REHABILITATION MANAGEMENT PLAN

Mt Boppy Gold Mine

FINAL

August 2022

Environmental & Social Consultants

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Mt Boppy Gold Mine

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Manuka Resources

Project Director:	Alex Irwin
Project Manager:	Alex Irwin
Report No.	22549/R01
Date:	August 2022

Environmental & Social Consultants

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
1	A. Irwin	16 June 2022	A. Irwin	16 June 2022
Final	A. Irwin	15 August 2022	A. Irwin	15 August 2022

Summary Table

Mt Boppy Gold Mine Rehabilitation Management Plan	
Name of Mine:	Mt Boppy Gold Mine
Rehabilitation Management Plan Commencement Date	01 August 2022
Rehabilitation Management Plan Revision Dates and Version Numbers	Version 1: 01 August 2022
Mining Leases	ML311, ML1681, MPL240, GL3255, GL5836, GL5848, GL5898
Name of Lease Holder:	Manuka Resources Ltd
Date of Submission:	16 August 2022

Table of Contents

Figures

Tables

Appendices

1.0 Introduction to Mining Project

This Rehabilitation Management Plan (RMP) for Mt Boppy Gold Mine (the Mine) has been prepared by Umwelt to demonstrate compliance with the following conditions of consent:

- Condition 18 of Development Consent 2011/LD00070REV01 (the Development Consent)
- Conditions 3 of Gold Leases (GL) 3255, GL 5836, GL 5848, and GL 5898
- Condition 3 of Mining Leases (ML) 311 and ML 1681, and
- Condition 3 of Mining Purpose Lease (MPL) 240.

This RMP follows the format and content requirements identified in the Form and Way: Rehabilitation management plan for large mines (Form & Way RMP) published in September 2020 (Version 1) by the NSW Resources Regulator.

1.1 History of Operations

The Mine is located on the Western Region of New South Wales (NSW), approximately 275 kilometres (km) west-northwest of Dubbo and 48 km east of Cobar. The Mine is situated on the western side of the Gilgunnia-Canbelego Road adjacent to the township of Canbelego and comprised of seven mining tenements (refer to the **Summary Table** for the mine authorisation details). **Figure 1.1** provides a Locality Plan of the Mine within the Western NSW Region.

The Mine was historically worked as an underground mine from 1895 to 1927, and in its day was one of the largest gold producers in Australia, producing some 417,000 ounces of gold from ore with a notional grade of 15 g/t gold (12.2 g/t gold recovered). The sporadic operations of the Mine up to 2002 added a further 7,000 ounces of gold production. This included gold recovered from the first Carbon-In-Pulp (CIP) plant built in Australia in 1975 at Mount Boppy to re-treat the historic tailings.

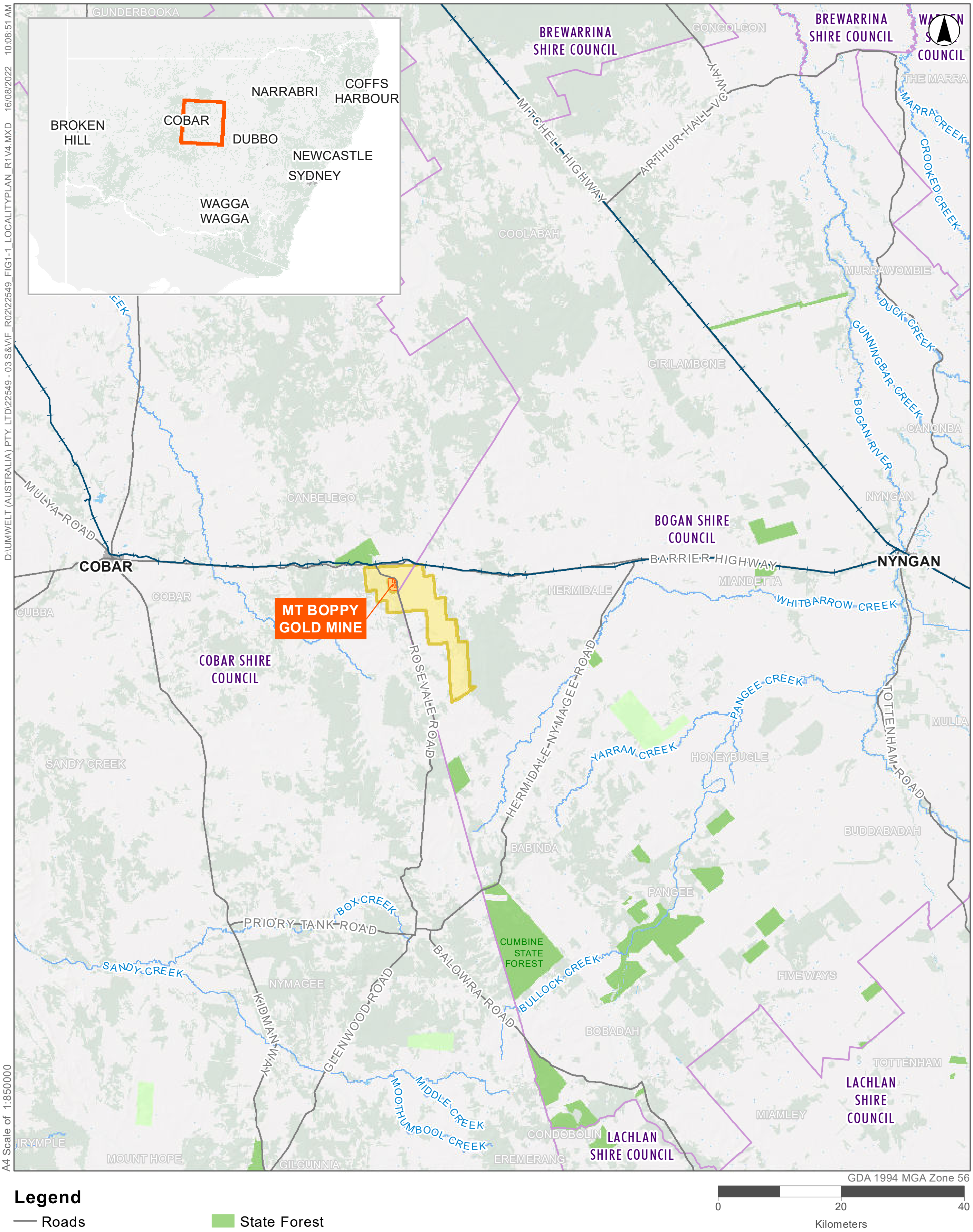
Through a process of expansions and acquisitions since underground mining initially commenced in 1901, the one hundred years of historical operations resulted in the progressive development of the Mine to include: surface tailings storage facilities (TSF), a relatively small open-cut void, process plant and other ancillary equipment remaining at the Mine.

The following provides an overview of the most recent operations at the Mine.

1.1.1 Polymetals Pty Ltd (1993 – 2015)

In 1993, Polymetals Pty Ltd (Polymetals) purchased the Mine from Epoch Minerals and was used for the treatment of silver and gold-bearing supergene tailings transported from the Pasminco-owned Elura Mine[1]. Polymetals subsequently lodged a development application to recommence mining in 2001 and commenced mining activities in 2002.

[1] Elura Mine is now the Endeavour Mine owned by CBH Resources Limited.



Legend

- Roads
- Railway
- Watercourses
- Local Government Area
- Built Up Areas
- Waterbodies
- State Forest
- NPWS Estate
- Native Vegetation Areas
- Mt Boppy Gold Mine
- Mt Boppy Exploration Lease

FIGURE 1.1

MT BOPPY GOLD MINE
Local Setting and Locality Pan

Data source: New South Wales State Government, SEED

Mining operations in 2002 under the management of Polymetals included the conversion of the underground mine to an open cut operation, the extension of the open cut, and extension to TSF 3. A total of 68,000 ounces of gold was produced using the first Cyanide Carbon in Leach plant in Australia between 2002 and 2005 with the historic tailings dams of the Mine capped to provide stable landforms and to minimise dust emissions. In December 2005 mining operations were placed on hold, and care and maintenance activities were implemented up until February 2015.

Two development applications have been lodged and approved by Cobar Shire Council and Development Consent 2006/LDA-00015 was approved in 2006 for the recommencement of mining within the two pits, transportation of ore to Peak Gold Mine and rehabilitation of the Mine. A subsequent development consent (2011/LD-00070) was issued in 2012 for the continuation of mining and processing of ore at an upgraded processing plant on the Mine Site.

1.1.2 Black Oak Minerals Limited (2015 – 2016)

During the care and maintenance phase of the Mine in early 2015, ore processing infrastructure was removed from the site except for the crusher plant which was refurbished and recommissioned by Black Oak Minerals Limited (BOML) the parent company of Polymetals. Under the approved Development Consent 2006/LDA-00015, BOML commenced pre-stripping operations in early March 2015.

In March 2015, BOML lodged an application with Cobar Shire Council to modify Development Consent 2011/LD-00070. On 27 July 2015, the application was approved and Development Consent 2011/LD-00070REV01 was granted. Mining operations recommenced its ore extraction and the transportation of ore to the nearby Manuka Silver Mine for processing.

The Mine continued its operations until November 2015 when the appointment of Receivers and Managers brought operations to a close. Between March and November 2015, BOML mined approximately 1.4 million bank cubic metres (BCM) of waste and ore comprising of 2,960,915 tonnes (1,379,700 BCM) of waste and 134,509 tonnes (58,270 BCM) of ore.

1.1.3 Manuka Resources Limited (2016 – 2022)

In 2016, the Mine was acquired by Mt Boppy Resources Pty Ltd (MBR). At the time of sale Manuka Resources was a minority shareholder of MBR. MBR became a wholly owned subsidiary of Manuka Resources in June 2019.

Between 2016 and 2019, under the direction of the NSW Environment Protection Authority (NSW EPA) extensive earthworks improvements have been made to store bore water produced when dewatering the mine pit. The earthworks were coordinated by MAAS Group Holdings, the then majority shareholder, and works carried out by Neill's Earthmoving, now the primary contractor of the Mine.

Before the recommencement of mining activities in 2020, pit dewatering activities and some construction activities were required at the onset of Manuka Resources operations. Despite efforts to provide the water to local landowners, difficulties in gaining approvals to export mine water at stock quality were too slow to materialise, as such an evaporation dam was constructed. The evaporation dam was constructed in an area to the west of the open pit and south of the waste rock emplacement. Taking up a space approximately 22,500 m^2 in size, its construction represents the only major activity that occurred outside of the original disturbance area of the mining lease.

Since commencement of mining operations, MBR has continued with the mining and processing strategy started by BOML. Mainly mining of ore from Mt Boppy and hauling the ore to the Wonawinta Silver Mine (now Manuka Silver Mine, also owned by Manuka Resources) for processing.

Processing operations at the Mine include a mobile crushing plant used to crush ore mined from the open pit. All other processing operations are conducted at the processing plant located at Manuka Silver Mine.

Exploration activities undertaken by Manuka Resources at Mt Boppy Gold Mine include:

- Rotary Air blast (RAB) drilling in the southern part of ML 1681 consisting of 62 holes for 1,775 m that is part of a not yet fully completed 10,000 m plus regional RAB drilling program in the northern part of EL 5842.

- RC drilling collared from surface on the pre-existing haul road adjacent to the southern Mt Boppy open pit consisting of 7 holes for 1,382 m.

During 2021, work was undertaken to develop a Materials Characterisation and Rehabilitation Assessment Program (Landloch Pty Ltd, 2021) to assist in the development and success of the site rehabilitation plan. Manuka Resources engaged with soils and landform design consultants Landloch Pty Ltd (Landloch) to provide technical support in the design of a stable waste rock emplacement (WRE) and tailings facility that can support vegetation and grazing post mining.

Other rehabilitation activities undertaken since Manuka Resources commenced mining operations in 2020 include:

- Erection of a boundary herbivore exclusion fence around disturbance areas within the mine site to reduce grazing pressure in rehabilitation areas.

- Use of irrigation system to establish ground cover along the south and eastern batters of the TSF.

- Soil characterisation studies (Landloch Pty Ltd, 2021) undertaken to assess suitable rehabilitation material and assess areas of existing batters.

- Erosion modelling and Final landforms designed (Landloch Pty Ltd, 2021a) for both the tailings storage facility and the waste rock emplacement.

- Minor earthworks to the TSF were carried out to provide drainage that creates a water shedding landform.

- Approximately 10,200 LCM of weathered overburden material has been stockpiled on the WRE and will be recovered to supplement the soil material as a growth medium.

- All former plant has been decommissioned and some of the reusable plant is still stored on site for subsequent removal if of no value.

- Plant and concrete foundations have been broken and removed from site.

- The raw and process ponds have had the liners removed and the ponds have been backfilled. The area has now been incorporated into the ROM pad area.

The Development Consent does not specify an approved life of mine but limits mining to a depth of approximately 160 m AHD. Based on current plans for mining the remaining ore reserves of the open cut, mining is expected to be completed in 2024, however, further ore reserves below 160 mAHD would extend the life of mine by several years. Planning is ongoing with respect to confirmation of ore reserves and approval of mining at greater depth.

The Mine will continue with implementing landform designs, dewatering, and maintenance site activities planned will be undertaken in accordance with this new RMP from 1 August 2022 onwards.

1.2 Current Development Consents, Leases and Licences

Tables 1.1, **1.2** and **1.3** provide summaries of current development approvals granted under the *Environmental Planning and Assessment Act 1979* ('EP&A Act'); exploration licences, assessment leases and mining leases granted *granted under the Mining Act 1992;* and other approvals, licences, or authorities issued by Government agencies that are relevant to the progress of mining operation and rehabilitation activities for the Mine. **Figure 1.2** identifies the relevant mine authorisation boundaries.

Table 1.1 List of Development Approvals

Development Approvals	Date Granted	Expiry Date	Details/Comments
Development Consent 2012/LD-00034	22 Nov 2012	Not Applicable	Granted by Cobar Shire Council for the expansion of the off-lease mining camp.
Development Consent 2011/LD-00070	27 Sep 2012	Not Specified	Granted for the continuation of mining and processing of ore at an upgraded processing plant on the Mine Site.
Development Consent 2011/LD-00070-REV01	27 Jul 2015	Not Specified	Modification of development consent granted by Cobar Shire Council to add 5 new conditions, and to alter specific conditions within the original development consent. Condition 1 was altered to include the 2015 Statement of Environmental Effects ([SEE] Reference No. 569/05) as an legal supplementary document. Condition 23 was altered to modify the stated timeframe to "the determination date of the first modification approval of the consent." New Conditions (i) to (v) were added for the approval of, and the supplementary conditions for: the submission of required plans; obtaining site specific licences; granting the extension and operation of the mine including mining of approximately 630,000 t of ore, the management of potentially acid forming waste rock, the transportation of ore to the Manuka Mine, and the construction of temporary mine water storage dams, roadways and road drainage; 24-hour 7-days per week operations, and additional rehabilitation requirements.

Table 1.2 List of Current Mine Authorisation

Lease	Date Issued	Expiry Date	Details/Comments
Gold Lease (GL) 3255	20 May 1926	20 May 2033	Granted by NSW Trade and Investment (NSW T&I) incorporating 8.281 ha (shown as Plan No. G20748) with no surface exceptions or depth restrictions.
GL 5836	15 Jun 1965	15 Jun 2033	Granted by NSW T&I incorporating 6.045 ha with no surface exceptions or depth restrictions.
GL 5848	15 Feb 1968	15 Jun 2033	Granted by NSW T&I incorporating 8.625 ha with no surface exceptions or depth restrictions.
GL 5898	21 Jun 1972	12 Dec 2033	Granted by NSW T&I incorporating 7.512 ha with no surface exceptions or depth restrictions.
Mining Lease (ML) 311	08 Dec 1976	12 Dec 2033	Granted by NSW T&I incorporating 10.117 ha with no surface exceptions and a depth restriction of 3 m.
Mining Purpose Lease (MPL) 240	17 Jan 1986	12 Dec 2033	Granted by NSW T&I incorporating 17.8 ha with no surface exceptions and a depth restriction of 2 m.
ML 1681	12 Dec 2012	12 Dec 2033	Granted by NSW T&I incorporating 188.1ha with no surface exceptions or depth restrictions.

Table 1.3 Other Approvals, Leases and Licences

Other Approvals, Leases and Licences	Date Issued	Expiry Date	Details/Comments
Environment Protection Licence No. 20192	10 Jan 2013	Not Applicable	Issued by the NSW EPA under the Protection of the Environment Operations Act 1997. ('POEO Act'). Current licence version is Notice No: 1566717.
Groundwater Licence 85BL256088	24 May 2011	Not Applicable	Issued by the (then) NSW Office of Water (NOW) for monitoring bores PBP001, PBP003, PBP004, PBP018, PBP019 and PBP020.
Groundwater Licence 85WA752612	16 Jan 2012	16 March 2025	Issued by the (then) NOW for the water supply works associated with three water supply bores within Lot 7301 DP 1170536.
Groundwater Licence 85WA753524	10 Jun 2013	06 June 2023	Issued by the (then) NOW for the water supply works associated with excavation of the open cut pit.
Water Access Licence WAL30045	14 Jun 2012	Not Applicable	Issued by the (then) NOW providing entitlement to 250ML from the Lachlan Fold Belt MDB Groundwater Source.

1.3 Land Ownership and Land Use

1.3.1 Land Ownership

Most of the land of Mine is Temporary Town Common (Crown Land) with a small area located over privately owned freehold land (which will not be disturbed as part of the approved mining operations). Small sections of GL 5848 and GL 5898 also overlap allotments in the residential area of the Canbelego Township. Previous advice from the Cobar Shire Council is that these allotments are not valued or rated by the Council and considered vacant Crown land.

Most other areas within the Canbelego Township are either Crown Land, owned by Cobar Shire Council or freehold land owned by the Company. A small number of freehold land parcels are privately owned of which three have habitable residences. The remaining residences are located on Company owned land.

Table 1.4 identifies the land tenure of land on and adjacent to the mining leases. Land surrounding the Mine is either residential (Canbelego township) or grazing land.

Table 1.4 Land tenure of lots within and adjacent to the Mine

Lot//DP	Land Tenure	Land Ownership
7301//1170536	Canbelego Common Trust	State of NSW
7006//1031029	Cobar Shire Council	State of NSW
7304//1154453	Crown Lands - Dubbo	State of NSW
7302//1170536	Crown Lands - Western	State of NSW
6//751314	Crown Lands - Western	State of NSW
7300//1170536	Crown Lands - Western	State of NSW
7005//1031029	Local Land Services	State of NSW
5//751314	Local Land Services	State of NSW
7004//1030757	Local Land Services	State of NSW
4249//766877	Crown Lands – Western	State of NSW

Figure 1.2 presents the land ownership of and surrounding the Mine.

1.3.2 Land Use

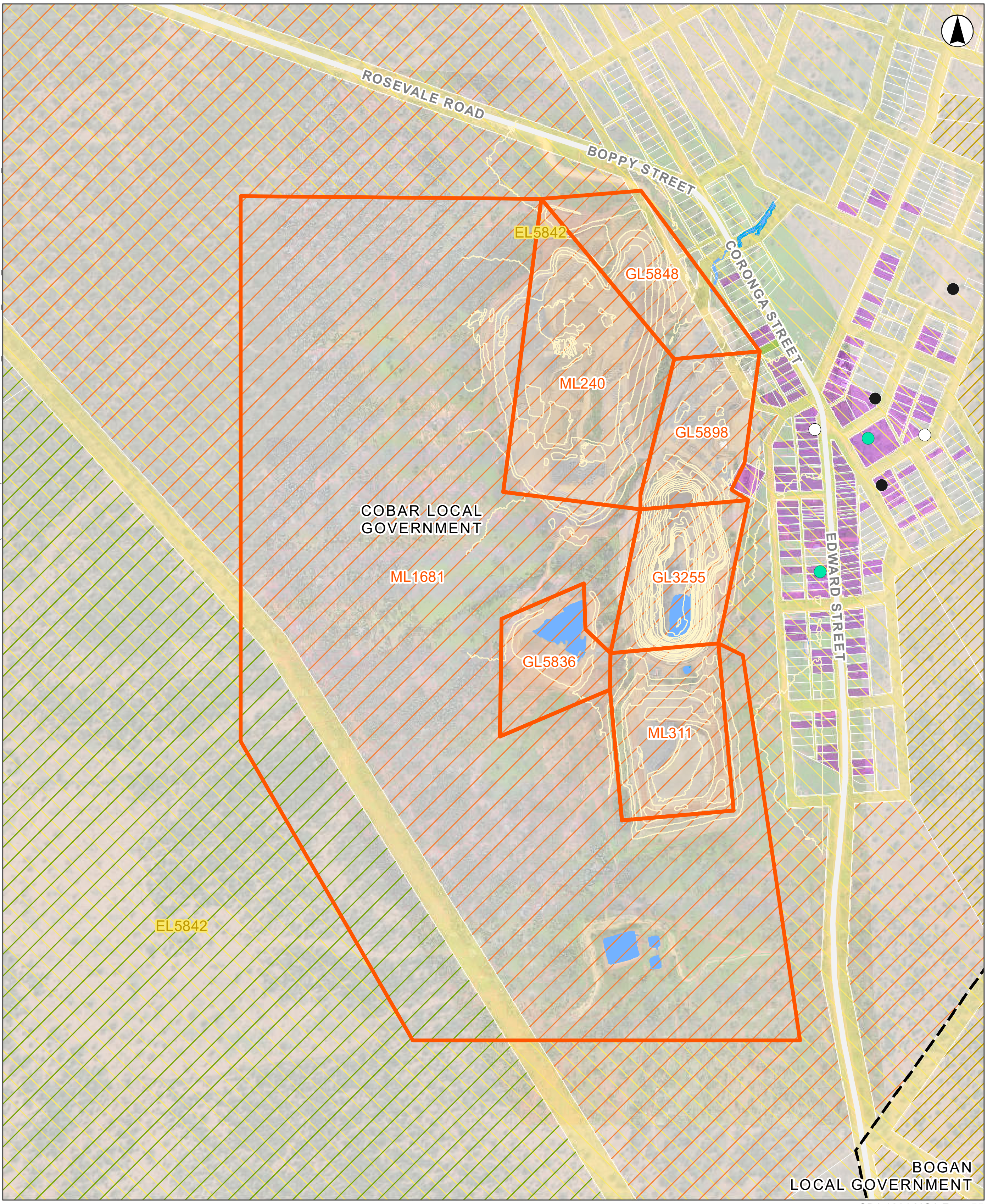
There is a long history of mining on the Mine Site (refer to **Section 1.1**) and the land contained within the Mine is highly disturbed from over a century of mining activities.

Land not currently part of the active Mine operation, as well as the land surrounding the Mine in the Canbelego region comprises:

- pastoral activities on native and low-quality improved pasture
- intact native vegetation, predominantly on Mt Boppy, and
- Canbelego State Forest located to the north of the Barrier Highway.

There is currently no pastoral activity undertaken on the non-mining areas of the Mine with low density grazing undertaken on the land surrounding the Mine. The region is unsuitable for permanent cropping activity due to the poor quality of the soils combined with the low and unreliable rainfall patterns.

There is very little remaining native vegetation on the site with the original vegetation being either cleared or infested with weeds. Previously completed field surveys indicate that the western section of the Mine Site is dominated by the Benson 103 Vegetation community, with the remainder of the Mine Site vegetation classified as disturbed.



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Legend

- Company-owned
- Privately-owned
- Uninhabitable
- 5m Site Contours (210331)
- Roads
- Water
- Water line
- Local Government Area
- Mt Boppy Gold Mine
- Mt Boppy Exploration Lease
- Waterbody
- Water line

Tenure

- Crown Land
- Freehold
- Local Government Authority
- Road Reserve

Land Use (EIS)

- Crown Land
- Grazing
- Temporary Town Common

FIGURE 1.2

MT BOPPY GOLD MINE
Land Ownership and
Land Use

Data source: New South Wales State Government, SEED

Two Aboriginal heritage items (scarred trees) have been identified within the Mine Site and a total of 24 European heritage items have previously been identified from historical mining activities.

Figure 1.2 presents the land uses of the Mine and surrounding land as described above.

1.3.3 Land Ownership and Land Use Figure

Figure 1.2 to **Figure 1.3** show the following land ownership, land use, and environmental features of the local setting

Legend

- 5m Site Contours (210331)
- Roads
- Water
- Water line
- Local Government Area
- Mt Boppy Gold Mine
- Heritage Areas
- Waterbody
- Water line

Vegetation Communities

- Benson 103
- Unknown Vegetation Community
- Pepper Tree (Exotic)
- Water
- Disturbed/Cleared/Invasive/Native Shrub
- Disturbed/Cleared

FIGURE 1.3

MT BOPPY GOLD MINE
Environmental Features

Data source: New South Wales State Government, SEED

2.0 Final Land Use

2.1 Regulatory Requirements for Rehabilitation

Regulatory requirements relating to rehabilitation of the Mine include:

- Standard conditions of mining authorisations (as nominated by Mining Amendment (Standard Conditions of Mining Leases—Rehabilitation) Regulation 2021 [NSW] Schedule 1 Amendment of Mining Regulation 2016.
- Relevant conditions of DA 2011/LD – 00070REV01.
- Commitments made in environmental assessments supporting development consent.

Table 2.1 identifies the regulatory requirements relating to rehabilitation and whether each requirement applies to the entire site or to a specific domain or a defined parcel of land, as well as the timing to meet each requirement.

Table 2.1 Regulatory requirements for rehabilitation - Development Consent 2011/LD- 00070REV01

Requirement	Source	Land to which it applies	Timing	Section
Rehabilitation to occur as soon as reasonably practicable after disturbance The holder of a mining lease must rehabilitate land and water in the mining area that is disturbed by activities under the mining lease as soon as reasonably practicable after the disturbance occurs.	Mining Amendment Regulation 2021 Schedule 1, Part 2, Division 1, Clause 5	Entire Site	Ongoing	**6.0**
Rehabilitation must achieve final land use 1. The holder of a mining lease must ensure that rehabilitation of the mining area achieves the final land use for the mining area. 2. The holder of the mining lease must ensure any planning approval has been obtained that is necessary to enable the holder to comply with subclause (1). 3. The holder of the mining lease must identify and record any reasonably foreseeable hazard that presents a risk to the holder's ability to comply with subclause (1).	Mining Amendment Regulation 2021 Schedule 1, Part 2, Division 1, Clause 6	Entire Site	Ongoing	**5.0 – 10.0**

Requirement	Source	Land to which it applies	Timing	Section
Rehabilitation risk assessment 1. The holder of a mining lease must conduct a risk assessment (a rehabilitation risk assessment) that— a. identifies, assesses and evaluates the risks that need to be addressed to achieve the following in relation to the mining lease— i. the rehabilitation objectives, ii. the rehabilitation completion criteria, iii. for large mines—the final land use as spatially depicted in the final landform and rehabilitation plan, and b. identifies the measures that need to be implemented to eliminate, minimise or mitigate the risks. 2. The holder of the mining lease must implement the measures identified 3. The holder of a mining lease must conduct a rehabilitation risk assessment— a. for a large mine—before preparing a rehabilitation management plan, and b. for a small mine—before preparing the rehabilitation outcome documents for the mine, and c. whenever a hazard is identified under clause 6(3)—as soon as reasonably practicable after it is identified, and d. whenever given a written direction to do so by the Secretary	Mining Amendment Regulation 2021 Schedule 1, Part 2, Division 2, Clause 7	Entire Site	1 August 2022	**3.0**

Requirement	Source	Land to which it applies	Timing	Section
Rehabilitation management plans for large mines 1. The holder of a mining lease relating to a large mine must prepare a plan (a rehabilitation management plan) for the mining lease … 2. If a rehabilitation outcome document has not been approved by the Secretary, the holder of the mining lease must include a proposed version of the document. 3. A rehabilitation management plan is not required to be given to the Secretary for approval. 4. The holder of the mining lease— a. must implement the matters set out in the rehabilitation management plan, and b. if the forward program specifies timeframes for the implementation of the matters—must implement the matters within those timeframes.	Mining Amendment Regulation 2021 Schedule 1, Part 2, Division 3, Clause 10	Entire Site	1 August 2022	**This RMP**
Amendment of rehabilitation management plans 1. The holder of a mining lease must amend the rehabilitation management plan for the mining lease as follows— a. to substitute the proposed version of a rehabilitation outcome document with the version approved by the Secretary—within 30 days after the document is approved, b. as a consequence of an amendment made under clause 14 to a rehabilitation outcome document—within 30 days after the amendment is made, c. to reflect any changes to the risk control measures in the prepared plan that are identified in a rehabilitation risk assessment—as soon as practicable after the rehabilitation risk assessment is conducted, d. whenever given a written direction to do so by the Secretary—in accordance with the direction.	Mining Amendment Regulation 2021 Schedule 1, Part 2, Division 3, Clause 11	Entire Site	As required	**11.0**

Requirement	Source	Land to which it applies	Timing	Section
Rehabilitation outcome documents 1. The holder of a mining lease must prepare the following documents (the rehabilitation outcome documents) for the mining lease and give them to the Secretary for approval— a. the rehabilitation objectives statement, which sets out the rehabilitation objectives required to achieve the final land use for the mining area, b. the rehabilitation completion criteria statement, which sets out criteria, the completion of which will demonstrate the achievement of the rehabilitation objectives, c. for a large mine, the final landform and rehabilitation plan, showing aspatial depiction of the final land use. 2. If the final land use for the mining area is required by a condition of development consent for activities under the mining lease, the holder of the mining lease must ensure the rehabilitation outcome documents are consistent with that condition.	Mining Amendment Regulation 2021 Schedule 1, Part 2, Division 3, Clause 12	Entire Site	1 August 2022	**4.0**

Requirement	Source	Land to which it applies	Timing	Section
Forward program and annual rehabilitation report 1. The holder of a mining lease must prepare a program (a forward program) for the mining lease that includes the following— a. a schedule of mining activities for the mining area for the next 3 years, b. a summary of the spatial progression of rehabilitation through its various phases for the next 3 years, c. a requirement that the rehabilitation of land and water disturbed by mining activities under the mining lease must occur as soon as reasonably practicable after the disturbance occurs. 2. The holder of a mining lease must prepare a report (an annual rehabilitation report) for the mining lease that includes— a. a description of the rehabilitation undertaken over the annual reporting period, b. a report demonstrating the progress made through the phases of rehabilitation provided for in the forward program applying to the reporting period, c. a report demonstrating progress made towards the achievement of the following— i. the objectives set out in the rehabilitation objectives statement, ii. the criteria set out in the rehabilitation completion criteria statement, iii. for large mines—the final land use as spatially depicted in the final landform and rehabilitation plan. …	Mining Amendment Regulation 2021 Schedule 1, Part 2, Division 3, Clause 13	Entire Site	1 August 2022 (then within 60 days of end reporting period)	**N/A**
Certain documents to be publicly available 1. This clause applies to the following documents— a. a rehabilitation management plan, b. a forward program, c. an annual rehabilitation report …	Mining Amendment Regulation 2021 Schedule 1, Part 2, Division 3, Clause 16	Entire Site	15 August 2022	**11.0**

Requirement	Source	Land to which it applies	Timing	Section
The site is to be rehabilitated to the satisfaction of the Director, Environmental Sustainability in the DRE[2].	DA 2011/LD-00070 Condition (iv) (A)	Entire Site	Mine Closure	**4.0, 5.0**
Rehabilitation must be substantially consistent with the rehabilitation objectives stated in the SoEE (RWC, 2015) and DRE's objectives below.	DA 2011/LD-00070 Condition (iv) (A)			
Mine Site Safe, stable, and non-polluting, fit for the purpose of the intended post-mining land use(s).		Entire site	Mine closure	**4.0, 5.0**
Rehabilitation materials Materials (including topsoil, substrates and seeds of the disturbed areas) are recovered, appropriately managed, and used effectively as resources in the rehabilitation.		Entire site	Ongoing	**6.2.1, 9.0, 10.0**
Landforms Final landforms sustain the intended land use for the post-mining domain(s). Final landforms are consistent with and complement the topography of the surrounding region to minimise the visual prominence of the final landforms in the post mining landscape. Final landforms incorporate design relief patterns and principals for consistent with natural drainage.		Entire Site	Mine Closure	**4.0, 5.0**
Water Quality Water retained on site is fit for the intended land use(s) for the post-mining domain(s). Water discharged from site is consistent with the baseline ecological, hydrological, and geomorphic conditions of the creeks prior to mining disturbance. Water management is consistent with the regional catchment management strategy.		Open Cut Void	Mine Closure	**4.0, 5.0**
Native flora and fauna Size, locations and species of native tree lots and corridors are established to sustain biodiversity habitats. Species are selected that re-establishes and complements regional and local biodiversity.		Entire Site	Mine Closure Ongoing	**4.0, 5.0**
Post-mining agricultural The land capability classification for the relevant nominated agricultural pursuit for each domain is established and self-sustaining within 5 years of land use establishment (first planting of vegetation).		Entire Site	Mine closure	**4.0, 5.0**
The proponent shall carry out rehabilitation of disturbed areas progressively, as soon as reasonably practicable, to the satisfaction of the Director of Environmental Sustainability in DRE.	Condition (iv) (B)	Entire site	Ongoing	**4.0, 6.0**

[2] The former Division of Resources and Energy (DRE) is now the NSW Resources Regulator.

Requirement	Source	Land to which it applies	Timing	Section
The proponent must prepare and implement a Rehabilitation Plan to the satisfaction of the Director Environmental Sustainability of the DRE.	Condition (iv) (C)	Entire Site	1 August 2022	**This RMP**
Land Use Provide native vegetation communities suitable for intermittent and very low intensity grazing uses.	Statement of Environmental Effects (RWC, 2015)	Entire Site	Mine closure	**6.2.5**
Surface Infrastructure Decommission and remove all surface infrastructure (unless required for a lawful post-mining land use).		Infrastructure Domain	Mine closure	**6.2.2**
Landform Provide a geotechnically stable landform.		Entire Site	Ongoing	**6.2.3**
Provide a non-polluting landform.		Entire Site	Ongoing	**6.2.3**
Construct a safety bund around the open cut void with appropriate signage.		Open Cut Void	Mine closure	**6.2.3**
Biodiversity Revegetated areas provide a vegetation community with maintenance requirements no greater than adjoining vegetation / analogue sites not disturbed by mining activities.		Entire Site	Mine closure	**6.2.5**
Revegetated areas contain species consistent with surrounding vegetation communities.		Entire Site	Mine closure	**6.2.5**
Allow for the relinquishment of the mining tenements and the return of the security lodged over the Mining Lease within a reasonable time after the end of the mine life.		Entire Site	Mine closure	**6.2**

2.2 Final Land Use Options Assessment

The primary goal is to create stable final landforms with acceptable post-mining land use and capability. More specifically the post-mining land use goals are:

- To return the overall site to native vegetation communities suitable for intermittent and very low intensity grazing uses.
- To return the flatter areas of the site to Land and Soil Capability[3] (LSC) Class VI which can support very low intensity grazing.
- To return the batters of WRE and TSF 3 to LSC Class VII which is suitable for native vegetation conservation.

[3] The land and soil capability (LSC) assessment scheme has been developed for NSW, updates the old Rural Land Capability Class (RLCC) mapping system designed in 1986 by the Soil and Conservation Service for NSW. The LSC assessment scheme retains the earlier eight RLCC system but places additional emphasis on specific soil limitations and their management.**Invalid source specified.**

- To retain the open cut void as a water storage (LSC Class VIII) which provides a landscape feature that is non-polluting.

Final land uses considered in the past for the Mine Site are summarised below.

1. Return to grazing:

   Land use on properties surrounding the Mine Site includes limited agricultural (very low-quality grazing), or essentially vacant Crown Land. At present, the Mine Site is subject to minimal productive grazing uses due to exclusion fencing for part of the site, the previous disturbances and very poor quality of the existing pasture, reflecting the generally low quality of the soils and semi-arid climate. Nevertheless, reinstatement of vegetation types that are compatible with rural uses (notably saltbush) has previously been an aim of the project rehabilitation. However, due to the inherently poor condition of the country, grazing pressure would need to be maintained at very low levels once a suitable cover had been established, especially given current grazing pressures by kangaroos and feral goats (which are a regional land management issue).

2. Industry development including waste disposal:

   Given the previous and proposed status as a mining operation, some form of industrial development could be developed. However, the site is too isolated and services too poor to enable a viable concern to become established. This use has thus been removed from further consideration. It is noted that the site was initially considered in the early 1980s by the State government at the time for the disposal of radioactive wastes (partly due to the isolated nature of the site and absence of significant surface and groundwater conditions) but was not progressed for various community reasons.

3. Conservation:

   While there are some areas of conservation significance to the west of the Mine Site, notably on the slopes of Mt Boppy proper, there are no areas within or in close proximity to the Mine Site that are considered suitable for conservation protection in their current condition.

   While rehabilitation measures will aim to re-establish a viable native ecosystem, the outcome is unlikely to be of significant conservation interest or value.

4. Tourism:

   Upon closure, the open pit may be of some interest to tourists travelling in the general Cobar region. However, the constraints of isolation of the site from other support services, general security issues and the availability of other examples of mining in closer proximity to Cobar which are more suited for tourism activity preclude this option.

Based on the above assessment (originally presented in *Section 2.11.2* of the 2011 Environmental Impact Statement [EIS]) it is considered that establishment of site conditions that have native vegetation communities suitable for intermittent and very low intensity grazing uses is the preferred land use option.

The batters of the WRE and TSF 3 will be rehabilitated to native vegetation, however, as they will be unsuitable for grazing and will have a land use of passive nature conservation.

The open cut pit will not be suitable for any form of grazing or vegetative rehabilitation and will be retained as a water storage which could potentially be utilised for livestock watering or industrial uses. However, it is considered most likely that the open cut area will, for the foreseeable future, simply provide a landscape feature.

The Mt Boppy Gold Mine Materials Characterisation Program for Rehabilitation Report (Landloch Pty Ltd, 2021) generally supported the intended final land use option with LSC classes VI and VII as *achievable.*

2.2.1 Stakeholder Consultation

As part of the original development application process for DA 2011/LD-00070 and for the subsequent modification in 2015, formal consultation was held with relevant stakeholders from the community, local aboriginal groups and government agencies. Consultation included discussion of the planned rehabilitation of the site and return to very low intensity grazing and vacant Crown land. The outcome of the consultation on the rehabilitation objectives and performance criteria is further discussed in **Section 4.2**.

Final Land Use Statement

The final land uses for the Mine Site will provide rehabilitated areas consisting of low intensity agricultural uses (LSC Class VI); passive nature conservation (LSC VII); with sites compatible for wildlife refuge, and for preservation of natural vegetation landscapes, including water storage features (LSC Class VIII).

The conceptual *Final Landform and Rehabilitation Plan* (FLRP) is provided by **Plan 1** (Final Landform Features) and **Plan 2** (Final Landform Contours) (refer to **Section 5.1**). The final landform and the rehabilitation are designed to achieve the rehabilitation objectives and produce a stable landform and sustainable vegetation communities that are ecologically and visually consistent with the surrounding area.

2.3 Final Land Use and Mining Domains

Final land use and mining domains at the Mine have been defined in accordance with the *Form and Way for Rehabilitation Management Plans for Large Mines* (NSW RR, 2021) and are discussed in **Section 2.3.1** and **Section 2.4.2**. The final land use and mining domains are spatially defined in **Section 5.1**.

2.3.1 Final Land Use Domains

The final land use domains for the Mine are detailed in **Table 2.2**.

Table 2.2 Mt Boppy Final Land Use Domains

Final Land Use Domain	Description
Infrastructure	The domain includes built infrastructure proposed to be retained for future use e.g., a long-term access road to be retained through the Mine Site.
Native Ecosystem	Self-sustaining native ecosystems.
Agricultural – Grazing	Establishment of very low to low intensity agricultural grassland grazing areas and passive nature conservation.

Final Land Use Domain	Description
Water Management Areas	Water Management areas that form part of the final landform design. This domain will include the existing creek diversion.
Final Void	Final remaining void area/s from mining extraction areas that form part of the final landform design.
Heritage Area	Protected area of two sites of cultural importance within the mining lease boundary.

2.3.2 Mining Domains

The current mining domains described in **Table 2.3** below are categorised on the basis of mine-related activities occurring within each domain.

Table 2.3 Mining Domains

Mining Domain	Description
Infrastructure Area	Demountable Site Office Heavy Vehicle Workshop Access Haul Roads Hardstand Areas
Tailings Storage Facility	TSF 3 TSF Batters
Water Management Area	Temporary Water Storage Dam Existing Creek Diversion Four Sediment Basins Containment Dam Council Water Storage Dams
Overburden Emplacement Area	Waste Rock Emplacement Area Capped TSF Areas Approved Extension of the Waste Rock Emplacement Area
Active Mining Area (Open Cut Void)	Open Cut Void Adjacent Safety Bund
Other: Stockpile Area	ROM Pad Area Former Mill Process Area Raw Water Pond Process Pond Pollution Pond
Other: Passive Land Management	Undisturbed areas of the mining leases, where no active rehabilitation required, for low intensity agricultural grassland grazing areas and passive nature conservation Aboriginal Heritage Sites

3.0 Rehabilitation Risk Assessment

The adopted approach to assessing the risks of rehabilitation for the Mt Boppy Gold Mine ("the Mine") are in accordance with the following Australian Standards[4] and Guidelines below:

- HB 203:2012 Managing environment-related risk Handbook.
- AS/NZS ISO 31000:2018 Risk Management – Guidelines.
- Table 1: Rehabilitation Risk Assessment - Potential Risks in Guideline: Rehabilitation Risk Assessment[5].

The method used for the risk assessment adopts principals of AS NZS ISO 31000:2018 Risk Management - Guidelines and the NSW RR bowtie risk assessment for operational and rehabilitation phases, the risk assessment encompassed the following key steps:

- identifying the related risks, including the risk consequence
- analysing the risks using a qualitative risk approach (i.e. identifying existing controls, determining specific consequences/likelihoods and then determining the residual level of risk)
- evaluating the risks.
- establishing controls to mitigate or treat the identified risks.

A rehabilitation risk assessment was held undertaken by Manuka Resources Ltd (Manuka) in November 2021 to ensure that the results presented in **Table 3.1** are relevant and are not inconsistent with the desired rehabilitation outcomes of the Mine. The risk ranking has been determined largely on the outcomes of the assessments completed for the 2011 EIS (Polymetals 2011), the 2015 SoEE (RWC, 2015) and other documentation submitted to obtain approval.

Initially 75 risks to rehabilitation were identified during the process of the risk assessment, however, these have subsequently been consolidated down to 38 based on equivalence of risk factors and management. Of these risks, six were ranked as Critical, 20 were ranked as high, eight were ranked as medium and the remaining (six) ranked low (based on the highest risk ranking where consolidation of risks has been completed). **Table 3.1** presents a summary of the November 2021 risk assessment.

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4 The HB 20.3:2012 Handbook supersedes *HB 203:2006 – Environmental risk management – Principles and process*. The AS/NZS ISO 31000:2018 supersedes the former Australian Standard *AS/NZS 4360:2004 – Risk Management*. The *AS/NZS ISO 31000:2018* Standard is identical with and has been reproduced from the *ISO 31:2018 Risk Management -Guidelines.*

5 Published by *NSW Resources Regulator* on 02 July 2021.

Table 3.1 Rehabilitation risks identified

Consolidated Risk	Risk Reference	Ranking	Addressed in Section
Rehabilitation Phase - General			
Rehabilitation personnel lack clearly defined responsibilities, skills and or experience due to loss of corporate and site knowledge from high turnover in workforce.	R1	High	**6.2.1**
Insufficient funding for/or prioritisation of rehabilitation activities and poor cost control leading to inadequate provision to meet full cost of closure. Also considers the risk of asset theft during closure process.	R2	High	**6.2.1**
Failure to identify or comply with all legal and other obligations relating to closure; and/or failure to meet rehabilitation objectives and relevant completion criteria being evidence of safe, stable, non-polluting, and other sustaining metrics.	R3	High	**6.2.7**
Failure to meet expectations of the community, government, landholders, Non-Government Organisations (NGO's). Includes risk of Dam Safety and Resources Regulator not approving closure of Tailings Facility.	R4, R12	High	**6.2.3**
Inadequate consideration of rehabilitation and proposed landforms and final voids in mine planning	R5	Critical	**6.2.3**
Design and construction of waste landforms and emplacement areas undertaken without detailed understanding of the physical and geotechnical properties, chemical composition, and geochemical characteristics of the mine waste (e.g., Potentially Acid Forming (PAF) wastes and salinity)	R6	Critical	**6.2.3**
Proposed final landform designs are not long-term stable (to allow relinquishment)	R7	Critical	**6.2.1**
Large rehabilitation backlog causing delay to closure execution and schedule.	R8, R23	Medium	**6.2.3**
Unavailability of personnel and/or contractors, and machinery to complete closure and rehabilitation works leading to extended maintenance and monitoring requirements until relinquishment.	R9, R13-R15	High	**6.2.1**
Less than adequate community engagement or involvement in closure planning leading to impacts of closure on local and regional communities (e.g., direct, and indirect employment, impacts on local business and poor community perception impacting on company reputation	R10, R11	Medium	**6.2.1**
Health and safety systems unsuitable for closure of hazardous areas (e.g., high-walls and tailings dams) risking health & safety of employees & community during closure & post closure phases. Considers risk of increased public access to site.	R16-R18, R20	Low	**6.2.2**
Asset theft during closure process	R19	Low	**6.2.2**
Insufficient funding for rehabilitation due to inadequate provisioning or poor cost control	R21-R22	High	**6.2.2**

Consolidated Risk	Risk Reference	Ranking	Addressed in Section
Rehabilitation Phase – Active Mining			
Disturbance activities results in: • mismanagement of soils and materials handling • minimal biological resource salvage and maintenance through clearing, salvage, and handling practices. • loss of opportunity to salvage material or protect land prior and during ground disturbance works • insufficient / inadequate material for rehabilitation. • clearing in adverse seasonal and weather conditions when salvaging biological resources.	R24-R26, R29-R30, R32-R33	High	**6.2.1**
Adverse or incorrect geochemical/chemical composition of imported and site salvaged materials for capping and rehabilitation	R27	Low	**6.2.1**
Environmental monitoring of disturbance activities records adverse surface and groundwater quality and quantity and impacts to known and unknown cultural & European heritage items.	R28, R34	High	**6.2.1**
Rehabilitation Phase - Decommissioning			
Disturbance activities results in impacts on heritage items.	R35	High	**6.2.2**
Hazards associated with retained infrastructure, buildings and fixed plant during decommission and demolition	R36, R39	Medium	**6.2.2**
Contamination resulting from disturbance activities, includes: • storage and use of hydrocarbons/chemicals, • drilling fluids, • spillage of dirty or produced saline water, • sewage, polychlorinated biphenyls (PCBs), • asbestos, • radiation. • site services including equipment storage areas, hardstand areas, roadways, sealed and unsealed roads and car parks.	R37-R38, R40	Medium	**6.2.2**
Incomplete exploration activity and less than adequate TSF capping design resulting in waste materials or contaminated lands.	R41-R42	Medium	**6.2.2**
Rehabilitation Phase – Landform Establishment			
Failed or poor-quality rehabilitation due to erosion and mass movement issues	R43	High	**6.2.3**
Landform modification required due to geochemically and/or geotechnically unsuitable tailings, reject and overburden materials or construction not in accordance with design	R44, R52	Medium	**6.2.3**
Proposed final landform designs are not long-term stable and are not acceptable to allow relinquishment due to rehabilitation criteria not met leading to failure to achieve final land use and obtain approval of the Final Void.	R45-R46, R48-R49	High	**6.2.3**
Lack of availability of suitable materials for encapsulation or capping of adverse materials.	R47	Critical	**6.2.3**

Consolidated Risk	Risk Reference	Ranking	Addressed in Section
Failed rehabilitation due to inappropriate rehabilitation design, techniques, implementation	R50	High	**6.2.3**
Remaining water infrastructure for final land use not approved to remain on site post closure, or remaining infrastructure poses health and safety risk, environmental ongoing monitoring requirements.	R51	High	**6.2.3**
Rehabilitation Phase – Growth Medium Development			
Lack of subsoil and topsoil and/or inadequate quality to support revegetation or agricultural land capability (e.g., lack of organic matter, nutrient deficiency, lack of soil biota, adverse soil chemical properties, exposed hostile geochemical materials, and any other factors impeding the effective rooting depth).	R53-R55	High	**6.2.4**
General methodologies causing delay to timing of rehabilitation or resulting in failed or poor-quality rehabilitation	R56-R58	Medium	**6.2.4**
Rehabilitation Phase – Landform Ecosystem and Land Use Establishment/Development			
Revegetation (native and agricultural land uses) impacted by lack of availability and quality of target seed resources, including genetic integrity.	R59-R60	High	**6.2.5**
Inadequate management of weed and pests.	R61	High	**6.2.5**
Long-term impacts related to water due to failure of drainage and water management / storage structures and poor water quality and offsite discharges.	R62, R66	High	**6.2.5**
Rehabilitation adversely affected by climate change, bushfire, drought, flood, etc. Impacting long-term persistence and resilience of vegetation, including response to fire and grazing ultimately leading to failed or poor-quality rehabilitation	R63, R65	Critical	**6.2.5**
Failure to achieve final land use.	R64	High	**6.2.5**
Damage to rehabilitation (e.g. fauna, domestic stock, vandalism, vehicular interactions, bushfire, insects and plant disease).	R67, R68	High	**6.2.6**
Revegetation of the native ecosystem impacted by insufficient establishment of target species and limited species diversity.	R69, R71	Medium	**6.2.6**
Lack of infrastructure to support intended final land use (e.g., dams, fences, and watering facilities).	R70	Low	**6.2.6**
Rehabilitation Phase - Completion			
Delayed tenement relinquishment due to poor rehabilitation failing to meet completion criteria and inability to dispose of land asset post closure leading to offset improvement and management required for a prolonged period after closure.	R72-R74	Critical	**6.2.1**
Rehabilitation Phase - Mine Subsidence Affected Areas			
Issues relating to mine subsidence affecting final landform and closure such as greater settlement than anticipated in backfilled pit areas or waste rock emplacements (WREs).	R75	High	**6.3**

4.0 Rehabilitation Objectives and Rehabilitation Completion Criteria

4.1 Rehabilitation Objectives and Rehabilitation Completion Criteria

The Company's rehabilitation objectives for the Mine can be defined in the short term and long term.

Short Term Rehabilitation Objectives

The short-term rehabilitation objectives are:

- to stabilise all earthworks to minimise erosion and the generation of sediment-laden water as drainage lines and disturbed areas no longer required for mine-related activities
- to reduce the visibility of the activities from adjacent properties and the local road network.

Long Term Rehabilitation Objectives

To achieve the nominated post mining land use goals, the Company's long-term objectives are to:

- provide native vegetation communities suitable for intermittent and very low intensity grazing uses
- decommission and remove all surface infrastructure (unless required for a lawful post-mining land use)
- provide a geotechnically stable landform
- provide a non-polluting landform
- construct a safety bund around the open cut void with appropriate signage
- establish vegetation with maintenance requirements no greater than adjoining vegetation / analogue sites not disturbed by mining activities
- include species consistent with surrounding vegetation communities
- allow for the relinquishment of the mining tenements and the return of the security lodged over the Mining Lease within a reasonable time after the end of the mine life.

The long-term objectives of rehabilitation along with its completion criteria for successful achievement of each final land use domain, are detailed in **Table 4.1**. These have been developed based on the public and government agency review undertaken for the 2011 EIS (Polymetals, 2011) and 2012 Response to Submissions (Polymetals, 2012).

Table 4.1 Proposed Performance Indicators and Rehabilitation Completion Criteria

Final Land Use Domain	Mining Domain	Spatial Reference	Rehabilitation Objective	Indicator (s)	Rehabilitation Completion Criteria	Validation Methods
I - Infrastructure	1 - Infrastructure Area	I1	Create a low-maintenance, geotechnically stable and safe landform that is secure and non-polluting.	Removal of all services (power, water, communications) that have been connected on the site as part of the operation.	Unless specified to be retained, all utility services are removed.	Statement provided, utility service disconnection record / notification. Monitoring of decommissioning/removal using Inspection Test Plan (ITP) documentation which will include key hold points, relinquishment inspection & reporting. Photographic records, and copies of relevant approvals / permits for any retained utility services.
				Decommissioning and/or removal of all infrastructure, mobile plant and equipment, hard stands, hydrocarbon storage tanks, portable office complex, camp facilities, generators, pipelines, etc.	All infrastructure and associated infrastructures, mobile plant and equipment removed from site.	Monitoring of decommissioning/removal using ITP documentation which will include key hold points, relinquishment inspection & reporting. Photographic records, and copies of relevant approvals / permits.
				Removal of haul roads not required for the final land use. All sections of access road to be retained is reduced in width / size for final land use	Roads removed, unless specified to be retained. Long-term access road is reduced in width suitable for final land use.	Monitoring of decommissioning/removal using ITP documentation which will include key hold points, relinquishment inspection & reporting. Photographic records, and copies of relevant approvals / permits.
				Contaminated land/areas identified, land, assessed for potential soil contamination and remediated prior to land rehabilitation.	Remediated land/areas within acceptable limits for final land use.	Monitoring of decommissioning/removal using ITP documentation which will include key hold points, relinquishment inspection & reporting. Photographic records, and copies of relevant approvals / permits. Soil test results from NATA approved Laboratory and Contamination Reports prepared by qualified person.
			All infrastructure that is to remain as part of the final land use is safe and does not pose any hazard to the community.	Potential hazards have been identified, isolated, and secured, and removed from site. All potential hazards isolated and secured, hazardous materials removed from site and transported to an acceptable waste management facility.	All potential hazards isolated and secured. No known hazardous material left onsite.	Monitoring of decommissioning/removal using ITP documentation which will include key hold points, relinquishment inspection & reporting. Photographic records, and copies of relevant approvals / permits, and waste tracking records.

