA	NA	NA	
31.00	32.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
32.00	33.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
33.00	34.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
34.00	35.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
35.00	36.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
36.00	37.00	1.00	1.00	0.00	99	UZZ	W5 - W6	R2	NA	NA	NA	NA	
37.00	38.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	37 to 44m saprock, Poor rock
38.00	39.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
39.00	40.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
40.00	41.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
41.00	42.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
42.00	43.00	1.00	1.00	0.00	99	UZZ	W4	R2	Jn	Oxide S 1mm	S1	R	
43.00	44.00	1.00	1.00	0.00	99	UZZ/ SIF	W4	R2	Jn	Oxide S 1mm	S1	R	
44.00	45.00	1.00	1.00	0.62	6	SIF	W2 - W3	R2	Bed	Oxide S 1mm	S1	R	44 to 50m Fair rock
45.00	46.00	1.00	1.00	0.76	7	SIF	W2 - W3	R2	Bed	Oxide H ≤ 1mm	H1	R	
46.00	47.00	1.00	1.00	0.89	4	SIF	W2 - W3	R2	Bed	Oxide H ≤ 1mm	H1	R	
47.00	48.00	1.00	1.00	0.55	8	SIC/ OZZ	W2 - W3	R2	Bed	Oxide H ≤ 1mm	H1	R	
48.00	49.00	1.00	1.00	0.51	8	VQZ/ SIC/ OZZ	W2 - W3	R2	Vn	Nil	Nil	VR	
49.00	50.00	1.00	1.00	0.85	6	VQZ/ SIC	W2 - W3	R2	Vn	Oxide H ≤ 1mm	H1	VR	
50.00	51.00	1.00	1.00	0.45	12	SIF	W2	R5	Bed	Clay 2mm	S1	R	50 to 64m frequent partings on bedding, Fair rock
51.00	52.00	1.00	1.00	0.78	5	SIF	W2	R5	Bed	Clay 2mm	S1	R	
52.00	53.00	1.00	1.00	0.89	3	SIF/ WCU	W2	R5	Jn	Oxide H ≤ 1mm	H1	R	
53.00	54.00	1.00	1.00	0.61	10	SIF	W2	R5	Jn	Oxide H ≤ 1mm	H1	VR	
54.00	55.00	1.00	1.00	0.49	8	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
55.00	56.00	1.00	1.00	0.54	5	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
56.00	57.00	1.00	1.00	0.36	8	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
57.00	58.00	1.00	1.00	0.32	15	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
58.00	59.00	1.00	1.00	0.57	12	SIF	W2	R5	Bed	Nil	Nil	R	
59.00	60.00	1.00	1.00	0.00	20+	SIF	W2	R5	Jn	Oxide H ≤ 1mm	H1	VR	
60.00	61.00	1.00	1.00	0.00	17	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
61.00	62.00	1.00	1.00	0.37	16	SIF	W2	R5	Bed	Oxide H ≤ 1mm	H1	R	
62.00	63.00	1.00	1.00	0.68	5	SIF	W2	R5	Jn	Oxide H ≤ 1mm	H1	VR	
63.00	64.00	1.00	1.00	0.12	15	SIF	W1	R5	Jn	Carb H 1mm	H1	R	
64.00	65.00	1.00	1.00	0.11	20+	SIF	W1	R5	Bed	Nil	Nil	R	64 to 66m BIF contact, more fractured/ broken Fair to Poor
65.00	66.00	1.00	1.00	0.00	20+	SIF	W1	R5	Bed	Nil	Nil	R	
66.00	67.00	1.00	1.00	0.83	4	SIF	W1	R5	Jn	Nil	Nil	VR	66 to 70m brecciated BIF, Good rock
67.00	68.00	1.00	1.00	1.00	1	SIF	W1	R5	Jn	Nil	Nil	VR	
68.00	69.00	1.00	1.00	0.91	4	SIF	W1	R5	Jn	Nil	Nil	VR	
69.00	70.00	1.00	1.00	0.90	2	SIF	W1	R5	Jn	Nil	Nil	VR	
70.00	71.00	1.00	1.00	0.92	3	SIF	W1	R5	Jn	Nil	Nil	R	70 to 85m BIF & mafic, Good to Very Good rock
71.00	72.00	1.00	1.00	1.00	0	SIF	W1	R5	Jn	Nil	Nil	R	
72.00	73.00	1.00	1.00	1.00	1	SIF	W1	R5	Jn	Oxide H ≤ 1mm	H1	VR	
73.00	74.00	1.00	1.00	1.00	3	SIF	W1	R5	Bed	Nil	Nil	VR	
74.00	75.00	1.00	1.00	1.00	3	SIF	W1	R5	Jn	Oxide H ≤ 1mm	H1	R	
75.00	76.00	1.00	1.00	1.00	3	SIF/ UZZ	W1	R5	Bed	Nil	Nil	R	
76.00	77.00	1.00	1.00	0.55	6	MDZ/ SIF	W1	R5	Jn	Nil	Nil	R	
77.00	78.00	1.00	1.00	1.00	4	MDZ	W1	R5	Jn	Carb H ≤ 1mm	H1	R	
78.00	79.00	1.00	1.00	1.00	1	MDZ	W1	R5	Jn	Carb H ≤ 1mm	H1	R	
79.00	80.00	1.00	1.00	0.92	3	UAC/ MDZ	W1	R5	Jn	Nil	Nil	R	
80.00	81.00	1.00	1.00	1.00	3	UAC	W1	R5	Jn	Nil	Nil	R	
81.00	82.00	1.00	1.00	1.00	2	UAC	W1	R5	Jn	Nil	Nil	VR	
82.00	83.00	1.00	1.00	0.89	4	UAC	W1	R5	Jn	Nil	Nil	R	
83.00	84.00	1.00	1.00	1.00	1	UAC	W1	R5	Jn	Nil	Nil	VR	
84.00	85.00	1.00	1.00	1.00	3	UAC	W1	R5	Jn	Nil	Nil	VR	
85.00	86.00	1.00	1.00	0.51	20+	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	85m to EOH, UM, some broken zones, Fair to Good rock
86.00	87.00	1.00	1.00	0.48	20+	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
87.00	88.00	1.00	1.00	0.92	4	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
88.00	89.00	1.00	1.00	1.00	0	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
89.00	90.00	1.00	1.00	1.00	1	UAC	W1	R4 - R5	Jn	Nil	Nil	R	
90.00	91.00	1.00	1.00	0.53	5	UAC	W1	R4 - R5	Jn	Nil	Nil	R	
91.00	92.00	1.00	1.00	0.38	11	UAC	W1	R4 - R5	Jn	Carb H 1mm	H1	VR	
92.00	93.00	1.00	1.00	0.11	18	UAC	W1	R4 - R5	Jn	Nil	Nil	SM	
93.00	94.00	1.00	1.00	0.58	18	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
94.00	95.00	1.00	1.00	0.00	20+	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
95.00	96.00	1.00	1.00	0.31	11	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	
96.00	96.30	0.30	0.30	0.23	1	UAC	W1	R4 - R5	Jn	Nil	Nil	VR	

From (m)	Calculated Parameters				RMR89 Rating				Joint Conditions					
	Recovery %	RQD %	Fractures FF (p/m)	Spacing SP (mm)	IRS (15)	RQD (20)	Spacing (20)	Water (15)	Persistence (6)	Separation (6)	Roughness (6)	Infill (6)	Weathering (6)	RMR89' (100)
0.00	0	0	990000	0	15	3	5	15	3	3	0	6	0	12
1.00	80	0	124	8	15	3	5	15	3	3	0	6	0	12
2.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
3.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
4.00	40	0	248	4	15	3	5	15	3	3	0	6	0	12
5.00	20	0	495	2	15	3	5	15	3	3	0	6	0	12
6.00	40	0	248	4	15	3	5	15	3	3	0	6	0	12
7.00	10	0	990	1	15	3	5	15	3	3	0	6	0	12
8.00	70	0	141	7	15	3	5	15	3	3	0	6	0	12
9.00	60	0	165	6	15	3	5	15	3	3	0	6	0	12
10.00	90	0	110	9	15	3	5	15	3	3	0	6	0	12
11.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
12.00	60	0	165	6	15	3	5	15	3	3	0	6	0	12
13.00	60	0	165	6	15	3	5	15	3	3	0	6	0	12
14.00	60	0	165	6	15	3	5	15	3	3	0	6	0	12
15.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
16.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
17.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
18.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
19.00	70	0	141	7	2	3	5	15	3	3	0	6	0	12
20.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
21.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
22.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
23.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
24.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
25.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
26.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
27.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
28.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
29.00	100	0	99	10	15	3	5	15	3	3	0	6	0	12
30.00	100	0	99	10	0	3	5	15	3	3	0	6	0	12
31.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
32.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
33.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
34.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
35.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
36.00	100	0	99	10	2	3	5	15	3	3	0	6	0	12
37.00	100	0	99	10	2	3	5	15	3	3	5	2	1	12
38.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
39.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
40.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
41.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
42.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
43.00	100	0	99	10	2	3	5	15	3	3	5	2	1	39
44.00	100	62	6	167	2	13	8	15	3	3	5	2	0	51
45.00	100	76	7	143	2	17	8	15	3	3	5	4	0	57
46.00	100	89	4	250	2	17	10	15	3	3	5	4	0	59
47.00	100	55	8	125	2	13	8	15	3	3	5	4	0	53
48.00	100	51	8	125	2	13	8	15	3	3	6	6	0	56
49.00	100	85	6	167	2	17	8	15	3	3	6	4	0	58
50.00	100	45	12	83	12	8	8	15	3	3	5	2	5	61
51.00	100	78	5	200	12	17	8	15	3	3	5	2	5	70
52.00	100	89	3	333	12	17	10	15	3	3	5	4	5	74
53.00	100	61	10	100	12	13	8	15	3	3	6	4	5	69
54.00	100	49	8	125	12	8	8	15	3	3	5	4	5	63
55.00	100	54	5	200	12	13	8	15	3	3	5	4	5	68
56.00	100	36	8	125	12	8	8	15	3	3	5	4	5	63
57.00	100	32	15	67	12	8	8	15	3	3	5	4	5	63
58.00	100	57	12	83	12	13	8	15	3	3	5	6	5	70
59.00	100	0	20	50	12	3	5	15	3	3	6	4	5	56
60.00	100	0	17	59	12	3	5	15	3	3	5	4	5	55
61.00	100	37	16	63	12	8	8	15	3	3	5	4	5	63
62.00	100	68	5	200	12	13	8	15	3	3	6	4	5	69
63.00	100	12	15	67	12	3	8	15	3	3	5	4	6	59
64.00	100	11	20	50	12	3	5	15	3	3	5	6	6	58
65.00	100	0	20	50	12	3	5	15	3	3	5	6	6	58
66.00	100	83	4	250	12	17	10	15	3	3	6	6	6	78
67.00	100	100	1	1000	12	20	15	15	3	3	6	6	6	86
68.00	100	91	4	250	12	20	10	15	3	3	6	6	6	81
69.00	100	90	2	500	12	17	10	15	3	3	6	6	6	78
70.00	100	92	3	333	12	20	10	15	3	3	5	6	6	80
71.00	100	100	0	9999	12	20	20	15	3	3	5	6	6	90
72.00	100	100	1	1000	12	20	15	15	3	3	6	4	6	84
73.00	100	100	3	333	12	20	10	15	3	3	6	6	6	81
74.00	100	100	3	333	12	20	10	15	3	3	5	4	6	78
75.00	100	100	3	333	12	20	10	15	3	3	5	6	6	80
76.00	100	55	6	167	12	13	8	15	3	3	5	6	6	71
77.00	100	100	4	250	12	20	10	15	3	3	5	4	6	78
78.00	100	100	1	1000	12	20	15	15	3	3	5	4	6	83
79.00	100	92	3	333	12	20	10	15	3	3	5	6	6	80
80.00	100	100	3	333	12	20	10	15	3	3	5	6	6	80
81.00	100	100	2	500	12	20	10	15	3	3	6	6	6	81
82.00	100	89	4	250	12	17	10	15	3	3	5	6	6	77
83.00	100	100	1	1000	12	20	15	15	3	3	6	6	6	86
84.00	100	100	3	333	12	20	10	15	3	3	6	6	6	81
85.00	100	51	20	50	15	13	5	15	3	3	6	6	6	72
86.00	100	48	20	50	15	8	5	15	3	3	6	6	6	67
87.00	100	92	4	250	15	20	10	15	3	3	6	6	6	84
88.00	100	100	0	9999	15	20	20	15	3	3	6	6	6	94
89.00	100	100	1	1000	15	20	15	15	3	3	5	6	6	88
90.00	100	53	5	200	15	13	8	15	3	3	5	6	6	74
91.00	100	38	11	91	15	8	8	15	3	3	6	4	6	68
92.00	100	11	18	56	15	3	5	15	3	3	1	6	6	57
93.00	100	58	18	56	15	13	5	15	3	3	6	6	6	72
94.00	100	0	20	50	15	3	5	15	3	3	6	6	6	62
95.00	100	31	11	91	15	8	8	15	3	3	6	6	6	70
96.00	100	77	3	300	15	17	10	15	3	3	6	6	6	81



MRMR Calcs

Drill Record		RMR	MRMR Calcs					
From (m)	To (m)	RMR89	Weathering	Joint Orientation	Induced Stress	Blasting effects	Total Adjustment	MRMR
0.00	1.00	12	0.96	0.80	1.00	0.94	0.72	9
1.00	2.00	12	0.96	0.80	1.00	0.94	0.72	9
2.00	3.00	12	0.96	0.80	1.00	0.94	0.72	9
3.00	4.00	12	0.96	0.80	1.00	0.94	0.72	9
4.00	5.00	12	0.96	0.80	1.00	0.94	0.72	9
5.00	6.00	12	0.96	0.80	1.00	0.94	0.72	9
6.00	7.00	12	0.96	0.80	1.00	0.94	0.72	9
7.00	8.00	12	0.96	0.80	1.00	0.94	0.72	9
8.00	9.00	12	0.96	0.80	1.00	0.94	0.72	9
9.00	10.00	12	0.96	0.80	1.00	0.94	0.72	9
10.00	11.00	12	0.96	0.80	1.00	0.94	0.72	9
11.00	12.00	12	0.96	0.80	1.00	0.94	0.72	9
12.00	13.00	12	0.96	0.80	1.00	0.94	0.72	9
13.00	14.00	12	0.96	0.80	1.00	0.94	0.72	9
14.00	15.00	12	0.96	0.80	1.00	0.94	0.72	9
15.00	16.00	12	0.96	0.80	1.00	0.94	0.72	9
16.00	17.00	12	0.96	0.80	1.00	0.94	0.72	9
17.00	18.00	12	0.96	0.80	1.00	0.94	0.72	9
18.00	19.00	12	0.96	0.80	1.00	0.94	0.72	9
19.00	20.00	12	0.96	0.80	1.00	0.94	0.72	9
20.00	21.00	12	0.96	0.80	1.00	0.94	0.72	9
21.00	22.00	12	0.96	0.80	1.00	0.94	0.72	9
22.00	23.00	12	0.96	0.80	1.00	0.94	0.72	9
23.00	24.00	12	0.96	0.80	1.00	0.94	0.72	9
24.00	25.00	12	0.96	0.80	1.00	0.94	0.72	9
25.00	26.00	12	0.96	0.80	1.00	0.94	0.72	9
26.00	27.00	12	0.96	0.80	1.00	0.94	0.72	9
27.00	28.00	12	0.96	0.80	1.00	0.94	0.72	9
28.00	29.00	12	0.96	0.80	1.00	0.94	0.72	9
29.00	30.00	12	0.96	0.80	1.00	0.94	0.72	9
30.00	31.00	12	0.96	0.80	1.00	0.94	0.72	9
31.00	32.00	12	0.96	0.80	1.00	0.94	0.72	9
32.00	33.00	12	0.96	0.80	1.00	0.94	0.72	9
33.00	34.00	12	0.96	0.80	1.00	0.94	0.72	9
34.00	35.00	12	0.96	0.80	1.00	0.94	0.72	9
35.00	36.00	12	0.96	0.80	1.00	0.94	0.72	9
36.00	37.00	12	0.96	0.80	1.00	0.94	0.72	9
37.00	38.00	12	0.96	0.80	1.00	0.94	0.72	9
38.00	39.00	39	0.96	0.80	1.00	0.94	0.72	28
39.00	40.00	39	0.96	0.80	1.00	0.94	0.72	28
40.00	41.00	39	0.96	0.80	1.00	0.94	0.72	28
41.00	42.00	39	0.96	0.80	1.00	0.94	0.72	28
42.00	43.00	39	0.96	0.80	1.00	0.94	0.72	28
43.00	44.00	39	0.96	0.80	1.00	0.94	0.72	28
44.00	45.00	51	0.96	0.80	1.00	0.94	0.72	37
45.00	46.00	57	0.96	0.80	1.00	0.94	0.72	41
46.00	47.00	59	0.96	0.80	1.00	0.94	0.72	43
47.00	48.00	53	0.96	0.80	1.00	0.94	0.72	38
48.00	49.00	56	0.96	0.80	1.00	0.94	0.72	40
49.00	50.00	58	0.96	0.80	1.00	0.94	0.72	42
50.00	51.00	61	0.96	0.80	1.00	0.94	0.72	44
51.00	52.00	70	0.96	0.80	1.00	0.94	0.72	51
52.00	53.00	74	0.96	0.80	1.00	0.94	0.72	53
53.00	54.00	69	0.96	0.80	1.00	0.94	0.72	50
54.00	55.00	63	0.96	0.80	1.00	0.94	0.72	45
55.00	56.00	68	0.96	0.80	1.00	0.94	0.72	49
56.00	57.00	63	0.96	0.80	1.00	0.94	0.72	45
57.00	58.00	63	0.96	0.80	1.00	0.94	0.72	45
58.00	59.00	70	0.96	0.80	1.00	0.94	0.72	51
59.00	60.00	56	0.96	0.80	1.00	0.94	0.72	40
60.00	61.00	55	0.96	0.80	1.00	0.94	0.72	40
61.00	62.00	63	0.96	0.80	1.00	0.94	0.72	45
62.00	63.00	69	0.96	0.80	1.00	0.94	0.72	50
63.00	64.00	59	0.96	0.80	1.00	0.94	0.72	43
64.00	65.00	58	0.96	0.80	1.00	0.94	0.72	42
65.00	66.00	58	0.96	0.80	1.00	0.94	0.72	42
66.00	67.00	78	0.96	0.80	1.00	0.94	0.72	56
67.00	68.00	86	0.96	0.80	1.00	0.94	0.72	62
68.00	69.00	81	0.96	0.80	1.00	0.94	0.72	58
69.00	70.00	78	0.96	0.80	1.00	0.94	0.72	56
70.00	71.00	80	0.96	0.80	1.00	0.94	0.72	58
71.00	72.00	90	0.96	0.80	1.00	0.94	0.72	65
72.00	73.00	84	0.96	0.80	1.00	0.94	0.72	61
73.00	74.00	81	0.96	0.80	1.00	0.94	0.72	58
74.00	75.00	78	0.96	0.80	1.00	0.94	0.72	56
75.00	76.00	80	0.96	0.80	1.00	0.94	0.72	58
76.00	77.00	71	0.96	0.80	1.00	0.94	0.72	51
77.00	78.00	78	0.96	0.80	1.00	0.94	0.72	56
78.00	79.00	83	0.96	0.80	1.00	0.94	0.72	60
79.00	80.00	80	0.96	0.80	1.00	0.94	0.72	58
80.00	81.00	80	0.96	0.80	1.00	0.94	0.72	58
81.00	82.00	81	0.96	0.80	1.00	0.94	0.72	58
82.00	83.00	77	0.96	0.80	1.00	0.94	0.72	56
83.00	84.00	86	0.96	0.80	1.00	0.94	0.72	62
84.00	85.00	81	0.96	0.80	1.00	0.94	0.72	58
85.00	86.00	72	0.96	0.80	1.00	0.94	0.72	52
86.00	87.00	67	0.96	0.80	1.00	0.94	0.72	48
87.00	88.00	84	0.96	0.80	1.00	0.94	0.72	61
88.00	89.00	94	0.96	0.80	1.00	0.94	0.72	68
89.00	90.00	88	0.96	0.80	1.00	0.94	0.72	64
90.00	91.00	74	0.96	0.80	1.00	0.94	0.72	53
91.00	92.00	68	0.96	0.80	1.00	0.94	0.72	49
92.00	93.00	57	0.96	0.80	1.00	0.94	0.72	41
93.00	94.00	72	0.96	0.80	1.00	0.94	0.72	52
94.00	95.00	62	0.96	0.80	1.00	0.94	0.72	45
95.00	96.00	70	0.96	0.80	1.00	0.94	0.72	51
96.00	96.30	81	0.96	0.80	1.00	0.94	0.72	58

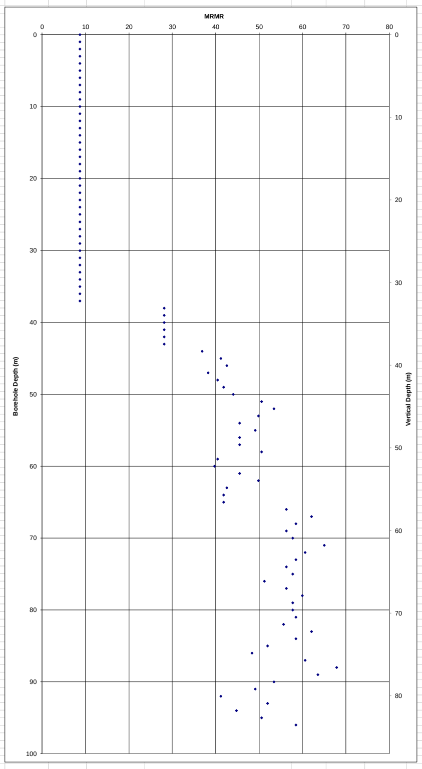


Figure A3 Borehole FBDD-003 summary geotechnical log, RMR and MRMR rock mass classification

APPENDIX B

LABORATORY ROCK PROPERTY TEST RESULTS

UNIAXIAL COMPRESSIVE STRENGTH (UCS)

ELASTIC PROPERTY DETERMINATIONS (UCSE)

MULTI-STAGE DEFECT DIRECT SHEAR

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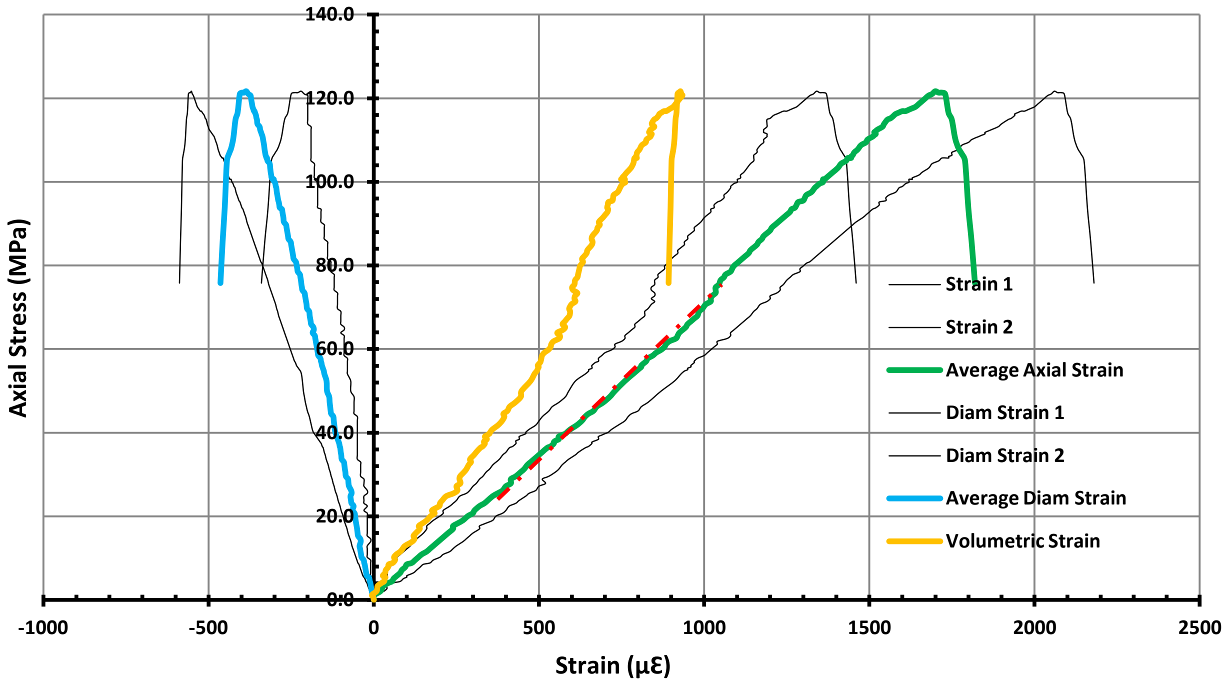
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS01	Lab:	EPLab
Sample ID:	FBDD-001_UCS01_UCSE		
Depth (m):	46.35 - 46.56	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	SIF
Checked by:	Phil		
Length (mm):	152.09	**Length/Diameter Ratio:**	2.49
Diameter (mm):	61.20	**Bulk Density (t/m³):**	3.22
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)			**121.70**	
Young's Modulus (GPa)			**Poisson's Ratio**	
Secant (0-50%)		**73.70**	**0.220**	
Tangent		**73.29**	**0.214**	
Foliation Angle (°)	**78.2**	**Failure Mode: Shear**	**Moisture Content (%)**	**0.00**
			Bulk Density (t/m³)	**3.22**

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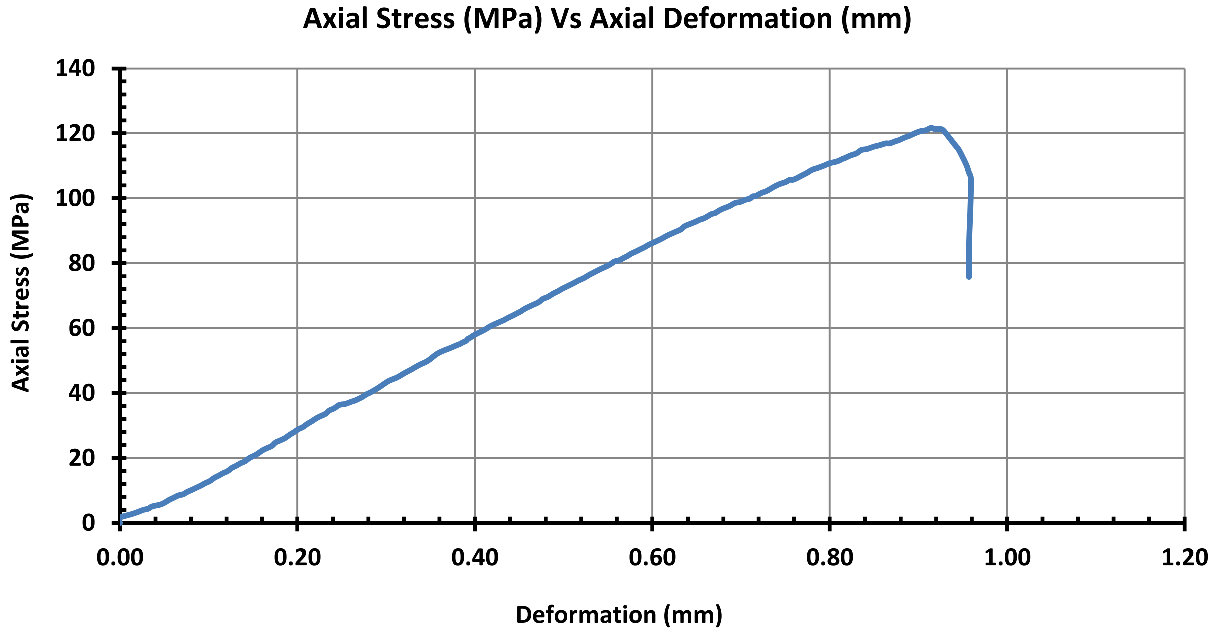
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS01	Lab:	EPLab
Sample ID:	FBDD-001_UCS01_UCSE		
Depth (m):	46.35 - 46.56	Room Temperature at Test:	18°C



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **26.9°** **Intact Shear**

Comments:

Stored and tested the Sample as received, samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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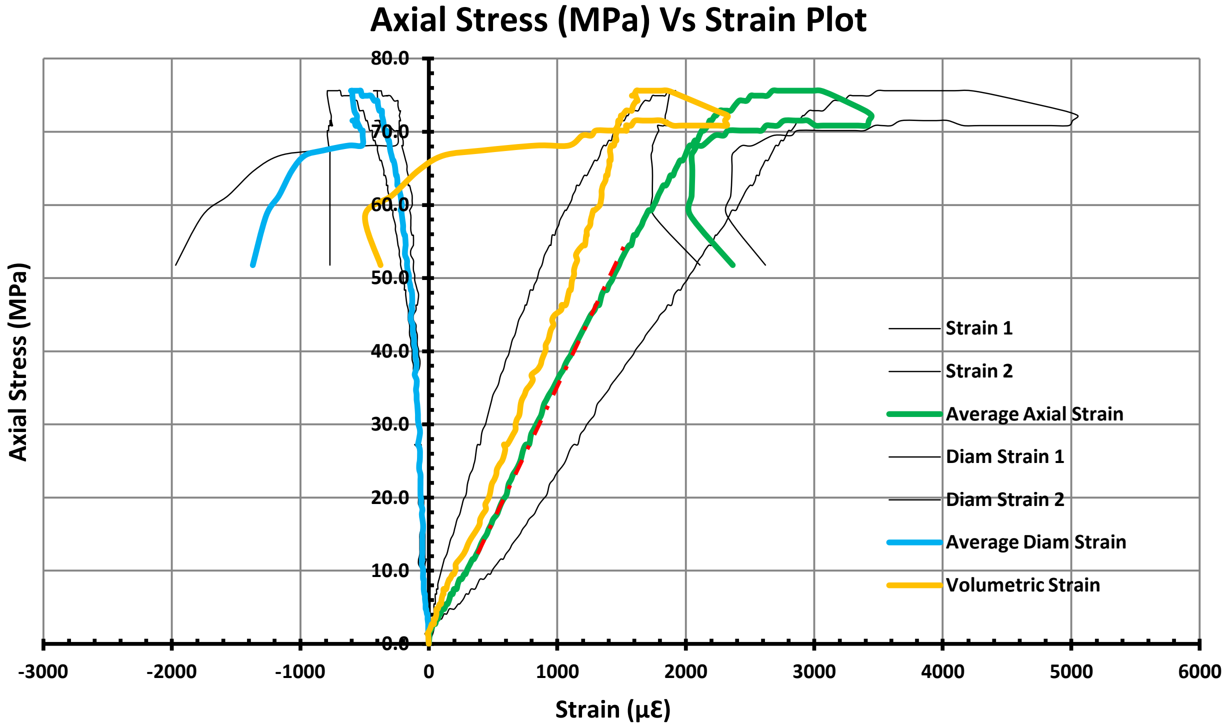
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS02	Lab:	EPLab
Sample ID:	FBDD-001_UCS02_UCSE		
Depth (m):	51.21 - 51.46	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	SIF
Checked by:	Phil		
Length (mm):	15.01	**Length/Diameter Ratio:**	0.25
Diameter (mm):	61.14	**Bulk Density (t/m³):**	30.87
Rate of Loading (mm/min):	0.025		



Max UCS (MPa)				**75.62**	
Young's Modulus (GPa)				**Poisson's Ratio**	
Secant (0-50%)		**30.91**		**0.166**	
Tangent		**33.46**		**0.145**	
Foliation Angle (°)	**69.5**	**Failure Mode**	**Shear**	**Moisture Content (%)**	**0.00**
				Bulk Density (t/m³)	**30.87**

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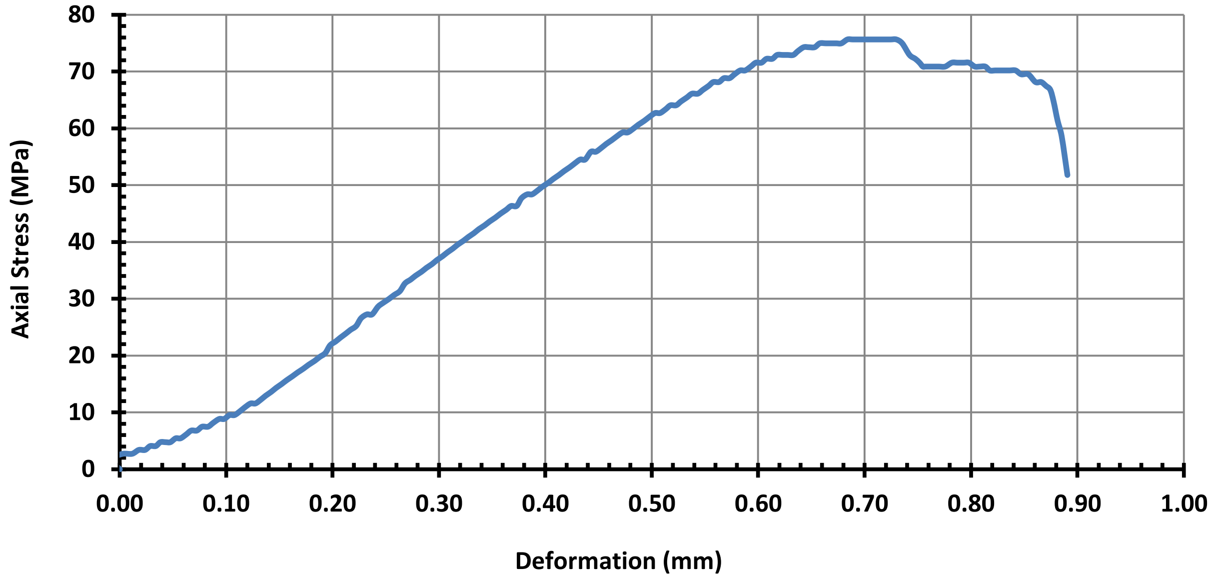
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS02	Lab:	EPLab
Sample ID:	FBDD-001_UCS02_UCSE		
Depth (m):	51.21 - 51.46	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **16.9°** **Intact Shear**

Comments:

Stored and tested the Sample as received, samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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E-Precision Laboratory

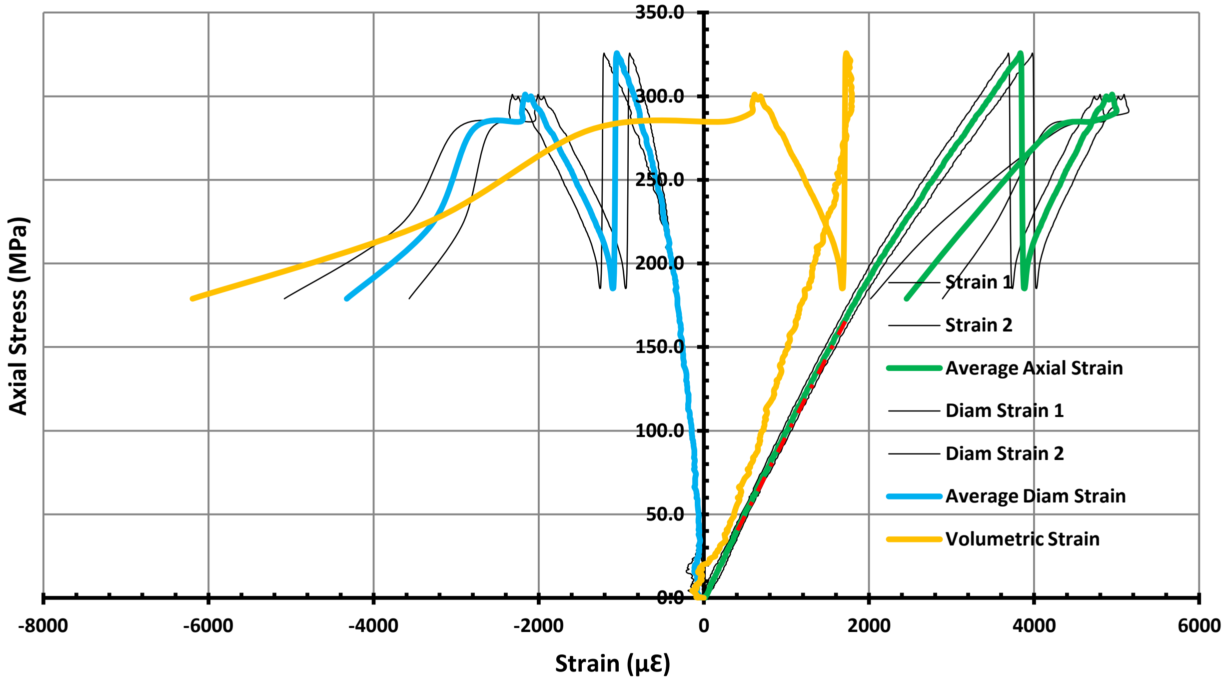
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS03	Lab:	EPLab
Sample ID:	FBDD-001_UCS03_UCSE		
Depth (m):	61.75 - 61.97	Room Temperature at Test:	18°C

Tested by:	Phil	**Geology:**	SIF
Checked by:	Phil		
Length (mm):	150.53	**Length/Diameter Ratio:**	2.47
Diameter (mm):	61.01	**Bulk Density (t/m³):**	3.50
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)		**325.65**	
Young's Modulus (GPa)		**Poisson's Ratio**	
Secant (0-50%)	**99.38**	**0.152**	
Tangent	**99.54**	**0.150**	

Foliation Angle (°)	**N/A**	**Failure Mode**	**Shear**	**Moisture Content (%)** **Bulk Density (t/m³)**	**0.00** **3.50**

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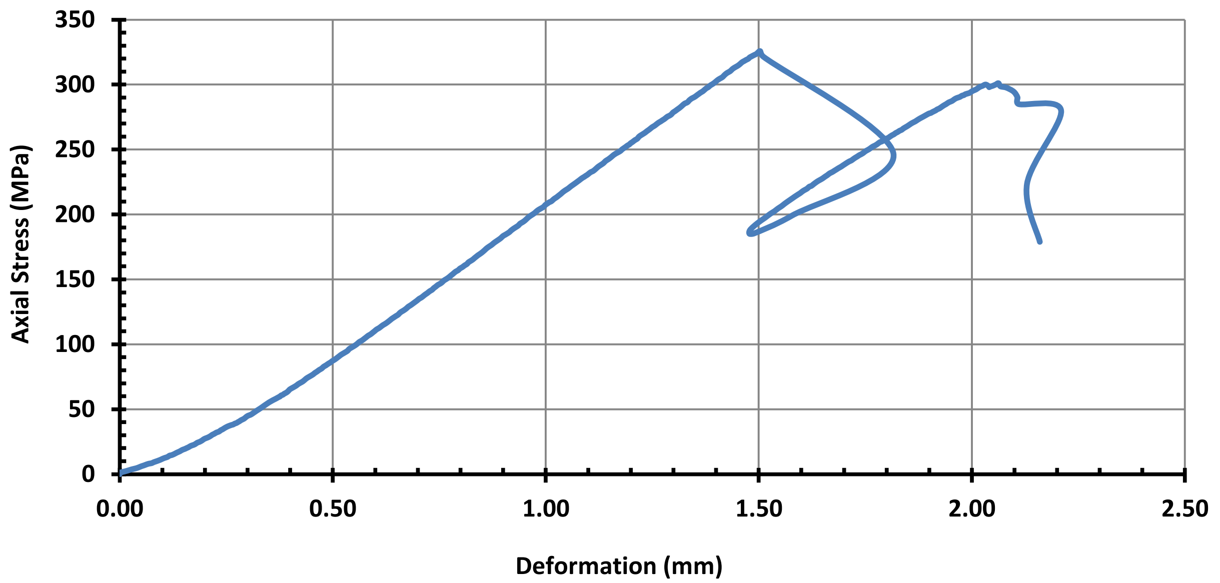
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS03	Lab:	EPLab
Sample ID:	FBDD-001_UCS03_UCSE		
Depth (m):	61.75 - 61.97	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **33.5°** **Intact Shear**

Comments:

Stored and tested the Sample as received, samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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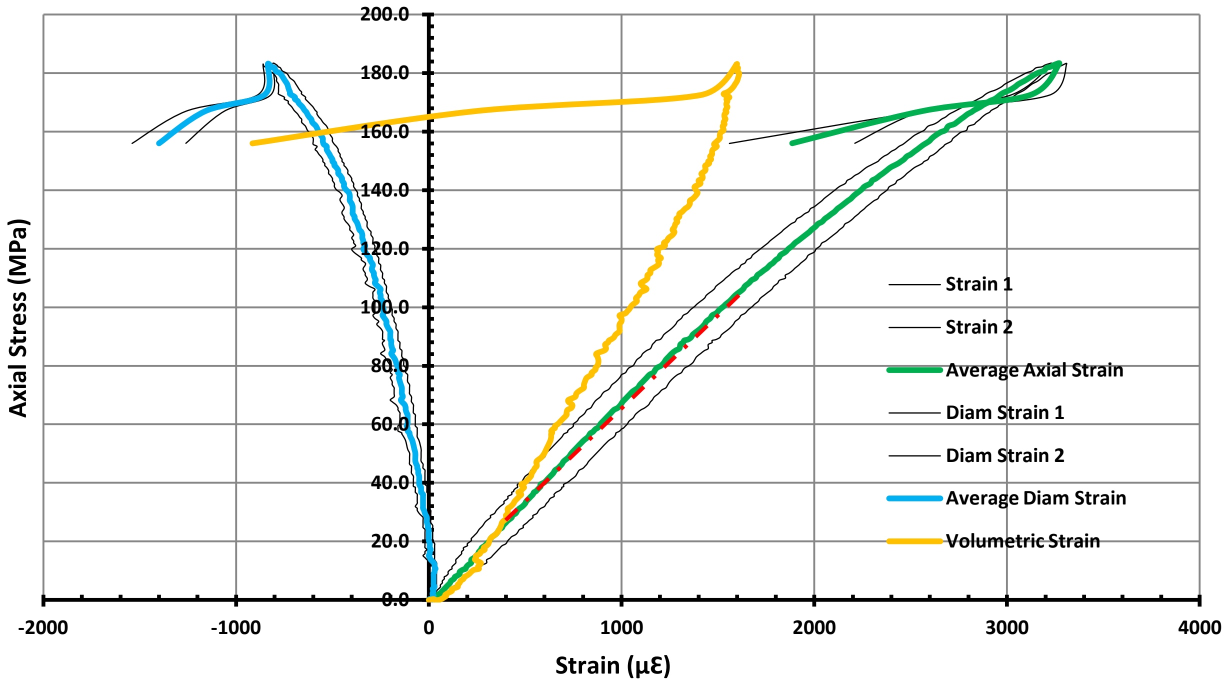
E-PRECISION LABORATORY

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS04	Lab:	EPLab
Sample ID:	FBDD-001_UCS04_UCSE		
Depth (m):	78.3 - 78.59	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	MDZ
Checked by:	Phil		
Length (mm):	150.41	**Length/Diameter Ratio:**	2.47
Diameter (mm):	60.87	**Bulk Density (t/m³):**	2.76
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)				**183.16**	
Young's Modulus (GPa)				**Poisson's Ratio**	
Secant (0-50%)			**65.58**	**0.157**	
Tangent			**66.82**	**0.155**	
Foliation Angle (°)	**N/A**	**Failure Mode**	**Shear**	**Moisture Content (%)**	**0.00**
				Bulk Density (t/m³)	**2.76**

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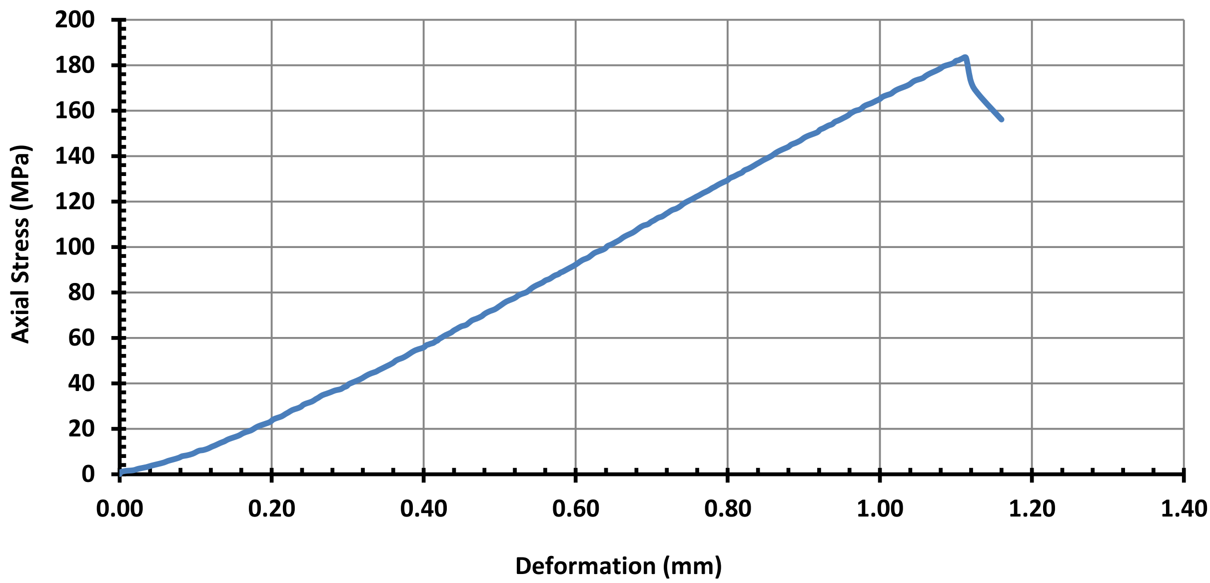
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS04	Lab:	EPLab
Sample ID:	FBDD-001_UCS04_UCSE		
Depth (m):	78.3 - 78.59	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **27.7°** **Intact Shear**

Comments:

Stored and tested the Sample as received, samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

The results of tests performed apply only to the specific sample at time of test unless otherwise clearly stated. Reference should be made to E-Precision Laboratory's "Standard Terms and Conditions" E-Precision Laboratory ABN 431 559 578 87

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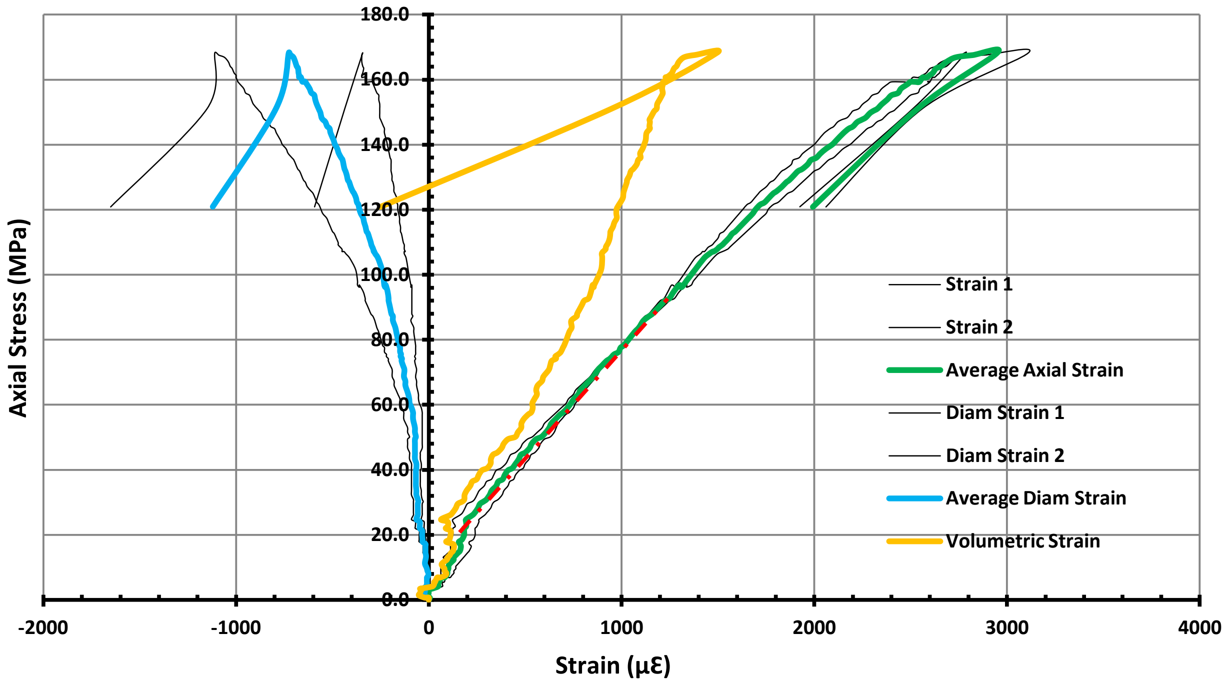
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS05	Lab:	EPLab
Sample ID:	FBDD-001_UCS05_UCSE		
Depth (m):	84.65 - 84.88	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	UAC
Checked by:	Phil		
Length (mm):	150.71	**Length/Diameter Ratio:**	2.48
Diameter (mm):	60.89	**Bulk Density (t/m³):**	2.92
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)		**168.27**	
Young's Modulus (GPa)		**Poisson's Ratio**	
Secant (0-50%)	**66.92**	**0.233**	
Tangent	**70.73**	**0.210**	
Foliation Angle (°)	**N/A**	**Moisture Content (%)**	**0.00**
Failure Mode	**Shear**	**Bulk Density (t/m³)**	**2.92**

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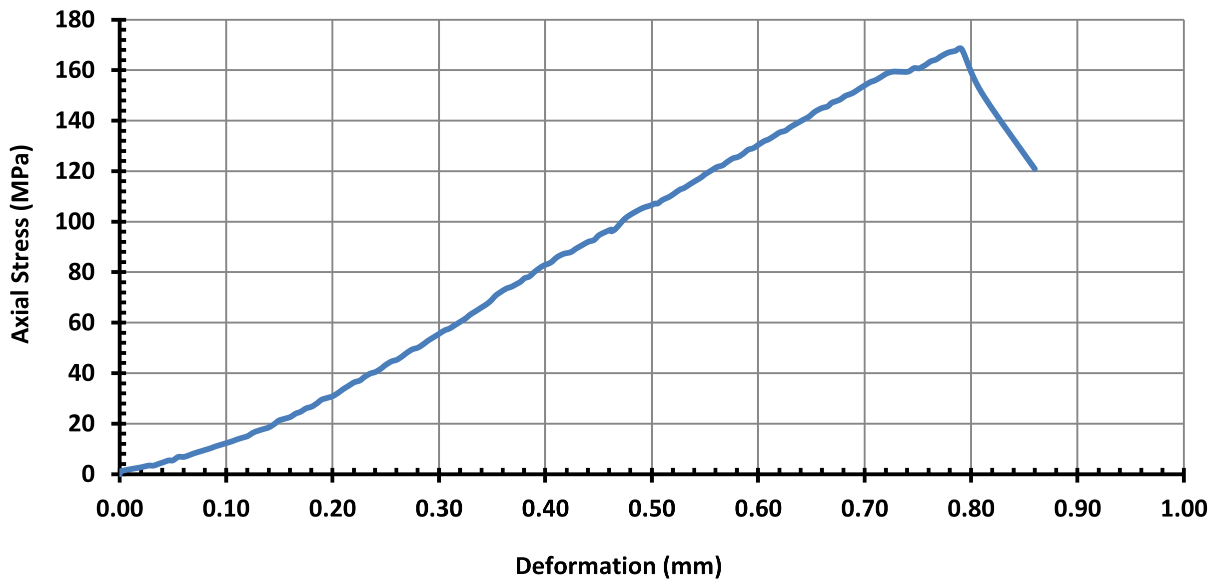
E-Precision Laboratory

UCS & DEFORMATION TEST REPORT

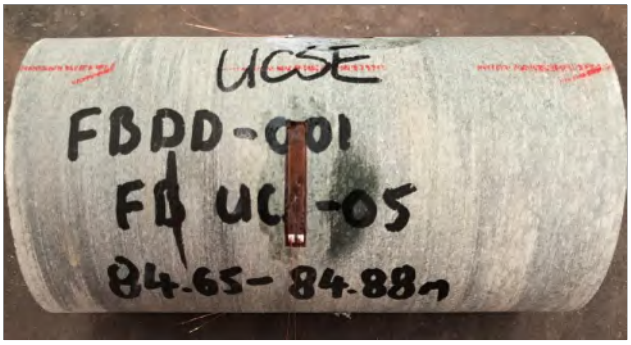
Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_UCS05	Lab:	EPLab
Sample ID:	FBDD-001_UCS05_UCSE		
Depth (m):	84.65 - 84.88	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo



Post Test Photo

Failure Angle to Vertical: **27.7°** **Intact Shear**

Comments:

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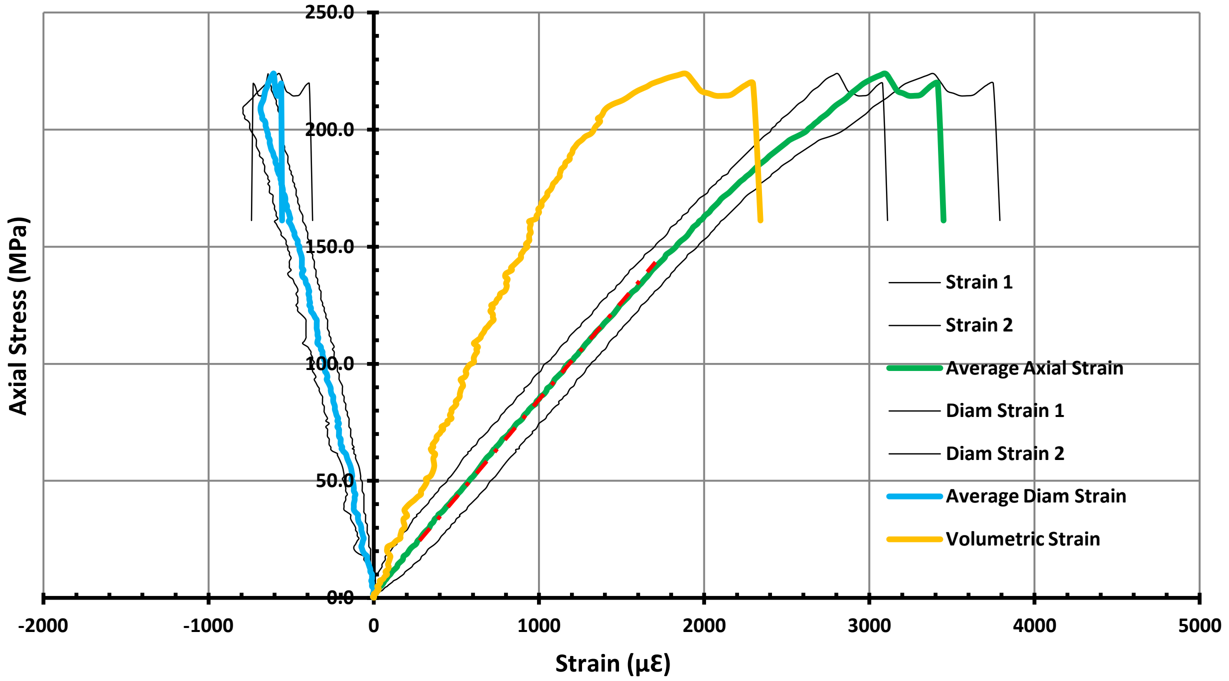
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	15/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-003_UCS06	Lab:	EPLab
Sample ID:	FBDD-003_UCS06_UCSE		
Depth (m):	77.28 - 77.49	Room Temperature at Test:	18°C

Tested by:	Phil	**Geology:**	MDZ
Checked by:	Phil		
Length (mm):	145.63	**Length/Diameter Ratio:**	2.41
Diameter (mm):	60.47	**Bulk Density (t/m³):**	2.80
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)		**223.89**	
Young's Modulus (GPa)		**Poisson's Ratio**	
Secant (0-50%)	**82.65**	**0.250**	
Tangent	**83.57**	**0.252**	

Foliation Angle (°)	**N/A**	**Failure Mode**	**Shear**	**Moisture Content (%)** **Bulk Density (t/m³)**	**0.00** **2.80**

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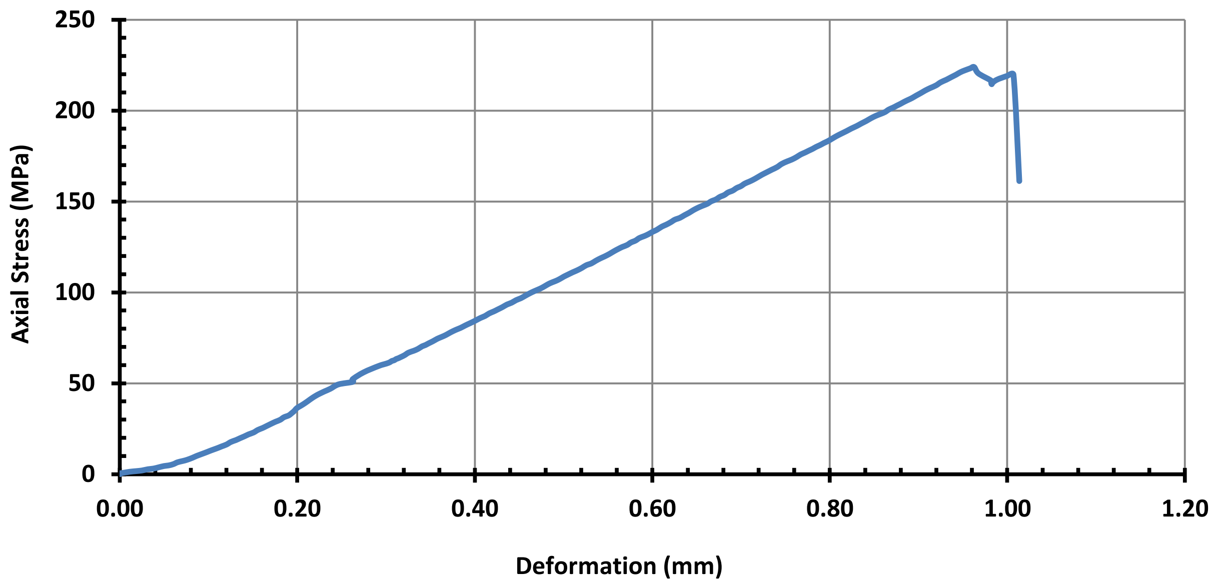
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	15/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-003_UCS06	Lab:	EPLab
Sample ID:	FBDD-003_UCS06_UCSE		
Depth (m):	77.28 - 77.49	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **23.1°** **Intact Shear**

Comments:

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E-PRECISION LABORATORY

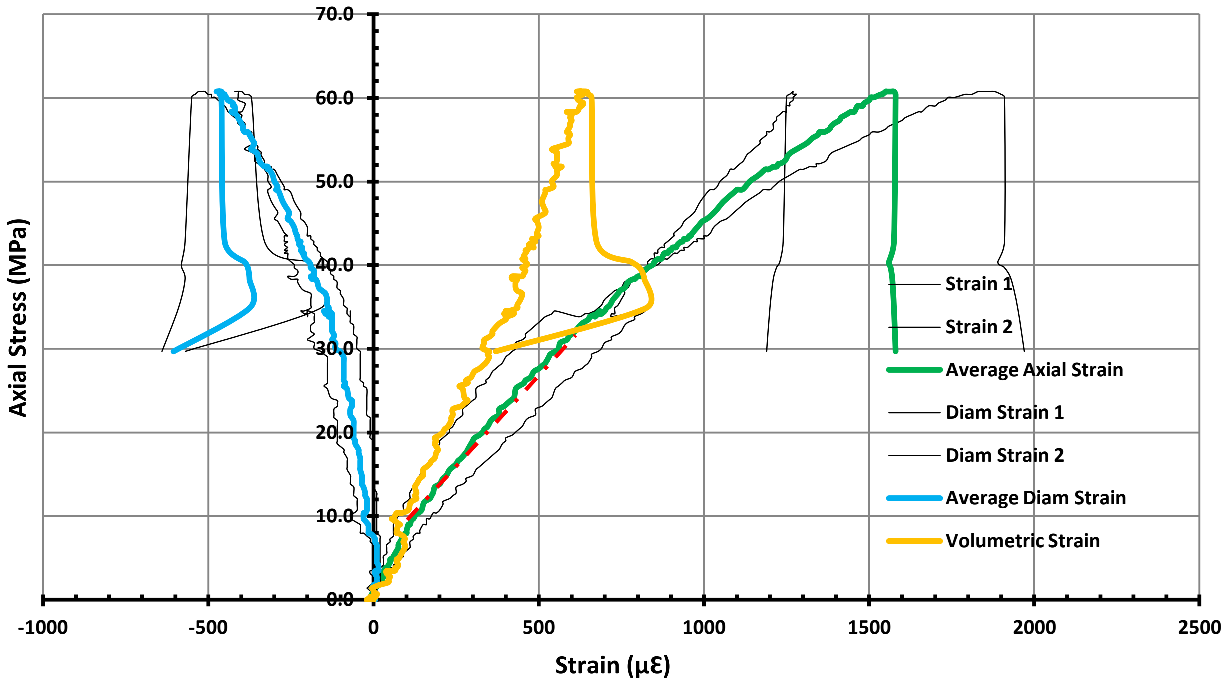
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	15/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-003_UCS07	Lab:	EPLab
Sample ID:	FBDD-003_UCS07_UCSE		
Depth (m):	88.62 - 88.85	Room Temperature at Test:	18°C

Tested by:	Phil	**Geology:**	UAC
Checked by:	Phil		
Length (mm):	148.19	**Length/Diameter Ratio:**	2.44
Diameter (mm):	60.72	**Bulk Density (t/m³):**	2.91
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)		**60.78**	
Young's Modulus (GPa)		**Poisson's Ratio**	
Secant (0-50%)	**46.05**	**0.237**	
Tangent	**48.52**	**0.234**	
Foliation Angle (°)	**N/A**	**Failure Mode**	**Shear**
Moisture Content (%)	**0.00**		
Bulk Density (t/m³)	**2.91**		

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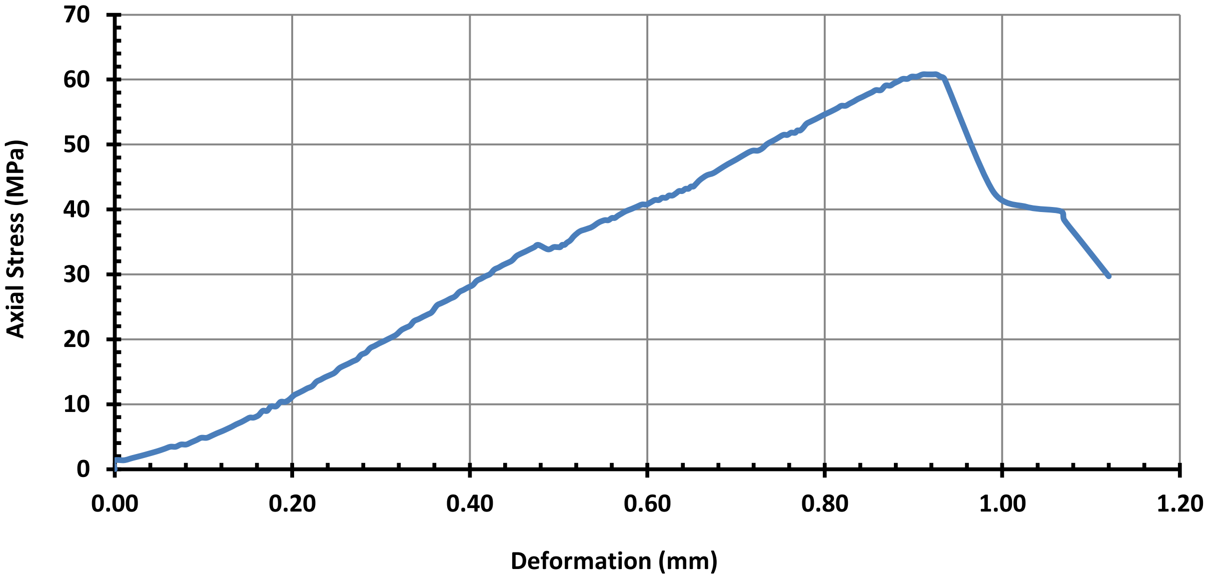
E-Precision Laboratory

UCS & DEFORMATION TEST REPORT

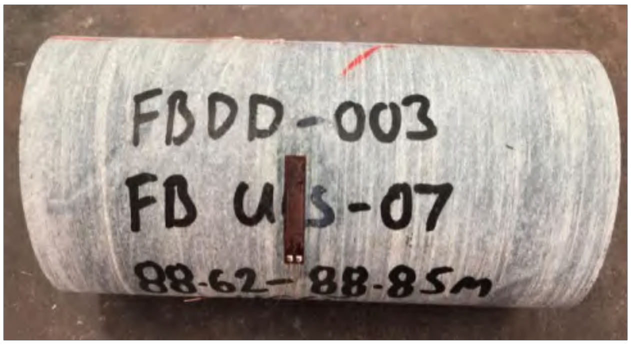
Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	15/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-003_UCS07	Lab:	EPLab
Sample ID:	FBDD-003_UCS07_UCSE		
Depth (m):	88.62 - 88.85	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo



Post Test Photo

Failure Angle to Vertical: **49.6°** **Shear on Structure**

Comments:

Stored and tested the Sample as received, samples supplied by the Client

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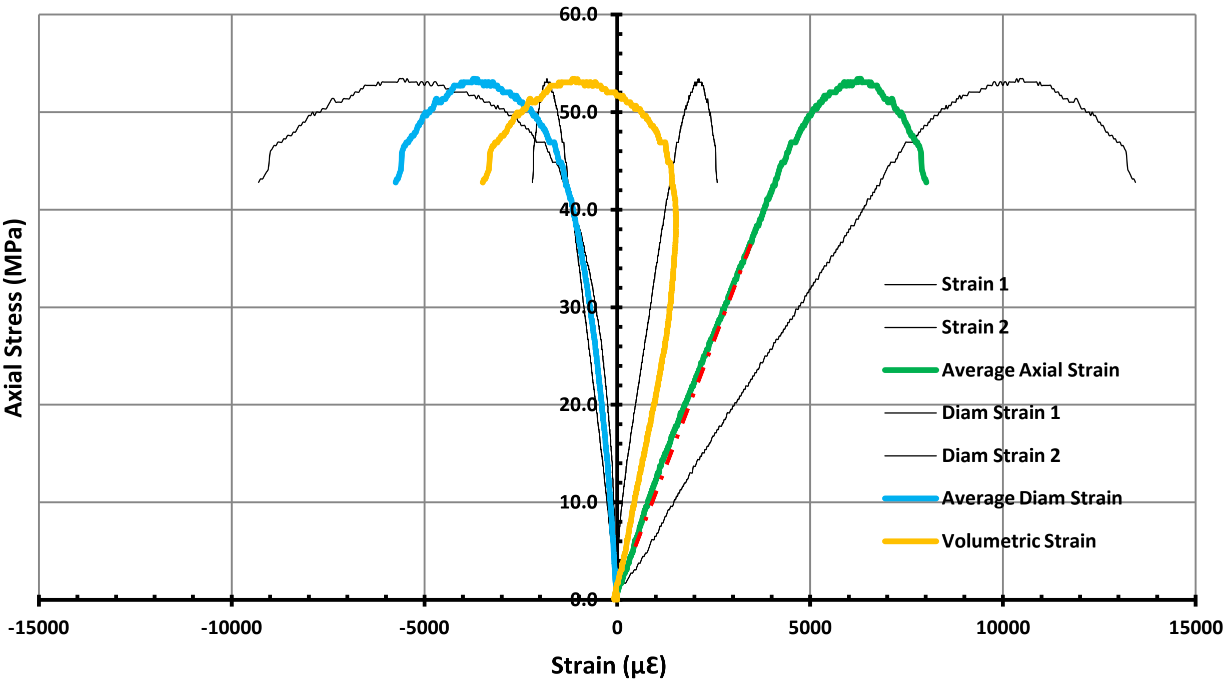
UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-002_UCS08	Lab:	EPLab
Sample ID:	FBDD-002_UCS08_UCSE		
Depth (m):	55.21 - 55.44	Room Temperature at Test:	18°C
Tested by:	Phil	**Geology:**	MDZ
Checked by:	Phil		
Length (mm):	152.15	**Length/Diameter Ratio:**	2.50
Diameter (mm):	60.98	**Bulk Density (t/m³):**	2.66
Rate of Loading (mm/min):	0.025		

Axial Stress (MPa) Vs Strain Plot



Max UCS (MPa)		**53.41**
Young's Modulus (GPa)		**Poisson's Ratio**
Secant (0-50%)	**11.11**	**0.235**
Tangent	**11.45**	**0.230**

Foliation Angle (°)	**N/A**	**Failure Mode**	**Shear**	**Moisture Content (%)**	**0.00**
				Bulk Density (t/m³)	**2.66**

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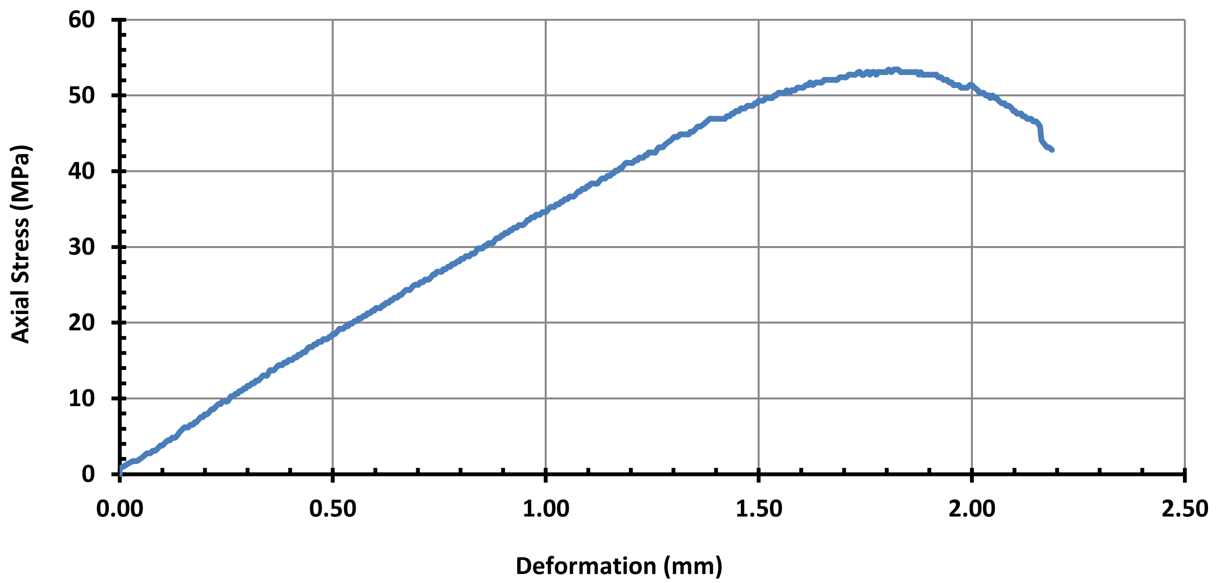
E-Precision Laboratory

UCS & DEFORMATION TEST REPORT

Test Method: AS 4133.4.2.1 & ISRM Method

Client:	O'Bryan & Associates	Date Tested:	14/11/2020
Project:	Ramelius Symes Find and Die Hardy	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-002_UCS08	Lab:	EPLab
Sample ID:	FBDD-002_UCS08_UCSE		
Depth (m):	55.21 - 55.44	Room Temperature at Test:	18°C

Axial Stress (MPa) Vs Axial Deformation (mm)



Pre-Test Photo

Post Test Photo

Failure Angle to Vertical: **28.7°** **Intact Shear**

Comments:

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Authorised Signature (Geotechnical Engineer):

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E-Precision Laboratory

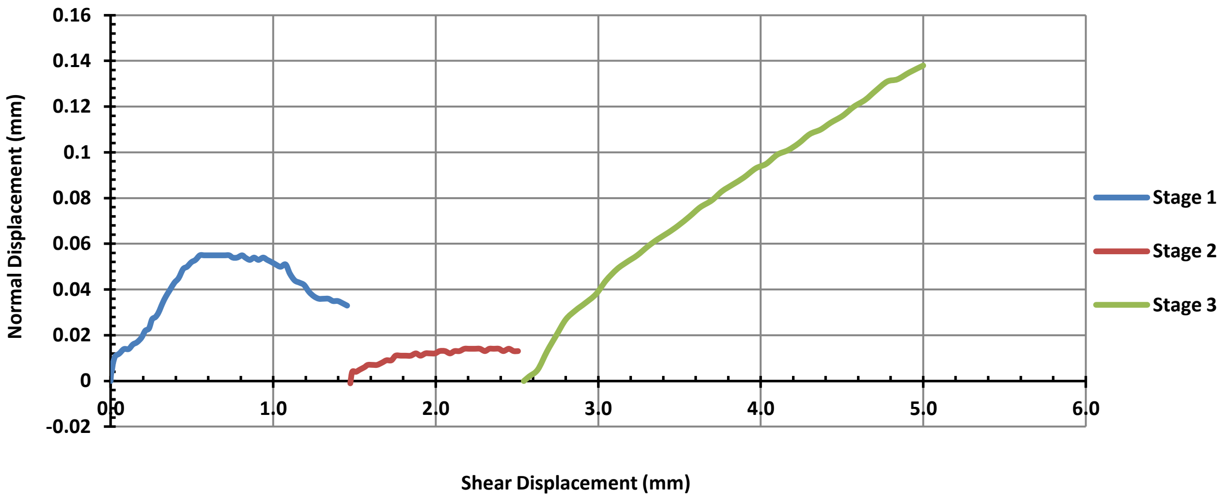
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

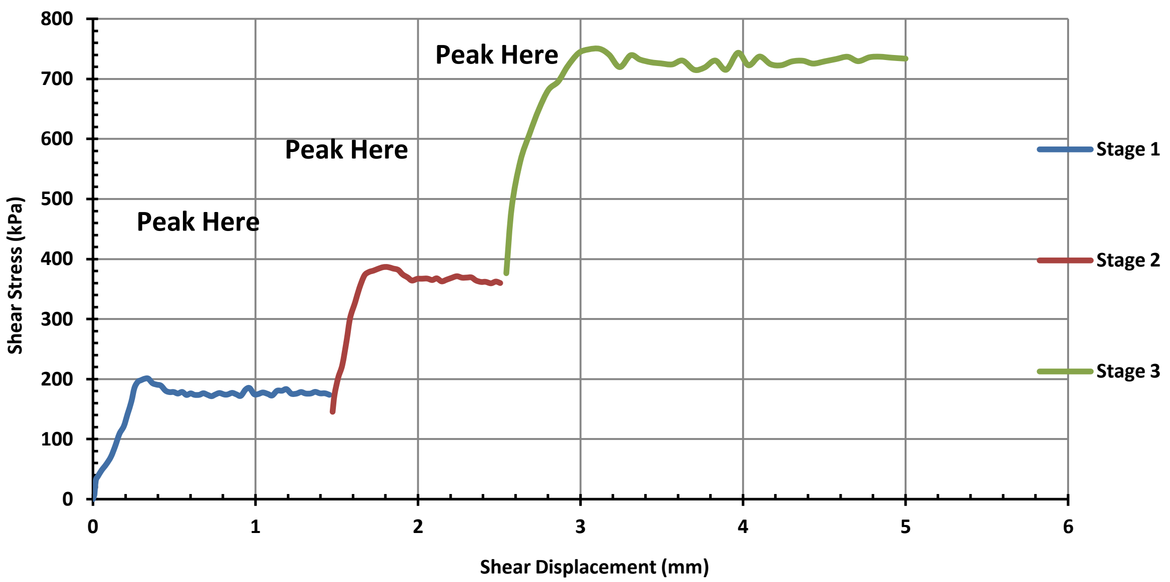
Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS01	Lab:	EPLab
Lab ID:	FBDD-001_DS01_DST3		
Depth (m):	47.55 - 47.68	Room Temperature at Test:	20°

Type of Test:	Natural Defect	**Geology:**	SIF
Dimensions (mm):	82.70 x 60.92	**Shear Plane Dip Angle (°):**	47
Rate of Strain (mm/min):	0.008	**Initial Bulk Density (t/m³):**	2.88
Failure Criteria:	Shear	**Moisture Content (%):**	0.00

Normal Displacement Vs Shear Displacement Plot



Shear Stress Vs Shear Displacement Plot



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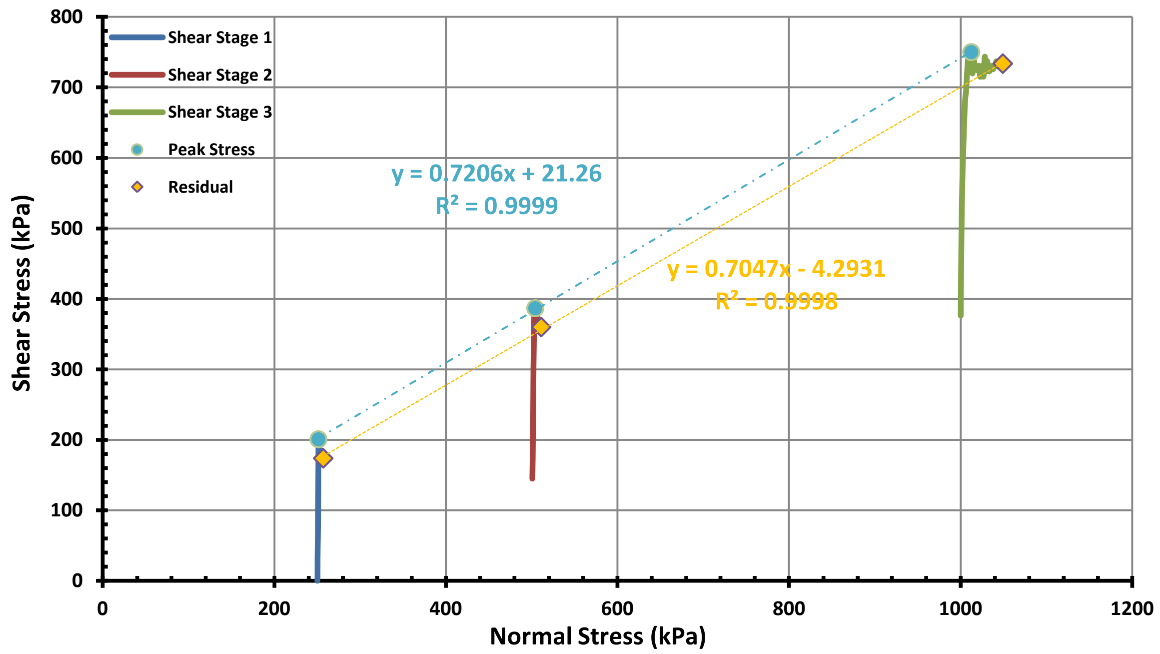
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS01	Lab:	EPLab
Sample ID:	FBDD-001_DS01_DST3		
Depth (m):	47.55 - 47.68	Room Temperature at Test:	20°

(Peak/Residual) Normal Stress Vs Shear Stress



Defect Surface: Undulating Rough Surface with sandy infill
Dip Angle (°): 47

			Normal Stress (kPa)		Shear Stress (kPa)	
Peak	**Shear Angle (°)**	35.79	Stage 1	251	Stage 1	201
	Cohesion (kPa)	21.26	Stage 2	504	Stage 2	387
	R^2	0.9999	Stage 3	1012	Stage 3	750
			Stage 4	-	Stage 4	-
Ultimate / Residual	**Shear Angle (°)**	34.99	**Normal Stress (kPa)**		**Shear Stress (kPa)**	
	Cohesion (kPa)	0.00	Stage 1	257	Stage 1	174
	R^2	0.9998	Stage 2	511	Stage 2	360
			Stage 3	1049	Stage 3	734
			Stage 4	-	Stage 4	-

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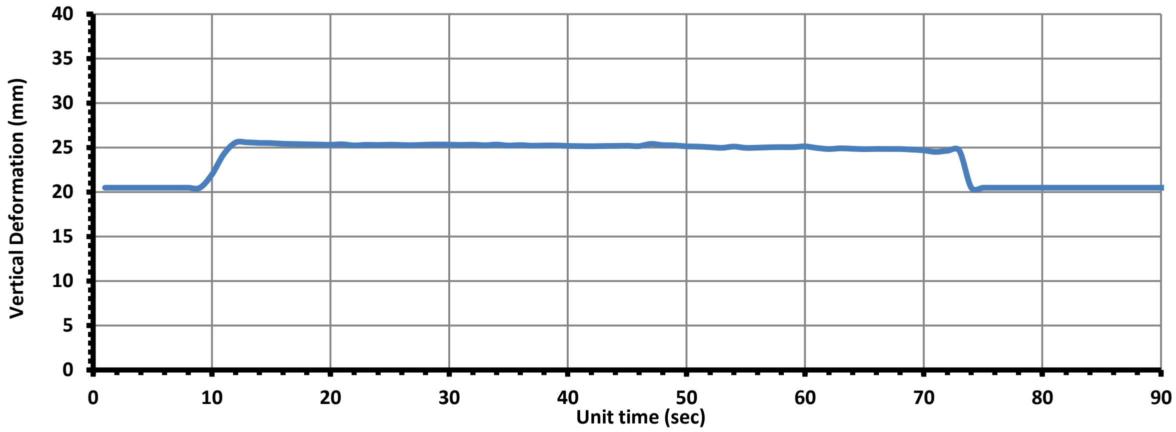
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS01	Lab:	EPLab
Sample ID:	FBDD-001_DS01_DST3		
Depth (m):	47.55 - 47.68	Room Temperature at Test:	20°

Sample Surface Profile Pre and Post Testing (Centre Section)

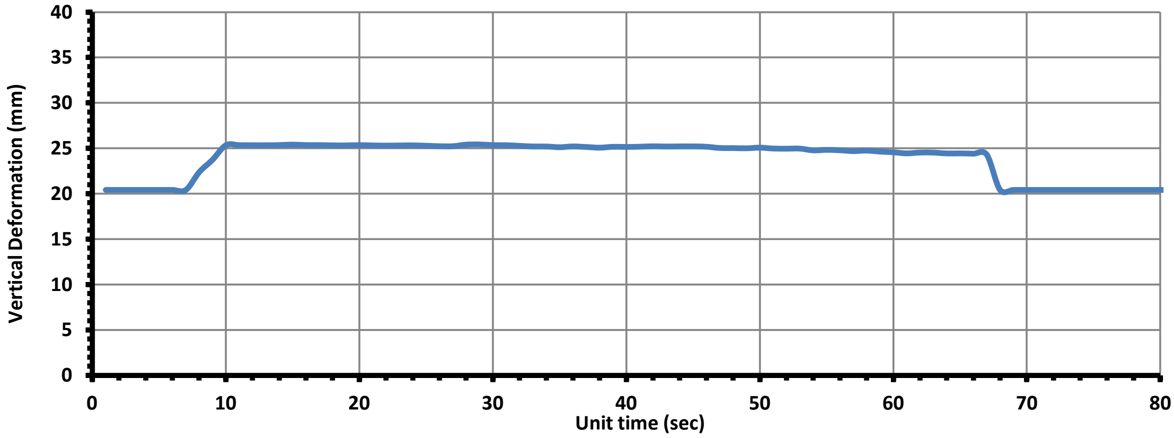
Before Shearing



After Shearing

Direction of Shearing

Y-Y Axis



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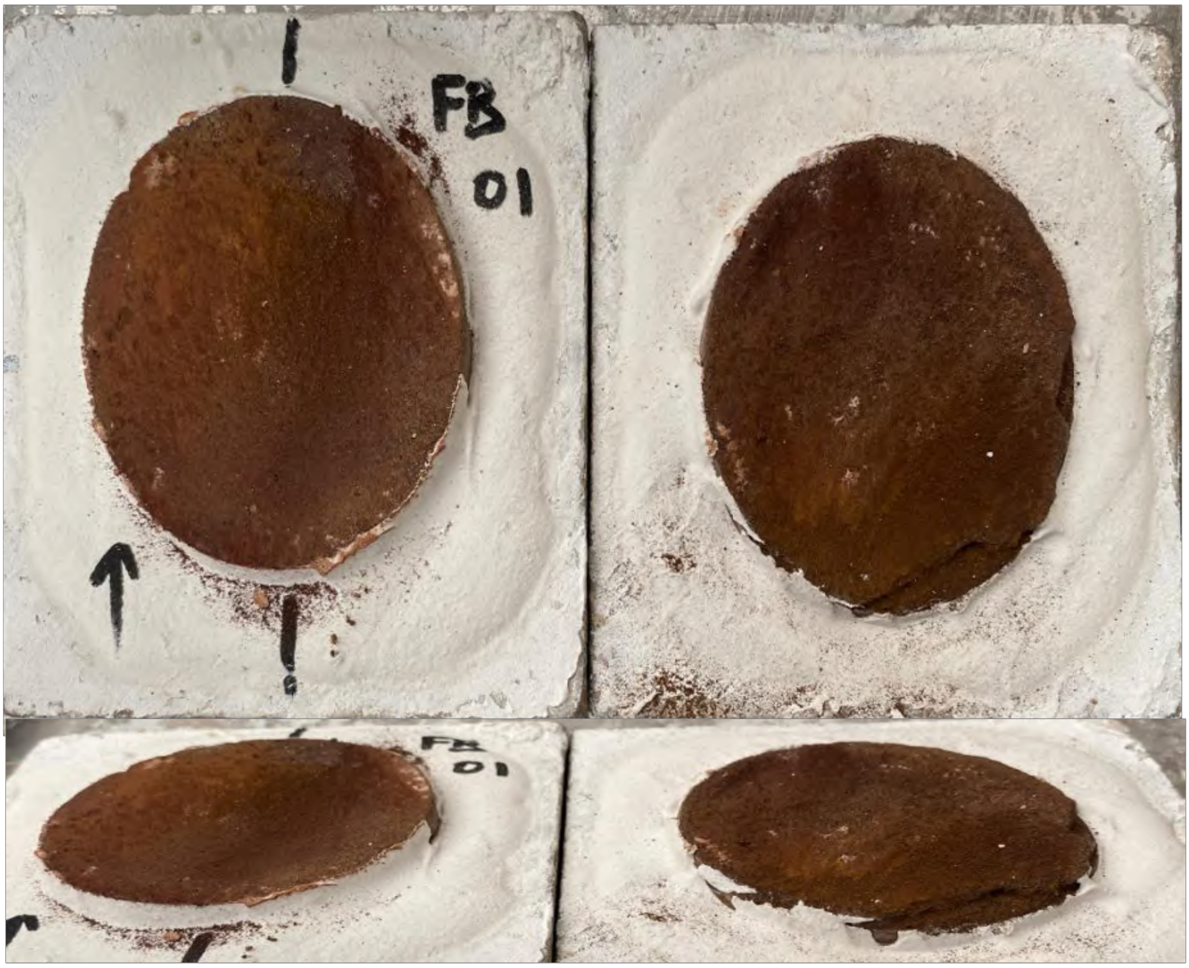
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS01	Lab:	EPLab
Sample ID:	FBDD-001_DS01_DST3		
Depth (m):	47.55 - 47.68	Room Temperature at Test:	20°

Sample Photo Post Testing



Notes: Surface profile drawn using Laser

Stored and Tested the Sample as received
Samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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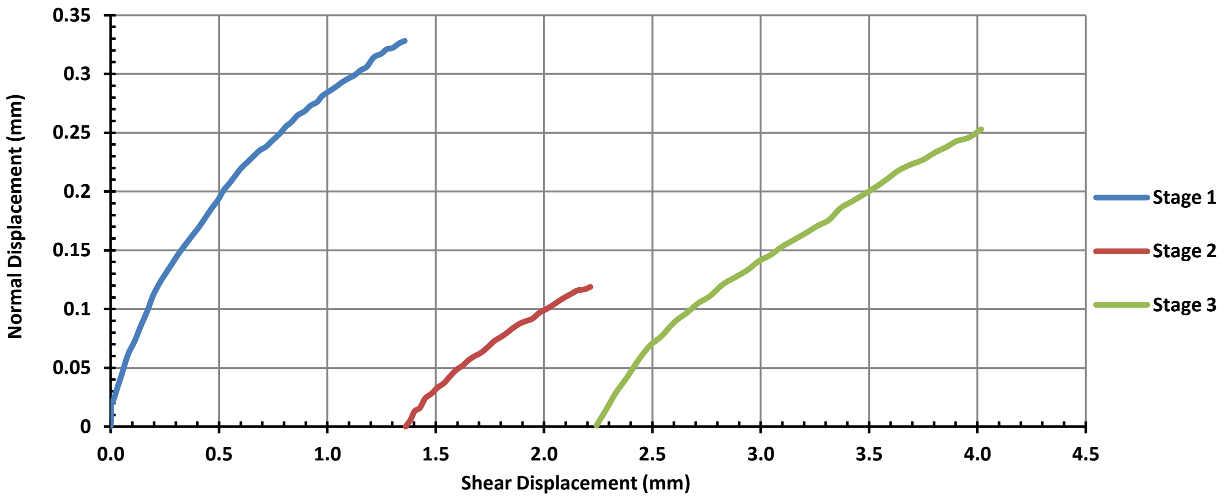
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

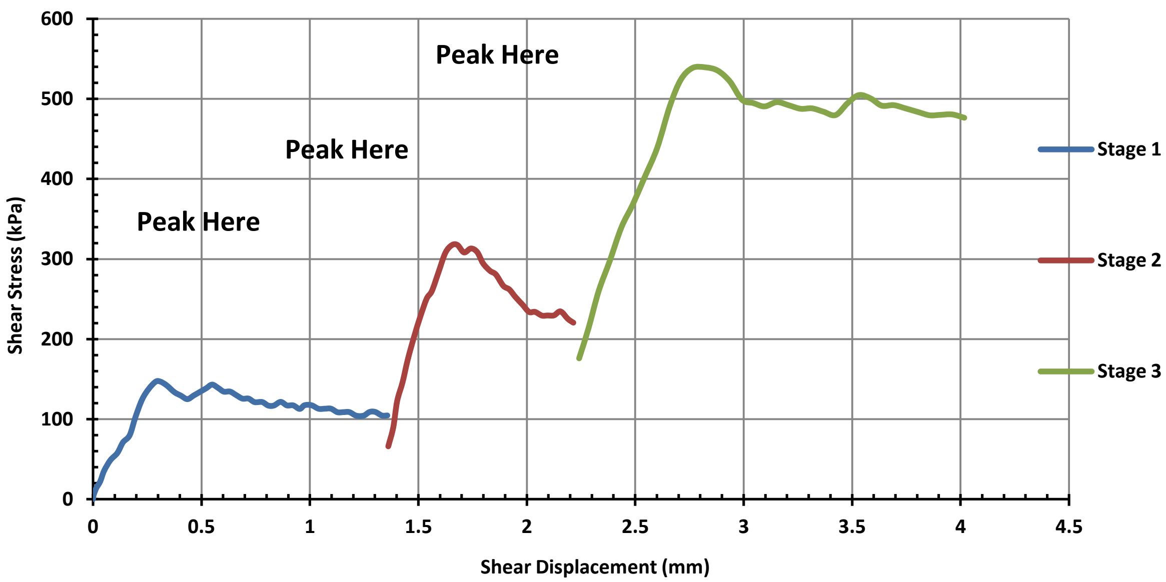
Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS02	Lab:	EPLab
Lab ID:	FBDD-001_DS02_DST3		
Depth (m):	97.84 - 98.00	Room Temperature at Test:	20°

Type of Test:	Natural Defect	**Geology:**	UAC
Dimensions (mm):	66.28 x 60.81	**Shear Plane Dip Angle (°):**	68.9
Rate of Strain (mm/min):	0.008	**Initial Bulk Density (t/m³):**	2.95
Failure Criteria:	Shear	**Moisture Content (%):**	0.00

Normal Displacement Vs Shear Displacement Plot



Shear Stress Vs Shear Displacement Plot



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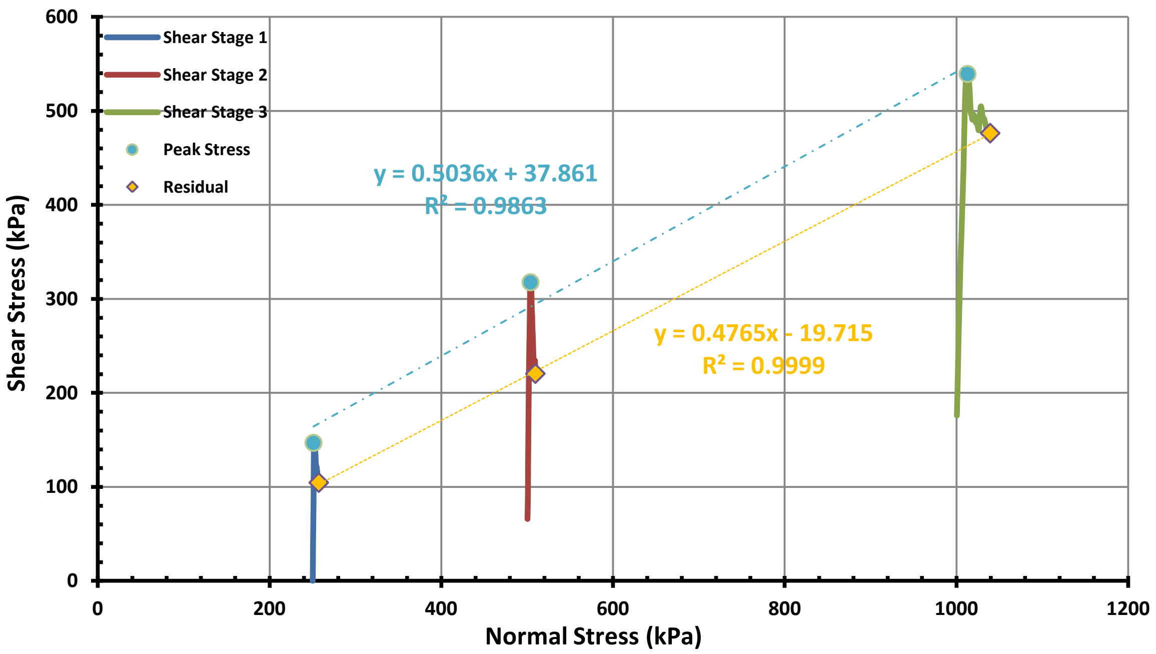
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS02	Lab:	EPLab
Sample ID:	FBDD-001_DS02_DST3		
Depth (m):	97.84 - 98.00	Room Temperature at Test:	20°

(Peak/Residual) Normal Stress Vs Shear Stress



Defect Surface: Undulating Smooth Surface with intrusive infill

Dip Angle (°): 68.9

			Normal Stress (kPa)		Shear Stress (kPa)	
Peak	**Shear Angle (°)**	26.57	Stage 1	251	Stage 1	147
	Cohesion (kPa)	37.86	Stage 2	504	Stage 2	318
	R^2	0.9863	Stage 3	1013	Stage 3	539
			Stage 4	-	Stage 4	-
Ultimate / Residual	**Shear Angle (°)**	25.64	**Normal Stress (kPa)**		**Shear Stress (kPa)**	
	Cohesion (kPa)	0.00	Stage 1	257	Stage 1	105
	R^2	0.9998	Stage 2	510	Stage 2	221
			Stage 3	1039	Stage 3	476
			Stage 4	-	Stage 4	-

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E-PRECISION LABORATORY

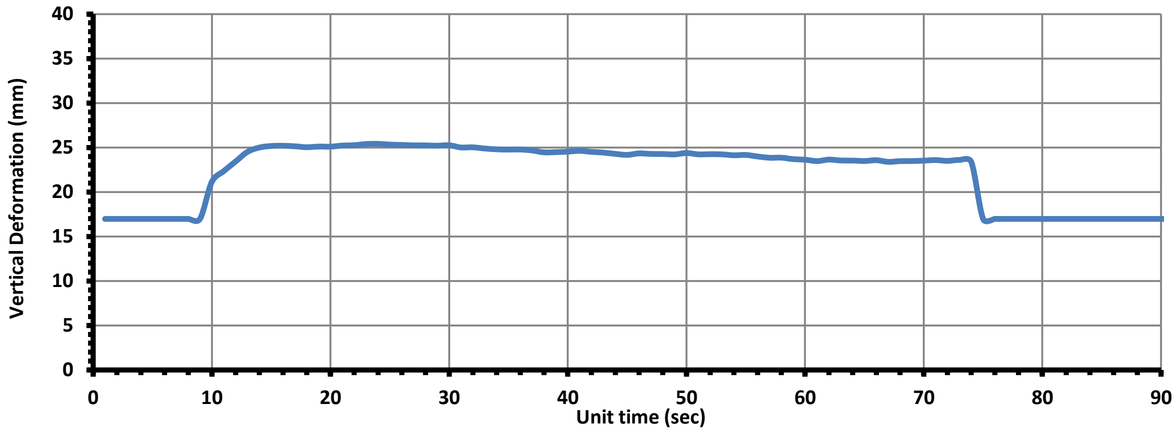
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS02	Lab:	EPLab
Sample ID:	FBDD-001_DS02_DST3		
Depth (m):	97.84 - 98.00	Room Temperature at Test:	20°

Sample Surface Profile Pre and Post Testing (Centre Section)

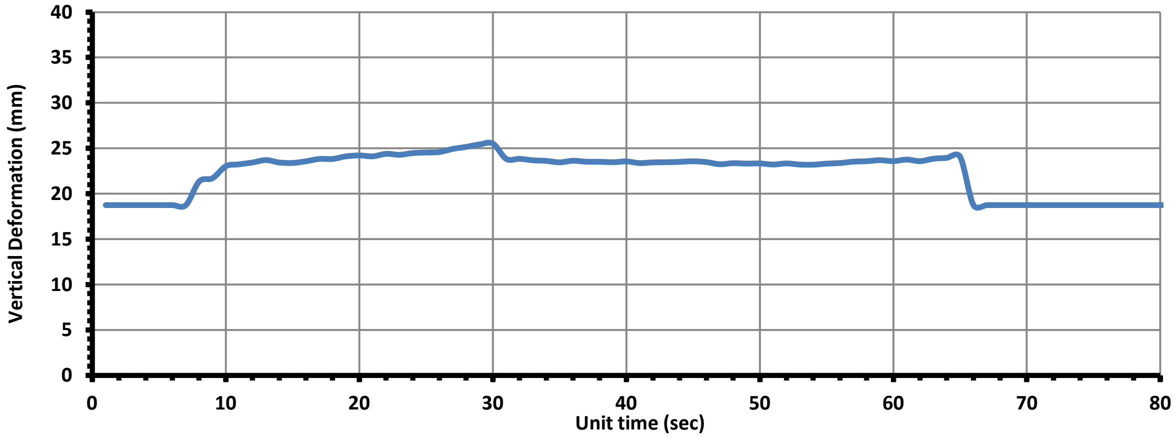
Before Shearing



After Shearing

Direction of Shearing

Y-Y Axis



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Method: ASTMD5607 / In-house Method

Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-001_DS02	Lab:	EPLab
Sample ID:	FBDD-001_DS02_DST3		
Depth (m):	97.84 - 98.00	Room Temperature at Test:	20°

Sample Photo Post Testing

Notes: Surface profile drawn using Laser

Stored and Tested the Sample as received
Samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

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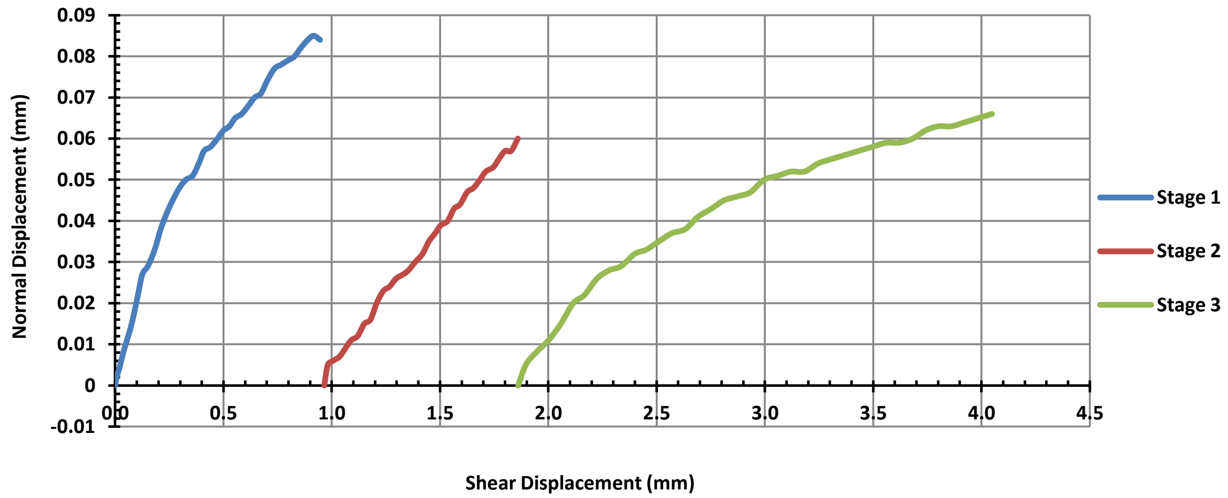
DIRECT SHEAR TEST REPORT

Method: ASTMD5607 / In-house Method

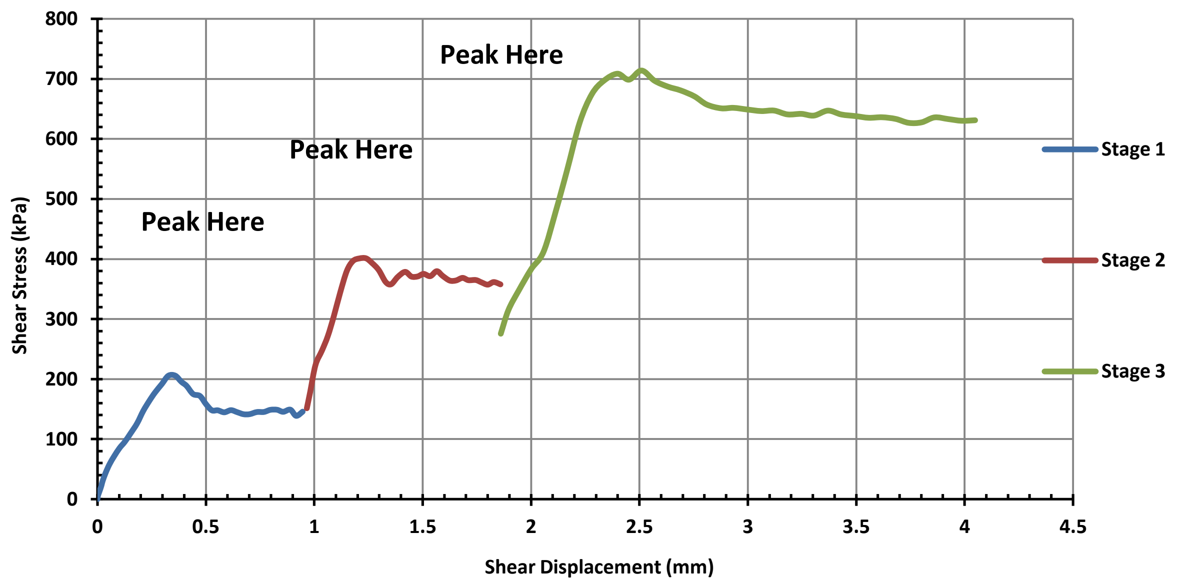
Client:	O'Bryan and Associates	Date Tested:	19/11/2020
Project:	Ramelius Die Hardy and Symes Find	EP Lab Job Number:	OBRYAN
Sample No:	FBDD-002_DS03	Lab:	EPLab
Lab ID:	FBDD-002_DS03_DST3		
Depth (m):	29.38 - 29.52	Room Temperature at Test:	20°

Type of Test:	Natural Defect	**Geology:**	SIF
Dimensions (mm):	61.53 x 60.87	**Shear Plane Dip Angle (°):**	85.9
Rate of Strain (mm/min):	0.008	**Initial Bulk Density (t/m³):**	2.85
Failure Criteria:	Shear	**Moisture Content (%):**	0.00

Normal Displacement Vs Shear Displacement Plot



Shear Stress Vs Shear Displacement Plot



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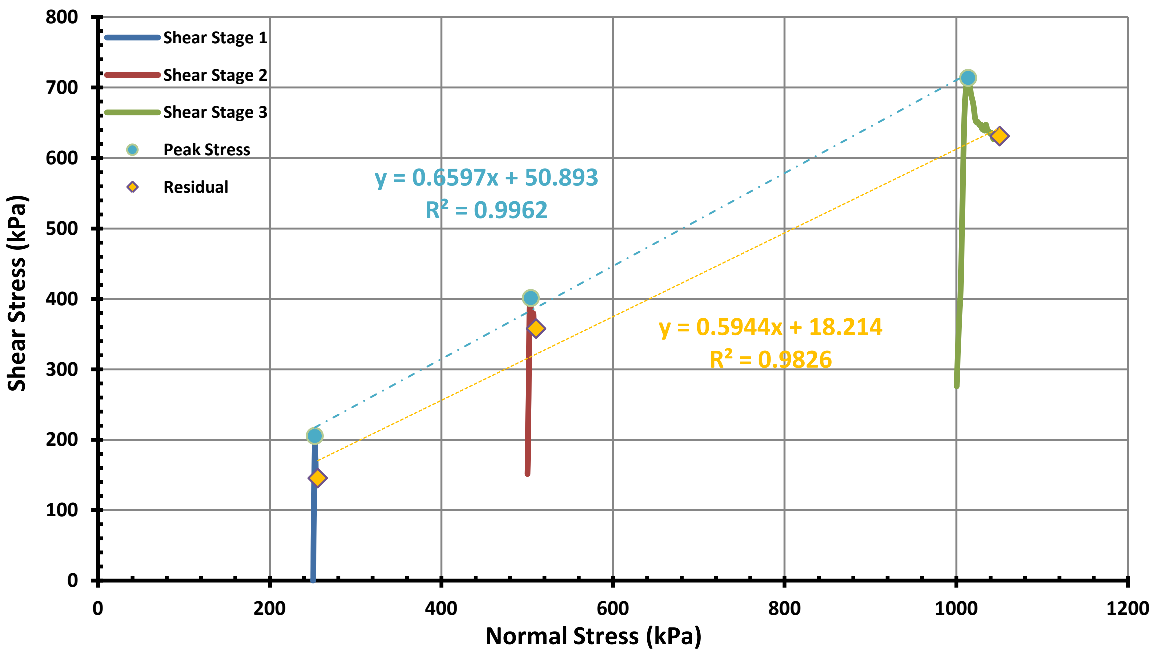
Sample No:	FBDD-002_DS03	Lab:	EPLab
Sample ID:	FBDD-002_DS03_DST3		
Depth (m):	29.38 - 29.52	Room Temperature at Test:	20°

(Peak/Residual) Normal Stress Vs Shear Stress



Defect Surface: Planar Rough Surface with Sandy Infill

Dip Angle (°): 85.9

Peak			Normal Stress (kPa)		Shear Stress (kPa)	
	Shear Angle (°)	33.42	Stage 1	252	Stage 1	206
	Cohesion (kPa)	50.89	Stage 2	504	Stage 2	401
	R^2	0.9962	Stage 3	1014	Stage 3	714
			Stage 4	-	Stage 4	-

Ultimate / Residual			Normal Stress (kPa)		Shear Stress (kPa)	
	Shear Angle (°)	30.71	Stage 1	256	Stage 1	146
	Cohesion (kPa)	18.21	Stage 2	510	Stage 2	358
	R^2	0.9826	Stage 3	1051	Stage 3	631
			Stage 4	-	Stage 4	-

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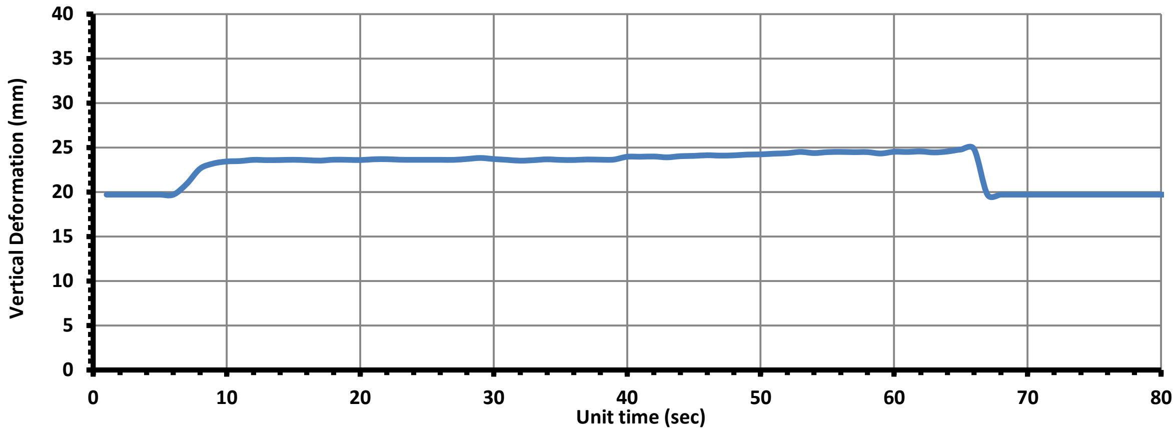
Sample ID:	FBDD-002_DS03_DST3		
Depth (m):	29.38 - 29.52	Room Temperature at Test:	20°

Sample Surface Profile Pre and Post Testing (Centre Section)

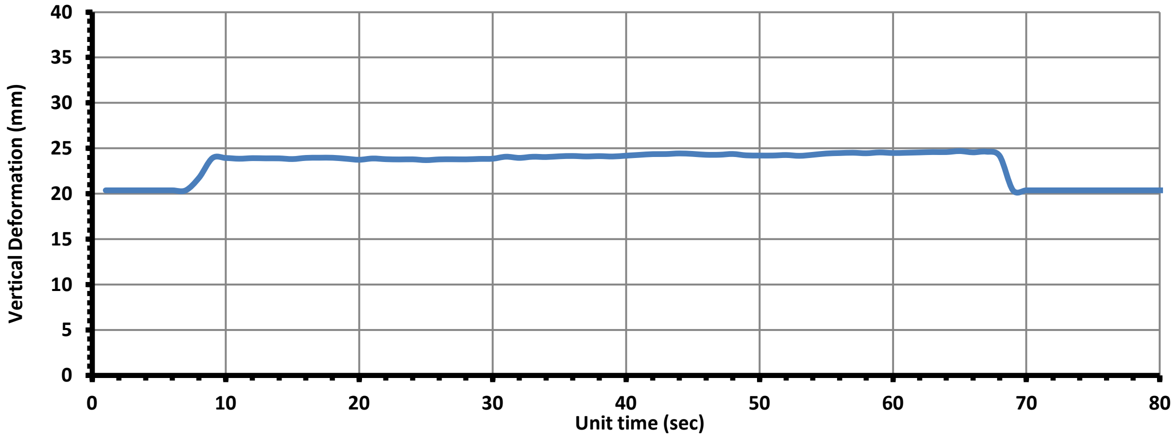
Before Shearing



After Shearing

Direction of Shearing

Y-Y Axis



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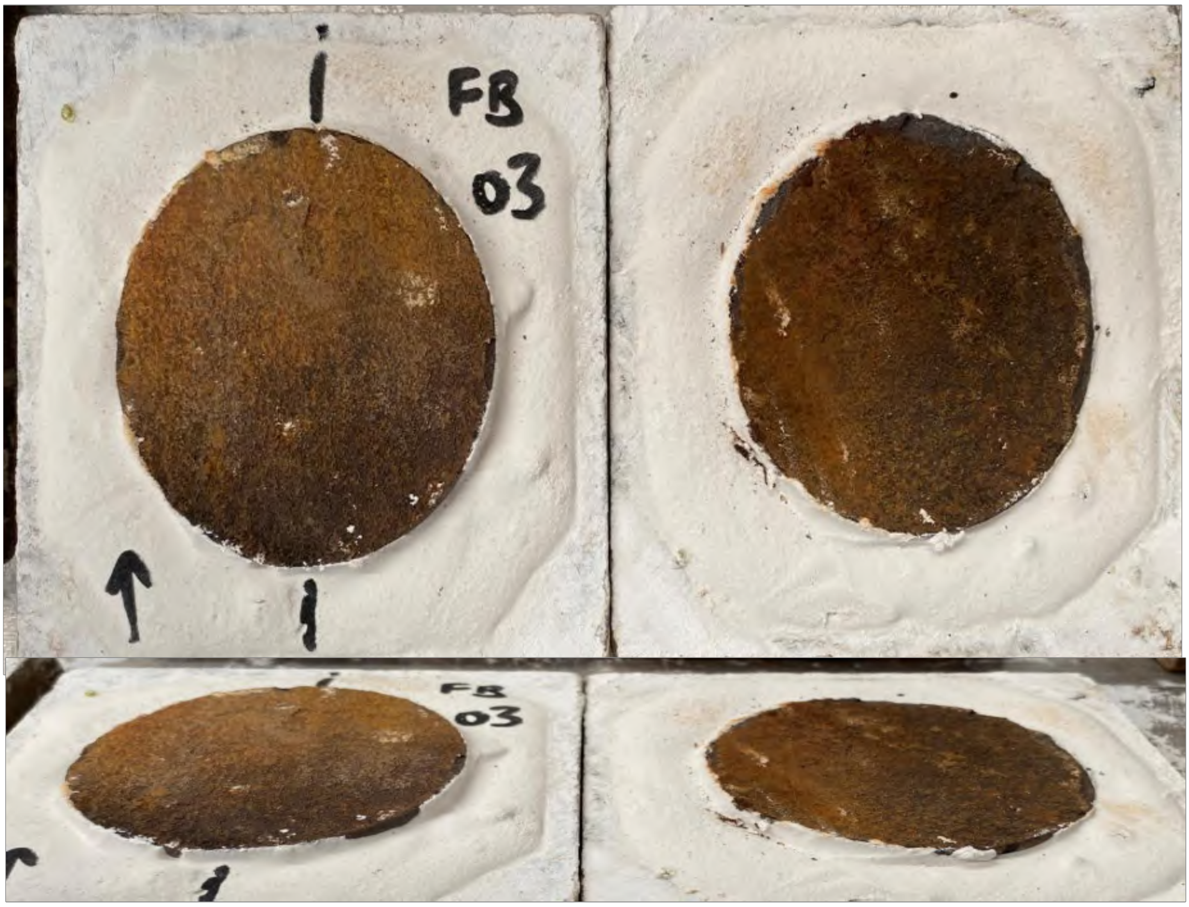
Depth (m):	29.38 - 29.52	Room Temperature at Test:	20°

Sample Photo Post Testing



Notes: Surface profile drawn using Laser

Stored and Tested the Sample as received
Samples supplied by the Client

Authorised Signature (Geotechnical Engineer):

APPENDIX C

Rehabilitated Landform Design Guidance (Landloch)

REHABILITATED LANDFORM DESIGN GUIDANCE: DIE HARDY

Ramelius Resources

June 2021

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Web site: www.landloch.com.au
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Project Number: 2415.21b

Report Title: Rehabilitated landform design guidance: Die Hardy

Client: Ramelius Resources

Review History

Version Number	Prepared by:	Reviewed by:	Date
0 (Draft)	E. Howard		10/06/2021
1 (Draft)	E. Howard		21/06/2021
2 (Final)	E. Howard		21/06/2021

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1 INTRODUCTION

Ramelius Resources (Ramelius) are seeking approval to mine the Die Hardy gold project (Die Hardy). The project is located within the Mount Jackson goldfield, in the Yilgarn Shire of Western Australia, ~140km north of Southern Cross and 400km north east of Perth (Figure 1). Die Hardy consists of four sites:

- Die Hardy Central, Die Hardy North, and Die Hardy South, all located within mining tenement M77/1272; and
- Red Legs, located within mining tenement M77/1271.

Landloch Pty Ltd (Landloch) has considered issues related to the long-term erosional stability of the mine waste dumps at Die Hardy. The configurations of these facilities are currently not confirmed. Therefore, this document seeks to address erosion and landform stability issues without expressly referencing specific waste geometries.

2 CLOSURE EXPECTATIONS

2.1 Regulator expectations

The primary Western Australian mining regulator involved with waste landforms and closure is the Department of Mines, Industry Regulation and Safety (DMIRS)[1]. DMIRS has provided a range of guidance documents that relate to landform design. In addition, the Australian Government has produced a range of handbooks as part of the Leading Practice Sustainable Development Program (LPSDP) for the Mining Industry. The Mine Closure (LPSDP 2016a) and Mine Rehabilitation (LPSDP 2016b) handbooks are applicable to rehabilitation of waste dumps.

2.1.1 DMIRS

DMIRS takes an objective-based, non-prescriptive approach to assessing the suitability of waste dump closure designs. It is their expectation that mining proponents provide detail about how their project will meet DMIRS' stated broad objectives. These objectives are stated in the completion criteria framework document recently endorsed by DMIRS (Young *et al.* 2019), and in Appendix 2 of the recently updated Mine Closure Plan Guidance (DMIRS 2020):

> *"DMIRS' objective for rehabilitation and mine closure is that mining activities are rehabilitated and closed in a manner to make them (physically) safe to humans and animals, (geo-technically) stable, (geo-chemically) non-polluting/non-contaminating, and capable of sustaining an agreed post-mining land use, and without unacceptable liability to the State."*

[1] Formerly known as the Department of Mines and Petroleum (DMP).

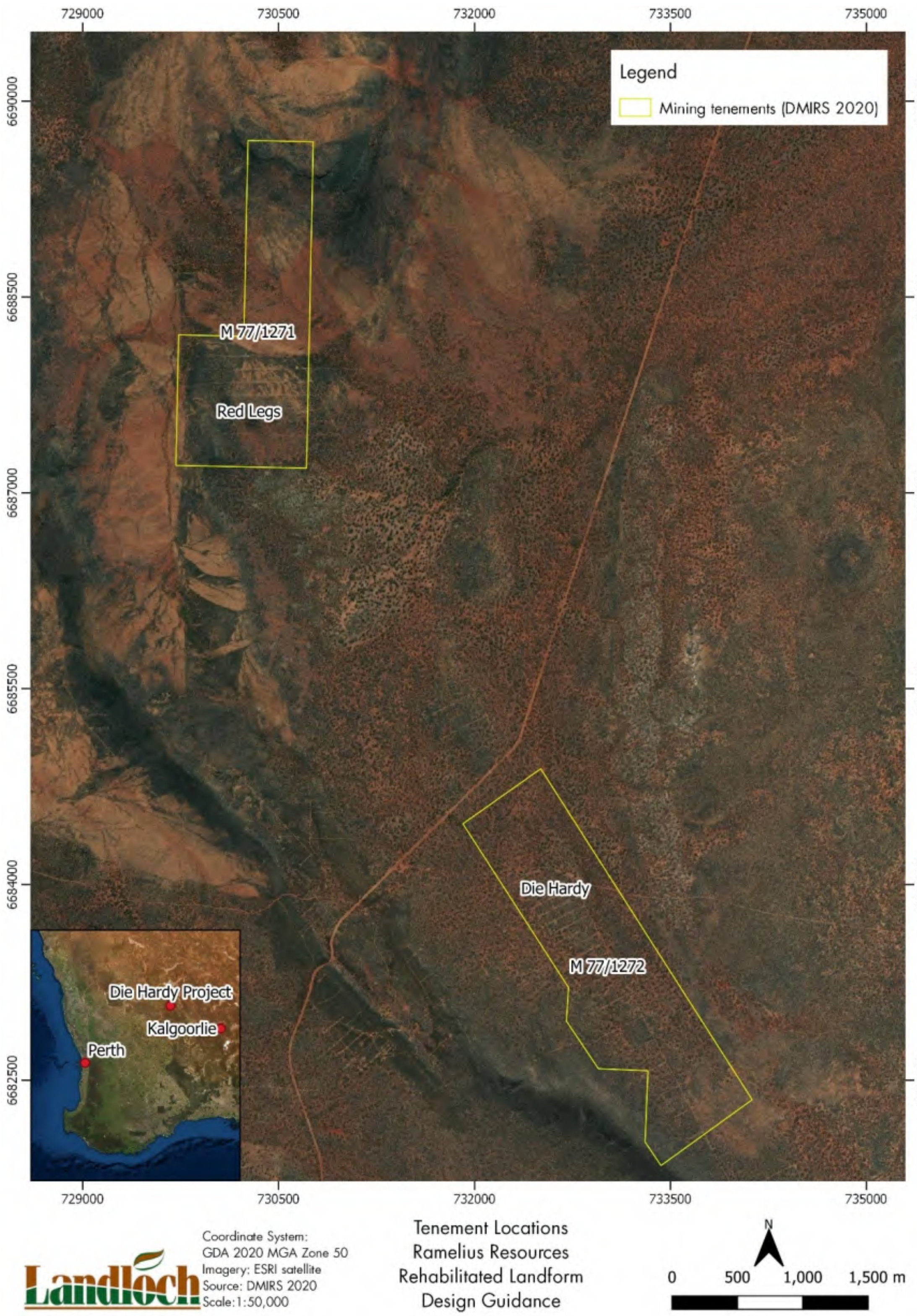

Figure 1: Location of tenements M77/1271 and M77/1272 within which Die Hardy is located.

Based on these broad objectives, land with a post mining land use consistent with 'Conservation and Natural Environments'[2] or 'Production from Relatively Natural Environments'[3] as defined using the Australian Land Use and Management classification (ABARES 2016) would require the development of vegetation consistent with the end land use (e.g., rangeland species) and would need to be non-polluting.

DMIRS' objectives are further detailed on page 27 of DMIRS (2020). Below are some relevant sections[4]:

> *From the project approval stage throughout mine life, the mine closure plan should demonstrate that ecologically sustainable mine closure can be achieved consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State.*
>
> …
>
> *Materials characterisation needs to be carried out prior to project approval to a sufficient level of detail to develop a workable closure plan. This is fundamental to effective closure planning. For existing operations, this work should start as soon as possible. Materials characterisation should include the identification of materials with potential to produce acid, metalliferous or saline drainage, dispersive materials, erosive rock, fibrous and asbestiform materials, and radioactive materials, as well as benign materials intended for use in mine rehabilitation activities. The identification of good quality rehabilitation material (e.g. benign, fresh rock) should also be carried out.*

Specific guidance provided by the DMIRS for waste dumps (DMP 2009) includes:

> *"When selecting the location of any waste rock dump please:*
>
> - *Take into account tenement boundaries and any natural features of the landform;*
> - *Don't interrupt significant drainage lines;*
> - *Blend the dumps into natural hill sides if possible;*
> - *Choose a location that will not be in the way of any possible future pit cut back or any other development;*
> - *Make sure the toe of any waste dump is not closer to the pit than the abandonment bund for that pit;*
> - *Design the pit abandonment bund according to the Department of Mines and Petroleum's guidelines;*
> - *Backfill earlier mined out pits if you can.*
>
> …
>
> *Design the profile of the dump (e.g. height and slope angles) to ensure that the final structure is safe, stable and not prone to significant erosion. Factors that should be considered in the design are material types, proposed vegetation cover, natural*

[2] Conservation purposes based on maintaining the essentially natural ecosystems present.

[3] Primary production with limited change to the native vegetation.

[4] Red underlining is Landloch's emphasis

topography and climate. Generally, more dispersive material, poorer topsoil and high dumps will require flatter outer slopes. Only the best conditions and stable materials would justify slopes approaching 20 degrees.

A major cause of serious erosion on newly created landforms is the lack of adequate drainage control. It is therefore essential to design and construct drainage control measures that will handle expected rainfall events. In arid regions, it is preferable to design the dump profile to be water retaining. This means that the top surface, berms and batters need to be constructed so that they hold the maximum expected rainfall event. The construction of suitably engineered impoundments on the flat surfaces and deep ripping at suitable intervals on the sloping surfaces will generally achieve the necessary control. Minimising slope lengths will help reduce water velocity and therefore reduce erosion potential.

2.1.2 LPSDP handbooks

The Australian Government's Mine Closure handbook (LPSDP 2016a) usefully defines a functional ecosystem (that is implicit in DMIRS' stated closure objectives) as, *"an ecosystem that is stable (not subject to high rates of erosion), is effective in retaining water and nutrients, and is self-sustaining."*

It also provides these useful guiding thoughts:

"The difficulties faced in the restoration of functioning ecosystems on such landforms, often under extreme ranges in temperature and rainfall, are often exacerbated by the properties of the waste material. The physical, chemical and geochemical characterisation of mine waste materials is used to identify potentially problematic waste—for example, potentially acid-forming, sodic or saline waste—or waste units suitable for use as near-surface growth medium, water-holding material or surface armour.

Identification of these characteristics—viewed in conjunction with local climatic conditions, the effects of climate change, the way waste materials are likely to weather and develop over time, and target closure objectives and completion criteria—is paramount to appropriate landform design.

…

The nature of the landform surface directly affects critical long-term objectives, such as resistance to erosion, the integrity of encapsulation of hostile wastes, the capacity to accept and store rainfall, and the ability to support plant growth. Ultimately, slope configuration, and the nature of surface material on those slopes, should be interdependent, with slope angle and length being constrained by the relative capacity of the surface material to resist erosion. Vegetation communities are typically one of the most visible outcomes of mine rehabilitation and thus are a logical focus of rehabilitation planning; however, success in establishing the community depends on creating an appropriate soil environment that forms a stable, functional cover.

The Australian Government's Mine Rehabilitation handbook (LPSDP 2016b) includes landform design as an integral part of rehabilitation. It also defines the characteristics of high and low risk landforms. These are summarised in Table 1 below, are a guide only, and are not absolutely prescriptive. That said, they do highlight the importance of materials, climate, and the shape of the landform when defining landform risk. Considering shape without also factoring in materials and climate is more likely to lead either the failure (and avoidable remediation costs) or to an overly conservative landform (and avoidable construction costs).

Table 1: Summary of high and low risk waste landform batter profiles

Low-risk Landforms	High-risk Landforms
High vegetation cover levels, effective at reducing erosion	Low vegetation cover levels, ineffective at reducing erosion
Low-moderate rainfall erosivity, associated with rain of low intensity and total values.	High rainfall erosivity associated with rain or high intensity and total values.
Low batter slope height (commonly ≤20m)	High batter slope heights (the definition of 'high' varies with climate and materials but in many situations ≥60m would be considered high)
Low erodibility materials, often with significant amounts of competent rock	Highly erodible materials, often with significant amounts of fine-grained materials
Capacity to reduce batter gradients to effective levels during rehabilitation	Limited capacity to reduce batter gradients to effective levels (i.e., footprint constraints)

2.1.3 Summary of regulator expectations

There is an expectation that landform designs meet the broad closure objectives stated by DMIRS. In order to meet these objectives, landform designs must objectively demonstrate that the landform shape (height, gradient, profile shape, footprint) is consistent with the constraints imposed on it by the climate, and the soil and waste material properties. This is achieved through assessment of long-term erosion potential, for which a range of erosion models are available.

There is an expectation in all the guidance documents that rehabilitation of waste landforms include revegetation. This is particularly clear given DMIRS has recently endorsed the closure criteria document in which the post-mining land use options all include vegetation consistent with the post-mining land use (no unvegetated post mining land use is contemplated).

2.2 Landloch's experience

2.2.1 Need for erosion modelling

WA mining regulators (DMIRS specifically) very commonly require that there be a clear link between the waste dump design and the soil and waste material properties. Results of erosion modelling and landform evolution modelling are typically requested, with an increasing expectation for these tasks to have been completed as materials become available and as the site nears the end of mine life.

Early implementation of landform designs underpinned by erosion modelling will increase the likelihood that designs are constructed cost effectively and in line with closure expectations.

2.2.2 Waste landform design life

DMIRS (2020) provides a reference point that is helpful in setting a design life for rehabilitated waste dumps. It states on page 16 that:

> *Development of completion criteria and associated performance indicators should commence upfront in the project approval stage for new projects or as early as possible for existing operations, and be reviewed and refined throughout the development and operation of the project to respond to monitoring, research and trial information and any other information or change as appropriate. The identified completion criteria and associated performance indicators must be able to demonstrate that rehabilitation is progressing as anticipated, particularly where mathematical modelling is utilised to predict long term (usually 300 years or longer) environmental performance (e.g. waste rock landforms).*

Therefore, it seems appropriate to design waste dumps for closure using a design life of ~300 years and adopt an acceptable risk of failure within that period (it is impossible to design a landform that poses zero risk at closure).

2.2.3 Assessing waste dump erosion risk

Assessment of long-term erosion risk of mine waste dump batters commonly does not consider erosion from individual storms. Rather, it defines acceptable erosion based on long-term erosion rates. This is because the available erosion benchmarks against which erosion can be assessed are almost always measures of long-term rates. These benchmarks include naturally occurring erosion rates and rates of soil formation, both of which are measured over decades or centuries and not for individual events.

It is important to note that elevated erosion of a batter during a large rainfall event does not necessarily cause irreversible changes to the batter surface condition such that all subsequent rainfall events yield higher erosion rates. It is the engineered runoff control structures that represent points in the landform design that can irreversibly change (i.e., fail) in a significant rainfall event. These structures include waste dump top crest bunds, mid-batter berms, rock drains, and toe drains. These features introduce a "brittleness" to a rehabilitation design.

For this reason, it is important to determine an appropriate design storm for use in designing engineering control structures for closure (but not for batter shapes). The design storms for closure planning will be much rarer (i.e., larger) than the design storms adopted during construction or operations is it cannot be assumed that ongoing maintenance of control structures will occur after waste dump rehabilitation.

2.2.4 Design storms for design of engineering structures

To inform what is an acceptable design storm for closure, Landloch considered the relationship between design storm events and risk outlined in the Guidelines on Tailings Dams (ANCOLD 2012) for structures with a shorter design life and then applied that risk to closure designs with a 300 year design life. The ANCOLD Guidelines are a commonly used engineering guidance document used to establish appropriate engineering design storms based on risk. These storms are defined by their Annual Exceedance Probabilities (AEP)[5]. Adopting the Guideline's approach for designing a tailings dam's spillway or freeboard in a location where the consequence of failure is minor or medium[6], and the population at direct risk (at closure in this instance) would be less than 10, the resultant risk rating is "very low" to "significant", and the recommended AEP is between 1% and 0.1%. Assuming an operational design life of 50 years, this equates to a 5-39% probability of the design storm being exceeded once in 50 years.

If a probability of failure of 10% is adopted (within the range currently accepted during operations for a TSF but towards the lower end of the range), for a design life of 300 years, this equates to an AEP of 0.04%, equivalent to an Annual Recurrence Interval (ARI) of 2,500 years.

Adoption of a design storm event with an AEP of 0.04% seems reasonable for design of engineered runoff control structures for rehabilitated waste dump at Die Hardy. A design storm with this AEP is considered an 'extreme' design storm event within the Australian Rainfall and Runoff design rainfall classification scheme[7] (Ball *et al.* 2019). Adoption of even more extreme design storms would only be adopted if the risk posed by erosion at Die Hardy can be shown to be greater than outlined above.

---

[5] AEP is the probability that a given event accumulated over a given duration will be exceeded in any one year.

[6] Cost of damage to infrastructure <\$10M; <100 people affected; Social dislocation <100 people or <20 business months; <1km² impacted; impact duration <1 year; damage to the environment limited to items of low conservation value (degraded or cleared land, ephemeral streams, non-endangered flora and fauna), and remediation possible. Cost of damage to infrastructure \$10M-\$100M; 100-1000 people affected; 100-1000 person or 20-2000 business months dislocated; <5km² impacted; impact duration <5 years; significant effects on rural land and local flora and fauna. Limited effects on items of local and state natural heritage, and limited effects on native flora and fauna within forestry, aquatic and conservation reserves, or recognised habitat corridors, wetlands, or fish breeding areas.