Final Land Use Domain	Mining Domain	Spatial Reference	Rehabilitation Objective	Indicator (s)	Rehabilitation Completion Criteria	Validation Methods
			Established final landform is non-polluting, free draining, stable and permanent.	No pooling of water is observed. Drainage line alongside of long-term access roads are constructed "naturally" as possible and compliments its immediate surrounds, freely drains, are stable and not eroding. 'Downstream' water quality demonstrates compliance with Section 120 of the *Protection of the Environment Operations Act 1997* .	Mapping confirms that the landform is free draining. Final landforms incorporate design relief patterns and principals for consistent with natural drainage. 'Downstream' water quality records total suspended solids <50mg/L or within 10% of 'upstream' levels (whichever is the greater). No 'active' erosion or sedimentation visible.	Final survey plans, photographic records throughout the phases of rehabilitation. Monitoring of Domain after rain events to confirm drainage line alongside the long-term access roads freely drains and do not create erosion or carry sediments downstream. Water quality testing in accordance with the surface water monitoring plan approved as part of the OEMP. Monitoring reported through Annual Returns and ARRs and RMP. Monthly during operations and quarterly for 5 years following completion of final landform works.
			Final landforms sustain the intended land use for the post-mining domain(s).	Rehabilitation monitoring confirms revegetated areas contain species consistent with surrounding vegetation communities. Rehabilitation monitoring confirms the presence of emergent species within revegetated areas indicating vegetation are established and self-sustaining. Rehabilitation monitoring confirms the non- native and non-target species (weeds) represent less than 10% of projected foliage cover or equivalent to surrounding vegetation /analogue sites not disturbed by mining activities.	The final landform is established and self-sustaining within 5 years of land use establishment (first planting of vegetation).	Final survey plans, photographic records throughout the phases of rehabilitation.
			Allow for the relinquishment of the mining tenements and the return of the security lodged over the Mining Lease within a reasonable time after the end of the mine life	Within 10 years of final rehabilitation.	Demonstrated compliance with all completion criteria for this Final Land use Domain. Lease is relinquished and security bond returned.	Final inspection and Relinquishment Report prepared by suitably qualified or experienced person. Return of Security Bond.
B – Agricultural – Grazing	1 - Infrastructure Area 2 – Tailings Infrastructure Area 4 – Overburden Emplacement Area	B1 B2 B4 B8	Domain is fit for the purpose of the intended post-mining land use.	Decommission and removal all surface infrastructure, i.e., mobile plant and equipment, hard stands, ROM pads, pipelines, former mill, process area, raw water pond, process pond and pollution control pond.	All surface infrastructure, mobile plant and equipment removed from site.	Monitoring of decommissioning/removal using Inspection Test Plan (ITP) documentation which will include key hold points, relinquishment inspection & reporting. Photographic records, and copies of relevant approvals / permits. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.

Final Land Use Domain	Mining Domain	Spatial Reference	Rehabilitation Objective	Indicator (s)	Rehabilitation Completion Criteria	Validation Methods
	8 – Other: Stockpiled Material and Associated Areas 8 – Other: Passive Land Management Area		The land capability classifications for the relevant mining domains are established and self-sustaining within 5 years of land use establishment (first planting of vegetation).	Selected native flora compliments the local and regional biodiversity and appropriate for the relevant LSC Class. Selected native flora quickly re-establishes and does not die following revegetation of the final landform. Landform suitable for growth media establishment.	Final landforms sustain the intended land use for the post-mining domain. Final landforms are consistent with and complement the topography of the surrounding region. Established vegetation minimises the visual prominence of the final landforms in the post mining landscape. Final landforms meet LSC Class VI, VII, and VIII slope design criteria, i.e., and use restricted to intermittent and very low intensity grazing and passive nature conservation.	Photographic records throughout the phases of rehabilitation. Monitoring of revegetated area for 5 years from first planting of vegetation. Monitoring results reported through AEMR, ARRs, RMP and EPL Annual Returns. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.
			Stable and permanent landform established	Final landform of Domain 5 is profiled to a maximum slope of 18° (~33%). Final landforms of Domain 2 and Domain 4 are profiled to have its Lower slopes up to 18º (~33%) and upper slopes up to 37º (~75%) with 5m berm (overall slope ~20º [~36%]). Batters with gradients steeper than 35% are seeded by hydromulching and applied with surficial layer of mulch.	Successful completion of revegetation program. Established plants and grasses are growing and self-sustaining. Final landforms meet LSC Class VI, VII, and VIII slope design criteria. No observable 'active' erosion or sedimentation.	Monitoring of plants and grasses, photograph records throughout the revegetation program. Monthly erosion and sediment control, and water monitoring during operations and quarterly for 5 years following completion of final landform works. Monitoring within 5 years of land use establishment (first planting of vegetation) and following the completion of Final landform. Monitoring results reported through AEMR, ARRs, RMP and EPL Annual Returns. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.
			The structure of the encapsulated PAF material (TSF and WRE) is a geotechnically stable landform.	PAF encapsulation area properly formed and capped according to relevant engineering design.	A minimum 900mm impermeable clay cap (1 x 10-9m/s) and non-acid forming store and release cover is present. Geotechnical assessment based on site specific review confirm that the encapsulation area is structurally stable, will not leak and no further earthworks / profiling will be required.	ITPs including photographs, prepared by qualified person during placement of capping and cover layers. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.
			The encapsulated PAF material (TSF and WRE) is non-polluting landform.	Groundwater monitoring results indicate that the pH is not decreasing 'downstream' of both TSF 3 and WRE's encapsulation area. Groundwater quality obligations set out in: Groundwater Monitoring Plan, EPL 20192, and relevant water quality guidelines.	Water quality monitoring results for 5 years demonstrate the landform is non-polluting (both surface land and water, and groundwater).	Groundwater quality monitored quarterly during operations and for 5 years following completion of final landform works. Groundwater quality test results from a NATA approved lab and analysis of results confirming its compliance. Water monitoring results and photographs reported through

Final Land Use Domain	Mining Domain	Spatial Reference	Rehabilitation Objective	Indicator (s)	Rehabilitation Completion Criteria	Validation Methods
						AEMR, ARRs and EPL Annual Returns. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person. Surrender of relevant leases and licences.
			Landform is non-polluting, free draining.	No water pooling different Domains, and specifically on the upper surface of the TSF. Suitable water management structures (e.g. surface water controls such as drainage lines) constructed as "naturally" as possible, designed for 1 in 100 year ARI event, freely drains, structurally stable and not eroding. Observed water runoff drains freely within the reconstructed contours and along drainage lines of the final landform. Water quality monitoring results to show the landform is non-polluting (both surface land and water, and groundwater). 'Downstream' water quality monitoring records total suspended solids <50mg/L or within 10% of 'upstream' levels (whichever is the greater).	Mapping confirms that the final landform is free draining. Water management structures of the final landform are designed in accordance with the Blue Book (Landcom, 2004). Final landform surface water quality complies with EPL 20192 and meet the objective of Section 120 of the (POEO Act). Final landform incorporates design relief patterns and principles that is consistent with natural drainage and groundcover of the area.	Relevant Plans are prepared by suitably qualified surveyor. Water management structures are constructed per survey plans, photographic records throughout the phases of rehabilitation and following completion of final landform. Monitoring after rain events to confirm drainage line freely drains without creating erosion or carrying sediments downstream, and no water pooling at key areas within the different Mining domains. Monthly water monitoring during operations and quarterly for 5 years following completion of final landform works. Analysis of water quality results from a NATA approved lab and confirm compliance. Monitoring results and photographs are reported through AEMR, ARRs, RMP and EPL Annual Returns. Final inspection and relinquishment report prepared by suitably qualified or experienced person. Surrender of relevant leases and licences.
			Removal of all stockpiled materials not required for use as rehabilitation resource material.	Stockpiled materials are identified, characterised, and appropriately managed prior to being effectively used as growth media resource for land rehabilitation. All remaining stockpiles (including ore) not identified as a resource for rehabilitation are removed.	Segregation of characterised stockpiled materials. Characterised stockpiled materials treated and classified as either Primary or Secondary Growth Media. No stockpiled materials left at the Mine.	ITPs, Hold Points and Photographic records throughout the phases of soil treatment segregation and removal. Final Inspection and Relinquishment Report prepared by suitably qualified or experienced person.

Final Land Use Domain	Mining Domain	Spatial Reference	Rehabilitation Objective	Indicator (s)	Rehabilitation Completion Criteria	Validation Methods
			Establish soil / growing medium suitable for establishment of grassland or woodland vegetation community.	Treated stockpiled materials classified as Primary and Secondary Growth Media. Compacted surfaces are deep ripped along contour. Minimum growth medium depth of 50mm over new disturbance areas, TSF3 and PAF encapsulation area Analysis of soil samples (1 bulk sample per ha) record parameters as follows: pH – 6.0 to 8.5; and electrical conductivity <0.4d S/m.	Primary and Secondary Growth Media effectively used across the site. Stockpiled material effectively used to reduce erosion, and to promote plant growth and establishment. Ripped areas ready for revegetation. Key soil characteristics generally within the range of pre-disturbance soil characteristics. Small 'test pits' (5 per ha) dug and photographed to show final soil depth. Report indicates required thickness are achieved.	Treatment rates for stockpiled materials according to **Table 6** of the Landloch Report (March 2021, Rev1). ITPs with stop/hold points, and photographs records of, phases of soil treatment, soil ripping and spreading operations. Photographs of test pits reported through AEMR or relinquishment report. Soil analysis report (included in AEMR or relinquishment report). Monitoring following deep ripping and spreading of soil, annually for 5 years. Monitoring Report prepared by suitably qualified and experienced person. The report includes a summary of performance of the treatment area(s) against local benchmark / analogue monitoring points and photographs. Monitoring results reported through AEMR, ARRs, RMP. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.
			Provide a cover of soil over above ground landforms that will enable the establishment of and sustain the nominated vegetation.	Timber debris stockpiles used to increase hydraulic roughness of slope batters to help store sediment, aid in water retention and act as ground cover.	Stockpiled material effectively used to reduce erosion, and to promote plant growth and establishment.	
			Selection and establishment of vegetation communities with a similar species composition to the surrounding native vegetation communities complementing regional and local biodiversity.	Species mix for revegetation applied in accordance with species outlined **Table 6-I.** Size, locations and species of native tree lots and corridors are established to sustain biodiversity habitats. No "active" erosion or visible sedimentation on the rehabilitated area. Total projected foliage cover is greater than 50% but targeting 70% cover or equivalent to analogue sites not disturbed by mining. Weed and pest species identified, and management/ control programs are in place.	Revegetation monitoring reports confirm that, after 2 years from planting, >70% of the total number of species established are either in accordance with the applied species mix or local native species and represent >50% to 70% of the total projected foliage cover. The rehabilitated area does not constitute an erosion hazard. Domestic grazing animals are excluded from the rehabilitation area (except if controlled grazing is required for ecosystem development).	Establish a minimum of two monitoring points in each treatment area and at least three in the desired local benchmark community / analogue sites. Monitoring within 5 years of land use establishment (first planting of vegetation) and following the completion of Final landform. Annual revegetation monitoring for a minimum of 5 years. Formal bi-annual monitoring during spring and autumn to control targeted, competing and out of control weed/non-native species, with follow-up spot spraying of emergent weed species. Formal bi-annual monitoring (July and January) to measure and
			Maintenance of self-sustaining vegetation communities with a similar species composition to the surrounding native vegetation communities and capable of very light intensity grazing uses.	New growth of endemic species is observable at rehabilitated areas. Weeds are appropriately controlled, do not compete with established vegetation, and do not impact on rehabilitated area.	Monitoring programs demonstrates successful regeneration of rehabilitated area. Revegetation monitoring confirms that, after 2 years, the non-native / non-target species (weeds) represent less than 20% of projected foliage cover or equivalent to analogue sites not disturbed by mining activities.	

Final Land Use Domain	Mining Domain	Spatial Reference	Rehabilitation Objective	Indicator (s)	Rehabilitation Completion Criteria	Validation Methods
				Relevant conditions under the ***Biosecurity Act 2015*** and site-specific **Weed Control Orders; Weed Control Program.** Observable vertebrate pest population onsite is lower in number compared to the previous year. Grazing by native and domestic fauna not adversely impacting on ecosystem development.	Priority weeds or Weeds of National Significance (WoNS) are under control and not impacting on the rehabilitated area. Revegetation monitoring reports confirm appropriate level of grazing / equivalent to analogue sites not disturbed by mining	control targeted vertebrate pest and native fauna numbers. Monitoring Reports prepared by suitably qualified and experienced person. The report includes a summary of performance of the treatment area(s) against local benchmark / analogue monitoring points and photographs Monitoring results reported through AEMR, ARRs, RMP. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.
			Revegetated areas provide a vegetation community with maintenance requirements no greater than adjoining vegetation / analogue sites not disturbed by mining activities.	Analysis of soil samples (1 bulk sample per ha) record parameters as follows: pH – no more than 10% lower than analogue sites after 5 years; and electrical conductivity is < 0.4d S/m after 5 years. Monitoring at analogue sites Native species diversity and coverage consistent with local benchmark / analogue sites. Weed control requirements no greater than analogue sites.	Key soil characteristics remain within acceptable range for plant establishment growth and development of emergent endemic species. Vegetation is well established growing and self-sustaining with observable successive generations of endemic species. Revegetation/biodiversity monitoring reports confirm that, after 5 years from planting, >80% of the total number of species established are either in accordance with the applied species mix or local native species and represent >60% to 80% of the total projected foliage cover.	Soil analysis report included in AEMR, ARRs, RMP and Relinquishment Report. Monitoring Reports prepared by suitably qualified and experienced person. The report includes a summary of performance of the treatment area(s) against local benchmark / analogue monitoring points and photographs Monitoring results reported through AEMR, ARRs, RMP. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.
F- Water Management Area	3 - Water Management Area	F3	Decommission and remove all surface infrastructure (unless required for a lawful post mining land use).	All associated infrastructure (pipelines, pumps, sediment fences etc) no longer required are removed (unless required for a lawful post mining land use). Retained infrastructure (e.g., fences, etc.) requiring maintenance are repaired prior to the Final Inspection.	No associated infrastructure at water management areas. Retained infrastructure are fit for purpose and maintenance is not required.	Status of decommissioning reported through ARRs and RMP. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person. The Report includes a summary of the decommissioning and photograph records.

Final Land Use Domain	Mining Domain	Spatial Reference	Rehabilitation Objective	Indicator (s)	Rehabilitation Completion Criteria	Validation Methods
			Provide permanent landform that are geotechnically safe, stable, and fit for the purpose of the intended long term water management.	Sediment basins are stable and contain a suitably stable spillway for overflow of water to surrounding drainage lines. Creek diversion, drainage lines, basin walls are protected from erosion with design specific ground cover per Blue Book RUSLE calculation guidelines. Geotechnical assessment undertaken following the completion of mining confirm that water management structures (batters/basin walls, spillways, creek diversions, dams) are not likely to actively erode or 'slip' to an extent requiring further earthworks and profiling.	Water management structures are designed for 1 in 100-year ARI event and constructed as "naturally" as possible. Basin walls and spillways do not show signs of active erosion and are assessed to be stable. Creek diversion remains stable, do not present observable erosion and is not a source of water pollution / sedimentation.	Photograph records of reconstruction and rehabilitation of water management structures. Status and progress of the reconstructed sections of the water management structures are reported in the ARRs and RMP. Monitoring within 5 years of land use establishment (first planting / application of vegetative groundcovers). Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.
			Water management areas are free-draining and non-polluting.	No visible evidence of unwanted water pooling within the mining lease. Observed water runoff drains freely within the reconstructed contours and along drainage lines and does not cause erosion hazards to designated sediment basins. Water quality monitoring results comply with the water criteria levels in the Soil and Water Management Plan, and Limit Conditions identified in EPL 20192. 'Downstream' water quality monitoring records total suspended solids <50mg/L or within 10% of 'upstream' levels (whichever is the greater). Water discharged from site is consistent with the baseline ecological, hydrological, and geomorphic conditions of the creeks prior to mining disturbance	Mapping confirms that the landform is free draining. Water quality monitoring results for 5 years demonstrate the water management areas are non-polluting. Water quality meets the objective of Section 120 of the *Protection of the Environment Operations Act 1997*. Water management is consistent with the regional catchment management strategy.	As constructed survey plans, photograph records. Monthly water monitoring during operations and quarterly for 5 years following completion of final landform works. Water quality test result from a NATA approved laboratory and test results comply with EPL 20192. Water monitoring results are reported in the ARR, EPL Annual Returns, and RMP. Final inspection and Relinquishment Report prepared by suitably qualified or experienced person.
			Water retained onsite is for the intended land use for the post-mining domain.	Water management areas are free of contamination and meet the requirements for stock drinking water and EPL 20192.		Surrender of water licences and EPL 20192.
			Allow for the relinquishment of the mining tenements and the return of the security lodged over the Mining Lease within a reasonable time after the end of the mine life.	Within 10 years of final rehabilitation.	Demonstrated compliance with all completion criteria for this Final Land use Domain. Lease is relinquished and security bond returned.	Final inspection and Relinquishment Report prepared by suitably qualified or experienced person. Security bond returned.
J - Final Void	5 - Active Mining Area (Open cut void and Adjacent safety bund)	J5	All mobile equipment has been removed	Mobile equipment has been removed during the decommissioning phase.	No remaining mobile equipment.	Final inspection following completion of final landform establishment, and relinquishment report prepared by suitably qualified or experienced person.
			Provide a final landform that is non-polluting, is safe and secure, geotechnically stable, and fit for the	LSC Class VII – i.e., not suitable for agriculture or revegetation.	Highwalls appropriately blast profiled, and geotechnically stable.	Plan(s) prepared by surveyor and photographs included in ARRs, and RMP.

Final Land Use Domain	Mining Domain	Spatial Reference	Rehabilitation Objective	Indicator (s)	Rehabilitation Completion Criteria	Validation Methods
			purpose of the intended post-mining land use(s).	Retained slopes of the void are not likely to actively erode or 'slip', and no longer require further earthworks and profiling. Overall highwall slope no greater than 700 or as specified in geotechnical review. A 2-metre-high safety bund with steep batters is constructed around the open cut void. Higher bund constructed where the haul road enters the open cut.	Warning signs erected at regular intervals. A completed safety bund with sufficient height and distance surrounds the open cut void to prevent stock and vehicular access. Demonstrated compliance with all performance indicators. Geotechnical assessment based on site specific review and, determines that the retained slopes are not likely to actively erode or 'slip' to an extent requiring further earthworks and profiling.	Geotechnical assessment undertaken by a qualified person following the completion of mining, and Geotechnical Review / Report prepared by a suitably qualified person. Final inspection following completion of final landform establishment, and relinquishment report prepared by suitably qualified or experienced person.
			Water retained within the void is fit for the intended land use.	Water quality monitoring results to show the landform is non-polluting.	Water quality monitoring results to show the landform is non-polluting.	Water monitoring program Final inspection following completion of final landform establishment, and relinquishment report prepared by suitably qualified or experienced person.
H -Heritage Area	8 – Other: Aboriginal heritage sites and European heritage sites	H8	Inclusion of management practices for conservation of Aboriginal cultural heritage values, and consideration of these sites within a regional Aboriginal and European heritage context.	Heritage sites are cordoned off for their protection. Aboriginal sites formally entered onto the Heritage NSW[6] Aboriginal Heritage Information Management System (AHIMS)	Appropriate conservation management practices implemented until relinquishment of Mining Lease. Consultation with the Aboriginal People with a cultural association with the Land prior to relinquishment of the Lease.	Existing protocols relating to site staff induction and training and the unexpected discovery of sites or artefacts with Aboriginal cultural heritage value. Final inspection and Relinquishment Report prepared by Aboriginal Elder or representative, and/or suitably qualified person.
			Allow for the relinquishment of the mining tenements and the return of the security lodged over the Mining Lease within a reasonable time after the end of the mine life.	Within 10 years of final rehabilitation.	Demonstrated compliance with all completion criteria for this Final Land use Domain. Lease is relinquished and security bond returned.	Final inspection and Relinquishment Report prepared by suitably qualified or experienced person. Security bond returned.

[6] DECCW was formerly responsible for the protection of Aboriginal culture heritage. Following the recent restructure, the protection of Aboriginal cultural heritage in NSW is the joint responsibility of Heritage NSW and the Department of Planning Infrastructure and Environment (DPIE) under the *National Parks and Wildlife Act 1974* (NPW Act). The Heritage NSW provide an integrated approach to conserving both Aboriginal cultural heritage and environmental heritage, and also support *The Heritage Council of NSW* to carry out functions under the *NPW Act 1974* and the *Heritage Act 1977.*

4.2 Rehabilitation Objectives and Rehabilitation Completion Criteria – Stakeholder Consultation

4.2.1 Community Consultation

Since acquiring the Mine, the Company has regularly contacted residents of Canbelego regarding activities and operations and its personnel are well known to the local community. Formal meetings were held with residents and landholders from the surrounding area as part of the original development application process for DA 2011/LD-00070 and for the subsequent modification in 2015. These meetings included discussion of the planned rehabilitation of the site and return to very low intensity grazing and vacant Crown land.

Prior to the submission of the RMP, a letter containing the proposed rehabilitation objectives and completion criteria was circulated to local residents who were invited to review and provide feedback. No objections or other feedback were received, and no further actions were undertaken in relation to the rehabilitation objectives and completion criteria.

Consultation will continue with these residents to keep them informed of the ongoing operations, however, as no specific agreements, objections or other expectations regarding the post mining land use or rehabilitation objectives were raised by the community during consultation, no alterations to the final land use are proposed.

4.2.2 Consultation with Aboriginal Groups

Extensive consultation has occurred between site and the Traditional Owners for the area, namely, the Ngiyampaa people. An agreement has been signed with the Ngiyampaa people which includes pre-development surveys for any proposed areas of disturbance. All site investigations have been completed in consultation with the Ngiyampaa people.

As no specific agreements, objections or expectations regarding the post mining land use or rehabilitation objectives were identified during consultation, no alterations to the final land use are proposed.

4.2.3 Government Agency Consultation

The Company and or its representatives undertook consultation with the following government agencies throughout the development assessment process for the currently operations.

- NSW Division of Resources and Energy (DRE).
- Cobar Shire Council (CS Council).
- NSW Environment Protection Authority (EPA).
- Biodiversity Conservation Division (BCD),
- Heritage NSW.
- Department of Planning and Environment – Water (DPE-Water.

- Department of Planning and Environment - Crown Lands (DPE-CL).
- Transport for NSW (TfNSW).

As part of DA 2011/LD-00070REV01, the (then) DRE required that rehabilitation must be consistent with specified rehabilitation objectives outlined within their submission. The rehabilitation objectives identified in **Section 4.1** and **Table 4.2** are consistent with the objectives then specified by the DRE and referenced in DA 2011/LD-00070REV01.

Following the issue of DA 2011/LD-00070REV01, a copy of the Mining Operations Plan (dated August 2015 by Black Oak Minerals Limited) was circulated to the DRE and following agencies for comment:

- DPE-CL
- NSW EPA
- CS Council
- Department of Primary Industry – Catchments and Lands (DPI)
- NSW BCD
- Heritage NSW, and
- DPE-Water.

Comments were raised in relation to control of pests and ensuring any soil material brought to site is free of weeds. DPI also requested to be consulted should any changes to the final landform and rehabilitation occur. However, no specific comments or concerns relating to the proposed rehabilitation objectives, completion criteria or land use were raised.

A meeting with representatives of the NSW RR was held in Maitland on 22 November 2019 to discuss the planned resumption of mining activities at the Mine. The operational performance of the previous owner of the Mine, Black Oak Minerals Limited, was also discussed. It is acknowledged that operations under the previous owner were not in accordance with the previous MOP, particularly those associated with rehabilitation commitments. In light of this, the Company carefully reviewed the rehabilitation commitments, milestones and methodologies and commissioned several rehabilitation research projects and trials (refer to **Section 9.1**) to support future approach to rehabilitation.

Prior to the submission of the RMP, a letter containing the rehabilitation objectives and completion criteria was circulated to the following agencies:

- NSW RR
- Cobar Shire Council
- NSW BCT
- DPE Crown Lands

Each agency was invited to review and provide feedback on the rehabilitation objectives and completion criteria. No objections or other feedback were received, and as such no further actions were undertaken.

Table 4.2 Final Land Use Options Assessment Consultation Process

Date	Stakeholder	Consultation Activities and Method	Matter Subject to Consultation	Outcomes of Consultation (Rehabilitation and Land Use)
2011	CS Council	2011 EIS submission	Surface water management including water supply, groundwater, waste rock management including acid rock drainage, flora and fauna, Aboriginal and European cultural heritage values, noise and vibration, air quality, process and chemical handling and waste management and local community issues.	Submissions were received from: • NSW EPA • NSW Office of Water • Division of Resource and Energy • Cobar Water Board • DPI – Catchment Land • one landowner Of the six submissions two contained requests for further information and the rest contained comments for consideration.
2012	Division of Resources & Energy	Written request for information and Comments for consideration on the Mt Boppy Gold Mine Redevelopment Project. Received as a submission in response to the EIS submission 2011.	Post mining land use, available rehabilitation resources, rehabilitation methodology and conceptual landform design	All requests for information and comments for consideration were addressed in the Polymetals document *Response to Submissions, Development Application 2011/LD-00070 2012*
2012	Environmental Protection Agency NSW	Written request for information received as a submission in response to the EIS submission 2011.	Biodiversity, Aboriginal heritage, noise, air pollution, surface water, groundwater, hazardous material management, and waste.	Agreement to offset disturbances at mine site with 25ha biodiversity offset area. Clarification of significance of Aboriginal Cultural Heritage sites.
2012	DPI – Catchment and Lands	Comments for consideration on the Mt Boppy Gold Mine Redevelopment Project. Received as a submission in response to the EIS submission 2011. Reference WL04A50	Native vegetation, water supply, dust suppression, monitoring, water management regime, contaminated water, chemical disposal, groundwater, rehabilitation,	Further information was provided to Catchment and Lands covering all comments made in their submission. Areas specific to final land use include Retention of some internal roads, use of natural vegetation during rehabilitation and a commitment to consult DPI Catchment and Lands when preparing a biodiversity offset strategy.

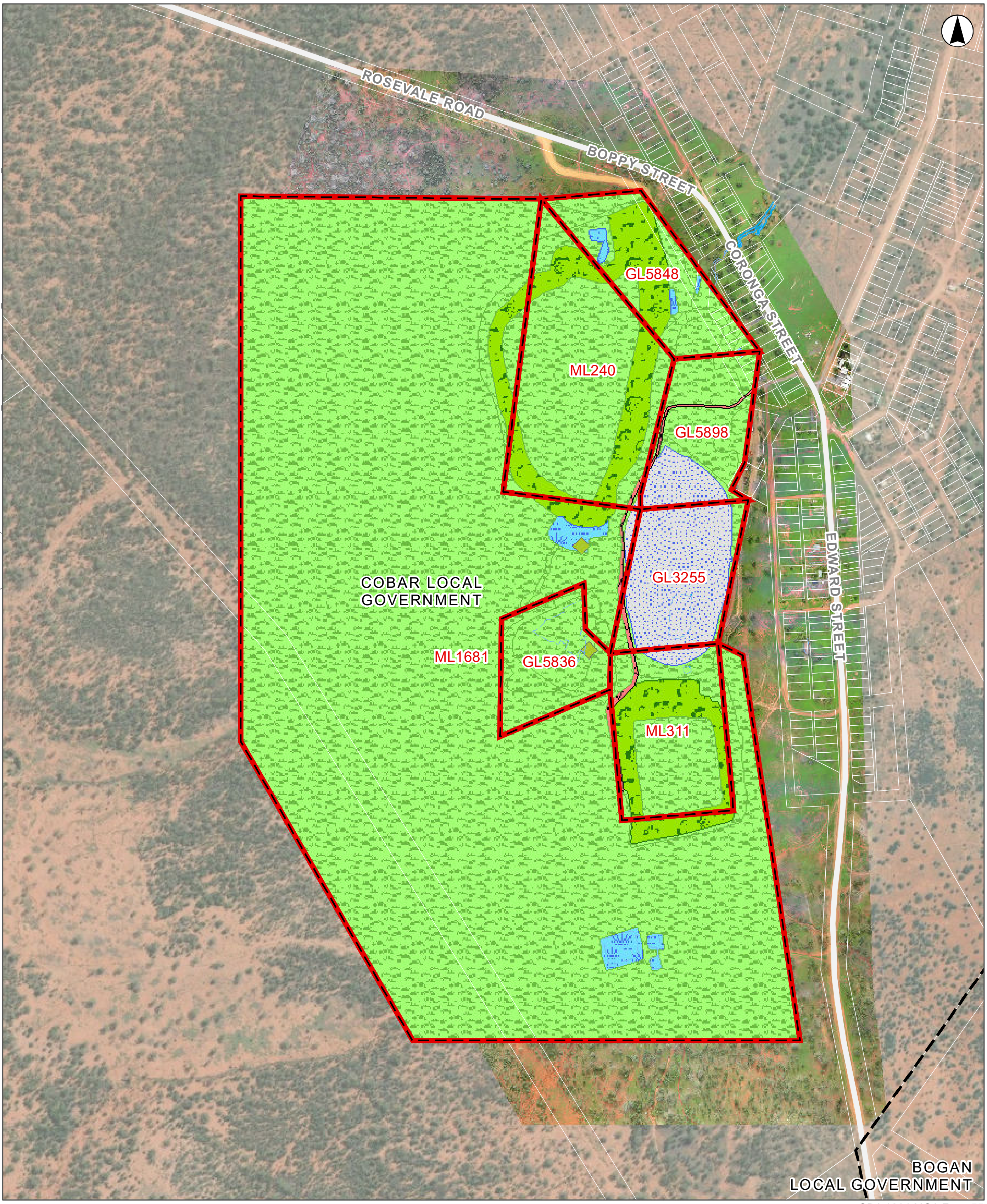
Date	Stakeholder	Consultation Activities and Method	Matter Subject to Consultation	Outcomes of Consultation (Rehabilitation and Land Use)
2015	Residents of Canbelego	Formal meetings were held with residents and landholders from the surrounding area as part of the original development application process for DA 2011/LD-00070 and for the subsequent modification in 2015.	Meetings included discussion of the planned rehabilitation of the site and return to very low intensity grazing and vacant Crown land.	No public submissions or objections were received in relation to the 2015 modification application which states that the preferred land use is native vegetation communities suitable for intermittent and very low intensity grazing.
2020	NSW Resources Regulator	TAP assessment	Soils characterization and availability of resources for rehabilitation	Soils characterization testing was completed to assess the availability of material required to achieve the proposed final land use.
2022	NSW RR CS Council BCT DPE-Lands Residents of Canbelego	Written request for feedback on rehabilitation objectives and consultation criteria.	The rehabilitation objectives, performance indicators and completion criteria that have been established and which Manuka Resources proposes to retain, subject to consideration of feedback received from the relevant stakeholders.	No feedback or objections were received in relation to the rehabilitation objectives, performance indicators and completion criteria proposed for the Mine Site.

5.0 Final Landform and Rehabilitation Plan

The final landform and rehabilitation plan are defined under Clause 12 of the Regulation as Rehabilitation Outcome Documents required to be submitted to the Secretary for approval. The final landform and rehabilitation plan is provided in this RMP to satisfy the requirement Clause 12(1)(c) of the Regulation.

5.1 Final Landform and Rehabilitation Plan – Electronic Copy

In accordance with the requirements of the RMP guidelines, a Final Land Use and Rehabilitation Plan (**FLRP Plans 1** and **2**) has been prepared to show the proposed final land use and final landform at the end of mine life for the site.



Legend

- Roads
- Water
- Water line
- Local Government Area
- Project Approval Boundary
- Minerals - Current Titles

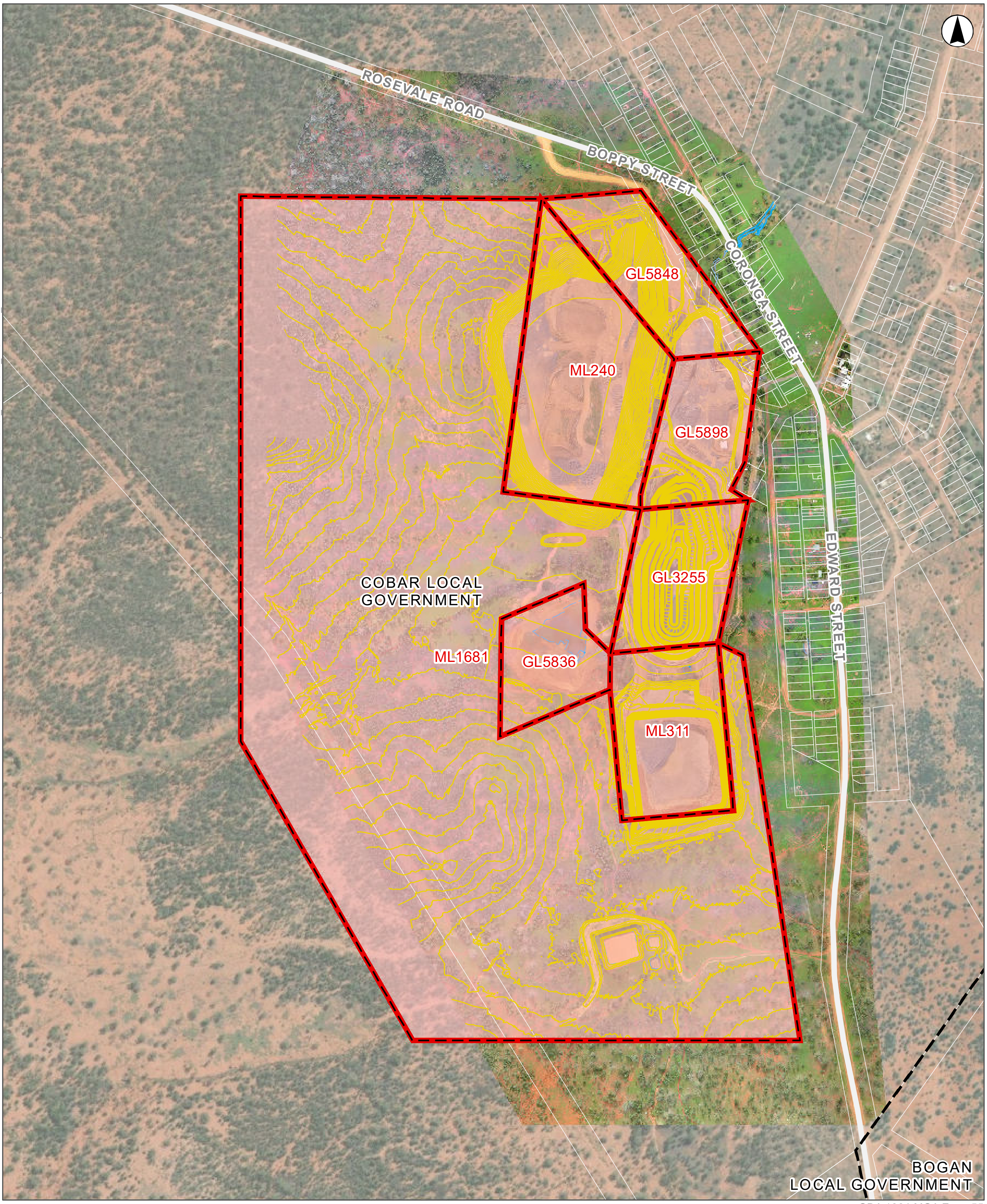
Final Landuse

- Agricultural – Grazing
- Final Void
- Heritage Area
- Infrastructure
- Native Ecosystem
- Water Management Areas

FLRP PLAN 1

MT BOPPY GOLD MINE
Final Landform Features

Data source: New South Wales State Government, SEED



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A4 Scale of 1:12499.96

GDA 1994 MGA Zone 55

0 200 400

Metres

Legend

- Roads
- Water
- Water line
- Final Landform Contours
- Local Government Area
- Project Approval Boundary
- Minerals - Current Titles

FLRP PLAN 2

MT BOPPY GOLD MINE
Final Landform Contours

Data source: New South Wales State Government, SEED

6.0 Rehabilitation Implementation

6.1 Life of Mine Rehabilitation Schedule

Mining at Mt Boppy is approaching the limits approved by the development consent (depth of mining to approximately 160 mAHD), however, access to the remaining ore reserves and therefore completion of mining is currently prevented as a result of an accumulation of water within the open cut void. The Company also notes that exploration, resource definition and mine planning is ongoing with additional ore identified below 160 mAHD which is likely to be incorporated into approved mine plans (subject to development approval). The Company also notes that material contained within the Waste Rock Emplacement (WRE) is planned to be used for rehabilitation of other domains at the Mine, e.g. capping the TSF and infrastructure areas, as well as stabilising sections of the final open cut. This waste rock could be drawn from the WRE or the open cut void. Therefore, until final mine plans, including use of waste rock for rehabilitation activities are finalised, landform preparation and rehabilitation of the open cut, WRE and infrastructure areas cannot be planned with certainty. As a consequence, rehabilitation works on the open cut void and Waste Rock Emplacement (WRE) will be delayed until 2026 and beyond.

The immediate focus of rehabilitation is on the preparation of the TSF landform for rehabilitation, a process which is expected to take approximately 3 years to complete.

Following this initial RMP Period and following confirmation of waste rock requirements and future mining, the Company, rehabilitation works will progress to landform preparation on the WRE and revegetation on the TSF. Following the completion of mining and transportation of ore from the Mine, the remaining areas of the Mine will commence their early phase of rehabilitation.

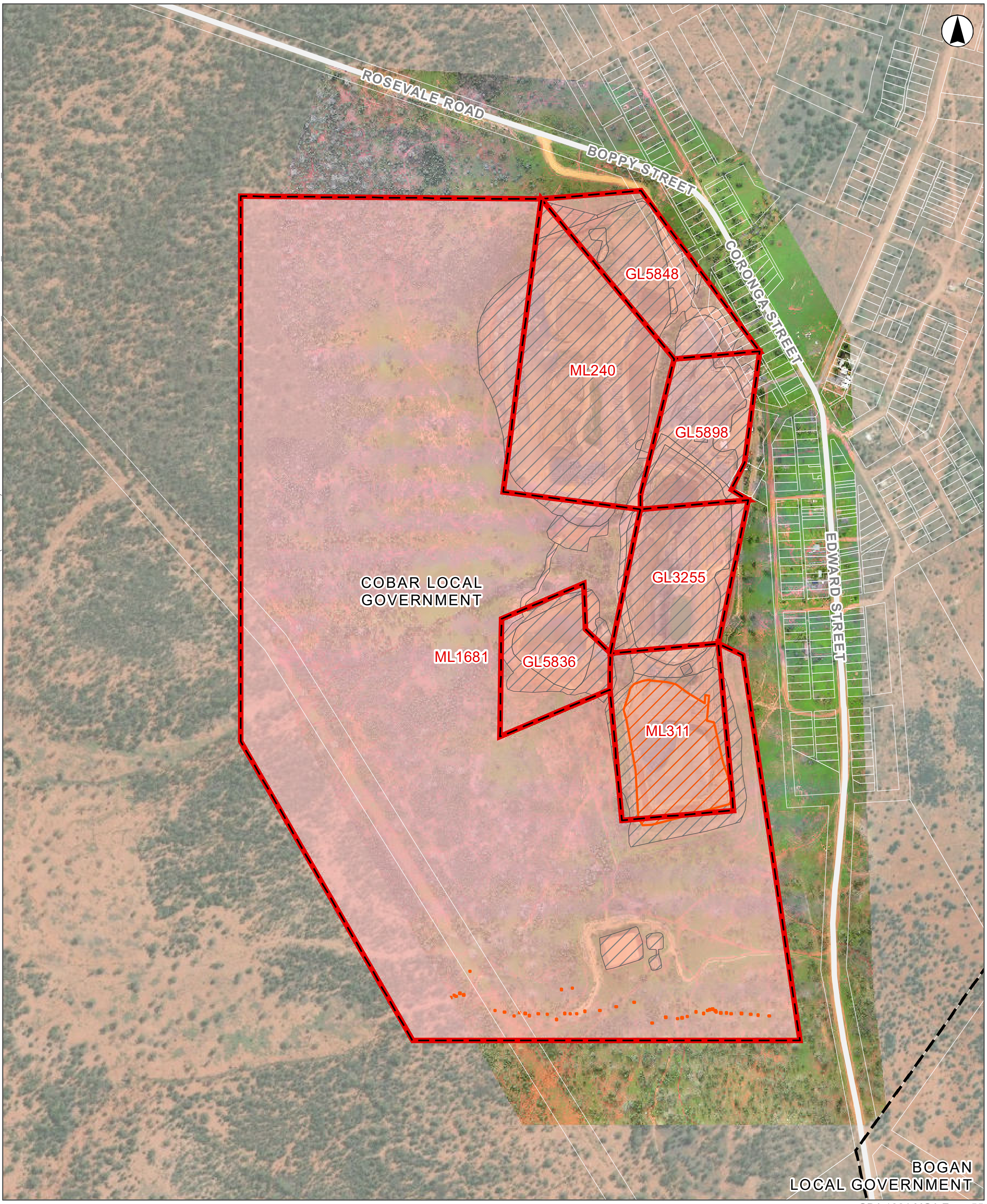
The early rehabilitation phase (Decommissioning, Landform Establishment, and the Growth Medium Development) will include the mine closure engineering activities i.e., the removal of key infrastructure no longer required onsite, redesigning of retained associated infrastructure (long term access roads, water management infrastructure, etc) where necessary to suit the final land use, and final landform construction and development of vegetation substrate in preparation for the vegetative rehabilitation phase (Ecosystem and land use establishment, and the Ecosystem and land use development).

Without considering inclement weather conditions, and assuming no additional mining at Mt Boppy, the approximate timeframe to complete rehabilitation phase is as follows.

Table 6.1 Indicative Rehabilitation Schedule

Phase	Description	Completion by (estimate)
1	TSF: Land Prepared for Rehabilitation	2025
2	WRE / Open Cut: Land Prepared for Rehabilitation TSF: Ecosystem Establishment (revegetation)	2026-2027
3	Mine decommissioning Ecosystem Establishment of all domains	2028-2030

Figure 6.1 and **Figure 6.2** provides the conceptual rehabilitation and final landform status as of 2025 and 2030.



A4 Scale of 1:12499.96

GDA 1994 MGA Zone 55

0 200 400
Metres

Legend

- Roads
- Local Government Area
- Project Approval Boundary
- Existing Disturbance
- Minerals - Current Titles

Forecast Data

- Forecast Land Prepared for Rehabilitation

FIGURE 6.1

MT BOPPY GOLD MINE
Life of Mine Rehabilitation
Schedule (Year 2025)

Data source: New South Wales State Government, SEED

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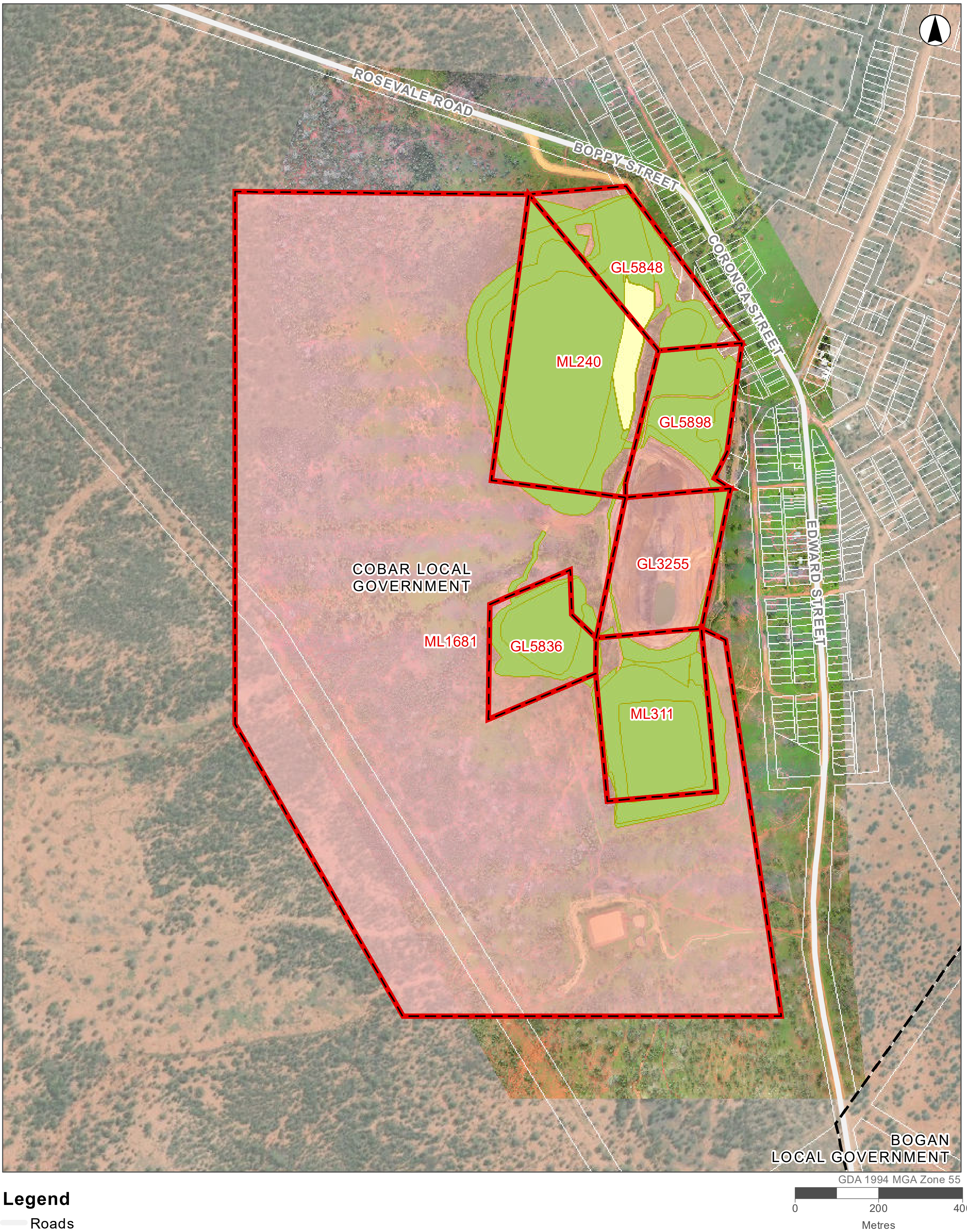

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Legend

Roads
Local Government Area
Project Approval Boundary
Minerals - Current Titles

Rehabilitation

Landform Establishment
Ecosystem and Land Use Establishment

FIGURE 6.2

MT BOPPY GOLD MINE
Indicative Life of Mine Rehabilitation Schedule (Year 2030)

Data source: New South Wales State Government, SEED

6.2 Phases of Rehabilitation and General Methodologies

The rehabilitation hierarchy used in this RMP follows the new requirements outlined in the *Form & Way Guideline For Large Mines* (NSW Resources Regulator, 2021).

6.2.1 Active Mining

The following section summarises how key aspects in the active mining phase are managed at the Mine Site.

a. Soils and Materials

No further soil stripping is expected to be required during this RMP term.

The general process for the management of topsoils to preserve their quality for future rehabilitation outcomes is as follows.

- Sampling and soil analysis and characterisation to identify the nature of the material and determine any ameliorant techniques that may need to be applied. This includes:
  - results from the materials characterisation study identified soil type materials that could potentially be used as primary growth media.
  - key findings and recommendations from the Mt Boppy Gold Mine Materials Characterisation Program for Rehabilitation Report (Landloch Pty Ltd, 2021) (refer to **Appendix 1**).
- An inventory of soil/growth media retained vs soil required for rehabilitation is maintained. The currently stockpiled soil material and weathered overburden will provide sufficient material to apply a 0.05 m depth of growth media across the final WRE, capped TSF and ROM pad (total area of 34.4 ha which equates to a requirement for 17,200 cm^3 soil). This includes:
  - approximately 10,600 loose cubic metres (lcm) of stockpiled soil
  - 10,200 lcm of weathered overburden material stockpiled on the WRE (which will be recovered and used to supplement the soil material as a growth medium)
- The surplus soil and weathered overburden (~3,600 lcm) will be spread across selected infrastructure areas or used to increase the soil depth across the flatter areas of the WRE and TSF.
- Over the majority of the infrastructure area, a base of weathered material and soil is present. With appropriate treatment, namely deep ripping and soil amendment, this is expected to provide an adequate growth medium.

b. Flora

No further vegetation clearing is required for the Mine.

There are no threatened flora species of conservation significance on the mine site and remnant vegetation communities are highly disturbed and degraded and of limited ecological value. As such, no threatened species, or species habitat to be included in rehabilitation.

Management measures to be impacted to maximise rehabilitation benefits and final land use objectives are as follows.

- Paths for movement of mobile equipment are clearly defined to avoid additional disturbance to native vegetation / flora.
- Cleared native vegetation is track rolled and stockpiled to provide organic matter for future spreading over rehabilitated areas.
- Inspections of rehabilitation and existing vegetation at the Mine is undertaken to review presence of weeds. Weed management contractors will be engaged as required to reduce the spread and presence of weeds to meet rehabilitation objective and criteria.
- The revegetation program is further discussed in **Section 6.2.5**.

c. Fauna

No targeted measures are proposed. The following general fauna management measures will be implemented by the Environmental Officer or their delegate:

- The stockpiled vegetation will be monitored for rabbits and other pest species. Implementation of pest management strategies to reduce the number of vertebrate pests is further discussed in **Section 6.2.5.**
- While the previous ecological surveys concluded that no hollow bearing trees were located within the disturbance areas. No further disturbance is expected during this RMP term however, if required, pre-clearance surveys shall be completed to verify potential fauna roosting at any identified hollow trees.

d. Rock/Overburden Emplacement

Rock / overburden emplacement will continue to be placed on non-rehabilitated areas of the WRE.

e. Waste Management

Production waste is restricted to overburden and managed as described in **Section 6.2.1d**.

The mining operations does not require any significant volume of hazardous materials. There are no chemical reagents stored or utilised on the site.

In most cases, non-production waste generated during mining and rehabilitation activities will be collected at the Mine and removed for disposal or recycling by a suitably qualified contractor. **Table 6.2** presents an estimate of the non-production waste and briefly describes how each class of waste will be stored and subsequently removed from the Mine.

Table 6.2 Non-Production Waste Management

Waste Type	Storage/Management	Removal/Disposal
Putrescible waste (including food scraps)	Covered bins or skips located at lunch areas, offices, outside workshops and elsewhere as required. Where these bins are located in open areas, they will be fitted with animal proof lids.	Collected on a regular basis by a licensed contractor and transported to an appropriately licensed facility for disposal.

Waste Type	Storage/Management	Removal/Disposal
General Recyclables	Covered bins or skips located at lunch areas, offices, outside workshops and elsewhere as required. Where these bins are located in open areas, they will be fitted with animal proof lids.	Collected on a regular basis by a licensed contractor and transported to an appropriately licensed facility for recycling.
Waste Oils and Greases	Placed within the bunded tank within the workshop area. Where required, smaller, temporary storage containers may be positioned close to work areas, with the contents of those containers transferred to the larger storage tank.	Collected on an as needs basis by a licensed contractor and transported to an appropriately licensed facility for recycling.
Contaminated soils	Soils within and surrounding former infrastructure areas will be assessed for potential contamination. Contaminated material will be managed in accordance with the guidelines under the *Contaminated Land Management Act 1997*.	Any contamination present will be remediated, and contaminated material will be treated or appropriately disposed of.

f. Geology and Geochemistry

The characteristics of the ore to be extracted is described as follows:

- Host rock comprised mostly quartz and clay-sericite.
- Predominant sulphide is pyrite.
- Minor sulphide is sphalerite with rare minute inclusions of galena.
- No arsenopyrite has been identified.

Waste rock has been characterised in relation to the potential for acid forming materials. Whilst the Mine does not have a history of acid mine drainage, during exploration and mine planning a proportion of the waste rock has been identified as PAF material.

Based on laboratory testing, waste rock with a sulphur percentage of 0.3% and above will be managed as PAF material. Waste rock material with total sulphur content greater than 1% (~102 000bcm) is considered to be 'increased risk' material and will be placed within the existing TSF 3 structure prior to capping.

The remaining 'moderate risk' PAF material with total sulphur content between 0.3% and 1% (~191,000bcm) has been placed within specially designed sections of the WRE. The location of encapsulation has been mapped and retained such that future campaigns to source waste rock for TSF capping material do not disturb this.

g. Material Prone to Spontaneous Combustion

As no ore material on site is prone to spontaneous combustion no specific management measures are necessary.

h. Material Prone to Acid Mine Drainage

In 2015, four tailings and twenty waste rock samples were collected by RGS for analysis (static and kinetic tests) to understand the acid neutralising and acid generating characteristics of these materials (RGS, 2015). Soil quality (effective CEC and Exchangeable Sodium Percentage [ESP]) of strongly oxidised/weathered waste rock samples was also investigated to determine its potential as component of capping materials at the WRE and TSF3.

Material characterisation provided by the RGS (2015) has allowed the risk of acid formation to be categorised. Potentially Acid Forming (PAF) material will be managed as follows.

- Material with total sulphur content greater than 1% has been categorised as being an 'increased risk' of containing Potentially Acid Forming (PAF) material.
- This material will be paddock dumped over the existing tailings surface in piles approximately 3m high.
- These will be pushed out by a bulldozer to compact and push into the tailings surface and lime added at a conservative rate of 30t/ha.
- A clay liner will then be compacted over the PAF material to a minimum depth of 0.9m and with a permeability of 1 x 10^{-9}m/s.
- NAF material (sulfur content <1%) will then be paddock dumped and dozer profiled to create a minimum 2m thick store and release cover.
- The profiled surface will be free-draining with appropriate water management structures.

This process is also described in the Mine Waste Management Plan (Appendix F of the Mine Operational Environmental Management Plan [OEMP])

With the placement of PAF material as defined, no acid mine drainage issues should arise or present issues for rehabilitation. This will be monitored through visual inspections, surface water and groundwater monitoring.

i. Ore Beneficiation Waste Management (Rejects and Tailings Disposal)

There is no ore beneficiation currently undertaken at the Mine. Tailings generated by previous operations is current stored within the TSF.

j. Erosion and Sediment Control

The nature of the soils on the Mine Site has been classified by a report completed by SEEC in 2011 to support a modification to the development consent (SEEC, 2011). This report categorised soil types by their susceptibility to erosion and their potential for use in the land rehabilitation. Six test pits were excavated across the site to collect soil samples for analysis.

In summary, the following principal surface water and erosion control measures will be implemented during rehabilitation and closure.

- Maintenance of the completed clean and dirty water drains.

- Maintenance and operation of the sediment basins, in accordance with, as a minimum, the 'Blue Book' standards, and direction of stormwater runoff from the waste rock emplacement to these basins.
- Maintenance of the containment dams to provide a minimum freeboard for a 1 in 100-year ARI 72hr rainfall event.
- Installation of additional temporary erosion and sediment control devices (including sediment fencing, hay bales, jute mesh etc.) as required.
- Surface water monitoring will be undertaken within the sediment basins, containment dams, open cut sump and upstream and downstream within the creek diversion during flow events, on at least a quarterly basis (subject to flows).
- Sediment basins will be inspected weekly (during operations) and following significant rainfall (>25mm in 24hrs) with the following information recorded:
    - Remaining storage volume within the sediment basins.
    - Evidence of overflow and condition of downstream catchment.
    - Water colour within the sediment basins (e.g., highly turbid, brown, clear, etc).
    - Presence of any oily film.
    - The general condition of the water management structures including any areas of active erosion and level of sedimentation.
- Inspections of the three creek crossings will also be completed following periods of flow within Mulga Creek. The following maintenance will be completed (as required):
    - Removal of any build-up of vegetation or other debris around the culvert entrance.
    - Recovery of gravel following flow events to maintain the minimum 200mm depth.

Increased rainfall in 2021 (on top of a wet 2020) has resulted in a rapid increase in groundcover vegetation. This has stabilised much of the former disturbed areas of the site reducing erosion and sedimentation. The continued flora growth through the year of 2021 is a positive indication that stabilisation of disturbed areas can be achieved through reprofiling and seeding of disturbance areas. Planting methods will be employed by Manuka Resources when final landforms are completed which should result in stabilization of disturbed areas.

k. Ongoing Management of Biological Resources for Use in Rehabilitation

Refer to **Section 6.2.1a** for specific details on the ongoing management of biological resources for use in rehabilitation.

l. Mine Subsidence

Whilst underground mining has historically been undertaken within the area, the majority occurs within the footprint of the open cut. Furthermore, the potential for blasting to result in the collapse of any underground workings, not contained within the immediate blast zone, is considered to be non-existent.

At closure, appropriate safety bunding and signage will be retained around the perimeter of the open cut pit. The final location of the bund will be such that it is at a sufficient distance from the pit edge so that any potential for pit wall failure will not intercept the bund. The closure bund will typically be a minimum of 2m high with 2.5:1 V:H batters, however, where the haul road enters the pit, the bund will be increased in height to further prevent stock and vehicular access. Appropriate warning signs will also be installed at regular intervals around the outside of the bund.

m. Management of Potential Cultural and Heritage Issues

Due to the previous amount of disturbance within the mine site, the likelihood of disturbance of natural or Aboriginal heritage items is considered negligible for planned rehabilitation activities. Management cultural heritage issues on the site will be undertake in accordance with the Cultural Heritage Management Plan (CHMP) (BOML, 2015)).

The CHMP outlines management measures for the protection of heritage sites across the Mine.

n. Exploration Activities

Drilling within the open cut is forecast to further define the resource. Drilling may also occur on the Exploration Licence immediately east of the open cut (Boppy South) with a view to converting that portion of the EL to an ML subject to drilling outcomes. This is dependent on progress with the recommencement of mining and processing in the existing pit.

Construction, sealing and decommissioning of boreholes will be in accordance with relevant standards and guidelines published by the Department of Planning, Industry and Environment – Division of Resources and Geoscience (DRG) and in force at the time.

Where required, monitoring bores will be licenced under the *Water Management Act 2000* or the *Water Act 1912*, depending on the aquifers being intersected and monitored.

6.2.2 Decommissioning

Decommissioning of the Mine include the cessation of infrastructure usage, disconnection of remaining services, demolition, and removal from site. Remediation of any contamination will also be undertaken during this phase.

Manuka Resources will develop a detailed Closure RMP in consultation with the Resources Regulator and other stakeholders within three years of mine closure. This will include details covering the evaluation of re-use opportunities for facilities, infrastructure and services on the site.

a. Site Security

Considering the isolated nature of the site and restricted access there will be minimal risk to public safety. Current site security measures in place at the Mine Site include:

- Restricting access to the Mine by rural fencing and bunding.
- Additional bunding is also in place around the existing open cut.
- Fencing is inspected on a regular basis.

- All site visitors are required to report to the caretaker prior to entry.

- Site safety inductions are conducted at the site, with all authorised visitors accompanied by a company representative.

Site security during the decommissioning phase will be described in detail in the Mine Closure Plan and will include:

- Existing fences may form part of site boundary and the site shall be secured during and after construction hours of rehabilitation areas.

- Construction signage labelled "**DANGER CONSTRUCTION SITE DO NOT ENTER**" will be placed along the main entry of areas currently being rehabilitated.

- All site security incidents will be reported immediately when to the operations manager and/or available representative.

b. Infrastructure to be removed or demolished

Following the completion of mining, hardstand areas around the open cut and WRE will be trimmed and profiled, soil will be treated with ameliorants and deep ripped, and revegetated with suitable flora species.

Decommissioning and demolition activities will proceed as follows.

- All mobile equipment, pumps, and piping will be removed from the open cut.

- Disconnection of switch boards and electrical connections by a licenced electrician.

- Recovery and removal of all consumables and equipment, including the redundant plant and equipment in various storage areas. Any waste material will either be taken to a licenced facility or collected by a licenced waste contractor.

- Excavation and on-site treatment of any known hydrocarbon contaminated material

- Loading of the demountable office building for off-site use/sale/recycling.

- Dismantling of the heavy vehicle workshop and transportation off site.

- Demolition of the workshop shed and removed as scrap to the Cobar Waste Disposal Depot.

- Breaking of all concrete footings / pads and removal to the Cobar Waste Disposal Facility or concrete recycler.

- Completion of a contamination assessment and removal and treatment / disposal of any remaining contamination (if identified).

- Pending suitability of water quality, water from the open cut may be utilised to irrigate the rehabilitated areas to assist with vegetation establishment.

- Appropriate safety bunding and signage will be retained around the perimeter of the open cut pit.

Details on the final landform construction are discussed further below in **Section 6.2.3.**

c. Buildings, Structures, and Fixed Plant to be Retained

As part of the mine closure process, infrastructure that is required to complete rehabilitation activities will not be removed until required. Infrastructure to remain during the majority of the RMP term is as follows.

- Current site office and workshop: a demountable site office and a heavy vehicle workshop have been established to the east and south respectively of the former mill and process area. These areas will remain active during the majority of this RMP term.

- Access Roads**:** sections of access road that are required for ongoing care and maintenance activities and long-term access will be retained.

d. Management of Carbonaceous/Contaminated Material

All ore will have been removed from the Mine site. Carbonaceous material, if reported, will be suitably capped to support the final land use, or removed and rehabilitated.

Contaminated material will be managed in accordance with the guidelines under the *Contaminated Land Management Act 1997*.

Soils within and surrounding former infrastructure areas will be assessed for potential contamination. Any contaminated material, which cannot be encapsulated within TSF 3, i.e., if encapsulation of PAF is complete and rehabilitation, has commenced, the contaminated material will be removed to the Cobar Waste Disposal Depot, a licenced waste disposal facility. A final contamination assessment will be completed prior to site relinquishment to demonstrate that no contamination remains on site.

e. Hazardous materials management

There are no processing reagents, laboratory chemicals or other hazardous materials stored on site. Reagents, alkalis, and acids used during on-site processing between 2002 and 2005 have previously been removed from site.

Diesel is stored in a 70,000L capacity self-bunded container tank adjacent to the mine workshop and used for light vehicle refuelling. The Mine maintains records of diesel deliveries and usage. All remaining diesels will be either utilised or disposed of at an authorised facility. The storage tank will be removed and, depending on the condition, either sold or disposed of at an authorised facility.

f. Underground infrastructure

At the completion of mining, all mobile equipment, pumps, and piping will be removed from the open cut. Appropriate safety bunding and signage will be retained around the perimeter of the open cut. The final location of the bund will be such that it is at a sufficient distance from the pit edge so that any potential for pit wall failure will not intercept the bund.

The closure bund will typically be a minimum of 2m high with 2.5V:1H batters. The bund where the haul road enters the pit will be increased in height to further prevent stock and vehicular access.

6.2.3 Landform Establishment

The section provides an overview of the key characteristics of the final landform as shown in the final landform and rehabilitation plan (**Plan 1** and **Plan 2**), with the key items addressed below.

a. Water Management Infrastructure

Following the completion of mining, the remaining water within the temporary mine water storage dams will be pumped back into the final open cut void followed by the recovery of all pumps and pipelines. The following earthworks are proposed to achieve the final land use for the water infrastructure areas on the Mine site.

- Storage dams:
  - The material excavated to create the dams will be pushed back into the dams and profiled using a bulldozer to create a free draining landform.
  - Soil material recovered during the construction of the dams will be respread, and the area revegetated in accordance with the revegetation process outlined in **Section 6.2.5**.
- Sediment basins:
  - The sediment basins will be retained at the end of the RMP term for long-term water management of the rehabilitated WRE.
  - If the WRE is suitably stabilised before the end of this RMP term and water quality received within the basins meet the applicable water quality criteria, then the sediment basins will be 'decommissioned' and no longer be managed to prevent overflow.
  - Any sediment build-up within the basins will be removed and buried within the WRE.
  - The spillways of the basins will be inspected and, if required, additional stabilisation undertaken (such as rock armouring) to ensure long-term integrity.
  - The existing creek diversion and Council water storage dams will be retained in their current form with no rehabilitation activities applicable.

b. Final landform Construction: General Requirements

The development of the post-mining landform for the Mine aims to create a low maintenance, geotechnically stable and safe landform that is secure, non-polluting, and which are commensurate with the surrounding land fabric as far as practicable, for intermittent and very low intensity grazing uses.

Inspections of the landforms will be conducted regularly following rehabilitation to ensure the design is appropriate and landform stability is achieved to prevent erosion and create a suitable growth medium for vegetation.

To manage runoff and erosion impacts to the nearby creeks, surface water sampling and analysis will continue in accordance with a Soil and Water Management Plan (SWMP) for the Mine (BOML, 2015). Other water management infrastructure such as the sediment basins and a Council dam will remain and be stabilised to provide long-term water management for grazing stock.

c. Final landform construction: reject emplacement areas and tailings dams

Waste Rock Emplacement

The general final land use design of the WRE is as follows.

- Total Area: 22.2 ha (including previous WRE area).
- Maximum height: 20 m.
- Lift height: 10 m.
- Number of lifts: 2.
- Berm widths: 5 – 10 m.
- Batter slopes: 37° (upper), 18° (lower).

The WRE will be progressively constructed through paddock dumping of NAF material and profiling using a bulldozer in accordance with the landform design.

This WRE design will mimic a concave outer slope profile consistent with surrounding natural landforms. All areas that are to be used for emplacement of waste rock have been sterilised with respect to resource potential.

Within the WRE will be specially designed areas for the encapsulation of the 'moderate risk' PAF material.

This area will be designed as follows.

- A base layer of NAF material will be placed to a minimum of 3m to provide for drainage beneath the WRE without overlaying PAF material being subject to wetting and drying.
- PAF material will then be placed on top of the NAF material and lime added at a highly conservative rate of 30t/ha.
- The limed PAF material will then be covered by a clay capping with a minimum depth of 900 mm providing an impermeable layer with a maximum permeability of 1 x 10-9 m/s.
- The clay capping will then be covered using selected NAF material to a depth of approximately 2 m with an overlaying soil cover to provide a vegetated store and release layer.

This design will ensure that there is negligible percolation into the PAF material and provides a three-fold management system, i.e., store and release cover, clay capping and lime for waste rock passivation and neutralisation in the event that any acid were to be generated.

Stockpiled Material

The ROM pad which contains stockpiled material will remain active during the reporting period. Following the completion of ore transportation, all ore will have been removed from the ROM pad. The ROM pad will then be profiled using a bulldozer to provide a free-draining landform deep ripped and, if available, soil material or suitably weathered overburden spread to a thickness of 50 mm. The area will then be revegetated in accordance with the species and revegetation process outlined in **Section 6.2.5**.

Tailings Storage Facility

There is a former historic tailings placement area (within GL 5836). However, all tailings had been previously removed and there is no contamination evident, and a temporary mine water storage dam has been constructed within this area. Whilst soil testing has previously been undertaken in 2010, further testing will be undertaken at mine closure to demonstrate that no contamination is present

ROM ore is crushed on-site, however, further processing and liberation of gold is undertaken off site at the Manuka Mine. Therefore, as no mineral processing is undertaken on site, no process residues or tailings will be generated. However, the existing TSF 3 is utilised for the storage of 'increased risk' PAF material (>1% S) prior to capping with NAF material.

As TSF 3 has been constructed for the management of PAF tailings material, the placement of 'increased risk' PAF waste rock within the existing TSF 3 will consolidate all 'increased risk' materials in one location. The existing tailings will also restrict the passage of oxygen to the base of the PAF material, which will be aimed at the highly conservative rate of 30t/ha and subsequently clay capped, covered with NAF material, and rehabilitated similarly to the PAF encapsulation area within the WRE.

d. Final landform construction: final voids, highwalls and low walls

The closure bund will typically be a minimum of 2 m high with 2.5:1 V:H batters, however, where the haul road enters the pit, the bund will be increased in height to further prevent stock and vehicular access. Appropriate warning signs will also be installed at regular intervals around theoutside of the bund.

No demolition activities are relevant to this domain. Backfill of the open cut void is not practical or economic and will be retained. however, design of the void (see **Figure 6.3**) provides for a stable structure, with highwall slope no greater than 70^o, which will not require ongoing management.

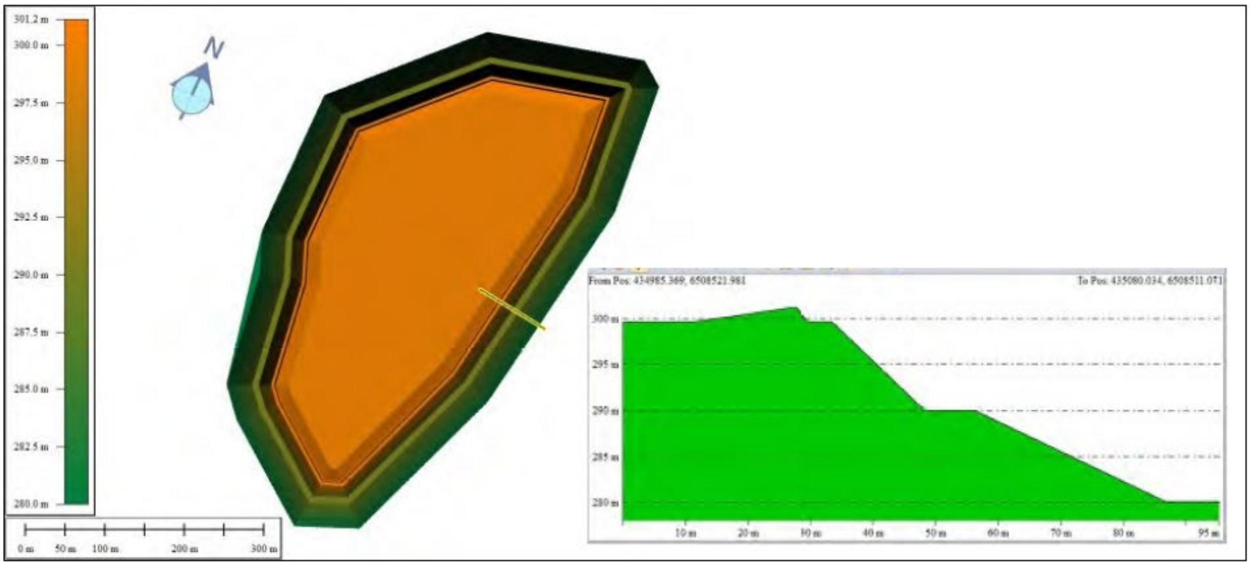

Figure 6.3 Conceptual Design of the Final Landform for the WRE

e. Construction of Creek/River Diversion Works

The existing creek (ephemeral flows) diversion was constructed in the early 1900s and has not been modified by the Company or its predecessor companies. The creek is currently stable with no specific rehabilitation requirements known and no specific rehabilitation works planned.

6.2.4 Growth Medium Development

The growth medium development phase involves the placement of oxidised overburden, subsoil and available topsoil on the final landform and preparation of the surface for revegetation. Soil preparation will include fertiliser and ameliorant application (e.g., gypsum, etc), and ripping or scarifying the surface. Use of non-persistent cover crops will be used to stabilise the soil surface.

Growth medium development activities include:

- Characterisation of the geochemical nature of the substrate and associated materials
- Soil Preparation using fertilisers to provide:
    - Phosphorus (Colwell) content of the topsoil to within a target concentration of 25–40 mg/kg, being comparable to analogue sites (i.e., Natural Ground Topsoil)
    - An appreciable source of nitrogen.
    - Improved levels of calcium.
    - Reduced potential for dispersion.
- Fertiliser will be applied at seeding. It can be broadcast with a spreader, applied hydraulically, or pneumatically. Spreaders are typically suitable for slopes with gradients less than 35 %, and pneumatic or hydraulic applications will be required for steeper slopes.
- Gypsum has been recommended for sodic/dispersive materials or where calcium is low. Gypsum will be applied during soil preparation stages in a manner that allows for as thorough mixing as is practicable into the surface materials. It will be applied prior to seed and fertiliser applications

Soil preparation for slopes on site will include the following:

- Slope gradients less than approximately 35%:
    - Aim to incorporate gypsum into the upper 0.3 m of materials.
    - Relieve compaction by deep ripping along the contour to a depth of 0.5 m to 1.0 m, with rip lines 1.0 m apart.
    - Deep ripping should be followed by shallow ripping/scarifying to incorporate gypsum amendments more thoroughly into the upper 0.3 m of materials.
- Slope gradients greater than approximately 35%, or when ripping/scarifying along the contour is not practicable (or safe):
    - Aim to incorporate gypsum into the upper 0.5 m of materials.

- Double the gypsum rate recommended.
- When shaping up the batters in preparation for rehabilitation, incorporate gypsum into caping materials on the plateau of the landform then pushing down the batter.

In addition to the SWMP, control of erosion will be implemented in areas observed to be displaying relevant characteristics, e.g. gullying, through visual monitoring. Visual observations will focus on drainage areas (where applicable), trafficable areas (e.g., access tracks including creek crossings), and the WRE. The following measures may be used to control erosion:

- Selective plantings/direct seeding of local endemic species to stabilise the soil.
- Surface water management structures (e.g., temporary sediment traps such as straw bales).
- Non-persistent grass species for groundcover management and grazing management.
- A minimum groundcover of 40% will be maintained with a goal of over 80% for the majority of the time. This will ensure the required groundcover to stabilise soil and prevent erosion are be achieved.

Ripping is required to break up compacted layers near the surface to increase water infiltration and rooting depth and reduce rates of runoff and erosion. Ripping is also critical in the incorporation of ameliorants to address sodic and acidic conditions.

- Key mobile equipment and procedures for soil ripping
  - Use ripping tynes on a bulldozer or tractor-mounted three-point linkage for ripping
  - Depending on the spacing of tynes and field conditions, multiple offset passes and cross ripping over the same area may be necessary to achieve the desired results.
- Desired results (completion criteria) for soil ripping:
  - Deep ripping along the contour to a depth of 0.5 m to 1.0 m to relieve compaction.
  - Rip lines are approximately 1.0 m apart.
  - Surface with a high degree of surface roughness that present a less erodible exterior.
  - Provide depressions to capture seed, fertiliser, water, and litter that will promote plant growth.
- While rip lines in non-rocky materials will subside and generally be unnoticeable within a few years, it is normal to observe a high degree of surface roughness persisting in rocky materials for many decades to come.
- When ripping is not allowed:
  - Avoid ripping wet soils or waterlogged areas. This can increase compaction and form hardpans under the wheel / track lines.
  - Avoid ripping perpendicular to the contour. This will increase erosion.

- Only rip along the contours on slopes with gradients less than 35 % due to the potential for plant/vehicle rolling over.

Weed Control

A number of environmental and priority weeds are known to occur at the Mine Site (refer to **Table 6.3**). Initially primary weed control will take place targeting the priority weeds as well as any other environmental weeds present in the offset area. However, if new weed species are found during monitoring those new weed species will also be controlled.

Table 6.3 Priority Weeds and Control Methods

Common Name	Scientific Name	Control Methods (DPI, 2018)
Galvanised burr	*Bassia birchii*	Herbicide Application
Bathurst burr	*Xanthium spinosum*	Herbicide Application

Recommended techniques for the control of priority weeds that have been published by DPI Agriculture will be consulted prior to weed control, e.g., New South Wales Weed Control Handbook (DPI, 2018) and resources on the NSW WeedWise website. Local weed management plans published by the Local Councils also provide information on the control of priority weeds.

Revegetation works are to continue based on seasonal opportunities and rainfall. Re-seeding and re-planting activities will only occur if favourable seasonal conditions occur to increase chances of survival and propagation.

6.2.5 Ecosystem and Land Use Establishment

The ecosystem and land use establishment phase involves the establishment and maintenance of vegetation on the completed landform. On completion of ecosystem and land use establishment for a final land use of native vegetation, a cover of native groundcover will have replaced the non-persistent cover crop.

Revegetation will then comprise seeding/planting of native vegetation focusing on groundcover. Seeding will be completed as soon as practicable after placement of soil material / growth media, and before the surface forms a crust to achieve an optimal surface microhabitat.

Table 6.4 provides a list of recommended type and range of species to be planted, including short lived species (non-persistent cover crops), to achieve the Mine's intended revegetation outcome.

Table 6.4 Recommended flora species for the revegetation

Genus	Species	Common Name	Comments
Trees			
Brachychiton	populneus	Kurrajong	Local to Mine Site
Eucalyptus	microcarpa	Grey Box	Local to Mine Site
Eucalyptus	populnea	Bimble Box	Local to Mine Site
Eucalyptus	viridis	Green Mallee	Locally occurring on shallow / rocky soils

Genus	Species	Common Name	Comments
Allocasuarina	luehmannii	Buloke	Regionally occurring on a variety of soils
Callitris	glaucophylla	White Cypress Pine	Indigenous to Mine Site
Callitris	endlicheri	Black Cypress Pine	Locally occurring on shallow / rocky soils
Eucalyptus	dwyeri	Dwyer's Red Gum	Locally occurring on shallow / rocky soils
Eucalyptus	vicina	Hill Red Gum	Locally occurring on shallow / rocky soils
Eucalyptus	morrisii	Grey Mallee	Locally occurring on shallow / rocky soils
Eucalyptus	intertexta	Coolibah	Indigenous to Mine Site
Shrubs			
Acacia	brachystachya	Umbrella Mulga	Locally occurring on shallow / rocky soils. Seedlings very susceptible to grazing.
Acacia	colletioides	Wait-a-while	Locally occurring in Box Woodlands.
Acacia	deanei	Dean's Wattle	Locally occurring in Box Woodlands. Susceptible to grazing when young.
Acacia	decora	Western Golden Wattle	Locally occurring in Box Woodlands. Very susceptible to grazing.
Acacia	hakeoides	Hakea Wattle	Locally occurring in Box Woodlands. Very susceptible to grazing.
Acacia	triptera	Spur-wing Wattle	Locally occurring in Mallee / Box Woodlands.
Senna	artemisioides	Silver Cassia	Locally occurring in Box Woodlands.
Dodonaea	truncatiales	Propellor Hopbush	Locally occurring on shallow / rocky soils.
Geijera	parviflora	Wilga	-
Acacia	aneura	Mulga	Indigenous to mine site area
Acacia	excelsa	Ironwood	Indigenous to mine site
Acacia	doratoxylon	Currawang	Locally occurring on shallow / rocky soils
Acacia	difformis	Drooping Wattle	Regionally occurring on shallow soils
Acacia	lineata	Streaked Wattle	Locally occurring on shallow or rocky soils
Acacia	montana	Mallee Wattle	Regionally occurring on shallow or rocky soils
Exocarpos	aphyllus	Leafless Cherry	Locally occurring on shallow / rocky soils
Pandorea	pandorana	Wonga Vine	Locally occurring on shallow / rocky soils
Pittosporum	Angustifolium	Butterbush	Regionally occurring on a variety of soils
Pultenaea	microphylla	Spreading Bush-pea	Locally occurring on shallow or rocky soils
Santalum	acuminatum	Quandong	Regionally occurring on a variety of soils
Groundcover			
Poaceae	Aristida ramosa	-	Locally occurring.
Poaceae	Austrodanthonia caespitosa	White-Top	Locally occurring.
Poaceae	Austrostipa scabra	-	Locally occurring.
Poaceae	Chloris truncata	Windmill Grass	Locally occurring.
Poaceae	Digitaria brownii	Cotton Panic Grass	Locally occurring.
Poaceae	Themeda australis	Kangaroo Grass	Locally occurring.

Genus	Species	Common Name	Comments
Chenopodiacae	Einadia nutans	Climbing Saltbush	Locally occurring.
Chenopodiacae	Enchylaena tomentosa	Ruby Saltbush	Locally occurring.
-	-	Sterile Millet	Temporary stabilisation only – non persistent.
-	-	Perennial Ryegrass	Temporary stabilisation only – non persistent.

Source: Knop (2011) & OzArk

The seeds will be sourced in bulk off-site.

The establishment of vegetation associated with the native ecosystem final land use will be managed as follows:

- Seeding will be completed as soon as practicable after placement of soil material / growth medium and before the surface forms a crust so as to achieve an optimal surface microhabitat.
- Rehabilitation trials and monitoring completed to date indicates that planting of tube stock at the Mine only has limited success. Therefore, revegetation will be undertaken by either direct or mechanical seeding.
- Direct seeding lines for tree species will be spaced a minimum of 6 m apart on flat areas and 8 m on slopes to provide sufficient space for establishment and maintenance of groundcover species. Seeding rates will need to be high due to potential impact of grazing animals and will be approximately 1.5kg per kilometre.
- Revegetation will be applied by either direct or mechanical seeding. Seeds can be broadcasted with a spreader, applied hydraulically or pneumatically.
- Broadcast seeding
    - Seeds are scattered across the prepared primary growth media.
    - Lightly work the spread seeds into the soil by harrowing (i.e. raking, tracking, chain dragging, rolling) to improve the seed-soil contact, to allow for better moisture absorption for germination, and to provide a shallow covering of soil that affords some protection to the seed from drying conditions and predation from ants and birds. Harrowing will be restricted to generally not practicable on slopes with gradients greater than 35%.
- Hydromulching being the hydraulic application of a seed and mulch mixture
    - Batters with gradients steeper than 35% are well suited to seeding by hydromulching and will benefit greatly with the application of a surficial layer of mulch.
    - Under dry land conditions (i.e., not irrigated), hydromulch will be an enhanced product that includes a bonded fibre matrix (BFM) hydromulch with added organics.
    - On batters with gradients steeper than 35% that have no contour rip lines, the application rate needs to provide 100 % cover in order to optimise erosion protection and provide water retention benefits.

Revegetation works will be undertaken based on season opportunities and rainfall. Seeds are collected from native trees, shrubs, and grasses on an opportunistic basis around the mine holding and surrounding township areas. These will be potted out and will be redistributed on rehabilitation areas as seasonal conditions become favourable.

6.2.6 Ecosystem and Land Use Development

Weed and Pest Management Controls

The following control measures will be used to manage weed and feral animals on rehabilitation areas:

- Inspection of source soils stockpiles and if dominated by weed species, an herbicide targeting the particular weed species will be applied prior to respreading.
- Regular inspection of rehabilitation sites.
- A 1 m x 1 m quadrat monitoring approach will be undertaken with the percentage cover by weeds recorded.
- On initial establishment of vegetation, weed species coverage of 50% (no WONS/biosecurity weed species) will be acceptable as the cover is important in stabilising the soil.
- After 6 months, the acceptable weed species coverage will be 20% (and no WONS/biosecurity weed species).

Erosion and Drainage Controls

Gravelly Topsoil stockpiled materials and the Waste Rock Oxide has been identified as having good potential for use in rehabilitation of steep batters. These materials have negligible to low levels of physicochemical limitations to plant growth and appreciable coarse gravel contents that lead to armouring of the surface and increased resistance to erosion.

Vegetative debris at the surface will increase the hydraulic roughness and improve the batter slope's capacity to store water and sediment. It will provide structure to capture leaf litter and native seeds, and microrelief to promote seed germination and plant establishment.

Environmental monitoring and management

Rehabilitation monitoring and management is further discussed in **Section 8.2.**

Maintenance Fertilising

Rates of fertiliser and amendments for the different materials are presented in the Material Characterisation Program for Rehabilitation (Landloch Pty Ltd, 2021) in **Appendix 1.** These rates aim to provide phosphorus (Colwell) content of the topsoil to within a target concentration of 25–40 mg/kg, being comparable to analogue sites (i.e., Natural Ground Topsoil); an appreciable source of nitrogen; improved levels of calcium; and reduced potential for dispersion.

Repair of Fence Lines, Access Tracks and Other Related Land Management Activities.

In regard to grazing pressure management during the rehabilitation phase and the need to prevent access to rehabilitating areas by kangaroos and feral goats, Manuka Resources propose the erection of a large herbivore exclusion fence around disturbance areas within the Mine Site to eliminate on- site feral goat populations from disturbed and rehabilitating areas. The fence will be a small hinge joint netting fence with additional salvage wires, resulting in a fence approximately 1,200 mm high. This fence is low-maintenance and will discourage kangaroo movement and stop re- population by feral goats, however, small mammal and reptile movement will not be impacted.

6.3 Rehabilitation of Areas Affected by Subsidence

Whilst underground mining has historically been undertaken within the area, the majority occurs within the footprint of the open cut. Therefore, the Mine is not expected to result in any subsidence.

7.0 Rehabilitation Quality Assurance Process

7.1 Rehabilitation Quality Assurance Process for Each Rehabilitation Phase

A Rehabilitation Quality Assurance Process (RQAP) will be implemented though the Life of Mine for each phase of rehabilitation. The RQAP will ensure that:

- rehabilitation is being implemented in accordance with the nominated methodologies
- identified risks to rehabilitation are being adequately addressed at each phase of rehabilitation
- identification of those responsible for implementation.

Manuka Resources will implement the RQAP through every phase of rehabilitation. The RQAP will include inspections, monitoring and documentation to ensure that each step of rehabilitation activity has been completed in accordance with the nominated methodologies prior to proceeding to the next phase of rehabilitation.

The quality assurance process will be implemented throughout the life of the operation, refer to **Table 7.1.**

Table 7.1 Rehabilitation Quality Assurance Process

Rehabilitation Phase	Quality Assurance Actions and Processes	Methods for Documenting and Recording Process	Method and Timeframe for Reviewing and Refining Process
Active Mining	• up to date mine plans. • maintenance of a topsoil inventory to document stripped, stockpiled and re-spread resources. • regular inspections of temporary and permanent erosion and sediment controls. • regular inspections to identify potential weed infestations. • documentation of all weed management and eradication programs and follow-up inspections.	Inspections and documentation. Rehabilitation monitoring program. Annual monitoring and reporting.	Process reviewed annually and/or following an incident.
Decommissioning	• inspections and demolition reports to confirm all relevant infrastructure and utility services has been removed. • validation testing to ensure any contamination has been appropriately remediated and/or removed.	Inspections and documentation. Compliance reporting.	Process reviewed annually and/or following an incident.
Landform Establishment	• survey and preparation of as constructed drawings of final constructed slopes, landforms, and water drainage structures. • recording depths of ripping of rehabilitation areas.	Inspections and documentation, Landform establishment records. Annual monitoring and reporting.	Process reviewed annually and/or following an incident.
Growth Medium Development	• registers of topsoil and/or soil substitute stockpiles (e.g., biosolids), including management records (such as stripping/stockpiling dates, weed control, inoculation with microbes, etc), and land and soil capability assessments to confirm that rehabilitation meets the nominated land capability classes. • records of identification and management of actual acid forming, potentially acid forming (PAF) and non-acid forming (NAF) material and ongoing monitoring. • soil testing results to confirm appropriate soil geochemical parameters for plant establishment.	Inspections and documentation. Rehabilitation monitoring program. Annual monitoring and reporting.	Process reviewed annually and/or following an incident.

Rehabilitation Phase	Quality Assurance Actions and Processes	Methods for Documenting and Recording Process	Method and Timeframe for Reviewing and Refining Process
Ecosystem and Land Use Establishment	• Documentation of seeding or planting activities undertaken including: ○ date of planting; ○ weather conditions; ○ seed mix; ○ seeding rate (kg/ha) and/or planting rate (tubestock/ha); ○ fertiliser rate (kg/ha); • records of the salvage of all rehabilitation resources including suitable capping materials, topsoils/subsoils, seeds, habitat structures (e.g. tree hollows and rocks) for use in rehabilitation; • regular site inspections of rehabilitated areas to allow early identification of any emerging threats to rehabilitation; • rehabilitation monitoring in accordance with PART 8 – on page 118 to monitor the success of rehabilitation; • water monitoring to confirm runoff from the landform is within EPL criteria; • regular inspections to identify potential weed and feral animal infestations; and • documentation of all weed management and eradication programs and follow-up inspections.	Rehabilitation monitoring program. Annual Monitoring and reporting.	Process reviewed annually and/or following an incident.
Ecosystem and Land Use Development	• rehabilitation monitoring in accordance with PART 8 – on page 118 to monitor the success of rehabilitation. • regular site inspections of rehabilitated areas to allow early identification of any emerging threats to rehabilitation. • regular inspections to identify potential weed infestations. • documentation of all weed management and eradication programs and follow-up inspections	Rehabilitation monitoring program. Annual monitoring and reporting.	Process reviewed annually and/or following an incident.

7.2 Rehabilitation Quality Assurance Process Implementation Program

7.2.1 The Responsibilities for Implementation

Table 7.2 outlines the roles and responsibilities of personnel who have responsibility for monitoring, review, and implementation for this RMP.

Table 7.2 Responsibilities for the implementation of the rehabilitation QA process.

Role	Responsibilities
Mine Manager	Accountable for the overall environmental performance of the operations, including the outcomes of this RMP. Ensure that mine planning is compliant with the requirements of the RMP and applicable approvals. Provide necessary resources required to implement the rehabilitation process outlined within the RMP. Ensure employees are competent through training and awareness programs.
Environmental Officer	Ensure the implementation of this RMP, including reporting of non-compliances with the trigger values, and subsequent implementation of the relevant action plan. Ensure that monitoring, report review, and preparation are undertaken as outlined within this RMP and associated management plans. Report the progress of rehabilitation and monitoring in the relevant AEMR.
All workers	Follow direction provided by the NSW Resources Regulator. Ensure operations are consistent with the plans and objectives detailed in this RMP.

7.2.2 How the Process will be Formally Documented and Recorded

Manuka Resources will maintain records of each rehabilitation phase which will assist to provide context to rehabilitation monitoring results and to inform potential contingency measures and/or changes to rehabilitation methods and practices. The records will include, but will not necessarily be limited to:

- plans showing the location and type of rehabilitation activities conducted (e.g., woodland, pasture or native grassland rehabilitation)
- the target vegetation communities and species list for the target community
- substrate characterisation details where relevant
- details of site preparation techniques (e.g., ripping depth, soil replacement depth, soil source, any soil ameliorants applied and associated rates of soil ameliorants)
- seed source, record of any seed pre-treatment undertaken and species ratios within seed mix or tube stock planted
- revegetation methodology (i.e. direct seeding or tube stock planting)
- time of sowing/planting and weather conditions at the time.

To verify that the work processes are effective inspection and testing activities shall be performed.

Inspection and Testing Plans (ITP's) are a pre-determined and documented methodology for ensuring Quality Control (QC) throughout an activity or program of works. ITP's are developed at the design or specification stage and in accordance with the scope of work. These are available on site and completed as works progress, with identified hold and witness points included to ensure quality standards are met.

Inspection Check Sheets shall be used to verify the activities outlined in the ITP have been carried out. Completed check sheets (signed and dated by respective parties) shall be maintained in the project file for verification and records keeping.

Compliance with critical aspects of the rehabilitation phase is addressed via the use of nominated Hold Points and Witness Points. Hold points and witness points are developed to ensure key steps of the rehabilitation phase are captured to form part of the ITP.

Hold Points and Witness Points are addressed in Work Methodologies and ITPs where appropriate. It is the responsibility of the Project Engineer/Supervisor to ensure that hold points identified in the Contract and ITP's are implemented.

Records shall be maintained of all hold points and witness points that have been passed.

Opportunities for improvement are identified through the Monthly Reporting, Audit results, and seeking input from the project team. They are managed through the ***Manuka Hub,*** action registers or meeting minutes to ensure proposed improvements are completed in a timely manner. Opportunities and outcomes will be communicated using email and site meetings.

From a QA/ QC perspective, non-conformances include:

- re-work
- missed witness/hold points
- deficiencies identified during audits and inspections
- items that are inspected or tested and are found not to comply with defined acceptance criteria or specified requirements.

If nonconformance is detected after delivery or use, Manuka Resources will act appropriate to the effects, or potential effects, of the non-conformity.

7.2.3 How the Process will be Reviewed and Refined over Time to Promote Continuous Improvement

Rehabilitation practices will be subject to regular review to ensure to identify areas that may require improvement. The review process may include formalised procedures such as internal and external audits or feedback from consultation, and/or following special occurrences.

Rehabilitation practices will be regularly reviewed against current industry recognised rehabilitation controls and techniques to identify out-of-date methodologies and/or verify any gaps with the response plans and monitoring programs currently implemented and cross-check any differences in the desired long-term sustainable outcomes. The rehabilitation objectives and completion criteria are redefined accordingly and rehabilitation practices consequently redesigned and executed as soon as practicable to:

- achieve the rehabilitation outcomes in an acceptable timeframe
- monitor the rehabilitated areas, and
- results are assessed against the agreed criteria.

Management plans specific to the Mine's rehabilitation program will be reviewed and updated to ensure that routine monitoring and inspection of control measures onsite are maintained, risks promptly addressed, and outcomes of the inspection are always recorded.

Formalised quality assurance process will be designed and followed throughout the life cycle of rehabilitation. Procedures on recording of key data at each rehabilitation phase (e.g. actual methodologies undertaken, weather, etc) will be captured by responsible personnel.

8.0 Rehabilitation Monitoring Program

Rehabilitation planning and monitoring will focus on determining whether progress towards achieving the relevant performance indicators and completion and relinquishment criteria presented in the **Section 4.0** are being achieved. The rehabilitation planning will be very focused on maximising the use of heavy equipment and people on site and ensuring final landforms and material placement is maintained as a priority while the resources are readily available to achieve the planned outcomes.

8.1 Analogue Site Baseline Monitoring

Several previous rehabilitation trials have been undertaken at the Mine Site. The most recent trial work occurred between 2007 and 2015 and covered an area of 1 ha and included:

- four photo monitoring points; and
- seven transect lines.

Monitoring was undertaken on an annual basis and included measurement of number of seedlings, assessment of grazing pressure, presence of weed species and groundcover (e.g., bare soil, vegetation, litter, rock etc.).

Four analogue sites were also established in 2011 and were also monitored in the same manner to provide comparative data.

Whilst the rehabilitation trial areas are incorporated into the modified WRE, monitoring of the analogue sites is not active, one of the sites that has pest exclusion fencing provides a good control site for observation of the impact of feral goats and their impact on natural revegetation in the area after rainfall.

8.2 Rehabilitation Establishment Monitoring

Rehabilitation establishment sites are monitored annually for a minimum of five years after initial rehab has begun. A decision for further monitoring of these sites will be made after this period, depending on performance against relinquishment criteria for rehabilitation.

Monitoring will occur monthly during operations and quarterly for five years following completion of final landform works. A minimum of two monitoring points in each treatment area will be established and recorded against the local benchmark community / analogue sites.

The annual monitoring reports will be prepared by suitably qualified and experienced person. The report will include a summary of performance of the treatment area(s) against local benchmark / or analogue sites.

Water quality testing and monitoring will continue until relinquishment in accordance with the surface water monitoring plan approved as part of the OEMP.

8.3 Measuring Performance Against Rehabilitation Objectives and Rehabilitation Completion Criteria

Performance indicators and completion criteria provide a means by which the progress of rehabilitation can be measured to quantitatively demonstrate the successful achievement of a biophysical process, i.e., the standards that are to be met by successful rehabilitation.

Rehabilitation indicators and performance criteria are inter-related as a performance indicator is an attribute of the biophysical environment (e.g., percentage cover of native vegetation, pH, slope, soil depth etc.) that can be used to approximate the progression of the biophysical process against a defined end point, i.e., the completion/relinquishment criterion.

Table 4.2 provides the performance indicators and completion criteria developed for the Mine to achieve the nominated post mining land use goals and rehabilitation objectives (refer to **Section 4.0**).

It is noted that details of monitoring completed against completion criteria will be reported through the respective Annual Rehabilitation Report (ARR) and either a final ARR or separate relinquishment report for relinquishment of the Mine Site.

9.0 Rehabilitation Research and Trials

9.1 Current Rehabilitation Research and Trials

The Mine's resident caretaker has continued harvesting seeds of local species since the last reporting period. These have predominately been Native Blackthorn and Warrior Bush.

Several previous rehabilitation trials have been undertaken at the Mine Site. The most recent trial work occurred between 2007 and 2015 and covered an area of 1 ha and included four photo monitoring points and seven transect lines. Monitoring was undertaken on an annual basis and included measurement of number of seedlings, assessment of grazing pressure, presence of weed species and groundcover (e.g., bare soil, vegetation, litter, rock etc.). The results of this monitoring were presented within the respective AEMRs by previous operators.

Four analogue sites were also established in 2011 and were also monitored in the same manner to provide comparative data. The results of this monitoring was also presented within the respective AEMRs.

Whilst the rehabilitation trial areas are now incorporated into the modified WRE and monitoring of the analogue sites is not active, one of the sites that has pest exclusion fencing provides a good control site for observation of the impact of feral goats and their impact on natural revegetation in the area after rainfall.

9.2 Future Rehabilitation Research and Trials

Research trials recommended by soil specialists Landloch (Landloch Pty Ltd, 2021) and ecologists AREA consultants (AREA, 2022) will be reviewed and confirmed as part of the first Annual Rehabilitation Report.

Rehabilitation research trials to develop various growth media soils and revegetation techniques are planned to be conducted on the western side of the TSF and WRE (two proposed test site areas).

10.0 Intervention and Adaptive Management

10.1 Adaptive Management

Adaptive management of this RMP will be responsive to any new and relevant data that may arise through the rehabilitation monitoring (**Section 8.0**), legislative change or any other studies completed for the Mine's rehabilitation program (refer to **Section 6.0**). This will enable a flexible approach to management commitments, allowing ongoing feedback and continually improve and implement rehabilitation practices described in this RMP.

Adaptive management will be a key mechanism to address the major threats to, current and emerging risks to, the successful implementation of rehabilitation. Adaptive management steps include regular review of the RMP, including adaptation of targets and performance indicators, recognising potential risks to the successful implementation of the RMP and having a framework in place for corrective actions.

Where rehabilitation monitoring indicates that there is a significant threat to rehabilitation, Manuka Resources will undertake adaptive management in accordance with the Rehabilitation Trigger Action Response Plan (TARP) described in **Section 10.2**.

10.2 Threats to Rehabilitation and Trigger Action Response Plan

Section 3.0 of this RMP presents an assessment of environmental risks associated with the Mine. Similarly, this subsection presents an analysis of the specific risks or threats to rehabilitation within the Mine Site. This analysis of threats to rehabilitation has been prepared broadly in accordance with the requirements of *AS/NZS ISO31000:2009 Risk Management – Principles & Guidelines.*

Threats to rehabilitation were identified based on the rehabilitation risks identified in the risk assessment conducted by Manuka Resources (refer to **Section 3.0**. Risks were determined based on implementation of industry standard mitigation measures and the rehabilitation commitments. Where risks were determined to be unacceptable, namely those risks classified as "high" or above, a Trigger Action Response Plan (TARP) has been developed and is presented in **Table 10.1**.

Table 10.1 Trigger Action Response Plan

Rehabilitation Threat	Trigger	Response	Risk Ranking	TARP ID
Rehabilitation personnel lack clearly defined responsibilities, skills and or experience.	Loss of corporate and site knowledge from high turnover in workforce.	Review concern and options for reducing staff turnover and implement viable option for knowledge sharing.	High	T-01
Insufficient funding for/or prioritisation of rehabilitation activities.	Poor cost control leading to inadequate provision to meet full cost of closure. Asset theft during closure process.	Investigate and implement improvement options with Site Management	High	T-02
Failure to identify or comply with all legal and other obligations relating to closure. and/or	Failure to meet rehabilitation objectives and relevant completion criteria being evidence of safe, stable, non-polluting, and other sustaining metrics.	In consultation with relevant stakeholders, assess options to re-assess rehabilitation obligations and re-form the area to meet requirements.	High	T-03
Failure to meet expectations of the community, government, landholders, Non-Government Organisations (NGO's). Includes risk of Dam Safety and Resources Regulator not approving closure of Tailings Facility.	Failure to meet rehabilitation objectives and relevant completion criteria being evidence of safe, stable, non-polluting, and other sustaining metrics.	In consultation with relevant stakeholders, assess options to re-assess rehabilitation obligations and re-form the area to meet requirements.	High	T-04
Inadequate consideration of rehabilitation and proposed landforms and final voids in mine planning	Failure to meet rehabilitation objectives and relevant completion criteria being evidence of safe, stable, non-polluting, and other sustaining metrics.	In consultation with relevant stakeholders, assess options to re-assess rehabilitation obligations and re-form the area to meet requirements.	Critical	T-05
Design and construction of waste landforms and emplacement areas undertaken without detailed understanding of the physical and geotechnical properties, chemical composition, and geochemical characteristics of the mine waste (e.g., Potentially Acid Forming (PAF) wastes and salinity)	Elevated water quality readings. Contamination assessment identifies contaminated land present within Mine Site. Soil or vegetation criteria do not meet the Rehabilitation Monitoring Report criteria	Recommendations of contamination assessment implemented. Verification monitoring / testing undertaken to confirm contamination has been completely removed.	Critical	T-06

Rehabilitation Threat	Trigger	Response	Risk Ranking	TARP ID
Proposed final landform designs are not long-term stable (to allow relinquishment)	Landform does not meet the rehabilitation objectives and relevant completion criteria.	Suitably qualified geotechnical engineer engaged to assess the instability and provide a range of recommendations to remediate the instability. Recommendations to be implemented in consultation with relevant agency stakeholders. .	Critical	T07
Unavailability of personnel and/or contractors, and machinery to complete closure and rehabilitation works.	Extended maintenance and monitoring requirements until relinquishment.	Investigate and implement improvement options with Site Management	High	T-08
Disturbance activities results in: **mismanagement of soils and materials handling** **minimal biological resource salvage and maintenance through clearing, salvage, and handling practices.** **loss of opportunity to salvage material or protect land prior and during ground disturbance works** **insufficient / inadequate material for rehabilitation.** **clearing in adverse seasonal and weather conditions when salvaging biological resources.**	Soil and materials do not meet rehabilitation objectives and relevant completion criteria.	Suitable source of additional soil material / growth medium to be identified, including the need for importation of material from off site. Investigation into measures that may be implemented to ameliorate other materials to make them suitable for use as a growth medium.	High	T-09
Environmental monitoring of disturbance activities records adverse surface and groundwater quality and quantity and impacts to known and unknown cultural & European heritage items.	Elevated water quality readings. Identification of unknown Cultural and European heritage items.	Follow management actions identified in Cultural Heritage Management Plan. Implement any action required to ensure compliance with OEH and Traditional Owner requirements.	High	T-10

Rehabilitation Threat	Trigger	Response	Risk Ranking	TARP ID
Failed or poor-quality rehabilitation due to erosion and mass movement issues	Materials characterisation data does not meet rehabilitation objectives and relevant completion criteria. Inadequate topsoil available.	A suitably qualified professional in sediment and erosion control will engaged to prepare an assessment report and recommendations to be implemented. Continue monitoring and taking photo records.	High	T-11
Proposed final landform designs are not long-term stable and are not acceptable to allow relinquishment due to rehabilitation criteria not met leading to failure to achieve final land use and obtain approval of the Final Void.	Voids extend past predicted extent. Landform does not meet the rehabilitation objectives and relevant completion criteria.	Slopes to be reduced until all slopes meet approved final landform unless final landform considered stable by geotechnical review and vegetation establishment success meets completion criteria.	High	T-12
Lack of availability of suitable materials for encapsulation or capping of adverse materials.	Inadequate topsoil available. PAF encapsulation causing acid mine drainage.	Contamination assessment conducted and recommendation of contamination assessment implemented.	Critical	T-13
Remaining water infrastructure for final land use not approved to remain on site post closure, or remaining infrastructure poses health and safety risk, environmental ongoing monitoring requirements.	Water quality triggers are exceeded. Water management structures fail. Visual inspections identify pooling water / poorly drained areas.	Re-profile slopes or install drainage to provide a stable free-draining landform.	High	T-14
Lack of subsoil and topsoil and/or inadequate quality to support revegetation or agricultural land capability.	Soil inventory indicates a deficit of soil material.	Suitable source of additional soil material / growth medium to be identified, including the need for importation of material from off site. Investigation into measures that may be implemented to ameliorate other materials to make them suitable for use as a growth medium.	High	T-15

Rehabilitation Threat	Trigger	Response	Risk Ranking	TARP ID
Revegetation (native and agricultural land uses) impacted by lack of availability and quality of target seed resources, including genetic integrity.	Incorrect species established on final landform. Miscalculation of species mix required. Diversity of vegetation does not meet rehabilitation objectives and relevant completion criteria.	Suitably qualified ecologist or revegetation / rehabilitation expert engaged to assess reasons for divergence of failure of target or local vegetation establishment and recommend actions to ensure that the final vegetation community corresponds as closely as possible to the target community. Additional actions may include: • sowing of additional seed mix for targeted species or additional local species • use of tubestock, seed and mulch mix or other application techniques • soil amelioration works such as addition of gypsum, lime, fertiliser etc.; and • additional weed control activities (mechanical and / or chemical) and/or pest management as required.	High	T-15
Inadequate management of weed and pests.	Elevated weed and feral animal populations identified within surveys	Implement improvement program in consultation with ecologist and monitor through rehabilitation monitoring program.	High	T-16

Rehabilitation Threat	Trigger	Response	Risk Ranking	TARP ID
Rehabilitation adversely affected by climate change, bushfire, drought, flood, etc. Impacting long-term persistence and resilience of vegetation, including response to fire and grazing ultimately leading to failed or poor-quality rehabilitation	Bushfires and rain fall events pass control measures. Diversity of vegetation does not meet rehabilitation objectives and relevant completion criteria.	Revise bushfire controls with Rural Fire Service. Suitably qualified ecologist or revegetation / rehabilitation expert engaged to assess reasons for divergence of failure of target or local vegetation establishment and recommend actions to ensure that the final vegetation community corresponds as closely as possible to the target community. Additional actions may include: • sowing of additional seed mix for targeted species or additional local species • use of tubestock, seed and mulch mix or other application techniques • soil amelioration works such as addition of gypsum, lime, fertiliser etc.; and • additional weed control activities (mechanical and / or chemical) and/or pest management as required.	Critical	T-17
Mine subsidence affecting final landform and closure.	Greater settlement than anticipated in backfilled pit areas or waste rock emplacements (WREs). Final Void does not meet rehabilitation objectives and relevant completion criteria.	In consultation with DPE, assess options to re-form the area to meet requirements.	High	T-18

11.0 Review, Revision and Implementation

This RMP will be reviewed annually and amended under the following circumstances:

- to substitute the proposed version of a rehabilitation outcome document with the version approved by the Secretary—within 30 days after the document is approved
- as a consequence of an amendment made under clause 14 to a rehabilitation outcome document—within 30 days after the amendment is made
- to reflect any changes to the risk control measures in the prepared plan that are identified in a rehabilitation risk assessment—as soon as practicable after the rehabilitation risk assessment is conducted
- whenever given a written direction to do so by the Secretary—in accordance with the direction.

The RMP will also be reviewed and amended as required under the following:

- receipt of any approvals under the *Environmental Planning and Assessment Act 1979* and/or at least 2 months prior to expiry
- major changes in delivery methodology of a rehabilitation phase
- changes to landform or revegetation design, and/or
- identification of new risks or foreseeable hazards to rehabilitation are identified.

Review and revision to the RMP could also be triggered by (but may not be limited to) the following circumstances:

- Changes to the rehabilitation objectives, rehabilitation completion criteria or final landform and rehabilitation plan.
- Any changes to the risk control measures in the rehabilitation management plan that are identified in a rehabilitation risk assessment.
- Where a directive in writing is made by a regulatory agency to the Mine, or
- Updates required to provide more detailed information and additional specifics on the rehabilitation activities.

Any change to the RMP will be communicated to all site personnel during daily start-ups and displayed in the crib room. Changes will also be discussed and communicated as part of the implementation plan.

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APPENDIX 1

Mt Boppy Gold Mine Materials Characterisation Program for Rehabilitation Report

Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation

Material Characterisation Program for Rehabilitation

March 2021

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Project Number: 3467.20a

Report Title: Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation. Material Characterisation Program for Rehabilitation.

Client: Manuka Resources Ltd

Review History

Version	Prepared by	Reviewed by	Date
Draft A	Simon Buchanan	Cathie Shorthouse	18 Feb 2021
Draft B	Simon Buchanan	Rob Loch	22 Feb 2021
Rev 0	Simon Buchanan		24 Feb 2021
Rev 1	Simon Buchanan		31 Mar 2021

CONTENTS

1 INTRODUCTION

Manuka Resources engaged Landloch to provide technical design support for rehabilitation of the closure of Mount Boppy Gold Mine (the Mine). Specifically, landform designs are required for a stable waste rock emplacement (WRE) and tailings storage facility (TSF) that will be capable of supporting vegetation and the designated post mining land uses.

To ensure the constructed landforms are able to support vegetation and are sufficiently resilient to erosion, the growth media quality and erodibility of soils to be used as capping material needs to be considered. This Material Characterisation Program describes and characterises the materials identified on-site for use in rehabilitation in the *Mine Operation Plan* (R.W Corkery & Co, 2020) and reviews other mine documents. It also identities materials that warrant further testing to measure site specific erodibility properties. These erodibility values are required for erosion modelling to determine landform design rules.

Some information contained in this report was previously presented in the report titled *Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation. Review of Existing Soil Data and Preliminary Screening Sampling and Analysis Plan* (Landloch, 2020). This report supersedes the previous report.

1.1 Project Description

Mount Boppy Resources Pty Ltd is a wholly owned subsidiary of Manuka Resources Ltd, that took control of the Mine in 2019. The mining complex at Mount Boppy has grown through a process of expansions and acquisitions since underground mining initially commenced in 1901. Open-cut mining activities, including the current open-cut void commenced at the Mine in 2002 (R.W Corkery & Co, 2020).

The general arrangement of the Mine is provided in Figure A1 (Appendix A).

1.2 Scope of Work

Landloch's scope of work involved the following tasks:

i. Reviewing previous soils and land assessments undertaken at the Mine.
ii. Conducting data gap analysis to determine information required to:
    - o Develop an inventory of materials available for landform construction and rehabilitation; and
    - o Assess the suitability of materials as a plant growth media.
iii. Preparation of a sampling and analysis plan for fieldworks (documented in *Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation. Review of Existing Soil Data and Preliminary Screening Sampling and Analysis Plan* (Landloch, 2020)).
iv. Implementation of the sampling and analysis plan.
v. Laboratory analysis.
vi. Data interpretation, material characterisation, and preparation of this report.