[7] AR&R design rainfall classes – Very frequent: 12 to 1 exceedances per year (EY); Frequent: 1 EY to 0.1 AEP; Infrequent: 0.1 to 0.01 AEP; Rare: 0.01 to 0.0005 AEP; Extreme: <0.0005 AEP.

There is currently a trend among WA regulators (that is not yet found in any published guideline) to request that Probable Maximum Precipitation (PMP) events be included in landform designs. The PMP is generally equated to an event with an ARI of 10 million years (AEP of 0.00001%). The likelihood of such an event occurring in 300 years is 0.003%. In other words, there is a 99.997% chance that the PMP would not occur in 300 years.

Inclusion of such extreme events in landform designs is not warranted and stands at odds to standard engineering practice. Such extreme events are only adopted when the consequence of failure is high to extreme, that is where failure has potential to cause loss of thousands of lives and property damage in the order of >$1B. In practice, erosional failure of a waste landform at Die Hardy is very unlikely to result in extreme discharges of runoff or sediment that would cause loss of life or very expensive property damage.

2.2.5 Erosion benchmarks for use in landform design

Assessing the potential erosional stability of rehabilitated landform designs requires the use of erosion and/or landform evolution models to consider long-term erosional performance. Critical to the modelling process is the establishment of an erosion benchmark at or below which landform designs are deemed acceptably stable, and above which design are deemed unacceptable.

A wide range of approaches have been used to define erosion benchmark values, including linking it to:

- rates of soil formation;
- maintenance of soil quality, which may include considerations of plant productivity, effective soil depth, and soil organic matter and nutrient stores;
- rates of natural erosion in adjoining areas;
- potential for gully formation; and
- water quality impacts.

A recent review of data for the Pilbara region (which would be broadly applicable for Die Hardy given the arid climate) (Howard and Loch 2019) found that a mean average annual rate of 6t/ha/y and a peak average annual rate of 12t/ha/y would be suitable for design purposes where the risk is defined as ‘moderate’. A ‘moderate’ risk rating seems appropriate for Die Hardy because there will be significant proportions of fine grained wastes that will not present as durable, blocky rock, and because of the potential for erosion to cause degradation (rather than functional loss) of the wider ecosystem.

2.2.6 Landform shape limitations

Depending on the erodibility of the materials on site, it is possible for the erosion model predictions to indicate that quite steep, high, and/or long slopes would be stable. However, Landloch has observed that very long and/or very steep waste dump batters are quite difficult to construct in practice because of the need for very exacting quality control measures.

Very narrow mid-slope berms (5-10m once the rehabilitation shape has been created) have also been questioned by the regulators because these small widths have been observed to consistently lead to rehabilitation failure. Rather, widths are expected to be set based on their ability to contain a rare rainfall event. For this guidance document these structures are set based on an event with an AEP of 0.04%.

Gradients steeper than 18-20° are typically not readily accepted by the regulators because they:

- Are unsafe to traverse with machinery.
- Have also long been associated with poor vegetation establishment (DME 1996).
- Cannot be ripped and spread with topsoil, reducing vegetation growth potential.

For this guidance document, a maximum batter gradient of 18° was adopted.

3 RAINFALL AND VEGETATION

Erosion potential of waste dumps is strongly influenced by the near-surface materials that are being stored, the shape of the landforms constructed, and the climate. With regards to climate, rainfall is most critical for landform design as rainfall totals and rainfall intensities influence runoff potential which in turn influence erosion potential.

3.1 Rainfall

Die Hardy has an arid, desert climate with distinct summer and winter rainfall patterns. The Bureau of Meteorology (BoM) weather stations located near Die Hardy include Turkey Hill (12079), located ~90km south of Die Hardy. Patched point data for this site was sourced for the period 1 January 1929 to 31 March 2021.

The median annual rainfall is 298mm and the mean annual rainfall is 297mm, indicating that there is little skew in the annual data due to rare large or small annual rainfall totals. This can be seen in the histogram of annual rainfall values for Turkey Hill, shown in Figure 2. Of the 92 years of rainfall data considered, the year 1999 had an annual rainfall of 662mm and 1940 had an annual rainfall of 116mm.

Die Hardy's annual rainfall patterns are temporally highly variable (Figure 3). Although on an annual basis, the long-term average rainfall values are consistent with an arid climate, it is important to note that there are periods of higher rainfall activity, which means that erosion is likely to also be variable from year to year.

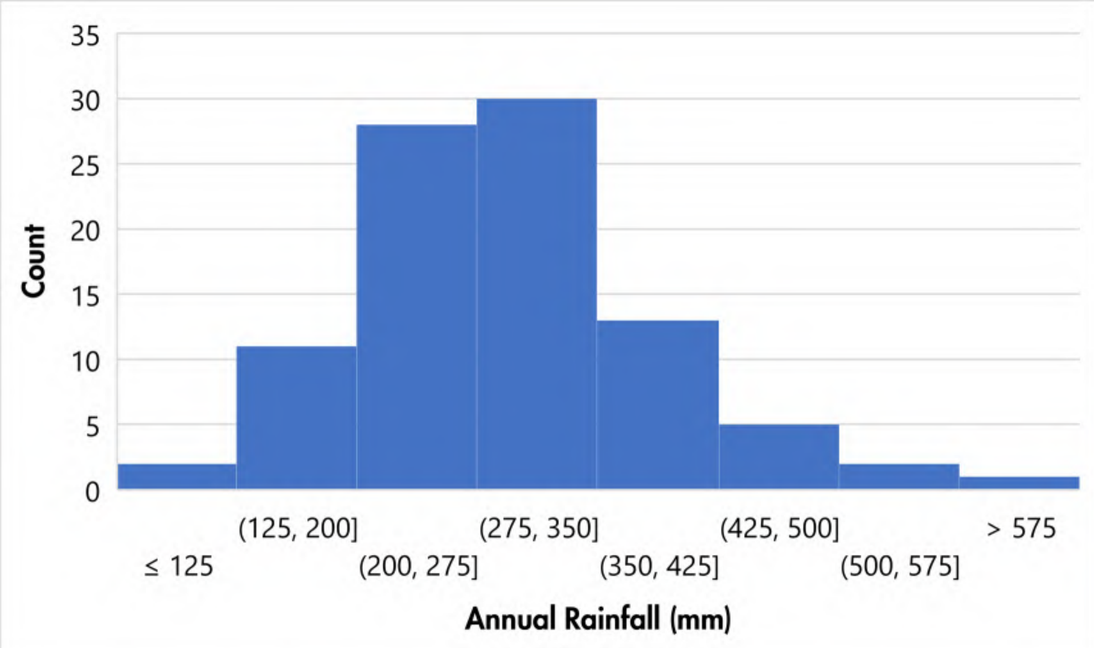

Figure 2: Histogram of annual rainfall totals for Turkey Hill (12079)

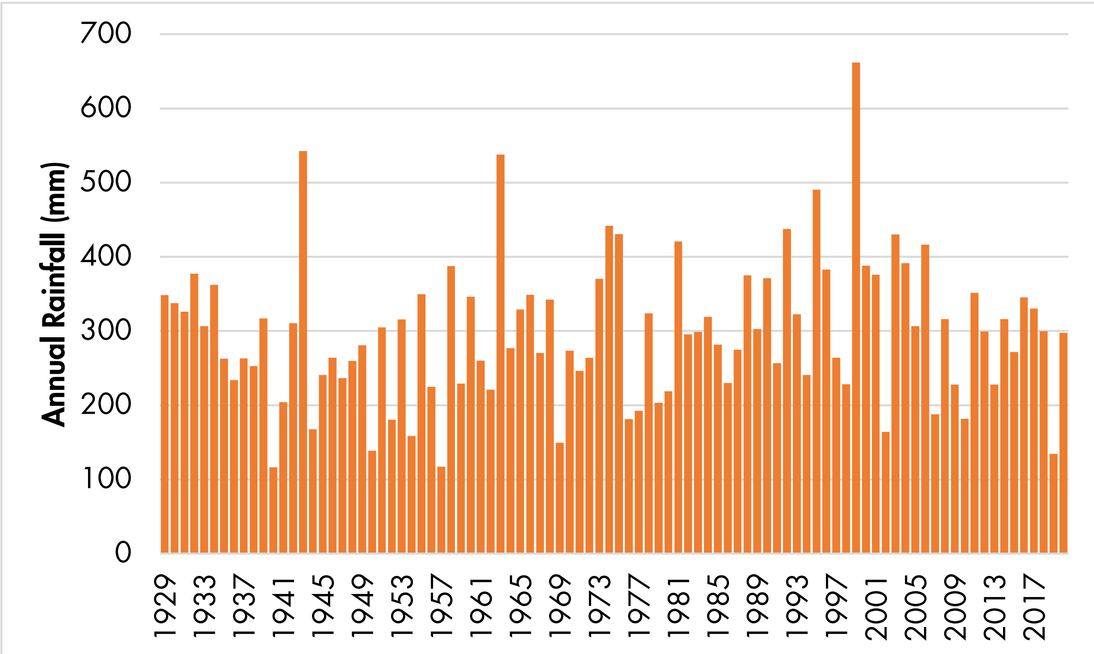

Figure 3: Annual rainfall totals, Turkey Hill (1929-2020).

Average monthly rainfall is highest during the winter months of June to August, and the shoulder month of May. Average rainfall in May to August range from 31-41mm. The remaining months have average rainfalls ranging from 14-26mm (Figure 4).

Annual rainfall values of <300mm will mean that vegetation levels are likely to be low and a high proportion of the land surface will be bare and exposed to the erosive forces of rain and to surface runoff.

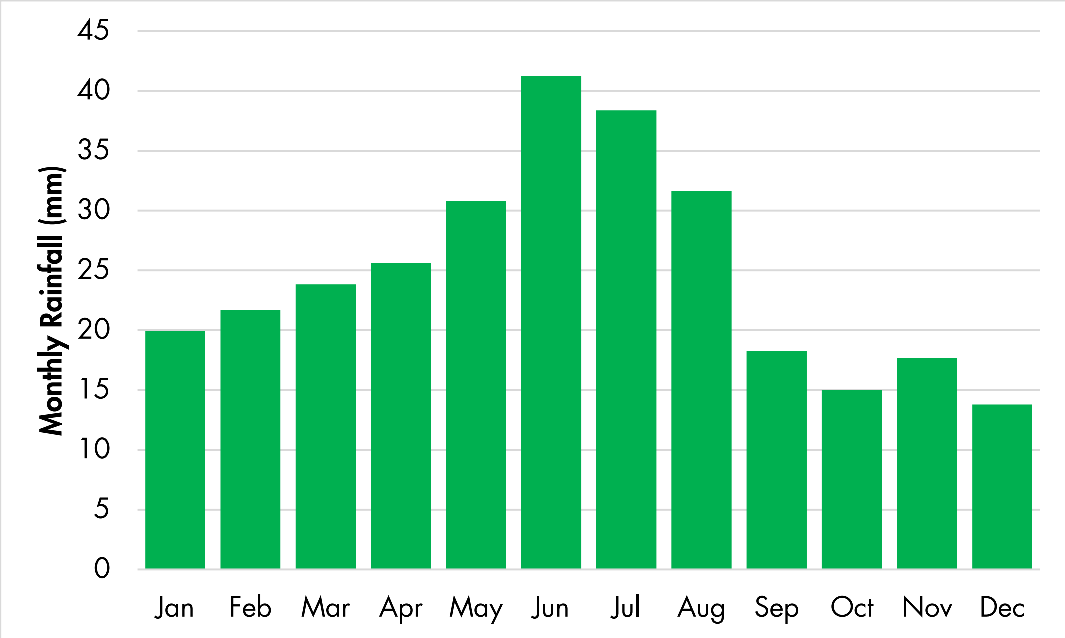

Figure 4: Mean monthly rainfall for Turkey Hill (1929-2020).

3.2 Rainfall erosivity

The erosive force of rain is expressed by rainfall erosivity. Historical rainfall erosivity mapping shows annual erosivity values for the Die Hardy area of 500MJ.mm/(ha.hr.yr) (Rosewell 1993). In terms of waste dump erosional stability, it can be expected that Die Hardy is in a climate that makes erosion by water likely, particularly on steep waste dump batter slopes. Monthly erosivity distributions (based on data from Vrieling et al (2014)) are shown in Figure 5. Monthly erosivity trends closely follow monthly rainfall trends. This indicates that the erosivity is suitably distributed throughout the year.

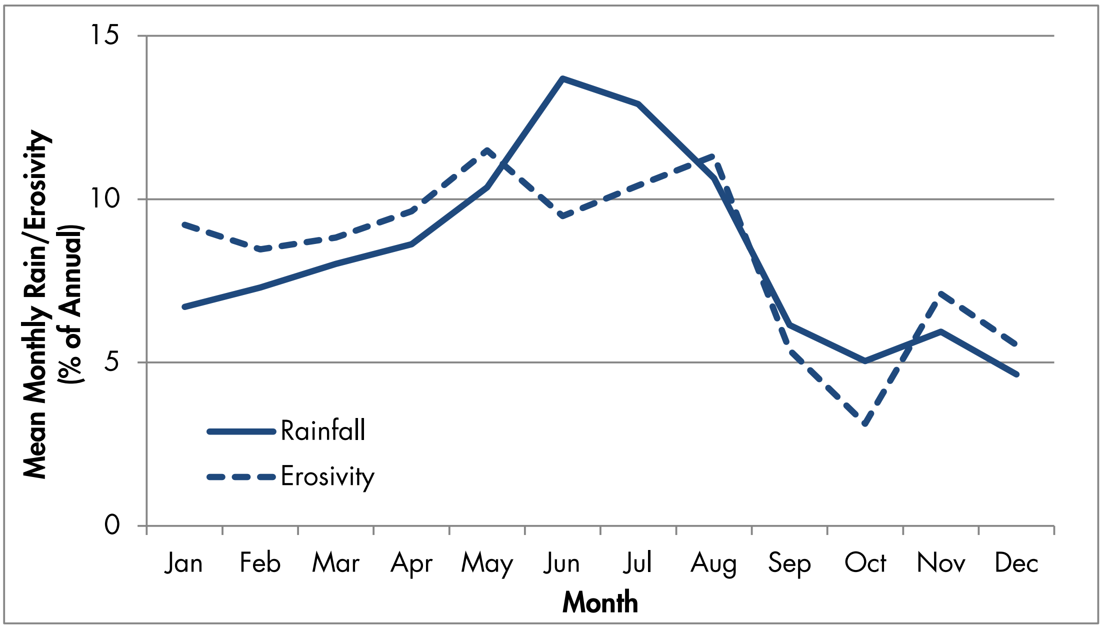

Figure 5: Mean monthly erosivity and rainfall for Die Hardy, expressed as a percentage of the mean annual total values.

3.3 Vegetation impacts on erosion

The WA Department of Agriculture has previously mapped land systems for the rangelands regions of WA. For the Die Hardy area, the land is defined as consisting of[8]:

- Ridges of banded iron formation supporting dense mixed shrublands with emergent native pines, mallees and casuarinas;
- Sandy plains supporting tall shrublands of mulga and bowgada with patchy wanderrie grasses; and
- Alluvial plains supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.

Values for bare ground for the area range from 30-50%[9], meaning canopy cover levels of 50-70%. Shrublands and grasslands with 50-70% canopy cover tend to have surface contact cover levels (grasses in direct contact with the surface) in the order of 2-10% (Payne and Mitchell 2002). Erosion control by vegetation is largely achieved through the presence of grasses that are in direct contact with the soil surface (i.e., surface contact cover). The Revised Universal Soil Loss Equation's (RUSLE) (Renard et al. 1997) cover factor provides a useful benchmark when the effects of vegetation on erosion are being considered. Figure 6 is a typical curve relating erosion by water and surface contact cover for an arid zone. The soil loss ratio is the ratio of erosion from a surface with a certain level of cover to erosion from an unvegetated (bare) soil.

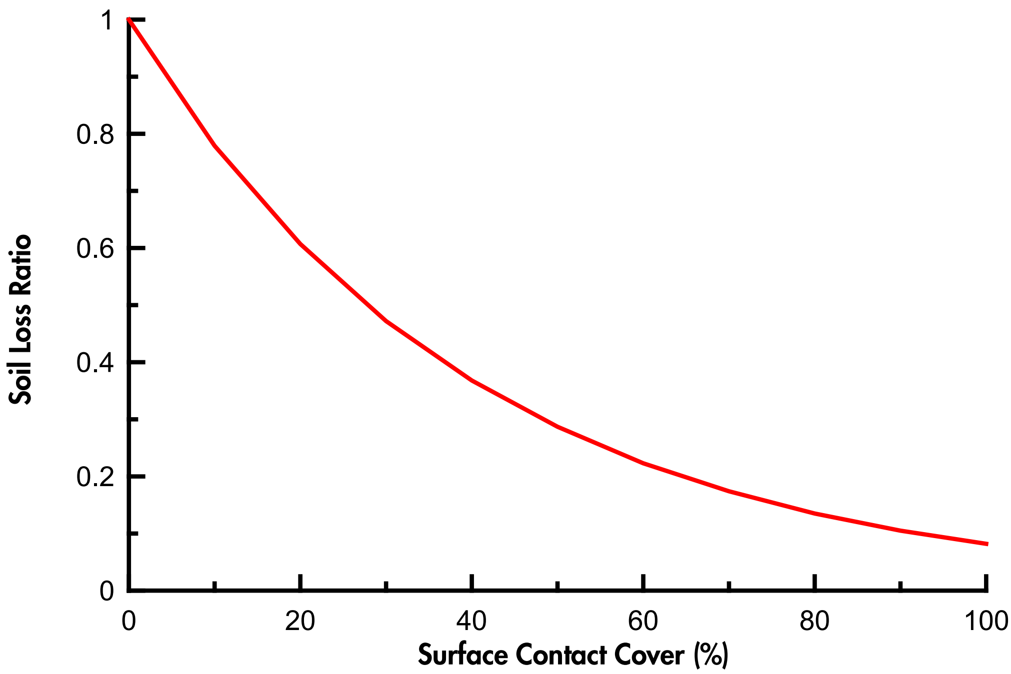

Figure 6: Soil loss ratio for a range of surface contact cover levels.

[8] https://maps.agric.wa.gov.au/nrm-info/
[9] https://maps.tern.org.au

For a 2-10% surface contact cover level, erosion could be expected to be ~90% of the erosion that would occur from an unvegetated surface. Therefore, although vegetation has some impact on soil erosion, it is unlikely to be able to manage erosion risk in the long-term at Die Hardy.

This means that the surface created during rehabilitation must be suitably stable against erosion without the assistance of vegetation. This approach will ensure stability is reached quickly, and that periodic events such as fire or drought, and other pressures such as animal grazing will not adversely impact erosion potential. Further, surfaces that are erosionally stable are also more likely to support the germination and growth of vegetation than surfaces that are mobile and erosion prone.

4 MATERIAL CHARACTERISATION

The key soils and mining wastes at Die Hardy were characterised in order to consider their usefulness in terms of rehabilitation. This section details the material types identified and the characterisation of these materials from a rehabilitation perspective.

4.1 Material types

4.1.1 Soils

Eighteen (18) soil samples were collected from Die Hardy and Red Legs. Two (sites 11 and 12) were located between Die Hardy and Red Legs and were not considered in this study. The coordinates of these soil samples are listed in Table 2 and shown in Figures 7 and 8.

Table 2: Soil sample coordinates (MGA Zone 50)

Deposit	Sample ID	Easting (m)	Northing (m)
Die Hardy	SCDH001	732314	6684863
	SCDH002	732462	6684547
	SCDH003	732645	6684349
	SCDH004	732365	6684312
	SCDH005	732741	6684069
	SCDH006	732975	6683926
	SCDH007	732998	6683574
	SCDH008	732667	6683560
	SCDH009	733214	6683396
	SCDH010	733027	6683212
Red Legs	SCDH013	730719	6687878
	SCDH016	730365	6688058
	SCDH018	730486	6687853
	SCDH014	730012	6687848
	SCDH019	730632	6687640
	SCDH015	730377	6687627
	SCDH017	730174	6687646
	SCDH020	730511	6687445

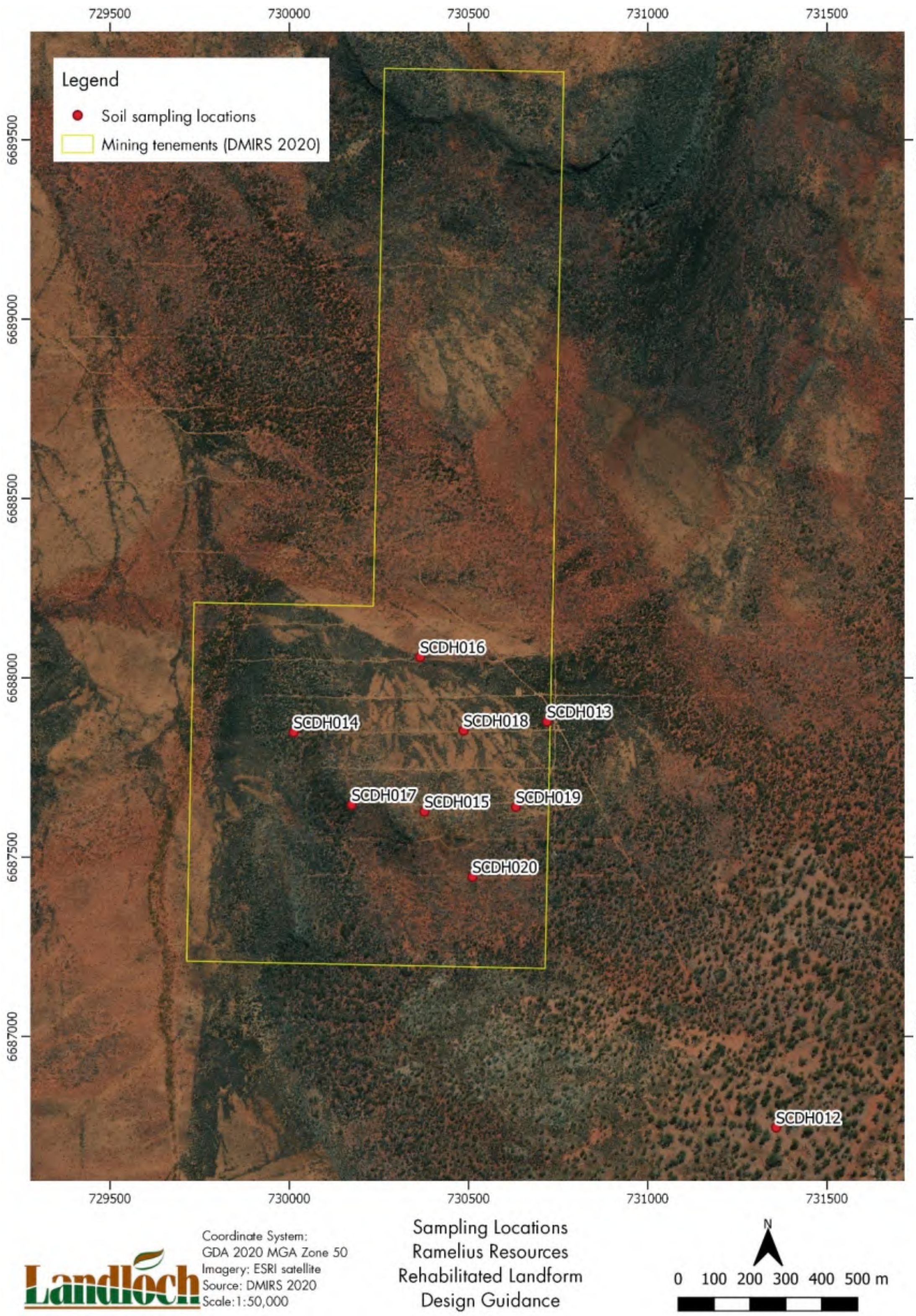

Figure 7: Soil sample locations of Red Legs.

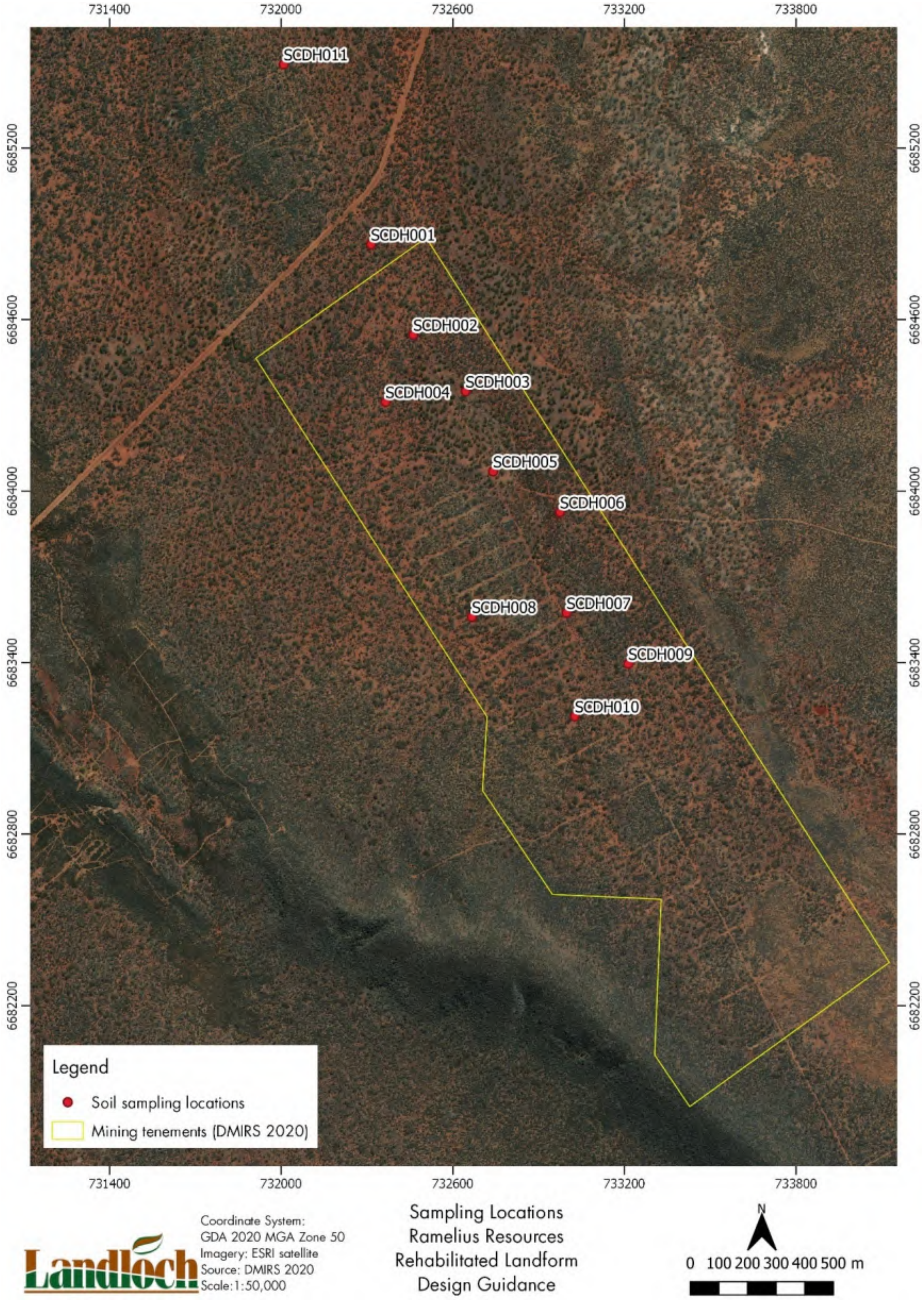

Figure 8: Soil sample locations of Die Hardy.

4.1.2 Wastes

The waste types for Die Hardy include Laterite, BIF (Banded Iron Formation), Mafic, and Ultramafic. Ramelius provided waste volumes[10] to Landloch on 4 March 2021. These volumes are given in Table 3. The volume data indicates that the majority of wastes are oxidised or transition materials. Only 1% of the Die Hardy waste is classed as fresh. The samples included mafic wastes that are not indicated to be present within the proposed pit. Data for these materials are included in the report, but are not used when considering waste dump design risks.

Table 3: Waste volumes

Waste Type	Oxide	Transition	Fresh
Ultramafic	935,610	31,454	23,650
Laterite	673,031	4,000	
BIF	337,050	1,001,956	5,531
Proportion	65%	34%	1%

Fifteen (15) waste samples were collected from Die Hardy. The coordinates and a description of the waste samples are listed in Table 4. The locations of drill hole collars from which the waste samples were taken are shown in Figure 9.

Table 4: Waste sample details (MGA Zone 50)

Sample ID	Hole ID*	Easting (m)	Northing (m)	From (m)	To (m)	Rock Type	Oxidation
WCDH001	0070	732479	6684011	4	7	Laterite	Oxide
WCDH002				30	33	BIF	Transition
WCDH003	0064	732550	6683912	10	13	Mafic	Oxide
WCDH004				33	36	BIF	Transition
WCDH005				60	63	Mafic	Fresh
WCDH006	0039	732712	6683725	3	6	Laterite	Oxide
WCDH007				30	33	BIF	Transition
WCDH008	0028	732754	6683567	27	30	Ultramafic	Oxide
WCDH009				67	70	BIF	Fresh
WCDH010	0015	732873	6683403	2	5	Laterite	Oxide
WCDH011				30	33	BIF	Oxide
WCDH012				42	45	BIF	Transition
WCDH013	0011	732930	6683387	5	8	Mafic	Oxide
WCDH014				15	18	BIF	Oxide
WCDH015	0013	732896	6683370	67	70	Ultramafic	Fresh

* All holes have the prefix FBRC

[10] Based on the CLIPPED_DH_0221_V4.DTM design file

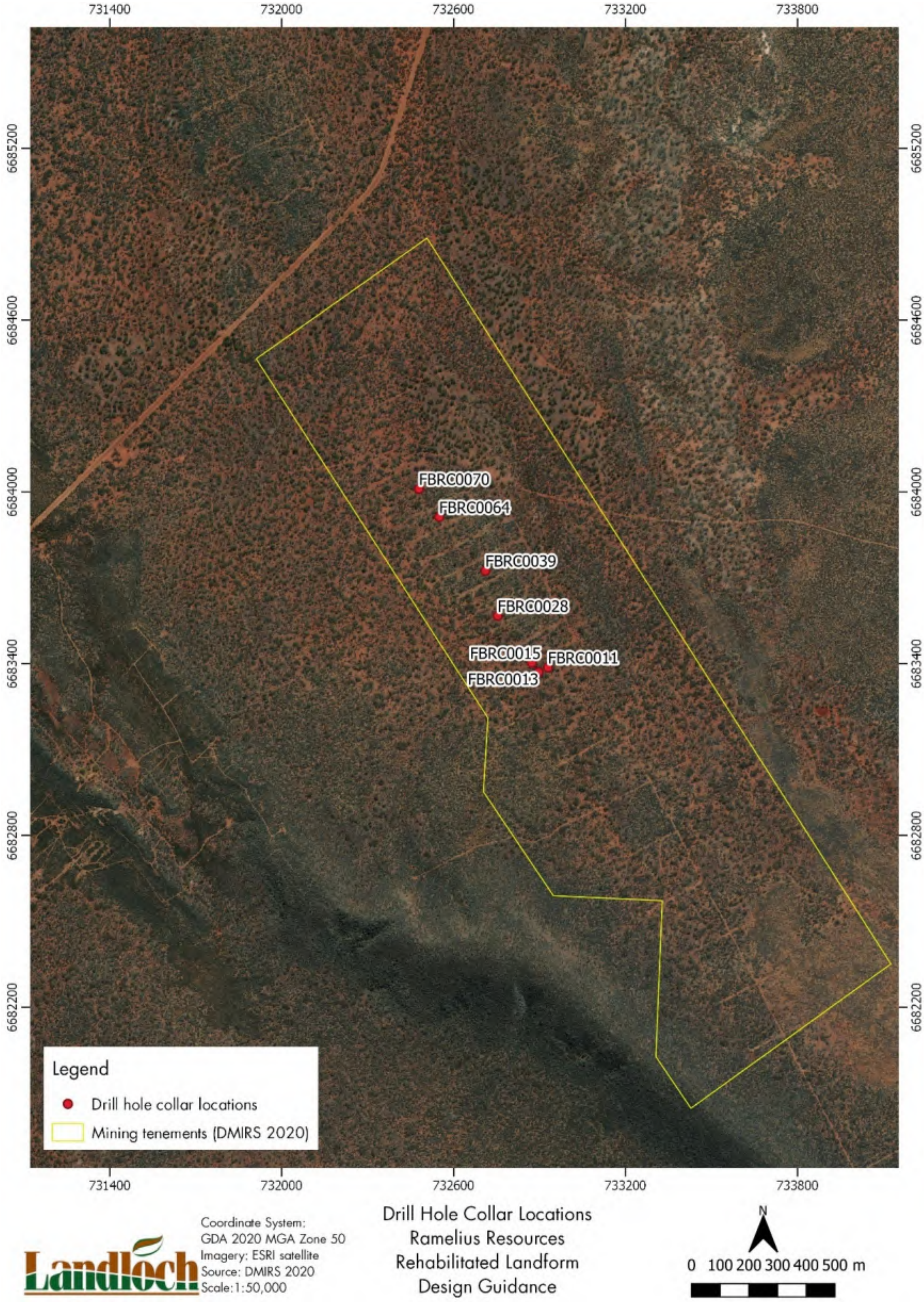

Figure 9: Collar locations of drill holes from which waste samples were sourced.

4.2 Sample testing

4.2.1 Soils

The 20 soil samples were collected and tested by Ramelius. The following basic material properties were considered:

- $pH_{1:5}$ ($CaCl_2$), converted to Ph (water) by adding 0.7 pH units;
- $EC_{1:5}$;
- Total N and P;
- Organic C;
- Exchangeable cations (Ca^{2+}, Mg^{2+}, K^+, Na^+, Al^{3+});
- Effective cation exchange capacity (ECEC);
- Exchangeable sodium percent (ESP);
- Stone content;
- Particle size distribution (sand, silt, clay); and
- Emerson dispersion class.

4.2.2 Wastes

The 15 wastes samples were collected and tested by Ramelius. Issues related to acid and metalliferous drainage are not considered in this report. As such, of the testing completed by Ramelius, only the EC and NAG pH values were considered.

Landloch conducted testing on the available rock chips in the RC drilling material for the following:

- Water absorption;
- Rock density; and
- Rock hardness.

4.3 Data interpretation

The basic material characterisation testing data were interpreted based on Landloch's experience and within the context of available guidelines, such as:

- *Interpreting soil test results – What do all the numbers mean?*, 3rd edition, P. Hazelton & B. Murphy (CSIRO Publishing, Clayton South); and
- *The Rock Manual – The use of rock in hydraulic engineering*, 2nd edition, CIRIA, CUR & CETMEF (CIRIA, London).

4.4 Soils

The results of the soils testing are given in Table 5.

Table 5: Basic characterisation data for the soils.

Sample ID	pH (water)	EC$_{1:5}$ (dS/m)	Exchangeable Cations (meq/100g)						ESP (%)	Emerson Class	N (mg/kg)	Org C (%)	P (mg/kg)	Stones (>2mm) (%)	Particle Size (<2mm)		
			CEC	Ca	K	Mg	Na	Al							Sand. (%)	Silt. (%)	Clay. (%)
Die Hardy																	
SCDH001	6.1	0.03	8	3.1	0.22	1.1	0.06	<0.02	0.8	2	350	0.55	180	40.6	74	10	17
SCDH002	6.7	0.02	9	5.1	0.86	1.2	0.07		0.8	2	340	0.51	210	7.0	64	14	22
SCDH003	8.8	0.07	19	15	0.49	2.1	0.13		0.7	1	370	0.47	120	27.5	75	15	10
SCDH004	4.9	0.01	6	1.6	0.18	0.48	0.02		0.4	3	380	0.66	180	11.9	77	6	17
SCDH005	8.3	0.20	28	13	0.75	8.2	2.5		9	1	420	0.50	110	31.5	59	22	19
SCDH006	8.4	0.06	19	12	0.48	3.7	0.08		0.4	1	420	0.50	130	29.7	72	17	11
SCDH007	5.8	0.02	7	3.6	0.24	0.82	0.02	0.02	0.3	3	380	0.62	190	37.5	76	8	16
SCDH008	6.1	0.01	5	1.8	0.22	0.8	0.04	<0.02	0.7	2	270	0.43	190	18.6	83	6	12
SCDH009	6.2	0.02	6	2.5	0.45	0.78	0.04		0.7	2	370	0.48	180	17.3	78	9	13
SCDH010	4.8	0.02	6	0.65	0.16	0.29	<0.02	0.88	0.2	2	410	0.58	170	38.4	71	11	18
Red Legs																	
SCDH013	4.8	0.02	4	0.09	0.04	0.03	<0.02	0.66	0.2	5	230	0.49	110	43.0	84	8	8
SCDH016	6.8	0.07	7	7.6	0.46	1	0.08		1.2	3	930	1.94	110	30.0	82	8	11
SCDH018	6.1	0.04	8	4.8	0.24	0.46	0.02	0.05	0.3	3	500	1.33	120	38.4	85	8	7
SCDH014	5.0	0.03	5	0.75	0.08	0.3	0.04	0.44	0.8	5	380	0.85	150	51.8	79	8	13
SCDH019	4.9	0.02	4	0.44	0.07	0.1	<0.02	0.64	0.2	5	240	0.37	130	44.8	83	7	11
SCDH015	5.4	0.04	5	1.5	0.13	0.23	<0.02	0.13	0.3	5	420	0.78	200	37.5	77	9	14
SCDH017	5.3	0.08	5	2.4	0.31	1.1	0.08	0.21	1.5	3	800	1.94	220	25.3	67	11	22
SCDH020	4.8	0.02	5	0.55	0.09	0.11	<0.02	0.8	0.2	3	350	0.63	170	25.9	82	5	13

4.4.1 Soil pH

The soils have strongly acid to moderately alkaline pH values. The mean value is 6.1 (slightly acid). All soils at Red Legs were strongly to mildly acidic. Three of the ten samples (3, 5, and 6) from Die Hardy were alkaline and the remainder were acidic.

A difference in pH of strongly acid to slightly acidic at Red Legs is unlikely to impact on the relative availability of the key elements for plants such as Nitrogen, Phosphorus, Potassium, and Sulphur. The alkaline soils at Die Hardy may result in different nutrient availability compared to the acidic soils. As such, there is value in considering vegetation differences between the alkaline and acidic soils and ensuring that future seeding incorporates species that are capable to deal with either (or both) acidic and alkaline soils.

4.4.2 Soil $EC_{1:5}$

The salinity (EC) of all but one of the soil samples are classed as very low or low. Sample SCDH005 was classed as having medium salinity. These values are unlikely to have a negative effect in terms of plant response. Salinity is unlikely to pose a risk to successful plant growth as part of rehabilitation.

4.4.3 Particle size

The soils generally contain appreciable stones (>20%) and would be classed as gravelly or stony soils.

The Die Hardy and Red Legs soils have a loamy sand to loam texture. This is equivalent to clay contents ranging from 7-22%. Soils commonly have sandy loam textures.

The gravelly/stony loam nature of the surface soils will mean that the soils will be prone to water erosion, but that the stone fraction will assist in providing some protection against detachment.

4.4.4 Exchangeable cations and structural decline

Structural decline of the soil fine fraction can be considered from a range of perspectives. Four perspectives are considered in this report.

First, the Exchangeable Sodium Percentage (ESP) is an indicator of structural decline caused by clay dispersion. Typically, ESP values >6% indicate an increased risk of clay dispersion, though clay dispersion is influenced by complex interactions between exchangeable cation types, salt concentrations, and clay content. Second, magnesic soils (those with elevated exchangeable magnesium concentrations relative to the other exchangeable cations) can be dispersive even when the ESP is <6%. Third, very low salinity can also increase the tendency for soil structural decline, even in soils that, by definition, are not otherwise dispersive. The Electrochemical Stability Index (ESI) has recently been developed as a means of considering the relationship between sodicity and salinity. The ESI is defined as the ratio of $EC_{1:5}$ and ESP. A tentative critical ESI value for soils is 0.05. Materials with ESI <0.05 can be considered potentially prone to structural decline caused by clay dispersion. Finally, materials with very high fine sand, silt, and clay fractions (fine sand + silt + clay >70%) are increasingly prone to mobilisation of these fine particles within the macropores of the soil matrix.

To capture these complexities, a material's tendency for structural decline has been defined based on four sets of conditions. If any of these sets of conditions are true, the material is classified as being prone to structural decline:

Condition 1) ESP-based criteria:

- ESP > 6%,
- clay content >10%,
- ECEC >3meq/100g, and
- exchangeable sodium concentration >0.3meq/100g.

Condition 2) Exchangeable Mg-based criteria:

- clay content >10%;
- ECEC >3meq/100g; and
- Ratio of exchangeable Ca to exchangeable Mg <0.5.

Condition 3) ESI-based criteria:

- clay content >10%,
- ECEC >3meq/100g,
- exchangeable sodium concentration >0.3meq/100g, and
- ESI <0.05.

Condition 4) PSD-based criteria:

- Fine sand + silt + clay >70%

Based on these conditions, the soils are generally not prone to structural decline. They typically have low ESP (only one value was greater than 6%), ESI >0.05 on all but two samples, Ca:Mg ratios greater than 0.5, and acceptable fine sand + silt + clay fractions (only one value was greater than 70%).

4.4.5 Fertility

4.4.5.1 Organic C

Soil carbon and the associated biological activity is often the attribute that distinguishes soil from the underlying material (including subsoils). Increasing organic C increases water retention, decreases runoff potential, and reduces erosion potential, although the degree to which it does these varies from soil to soil. Although organic Carbon is likely to have an impact on erosion potential, it should be noted that it is confined to relatively shallow soil depths and its influence on soil physical properties diminishes rapidly with soil depth as a result. Murphy (2015) suggests than the largest influence of organic Carbon is on the surface 0.1m and reduces significantly in soil depths at 0.2m. Similar findings were reported by Loch *et al.* (2008) for more arid zone soils.

This is important in the context of soil use in mine rehabilitation. Often, soil stripping activities will strip and homogenise soils to 0.2-0.3m (or deeper), meaning than the homogenised soil will have Organic C levels ~2 times (or more) lower straight after stripping. Also, during stripping and stockpiling, much of the Organic C that is bound up in the organic matter is disturbed and reduced. This means that soils used in mining quite often have depleted Organic C levels (Spain *et al.* 1995). When subsoils and wastes with little to no Organic C prior to their disturbance are considered, it is clear that their Organic C levels will likely be very low.

A suggested value of low Organic C that could be used to define erosion prone soils would be <0.5%, with values >1.5% being a value for soils that support vegetation[11]. An Organic C value of 0.5% is associated with poor soil structure and very low soil health. Rates >1.5% are associated with moderate to high soil health, improved structural stability, and improved vegetation (Hazelton and Murphy 2016).

The majority of soil (~75%) have Organic C levels (>0.5%). The remaining 25% has low Organic C. This indicates that the organic matter levels are generally acceptable and for most soils would be beneficial to reducing erosion potential.

4.4.5.2 Total N and P

Total N values are very low to low for all samples. That said, the C/N ratio for all except one sample is <25, indicating the decomposition of organic matter will not be slowed by a lack of Nitrogen. Total P values are all low but consistent with arid land soils from the Goldfields area.

4.5 Wastes

The results of the waste testing are given in Table 6.

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[11] It is noted that organic Carbon is different to organic matter. Organic matter is a term that is usually used in the broadest sense to describe a wide range of organic components in the soil, including living and non-living organic materials. Organic matter and organic carbon are usually expressed as a percentage of the soil by weight. When results are presented and interpreted, care should be taken to note whether organic matter or organic carbon levels are indicated. Organic matter is calculated from the levels of organic carbon in the soil, by multiplying by ~1.75. This factor assumes that the organic matter in the soil has a constant carbon composition of ~57%. The actual conversion factors of organic carbon to organic matter do vary from 1.72–2.00.

Table 6: Waste testing results

Sample ID	Rock Type	Oxidation	NAG pH (pH Units(	$EC_{1:5}$ dS/m	Average Rock Density (g/cm³)	Average Water Absorption (%)	Rock Durability
WPH45001	Laterite	Oxide	7.98	2.28	2.2	7.2	R2 - Weak
WPH45002	BIF	Transition	7.33	0.40	2.0	18.6	R2 - Weak
WPH45003	Mafic	Oxide	7.68	1.43	Disintegrated	Disintegrated	R1 – Very Weak
WPH45004	BIF	Transition	7.51	0.09	3.0	2.5	R4 - Strong
WPH45005	Mafic	Fresh	8.34	0.18	4.4	0.0	R6 - Extremely Strong
WPH45006	Laterite	Oxide	7.33	0.04	2.3	10.8	R4 - Strong
WPH45007	BIF	Transition	7.85	0.10	1.9	13.8	R1 – Very Weak
WPH45008	Ultramafic	Oxide	7.70	1.56	2.7	4.5	R2 - Weak
WPH45009	BIF	Fresh	6.24	0.75	2.8	3.9	R4 - Strong
WPH45010	Laterite	Oxide	7.49	1.19	3.3	1.6	R3 - Medium Strong
WPH45011	BIF	Oxide	7.60	0.66	2.7	0.2	R4 - Strong
WPH45012	BIF	Transition	7.46	0.51	4.8	1.7	R5 - Very Strong
WPH45013	Mafic	Oxide	7.69	0.69	2.0	15.9	R1 – Very Weak
WPH45014	BIF	Oxide	7.64	0.39	2.1	20.1	R1 – Very Weak
WPH45015	Ultramafic	Fresh	7.92	0.12	3.2	1.7	R5 - Very Strong

4.5.1 Material pH

The pH values of the wastes have not been measured. However, the NAG pH (pH value of the sample after complete oxidation of its sulphide content during the Net Acid Generation test) is available. Based on the NAG pH values the wastes sampled are alkaline. This means that the wastes generally have higher pH values than the soils. The alkaline wastes may result in different nutrient availability compared to the acidic soils. As such, there is value in considering incorporation of species that are adapted to alkaline conditions.

4.5.2 Material EC

The salinity ($EC_{1:5}$) the wastes are variable, ranging from very low (0.04dS/m) to extreme (2.28dS/m). The median value is 0.5dS/m which is classed as high. Salinity values of 0.7-1.4dS/m are likely to impact the growth of salt sensitive and moderately tolerant species, and salinity values of 2.28dS/m are likely to limit the growth of even salt tolerant WA rangeland species (Tanji and Kielen 2002).

The salinity values for the wastes are often higher than those measured for the soils. Their use at or near the surface (i.e., within the active rooting zone) should be avoided. Given that the wastes are also likely to be dominated by fines (see discussion below on rock durability), there is also a risk that salts from the waste may rise into the lower salinity sandy loam surface soils if they are placed over the saline wastes. The likelihood and consequences of this risk should be assessed through solute balance modelling supported by field trials that considers long-term rainfall patterns. For this report, it is considered prudent to assume that the waste dump will likely be moderately saline and capable of supporting only more salt tolerant shrub and tree species. Establishment of species that produce high levels of surface contact cover is unlikely.

4.5.3 Rock durability

An assessment of the durability of the rocky component of the RC drilling material provided was conducted in order to consider the likely character of the wastes that would be extracted and be present within a constructed waste landform. The testing used the available rock chips found within the sample provided.

The assessment of the rock component followed a selection of the quality and durability criteria provided in the Rock Manual. (CIRIA et al 2007). The Schmidt hammer values were used to assess hardness and were those from (ISRM 1978). A summary of the classification scheme used in given in Table 7.

Each of the samples were assessed using these guide values. The 'average' guide value was adopted for each sample as its suitability for use as an armourstone. This is turn was used to consider whether the materials would be and remain rocky once extracted or be fine-grained. Rocky materials can be treated as more erosion resistant than fine grained materials. The results of this assessment are given in Table 8.

Table 7: Rock quality classification system

Criteria	Unit	Quality and Durability Guide			
		Excellent (4)	Good (3)	Marginal (2)	Poor (1)
Lithology	-	Unfoliated igneous and metamorphic rocks, quartzites, and highly cemented sandstones, compact crystalline limestones	Crystalline dolomites, crystalline limestone, moderately well cemented sandstones	Argillaceous limestones, poorly cemented sandstones, dolomite reef rock with void cavities	Shaly limestones, reef breccia, shale, siltstone, slate, schist, chalk, gypsiferous carbonates
Rock density	g/cm^3	>2.7	2.5-2.7	2.3-2.5	<2.3
Water absorption	%	<0.5	0.5-2.0	2.0-6.0	>6.0
Hardness	-	VS, ES	S	MS	W, VW, EW

Table 8: Results of the rock durability assessment

Sample ID	Rock Type	Oxidation	Average Rock Density (g/cm^3)	Average Water Absorption (%)	Hardness	Durability
WPH45001	Laterite	Oxide	2.2	7.2	W	Poor
WPH45002	BIF	Transition	2.0	18.6	W	Poor
WPH45003	Mafic	Oxide	Disintegrated	Disintegrated	VW	Poor
WPH45004	BIF	Transition	3.0	2.5	S	Good
WPH45005	Mafic	Fresh	4.4	0.0	ES	Excellent
WPH45006	Laterite	Oxide	2.3	10.8	S	Poor
WPH45007	BIF	Transition	1.9	13.8	VW	Poor
WPH45008	Ultramafic	Oxide	2.7	4.5	W	Marginal
WPH45009	BIF	Fresh	2.8	3.9	S	Good
WPH45010	Laterite	Oxide	3.3	1.6	MS	Marginal
WPH45011	BIF	Oxide	2.7	0.2	S	Good
WPH45012	BIF	Transition	4.8	1.7	VS	Excellent
WPH45013	Mafic	Oxide	2.0	15.9	VW	Poor
WPH45014	BIF	Oxide	2.1	20.1	VW	Poor
WPH45015	Ultramafic	Fresh	3.2	1.7	VS	Excellent

The laterite materials have poor to marginal durability and are considered to likely present within a waste dump as wastes that are dominated by fines (with some coarse fraction). Oxidised mafic and ultramafic wastes have poor to marginal durability and would present as a waste dominated by fines. Fresh mafic and ultramafic wastes have excellent durability and would likely remain blocky (thought fines would be present).Oxidised and transition BIF wastes have poor to excellent durability, though the majority of the samples were classed as poor. These waste types could be considered likely to be dominated by fines, though with some coarse fraction. Fresh BIF wastes has good to excellent durability and would likely remain blocky (though fines would be present).

The materials have been ranked in terms of erosion resistance as follows (from most resistant to least resistant):

- Fresh BIF, mafic and ultramafic;
- Oxidised and transition BIF; and
- Oxidised laterite mafic, and ultramafic.

5 USING SOILS AND WASTES

5.1 Soils

The soils appear suitable for use as a growth medium. They are generally acidic, though some alkaline soils are present. They have low salinity and are gravelly loamy sand to gravelly loam in texture. They are generally not prone to dispersion and not prone to structural decline. They have low fertility, particularly low Nitrogen levels.

5.2 Wastes

The wastes typically have alkaline pH values. This is in contrast to the soils that are commonly acidic. This may have a negative impact on the quantity and type of vegetation that can establish on a waste dump when the wastes are placed close near the active root zone (i.e., within the surface 0.5-1.0m).

The salinity values for the wastes are often higher than those measured for the soils. Their use at or near the surface (i.e., within the active rooting zone) should be avoided. If used near the surface, there is a risk that capillary rise of salts may occur and increase the salinity of the overlying soils. For this reason, it appear prudent to include salt tolerant species into the rehabilitation seed mix.

The wastes generally have poor rock durability, particularly considering that only 1% of the waste volume is classed as fresh and 99% is either oxidised or transition waste. Therefore, armouring of rehabilitation batters with durable rock is not considered achievable as an erosion mitigation strategy for rehabilitation of waste dumps at Die Hardy. Armouring with tree debris may be possible given the site is located within dense mixed shrublands and grasslands.

5.2.1 Laterite

The laterite materials make up 22% of the waste material. They have poor to marginal durability and are considered to likely present as gravelly fines. They are not suitable for use as a rock armour, but could be used as a material for roads or laydown areas as it will likely compact well. Further geotechnical testing of the laterites should occur as part of engineering design work if they are to be used for this purpose. If placed within the waste dump, these materials should be scheduled so that they are placed nearer the surface than the other oxidised and transitional wastes such as the oxidised and transitional BIF and ultramafics.

5.2.2 BIF wastes

Oxidised and transition BIF wastes make up 44% of the total waste volume. They have poor to excellent durability, though the majority of the samples were classed as poor. These waste types could be considered likely to be dominated by fines, though with some coarse fraction. Although not suitable for use as a rock armour material, these wastes could be considered for use as an abandonment bund material, particularly given that there is very little unweathered materials present. These represent the most durable of the weathered materials. If placed within the waste dump, they should be scheduled such that they are buried within the dump and not located near the surface. If possible, the laterite wastes could be placed closer to the surface than the oxidised or transitional BIF materials.

Fresh BIF wastes make up 0.2% of the waste volume. They have good to excellent durability and would likely remain blocky (though fines would be present). Their small volume means that they are unable to be used as armouring of batters during rehabilitation. But they could be used as rock in high risk erosion zones such as areas prone to flooding, or inlet and outlets of surface water drainage systems. If placed within the waste dump, they should be scheduled such that they are located at the final rehabilitated surface as they will offer some erosion potential.

5.2.3 Ultramafic wastes

Oxidised and transitional mafic and ultramafic wastes make up 32% of the total waste volume. They have poor to marginal durability and would present as a waste dominated by fines. These materials should be placed within the waste dump. If possible, they should be buried under or co-mingled with the oxidised and transitional BIF wastes.

The oxidised BIF and transitional wastes are likely more suitable for using as abandonment bund material than these materials. They should be used for that purpose in preference to weathered materials.

Fresh mafic and ultramafic wastes make up 0.8% of the total waste volume. They have excellent durability and would likely remain blocky (thought fines would be present). Similar to the fresh BIF wastes, their small volume means that they are unable to be used as armouring of batters during rehabilitation. But they could be used as rock in high risk erosion zones such as areas prone to flooding, or inlet and outlets of surface water drainage systems. If placed within the waste dump, the fresh ultramafics should be scheduled such that they are located at the final rehabilitated surface as they will offer some erosion potential.

6 EROSION MODELLING

6.1 Material erodibility

Different surfaces were assessed for erosion potential using the WEPP erosion model. A summary of the WEPP (Water Erosion Prediction Project) erosion model is provided below. The following material types were considered in the sections below:

- Gravelly soil – a fine grained soil with an appreciable amount of gravel and/or stones, a sandy loam texture, moderate permeability, and low tendency for structural decline.
- Gravelly soils with tree debris – the soil as described above, but with addition of 40% tree debris.

Erodibility parameters for the gravelly soil were estimated by comparing the baseline properties (Table 5) to materials with similar baseline properties that Landloch have previously assessed for erodibility using laboratory or field based techniques. A rill spacing of 3m was assumed for modelling of the gravelly soils. These techniques include the application of simulated rain and simulated overland flows. The erodibility parameters are material-specific and were used to predict long-term erosion.

The impact of addition of 40% tree debris cover was assumed to reduce erosion rates by 60% (see Figure 6) while also limiting the ability of surface runoff to accumulate. Therefore, a rill spacing of 1.5m was adopted for modelling of surfaces with tree debris added.

Other site-specific conditions (i.e., climate and landform batter shape) are considered within the erosion model itself.

6.2 Computer simulation of runoff and erosion

6.2.1 The WEPP model

The WEPP model was developed by the United States Department of Agriculture to predict runoff, erosion, and deposition for hillslopes. WEPP is a simulation model with a daily input time step, although shorter time steps are used by internal calculations on days when rainfall occurs. Plant and soil characteristics important to erosion processes are updated every day. When rainfall occurs, those plant and soil characteristics are considered in determining the likelihood of runoff. If runoff is predicted to occur, the model computes sediment detachment, transport, and deposition at points along the slope profile.

The erosion component of the WEPP model uses a steady-state sediment continuity equation as the basis for the erosion computations. Soil detachment in interrill areas is calculated as a function of the effective rainfall intensity and runoff rate. Soil detachment in rills is predicted to occur if the flow hydraulic shear stress is greater than the soil's critical shear stress, and when the sediment load of the flow is below its transport capacity. Deposition in rills is computed when the sediment load is greater than the capacity of the flow to transport it.

6.2.2 Climate file

All WEPP model simulations completed by Landloch use a 100-year stochastic climate sequence for the site developed from observed daily and sub-daily data from nearby weather stations. For each day of simulation, WEPP requires ten daily weather variables:

- Precipitation (mm),
- Precipitation duration (hr),
- Peak storm intensity,
- Time to storm peak,
- Average minimum temperature,
- Average maximum temperature,
- Dew point temperature,
- Solar radiation,
- Wind speed, and
- Wind direction.

Of these, the four rainfall-related variables (underlined in list above) are of particular importance because previous studies have shown that predicted runoff and erosion are most sensitive to these rainfall variables (Nearing et al. 1990; Chaves and Nearing 1991).

For most sites around the world, complete historical weather data on these variables are not available. To use WEPP for runoff and erosion prediction, synthetic weather sequences that statistically preserve the mean and variations in the historical observations are required. CLIGEN is a stochastic weather generator that can be used to provide WEPP climate input files. CLIGEN has been extensively assessed for a wide range of climates, and it was found that CLIGEN was most suitable to provide the required climate input for WEPP to predict runoff and erosion (Yu 2003).

Daily rainfall data were sourced for Die Hardy from Turkey Hill (Bureau of Meteorology station 12079) from January 1929 to March 2021. Turkey Hill is ~90km south of Die Hardy. Patched point data were sourced from SILO (Scientific Information for Land Owners) data service managed by the Queensland Government. Sub-daily (6-minute) rainfall (pluviograph) data were sourced from the Bureau of Meteorology for Merredin. This site contains pluviograph data from January 1966 until March 2011, with an effective record length of approximately 43.1 years.

Using these data sets, the following parameter values were computed and used to develop the synthetic climate sequence for Die Hardy:

- Mean daily rainfall on wet days for each month,
- Standard deviation and skewness coefficient of daily rainfall for each month,
- Probability of a wet day following a dry day for each month,
- Probability of a wet day following a wet day for each month,
- Mean daily max. temperature for each month,
- Standard deviation of daily max. temperature for each month,
- Mean daily min. temperature for each month,
- Standard deviation of daily min. temperature for each month,
- Mean maximum 30-min rainfall intensity for each month, and
- Probability distribution of the dimensionless time to peak storm intensity.

These parameters were used to create a CLIGEN parameter file for the site. Wind data were not synthesised by CLIGEN because Priestley-Taylor's method for estimating the potential evaporation will automatically be used by WEPP. A 100-year climate sequence was generated using CLIGEN version 5.1 (Yu 2002).

The average annual rainfall totals for both the Turkey Hill observed data (1929-2021) and the CLIGEN climate sequence are the same (297mm/y). The average monthly rainfall of the CLIGEN climate sequence is compared with the observed data from Turkey Hill in Figure 10. The absolute error between the CLIGEN sequence and the observed monthly averages is less than 0.01mm/month, equivalent to less than 1mm difference over the entire year. Daily rainfall totals were compared using their Annual Exceedance Probability (AEP) (Figure 11). The data shows that the daily rainfall totals in the CLIGEN sequence closely match the observed data. For example, the observed storm event with an AEP of 1% had a total of 190mm, compared to the CLIGEN value of 194mm. The observed storm event with an AEP of 1.1% had a total of 114mm, compared to the CLIGEN value of 123mm for an AEP of 1%. The observed storm event with an AEP of 2% was 90mm, the same as the CLIGEN value for the event with the same AEP.

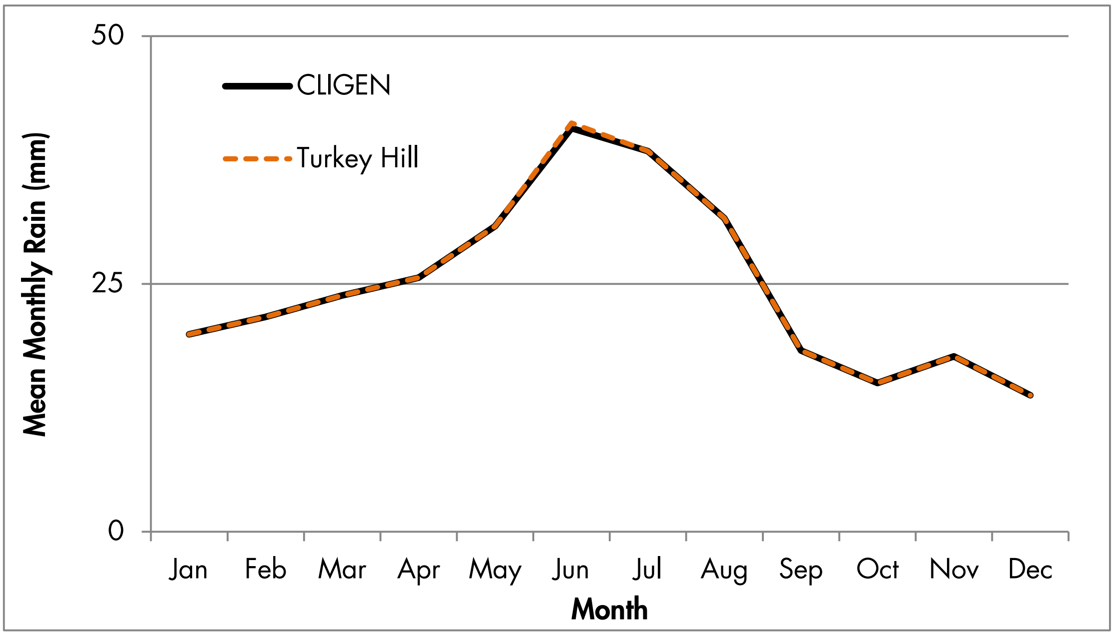

Figure 10: Comparison of CLIGEN mean monthly rainfall with observed data from Turkey Hill (1929-2021).

Based on this analysis it is concluded that the CLIGEN climate sequence:

- reproduces average annual rainfall totals;
- reproduces mean monthly rainfall totals;
- reproduces daily rainfall totals and their AEP;
- has similar average annual erosivity values to those reported in the available literature;
- has a similar amount of annual erosivity to published values and a similar pattern of monthly erosivity to that of mean monthly rainfall; and
- can be used within the WEPP model to predict long-term erosion for Die Hardy.

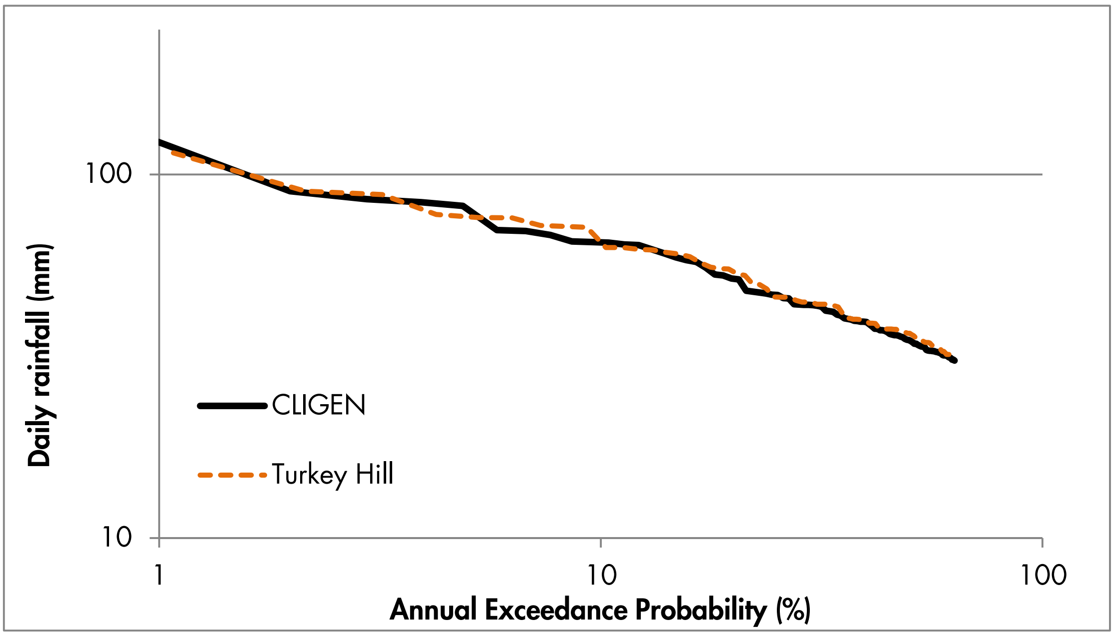

Figure 11: Comparison of daily rainfall totals in the CLIGEN sequence with the daily rainfall totals observed at Turkey Hill (1929-2021).

6.2.3 Other model assumptions

All WEPP models have assumed a minimum cover thickness of 0.5m over any underlying sub-layer. Therefore, surfaces that include soil could assume a soil thickness of 0.5m over any underlying layer. All erosion predictions given below assume that water is controlled on the dump top (i.e., crest bunds are present) and that no cross slope berms were installed. All erosion predictions assume that the underlying wastes are less permeable than the soils. A rill spacing of 4m was assumed for modelling of the gravelly soil, and 1.5m was assumed for the soil when tree debris was applied. When tree debris was applied the WEPP model rate was multiplied by 0.368 (as well as using the reduce rill spacing) to account for application of 40% tree debris. Figure 12 shows graphically what different levels of cover will look like (black squares are representative of the tree debris in this case.)

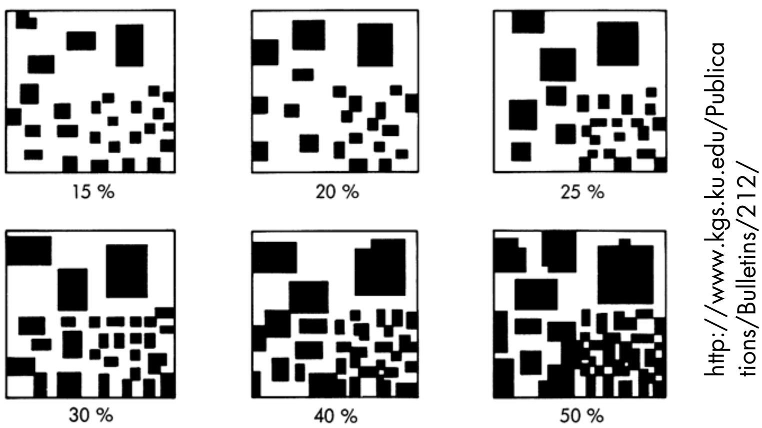

Figure 12: Graphic for estimating different levels of cover. Each quarter of any one square has the same amount of black but with the black areas having different sizes.

6.3 Proposed Die Hardy landform

Ramelius plan to adopt a rehabilitation waste landform at Die Hardy with the following characteristics:

- Number of lifts: 1
- Batter shape: Uniform (single gradient)
- Maximum landform height: 20m
- Batter gradient: 18° (32.5%)

Details of the landform as supplied by Ramelius are given in Figures 13 and 14.

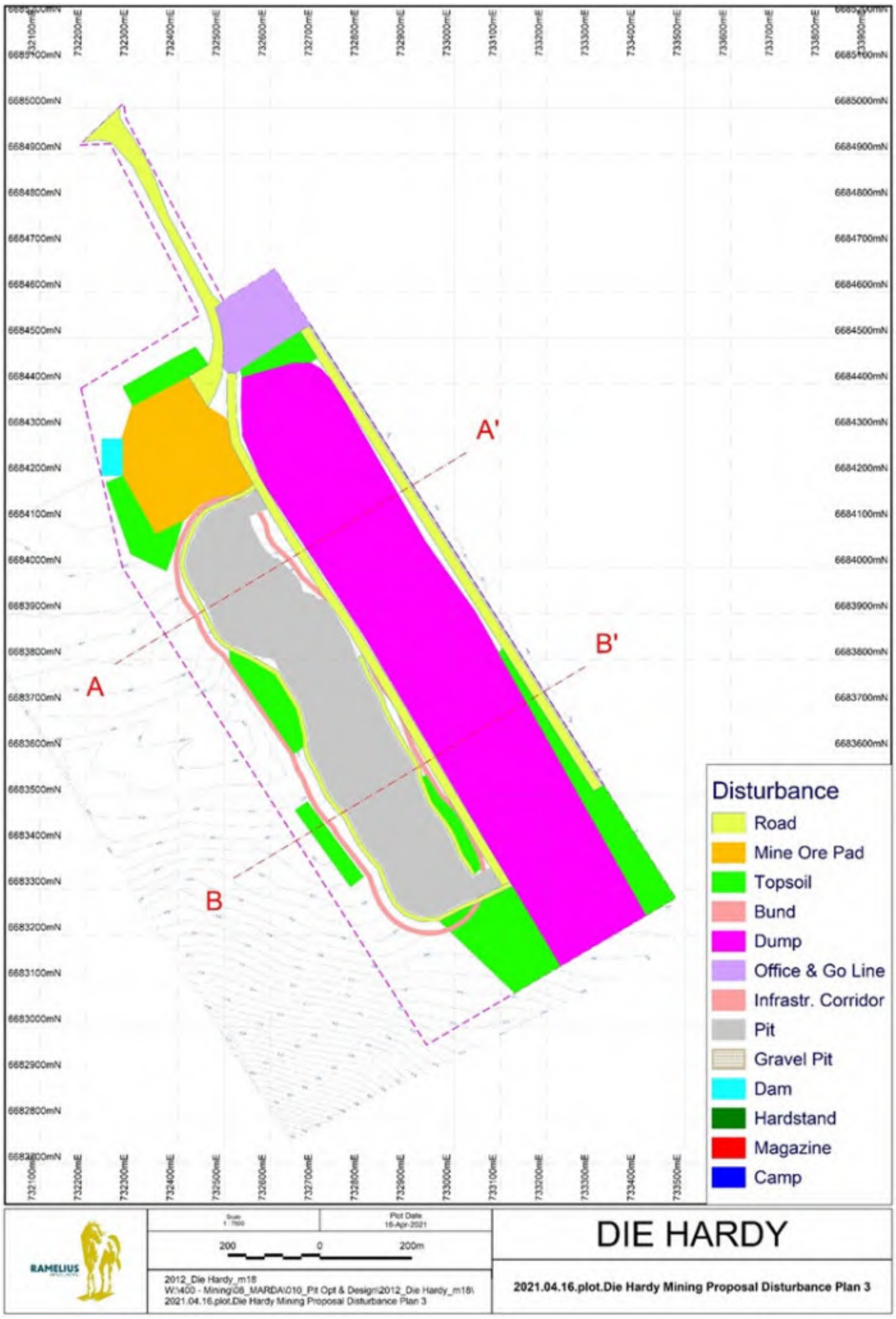

Figure 13: Waste dump (pink) in plan view showing location od sections A-A′ and B-B′

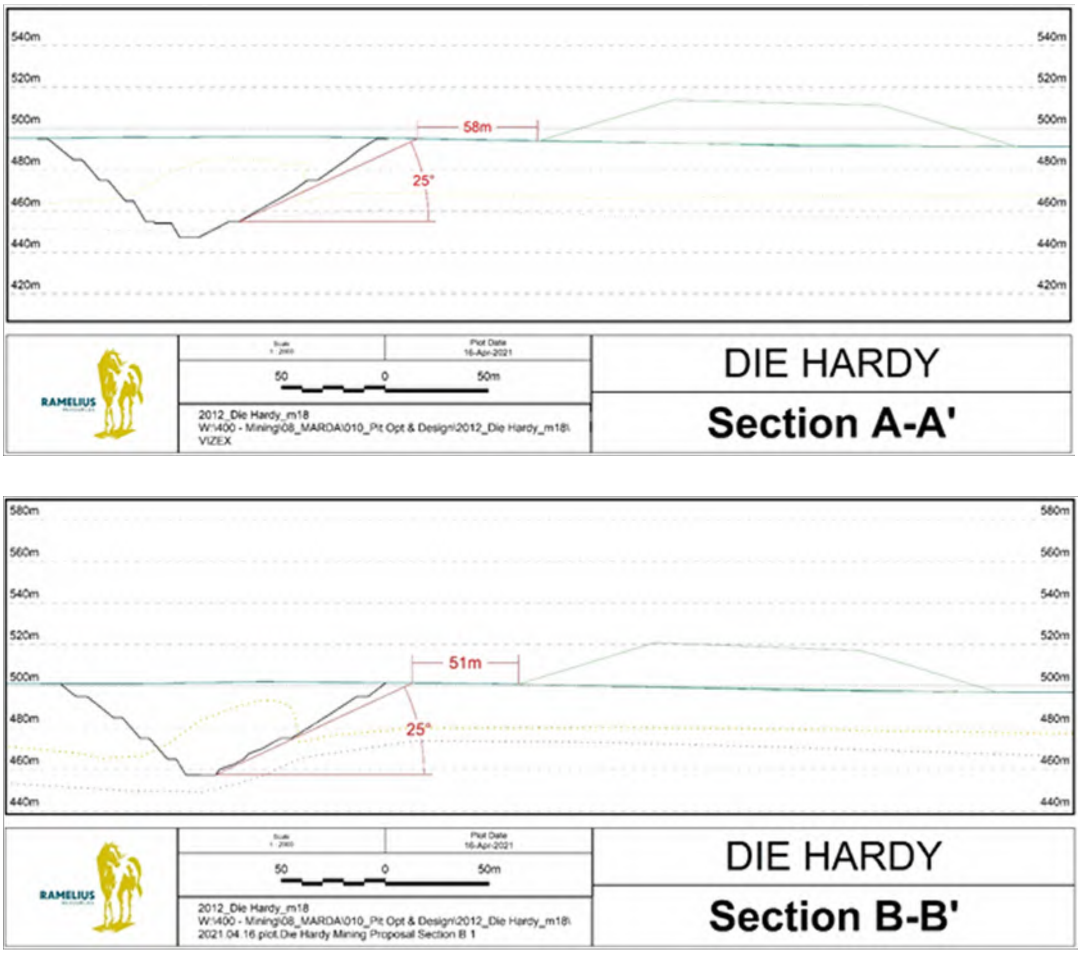

Figure 14: Cross section A-A′ (top) and B-B′ of the Die Hardy waste dump

7 WATER EROSION PREDICTIONS

For all erosion predictions presented in tables in this section, the cells shaded green represent batter geometries that produce acceptable erosion rates[12]. Cells shaded orange represent batter geometries that produce unacceptable erosion rates.

7.1 Linear profiles

2-D batter slope geometries consistent with the planned dump geometry were considered for long-term erosion, with the results tabulated in Table 7. A batter heights of 20m and uniform gradient of 18° was considered. Results are given for the case where 40% tree debris is added, and when tree debris is not added.

[12] Acceptable erosion rates are mean average annual erosion rates <=6t/ha/y and peak average annual erosion rates <=12/t/ha/y.

Table 7: Long-term erosion predictions for gravelly soil

Linear Batter Gradient (°)	Linear Batter Gradient (%)	Batter Height (m)	Batter Footprint (m)	WEPP-Predicted Average Annual Erosion (t/ha/y)			
				0% Tree Debris		40% Tree Debris	
				Mean	Peak	Mean	Peak
18	32.5	20	62	8.4	22	1.1	4.8

Batter heights of 20 are predicted to erode at unacceptable rates for gradients of 18° (Table 7). Lowering gradients to as low as 12° was also shown to yield unacceptable rates.

The impact of the application of tree debris was considered. It is assumed that addition of durable fresh rock is not possible given it is in short supply on site. Application of tree debris in order to achieve 40% cover is predicted to reduce erosion rates to acceptable levels for batters of up to 30m and gradients of 18° (Table 7). Tree debris should be applied to the lower third of the batter; it is not required to be spread over the entire batter, only on the lower section where erosion rates are predicted to exceed acceptable peak erosion rates.

7.2 Concave profiles

Concave profiles were developed for total waste dump heights of 20m and 30m. A height of 20m was consistent with the current design height. However, if a concave profile was adopted, it is likely that the total storage volume for the dump would be reduced. Given that it seems unlikely that the footprint can be increased (Figure 13 shows that the dump is quite footprint constrained), the option is to maintain the storage capacity are to increase the dump height. This could be done by either:

1. Adopting a single concave options with a larger total height (hence modelling 30m); or
2. Adoption of a single 20m high concave, with the remaining waste stored in a small lift built on the top of the waste, but with its toe well away from the crest of the concave.

The case where no tree debris was applied was modelled. However, if it is available, it should be placed at the points where the gradients change as a means of further reducing erosion risk and encouraging vegetation establishment. The erosion modelling results are shown in Table 8 and given graphically in Figures 15 and 16.

7.3 A note of vegetation and erosion control

All of the WEPP erosion predictions assume no impact of standing vegetation on erosion control. If vegetation were to establish, erosional stability would improve. However, the potential benefit (assuming ~5% surface contact cover is achieved) would be in the order of 10% reduction in erosion rates.

Table 8: WEPP predicted erosion rates for the gravelly soil applied on variable concave batter profiles at 20m and 30m batter heights. 0% tree debris cover is assumed.

Horizontal Distance from Crest (m)	Vertical Distance from Crest (m)	Gradient (°)	Gradient (%)	Average annual erosion (t/ha/y)	
				Mean	Peak
20m High – 3 Stage Concave					
0 – 30.8	20 - 10	18	32.5	4.3	11
30.8 – 50.9	10 – 5	14	24.9		
50.9 – 76.6	5 - 0	11	19.4		
30m High – 4 Stage Concave					
0 – 30.8	30 - 20	18	32.5	4.7	11
30.8 – 50.9	20 – 15	14	24.9		
50.9 – 76.6	15 - 10	11	19.4		
76.6 – 140	10 – 0	9	15.8		

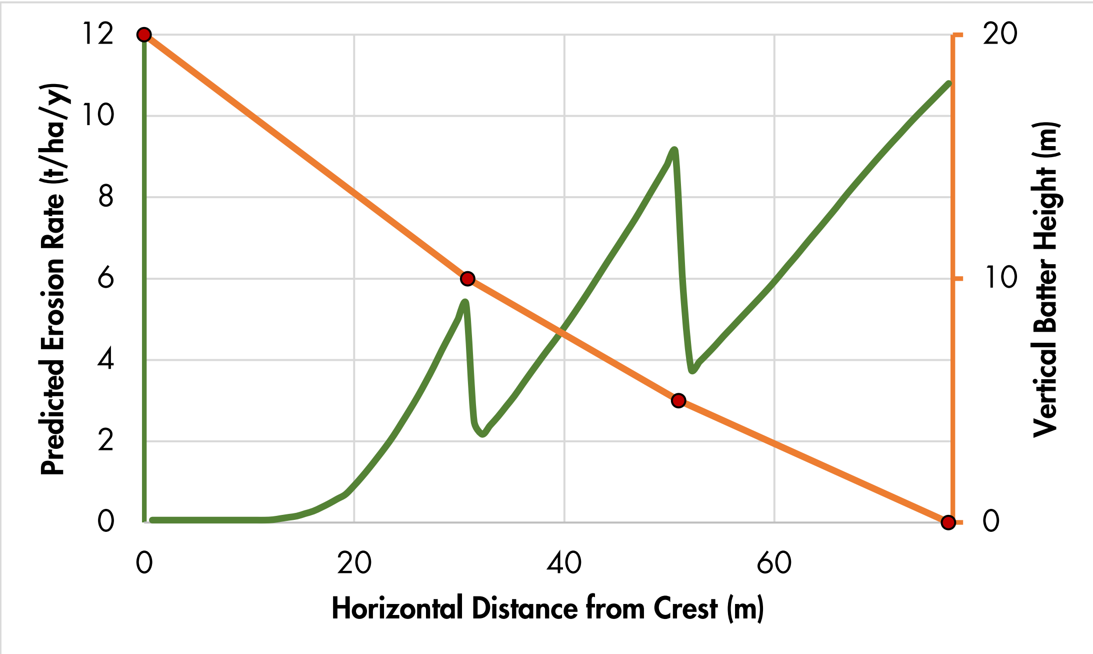

Figure 15: Predicted erosion along a 20m high concave slope with gravelly soil applied. The concave profile is described in Table 8.

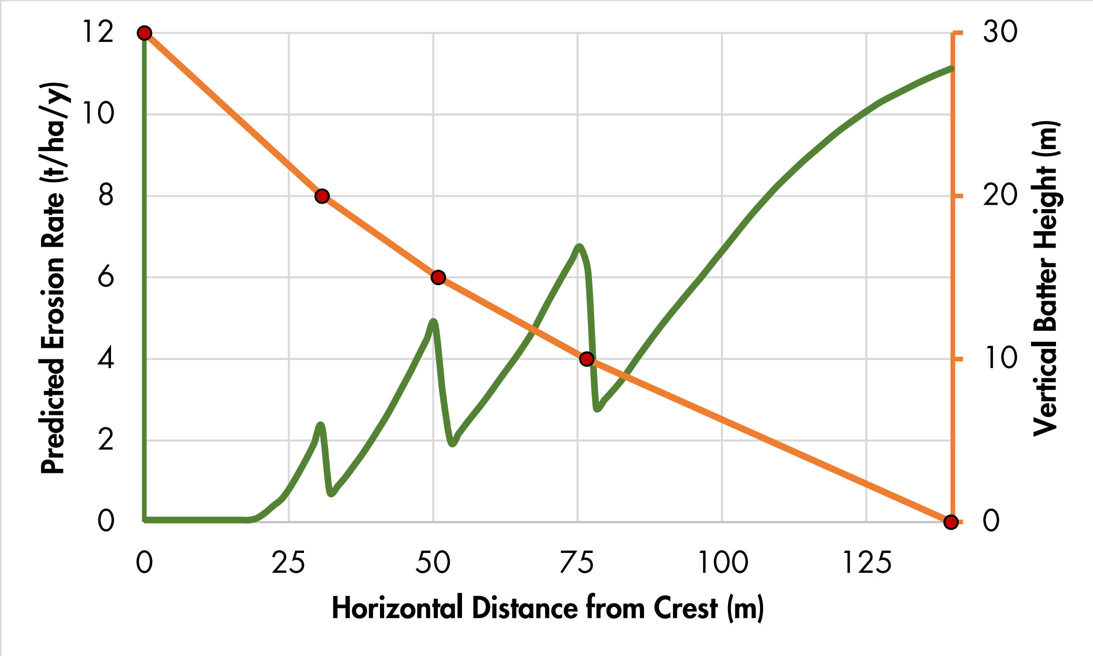

Figure 16: Predicted erosion along a 30m high concave slope with gravelly soil applied. The concave profile is described in Table 8.

8 ENGINEERED RUNOFF CONTROL STRUCTURES

8.1 Cross-slope berms

The erosion predictions indicate that cross-slope berms are not required for landforms with uniform gradient (18°) profiles up to 20m high if tree debris is applied. For the concave options, cross slope berms are not predicted to be necessary.

It is recommended that cross-slope berms be avoided (at present they are not required in any case). This is because the underlying oxidised waste is likely to have low permeability, meaning that when runoff occurs, berms will experience prolonged ponding. Although it cannot be shown from the available data, many oxidised wastes in the arid regions of Western Australia are prone to dispersion. Prolonged ponding of runoff over dispersive oxidised waste increases the risk of tunnel erosion and landform failure. If berms are contemplated in the future (e.g. if the design changes), the berm design must consider this risk and also be able to manage runoff and sediment from extreme runoff events.

If a concave option with a small additional lift on the dump top to store the required waste volume is adopted, there would be a need to use a berm. The berms should be at least 20m wide, and have a backslope of at least 5° in order to manage future runoff and sediment in the long term.

8.2 Crest bunds

Crest bunds are often placed on the very edge of the flat waste dump. They are placed in order to mitigate the risk posed by uncontrolled discharge from the landform top to the steep-gradient outer batter slopes. They are essential when designing a water retaining landform.

When used, crest bunds should be constructed from stable materials that are not prone to structural decline. They should be constructed such that their outer face has the same gradient as the outer slope of the landform. Their inner face should be sloped at an angle of 10% so that water (if it ponds) does not pond near the outer face of the landform. The top of the bund should be at least 2m wide. The height is set so that an extreme rainfall event can be stored, while allowing for some lateral movement of water and some freeboard. A minimum height of 1m is recommended for Die Hardy.

8.3 Cross bunds

For larger waste dumps, it is recommended that the top of the dump be separated into 2-3ha segment by installation of cross bunds. These are small (0.5m high) bunds that run across the top of the waste dump and mesh into the crest bunds.

8.4 Toe drains/bunds

In the instance where the risk of off-site impact of sediment movement is low, and where landforms are designed to erode at acceptable rates, there is no need for a toe drain or bund to contain eroded sediment. This is because the erosion rates are similar to those that occur naturally in the surrounding environment.

9 GENERAL LANDFORM GUIDANCE

9.1 Waste dump top

The top of the rehabilitated waste dump must be level (i.e., at a fixed RL). It must not be sloping such that water can flow laterally and accumulate on one side of the dump top. If this were to occur, uncontrolled discharge of runoff could occur and cause erosion failure of the batter slopes.

9.2 Flood protection

If waste dump batters are located within the 100-year flood line, rock armour protection is recommended for the impacts batter areas. This armouring should be sized according to a surface water flow study that calculates the potential flow velocities that will be experienced. The fresh BIF waste rock will likely be a suitable source of rock armour for flood protection works, assuming the correct rock sizes can be sourced either from the run of mine waste, or from crushing to reduce the size or utilising special blasting patterns to produce the large size required. The required rock size will depend on the final placement of the waste dumps relative to the flood flows. If the fresh BIF waste is to be used for this purpose it must be segregated and stockpiled because it is in very limited supply (1% of the total waste volume is fresh BIF).

Alternately, flood bunds are also used in some cases to divert water away from the waste landforms rather than allowing the water to interact with the landform batter.

9.3 Ramps

Ramps are a consistent source of failure in rehabilitated landforms. Where possible, ramps should be removed as part of the rehabilitation of the landform. Where they are left, their erosion potential must be assessed using a 3-D landform evolution model.

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APPENDIX D

Soil and waste rock test results - Ramelius

ChemCentre

Scientific Services Division

Report of Examination

Resources and Chemistry Precinct
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www.chemcentre.wa.gov.au
ABN 40 991 885 705

Purchase Order: 51180
Your Reference:
ChemCentre Reference: 19S4306 R0

Ramelius Marda Gold Project
1/130 Royal St
East Perth 6004

Attention: Glenn Firth

Final Report on 20 samples of soil received on 03/04/2020

LAB ID	Client ID and Description
19S4306 / 001	SCDH 001
19S4306 / 002	SCDH 002
19S4306 / 003	SCDH 003
19S4306 / 004	SCDH 004
19S4306 / 005	SCDH 005
19S4306 / 006	SCDH 006
19S4306 / 007	SCDH 007
19S4306 / 008	SCDH 008
19S4306 / 009	SCDH 009
19S4306 / 010	SCDH 010
19S4306 / 011	SCDH 011
19S4306 / 012	SCDH 012
19S4306 / 013	SCDH 013
19S4306 / 014	SCDH 014
19S4306 / 015	SCDH 015
19S4306 / 016	SCDH 016
19S4306 / 017	SCDH 017
19S4306 / 018	SCDH 018
19S4306 / 019	SCDH 019
19S4306 / 020	SCDH 020

Analyte		Stones	EC	pH	Sand.	Silt.	Clay.
Method		(>2mm)	(1:5)	(CaCl2)	fraction	fraction	fraction
Unit		%	mS/m		%	%	%
Lab ID	Client ID						
19S4306/001	SCDH 001	40.6	3	5.4	73.5	9.5	17.0
19S4306/002	SCDH 002	7.0	2	6.0	64.0	14.0	22.0
19S4306/003	SCDH 003	27.5	7	8.1	75.0	15.0	10.0
19S4306/004	SCDH 004	11.9	1	4.2	77.0	6.0	17.0
19S4306/005	SCDH 005	31.5	20	7.6	59.0	22.0	19.0
19S4306/006	SCDH 006	29.7	6	7.7	72.0	17.0	11.0
19S4306/007	SCDH 007	37.5	2	5.1	76.0	8.0	16.0
19S4306/008	SCDH 008	18.6	1	5.4	82.5	6.0	11.5
19S4306/009	SCDH 009	17.3	2	5.5	78.0	9.0	13.0
19S4306/010	SCDH 010	38.4	2	4.1	71.0	11.0	18.0
19S4306/011	SCDH 011	36.4	2	3.9	81.0	6.0	13.0
19S4306/012	SCDH 012	25.2	13	8.2	72.0	16.0	12.0
19S4306/013	SCDH 013	43.0	2	4.1	84.0	8.0	8.0
19S4306/014	SCDH 014	30.0	7	6.1	81.5	8.0	10.5
19S4306/015	SCDH 015	38.4	4	5.4	85.0	8.0	7.0
19S4306/016	SCDH 016	51.8	3	4.3	79.0	8.0	13.0
19S4306/017	SCDH 017	44.8	2	4.2	83.0	6.5	10.5
19S4306/018	SCDH 018	37.5	4	4.7	77.0	9.0	14.0
19S4306/019	SCDH 019	25.3	8	4.6	67.0	11.0	22.0
19S4306/020	SCDH 020	25.9	2	4.1	82.0	5.0	13.0

Analyte		OrgC	BSP%	Emerson	ESP	N	P
Method		(W/B)	(calc)	Class	(calc)	(total)	(totals)
Unit		%	%		%	%	mg/kg
Lab ID	Client ID						
19S4306/001	SCDH 001	0.55	58	2	0.8	0.035	180
19S4306/002	SCDH 002	0.51	77	2	0.8	0.034	210
19S4306/003	SCDH 003	0.47	96	1	0.7	0.037	120
19S4306/004	SCDH 004	0.66	37	3	0.4	0.038	180
19S4306/005	SCDH 005	0.50	87	1	9.0	0.042	110
19S4306/006	SCDH 006	0.50	88	1	0.4	0.042	130
19S4306/007	SCDH 007	0.62	66	3	0.3	0.038	190
19S4306/008	SCDH 008	0.43	54	2	0.7	0.027	190
19S4306/009	SCDH 009	0.48	61	2	0.7	0.037	180
19S4306/010	SCDH 010	0.58	19	2	0.2	0.041	170
19S4306/011	SCDH 011	0.43	7	5	0.1	0.026	130
19S4306/012	SCDH 012	0.89	96	1	4.8	0.071	130
19S4306/013	SCDH 013	0.49	5	5	0.2	0.023	110
19S4306/014	SCDH 014	1.94	>110	3	1.2	0.093	110
19S4306/015	SCDH 015	1.33	70	3	0.3	0.050	120
19S4306/016	SCDH 016	0.85	24	5	0.8	0.038	150
19S4306/017	SCDH 017	0.37	15	5	0.2	0.024	130
19S4306/018	SCDH 018	0.78	35	5	0.3	0.042	200
19S4306/019	SCDH 019	1.94	74	3	1.5	0.080	220
19S4306/020	SCDH 020	0.63	16	3	0.2	0.035	170

Analyte		CEC	Ca	K	Mg	Na	Al
Method		(NH4Cl)	(exch)	(exch)	(exch)	(exch)	(exch)
Unit		cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg
Lab ID	Client ID						
19S4306/001	SCDH 001	8	3.1	0.22	1.1	0.06	<0.02
19S4306/002	SCDH 002	9	5.1	0.86	1.2	0.07	
19S4306/003	SCDH 003	19	15	0.49	2.1	0.13	
19S4306/004	SCDH 004	6	1.6	0.18	0.48	0.02	
19S4306/005A	SCDH 005	28	13	0.75	8.2	2.5	
19S4306/006	SCDH 006	19	12	0.48	3.7	0.08	
19S4306/007	SCDH 007	7	3.6	0.24	0.82	0.02	0.02
19S4306/008	SCDH 008	5	1.8	0.22	0.80	0.04	<0.02
19S4306/009	SCDH 009	6	2.5	0.45	0.78	0.04	
19S4306/010A	SCDH 010	6	0.65	0.16	0.29	<0.02	0.88
19S4306/011	SCDH 011	4	0.16	0.09	0.06	<0.02	1.2
19S4306/012	SCDH 012	18	12	1.0	3.3	0.84	
19S4306/013	SCDH 013	4	0.09	0.04	0.03	<0.02	0.66
19S4306/014	SCDH 014	7	7.6	0.46	1.0	0.08	
19S4306/015	SCDH 015	8	4.8	0.24	0.46	0.02	0.05
19S4306/016	SCDH 016	5	0.75	0.08	0.30	0.04	0.44
19S4306/017	SCDH 017	4	0.44	0.07	0.10	<0.02	0.64
19S4306/018	SCDH 018	5	1.5	0.13	0.23	<0.02	0.13
19S4306/019	SCDH 019	5	2.4	0.31	1.1	0.08	0.21
19S4306/020A	SCDH 020	5	0.55	0.09	0.11	<0.02	0.80

Analyte		Mn	Al	B	Ca	Cd	Co
Method		(exch)	(M3)	(M3)	(M3)	(M3)	(M3)
Unit		cmol(+)/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Lab ID	Client ID						
19S4306/001	SCDH 001	0.04	>550	0.7	630	0.06	1.8
19S4306/002	SCDH 002		>550	1.9	1000	0.06	3.6
19S4306/003	SCDH 003		>550	<0.1	>5500	0.09	0.61
19S4306/004	SCDH 004		>550	0.5	330	0.04	0.43
19S4306/005A	SCDH 005		>550	1.9	2800	0.10	3.2
19S4306/006	SCDH 006		>550	0.8	2800	0.10	3.6
19S4306/007	SCDH 007	0.11	>550	<0.1	690	0.06	1.6
19S4306/008	SCDH 008	0.04	>550	0.9	370	0.06	0.89
19S4306/009	SCDH 009		>550	0.5	480	0.06	1.5
19S4306/010A	SCDH 010	0.06	>550	<0.3	130	0.05	0.30
19S4306/011	SCDH 011	<0.02	>550	0.2	34	0.03	0.02
19S4306/012	SCDH 012		>550	2.8	>5500	0.13	0.70
19S4306/013	SCDH 013	<0.02	>550	<0.1	27	0.04	0.04
19S4306/014	SCDH 014		>550	1.1	1500	0.06	0.45
19S4306/015	SCDH 015	0.05	>550	<0.1	810	0.06	0.17
19S4306/016	SCDH 016	0.07	>550	<0.1	160	0.04	0.27
19S4306/017	SCDH 017	0.02	>550	<0.1	95	0.03	0.02
19S4306/018	SCDH 018	0.05	>550	<0.1	310	0.04	0.11
19S4306/019	SCDH 019	0.12	>550	0.2	460	0.04	0.09
19S4306/020A	SCDH 020	0.03	>550	<0.1	110	0.04	0.15

Analyte		Cu	Fe	K	Mg	Mn	Mo
Method		(M3)	(M3)	(M3)	(M3)	(M3)	(M3)
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Lab ID	Client ID						
19S4306/001	SCDH 001	1.5	29	120	140	91	<0.01
19S4306/002	SCDH 002	2.2	28	300	150	140	0.01
19S4306/003	SCDH 003	1.4	25	190	470	42	<0.01
19S4306/004	SCDH 004	0.8	32	97	61	25	0.01
19S4306/005	SCDH 005	1.2	50	320	>1000	69	<0.01
19S4306/006	SCDH 006	1.9	45	200	690	120	<0.01
19S4306/007	SCDH 007	1.7	38	120	100	160	<0.01
19S4306/008	SCDH 008	1.0	24	110	99	91	<0.01
19S4306/009	SCDH 009	1.3	26	160	96	110	<0.01
19S4306/010A	SCDH 010	1.2	24	91	36	21	<0.01
19S4306/011	SCDH 011	0.8	31	56	<10	2.2	<0.01
19S4306/012	SCDH 012	1.3	38	440	950	64	<0.01
19S4306/013	SCDH 013	0.5	34	28	<10	2.3	<0.01
19S4306/014	SCDH 014	1.0	50	160	130	76	<0.01
19S4306/015	SCDH 015	0.8	56	120	54	51	<0.01
19S4306/016	SCDH 016	1.6	51	52	38	41	<0.01
19S4306/017	SCDH 017	0.5	27	47	13	9.3	<0.01
19S4306/018	SCDH 018	1.0	37	76	31	39	<0.01
19S4306/019	SCDH 019	4.4	62	140	130	58	<0.01
19S4306/020A	SCDH 020	1.1	32	57	15	12	<0.01

Analyte		Na	Ni	P	S	Zn	As
Method		(M3)	(M3)	(M3)	(M3)	(M3)	(M3)
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Lab ID	Client ID						
19S4306/001A	SCDH 001	11	1.1	5	7	0.9	<0.1
19S4306/002	SCDH 002	9	1.7	6	4	1.1	<0.1
19S4306/003	SCDH 003	11	1.0	13	5	0.7	0.1
19S4306/004	SCDH 004	3	0.4	3	7	0.3	<0.1
19S4306/005A	SCDH 005	700	3.2	5	3	0.6	<0.1
19S4306/006	SCDH 006	11	3.3	12	3	1.4	<0.1
19S4306/007	SCDH 007	2	1.4	10	4	1.3	<0.1
19S4306/008	SCDH 008	5	0.4	8	3	1.3	<0.1
19S4306/009	SCDH 009	6	0.6	5	5	0.9	<0.1
19S4306/010A	SCDH 010	<1	0.3	4	14	0.6	<0.1
19S4306/011	SCDH 011	<1	0.1	2	28	0.2	<0.1
19S4306/012	SCDH 012	180	2.7	13	12	1.0	0.1
19S4306/013	SCDH 013	<1	0.1	2	40	0.6	<0.1
19S4306/014	SCDH 014	12	0.4	4	9	0.7	<0.1
19S4306/015	SCDH 015	2	0.2	4	11	0.5	<0.1
19S4306/016	SCDH 016	5	0.5	3	20	0.7	<0.1
19S4306/017	SCDH 017	<1	<0.1	2	45	0.3	<0.1
19S4306/018	SCDH 018	<1	0.1	2	23	0.5	<0.1
19S4306/019	SCDH 019	13	0.3	2	25	1.1	<0.1
19S4306/020A	SCDH 020	<1	0.3	3	16	0.3	<0.1

Analyte		Pb	Se
Method		(M3)	(M3)
Unit		mg/kg	mg/kg
Lab ID	Client ID		
19S4306/001A	SCDH 001	1.0	<0.1
19S4306/002	SCDH 002	1.2	<0.1
19S4306/003	SCDH 003	0.4	<0.1
19S4306/004	SCDH 004	1.1	<0.1
19S4306/005A	SCDH 005	0.5	<0.1
19S4306/006	SCDH 006	0.8	<0.1
19S4306/007	SCDH 007	0.7	<0.1
19S4306/008	SCDH 008	0.8	0.2
19S4306/009	SCDH 009	0.8	<0.1
19S4306/010A	SCDH 010	1.5	<0.1
19S4306/011	SCDH 011	1.0	<0.1
19S4306/012	SCDH 012	0.5	<0.1
19S4306/013	SCDH 013	0.9	<0.1
19S4306/014	SCDH 014	0.6	0.1
19S4306/015	SCDH 015	0.7	<0.1
19S4306/016	SCDH 016	0.9	<0.1
19S4306/017	SCDH 017	0.9	<0.1
19S4306/018	SCDH 018	0.8	<0.1
19S4306/019	SCDH 019	0.8	<0.1
19S4306/020A	SCDH 020	0.9	<0.1

Analyte	Method	Description
Stones	(>2mm)	Stones - sieved particles greater than 2 mm (sample preparation method manual 3.3.2)
EC	(1:5)	Electrical conductivity of 1:5 soil extract at 25 C by in-house method S02
pH	(CaCl2)	pH of 1:5 soil extract in 0.01M CaCl2 by in-house method S03
BSP%	(calc)	BSP%, Base Saturation Percenatge (calculated)
ESP	(calc)	Exchangeable Sodium Percentage (calculated)
K	(exch)	Potassium, K exchangeable (ref. Rayment & Lyons 2011)
Mg	(exch)	Magnesium, Mg exchangeable (ref. Rayment & Lyons 2011)
Mn	(exch)	Manganese, Mn exchangeable (ref. Rayment & Lyons 2011)
Na	(exch)	Sodium, Na exchangeable (ref. Rayment & Lyons 2011)
Ca	(exch)	Calcium, Ca exchangeable (ref. Rayment & Lyons 2011)
Al	(exch)	Aluminium, Al exchangeable (ref. Rayment & Lyons 2011)
Al	(M3)	Aluminium,Al extracted by Mehlich No 3 - method S42
As	(M3)	Arsenic, As extracted by Mehlich No 3 - method S42
B	(M3)	Boron,B extracted by Mehlich No 3 - method S42
Ca	(M3)	Calcium,Ca extracted by Mehlich No 3 - method S42
Cd	(M3)	Cadmium,Cd extracted by Mehlich No 3 - method S42
Co	(M3)	Cobalt,Co extracted by Mehlich No 3 - method S42
Cu	(M3)	Copper,Cu extracted by Mehlich No 3 - method S42
Fe	(M3)	Iron, Fe extracted by Mehlich No 3 - method S42
Na	(M3)	Sodium, Na extracted by Mehlich No 3 - method S42
Ni	(M3)	Nickel, Ni extracted by Mehlich No 3 - method S42
P	(M3)	Phosphorus, P extracted by Mehlich No 3 - method S42
Pb	(M3)	Lead, Pb extracted by Mehlich No 3 - method S42
Mn	(M3)	Manganese, Mn extracted by Mehlich No 3 - method S42
Mo	(M3)	Molybdenum, Mo extracted by Mehlich No 3 - method S42
Mg	(M3)	Magnesium, Mg extracted by Mehlich No 3 - method S42
K	(M3)	Potassium, K extracted by Mehlich No 3 - method S42
S	(M3)	Sulphur, S extracted by Mehlich No 3 - method S42
Se	(M3)	Selenium, Se extracted by Mehlich No 3 - method S42
Zn	(M3)	Zinc, Zn extracted by Mehlich No 3 - method S42
CEC	(NH4Cl)	Cation Exchange Capacity, 1M NH4Cl method S22.0
N	(total)	Nitrogen N, total by method S10
P	(totals)	Phosphorus,P Total by method S14
OrgC	(W/B)	Organic Carbon C, Walkley and Black method S09.
Emerson	Class	Emerson class number by AS 1289 C.8.1
Clay.	fraction	Clay, less than 0.002mm by method S06. ref. Australian Standard AS1289.C6.3
Silt.	fraction	Silt, 0.02 to 0.002mm by method S06. ref. Australian Standard AS1289.C6.3
Sand.	fraction	Sand, 0.02 to 2.0mm by method S06. ref. Australian Standard AS1289.C6.3

Results are based on a air-dry (40C) , < 2 mm basis. Stones (>2mm) if present are reported on an air dry whole sample basis.

EMERSON CLASS CLASSIFICATION

The swelling and dispersive properties of the soils were tested by placing natural peds and samples re-moulded at or near field capacity moisture content in deionised water. Based on their slaking and dispersive behaviour, the samples were classified into one of 8 classes according to the Emerson Classification scheme as described in Australian Standard AS 1289.C8.1-1980.

Summary of classification scheme:

Class 1 Soil slakes, air-dried crumbs are strongly dispersive
Class 2 Soil slakes, air-dried crumbs show slight to moderate dispersion
Class 3 Soil slakes, air-dried crumbs do not disperse, re-moulded soil disperses
Class 4 Soil slakes, air-dried crumbs do not disperse, calcium carbonate or calcium sulphate are present.
Class 5 Soil slakes, air-dried and re-moulded soil do not disperse, 1:5 soil:water extract remains dispersed after 5 minutes.
Class 6 Soil slakes, air-dried and re-moulded soil do not disperse, 1:5 soil:water extract begins to flocculate within 5 minutes
Class 7 Soil does not slake, air-dried crumbs remain coherent and swell.
Class 8 Soil does not slake, air-dried crumbs remain coherent, but do not swell.

A sample with a result of 0, indicates the sample was not suitable for the test, i.e air-dried sample did not conatin soil peds between 4.75 - 2.36mm diameter.

Exchangeable Sodium Percentage (ESP)

The ESP is a measure of sodicity (i.e exchangeable Na+) based on a soils exchange complex . High levels of sodium can adversley effect plant growth and soil structure.
The table below (categorised by Northcote and Skene, 1972) relates % ESP to soil sodicity. This table should only be used as a guide as it tolerance can vary on soil type and plant species.

ESP<6 non-sodic
ESP6-15 sodic
ESP>15 strongly sodic

Multi-Element Soil Extraction Universal Extractants (Mehlich No.3)

The Mehlich No.3 Test is an alternate soil test using universal extractants for multi-elemental analysis. Results obtained using the Mehlich 3 extractant are highly correlated with the standard "single element" soil tests currently used for a wide range of Western Australian soil types. The test provides information on the amount of plant-available nutrients including phosphorus, potassium, sulphur, calcium, magnesium, sodium, boron, copper, iron, manganese and zinc, in the soil . It can be used as a "screening*" tool (see note below) to measure concentrations of cobalt, aluminium, molybdenum and toxic metals such as cadmium, lead, arsenic, selenium and nickel in soil. It is ideally suited to acid and neutral soils, the amounts of nutrients extracted being similar to those of other soil tests used in WA .

*Results that are reported as ">" are outside the linear range of the calibration and outside the scope of the method. This results should only be used as a guide and consideration should be given to a more specific test method if the actual "value" need to be determined, hence these results should only be used as a guide.
Bolland, Allen & Walton. Aust J Soil Research 2002.
Soil Chemical Methods, Australasia (Rayment & Lyons) 2010Particle size analysis data of these soils, in the form of an Excel spreadsheet, are attached. The silt and clay components were determined by sedimentation using Stokes' Law principles whereas the sand fractions were determined by dry sieving the >0.075 mm fraction.
Note: the fraction in the "Diff." column is 100 - (sum of all other fractions). This fraction will include any soluble salts and most of the organic matter in the sample.

B. Price

Barry Price
Snr Chemist & Research Officer
Scientific Services Division
27-May-2020

ABN: 30 008 127 802

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

35 Cormack Road
Wingfield SA 5013

Telephone (08) 8416 5200
Facsimile (08) 8234 0355

Reference:	**aa044924**
Date Finished:	09/04/2020
Order:	100721
Project:	Die Hardy
Date Received:	20/03/2020
Type of Sample:	RAB\RC
Samples Analysed:	**15**

FINAL ANALYSIS REPORT

Analysis of Mineral Samples

for

Mt Magnet Gold

PO Box 83 Mt Magnet WA 6638

Attention: Mr Rob Hutchison

Authorised By:

Vaughn Noble
Senior Chemist

Fabian Gregus
Chemist

Michael Grieger
Chemist

Jenet Hwende
Laboratory Manager

Bureau Veritas Minerals Pty Ltd
MINERAL TESTING & LABORATORY SERVICES

ABN: 30 008 127 802

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Method	**TC003**	**GC009**	**SIE5**	**SIE5**	**SIE5**	**SIE5**	**SIE5**	**SIE5**
Result Name	**S**	**SO4**	**ANC**	**NAG**	**NAG pH**	**NAG 4.5**	**NAG 7.0**	**NAPP**
Units	**%**	**%**	**KgH2SO4 /tonne**	**KgH2SO4 /tonne**	**pH_unit**	**KgH2SO4 /tonne**	**KgH2SO4 /tonne**	**KgH2SO4 /tonne**
Detection Limit	0.01	0.01	1	0.5	0.01	0.5	0.5	1
WCDH001	0.10	0.27	34	<0.5	7.98	<0.5	<0.5	-31
WCDH002	0.03	0.09	0	<0.5	7.33	<0.5	<0.5	1
WCDH003	0.04	0.12	2	<0.5	7.68	<0.5	<0.5	-1
WCDH004	<0.01	<0.01	-2	<0.5	7.51	<0.5	<0.5	2
WCDH005	0.17	0.05	47	<0.5	8.34	<0.5	<0.5	-42
WCDH006	0.07	0.11	2	<0.5	7.33	<0.5	<0.5	0
WCDH007	0.04	0.07	5	<0.5	7.85	<0.5	<0.5	-4
WCDH008	0.04	0.12	14	<0.5	7.70	<0.5	<0.5	-13
WCDH009	0.49	0.32	47	0.5	6.24	<0.5	0.5	-32
WCDH010	0.13	0.38	2	<0.5	7.49	<0.5	<0.5	2
WCDH011	0.06	0.15	0	<0.5	7.60	<0.5	<0.5	2
WCDH012	0.09	0.11	10	<0.5	7.46	<0.5	<0.5	-7
WCDH013	0.08	0.21	5	<0.5	7.69	<0.5	<0.5	-3
WCDH014	0.04	0.11	0	<0.5	7.64	<0.5	<0.5	1
WCDH015	0.02	<0.01	19	<0.5	7.92	<0.5	<0.5	-18

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Method	SIE6	IND7	IND7	IND7	IND7	IND7	IND7	IND7
Result Name	**EC**	**As**	**Cd**	**Cr**	**Hg**	**Mo**	**Ni**	**Pb**
Units	**uS/cm**	**mg/L**	**mg/L**	**mg/L**	**ug/L**	**mg/L**	**mg/L**	**mg/L**
Detection Limit	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
WCDH001	2278	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH002	395	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH003	1428	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH004	86	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH005	180	<0.1	<0.1	0.2	<0.1	<0.1	0.1	<0.1
WCDH006	37	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH007	101	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH008	1558	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH009	752	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
WCDH010	1186	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH011	658	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH012	506	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH013	694	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WCDH014	388	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
WCDH015	120	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1

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Method	**IND7**
Result Name	**Zn**
Units	**mg/L**
Detection Limit	0.1
WCDH001	<0.1
WCDH002	<0.1
WCDH003	<0.1
WCDH004	<0.1
WCDH005	<0.1
WCDH006	<0.1
WCDH007	<0.1
WCDH008	<0.1
WCDH009	0.4
WCDH010	<0.1
WCDH011	<0.1
WCDH012	<0.1
WCDH013	<0.1
WCDH014	<0.1
WCDH015	0.2

****

ABN: 30 008 127 802
35 Cormack Road
Wingfield SA 5013
Telephone (08) 8416 5200
Facsimile (08) 8234 0355

****
These results pertain to the samples as received at this laboratory.
Where standards are reported, the nominal value for the element is reported above the result found.

"NR" Implies result is not required for this determination

Sample Storage
****

The excess material (Residue) will be held after 30 days

The pulp samples (Pulp) will be held after 60 days as per instructions.

Sample Preparation
****

Digest and Analysis:
****

The samples have been digested with hot concentrated hydrochloric acid. All soluble sulphates (except for some barium and strontium sulphates that occur in reasonably high concentrations) remain in solution.

SO4
have been determined by Inductively Coupled Plasma (ICP) Optical Emission Spectrometry.

Total Combustion S & C

S
have been determined by Total Combustion Analysis.

Total dissolved salts (TDS) have been calculated from conductivity measurements.

EC
have been determined using a conductivity meter.

A test portion is extracted in a buffer then leached by a rotating extraction for at least 16 hours. The TCLP extract is then filtered, concentrated by evaporation, acidified with nitric acid for the determination of the elements of interest. (AS4439)

Cr
have been determined by Inductively Coupled Plasma (ICP) Optical Emission Spectrometry.
Hg
have been Analysed by AAS Cold Vapour
As,Cd,Mo,Ni,Pb,Zn
have been determined by Inductively Coupled Plasma (ICP) Mass Spectrometry.

Acid Neutralizing Capacity (ANC), Net Acid Generation (NAG) and Net Acid Production Potential (NAPP)

NAG,NAG,4.5,NAG,7.0,NAG,pH,NAPP
have been NAG Titration

ANC
have been determined volumetrically.

APPENDIX E

Hydrological assessment (MWES)

APPENDIX F
Targeted flora search (Botanica)

Phone: (08) 9093 0024
Mobile: 0419 916 034
Email: jim@botanicaconsulting.com.au
52 to 56 Oroya St, Boulder
PO Box 2027 Boulder WA 6432
ABN 47141175297

Glenn Firth
Group Environmental Manager
Ramelius Resources Limited
glenfirth@rameliusresources.com.au

20th December 2019

RE: Targeted search for conservation significant flora/vegetation-Die Hardy and Red Legs exploration program

Dear Glenn,

Botanica Consulting (BC) was commissioned by Ramelius Resources Limited (Ramelius) to undertake a targeted search for conservation significant flora/ vegetation and Malleefowl of the Die Hardy (previously referred to as the Fiddleback prospect) and Red Legs exploration programme (referred to as the survey area), located within tenements E77/2141, E77/2171, M77/1271 and M77/1272. A map of the survey area is provided in Figure 1. The survey area is located approximately 140 km north of Southern Cross and approximately 350 km east of Perth, Western Australia, within the ex Diemals Station which is managed by DBCA (Figure 2). The survey area covers an area of approximately 23.4 ha and included surveying approximately 6.7km of proposed drill lines (majority of which were located along existing drill lines) and 5.3km of existing access tracks. Each drill line was accessed via existing cleared tracks. The fieldwork was conducted on the 11th and 28th November 2019 by two BC staff members (Jim Williams and Matthew Newlands). A handheld GPS was used to record the locations of tracks traversed and locations of any conservation significant flora/vegetation (recorded in GDA 94 format). The survey area was traversed on foot and by Four Wheel Drive.

Figure 1: Survey Area Map

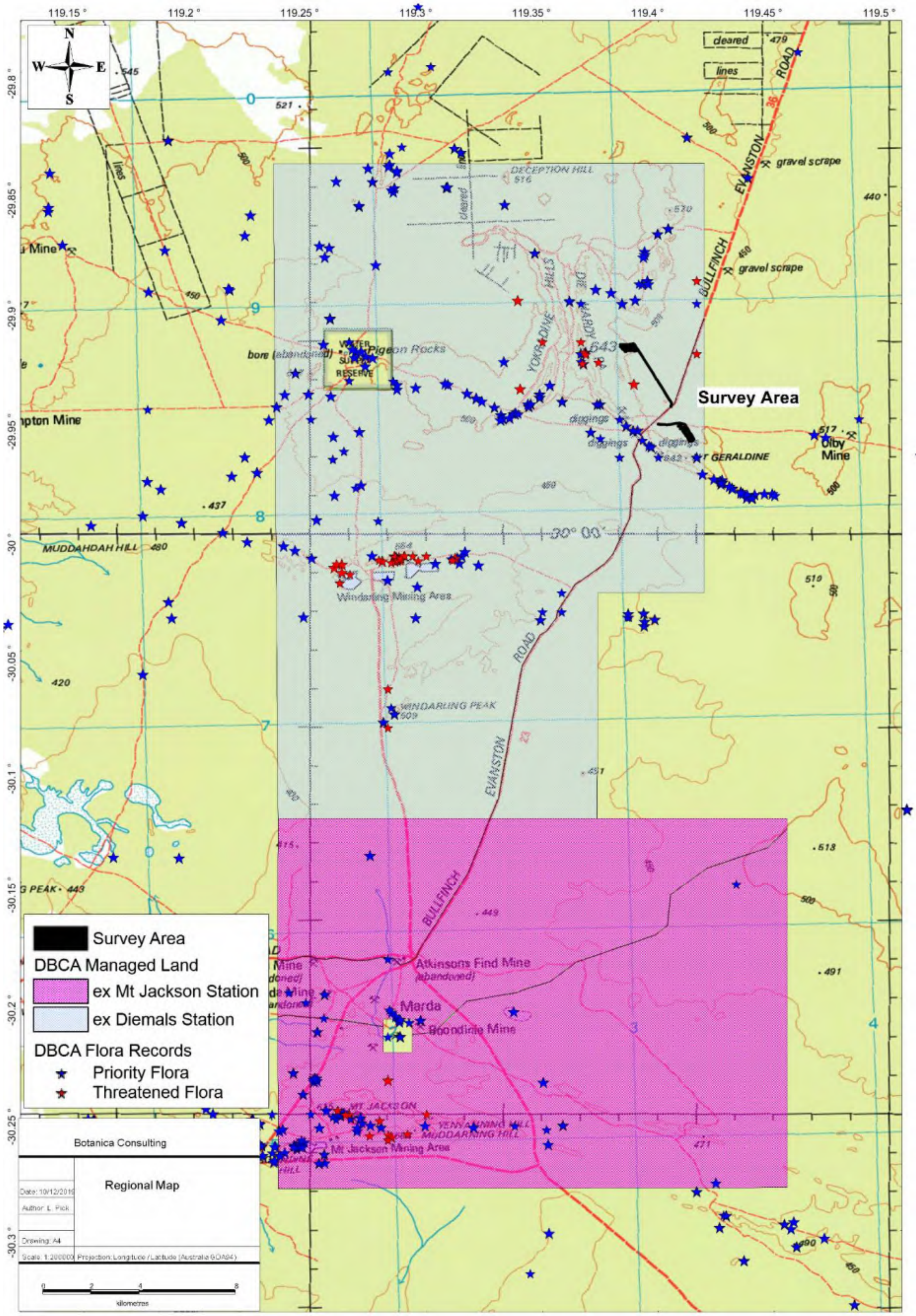


Figure 2: Regional Map including DBCA Managed Land

Background Information

Previous flora/vegetation surveys within the local area were reviewed prior to undertaking the priority searches:

- Biota Environmental Sciences (2014) Southern Koolyanobbing Range Vertebrate Fauna Survey, Cliffs Asia Pacific Iron Ore Pty Ltd
- Woodman Environmental Consulting (2014) Cliffs Asia Pacific Iron Ore Pty Ltd, Southern Koolyanobbing Range, Flora and Vegetation Assessment.
- Rapallo Environmental (2012) Level 2 Flora and Vegetation and of Mt King Central, Golden Orb and King Brown for Southern Cross Goldfields
- Rapallo Environmental (2012) Level 2 Flora and Vegetation Survey of Mt King Tenement (M77/394) and Associated Infrastructure for Southern Cross Goldfields Ltd
- Rapallo Environmental (2011) Reconnaissance Flora Survey of Mt King Tenement – M77/394 for Southern Cross Goldfields Ltd
- Botanica Consulting (2011) Level 2 Flora and Vegetation Survey, Golden Orb Survey Area, Southern Cross Goldfields
- Botanica Consulting (2010) Level 2 Flora and Vegetation Survey, King Brown Survey Area, Southern Cross Goldfields,
- Botanica Consulting (2010) Level 2 Flora and Vegetation Survey, Mt King Survey Area, Southern Cross Goldfields,
- Western Botanical (2009) Flora & Vegetation Survey of Western Jackson Range
- Western Botanical (2005) Flora & Vegetation Assessment for Proposed Exploration in the Evanston Area, Diemals Station
- Western Botanical (2015) Fiddleback Project, Level 2 Flora and Vegetation Survey.
- Western Botanical (2019) Desktop review of the Flora and Vegetation of the Red Legs, Fiddleback and Mt King Prospects.

A literature review consisting of a combined search of the Department of Biodiversity, Conservation and Attractions (DBCA) Flora of Conservation Significance databases (DBCA, 2019a), NatureMap search (DBCA, 2019b) and Department of Environment and Energy (DoEE) Protected Matters search (DoEE, 2019) resulted in four Threatened Flora and 35 Priority Flora occurring within a 20km radius of the survey area (Table 1). No Threatened or Priority Flora were listed on the DBCA Flora of Conservation Significance databases as occurring within the survey area (Figure 2).

Table 1: Threatened/Priority Flora within 20km of the survey area

Taxon	EPBC Act	BC Act	DBCA Priority	Description (WAHERB, 2019)
Acacia adinophylla			P1	Prostrate or erect tangled shrub, 0.15-1.6 m high, to 3 m wide. Fl. yellow, Sep to Nov. Stony loamy or sandy soils, clay. Ironstone ridges, undulating plains (WAHERB 2019)
Austrostipa blackii			P3	Tufted perennial, grass-like or herb, 1 m high. Fl. Sep to Nov. (WAHERB 2019)
Banksia arborea			P4	Tree or shrub (large), 2-8 m high. Fl. yellow, Mar to May or Sep to Oct. Stony loam. Ironstone hills. (WAHERB 2019)
Banksia rufa subsp. *chelomacarpa*			P3	Prostrate shrub, to 0.45 m high. Fl. yellow, Jul to Oct. Sandy loam over gravel. (WAHERB 2019)
Beyeria rostellata			P1	Spindly resinous or viscid shrub to 1.8 high, bark grey and fibrous, young shoots pale green, recurved leaves. Fl green-yellow (Woodman 2014)
Bossiaea sp. Jackson Range (G. Cockerton & S. McNee LCS 13614)			P3	Dense, spinescent shrub to 1.4 m. Flowers yellow and red, July. (Woodman 2014)
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)			P3	No description available

Taxon	EPBC Act	BC Act	DBCA Priority	Description (WAHERB, 2019)
Calytrix paucicostata			P2	Shrub, 0.5-1(-2) m high. Fl. pink & yellow, Sep to Oct. Yellow or grey sand. Sand dunes. (WAHERB 2019)
Calytrix viscida			P1	No description available
Cyathostemon verrucous			P3	No description available
Eucalyptus formanii			P4	Tree or (occasionally mallee), 3-11 m high, bark flaky & fibrous on the trunk. Fl. white, Dec or Jan to Apr. Red sand. Ironstone slopes. (WAHERB 2019)
Frankenia georgei			P1	Small shrub. Fl. pink, Dec. Rocky slopes. (WAHERB 2019)
Grevillea erectiloba			P4	Shrub, 1-3 m high. Fl. red, Sep to Oct. Gravelly loam. Lateritic ridges. (WAHERB 2019)
Grevillea georgeana			P3	Erect to widely spreading shrub, 1-3 m high, up to 4 m wide. Fl. red/red & pink & cream, Jan or Mar or Sep to Nov. Stony loam/clay. Ironstone hilltops & slopes. (WAHERB 2019)
Hysterobaeckea ochropetala subsp. *ochropetala*			P1	*Distribution and habitat.* Extends from the Diemals Station area south-west to Mt Moore and south-east to Jaurdi Station (Figure 4). Occurs in yellow sand or other sandy habitats, some records being of sand over laterite. (Rye 2018)
Hysterobaeckea cornuta			P3	No description available
Jacksonia Jackson			P1	Erect, spreading shrub, 0.25-0.3 m high, to 0.45 m wide. Fl. yellow-orange, Jul to Sep. Stony loam, clay, ironstone gravel. Hill. (WAHERB 2019)
Lepidosperma ferricola			P3	Tufted rhizomatous, perennial, herb (sedge), leaves 0.32-1.05 m high, culms and leaves spirodistichous. Well-drained stony loam, silty clay, banded ironstone. On rocky ledges, scree slopes, crevices and ravines. (Barret 2007)
Lepidosperma jacksonense			P1	Tufted rhizomatous, perennial, herb (sedge), leaves 0.23-0.67 m high, culms and leaves distichous. Silty, sandy loam with chert outcrops. Mod-slopes. (Barret 2007)
Lepidosperma sp. Pigeon Rocks (H. Pringle 30237)			P3	No description available
Leptospermum macgillivrayi			P3	Divaricate shrub, to 1 m high. Fl. probably Aug to Sep. Loam. Decaying granite outcrops (WAHERB 2019)
Leucopogon sp. Yanneymooning (F. Mollemans 3797)			P3	Compact shrub, to 0.6 m high. Fl. white, May. White-grey sandy clay, brown gritty loam over granite, skeletal soils. Tops of valleys, hills and breakaways. (WAHERB 2019)
Malleostemon sp. Adelong (G.J. Keighery 11825)			P2	No description available
Melichrus sp. Bungalbin Hill (F.H. & M.P. Mollemans 3069)			P3	No description available
Mirbelia ferricola			P3	Shrub to 3 m tall and 2 m wide, appearing leafless (leaves reduced to scales), flowers yellow with red, Jun-Nov. (Woodman 2014)
Neurachne annularis			P3	Tussock-forming perennial, grass-like or herb, to 0.75 m high. Shallow red-brown sandy loam, yellowish-red loam, sometimes with ironstone gravel or stones. Among rocks on tops, sides and bases of banded ironstone ranges. (WAHERB 2019)
Notisia intonsa			P3	No description available

Taxon	EPBC Act	BC Act	DBCA Priority	Description (WAHERB, 2019)
Philotheca coateana			P3	Shrub, 0.3-0.5 m high, branchlets glabrous; leaf blades 3-4 mm long; flowers terminal, solitary; petals 7-9 mm long. Fl. white & pink, Aug to Sep. Red sand. (WAHERB 2019)
Philotheca deserti subsp. *brevifolia*			P3	Erect shrub, ca 1 m high, leaves fusiform to narrowly obovoid, 3-5 mm long. Fl. white, Sep. Red sandy clay. (WAHERB 2019)
Psammomoya grandiflora			P3	Erect, spreading shrub, to 0.8 m high. Fl. white, Aug to Oct. Red loam, sand, jasperlite. Sandplains, rocky country. (WAHERB 2019)
Ricinocarpos brevis	EN	EN		Shrub, to 1.8 m high. Fl. white, Jun to Jul. Rocky hillslopes, rock outcrops. (WAHERB 2019)
Rinzia triplex			P3	No description available
Sowerbaea multicaulis			P4	Tufted perennial, herb, 0.075-0.25 m high. Fl. purple-violet, Oct to Dec or Jan. Yellow-brown sand. (WAHERB 2019)
Stenanthemum newbeyi			P3	Erect or spreading shrub, 1-1.6 m high. Fl. yellow, Aug to Sep or Dec or Jan. Clayey sand, clay or loam over laterite or ironstone. Hillslopes. (WAHERB 2019)
Styphelia sp. Bullfinch (M. Hislop 3574)			P3	Compact shrub to 1 m high x 0.7 m wide, intricately but openly branched. Flowers cream, bud apex pink, anthers purple, Apr to July. (WAHERB 2019)
Stylidium choreanthum			P3	Creeping perennial, herb, 0.01-0.03 m high, to 0.3 m wide. Fl. pink/white, Sep to Nov. White/yellow or red sand. Plains. (WAHERB 2019)
Tetratheca paynterae subsp. *cremnobata*	EN	VU		Clumped, multistemmed, leafless shrub, to 1 m high. Fl. purple, Jun. Shallow red-brown loam, clayey silt, ironstone. Outcrops, ridges, breakaways, rocky slopes. (WAHERB 2019)
Tetratheca harperi	VU	VU		Multi-stemmed, leafless shrub, 0.2-0.4 m high. Fl. pink, May or Sep to Nov. Stony loam. Rocky outcrops, rock crevices. a harperi. (WAHERB 2019)
Tetratheca paynterae subsp. *paynterae*	EN	CR		Dwarf, leafless shrub, to 0.5 m high. Fl. pink. Brown clay loam, silty sandy or clayey loam, ironstone, jasperite. Mid-upper slopes, rock crevices, ridges and cliffs. (WAHERB 2019)

Results

<u>Flora</u>

No Threatened Flora taxa pursuant to the *Biodiversity Conservation* (BC) *Act 2016* and the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* were identified within the survey area. Three Priority Flora taxa were identified within the survey area as shown in Figure 3:

1. *Banksia arborea* (P3);
2. *Eucalyptus formanii* (P4); and
3. *Grevillea georgeana* (P3).

GPS records of each taxon are provided in Attachment 1.

The DBCA lists and manages 'Priority' species which are under consideration for declaration as Threatened Flora. These priority species have no formal legal protection until they are endorsed by the Minister as being Threatened under the BC Act. Clearing of any locations of Priority Flora should be avoided. Should disturbance to these plant locations not be able to be avoided, DBCA recommends consulting with the DBCA Species and Communities Program. Details on the newly identified records of each taxon will be reported to DBCA for their records.

***Banksia arborea* (P3)**

Botanica recorded three locations of this taxon (total of three plants) during the survey (Figure 3a). Based on DBCA records, this taxon has been previously recorded approximately 1.6km west of the Red Legs survey area. One record of this taxon was recorded at one drill hole. The remaining two records were recorded on one drill line (existing cleared line) as shown in Figure 3a.

Plate 1: *Banksia arborea* (P3)

***Eucalyptus formanii* (P4)**

Botanica recorded 106 locations of this taxon (total of 106 plants) during the survey. Based on DBCA records, the closest DBCA record of this taxon is located approximately 1.6km west of the Red Legs survey area. 24 locations of this taxon were recorded at eight proposed drill holes as shown in Figure 3a. All other records of this taxon are located along proposed drill lines/ existing access tracks (Figure 3a).

Plate 2: *Eucalyptus formanii* (P4)

***Grevillea georgeana* (P3)**

Botanica recorded 66 locations of this taxon (total of 66 plants) during the survey. Based on DBCA records, the closest DBCA record of this taxon is located approximately 1.6km west of the Red Legs survey area. 13 locations of this taxon were recorded at five proposed drill holes as shown in Figure 3a. All other records of this taxon are located along proposed drill lines/ existing access tracks (Figure 3a).