2 DESKTOP REVIEW

The Mine is located near Canbelego in western New South Wales. Most of the land within the mining tenement is Crown Land with a small area located over privately owned freehold land.

2.1 Climate

The Study Area is situated in a persistently dry semi-arid climatic zone with hot summers and cool to mild winters.

Average monthly maximum temperatures typically range from 13°C - 20°C in winter and between 28°C - 39°C in summer. Summer temperatures can exceed 40°C for short periods.

Average monthly minimum temperatures range from 2°C - 8°C in winter to and 14°C - 24°C in summer (BoM, 2020). Frosts are frequent through the winter (NSW National Parks and Wildlife Service, 2003).

Rainfall is relatively uniformly distributed throughout the year, with a median annual rainfall for Cobar of 390 mm. However, rainfall can be extremely variable in late spring and early summer when the highest observed falls have been more than 200 mm in any one month.

Average evaporation exceeds the average rainfall throughout the year (NSW National Parks and Wildlife Service, 2003).

2.2 Topography

The Mine site is located within the Barwon-Darling River catchment. Surface drainage at the mine and surrounding area is characterised by poorly defined ephemeral streams. Runoff from the Mine drains to Mulga Creek in the east or Yanda Creek in the south.

The surrounding land consists of gently undulating landforms with low ridges and occasionally prominent ridges and ranges. The most prominent topographical feature in the vicinity is Mount Boppy to the northeast with an elevation of 406 m.

Total natural relief across the mining lease is 30 m, with elevations ranging from 275 m in the northeast to 305 m in the low rises to the west (Figure 1). The deepest points of the Pits are approximately 70 m below the natural surface (RL~210m).

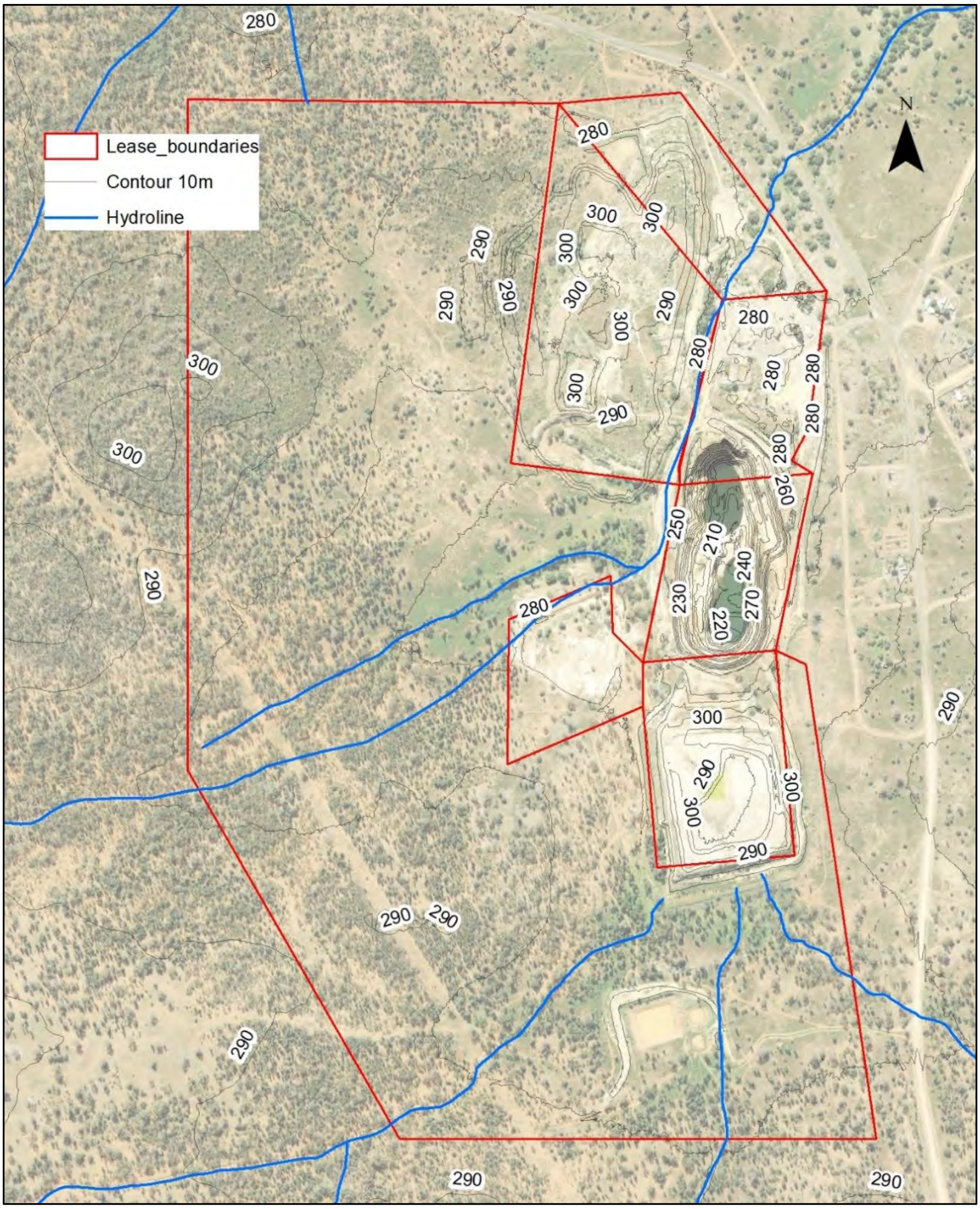


Figure 1. Topography the Study Area.

The gradients of the areas adjacent to the mining operations are typically less than 3 % on the undulating plain, increasing to 3 - 10 % on residual rises.

Within the Mine, gradients of the existing batters on the WRE and TSF are generally between 10 – 33 %, although there are some angle of repose batters on the WRE with gradients of 145–170 % (55 - 60°). The gradients of benches and plateaus of these structures are generally less than 10 % (5 - 6°) (Figure 2).

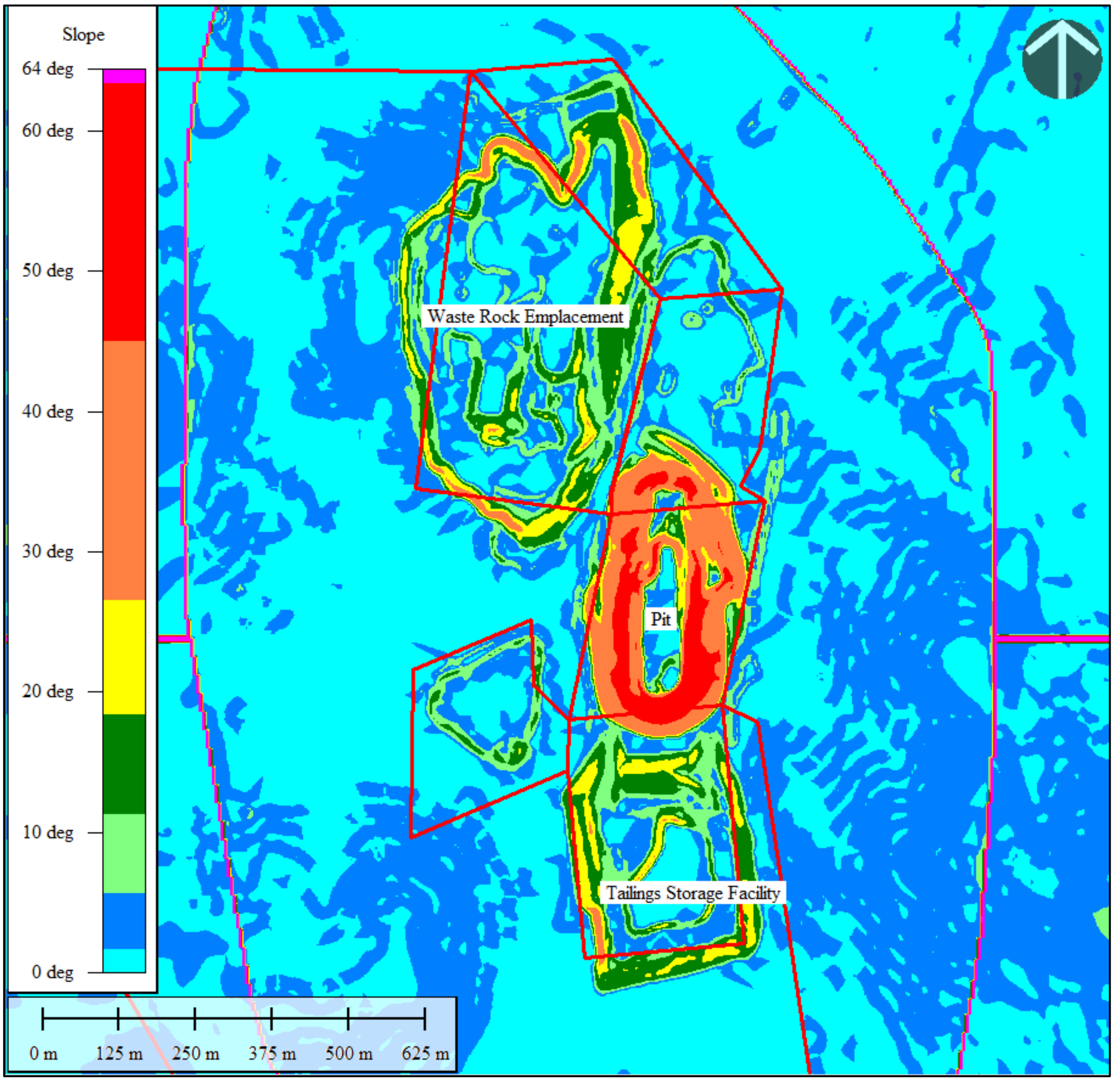


Figure 2. Existing slopes of the Study Area.

2.3 Geology

The Canbelego Regional Geology 1:100 000 mapping indicates there are four main broad geological units in the Study Area (Felton E.A., Brown R.E. and Fail A.P., 1985). The distribution of geological units is provided in (Figure 3)

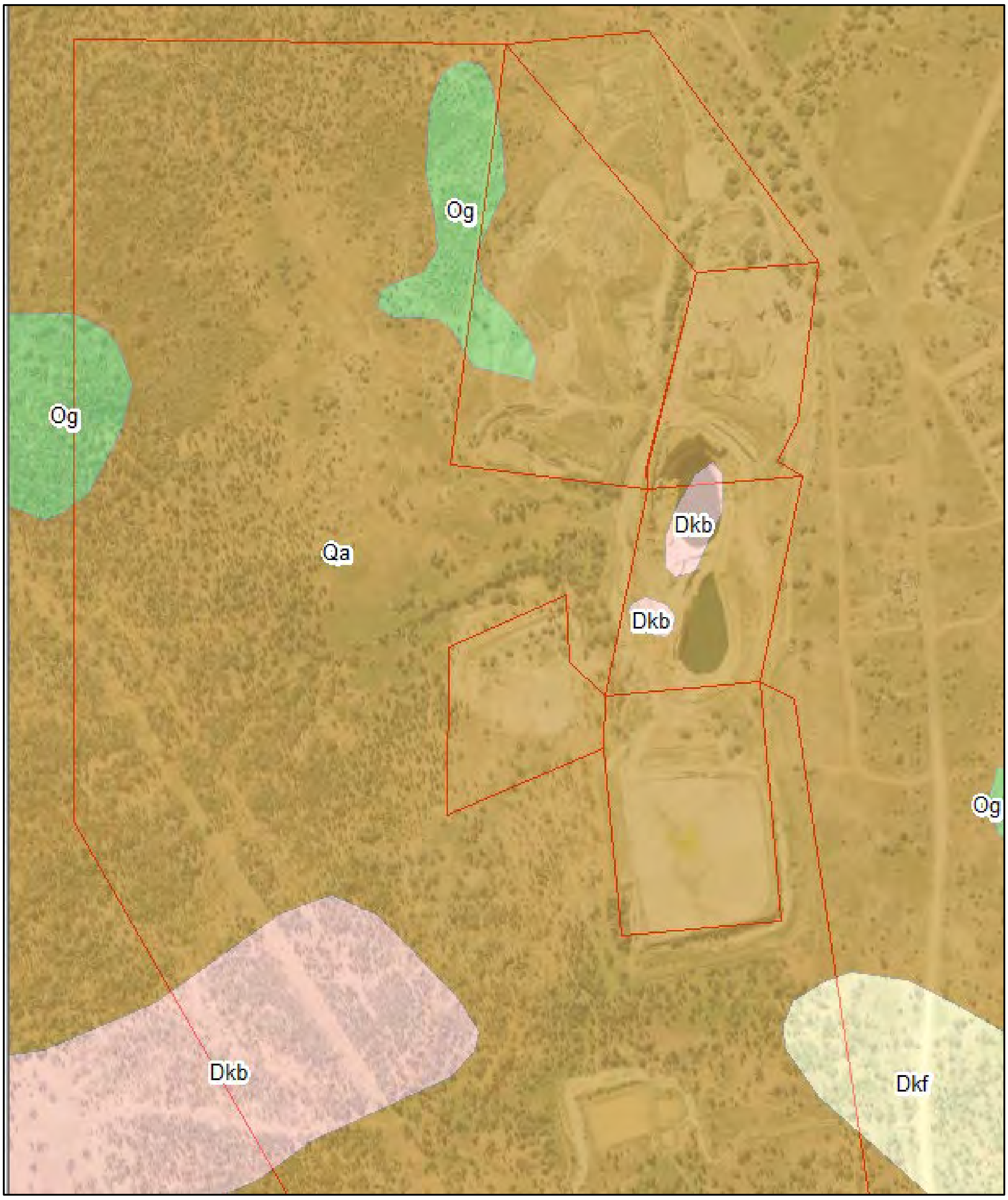


Figure 3. The geological units of the Study Area include Baledmund Formation (Dkb), Quaternary Alluvium (Qa), and Girilambone Group (Og), and Florida Volcanics (Dkf).

A description of the geological units is provided in Table 1. The Florida Volcanics are believed to be the source of gold at Mount Boppy.

Table 1. Primary geological units relevant to the Study Area (Felton E.A., Brown R.E. and Fail A.P., 1985).

Geological unit	Map code	Description
Quaternary Alluvium	Qa	Consists of layers of gravel, sand, silt and clay sediments.
Baledmund Formation	Dkb	Thinly laminated, commonly ferruginous, occasionally calcareous, siltstone and minor interbedded, well-sorted fine-grained lithic-quartz sandstone. Boulder to granule polymictic conglomerate and sedimentary breccia are variably developed at the base.
Girilambone Group	Og	Deformed and metamorphosed, micaceous, quartzose and quartz-lithic sandstone, pelite, chert; minor intercalations of polymictic conglomerate, siltstone, quartzite, and mafic and intermediate volcanics; black shale.
Florida Volcanics	Dkf	Rhyolitic and rhyodacitic lithic-crystal tuff and volcanic breccia, rhyolite lava, flow-foliated porphyritic dacite and minor siltstone

2.4 Land Systems and Soils

Land systems are areas or groups of areas that have a recurring pattern of topography, soils and vegetation. They reflect variations in soil type, geology, landform, drainage and vegetation. The Study Area is situated within the Cobar Land System and is described as (P.J. Walker, 1991):

- Slightly undulating rounded ridges and higher residuals of Silurian and Ordovician sedimentary and metamorphic rocks with overlying residual and colluvial gravel and quartz.
- General undulating relief is 10 m and 20 m on residual hills.
- Well defined dendritic drainage lines of Quaternary Alluvium ranging in width from 10 - 1,000 m.

Other land systems in the region will remain undisturbed by the Mine and include Mineshaft, Boppy and Wynwood Land Systems.

Relevant details of landforms of the Cobar Land System are provided in Table 2.

Table 2. Summary details of landforms in the Cobar Land System (P.J. Walker, 1991).

Landforms	Soil Groups	Vegetation
Residual rises / low hills. Slopes to 20 % and 300 m long; relief to 20 m. Small areas of Mineshaft Land System are also included.	Earthy or sandy lithosols with variable outcropping rock and surface stone, some gravelly red earths.	Dense to scattered mulga (*Acacia aneura*), green mallee (*Eucalyptus viridis*), and red box (*E. intertexta*); dense silver cassia (*Cassia artemisioides*), lobe-leaf hopbush (*Dodonaea lobulata*), budda (*Eremophila mitchellii*), emu bush (*E. longifolia*), and green fuchsia-bush (*E. serrulata*); abundant variable speargrass (Stipa variabilis), purple burr-daisy (*Calotis cuneifolia*), rock fern (*Cheilanthes tenuifolia*), long greybeard grass (*Amphipogon caricinus*), grey copperburr (*Sclerolaena diacantha*), and No. 9 wire grass (*Aristida jerichoensis*).
Ridge crests and upper slopes. Slopes to 5 % and 500 m long; relief to 10 m.	Lithosols of loamy or sandy loam texture, with shallow acid red earths; plentiful surface quartz gravel and rock fragments, slight ferruginous gravel.	Moderate to dense red box, mulga, green mallee and white cypress pine (*Callitris columellaris*); dense to moderate budda, silver cassia, punty bush (*Cassia eremophila*) and turpentine (*Eremophila sturtii*); sparse No. 9 wire grass, variable speargrass, other grasses and forbs.
Lower slopes and very low ridges. Slopes to 2 %, up to 1 km long; relief to 5 m.	Moderately deep red earths and calcareous red earths usually within hardpan; earthy lithosols.	Moderate bimble box (*Eucalyptus populnea*), mulga, white cypress pine and red box; moderate to dense budda, turpentine, punty bush and emu bush; sparse to moderate No. 9 wire grass, variable speargrass, grey copperburr, purple love grass (*Eragrostis lacunaria*), purple burr-daisy and forbs.
Smaller drainage lines. Level to 2 % slope, relief to 3 m; 10 m to 200 m wide.	Deep to moderately deep red earths with loam to clay loam surface texture over hard pan; slight gravel.	Dense to moderate bimble box, white cypress pine, mulga, red box and wilga (*Geijera parviflora*); dense budda, turpentine, punty bush and broad-leaf hopbush (*Dodonaea viscosa*); sparse to abundant No. 9 wire grass, variable speargrass, other grasses and forbs.
Larger drainage lines. Level, 200 m to 1 km wide; formed by merger of smaller drainage lines.	Deep calcareous and neutral red earths with loamy, silty and clay loam surface texture over hardpan; slight if any gravel.	Dense (except where cleared) bimble box, white cypress pine, mulga, yarran (*Acacia homalophylla*) and ironwood (*A. excelsa*); dense to moderate punty bush, budda, turpentine, broad-leaf hopbush and dogwood (*Myoporum deserti*); sparse to abundant No. 9 wire grass, variable speargrass, other grasses and forbs.

In broad terms, the topsoil materials of the Cobar Land System are generally *sandy* or *loamy* textured with clay contents of less than 15 % and 15–35 %, respectively.

The locality and distribution of land systems units are presented in Figure 4.

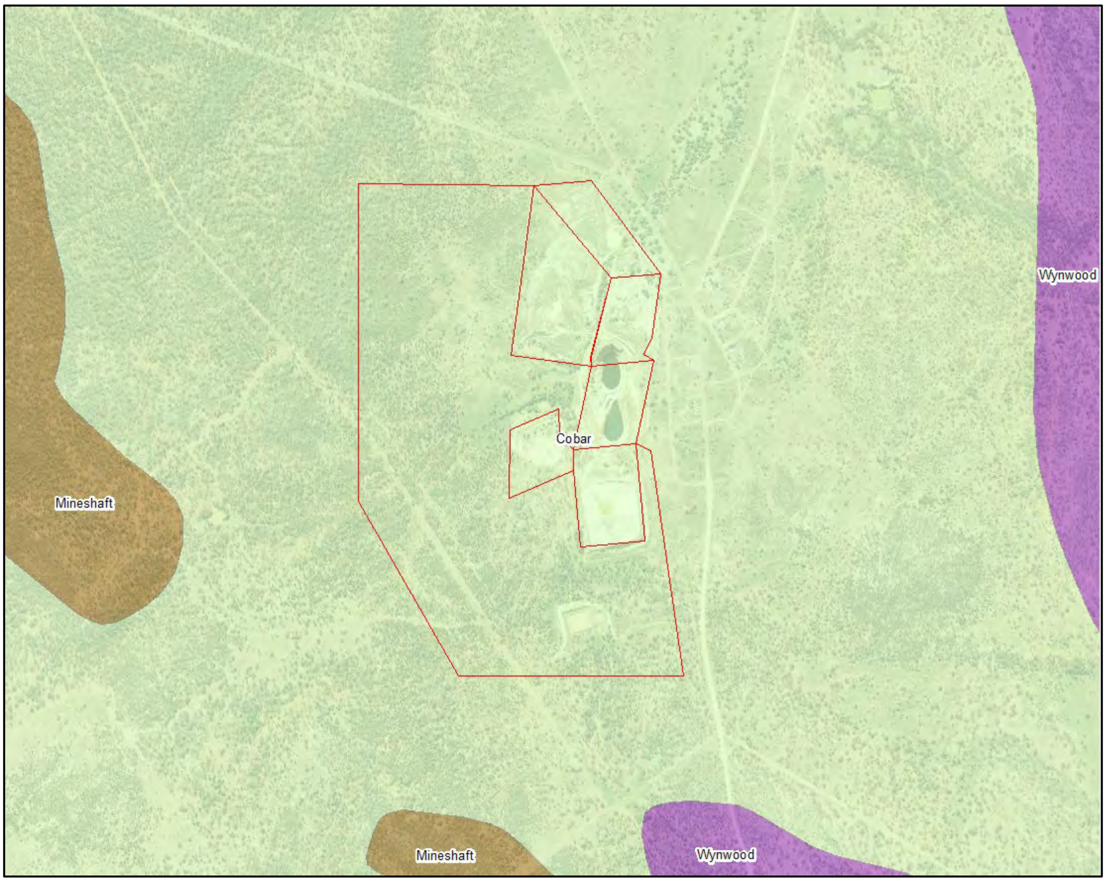


Figure 4. Land systems in the vicinity of the Mine.

2.5 Existing Soil and Material Characterisation Data

The Mine provided the following relevant information regarding overburden and soil materials that were considered relevant to this study.

2.5.1 Overburden (Waste Rock)

The key non-ore sedimentary materials that make up the overburden are predominantly sedimentary breccia, succeeded by bedded quartz–lithic arenite and quartz pebble conglomerate with intercalated siltstone.

Overburden materials are likely to be strongly oxidised (weathered), non-acid forming (NAF), low in sulphur, relatively benign with little acid neutralising capacity (RGS, 2015). This material will be used as growth medium and placed as a capping layer above potential acid forming material.

The Mine has demonstrated the oxidised overburden is able to support vigorous plant growth (See Sections 4.3.2 and 4.5.1).

'Increased risk' potential acid forming (PAF) materials (i.e. containing > 1 % total sulfur) are recovered from 50 - 165 m below ground level. These materials will be placed within the existing TSF structure prior to capping.

The remaining 'moderate risk' PAF material with a total sulfur content between 0.3 % and 1 % will be placed within the WRE (Mt Boppy Resources, 2020).

2.5.2 Soils

A soil assessment was undertaken as part of a previous environmental assessment for a proposed expansion circa 2011. A total of six test pits were excavated across the Mine site (Appendix A). The dominant soil type identified within the survey area is loamy or sandy loam gravelly lithosols.

The soil assessment report (SEEC, 2011) provides the following detail about the soil material:

- Profiles are shallow and gravelly (400 mm to 1,200 mm deep).
- Topsoil is non-saline; low in organic matter; slightly acidic to slightly alkaline; and non-sodic; subsoils can be slightly to moderately saline (EC 0.28 - 0.4 dS/m).
- Topsoil fertility was not tested in the 2011 program.

The Mount Boppy Mine Operation Plan - MOP (R.W Corkery & Co, 2020) provides the following details about the soil materials.

- The soils are highly erodible but are relatively coarse grained and not dispersible.
- Although the soils are erodible, the low slope gradients and low rainfall erosivity means the soil loss class is 'Very Low'.
- Soil improvement will be best achieved by incorporating organic matter and/or addition of soil ameliorants like gypsum.

2.5.3 Soil materials to potentially borrow

A disturbance approval (DA 2011/LD-00070 – REV 1) is outlined in the *Soil and Water Management Plan* (SWMP) (R.W. Corkery & Co, 2016). The approval allows disturbance within the area identified as Catchment D5 (A1 – Appendix A) for the purpose of mine water storage and evaporation ponds. While the ponds are no longer required the most recent modification of the MOP provides for the recovery of up to 46,000 m^3 of topsoil and subsoil from this area.

2.5.4 Tailings and PAF Waste Rock Materials

Tailings and PAF waste rock materials were excluded from this material characterisation program and they are not intended for use as a primary or secondary growth media.

A previous geochemical study reports the PAF waste rock and tailings will be highly acidic It reports waste rock leachate with pH values of approximately 3, and tailings materials with pH values between 3.7 and 4.2 (RGS, 2015). Such low pH values will severely limit the proliferation of roots and plant growth.

It is also reported the tailings materials have high salt contents to a degree that would likely restrict plant growth; however, this cannot be confirmed as the types of salts are not defined in the report. The tailings are prone to capillary rise with an accumulation of salts at the surface. Subsurface electrical conductivity$_{1:5}$ values were 1–1.5 dS/m, and increased to 3–4 dS/m at the surface (RGS, 2015).

The current intent at closure is to either bury or layer PAF materials at least 2 m below the surface of the TSF and WRE. PAF materials will be capped with NAF waste rock materials and revegetated (R.W Corkery & Co, 2020). Further details are provided in Section 2.6.

2.6 Post Mining Landforms

The final landform and drainage design at Mount Boppy aims to provide a stable and non-polluting landform that is compatible with the surrounding landscape and is detailed in the Mount Boppy MOP.

The MOP provides final landform details for the six rehabilitation domains at the Mine. The two relevant rehabilitation domains for this assessment include:

- Domain 2 – Tailings Storage Facility; and
- Domain 4 – Waste Rock Emplacement.

Final landform details for each domain are summarised in the Table 3.

Table 3. Summary of landform details provided in the MOP for relevant domains (R.W Corkery & Co, 2020).

Domain	Final Landform Details
2	<u>Tailings Storage Facility</u> PAF material will be paddock dumped over the existing tailings surface in piles approximately 3 m high. The piles will be pushed out by a bulldozer to compact and push onto the tailings' surface with lime added at a conservative rate of 30 t/ha. A clay liner will then be compacted over the PAF material to a minimum depth of 0.9 m and with a permeability of 1 x 10^{-9} m/s. Finally, NAF material will be paddock dumped and dozer profiled to create a minimum 2 m thick store and release cover. The profiled surface will be free-draining with appropriate water management structures.
4	<u>Waste Rock Emplacement</u> The WRE will be progressively constructed through paddock dumping of NAF material and profiling using a bulldozer. Specially designed PAF encapsulation areas within the WRE will be similarly formed through paddock dumping, with a base layer of NAF material to a minimum thickness of 3 m. The NAF material will be selected to provide good drainage beneath the WRE such that the PAF material is not subject to wetting and drying cycles. PAF material will be built up in lifts to a maximum of approximately 15 m thick with NAF material used to form the batters of the WRE. The areas of PAF encapsulation will be progressively limed, clay capped and covered with NAF.

The Mine intends to utilise oxidised overburden, subsoil, and available topsoil as growth media for vegetation on the final landforms. The MOP (R.W Corkery & Co, 2020) outlines that stockpiled soil material and weathered overburden will provide sufficient material to apply a 50 mm depth of growth medium across the final WRE, capped TSF 3 and ROM pad. The remaining soil and weathered overburden will be spread across infrastructure areas and used to increase the soil depth across flatter areas of the WRE.

2.6.1 Waste Rock Emplacement landform

The concept design for the WRE includes a plateau at approximately 20 m above the surrounding ground surface. It will incorporate a crest bund to prevent water running into the batters. The gradient of the plateau will be approximately 1° (1-2 %) with a southerly aspect and drain towards the pit.

The batters of the WRE are planned to be shaped with the lower section at a gradient of 18° (33 %) and the upper section at 33° (67 %). These sections are separated by a bench that is 5-10 m wide (Figures 5 and 6).

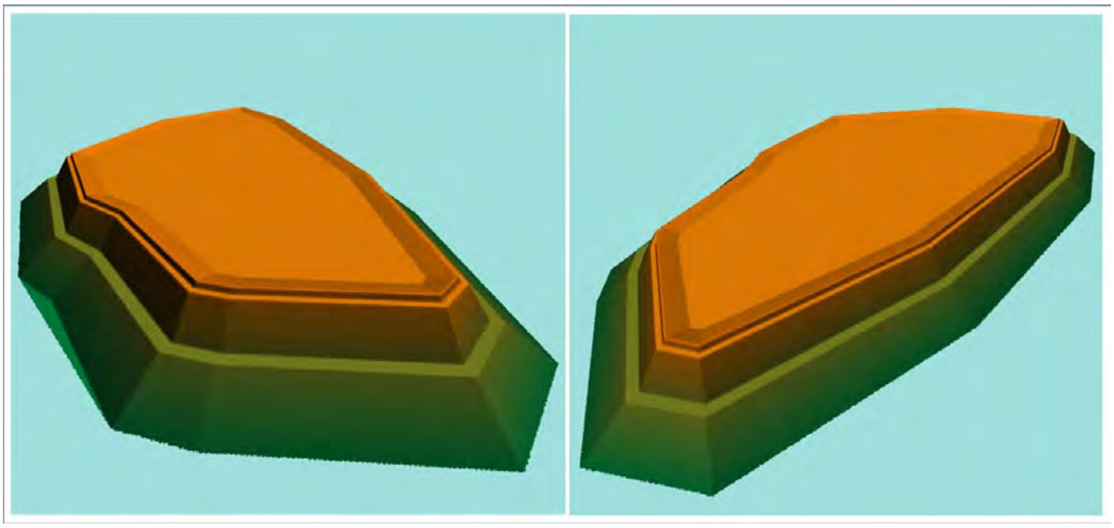


Figure 5. Conceptual design of the final landform for the WRE. It includes a crest bund and mid-slope bench on batters. Left image is facing north east, right image is facing northwest.

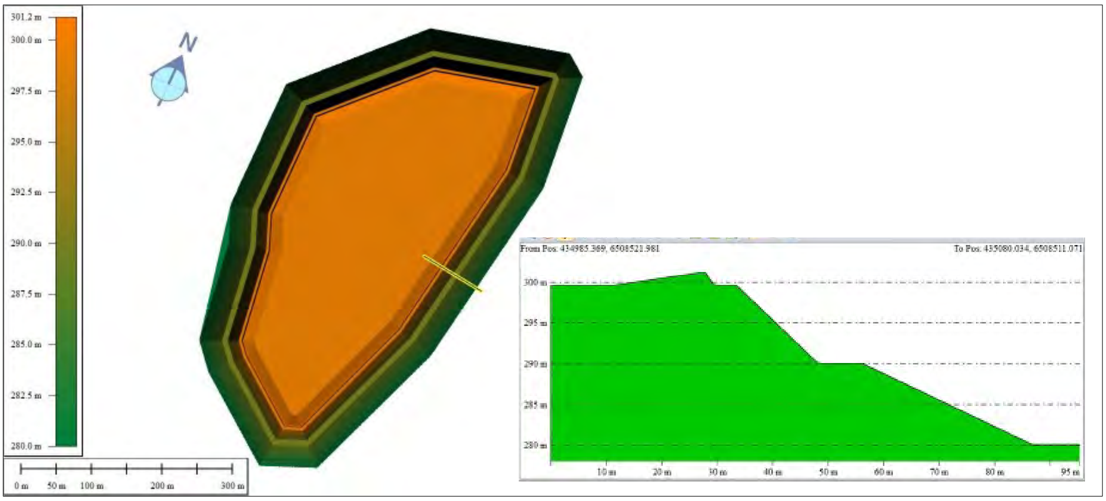


Figure 6. Conceptual design of the final landform for the WRE. Total relief is 20 m with the lower section at a gradient of 18° (33 %) and an upper section at 33° (67 %).

2.6.2 Tailings Storage Facility landform

The concept design for the TSF includes a plateau at approximately 15 m above the surrounding ground surface. It will incorporate a crest bund to prevent water running into the batters as included on the WRE. The gradient of the plateau will be approximately 1° (1 - 2 %) with a northerly aspect and drain towards the Pit. The batters are to be near linear at a gradient of 18° (33 %) (Figures 7 and 8).

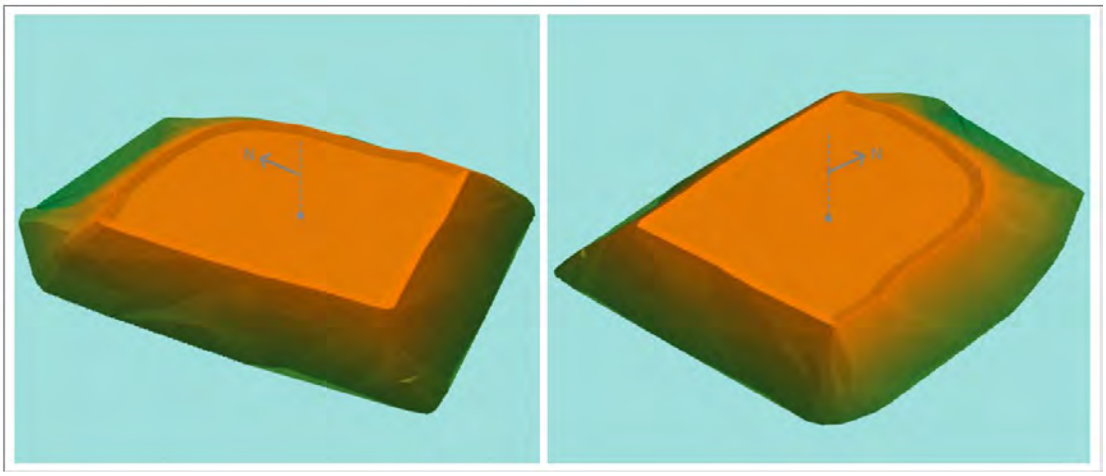


Figure 7. Conceptual design of the final landform for the TSF. It includes a crest bund.

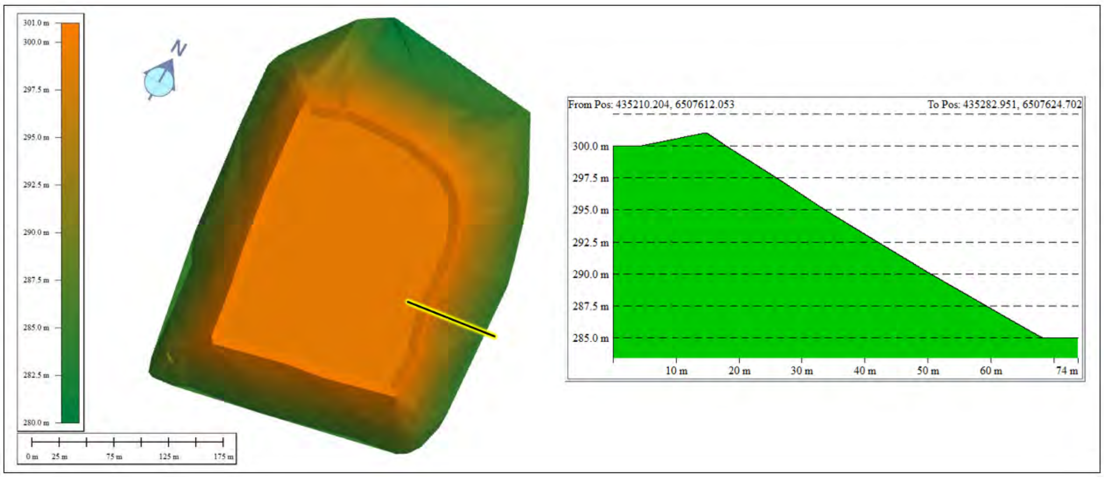


Figure 8. Conceptual design of the final landform for the TSF. Total relief is 15 m batters at a gradient of 18° (33 %).

2.7 Post Mining Land Uses

The current MOP commitments regarding post mining land use are to establish predominantly native vegetation communities suitable for intermittent and very low intensity grazing with a Rural Land Capability Class VI. The main exception is the batters of the WRE and TSF that are intended to be rehabilitated to a Rural Land Capability Class VII consisting of native vegetation with a land use of passive nature conservation (R.W Corkery & Co, 2020).

Of relevance to post mining land uses

- Rural Land Capability Class (RLCC) VI requires slopes < 33% and a soil depth of >250mm. This may be achievable with 50mm of topsoil placed on NAF waste provided the overburden can support vegetation and does not contain hazards to plant growth (e.g. extreme acidity/alkalinity, salts, etc)
- RLCC VII requires slopes < 50%. This is a potential conflict with the 10 m upper lift on the WRE, as it is currently planned to have a post mining RLCC VII. The gradients of the conceptual WRE landform are to be ~67 %, which correlates to RLCC VIII.

2.8 Revegetation

Rehabilitation trials and monitoring completed to date indicate that planting of tube stock at the Mine has limited success. Therefore, the current preference for revegetation is either direct or mechanical seeding of grass, tree, and shrub species (R.W Corkery & Co, 2020).

3 METHODOLOGY

3.1 Field Program

The field program was undertaken between 26 and 29 November 2020 by Simon Buchanan from Landloch. Simon is a practicing land resource scientist with 20 years' experience in construction, project management, and land resource management. Since 2011 Simon has been recognised as a Certified Professional Soil Scientist (CPSS) and a Certified Professional in Erosion and Sediment Control (CPESC).

Site conditions were relatively dry at the time of inspection. For the preceding months, the Bureau of Meteorology records for Cobar report rainfall depths of 26 mm in September, 11 mm in October, and 5 mm in November 2020.

3.2 Materials

The following materials were targeted for consideration as potential growth media in the landform design process:

1. Topsoil materials;
2. Subsoil materials; and
3. NAF waste rock overburden.

All materials were characterised in terms of basic chemical and physical fertility properties.

Any materials with the potential to be placed at the surface for use as topsoil / primary growth media were subjected to more thorough fertility assessment.

3.3 Sampling Plan

The sampling plan is provided in Table 4.

Table 4. Sampling plan for the material characterisation program (analytical suites are detailed in Section 3.5).

Material	Detail	Samples	Analytical Suite 1	Analytical Suite 2	Rock Properties
Natural ground (reference/ analogue)	Topsoil	6	6	6	-
	Subsoil - Upper	6	6	6	-
	Subsoil – Lower	6	-	-	-
Stockpile	Gravelly Topsoil	8	8	8	
	Non-gravelly Topsoil	6	6	6	
Overburden	Fresh NAF overburden	8	8		
	(Aged) Oxide NAF overburden	8	8	4	4
	(Aged) Oxide NAF overburden with vegetation	4	4	4	
Total Number of Samples		42	46	34	4

3.4 Sample Collection

Samples for chemical analysis were placed into separate bags. All samples were identified using the project name, unique profile number and depth range from where the sample was taken.

Natural ground surface samples were composites obtained by combining at least five sub-samples taken at random within a 10 m radius. All other samples collected were as discrete grab samples.

The mass of samples was approximately 0.5–1 kg for soil/non-rocky materials and 10–15 kg for rocky materials (coarse fragments greater than 50 %).

Data recorded at sites included:

- unique identification;
- geospatial location;
- nature of exposure;
- current land use and/or land cover;
- current surface condition;
- slope gradient description;
- presence of erosion;
- rock outcrops/ coarse fragment cover; and
- photographs of the site and profile.

3.5 Laboratory Analysis

Laboratory analysis for Suite 1 and Suite 2 was undertaken by East West Enviro Ag laboratory in Tamworth, NSW. This laboratory is accredited with National Association of Testing Authorities (NATA) and Australian Soil and Plant Analysis Council (ASPAC) certifications.

Testing of rock properties was undertaken Landloch's facility in Newcastle, NSW.

Details of laboratory tests are provided below.

3.5.1 Suite 1

Suite 1 testing included:

- $pH_{1:5}$ (water);
- Electrical conductivity ($EC_{1:5}$) and chloride;
- Exchangeable cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Al^{3+}) with calculations of exchangeable sodium percent (ESP), effective cation exchange capacity (ECEC), and Ca:Mg ratio; and
- Field texture.

3.5.2 Suite 2

Suite 2 testing included:

- Suite 1 tests;
- Total nitrogen and Total phosphorous;
- Available (Cowell) phosphorous, potassium, and (KCl) sulfur;
- Organic Carbon;
- Extractable trace elements (Cu, Zn, Mn, Fe and B);
- Particle size analysis (clay <2 µm, silt 2-20 µm, very fine sand (20-100 µm), fine sand 100-200 µm, coarse sand 200-2,000 µm, gravel >2,000 µm); and
- Emerson Dispersion Class.

3.5.3 Rock properties

Rock property testing included -

- Slake soundness;
- Rock particle density;
- Water absorption; and
- Particle size distribution using scaled digital images.

4 FINDINGS

The three categories of materials characterised as part of this assessment include -

- Natural ground;
- Soil stockpiles; and
- Waste.

Details of these materials are provided below. Site locations are provided on Figure A1 and Table B1. Site description records and laboratory results are provided in Appendix B.

4.1 Natural Ground

A total of six natural ground sites were described. These were situated to the west of WRE, in and surrounding, the area referred to as 'Catchment D5' in some Mount Boppy Gold Mine documents (Figure A1, Appendix A).

The soil profiles were relatively similar at all locations. The generalised soil profile is provided in Table 5. Records of surface description and soil profiles are included in Tables B2, B3, B5, B6 and B7 (Appendix B).

Table 5. General soil profile of the natural ground sites.

Layer	Description
Surface	Hardsetting surface with coarse fragment content of 10 – 20 %. Groundcover was generally 40-80 % with a green vegetation to litter ratio of approximately 1:1.
0.0 to 0.1–0.2m (Topsoil)	Brown slightly gravelly sandy clay loam with 10–20 % content of gravel less than 60 mm in diameter.
0.1–0.2m to 0.4–0.5m (Upper subsoil)	Pale reddish brown moderately gravelly clay loam / light clay with 10–80 % content of gravel less than 60 mm in diameter.
0.4–0.5m to > 1.0m (Lower subsoil)	Pale yellow / pale brown very gravelly sandy clay loam to light medium clay with 40–80 % content of gravel less than 60 mm in diameter.

Photograph 1. Soil landscape of natural ground at Site MB05. Groundcover was 60-80 % consisting of mainly of grasses and forbs in a sparse open woodland.

Photograph 2. Ground condition of natural ground at Site MB05. Surface coarse fragment content was 10–20 %.

Photograph 3. Soil profile of natural ground to the west of WRE (Site CD5-01). Soil profiles in this area contained appreciable gravel content.

Photograph 4. The gravel content of natural ground to the east of WRE increased with depth generally being 10–20 % in topsoil, 40–60 % in upper subsoil and 40-80 % in lower subsoil.

Laboratory data are presented in Tables B5, B6 and B7 (Appendix B). Key features are detailed below:

4.1.1 Topsoil

Brown, slightly gravelly, sandy clay loam with 10–20 % content of gravel less than 60 mm in diameter. Physicochemical properties include:

- Neutral to mildly acidic pH;
- Very low salinity;
- Generally non-sodic and stable to rapid wetting. Sometimes sodic and slightly dispersive;
- Low to very low cation exchange capacity and ability to retain nutrients;
- Low levels of calcium;
- Moderate levels of organic matter, nitrogen, phosphorous, potassium, sulfur and magnesium; and
- Clay and silt content is approximately 15 % and 5-10 % respectively.

4.1.2 Upper subsoil

Pale reddish brown moderately gravelly clay loam / light clay with 10–80 % content of gravel less than 60 mm in diameter. Physicochemical properties include:

- Neutral to mildly acidic pH;
- Very low salinity;

- Generally non-sodic and stable to rapid wetting. Sometimes sodic and slightly dispersive;
- Low to very low cation exchange capacity and ability to retain nutrients;
- Low levels of organic matter, nitrogen, and calcium;
- Moderate levels of available phosphorous, potassium, sulfur, and magnesium; and
- Clay and silt content is approximately 5–10 % and 5 % respectively.

4.1.3 Lower subsoil

Pale yellow / pale brown very gravelly sandy clay loam to light medium clay with 40–80 % gravel content of less than 60 mm in diameter. Physicochemical properties include:

- Neutral to strong alkalinity;
- Very low salinity;
- Generally sodic and expected to be dispersive;
- Low to very low cation exchange capacity and ability to retain nutrients; and
- Micronutrient fertility and particle size analysis was not assessed.

These features of the natural ground samples are mostly comparable to those reported in a previous soil assessment (SEEC, 2011) and in the MOP (R.W Corkery & Co, 2020). The exception is that the MOP reports topsoil and subsoil natural ground to be non-dispersive but in this study these materials are reported as being dispersive.

4.2 Soil Stockpiles

Several soil stockpiles were identified during fieldwork. Their locations are provided in Figure A2 (Appendix A) and laboratory data is in Tables B8, B9, and B13. These stockpiles have been categorised and named Gravelly Topsoil or Non-Gravelly Topsoil in this report.

4.2.1 Gravelly Topsoil

Gravelly Topsoil is brown, moderately gravelly sandy clay loam with coarse fragment content generally 40–60 % and less than 60 mm in diameter.

The key physicochemical properties are:

- Mildly acidic pH;
- Very low salinity;
- Non-sodic but slightly dispersive;
- Low to very low cation exchange capacity and ability to retain nutrients;
- Low levels of organic matter, nitrogen, and calcium;
- Moderate levels of, phosphorous, potassium, sulfur and magnesium;
- Clay and silt content approximately 10-15 % and 5-10 %, respectively; and

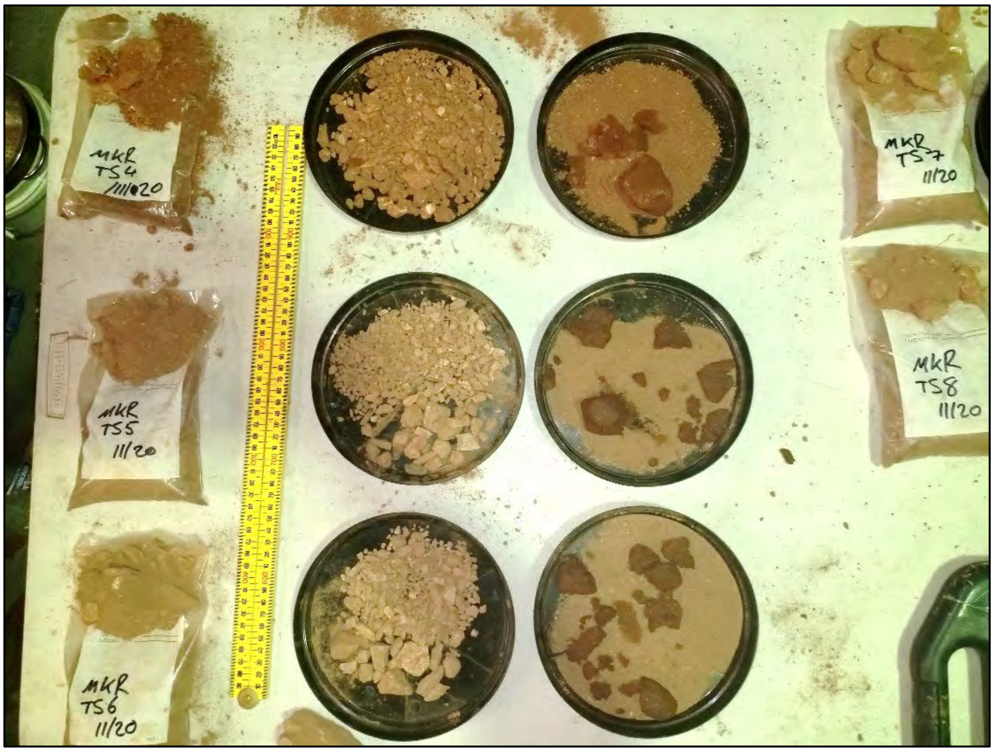
- Coarse fragment sizing d_{50} and d_{90} of armoured surface of is 30–40 mm and 80 mm, respectively.

Photographs 5 to 7 are representative of the Gravelly Topsoil at the Mine.

These materials share similar properties to the topsoil and upper subsoil materials described at the natural ground sites. Photographs 8 and 9 show stockpiles of the Gravelly Topsoil supporting vegetation that is understood to have been recruited naturally.

Photograph 5. Gravelly Topsoil stockpile (Site TS1) in an armored condition from rainfall.

Photograph 6. Gravelly Topsoil stockpile (Site TS1) is newly disturbed.



Photograph 7. The rock content of the Gravelly Topsoil stockpile materials was generally 40–60 %. These samples are from Sites TS4, TS5, and TS6.

	
Photograph 8. Vegetation on batter of Gravelly Topsoil stockpile (Site TS6). The stockpile is on the right of the frame.	**Photograph 9.** Gravelly Topsoil stockpile (Site TS7), in the centre of the frame (foreground), is covere in vegation. The western batter of the WRE is on the right of frame.

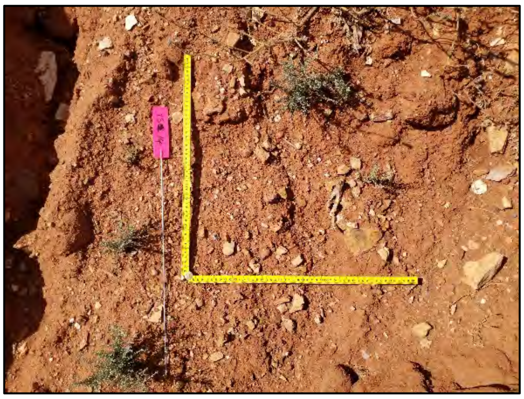
4.2.2 Non-Gravelly Topsoil

Non-Gravelly Topsoil is pale reddish brown light clay with gravel content less than 10 % and less than 60 mm in diameter. Key physicochemical properties are:

- Mild to strong alkalinity;
- Very low salinity;
- Sodic and dispersive;
- Low to very low cation exchange capacity and ability to retain nutrients;
- Low levels of organic matter, nitrogen, phosphorous and calcium;
- Moderate levels of potassium, sulfur and magnesium; and
- Clay and silt content approximately 15–20 % and 10–15 % respectively.

Photographs 10 to 12 are representative of Non-Gravelly Topsoils at the Mine.

These materials are dissimilar to the topsoil and upper subsoil materials described at the natural ground sites as they have appreciably lower gravel content, are more heavily textured, and generally dispersive.



Photograph 10. Non-Gravelly Topsoil stockpile (Site TS14) in an armoured condition from rainfall.

Photograph 11. Non-Gravelly Topsoil stockpile (Site TS14) newly disturbed.

Photograph 12. The rock content of the Non-Gravelly Topsoil stockpile materials was generally less than 10 %. These samples are from Sites TS12, TS13, and TS14.

4.3 Waste Materials

The waste materials consist of overburden (and inter-burden materials) around the gold bearing ore and are predominantly comprised of sedimentary breccia, succeeded by bedded quartz–lithic arenite and quartz pebble conglomerate with intercalated siltstone.

The waste rock materials are predominantly NAF, low in sulphur, contain little acid neutralising capacity and are relatively benign (RGS, 2015). Experience at the Mine indicates if the waste rock is exposed to weathering, after a few years the material becomes favourable to plant growth.

PAF materials are also present. These are being buried in the TSF and WRE and will not be utilised as plant growth media (Mt Boppy Resources, 2020).

The waste rock materials characterised included:

- Waste Rock (Weathered) Oxide;
- Rehabilitated Waste Rock Oxide; and
- Fresh Waste Rock (Waste Rock Fresh).

Sample locations are presented on Figure A2 (Appendix A) and laboratory data are in Tables B10 to B13.

4.3.1 Waste Rock (Weathered) Oxide

Waste Rock Oxide is rocky material with loamy sand textured fines. Key physicochemical properties are:

- Mild to moderate alkalinity with mean pH 7.9 and typical range 7.5–8.3;
- Salinity is generally low, however sometimes high, but not extreme;
- Highly sodic but not dispersive;
- Very low cation exchange capacity and ability to retain nutrients;
- Very low levels of organic matter, nitrogen, potassium, magnesium, and calcium;
- Moderate to high levels of phosphorous and sulfur;
- Clay and silt content is approximately 5 % and 5 %, respectively;
- Coarse fragment sizing d_{50} and d_{90} of armoured surface of is 50–100 mm and 200–300 mm, respectively;
- Particle density mean is 2.4 g/cm^3 (CI $_{95\%}$ +/- 0.1 g/cm^3); and
- Water absorption mean is 4.8 % (CI $_{95\%}$ +/- 1.2 %).

Photographs 13 and 14 are representative of Waste Rock Oxide at the Mine.

These pH data differ to the findings in a previous geochemical report (RGS, 2015) for Waste Rock Oxide, in that lower pH values are reported as between 5.5–6.5. The reason is likely due to the difference in sample preparation.

In this Landloch program, laboratory testing was conducted on the <2.0 mm fines component, obtained by sieving bulk waste rock samples.

In the RGS program a different procedure was adopted. The prepared rock samples were obtained by crushing (where necessary) and pulverising to ≤ 0.075 mm particle size. This generates a large sample surface area in contact with the resultant assay solution, providing greater potential for dissolution and reaction. It represents an assumed initial 'worst case' scenario for these materials (RGS, 2015).

	
Photograph 13. Waste Rock Oxide material (Site WRO1) in an armored condition from rainfall.	**Photograph 14.** Waste Rock Oxide material (Site WRO1) newly disturbed.

4.3.2 Rehabilitated Waste Rock Oxide

Rehabilitated Waste Rock Oxide is rocky material with loamy sand textured fines. Key physicochemical properties are:

- Mild to moderate alkalinity with mean pH 8.3 and typical range 8.2–8.5;
- Salinity is low;
- Highly sodic and slightly dispersive;
- Very low cation exchange capacity and ability to retain nutrients;
- Very low levels of organic matter, nitrogen, magnesium, and calcium; and
- Moderate to high levels of phosphorous and sulfur.

Photographs 15 and 16 are representative of Rehabilitated Waste Rock Oxide at the Mine.

Laboratory results for samples of this waste material were comparable to the Waste Rock Oxide samples except there was no incidence of elevated salinity, and most samples were slightly dispersive.

	
Photograph 15. Rehabilitated Waste Rock Oxide (Site WRO1) with vegetation and in an armored condition from rainfall.	**Photograph 16.** Rehabilitated Waste Rock Oxide (Site WRO1) newly disturbed.