Plate 3: *Grevillea georgeana* (P3)

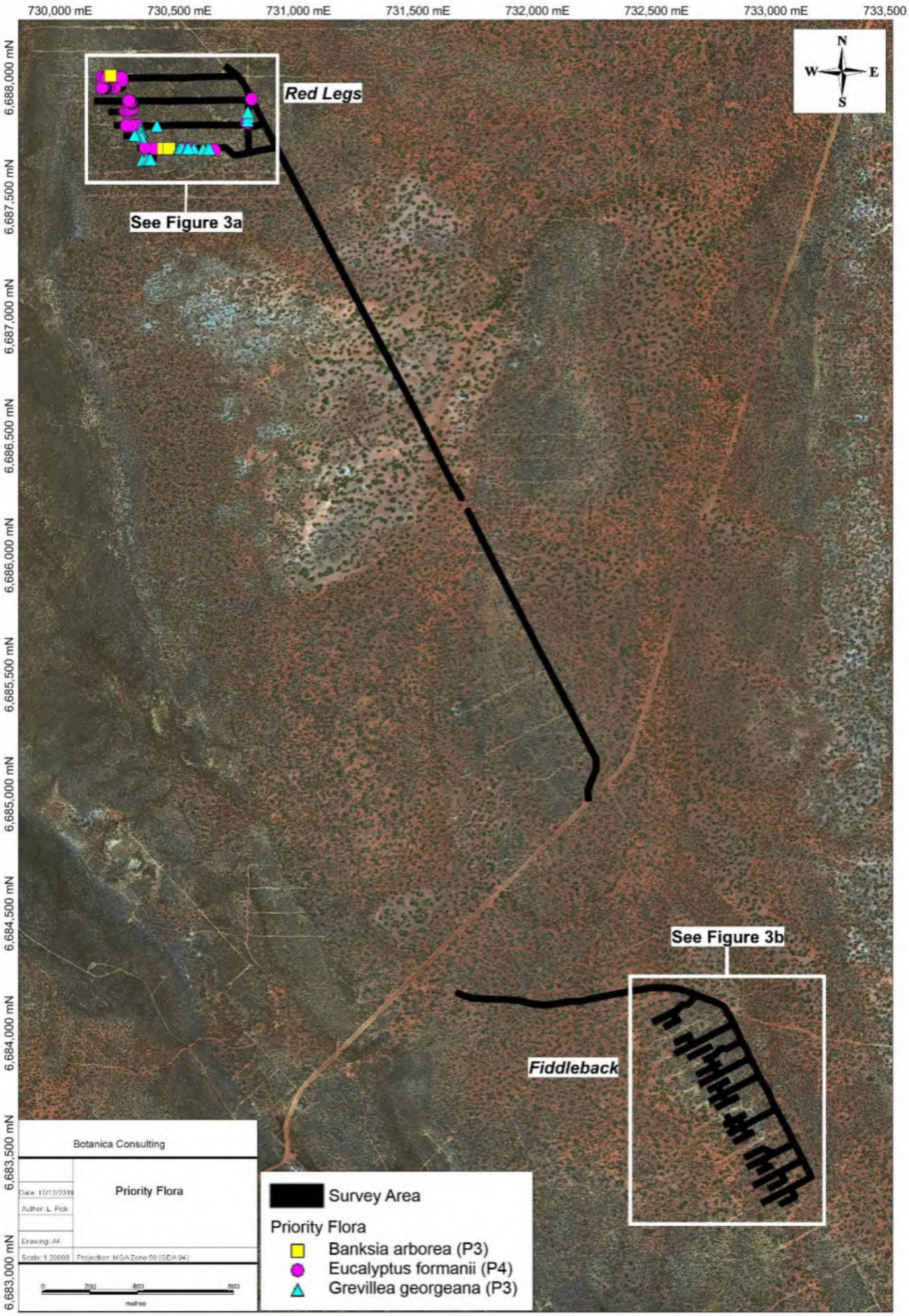


Figure 3: Priority Flora records within the survey area

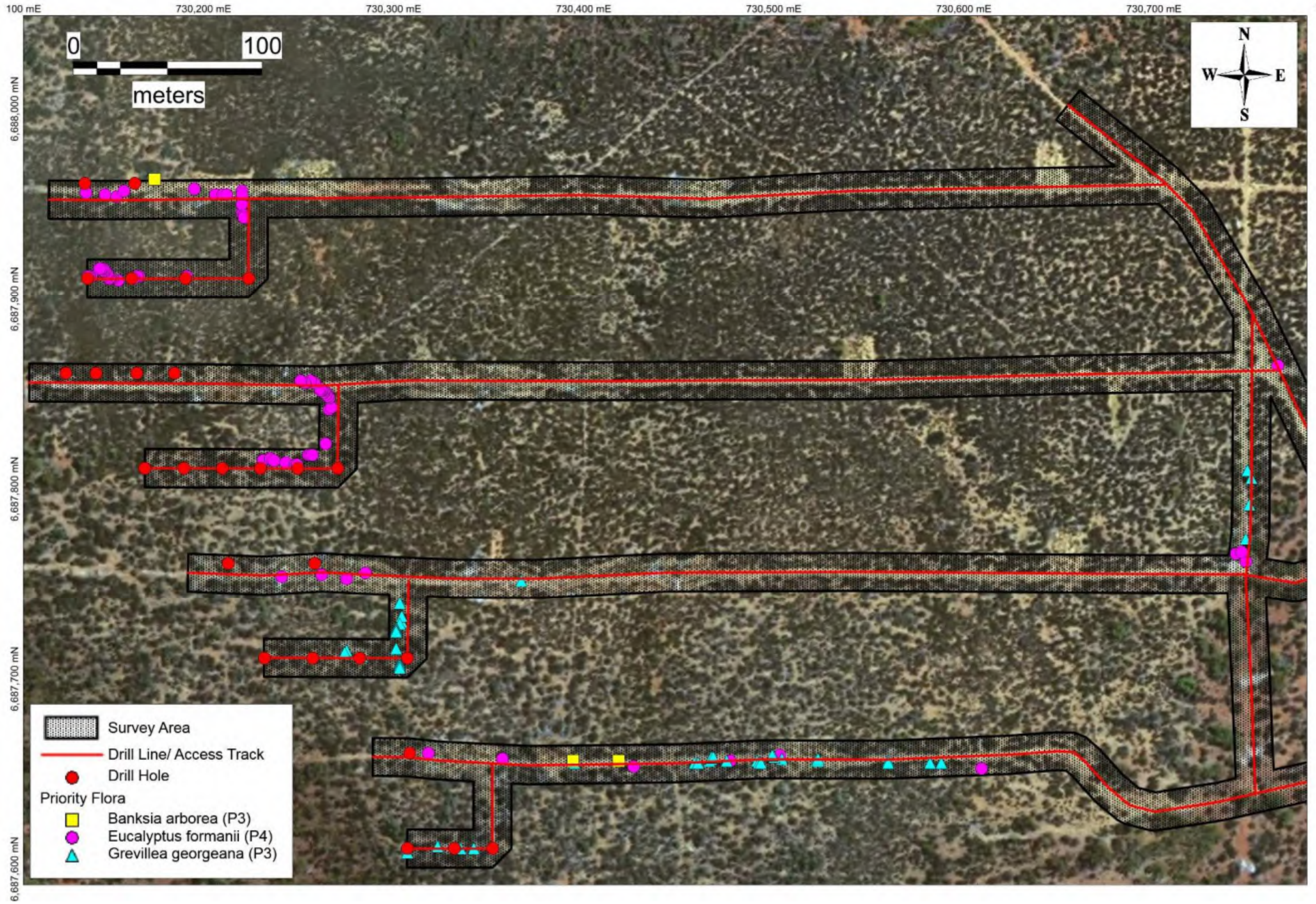


Figure 3a: Priority Flora records in relation to the Red Legs exploration program

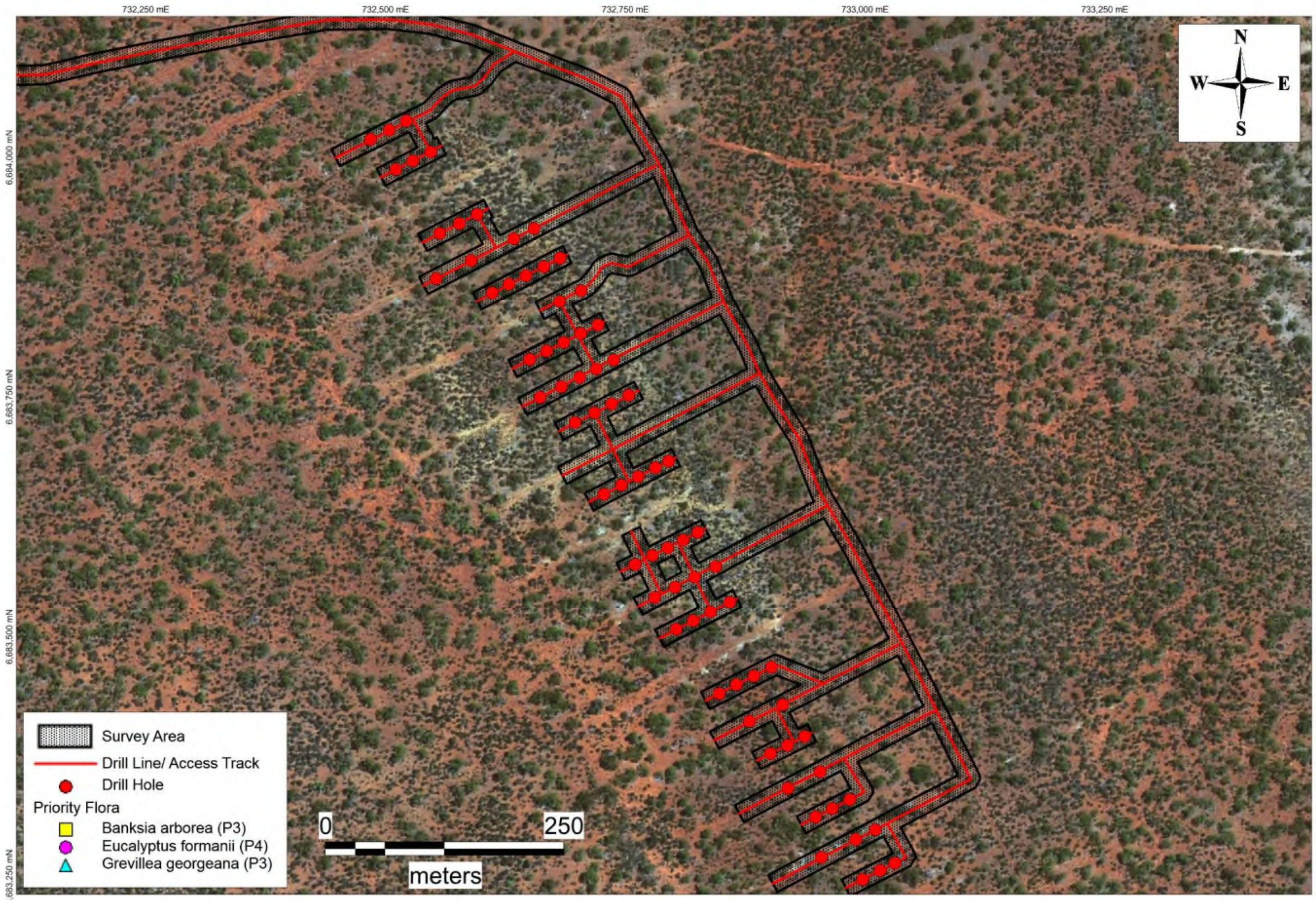


Figure 3b: Priority Flora records in relation to the Die Hardy exploration program

Vegetation

Four vegetation associations were recorded within the survey area as listed in Table 2 and shown in Figure 4. Approximately 20.5 ha of the survey area (~88% of the total survey area) is located within the boundary (including 500m buffer) of a Priority 1 Ecological Community; Die Hardy Range/Diemels vegetation complex (banded ironstone formation) which encompasses an area of 16,500 ha. The total survey area (23.4 ha) represents 0.14% of the total extent of this PEC. A map showing Priority Ecological Communities in relation to the survey area is provided in Figure 5.

Table 2: Vegetation Associations recorded within the survey area

Vegetation Code	Vegetation Association	Area (ha)	Area (%)	Photo
CLP-EW1	Low woodland of *Eucalyptus concinna* over mid open shrubland of *Acacia ramulosa* and low sparse shrubland of *Ptilotus obovatus* on clay-loam plain	2.6	11.1	
CLP-EW2	Low woodland of *Eucalyptus salmonophloia/ E. salubris* over mid sparse shrubland of *Acacia tetragonophylla* and low chenopod shrubland of *Atriplex stipitata* on clay-loam plain	11.5	49.1	

Vegetation Code	Vegetation Association	Area (ha)	Area (%)	Photo
HS-CFW1	Mid shrubland of *Allocasuarina campestris* over low sparse shrubland of *Goodenia* spp. on hillslope	6.3	26.9	
HS-EW1	Low open woodland of *Eucalyptus concinna* over mid shrubland of *Acacia ramulosa* and low sparse shrubland of *Ptilotus obovatus* on hillslope	3	12.8	
TOTAL		**23.4**	**100**	

Figure 4: Vegetation Associations within the survey area

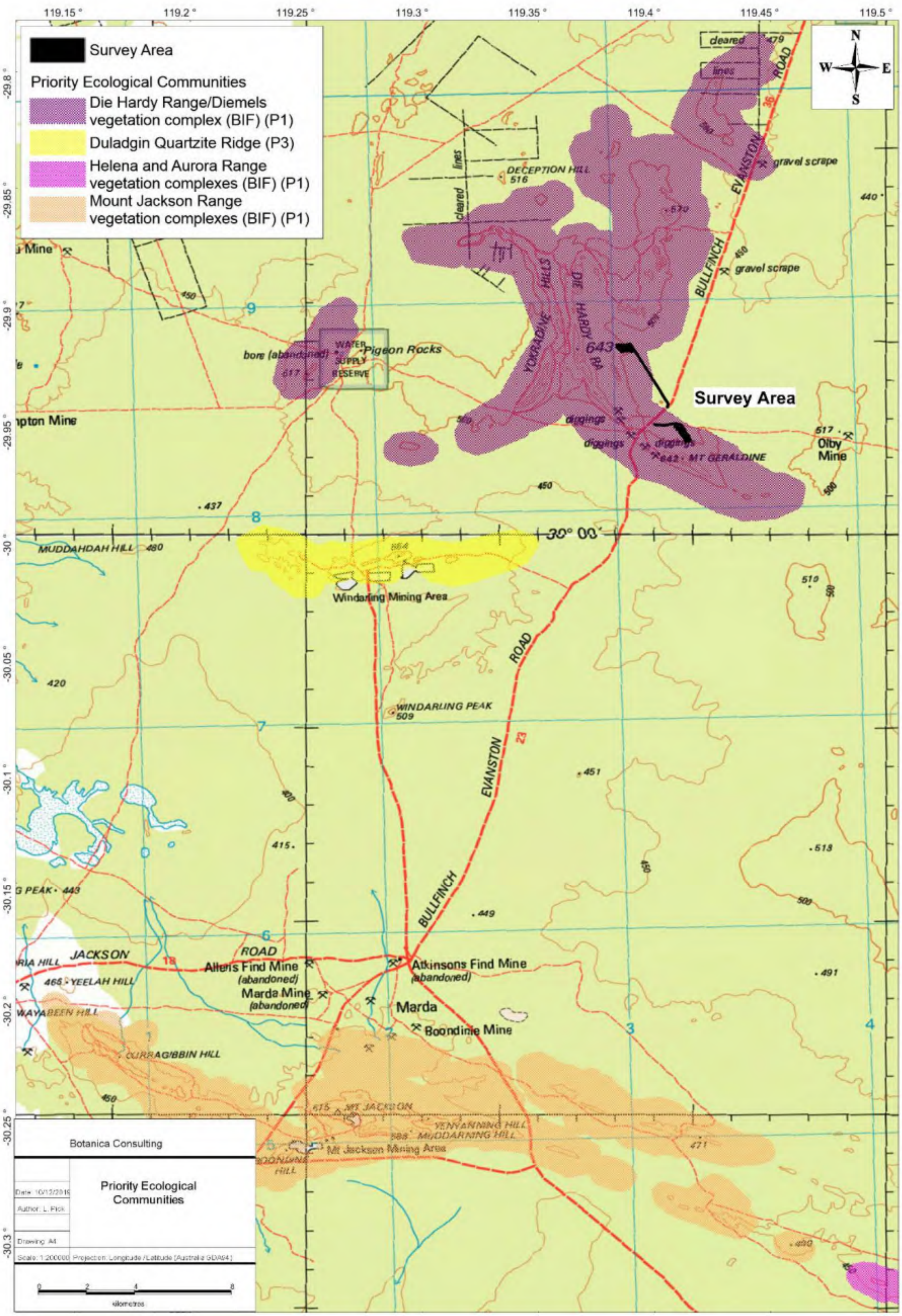


Figure 5: Priority Ecological Communities in relation to the survey area

Fauna

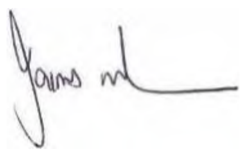
There was no evidence of Malleefowl mounds or other evidence of Malleefowl activity (tracks, feathers or bird observations etc.) observed during the survey.

Conclusion

Majority of the proposed drilling is located within areas of existing disturbance (as shown in Figure 3a and 3b), therefore clearing of mature Eucalypts will be avoided and disturbance to native vegetation will be minimised. Clearing of any locations of Priority Flora should be avoided. Should disturbance to these plant locations not be able to be avoided, DBCA recommends consulting with the DBCA Species and Communities Program.

Should you have any questions, please do not hesitate to contact me.

Regards,



Jim Williams

Director

Attachment 1: GPS coordinates of Priority Flora recorded by Botanica (GDA94)

Taxon	Zone	Easting	Northing	Elevation
Banksia arborea (P3)	50 J	730167	6687952	519 m
Banksia arborea (P3)	50 J	730387	6687646	528 m
Banksia arborea (P3)	50 J	730411	6687646	527 m
Eucalyptus formanii (P4)	50 J	730758	6687854	501 m
Eucalyptus formanii (P4)	50 J	730741	6687751	502 m
Eucalyptus formanii (P4)	50 J	730736	6687755	503 m
Eucalyptus formanii (P4)	50 J	730739	6687756	503 m
Eucalyptus formanii (P4)	50 J	730278	6687745	527 m
Eucalyptus formanii (P4)	50 J	730268	6687742	528 m
Eucalyptus formanii (P4)	50 J	730255	6687744	530 m
Eucalyptus formanii (P4)	50 J	730234	6687743	530 m
Eucalyptus formanii (P4)	50 J	730311	6687650	533 m
Eucalyptus formanii (P4)	50 J	730350	6687647	531 m
Eucalyptus formanii (P4)	50 J	730419	6687643	523 m
Eucalyptus formanii (P4)	50 J	730470	6687646	525 m
Eucalyptus formanii (P4)	50 J	730496	6687649	525 m
Eucalyptus formanii (P4)	50 J	730602	6687642	516 m
Eucalyptus formanii (P4)	50 J	730224	6687804	522 m
Eucalyptus formanii (P4)	50 J	730228	6687805	523 m
Eucalyptus formanii (P4)	50 J	730230	6687804	523 m
Eucalyptus formanii (P4)	50 J	730236	6687803	523 m
Eucalyptus formanii (P4)	50 J	730241	6687802	523 m
Eucalyptus formanii (P4)	50 J	730242	6687802	523 m
Eucalyptus formanii (P4)	50 J	730248	6687807	522 m
Eucalyptus formanii (P4)	50 J	730248	6687807	522 m
Eucalyptus formanii (P4)	50 J	730248	6687807	522 m
Eucalyptus formanii (P4)	50 J	730249	6687807	522 m
Eucalyptus formanii (P4)	50 J	730249	6687807	522 m
Eucalyptus formanii (P4)	50 J	730249	6687807	522 m
Eucalyptus formanii (P4)	50 J	730249	6687807	522 m
Eucalyptus formanii (P4)	50 J	730250	6687807	522 m
Eucalyptus formanii (P4)	50 J	730257	6687813	521 m
Eucalyptus formanii (P4)	50 J	730259	6687831	520 m
Eucalyptus formanii (P4)	50 J	730259	6687831	520 m
Eucalyptus formanii (P4)	50 J	730260	6687832	520 m
Eucalyptus formanii (P4)	50 J	730259	6687837	519 m
Eucalyptus formanii (P4)	50 J	730258	6687838	519 m
Eucalyptus formanii (P4)	50 J	730258	6687838	519 m
Eucalyptus formanii (P4)	50 J	730258	6687838	519 m
Eucalyptus formanii (P4)	50 J	730258	6687839	519 m
Eucalyptus formanii (P4)	50 J	730257	6687839	519 m
Eucalyptus formanii (P4)	50 J	730257	6687839	519 m

Taxon	Zone	Easting	Northing	Elevation
Eucalyptus formanii (P4)	50 J	730257	6687839	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687840	519 m
Eucalyptus formanii (P4)	50 J	730256	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730255	6687841	519 m
Eucalyptus formanii (P4)	50 J	730254	6687841	519 m
Eucalyptus formanii (P4)	50 J	730254	6687842	519 m
Eucalyptus formanii (P4)	50 J	730254	6687842	519 m
Eucalyptus formanii (P4)	50 J	730254	6687842	519 m
Eucalyptus formanii (P4)	50 J	730251	6687845	519 m
Eucalyptus formanii (P4)	50 J	730249	6687846	519 m
Eucalyptus formanii (P4)	50 J	730247	6687845	518 m
Eucalyptus formanii (P4)	50 J	730246	6687845	518 m
Eucalyptus formanii (P4)	50 J	730244	6687846	518 m
Eucalyptus formanii (P4)	50 J	730213	6687946	516 m
Eucalyptus formanii (P4)	50 J	730213	6687939	517 m
Eucalyptus formanii (P4)	50 J	730213	6687934	517 m
Eucalyptus formanii (P4)	50 J	730214	6687933	517 m
Eucalyptus formanii (P4)	50 J	730214	6687933	517 m
Eucalyptus formanii (P4)	50 J	730214	6687932	517 m
Eucalyptus formanii (P4)	50 J	730184	6687901	518 m
Eucalyptus formanii (P4)	50 J	730159	6687901	521 m
Eucalyptus formanii (P4)	50 J	730158	6687901	521 m
Eucalyptus formanii (P4)	50 J	730156	6687900	521 m
Eucalyptus formanii (P4)	50 J	730148	6687899	522 m
Eucalyptus formanii (P4)	50 J	730148	6687899	522 m
Eucalyptus formanii (P4)	50 J	730145	6687900	522 m
Eucalyptus formanii (P4)	50 J	730144	6687900	522 m
Eucalyptus formanii (P4)	50 J	730144	6687900	522 m
Eucalyptus formanii (P4)	50 J	730144	6687900	522 m
Eucalyptus formanii (P4)	50 J	730143	6687900	522 m
Eucalyptus formanii (P4)	50 J	730143	6687900	522 m
Eucalyptus formanii (P4)	50 J	730143	6687900	522 m
Eucalyptus formanii (P4)	50 J	730142	6687901	522 m

Taxon	Zone	Easting	Northing	Elevation
Eucalyptus formanii (P4)	50 J	730142	6687901	522 m
Eucalyptus formanii (P4)	50 J	730142	6687902	522 m
Eucalyptus formanii (P4)	50 J	730142	6687903	522 m
Eucalyptus formanii (P4)	50 J	730141	6687904	522 m
Eucalyptus formanii (P4)	50 J	730141	6687904	523 m
Eucalyptus formanii (P4)	50 J	730140	6687904	523 m
Eucalyptus formanii (P4)	50 J	730140	6687905	523 m
Eucalyptus formanii (P4)	50 J	730139	6687905	523 m
Eucalyptus formanii (P4)	50 J	730139	6687905	523 m
Eucalyptus formanii (P4)	50 J	730139	6687905	523 m
Eucalyptus formanii (P4)	50 J	730138	6687905	523 m
Eucalyptus formanii (P4)	50 J	730134	6687901	523 m
Eucalyptus formanii (P4)	50 J	730133	6687901	523 m
Eucalyptus formanii (P4)	50 J	730133	6687901	523 m
Eucalyptus formanii (P4)	50 J	730132	6687901	523 m
Eucalyptus formanii (P4)	50 J	730132	6687901	523 m
Eucalyptus formanii (P4)	50 J	730131	6687945	524 m
Eucalyptus formanii (P4)	50 J	730141	6687944	522 m
Eucalyptus formanii (P4)	50 J	730147	6687943	521 m
Eucalyptus formanii (P4)	50 J	730151	6687946	521 m
Eucalyptus formanii (P4)	50 J	730188	6687947	519 m
Eucalyptus formanii (P4)	50 J	730199	6687944	518 m
Eucalyptus formanii (P4)	50 J	730203	6687944	517 m
Eucalyptus formanii (P4)	50 J	730205	6687944	517 m
Eucalyptus formanii (P4)	50 J	730213	6687944	517 m
Grevillea georgeana (P3)	50 J	730360	6687741	517 m
Grevillea georgeana (P3)	50 J	730296	6687729	524 m
Grevillea georgeana (P3)	50 J	730297	6687722	525 m
Grevillea georgeana (P3)	50 J	730297	6687722	525 m
Grevillea georgeana (P3)	50 J	730297	6687719	525 m
Grevillea georgeana (P3)	50 J	730297	6687719	525 m
Grevillea georgeana (P3)	50 J	730296	6687718	526 m
Grevillea georgeana (P3)	50 J	730294	6687716	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687715	526 m
Grevillea georgeana (P3)	50 J	730294	6687714	526 m
Grevillea georgeana (P3)	50 J	730294	6687714	526 m
Grevillea georgeana (P3)	50 J	730294	6687714	526 m

Taxon	Zone	Easting	Northing	Elevation
Grevillea georgeana (P3)	50 J	730294	6687714	526 m
Grevillea georgeana (P3)	50 J	730294	6687705	527 m
Grevillea georgeana (P3)	50 J	730296	6687698	528 m
Grevillea georgeana (P3)	50 J	730296	6687698	528 m
Grevillea georgeana (P3)	50 J	730296	6687697	528 m
Grevillea georgeana (P3)	50 J	730296	6687697	528 m
Grevillea georgeana (P3)	50 J	730296	6687697	528 m
Grevillea georgeana (P3)	50 J	730296	6687697	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687696	528 m
Grevillea georgeana (P3)	50 J	730296	6687695	528 m
Grevillea georgeana (P3)	50 J	730276	6687701	529 m
Grevillea georgeana (P3)	50 J	730268	6687704	529 m
Grevillea georgeana (P3)	50 J	730268	6687704	529 m
Grevillea georgeana (P3)	50 J	730267	6687703	530 m
Grevillea georgeana (P3)	50 J	730267	6687703	530 m
Grevillea georgeana (P3)	50 J	730300	6687598	537 m
Grevillea georgeana (P3)	50 J	730316	6687601	537 m
Grevillea georgeana (P3)	50 J	730327	6687600	537 m
Grevillea georgeana (P3)	50 J	730328	6687600	537 m
Grevillea georgeana (P3)	50 J	730335	6687600	536 m
Grevillea georgeana (P3)	50 J	730388	6687645	528 m
Grevillea georgeana (P3)	50 J	730451	6687645	526 m
Grevillea georgeana (P3)	50 J	730453	6687645	526 m
Grevillea georgeana (P3)	50 J	730459	6687646	527 m
Grevillea georgeana (P3)	50 J	730460	6687647	527 m
Grevillea georgeana (P3)	50 J	730460	6687648	527 m
Grevillea georgeana (P3)	50 J	730461	6687648	527 m
Grevillea georgeana (P3)	50 J	730468	6687646	527 m
Grevillea georgeana (P3)	50 J	730484	6687646	527 m
Grevillea georgeana (P3)	50 J	730485	6687645	527 m
Grevillea georgeana (P3)	50 J	730486	6687645	527 m
Grevillea georgeana (P3)	50 J	730493	6687648	526 m
Grevillea georgeana (P3)	50 J	730492	6687649	526 m
Grevillea georgeana (P3)	50 J	730497	6687647	526 m
Grevillea georgeana (P3)	50 J	730515	6687646	525 m
Grevillea georgeana (P3)	50 J	730516	6687646	525 m
Grevillea georgeana (P3)	50 J	730516	6687647	525 m
Grevillea georgeana (P3)	50 J	730553	6687646	523 m

Taxon	Zone	Easting	Northing	Elevation
Grevillea georgeana (P3)	50 J	730553	6687645	523 m
Grevillea georgeana (P3)	50 J	730575	6687645	521 m
Grevillea georgeana (P3)	50 J	730581	6687645	519 m
Grevillea georgeana (P3)	50 J	730741	6687763	506 m
Grevillea georgeana (P3)	50 J	730743	6687781	506 m
Grevillea georgeana (P3)	50 J	730744	6687795	504 m
Grevillea georgeana (P3)	50 J	730742	6687799	504 m

APPENDIX G
Fauna assessment (APM)

SOUTHERN CROSS GOLDFIELDS LTD

LEVEL 1 FAUNA ASSESSMENT

August 2014

Level 1 Fauna Assessment

FOR THE MARDA EAST PROJECT

Tenements R 77/1, R 77/2, L 77/261

animal plant mineral

SXG001 – Southern Cross Goldfields Limited - Level 1 Fauna Assessment of the Marda East Project

This report was completed by:

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Disclaimer

EXECUTIVE SUMMARY

Southern Cross Goldfields Limited is developing the Marda East Project, located approximately 140 km north of Southern Cross. The Project includes two ore deposits, Red Legs and Fiddleback which are approximately 3.5 km apart and joined by a proposed haul route which crosses the Bulfinch-Evanstone Road. These areas are approximately 12 ha and 33 ha in size, respectively, and are located within a Survey area of approximately 245 ha.

Animal Plant Mineral Pty Ltd was engaged in June 2014 to undertake a Level 1 fauna assessment in order to provide sufficient information for SXG to accurately assess the likely impact of mining activities on biodiversity, fauna and habitat values of conservation significance in a local and regional context.

The Survey area is located in a semi-arid Mediterranean climate in the Coolgardie Bioregion and encompasses four land systems; Campsite, Dryandra, Moriarty and Yowie, with the majority of the Survey area falling within the Campsite land system.

The Project resides within the Department of Parks and Wildlife Act Section 5(1)(h) proposed 'Conservation and Mining Reserve' and borders the Mount Manning - Helena and Aurora Ranges Conservation Park at the south eastern corner of the Fiddleback prospect. Additionally, the north western boundary of the Red Legs prospect abuts a proposed 'Class A' Nature Reserve which encompasses the Priority 1 Die Hardy Range Banded Ironstone Formation. The south eastern corner of the Fiddleback prospect borders the Mount Manning - Helena and Aurora Ranges Conservation Park and the Mount Manning Range Nature Reserve and Mount Manning Range Conservation Park are located toward the east and within 20 km.

A desktop survey of the EPBC Act Protected Matters, NatureMap and DPaw databases was conducted to develop a list of conservation significant fauna.

A field survey was conducted to assess fauna habitat and conduct targeted searches for Shield-backed Trapdoor Spiders and Tree-stem Trapdoor Spiders whilst also ground truthing Malleefowl mound activity of mounds located during the flora and vegetation survey conducted in 2012 by Western Botanical.

Based on searches of the Protected Matters and NatureMap databases, 14 species of conservation significance could potentially occur in the Survey area. However, after an analysis of fauna habitats within the Project area it was determined that 4 of the species are unlikely to occur, 3 species have the potential to occur, 6 are likely to occur, and one species (Malleefowl) has been recorded in the Survey area.

The small scale of the Survey area was considered and was allocated six habitat types; Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain; Low Eucalypt Woodland over Acacia Shrubland on Alluvial Plain; Low Eucalypt Woodland over Acacia on Rocky Rises; Low Eucalypt Woodland over Spinifex on Alluvial Plain; Dense Shrubland on Rocky Rises and Dense Shrubland on Alluvial Plain.

Fauna habitat of greatest value to fauna species occurring within the Survey area was Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain.

An intensive presence/absence search for the Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider at 15 sites over five of the six different habitat types did not locate either spider or evidence of trapdoor burrows. It is considered unlikely that these two spider species are using the Survey area.

Malleefowl mounds and tracks have been recorded in the Survey area and this species appears to prefer two particular fauna habitats in the Project area that, together, account for 15.71 ha of the area surveyed. These

habitats were the Dense Shrubland on Alluvial Plain and Dense Shrubland on Rocky Rises. Two of the 11 mounds were classified as active during the 2013 and again during the current survey (site number 1 and site number 11). Remains of a Malleefowl suspected to be predated on by a fox were found at site 11. Nine recommendations for future Malleefowl management have been proposed.

No other species of conservation significance were recorded during the survey however the peregrine Falcon, Australian Bustard, Major Mitchell's Cockatoo, Fork-tailed Swift, Rainbow Bee-eater, Shy Heathwren and the Greater Long-eared Bat have been recorded in the local area and have the potential to occur in the Project area.

APM recommends that, rather than investing resources into another baseline fauna survey of the Project area in Spring 2014, the Client should focus any further survey effort on a subset of the fauna species of conservation significance that may occur, but have not yet been located in the Project area. APM proposes a nest hollow assessment and trapping program be undertaken in Spring 2014 targeting populations of Numbat, Major Mitchell's Cockatoo and the Greater Long-eared Bat.

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LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviation	Meaning
APM	Animal Plant Mineral Proprietary Limited
BIF	Banded Ironstone Formation
BoM	Bureau of Meteorology
DoE	Department of the Environment
DPaW	Department of Parks and Wildlife
EPA	Environmental Protection Authority
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
MNES	Matters of National Environmental Significance
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities (now the Department of the Environment)
SRE	Short Range Endemic
SXG	Southern Cross Goldfields Limited
WA	Western Australia
WC Act	*Wildlife Conservation Act 1950*

Symbols and Units	Meaning
^{o}C	Degrees Celsius
cm	Centimetres
ha	Hectares
km	Kilometres
mm	Millimetres

1 INTRODUCTION

1.1 PROJECT AND LOCATION

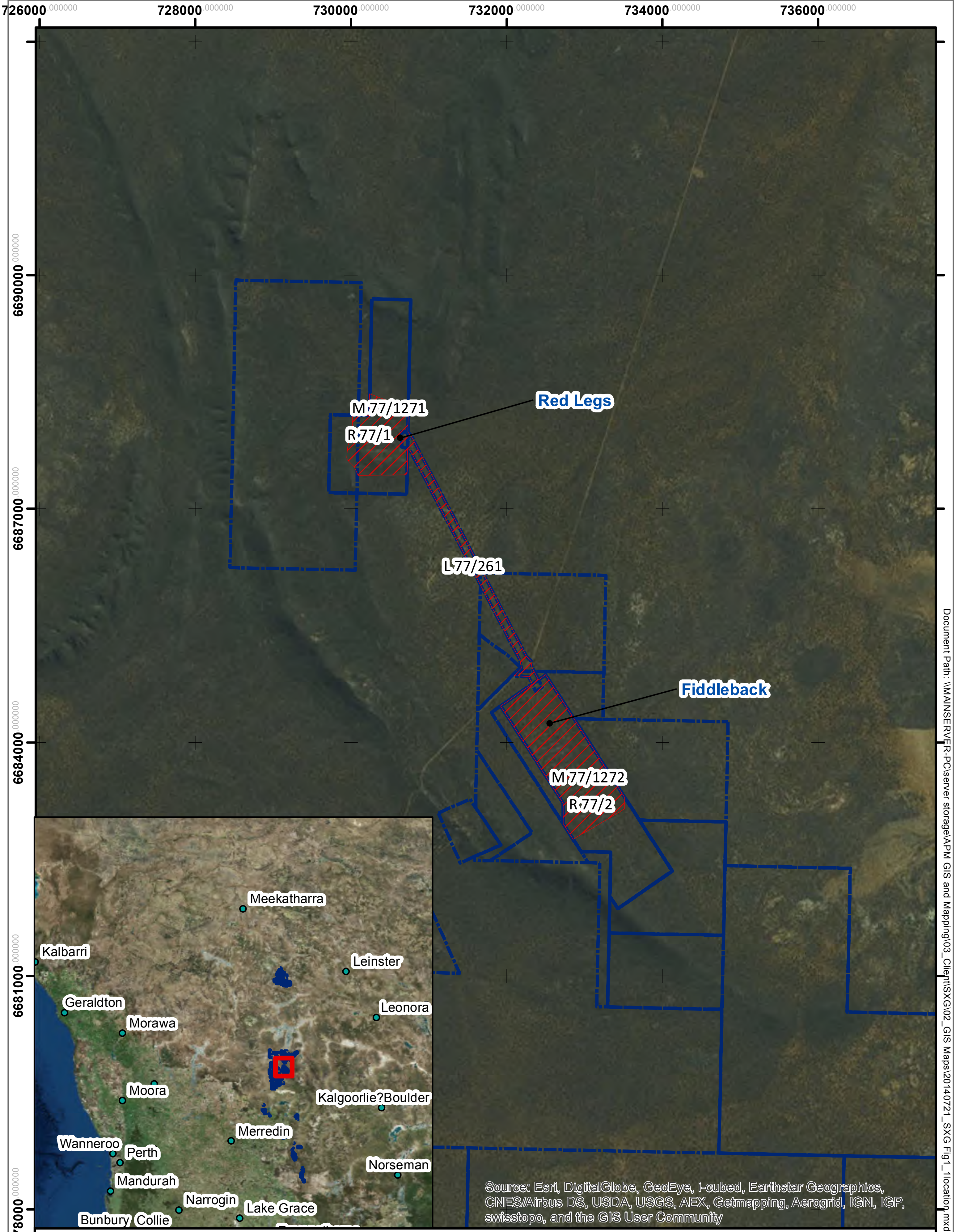
Southern Cross Goldfields Limited (SXG) is an ASX-listed company which is developing a long-term gold business based on a portfolio of production and exploration assets in Western Australia (WA) and New South Wales.

SXG completed a positive Feasibility Study in 2012 on the Marda Project in WA; this was based on the development of a greenfields gold project with open pit mines, processing facility and associated support infrastructure located at Marda Central.

SXG is now looking to progress approvals for the ore bodies 35 km north-east of the Marda Central pits, known as the Marda East Project (the Project), which includes two ore deposits, Red Legs and Fiddleback (previously named Die Hardy). These two deposits are approximately 3.5 km apart and joined by a proposed haul route which crosses the Bulfinch-Evanstone Road. These areas are approximately 12 ha and 33 ha in size, respectively, and are located within a Survey area of approximately 245 ha.

The Project is located approximately 140 km north of Southern Cross (Figure 1-1), comes under the jurisdiction of the Menzies Shire and is part of the Yilgarn Mineral Field. The Project is on the former Diemals Pastoral Station lease that is currently destocked and now a Department of Parks and Wildlife (DPaW) Act Section 5(1)(h) proposed ‘Conservation and Mining Reserve’. A proposed ‘Class A’ Nature Reserve in the Die Hardy Range occurs immediately adjacent to the north-western boundary of the Red Legs prospect. Additionally the project area borders The Mount Manning - Helena and Aurora Ranges Conservation Park at the south eastern corner of the Fiddleback prospect.

The Project is located within 20 km of the Mount Manning Range Nature Reserve and the Mount Manning Range Conservation Park and a portion of the Project is located on the south eastern flanks of the Die Hardy Range, a Banded Ironstone Formation (BIF) and classified as a Priority 1 (P1) Priority Ecological Community (PEC).



Legend

Figure 1.1: Location of the Marda East Project, WA

Date: 21/07/2014

Marda East Project Survey Area

Southern Cross Goldfield Ltd Tenements

Coordinate System: GDA 1994 MGA Zone 50

Document Name: 20140721_SXG Fig1_1location

Author: T Smith

1.2 Scope of Work

Animal Plant Mineral Pty Ltd (APM) was engaged by SXG in June 2014 to undertake a Level 1 fauna assessment in an area of approximately 245 hectares (ha), defined by SXG (Survey area) (Figure 1-1), encompassing the Red Legs and Fiddleback deposits which are located approximately 3.5 km apart and linked by a haul road corridor 100 metres (m) wide.

The assessment was designed in accordance with a Level 1 fauna survey (Reconnaissance survey) as defined in Environmental Protection Authority Position Statement 3 (Environment Protection Authority (EPA) 2002), Guidance Statement 56 (EPA 2004) and Guidance Statement 20 (EPA 2009).

The objectives of the survey were to:

- Enhance the level of knowledge regarding vertebrate fauna and short range endemic invertebrates (SREs) at a local scale and place it in a regional context.
- Provide sufficient information for SXG to accurately assess the likely impact of mining activities on biodiversity, fauna and habitat values of conservation significance in a local and regional context.

2 EXISTING ENVIRONMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 Climate

The Survey area is located in a semi-arid Mediterranean climate. Temperatures are strongly seasonal with hot summers (December – February) and cooler winters (June – August); rainfall predominantly occurs in late summer, autumn and winter.

Data was sourced from two different locations in order to compile the most relevant climate information for the Survey area. The Bureau of Meteorology (BoM) have been recording rainfall data from the Windarling station (BoM Site Number 012141), approximately 12 km south west of the Survey area, since 2004. Temperature data was sourced from the Southern Cross Airfield station (BoM Site Number 12320; opened in 1996), approximately 140 km south of the Survey area.

Average monthly temperature and rainfall data is presented in Table 2-1. Recorded data suggests that the Survey area is likely to receive approximately 277 mm of rain on an annual basis and experience temperatures ranging between 3 °C and 35 °C. Although rainfall and daily temperatures in the Project area may vary slightly, data from the above mentioned Research Stations provides a good indication of climatic conditions within the region.

Table 2-1: Southern Cross Airfield Station Temperature Data and Windarling Station Rainfall Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Max Temp (°C) (Southern Cross Airfield)	34.7	33.7	30.5	26.4	21.5	17.9	16.6	18.5	21.5	26.3	29.9	32.7	25.8
Mean Min Temp (°C) (Southern Cross Airfield)	17.7	17.6	15.0	11.6	7.6	4.6	3.4	3.4	5.1	9.1	12.9	15.3	10.2
Mean Rainfall (mm) (Windarling)	49.9	32.6	24.9	26.1	22.4	22.8	28.8	17.0	19.0	10.7	14.6	12.0	276.5
2014 Rainfall (mm) (Windarling)	162.4	2.5	10.2	60.2	44.0	8.8	Not yet reported by BoM						

Source: http://www.bom.gov.au

2.1.2 Bioregions and Systems

Mapping for the Interim Biogeographic Regionalisation for Australia (IBRA version 6.1) programme placed the Project area in the Southern Cross subregion of the Coolgardie Bioregion (SEWPaC, undated). The subregion and bioregion, respectively, is described in McKenzie et al. 2002 as follows:

"The Southern Cross subregion comprises gently undulating uplands on granite strata and broad valleys with bands of low greenstone hills."

"The Coolgardie Bioregion is within the Yilgarn Craton. Its granite basement includes Archaean Greenstone intrusions in parallel belts. Drainage is occluded. The climate is arid to semi-arid warm Mediterranean with 250-300mm of mainly winter rainfall. Diverse woodlands, rich in endemic eucalypts, occur on low greenstone

hills, on alluvial soils on the valley floors, around the saline playas of the region's occluded drainage system, and on broad plains of calcareous earths.

The granite basement outcrops at mid-level in the landscape. It supports swards of 'granite grass', wattle shrublands and York Gum. The playa lakes support dwarf shrublands of samphire. Sand lunettes are associated with playas along the broad valley floors, and sand sheets surround the granite outcrops.

Upper levels in the landscape are the eroded remnants of a Tertiary lateritic duricrust, with yellow (in the Southern Cross subregion) or red (in the Eastern Goldfields subregion) sandplains, gravel plains and laterite breakaways. These support scrubs and mallees. In the west, these scrubs are rich in endemic Proteaceae; in the east they are rich in endemic acacias."

The Project lies adjacent to the Die Hardy Range, which is one of many Banded Ironstone Formations (BIFs) in the region. These BIF ranges have been recognised for the unique compositions of flora and fauna and for supporting rare and endemic plant species (DEC 2007).

The Priority One (P1) Die Hardy Range / Diemels vegetation complex (banded ironstone formation), Priority Ecological Community (PEC) covers an area of 10,547.54 ha and occurs around the Banded Ironstone Formation geology of the Die Hardy Ranges and the adjacent Yokradine Hills, inclusive of the midslopes, lower slopes and portions of the adjacent plains. The Marda East Project area intersects this PEC with 107.18 ha of the project area mapped by Western Botanical (2014) occurring within the PEC (representing 1.02 % of the total PEC). Ten of the 12 vegetation associations mapped by Western Botanical in the Project area form part of the Priority 1 PEC vegetation complex (banded ironstone formation).

2.1.3 Land Systems Mapping

The Rangeland Land System Mapping for Western Australia dataset (Department of Agriculture and Food, 2009) was consulted to further facilitate a broad assessment of the regional representation of vegetation that occurs in the Survey area. A land system is defined as 'an area or group of areas, throughout which there is a recurring pattern of topography, soils and vegetation'. Four land systems were mapped within the Survey area by Payne *et al.* (1998):

- **Campsite:** Alluvial plains; very gently inclined plains receiving sheet wash from mafic hills, gently undulating calcareous stony upper plains (erosional) and occasional narrow concentrated drainage tracts. Supports eucalypt woodlands with halophytic understoreys and eucalypt-acacia shrublands.

- **Dryandra:** Conspicuous banded ironstone and jaspilite ridges and hills with hill slopes of variable country rock, relief up to 150 m or more. Supports dense mixed shrublands with emergent native pines, mallees and casuarinas.

- **Moriarty:** Low greenstone rises and stony plains, with local pockets of lateritic duricrust on weathered greenstone, very gently undulating plains with stony lag and alluvial plains with texture contrast soils. Supports chenopod, halophytic and acacia shrublands with patchy eucalypt over storeys.

- **Yowie:** Sandy plains with negligible surface drainage features. Supports shrublands of mulga and bowgada with common mallee eucalypts and patchy wanderrie grasses.

The majority of the Survey area is within the Campsite land system (171.02 ha) followed by the Dryandra land system (61.19 ha); these two land systems represent 94.6% of the Survey area (245 ha).

2.1 PREVIOUS SURVEYS

No fauna surveys have been undertaken in the specific Project area however, previous work has been done at Marda Central:

- Bamford Consulting Ecologists, Level 1 Fauna Assessment of Proposed haul Roads, Camps and Airstrips, 2013.
- Bamford Consulting Ecologists, Targeted Fauna (Malleefowl), Marda Gold Project, 2013.
- Rapallo Environmental, Short Range Endemic Fauna Desktop and Risk Assessment of the Marda Gold Project, 2012.

Additionally biological surveys have been undertaken in nearby areas:

- Ecologia, Terrestrial and Subterranean Fauna Assessment, J4 Mine and Haul Road, 2013.
- Cliffs, Koolyanobbing Iron Ore Project, Biodiversity and Research Management Plan, 2009.
- Ninox Wildlife Consulting, Fauna Survey of the Carina Prospect, 2009.
- Terrestrial Ecosystems, Tree Hollow Assessment for Cockatoos at Battler, King Brown Marda and Golden Orb, 2011.

Level 1 flora and vegetation studies of portions of the Red Legs and Fiddleback deposits have been undertaken for exploration Programme of Work purposes and a Level 2 flora and vegetation survey was completed by Western Botanical in spring 2013 (reported in 2014).

The Western Botanical report provides a detailed summary of previous local and regional botanical surveys in addition to their own comprehensive reporting on the Project area specifically. This report should be considered with reference to the Western Botanical report.

3 METHODOLOGY

3.1 LEGISLATION

Species considered to be of national conservation significance (MNES) are protected under the *Environmental Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). Under this Act, activities that may have a significant impact on a species of national conservation significance must be referred to the Department of the Environment (DoE), formerly the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), for assessment.

In WA, all native fauna species are protected under the *Wildlife Conservation Act 1950* (*WC Act*). Fauna species that are considered rare, threatened with extinction or have high conservation value are specially protected by four schedules in this Act (Appendix 1). The DPaW also classifies some other fauna under five different Priority codes (Appendix 1).

In addition, some species of fauna are covered under the 1991 Australian and New Zealand Environment Conservation Council (ANZECC) Convention (Commonwealth (Cth)), while certain birds are listed under the 1974 Japan and Australian Migratory Bird Agreement (JAMBA) (Cth) and the 1986 China and Australian Migratory Bird Agreement (CAMBA) (Cth). More recently Australia and the Republic of Korea agreed to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA. The Republic of Korea-Australian Migratory Bird Agreement (ROKAMBA) was entered into force in 2007. All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as MNES under the *EPBC Act*.

3.2 DESKTOP METHODOLOGY

A comprehensive list of conservation significant fauna known to occur in the area was assimilated using online database searches:

- A search of the *EPBC Act* list of protected species was undertaken using the Protected Matters Search Tool to identify fauna considered to be a MNES (Appendix 2). This search was conducted using a polygon that covered the Project area and included a 10 km buffer area. The coordinates for the polygon were as follows: -29.8382E, 118.47619S; -29.8382, 119382202 S; -30.70872E, 119.82202; -30.70872E, 118.47619S; -29.8382 E, 118.47619S.

- A search for fauna previously recorded within 40 km using a centre point at (119°16'50''E, 30°01'00''S) was undertaken using NatureMap (Appendix 3). The records include historical data on specimens held in the WA Museum and the DPaW Fauna Database.

- A request was made for a search of the DPaW databases for threatened and priority fauna. This search was conducted using a spot location (119°16'50''E, 30°01'00''S) with a 40km buffer area to adequately encompass the Survey area.

3.3 TAXONOMY AND NOMENCLATURE

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum's *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (2012) with alternative bird taxonomy from Christidis and Boles (2008) given in parentheses. Common names of species were used throughout the text where possible and scientific names were used in the tables and appendices with the corresponding common names.

3.4 Fieldwork Methodology

The Level 1 targeted field survey was conducted between June 20th and June 22nd 2014. The survey was designed to assess fauna habitat of the Survey area and the presence of three target species; Malleefowl *Leipoa ocellata* (protected under the *EPBC Act*), Shield-backed Trapdoor Spider *Idiosoma nigrum* (protected under the *EPBC Act*) and Tree-stem Trapdoor Spider *Aganippe castellum* (protected under the *WC Act*). Additionally, opportunistic observations of other species were recorded at all times.

3.4.1 Fauna Habitat

To produce a fauna habitat map of the Survey area, the types of fauna habitat present were assessed and cross-referenced with the vegetation map produced by Western Botanical in 2014.

Vegetation condition is an important aspect of fauna habitat; higher quality of vegetation condition results in higher value fauna habitat. Vegetation condition at the Project was assessed by Western Botanical (2014) and was considered to be in Excellent to Very Good condition. The vegetation structure was considered to be intact with the exception of historic drill lines, drill pads and access tracks previously cleared during exploration drilling; however these areas were observed to be regenerating and recovering well.

The areas and percentages of potential impact on the fauna habitats were calculated using the boundaries and extents of the vegetation associations mapped by Western Botanical (2014). Western Botanical (2014) mapped vegetation over 245.29 ha within the Marda East tenements. Presently the total proposed impact footprint of the Marda East project is expected to be 67.18 ha.

3.4.2 Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider

Spider search sites were located in different habitats across the Survey area and outside of the defined Survey area; a total of 15 sites were searched, of these 12 were within the Survey area.

Search sites comprised minimum 10 x 10 metre quadrats which were searched for a minimum of 15 minutes each for signs of the spiders’ burrows. Any burrows found were to be measured, photographed and logged in the GPS.

3.4.3 Malleefowl

Western Botanical recorded Malleefowl mounds that were opportunistically encountered within the Marda East Project area during their Level 2 Flora and Vegetation Assessment; a total of 11 mounds were recorded. These mounds were revisited and assessed during the current survey; the mounds were re-classified by zoologists as Active or Inactive.

Active mounds would show signs of fresh scratching or loose soil and Malleefowl footprints may be observed; active mounds would likely contain abundant plant material and shell fragments may be evident. Inactive mounds would likely have compacted soil, limited or no plant material and show signs of weathering, erosion and/or colonisation by plants.

3.5 Contributing Authors

The strategy for the fauna assessment was developed and managed by APM Principal Biologist Dr Mitch Ladyman.

The field component of this survey was undertaken by Dr Mitch Ladyman and Mr Shane McAdam.

The subsequent reporting was completed by Dr Mitch Ladyman and Mr Shane McAdam with assistance from Ms Corinne Chambers.

4 RESULTS

4.1 DESKTOP SURVEY

Based on searches of the Protected Matters and NatureMap databases, 14 species of conservation significance could potentially occur in the Survey area. These species comprise 10 birds, two mammals and two reptiles (Table 4-1).

A likelihood of occurrence analysis revealed that 4 of the species are unlikely to occur, 6 are likely to occur, 3 species have the potential to occur and one species (Malleefowl) has been recorded in the Survey area. The total list of conservation significant species and the likelihood of their occurrence in the Survey area is presented in Table 4-1.

Table 4-1: List of Conservation Significant Species potentially occurring in the Survey area

Species	Conservation Status			Habitat Description	Likelihood of Occurrence
	Commonwealth (*EPBC Act*)	State (*WC Act*)	DPaW (Priority Status)		
BIRDS					
Malleefowl *Leipoa ocellata*	Vulnerable	Schedule 1 Division 2		Malleefowl occurs in semi-arid and arid zones in temperate Australia. It mainly occupies shrubland and low woodland dominated by multi-stemmed Eucalypt species on sandy or loamy soils with an abundance of leaf litter (DoE SPRAT 2014).	**Occurs** Active mounds recorded in the Survey area. Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally
Cattle Egret *Ardea ibis*	Migratory Wetland Species			The Cattle Egret is classed as a migrant, as it was originally from Asia. The species often feeds with cattle, eating insects disturbed by the cattle as they graze. The Cattle Egret can also be seen feeding in fresh water environments if conditions are favourable and frogs and tadpoles are abundant. This species can be present at all times of the year and roosts in colonies (DoE SPRAT 2014).	**Unlikely to occur** Suitable habitat is unavailable.
Great Egret *Ardea alba*	Migratory Wetland Species			This species is classified as migratory but there is little evidence to support this. The Great Egret is present at all times of year in fresh and saltwater environments. Great Egrets are widespread in Australia. They occur in all states and territories of mainland Australia and in Tasmania. They often occur solitarily, or in small groups when feeding. They roost in large flocks that may consist of hundreds of birds. They live in a wide variety of habitats ranging from inland to coastal. The species usually frequents shallow waters. They mainly forage by wading through water consuming a diet of fish, molluscs, crustaceans, lizards, snakes, frogs and small mammals and birds (DoE SPRAT 2014).	**Unlikely to occur** Suitable habitat is unavailable.

Species	Conservation Status			Habitat Description	Likelihood of Occurrence
	Commonwealth (*EPBC Act*)	State (*WC Act*)	DPaW (Priority Status)		
Peregrine Falcon *Falco peregrinus (inc.* subsp. *macropus)*		Schedule 4 Division 2		The Peregrine Falcon is found in most habitats and altitudes throughout Australia. This species requires abundant avian prey and secure nest sites. The Peregrine Falcon prefers coastal and inland cliffs or open woodlands near water, but can even be found nesting on tall city buildings (DoE SPRAT 2014).	**Potential to occur** This species may nest in the BIF ranges and forage over the Survey area. However it would not be dependent on habitats within the Survey area.
Australian Bustard *Ardeotis australis*			Priority 4	Australian Bustards are found in tussock grassland, *Triodia* hummock grassland, grassy woodland, low shrublands and structurally similar artificial habitats such as croplands and golf-courses. They will also use denser vegetation when this has been opened up by recent burning (Garnett and Crowley 2000).	**Likely to occur** Species has been recorded in the local area (DPaW 2013). Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally
Major Mitchell's Cockatoo *Cacatua leadbeateri*		Schedule 4 Division 2		Major Mitchell's Cockatoos occur in sparsely timbered grasslands, scrublands, stands of Casuarinas along sand ridges and covering rocky outcrops, and mallee. They are always found in the vicinity of water and they require large, old, hollow-bearing Eucalypts for breeding (Johnstone and Storr 1998).	**Likely to occur** Species has been recorded in the local area (DPaW 2013). Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally
Fork-tailed Swift *Apus pacificus*	Migratory Marine Species			The Fork-tailed Swift is a migratory species. Individuals are almost exclusively aerial and feed at high altitudes. During thunderstorms and cyclones birds forage lower to the ground, and emergent termites are one source of food that brings this species down to lower altitudes (DoE SPRAT 2014).	**Potential to occur** May utilise the local area while hawking for insects. Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally

Species	Conservation Status			Habitat Description	Likelihood of Occurrence
	Commonwealth (*EPBC Act*)	State (*WC Act*)	DPaW (Priority Status)		
Rainbow Bee-eater *Merops ornatus*	Migratory Terrestrial Species			This species is moderately common to common in open woodland and near water. Though the Rainbow Bee-eater is classified as a migratory, not all individuals of the species migrate. It is most commonly observed in ones and twos but is occasionally seen in small flocks of up to 100 individuals (DoE SPRAT 2014).	**Likely to occur** Species has been recorded in the local area (DPaW 2013). Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally
Hooded (Dotterel) Plover *Thinornis (Charadrius) rubricollis*			Priority 4	The Hooded Dotterel is medium in size for a plover, stocky, and pale in colour with a distinct black hood, white collar, red bill and red legs. In Western Australia, Hooded Plovers are generally recorded on ocean beaches and salt lakes where they feed on insects, sandhoppers (*Orchestia* sp.), small bivalves, and soldier crabs (*Mictyris platycheles*). The species also nests on the beaches or in adjacent dunes.	**Unlikely to occur** Suitable habitat is unavailable.
Shy Heathwren *Hylacloa cauta* subsp. *whitlocki*			Priority 4	The Shy Heathwren (Grasswren, Hylacola) is a small passerine (perching bird) that inhabits shrublands and eucalypt woodlands, but will also utilise post fire regeneration and uncleared road verges. It prefers stony hills and is distributed across the south west of Western Australia, east and north of the Darling Scarp. Nesting close to the ground or on the ground amongst vegetation this species is especially vulnerable to feral predators.	**Likely to Occur** Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally.
MAMMALS					
Numbat *Myrmecobius fasciatus*	Vulnerable			Falling within the Critical Weight Range (35 – 5500 grms), populations of this small marsupial have been decimated by feral predators across its range. A highly specialised diet of termites also determines that this species has very specific habitat requirements. Eucalypt woodlands are the primary habitat of this species as they provide hollows for refuge and nesting, and an abundance of termites on which to feed.	**Potential to Occur** There is potential for this species to occur based on the availability of habitat. However, the likelihood of occurrence is low due to the rarity of the species.

Species	Conservation Status			Habitat Description	Likelihood of Occurrence
	Commonwealth (*EPBC Act*)	State (*WC Act*)	DPaW (Priority Status)		
Greater Long-eared Bat *Nyctophilus major*			Priority 4	Known to be wide-spread in the arid Coolgardie Bioregions, the taxonomy of this species is presently unclear. It is common but patchily distributed through eucalypt woodlands with well-defined shrub strata. It feeds by gleaning invertebrates from the surfaces of vegetation and can be found feeding from the ground. Secure populations are known to occur in the Mount Manning Nature Reserve.	**Likely to Occur** Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally.
INVERTEBRATES					
Shield-backed Trapdoor Spider *Idiosoma nigrum*	Vulnerable	Schedule 1 Division 7		Burrows tend to be located in soil dominated by clay/loam and rock or by sandy clay/loam and rock. This environment is necessary to provide a microhabitat that supports tubular burrows that are 20-30 cm deep with a trapdoor diameter of >2.0 cm (Main 1992) that provide stable temperature and humidity conditions which perpetuate when they close their burrow during the late summer months and aestivate (Main 1985).	**Unlikely to occur** Though habitat is present the Naturemap search does not indicate the species has been recorded near the Survey area. The larger area of the MNES search indicates a presence regionally.
Tree-stem Trapdoor Spider *Aganippe castellium*			Priority 4	The Tree-stem Trapdoor inhabits areas that are prone to localised flooding and, as such, construct burrows with elevated palisades around the entrance, comprising leaves and twigs that deflect water. As for most mygalomorph spiders individuals are long lived and invest significant time in burrow construction. Thus, trampling and habitat destruction from fire have a significant impact on local populations. This contributes to the species conservation significance.	**Likely to Occur** Abundant suitable habitat in the Survey area. However habitat is not limited to the Survey area and is broadly available locally.

4.2 Field Survey

4.2.1 Fauna Habitat

Fauna assemblages are closely aligned with available habitats. The habitat types chosen represent a scale relevant to the small size of the Survey area in relation to the surrounding landscape and largely reflect landform, soil type and vegetation communities.

The Survey area covers six habitat types (Figure 4-1):

- Tall *Eucalypt* Woodland over Halophytic understorey on Alluvial Plain.
- Low *Eucalypt* Woodland over Acacia Shrubland on Alluvial Plain.
- Low *Eucalypt* Woodland over Acacia on Rocky Rises.
- Low *Eucalypt* Woodland over Spinifex on Alluvial Plain.
- Dense Shrubland on Rocky Rises.
- Dense Shrubland on Alluvial Plain.

A summary of these six habitats are provided in Table 4-2.

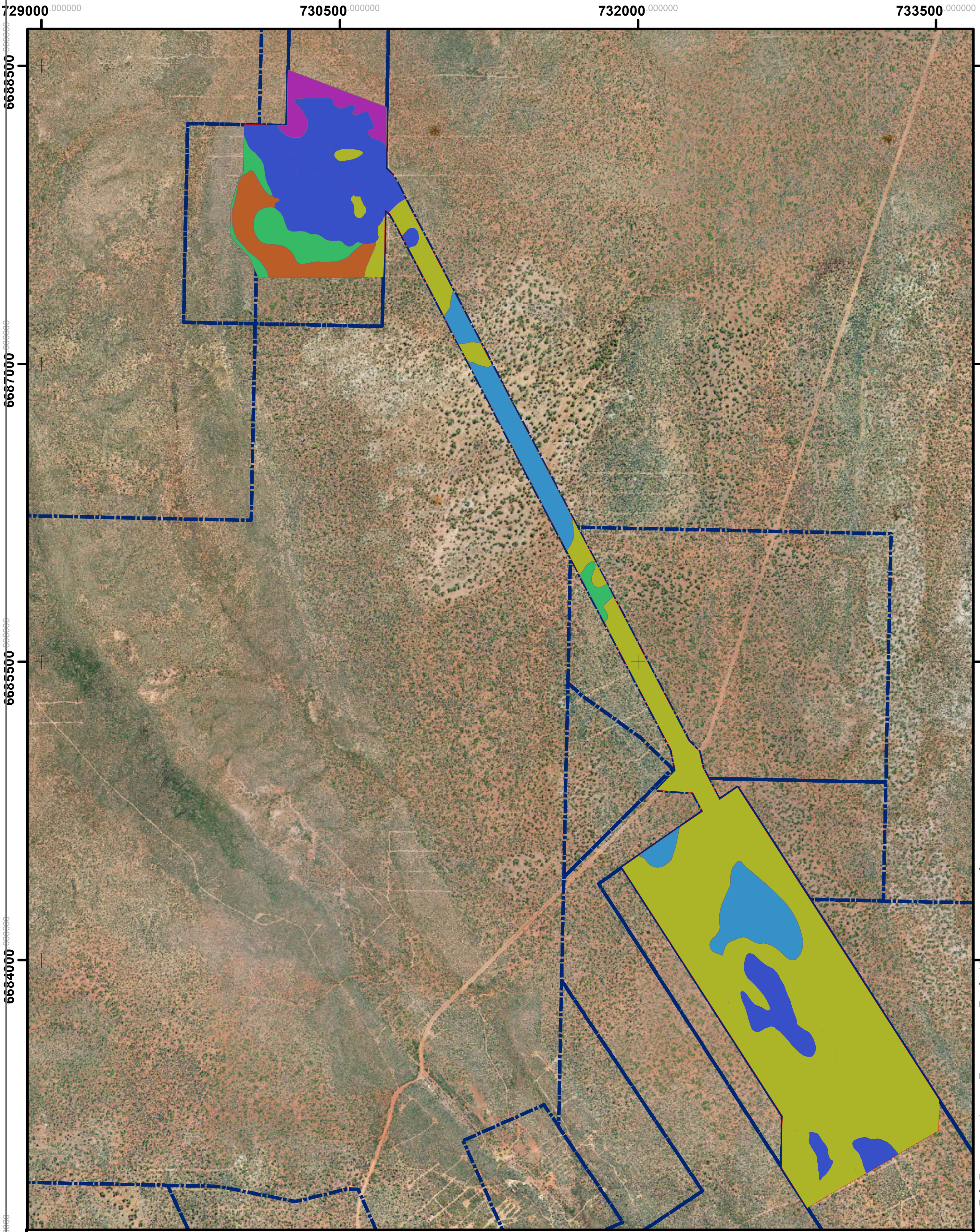


Figure 4.1: Fauna Habitat of the Marda East Survey Area

Legend

- Marda East Project Survey Area
- Southern Cross Goldfield Ltd Tenements

Fauna Habitat Descriptions

- Dense shrubland on alluvial plain
- Dense shrubland on rocky rises
- Low eucalypt woodland over acacia shrubland on alluvial plain
- Low eucalypt woodland over acacia shrubland on rocky rises
- Low eucalypt woodland over spinifex on alluvial plain
- Tall eucalypt woodland over halophytic understory on alluvial plains

N

Date: 29/07/2014

530 265 0 530 Meters

Coordinate System: GDA 1994 MGA Zone 50

Document Name: 20140729_Fig4_1FaunaHabitat

Author: ems@animalplantmineral.com.au

Table 4-2: Summary of Habitat Types identified in the Survey area

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Tall *Eucalypt* Woodland over Halophytic understorey on Alluvial Plain	Alluvial plain prone to flooding; gravelly clay substrate supporting tall, moderately large, hollow bearing *Eucalypts*, a variety of mid-level shrubs, surface herbs and low level halophytes.  	• Hollow bearing *Eucalypts* with a range of hollow diameters on living trees and deadfall timber. • Exfoliating bark. • Detritus around the base of larger trees. • Range of vegetation strata suitable to a variety of passerine and non-passerine birds. • Relatively dense shrubs providing cover for cryptic small geckonids. • Termitaria in standing and fallen dead timber. • Ground not especially suited to burrowing species. • Halophytes may attract a small subset of the fauna assemblage that may not occur elsewhere in the Survey area.	• Tree-stem Trapdoor Spider (Priority 4) – patches of substrate suitable for burrow construction. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging and nesting. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging and nesting where suitable hollows can be sourced. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over and roosting within upper vegetation strata. • Shy Heathwren (western) (Priority 4) – foraging but not likely nesting. • Rainbow Bee-eater (International Agreement) – foraging only. • Greater Long-eared Bat (Priority 4) – foraging and roosting in hollows. • Numbat (Vulnerable) – foraging and refuging in suitable hollows.

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Low *Eucalypt* Woodland over Acacia shrubland on Alluvial Plain	Gravelly clay loam substrate; this habitat is situated on an alluvial plain however a slight gradient means the habitat is subject to surface water flow but not flooding. *Eucalypt* woodland and open *Acacia* shrubland.  	• Hollow bearing *Eucalypts* with a range of hollow diameters on living trees and deadfall timber. • Exfoliating bark. • Detritus around the base of larger trees. • Range of vegetation strata suitable to a variety of passerine and non-passerine birds. • Relatively dense shrubs providing cover for cryptic small geckonids. • Termitaria in standing and fallen dead timber. • Gravelly clay loam ideal for burrowing.	• Tree-stem Trapdoor Spider (Priority 4) – patches of substrate suitable for burrow construction. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging and nesting. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging and nesting where suitable hollows can be sourced. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over and roosting within upper vegetation strata. • Shy Heathwren (western) (Priority 4) – foraging but not likely nesting. • Rainbow Bee-eater (International Agreement) – foraging only. • Greater Long-eared Bat (Priority 4) – foraging and roosting in hollows. • Numbat (Vulnerable) – primarily foraging and possible temporary refuge in marginally suitable hollows.

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Low *Eucalypt* Woodland over Acacia shrubland on Rocky Rises	Similar to the Low Eucalypt Woodland over Acacia shrubland on Alluvial Plain habitat in terms of vegetation and detritus however this habitat comprises steeper slopes with more variable and rocky substrate.  	• Fewer and smaller hollow bearing *Eucalypts* with a limited diameter hollows suitable for bats, some reptiles and smaller hollow nesting birds. • Limited exfoliating bark. • Limited detritus due to the presence of smaller trees. • Limited vegetation strata due to the presence of smaller trees. • Relatively dense shrubs providing cover for cryptic small geckonids. • Patches of gravelly loam suitable for burrowing but dominated by rocky areas less suitable.	• Tree-stem Trapdoor Spider (Priority 4) – patches of substrate suitable for burrow construction. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging and nesting. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging and nesting where suitable hollows can be sourced. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over and roosting within upper vegetation strata. • Shy Heathwren (western) (Priority 4) – foraging but not likely nesting. • Rainbow Bee-eater (International Agreement) – foraging only. • Greater Long-eared Bat (Priority 4) – foraging and roosting in hollows. • Numbat (Vulnerable) – primarily foraging and possible temporary refuge in marginally suitable hollows.

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Low *Eucalypt* Woodland over Spinifex on Alluvial Plain	Similar to Low *Eucalypt* Woodland habitats in terms of vegetation structure with the addition of *Triodia* hummocks (± 30cm in height). Fallen logs are present however gravel and rocks are absent and the alluvial plain substrate consists of sandy loam.  	• Valuable and less well-represented habitat. • A significant number of hollow bearing *Eucalypts*, both standing and deadfall. • Exfoliating bark. • Substrate very well suited to a variety of burrowing invertebrates, small mammals and reptiles. • Valuable patches of detritus comprising rotting timber and leaf litter. • Less diverse vegetation strata supporting a less diverse avifauna assemblage. • Unique habitat due to the presence of spinifex which, alone, can support a unique fauna assemblage.	• Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging. Not likely to nest due to substrate. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging, with nesting possible in larger eucalypts. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over canopy and roosting within canopy but not nesting. • Shy Heathwren (western) (Priority 4) – potentially foraging but unlikely nesting. • Rainbow Bee-eater (International Agreement) – foraging and nesting. • Greater Long-eared Bat (Priority 4) – foraging and roosting. • Numbat (Vulnerable) – foraging only.

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Dense Shrubland on Rocky Rises	Slightly elevated heath land with a stony substrate; subject to dendritic drainage.  	• Dendritic drainage creates incisions in the landscape that provides some crevice habitat used as refuge by small reptiles. • Small rocky breakaways also provide rocks of suitable size for refuge for dragons and geckonids. • Dense shrubs provide abundant habitat for small passerine birds. • Shrubs also drop significant detritus around the base providing habitat resources for trapdoor spiders. • Detritus and soil, combined, provides foraging and nesting habitat resources for malleefowl.	• Tree-stem Trapdoor Spider (Priority 4) – patchy substrate suitable for burrowing. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – foraging only. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging only. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over the canopy. • Shy Heathwren (western) (Priority 4) – foraging and nesting in the low dense shrubland vegetation. • Mallefowl (Threatened) – foraging and nesting. • Greater Long-eared Bat (Priority 4) – foraging only.

Habitat Type	Description of Habitat	Representative Faunal Habitat Attributes	Conservation Significant Species that may Potentially Occur in Habitat
Dense Shrubland on Alluvial Plain	Similar to the Dense Shrubland on Rocky Rises habitat in terms of vegetation however this habitat is not elevated and has a less rocky substrate which is more comparable to the Low *Eucalypt* Woodland on Alluvial Plain habitats.  	• Dense shrubs provide abundant habitat for small passerine birds. • Shrubs also drop significant detritus around the base providing habitat resources for trapdoor spiders. • Detritus and soil, combined, provides foraging and nesting habitat resources for malleefowl. • Gravelly clay loam ideal for burrowing.	• Tree-stem Trapdoor Spider (Priority 4) – suitable for burrow construction. • Fork-tailed Swift (International Agreement) – foraging over the canopy. • Australian Bustard (Priority 4) – predominantly foraging. • Major Mitchell's Cockatoo (Other Specially Protected Fauna) – foraging within shrub strata. • Peregrine Falcon (Other Specially Protected Fauna) – foraging over the canopy. • Shy Heathwren (western) (Priority 4) – foraging and nesting in the dense base of shrubland vegetation. • Mallefowl (Threatened) – foraging and nesting. • Greater Long-eared Bat (Priority 4) – foraging only.

4.2.2 Habitat Impact

The potential impact on the habitats considered most valuable to fauna species of conservation significance are outlined in Table 4-3. The total proposed impact footprint of the Marda East project is expected to be 67.18 ha. Western Botanical mapped vegetation associations over 245.29 ha and the boundaries and extents of these vegetation associations have been used to calculate the boundaries and extents of the fauna habitats.

Impacts to integral components of the fauna habitat that are limited in their availability are of most concern. These include nesting hollows or nesting sites for birds and refuge sites for other animals. It is the impacts on these limited resources that have been calculated and presented in Table 4-3.

All of the conservation significant fauna listed in Tables 4-2 and 4-3 are expected to forage broadly across their requisite habitats within and outside of the Project area. Those species that forage widely over all habitat within the project area will lose a total of 67.18 ha of foraging habitat once clearing has been completed. As these species are not specifically dependent on habitats within the Project area for feeding the loss of feeding habitat associated with the development of the Project is insignificant in a Regional context.

Approximately 61 ha of the Dryandra and 171 ha of the Campsite land systems occurs within the Marda East project area. The area of Dryandra and Campsite land systems that intersects or occurs adjacent to the Project area spans some 5387 ha and 1421 ha, respectively. Therefore the impact to areas of these two land systems is insignificant (Table 4-4).

4.2.3 Impact to Banded Iron Formations and Conservation Reserves

The proposed 'Class A' Nature Reserve in the Die Hardy Range occurs immediately adjacent the north-western boundary of the Red Legs prospect. The proposed mine impact footprint for the Red Legs deposit spans two conical hills less than 1km east of the Die Hardy Range ridgeline. Though part of the Banded Ironstone Formation geology of the Die Hardy Ranges and the adjacent Yokradine Hills, which includes midslopes and lower slopes, these conical hills do not support any fauna habitats that are of particular value to fauna species normally associated with banded ironstone formations. For instance, there are no south-facing vertical cliffs that confer the benefits of lower temperatures and higher humidity to many BIF short range endemic invertebrate species. There are also no cliffs to be used by nesting Peregrine Falcons. Disturbance to these conical hills is unlikely to isolate or fragment any populations of fauna inhabiting these slope habitats.

Proximity to the Die Hardy Range also places the Red Legs deposit within, and parts of the Haul Road and Fiddleback deposit partially within the Priority One (P1) Die Hardy Range / Diemels vegetation complex (banded ironstone formation) Priority Ecological Community (PEC). The boundary of this PEC also follows the Banded Ironstone Formation geology of the Die Hardy Ranges and the adjacent Yokradine Hills, inclusive of the mid and low slopes. Western Botanical (2014) report that 107.18 ha of the Marda East Project intersects this PEC and, thus, has the potential to cause impact to 1.02% of the PEC.

However, the fauna habitat of greatest value to fauna species occurring within the Project area was Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain (mapped as Vegetation Association 2.7 in Western Botanical (2014)) and this vegetation association is not included vegetation of conservation significance associated with this PEC. Therefore, impacts to the PEC are not likely to significantly impact the fauna habitat values of the region.

Table 4-3: List of Conservation Significant Species and the Potential for Impact on Habitat

		Presence/Absence	Resource Specific Dependency	Area Mapped (ha)	Proposed Impact (ha)	% Impact on Total Area Mapped	% of Total Impact Area
Malleefowl	*Leipoa ocellata*	Occurs	Nesting habitat	59.42	15.71	26.44	23.38
Cattle Egret	*Ardea ibis*	Not present based on habitat	n/a	n/a	n/a	n/a	n/a
Great Egret	*Ardea alba*	Not Present based on habitat	n/a	n/a	n/a	n/a	n/a
Peregrine Falcon	*Falco peregrinus (inc. subsp. macropus)*	Potential	Project area wide foraging only	245.29	67.18	27.39	100.00
Australian Bustard	*Ardeotis australis*	Likely	Project area wide foraging only	245.29	67.18	27.39	100.00
Major Mitchell's Cockatoo	*Cacatua leadbeateri*	Likely	Nesting habitat	26.32	7.17	27.24	10.67
Fork-tailed Swift	*Apus pacificus*	Potential	Project area wide foraging only	245.29	67.18	27.39	100.00
Rainbow Bee-eater	*Merops ornatus*	Likely	Nesting habitat	26.32	7.17	27.24	10.67
Hooded (Dotterel) Plover	*Thinornis (Charadrius) rubricollis*	Not Present	n/a	n/a	n/a	n/a	n/a
Shy Heathwren	*Hylacloa cauta subsp. whitlocki*	Likely	Nesting habitat	22.31	2.83	12.68	4.21
Numbat	*Myrmecobius fasciatus*	Potential	Denning habitat	26.32	7.17	27.24	10.67
Greater Long-eared Bat	*Nyctophilus major*	Likely	Roosting habitat	185.87	32.86	17.68	48.91
Shield-backed Trapdoor Spider	*Idiosoma nigrum*	Not present based on survey	n/a	n/a	n/a	n/a	n/a
Tree-stem Trapdoor Spider	*Aganippe castellium*	Not present based on survey	n/a	n/a	n/a	n/a	n/a

Table 4-4: Percentage Areas of Impact Relative to Land Systems.

	Area of Land System Within Project Area (ha)	Area of Land System Within or Immediately Adjacent Project Area (ha)	% Impact of Project on Land System Within or Immediately Adjacent Project Area (ha)	Total Area of Land System in the Region	% of Project Area in the Context of Regional Land System
Dryandra	61	5387	1.13	35301	0.1728
Campsite	171	1421	12.03	148931	0.1148
Moriaty	6	93	6.45	259563	0.0023
Yowie	7	2980	0.23	1622816	0.0004

4.2.4 Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider

An intensive presence/absence search for the Shield-backed Trapdoor Spider and Tree-stem Trapdoor Spider at 15 sites over five of the six different habitat types did not locate either spider or evidence of trapdoor burrows.

The Low *Eucalypt* Woodland over Spinifex on Alluvial Plain was not searched due to lack of suitable habitat.

The search effort totalled 7 person hours and search locations are presented in Figure 4-2.

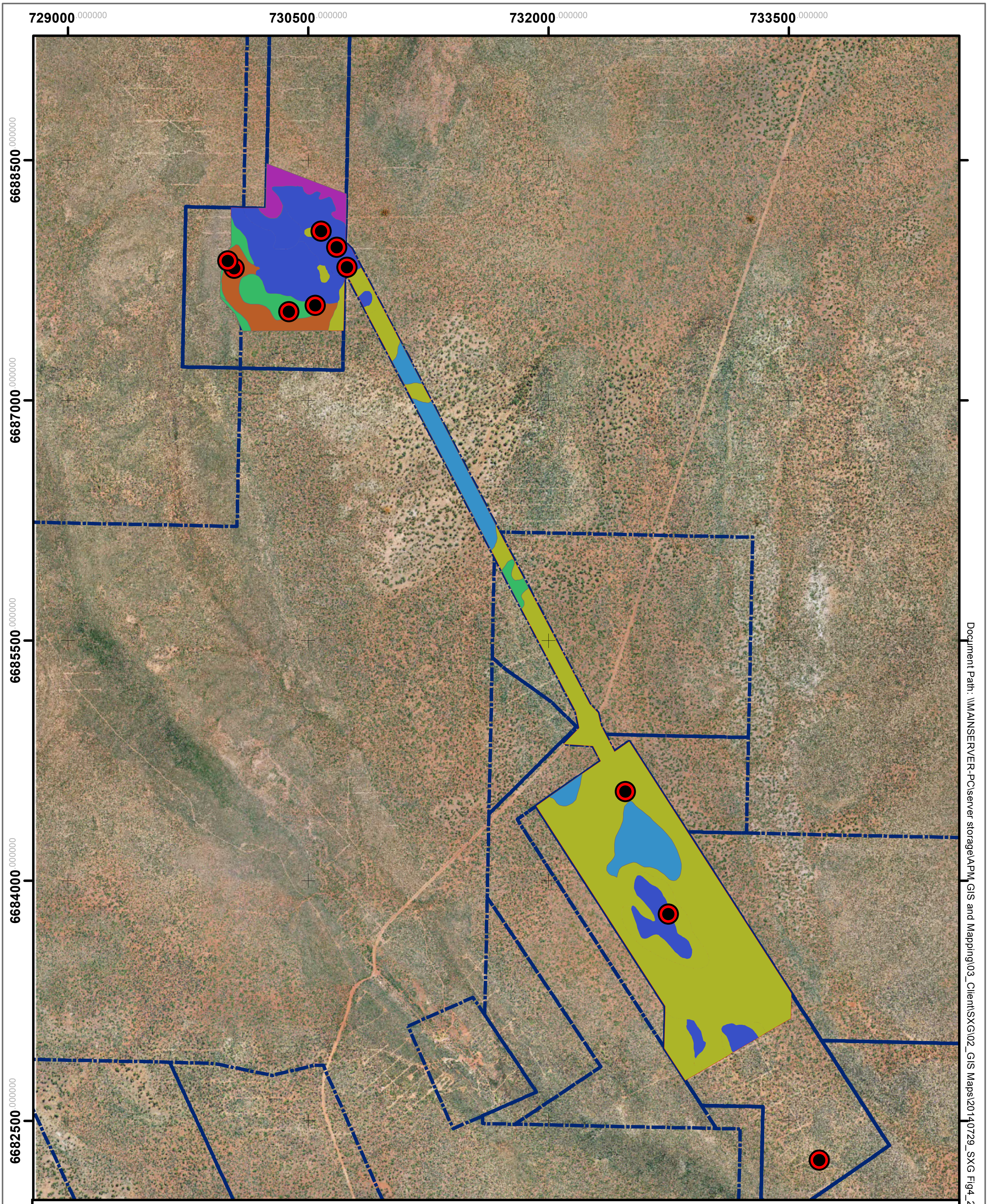


Figure 4.2: Shield-backed and Tree-stem Trapdoor Spider Search Locations

Legend

- Spider Search Locations
- Marda East Project Survey Area
- *Southern Cross Goldfield Ltd Tenements*

Fauna Habitat Descriptions

- Dense shrubland on alluvial plain
- Dense shrubland on rocky rises
- Low eucalypt woodland over acacia shrubland on alluvial plain
- Low eucalypt woodland over acacia shrubland on rocky rises
- Low eucalypt woodland over spinifex on alluvial plain
- Tall eucalypt woodland over halophytic understory on alluvial plains

N

Date: 29/07/2014

640 320 0 640 Meters

Coordinate System: GDA 1994 MGA Zone 50

Document Name: 20140729_SXG Fig4_2Spidersearches

Author: ems@animalplantmineral.com.au

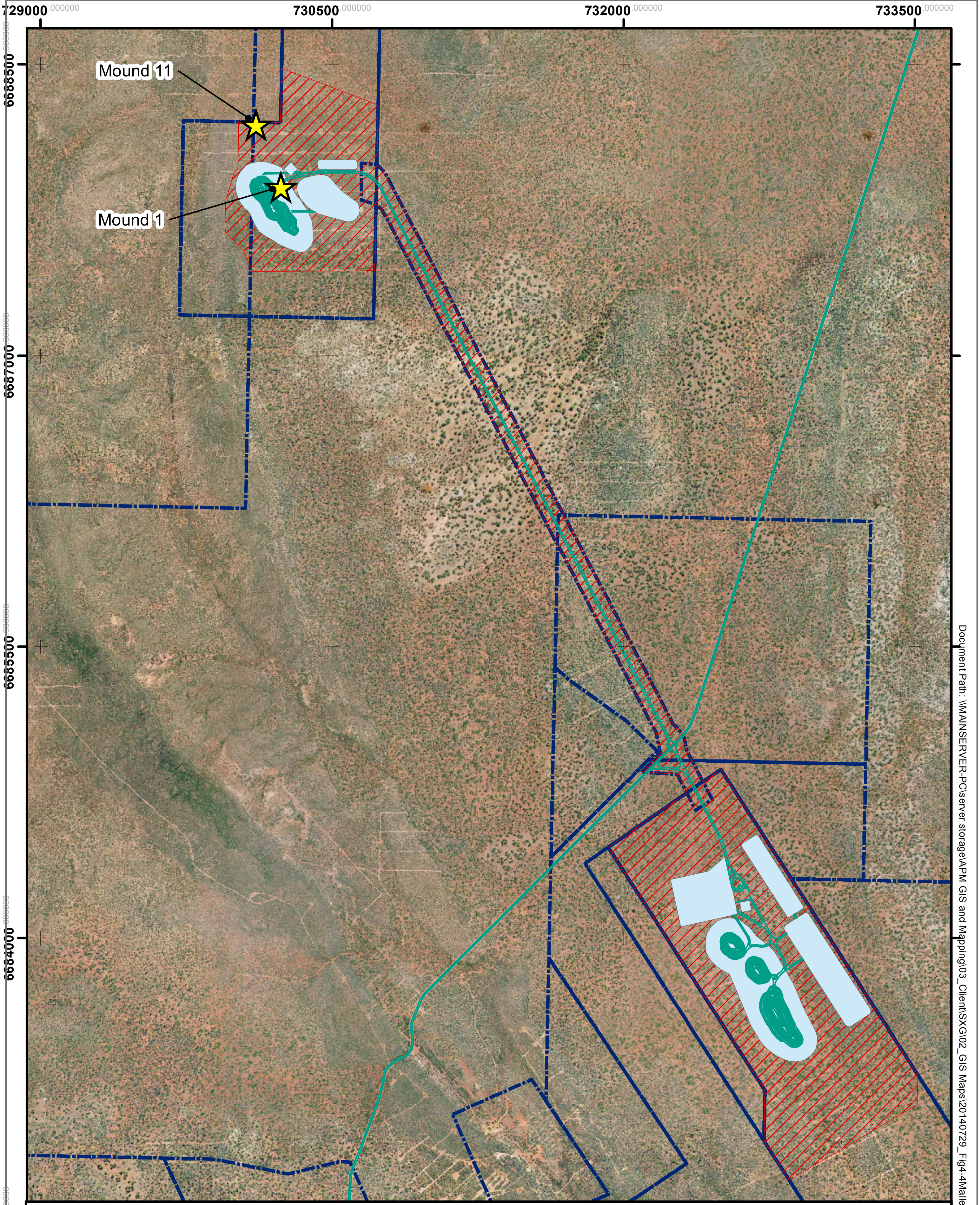
4.2.5 Malleefowl

In 2013 Western Botanical searched the Survey area utilising an intensive foot transect methodology intent on visually covering the entire site. During this search they located 11 Malleefowl mounds.

Of the 11 mounds previously recorded eight were within the Red Legs prospect, two within the Haul Road alignment and one at the Fiddleback prospect. Only two of the 11 mounds were classified as active during the 2013 survey; these were at site number 1 and site number 11. The current survey confirmed that only these same two mounds are presently active. Photographs of the active mounds are provided in Figure 4-3 and the locations are provided in Figure 4-4.

Figure 4-3: Active Malleefowl Mounds

The remains of a predated (potentially by a fox) Malleefowl were located in close proximity (approximately 2m away) to the mound at site number 11.



Legend

Figure 4.4: Active Malleefowl Mound Locations

Active Malleefowl Mounds 2014

Marda East Project Survey Area

Proposed Infrastructure

Proposed Infrastructure Disturbance Area

Southern Cross Goldfield Ltd Tenements

N

Date: 29/07/2014

530 265 0 530 Meters

Coordinate System: GDA 1994 MGA Zone 50

Document Name: 20140729_Fig4-4MalleeFowlMounds

Author: ems@animalplantmineral.com.au

4.2.6 Feral Animals

There were many signs of the presence of rabbits throughout the Survey area and it is suspected that the predated Malleefowl had been killed by a fox. Both of these species are listed as potentially occurring within the area by the Protected Matters search.

5 DISCUSSION

5.1 PREVIOUSLY RECORDED FAUNA OF CONSERVATION SIGNIFICANCE

Based on searches of the Protected Matters and NatureMap databases, 14 species of conservation significance had previously been recorded in the search radius around the Project area. Four of these were immediately discounted due to a lack of requisite habitat. Only one species, the Malleefowl, was recorded during the present survey and one species, the Tree-stem Spider, was discounted after intensive searching failed to record any evidence of this species.

Of the remaining eight remaining species, five were determined likely to occur and three have the potential to occur based on the presence of suitable habitat and the frequency at which these species are normally encountered.

Prior to the field survey a formal request was made to DPAW WA for data contained within the Department's Threatened Fauna database, which includes species which are declared as 'Rare or likely to become extinct (Schedule 1)', 'Birds protected under an international agreement (Schedule 3)', and 'Other specially protected fauna (Schedule 4)'. These data are the most accurate and reliable in determining historical presence/absence.

Of the eight remaining species likely to occur or having the potential to occur in the Project area the DPAW WA Threatened Fauna database search revealed the following:

- The Peregrine Falcon was recorded most recently in the Yokradine Hills and Diemels area in 2000.
- The Australian Bustard was observed on the Mount Jackson Road and at the Golden Orb mine site in 2012 and 2011, respectively.
- The Major Mitchell's Cockatoo was recorded at the Golden Orb mine site in 2011.
- The Fork-tailed Swift was recorded over Lake Deborah (46km SSW) in 2012.
- The Rainbow Bee-eater has been formerly reported on 22 occasions within the search radius since 2000.
- The Shy Heathwren was recorded once at Mount Jackson in 2000.
- The Greater Long-eared Bat was recorded on two occasions at Mount Jackson in 2012 and 2013.

The DPAW Threatened Fauna database search returned records of the Priority 4 Crested Bellbird (Southern) *Oreoica gutturalis gutturalis* (Vigors & Horsfield, 1827). These records did not appear on the Naturemap search which returned records only for the Crested Bellbird. The Project area occurs on the boundary of the distribution of the two variants of this species. Therefore, it is likely that the Threatened Fauna data base records, one of which is more southerly in Lake Deborah have detected the Southern variant where the Naturemap record (the lower extent of which was north of Lake Deborah) did not.

The Numbat was not recorded in either the DPAW Threatened Fauna search or the Naturemap search. This species was included in the fauna assessment as it appeared in the broader MNES search. Moreover, suitable habitat for this species was shown to be present within the Project area. It should be clearly stated that this species has not been recorded in the local area around the Marda East project and its consideration in this fauna assessment is purely precautionary as this species is so rarely recorded that exact habitat preferences and extents are not known with certainty.

5.2 MALLEEFOWL

Malleefowl are sedentary and most individuals establish pairs and remain in the same area throughout the year (see Frith, 1962b; Marchant & Higgins, 1993; Benshemesh, 2000; Garnett & Crowley, 2000). Over the course of a year, adult pairs may roam over an area of one to several kilometres. During the breeding season, males remain close to the nest most of the time. Individuals may display local shifts in home range between seasons or years.

Egg-laying usually starts in September until mid- to late-summer or sometimes early autumn. Chicks usually begin hatching and emerging from the mound in November. Most usually emerge before January but in some seasons hatching may continue until March. Young birds disperse long distances after leaving the nest without any assistance or parental care from the adults.

The Malleefowl occupies semi-arid to arid shrublands and low woodlands dominated by mallee and associated habitats, such as broombush Melaleuca uncinata and native pine Callitris spp. scrub (Frith 1962a, b; Marchant & Higgins, 1993; Benshemish, 1999; Garnett & Crowley, 2000). Malleefowl favour mallee that is long unburnt and ungrazed. In the Project area Malleefowl have been recorded in, or are very likely to utilise two of the fauna habitats Dense Shrubland on Alluvial Plain and Dense Shrubland on Rocky Rises. These two fauna habitats are analogous with Vegetation Associations 1.1, 1.2, 1.4, 2.6, 3.1, 3.2 and 3.3 which collectively account for 15.71 ha, or 23.38 % of the total proposed impact footprint (67.18 ha).

The loss of habitat equates to 26.44 % of the total suitable Malleefowl habitat mapped in the Project Area. However, significant areas of suitable Malleefowl habitat occurs outside of proposed disturbance areas within the tenements. Areas of the Dryandra, Yowie and Moriarty land systems that directly intersect or occur adjacent to the Project area cover 4,494 ha and each of these land systems contain vegetation and land form features that provide both feeding and nesting habitat for this species. Therefore, the impact associated with this Project is not considered significant in a local context. Regionally, these land systems cover 2, 031, 310 ha.

The active mound recorded as Site 11 occurs adjacent the boundary of the Red Legs survey area and is approximately 300m away from the proposed Red Legs abandonment bund and any other proposed disturbance. The active mound recorded as Site 1 is located between the abandonment bund and the pit at the Red Legs deposit and will likely be impacted should the Project proceed.

- Recommendation 1 – Monitor mound Site 1 quarterly in the 12 months prior to clearing and construction to determine if the mound being used by Malleefowl; and
- Recommendation 2 – If evidence of use is observed and disturbance of a Malleefowl mound is unavoidable, undertake development with regard to advice from the Commonwealth Department of Sustainability Environment Water People and Communities and the WA DPaW.

Any other active Mallefowl mounds not presently within the direct impact footprint, or those that may be used in the future, should be buffered and management actions put in place to prevent disturbance where possible.

In order to prevent potential fatalities to Malleefowl the following management strategies are recommended for implementation:

- Recommendation 3 – Lower traffic speeds in the vicinity of historic mounds;
- Recommendation 4 – Monitoring existing mounds annually for evidence of use;
- Recommendation 5 – Avoid disturbance of any actively used mound with a buffer of 250m or as advised under Recommendation 2;

- Recommendation 6 – Where practical, avoid disturbance to existing (historical or inactive) mounds with a buffer of 50m;
- Recommendation 7 – Include Malleefowl identification training in Site induction;
- Recommendation 8 – Ensure all personnel record sightings of Malleefowl and report these to the Manager Environment; and
- Recommendation 9 – ensure all personnel record newly discovered Malleefowl mounds and report these to the Manager Environment

5.3 MAJOR MITCHELL'S COCKATOO

Major Mitchell's Cockatoos occur in sparsely timbered grasslands, scrublands, stands of Casuarinas along sand ridges and covering rocky outcrops, and mallee. They are always found in the vicinity of water and they require large, old, hollow-bearing Eucalypts for breeding (Johnstone and Storr 1998). The nesting hollows required for breeding are the major limiting factor in the persistence of this species across its range.

This species is moderately common in in the north-eastern interior and northern wheat belt. Generally rare and patchily distributed flocks of only up to 40 birds are typically recorded. The Major Mitchell's Cockatoo has only been recorded as breeding in the wheat belt and is specifically dependant on the hollows of larger trees. In the Project area valuable habitat for this species would occur in Tall Eucalypt Woodland over Halophytic Understory (mapped as Vegetation Association 2.7 in Western Botanical (2014)).

The current mine and infrastructure plan indicates that only 27.24% of the total of this habitat mapped by Western Botanical (2014) would be disturbed by the Project. The area proposed to be impacted is 10.67% of the total proposed impact area.

Tall Eucalypt Woodland over Halophytic Understory (analogous with Vegetation Association 2.7 (Western Botanical, 2014)) is the key indicator of the Campsite land system. The area of this land system that directly intersects or occurs adjacent to the Project area covers 5,387 ha and provides nesting habitat to local populations of this species. The 7.17 ha proposed to be disturbed represents only 0.013% of this land system locally. Therefore, the impact associated with this Project is not considered significant in a local context. Regionally, this land systems covers 35, 301 ha.

Efforts to reduce the disturbance of this habitat through reduced clearing or consideration to the impact footprint of the haul road would contribute significantly to the conservation of this species. Additionally, fire management and feral predator control would lead to net positive impacts of mining on this species.

- Recommendation 1 – Undertake a nest hollow assessment in the Tall Eucalypt Woodland over Halophytic Understory habitat that occurs across the Project area. The methodology should be consistent with that used previously in the Marda Central project;
- Recommendation 2 – Where practical, re-align the Haul Road to avoid impact to mature hollow-bearing eucalypt species;
- Recommendation 3 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 4 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.4 Rainbow Bee-eater

The Rainbow Bee-eater is a migratory species that is common and broadly distributed across Australia. Threats to this species centre around burrow invasion and predation of nestlings, as the species nests in hollows on the ground. Nests are made in vertical banks in loamy plains, and optimal nesting habitat occurs with Tall Eucalypt over Halophytic Understory fauna habitat, due primarily to the dominant alluvial soil profile.

The current mine and infrastructure plan indicates that only 27.24% of the total of this habitat mapped by Western Botanical (2014) would be disturbed by the Project. The area proposed to be impacted is 10.67% of the total proposed impact area.

The Campsite land system soil structure is described as very gently inclined alluvial plains receiving sheet wash from mafic hills, gently undulating calcareous stony upper plains (erosional) and occasional narrow concentrated drainage tracts), all components of which are favoured by the Rainbow Bee-eater for nesting. The area of this land system that directly intersects or occurs adjacent to the Project area covers 5,387 ha and provides nesting habitat to local populations of this species. The 7.17 ha proposed to be disturbed represents only 0.013% of this land system locally. Therefore, the impact associated with this Project is not considered significant in a local context. Regionally, this land systems covers 35, 301 ha.

Mining can actually have a net positive impact on this species as Rainbow bee-eaters often nest in the soft loamy spoil heaps left during road construction (wind rows) (Ladyman pers. obs) or in disused mine pit walls. Feral fauna control can also greatly enhance fledgling success of populations that occur locally around mine sites.

- Recommendation 1 – Undertake a nest hollow assessment in the Tall Eucalypt Woodland over Halophytic Understory habitat that occurs across the Project area. The methodology should be consistent with that used previously in the Marda Central project;
- Recommendation 2 – Following road construction, schedule road maintenance (grading) during the period between February and July to avoid impacts on breeding birds ;
- Recommendation 3 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 4 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.5 Shy Heathwren

The Shy Heathwren (Grasswren, Hylacola) is a small passerine (perching bird) that inhabits shrublands and eucalypt woodlands, but will also utilise post fire regeneration and uncleared road verges. It prefers stony hills and is distributed across the south west of Western Australia, east and north of the Darling Scarp.

This species is most likely to occur in Dense Shrubland on Rocky Rise and Low Eucalyptus Woodland over Acacia Shrubland on Rocky Rise fauna habitats. These are analogous to Vegetation Associations 1.4, 1.2,2.3 and 3.1 mapped by Western Botanical (2014) which collectively account for 2.83 ha, or 4.21 % of the total proposed impact footprint (67.18 ha).

The loss of habitat equates to 12.68 % of the total suitable Shy Heathwren habitat mapped in the Project Area. However, significant areas of suitable habitat occur outside of proposed disturbance areas within the tenements. Areas of the Dryandra and Moriarty land systems that directly intersect or occur adjacent to the Project area cover 5,480 ha and each of these land systems contain vegetation and land form features that provide both feeding and nesting habitat for this species. Therefore, the impact associated with this Project is not considered significant in a local context. Regionally, these land systems cover 294,864 ha.

Nesting close to the ground or on the ground amongst vegetation, this species is especially vulnerable to feral predators and fire is a continuous threat to nestlings and also food availability. Common management practices associated with mining, such as fire mitigation and feral control, could positively influence the habitat value and availability of habitat to this species.

- Recommendation 1 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 2 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.6 Numbat

It is unlikely that this species occurs in the project area. However, as suitable habitat is available and the project area is within the historical range of this species (Van Dyck and Strahan, 2008) its potential presence cannot be ignored. In the Project area valuable habitat for this species would occur in Tall Eucalypt Woodland over Halophytic Understory (mapped as Vegetation Association 2.7 in Western Botanical (2014)).

The current mine and infrastructure plan indicates that only 27.24% of the total of this habitat mapped by Western Botanical (2014) would be disturbed by the Project. The area proposed to be impacted is 10.67% of the total proposed impact area.

As described in Section 5.3 this fauna habitat also defines the major elements of the Campsite land system. Therefore, habitat suitable for refuging Numbats is present locally over an area of 5,387 and 35, 301 ha regionally.

Predation is the single greatest threat to this species as it is able to occupy any and all habitats that have hollows suitable for refuge and termites available for feeding. Wildfires destroy the fallen timber within which the Numbats regularly retreat. In turn, this leaves them far more vulnerable to predation.

If clearing can be minimised in Fauna Habitat Tall eucalypt woodland over halophytic understory then valuable refuge habitat will be immediately preserved. Ongoing fire control and feral management over the life of the project will contribute significantly to the preservation of this species.

- Recommendation 1 – Undertake an intensive trapping program in early October to determine if the species is present in the area;
- Recommendation 2 – Where practical, re-align the Haul Road to avoid impact to mature hollow-bearing eucalypt species;
- Recommendation 3 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 4 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.7 Greater Long-eared Bat

Local populations of Greater Long-eared Bat have the potential to be impacted by the Project. This species can roost in hollow limbs with only a small diameter, making four of the fauna habitats supporting eucalypt woodland available for roosting.

The current mine and infrastructure plan indicates that only 17.68% of the total of this habitat mapped by Western Botanical (2014) would be disturbed by the Project. The area of suitable habitat proposed to be impacted is 48.91% of the total proposed impact area. Therefore, the Project has the potential to have the greatest impact on this species within the actual impact footprint. However, roosting habitat for this species is broadly available; more so than for any of the other species reported. Habitat requirements are met in a range of vegetation associations on a range of land forms across all four of the Land Systems intersected by the project area. Thus there is a total of 9,881 ha of habitat available for this species in the areas of the land systems that intersect or lie adjacent to the Project area and 2,066,611 regionally. Finally, the most secure populations of this species are known to occur within the Mount Manning Nature Reserve.

As described in Section 5.3 this fauna habitat also defines the major elements of the Campsite land system. Therefore, habitat suitable for refuging Numbats is present locally over an area of 5,387 and 35, 301 ha regionally.

- Recommendation 1 – Where practical, re-align the Haul Road to avoid impact to mature hollow-bearing eucalypt species;
- Recommendation 2 – Develop and implement a Fire Management Plan for the Marda East Project; and
- Recommendation 3 – Develop and implement a Feral Fauna Management Plan for the Marda East Project.

5.8 Tree-stem Trapdoor Spider

The Tree-stem Trapdoor Spider has been previously recorded from the lower slopes to the top of the ridges of the Koolyanobbing Range, in a range of vegetation types (Bamford Consulting Ecologists, 2009). They have also been recorded at Mount Jackson, Helena and Aurora Range and the Die Hardy Range (Cliffs Natural Resources 2009). These ranges surround the Survey area in relatively close proximity. However, as landforms, they are very dissimilar to the Survey area. The Threatened Fauna database search returned 48 records in the search area.

This species is able to burrow in gravelly loam and rocky soils and its absence from heavy loam or clay soil supporting eucalypt over saltbush discounts the potential presence from a number of the fauna habitat types.

Where the species was known to occur at Koolyanobbing Range, individuals were estimated at a density of 74 spiders per hectare. As the burrows are elevated from the ground surface and constructed abutting the base of shrubs they are relatively easy to find. Despite vigorous searching not a single individual or burrow was located during the current survey.

Unlike many mygalomorphs, recent work has revealed that broadly disjunct populations of Tree-stem Trapdoor Spiders are not genetically distinct and therefore cannot be defined as Short Range Endemics. Moreover, the Survey area represents common landforms that are broadly distributed in the region with a high degree of connectivity.

The lack of burrows present in the survey area and the connectivity of landforms and habitats ensure that the Project is unlikely to impact this species.

5.9 Other Protected Species

The seven remaining protected species have the potential to be present in the Survey area, but are not specifically dependent upon it. Moreover, these species are not actually dependent upon any of the fauna habitats represented within the Survey area.

The Fork-tailed Swift, Peregrine Falcon and Australian Bustard may all be transient visitors to the Survey area but all four species forage over a wide variety of habitats across the landscape. The Fork-tailed Swift is almost exclusively aerial, even roosting on the wing. Thus disturbances associated with mining have little or no impact on this species. The major resource limitation for the Peregrine Falcon is suitable nest sites which are typically on vertical cliffs. Any peregrine falcons observed in future surveys would likely be nesting in the nearby ranges. Thus mining related disturbances will not impact nesting and, as the species feeds predominantly on birds, the potential for mining impacts on prey is reduced. Mining can actually have a net positive impact as Peregrine Falcons are frequently observed nesting in the walls of disused mine pits (Ladyman pers. obs). Australian Bustards are nomadic, wandering broadly across the plains and showing no specific habitat or territory affinities. Destocking, fire management and feral fauna control associated with mining can often lead to better security for local populations of this species.

The Shield-backed Trapdoor Spider is generally found from the lower to upper slopes of ironstone ridges; not on the very low slopes or surrounding plains. Burrows are generally constructed in cobble soils with gravel and loam. There is most often an association with rock outcrops and Acacia shrubs, particularly *Acacia ramulosa*.

In suitable habitat, and where known to be present, Shield-backed Trapdoor Spiders occur at densities of 250 – 300 burrows per hectare or three burrows in a 10 x 10 m sampling quadrat. Though cryptic, once one burrow is located they become progressively easier to find as local clusters of individuals tend to construct very similar burrows.

Despite the intensive searching, not a single burrow was located in the Survey area. It may be that the topography is too low. Generally this species show a preference for burrowing at the base of south-facing slopes which have a lower average annual temperature and higher humidity which contributes to water conservation. The flatter topography of the Survey area would not confer any such advantages, particularly in comparison to the surrounding ranges where the species is known to occur.

5.10 Feral Animals

Though the only direct evidence of feral fauna was the ubiquitous presence of rabbit middens across the Project area, secondary evidence of either cats or foxes was present in the form of the predated Malleefowl. There is no question that both of these species would be common to the Project area. Active control of ferals is the best management strategy and, in remote areas such as this, operation mines are able to commit to and undertake such control.

5.11 Impact to Banded Iron Formations and Conservation Reserves

The conical hills that will be directly impacted by the Red Legs mine occur within the midslopes and lower slopes of the Die Hardy Ranges and the adjacent Yokradine Hills. Outside of the R77/1, these mid slopes and lower slopes are generally considered as landscapes worthy of conservation and, as such, are included in the proposed ‘Class A’ Nature Reserve. However, these conical hills are outside of the proposed nature reserve and do not support any fauna habitats that are of particular value to fauna species normally associated with banded ironstone formations.

Western Botanical (2014) report that 107.18 ha of the Marda East Project intersects the Priority One (P1) Die Hardy Range / Diemels vegetation complex (banded ironstone formation) Priority Ecological Community (PEC), with potential to cause impact to 1.02% of the PEC.

However, the fauna habitat of greatest value to fauna species occurring within the Project area was Tall Eucalypt Woodland over Halophytic understorey on Alluvial Plain (mapped as Vegetation Association 2.7 in Western Botanical (2014)) and this vegetation association is not included vegetation of conservation significance associated with this PEC. Therefore, impacts to the PEC are not likely to significantly impact the fauna habitat values of the region.

5.12 FURTHER STUDIES

Due to the proximity of the Project area to a number of conservation reserves and proposed nature reserves, and due to the number of proposed and operational mines in the local area the region has been subjected to a number of baseline biological surveys.

With a total disturbance area of only 67.18 ha occurring within vegetation associations, fauna habitats and land forms that are broadly distributed it is unlikely that the Project will have a significant impact on the common fauna assemblages.

APM recommends that, rather than investing resources into another baseline fauna survey of the Project area in Spring 2014, the Client should focus any further survey effort on a subset of the fauna species of conservation significance likely to occur in the Project area.

APM recommends that a nest hollow assessment and trapping program be undertaken in Spring 2014 targeting populations of Numbat, Major Mitchell's Cockatoo and the Greater Long-eared Bat.

6 REFERENCES

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7 APPENDICES

Appendix 1: Fauna Conservation Codes

Definitions of Fauna Conservation Codes

Definitions used in the *EPBC Act* and *WC Act*.

Extinct: Taxa not definitely located in the wild during the past 50 years.

Extinct in the wild: Taxa known to survive only in captivity.

Critically Endangered: Taxa facing an extremely high risk of extinction in the wild in the immediate future.

Endangered: Taxa facing a very high risk of extinction in the wild in the near future.

Vulnerable: Taxa facing a very high risk of extinction in the wild in the medium-term future.

Near Threatened: Taxa that risk becoming Vulnerable in the wild.

Conservation Dependent: Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

Data Deficient: Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Least Concern: Taxa that are not Threatened.

Schedules used in the *WC Act*.

Schedule 1: Fauna that are rare or likely to become extinct.

Schedule 2: Fauna presumed to be extinct.

Schedule 3: Migratory birds that are listed under international treaties.

Schedule 4: Other specially protected fauna.

DEC recognises five levels of priority fauna:

Priority 1: Taxa with few, poorly known populations on threatened lands.
Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority 2: Taxa with few, poorly known populations on conservation lands.
Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority 3: Taxa with several, poorly known populations, some on conservation lands.
Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority 4: Taxa in need of monitoring.
Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.

Priority 5: Taxa in need of monitoring.
Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix 2: Protected Matters Database Search Results

Australian Government

Department of the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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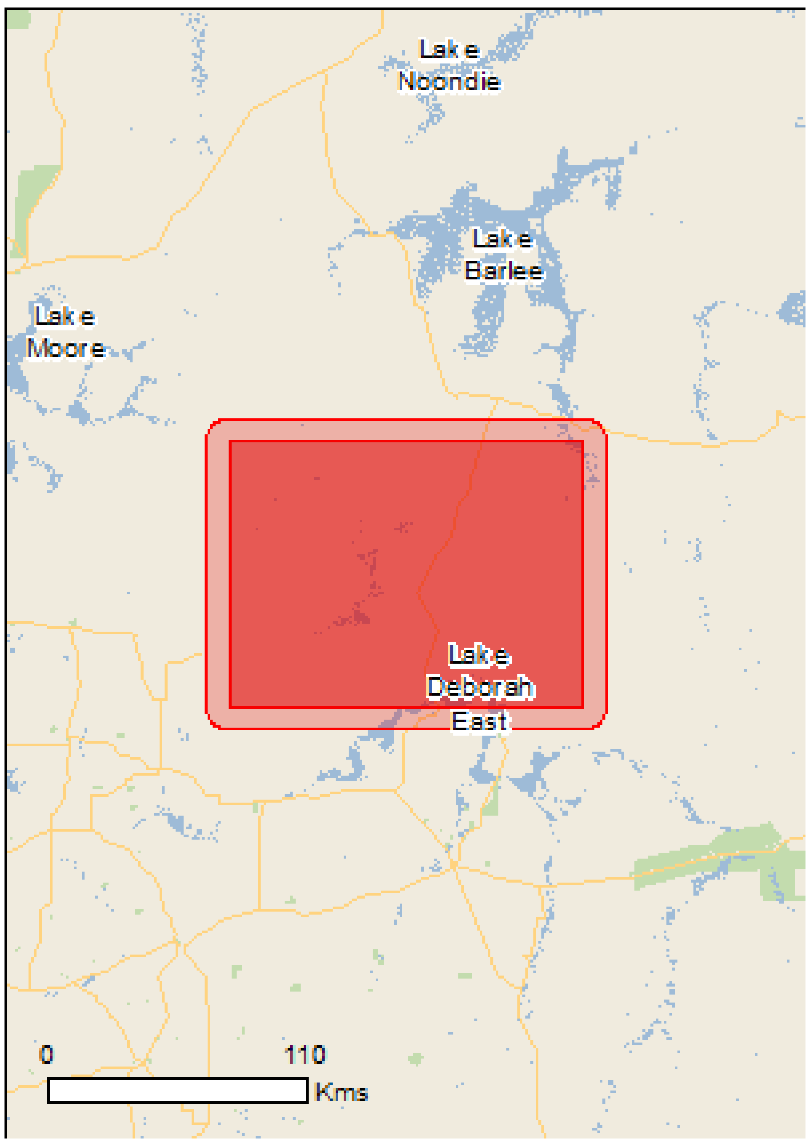

Coordinates

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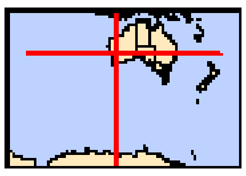

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	23
Listed Migratory Species:	4

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	4
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	3
State and Territory Reserves:	14
Regional Forest Agreements:	None
Invasive Species:	14
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Myrmecobius fasciatus Numbat [294]	Vulnerable	Species or species habitat likely to occur within area
Other		
Idiosoma nigrum Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Acacia denticulosa Sandpaper Wattle [20600]	Vulnerable	Species or species habitat likely to occur within area
Acacia lobulata Chiddarcooping Wattle [55567]	Endangered	Species or species habitat known to occur within area
Acacia sciophanes Wundowlin Wattle, Ghost Wattle [17877]	Endangered	Species or species habitat may occur within area
Boronia adamsiana Barbalin Boronia [16935]	Vulnerable	Species or species habitat likely to occur within area
Eremophila resinosa Resinous Eremophila [11735]	Endangered	Species or species habitat likely to occur within area
Eremophila virens Campion Eremophila, Green-flowered Emu bush	Endangered	Species or species

Name	Status	Type of Presence
[21433]		habitat known to occur within area
Eremophila viscida Varnish Bush [2394]	Endangered	Species or species habitat likely to occur within area
Eucalyptus brevipes Mukinbudin Mallee [7495]	Endangered	Species or species habitat likely to occur within area
Eucalyptus recta Silver Mallet [56430]	Endangered	Species or species habitat likely to occur within area
Gastrolobium diabolophyllum Bodallin Poison [78384]	Critically Endangered	Species or species habitat likely to occur within area
Grevillea pythara Pythara Grevillea [64525]	Endangered	Species or species habitat may occur within area
Leucopogon spectabilis Ironstone Beard-heath [83012]	Critically Endangered	Species or species habitat known to occur within area
Melaleuca sciotostyla Wongan Melaleuca [24324]	Endangered	Species or species habitat known to occur within area
Myriophyllum lapidicola Chiddarcooping myriophyllum [55940]	Endangered	Species or species habitat known to occur within area
Pityrodia axillaris Native Foxglove, Woolly Foxglove [17376]	Critically Endangered	Species or species habitat may occur within area
Ricinocarpos brevis [82879]	Endangered	Species or species habitat known to occur within area
Roycea pycnophylloides Saltmat [21161]	Endangered	Species or species habitat likely to occur within area
Tetratheca aphylla Bungalbin Tetratheca [2915]	Vulnerable	Species or species habitat likely to occur within area
Tetratheca harperi Jackson Tetratheca [6251]	Vulnerable	Species or species habitat likely to occur within area
Tetratheca paynterae Paynter's Tetratheca [66451]	Endangered	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Lake Moore Area	WA	Registered
Mount Manning Nature Reserve	WA	Registered
Walyahmoning Rock Nature Reserve	WA	Registered

State and Territory Reserves [Resource Information]

Name	State
Geeraning	WA
Jouerdine	WA
Karroun Hill	WA
Mount Manning Range	WA
Mount Manning Range	WA
Unnamed WA23991	WA
Unnamed WA32864	WA
Unnamed WA32865	WA
Unnamed WA32993	WA
Unnamed WA36918	WA
Unnamed WA38800	WA
Unnamed WA44446	WA
Walyahmoning	WA
Yanneymooning	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa		
Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Carrichtera annua		
Ward's Weed [9511]		Species or species habitat likely to occur within area
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera		
Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area

Coordinates

-29.8382 118.47619,-29.8382 119.82202,-30.70872 119.82202,-30.70872 118.47619,-29.8382 118.47619

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix 3: NatureMap Database Search Results

NatureMap Species Report

Created By Guest user on 06/05/2014

Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	119°16' 50" E,30°01' 00" S
Buffer	40km
Group By	Kingdom

Kingdom	Species	Records
Animalia	271	3245
Fungi	6	8
Plantae	601	4212
TOTAL	**878**	**7465**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Animalia					
1.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
2.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
3.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
4.	24264	*Acanthiza robustirostris (Slaty-backed Thornbill)*			
5.	24265	*Acanthiza uropygialis (Chestnut-rumped Thornbill)*			
6.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
7.	25536	*Accipiter fasciatus (Brown Goshawk)*			
8.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
9.	33902	*Aganippe castellum (Tree-stem Trapdoor Spider)*		P4	
10.	-11966	*Aname tepperi*			
11.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
12.	24561	*Anthochaera carunculata (Red Wattlebird)*			
13.	25670	*Anthus australis (Australian Pipit)*			
14.	25528	*Aphelocephala leucopsis (Southern Whiteface)*			
15.	24266	*Aphelocephala leucopsis subsp. castaneiventris (Southern Whiteface)*			
16.	25554	*Apus pacificus (Fork-tailed Swift)*		IA	
17.	24285	*Aquila audax (Wedge-tailed Eagle)*			
18.	24610	*Ardeotis australis (Australian Bustard)*		P4	
19.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
20.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
21.	24355	*Artamus minor (Little Woodswallow)*			
22.	24356	*Artamus personatus (Masked Woodswallow)*			
23.	-1794	*Arthrorhabdus paucispinus*			
24.	-12070	*Atelomastix bamfordi*			
25.	-11973	*Badumna insignis*			
26.	24251	*Bos taurus (European Cattle)*	Y		
27.	42381	*Brachyurophis semifasciatus (Southern Shovel-nosed Snake)*			
28.	24722	*Cacatua leadbeateri (Major Mitchell's Cockatoo)*		S	
29.	25715	*Cacatua roseicapilla (Galah)*			
30.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
31.	24269	*Calamanthus campestris (Rufous Fieldwren)*			
32.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
33.	24732	*Calyptorhynchus banksii subsp. samueli (Red-tailed Black-Cockatoo)*			
34.	24039	*Canis lupus subsp. dingo (Dingo)*	Y		
35.	24086	*Cercartetus concinnus (Western Pygmy-possum, Mundarda)*			
36.	-12508	*Cercophonius michaelseni*			
37.	24564	*Certhionyx variegatus (Pied Honeyeater)*			
38.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
39.	24187	*Chalinolobus morio (Chocolate Wattled Bat)*			
40.	24376	*Charadrius rubricollis (Hooded Plover)*		P4	
41.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
42.	24434	*Chrysococcyx osculans (Black-eared Cuckoo)*			
43.	24834	*Cincloramphus mathewsi (Rufous Songlark)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
44.	25580	*Cinclosoma castaneothorax (Chestnut-breasted Quail-thrush)*			
45.	30956	*Cinclosoma castanotus (Chestnut Quail-thrush)*			
46.	25581	*Climacteris affinis (White-browed Treecreeper)*			
47.	24393	*Climacteris affinis subsp. superciliosa (White-browed Treecreeper)*			
48.	24396	*Climacteris rufa (Rufous Treecreeper)*			
49.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
50.	24613	*Colluricincla harmonica subsp. rufiventris (Grey Shrike-thrush)*			
51.	24361	*Coracina maxima (Ground Cuckoo-shrike)*			
52.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
53.	-1732	*Cormocephalus strigosus*			
54.	-1739	*Cormocephalus turneri*			
55.	24416	*Corvus bennetti (Little Crow)*			
56.	25592	*Corvus coronoides (Australian Raven)*			
57.	24417	*Corvus coronoides subsp. perplexus (Australian Raven)*			
58.	25593	*Corvus orru (Torresian Crow)*			
59.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
60.	25595	*Cracticus tibicen (Australian Magpie)*			
61.	24422	*Cracticus tibicen subsp. dorsalis (White-backed Magpie)*			
62.	25596	*Cracticus torquatus (Grey Butcherbird)*			
63.	24424	*Cracticus torquatus subsp. torquatus (Grey Butcherbird)*			
64.	25456	*Crenadactylus ocellatus (Clawless Gecko)*			
65.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
66.	30893	*Cryptoblepharus buchananii*			
67.	25020	*Cryptoblepharus plagiocephalus*			
68.	24871	*Ctenophorus cristatus (Bicycle Dragon)*			
69.	24873	*Ctenophorus fordi (Mallee Sand Dragon)*			
70.	25459	*Ctenophorus isolepis (Crested Dragon, Military Dragon)*			
71.	24879	*Ctenophorus maculatus subsp. griseus (Spotted Military Dragon)*			
72.	24883	*Ctenophorus ornatus (Ornate Crevice-Dragon)*			
73.	24886	*Ctenophorus reticulatus (Western Netted Dragon)*			
74.	24889	*Ctenophorus scutulatus (Lozenge-marked Dragon)*			
75.	25026	*Ctenotus atlas*			
76.	25052	*Ctenotus leonhardii*			
77.	25054	*Ctenotus mimetes*			
78.	25074	*Ctenotus schomburgkii*			
79.	25075	*Ctenotus severus*			
80.	25465	*Ctenotus uber (Spotted Ctenotus)*			
81.	25080	*Ctenotus uber subsp. uber (Spotted Ctenotus)*			
82.	25089	*Cyclodomorphus melanops subsp. elongatus (Slender Blue-tongue)*			
83.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
84.	24606	*Daphoenositta chrysoptera subsp. pileata (Varied Sittella, Black-capped Sitella)*			
85.	24995	*Delma australis*			
86.	24997	*Delma butleri*			
87.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
88.	25295	*Demansia psammophis subsp. cupreiceps (Yellow-faced Whipsnake)*			
89.	25247	*Demansia psammophis subsp. psammophis (Yellow-faced Whipsnake)*			
90.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
91.	24441	*Dicaeum hirundinaceum subsp. hirundinaceum (Mistletoebird)*			
92.	25469	*Diplodactylus granariensis*			
93.	24929	*Diplodactylus granariensis subsp. granariensis*			
94.	24940	*Diplodactylus pulcher*			
95.	24470	*Dromaius novaehollandiae (Emu)*			
96.	24650	*Drymodes brunneopygia (Southern Scrub-robin)*			
97.	25092	*Egernia depressa (Southern Pygmy Spiny-tailed Skink)*			
98.	25094	*Egernia formosa*			
99.	24651	*Eopsaltria australis subsp. griseogularis (Western Yellow Robin)*			
100.	24567	*Epthianura albifrons (White-fronted Chat)*			
101.	24570	*Epthianura tricolor (Crimson Chat)*			
102.	24258	*Equus caballus (Horse)*	Y		
103.	25109	*Eremiascincus richardsonii (Broad-banded Sand Swimmer)*			
104.	-1804	*Ethmostigmus curtipes*			
105.	-1667	*Ethmostigmus rubripes*			
106.	24368	*Eurostopodus argus (Spotted Nightjar)*			
107.	25621	*Falco berigora (Brown Falcon)*			
108.	24471	*Falco berigora subsp. berigora (Brown Falcon)*			
109.	25622	*Falco cenchroides (Australian Kestrel)*			
110.	24472	*Falco cenchroides subsp. cenchroides (Australian Kestrel)*			
111.	25623	*Falco longipennis (Australian Hobby)*			
112.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
113.	24475	*Falco peregrinus subsp. macropus (Australian Peregrine Falcon)*		S	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
114.	24041	*Felis catus (Cat)*	Y		
115.	24957	*Gehyra purpurascens*			
116.	24959	*Gehyra variegata*			
117.	-13016	*Geogarypus taylori*			
118.	25530	*Gerygone fusca (Western Gerygone)*			
119.	24735	*Glossopsitta porphyrocephala (Purple-crowned Lorikeet)*			
120.	24443	*Grallina cyanoleuca (Magpie-lark)*			
121.	25408	*Heleioporus albopunctatus (Western Spotted Frog)*			
122.	25474	*Hemiergis initialis*			
123.	25115	*Hemiergis initialis subsp. initialis*			
124.	42408	*Hesperoedura reticulata*			
125.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
126.	24491	*Hirundo neoxena (Welcome Swallow)*			
127.	25629	*Hirundo nigricans (Tree Martin)*			
128.	24492	*Hirundo nigricans subsp. nigricans (Tree Martin)*			
129.	-12894	*Hoggicosa forresti*			
130.	-13410	*Hoggicosa storri*			
131.	-12660	*Hogna pexa*			
132.	-11716	*Holconia westralia*			
133.	34001	*Hylacola cauta subsp. whitlocki (Shy Heathwren (western))*		P4	
134.	-1695	*Isometroides vescus*			
135.	-11972	*Isopeda magna*			
136.	24367	*Lalage tricolor (White-winged Triller)*			
137.	24557	*Leipoa ocellata (Malleefowl)*		T	
138.	25137	*Lerista gerrardii*			
139.	30927	*Lerista kingi*			
140.	-18207	*Lerista kingi*			
141.	25482	*Lerista macropisthopus*			
142.	25149	*Lerista macropisthopus subsp. macropisthopus*			
143.	25155	*Lerista muelleri*			
144.	42411	*Lerista timida*			
145.	25005	*Lialis burtonis*			
146.	25659	*Lichenostomus leucotis (White-eared Honeyeater)*			
147.	24576	*Lichenostomus leucotis subsp. novaenorciae (White-eared Honeyeater)*			
148.	25661	*Lichmera indistincta (Brown Honeyeater)*			
149.	24582	*Lichmera indistincta subsp. indistincta (Brown Honeyeater)*			
150.	41411	*Liopholis inornata (Desert Skink)*			
151.	30935	*Lucasium maini*			
152.	25489	*Macropus robustus (Euro)*			
153.	24135	*Macropus robustus subsp. erubescens (Euro, Biggada)*			
154.	24136	*Macropus rufus (Red Kangaroo, Marlu)*			
155.	-12475	*Mainosa longipes*			
156.	24544	*Malurus lamberti subsp. assimilis (Variegated Fairy-wren)*			
157.	24551	*Malurus pulcherrimus (Blue-breasted Fairy-wren)*			
158.	25654	*Malurus splendens (Splendid Fairy-wren)*			
159.	24552	*Malurus splendens subsp. splendens (Splendid Fairy-wren)*			
160.	24583	*Manorina flavigula (Yellow-throated Miner)*			
161.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
162.	24586	*Melithreptus brevirostris subsp. leucogenys (Brown-headed Honeyeater)*			
163.	25184	*Menetia greyii*			
164.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	
165.	25693	*Microeca fascinans (Jacky Winter)*			
166.	24654	*Microeca fascinans subsp. assimilis (Jacky Winter)*			
167.	-11748	*Missulena occatoria*			
168.	24904	*Moloch horridus (Thorny Devil)*			
169.	25190	*Morethia butleri*			
170.	24184	*Mormopterus planiceps (Southern Freetail-bat)*			
171.	24223	*Mus musculus (House Mouse)*	Y		
172.	25425	*Neobatrachus kunapalari (Kunapalari Frog)*			
173.	25426	*Neobatrachus pelobatoides (Humming Frog)*			
174.	24737	*Neophema bourkii (Bourke's Parrot)*			
175.	24740	*Neophema splendida (Scarlet-chested Parrot)*			
176.	24094	*Ningaui ridei (Wongai Ningaui)*			
177.	24096	*Ningaui yvonneae (Southern Ningaui)*			
178.	25748	*Ninox novaeseelandiae (Boobook Owl)*			
179.	24224	*Notomys alexis (Spinifex Hopping-mouse)*			
180.	24229	*Notomys mitchellii (Mitchell's Hopping-mouse)*			
181.	-18081	*Notomys sp.*			
182.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
183.	41424	*Nyctophilus major (Greater Long-eared Bat)*		P4	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
184.	43367	*Nyctophilus major subsp. tor (Southern Long-eared Bat)*			
185.	24742	*Nymphicus hollandicus (Cockatiel)*			
186.	24618	*Oreoica gutturalis (Crested Bellbird)*			
187.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
188.	24619	*Pachycephala inornata (Gilbert's Whistler)*			
189.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
190.	24624	*Pachycephala rufiventris subsp. rufiventris (Rufous Whistler)*			
191.	25254	*Parasuta monachus*			
192.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
193.	25682	*Pardalotus striatus (Striated Pardalote)*			
194.	24630	*Pardalotus striatus subsp. westraliensis (Striated Pardalote)*			
195.	24658	*Petroica cucullata (Hooded Robin)*			
196.	24659	*Petroica goodenovii (Red-capped Robin)*			
197.	24409	*Phaps chalcoptera (Common Bronzewing)*			
198.	-11765	*Phryssonotus novaehollandiae*			
199.	24748	*Platycercus varius (Mulga Parrot)*			
200.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
201.	24750	*Platycercus zonarius subsp. semitorquatus (Twenty-eight Parrot)*			
202.	24751	*Platycercus zonarius subsp. zonarius (Port Lincoln Parrot)*			
203.	25703	*Podargus strigoides (Tawny Frogmouth)*			
204.	24679	*Podargus strigoides subsp. brachypterus (Tawny Frogmouth)*			
205.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
206.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
207.	25722	*Polytelis anthopeplus (Regent Parrot)*			
208.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
209.	24106	*Pseudantechinus woolleyae (Woolley's Pseudantechinus)*			
210.	25261	*Pseudechis australis (Mulga Snake)*			
211.	24230	*Pseudomys albocinereus (Ash-grey Mouse)*			
212.	24232	*Pseudomys bolami (Bolam's Mouse)*			
213.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
214.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
215.	25434	*Pseudophryne occidentalis (Western Toadlet)*			
216.	42340	*Ptilotula ornatus (Yellow-plumed Honeyeater)*			
217.	42344	*Purnella albifrons (White-fronted Honeyeater)*			
218.	25008	*Pygopus lepidopodus (Common Scaly Foot)*			
219.	25009	*Pygopus nigriceps*			
220.	24278	*Pyrrholaemus brunneus (Redthroat)*			
221.	25271	*Ramphotyphlops australis*			
222.	30824	*Ramphotyphlops bicolor*			
223.	25273	*Ramphotyphlops bituberculatus*			
224.	25285	*Ramphotyphlops pinguis*			
225.	-13795	*Rhipidura albicauda*			
226.	25613	*Rhipidura fuliginosa (Grey Fantail)*			
227.	24452	*Rhipidura fuliginosa subsp. preissi (Grey Fantail)*			
228.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
229.	24454	*Rhipidura leucophrys subsp. leucophrys (Willie Wagtail)*			
230.	24982	*Rhynchoedura ornata (Western Beaked Gecko)*			
231.	-1709	*Scolopendra laeta*			
232.	-1847	*Scolopendra morsitans*			
233.	24199	*Scotorepens balstoni (Inland Broad-nosed Bat)*			
234.	-11998	*Selenotholus foelschei*			
235.	25266	*Simoselaps bertholdi (Jan's Banded Snake)*			
236.	30948	*Smicrornis brevirostris (Weebill)*			
237.	24108	*Sminthopsis crassicaudata (Fat-tailed Dunnart)*			
238.	24109	*Sminthopsis dolichura (Little long-tailed Dunnart)*			
239.	25515	*Sminthopsis griseoventer (Grey-bellied Dunnart)*			
240.	24114	*Sminthopsis hirtipes (Hairy-footed Dunnart)*			
241.	24116	*Sminthopsis macroura (Stripe-faced Dunnart)*			
242.	-18122	*Sminthopsis murina*			
243.	25597	*Strepera versicolor (Grey Currawong)*			
244.	24426	*Strepera versicolor subsp. plumbea (Grey Currawong)*			
245.	24923	*Strophurus assimilis (Goldfields Spiny-tailed Gecko)*			
246.	24927	*Strophurus elderi*			
247.	42310	*Sugomel niger (Black Honeyeater)*			
248.	25269	*Suta fasciata (Rosen's Snake)*			
249.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
250.	24185	*Tadarida australis (White-striped Freetail-bat)*			
251.	30870	*Taeniopygia guttata (Zebra Finch)*			
252.	30871	*Taeniopygia guttata subsp. castanotis (Zebra Finch)*			
253.	-11995	*Tamopsis transiens*			Y

	Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area[1]
254.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
255.	42351	*Todiramphus pyrrhopygius (Red-backed Kingfisher)*			
256.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
257.	24851	*Turnix velox (Little Button-quail)*			
258.	30814	*Tympanocryptis cephalus (Pebble Dragon)*			
259.	24983	*Underwoodisaurus milii (Barking Gecko)*			
260.	-11701	*Urodacus novaehollandiae*			
261.	-13359	*Urodacus similis*			
262.	24386	*Vanellus tricolor (Banded Lapwing)*			
263.	25211	*Varanus caudolineatus*			
264.	25216	*Varanus giganteus (Perentie)*			
265.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
266.	25222	*Varanus panoptes subsp. panoptes*			
267.	25526	*Varanus tristis (Racehorse Monitor)*			
268.	25227	*Varanus tristis subsp. tristis (Racehorse Monitor)*			
269.	24202	*Vespadelus baverstocki (Inland Forest Bat)*			
270.	24206	*Vespadelus regulus (Southern Forest Bat)*			
271.	-12194	*Wesmaldra talgomine*			

Fungi

	Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area[1]
272.	42104	*Buellia albula*			
273.	27722	*Diploschistes ocellatus*			
274.	27763	*Haematomma eremaeum*			
275.	27999	*Psora crystallifera*			
276.	28356	*Xanthoparmelia verrucella*			
277.	28186	*Xanthoparmelia versicolor*			