4.3.3 Fresh Waste Rock

Fresh Waste Rock is rocky material with loamy sand textured fines. Key physicochemical properties are:

- Acidic, with a mean value of 5.2 and typical range of 3.0–7.0;
- Elevated salinity, but not due to chloride-based salts;
- Highly sodic and but not dispersive;
- Very low cation exchange capacity and ability to retain nutrients;
- Clay and silt content approximately 5 % and 5 %, respectively;
- Particle density mean is 2.6 g/cm^3 ($CI_{95\%}$ +/- 0.1 g/cm^3); and
- Water absorption mean is 1.7 % ($CI_{95\%}$ +/- 1.5 %).

Photographs 17 and 18 are representative of Fresh Waste Rock at the Mine.

Macro and micronutrients were not assessed due to the elevated acidity and salinity constraints reported in Suite 1 tests.

Compared to Waste Rock Oxide samples, the less weathered Fresh Waste Rock materials are highly acidic and more saline, slightly denser and have lower water absorption properties.

Photograph 17. Fresh Waste Rock material (Site WRF6) in an armored condition from rainfall.

Photograph 18. Fresh Waste Rock material (Site WRF6) newly disturbed.

4.4 Existing Rehabilitation Trials

There are established rehabilitation trials underway on the tailings dam and on a portion of the eastern batter on WRE. Details are provided below.

4.4.1 Tailings' dam batters - Waste Rock Oxide

The rehabilitation trial on the tailings' dam batters is understood to have been established in the 1990s. The batter relief is approximately 10–15 m with slopes 30–35 m long. Batter shape is near linear with some slightly concave and slightly convex sections at gradients of 35–40 % (Figure 90).

The batter was formed from Waste Rock Oxide materials that had been cross ripped along the contour, as evidenced by scarring. The surface condition was firm with an armoured surface of 50-90 % rocky fragments < 200 mm in diameter.

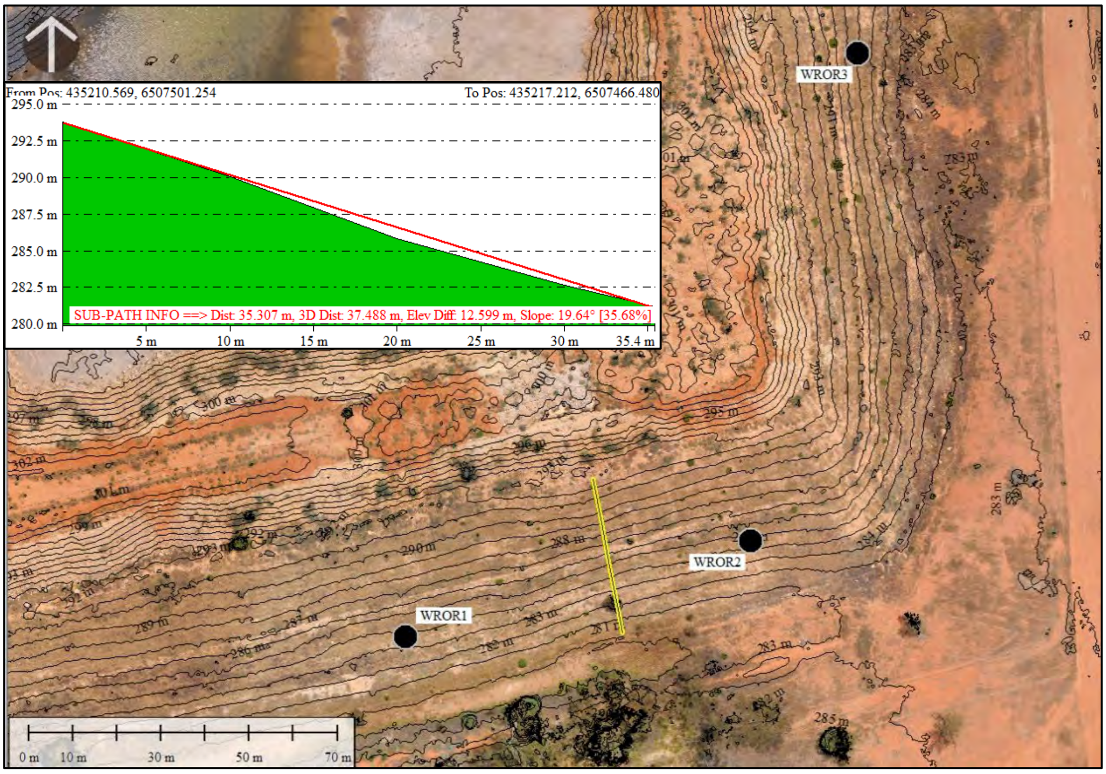


Figure 9. Typical cross section of TSF batter. Relief 10–15 m, near-linear slope at 35-40 %, approximately 35 m long. Ground observation sites are WROR1, WROR2, and WROR3.

Ground cover was generally 80–100 %, consisting of grasses and forbs with a green/dry matter ratio of 1:1 (Table B2). Laboratory data indicate that, compared to stockpiled Waste Rock Oxide materials, no fertiliser, gypsum, or other amendments have been added to the Waste Rock Oxide on these batters.

The batter appears to be successful in providing a stable and non-polluting surface.

Photograph 19. Appreciable rock content of 50–90 % in the armored surface of the TSF (Site WROR2).

Photograph 20. View of batter on the TSF with vegetation growing directly in the Waste Rock Oxide materials (Site WROR2). Groundcover was 80-100 %.

4.4.2 WRE batter - topsoil

A rehabilitation trial on the WRE was established circa 1995. The batter relief is approximately 20 m with slope lengths of 65 m. Batter shape is linear with a gradient of 35 % (Figure 10).

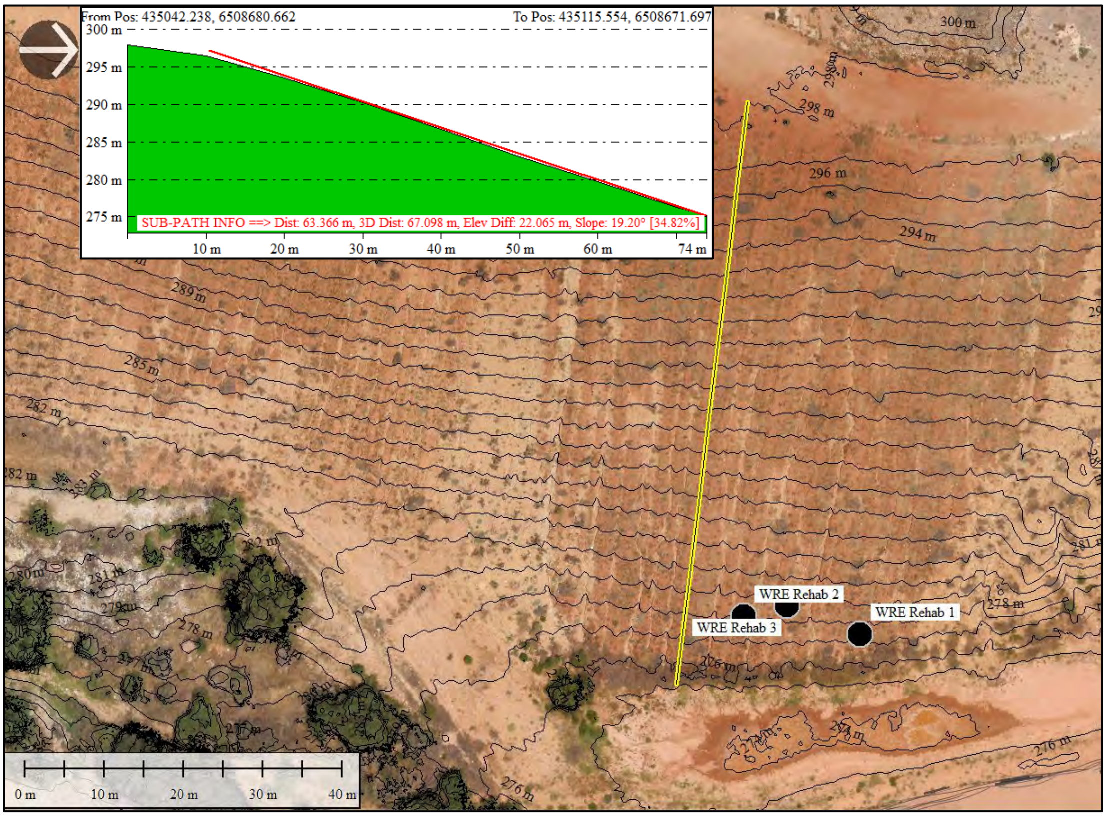


Figure 10. Typical cross section of rehabilitated batter on WRE. Relief 20 m, near-linear slope at 35 %, approximately 65 m in length. Ground observation sites included WRE Rehab 1, WRE Rehab 2, and WRE Rehab 3.

The ground surface contained excessive rilling with spacing generally 1 - 3m. The depth of rill was limited by the underlying waste rock materials, typically at depths of 0.1 - 0.25 m below ground surface (Photographs 20 and 21).

Vegetation cover of inter-rill areas was 60–80 % with a surface coarse fragment content of 20–40 %.

	
Photograph 21. Rill at Site WRE Rehab 1. Depth approximately 0.25 m, width is 0.15 - 0.5 m.	**Photograph 22.** Rill spacing at Site WRE Rehab 2 was approximately 2 m.

4.5 Timber Debris Stockpile

The timber debris stockpiled on the plateau of the WRE has the potential to be used in rehabilitation (Photograph 23). Application of vegetative debris to the surface will reduce erosion and improve the potential for growth of vegetation.

Photograph 23. Timber debris stockpile on the WRE. The log diameters generally range from 0.1- 0.3 m. The 1m x 1m ruler is placed to indicate the scale of the stockpile.

Vegetative debris at the surface will increase the hydraulic roughness and improve the batter slope's capacity to store water and sediment. It will provide structure to capture leaf litter and native seeds, and microrelief to promote seed germination and plant establishment.

Photographs 24 and 25 show examples from other mine sites situated in similar semi-arid climates where vegetative debris has been placed on the ground surface at rehabilitation to promote plant growth and reduce erosion.

Photograph 24. The establishment of vegetation through debris that had been spread and track rolled - Ginkgo Mine, western NSW.

Photograph 25. Spreading tree debris on freshly placed topsoil – Murrin Murrin Operation, WA.

5 GROWTH MEDIA SUITABILITY CRITERION

The materials encountered have been classified according to their ability to support plant growth, as either *primary* or *secondary* growth media.

5.1 Primary Growth Media

Primary growth media infers the ability of materials to be used as a 'topsoil' or topsoil surrogate.

It is the upper-most layer of soil/materials placed over the rehabilitated area. In most situations it will be up to 0.15–0.3 m deep and consist of surface soil (topsoil) materials recovered prior to mining.

Compared to subsoil and overburden materials, it is typically higher in organic matter, micronutrients, and has low to negligible limitation to plant growth.

5.2 Secondary Growth Media

Secondary growth media infers the ability of materials to be used as a 'substrate' or substrate surrogate.

It is the subsurface layer placed on the rehabilitation area prior to covering with a primary growth media. Its prime purpose is to increase the soil water storage capacity of the soil profile and/or to meet the soil depth criterion for certain vegetive post-mining land uses and target vegetation communities.

In some circumstances, it may be improved by the addition of amendments (e.g. gypsum, lime, organic matter) to convert into a primary growth media. However the cost and practicability of such amendments are often prohibitive.

5.3 Suitability Classification

A four class suitability system is applied in the evaluation of materials as growth media. These classes are defined as follows:

Class A – Good Quality

- Negligible limitations to plant growth.
- Good quality material for intended purpose.
- *Nil* to *low* levels of amendment will be required.

Class B – Fair Quality

- Minor limitations to plant growth.
- Reasonable quality material for intended purpose.
- *Low* to *moderate* levels of amendment may will be required.

Class C – Marginal Quality

- Moderate limitations to plant growth.
- *Moderate* to *high* levels of amendment may be required to improve material quality to support plant growth.

Class D – Not Suitable

- Severe limitations to plant growth.
- It will generally be uneconomic or unviable to amend materials to the degree needed to support plant growth.

Suitability of materials as Primary Growth Media or Secondary Growth Media is presented with recommendations, and fertiliser and ameliorants rates in Table 7.

6 SOIL MANAGEMENT AND REVEGETATION

Specifics relating to soil preparation, and revegetation are provided below.

6.1 Soil Preparation

Ripping is required to breaking up compacted layers near the surface. This will increase water infiltration and rooting depth, and reduce rates of runoff and erosion. It is also critical in the incorporation of ameliorates to address sodic and acidic conditions.

Relieve compaction by deep ripping along the contour to a depth of 0.5 m to 1.0 m, with rip lines approximately 1.0 m apart. Ripping is usually performed with a ripping tynes on a bulldozer or tractor-mounted three-point linkage. Depending on the spacing of tynes and field conditions, multiple offset passes and cross ripping over the same area may be necessary to achieve the desired results.

Ripping results is a surface with a high degree of *surface roughness* that with present a less erodible exterior, and provide depressions to capture seed, fertiliser, water, and litter that will promote plant growth. A high degree of surface roughness will persist in rocky materials for many decades or more, however, in non-rocky materials the rip lines will subside and generally be unnoticeable within a few years.

Do not rip:

- Wet soils or waterlogged areas. This can increase compaction and form hard pans under the wheel / track lines; or
- Perpendicular to the contour. This will increase erosion.

Ripping along the contour is typically restricted to slopes with gradients less than 35 % due to the potential for plant/vehicle roll over.

6.2 Fertiliser and Ameliorants

Rates of fertiliser and amendments for the different materials are presented in Table 7. These rates aim to provide:

- Phosphorus (Colwell) content of the topsoil to within a target concentration of 25–40 mg/kg, being comparable to analogue sites (i.e. Natural Ground Topsoil);
- An appreciable source of nitrogen;
- Improved levels of calcium; and
- Reduced potential for dispersion.

6.2.1 Gypsum

Gypsum has been recommended for sodic/dispersive materials or where calcium is low.

Gypsum should be applied during soil preparation stages in a manner that allows for as thorough mixing as is practicable into the surface materials. It should be applied prior to seed and fertiliser applications.

- Slope gradients less than approximately 35 %:
    - o Aim to incorporate gypsum into the upper 0.3 m of materials.
    - o Relieve compaction by deep ripping along the contour to a depth of 0.5 m to 1.0 m, with rip lines 1.0 m apart.
    - o Deep ripping should be followed by shallow ripping/scarifying to incorporate gypsum amendments more thoroughly into the upper 0.3 m of materials.
- Slope gradients greater than approximately 35 %, or when ripping/scarifying along the contour is not practicable (or safe):
    - o Aim to incorporate gypsum into the upper 0.5 m of materials.

- Double the gypsum rate recommended in Table 7.
- When shaping up the batters in preparation for rehabilitation, incorporate gypsum into caping materials on the plateau of the landform then pushing down the batter.

6.2.2 Fertiliser

Blood and bone fertiliser (N: ~5%, P: ~5%, K: <1 %) has been specified as it will provide the slow-release of nutrients to complement the low rainfall and challenging temperatures experienced by the Mine.

Fertiliser should be applied at seeding. It can be broadcast with a spreader, applied hydraulically, or pneumatically. Spreaders are typically suitable for slopes with gradients less than 35 %, and pneumatic or hydraulic applications will be required for steeper slopes.

Table 6. Fertiliser and ameliorant treatment rates for materials and growth media suitability classification.

Material	Limitations	Amendments	Growth Media Suitability	
			Primary	Secondary
Natural Ground Topsoil	• Sometimes sodic and slightly dispersive. • Low to very low ability to retain nutrients. • Low calcium.	• Gypsum: 0.5 t/ha per 0.3 m soil depth. • Blood and Bone fertiliser at 350 kg/ha.	1A	2A
Natural Ground Upper Subsoil	• Gravel content 10–80 % • Sometimes sodic and slightly dispersive. • Low ability to retain nutrients. • Low organic matter, nitrogen, and calcium.	• Gypsum: 1 t/ha per 0.3 m soil depth. • Blood and Bone fertiliser at 750 kg/ha	1B	2A
Natural Ground Lower Subsoil	• Gravel content 40–80 %. • Generally sodic and expected to be dispersive. • Low ability to retain nutrients. • Low organic matter, macro and micronutrients.	• Nil treatment • Soil quality:	1D	2D
Gravelly Topsoil	• Non-sodic but slightly dispersive. • Low ability to retain nutrients. • Low levels of organic matter, nitrogen, and calcium.	• Gypsum: 0.5 t/ha per 0.3 m soil depth. • Blood and Bone fertiliser at 500 kg/ha. • Post treatment soil quality: 1A	1A	2A
Non-Gravelly Topsoil	• Sodic and dispersive. • Low ability to retain nutrients. • Low levels of organic matter, nitrogen, phosphorous and calcium.	• Gypsum: 1.5 t/ha per 0.3 m soil depth. • Blood and Bone fertiliser at 1,000 kg/ha.	1B	2A
Waste Rock Oxide	• Salinity is sometimes high. • Highly sodic and slightly dispersive. • Very low ability to retain nutrients.	• Gypsum: 1.5 t/ha per 0.3 m soil depth. • Blood and Bone fertiliser at 600 kg/ha.	1B	2A

Material	Limitations	Amendments	Growth Media Suitability	
			Primary	Secondary
	• Very low organic matter, nitrogen, potassium, magnesium, and calcium.			
Fresh Waste Rock	• Commonly strongly acidic. Typical range of pH 3.0–7.0. • Elevated salinity. • Highly sodic and but not dispersive. • Very low ability to retain nutrients.	• Nil treatment	1D	2D

Notes:

Class A – Good Quality: Negligible limitations to plant growth.

Class B – Fair Quality: Minor limitations to plant growth.

Class C – Marginal Quality: Moderate limitations to plant growth.

Class D – Not Suitable: Severe limitations to plant growth.

6.3 Seeding

Seeds can be broadcast with a spreader, applied hydraulically or pneumatically.

6.3.1 Broadcast seeding

Broadcast seeding involves scattering seed across prepared primary growth media. Once spread, best results are achieved when seed is lightly worked into the soil by harrowing (or raking, tracking, chain dragging, rolling etc.). This improves the seed-soil contact, allowing seed to better absorb moisture for germination, and provides a shallow covering of soil that affords some protection to the seed from drying conditions and predation from ants and birds.

Harrowing is generally not practicable on slopes with gradients greater than 35 %. Seed/soil contact is achieved when rainfall washes seed into depressions and covers it with soil entrained in runoff. It is not as effective as harrowing but it's still acceptable. Compensation can be made by increasing the seeding rate, or undertaking follow-up seeding at a later time. Having a high degree of surface roughness greatly improves the effectiveness of broadcast seeding on slopes.

6.3.2 Hydromulching

Hydromulching is the hydraulic application of a seed and mulch mixture. Fertiliser, colouring, soil amendments and conditioners can be included in the mixture sprayed onto the soil surface or applied separately. The degree of surface protection and longevity of the product are largely dependent upon the application rate, the type of fibre, and the tackifiers used. Product suppliers and installers use these factors to differentiate their product in the marketplace.

Batters with gradients steeper than 35 % are well suited to seeding by hyromulching and will benefit greatly with the application of a surficial layer of mulch. The mulch (and tackifiers) provide the soil surface with an initial level of protection against rain drop impact and sheet erosion until vegetation is established, after which long-term stabilisation is provided by plants, roots, and leaf litter. The mulch layer also provides favourable conditions for plant establishment by reducing water loss via evaporation and providing good seed/soil contact for germination, and protects seeds from predation and washing away.

Under dry land conditions (i.e. not irrigated), hydromulch should be an enhanced product that includes a bonded fibre matrix (BFM) hydromulch with added organics. The hydromulch will need to remain effective for six months or longer. Example products include EnviroMatrix (Supplier: EnviroStraw) and ProGanics with ProMatrix EFM (Supplier: DuraVeg).

On batters with gradients steeper than 35 % that have no contour rip lines, the application rate needs to provide 100 % cover in order to optimise erosion protection and provide water retention benefits. Hydromulch application rates for these batters are presented in Table 8.

Table 7. Hydromulch rates for batters with steep gradients (>33.5 %).

Product	Standard Rate (t/ha)	High Rate (t/ha)
EnviroMatrix	6–8	8–10
EnviroBond	0.4	0.5
ProGanics	4	4
ProMatrix EFM	4	6

6.4 Compost Blanket

Compost blankets can be used as a medium to pneumatically apply seed and growth media to the batters. Unfortunately, they are considered unsuitable for revegetation at the Mine, mainly due to the scarcity of water. Compost blankets are highly prone to erosion until an appreciable root mat is established, because of the low particle density of compost, poor coherence of particles, and an appreciable portion of the compost often floats.

To reduce the erosion risk of compost blankets applied to batters, they are typically watered daily for a minimum period of four weeks to promote the establishment of the cover crop and roots. Irrigation water must be low in salinity and sodicity.

Given the Mine's considerable distance to a source compost of suitable quality and volume and the shortage of good quality water in the region, compost blanket is not considered to be a viable option for revegetation at any sort of appreciable scale.

7 RECOMENDATIONS

This Material Characterisation Program describes and characterises the materials identified on-site for use in rehabilitation, as per the Mine Operation Plan and other project related documents. Two recommendations are also provided.

7.1 Detailed Erodibility Testing

This program identified Gravelly Topsoil stockpiled materials and the Waste Rock Oxide as having good potential for use in rehabilitation of steep batters. These materials have negligible to low levels of physicochemical limitations to plant growth and appreciable coarse gravel contents that lead to armouring of the surface and increased resistance to erosion.

It is recommended that further testing be undertaken on these materials to derive material-specific values for use in erosion modelling. Modelling will aim to develop design rules for profiles of engineered landforms. Batter shapes, profiles and slopes must be designed to ensure gradients and slope lengths restrict erosion to a tolerable rate. Material testing data can also be used as inputs for landform evolution software to assess landforms for potential 'erosion hotspots' and to evaluate how they will alter over time.

7.2 Post Mining Land Uses

There is a potential conflict with the 10 m upper lift on the WRE currently planned to have a post mining RLCC VII. At present the gradients of the conceptual WRE landform are to be ~67 %, that correlates to a RLCC VIII.

It is recommended this discrepancy be considered further by the Mine.

8 REFERENCES

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APPENDIX A: MAPS AND FIGURES

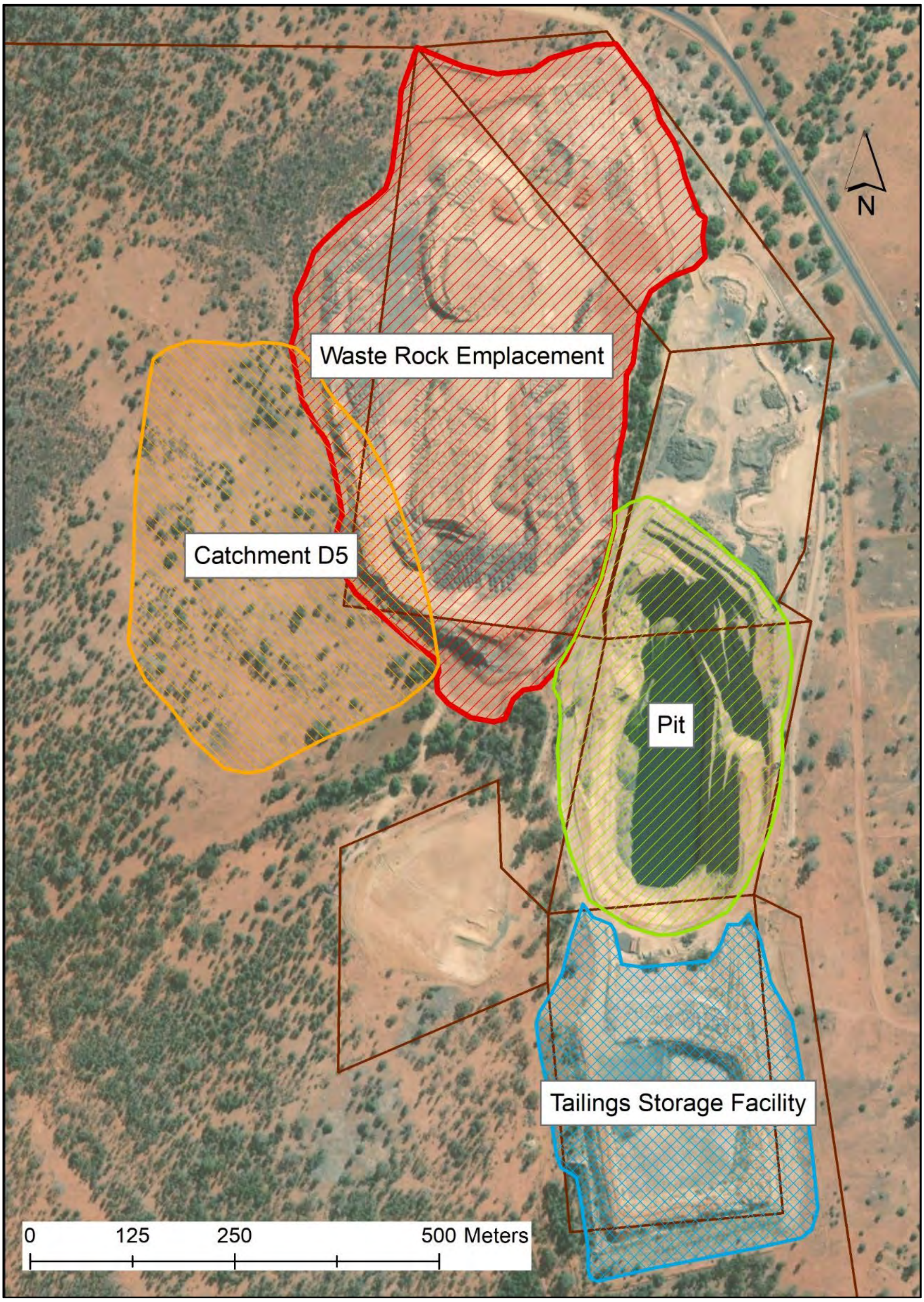


Figure A1. General arrangement of the Mine.

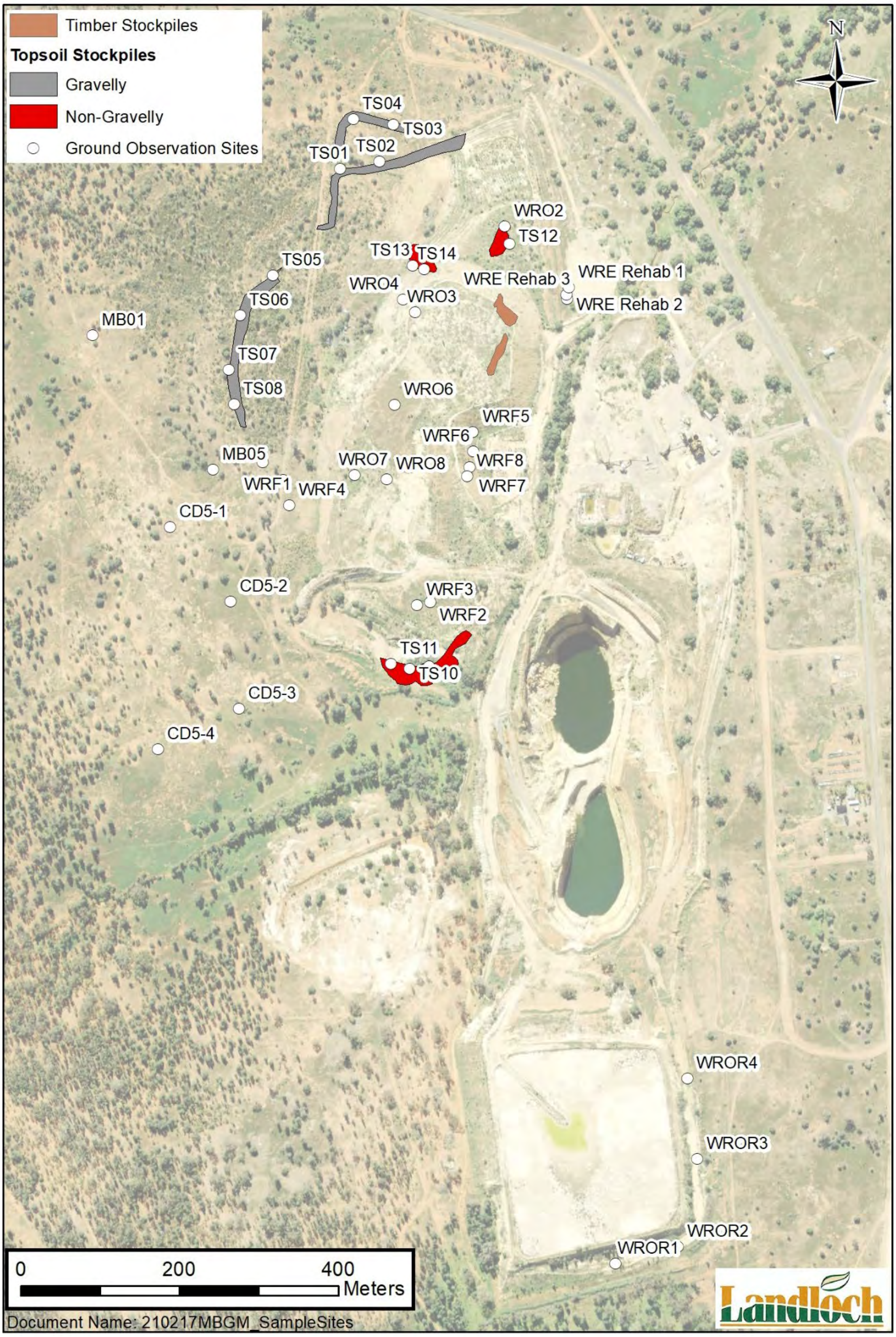


Figure A2. Locations of ground observation sites and topsoil stockpiles.

APPENDIX B: TABLES

Table B1: Ground Observation Site Locations

Site ID	Type	UTM	LATITUDE	LONGITUDE
CD5 01	Natural ground	55 J 434608.53 6508393.499	-31.55759958	146.3109954
CD5 02	Natural ground	55 J 434685.26 6508306.454	-31.55838923	146.3117981
CD5 03	Natural ground	55 J 434693.83 6508163.882	-31.55967597	146.3118789
CD5 04	Natural ground	55 J 434589.86 6508114.588	-31.56011479	146.3107802
MB01	Natural ground	55 J 434509.39 6508634.276	-31.55542171	146.3099668
MB05	Natural ground	55 J 434661.25 6508466.475	-31.55694419	146.3115557
WROR1	Rehabilitated Waste Rock Oxide	55 J 435166.61 6507468.528	-31.56597602	146.3168145
WROR2	Rehabilitated Waste Rock Oxide	55 J 435219.72 6507478.359	-31.56589032	146.3173747
WROR3	Rehabilitated Waste Rock Oxide	55 J 435272.40 6507598.411	-31.5648102	146.3179377
WROR4	Rehabilitated Waste Rock Oxide	55 J 435256.93 6507700.465	-31.56388862	146.3177814
TS01	Gravelly topsoil stockpile	55 J 434821.91 6508843.255	-31.55355407	146.3132733
TS02	Gravelly topsoil stockpile	55 J 434872.30 6508851.805	-31.55347978	146.3138047
TS03	Gravelly topsoil stockpile	55 J 434887.63 6508899.277	-31.55305236	146.3139693
TS04	Gravelly topsoil stockpile	55 J 434839.10 6508908.442	-31.55296694	146.3134587
TS05	Gravelly topsoil stockpile	55 J 434736.35 6508710.440	-31.55474745	146.312363
TS06	Gravelly topsoil stockpile	55 J 434692.91 6508659.942	-31.55520058	146.311902
TS07	Gravelly topsoil stockpile	55 J 434684.72 6508591.076	-31.5558214	146.3118112
TS08	Gravelly topsoil stockpile	55 J 434688.06 6508549.866	-31.55619338	146.3118437
TS09	Non-gravelly topsoil stockpile	55 J 434932.77 6508221.304	-31.55917145	146.3144002
TS10	Non-gravelly topsoil stockpile	55 J 434926.21 6508221.421	-31.55917002	146.3143311
TS11	Non-gravelly topsoil stockpile	55 J 435013.36 6508751.445	-31.55439318	146.3152843
TS12	Non-gravelly topsoil stockpile	55 J 435033.70 6508751.065	-31.55439775	146.3154985
TS13	Non-gravelly topsoil stockpile	55 J 434912.36 6508720.126	-31.55467003	146.3142181
TS14	Non-gravelly topsoil stockpile	55 J 434914.35 6508723.242	-31.55464203	146.3142392
WRF1	Waste Rock Fresh	55 J 434726.27 6508475.783	-31.55686391	146.3122413
WRF1	Waste Rock Fresh	55 J 434730.64 6508459.311	-31.55701276	146.3122863
WRF2	Waste Rock Fresh	55 J 434932.88 6508294.328	-31.55851265	146.3144062
WRF3	Waste Rock Fresh	55 J 434919.12 6508292.247	-31.55853065	146.314261
WRF4	Waste Rock Fresh	55 J 434755.75 6508422.925	-31.55734245	146.3125484
WRF5	Waste Rock Fresh	55 J 434987.94 6508511.086	-31.55656022	146.3150007
WRF6	Waste Rock Fresh	55 J 434984.47 6508491.303	-31.55673849	146.3149628
WRF7	Waste Rock Fresh	55 J 434983.59 6508474.673	-31.55688848	146.3149524
WRF8	Waste Rock Fresh	55 J 434980.95 6508458.917	-31.55703047	146.3149235
WRO1	Waste Rock Fresh	55 J 434736.12 6508466.978	-31.55694391	146.3123446
WR01	Waste Rock Oxide	55 J 434745.16 6508452.246	-31.55707733	146.3124388
WRO2	Waste Rock Oxide	55 J 435030.50 6508774.638	-31.5541849	146.3154664
WR03	Waste Rock Oxide	55 J 434914.83 6508666.464	-31.55515429	146.3142406
WRO4	Waste Rock Oxide	55 J 434916.71 6508660.713	-31.55520629	146.31426
WRO5	Waste Rock Oxide	55 J 434934.97 6508559.965	-31.55611624	146.3144458
WRO6	Waste Rock Oxide	55 J 434890.07 6508545.370	-31.55624538	146.3139717
WRO7	Waste Rock Oxide	55 J 434844.06 6508462.557	-31.5569899	146.3134815
WRO8	Waste Rock Oxide	55 J 434876.98 6508455.226	-31.5570579	146.3138279

Table B2: Surface Descriptions

Site ID	Type	Slope (%)	Groundcover % (veg)	Veg/Litter	Stoniness (abundance)	Stoniness (size)	Surface Condition	Rock Outcrop (abundance and size)	Gilgai and Microrelief (type, depth, size)
CD5 01	Natural ground	4	60-80%	50/50	10-20%	<20mm	Hardsetting	nil	Nil
CD5 02	Natural ground	3	60-80%	50/50	2-10%	<20mm	Firm	nil	Nil
CD5 03	Natural ground	2	60-80%	50/50	10-20%	<20mm	Hardsetting	nil	Nil
CD5 04	Natural ground	2	40-60%	50/50	10-20%	<20mm	Hardsetting	nil	Nil
MB01	Natural ground	3	20-40%	50/50	2-10%	<20mm	Hardsetting	nil	Nil
MB05	Natural ground	5	60-80%	50/50	10-20%	<20mm	Hardsetting	nil	Nil
WROR1	Rehabilitated Waste Rock Oxide	30	80-100%	50/50	50-90%	<200mm	Firm	nil	Nil
WROR2	Rehabilitated Waste Rock Oxide	30	80-100%	50/50	50-90%	<200mm	Firm	nil	Nil
WROR3	Rehabilitated Waste Rock Oxide	30	80-100%	50/50	50-90%	<200mm	Firm	nil	Nil
WROR4	Rehabilitated Waste Rock Oxide	30	80-100%	50/50	50-90%	<200mm	Firm	nil	Nil

Table B3: Soil Profile Descriptions

Date	Field Order	Site ID	Total Depth (m)	Layer	Lower Depth (m)	Texture	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Comments	Sample ID / Depth (m)
							Secondary	Primary		%	Size (mm)	Shape	%	Size (mm)	Shape		
27/11/2020	**1**	**CD5.1**	**1.0**	**1**	0.2	Sandy Clay Loam		Brown	10-20	10-20	6-20	Sub-angular					CD5: 1.1
				2	0.4	Clay Loam	Pale Red	Brown	40-60	30-40	6-20	Sub-angular	10-20	20-60	Sub-angular		CD5: 1.2
				3	>1.0	Clay Loam Sandy	Pale Yellow	Pale Brown	40-60	20-30	6-20	Sub-angular	10-20	20-60	Sub-angular		CD5: 1.3
27/11/2020	**2**	**CD5.2**	**1.0**	**1**	0.2	Sandy Clay Loam		Brown	5-10	5-10	2-6	Sub-angular					CD5: 2.1
				2	0.45	Light Clay	Pale Red	Brown	10-20	5-10	6-20	Sub-angular	5-10	6-20	Sub-angular		CD5: 2.2
				3	>1.0	Light Clay	Pale Yellow	Pale Brown	60-80	20-30	6-20	Sub-angular	40-60	20-60	Sub-angular		CD5: 2.3
27/11/2020	**3**	**CD5.3**	**1.0**	**1**	0.1	Sandy Clay Loam		Brown	10-20	5-10	2-6	Sub-angular	5-10	6-20	Sub-angular		CD5: 3.1
				2	0.4	Light Clay	Pale Red	Brown	40-60	10-20	2-6	Sub-angular	30-40	20-60	Sub-angular		CD5: 3.2
				3	>1.0	Light Medium Clay	Pale Orange	Pale Red	30-40	20-30	2-6	Sub-angular	10-20	6-20	Sub-angular		CD5: 3.3
27/11/2020	**4**	**CD5.4**	**1.0**	**1**	0.15	Sandy Clay Loam		Brown	2-5	2-5	2-6	Sub-angular					CD5: 4.1
				2	0.55	Light Clay		Brown	60-80	40-60	6-20	Sub-angular	20-30	20-60	Sub-angular		CD5: 4.2
				3	>1.0	Light Medium Clay	Pale Yellow	Pale Brown	40-60	40-60	6-20	Sub-angular	5-10	20-60	Sub-angular		CD5: 4.3
27/11/2020	**5**	**MB01**	**1.0**	**1**	0.15	Sandy Loam		Brown	5-10	5-10	2-6	Sub-angular					MB1.1
				2	0.45	Clay Loam Sandy	Pale Red	Brown	60-80	60-80	6-20	Sub-angular	5-10	20-60	Sub-angular		MB1.2
				3	>1.0	Light Clay	Red	Brown	60-80	60-80	20-60	Sub-angular	2-5	2-6	Sub-angular		MB1.3
27/11/2020	**6**	**MB05**	**1.0**	**1**	0.1	Sandy Clay Loam		Brown	40-60	20-30	6-20	Sub-angular	10-20	20-60	Sub-angular		MB5.1
				2	0.4	Sandy Clay Loam	Pale Red	Brown	60-80	40-60	6-20	Sub-angular	40-60	20-60	Sub-angular		MB5.2
				3	>1.0	Sandy Clay Loam	Pale Yellow	Pale Brown	40-60	30-40	6-20	Angular	10-20	20-60	Sub-angular		MB5.3

Table B4 - Stockpiled Material and Waste Descriptions

Field Order	Date	Site ID	Total Depth (m)	Texture Group 1°	Texture Field	Colour (rapid)		Total Coarse Fragment %	Coarse Fragments 1°			Coarse Fragments 2°			Origin (i.e topsoil, subsoil, overburden); Parent Materials; and Proportions	Comments	Sample ID / Depth (m)	Sample Type
						Secondary	Primary		%	Size	Shape (mm)	%	Size (mm)	Shape				
4	**27/11/2020**	**TS01**	**2**	GRAVELLY LOAM	Sandy Clay Loam		Brown	40-60	20-30	6-20	Angular	20-30	20-60	Angular	Topsoil with upper subsoil	Gravelly	TS1	
3	**27/11/2020**	**TS02**	**2**	GRAVELLY LOAM	Sandy Clay Loam		Brown	10-20	10-20	6-20	Angular				Topsoil with upper subsoil	Gravelly with 5% timber inclusions	TS2	
2	**27/11/2020**	**TS03**	**2**	GRAVELLY LOAM	Sandy Clay Loam		Brown	5-10	5-10	6-20	Angular	<2	20-60	Angular	Topsoil with upper subsoil	Gravelly	TS3	
1	**27/11/2020**	**TS04**	**2**	GRAVELLY LOAM	Sandy Clay Loam	Pale Red	Brown	40-60	30-40	2-6	Angular	10-20	6-20	Angular	Topsoil with upper subsoil	Gravelly	TS4	
10	**27/11/2020**	**TS05**	**2**	GRAVELLY LOAM	Sandy Loam		Brown	40-60	20-30	2-6	Angular	10-20	6-20	Angular	Topsoil with upper subsoil	Gravelly	TS05	
9	**27/11/2020**	**TS06**	**2**	GRAVELLY LOAM	Sandy Clay Loam		Brown	40-60	20-30	6-20	Angular	5-10	20-60	Angular	Topsoil with upper subsoil	Gravelly	TS06	
8	**27/11/2020**	**TS07**	**2.5**	GRAVELLY LOAM	Sandy Clay Loam		Brown	40-60	20-30	6-20	Angular	20-30	20-60	Angular	Topsoil with upper subsoil	Gravelly	TS07	
7	**27/11/2020**	**TS08**	**3**	GRAVELLY LOAM	Sandy Clay Loam		Brown	40-60	20-30	6-20	Angular	20-30	20-60	Angular	Topsoil with upper subsoil	Gravelly	TS08	
15	**27/11/2020**	**TS09**	**3**	LOAM	Light Clay	Pale Red	Brown	5-10	5-10	2-6	Angular				Topsoil	Non gravely	TS09	
16	**27/11/2020**	**TS10**	**3**	LOAM	Light Clay	Pale Red	Brown	5-10	5-10	2-6	Angular				Topsoil	Non gravely	TS10	Grab
17	**27/11/2020**	**TS11**	**4**	LOAM	Light Clay	Pale Red	Brown	5-10	5-10	2-6	Angular				Topsoil	Non gravely	TS11	Grab
18	**27/11/2020**	**TS12**	**4**	LOAM	Light Clay	Pale Red	Brown	2-5	2-5	2-6	Angular				Topsoil	Non gravely	TS12	Grab
24	**27/11/2020**	**TS13**	**4**	LOAM	Light Clay	Pale Red	Brown	2-5	2-5	2-6	Angular				Topsoil	Non gravely	TS13	Grab
25	**27/11/2020**	**TS14**	**4**	LOAM	Light Clay	Pale Red	Brown	2-5	2-5	2-6	Angular				Topsoil	Non gravely	TS14	Grab
23	**27/11/2020**	**WRF1**	**2**	GRAVELLY SAND	Clayey Sand		Grey		60-80						Waste Rock	Gravel and cobbles	WRF1	Grab
19	**27/11/2020**	**WRF2**	**2**	GRAVELLY SAND	Clayey Sand		Grey		60-80						Waste Rock	Gravel and cobbles	WRF2	Grab
20	**27/11/2020**	**WRF3**	**2**	GRAVELLY SAND	Clayey Sand		Grey		60-80						Waste Rock	Gravel and cobbles	WRF3	Grab
21	**27/11/2020**	**WRF4**	**2**	GRAVELLY SAND	Clayey Sand		Grey		60-80						Waste Rock	Gravel and cobbles	WRF4	Grab
33	**28/11/2020**	**WRF5**	**2**	GRAVELLY SAND	Sand		Grey		60-80						Waste Rock	Gravel and cobbles	WRF5	Grab
34	**28/11/2020**	**WRF6**	**2**	GRAVELLY SAND	Clayey Sand		Grey		60-80						Waste Rock	Gravel and cobbles	WRF6	Grab
35	**28/11/2020**	**WRF7**	**2**	GRAVELLY SAND	Clayey Sand		Grey		60-80						Waste Rock	Gravel and cobbles	WRF7	Grab
36	**28/11/2020**	**WRF8**	**2**	GRAVELLY SAND	Clayey Sand		Grey		60-80						Waste Rock	Gravel and cobbles	WRF8	Grab
22	**27/11/2020**	**WRO1**	**2**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WRO1	Grab
26	**28/11/2020**	**WRO2**	**2**	GRAVELLY SAND	Sandy Loam		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WRO2	Grab
27	**28/11/2020**	**WRO3**	**2**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WRO3	Grab
28	**28/11/2020**	**WRO4**	**2**	GRAVELLY SAND	Clayey Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WRO4	Grab
29	**28/11/2020**	**WRO5**	**2**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WRO5	Grab
30	**28/11/2020**	**WRO6**	**2**	GRAVELLY SAND	Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WRO6	Grab
31	**28/11/2020**	**WRO7**	**2**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WRO7	Grab
32	**28/11/2020**	**WRO8**	**2**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WRO8	Grab
29	**28/11/2020**	**WROR1**	**0.5**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WROR1	Grab
30	**28/11/2020**	**WROR2**	**0.5**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WROR2	Grab
31	**28/11/2020**	**WROR3**	**0.5**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WROR3	Grab
32	**28/11/2020**	**WROR4**	**0.5**	GRAVELLY SAND	Loamy Sand		Pale Yellow		60-80						Waste Rock	Gravel and cobbles	WROR4	Grab

TABLE B5. Laboratory Results
Natural Ground - Topsoil

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	201484-1		201484-4		201484-7		201484-10		201484-13		201484-16	
	Sample ID	CD5: 1.1		CD5: 2.1		CD5: 3.1		CD5: 4.1		MB1.1		MB5.1	
	Sample Depth (m)												
	Field Texture	SCL		SCL		SCL		SCL		SL		SCL	
Analyses	**Unit**												
pH - Water	pH units	6.4	*L.Acid*	5.9	*M.acid*	7.3	*Neutral*	6.2	*L.Acid*	6.0	*M.acid*	6.0	*M.acid*
Electrical Conductivity	dS/m	0.10	*L.Sal*	0.09	*L.Sal*	0.07	*VL.Sal*	0.04	*VL.Sal*	0.03	*VL.Sal*	0.07	*VL.Sal*
Chloride	mg/kg	32	*VL.Sal*	19	*VL.Sal*	16	*VL.Sal*	6	*VL.Sal*	8	*VL.Sal*	17	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	1573	*M*	1538	*M*	807	*L*	1391	*L*	799	*L*	1939	*M*
Total Phosphorus - Nitric/Perchloric	mg/kg	352	*	388	*	344	*	318	*	235	*	380	*
Phosphorus - Colwell extr	mg/kg	24	*M*	39	*H*	22	*M*	23	*M*	16	*M*	21	*M*
Potassium - Colwell ext	mg/kg	880	*H*	856	*H*	730	*H*	582	*H*	379	*H*	716	*H*
Sulphur - KCl	mg/kg	11.10	*M*	16.50	*H*	7.93	*L*	8.29	*M*	85.70	*VH*	11.10	*M*
Organic Carbon	%	1.58	*M*	1.47	*M*	1.04	*M*	1.56	*M*	0.96	*L*	2.06	*H*
Copper	mg/kg	1.35	*M*	1.23	*M*	0.91	*M*	1.61	*M*	0.80	*M*	2.45	*M*
Iron	mg/kg	42	*	35	*	42	*	18	*	48	*	53	*
Manganese	mg/kg	70.80	*H*	78.10	*H*	53.30	*H*	47.80	*M*	57.10	*H*	83.80	*H*
Zinc	mg/kg	8.25	*H*	7.81	*H*	2.76	*M*	2.91	*M*	0.85	*M*	19.10	*VH*
Boron	mg/kg	0.77	*L*	0.65	*L*	0.65	*L*	0.68	*L*	0.41	*VL*	0.65	*L*
Cation Extraction Method	Rayment& Lyons	15A1	*	15A1	*	15C1	*	15A1	*	15A1	*	15A1	*
Cation Exchange Capacity	meq/100g	7.1	*L*	7.4	*L*	3.6	*VL*	7.0	*L*	5.1	*VL*	7.5	*L*
Ex Calcium Percent	%	52.0	*L*	54.6	*L*	45.0	*L*	54.0	*L*	56.1	*L*	57.8	*L*
Ex Magnesium Percent	%	21.8	*H*	19.1	*H*	18.1	*H*	30.1	*H*	25.8	*H*	20.0	*H*
Ex Potassium Percent	%	20.4	*H*	24.5	*H*	27.8	*H*	15.1	*H*	17.0	*H*	19.0	*H*
Ex Sodium Percent	%	5.6	*N.Sodic*	1.6	*N.Sodic*	8.8	*Sodic*	0.6	*N.Sodic*	0.8	*N.Sodic*	3.0	*N.Sodic*
Ex Aluminium Percent	%	0.2	*VL*	0.2	*VL*	0.3	*VL*	0.2	*VL*	0.2	*VL*	0.2	*VL*
Exchangeable Calcium	mg/kg	735.0	*	806.0	*	324.0	*	761.0	*	576.0	*	870.0	*
Exchangeable Magnesium	mg/kg	185.0	*	169.0	*	78.0	*	254.0	*	159.0	*	181.0	*
Exchangeable Potassium	mg/kg	562.0	*	704.0	*	390.0	*	414.0	*	341.0	*	557.0	*
Exchangeable Sodium	mg/kg	91.7	*	26.3	*	72.9	*	10.0	*	10.0	*	52.6	*
Exchangeable Aluminium	mg/kg	1.0	*	1.5	*	1.0	*	1.5	*	1.0	*	1.2	*
Exchangeable Calcium	meq/100g	3.7	*L*	4.0	*L*	1.6	*VL*	3.8	*L*	2.9	*L*	4.4	*L*
Exchangeable Magnesium	meq/100g	1.5	*M*	1.4	*M*	0.7	*L*	2.1	*M*	1.3	*M*	1.5	*M*
Exchangeable Potassium	meq/100g	1.4	*H*	1.8	*H*	1.0	*H*	1.1	*H*	0.9	*H*	1.4	*H*
Exchangeable Sodium	meq/100g	0.4	*M*	0.1	*L*	0.3	*M*	0.0	*VL*	0.0	*VL*	0.2	*L*
Exchangeable Aluminium	meq/100g	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*
Calcium/Magnesium Ratio	-	2.4	*Low Ca*	2.9	*Low Ca*	2.5	*Low Ca*	1.8	*Low Ca*	2.2	*Low Ca*	2.9	*Low Ca*
Gravel >2.0mm	%	6.7	*		*	15.5	*		*	4.4	*		*
Coarse Sand 0.2-2.0mm	%	26.8	*		*	21.1	*		*	26.3	*		*
Fine Sand 0.02-0.2mm	%	42.5	*		*	40.1	*		*	46.6	*		*
Silt 0.002-0.02mm	%	9.5	*		*	7.1	*		*	7.9	*		*
Clay <0.002mm	%	14.5	*		*	16.2	*		*	14.7	*		*
ADMC	%	1.1	*		*	1.1	*		*	2.1	*		*
Emerson Aggregate	Class	7.0	*Stable*	7.0	*Stable*	7.0	*Stable*	7.0	*Stable*	3b	*Slight Disp*	7.0	*Stable*
Phosphorus Buffer Index	mg/kg	46.1	*	53.2	*	57.0	*	55.8	*	52.9	*	46.8	*

TABLE B5. Laboratory Results
Natural Ground - Topsoil

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	Mean		LCL 95%	UCL 95%	Std Dev	Count	CI 95% (+/-)	10%ile		90%ile		Min	Max
	Sample ID													
	Sample Depth (m)													
	Field Texture													
Analyses	**Unit**													
pH - Water	pH units	6.3	L.Acid	5.9	6.7	0.5	6	0.4	6.0	M.acid	6.9	Neutral	5.9	7.3
Electrical Conductivity	dS/m	0.07	VL.Sal	0.04	0.09	0.03	6	0.02	0.04	VL.Sal	0.10	L.Sal	0.03	0.10
Chloride	mg/kg	16	VL.Sal	9	24	9	6	7	7	VL.Sal	25	VL.Sal	6	32
Total Nitrogen - Kjeldahl	mg/kg	1341	L	978	1705	454	6	363	803	L	1756	M	799	1939
Total Phosphorus - Nitric/Perchloric	mg/kg	336	*	292	381	56	6	45	277	*	384	*	235	388
Phosphorus - Colwell extr	mg/kg	24	H	18	30	8	6	6	18	M	31	H	16	39
Potassium - Colwell ext	mg/kg	691	H	541	840	187	6	149	481	H	868	H	379	880
Sulphur - KCl	mg/kg	23.44	VH	-1.09	47.97	30.66	6	24.53	8.11	M	51.10	VH	7.93	85.70
Organic Carbon	%	1.45	M	1.12	1.77	0.40	6	0.32	1.00	M	1.82	H	0.96	2.06
Copper	mg/kg	1.39	M	0.91	1.87	0.60	6	0.48	0.86	M	2.03	M	0.80	2.45
Iron	mg/kg	40	*	30	50	12	6	10	26	*	51	*	18	53
Manganese	mg/kg	65.15	H	53.53	76.77	14.52	6	11.62	50.55	H	80.95	H	47.80	83.80
Zinc	mg/kg	6.95	H	1.63	12.27	6.65	6	5.32	1.81	M	13.68	H	0.85	19.10
Boron	mg/kg	0.64	L	0.54	0.73	0.12	6	0.10	0.53	L	0.73	L	0.41	0.77
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	6.3	L	5.0	7.6	1.6	6	1.3	4.4	VL	7.5	L	3.6	7.5
Ex Calcium Percent	%	53.3	L	49.7	56.8	4.5	6	3.6	48.5	L	56.9	L	45.0	57.8
Ex Magnesium Percent	%	22.5	H	18.8	26.2	4.6	6	3.7	18.6	H	27.9	H	18.1	30.1
Ex Potassium Percent	%	20.6	H	16.8	24.4	4.7	6	3.8	16.1	H	26.1	H	15.1	27.8
Ex Sodium Percent	%	3.4	N.Sodic	0.8	6.0	3.2	6	2.6	0.7	N.Sodic	7.2	Sodic	0.6	8.8
Ex Aluminium Percent	%	0.2	VL	0.2	0.3	0.1	6	0.0	0.2	VL	0.3	VL	0.2	0.3
Exchangeable Calcium	mg/kg	678.7	*	519.0	838.3	199.6	6	159.7	450.0	*	838.0	*	324.0	870.0
Exchangeable Magnesium	mg/kg	171.0	*	125.8	216.2	56.5	6	45.2	118.5	*	219.5	*	78.0	254.0
Exchangeable Potassium	mg/kg	494.7	*	385.4	604.0	136.6	6	109.3	365.5	*	633.0	*	341.0	704.0
Exchangeable Sodium	mg/kg	43.9	*	16.6	71.2	34.1	6	27.3	10.0	*	82.3	*	10.0	91.7
Exchangeable Aluminium	mg/kg	1.2	*	1.0	1.4	0.2	6	0.2	1.0	*	1.5	*	1.0	1.5
Exchangeable Calcium	meq/100g	3.4	L	2.6	4.2	1.0	6	0.8	2.3	L	4.2	L	1.6	4.4
Exchangeable Magnesium	meq/100g	1.4	M	1.0	1.8	0.5	6	0.4	1.0	L	1.8	M	0.7	2.1
Exchangeable Potassium	meq/100g	1.3	H	1.0	1.5	0.4	6	0.3	0.9	H	1.6	H	0.9	1.8
Exchangeable Sodium	meq/100g	0.2	L	0.1	0.3	0.1	6	0.1	0.0	VL	0.4	M	0.0	0.4
Exchangeable Aluminium	meq/100g	0.0	H	0.0	0.0	0.0	6	0.0	0.0	H	0.0	H	0.0	0.0
Calcium/Magnesium Ratio	-	2.4	Low Ca	2.1	2.8	0.4	6	0.3	2.0	*	2.9	*	1.8	2.9
Gravel >2.0mm	%	8.9	*	2.2	15.5	5.9	3	6.6	4.9	*	13.7	*	4.4	15.5
Coarse Sand 0.2-2.0mm	%	24.7	*	21.2	28.3	3.2	3	3.6	22.1	*	26.7	*	21.1	26.8
Fine Sand 0.02-0.2mm	%	43.1	*	39.3	46.8	3.3	3	3.7	40.6	*	45.8	*	40.1	46.6
Silt 0.002-0.02mm	%	8.2	*	6.8	9.5	1.2	3	1.4	7.3	*	9.2	*	7.1	9.5
Clay <0.002mm	%	15.1	*	14.1	16.2	0.9	3	1.1	14.5	*	15.9	*	14.5	16.2
ADMC	%	1.4	*	0.8	2.1	0.6	3	0.6	1.1	*	1.9	*	1.1	2.1
Emerson Aggregate	Class	*	*	*	*	*	*	*	*	*	*	*	*	*
Phosphorus Buffer Index	mg/kg	*	*	*	*	*	*	*	*	*	*	*	*	*