Plantae

	Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area[1]
278.	4889	*Abutilon cryptopetalum*			
279.	4902	*Abutilon oxycarpum (Flannel Weed)*			
280.	16159	*Acacia acanthoclada subsp. acanthoclada*			
281.	14613	*Acacia acanthoclada subsp. glaucescens*			
282.	3199	*Acacia acuaria*			
283.	3200	*Acacia acuminata (Jam, Mangard)*			
284.	14044	*Acacia adinophylla*		P1	
285.	3216	*Acacia andrewsii*			
286.	3217	*Acacia aneura (Mulga, Wanari)*			
287.	3226	*Acacia assimilis*			
288.	15467	*Acacia assimilis subsp. assimilis*			
289.	3248	*Acacia burkittii (Sandhill Wattle)*			
290.	36417	*Acacia caesaneura*			
291.	23977	*Acacia cockertoniana*			
292.	3269	*Acacia coolgardiensis (Spinifex Wattle)*			
293.	3285	*Acacia daviesioides*			
294.	3301	*Acacia dielsii*			
295.	32118	*Acacia effusifolia*			
296.	12257	*Acacia enervia subsp. explicata*			
297.	3324	*Acacia erinacea*			
298.	3366	*Acacia hemiteles*			
299.	36418	*Acacia incurvaneura*			
300.	3393	*Acacia jennerae*			
301.	3395	*Acacia jibberdingensis*			
302.	3399	*Acacia kempeana (Witchetty Bush, Ilykuwara)*			
303.	3419	*Acacia ligulata (Umbrella Bush, Watarka)*			
304.	3426	*Acacia longispinea*			
305.	36416	*Acacia mulganeura*			
306.	15290	*Acacia neurophylla subsp. erugata*			
307.	3495	*Acacia prainii (Prain's Wattle)*			
308.	3507	*Acacia quadrimarginea*			
309.	3510	*Acacia ramulosa (Horse Mulga)*			
310.	19499	*Acacia ramulosa var. ramulosa*			
311.	3513	*Acacia resinimarginea*			
312.	16145	*Acacia resinosa*			
313.	3545	*Acacia sibina*			
314.	30717	*Acacia sp. Mt Jackson (B. Ryan 176)*			
315.	3555	*Acacia steedmanii*			
316.	23525	*Acacia steedmanii subsp. steedmanii*			
317.	3577	*Acacia tetragonophylla (Kurara, Wakalpuka)*			
318.	7817	*Actinobole uliginosum (Flannel Cudweed)*			
319.	184	*Aira caryophyllea (Silvery Hairgrass)*	Y		
320.	1720	*Allocasuarina acutivalvis*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
321.	13904	*Allocasuarina acutivalvis subsp. acutivalvis*			
322.	13905	*Allocasuarina acutivalvis subsp. prinsepiana*			
323.	1721	*Allocasuarina campestris*			
324.	1722	*Allocasuarina corniculata*			
325.	1725	*Allocasuarina dielsiana (Northern Sheoak)*			
326.	12657	*Allocasuarina eriochlamys*			
327.	13906	*Allocasuarina eriochlamys subsp. eriochlamys*			
328.	1730	*Allocasuarina helmsii*			
329.	12655	*Allocasuarina spinosissima*			
330.	1738	*Allocasuarina tessellata*		P1	
331.	19467	*Aluta appressa*			
332.	19466	*Aluta aspera subsp. aspera*			
333.	6565	*Alyxia buxifolia (Dysentery Bush)*			
334.	14636	*Alyxia tetanifolia*		P3	
335.	12025	*Amphipogon caricinus var. caricinus*			
336.	199	*Amphipogon strictus (Greybeard Grass)*			
337.	2369	*Amyema benthamii*			
338.	13267	*Amyema linophylla subsp. linophylla*			
339.	2380	*Amyema miquelii (Stalked Mistletoe)*			
340.	2382	*Amyema nestor*			
341.	40910	*Androcalva luteiflora (Yellow-flowered Rulingia)*			
342.	7836	*Angianthus tomentosus (Camel-grass)*			
343.	207	*Aristida contorta (Bunched Kerosene Grass)*			
344.	210	*Aristida holathera*			
345.	1265	*Arthropodium curvipes*			
346.	17039	*Astartea sp. Mt Dimer (C. McChesney TRL4/72)*		P1	Y
347.	7846	*Asteridea athrixioides*			
348.	7847	*Asteridea chaetopoda*			
349.	2469	*Atriplex nummularia (Old Man Saltbush)*			
350.	11516	*Atriplex nummularia subsp. spathulata (Old Man Saltbush)*			
351.	11525	*Atriplex paludosa subsp. baudinii*			
352.	11791	*Atriplex quadrivalvata var. quadrivalvata*			
353.	2481	*Atriplex vesicaria (Bladder Saltbush)*			
354.	17232	*Austrostipa blackii*		P3	
355.	17237	*Austrostipa elegantissima*			
356.	17246	*Austrostipa nitida*			
357.	19588	*Austrostipa nodosa*			
358.	17247	*Austrostipa platychaeta*			
359.	17251	*Austrostipa scabra*			
360.	17255	*Austrostipa trichophylla*			
361.	5341	*Baeckea crispiflora*			
362.	5344	*Baeckea elderiana*			
363.	5356	*Baeckea muricata*			
364.	5357	*Baeckea ochropetala*		P1	
365.	16737	*Baeckea sp. Bencubbin-Koorda (M.E. Trudgen 5421)*			
366.	20617	*Baeckea sp. Bungalbin Hill (B.J. Lepschi & L.A. Craven 4586)*		P3	
367.	20616	*Baeckea sp. Die Hardy Range (E. Mattiske J91)*		P1	Y
368.	20690	*Baeckea sp. Mt Jackson (G.J. Keighery 4362)*		P1	Y
369.	20804	*Baeckea sp. Parker Range (M. Hislop & F. Hort MH 2968)*		P3	
370.	20681	*Baeckea sp. Pigeon Rocks (D. Grace DJP 281)*		P1	Y
371.	32685	*Banksia arborea (Yilgarn Dryandra)*		P4	
372.	1815	*Banksia elderiana (Swordfish Banksia)*			
373.	7852	*Bellida graminea (Rosy Bellida)*			
374.	34259	*Beyeria rostellata*		P1	
375.	7856	*Blennospora drummondii*			
376.	4409	*Boronia coerulescens*			
377.	1267	*Borya constricta*			
378.	33023	*Bossiaea sp. Jackson Range (G. Cockerton & S. McNee LCS 13614)*		P3	
379.	3722	*Bossiaea walkeri*			
380.	4999	*Brachychiton gregorii (Desert Kurrajong, Ngalta)*			
381.	7871	*Brachyscome ciliaris*			
382.	18431	*Brachyscome ciliaris var. ciliaris*			
383.	11884	*Brachyscome ciliaris var. lanuginosa*			
384.	7872	*Brachyscome ciliocarpa*			
385.	7880	*Brachyscome lineariloba*			
386.	7882	*Brachyscome perpusilla*			
387.	7883	*Brachyscome pusilla*			
388.	247	*Bromus arenarius (Sand Brome)*			
389.	249	*Bromus diandrus (Great Brome)*	Y		
390.	253	*Bromus rubens (Red Brome)*	Y		

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
391.	7413	*Brunonia australis (Native Cornflower)*			
392.	3167	*Bursaria occidentalis*			
393.	15355	*Caladenia hirta subsp. rosea*			
394.	15357	*Caladenia incrassata*			
395.	19219	*Caladenia mesocera*			
396.	1614	*Caladenia roei (Ant Orchid)*			
397.	30797	*Caladenia saxicola*			
398.	1617	*Caladenia sigmoidea*			
399.	18594	*Caladenia sp. Muddarning Hill (S.D. Hopper 4013)*			
400.	2853	*Calandrinia eremaea (Twining Purslane)*			
401.	20478	*Calandrinia sp. Blackberry (D.M. Porter 171)*			
402.	19455	*Calandrinia sp. Bungalbin (G.J. Keighery & N. Gibson 1656)*			
403.	92	*Callitris canescens*			
404.	8466	*Callitris columellaris (White Cypress Pine)*			
405.	96	*Callitris preissii (Rottnest Island Pine, Maro)*			
406.	8637	*Callitris verrucosa*			
407.	5408	*Calothamnus gilesii*			
408.	13232	*Calothamnus superbus*		P1	
409.	7903	*Calotis hispidula (Bindy Eye)*			
410.	7905	*Calotis multicaulis (Many-stemmed Burr-daisy)*			
411.	16492	*Calycopeplus paucifolius*			
412.	5442	*Calytrix birdii*			
413.	5452	*Calytrix divergens*			
414.	5470	*Calytrix paucicostata*		P2	
415.	28241	*Calytrix sp. Paynes Find (F. & J. Hort 1188)*			
416.	43545	*Calytrix viscida*		P1	Y
417.	3008	*Carrichtera annua (Ward's Weed)*	Y		
418.	7911	*Carthamus lanatus (Saffron Thistle)*	Y		
419.	2955	*Cassytha nodiflora*			
420.	12658	*Casuarina pauper (Black Oak)*			
421.	7916	*Centaurea melitensis (Maltese Cockspur)*	Y		
422.	7922	*Cephalipterum drummondii (Pompom Head)*			
423.	7924	*Ceratogyne obionoides (Wingwort)*			
424.	1215	*Chamaexeros fimbriata*			
425.	1216	*Chamaexeros macranthera*			
426.	12796	*Cheilanthes adiantoides*			
427.	31	*Cheilanthes austrotenuifolia*			
428.	32	*Cheilanthes brownii*			
429.	37	*Cheilanthes lasiophylla (Woolly Cloak Fern)*			
430.	12818	*Cheilanthes sieberi subsp. sieberi*			
431.	3168	*Cheiranthera filifolia*			
432.	7933	*Chthonocephalus pseudevax (Woolly Groundheads)*			
433.	4555	*Comesperma integerrimum*			
434.	7943	*Cotula australis (Common Cotula)*			
435.	3137	*Crassula colorata (Dense Stonecrop)*			
436.	11709	*Crassula colorata var. acuminata*			
437.	11563	*Crassula colorata var. colorata*			
438.	11349	*Crassula decumbens var. decumbens*			
439.	3139	*Crassula exserta*			
440.	20268	*Crassula tetramera*			
441.	7951	*Cratystylis subspinescens (Australian Sage, Spiny Grey Bush)*			
442.	4791	*Cryptandra apetala*			
443.	13471	*Cryptandra connata*			
444.	16185	*Cryptandra graniticola*			
445.	6663	*Cuscuta epithymum (Lesser Dodder, Greater Dodder)*	Y		
446.	15400	*Cyanicula amplexans*			
447.	6747	*Cyanostegia angustifolia (Tinsel-flower)*			
448.	7438	*Dampiera eriocephala (Woolly-headed Dampiera)*			
449.	7469	*Dampiera roycei*			
450.	6218	*Daucus glochidiatus (Australian Carrot)*			
451.	15505	*Daviesia incrassata subsp. incrassata*			
452.	3836	*Daviesia purpurascens (Purple-leaved Daviesia)*			
453.	1259	*Dianella revoluta (Blueberry Lily)*			
454.	11636	*Dianella revoluta var. divaricata*			
455.	6771	*Dicrastylis parvifolia*			
456.	29315	*Dicrastylis rugosifolia*			
457.	15436	*Diuris porrifolia*			
458.	4752	*Dodonaea adenophora*			
459.	4766	*Dodonaea inaequifolia*			
460.	4769	*Dodonaea lobulata (Bead Hopbush)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
461.	12034	*Dodonaea microzyga var. acrolobata*			
462.	4775	*Dodonaea pinifolia*			
463.	4779	*Dodonaea rigida*			
464.	4780	*Dodonaea stenozyga*			
465.	4782	*Dodonaea viscosa (Sticky Hopbush)*			
466.	11674	*Dodonaea viscosa subsp. mucronata*			
467.	11202	*Dodonaea viscosa subsp. spatulata (Sticky Hop-bush)*			
468.	3106	*Drosera macrantha (Bridal Rainbow)*			
469.	14298	*Drosera macrantha subsp. macrantha*			
470.	3109	*Drosera menziesii (Pink Rainbow)*			
471.	33479	*Dysphania melanocarpa (Black Crumbweed)*			
472.	33597	*Dysphania melanocarpa forma melanocarpa (Black Goosefoot)*			
473.	2510	*Enchylaena lanata*			
474.	2511	*Enchylaena tomentosa (Barrier Saltbush)*			
475.	12064	*Enchylaena tomentosa var. tomentosa (Barrier Saltbush)*			
476.	357	*Enneapogon caerulescens (Limestone Grass)*			
477.	32353	*Entosthodon apophysatus*			
478.	378	*Eragrostis dielsii (Mallee Lovegrass)*			
479.	7180	*Eremophila alternifolia (Poverty Bush)*			
480.	13807	*Eremophila caperata*			
481.	7189	*Eremophila clarkei (Turpentine Bush)*			
482.	7193	*Eremophila decipiens (Slender Fuchsia)*			
483.	14895	*Eremophila decipiens subsp. decipiens*			
484.	7204	*Eremophila eriocalyx (Desert Pride)*			
485.	7206	*Eremophila falcata*			
486.	7208	*Eremophila forrestii (Wilcox Bush)*			
487.	15052	*Eremophila forrestii subsp. forrestii*			
488.	7211	*Eremophila georgei*			
489.	7215	*Eremophila glabra (Tar Bush)*			
490.	14340	*Eremophila glabra subsp. glabra*			
491.	14191	*Eremophila glabra subsp. tomentosa*			
492.	7216	*Eremophila glutinosa*			
493.	7219	*Eremophila granitica (Thin-leaved Poverty Bush)*			
494.	7225	*Eremophila interstans*			
495.	7226	*Eremophila ionantha (Violet-flowered Eremophila)*			
496.	7230	*Eremophila latrobei (Warty Fuchsia Bush, Mintjingka)*			
497.	17576	*Eremophila latrobei subsp. latrobei*			
498.	7240	*Eremophila metallicorum*			
499.	7246	*Eremophila oldfieldii (Pixie Bush)*			
500.	15003	*Eremophila oldfieldii subsp. angustifolia*			
501.	7247	*Eremophila oppositifolia (Weeooka)*			
502.	18570	*Eremophila oppositifolia subsp. angustifolia*			
503.	7250	*Eremophila pantonii*			
504.	7267	*Eremophila scoparia (Broom Bush ()*			
505.	7269	*Eremophila serrulata (Serrate-leaved Eremophila)*			
506.	19528	*Eremophila sp. Mt Jackson (G.J. Keighery 4372)*			
507.	417	*Eriachne pulchella (Pretty Wanderrie)*			
508.	16486	*Eriachne pulchella subsp. pulchella*			
509.	20718	*Ericksonella saccharata*			
510.	2514	*Eriochiton sclerolaenoides (Woolly Bindii)*			
511.	4331	*Erodium aureum*	Y		
512.	4333	*Erodium cicutarium (Common Storksbill)*	Y		
513.	4334	*Erodium crinitum (Corkscrew)*			
514.	4335	*Erodium cygnorum (Blue Heronsbill)*			
515.	14377	*Erymophyllum ramosum subsp. ramosum*			
516.	13516	*Eucalyptus aequioperta*			
517.	5565	*Eucalyptus brachycorys (Cowcowing Mallee)*			
518.	12904	*Eucalyptus capillosa*			
519.	12903	*Eucalyptus capillosa subsp. capillosa (Wheatbelt Wandoo)*			
520.	5592	*Eucalyptus clelandii (Cleland's Blackbutt)*			
521.	5595	*Eucalyptus comitae-vallis (Comet Vale Mallee)*			
522.	5596	*Eucalyptus concinna (Victoria Desert Mallee)*			
523.	5605	*Eucalyptus cornuta (Yate, Yeid)*			
524.	5607	*Eucalyptus corrugata (Rough-fruited Mallee)*			
525.	5632	*Eucalyptus ebbanoensis (Sandplain Mallee)*			
526.	13549	*Eucalyptus ebbanoensis subsp. ebbanoensis*			
527.	18349	*Eucalyptus ebbanoensis subsp. glauciramula*			
528.	5641	*Eucalyptus ewartiana (Ewart's Mallee)*			
529.	5651	*Eucalyptus formanii*		P4	
530.	5665	*Eucalyptus griffithsii (Griffith's Grey Gum)*			

NatureMap
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	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
531.	5673	*Eucalyptus horistes*			
532.	19523	*Eucalyptus kochii subsp. amaryssia*			
533.	15670	*Eucalyptus kochii subsp. plenissima*			
534.	5696	*Eucalyptus leptopoda (Tammin Mallee)*			
535.	13059	*Eucalyptus leptopoda subsp. leptopoda*			
536.	13056	*Eucalyptus leptopoda subsp. subluta*			
537.	20802	*Eucalyptus longissima*			
538.	5702	*Eucalyptus loxophleba (York Gum, Dwoda)*			
539.	13037	*Eucalyptus loxophleba subsp. lissophloia*			
540.	13038	*Eucalyptus loxophleba subsp. supralaevis*			
541.	19323	*Eucalyptus moderata*			
542.	5725	*Eucalyptus oldfieldii (Oldfield's Mallee)*			
543.	5726	*Eucalyptus oleosa (Giant Mallee)*			
544.	20091	*Eucalyptus oleosa subsp. oleosa*			
545.	5731	*Eucalyptus orbifolia (Round-leaved Mallee)*			
546.	5742	*Eucalyptus petraea (Granite Rock Box)*			
547.	13520	*Eucalyptus polita*			
548.	12380	*Eucalyptus ravida (Silver-topped Gimlet)*			
549.	5761	*Eucalyptus rigidula (Stiff-leaved Mallee)*			
550.	5766	*Eucalyptus salmonophloia (Salmon Gum, Wurak)*			
551.	5767	*Eucalyptus salubris (Gimlet)*			
552.	5772	*Eucalyptus sheathiana (Ribbon-barked Gum)*			
553.	12883	*Eucalyptus subangusta subsp. subangusta*			
554.	5793	*Eucalyptus transcontinentalis (Redwood, Pungul)*			
555.	15799	*Eucalyptus trichopoda*			
556.	5802	*Eucalyptus yilgarnensis (Yorrell)*			
557.	4617	*Euphorbia australis (Namana)*			
558.	16722	*Euryomyrtus maidenii*			
559.	19723	*Euryomyrtus patrickiae*			
560.	20711	*Eutaxia leptophylla*			
561.	10977	*Exocarpos aphyllus (Leafless Ballart)*			
562.	5197	*Frankenia desertorum*			
563.	5204	*Frankenia interioris*			
564.	17348	*Galium aparine (Goosegrass)*	Y		
565.	7323	*Galium murale (Small Goosegrass)*	Y		
566.	25797	*Galium spurium*	Y		
567.	12780	*Gilberta tenuifolia*			
568.	7977	*Gilruthia osbornei*			
569.	6144	*Glischrocaryon flavescens*			
570.	7061	*Glossostigma drummondii (Mudmat)*			
571.	19925	*Glycine peratosa*			
572.	7988	*Gnephosis arachnoidea (Cobwebby-headed Gnephosis)*			
573.	7996	*Gnephosis intonsa (Shaggy Gnephosis)*		P3	
574.	17721	*Gnephosis sp. Norseman (K.R. Newbey 8096)*		P3	
575.	8002	*Gnephosis tenuissima*			
576.	6159	*Gonocarpus nodulosus*			
577.	7495	*Goodenia berardiana*			
578.	7514	*Goodenia havilandii*			
579.	12523	*Goodenia helmsii*			
580.	7531	*Goodenia occidentalis*			
581.	1949	*Grevillea acuaria*			
582.	8830	*Grevillea ceratocarpa*			
583.	1998	*Grevillea erectiloba*		P4	
584.	2000	*Grevillea eriobotrya (Woolly Cluster Grevillea)*			
585.	2004	*Grevillea extorris*			
586.	2009	*Grevillea georgeana*		P3	
587.	2047	*Grevillea nematophylla*			
588.	19541	*Grevillea nematophylla subsp. nematophylla*			
589.	2051	*Grevillea obliquistigma*			
590.	15981	*Grevillea obliquistigma subsp. obliquistigma*			
591.	2057	*Grevillea paradoxa (Bottlebrush Grevillea)*			
592.	15766	*Grevillea shuttleworthiana subsp. obovata*			
593.	2106	*Grevillea tetrapleura*		P4	
594.	15982	*Grevillea zygoloba*			
595.	32386	*Grimmia laevigata*			
596.	2182	*Hakea minyma*			
597.	17557	*Hakea recurva subsp. recurva*			
598.	29840	*Halgania cyanea var. Allambi Stn (B.W. Strong 676)*			
599.	31117	*Halgania cyanea var. Charleville (R.W. Purdie +111)*			
600.	17491	*Halgania cyanea var. cyanea*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
601.	6691	*Halgania integerrima*			
602.	6174	*Haloragis gossei*			
603.	6180	*Haloragis trigonocarpa*			
604.	17725	*Hannafordia bissillii subsp. latifolia*			
605.	3016	*Heliophila pusilla*	Y		
606.	6843	*Hemigenia brachyphylla*			
607.	6862	*Hemigenia pedunculata*			
608.	5122	*Hibbertia eatoniae*			
609.	5124	*Hibbertia exasperata*			
610.	5165	*Hibbertia rostellata*			
611.	5166	*Hibbertia rupicola*			
612.	5171	*Hibbertia spicata*			
613.	5815	*Homalocalyx thryptomenoides*			
614.	12742	*Hyalosperma demissum*			
615.	11973	*Hybanthus floribundus subsp. curvifolius*			
616.	6239	*Hydrocotyle rugulosa*			
617.	8086	*Hypochaeris glabra (Smooth Catsear)*	Y		
618.	7	*Isoetes australis*			
619.	8087	*Isoetopsis graminifolia (Cushion Grass)*			
620.	7397	*Isotoma petraea (Rock Isotome, Tundiwari)*			
621.	14746	*Jacksonia jackson*		P1	Y
622.	4044	*Kennedia prostrata (Scarlet Runner)*			
623.	13729	*Keraudrenia velutina*			
624.	19892	*Keraudrenia velutina subsp. velutina*			
625.	5840	*Kunzea pulchella (Granite Kunzea)*			
626.	6779	*Lachnostachys coolgardiensis*			
627.	13284	*Lawrencella rosea*			
628.	19726	*Leiocarpa semicalva*			
629.	19727	*Leiocarpa semicalva subsp. semicalva*			
630.	12628	*Lemooria burkittii*			
631.	3033	*Lepidium oxytrichum*			
632.	31770	*Lepidosperma ferricola*		P3	
633.	31766	*Lepidosperma jacksonense*		P1	Y
634.	29138	*Lepidosperma sp. Pigeon Rocks (H. Pringle 30237)*		P3	
635.	12687	*Leptospermum macgillivrayi*		P1	
636.	13260	*Leucochrysum fitzgibbonii*			
637.	16049	*Leucopogon sp. Clyde Hill (M.A. Burgman 1207)*			
638.	20371	*Leucopogon sp. Salt Lake (G.F. Craig 3069)*			
639.	7670	*Levenhookia dubia (Hairy Stylewort)*			
640.	7676	*Levenhookia pusilla (Midget Stylewort)*			
641.	7403	*Lobelia heterophylla (Wing-seeded Lobelia)*			
642.	2533	*Maireana amoena*			
643.	2538	*Maireana carnosa (Cottony Bluebush)*			
644.	2543	*Maireana eriosphaera*			
645.	2544	*Maireana georgei (Satiny Bluebush)*			
646.	2555	*Maireana pentatropis*			
647.	2556	*Maireana planifolia (Low Bluebush)*			
648.	2561	*Maireana radiata*			
649.	2567	*Maireana tomentosa (Felty Bluebush)*			
650.	11662	*Maireana tomentosa subsp. tomentosa*			
651.	2568	*Maireana trichoptera (Downy Bluebush)*			
652.	5865	*Malleostemon roseus*			
653.	16295	*Malleostemon sp. Adelong (G.J. Keighery 11825)*		P2	
654.	5866	*Malleostemon tuberculatus*			
655.	12949	*Marsdenia australis*			
656.	74	*Marsilea drummondii (Common Nardoo)*			
657.	4077	*Medicago minima (Small Burr Medic)*	Y		
658.	4079	*Medicago polymorpha (Burr Medic)*	Y		
659.	5869	*Melaleuca acuminata*			
660.	20284	*Melaleuca atroviridis*			
661.	5896	*Melaleuca cordata*			
662.	5908	*Melaleuca eleuterostachya*			
663.	5912	*Melaleuca fulgens (Scarlet Honeymyrtle)*			
664.	19486	*Melaleuca hamata*			
665.	5929	*Melaleuca leiocarpa*			
666.	9183	*Melaleuca nematophylla (Wiry Honey-myrtle)*			
667.	5958	*Melaleuca radula (Graceful Honeymyrtle)*			
668.	41785	*Melichrus sp. Bungalbin Hill (F.H. & M.P. Mollemans 3069)*		P3	
669.	17643	*Microcorys sp. Mt Gibson (S. Patrick 2098)*			
670.	19787	*Micromyrtus monotaxis*			

	Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area[1]
671.	6000	*Micromyrtus racemosa*			
672.	8105	*Millotia myosotidifolia*			
673.	12631	*Millotia perpusilla*			
674.	8107	*Minuria cunninghamii (Bush Minuria)*			
675.	4089	*Mirbelia depressa*			
676.	41443	*Mirbelia ferricola*		P3	
677.	4094	*Mirbelia microphylla*			
678.	490	*Monachather paradoxus*			
679.	29418	*Monoculus monstrosus*	Y		
680.	31791	*Neurachne annularis*		P3	
681.	6976	*Nicotiana occidentalis (Native Tobacco)*			
682.	6978	*Nicotiana rotundifolia (Round-leaved Tobacco)*			
683.	8134	*Olearia exiguifolia (Small-leaved Daisy Bush)*			
684.	12734	*Olearia humilis*			
685.	8140	*Olearia muelleri (Goldfields Daisy)*			
686.	8145	*Olearia pimeleoides (Pimelea Daisybush, Burrobunga)*			
687.	8151	*Olearia stuartii*			
688.	8152	*Olearia subspicata (Spiked Daisy Bush)*			
689.	12670	*Parietaria cardiostegia*			
690.	10975	*Paspalidium basicladum*			
691.	518	*Paspalidium clementii (Clements Paspalidium)*			
692.	2259	*Persoonia coriacea (Leathery-leaf Persoonia)*			
693.	3674	*Petalostylis cassioides*			
694.	4497	*Phebalium canaliculatum*			
695.	4500	*Phebalium filifolium (Slender Phebalium)*			
696.	4504	*Phebalium tuberculosum*			
697.	18539	*Philotheca brucei*			
698.	18537	*Philotheca brucei subsp. brucei*			
699.	16833	*Philotheca coateana*		P3	
700.	18519	*Philotheca coccinea*			
701.	18386	*Philotheca deserti subsp. brevifolia*		P3	
702.	18385	*Philotheca deserti subsp. deserti*			
703.	18506	*Philotheca tomentella*			
704.	16177	*Phyllangium paradoxum*			
705.	4142	*Phyllota luehmannii*			
706.	5245	*Pimelea forrestiana*			
707.	5256	*Pimelea microcephala (Shrubby Riceflower, Banjine)*			
708.	11185	*Pimelea microcephala subsp. microcephala*			
709.	12104	*Pimelea spiculigera var. thesioides*			
710.	19744	*Pittosporum angustifolium*			
711.	7299	*Plantago debilis*			
712.	65	*Pleurosorus rutifolius (Blanket Fern)*			
713.	573	*Poa drummondiana (Knotted Poa)*			
714.	8172	*Podolepis canescens (Bright Podolepis, Grey Podolepis)*			
715.	8173	*Podolepis capillaris (Wiry Podolepis)*			
716.	8177	*Podolepis lessonii*			
717.	8181	*Podolepis tepperi*			
718.	8182	*Podotheca angustifolia (Sticky Longheads)*			
719.	8184	*Podotheca gnaphalioides (Golden Long-heads)*			
720.	12706	*Prostanthera althoferi*			
721.	15822	*Prostanthera althoferi subsp. althoferi*			
722.	6912	*Prostanthera campbellii*			
723.	6916	*Prostanthera grylloana*			
724.	6919	*Prostanthera magnifica (Magnificent Prostanthera)*			
725.	41650	*Prostanthera prostantheroides*			
726.	11986	*Prostanthera semiteres subsp. intricata*			
727.	4725	*Psammomoya choretroides*			
728.	16370	*Psammomoya grandiflora*			
729.	18155	*Psydrax suaveolens*			
730.	10778	*Pterostylis picta*			
731.	19327	*Pterostylis sp. dainty brown (N. Gibson & M. Lyons 3690)*			
732.	18657	*Pterostylis sp. inland (A.C. Beauglehole 11880)*			
733.	10897	*Pterostylis spathulata*			
734.	2690	*Ptilotus aervoides*			
735.	2707	*Ptilotus carlsonii*			
736.	2717	*Ptilotus divaricatus (Climbing Mulla Mulla)*			
737.	2718	*Ptilotus drummondii (Narrowleaf Mulla Mulla)*			
738.	41246	*Ptilotus exiliflorus*			
739.	2727	*Ptilotus gaudichaudii*			
740.	41506	*Ptilotus gaudichaudii subsp. gaudichaudii*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
741.	2730	*Ptilotus helichrysoides*			
742.	2732	*Ptilotus holosericeus*			
743.	2746	*Ptilotus nobilis (Tall Mulla Mulla)*			
744.	2747	*Ptilotus obovatus (Cotton Bush)*			
745.	15855	*Ptilotus schwartzii var. schwartzii*			
746.	41000	*Ptilotus sp. Goldfields (R. Davis 10796)*			
747.	2581	*Rhagodia drummondii*			
748.	11254	*Rhagodia preissii subsp. preissii*			
749.	13306	*Rhodanthe battii*			
750.	13241	*Rhodanthe chlorocephala subsp. rosea*			
751.	13300	*Rhodanthe citrina*			
752.	13305	*Rhodanthe heterantha*			
753.	13294	*Rhodanthe laevis*			
754.	13234	*Rhodanthe manglesii*			
755.	13238	*Rhodanthe maryonii*			
756.	13248	*Rhodanthe oppositifolia*			
757.	13249	*Rhodanthe oppositifolia subsp. oppositifolia*			
758.	13296	*Rhodanthe polycephala*			
759.	13252	*Rhodanthe pygmaea*			
760.	13253	*Rhodanthe rubella*			
761.	13254	*Rhodanthe stricta*			
762.	6599	*Rhyncharrhena linearis (Bush Bean, Wintjulanypa)*			
763.	14225	*Ricinocarpos brevis*		T	
764.	11151	*Rostraria pumila*	Y		
765.	30434	*Salsola australis*			
766.	2356	*Santalum acuminatum (Quandong, Warnga)*			
767.	2359	*Santalum spicatum (Sandalwood, Wilarak)*			
768.	13008	*Sarcostemma viminale*			
769.	7639	*Scaevola restiacea*			
770.	12586	*Scaevola spicigera*			
771.	7644	*Scaevola spinescens (Currant Bush, Maroon)*			
772.	8200	*Schoenia cassiniana (Schoenia)*			
773.	2606	*Sclerolaena cuneata (Yellow Bindii)*			
774.	2607	*Sclerolaena densiflora*			
775.	2609	*Sclerolaena diacantha (Grey Copperburr)*			
776.	2610	*Sclerolaena drummondii*			
777.	2615	*Sclerolaena fusiformis*			
778.	8877	*Sclerolaena gardneri*			
779.	2619	*Sclerolaena lanicuspis (Spinach Burr)*			
780.	2627	*Sclerolaena patenticuspis (Spear-fruit Saltbush)*			
781.	8206	*Senecio glomeratus (Cluster-headed Fireweed)*			
782.	8207	*Senecio glossanthus (Slender Groundsel)*			
783.	25881	*Senecio lacustrinus*			
784.	20161	*Senecio pinnatifolius*			
785.	8217	*Senecio quadridentatus*			
786.	17645	*Senna artemisioides*			
787.	12276	*Senna artemisioides subsp. filifolia*			
788.	17558	*Senna artemisioides subsp. x artemisioides*			
789.	16378	*Senna pleurocarpa*			
790.	12315	*Senna pleurocarpa var. angustifolia*			
791.	12314	*Senna pleurocarpa var. pleurocarpa*			
792.	4970	*Sida calyxhymenia (Tall Sida)*			
793.	31759	*Sida ectogama*			
794.	31854	*Sida sp. Excedentifolia (J.L. Egan 1925)*			
795.	31857	*Sida sp. Golden calyces glabrous (H.N. Foote 32)*			
796.	19712	*Sida sp. dark green fruits (S. van Leeuwen 2260)*			
797.	2909	*Silene gallica (French Catchfly)*	Y		
798.	7013	*Solanum hoplopetalum (Thorny Solanum)*			
799.	7018	*Solanum lasiophyllum (Flannel Bush, Mindjulu)*			
800.	7023	*Solanum nummularium (Money-leaved Solanum)*			
801.	7026	*Solanum orbiculatum (Wild Tomato)*			
802.	7028	*Solanum petrophilum (Rock Nightshade)*			
803.	7038	*Solanum terraneum*			
804.	8230	*Sonchus asper (Rough Sowthistle)*	Y		
805.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		
806.	12647	*Sondottia connata*			
807.	20767	*Spartothamnella sp. Helena & Aurora Range (P.G. Armstrong 155-109)*		P3	
808.	6827	*Spartothamnella teucriiflora*			
809.	19555	*Stackhousia muricata subsp. annual (W.R. Barker 2172)*			
810.	43541	*Stackhousia sp. Hairy fruited (E.N.S. Jackson 1387)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
811.	2917	*Stellaria filiformis (Thread Spurry)*			
812.	14797	*Stenanthemum newbeyi*		P3	
813.	16200	*Stenanthemum stipulosum*			
814.	3076	*Stenopetalum filifolium*			
815.	3077	*Stenopetalum lineare (Narrow Thread Petal)*			
816.	30212	*Stenopetalum lineare var. lineare*			
817.	3079	*Stenopetalum pedicellare*			
818.	8236	*Streptoglossa cylindriceps*			
819.	8238	*Streptoglossa liatroides*			
820.	7714	*Stylidium dielsianum (Tangle Triggerplant)*			
821.	7719	*Stylidium ecorne (Foot Triggerplant)*			
822.	7740	*Stylidium induratum (Desert Triggerplant)*			
823.	7810	*Stylidium yilgarnense (Yilgarn Triggerplant)*			
824.	33018	*Styphelia sp. Bullfinch (M. Hislop 3574)*		P3	
825.	4221	*Swainsona colutoides (Bladder Vetch)*			
826.	4231	*Swainsona kingii*			
827.	31918	*Tecticornia doleiformis (Samphire)*			
828.	33216	*Tecticornia sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)*			
829.	31717	*Tecticornia undulata*			
830.	2822	*Tetragonia eremaea*			
831.	16287	*Tetragonia moorei*			
832.	4534	*Tetratheca harperi (Jackson Tetratheca)*		T	Y
833.	13649	*Tetratheca paynterae*			Y
834.	23987	*Tetratheca paynterae subsp. cremnobata*		T	Y
835.	23988	*Tetratheca paynterae subsp. paynterae*		T	Y
836.	20732	*Thelymitra petrophila*			
837.	6050	*Thryptomene australis (Hook-leaf Thryptomene)*			
838.	19698	*Thryptomene australis subsp. australis*			
839.	6058	*Thryptomene kochii*			
840.	6068	*Thryptomene urceolaris*			
841.	674	*Thyridolepis mitchelliana (Mulga Grass)*			
842.	1338	*Thysanotus manglesianus (Fringed Lily)*			
843.	1343	*Thysanotus patersonii*			
844.	1352	*Thysanotus speckii*			
845.	19253	*Trachymene ceratocarpa*			
846.	6268	*Trachymene cyanopetala*			
847.	6279	*Trachymene ornata (Spongefruit)*			
848.	6280	*Trachymene pilosa (Native Parsnip)*			
849.	12652	*Trichanthodium skirrophorum*			
850.	17874	*Triodia rigidissima*			
851.	699	*Triodia scariosa*			
852.	13041	*Triodia tomentosa*			
853.	705	*Tripogon loliiformis (Five Minute Grass)*			
854.	8253	*Triptilodiscus pygmaeus*			
855.	16986	*Trymalium myrtillus subsp. myrtillus*			
856.	7656	*Velleia cycnopotamica*			
857.	7661	*Velleia hispida (Hispid Velleia)*			
858.	7664	*Velleia rosea (Pink Velleia)*			
859.	6087	*Verticordia helmsii*			
860.	8268	*Vittadinia humerata*			
861.	11018	*Vulpia muralis*	Y		
862.	724	*Vulpia myuros (Rat's Tail Fescue)*	Y		
863.	33101	*Vulpia myuros forma myuros*	Y		
864.	7386	*Wahlenbergia gracilenta (Annual Bluebell)*			
865.	7393	*Wahlenbergia tumidifructa*			
866.	8275	*Waitzia acuminata (Orange Immortelle)*			
867.	13331	*Waitzia acuminata var. acuminata*			
868.	6938	*Westringia cephalantha*			
869.	34602	*Westringia cephalantha var. cephalantha*			
870.	9247	*Westringia rigida (Stiff Westringia)*			
871.	1391	*Wurmbea densiflora*			
872.	1248	*Xerolirion divaricata (Basil's Asparagus)*			
873.	4386	*Zygophyllum aurantiacum (Shrubby Twinleaf)*			
874.	18140	*Zygophyllum eichleri*			
875.	4389	*Zygophyllum eremaeum*			
876.	4390	*Zygophyllum fruticulosum (Shrubby Twinleaf)*			
877.	4392	*Zygophyllum iodocarpum*			
878.	4394	*Zygophyllum ovatum (Dwarf Twinleaf)*			

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Assets | Engineering | Environment | Noise | Spatial | Waste

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Appendix J: Subterranean Fauna Report

Southern Cross Goldfields Pty Ltd

Marda Gold Project (Mining Leases M77/394, 646, 931 and 962): Subterranean Fauna Risk Assessment

Final Report

Prepared for Southern Cross Goldfields Pty Ltd by Bennelongia Pty Ltd

February 2013
Report 2013/187

Marda Gold Project (Mining Leases M77/394, 646, 931 and 962): Subterranean Fauna Risk Assessment

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February 2013

Report 2013/187

Cover photo: *Trichorhina* sp. B04

Client – Southern Cross Goldfields Pty Ltd

Report	Version	Prepared by	Checked by	Submitted to Client	
				Method	Date
Draft report	Vers. 1	Andrew Trotter Dean Main	Stuart Halse	email	30.i.13
Final report	Vers. 1	Rowan Lymbery	Andrew Trotter	email	26.ii.13

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EXECUTIVE SUMMARY

The Marda Gold Project (the Project) is located approximately 114 km north of Southern Cross in Western Australia. The Project lies within the Marda-Diemals greenstone belt within the central Yilgarn Craton. Southern Cross Goldfields Pty Ltd (SXG) proposes to develop a mine over a five year period to extract gold from four Marda Central deposits (Python, Dugite, Dolly Pot, Goldstream) and two outlying deposits 13-16 km away (King Brown and Golden Orb).

This report assesses the potential threats to subterranean fauna (troglofauna and stygofauna) species as a result of the Project. The objective of this desktop assessment was to review the current knowledge of subterranean fauna in the region and characterise the subterranean habitat at Marda Central and other deposits within a regional context to provide:

1. A basis for gauging the likelihood of subterranean fauna assemblages inhabiting the Project deposits;
2. A preliminary assessment of the possible conservation significance of such assemblages; and
3. Recommendations about future assessment requirements.

The main threat to any troglofauna species within the Project was considered to be mine pit excavation, while groundwater drawdown associated with mine pit dewatering was considered to be the principal threat to any stygofauna species present.

An assessment of the likely occurrence of subterranean fauna within the Project was based on records of the Western Australian Museum (WAM) database, previous environmental impact assessments and primary literature. All available data within a 50 by 50 km Search Area surrounding the Project were reviewed, with additional information from nearby mine sites.

The WAM database contained no stygofauna records in the Search Area, reflecting both few stygofauna surveys in the Search Area and the depauperate nature of stygofauna communities present where surveys occurred. Other surveys outside the Search Area, although nearby, also yielded few if any stygofauna.

It was concluded that it is most unlikely a significant stygofauna community inhabits the Project area; the few species collected nearby have wide distributions. Given the small groundwater drawdown cone predicted to be associated with the Project and the depauperate stygofauna community, it was recommended that no subterranean surveys are required for the purpose of environmental impact assessment.

At least 15 species of troglofauna have been recorded in the Search Area, including one species of spider, four species of isopod, four species of myriapod and five insect species. Four of these species are currently known only from the Jackson Range and one species is currently known only from the Windarling Range.

Information about troglofauna in the Search Area suggests it is likely that a troglofauna community of low or moderate species richness exists at the Project. It is also likely that some of the species present will have localised distributions, as a number of species recorded within the Search Area are restricted to single rocky ranges.

Despite the potential for species with localised distributions occurring in the Project area, it is considered highly unlikely mining will threaten the persistence of any species because of the small size

of the proposed mine pits. Their total area is 26 ha, with the individual pits ranging in size from approximately 1.5 to 11 ha. Troglofauna surveys of fractured rock habitats in Western Australia indicate that pits of this size are unlikely to threaten troglofauna species. The most comprehensive study of troglofauna ranges in the Western Australia has been for schizomids of the Robe Valley mesas, where the smallest recorded range was approximately 89 ha. The mesas are geologically very isolated, unlike the geology of the Project area. Given the relatively uniform Project area geology, it is most unlikely that species in the Project area have ranges almost two orders of magnitude smaller than schizomids in the Robe Valley.

While recognizing that subterranean fauna may be present in the Project area, given the low level of threat associated with such small mine pits, it is considered that no subterranean survey is required for the purpose of environmental impact assessment.

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1. INTRODUCTION

The Marda Gold Project (the Project) is located approximately 114 km north of Southern Cross in Western Australia. The Project lies within the Marda-Diemals greenstone belt within the central Yilgarn Craton (Figure 1.1). Southern Cross Goldfields Pty Ltd (SXG) proposes to develop a mine over a five year period to extract gold from four Marda Central deposits (Python, Dugite, Dolly Pot, Goldstream) and two outlying deposits 10-30 km away (King Brown and Golden Orb) (Figure 1.1). The Project covers an area of about 2680 ha and key activities and infrastructure will include:

- Open-cut mining extending below watertable;
- Extraction of 0.5 Mtpa of gold ore;
- Processing via a carbon leach plant at Marda Central, requiring annual groundwater extraction of approximately XXX ML from existing and planned production bores;
- Waste dumps to be located outside the pits;
- Tailings storage facility;
- Diesel fired power plant; and
- Air strip, accommodation camp, utilities and other supporting infrastructure.

This review assesses the subterranean fauna habitat, requirement for field survey and risk to subterranean fauna associated with the Proposal. The defining characteristic of subterranean fauna is that they spend all, or most, of their lifecycle underground and are morphologically adapted to the subterranean environment. Adaptations include pallid colouration, reduction or loss of eyes, elongate body, long slender appendages and well developed sensory setae.

A high proportion of subterranean species are short-range endemics (SREs), defined by Harvey (2002) as species with ranges of <10,000 km^2, although subterranean species often have much smaller ranges than this criterion. The restricted ranges of subterranean fauna species mean they are particularly vulnerable to extinction from anthropogenic activities and, hence, are a focus for conservation (see Fontaine *et al*. 2007).

There are two types of subterranean fauna species: stygofauna and troglofauna. Stygofauna occur in groundwater, whereas troglofauna are air-breathing and occur in the various unsaturated layers of the vadose zone (Gibert and Deharveng 2002). In general terms, stygofauna may be threatened by groundwater drawdown and troglofauna by excavation of soil and rock.

The areas of groundwater drawdown and mine pit excavation associated with the Project are likely to be small relative to the ranges of most subterranean fauna species. However, it is theoretically possible that the planned disturbance associated with the Project may threaten highly restricted species of subterranean fauna, if such species exist within the Project footprint.

The objective of this desktop assessment was to review the current knowledge of subterranean fauna in the region and characterise the subterranean habitat at Marda Central and other deposits within a regional context to provide:

1. A basis for gauging the likelihood of subterranean fauna assemblages inhabiting the Project deposits;
2. A preliminary assessment of the possible conservation significance of such assemblages; and
3. Recommendations about future assessment requirements.

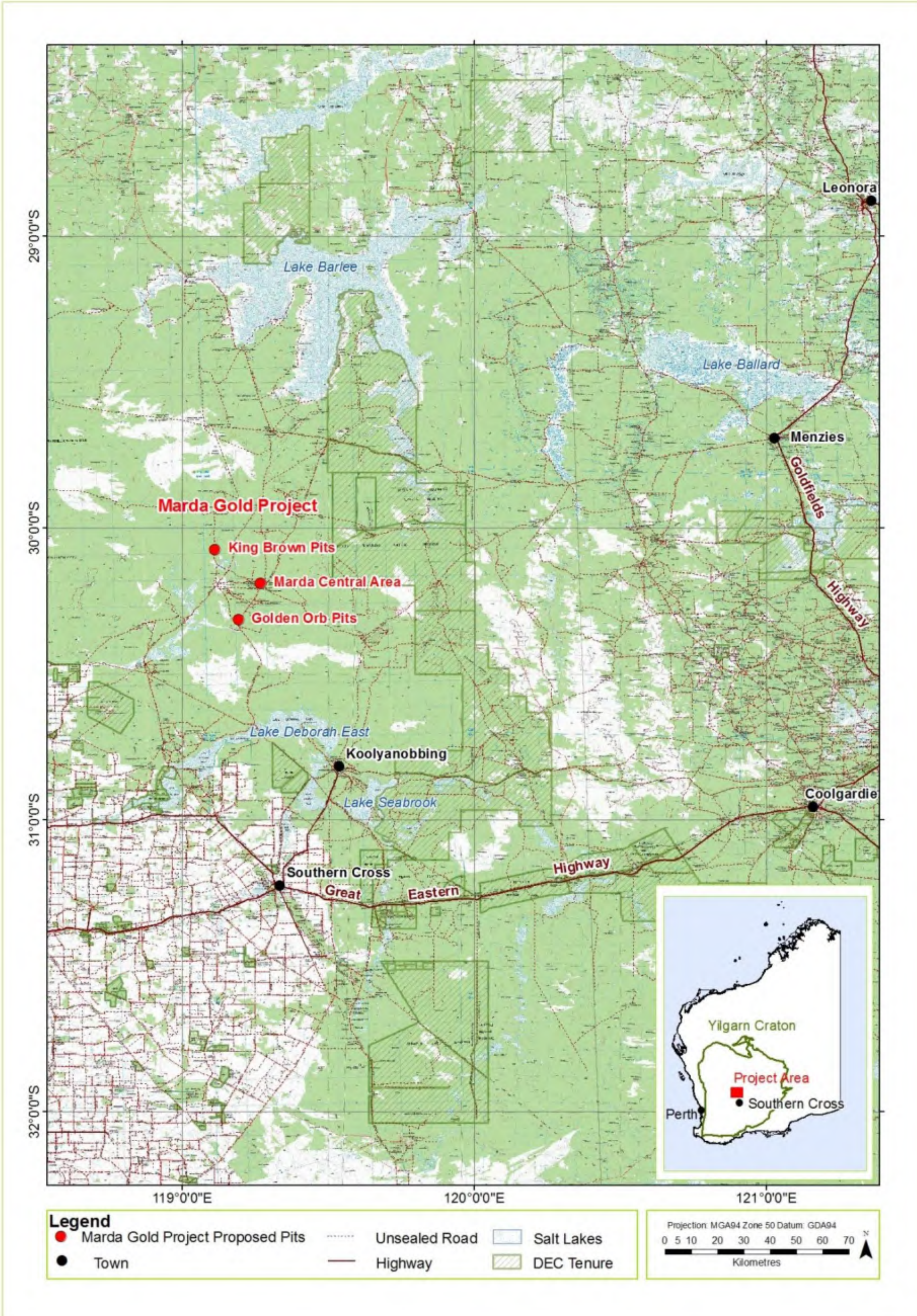

Figure 1.1. Location of the Marda Gold Project.

2. SITE DESCRIPTION

2.1. Geology

The Project is located in the south-eastern part of the Marda-Diemals greenstone belt within the Archaean Yilgarn Block. A craton-scale sinistral fault zone, the Mount Dimer Shear Zone, separates the Marda-Diemals greenstone belt from the Hunt Range greenstone belt to the north (Prodemas 2007).

Chen *et.al.* (2003) subdivided the Marda-Diemals belt into two greenstone successions. The lower 3000 My greenstone succession is characterised by mafic volcanics and Banded Iron Formation (BIF). A sequence of basalt and ultramafic rocks is overlain by the relatively thick BIF/chert unit, which is overlain by mafic volcanics. This lower greenstone succession is unconformably overlain by a 2730 My upper greenstone succession consisting of felsic to intermediate volcanic rocks and clastic sedimentary rocks.

The Project is intended to mine several discrete gold resources within the Marda-Diemals greenstone belt. The Marda Central group, located approximately 114 km north of Southern Cross, comprises the Dolly Pot, Dugite, Python and Goldstream deposits, with King Brown and Golden Orb located 13 km southwest and 16 km northwest respectively. Gold mineralisation occurs within all the major geological formations in the belt. Mineralisation at the Marda Central deposits and Golden Orb is hosted in BIF, whereas at King Brown mineralisation is hosted in basalt and/or ultramafic units.

The Marda Central deposits display common weathering, host rock and mineralisation characteristics and are therefore described as a group. They are found within a highly deformed segment of the Marda BIF and are characterised by strong quartz veining accompanied by silica, pyrite and sericite alteration. The structural context is dominated by isoclinal folds, low angle shears and late, high angle cross faults. Weathering of the deposits is substantially deeper than the surrounding area (Rock Team 2012).

Logged mafic and ultramafic units within the BIF at Marda Central were weathered to the extent of becoming clays. BIF units themselves were often logged as white cherty material, which may reflect pallid weathering of haematite /goethite units (Rock Team 2012). The abundant workings from previous mining confirmed these interpretations. Mullock heaps associated with vertical and northeast inclined shafts contain highly weathered fissile and jaspilitic cherts and BIFs, as well as pallid bleached quartz-kaolin rich units (Rock Team 2012).

Gold mineralisation at Marda Central correlates broadly with the extent of BIF, although differing slightly across the deposits. Python deposit mineralisation is hosted within the fold/fault thickened BIF. The country rock is fine-grained high-magnesium basalt weathered to significant depths. Mineralisation at Goldstream is associated with thin highly fractured/broken sub-vertical haematitic BIF units (Rock Team 2012).

South of Marda Central, Golden Orb exhibits similar degrees of weathering. The deposit is strongly weathered to an average depth of 80 m. Pallid clays were encountered at depths ranging from 25 to 40 m whilst mottled and ferruginous clays persisted to a vertical depth of between 60 m and 90 m. Gold mineralisation at Golden Orb followed the host chert unit over approximately 650 m of strike (Rock Team 2012).

Weathering of Marda BIF can also be seen north of Marda Central. The King Brown deposit is hosted by highly weathered ultramafic saprolitic clays with interspersed narrow highly degraded BIF units. Gold mineralisation is visible as platy flakes on fracture surfaces in quartz veins. These veins are associated with haematite staining on the footwall of a fractured and degraded BIF (Rock Team 2012).

2.2. Hydrogeology

The Project lies within the internal drainage division of Western Australia. The surface drainage of the Project area is poorly defined and consists mainly of broad sheet wash following short duration, high intensity storms. Occasional shallow, ephemeral drainage channels are present and small ephemeral creek beds arising within the project area flow north or north-west towards a chain of unnamed salt lakes. There are no salt lakes or significant claypans within the Project area (Pendragon 2013).

Ground water levels across Marda Central, King Brown and Golden Orb range lie approximately 11 to 76 m below the ground surface, depending on local topography. The main aquifer at Python is reported to be associated with highly fractured and jointed banded iron formation. Drilling records indicate that the degree of fracturing and associated main water strikes increased around the mafic contacts between 95 and 126 m below surface. Significant fracturing of the banded iron formation was recorded as deep as 154 m, while the vertical extent of the aquifer is currently undefined (Pendragon 2013).

Groundwater quality at Marda is variable, with circumneutral pH (7.0-8.4) and salinities ranging from fresh to hypersaline (860-118,000 µS/cm) (Pendragon 2013).

3. PROJECT DESCRIPTION AND POTENTIAL IMPACTS

3.1. Mining Activities Relevant to Subterranean Fauna

The Project proposes to mine gold in oxide and primary ore from multiple open pits and has an expected life of approximately five years. Activity will be concentrated in the Marda Central area at four mine pits (Python, Dugite, Dolly Pot and Goldstream). Satellite operations are planned a further two pits at King Brown and Golden Orb (located 16 and 13 km, respectively from Marda Central). The four pits of Marda Central are expected to have a total area of 11.3 ha, with the smallest pit occupying about 1.5 ha. The King Brown and Golden Orb pits are expected to be 3.5 and 11 ha, respectively.

Ore from all pits will be trucked to a 0.5 Mtpa conventional carbon in pulp/carbon leach (CIP/CIL) gold processing facility to be developed at Marda Central. Water for mining and operational purposes will be extracted from a BIF aquifer (approximately 60 m below ground surface).

Other major infrastructure at the Project will include a tailings storage facility, diesel fired power plant, water treatment facilities, communication facilities, new airstrip, accommodation camp, sewerage treatment ponds and landfill, all of which will be located at Marda Central.

3.2. Potential Impacts on Subterranean Fauna

Two types of mine-related impacts are recognised in this report: 1) *Primary Impacts* have the potential to threaten the persistence of subterranean fauna through direct removal of habitat; and 2) *Secondary Impacts* reduce habitat quality rather than removing it and are expected to have the potential to reduce population densities rather than threatening species persistence. Examples of secondary impacts are reduction in habitat quality as a result of nutrient enrichment from sewerage or increased turbidity from mine blasting (Scarsbrook and Fenwick 2003; Masciopinto *et al*. 2006).

When assessing the threat to subterranean fauna species from the proposed Project, only primary impacts were taken into consideration although it is recognised that the cumulative effect of secondary impacts may also be detrimental. Background on factors causing secondary impact is given in Appendix 1.

3.2.1. Potential Impacts on Stygofauna

Modelling indicates that, if significant groundwater impact as a result of dewatering is defined as drawdown ≥5 m, the approximate extent (i.e. radius) of groundwater impact around each mine pit will vary from 350 to 780 m (Table 3.1). Thus, the area of potential impact on stygofauna at King Brown is about 1.9 km^2. The area of impact at Golden Orb will be similar, while it will be less at the Marda Central deposits.

Table 3.1. Predicted dewatering flow rate and approximate radial extent of drawdown >5 m at different deposits (Pendragon 2013).

Pit	Dewatering flow rate (L/s)	Approximate Radial Influence (m)
King Brown	24	780
Golden Orb	16	740
Dolly Pot	7	565
Python	1	350

3.2.2. Potential Impacts on Troglofauna

Of all the mining activities at the Project, only *pit excavation* will represent significant habitat loss. This totals an area of approximately 26 ha.

4. SUBTERRANEAN FAUNA OCCURRENCE

4.1. Stygofauna

4.1.1. Habitats

Stygofauna inhabit subterranean spaces (fissures and voids) and occur in an array of different groundwater habitats including porous, karstic and fractured-rock aquifers, springs and the hyporheos of streams (Eberhard *et al*. 2005). In general terms, the likelihood of stygofauna occurring in an aquifer is directly related to its transmissivity (Gibert and Deharveng 2002).

The physiochemical tolerances of stygofauna have not been well defined, although some information is available on salinity tolerances and some broad principles can be inferred from the information available for surface species. Stygofauna have mostly been recorded in fresh to brackish groundwater but may occur in salinities up to 60,000 mg/L TDS (Watts and Humphreys 2006; Reeves *et al*., 2007; Ecologia 2009a).

4.1.2. Stygofauna of the Yilgarn

Considerable stygofauna survey has been undertaken by the Western Australian Museum (WAM) in calcretes of the palaeovalleys of the Yilgarn. It has been shown that individual calcrete aquifers frequently contain beetles, amphipods, isopods and bathynellids endemic to that aquifer (Cooper *et al*.

2002, 2007, 2008; Guzik *et al*. 2008). These restricted stygofauna communities have often been listed as either Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) (DEC 2009; 2010). In both cases, the communities are seen as having high conservation value during the assessment process.

Calcrete and, to a lesser extent, alluvium are typically considered to be the productive habitats for stygofauna in the Yilgarn. The relatively few surveys of stygofauna in other Yilgarn lithologies suggest other lithologies support at most few stygofauna species in low numbers. Most surveys in BIF have not found stygofauna, although a single *Microcyclops* copepod was recorded at Koolanooka (Ecologia 2007, 2008a,b; Bennelongia 2009a; GHD 2009).

4.1.2.1. Stygofauna in the Vicinity of the Project

A literature review of stygofauna records in the vicinity of the Project was used to assess the likelihood of stygofauna occurring at the Project itself. Records were compiled from previous environmental impact assessments, the WAM database and primary literature. All available data within a 50 by 50 km Search Area surrounding the Project (29°44'13.20"S to 30°38'49.20"S, 118°45'7.20"E to 119°47'2.40"E, Appendix 2) were reviewed.

The WAM database contained no records for the Search Area. This result reflects both the lack of stygofauna surveys in the Search Area and also the depauperate nature of stygofauna communities present where surveys have been done. The stygofauna survey at Windarling Range collected no animals (Bennelongia 2010a).

Surveys conducted in the vicinity of the Search Area have also yielded few, if any, stygofauna. Only nematodes or no stygofauna at all were collected from BIF aquifers in pilot-scale surveys at Lake Giles (80 km north-east of the Project) and Parker Range (190 km south-east) (Rockwater 2012). Bennelongia (2009b) collected no stygofauna from 20 samples at Carina deposit in the Hunt Range 73 km south-east of the Project (once again in BIF).

4.2. Troglofauna

4.2.1. Habitats

Troglofauna habitat is usually considered to occur between the lower layers of loose soil and sand (starting 3-4 m below the ground surface in Australia) and the interface with the groundwater (see Juberthie *et al*. 1981). Troglofauna presence is dependent on the structure of subterranean habitat and, as with stygofauna, if no fissures or voids are present in the subterranean strata no troglofauna will occur. Lateral connectivity of spaces is crucial to underground dispersal. Geological features such as major faults and dykes that block the continuity of habitat may act as barriers to dispersal, leading to species having highly restricted ranges.

Most troglofauna surveys for environmental assessment have been undertaken in areas of pisolite or BIF and it is been demonstrated in many surveys that these habitats are suitable for troglofauna. Information about the occurrence of troglofauna outside mineralized habitats is limited because mine development has been the primary reason for most of the surveys. However, troglofauna have also been collected from calcrete and alluvium in the Yilgarn and from karst in the Swan Coastal Plain (Barranco and Harvey 2008; Platnick 2008).

4.2.2. Troglofauna of the Yilgarn

The limited surveys that have been undertaken in the Yilgarn, for which information is available, have recorded modest troglofauna communities in calcretes above the watertable. Groups collected include palpigrads (Barranco and Harvey 2008), pseudoscorpions (Edward and Harvey 2008), spiders (Platnick 2008; Baehr *et al.* 2012) and isopods (S. Taiti in litt.). Outback Ecology (2011) collected 20 troglofauna species at Lake Way near Wiluna and cited unpublished WAM reports referring to “numerous [other] troglomorphic species” in Lake Way calcretes.

Other lithologies in the Yilgarn appear to support few troglofauna. Only three species representing three taxonomic groups (isopods, diplurans and thysanurans) were recorded in saprolitic rock at the Duketon Gold Project (Bennelongia 2010b). Only four species from four taxonomic groups (isopods, centipedes, diplurans and cockroaches) were collected at the Tropicana Project (Ecologia 2009b,c, 2010). Studies in BIF at Koolyanobbing, Mount Jackson and Hunt Range, Mt Dimmer and Yendilberin Hills have documented either depauperate or modest troglofaunal communities, depending on site, that include species of isopods, millipedes, centipedes, spiders, silverfish, beetles, symphylans, cockroaches, pauropods, bristletails and bugs (hemipterans) (Bennelongia 2008a,b, 2009a,b).

4.2.2.1. Troglofauna in the Vicinity of the Project

At least 15 species of troglofauna have been collected in the Search Area (Table 4.1). This includes one species of spider, four species of isopod, four species of myriapods and five insect species (Table 4.1). Four of the species are currently known only from Jackson Range (*Buddelundia?* sp. B02, *Cryptops* [*Trigonocryptops*] sp. B03, *Myrtonymus* sp. B05 and Pselaphinae sp. B04) and one species is currently known only from the Windarling Range (*Trichorhina* sp. B04).

Table 4.1. Troglofauna species collected in the Project Search Area.

Taxonomic Rank	Location in Search Area	Other Occurrences/Known Range
Arachnida		
Araneae		
Araneomorphae (nr Gnaphosidae) sp. B04	Jackson Range	Koolyanobbing Range (Bennelongia 2008a)
Malacostraca		
Isopoda		
Buddelundia? sp. B02	Jackson Range	Only known from Jackson Range
Philosciidae (*Haloniscus*?) sp. B04	Jackson Range	Koolyanobbing Range (Bennelongia 2008a)
Trichorhina sp. B02	Jackson Range	Koolyanobbing Range (Bennelongia 2008a)
Trichorhina sp. B04	Windarling Range	Only known from Windarling Range
Chilopoda		
Geophilomorpha		
Chilenophilidae sp. B01	Jackson Range	Hunt Range (Bennelongia 2009b)
Scolopendromorpha		
Cryptops (*Trigonocryptops*) sp. B03	Jackson Range	Only known from Jackson Range
Diplopoda		
Polyxenida		
Lophoproctidae sp. B01	Jackson Range and Windarling Range	Koolyanobbing Range (Bennelongia 2008a)
Pauropoda		
Pauropodina		
Pauropodidae sp. B08	Jackson Range	Lake Giles (Rockwater 2012)
Symphyla		
Cephalostigmata		
Hanseniella sp. B03	Jackson Range	Koolyanobbing Range (Bennelongia 2008a)
Insecta		
Thysanura		

Taxonomic Rank	Location in Search Area	Other Occurrences/Known Range
Hemitrinemura sp. B02	Jackson Range	Koolyanobbing Range (Bennelongia 2008a)
Hemiptera		
Meenoplidae sp.	Windarling Range	Immature specimen, very likely to be the same species that occurs at Koolyanobbing and Hunt ranges (Bennelongia 2008a, 2009a,b)
Coleoptera		
Curculionidae Genus 2 sp. B04	Jackson Range	Koolyanobbing Range (Bennelongia 2008a)
Myrtonymus sp. B05	Jackson Range	Only known from Jackson Range
Pselaphinae sp. B04	Jackson Range	Only known from Jackson Range

5. CONCLUSION AND RECOMMENDATIONS

Threats to the conservation of subterranean fauna from mining Marda Gold Project are related to both the likelihood of conservation significant subterranean fauna occurring and the spatial extent of predicted impacts from mining, relative to the distributions of restricted subterranean species.

5.1. Stygofauna

Information about the likelihood of stygofauna occurring within the Project and the possible threat to such communities suggests that there is little conservation threat to stygofauna species as a result of the project development for the following reasons:

1. No records of stygofauna were found within the Search Area around the Project;
2. Stygofauna communities in similar lithologies at neighbouring mine sites outside the Search Area are also depauperate;
3. The few stygofauna species collected at the neighbouring mine sites do not have tightly restricted distributions;
4. Mine operations will not impact calcrete or any other habitat type in which diverse subterranean communities have been recorded in the Yilgarn; and
5. The areas that may be potentially impacted by groundwater drawdown are significantly smaller than both the area of continuous subterranean habitat and the likely ranges of stygofauna species that may occur in the vicinity.

It is recommended that no subterranean surveys are required at for the purpose of environmental impact assessment of stygofauna.

5.2. Troglofauna

Information about the likelihood of troglofauna occurring within the Project area suggested it was likely that a troglofauna community of low or moderate species richness exists at the Project. It is also likely that some of the species present will have localised distributions, as a number of species recorded within the Search Area are restricted to single ranges.

Despite the potential for species with localised distributions occurring in the Project area, it is considered highly unlikely mining will threaten the persistence of any species because of the small size of the proposed mine pits. Their total area is 26 ha, with the individual pits ranging in size from approximately 1.5 to 11 ha. Troglofauna surveys of fractured rock habitats in Western Australia indicate that pits of this size are unlikely to threaten troglofauna species. The most comprehensive study of troglofauna ranges in the Western Australia has been for schizomids of the Robe Valley mesas, where the smallest recorded range was approximately 89 ha (Biota 2006; Harvey *et al*. 2008). The mesas are geologically very isolated, unlike the geology of the Project area. Given the relatively uniform Project area geology, it is most unlikely that species in the Project area have ranges almost two orders of magnitude smaller than schizomids in the Robe Valley.

While recognizing that subterranean fauna may be present in the Project area, given the low level of threat associated with such small mine pits, it is considered that no subterranean survey is required for the purpose of environmental impact assessment.

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7. APPENDICES

7.1.1. Appendix 1: Secondary Impacts of Mining on Subterranean Fauna.

De-watering below Troglofauna Habitat

The impact of a lowered watertable on subterranean humidity and, therefore, the quality of troglofauna habitat is poorly studied, but it may represent risk to troglofauna species in some cases. The extent to which humidity of the vadose zone is affected by depth to the watertable is unclear. Given that pockets of residual water probably remain trapped throughout de-watered areas and keep the overlying substrate saturated with water vapour, de-watering may have minimal impact on the humidity in the unsaturated zone. In addition, troglofauna may be able to avoid undesirable effects of a habitat drying out by moving deeper into the substrate if suitable habitat exists at depth. Overall, de-watering outside the proposed mine pits is not considered to be a significant risk to troglofauna.

Percussion from Blasting

Impacts on both stygofauna and troglofauna may occur through the physical effect of explosions. Blasting may also have indirect detrimental effects through altering underground structure (usually rock fragmentation and collapse of voids) and transient increases in groundwater turbidity. The effects of blasting are often referred to in grey literature but are poorly quantified and have not been related to ecological impacts. Any effects of blasting are likely to dissipate rapidly with distance from the pit and are not considered to be a significant threats to either stygofauna or troglofauna outside the proposed mine pits.

Overburden Stockpiles and Waste Dumps

These artificial landforms may cause localised reduction in rainfall recharge and associated entry of dissolved organic matter and nutrients because water runs off stockpiles rather than infiltrating through them and into the underlying ground. The effects of reduced carbon and nutrient input are likely to be expressed over many years and are likely to be greater for troglofauna than stygofauna (because lateral movement of groundwater should bring in carbon and nutrients). The extent of impacts on troglofauna will largely depend on the importance of chemoautotrophy in driving the subterranean system compared with infiltration-transported surface energy and nutrients. Stockpiles are unlikely to cause species extinctions, although population densities of species may decrease.

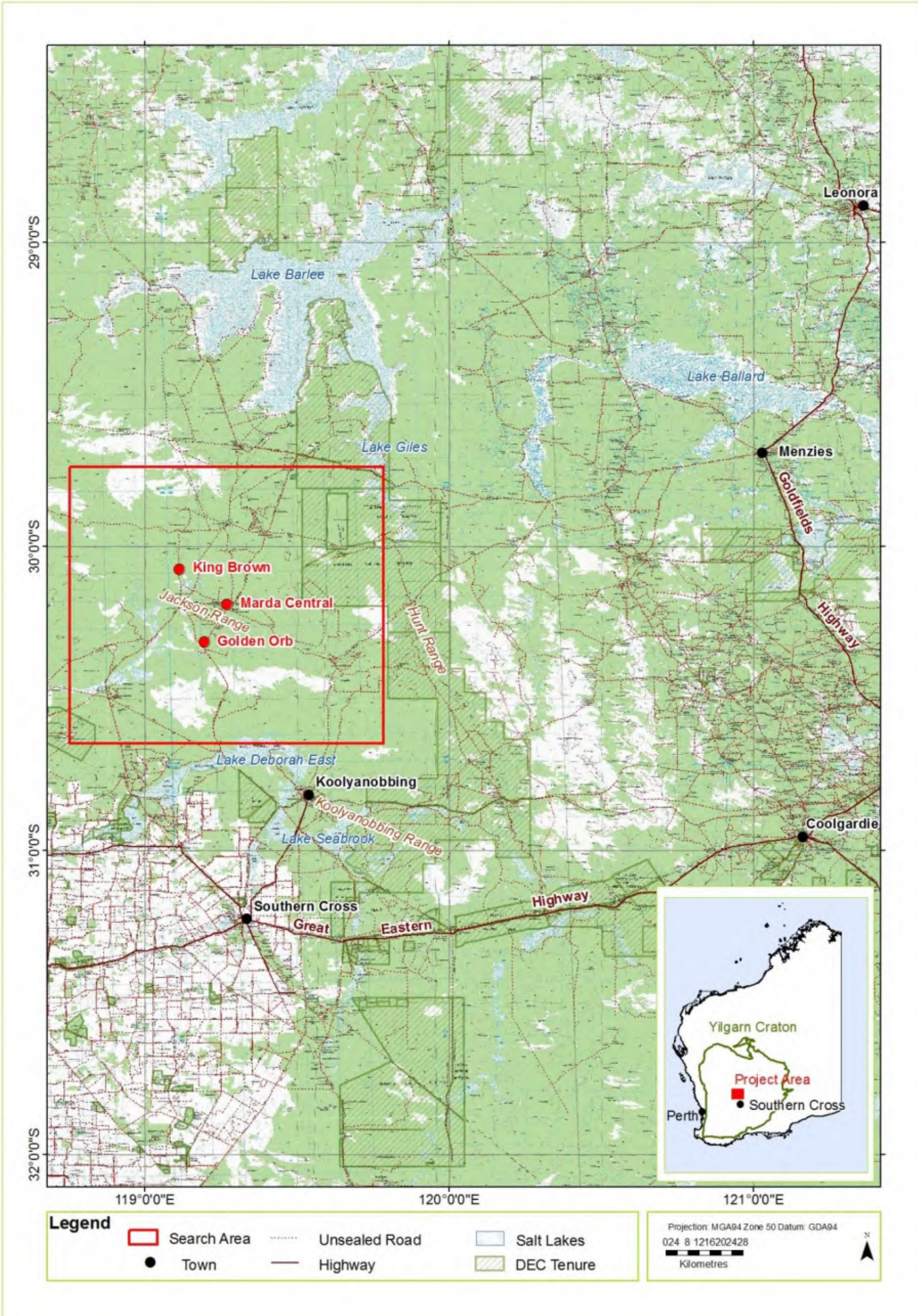
Aquifer Recharge with Poor Quality Water

Quality of recharge water declines during, and after, mining operations as a result of rock break up and soil disturbance (i.e. Gajowiec 1993; McAuley and Kozar 2006). Impacts can be minimised through management of surface water and installing drainage channels, sumps and pump in pits to prevent of recharge though the pit floor.

Contamination of Groundwater by Hydrocarbons

Any contamination is likely to be localised and may be minimised by engineering and management practices to ensure containment.

7.1.2. Appendix 2. Project Search Area



Appendix K: Malleefowl Management Plan

Marda Central and Die Hardy Gold Projects

Malleefowl Management Plan

M77/394, M77/646, M77/931, M77/962, L77/239 and L77/240

M77/1272 and L77/261

Document Control

Revision	Date	Author	Initials	Reviewer	Initials
Rev 0; Ver 1	1 January 2014	Bioscope	Bioscope	SXG	SXG
Rev 1; Ver 1	20 October 2021	Glenn Firth	GF	Duncan Coutts	DC

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1. BACKGROUND AND OBJECTIVE

As a fully-owned subsidiary of Ramelius Resources Limited (RMS), Marda Operations Pty Ltd (MOPL) operates the Marda Gold Project and is proposing a new project at Die Hardy. The project sites are located 425 km east of Perth, Western Australia, and approximately 120 km north of the town of Southern Cross. The Marda Project location is shown in Figure 1 and the Die Hardy Project in Figure 2. The project tenements (M77/394, M77/646, M77/931, M77/962, L77/239, L77/240, M77/1272 and L77/261) were originally owned by Southern Cross Goldfields (SXG). The first version of this Malleefowl Management Plan (Rev 0 Ver 1) was approved in 2014 as part of the Marda Central Mining Proposal. The same Plan was adopted by RMS for the 2019 Mining Proposal when RMS took ownership of the project tenements. The first version of this Malleefowl Management Plan was approved for use by MOPL to implement the Marda Central mining plan. Rev 1 Ver 1 is now the latest update to the Malleefowl Management Plan to include the proposed satellite pit at Die Hardy.

The Marda Gold Project comprises three mining areas; Marda Central, Golden Orb and King Brown, and a proposed new satellite pit called Die Hardy, approximately 30km north of Marda Central. Gold ore mined from the deposits are trucked to the Edna May mine site at Westonia for processing.

This management plan is outlines how potential environmental risks to Malleefowl as a result of the operations are addressed.

The Malleefowl (*Leipoa ocellata*) (Plate 1) is a bird listed under Federal legislation as Vulnerable and under State legislation as "*rare or ..... likely to become extinct*". The Malleefowl is recognised as an important endangered species in need of national conservation efforts, and a National Malleefowl Recovery Plan has been prepared (Benshemesh, 2001).

Malleefowl have been recorded in the vicinity of MOPL's mining and exploration target areas in the region.

Plate 1: Adult Malleefowl (photo taken by Dick Walker, Malleefowl Preservation Group).

The Malleefowl Management Plan has five key objectives. These are to:

- avoid and minimise impacts to Malleefowl from the Gold Projects;
- continue to identify, monitor and record Malleefowl activity within MOPL' project areas;
- monitor for any impacts on Malleefowl arising from MOPL's activities and ensure those impacts are managed;
- contribute to the conservation of Malleefowl by sharing data obtained with relevant stakeholders;
- continue to support introduced predator control; and
- continue to liaise with community groups and other stakeholders with specific interests in Malleefowl.

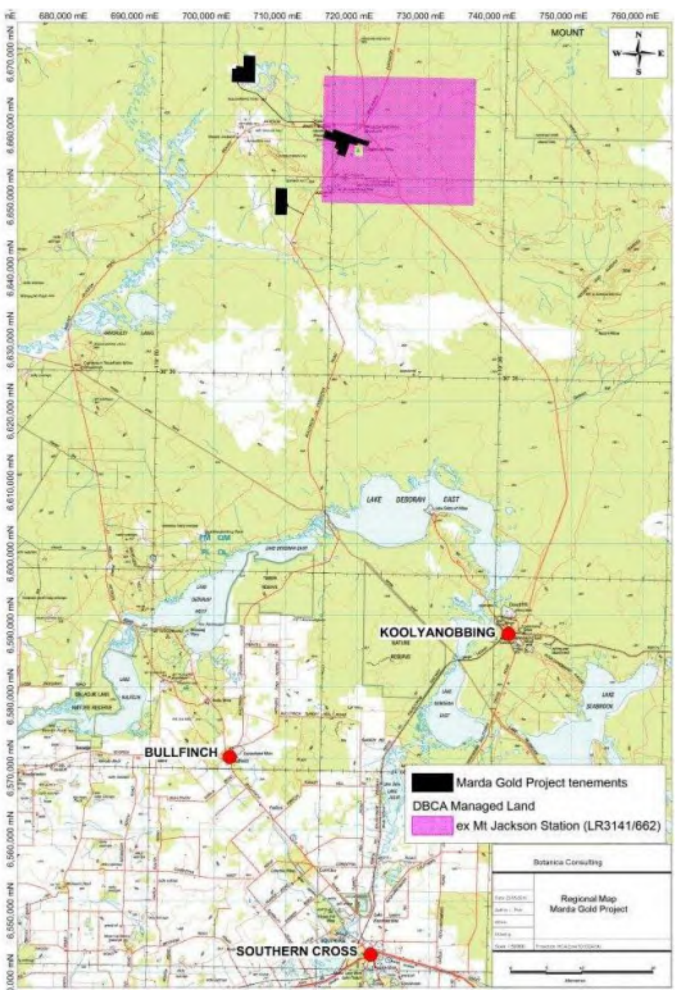


Figure 1: Marda Gold Project – Regional Location

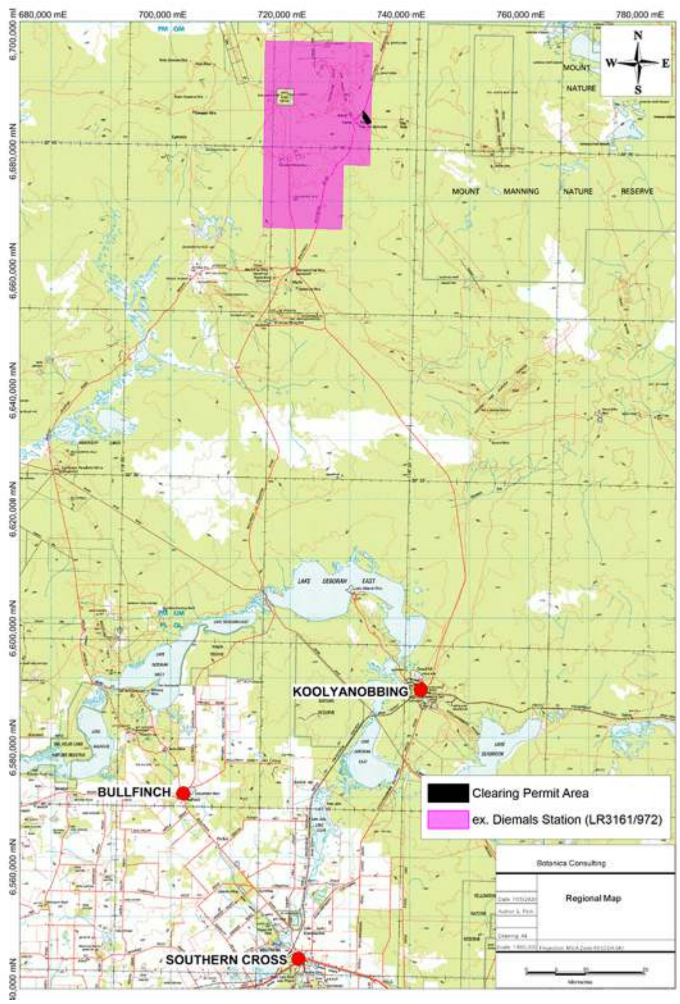


Figure 2: Die Hardy Gold Project – Regional Location

2. ABOUT THE MALLEEFOWL

2.1 ECOLOGY

Malleefowl belong to the family Megapodiidae, the megapodes or mound builders. The group is unique amongst birds in that its members use external sources of heat to incubate their eggs (Clark, 1964). The Malleefowl is the most southerly distributed of the three species of megapode that occur in Australia. It is restricted to the mainland and differs from all other extant megapodes in that it inhabits semi-arid and arid regions rather than damp forests. These dry regions are less conducive to the incubation methods employed by megapodes (Frith 1956a), and the Malleefowl has developed the most sophisticated and elaborate technique of incubation in the family (see Frith 1955, Frith 1956b, Frith 1959, Frith 1962b).

The adult Malleefowl is a large bird, growing to a height of 55 to 61 cm and weighing up to 1.5 kg. Malleefowl build mounds that utilise heat from the sun and composting vegetation to incubate eggs.

Most heat is generated from composting leaf litter with solar energy utilised later in the season (summer). Malleefowl mounds may be used over many generations and can attain an impressive size of 22 m in circumference and over one metre high. Malleefowl generally live as a pair and both sexes help to build the mound. However, once built, it is the male that maintains the mound at a constant temperature. Young usually hatch (an average of 18 eggs are laid each season) between November and January and are quite independent from their parents once they emerge from the mound.

Malleefowl feed opportunistically on insects, seeds (acacia species are a favourite), native herbs and flowers and are known to drink readily in captivity but thrive in natural bushland during summer without surface water. They have an average life span of 25-30 years and require large, long-unburnt blocks of mallee or other vegetation providing suitable habitat to survive.

More detailed information about the biology and ecology of Malleefowl can be found in the National Recovery Plan (Benshemesh, 2001) and from the WA Malleefowl Recovery Group.

Since European settlement of Australia, Malleefowl populations have been in decline (see Figure 3). This decline is believed to be due to:

- predation by feral animals such as cats and foxes;
- competition from feral herbivores, such as rabbits and goats; and
- habitat destruction/degradation and change in fire regimes (Benshemesh, 2000).

2.2 CONSERVATION STATUS

The Malleefowl is a threatened species under State and Commonwealth legislation. In Western Australia the species is listed as Vulnerable fauna under the *Biodiversity Conservation Act 2016*. Nationally it is also listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and internationally is on the IUCN Red List of Threatened Species as Vulnerable. In Western Australia, Malleefowl occur mainly in scrubs and thickets of Mallee (*Eucalyptus* spp.), Boree (*Melaleuca lanceolata*) and Bowgada (*Acacia linophylla*), and also other dense, litter-forming shrublands including Mulga (*Acacia aneura*) Shrublands. Nesting is typically restricted to dense shrublands (which provide protection and nesting material) on a range of substrates (such as sand, loam and gravel) while heavy (clayey) soils are avoided. Malleefowl will however forage in open areas adjacent to nesting habitat (Open Eucalypt Woodlands, grasslands, crop fields and around roads). (Bamford, 2013)

The species' distribution was once larger and less fragmented, but the widespread clearing of suitable habitat, coupled with the degradation of habitat by fire and livestock, and fox predation, have reduced Malleefowl numbers considerably (Bamford, 2013).

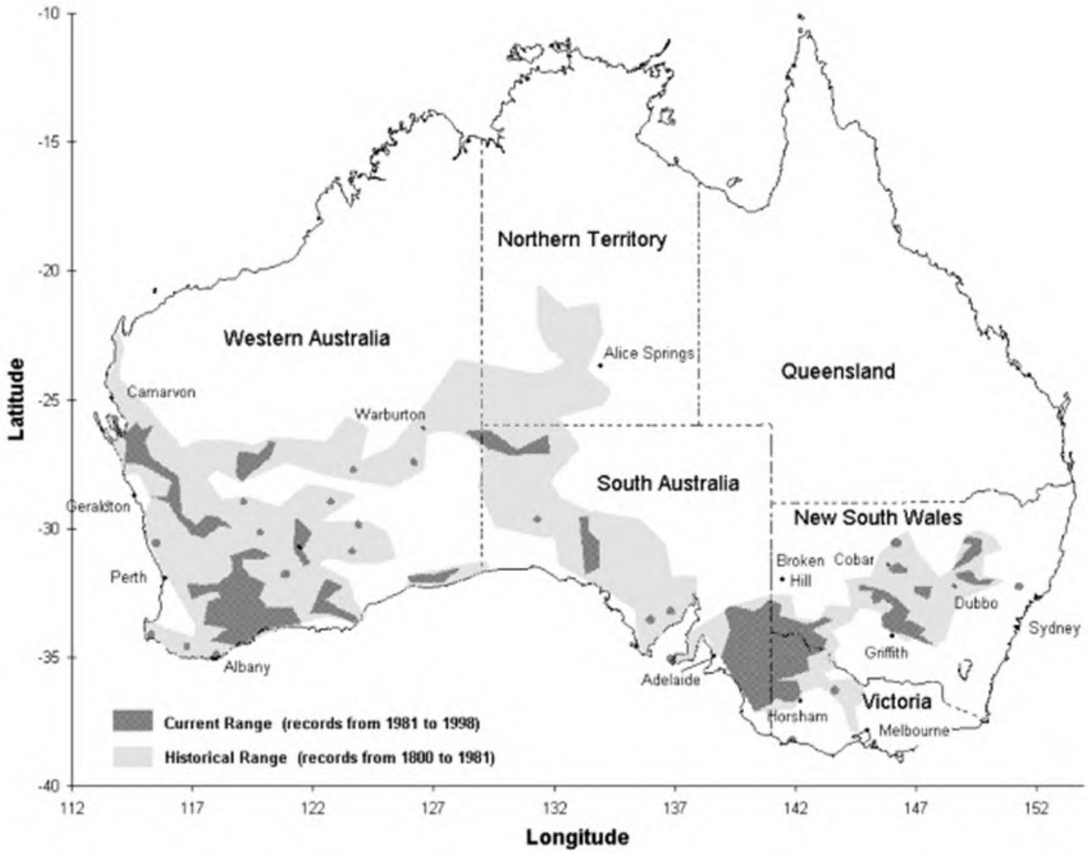


Figure 3: Malleefowl – current and historical ranges (from Benshemesh, 2001).

2.3 OCCURRENCE OF MALLEEFOWL AT MARDA AND DIE HARDY GOLD PROJECTS

Although there have been no confirmed sightings of Malleefowl during exploration or mining activities on the Marda Central Project tenements (Marda Central, Golden Orb or King Brown), it is likely that Malleefowl are present and utilise these three areas for foraging and roosting. A recent survey in October 2020 found that there is substantial suitable breeding habitat for Malleefowl within each of the areas investigated (Biostat, 2020). Six mounds were located during this survey in addition to mounds identified during the 2012 and 2008 surveys. An inactive mound is known from surveys conducted at the Die Hardy project (Botanica Consulting, 2019).

Projects in the near vicinity (Mt Jackson Iron Ore Project) have conducted surveys over a few years and have a reasonable collection of data for sightings and nest locations on and around the Mt Jackson range (Bamford 2008, 2009).

Bamford (2013) discusses the findings of surveys on all the areas included in the Project and concludes:

"All evidence of Malleefowl was recorded in vegetation considered to be suitable breeding habitat, that is, within dense shrublands on a gravelly/rocky substrate. Three Malleefowl mounds were recorded within the Marda Project tenements from dense shrublands containing mixed Acacia species and dense *Allocasuarina* sp. During previous surveys BCE has found mounds are concentrated on the slopes of hills, in gravelly loam soils where the vegetation consists of a dense tall shrubland (BCE, 2008). As expected, mounds were not found on heavy clay soils, such as within Eucalypt Woodland (heavy clay soils are not favoured for breeding, probably because they are difficult to work).

Although only three long-inactive mounds were found, they were inconspicuous and therefore some other inactive mounds may have been overlooked. The possibility of an active mound having been missed also exists, although searching of suitable habitat was extensive. Furthermore, even long-inactive mounds can become active, as a male bird will have several mounds within its territory but will only use one in any one year (Malleefowl Preservation Group 2012), and the presence of a feather in Marda Central indicates that the species is present even if not currently using the site for breeding.

Within the three tenements, approximately 400 ha of habitat suitable for mound construction were identified. However, much of this lies outside impact areas. The proposed King Brown pit and most of the proposed Marda pits lie within Eucalypt Woodland and outside of Malleefowl breeding habitat. The proposed pit at Golden Orb (approximately 6ha) does occur within Malleefowl breeding habitat. The home range of a male Malleefowl is in the order of 1 km^2, and thus the breeding habitat in Golden Orb represents about 6% of the home range of a single male (and contains a single long-inactive mound).

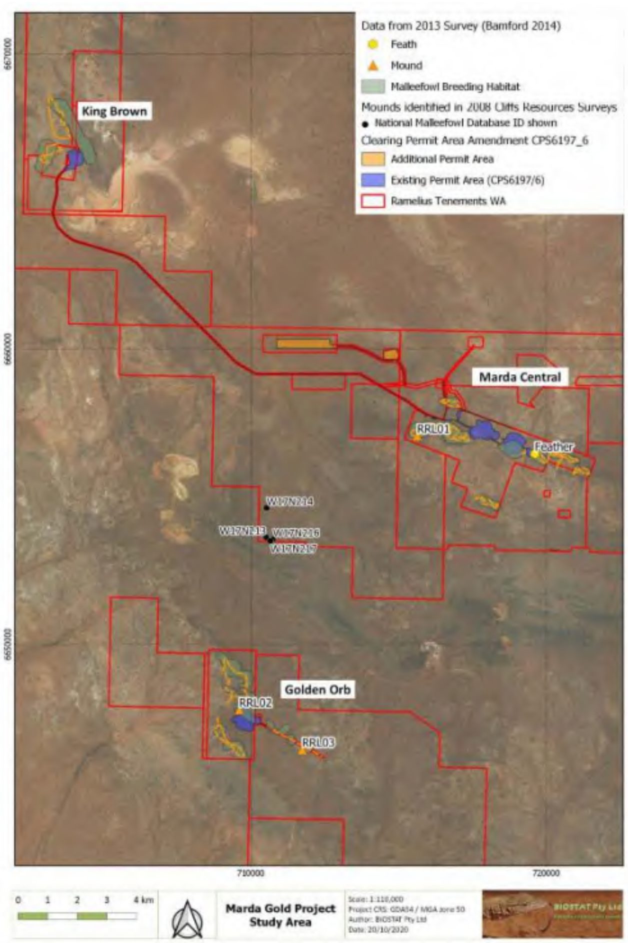
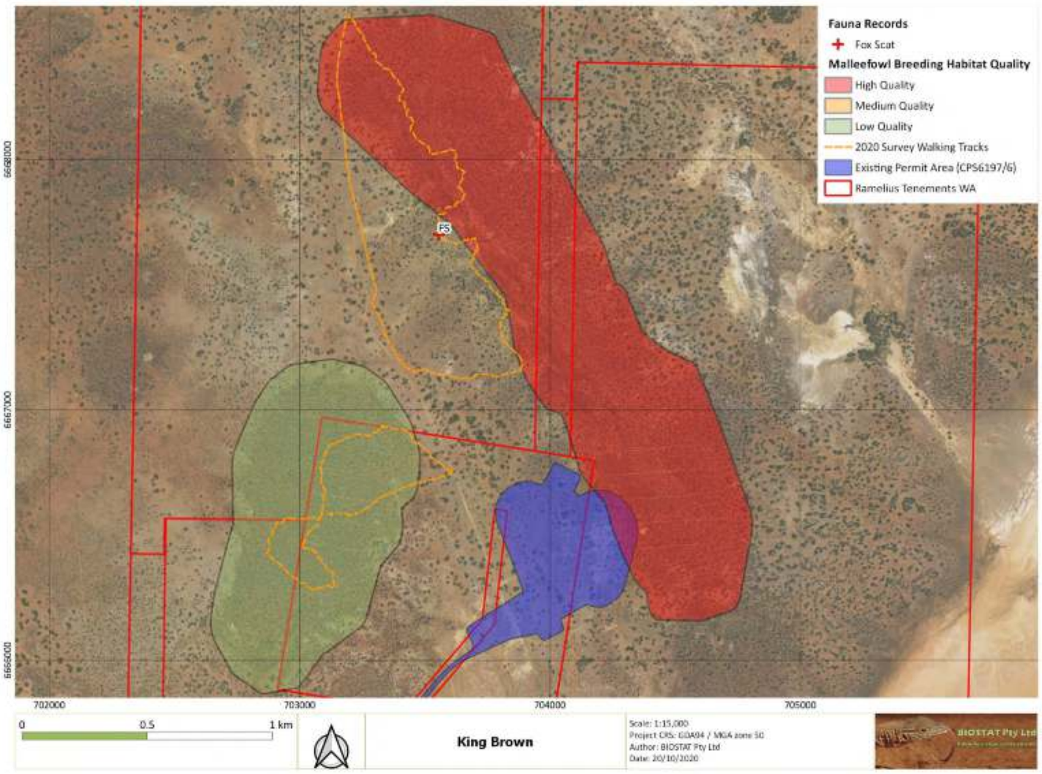
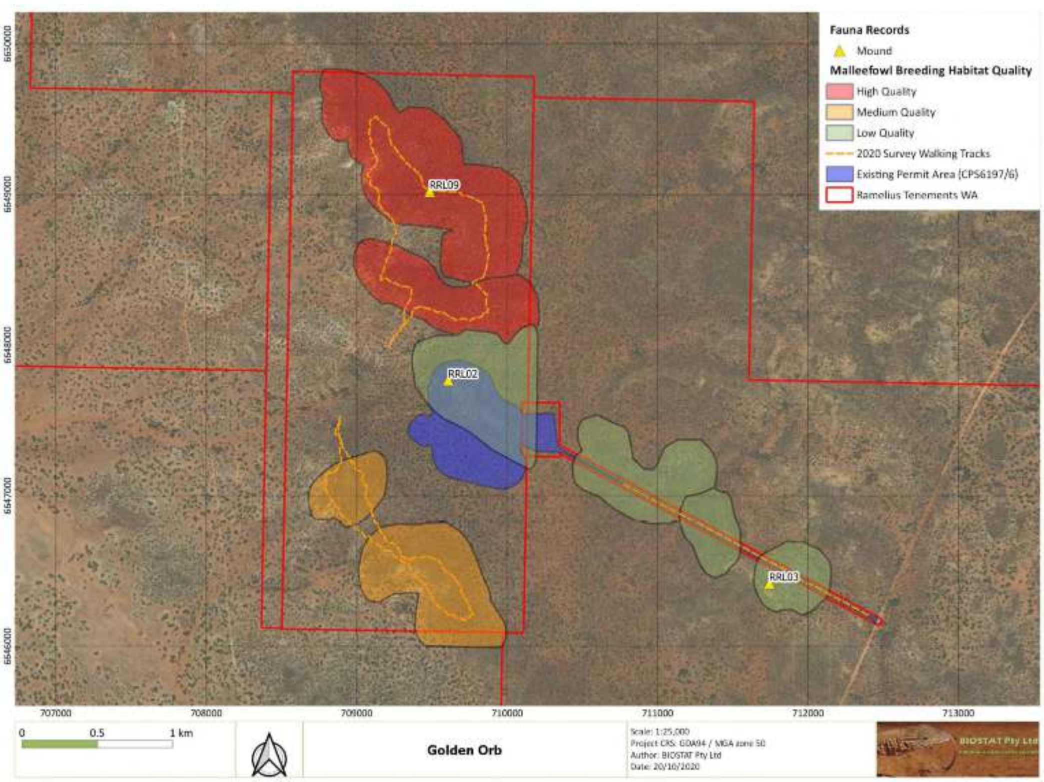


Figure 4: Area surveyed for Malleefowl at Marda Gold Project (2008 and 2014).


Fauna Records
Fox Scat
Malleefowl Breeding Habitat Quality
High Quality
Medium Quality
Low Quality
2020 Survey Walking Tracks
Existing Permit Area (CPS6197/6)
Ramelius Tenements WA
F5
6668000
6667000
6666000
702000
703000
704000
705000
0
0.5
1 km
King Brown
Scale: 1:15,000
Project CRS: GDA94 / MGA zone 50
Author: BIOSTAT Pty Ltd
Date: 20/10/2020
BIOSTAT Pty Ltd


Fauna Records
Mound
Malleefowl Breeding Habitat Quality
High Quality
Medium Quality
Low Quality
2020 Survey Walking Tracks
Existing Permit Area (CPS6197/6)
Ramelius Tenements WA
RRL09
RRL02
RRL03
6650000
6649000
6648000
6647000
6646000
707000
708000
709000
710000
711000
712000
713000
0
0.5
1 km
Golden Orb
Scale: 1:25,000
Project CRS: GDA94 / MGA zone 50
Author: BIOSTAT Pty Ltd
Date: 20/10/2020
BIOSTAT Pty Ltd

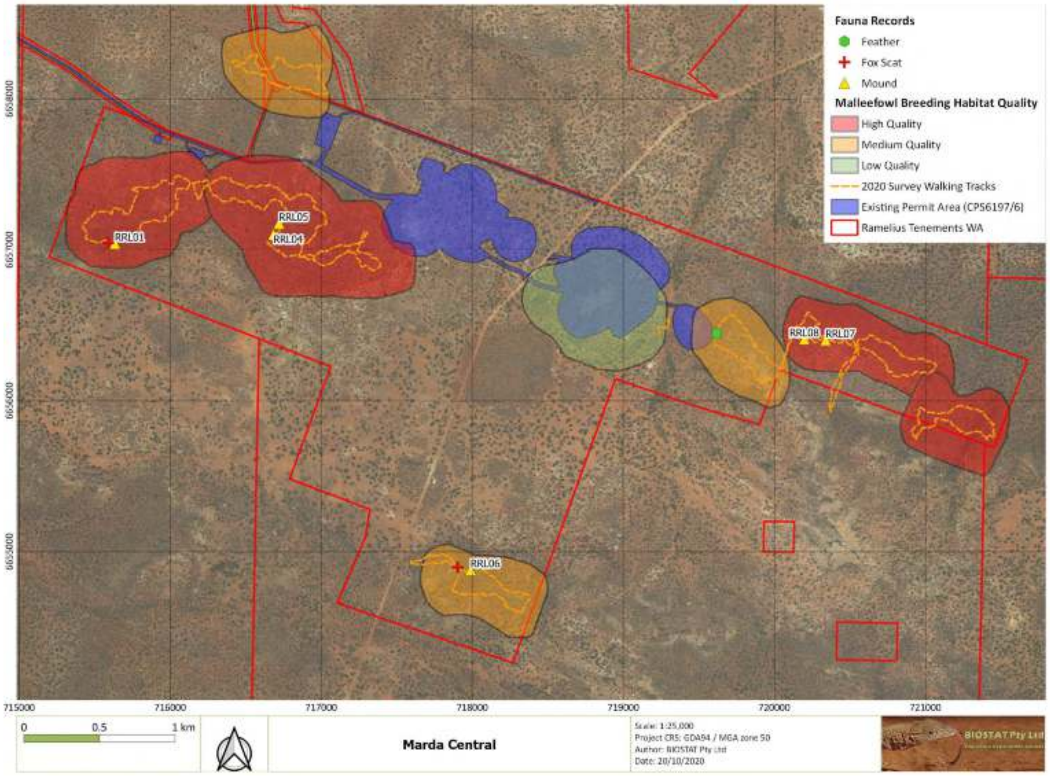


Figure 5: Areas surveyed for Malleefowl at Marda Gold Project (Biostat, 2020)

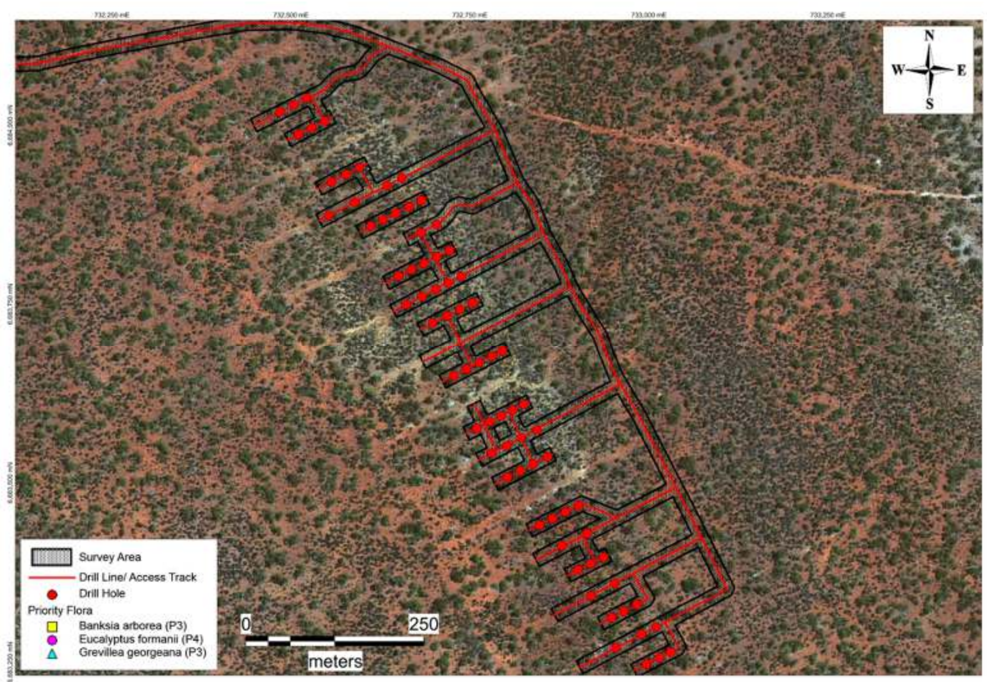


Figure 6: Area surveyed for Malleefowl at Die Hardy Gold Project (Botanica, 2019)

3. REGULATORY REQUIREMENTS, STANDARDS AND CONSULTATION

The WA *Biodiversity Conservation Act 2016* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* place an obligation on MOPL to protect the Malleefowl. The original 2014 Malleefowl Management Plan was developed in consultation with then Department of Parks and Wildlife (DPaW) as well as with representatives from stakeholder groups, including the then Malleefowl Preservation Group. MOPL has updated the Plan in 2021 to direct its activities with regard to the protection of the Malleefowl. MOPL will continue to liaise with the Department of Biodiversity, Conservation and Attractions (DBCA) and the WA Malleefowl Recovery Group, as required.

MOPL ensure that that this Plan addressed:

- distribution and abundance of the Malleefowl *Leipoa ocellata* around the site(s), including within the transport corridor and adjacent areas within which Malleefowl may be impacted;
- threats to the Malleefowl population from the Marda Gold Project inclusive of the Die Hardy satellite project;
- management objectives, strategy and actions (*e.g.*, baiting); and
- community involvement in Malleefowl conservation.

4. POTENTIAL IMPACTS

As outlined in Section 2.0, widespread vegetation clearance in agricultural areas has eliminated and fragmented much of the Malleefowl habitat, resulting in localised extinctions and fragmented populations (see Figure 3).

Within the Goldfields region, populations exist in suboptimal habitat with rainfall at the lower end of the range over which Malleefowl historically occurred. Any further clearing of native vegetation associated with Malleefowl can disperse any local populations.

The Marda Gold Project and Die Hardy Project will clear an area of approximately 300 ha. No Malleefowl were sighted during the several surveys conducted in 2008, 2004, 2019 and 2020.

No active (current use) or recently active (1-5 years) Malleefowl mounds were recorded within any of the project tenements surveys. Four old, inactive Malleefowl mounds were observed within the survey areas over this time. One historical mound was located in the Marda Central tenement and one historical mound in the Golden Orb tenement with a third historical mound along the Golden Orb Haul Road alignment. Additionally, a Malleefowl feather was recorded from the Marda Central tenement indicating the species moves through and utilises habitat within the tenement. It is expected that the vegetation clearing at the Marda Gold Project and Die Hardy Project will not impact on any existing populations.

Other than clearing, there are other major threats to Malleefowl (Table 1).

Table 1: Major Threats to Malleefowl (other than Clearing)

Threat	Description
Fire, particularly where extensive	Depending on vegetation type, the leaf litter required for mound building may take from 20 to 40 years to build up sufficiently for successful mound construction and breeding. Populations of the birds may suddenly be eliminated from areas that are burnt, and even if there are nearby sources of recruitment, recovery in the burnt area to breeding densities before the fire appears to be very slow and require 30 to 60 years.
Predation	Foxes prey upon Malleefowl eggs and birds of all ages and are likely to be a major threat to the conservation of the species. Feral dogs, dingos and cats are also likely to be predators of these birds. Predator control can have 'side effects', such as an increase in cat populations following dog baiting.
Vehicles	Malleefowl are particularly susceptible to road deaths as they have no 'road sense', and are slow moving, predominantly ground-dwelling animals. An increase in road deaths is possible where new roads are constructed or an increase in traffic levels occurs.
Grazing	The presence of goats and rabbits are likely to reduce the vegetation available to Malleefowl.

5. MANAGEMENT ACTIONS

MOPL will undertake the management actions outlined in Table 2.

Table 2: Impacts on Malleefowl – management actions

Management Actions	Timing	Responsibilities
Land Clearing		
1. Maintain a Ground Disturbance Permit system and related procedures that ensure no clearing of Active Malleefowl Mounds occurs without the necessary. If a Malleefowl mound is identified consultation with DBCA (Goldfields) will occur prior to clearing.	Ongoing and during construction and operations	Mine Manager
Fire		
2. Maintain a Bush Fire Management Plan and related procedures aimed at minimising the potential for unplanned fires and the provision of assistance for bush fire control.	Ongoing	Emergency Safety Officer
Predation		
3. In conjunction with the DBCA (Goldfields), plan and implement a predator control programme aimed at	As required	Group Environment Manager

Management Actions		Timing	Responsibilities
	reducing predator numbers in or near Malleefowl habitat that is close to operations		
4.	Conduct trapping for feral animals should they be observed in the vicinity of the camp, waste disposal facility, or other area managed by MOPL	As required	Group Environment Manager
5.	For the King Brown operations, ensure feral fauna control measures are implemented in accordance regulatory requirements	Annually	Group Environment Manager
6.	Maintain vehicle speed restrictions in and around known Malleefowl habitat	Ongoing	Mine Manager Emergency Safety Officer
7.	Maintain warning signs and restrict off-road vehicle usage in and around known Malleefowl habitat	Ongoing	Mine Manager Emergency Safety Officer
Education			
8.	Maintain a component on Malleefowl within the environmental induction and provide other training and educational materials or activities on a regular basis	Ongoing	Emergency Safety Officer Group Environment Manager
Surveys			
9.	In consultation with the DBCA and community stakeholders, such as the WA Malleefowl Recovery Group, develop and implement a Malleefowl survey programme aimed at improving regional knowledge and management	As required	Group Environment Manager
10.	Ensure monitoring of any located Malleefowl mounds is conducted in accordance with regulators requirements	Annually	Group Environment Manager
11.	Develop processes for the preservation of significant Malleefowl material for expert analysis	As required	Group Environment Manager
Reporting			
12.	Report all Malleefowl-related activities (*e.g.*, survey results, sightings *etc.*) to DBCA	Annually or otherwise as agreed.	Group Environment Manager
13.	Maintain a register of active and inactive mound locations	Ongoing	Group Environment Manager

Management Actions	Timing	Responsibilities
14. Report survey results to the National Malleefowl Recovery Plan Co-ordinator	Annually	Group Environment Manager
Contingency measures		
15. In the event that performance indicators are not being met, implement contingency measures in consultation with the DBCA	As required	Group Environment Manager
16. Obtain a licence under Section 40 of the *Biodiversity Conservation Act 2016* to authorise disturbance of mounds for monitoring. This is an annual licence with reporting requirements.	If needed	Group Environment Manager

6. MONITORING

Monitoring of Malleefowl occurs through annual mound surveys, general fauna surveys and through opportunistic observations.

7. PERFORMANCE INDICATORS

Table 3: Performance Indicators

	Indicator	Target
1.	Number of Malleefowl roadkill's from Project vehicles	Nil
2.	Disturbance of active mounds by Project activities	Nil
3.	Increase in feral animal populations as a consequence of MOPL' operations	Nil
4.	Abundance of Malleefowl in the vicinity of the MOPL' operations	No decrease as a result of MOPL's presence

8. RECORDS AND REPORTING

A summary of the outcome of Malleefowl surveys and related activities, such as predator control, will be presented within the Annual Environmental Report (AER) and copied to DBCA.

An audit of performance against the requirements of this plan will be undertaken by MOPL every three years.

9. REVIEW

Unless there are material changes to the Projects, or reporting indicates that the aims of the Plan are not being met, the Plan will be revised in 2022 (three years since 2019 Plan was approved for use and coinciding with the first triennial audit of the Plan). Any revisions to this Plan will include consultation with DBCA.

10. REFERENCES

Bamford Consulting Ecologists (2008) Review of Investigations into the Malleefowl Leipoa ocellata in the Mt Jackson area. 30 July 2008.

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Attachment 5
Native Vegetation Clearing Permit

GOVERNMENT OF
WESTERN AUSTRALIA

CLEARING PERMIT

Granted under section 51E of the Environmental Protection Act 1986

Purpose Permit number:	8931/1
Duration of Permit:	From 22 August 2020 to 21 August 2025
Permit Holder:	Marda Operations Pty Ltd

The Permit Holder is authorised to clear native vegetation subject to the following conditions of this Permit.

PART I - CLEARING AUTHORISED

1. **Land on which clearing is to be done**
   Mining Lease 77/1272
   Miscellaneous Licence 77/261

2. **Purpose for which clearing may be done**
   Clearing for the purposes of mineral production and associated activities.

3. **Area of Clearing**
   The Permit Holder must not clear more than 90 hectares of native vegetation. All clearing must be within the areas cross-hatched yellow on attached Plan 8931/1.

4. **Type of Clearing Authorised – staged clearing**
   The Permit Holder shall not clear native vegetation unless the purpose for which the clearing is authorised is enacted within six months of the authorised clearing being undertaken.

5. **Application**
   This Permit allows the Permit Holder to authorise persons, including employees, contractors and agents of the Permit Holder, to clear native vegetation for the purposes of this Permit subject to compliance with the conditions of this Permit and approval from the Permit Holder.

PART II - MANAGEMENT CONDITIONS

6. **Avoid, minimise and reduce the impacts and extent of clearing**
   In determining the amount of native vegetation to be cleared authorised under this Permit, the Permit Holder must have regard to the following principles, set out in order of preference:

   (a) avoid the clearing of native vegetation;
   (b) minimise the amount of native vegetation to be cleared; and
   (c) reduce the impact of clearing on any environmental value.

7. Weed control

When undertaking any clearing or other activity authorised under this Permit, the Permit Holder must take the following steps to minimise the risk of the introduction and spread of *weeds*:

(i) clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared;
(ii) ensure that no *weed*-affected soil, *mulch, fill* or other material is brought into the area to be cleared; and
(iii) restrict the movement of machines and other vehicles to the limits of the areas to be cleared.

8. Fauna Management - Malleefowl

Where clearing authorised under this Permit is to occur between 1 September and 31 January, the Permit Holder shall:

(a) Within two weeks prior to undertaking any clearing, engage an *environmental specialist* to conduct an inspection of the area to be cleared to identify *active (in use) Malleefowl (Leipoa ocellata) mounds.*

(b) Where an *active (in use) Malleefowl mound* is identified pursuant to Condition 8(a) of this Permit, the Permit Holder shall ensure that no clearing occurs within 50 metres of the mound, during the months of September through to January, unless first approved by the *CEO.*

PART III - RECORD KEEPING AND REPORTING

9. Records to be kept

The Permit Holder must maintain the following records for activities done pursuant to this Permit:

(a) In relation to the clearing of native vegetation authorised under this Permit:

(i) the location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;
(ii) the date that the area was cleared;
(iii) the size of the area cleared (in hectares); and
(iv) purpose for which clearing was undertaken.

(b) actions taken to avoid, minimise and reduce the impacts and the extent of clearing in accordance with Condition 6 of this Permit; and

(c) actions taken to minimise the introduction and spread of *weeds* in accordance with Condition 7 of this Permit.

(d) In relation to fauna management pursuant to Condition 8 of this Permit, the location of each *Leipoa ocellata* (Malleefowl) mound recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees.

10. Reporting

(a) The Permit Holder shall provide a report to the *CEO* by 31 July each year for the life of this Permit, demonstrating adherence to all conditions of this Permit, and setting out the records required under Condition 9 of this Permit in relation to clearing carried out between 1 July and 30 June of the previous financial year.

(b) Prior to 21 August 2025, the Permit Holder must provide to the *CEO* a written report of records required under Condition 9 of this Permit where these records have not already been provided under Condition 10(a) of this Permit.

DEFINITIONS
The following meanings are given to terms used in this Permit:

active (in use) Malleefowl mound means a mound with evidence of current Malleefowl (*Leipoa ocellata*) activity, such as: working of the mound; scratching; litter trails leading to the mound; or loose uncompacted surfaces. The form and structure of the mound will show that it is currently being prepared for egg laying or it already contains eggs;

CEO means the Chief Executive Officer of the Department responsible for administering the clearing provisions contained within the *Environmental Protection Act 1986* or an Officer with delegated authority under Section 20 of the *Environmental Protection Act 1986;*

environmental specialist means a person who holds a tertiary qualification in environmental science or equivalent, and has experience relevant to the type of environmental advice that an environmental specialist is required to provide under this Permit, or who is approved by the *CEO* as a suitable environmental specialist;

fill means material used to increase the ground level, or fill a hollow;

mulch means the use of organic matter, wood chips or rocks to slow the movement of water across the soil surface and to reduce evaporation;

weed/s means any plant -
(a) that is a declared pest under section 22 of the *Biosecurity and Agriculture Management Act 2007*; or
(b) published in a Department of Biodiversity, Conservation and Attractions Regional Weed Rankings Summary, regardless of ranking; or
(c) not indigenous to the area concerned.

Dan Endacott
General Manager Environmental Compliance
Resource and Environmental Compliance Division
30 July 2020

Officer with delegated authority under Section 20
of the *Environmental Protection Act 1986*

Government of Western Australia
Department of Mines, Industry Regulation and Safety

Clearing Permit Decision Report

1. Application details

1.1. Permit application details

Permit application No.:	8931/1
Permit type:	Purpose Permit

1.2. Proponent details

Proponent's name:	**Marda Operations Pty Ltd**

1.3. Property details

Property:	Mining Lease 77/1272 Miscellaneous Licence 77/261
Local Government Area:	Shire of Menzies Shire of Yilgarn
Colloquial name:	Die Hardy Gold Project

1.4. Application

Clearing Area (ha)	No. Trees	Method of Clearing	For the purpose of:
90		Mechanical Removal	Mineral Production and Associated Activities

1.5. Decision on application

Decision on Permit Application:	Grant
Decision Date:	30 July 2020

2. Site Information

2.1. Existing environment and information

2.1.1. Description of the native vegetation under application

Vegetation Description

The vegetation of the application area is broadly mapped as the following Beard vegetation associations:
19: Low woodland; mulga between sandridges;
141: Medium woodland; York gum, salmon gum & gimlet; and
202: Shrublands; mulga & *Acacia quadrimarginea* scrub (GIS Database).

A flora and vegetation survey was conducted over the application area by Western Botanical during October 2012 and November 2013. The following vegetation associations were recorded within the application area (Western Botanical, 2014):

1.1: *Acacia aneura* over *Baeckea elderiana* Shrubland.

2.1: *Eucalyptus corrugata*, *Eucalyptus oleosa* subsp. *oleosa*, and *Eucalyptus loxophleba* subsp. *lissophloia* with *Eucalyptus formanii* (P4) Low Woodland over *Acacia ramulosa* subsp. *ramulosa* over *Olearia muelleri*.

2.2: *Eucalyptus corrugata*, *Eucalyptus oleosa* subsp. *oleosa* Low Woodland over *Acacia ramulosa* subsp. *ramulosa*, *Acacia acuminata* over *Philotheca brucei* subsp. *brucei* and *Olearia muelleri*.

2.7: *Eucalyptus salmonophloia*, *Eucalyptus salubris* (Gimlet) Woodland over *Eremophila scoparia*, *Atriplex nummularia*, *Atriplex bunburyana*.

Clearing Description

Die Hardy Gold Project.
Marda Operations Pty Ltd proposes to clear up to 90 hectares of native vegetation within a boundary of approximately 101.805 hectares, for the purpose of mineral production and associated activities. The project is located approximately 140 kilometres north of Southern Cross, within the Shire of Menzies and the Shire of Yilgarn.

Vegetation Condition

Excellent: Vegetation structure intact; disturbance affecting individual species, weeds non-aggressive (Keighery, 1994).

To

Very Good: Vegetation structure altered; obvious signs of disturbance (Keighery, 1994).

Comment

The vegetation condition was derived from a vegetation survey conducted by Western Botanical (2014).

The proposed clearing is for an open pit, waste rock landform and topsoil stockpile.

3. Assessment of application against Clearing Principles

(a) Native vegetation should not be cleared if it comprises a high level of biological diversity.

Comments

Proposal is not likely to be at variance to this Principle

The clearing permit application area is located within the Southern Cross subregion of the Interim Biogeographic Regionalisation for Australia (IBRA) Coolgardie Bioregion (GIS Database). The Southern Cross subregion is characterised by gently undulating uplands dissected by broad valleys with bands of low greenstone hills. The subregion supports *Eucalyptus* woodlands, with endemic eucalypts occurring around salt lakes, low greenstone hills, valley alluvials and broads plains of calcareous earths. Salt lake surfaces support dwarf shrublands of samphire, while granite basement outcrops support swards of *Borya constricta*, with stands of *Acacia acuminata* and *Eucalyptus loxophleba* at mid-levels and Mallees and scrub-heaths on the uplands (CALM, 2002).

The application area falls on the northern edge of the area known as the Great Western Woodlands, which represents the largest and most intact eucalypt woodland remaining in southern Australia and is one of the best examples of its type in the world (DEC, 2010). The Great Western Woodlands covers a total area of approximately 16 million hectares, and is recognised for its flora and fauna species richness and high number of endemic flora species (DEC, 2010). However, at approximately 90 hectares in size, the clearing permit application area represents less than 0.01 percent of the area covered by the Great Western Woodlands, and the proposed clearing of 90 hectares is unlikely to have any significant impact on the conservation values of the Great Western Woodlands.

A level 2 flora and vegetation survey of the application area and surrounds was conducted by Western Botanical from 17 to 26 October 2012 and 5 to 12 November 2013 (Western Botanical, 2014). The vegetation of the application area was dominated by *Eucalyptus* woodlands with *Acacia* shrublands (Western Botanical, 2014). Vegetation types described within the application area are all represented in the surrounds, indicating a wider distribution (Western Botanical, 2014). No Threatened Ecological Communities were identified as potentially occurring in the application area and the field assessment of the application area did not record any (Western Botanical, 2014; GIS Database). Part of the application area falls within the Die Hardy Range/Diemels vegetation complex (banded ironstone formation) Priority 1 Ecological Community (Western Botanical, 2014; GIS Database). DBCA (2020a) advises that approximately 0.5% of this PEC will be impacted by the proposed clearing, and this is unlikely to have a significant impact on the conservation status of the PEC.

A total of 171 flora taxa from 74 genera and 34 families were recorded during the field surveys of the application area and surrounds (Western Botanical, 2014). Twenty five conservation significant flora were identified as previously being recorded within 20 kilometres of the application area, including three Threatened, four Priority 1, two Priority 2, 12 Priority 3 and four Priority 4 flora species (Western Botanical, 2014). However, only two Priority flora species were recorded during the field assessments of the application area: *Banksia arborea* (P4) and *Eucalyptus formanii* (P4) (Western Botanical, 2014). One *Banksia arborea* and 85 *Eucalyptus formanii* individuals may be impacted by the proposed clearing, however both species have multiple populations outside the application area on a regional scale (Botanica, 2020; Western Botanical, 2014). DBCA (2020a) has determined that the proposed clearing is unlikely to have a significant impact on the conservation status of these species.

A desktop assessment identified 184 fauna species having been previously recorded within 20 kilometres of the application area including 102 birds, three amphibians, 20 mammals, nine invertebrates and 50 reptiles (DBCA, 2020b). This includes three conservation significant fauna: Peregrine Falcon (*Falco peregrinus*, OS), Malleefowl (*Leipoa ocellata*, VU at a state and federal level), and Tree-stem Trapdoor Spider (*Aganippe castellum*, P4). Of the conservation significant species potentially present, Malleefowl were the only species identified as potentially being impacted by the proposed clearing as there is suitable nesting and foraging habitat within the application area and Malleefowl activity in the local area (AMP, 2014). Potential impacts to Malleefowl may be minimised with a fauna management condition. A targeted search for Tree-stem Trapdoor Spiders was conducted in 2014, however none were identified within the application area (APM, 2014). Peregrine Falcons are unlikely to be impacted by the proposed clearing as they are a highly mobile species with a large home range (APM, 2014).

The vegetation associations, fauna habitats and landform types present within the application area are well represented in surrounding areas (APM, 2014; Western Botanical, 2014; Botanica, 2020; GIS Database). The application area is unlikely to represent an area of higher biodiversity than surrounding areas, in either a local or regional context.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

Methodology

APM (2014)
Botanica (2020)
CALM (2002)
DBCA (2020a)
DBCA (2020b)
DEC (2010)
Western Botanical (2014)

GIS Database:
- IBRA Australia
- Pre-European Vegetation
- Threatened and Priority Ecological Communities Boundaries
- Threatened and Priority Ecological Communities Buffers
- Threatened and Priority Flora
- Threatened Fauna

(b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

Comments

Proposal may be at variance to this Principle

A level 1 fauna assessment was conducted over the application area by Animal Plant Mineral (APM) in June 2014. The following three fauna habitats have been recorded within the application area (APM, 2014):

- Tall *Eucalyptus* Woodland over Halophytic understorey on Alluvial Plain.
- Low *Eucalyptus* Woodland over *Acacia* Shrubland on Alluvial Plain.
- Dense Shrubland on Alluvial Plain.

APM (2014) identified 10 conservation significant fauna species that may potentially occur within the application area given there is suitable habitat. Seven of the 10 fauna species are considered likely to occur and three species were considered potentially occurring (APM, 2014). The fauna habitats present in the application area are not restricted and are broadly available locally (APM, 2014). Nine of the conservation significant fauna species are unlikely to be dependent on the habitat within the application area (APM, 2014).

Western Botanical (2014) opportunistically observed 11 Malleefowl mounds and two sets of footprints during a 2013 flora and vegetation survey, within 5 kilometres of the application area. One set of footprints were located within the application area and one mound was located in very close proximity to the application area (Western Botanical, 2014). APM (2014) revisited these mounds in 2014 and classified them as active or inactive. Two of the 11 were considered to be active by APM, located approximately 3.3 kilometres northwest of the application area (APM, 2014). The application area is ideal nesting and foraging habitat for Mallefowl, particularly the dense shrubland on alluvial plain habitat type (APM, 2014). The proposed clearing may impact Malleefowl given there is evidence of Malleefowl activity within the local area. Potential impacts to Malleefowl may be minimised by the implementation of a fauna management condition.

Based on the above, the proposed clearing may be at variance to this Principle.

Methodology

APM (2014)
Botanica (2020)
Western Botanical (2014)

GIS Database:
- Imagery
- Pre-European Vegetation
- Threatened Fauna

(c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

Comments

Proposal is not likely to be at variance to this Principle

There are no known records of Threatened flora within the application area (GIS Database). Flora surveys of the application area did not record any species of Threatened flora (Western Botanical, 2014; Botanica, 2020).

None of the vegetation types within the application area are known habitat for any species of Threatened flora. The vegetation proposed to be cleared is unlikely to be necessary for the continued existence of any species of Threatened (rare) flora (GIS Database; Western Botanical, 2014; Botanica, 2020).

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

Methodology

Western Botanical (2014)
Botanica (2020)

GIS Database:
- Pre-European Vegetation
- Threatened and Priority Flora

(d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.

Comments

Proposal is not likely to be at variance to this Principle

There are no known Threatened Ecological Communities (TECs) located within or in close proximity to the application area (GIS Database).

A flora and vegetation survey of the application area did not identify any TECs (Western Botanical, 2014; Botanica, 2020).

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

Methodology

Botanica (2020)
Western Botanical (2014)

GIS Database:
- Threatened and Priority Ecological Communities Boundaries
- Threatened and Priority Ecological Communities Buffers

(e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

Comments

Proposal is not at variance to this Principle

The application area falls within the Coolgardie Bioregion of the Interim Biogeographic Regionalisation for Australia (IBRA) (GIS Database). Approximately 97% of the pre-European vegetation still exists in the IBRA Coolgardie Bioregion (Government of Western Australia, 2019). The application area is broadly mapped as Beard vegetation associations 19: Low woodland; mulga between sandridges; 141: Medium woodland; York gum, salmon gum & gimlet; and 202: Shrublands; mulga & *Acacia quadrimarginea* scrub (GIS Database). Approximately 82-100% of the pre-European extent of each of these vegetation associations remains uncleared at both the state and bioregional level (Government of Western Australia, 2019).

Therefore, the application area does not represent a significant remnant of native vegetation in an area that has been extensively cleared.

	Pre-European area (ha)*	Current extent (ha)*	Remaining %*	Conservation Status**	Pre-European % in DBCA managed lands
IBRA Bioregion – Coolgardie	12,912,204	12,648,491	~97	Least Concern	16.39
Beard vegetation associations – WA					
19	4,385,295	4,384,249	~99	Least Concern	0.71
141	1,158,760	960,755	~82	Least Concern	35.29
202	448,529	448,343	~99	Least Concern	22.91
Beard vegetation associations – Coolgardie Bioregion					
19	10,302	10,300	~99	Least Concern	76.24
141	883,085	858,525	~97	Least Concern	46.39
202	6,122	6,122	~100	Least Concern	97.22

* Government of Western Australia (2019)
** Department of Natural Resources and Environment (2002)

Based on the above, the proposed clearing is not at variance to this Principle.

Methodology

Department of Natural Resources and Environment (2002)
Government of Western Australia (2019)

GIS Database:
- IBRA Australia
- Pre-European Vegetation

(f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

Comments **Proposal is not at variance to this Principle**
There are no watercourses or wetlands within the area proposed to clear (GIS Database).

Based on the above, the proposed clearing is not at variance to this Principle**.**

Methodology GIS Database:
- Hydrography, Lakes
- Hydrography, linear

(g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Comments **Proposal may be at variance to this Principle**
The application area lies within the Campsite land system (Payne et al., 1998). This land system has been mapped and described in technical bulletins produced by the former Department of Agriculture (now the Department of Primary Industries and Regional Development).

The Campsite land system is described as alluvial plains supporting eucalypt woodlands with saltbush understoreys and eucalypt-acacia shrublands. Alluvial plains of the Campsite land system are slightly susceptible to soil erosion if perennial shrub cover is substantially reduced (Payne et al., 1998).

Based on the above, the proposed clearing may be at variance to this Principle. Potential land degradation impacts as a result of the proposed clearing may be minimised by the implementation of a staged clearing condition.

Methodology Payne et al. (1998)

(h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

Comments **Proposal is not likely to be at variance to this Principle**
The application area is located within the former Diemals Pastoral Lease, managed by DBCA (formerly DPaW) (GIS Database). DBCA (2020a) has stated that the proposed clearing is unlikely to impact on the environmental values of the proposed conservation area.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

Methodology DBCA (2020a)

GIS Database:
- DPaW Tenure

(i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

Comments **Proposal is not likely to be at variance to this Principle**
There are no Public Drinking Water Source Areas within or in close proximity to the application area (GIS Database). There are no permanent or ephemeral watercourses or wetlands within the area proposed to clear (GIS Database).

The proposed clearing is unlikely to cause deterioration in the quality of underground water.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

Methodology GIS Database:
- Hydrography, Linear
- Public Drinking Water Source Areas

(j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

Comments **Proposal is not likely to be at variance to this Principle**
The climate of the region is arid to semi-arid, with an average rainfall of approximately 226.4 millimetres per year (BoM, 2020; CALM, 2002).

There are no permanent or ephemeral water courses or waterbodies within the application area (GIS Database). The proposed clearing is unlikely to increase the incidence or intensity of natural flooding events.

Based on the above, the proposed clearing is not likely to be at variance to this Principle.

Methodology BoM (2020)
CALM (2002)

GIS Database:
- Hydrographic Catchments - Catchments
- Hydrography, linear

Planning Instrument, Native Title, previous EPA decision or other matter.

Comments The clearing permit application was advertised on 29 June 2020 by the Department of Mines, Industry Regulation and Safety (DMIRS), inviting submissions from the public. No submissions were received in relation to this application.

There is one native title claim (WC2017/007) over the area under application (DPLH, 2020). This claim has been registered with the National Native Title Tribunal on behalf of the claimant group. However, the mining tenure has been granted in accordance with the future act regime of the *Native Title Act 1993* and the nature of the act (i.e. the proposed clearing activity) has been provided for in that process, therefore, the granting of a clearing permit is not a future act under the *Native Title Act 1993*.

There are no registered Aboriginal Sites of Significance within the application area (DPLH, 2020). It is the proponent's responsibility to comply with the *Aboriginal Heritage Act 1972* and ensure that no Aboriginal Sites of Significance are damaged through the clearing process.

It is the proponent's responsibility to liaise with the Department of Water and Environmental Regulation and the Department of Biodiversity, Conservation and Attractions, to determine whether a Works Approval, Water Licence, Bed and Banks Permit, or any other licences or approvals are required for the proposed works.

Methodology DPLH (2020)

4. References

APM (2014) Southern Cross Goldfields Ltd. Level 1 Fauna Assessment. Report prepared by Animal Plant Mineral, for Southern Cross Goldfields Ltd, August 2014.

BoM (2020) Bureau of Meteorology Website – Climate Data Online, Southern Cross Airfield. Bureau of Meteorology. http://www.bom.gov.au/climate/data/ (Accessed 28 July 2020).

Botanica (2020) Environmental Assessment. Die Hardy Gold Project. Clearing Permit Application. Report prepared by Botanica consulting, for Ramelius Resources, May 2020.

CALM (2002) A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002. Department of Conservation and Land Management, Western Australia.

DBCA (2020a) Advice received in relation to Clearing Permit Application CPS 8931/1. Species and Communities Branch, Department of Biodiversity, Conservation and Attractions, Western Australia, June 2020.

DBCA (2020b) NatureMap. Mapping Western Australia's Biodiversity. Government of Western Australia. https://naturemap.dbca.wa.gov.au/ (Accessed 29 July 2020)

DEC (2010) A Biodiversity and Cultural Conservation Strategy for the Great Western Woodlands. Department of Environment and Conservation, Western Australia.

DPLH (2020) Aboriginal Heritage Inquiry System. Department of Planning, Lands and Heritage. http://maps.daa.wa.gov.au/AHIS/ (Accessed 15 July 2020).

Department of Natural Resources and Environment (2002) Biodiversity Action Planning. Action planning for native biodiversity at multiple scales; catchment bioregional, landscape, local. Department of Natural Resources and Environment, Victoria.

Government of Western Australia (2019) 2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of March 2019. WA Department of Biodiversity, Conservation and Attractions, Perth. https://catalogue.data.wa.gov.au/dataset/dbca-statewide-vegetation-statistics

Keighery, B.J. (1994) Bushland Plant Survey: A Guide to Plant Community Survey for the Community. Wildflower Society of WA (Inc). Nedlands, Western Australia.

Payne, A.L., van Vreeswyk, A.M., Leighton, K.A., Pringle, H.J. and Hennig, P. (1998) An inventory and condition survey of the Sandstone-Yalgoo-Paynes Find area, Western Australia. Technical Bulletin 90. Department of Agriculture, South Perth, Western Australia.

Western Botanical (2014) Marda East Project. Level 2 Flora and Vegetation Survey. Southern Cross Goldfields. Report prepared by Western Botanical, for Southern Cross Goldfields Ltd, February 2014.

5. Glossary

Acronyms:

BoM	Bureau of Meteorology, Australian Government
DAA	Department of Aboriginal Affairs, Western Australia (now DPLH)
DAFWA	Department of Agriculture and Food, Western Australia (now DPIRD)
DBCA	Department of Biodiversity, Conservation and Attractions, Western Australia
DEC	Department of Environment and Conservation, Western Australia (now DBCA and DWER)
DoEE	Department of the Environment and Energy, Australian Government
DER	Department of Environment Regulation, Western Australia (now DWER)
DMIRS	Department of Mines, Industry Regulation and Safety, Western Australia
DMP	Department of Mines and Petroleum, Western Australia (now DMIRS)
DPIRD	Department of Primary Industries and Regional Development, Western Australia
DPLH	Department of Planning, Lands and Heritage, Western Australia
DRF	Declared Rare Flora
DoE	Department of the Environment, Australian Government (now DoEE)
DoW	Department of Water, Western Australia (now DWER)
DPaW	Department of Parks and Wildlife, Western Australia (now DBCA)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (now DoEE)
DWER	Department of Water and Environmental Regulation, Western Australia
EPA	Environmental Protection Authority, Western Australia
EP Act	*Environmental Protection Act 1986*, Western Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Federal Act)
GIS	Geographical Information System
ha	Hectare (10,000 square metres)
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for the Conservation of Nature and Natural Resources – commonly known as the World Conservation Union
PEC	Priority Ecological Community, Western Australia
RIWI Act	*Rights in Water and Irrigation Act 1914*, Western Australia
TEC	Threatened Ecological Community

Definitions:

{DBCA (2019) Conservation Codes for Western Australian Flora and Fauna. Department of Biodiversity, Conservation and Attractions, Western Australia}:-

T — **Threatened species:**

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR — **Critically endangered species**

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN — **Endangered species**

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU — **Vulnerable species**

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct Species:

EX **Extinct species**
Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW **Extinct in the wild species**
Species that *"is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species:

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI **Migratory species**
Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD **Species of special conservation interest (conservation dependent fauna)**
Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS **Other specially protected species**
Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

P **Priority species:**

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

P1 **Priority One - Poorly-known species**
Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

P2 **Priority Two - Poorly-known species**
Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

P3 **Priority Three - Poorly-known species**
Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

P4 **Priority Four - Rare, Near Threatened and other species in need of monitoring**
(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.
(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.
(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.