TABLE B6. Laboratory Results
Natural Ground - Upper Subsoil

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	201484-2		201484-5		201484-8		201484-11		201484-14		201484-17	
	Sample ID	CD5: 1.2		CD5: 2.2		CD5: 3.2		CD5: 4.2		MB1.2		MB5.2	
	Sample Depth (m)												
	Field Texture	CL		LC		LC		LC		CLS		SCL	
Analyses	**Unit**												
pH - Water	pH units	6.7	*Neutral*	7.3	*Neutral*	6.6	*L.Acid*	5.6	*H.Acid*	6.1	*L.Acid*	6.5	*L.Acid*
Electrical Conductivity	dS/m	0.05	*VL.Sal*	0.03	*VL.Sal*	0.03	*VL.Sal*	0.05	*VL.Sal*	0.04	*VL.Sal*	0.04	*VL.Sal*
Chloride	mg/kg	23	*VL.Sal*	7	*VL.Sal*	11	*VL.Sal*	13	*VL.Sal*	11	*VL.Sal*	15	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	828	*L*	479	*VL*	739	*L*	604	*L*	413	*VL*	675	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	317	*	252	*	270	*	250	*	192	*	254	*
Phosphorus - Colwell extr	mg/kg	17	*L*	21	*M*	24	*M*	16	*L*	16	*L*	18	*M*
Potassium - Colwell ext	mg/kg	301	*H*	315	*H*	217	*M*	114	*VL*	131	*L*	424	*H*
Sulphur - KCl	mg/kg	15.80	*H*	16.00	*H*	12.80	*H*	15.20	*H*	12.70	*H*	16.10	*H*
Organic Carbon	%	0.57	*VL*	0.39	*EL*	0.49	*VL*	0.32	*EL*	0.38	*EL*	0.51	*VL*
Copper	mg/kg	1.48	*M*	1.17	*M*	1.23	*M*	1.05	*M*	0.75	*M*	1.91	*M*
Iron	mg/kg	7	*	60	*	7	*	10	*	6	*	8	*
Manganese	mg/kg	30.30	*M*	46.20	*M*	18.30	*M*	18.10	*M*	2.80	*M*	21.90	*M*
Zinc	mg/kg	1.77	*M*	0.39	*L*	<0.20	*FALSE*	<0.20	*FALSE*	0.23	*L*	1.30	*M*
Boron	mg/kg	0.71	*L*	0.65	*L*	0.66	*L*	0.37	*VL*	0.47	*VL*	0.57	*L*
Cation Extraction Method	Rayment& Lyons	15A1	*	15C1	*	15A1	*	15A1	*	15A1	*	15A1	*
Cation Exchange Capacity	meq/100g	8.8	*L*	4.0	*VL*	8.3	*L*	5.1	*VL*	5.3	*VL*	6.3	*L*
Ex Calcium Percent	%	45.6	*L*	44.2	*L*	54.6	*L*	43.5	*L*	46.1	*L*	47.7	*L*
Ex Magnesium Percent	%	39.0	*H*	25.7	*H*	33.3	*H*	40.9	*H*	38.8	*H*	25.5	*H*
Ex Potassium Percent	%	11.8	*H*	18.2	*H*	10.2	*H*	9.7	*H*	10.1	*H*	22.2	*H*
Ex Sodium Percent	%	3.5	*N.Sodic*	11.6	*Sodic*	1.8	*N.Sodic*	5.4	*N.Sodic*	4.6	*N.Sodic*	4.5	*N.Sodic*
Ex Aluminium Percent	%	0.1	*VL*	0.3	*VL*	0.1	*VL*	0.6	*VL*	0.4	*VL*	0.2	*VL*
Exchangeable Calcium	mg/kg	805.0	*	358.0	*	903.0	*	447.0	*	485.0	*	599.0	*
Exchangeable Magnesium	mg/kg	413.0	*	125.0	*	331.0	*	252.0	*	245.0	*	192.0	*
Exchangeable Potassium	mg/kg	405.0	*	287.0	*	328.0	*	194.0	*	208.0	*	545.0	*
Exchangeable Sodium	mg/kg	71.9	*	108.0	*	33.5	*	63.3	*	56.0	*	64.6	*
Exchangeable Aluminium	mg/kg	1.0	*	1.1	*	1.0	*	2.8	*	1.8	*	1.0	*
Exchangeable Calcium	meq/100g	4.0	*L*	1.8	*VL*	4.5	*L*	2.2	*L*	2.4	*L*	3.0	*L*
Exchangeable Magnesium	meq/100g	3.4	*H*	1.0	*M*	2.8	*M*	2.1	*M*	2.0	*M*	1.6	*M*
Exchangeable Potassium	meq/100g	1.0	*H*	0.7	*H*	0.8	*H*	0.5	*M*	0.5	*M*	1.4	*H*
Exchangeable Sodium	meq/100g	0.3	*M*	0.5	*M*	0.1	*L*	0.3	*L*	0.2	*L*	0.3	*L*
Exchangeable Aluminium	meq/100g	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*E*	0.0	*VH*	0.0	*H*
Calcium/Magnesium Ratio	-	1.2	*Low Ca*	1.7	*Low Ca*	1.6	*Low Ca*	1.1	*Low Ca*	1.2	*Low Ca*	1.9	*Low Ca*
Gravel >2.0mm	%	33.9	*		*	36.3	*		*	58.8	*		*
Coarse Sand 0.2-2.0mm	%	11.5	*		*	8.4	*		*	4.5	*		*
Fine Sand 0.02-0.2mm	%	33.8	*		*	34.3	*		*	27.8	*		*
Silt 0.002-0.02mm	%	6.8	*		*	6.5	*		*	4.1	*		*
Clay <0.002mm	%	13.9	*		*	14.5	*		*	4.8	*		*
ADMC	%	2.5	*		*	3.3	*		*	1.0	*		*
Emerson Aggregate	Class	7.0	*Stable*	3b	*Slight Disp*	7.0	*Stable*	7.0	*Stable*	3b	*Slight Disp*	7.0	*Stable*
Phosphorus Buffer Index	mg/kg	47.3	*	55.1	*	55.9	*	51.1	*	39.3	*	42.6	*

TABLE B6. Laboratory Results
Natural Ground - Upper Subsoil

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	**Mean**		**LCL 95%**	**UCL 95%**	**Std Dev**	**Count**	**CI 95% (+/-)**	**10%ile**		**90%ile**		**Min**	**Max**
	Sample ID													
	Sample Depth (m)													
	Field Texture													
Analyses	**Unit**													
pH - Water	pH units	6.5	L.Acid	6.0	6.9	0.6	6	0.5	5.9	M.acid	7.0	Neutral	5.6	7.3
Electrical Conductivity	dS/m	0.04	VL.Sal	0.03	0.05	0.01	6	0.01	0.03	VL.Sal	0.05	VL.Sal	0.03	0.05
Chloride	mg/kg	13	VL.Sal	9	18	6	6	5	9	VL.Sal	19	VL.Sal	7	23
Total Nitrogen - Kjeldahl	mg/kg	623	L	497	749	157	6	126	446	VL	784	L	413	828
Total Phosphorus - Nitric/Perchloric	mg/kg	256	*	224	288	40	6	32	221	*	294	*	192	317
Phosphorus - Colwell extr	mg/kg	19	M	16	21	3	6	2	16	M	22	M	16	24
Potassium - Colwell ext	mg/kg	250	M	155	346	119	6	95	123	L	370	M	114	424
Sulphur - KCl	mg/kg	14.77	H	13.49	16.04	1.59	6	1.27	12.75	H	16.05	H	12.70	16.10
Organic Carbon	%	0.44	VL	0.37	0.52	0.09	6	0.08	0.35	EL	0.54	VL	0.32	0.57
Copper	mg/kg	1.27	M	0.95	1.58	0.40	6	0.32	0.90	M	1.70	M	0.75	1.91
Iron	mg/kg	16	*	-1	34	22	6	17	7	*	35	*	6	60
Manganese	mg/kg	22.93	M	11.36	34.51	14.47	6	11.58	10.45	M	38.25	M	2.80	46.20
Zinc	mg/kg	0.92	M	0.20	1.64	0.74	4	0.72	0.28	L	1.63	M	0.23	1.77
Boron	mg/kg	0.57	L	0.47	0.68	0.13	6	0.10	0.42	VL	0.69	L	0.37	0.71
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	6.3	L	4.8	7.8	1.9	6	1.5	4.6	VL	8.5	L	4.0	8.8
Ex Calcium Percent	%	46.9	L	43.7	50.2	4.0	6	3.2	43.8	L	51.1	L	43.5	54.6
Ex Magnesium Percent	%	33.9	H	28.4	39.4	6.9	6	5.5	25.6	H	39.9	H	25.5	40.9
Ex Potassium Percent	%	13.7	H	9.5	17.9	5.3	6	4.2	9.9	H	20.2	H	9.7	22.2
Ex Sodium Percent	%	5.2	N.Sodic	2.5	7.9	3.4	6	2.7	2.7	N.Sodic	8.5	Sodic	1.8	11.6
Ex Aluminium Percent	%	0.3	VL	0.1	0.4	0.2	6	0.1	0.1	VL	0.5	VL	0.1	0.6
Exchangeable Calcium	mg/kg	599.5	*	428.2	770.8	214.0	6	171.3	402.5	*	854.0	*	358.0	903.0
Exchangeable Magnesium	mg/kg	259.7	*	178.4	340.9	101.6	6	81.3	158.5	*	372.0	*	125.0	413.0
Exchangeable Potassium	mg/kg	327.8	*	222.3	433.4	132.0	6	105.6	201.0	*	475.0	*	194.0	545.0
Exchangeable Sodium	mg/kg	66.2	*	46.7	85.7	24.3	6	19.5	44.8	*	90.0	*	33.5	108.0
Exchangeable Aluminium	mg/kg	1.5	*	0.9	2.0	0.7	6	0.6	1.0	*	2.3	*	1.0	2.8
Exchangeable Calcium	meq/100g	3.0	L	2.1	3.9	1.1	6	0.9	2.0	L	4.3	L	1.8	4.5
Exchangeable Magnesium	meq/100g	2.2	M	1.5	2.8	0.8	6	0.7	1.3	M	3.1	H	1.0	3.4
Exchangeable Potassium	meq/100g	0.8	H	0.6	1.1	0.3	6	0.3	0.5	M	1.2	H	0.5	1.4
Exchangeable Sodium	meq/100g	0.3	L	0.2	0.4	0.1	6	0.1	0.2	L	0.4	M	0.1	0.5
Exchangeable Aluminium	meq/100g	0.0	H	0.0	0.0	0.0	6	0.0	0.0	H	0.0	VH	0.0	0.0
Calcium/Magnesium Ratio	-	1.4	Low Ca	1.2	1.7	0.3	6	0.3	1.1	*	1.8	*	1.1	1.9
Gravel >2.0mm	%	43.0	*	27.5	58.5	13.7	3	15.5	34.4	*	54.3	*	33.9	58.8
Coarse Sand 0.2-2.0mm	%	8.1	*	4.2	12.1	3.5	3	4.0	5.3	*	10.9	*	4.5	11.5
Fine Sand 0.02-0.2mm	%	32.0	*	27.9	36.1	3.6	3	4.1	29.0	*	34.2	*	27.8	34.3
Silt 0.002-0.02mm	%	5.8	*	4.1	7.5	1.5	3	1.7	4.6	*	6.7	*	4.1	6.8
Clay <0.002mm	%	11.1	*	4.9	17.2	5.4	3	6.2	6.6	*	14.4	*	4.8	14.5
ADMC	%	2.3	*	0.9	3.6	1.2	3	1.3	1.3	*	3.1	*	1.0	3.3
Emerson Aggregate	Class	*	*	*	*	*	*	*	*	*	*	*	*	*
Phosphorus Buffer Index	mg/kg	*	*	*	*	*	*	*	*	*	*	*	*	*

TABLE B7. Laboratory Results
Natural Ground - Lower Subsoil

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	201484-3		201484-6		201484-9		201484-12		201484-15		201484-18	
	Sample ID	CD5: 1.3		CD5: 2.3		CD5: 3.3		CD5: 4.3		MB1.3		MB5.3	
	Sample Depth (m)												
	Field Texture	CLS		LC		LMC		LMC		LC		SCL	
Analyses	**Unit**												
pH - Water	pH units	8.5	*H.Alk*	8.8	*H.Alk*	7.5	*L.Alk*	7.8	*L.Alk*	7.2	*Neutral*	7.4	*Neutral*
Electrical Conductivity	dS/m	0.15	*L.Sal*	0.18	*L.Sal*	0.10	*VL.Sal*	0.14	*L.Sal*	0.05	*VL.Sal*	0.07	*VL.Sal*
Chloride	mg/kg	29	*VL.Sal*	8	*VL.Sal*	35	*VL.Sal*	35	*VL.Sal*	7	*VL.Sal*	19	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg												
Total Phosphorus - Nitric/Perchloric	mg/kg												
Phosphorus - Colwell extr	mg/kg												
Potassium - Colwell ext	mg/kg												
Sulphur - KCl	mg/kg												
Organic Carbon	%												
Copper	mg/kg												
Iron	mg/kg												
Manganese	mg/kg												
Zinc	mg/kg												
Boron	mg/kg												
Cation Extraction Method	Rayment& Lyons												
Cation Exchange Capacity	meq/100g	7.2	*L*	12.7	*M*	12.9	*M*	9.6	*L*	7.0	*L*	2.0	*VL*
Ex Calcium Percent	%	29.6	*L*	38.2	*L*	43.4	*L*	29.8	*L*	37.5	*L*	31.6	*L*
Ex Magnesium Percent	%	56.0	*H*	48.2	*H*	45.6	*H*	53.7	*H*	41.9	*H*	33.5	*H*
Ex Potassium Percent	%	5.7	*H*	5.3	*H*	3.9	*Normal*	3.5	*Normal*	12.7	*H*	18.9	*H*
Ex Sodium Percent	%	8.6	*Sodic*	8.2	*Sodic*	7.0	*Sodic*	12.9	*Sodic*	7.8	*Sodic*	15.3	*H.Sodic*
Ex Aluminium Percent	%	0.2	*VL*	0.1	*VL*	0.1	*VL*	0.2	*VL*	0.2	*VL*	0.6	*VL*
Exchangeable Calcium	mg/kg	427.0	*	971.0	*	1117.0	*	574.0	*	526.0	*	125.0	*
Exchangeable Magnesium	mg/kg	485.0	*	736.0	*	705.0	*	621.0	*	353.0	*	79.5	*
Exchangeable Potassium	mg/kg	160.0	*	264.0	*	198.0	*	130.0	*	347.0	*	146.0	*
Exchangeable Sodium	mg/kg	142.0	*	239.0	*	206.0	*	285.0	*	126.0	*	69.6	*
Exchangeable Aluminium	mg/kg	1.0	*	1.0	*	1.2	*	1.4	*	1.0	*	1.0	*
Exchangeable Calcium	meq/100g	2.1	*L*	4.9	*L*	5.6	*M*	2.9	*L*	2.6	*L*	0.6	*VL*
Exchangeable Magnesium	meq/100g	4.0	*H*	6.1	*H*	5.9	*H*	5.2	*H*	2.9	*M*	0.7	*L*
Exchangeable Potassium	meq/100g	0.4	*M*	0.7	*M*	0.5	*M*	0.3	*M*	0.9	*H*	0.4	*M*
Exchangeable Sodium	meq/100g	0.6	*M*	1.0	*H*	0.9	*H*	1.2	*H*	0.5	*M*	0.3	*M*
Exchangeable Aluminium	meq/100g	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*
Calcium/Magnesium Ratio	-	0.5	*Low Ca*	0.8	*Low Ca*	1.0	*Low Ca*	0.6	*Low Ca*	0.9	*Low Ca*	0.9	*Low Ca*
Gravel >2.0mm	%		*		*		*		*		*		*
Coarse Sand 0.2-2.0mm	%		*		*		*		*		*		*
Fine Sand 0.02-0.2mm	%		*		*		*		*		*		*
Silt 0.002-0.02mm	%		*		*		*		*		*		*
Clay <0.002mm	%		*		*		*		*		*		*
ADMC	%		*		*		*		*		*		*
Emerson Aggregate	Class		*FALSE*		*FALSE*		*FALSE*		*FALSE*		*FALSE*		*FALSE*
Phosphorus Buffer Index	mg/kg		*		*		*		*		*		*

TABLE B7. Laboratory Results
Natural Ground - Lower Subsoil

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No	Mean		LCL 95%	UCL 95%	Std Dev	Count	CI 95% (+/-)	10%ile		90%ile		Min	Max
	Sample ID													
	Sample Depth (m)													
	Field Texture													
Analyses	**Unit**													
pH - Water	pH units	*7.9*	L.Alk	*7.3*	*8.4*	*0.6*	*6*	*0.5*	*7.3*	Neutral	*8.7*	H.Alk	*7.2*	*8.8*
Electrical Conductivity	dS/m	*0.12*	L.Sal	*0.07*	*0.16*	*0.05*	*6*	*0.04*	*0.06*	VL.Sal	*0.17*	L.Sal	*0.05*	*0.18*
Chloride	mg/kg	*22*	VL.Sal	*12*	*32*	*13*	*6*	*10*	*8*	VL.Sal	*35*	VL.Sal	*7*	*35*
Total Nitrogen - Kjeldahl	mg/kg													
Total Phosphorus - Nitric/Perchloric	mg/kg													
Phosphorus - Colwell extr	mg/kg													
Potassium - Colwell ext	mg/kg													
Sulphur - KCl	mg/kg													
Organic Carbon	%													
Copper	mg/kg													
Iron	mg/kg													
Manganese	mg/kg													
Zinc	mg/kg													
Boron	mg/kg													
Cation Extraction Method	Rayment& Lyons													
Cation Exchange Capacity	meq/100g	*8.6*	L	*5.3*	*11.9*	*4.1*	*6*	*3.3*	*4.5*	VL	*12.8*	M	*2.0*	*12.9*
Ex Calcium Percent	%	*35.0*	L	*30.6*	*39.4*	*5.5*	*6*	*4.4*	*29.7*	L	*40.8*	L	*29.6*	*43.4*
Ex Magnesium Percent	%	*46.5*	H	*39.9*	*53.1*	*8.2*	*6*	*6.6*	*37.7*	H	*54.9*	H	*33.5*	*56.0*
Ex Potassium Percent	%	*8.3*	H	*3.4*	*13.3*	*6.2*	*6*	*4.9*	*3.7*	Normal	*15.8*	H	*3.5*	*18.9*
Ex Sodium Percent	%	*9.9*	Sodic	*7.3*	*12.6*	*3.3*	*6*	*2.7*	*7.4*	Sodic	*14.1*	H.Sodic	*7.0*	*15.3*
Ex Aluminium Percent	%	*0.2*	VL	*0.1*	*0.3*	*0.2*	*6*	*0.1*	*0.1*	VL	*0.4*	VL	*0.1*	*0.6*
Exchangeable Calcium	mg/kg	*623.3*	*	*331.9*	*914.8*	*364.2*	*6*	*291.5*	*276.0*	*	*1044.0*	*	*125.0*	*1117.0*
Exchangeable Magnesium	mg/kg	*496.6*	*	*297.0*	*696.1*	*249.4*	*6*	*199.5*	*216.3*	*	*720.5*	*	*79.5*	*736.0*
Exchangeable Potassium	mg/kg	*207.5*	*	*140.8*	*274.2*	*83.4*	*6*	*66.7*	*138.0*	*	*305.5*	*	*130.0*	*347.0*
Exchangeable Sodium	mg/kg	*177.9*	*	*114.2*	*241.6*	*79.6*	*6*	*63.7*	*97.8*	*	*262.0*	*	*69.6*	*285.0*
Exchangeable Aluminium	mg/kg	*1.1*	*	*1.0*	*1.2*	*0.2*	*6*	*0.1*	*1.0*	*	*1.3*	*	*1.0*	*1.4*
Exchangeable Calcium	meq/100g	*3.1*	L	*1.7*	*4.6*	*1.8*	*6*	*1.5*	*1.4*	VL	*5.2*	M	*0.6*	*5.6*
Exchangeable Magnesium	meq/100g	*4.1*	H	*2.5*	*5.8*	*2.1*	*6*	*1.7*	*1.8*	M	*6.0*	H	*0.7*	*6.1*
Exchangeable Potassium	meq/100g	*0.5*	M	*0.4*	*0.7*	*0.2*	*6*	*0.2*	*0.4*	M	*0.8*	H	*0.3*	*0.9*
Exchangeable Sodium	meq/100g	*0.8*	H	*0.5*	*1.1*	*0.3*	*6*	*0.3*	*0.4*	M	*1.1*	H	*0.3*	*1.2*
Exchangeable Aluminium	meq/100g	*0.0*	H	*0.0*	*0.0*	*0.0*	*6*	*0.0*	*0.0*	H	*0.0*	H	*0.0*	*0.0*
Calcium/Magnesium Ratio	-	*0.8*	Low Ca	*0.6*	*0.9*	*0.2*	*6*	*0.2*	*0.5*	*	*0.9*	*	*0.5*	*1.0*
Gravel >2.0mm	%													
Coarse Sand 0.2-2.0mm	%													
Fine Sand 0.02-0.2mm	%													
Silt 0.002-0.02mm	%													
Clay <0.002mm	%													
ADMC	%													
Emerson Aggregate	Class	*	*	*	*	*	*	*	*	*	*	*	*	*
Phosphorus Buffer Index	mg/kg	*	*	*	*	*	*	*	*	*	*	*	*	*

TABLE B8. Laboratory Results
Topsoil Stockpile - Gravelly

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No	201484-19		201484-20		201484-21		201484-22		201484-23		201484-24		201484-25		201484-26	
	Sample ID	TS1		TS2		TS3		TS4		TS5		TS6		TS7		TS8	
	Sample Depth (m)																
	Field Texture	SCL		SCL		SCL		SCL		SL		SCL		SCL		SCL	
Analyses	**Unit**																
pH - Water	pH units	5.8	*M.acid*	7.0	*Neutral*	5.8	*M.acid*	6.2	*L.Acid*	6.2	*L.Acid*	5.3	*H.Acid*	6.0	*M.acid*	6.7	*Neutral*
Electrical Conductivity	dS/m	0.10	*L.Sal*	0.19	*M.Sal*	0.23	*M.Sal*	0.06	*VL.Sal*	0.07	*L.Sal*	0.07	*VL.Sal*	0.11	*L.Sal*	0.17	*L.Sal*
Chloride	mg/kg	19	*VL.Sal*	58	*VL.Sal*	11	*VL.Sal*	10	*VL.Sal*	21	*VL.Sal*	17	*VL.Sal*	13	*VL.Sal*	53	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	617	*L*	989	*L*	763	*L*	402	*VL*	906	*L*	965	*L*	759	*L*	1049	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	246	*	317	*	243	*	280	*	311	*	244	*	237	*	292	*
Phosphorus - Colwell extr	mg/kg	14	*L*	29	*M*	29	*M*	36	*H*	25	*H*	20	*M*	14	*L*	25	*M*
Potassium - Colwell ext	mg/kg	201	*M*	332	*H*	366	*H*	186	*M*	223	*H*	102	*VL*	191	*M*	335	*H*
Sulphur - KCl	mg/kg	15.80	*H*	28.10	*VH*	19.40	*H*	15.60	*H*	17.70	*H*	18.10	*H*	17.70	*H*	29.10	*VH*
Organic Carbon	%	0.75	*L*	0.95	*L*	0.69	*L*	0.37	*EL*	1.02	*M*	1.06	*M*	0.66	*L*	1.90	*H*
Copper	mg/kg	1.18	*M*	1.69	*M*	1.37	*M*	1.00	*M*	1.07	*M*	0.98	*M*	1.34	*M*	1.61	*M*
Iron	mg/kg	10	*	12	*	66	*	64	*	16	*	26	*	37	*	18	*
Manganese	mg/kg	14.20	*M*	26.30	*M*	54.00	*H*	34.90	*M*	22.50	*M*	34.90	*M*	35.80	*M*	22.00	*M*
Zinc	mg/kg	0.52	*M*	8.64	*H*	3.55	*M*	0.27	*L*	1.72	*M*	1.59	*M*	1.55	*M*	7.18	*H*
Boron	mg/kg	0.63	*L*	0.71	*L*	0.59	*L*	0.57	*L*	0.40	*VL*	0.44	*VL*	0.46	*VL*	0.73	*L*
Cation Extraction Method	Rayment& Lyons	15A1	*	15A1	*	15A1	*	15A1	*	15A1	*	15A1	*	15A1	*	15A1	*
Cation Exchange Capacity	meq/100g	7.0	*L*	9.1	*L*	7.7	*L*	6.1	*L*	6.4	*L*	5.1	*VL*	6.2	*L*	9.0	*L*
Ex Calcium Percent	%	55.6	*L*	64.1	*L*	55.3	*L*	54.4	*L*	58.5	*L*	48.2	*L*	58.5	*L*	62.3	*L*
Ex Magnesium Percent	%	30.5	*H*	21.1	*H*	24.9	*H*	32.6	*H*	25.2	*H*	38.5	*H*	27.7	*H*	22.1	*H*
Ex Potassium Percent	%	12.2	*H*	12.6	*H*	17.3	*H*	10.9	*H*	13.2	*H*	8.5	*H*	11.0	*H*	13.0	*H*
Ex Sodium Percent	%	1.5	*N.Sodic*	2.0	*N.Sodic*	2.4	*N.Sodic*	1.8	*N.Sodic*	3.0	*N.Sodic*	4.2	*N.Sodic*	2.4	*N.Sodic*	2.4	*N.Sodic*
Ex Aluminium Percent	%	0.2	*VL*	0.2	*VL*	0.1	*VL*	0.2	*VL*	0.2	*VL*	0.5	*VL*	0.4	*VL*	0.2	*VL*
Exchangeable Calcium	mg/kg	774.0	*	1172.0	*	853.0	*	665.0	*	744.0	*	491.0	*	728.0	*	1118.0	*
Exchangeable Magnesium	mg/kg	255.0	*	232.0	*	230.0	*	239.0	*	192.0	*	235.0	*	207.0	*	238.0	*
Exchangeable Potassium	mg/kg	331.0	*	448.0	*	520.0	*	260.0	*	326.0	*	169.0	*	268.0	*	454.0	*
Exchangeable Sodium	mg/kg	24.1	*	41.4	*	42.2	*	25.8	*	43.4	*	49.5	*	33.7	*	49.8	*
Exchangeable Aluminium	mg/kg	1.0	*	2.0	*	1.0	*	1.0	*	1.0	*	2.4	*	2.4	*	1.7	*
Exchangeable Calcium	meq/100g	3.9	*L*	5.9	*M*	4.3	*L*	3.3	*L*	3.7	*L*	2.5	*L*	3.6	*L*	5.6	*M*
Exchangeable Magnesium	meq/100g	2.1	*M*	1.9	*M*	1.9	*M*	2.0	*M*	1.6	*M*	2.0	*M*	1.7	*M*	2.0	*M*
Exchangeable Potassium	meq/100g	0.8	*H*	1.1	*H*	1.3	*H*	0.7	*M*	0.8	*H*	0.4	*M*	0.7	*M*	1.2	*H*
Exchangeable Sodium	meq/100g	0.1	*L*	0.2	*L*	0.2	*L*	0.1	*L*	0.2	*L*	0.2	*L*	0.1	*L*	0.2	*L*
Exchangeable Aluminium	meq/100g	0.0	*H*	0.0	*VH*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*VH*	0.0	*VH*	0.0	*VH*
Calcium/Magnesium Ratio	-	1.8	*Low Ca*	3.0	*Low Ca*	2.2	*Low Ca*	1.7	*Low Ca*	2.3	*Low Ca*	1.3	*Low Ca*	2.1	*Low Ca*	2.8	*Low Ca*
Gravel >2.0mm	%	50.3	*	13.4	*	18.9	*	29.2	*	28.3	*	28.1	*	30.8	*	24.7	*
Coarse Sand 0.2-2.0mm	%	6.9	*	21.5	*	21.1	*	16.4	*	24.3	*	25.4	*	20.5	*	20.8	*
Fine Sand 0.02-0.2mm	%	32.9	*	45.3	*	39.0	*	35.7	*	35.6	*	30.5	*	32.8	*	37.8	*
Silt 0.002-0.02mm	%	4.1	*	5.9	*	5.4	*	4.8	*	3.3	*	6.1	*	6.3	*	6.7	*
Clay <0.002mm	%	5.8	*	13.9	*	15.7	*	13.9	*	8.4	*	9.9	*	9.6	*	10.1	*
ADMC	%	1.3	*	3.6	*	3.3	*	4.8	*	1.1	*	1.8	*	2.6	*	1.4	*
Emerson Aggregate	Class	3b	*Slight Disp*	3b	*Slight Disp*	3b	*Slight Disp*	3b	*Slight Disp*	3b	*Slight Disp*	3b	*Slight Disp*	3b	*Slight Disp*	3b	*Slight Disp*
Phosphorus Buffer Index	mg/kg		*		*		*		*		*		*		*		*

TABLE B8. Laboratory Results
Topsoil Stockpile - Gravelly

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No Sample ID Sample Depth (m) Field Texture	Mean		LCL 95%	UCL 95%	Std Dev	Count	CI 95% (+/-)	10%ile		90%ile		Min	Max
Analyses	**Unit**													
pH - Water	pH units	6.1	L.Acid	5.8	6.5	0.5	8	0.4	5.7	M.acid	6.8	Neutral	5.3	7.0
Electrical Conductivity	dS/m	0.13	L.Sal	0.08	0.17	0.06	8	0.04	0.07	VL.Sal	0.20	M.Sal	0.06	0.23
Chloride	mg/kg	25	VL.Sal	12	39	19	8	13	10	VL.Sal	55	VL.Sal	10	58
Total Nitrogen - Kjeldahl	mg/kg	806	L	656	957	217	8	151	553	L	1007	L	402	1049
Total Phosphorus - Nitric/Perchloric	mg/kg	271	*	249	294	33	8	23	241	*	313	*	237	317
Phosphorus - Colwell extr	mg/kg	24	M	19	29	7	8	5	14	L	31	M	14	36
Potassium - Colwell ext	mg/kg	242	M	178	306	92	8	64	161	M	344	M	102	366
Sulphur - KCl	mg/kg	20.19	VH	16.49	23.89	5.34	8	3.70	15.74	H	28.40	VH	15.60	29.10
Organic Carbon	%	0.93	L	0.61	1.24	0.45	8	0.31	0.57	VL	1.31	M	0.37	1.90
Copper	mg/kg	1.28	M	1.09	1.47	0.27	8	0.19	0.99	M	1.63	M	0.98	1.69
Iron	mg/kg	31	*	16	47	22	8	16	11	*	64	*	10	66
Manganese	mg/kg	30.58	M	22.13	39.02	12.18	8	8.44	19.66	M	41.26	M	14.20	54.00
Zinc	mg/kg	3.13	M	0.96	5.30	3.13	8	2.17	0.45	L	7.62	H	0.27	8.64
Boron	mg/kg	0.57	L	0.48	0.65	0.12	8	0.09	0.43	VL	0.72	L	0.40	0.73
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	7.1	L	6.1	8.1	1.4	8	1.0	5.8	VL	9.0	L	5.1	9.1
Ex Calcium Percent	%	57.1	L	53.7	60.5	4.9	8	3.4	52.6	L	62.8	L	48.2	64.1
Ex Magnesium Percent	%	27.8	H	23.8	31.9	5.8	8	4.0	21.8	H	34.4	H	21.1	38.5
Ex Potassium Percent	%	12.3	H	10.6	14.1	2.5	8	1.7	10.2	H	14.4	H	8.5	17.3
Ex Sodium Percent	%	2.5	N.Sodic	1.9	3.0	0.8	8	0.6	1.7	N.Sodic	3.3	N.Sodic	1.5	4.2
Ex Aluminium Percent	%	0.3	VL	0.2	0.4	0.1	8	0.1	0.2	VL	0.5	VL	0.1	0.5
Exchangeable Calcium	mg/kg	818.1	*	660.5	975.8	227.5	8	157.7	612.8	*	1134.2	*	491.0	1172.0
Exchangeable Magnesium	mg/kg	228.5	*	214.8	242.2	19.8	8	13.7	202.5	*	243.8	*	192.0	255.0
Exchangeable Potassium	mg/kg	347.0	*	265.1	428.9	118.2	8	81.9	232.7	*	473.8	*	169.0	520.0
Exchangeable Sodium	mg/kg	38.7	*	31.9	45.6	9.9	8	6.9	25.3	*	49.6	*	24.1	49.8
Exchangeable Aluminium	mg/kg	1.6	*	1.1	2.0	0.6	8	0.4	1.0	*	2.4	*	1.0	2.4
Exchangeable Calcium	meq/100g	4.1	L	3.3	4.9	1.1	8	0.8	3.1	L	5.7	M	2.5	5.9
Exchangeable Magnesium	meq/100g	1.9	M	1.8	2.0	0.2	8	0.1	1.7	M	2.0	M	1.6	2.1
Exchangeable Potassium	meq/100g	0.9	H	0.7	1.1	0.3	8	0.2	0.6	M	1.2	H	0.4	1.3
Exchangeable Sodium	meq/100g	0.2	L	0.1	0.2	0.0	8	0.0	0.1	L	0.2	L	0.1	0.2
Exchangeable Aluminium	meq/100g	0.0	H	0.0	0.0	0.0	8	0.0	0.0	H	0.0	VH	0.0	0.0
Calcium/Magnesium Ratio	-	2.2	Low Ca	1.8	2.6	0.6	8	0.4	1.5	*	2.9	*	1.3	3.0
Gravel >2.0mm	%	28.0	*	20.5	35.4	10.8	8	7.5	17.3	*	36.7	*	13.4	50.3
Coarse Sand 0.2-2.0mm	%	19.6	*	15.6	23.6	5.8	8	4.0	13.6	*	24.6	*	6.9	25.4
Fine Sand 0.02-0.2mm	%	36.2	*	33.0	39.4	4.6	8	3.2	32.1	*	40.9	*	30.5	45.3
Silt 0.002-0.02mm	%	5.3	*	4.5	6.1	1.2	8	0.8	3.9	*	6.4	*	3.3	6.7
Clay <0.002mm	%	10.9	*	8.6	13.2	3.3	8	2.3	7.6	*	14.4	*	5.8	15.7
ADMC	%	2.5	*	1.6	3.4	1.3	8	0.9	1.2	*	3.9	*	1.1	4.8
Emerson Aggregate	Class	*	*	*	*	*	*	*	*	*	*	*	*	*
Phosphorus Buffer Index	mg/kg	*	*	*	*	*	*	*	*	*	*	*	*	*

TABLE B9. Laboratory Results
Topsoil Stockpile - Gravelly

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	201484-27		201484-28		201484-29		201484-30		201484-31		201484-32	
	Sample ID	TS9		TS10		TS11		TS12		TS13		TS14	
	Sample Depth (m)												
	Field Texture	LC		LC		LC		LC		LC		LC	
Analyses	**Unit**												
pH - Water	pH units	8.2	*M.Alk*	8.2	*M.Alk*	8.2	*M.Alk*	8.3	*M.Alk*	8.7	*H.Alk*	8.4	*M.Alk*
Electrical Conductivity	dS/m	0.12	*L.Sal*	0.13	*L.Sal*	0.10	*L.Sal*	0.16	*L.Sal*	0.14	*L.Sal*	0.15	*L.Sal*
Chloride	mg/kg	6	*VL.Sal*	14	*VL.Sal*	5	*VL.Sal*	19	*VL.Sal*	26	*VL.Sal*	37	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	348	*VL*	326	*VL*	371	*VL*	459	*VL*	256	*VL*	774	*L*
Total Phosphorus - Nitric/Perchloric	mg/kg	238	*	183	*	243	*	252	*	177	*	217	*
Phosphorus - Colwell extr	mg/kg	11	*L*	13	*L*	18	*M*	17	*L*	13	*L*	16	*L*
Potassium - Colwell ext	mg/kg	168	*L*	156	*L*	209	*M*	255	*M*	144	*L*	114	*VL*
Sulphur - KCl	mg/kg	17.10	*H*	18.70	*H*	17.80	*H*	21.10	*VH*	21.50	*VH*	33.70	*VH*
Organic Carbon	%	0.26	*EL*	0.34	*EL*	0.31	*EL*	0.39	*EL*	0.36	*EL*	0.19	*EL*
Copper	mg/kg	0.86	*M*	0.90	*M*	0.93	*M*	0.94	*M*	0.68	*M*	0.67	*M*
Iron	mg/kg	4	*	11	*	4	*	5	*	9	*	9	*
Manganese	mg/kg	3.98	*M*	2.57	*M*	4.67	*M*	5.94	*M*	3.16	*M*	2.51	*M*
Zinc	mg/kg	0.22	*VL*	1.06	*M*	0.45	*L*	3.04	*M*	0.29	*VL*	0.79	*L*
Boron	mg/kg	0.83	*L*	1.04	*M*	0.77	*L*	0.90	*L*	1.94	*M*	1.41	*M*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	6.1	*L*	7.2	*L*	6.4	*L*	5.0	*VL*	5.1	*VL*	4.9	*VL*
Ex Calcium Percent	%	56.5	*L*	44.8	*L*	59.2	*L*	54.9	*L*	37.5	*L*	45.6	*L*
Ex Magnesium Percent	%	23.0	*H*	38.3	*H*	19.2	*H*	22.4	*H*	39.6	*H*	34.0	*H*
Ex Potassium Percent	%	12.4	*H*	9.1	*H*	14.6	*H*	16.6	*H*	13.1	*H*	11.9	*H*
Ex Sodium Percent	%	7.9	*Sodic*	7.5	*Sodic*	6.5	*Sodic*	5.9	*N.Sodic*	9.6	*Sodic*	8.3	*Sodic*
Ex Aluminium Percent	%	0.2	*VL*	0.3	*VL*	0.5	*VL*	0.2	*VL*	0.2	*VL*	0.3	*VL*
Exchangeable Calcium	mg/kg	693.0	*	648.0	*	759.0	*	548.0	*	382.0	*	443.0	*
Exchangeable Magnesium	mg/kg	169.0	*	333.0	*	148.0	*	134.0	*	242.0	*	198.0	*
Exchangeable Potassium	mg/kg	296.0	*	258.0	*	364.0	*	322.0	*	261.0	*	225.0	*
Exchangeable Sodium	mg/kg	111.0	*	125.0	*	96.3	*	67.8	*	113.0	*	93.1	*
Exchangeable Aluminium	mg/kg	1.2	*	1.7	*	3.0	*	1.0	*	1.0	*	1.1	*
Exchangeable Calcium	meq/100g	3.5	*L*	3.2	*L*	3.8	*L*	2.7	*L*	1.9	*VL*	2.2	*L*
Exchangeable Magnesium	meq/100g	1.4	*M*	2.8	*M*	1.2	*M*	1.1	*M*	2.0	*M*	1.7	*M*
Exchangeable Potassium	meq/100g	0.8	*H*	0.7	*M*	0.9	*H*	0.8	*H*	0.7	*M*	0.6	*M*
Exchangeable Sodium	meq/100g	0.5	*M*	0.5	*M*	0.4	*M*	0.3	*L*	0.5	*M*	0.4	*M*
Exchangeable Aluminium	meq/100g	0.0	*H*	0.0	*VH*	0.0	*E*	0.0	*H*	0.0	*H*	0.0	*H*
Calcium/Magnesium Ratio	-	2.5	*Low Ca*	1.2	*Low Ca*	3.1	*Low Ca*	2.5	*Low Ca*	0.9	*Low Ca*	1.3	*Low Ca*
Gravel >2.0mm	%	3.6	*		*	0.6	*		*	6.7	*		*
Coarse Sand 0.2-2.0mm	%	16.4	*		*	21.9	*		*	23.3	*		*
Fine Sand 0.02-0.2mm	%	48.1	*		*	43.9	*		*	39.8	*		*
Silt 0.002-0.02mm	%	14.6	*		*	15.3	*		*	12.8	*		*
Clay <0.002mm	%	17.4	*		*	18.3	*		*	17.4	*		*
ADMC	%	6.9	*		*	7.8	*		*	9.2	*		*
Emerson Aggregate	Class	3b	*Slight Disp*			5.0	*Slaking*			2.0	*Disp.*		
Phosphorus Buffer Index	mg/kg		*		*		*		*		*		*

TABLE B9. Laboratory Results
Topsoil Stockpile - Gravelly

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	**Mean**		**LCL 95%**	**UCL 95%**	**Std Dev**	**Count**	**CI 95% (+/-)**	**10%ile**		**90%ile**		**Min**	**Max**
	Sample ID													
	Sample Depth (m)													
	Field Texture													
Analyses	**Unit**													
pH - Water	pH units	8.3	M.Alk	8.2	8.5	0.2	6	0.2	8.2	M.Alk	8.6	H.Alk	8.2	8.7
Electrical Conductivity	dS/m	0.13	L.Sal	0.12	0.15	0.02	6	0.02	0.11	L.Sal	0.16	L.Sal	0.10	0.16
Chloride	mg/kg	18	VL.Sal	8	28	12	6	10	6	VL.Sal	31	VL.Sal	5	37
Total Nitrogen - Kjeldahl	mg/kg	422	VL	275	570	184	6	148	291	VL	617	L	256	774
Total Phosphorus - Nitric/Perchloric	mg/kg	218	*	193	244	32	6	26	180	*	248	*	177	252
Phosphorus - Colwell extr	mg/kg	15	L	12	17	3	6	2	12	L	18	M	11	18
Potassium - Colwell ext	mg/kg	174	L	134	215	50	6	40	129	L	232	M	114	255
Sulphur - KCl	mg/kg	21.65	VH	16.72	26.58	6.16	6	4.93	17.45	H	27.60	VH	17.10	33.70
Organic Carbon	%	0.31	EL	0.25	0.37	0.07	6	0.06	0.23	EL	0.38	EL	0.19	0.39
Copper	mg/kg	0.83	M	0.73	0.93	0.12	6	0.10	0.68	M	0.94	M	0.67	0.94
Iron	mg/kg	7	*	5	10	3	6	2	4	*	10	*	4	11
Manganese	mg/kg	3.81	M	2.73	4.88	1.34	6	1.07	2.54	M	5.31	M	2.51	5.94
Zinc	mg/kg	0.98	M	0.13	1.82	1.06	6	0.85	0.26	VL	2.05	M	0.22	3.04
Boron	mg/kg	1.15	M	0.79	1.51	0.45	6	0.36	0.80	L	1.68	M	0.77	1.94
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	5.8	VL	5.0	6.6	1.0	6	0.8	4.9	VL	6.8	L	4.9	7.2
Ex Calcium Percent	%	49.7	L	43.0	56.5	8.4	6	6.7	41.1	L	57.9	L	37.5	59.2
Ex Magnesium Percent	%	29.4	H	22.3	36.5	8.9	6	7.1	20.8	H	38.9	H	19.2	39.6
Ex Potassium Percent	%	12.9	H	10.9	14.9	2.5	6	2.0	10.5	H	15.6	H	9.1	16.6
Ex Sodium Percent	%	7.6	Sodic	6.6	8.7	1.3	6	1.1	6.2	Sodic	9.0	Sodic	5.9	9.6
Ex Aluminium Percent	%	0.3	VL	0.2	0.4	0.1	6	0.1	0.2	VL	0.4	VL	0.2	0.5
Exchangeable Calcium	mg/kg	578.8	*	461.0	696.7	147.3	6	117.8	412.5	*	726.0	*	382.0	759.0
Exchangeable Magnesium	mg/kg	204.0	*	144.8	263.2	74.0	6	59.2	141.0	*	287.5	*	134.0	333.0
Exchangeable Potassium	mg/kg	287.7	*	247.5	327.8	50.2	6	40.2	241.5	*	343.0	*	225.0	364.0
Exchangeable Sodium	mg/kg	101.0	*	85.0	117.1	20.0	6	16.0	80.5	*	119.0	*	67.8	125.0
Exchangeable Aluminium	mg/kg	1.5	*	0.9	2.1	0.8	6	0.6	1.0	*	2.4	*	1.0	3.0
Exchangeable Calcium	meq/100g	2.9	L	2.3	3.5	0.7	6	0.6	2.1	L	3.6	L	1.9	3.8
Exchangeable Magnesium	meq/100g	1.7	M	1.2	2.2	0.6	6	0.5	1.2	M	2.4	M	1.1	2.8
Exchangeable Potassium	meq/100g	0.7	H	0.6	0.8	0.1	6	0.1	0.6	M	0.9	H	0.6	0.9
Exchangeable Sodium	meq/100g	0.4	M	0.4	0.5	0.1	6	0.1	0.3	M	0.5	M	0.3	0.5
Exchangeable Aluminium	meq/100g	0.0	H	0.0	0.0	0.0	6	0.0	0.0	H	0.0	VH	0.0	0.0
Calcium/Magnesium Ratio	-	1.9	Low Ca	1.2	2.6	0.9	6	0.7	1.1	*	2.8	*	0.9	3.1
Gravel >2.0mm	%	3.6	*	0.2	7.1	3.1	3	3.5	1.2	*	6.1	*	0.6	6.7
Coarse Sand 0.2-2.0mm	%	20.5	*	16.4	24.7	3.6	3	4.1	17.5	*	23.0	*	16.4	23.3
Fine Sand 0.02-0.2mm	%	43.9	*	39.2	48.6	4.2	3	4.7	40.6	*	47.3	*	39.8	48.1
Silt 0.002-0.02mm	%	14.2	*	12.8	15.7	1.3	3	1.5	13.2	*	15.2	*	12.8	15.3
Clay <0.002mm	%	17.7	*	17.1	18.3	0.5	3	0.6	17.4	*	18.1	*	17.4	18.3
ADMC	%	8.0	*	6.6	9.3	1.2	3	1.3	7.1	*	8.9	*	6.9	9.2
Emerson Aggregate	Class	*	*	*	*	*	*	*	*	*	*	*	*	*
Phosphorus Buffer Index	mg/kg	*	*	*	*	*	*	*	*	*	*	*	*	*

TABLE B10. Laboratory Results
Waste Rock Fresh

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No	201484-33		201484-34		201484-35		201484-36		201484-37		201484-38		201484-39		201484-40	
	Sample ID	WRF1		WRF2		WRF3		WRF4		WRF5		WRF6		WRF7		WRF8	
	Sample Depth (m)																
	Field Texture	CS		CS		CS		CS		S		CS		CS		CS	
Analyses	**Unit**																
pH - Water	pH units	3.4	*E.Acid*	2.9	*E.Acid*	3.1	*E.Acid*	5.2	*H.Acid*	6.2	*L.Acid*	6.3	*L.Acid*	7.3	*Neutral*	6.9	*Neutral*
Electrical Conductivity	dS/m	1.58	*E.Sal*	1.16	*E.Sal*	1.94	*E.Sal*	1.76	*E.Sal*	0.21	*M.Sal*	0.37	*H.Sal*	0.15	*M.Sal*	0.28	*M.Sal*
Chloride	mg/kg	10	*VL.Sal*	7	*VL.Sal*	17	*VL.Sal*	76	*VL.Sal*	106	*L.Sal*	192	*L.Sal*	73	*VL.Sal*	142	*L.Sal*
Total Nitrogen - Kjeldahl	mg/kg																
Total Phosphorus - Nitric/Perchloric	mg/kg																
Phosphorus - Colwell extr	mg/kg																
Potassium - Colwell ext	mg/kg																
Sulphur - KCl	mg/kg																
Organic Carbon	%																
Copper	mg/kg																
Iron	mg/kg																
Manganese	mg/kg																
Zinc	mg/kg																
Boron	mg/kg																
Cation Extraction Method	Rayment& Lyons	15A2	*	15A2	*	15A2	*	15A2	*	15A1	*	15A2	*	15C1	*	15A1	*
Cation Exchange Capacity	meq/100g	6.9	*L*	3.4	*VL*	7.8	*L*	5.9	*VL*	3.2	*VL*	2.7	*VL*	1.4	*VL*	3.7	*VL*
Ex Calcium Percent	%	49.9	*L*	48.2	*L*	43.6	*L*	73.6	*Normal*	35.5	*L*	59.0	*L*	26.3	*L*	39.5	*L*
Ex Magnesium Percent	%	12.5	*Normal*	13.4	*Normal*	9.9	*L*	21.2	*H*	40.5	*H*	28.0	*H*	29.4	*H*	46.7	*H*
Ex Potassium Percent	%	2.1	*Normal*	4.3	*Normal*	1.9	*Normal*	3.1	*Normal*	7.1	*H*	9.0	*H*	24.9	*H*	3.1	*Normal*
Ex Sodium Percent	%	0.6	*N.Sodic*	1.3	*N.Sodic*	0.7	*N.Sodic*	2.0	*N.Sodic*	16.5	*H.Sodic*	3.4	*N.Sodic*	18.7	*H.Sodic*	10.5	*Sodic*
Ex Aluminium Percent	%	34.9	*H*	32.8	*H*	44.0	*VH*	0.2	*VL*	0.3	*VL*	0.6	*VL*	0.8	*VL*	0.3	*VL*
Exchangeable Calcium	mg/kg	687.0	*	330.0	*	681.0	*	875.0	*	228.0	*	320.0	*	75.9	*	293.0	*
Exchangeable Magnesium	mg/kg	103.0	*	55.0	*	92.4	*	151.0	*	156.0	*	91.1	*	51.0	*	208.0	*
Exchangeable Potassium	mg/kg	55.8	*	57.3	*	56.4	*	71.1	*	88.5	*	95.6	*	140.0	*	44.4	*
Exchangeable Sodium	mg/kg	10.0	*	10.0	*	13.2	*	27.1	*	122.0	*	21.5	*	62.0	*	89.3	*
Exchangeable Aluminium	mg/kg	216.0	*	101.0	*	309.0	*	1.0	*	1.0	*	1.4	*	1.0	*	1.1	*
Exchangeable Calcium	meq/100g	3.4	*L*	1.7	*VL*	3.4	*L*	4.4	*L*	1.1	*VL*	1.6	*VL*	0.4	*VL*	1.5	*VL*
Exchangeable Magnesium	meq/100g	0.9	*L*	0.5	*L*	0.8	*L*	1.3	*M*	1.3	*M*	0.8	*L*	0.4	*L*	1.7	*M*
Exchangeable Potassium	meq/100g	0.1	*VL*	0.1	*VL*	0.1	*VL*	0.2	*VL*	0.2	*L*	0.2	*L*	0.4	*M*	0.1	*VL*
Exchangeable Sodium	meq/100g	0.0	*VL*	0.0	*VL*	0.1	*VL*	0.1	*L*	0.5	*M*	0.1	*VL*	0.3	*L*	0.4	*M*
Exchangeable Aluminium	meq/100g	2.4	*E*	1.1	*E*	3.4	*E*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*
Calcium/Magnesium Ratio	-	4.0	*Balanced*	3.6	*Low Ca*	4.4	*Balanced*	3.5	*Low Ca*	0.9	*Low Ca*	2.1	*Low Ca*	0.9	*Low Ca*	0.8	*Low Ca*
Gravel >2.0mm	%	31.9	*		*	33.0	*		*	30.7	*		*	42.8	*		*
Coarse Sand 0.2-2.0mm	%	38.6	*		*	34.7	*		*	40.3	*		*	24.7	*		*
Fine Sand 0.02-0.2mm	%	20.0	*		*	21.0	*		*	19.7	*		*	20.5	*		*
Silt 0.002-0.02mm	%	5.0	*		*	5.9	*		*	7.4	*		*	7.4	*		*
Clay <0.002mm	%	4.5	*		*	5.4	*		*	1.9	*		*	4.8	*		*
ADMC	%	3.7	*		*	0.4	*		*	0.1	*		*	3.0	*		*
Emerson Aggregate	Class	6.0	*Slaking*			5.0	*Slaking*			5.0	*Slaking*			5.0	*Slaking*		
Phosphorus Buffer Index	mg/kg		*		*		*		*		*		*		*		*

TABLE B10. Laboratory Results
Waste Rock Fresh

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	Mean		LCL 95%	UCL 95%	Std Dev	Count	CI 95% (+/-)	10%ile		90%ile		Min	Max
	Sample ID													
	Sample Depth (m)													
	Field Texture													
Analyses	**Unit**													
pH - Water	pH units	5.2	H.Acid	3.9	6.4	1.8	8	1.2	3.0	E.Acid	7.0	Neutral	2.9	7.3
Electrical Conductivity	dS/m	0.93	VH.Sal	0.40	1.46	0.76	8	0.53	0.19	M.Sal	1.81	E.Sal	0.15	1.94
Chloride	mg/kg	78	VL.Sal	31	124	67	8	46	9	VL.Sal	157	L.Sal	7	192
Total Nitrogen - Kjeldahl	mg/kg													
Total Phosphorus - Nitric/Perchloric	mg/kg													
Phosphorus - Colwell extr	mg/kg													
Potassium - Colwell ext	mg/kg													
Sulphur - KCl	mg/kg													
Organic Carbon	%													
Copper	mg/kg													
Iron	mg/kg													
Manganese	mg/kg													
Zinc	mg/kg													
Boron	mg/kg													
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	4.4	VL	2.9	5.9	2.2	8	1.5	2.3	VL	7.2	L	1.4	7.8
Ex Calcium Percent	%	46.9	L	36.8	57.1	14.6	8	10.1	32.8	L	63.4	L	26.3	73.6
Ex Magnesium Percent	%	25.2	H	15.8	34.5	13.5	8	9.4	11.7	Normal	42.4	H	9.9	46.7
Ex Potassium Percent	%	6.9	H	1.6	12.2	7.7	8	5.3	2.0	Normal	13.8	H	1.9	24.9
Ex Sodium Percent	%	6.7	Sodic	1.6	11.9	7.5	8	5.2	0.7	N.Sodic	17.2	H.Sodic	0.6	18.7
Ex Aluminium Percent	%	14.2	M	0.9	27.6	19.3	8	13.4	0.3	VL	37.6	VH	0.2	44.0
Exchangeable Calcium	mg/kg	436.2	*	244.9	627.6	276.2	8	191.4	182.4	*	743.4	*	75.9	875.0
Exchangeable Magnesium	mg/kg	113.4	*	75.9	151.0	54.2	8	37.5	53.8	*	171.6	*	51.0	208.0
Exchangeable Potassium	mg/kg	76.1	*	54.5	97.7	31.2	8	21.6	52.4	*	108.9	*	44.4	140.0
Exchangeable Sodium	mg/kg	44.4	*	15.1	73.7	42.3	8	29.3	10.0	*	99.1	*	10.0	122.0
Exchangeable Aluminium	mg/kg	78.9	*	-4.9	162.8	121.0	8	83.9	1.0	*	243.9	*	1.0	309.0
Exchangeable Calcium	meq/100g	2.2	L	1.2	3.1	1.4	8	1.0	0.9	VL	3.7	L	0.4	4.4
Exchangeable Magnesium	meq/100g	0.9	L	0.6	1.3	0.5	8	0.3	0.4	L	1.4	M	0.4	1.7
Exchangeable Potassium	meq/100g	0.2	VL	0.1	0.3	0.1	8	0.1	0.1	VL	0.3	L	0.1	0.4
Exchangeable Sodium	meq/100g	0.2	L	0.1	0.3	0.2	8	0.1	0.0	VL	0.4	M	0.0	0.5
Exchangeable Aluminium	meq/100g	0.9	E	-0.1	1.8	1.3	8	0.9	0.0	H	2.7	E	0.0	3.4
Calcium/Magnesium Ratio	-	2.5	Low Ca	1.5	3.6	1.5	8	1.1	0.9	*	4.1	*	0.8	4.4
Gravel >2.0mm	%	34.6	*	29.2	40.0	5.5	4	5.4	31.1	*	39.9	*	30.7	42.8
Coarse Sand 0.2-2.0mm	%	34.6	*	27.7	41.4	7.0	4	6.8	27.7	*	39.8	*	24.7	40.3
Fine Sand 0.02-0.2mm	%	20.3	*	19.7	20.9	0.6	4	0.6	19.8	*	20.9	*	19.7	21.0
Silt 0.002-0.02mm	%	6.4	*	5.3	7.6	1.2	4	1.2	5.3	*	7.4	*	5.0	7.4
Clay <0.002mm	%	4.2	*	2.6	5.7	1.5	4	1.5	2.7	*	5.2	*	1.9	5.4
ADMC	%	1.8	*	0.0	3.6	1.8	4	1.8	0.2	*	3.5	*	0.1	3.7
Emerson Aggregate	Class	*	*	*	*	*	*	*	*	*	*	*	*	*
Phosphorus Buffer Index	mg/kg	*	*	*	*	*	*	*	*	*	*	*	*	*

TABLE B11. Laboratory Results
Waste Rock Oxide

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No	201484-41		201484-42		201484-43		201484-44		201484-45		201484-46		201484-47		201484-48	
	Sample ID	WRO1		WRO2		WRO3		WRO4		WRO5		WRO6		WRO7		WRO8	
	Sample Depth (m)																
	Field Texture	LS		SL		LS		CS		LS		S		LS		LS	
Analyses	**Unit**																
pH - Water	pH units	8.3	*M.Alk*	7.9	*L.Alk*	8.2	*M.Alk*	7.9	*M.Alk*	7.4	*L.Alk*	7.7	*L.Alk*	7.5	*L.Alk*	7.8	*L.Alk*
Electrical Conductivity	dS/m	0.35	*H.Sal*	0.93	*E.Sal*	0.07	*L.Sal*	0.22	*M.Sal*	0.56	*H.Sal*	0.20	*M.Sal*	0.21	*M.Sal*	0.06	*VL.Sal*
Chloride	mg/kg	250	*L.Sal*	225	*L.Sal*	28	*VL.Sal*	231	*L.Sal*	677	*H.Sal*	223	*L.Sal*	225	*L.Sal*	42	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	511	*L*	*		390	*VL*	*		344	*VL*	*		442	*VL*	*	
Total Phosphorus - Nitric/Perchloric	mg/kg	486	*	*		672	*	*		672	*	*		900	*	*	
Phosphorus - Colwell extr	mg/kg	17	*M*	*		18	*M*	*		27	*H*	*		31	*H*	*	
Potassium - Colwell ext	mg/kg	41	*VL*	*		51	*L*	*		49	*VL*	*		25	*VL*	*	
Sulphur - KCl	mg/kg	99.10	*VH*	*		28.10	*VH*	*		106.00	*VH*	*		30.80	*VH*	*	
Organic Carbon	%	0.38	*EL*	*		0.11	*EL*	*		0.11	*EL*	*		0.10	*EL*	*	
Copper	mg/kg	1.23	*M*	*		0.47	*M*	*		0.39	*M*	*		0.35	*M*	*	
Iron	mg/kg	5	*	*		2	*	*		2	*	*		2	*	*	
Manganese	mg/kg	3.44	*M*	*		1.49	*L*	*		0.92	*VL*	*		0.74	*VL*	*	
Zinc	mg/kg	9.92	*H*	*		7.22	*H*	*		1.49	*M*	*		0.83	*M*	*	
Boron	mg/kg	0.30	*VL*	*		0.30	*VL*	*		0.40	*VL*	*		0.32	*VL*	*	
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*	15C1	*	15C1		15C1	*	15C1	
Cation Exchange Capacity	meq/100g	1.3	*VL*	4.6	*VL*	1.1	*VL*	1.3	*VL*	1.2	*VL*	1.0	*VL*	1.0	*VL*	1.3	*VL*
Ex Calcium Percent	%	36.4	*L*	53.1	*L*	30.8	*L*	25.7	*L*	24.8	*L*	23.4	*L*	26.8	*L*	23.7	*L*
Ex Magnesium Percent	%	24.1	*H*	27.2	*H*	23.9	*H*	31.5	*H*	31.8	*H*	28.2	*H*	26.8	*H*	20.8	*H*
Ex Potassium Percent	%	14.7	*H*	9.1	*H*	18.0	*H*	15.9	*H*	14.3	*H*	16.8	*H*	16.5	*H*	24.2	*H*
Ex Sodium Percent	%	23.9	*H.Sodic*	10.2	*Sodic*	26.3	*H.Sodic*	26.2	*H.Sodic*	28.2	*H.Sodic*	30.5	*H.Sodic*	28.8	*H.Sodic*	30.4	*H.Sodic*
Ex Aluminium Percent	%	0.9	*VL*	0.4	*VL*	1.0	*VL*	0.8	*VL*	0.9	*VL*	1.1	*VL*	1.1	*VL*	0.9	*VL*
Exchangeable Calcium	mg/kg	94.5	*	488.0	*	66.1	*	67.3	*	62.0	*	47.8	*	55.9	*	59.8	*
Exchangeable Magnesium	mg/kg	37.6	*	150.0	*	30.7	*	49.5	*	47.6	*	34.6	*	33.5	*	31.5	*
Exchangeable Potassium	mg/kg	74.5	*	164.0	*	75.2	*	81.2	*	69.5	*	66.8	*	67.2	*	119.0	*
Exchangeable Sodium	mg/kg	71.4	*	108.0	*	64.7	*	78.9	*	81.0	*	71.8	*	68.9	*	88.0	*
Exchangeable Aluminium	mg/kg	1.0	*	1.7	*	1.0	*	1.0	*	1.0	*	1.0	*	1.0	*	1.0	*
Exchangeable Calcium	meq/100g	0.5	*VL*	2.4	*L*	0.3	*VL*	0.3	*VL*	0.3	*VL*	0.2	*VL*	0.3	*VL*	0.3	*VL*
Exchangeable Magnesium	meq/100g	0.3	*L*	1.3	*M*	0.3	*VL*	0.4	*L*	0.4	*L*	0.3	*VL*	0.3	*VL*	0.3	*VL*
Exchangeable Potassium	meq/100g	0.2	*VL*	0.4	*M*	0.2	*VL*	0.2	*L*	0.2	*VL*	0.2	*VL*	0.2	*VL*	0.3	*M*
Exchangeable Sodium	meq/100g	0.3	*M*	0.5	*M*	0.3	*L*	0.3	*M*	0.4	*M*	0.3	*M*	0.3	*L*	0.4	*M*
Exchangeable Aluminium	meq/100g	0.0	*H*	0.0	*VH*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*
Calcium/Magnesium Ratio	-	1.5	*Low Ca*	2.0	*Low Ca*	1.3	*Low Ca*	0.8	*Low Ca*	0.8	*Low Ca*	0.8	*Low Ca*	1.0	*Low Ca*	1.1	*Low Ca*
Gravel >2.0mm	%	35.2	*	20.8	*	45.4	*	35.3	*	39.7	*	42.7	*	35.2	*	41.4	*
Coarse Sand 0.2-2.0mm	%	29.0	*	19.4	*	24.2	*	16.7	*	25.3	*	20.4	*	25.7	*	25.9	*
Fine Sand 0.02-0.2mm	%	23.3	*	31.2	*	19.7	*	30.1	*	22.1	*	25.0	*	21.1	*	20.5	*
Silt 0.002-0.02mm	%	9.5	*	12.3	*	8.0	*	13.8	*	10.1	*	11.3	*	15.9	*	9.5	*
Clay <0.002mm	%	3.0	*	16.3	*	2.6	*	4.1	*	2.9	*	0.6	*	3.1	*	2.7	*
ADMC	%	5.1	*	8.0	*	4.3	*	4.2	*	3.3	*	3.7	*	2.7	*	4.6	*
Emerson Aggregate	Class	5.0	*Slaking*	5.0	*Slaking*	5.0	*Slaking*	5.0	*Slaking*	6.0	*Slaking*	5.0	*Slaking*	5.0	*Slaking*	5.0	*Slaking*
Phosphorus Buffer Index	mg/kg	32.5	*		*	33.6	*		*	33.6	*		*	40.3	*		*

TABLE B11. Laboratory Results
Waste Rock Oxide

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No	Mean		LCL 95%	UCL 95%	Std Dev	Count	CI 95% (+/-)	10%ile		90%ile		Min	Max
	Sample ID													
	Sample Depth (m)													
	Field Texture													
Analyses	**Unit**													
pH - Water	pH units	7.9	L.Alk	7.6	8.1	0.3	8	0.2	7.5	L.Alk	8.3	M.Alk	7.4	8.3
Electrical Conductivity	dS/m	0.33	M.Sal	0.12	0.53	0.29	8	0.20	0.07	VL.Sal	0.67	H.Sal	0.06	0.93
Chloride	mg/kg	238	L.Sal	100	375	199	8	138	38	VL.Sal	378	M.Sal	28	677
Total Nitrogen - Kjeldahl	mg/kg	422	VL	351	492	72	4	70	358	VL	490	VL	344	511
Total Phosphorus - Nitric/Perchloric	mg/kg	683	*	516	849	169	4	166	542	*	832	*	486	900
Phosphorus - Colwell extr	mg/kg	23	H	17	30	7	4	6	18	M	30	H	17	31
Potassium - Colwell ext	mg/kg	42	VL	30	53	12	4	11	30	VL	50	L	25	51
Sulphur - KCl	mg/kg	66.00	VH	24.53	107.47	42.31	4	41.47	28.91	VH	103.93	VH	28.10	106.00
Organic Carbon	%	0.18	EL	0.04	0.31	0.14	4	0.13	0.10	EL	0.30	EL	0.10	0.38
Copper	mg/kg	0.61	M	0.20	1.02	0.42	4	0.41	0.36	M	1.00	M	0.35	1.23
Iron	mg/kg	3	*	2	4	1	4	1	2	*	4	*	2	5
Manganese	mg/kg	1.65	L	0.44	2.86	1.24	4	1.21	0.79	VL	2.86	M	0.74	3.44
Zinc	mg/kg	4.87	M	0.53	9.20	4.43	4	4.34	1.03	M	9.11	H	0.83	9.92
Boron	mg/kg	0.33	VL	0.28	0.38	0.05	4	0.05	0.30	VL	0.38	VL	0.30	0.40
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	1.6	VL	0.8	2.4	1.2	8	0.8	1.0	VL	2.3	VL	1.0	4.6
Ex Calcium Percent	%	30.6	L	23.6	37.6	10.1	8	7.0	23.6	L	41.4	L	23.4	53.1
Ex Magnesium Percent	%	26.8	H	24.2	29.4	3.8	8	2.6	23.0	H	31.6	H	20.8	31.8
Ex Potassium Percent	%	16.2	H	13.3	19.1	4.2	8	2.9	12.7	H	19.9	H	9.1	24.2
Ex Sodium Percent	%	25.6	H.Sodic	21.0	30.1	6.6	8	4.6	19.8	H.Sodic	30.4	H.Sodic	10.2	30.5
Ex Aluminium Percent	%	0.9	VL	0.7	1.0	0.2	8	0.1	0.7	VL	1.1	VL	0.4	1.1
Exchangeable Calcium	mg/kg	117.7	*	13.6	221.8	150.2	8	104.1	53.5	*	212.6	*	47.8	488.0
Exchangeable Magnesium	mg/kg	51.9	*	24.0	79.8	40.3	8	27.9	31.3	*	79.7	*	30.7	150.0
Exchangeable Potassium	mg/kg	89.7	*	65.8	113.6	34.5	8	23.9	67.1	*	132.5	*	66.8	164.0
Exchangeable Sodium	mg/kg	79.1	*	69.5	88.7	13.8	8	9.6	67.6	*	94.0	*	64.7	108.0
Exchangeable Aluminium	mg/kg	1.1	*	0.9	1.3	0.2	8	0.2	1.0	*	1.2	*	1.0	1.7
Exchangeable Calcium	meq/100g	0.6	VL	0.1	1.1	0.8	8	0.5	0.3	VL	1.1	VL	0.2	2.4
Exchangeable Magnesium	meq/100g	0.4	L	0.2	0.7	0.3	8	0.2	0.3	VL	0.7	L	0.3	1.3
Exchangeable Potassium	meq/100g	0.2	L	0.2	0.3	0.1	8	0.1	0.2	VL	0.3	M	0.2	0.4
Exchangeable Sodium	meq/100g	0.3	M	0.3	0.4	0.1	8	0.0	0.3	L	0.4	M	0.3	0.5
Exchangeable Aluminium	meq/100g	0.0	H	0.0	0.0	0.0	8	0.0	0.0	H	0.0	H	0.0	0.0
Calcium/Magnesium Ratio	-	1.2	Low Ca	0.9	1.4	0.4	8	0.3	0.8	*	1.6	*	0.8	2.0
Gravel >2.0mm	%	37.0	*	31.7	42.2	7.6	8	5.2	30.9	*	43.5	*	20.8	45.4
Coarse Sand 0.2-2.0mm	%	23.3	*	20.5	26.2	4.1	8	2.8	18.6	*	26.8	*	16.7	29.0
Fine Sand 0.02-0.2mm	%	24.1	*	21.1	27.1	4.4	8	3.0	20.3	*	30.4	*	19.7	31.2
Silt 0.002-0.02mm	%	11.3	*	9.5	13.1	2.6	8	1.8	9.1	*	14.4	*	8.0	15.9
Clay <0.002mm	%	4.4	*	1.0	7.8	4.9	8	3.4	2.0	*	7.8	*	0.6	16.3
ADMC	%	4.5	*	3.4	5.6	1.6	8	1.1	3.1	*	6.0	*	2.7	8.0
Emerson Aggregate	Class	*	*	*	*	*	*	*	*	*	*	*	*	*
Phosphorus Buffer Index	mg/kg	*	*	*	*	*	*	*	*	*	*	*	*	*

TABLE B12. Laboratory Results
Waste Rock Oxide Rehab

East West Enviroag Project Number:	EW201484
Location:	MBGM (MKR)
Landloch J/N:	3467.20a
Sample Collection Date:	27/11/2020
Sample Receival Date:	12/07/2020
Sample Analysis Date:	15/01/2021

	Lab No	201484-49		201484-50		201484-51		201484-52	
	Sample ID	WRO-R1		WRO-R2		WRO-R3		WRO-R4	
	Sample Depth (m)								
	Field Texture	LS		LS		LS		LS	
Analyses	**Unit**								
pH - Water	pH units	8.5	*M.Alk*	8.4	*M.Alk*	8.1	*M.Alk*	8.4	*M.Alk*
Electrical Conductivity	dS/m	0.07	*L.Sal*	0.15	*M.Sal*	0.16	*M.Sal*	0.07	*L.Sal*
Chloride	mg/kg	16	*VL.Sal*	102	*L.Sal*	54	*VL.Sal*	17	*VL.Sal*
Total Nitrogen - Kjeldahl	mg/kg	280	*VL*	260	*VL*	597	*L*	268	*VL*
Total Phosphorus - Nitric/Perchloric	mg/kg	602	*	584	*	427	*	688	*
Phosphorus - Colwell extr	mg/kg	20	*M*	16	*M*	18	*M*	22	*H*
Potassium - Colwell ext	mg/kg	216	*H*	223	*H*	553	*H*	137	*L*
Sulphur - KCl	mg/kg	6.71	*L*	12.30	*H*	16.30	*H*	8.98	*M*
Organic Carbon	%	0.58	*VL*	0.49	*VL*	0.46	*VL*	0.32	*EL*
Copper	mg/kg	0.40	*M*	0.24	*L*	0.49	*M*	0.34	*M*
Iron	mg/kg	2	*	4	*	4	*	3	*
Manganese	mg/kg	17.20	*M*	16.00	*M*	18.10	*M*	16.00	*M*
Zinc	mg/kg	1.63	*M*	0.83	*M*	1.61	*M*	1.60	*M*
Boron	mg/kg	0.44	*VL*	0.41	*VL*	0.83	*L*	0.38	*VL*
Cation Extraction Method	Rayment& Lyons	15C1	*	15C1	*	15C1	*	15C1	*
Cation Exchange Capacity	meq/100g	1.6	*VL*	1.6	*VL*	3.3	*VL*	1.8	*VL*
Ex Calcium Percent	%	28.0	*L*	31.5	*L*	33.1	*L*	33.4	*L*
Ex Magnesium Percent	%	22.0	*H*	24.5	*H*	31.6	*H*	30.3	*H*
Ex Potassium Percent	%	22.1	*H*	25.0	*H*	25.6	*H*	17.1	*H*
Ex Sodium Percent	%	27.2	*H.Sodic*	18.3	*H.Sodic*	9.3	*Sodic*	18.5	*H.Sodic*
Ex Aluminium Percent	%	0.7	*VL*	0.7	*VL*	0.3	*VL*	0.6	*VL*
Exchangeable Calcium	mg/kg	87.7	*	98.9	*	218.0	*	118.0	*
Exchangeable Magnesium	mg/kg	41.4	*	46.2	*	125.0	*	64.1	*
Exchangeable Potassium	mg/kg	135.0	*	153.0	*	329.0	*	118.0	*
Exchangeable Sodium	mg/kg	97.8	*	66.0	*	70.4	*	75.2	*
Exchangeable Aluminium	mg/kg	1.0	*	1.0	*	1.0	*	1.0	*
Exchangeable Calcium	meq/100g	0.4	*VL*	0.5	*VL*	1.1	*VL*	0.6	*VL*
Exchangeable Magnesium	meq/100g	0.3	*L*	0.4	*L*	1.0	*M*	0.5	*L*
Exchangeable Potassium	meq/100g	0.3	*M*	0.4	*M*	0.8	*H*	0.3	*M*
Exchangeable Sodium	meq/100g	0.4	*M*	0.3	*L*	0.3	*M*	0.3	*M*
Exchangeable Aluminium	meq/100g	0.0	*H*	0.0	*H*	0.0	*H*	0.0	*H*
Calcium/Magnesium Ratio	-	1.3	*Low Ca*	1.3	*Low Ca*	1.0	*Low Ca*	1.1	*Low Ca*
Gravel >2.0mm	%	*	*	*	*	*	*	*	*
Coarse Sand 0.2-2.0mm	%	*	*	*	*	*	*	*	*
Fine Sand 0.02-0.2mm	%	*	*	*	*	*	*	*	*
Silt 0.002-0.02mm	%	*	*	*	*	*	*	*	*
Clay <0.002mm	%	*	*	*	*	*	*	*	*
ADMC	%	*	*	*	*	*	*	*	*
Emerson Aggregate	Class	3b	*Slight Disp*	5.0	*Slaking*	3b	*Slight Disp*	3b	*Slight Disp*
Phosphorus Buffer Index	mg/kg	22.9	*	25.2	*	25.0	*	20.0	*

TABLE B12. Laboratory Results
Waste Rock Oxide Rehab

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No	Mean		LCL 95%	UCL 95%	Std Dev	Count	CI 95% (+/-)	10%ile		90%ile		Min	Max
	Sample ID													
	Sample Depth (m)													
	Field Texture													
Analyses	**Unit**													
pH - Water	pH units	8.3	M.Alk	8.2	8.5	0.2	4	0.2	8.2	M.Alk	8.5	M.Alk	8.1	8.5
Electrical Conductivity	dS/m	0.11	L.Sal	0.06	0.16	0.05	4	0.05	0.07	VL.Sal	0.16	L.Sal	0.07	0.16
Chloride	mg/kg	47	VL.Sal	8	87	40	4	40	17	VL.Sal	88	VL.Sal	16	102
Total Nitrogen - Kjeldahl	mg/kg	351	VL	190	512	164	4	161	262	VL	502	L	260	597
Total Phosphorus - Nitric/Perchloric	mg/kg	575	*	469	682	109	4	107	474	*	662	*	427	688
Phosphorus - Colwell extr	mg/kg	19	M	16	21	3	4	3	16	M	21	H	16	22
Potassium - Colwell ext	mg/kg	282	H	101	463	185	4	181	161	M	454	H	137	553
Sulphur - KCl	mg/kg	11.07	M	6.98	15.16	4.17	4	4.09	7.39	L	15.10	H	6.71	16.30
Organic Carbon	%	0.46	VL	0.36	0.57	0.11	4	0.11	0.36	EL	0.55	VL	0.32	0.58
Copper	mg/kg	0.37	M	0.26	0.47	0.11	4	0.10	0.27	L	0.46	M	0.24	0.49
Iron	mg/kg	3	*	3	4	1	4	1	3	*	4	*	2	4
Manganese	mg/kg	16.83	M	15.82	17.83	1.02	4	1.00	16.00	M	17.83	M	16.00	18.10
Zinc	mg/kg	1.42	M	1.03	1.80	0.39	4	0.38	1.06	M	1.62	M	0.83	1.63
Boron	mg/kg	0.52	L	0.31	0.72	0.21	4	0.21	0.39	VL	0.71	L	0.38	0.83
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	2.0	VL	1.2	2.9	0.8	4	0.8	1.6	VL	2.8	VL	1.6	3.3
Ex Calcium Percent	%	31.5	L	29.1	33.9	2.5	4	2.4	29.1	L	33.3	L	28.0	33.4
Ex Magnesium Percent	%	27.1	H	22.6	31.6	4.6	4	4.5	22.8	H	31.2	H	22.0	31.6
Ex Potassium Percent	%	22.5	H	18.7	26.3	3.9	4	3.8	18.6	H	25.4	H	17.1	25.6
Ex Sodium Percent	%	18.3	H.Sodic	11.2	25.5	7.3	4	7.1	12.0	Sodic	24.6	H.Sodic	9.3	27.2
Ex Aluminium Percent	%	0.6	VL	0.4	0.8	0.2	4	0.2	0.4	VL	0.7	VL	0.3	0.7
Exchangeable Calcium	mg/kg	130.7	*	72.3	189.0	59.6	4	58.4	91.1	*	188.0	*	87.7	218.0
Exchangeable Magnesium	mg/kg	69.2	*	31.5	106.9	38.5	4	37.7	42.8	*	106.7	*	41.4	125.0
Exchangeable Potassium	mg/kg	183.8	*	87.8	279.7	97.9	4	95.9	123.1	*	276.2	*	118.0	329.0
Exchangeable Sodium	mg/kg	77.4	*	63.5	91.2	14.1	4	13.9	67.3	*	91.0	*	66.0	97.8
Exchangeable Aluminium	mg/kg	1.0	*	#NUM!	#NUM!	0.0	4	#NUM!	1.0	*	1.0	*	1.0	1.0
Exchangeable Calcium	meq/100g	0.7	VL	0.4	0.9	0.3	4	0.3	0.5	VL	0.9	VL	0.4	1.1
Exchangeable Magnesium	meq/100g	0.6	L	0.3	0.9	0.3	4	0.3	0.4	L	0.9	L	0.3	1.0
Exchangeable Potassium	meq/100g	0.5	M	0.2	0.7	0.3	4	0.2	0.3	M	0.7	H	0.3	0.8
Exchangeable Sodium	meq/100g	0.3	M	0.3	0.4	0.1	4	0.1	0.3	L	0.4	M	0.3	0.4
Exchangeable Aluminium	meq/100g	0.0	H	#NUM!	#NUM!	0.0	4	#NUM!	0.0	H	0.0	H	0.0	0.0
Calcium/Magnesium Ratio	-	1.2	Low Ca	1.1	1.3	0.1	4	0.1	1.1	*	1.3	*	1.0	1.3
Gravel >2.0mm	%													
Coarse Sand 0.2-2.0mm	%													
Fine Sand 0.02-0.2mm	%													
Silt 0.002-0.02mm	%													
Clay <0.002mm	%													
ADMC	%													
Emerson Aggregate	Class	*	*	*	*	*	*	*	*	*	*	*	*	*
Phosphorus Buffer Index	mg/kg	*	*	*	*	*	*	*	*	*	*	*	*	*

Table B13. Particle Size Distribution Derived by Photogrammetry

Site	Mt Boppy
Project Code	
Date	22/01/2021
Plot ID	TS1 - Gravelly Topsoil
Rocky Specific Gravity (g/cm³)	2.5

$D_{50(20)}$	mm	31
τ_c	Pa	21
Rock Cover	%	43
	% Passing	**Size (mm)**
PSD ex 20mm Particles	0	20
	10	21
	20	24
	30	26
	40	27
	50	31
	60	34
	70	37
	80	42
	90	54
	100	88

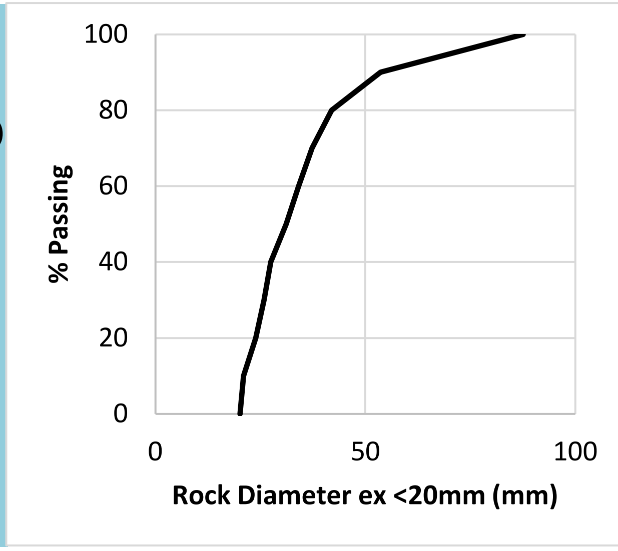


Table B13. Particle Size Distribution Derived by Photogrammetry

Site	Mt Boppy
Project Code	
Date	22/01/2021
Plot ID	TS5 - Gravelly Topsoil
Rocky Specific Gravity (g/cm³)	2.5

$D_{50(20)}$	mm	38
τ_c	Pa	26
Rock Cover	%	64
	% Passing	**Size (mm)**
PSD ex 20mm Particles	0	20
	10	22
	20	25
	30	29
	40	32
	50	38
	60	51
	70	58
	80	76
	90	145
	100	162

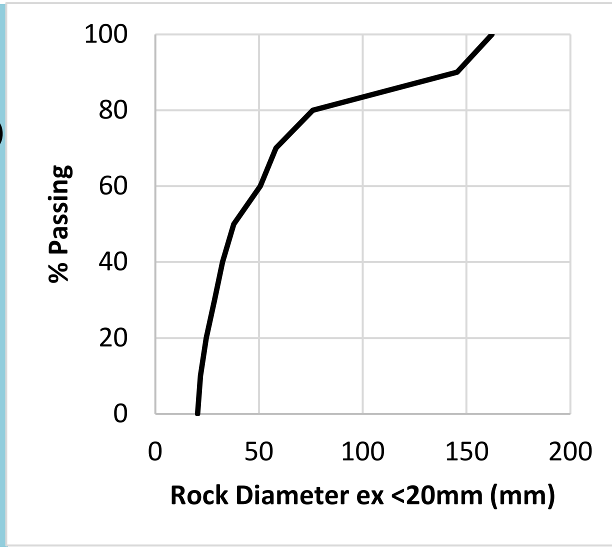


Table B13. Particle Size Distribution Derived by Photogrammetry

Site	Mt Boppy
Project Code	
Date	22/01/2021
Plot ID	TS6 - Gravelly Topsoil
Rocky Specific Gravity (g/cm³)	2.5

$D_{50(20)}$	mm	33
τ_c	Pa	23
Rock Cover	%	66
	% Passing	**Size (mm)**
PSD ex 20mm Particles	0	20
	10	23
	20	26
	30	28
	40	31
	50	33
	60	39
	70	47
	80	76
	90	85
	100	172

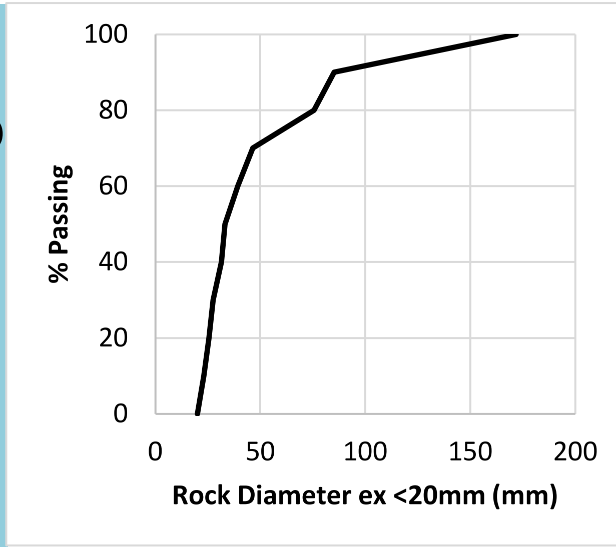


Table B13. Particle Size Distribution Derived by Photogrammetry

Site	Mt Boppy
Project Code	
Date	22/01/2021
Plot ID	TS7 - Gravelly Topsoil
Rocky Specific Gravity (g/cm³)	2.5

$D_{50(20)}$	mm	39
τ_c	Pa	27
Rock Cover	%	75
	% Passing	**Size (mm)**
PSD ex 20mm Particles	0	20
	10	23
	20	27
	30	30
	40	35
	50	39
	60	45
	70	52
	80	66
	90	84
	100	121

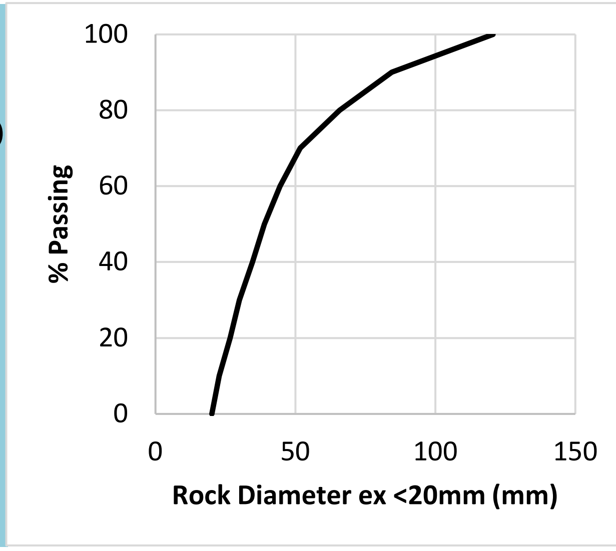


Table B13. Particle Size Distribution Derived by Photogrammetry

Site	Mt Boppy
Project Code	
Date	22/01/2021
Plot ID	WRO1 - Oxidised Waste Rock
Rocky Specific Gravity (g/cm³)	2.5

$D_{50(20)}$	mm	145
τ_c	Pa	100
Rock Cover	%	72
	% Passing	**Size (mm)**
	0	25
	10	58
	20	74
	30	90
PSD ex 20mm Particles	40	113
	50	145
	60	188
	70	227
	80	321
	90	401
	100	539

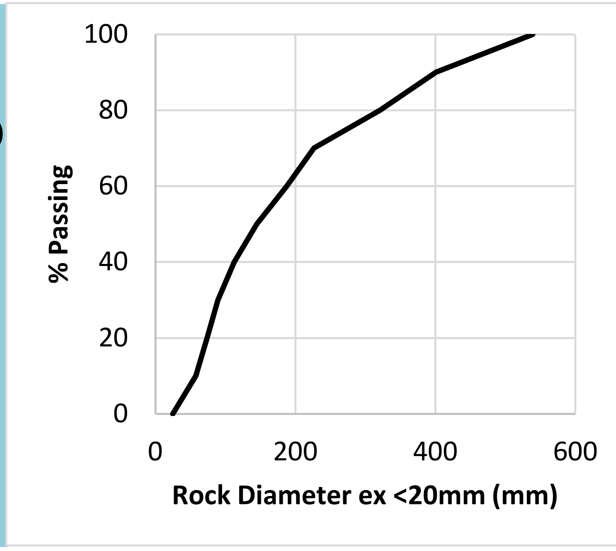


Table B13. Particle Size Distribution Derived by Photogrammetry

Site	Mt Boppy
Project Code	
Date	22/01/2021
Plot ID	WRO3 - Oxidised Waste Rock
Rocky Specific Gravity (g/cm³)	2.5

$D_{50(20)}$	mm	101
τ_c	Pa	69
Rock Cover	%	79
	% Passing	**Size (mm)**
PSD ex 20mm Particles	0	31
	10	48
	20	57
	30	67
	40	86
	50	101
	60	112
	70	159
	80	205
	90	341
	100	386

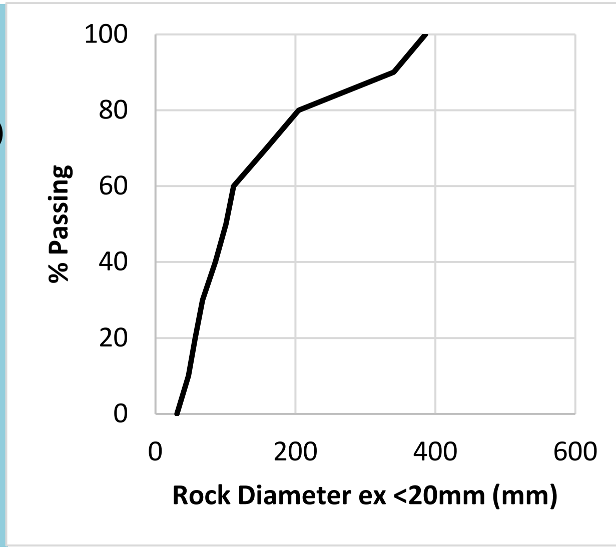


Table B13. Particle Size Distribution Derived by Photogrammetry

Site	Mt Boppy
Project Code	
Date	22/01/2021
Plot ID	WRO6 - Oxidised Waste Rock
Rocky Specific Gravity (g/cm³)	2.5

$D_{50(20)}$	mm	49
τ_c	Pa	34
Rock Cover	%	64
	% Passing	**Size (mm)**
	0	20
	10	23
	20	26
	30	33
PSD	40	39
ex 20mm	50	49
Particles	60	57
	70	70
	80	92
	90	126
	100	200

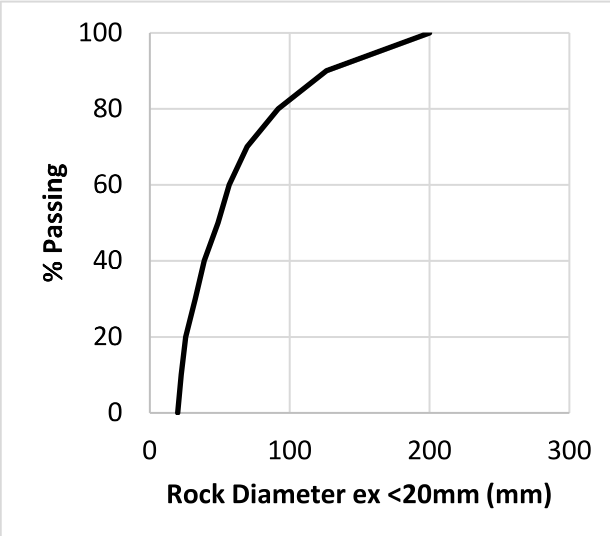
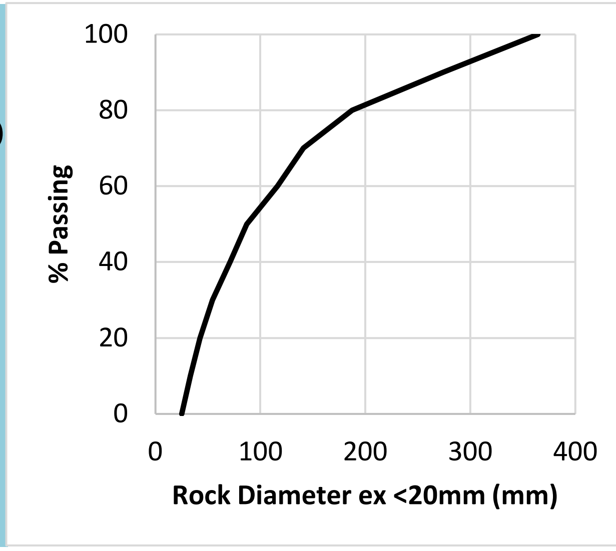


Table B13. Particle Size Distribution Derived by Photogrammetry

Site	Mt Boppy
Project Code	
Date	22/01/2021
Plot ID	WRO8 - Oxidised Waste Rock
Rocky Specific Gravity (g/cm³)	2.5

$D_{50(20)}$	mm	87
τ_c	Pa	60
Rock Cover	%	81
	% Passing	**Size (mm)**
	0	25
	10	33
	20	42
	30	54
PSD	40	71
ex 20mm	50	87
Particles	60	116
	70	141
	80	188
	90	275
	100	364



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Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation

Erodibility Testing and Modelling Report

March 2021

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Client: Manuka Resources Ltd.

Review History

Version Number	Prepared by:	Reviewed by:	Date
Draft A	Simon Buchanan	C Shorthouse	29 Mar 2021
Draft B	Simon Buchanan	Rob Loch	30 Mar 2021
Rev 0	Simon Buchanan		31 Mar 2021

TABLE OF CONTENTS

1 INTRODUCTION

Manuka Resources engaged Landloch to provide technical design support for the rehabilitation for closure of Mount Boppy Gold Mine (the Mine). Specifically, landform designs are required for a stable waste rock emplacement (WRE) and tailings storage facility (TSF) to be capable of supporting vegetation and the designated post mining land uses.

The purpose of this Erodibility Testing and Modelling Program is to provide criteria for adoption in the design of rehabilitated emplacement areas at the Mine. It details the laboratory-based erodibility testing on bulk samples of two materials. Test data were used to derive input parameters for the erosion modelling and to develop the design criteria.

1.1 Project Description

Mount Boppy Resources Pty Ltd is a wholly owned subsidiary of Manuka Resources Ltd, and took control of the Mine in 2019. The mining complex at Mount Boppy has grown through a process of expansions and acquisitions since underground mining initially commenced in 1901. Open-cut mining activities, including the current open-cut void commenced at the Mine in 2002 (R.W Corkery & Co, 2020).

The general arrangement of the Mine is provided in Figure A1 (Appendix A).

1.2 Scope of Work

The scope of work involved the following:

i. Characterisation of materials as growth media that have been identified for use in rehabilitation.

ii. Collection of bulk samples of two different materials that could potentially be used as primary growth media for the rehabilitation of WRE and TSF. These materials were described and detailed in the report titled *Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation. Material Characterisation Program for Rehabilitation,* (Landloch, 2021).

iii. Erodibility testing of the bulk samples. Replicate test plots and flumes were prepared and subjected to simulated rain and overland flows.

iv. Characterisation of settling velocity distributions of sediment derived from the rainfall simulation plots.

v. Derivation of parameters for erodibility and sediment data to be used as site specific inputs for erosion modelling.

vi. Erosion modelling on representative slopes and slope conditions for each material.

vii. Development of design criteria for use in the landform design process.

2 METHODOLOGY

2.1 Bulk Sample Collection

Bulk samples of two materials were collected for detailed erodibility testing. Materials were recovered with an excavator and placed in flexible intermediate bulk containers (bulka bags) by the Mine. The volume of each bulk sample was approximately 1 m^3. Materials were freighted to Landloch's Erosion Testing Facility in Toowoomba, Queensland for processing.

2.2 Erodibility Testing

Measurements were made using simulated rain and overland flows to enable derivation of erodibility parameters for the Water Erosion Prediction Project (WEPP) runoff/erosion model (Flanagan and Livingston 1995).

2.2.1 Rainfall simulation

The rainfall simulator used is of the design described by Loch *et al.* (2001), and applies simulated rain with a kinetic energy equivalent to that of natural rainfall at intensities >40 mm/h. As the simulated rain study is used to derive infiltration and interrill erosion parameters, the actual intensity applied does not affect the parameters obtained, provided it is sufficient to cause runoff, and has appropriate kinetic energy.

Triplicate plots 0.75 m square and 0.2 m deep were packed, compacted, and subjected to multiple wetting/drying cycles to ensure the test sample was consistent with soil that had consolidated naturally under rainfall.

The gradient of the plots was set at 20 % and simulated rain was applied for a period sufficient for the samples to reach steady infiltration/runoff rates. Runoff generated by simulated rain was sampled at regular intervals, and sediment concentrations were measured gravimetrically. Samples of the rain-wet surface were taken, when simulated rain stopped, for measurement of sediment settling velocity distributions using an automated settling column (Loch 2001).

The simulator uses rainwater in all tests to avoid any potential impacts of water quality on infiltration and on the disaggregation of sediment to finer sizes.

2.2.2 Overland flows

Studies of rill erodibility used flumes 2 m long, and 0.4 m wide. For all materials, three flumes were run, set at various gradients, ensuring that a wide range of flow tractive force was applied. In all cases, samples were packed, compacted, and subjected to multiple wetting/drying cycles to ensure the test sample was consistent with soil that had consolidated naturally under rainfall. For each flume, a range of flow rates and flow tractive forces was applied and sediment concentrations were measured at each different flow rate.

2.2.3 WEPP parameter derivation

Erodibility parameters required for the WEPP model are K_i (interrill erodibility), K_R (rill erodibility), and τ_c (critical shear for rill initiation). These parameters are used to predict changes in erosion processes and rates in response to changes in runoff, slope length, and land management. Also important are the Hydraulic Conductivity parameter (K_e) used in the model to predict runoff, and sediment settling velocity distributions, used to define the transportability of the eroded sediment.

2.3 Erosion Modelling

Two erosion models are involved in preparing the rehabilitated landform design for the Mine –

1. WEPP runoff/erosion model (Flanagan and Livingston 1995); and
2. SIBERIA landform evolution model (Willgoose *et al.* 1989).

Results of the WEPP erosion modelling study are reported in this document. Landloch will apply the SIBERIA model in a subsequent study once the landform design has been reviewed against the findings from this study.

The two models have extremely different structures and functions, and are selected for quite different purposes. This component of the landform development work focuses solely on derivation of WEPP parameters and the use of WEPP to derive landform design criteria.

The WEPP model effectively considers runoff and erosion on 2-dimensional batter slopes. It was developed by the United States Department of Agriculture (USDA) to predict runoff, erosion, and deposition for hillslopes and watersheds. It is a simulation model with a daily input time step, but internal calculations use sub-daily rainfall data (storm data) when predicting runoff and erosion for days on which rainfall occurs.

As a primary planning tool, WEPP has a number of advantages, including the ability to:

- Derive accurate erodibility parameters from laboratory or field erosion studies;
- Consider site-specific climate (typically using a 100-year synthetic file based on local data);
- Rapidly assess and compare a wide range of slope gradients, profile shapes, slope lengths, materials (soils), and surface vegetation cover;
- Provide erosion and runoff predictions at a range of time scales, from long term averages, daily data, or averages for specified periods or seasons; and
- Provide predictions of erosion rates at 100 points along a slope length, rather than simply averaging erosion rates over the entire slope length.

3 SITE SETTING

Relevant site setting details for erodibility testing of materials at the Mine follow.

3.1 Climate

The Study Area is situated in a persistently dry semi-arid climatic zone with hot summers and cool to mild winters.

Average monthly maximum temperatures in winter tend to range from 13°C to 20°C, and from 28°C to 39°C in summer (BoM, 2020). Summer temperatures can exceed 40°C for short periods.

Average monthly minimum temperatures in winter tend to range from 2°C to 8°C and from 14°C to 24°C in summer (BoM, 2020). Frosts are frequent through winter (NSW National Parks and Wildlife Service, 2003).

Rainfall is relatively uniformly distributed throughout the year, with a median annual rainfall for Cobar of 390 mm. However, rainfall can be extremely variable in late spring and early summer when the highest observed falls have been more than 200 mm in any one month.

Average evaporation exceeds the average rainfall throughout the year (NSW National Parks and Wildlife Service, 2003).

The annual rainfall erosivity (R-factor) for the region is 820 MJ.mm/ha.h.y (Yang, Chapman, Zhu, Tulau, & McInnes-Clarke, 2017). Values for monthly R-factors and erosivity ratings are provided in Table 1, and based on criteria presented in *Soils and Construction – Managing Urban Stormwater* (Landcom, 2004). The rainfall erosivity rating is *low* over summer and *low* or *very low* for the remainder of the year.

Table 1. Monthly rainfall and erosivity R-factor and rating for Cobar (Bureau of Meteorology, 2020).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	44	42.3	35	27.4	32.3	28.9	27.5	26.2	24.6	33.3	35.1	34.8
R Factor	93	89	74	58	68	61	58	55	52	70	74	73
Rating	L	L	L	VL	L	L	VL	VL	VL	L	L	L

Notes: Very low (VL), Low (L)

3.2 Post Mining Landforms and Land Uses

The post mining landforms and land uses are detailed in the *Mount Boppy Mining Operations Plan* (MOP) (R.W Corkery & Co, 2020). Details of relevant features are -

- The final landforms aim to provide a stable and non-polluting landform that are compatible with the surrounding landscape and suitable for the proposed final land use. The final landforms will also include any drainage structures needed for the area (R.W Corkery & Co, 2020).
- Post-mining land uses for the plateau of the TSF and WRE will predominantly be native vegetation communities suitable for intermittent and very low intensity grazing, and native conservation (Rural Land Capability Class VI). The batters of the WRE and TSF will be rehabilitated with native vegetation and have a post-mining land use of passive nature conservation (Rural Land Capability Class VII) (R.W Corkery & Co, 2020).

Final landform details and post-mining land uses for the WRE and TSF are provided in the Table 2.

Table 2. Summary of landform details provided in the MOP for relevant domains (R.W Corkery & Co, 2020).

Locality	Final Landform Details	Post-Mining Land Use
TSF	Relief approximately 15 m to 20 m. Plateau gradient no greater than 3 %. Batter gradients typically 30 % to 35 %. PAF material will be paddock dumped over the existing tailings surface in piles approximately 3 m high. These will be pushed out by a bulldozer to compact and push into the tailings surface and lime added at a conservative rate of 30 t/ha. A clay liner will then be compacted over the PAF material to a minimum depth of 0.9 m and with a permeability of 1 x 10^{-9} m/s. NAF material will then be paddock dumped and dozer profiled to create a minimum 2 m thick store and release cover. The profiled surface will be free-draining with appropriate water management structures.	Plateau LCC VI - (grazing and nature conservation) Batters LCC VII (nature conservation)
WRE	Relief approximately 20 m. Plateau gradient no greater than 3 %. Batters to consist of two lifts of approximately 10 m height - • Lower lift gradients typically 30 % to 35%. • Upper lift gradients approximately 65 %. The WRE will be progressively constructed through paddock dumping of NAF material and profiling using a bulldozer. Specially designed PAF encapsulation areas within the WRE will be similarly formed through paddock dumping of a base layer of NAF material to a minimum thickness of 3 m. The NAF material will be selected to provide good drainage beneath the WRE such that the PAF material is not subject wetting and drying cycles. PAF material will be built up in lifts to a maximum of approximately 15 m thickness with NAF material used to form the batters of the WRE. The areas of PAF encapsulation will be progressively limed, clay capped and covered with NAF.	Plateau LCC VI - (grazing and nature conservation) Batters LCC VII (nature conservation)

3.3 Revegetation Methodology

A summary of the revegetation methodology outlined in the MOP (R.W Corkery & Co, 2020) is provided below.

- Growth medium will be developed by placing oxidised overburden, subsoil and available topsoil on the final landform to prepare the surface for revegetation.

Soil preparation may include ameliorant application (e.g. gypsum / lime) and ripping or scarifying the surface.

- Rehabilitation trials and monitoring completed to date indicate that planting of tube stock at the Mine has limited success. Therefore, revegetation will be undertaken by either direct or mechanical seeding. Seeding will be completed as soon as practicable after placement of soil material / growth medium and before the surface forms a crust to achieve an optimal surface microhabitat (R.W Corkery & Co, 2020).
- Direct seeding lines for tree species will be spaced a minimum of 6 m apart on flat areas and 8 m on slopes to provide sufficient space for establishment and maintenance of groundcover species. Seeding rates will need to be high due to potential impact of grazing animals and will be approximately 1.5 kg/ha (R.W Corkery & Co, 2020).
- An alternate option is to place seed directly into contour rip lines where moisture will be captured (Knop, 2009), and has the benefit if using water more efficiently.

3.4 Representative Slopes

Representative slopes were prepared to determine appropriate gradient and slope length values for use as WEPP model inputs. The Mine provided computer aided drawing (CAD) files of the conceptual final landform for the WRE (as of January 2021). A digital elevation model (DEM) of the TSF was prepared by Landloch based on elevation LIDAR data captured by the Mine in November 2020.

A total of three transects were selected and described to represent the range of batter conditions on the landform. Details are provided in Table 1 and Figures 1 to 4.

Table 3. Details of representative slopes used for WEPP model input.

Transect	Slope shape	Details
WRE Batter	Complex of linear sections	Relief 22 m and horizontal length 90 m. Includes a: • Crest bund 1.5 m high with an external gradient of 33 %; leading onto an • Upper batter section at 65 % gradient with 10 m relief; leading on to a • Horizontal bench 5 m wide; leading to a • Lower batter section at 33 % gradient with 10 m relief.
TSF Batter	Simple near-linear slope	Relief 14 m and horizontal length 45 m.
Plateau	Simple near-linear slope	Relief 9 m, horizontal length 300 m, and gradient 3 %.

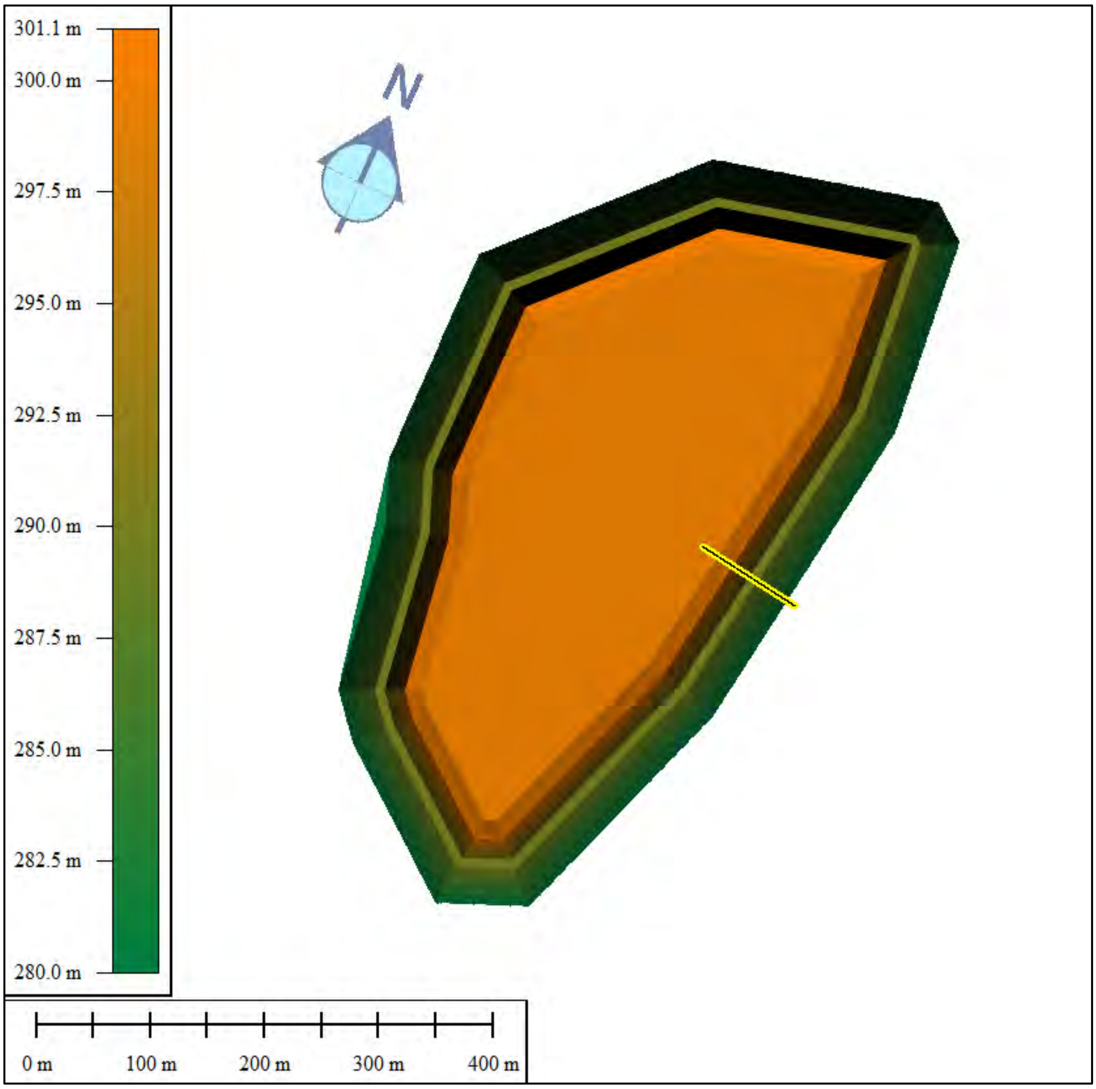

Figure 1. Conceptual final landform for the WRE. Representative slope/transect is indicated by the yellow line.

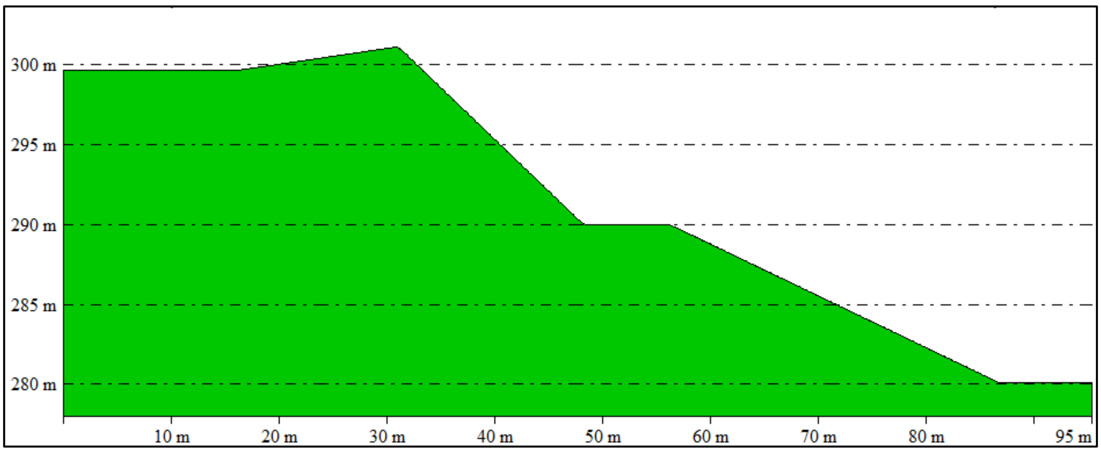

Figure 2. Representative transect of the WRE batter It includes a 1.5 m high crest bund with an external gradient of 33 %; leading onto the upper lift of 10 m with 65 % gradient; leading to 5 m wide horizontal bench then leading to a lower lift of 10 m at 33 % gradient.

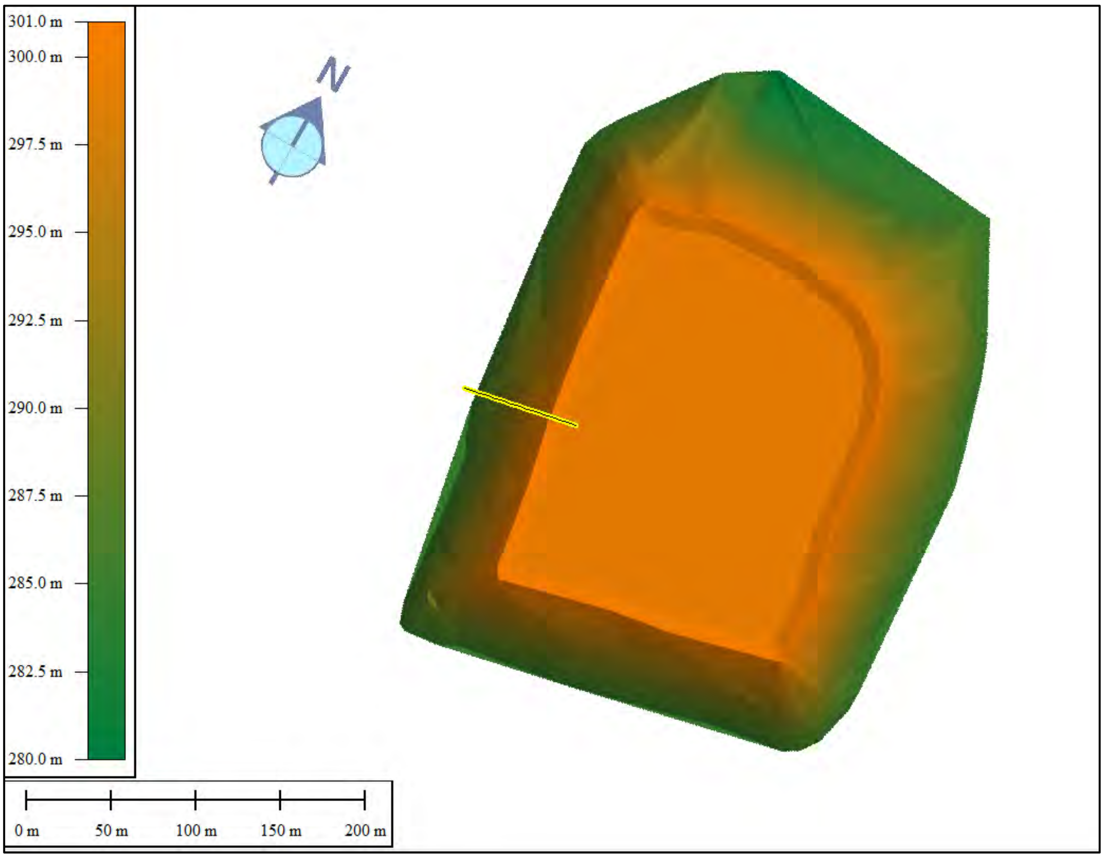

Figure 3. Conceptual final landform for the TSF. Representative slope/transect is indicated by the yellow line.

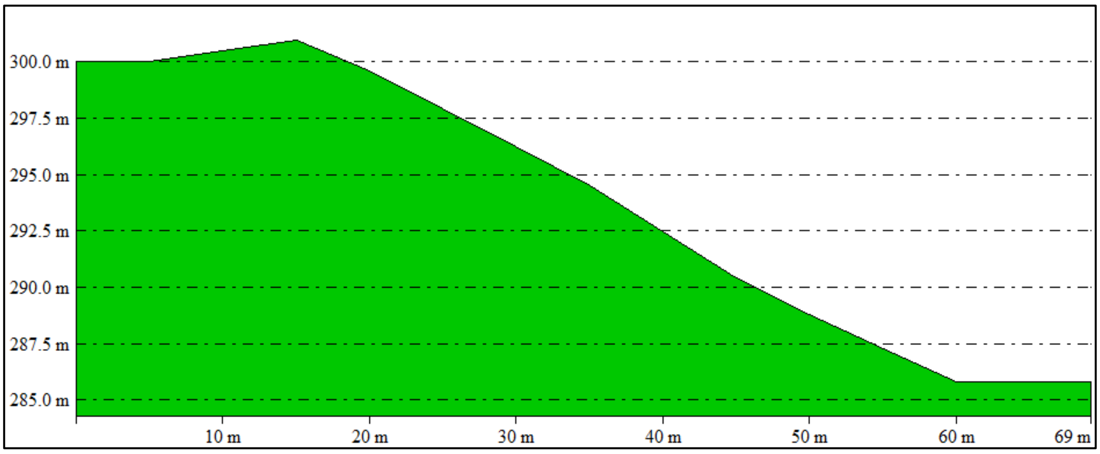

Figure 4. Representative transect of the TSF batter. The plateau includes a 1.5 m high crest bund with an external gradient of 10 % leading onto a linear slope of 14 m at 33.5 % gradient.

4 MATERIALS TESTED

The two materials tested were Gravelly Topsoil and Waste Rock Oxide.

Material selection is detailed in the report titled *Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation. Material Characterisation Program for Rehabilitation,* (Landloch, 2021)

Relevant details from that report on the properties of Gravelly Topsoil and Waste Rock Oxide are provided below. Laboratory data are presented in Appendix B, and photographs of each test plot are presented in Appendix C.

4.1 Gravelly Topsoil

Gravelly Topsoil is brown, moderately gravelly, sandy clay loam with coarse fragment content generally 40–60 % and less than 60 mm in diameter.

The key physicochemical properties are:

- Mildly acidic pH;
- Very low salinity;
- Non-sodic but slightly dispersive;
- Low to very low cation exchange capacity and ability to retain nutrients;
- Low levels of organic matter, nitrogen, and calcium;
- Moderate levels of phosphorous, potassium, sulfur and magnesium;
- Clay and silt content approximately 10-15 % and 5-10 %, respectively;
- Coarse fragment sizing d_{50} and d_{90} of armoured surface of is 30–40 mm and 80 mm, respectively; and
- Surface coverage of gravel and rock is 45-75 %.

Photographs 1 and 2 show representative Gravelly Topsoils. In a naturally weathered condition the surface coverage of gravel and rock is 45-75 % (Landloch 2020).

Photographs 3 and 4 show stockpiles of the Gravelly Topsoil supporting vegetation that is understood to have been recruited naturally. Groundcover on these stockpiles, defined as surface contact from vegetation (green matter and leaf litter), was typically less than 50 % and commonly less than 25 %.

Photograph 1. Gravelly Topsoil stockpile in an armored condition from rainfall. Rock coverage of armored surface is 45–75 %.

Photograph 2. Gravelly Topsoil stockpile newly disturbed.

	
Photograph 3. Vegetation on batter of a Gravelly Topsoil stockpile provides less than 25 % groundcover (surface contact) from vegetation. Plants included tussock grasses and forbes.	**Photograph 4**. Vegetation on another site of the Gravelly Topsoil stockpiled materials. Plants consisted of shrubs that provided less than 50 % groundcover (surface contact) from vegetation.

4.2 Waste Rock (Weathered) Oxide

Waste Rock Oxide is rocky material with loamy sand textured fines. Key physicochemical properties are:

- Mild to moderate alkalinity with mean pH 7.9 and typical range 7.5–8.3;
- Salinity is generally low, however sometimes high, but not extreme;
- Highly sodic and sometimes slightly dispersive;
- Very low cation exchange capacity and ability to retain nutrients;
- Very low levels of organic matter, nitrogen, potassium, magnesium, and calcium;
- Moderate to high levels of phosphorous and sulfur;
- Clay and silt content is approximately 5 % and 5 %, respectively;
- Coarse fragment sizing d_{50} and d_{90} of armoured surface of is 50–100 mm and 200–300 mm, respectively; and
- Surface coverage of gravel and rock is 65-80 %.

Photographs 5 and 6 show representative Waste Rock Oxides. In a naturally weathered condition the surface coverage of gravel and rock is 65-80 % (Landloch 2021).

Photographs 7 and 8 show the rehabilitation trial on the batters of the TSF, where vegetation is growing directly in Waste Rock Oxide. It is understood the vegetation was recruited naturally, and on these batters the groundcover was typically > 80 %.

	
Photograph 5. Waste Rock Oxide material in an armored condition from rainfall.	**Photograph 6.** Waste Rock Oxide material newly disturbed.

	
Photograph 7. Rehabilitated Waste Rock Oxide with vegetation and in an armored condition from rainfall.	**Photograph 8.** Rehabilitated Waste Rock Oxide batter. Plants consisted of grasses, forbs, and shrubs that provided more than 80 % groundcover (surface contact) from vegetation.

4.3 Existing Rehabilitation Trials

Existing rehabilitation trials are underway on the TSF batters and on a portion of the eastern batter on the WRE. Details are provided below.

4.3.1 Gravelly Topsoil - WRE batter

A rehabilitation trial on the WRE was established circa 1995. The batter relief is approximately 20 m with slope lengths of 65 m. Batter shape is linear with a gradient of 35 % (Figure 5).

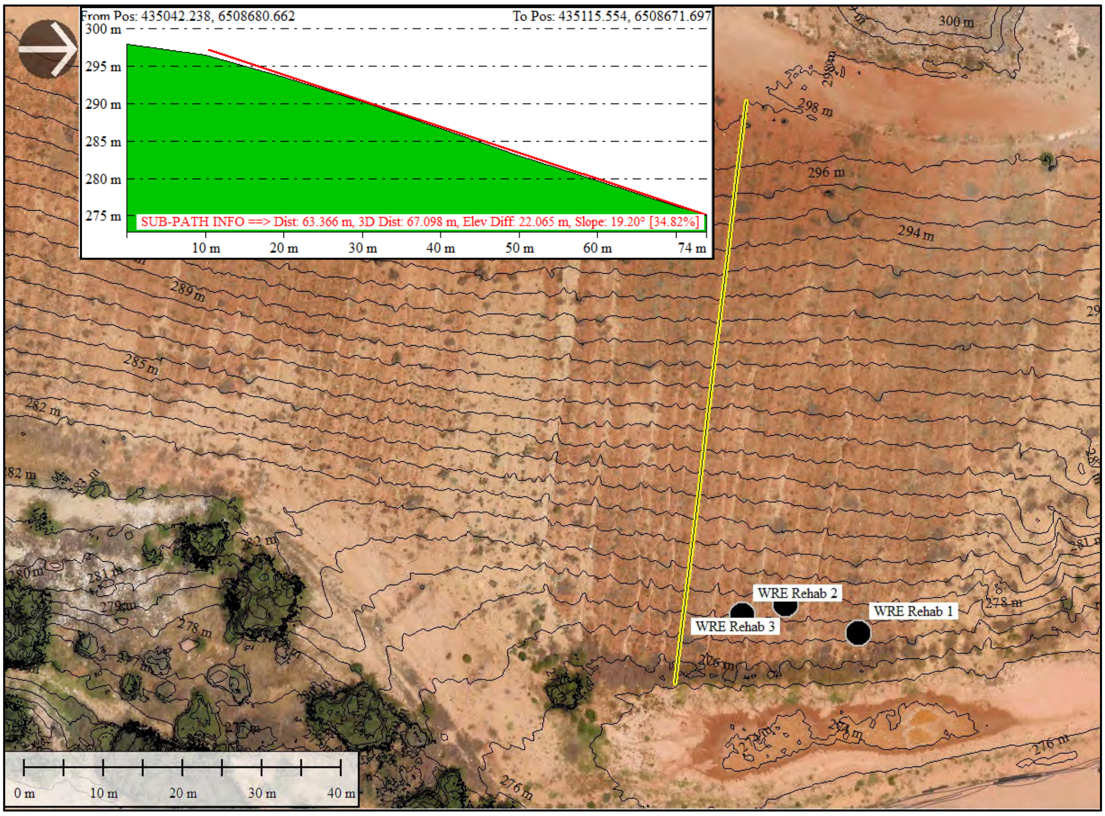

Figure 5. Insert: Typical cross section of rehabilitated batter on WRE. Relief 20 m, near-linear slope at 35 %, approximately 65 m in length.

The ground surface contained excessive rilling with spacing generally of 1–3 m. The depth of rill incision was limited by the underlying waste rock materials, typically 0.1–0.25 m below ground surface (Photographs 9 and 10).

Vegetation cover on interrill areas was 60–80 %, with a surface coarse fragment content of 20–40 %.

Photograph 9. Rill at Site WRE Rehab 1. Depth approximately 0.25 m, width is 0.15 - 0.5 m.

Photograph 10. Rill spacing at Site WRE Rehab 2 was approximately 2 m.

4.3.2 Waste Rock Oxide – Tailings dam batters

The rehabilitation trial on the tailings dam batters is understood to have been established in the 1990s. The batter relief is approximately 10–15 m with slopes 30–35 m long. Batter shape is near linear with both slightly concave and slightly convex sections at gradients of 35–40 % (Figure 6).

The batter was formed from waste rock oxide materials that had been cross ripped along the contour, as evidenced by scarring. The surface condition was firm with an armoured surface of 50-90 % rocky fragments < 200 mm in diameter.

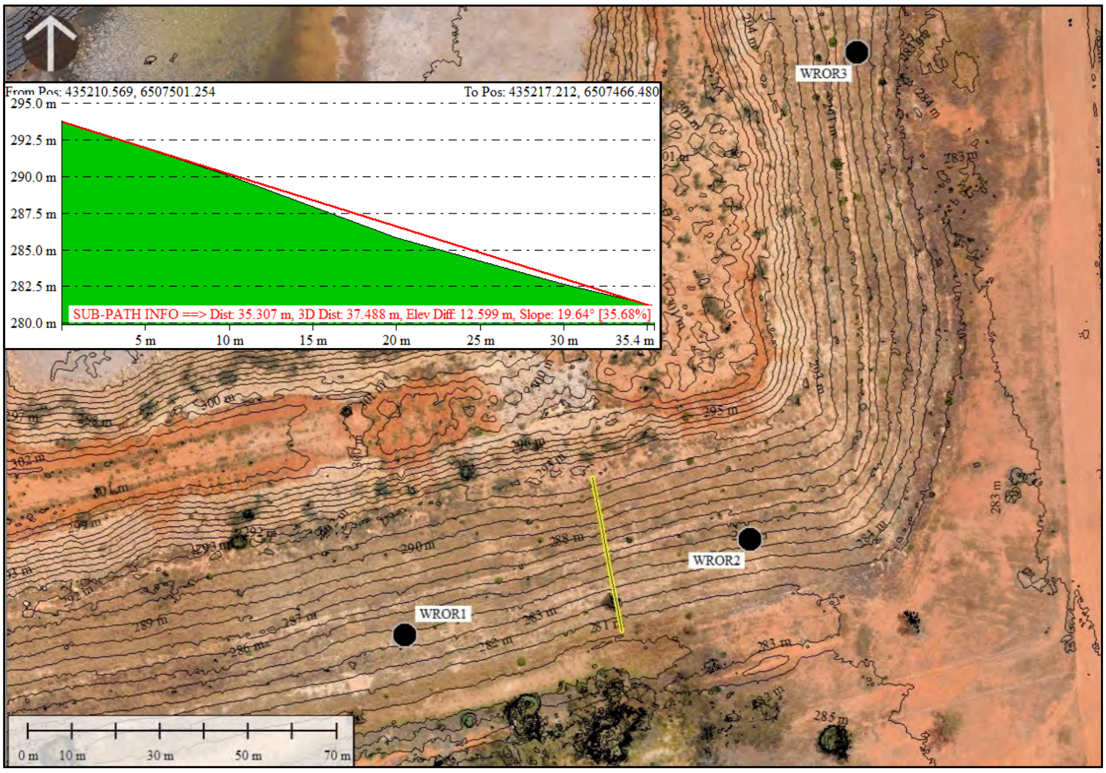

Figure 6. Typical cross section of TSF batter. Relief 10–15 m, near-linear slope at 35-40 %, approximately 35 m long.

Ground cover was generally 80–100 %, consisting of grasses and forbs with a green to dry matter ratio of approximately 1:1. Laboratory data indicate that, compared to stockpiled Waste Rock Oxide materials, no fertiliser, gypsum, or other amendments have been added to the Waste Rock Oxide on these batters.

The batter appears to be successful in providing a stable and non-polluting surface.

Photograph 11. Appreciable rock content of 50–90 % in the armored surface of the TSF (Site WROR2).

Photograph 12. View of batter on the TSF with vegetation growing directly in the Waste Rock Oxide materials (Site WROR2). Groundcover was 80-100 %.

5 SOIL LOSS TARGETS

This study used runoff and erosion modelling to identify landform options that would erode at rates low enough to provide long-term stability. Effectively, the landforms are planned to be consistent with tolerable rates of soil loss. Wischmeier and Smith (1978) defined tolerable soil loss for cropland as "*the maximum rate of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely.*"

A value of 11.2 t/ha/y averaged over an area of interest is often cited as a tolerable soil loss rate. However, that value was derived by US soil conservation agencies for deep, fertile cultivated soils, and has little relevance to most rehabilitated minesites. Using similar criteria to those applied for cropping land, a lower soil loss tolerance value of 4.5 t/ha/y was developed by US agencies for erosion of rangeland soils and shallow cultivated soils (Wight and Siddoway 1979).

Lower tolerance values are relevant to rangeland and minesite situations, as not only are the soils shallower and more susceptible to fertility decline, but the lack of regular tillage or disturbance means that any rills or points of scour that form are more likely to extend and develop into gullies over time. These are typically of concern for minesite landforms where there is no bedrock layer at depth to limit long-term deepening of rill features.

A key priority in setting a tolerable erosion target is the prevention of significant rill or gully development. On that basis, for slopes where long-term erosion risk (for a range of reasons) is considered low, then a mean average erosion rate for the whole slope of 5 t/ha/y and a mean maximum rate at any one point on the slope of 10 t/ha/y has commonly been applied by Landloch. Typically, the *low risk* category includes slopes where:

- The material underlying the topsoil layer is not dispersive and unlikely to be more erodible than the surface layer if exposed.
- Establishment of vigorous and sustainable vegetation is considered to be readily achievable.
- Rainfall in the area and soil fertility/productivity are such that there is a reasonable probability of vegetation stabilising any rills that form during rehabilitation establishment[1].
- The overall landform height is less than 50 m.

The erosion hazard is considered higher on slopes with criterion outside any of the above factors. In such situations a mean maximum erosion rate of 5 t/ha/y at any point on a batter slope[2] was used by Landloch in planning hazardous slopes on minesite landforms, on the basis that - at that value - rilling is largely if not completely absent. A similar approach using a risk assessment to determine target rates for both average and maximum erosion rates on slopes was outlined by Howard and Loch (2019).

In this instance, given that the semi-arid climate grazing by fauna and exotic animals (e.g. goats) will result in low levels of groundcover for extended periods, the target soil loss criterion applied is:

- a mean *average* erosion rate *for the whole slope* of 5 t/ha/y; and
- a mean *maximum* erosion rate *at any one point on the slope* of 10 t/ha/y.

6 ERODIBILITY PARAMETERS

Rainfall simulation and overland flow tests were performed on Gravelly Topsoil and Waste Rock Oxide to derive erodibility parameters for use as site specific input data for erosion modelling. Photographs of the test plots are provided in Appendix C.

Erodibility parameters varied for the Gravelly Topsoil and Waste Rock Oxide, as would be expected. The key parameters of materials considered in erosion modelling are provided in Table 4 and described below:

- Critical shear - the value above which a rapid increase in soil detachment per unit increase in shear stress occurs.
- Interrill erodibility - a measure of the soil resistance to detachment by raindrop impact.
- Rill erodibility - a measure of the soil resistance to detachment by concentrated rill flow. It is the increase in soil detachment per unit increase in shear stress of the flow.
- Steady infiltration rate – directly influences runoff rate. Runoff occurs once the rainfall intensity exceeds infiltration rate.

---

[1] This would be assessed on the basis of observations of colonisation of bare areas in existing rehabilitation with similar topsoil and subsoil.

[2] Typically, on linear batter profiles, erosion rates increase with slope length as detachment and transport by overland flow increase with increasing flow volumes.

- Surface roughness – relates to the micro-relief of the ground surface and any long lasting relief (e.g. crests and trough) formed by tillage or ripping.
- Soil analytical data on particle size analysis, cation exchange capacity, exchangeable sodium percentage, and soil aggregate stability to rapid wetting.

Table 4. Key input parameters of materials considered in erosion modelling.

Parameter		Gravelly Topsoil	Waste Rock Oxide
Clay	%	25.3	20.8
Silt	%	8.7	8.5
Sand	%	53.2	47.9
Coarse Fragments	%	12.7	22.8
Cation Exchange Capacity	meq/100g	4.3	5.2
Exchangeable sodium percentage	%	4.2	15.4
Aggregate stability	-	Slightly dispersive	Sometimes slightly dispersive
Steady Infiltration Rate	mm/hr	26.1	18.9
Critical Shear	Pa	8.7	2.5
Interrill erodibility	$Kg.s/m^4$	908,569	571,547
Rill erodibility	s/m	0.020	0.002
Surface Roughness	mm	30	70

7 EROSION SIMULATIONS

Simulations were carried out to:

1. Assess erosion potential of each material at differing levels of cover (0, 30 %, 50 %, and 70 %); and
2. Evaluate the rates of erosion and deposition on representative batters of the WRE and TSF.

All simulations used a 100-year climate file prepared for Cobar, NSW.

For each material, measured erodibility parameters and measured sediment equivalent sand size distributions were inputs to WEPP modelling.

7.1 Comparison of Bare Materials

For bare materials, rill spacing (across slope) was set at 4 m to simulate a moderate to well-formed batter surface with a low degree of micro-relief that does not concentrate flows. Higher input values for surface roughness were applied to the Waste Rock Oxide materials, as roughness was observed to persist in the rockier material (Section 4.3.2).

The predicted mean *maximum* erosion rates for the Gravelly Topsoil and Waste Rock Oxide materials on TSF batters for the bare surface (i.e. 0 % vegetation cover) were 460 t/ha/y and 120 t/ha/y, respectively. Similar, but slightly higher values, were predicted for the WRE batters with no vegetation cover.

Comparison of predicted erosion rates for a bare surface demonstrates how the different material parameters influence erosion (Figure 7). The lower *critical shear* of the Waste Rock Oxide is evidenced by the higher erosion rate within the first few metres of the crest of the batter where runoff occurs as shallow sheet flows. However, further down the batter where runoff begins to converge and form rills, the lower *rill erodibility* of Waste Rock Oxide results in less detachment of particles and lower rates of erosion compared to the Gravelly Topsoil materials.

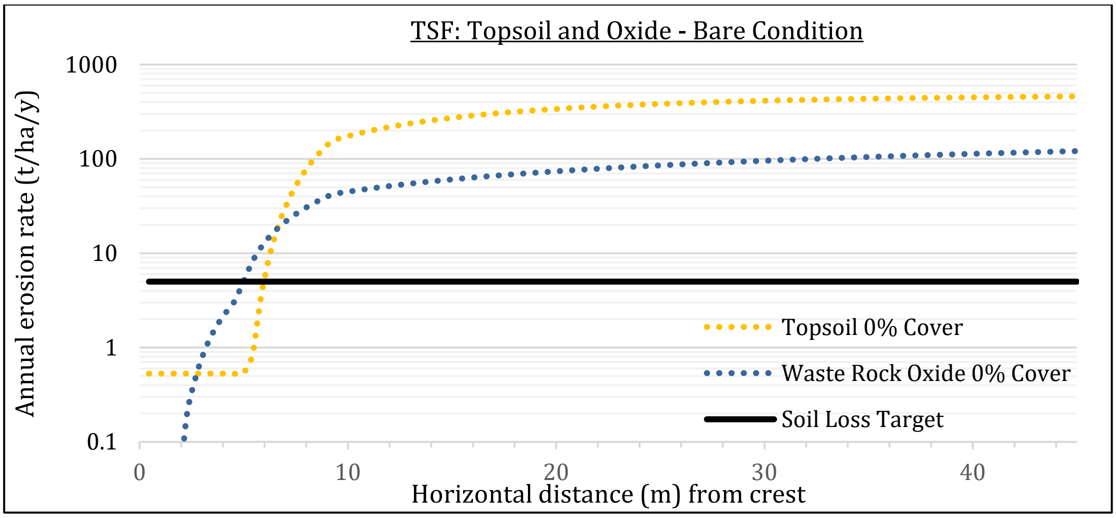

Figure 7. Predicted rates of erosion for bare materials on batter slopes of 33.5 % gradient for the Gravelly Topsoil and Waste Rock Oxide materials.

7.2 Impacts of Surface Vegetative Cover

The high rates of erosion shown for bare soils indicates that vegetation, and in particular surface vegetative cover such as grasses and forbs, will be an essential component of site stabilisation. Consequently, the simulations considered potential surface vegetative cover impacts in some detail. Overall, the simulations considered four surface vegetative cover conditions:

- Bare (0 % surface vegetative cover);
- 30 % surface vegetative cover;
- 50 % surface vegetative cover; and
- 70 % surface vegetative cover.

The levels of established and maintained surface vegetative cover were adopted based on site observations during soil sampling. Areas supporting vegetation had groundcover levels typically varying from 30 % to greater than 90 % (Landloch, 2021). The 30 % surface vegetative cover level was included as a reference of "poor to moderate" revegetation success for the region.

In terms of target ecosystems and their management, it should be noted that a major requirement for stability of batter slopes is to maintain the necessary level of surface vegetative cover.

7.2.1 Impacts from surface vegetation cover

The specific impacts of increased surface vegetation cover are:

- Increases in infiltration - resulting in lower run-off rates;
- Reductions in rill spacing due to greater root development - effectively decreasing the degree of cross-slope concentration of overland flows; and
- Protection of the surface from drop impacts and flow energy.

To simulate varying levels of surface vegetation cover:

- WEPP hydraulic conductivity parameter (K_e) was modified to account for impacts of cover on steady infiltration rates, as shown by rangeland research (Kato *et al.* 2009). Effectively, a steady infiltration rate generally increases by 7–10 mm/h for each 10 % increase in surface vegetation cover. As a conservative measure, steady infiltration was increased by 6 mm/h for every 10 % increase in surface vegetation cover.
- Rill spacing (degree of flow concentration across slope) was modified so that flows were less concentrated as surface vegetation cover increased. Adopted rill spacing values were 4 m, 3m, 2 m, and 1 m for cover levels of 0 %, 30 %, 50 % and 70 %, respectively.
- Cover (C) factors for the Revised Universal Soil Loss Equation (RUSLE) (Renard *et al.* 1997) were derived from reported values for rangeland surface vegetation cover published by the NSW Soil Conservation Service (NSW SCS, 1993).

7.2.2 Predicted runoff and erosion under surface vegetative cover

For both materials, WEPP simulations for representative batters of the WRE and TSF showed large reductions in predicted erosion, in response to surface vegetative cover (Figures 8–13). Reductions in annual runoff were significant factors in the reduction in predicted erosion. In all simulations, runoff was only produced in years when large rainfall events occurred.

Plateaus

Predicted erosion rates on the plateau were very low for both materials, even at low levels of cover (Figure 8). For cover levels of 30 % the erosion rate was no greater than 2.5 t/ha/y for either material, and well below the adopted soil loss target of 5 t/ha/y.

In the bare condition, the maximum erosion rate for Gravelly Topsoil material exceeded the soil loss target once (horizontal) slope lengths exceeded 120 m. The maximum erosion rate for the Gravelly Topsoil of 10–11 t/ha/y occurred at a (horizontal) slope length of approximately 200 m from the crest.

The maximum erosion rate for the Waste Rock Oxide in a bare condition was very low at 2.1 t/ha.y.

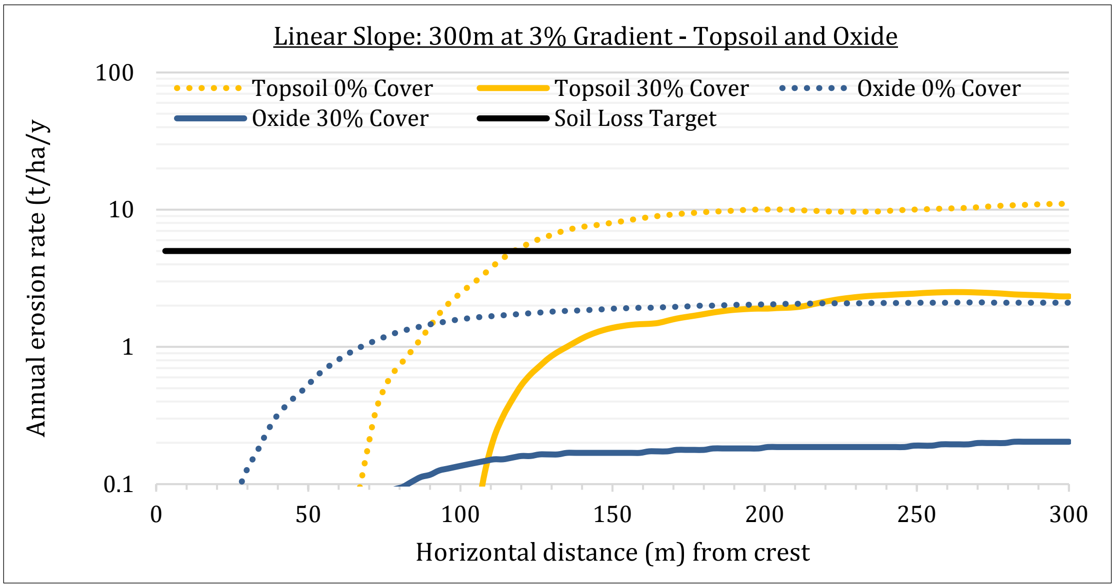

Figure 8. Predicted rates of erosion on plateaus of the TSF and WRE. Results for Gravelly Topsoil and Waste Rock Oxide materials are presented for both 0 % and 30 % cover.

Batters

Simulations demonstrate that Waste Rock Oxide materials are able to provide adequate resistance to erosion (mean soil loss rate < 5 t/ha) on the TSF and WRE batters where vegetative cover exceeds 60 % (Figures 9 and 11). Even at 50 % vegetation cover these batters are unlikely to be subject to appreciable erosion, as the predicted erosion rates were at a maximum of 6–7 t/ha/y at the toe of the batters.

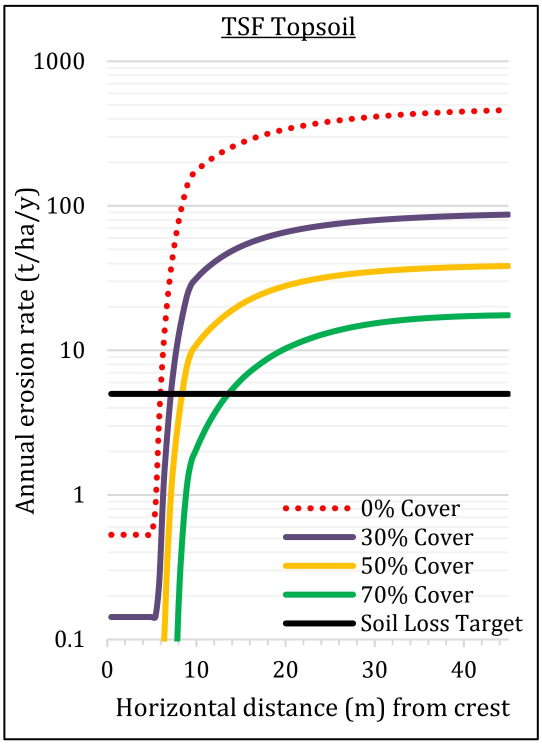

Figure 9. TSF Gravelly Topsoil: Soil loss target was exceeded for all cover conditions assessed.

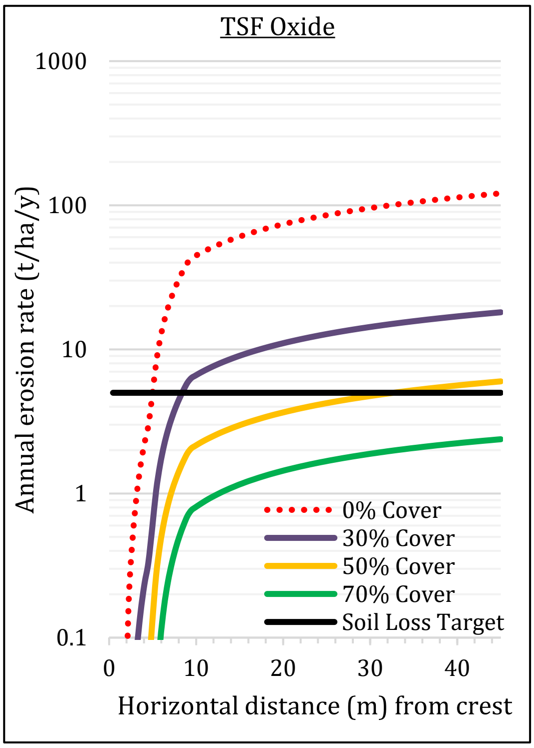

Figure 10. TSF Waste Rock Oxide: Soil loss target was achieved at approximately 55 % surface cover.

In contrast, the Gravelly Topsoil materials were much more erodible than Waste Rock Oxide materials on batters greater than 5 m in length. Simulations of batters with an appreciable surface cover of 70 % reported mean erosion rates near 20 t/ha/y, being four times greater than the adopted soil loss target (Figure 8 and 10). Hence, the Gravelly Topsoil materials are not suitable for use in batter revegetation on the TSF or WRE.

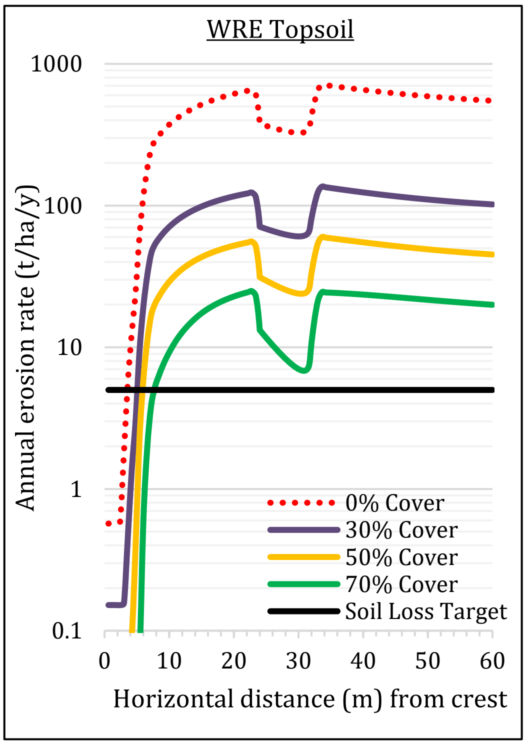

Figure 11. WRE Gravelly Topsoil: Soil loss target was exceeded for all cover conditions assessed.

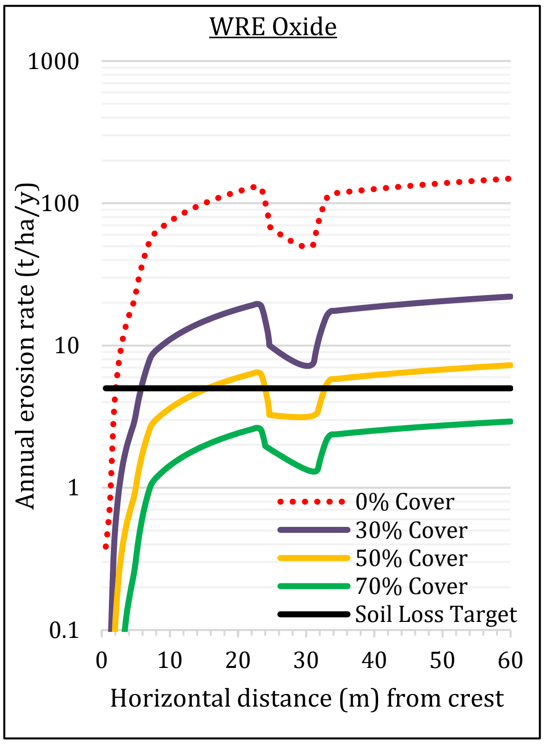

Figure 12. WRE Waster Rock Oxide: Soil loss target was achieved at approximately 60 % surface cover.

8 DISCUSSION

8.1 Erosion

Erosion modelling demonstrates the Gravelly Topsoil material is more erosive than the Waste Rock Oxide material. This is primarily due to due to two factors -

1. A higher degree of *surface roughness* is able to be maintained by the cobbly Waste Rock Oxide materials. This acts to reduce runoff and erosion as more water and sediment is retained in depressions.
2. Gravelly Topsoil is more prone to rill erosion, as was evidenced by the *rill erodibility* being an order of magnitude higher than that of the Waste Rock Oxide materials.

The Waste Rock Oxide materials are suitable capping materials for batters and the plateaus of the WRE and TSF. Predicted erosion was below the target soil loss rate of 5 t/ha on batters once vegetative groundcover (green/dry matter) exceeded 60 %.

To put these cover values in perspective, groundcover was measured to be generally 80–100 % in the rehabilitation trial on batters of the TSF with Waste Rock Oxide materials (Section 4.3.2). Hence a target cover of 60 % on the batters with Waste Rock Oxide cover should be a realistic and readily achievable goal for the Mine.

On plateaus with gradients of 3 % or less, soil loss was below the target rate for Waste Rock Oxide materials even devoid of vegetation.

The Gravelly Topsoil materials are suitable for revegetation of the plateaus of the TSF and WRE, but are not suitable for use on the batters, or any slopes longer than 5 m with gradients of 33 % or steeper. Where the Gravelly Topsoil is used on used on plateaus, vegetation groundcover (green/dry matter) must be a minimum of 30 % for an acceptable soil loss to be maintained. This level of ground cover should be readily achievable as the rehabilitation with Gravelly Topsoil on the WRE batter was observed to achieve groundcover of 20–40 % across the eroded surface (Section 4.3.1).

Modelling of TSF and WRE batters with Gravelly Topsoil materials and groundcover levels of 70 % predicted erosion rates at approximately 20 t/ha/y. This greatly exceeds the target soil loss rate. Predicted erosion rates were substantially higher for lower levels of cover. Hence, the use of Gravelly Topsoil on batters is not recommended.

8.2 Rural Land Capability Classes

Application of the Rural Land Capability Class (RLCC) criterion, as detailed in *Land Classifications of the Central West* – 2008 (NSW CWCMA, 2008), needs to be considered in the design of the TSF and WRE, and for post mining land use.

For the plateaus, RLCC VI is currently prescribed. This requires slopes with gradients less than 33 %, a soil depth greater than 250 mm, and materials that are not strongly sodic (i.e. exchangeable sodium percentage less than 15 %).

Both the Gravelly Topsoil and the Waste Rock Oxide materials could be used on plateaus, provided the upper 0.25 m of the profile is free of compacted layers (that would increase runoff and reduce plant growth), and adequate gypsum is applied to reduce sodicity to below 15 %. To better promote vegetation growth and groundcover development, it is recommended the ripping depth be no less than 0.5 m and the target sodicity be exchangeable sodium percentage less than 6 %.

On the batters of the WRE and TSF, RLCC VII is currently prescribed and requires gradients less than 50 %. The upper lifts of the batters of the WRE are at gradients of 65 % and exceed the slope threshold for LCC VII lands. Such steep land is classified as RLCC VIII land.

Both RLCC VII land (very low capable land) and RLCC VIII land (extremely low capable land) are suitable for native vegetation. The difference between the classes is that RLCC VII land is also suitable for selective forestry.

Considering the post-mining land uses in the MOP excludes forestry, and that this body of erosion modelling work has demonstrated that acceptably low soil loss rates can be achieved on the upper sections of the WRE batters at 65 %, it is proposed that post-mining land use for the batters of the WRE be revised from RLCC VII to RLCC VIII lands.

9 CONCLUSIONS: GUIDANCE FOR LANDFORM DESIGN

Key points arising from this Erodibility Testing and Modelling Program are:

1. The Gravelly Topsoil materials are much more prone to erosion than the Waste Rock Oxide materials.

2. Gravelly Topsoil materials are suitable for use in rehabilitation of the plateaus of the WRE and TSF provided at least 30 % vegetive groundcover (green/dry matter) is maintained, and -
    a. Slope breaks such as contour bunds, should be incorporated into the plateau intervals of 50–100 m to limit erosion during the vegetation establishment stage.
    b. Contour bunds should be shallow and broad and able to be readily trafficked by light vehicles, with a height of 0.3–0.5 m and a bund slope no steeper than 20 %.
    c. Contour bunds are to be discontinuous and off-set across the structures so that the plateau is free draining and surface runoff is torturous.
3. Gravelly Topsoil materials are <u>not suitable</u> for use in rehabilitation of the batters of the TSF or WRE.
4. Waste Rock Oxide materials are suitable for use in rehabilitation of the batters of the WRE and TSF, provided at least 60% vegetive groundcover (green/dry matter) is maintained.
5. Waste Rock Oxide materials used in rehabilitation of plateaus with gradients of 3 % or less can achieve the tolerable soil loss rate even with no vegetive cover.
6. Soil preparation works for rehabilitation of the Gravelly Topsoil and Waste Rock Oxide are the same. Works are to include, but not be limited to, the following:
    a. Apply gypsum at a rate adequate to ameliorate sodicity of the upper 0.3 m of materials to an exchangeable sodium percentage to 6 % (refer to rates in Landloch, 2021); then
    b. Rip *along the contour* to a depth of 0.5 m to relieve compaction and thoroughly incorporate gypsum (and lime). The final spacings of rip lines are to be approximately 0.5 m. Depending the spacing of tynes, multiple passes with ripping equipment may be required; then
    c. Apply seed, fertiliser and other amendments as required for the target vegetation community (See rates in Landloch, 2021).
7. Crest bunds are to be incorporated in the TSF and WRE landforms, with
    a. Height no less than 1.0 m;
    b. Internal gradient no steeper than 10 % and external gradient no steeper that 33%; and
    c. To be constructed prior to commencement of rehabilitation works on batters.
8. Chutes will need to be incorporated in the TSF and WRE to provide free draining landforms, noting -
    a. Chute designs are beyond the scope of this assessment.
    b. When designing the chutes, consideration should be given to how access will be provided to the plateaus to support the post-mining land use of grazing (RLCC VI).

c. It may be possible to incorporate access for stock and light vehicles into the chute.

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APPENDIX A: MAPS AND FIGURES

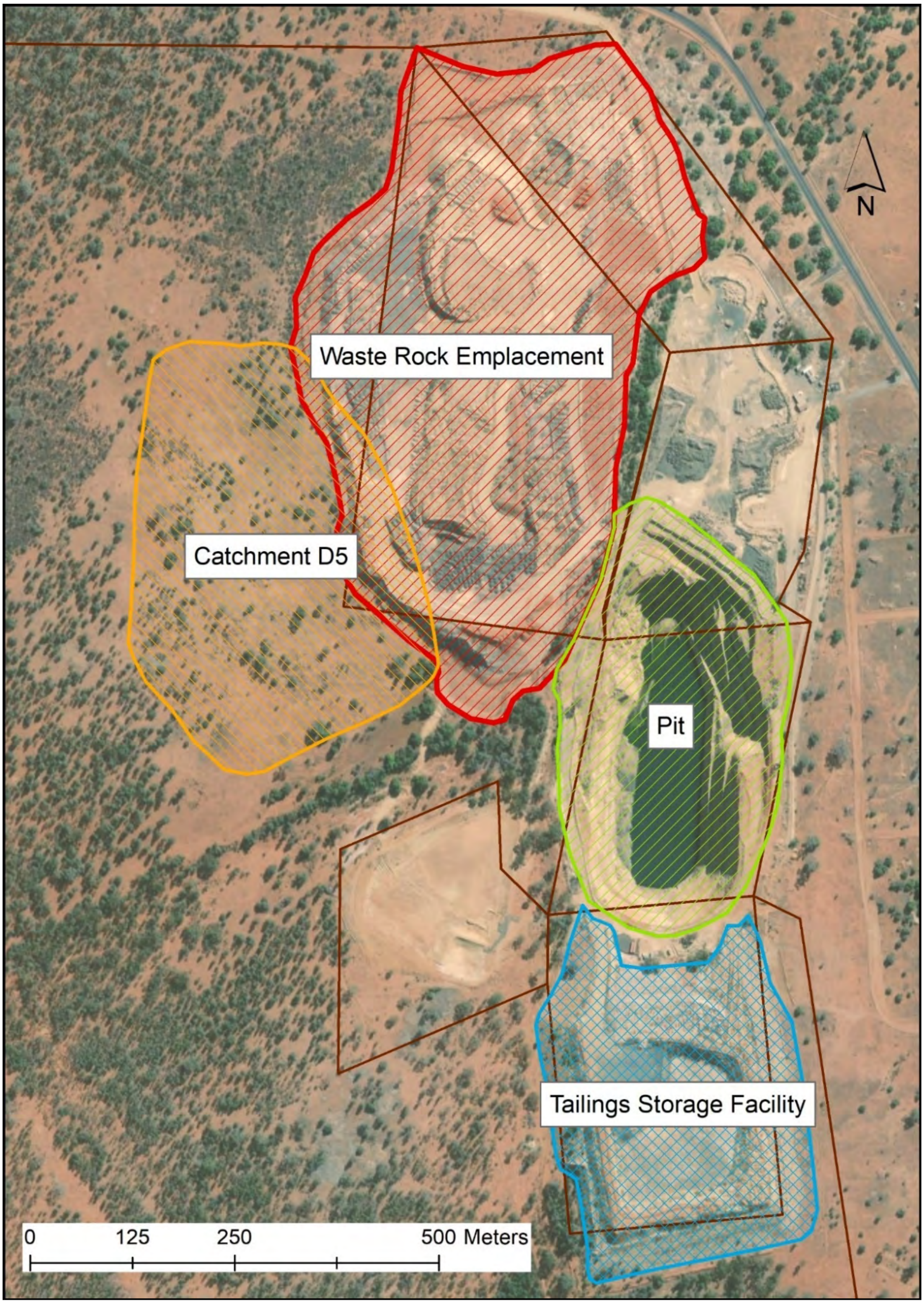

Figure A1. General arrangement of the Mine.

APPENDIX B: LABORATORY RESULTS

Gravelly Topsoil Stockpile

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No	Mean		LCL 95%	UCL 95%	Std Dev	Count	CI 95% (+/-)	10%ile		90%ile		Min	Max
	Sample ID													
	Sample Depth (m)													
	Field Texture													
Analyses	**Unit**													
pH - Water	pH units	6.1	L.Acid	5.8	6.5	0.5	8	0.4	5.7	M.acid	6.8	Neutral	5.3	7.0
Electrical Conductivity	dS/m	0.13	L.Sal	0.08	0.17	0.06	8	0.04	0.07	VL.Sal	0.20	M.Sal	0.06	0.23
Chloride	mg/kg	25	VL.Sal	12	39	19	8	13	10	VL.Sal	55	VL.Sal	10	58
Total Nitrogen - Kjeldahl	mg/kg	806	L	656	957	217	8	151	553	L	1007	L	402	1049
Total Phosphorus - Nitric/Perchloric	mg/kg	271	*	249	294	33	8	23	241	*	313	*	237	317
Phosphorus - Colwell extr	mg/kg	24	M	19	29	7	8	5	14	L	31	M	14	36
Potassium - Colwell ext	mg/kg	242	M	178	306	92	8	64	161	M	344	M	102	366
Sulphur - KCl	mg/kg	20.19	VH	16.49	23.89	5.34	8	3.70	15.74	H	28.40	VH	15.60	29.10
Organic Carbon	%	0.93	L	0.61	1.24	0.45	8	0.31	0.57	VL	1.31	M	0.37	1.90
Copper	mg/kg	1.28	M	1.09	1.47	0.27	8	0.19	0.99	M	1.63	M	0.98	1.69
Iron	mg/kg	31	*	16	47	22	8	16	11	*	64	*	10	66
Manganese	mg/kg	30.58	M	22.13	39.02	12.18	8	8.44	19.66	M	41.26	M	14.20	54.00
Zinc	mg/kg	3.13	M	0.96	5.30	3.13	8	2.17	0.45	L	7.62	H	0.27	8.64
Boron	mg/kg	0.57	L	0.48	0.65	0.12	8	0.09	0.43	VL	0.72	L	0.40	0.73
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	7.1	L	6.1	8.1	1.4	8	1.0	5.8	VL	9.0	L	5.1	9.1
Ex Calcium Percent	%	57.1	L	53.7	60.5	4.9	8	3.4	52.6	L	62.8	L	48.2	64.1
Ex Magnesium Percent	%	27.8	H	23.8	31.9	5.8	8	4.0	21.8	H	34.4	H	21.1	38.5
Ex Potassium Percent	%	12.3	H	10.6	14.1	2.5	8	1.7	10.2	H	14.4	H	8.5	17.3
Ex Sodium Percent	%	2.5	N.Sodic	1.9	3.0	0.8	8	0.6	1.7	N.Sodic	3.3	N.Sodic	1.5	4.2
Ex Aluminium Percent	%	0.3	VL	0.2	0.4	0.1	8	0.1	0.2	VL	0.5	VL	0.1	0.5
Exchangeable Calcium	mg/kg	818.1	*	660.5	975.8	227.5	8	157.7	612.8	*	1134.2	*	491.0	1172.0
Exchangeable Magnesium	mg/kg	228.5	*	214.8	242.2	19.8	8	13.7	202.5	*	243.8	*	192.0	255.0
Exchangeable Potassium	mg/kg	347.0	*	265.1	428.9	118.2	8	81.9	232.7	*	473.8	*	169.0	520.0
Exchangeable Sodium	mg/kg	38.7	*	31.9	45.6	9.9	8	6.9	25.3	*	49.6	*	24.1	49.8
Exchangeable Aluminium	mg/kg	1.6	*	1.1	2.0	0.6	8	0.4	1.0	*	2.4	*	1.0	2.4
Exchangeable Calcium	meq/100g	4.1	L	3.3	4.9	1.1	8	0.8	3.1	L	5.7	M	2.5	5.9
Exchangeable Magnesium	meq/100g	1.9	M	1.8	2.0	0.2	8	0.1	1.7	M	2.0	M	1.6	2.1
Exchangeable Potassium	meq/100g	0.9	H	0.7	1.1	0.3	8	0.2	0.6	M	1.2	H	0.4	1.3
Exchangeable Sodium	meq/100g	0.2	L	0.1	0.2	0.0	8	0.0	0.1	L	0.2	L	0.1	0.2
Exchangeable Aluminium	meq/100g	0.0	H	0.0	0.0	0.0	8	0.0	0.0	H	0.0	VH	0.0	0.0
Calcium/Magnesium Ratio	-	2.2	Low Ca	1.8	2.6	0.6	8	0.4	1.5	*	2.9	*	1.3	3.0
Gravel >2.0mm	%	28.0	*	20.5	35.4	10.8	8	7.5	17.3	*	36.7	*	13.4	50.3
Coarse Sand 0.2-2.0mm	%	19.6	*	15.6	23.6	5.8	8	4.0	13.6	*	24.6	*	6.9	25.4
Fine Sand 0.02-0.2mm	%	36.2	*	33.0	39.4	4.6	8	3.2	32.1	*	40.9	*	30.5	45.3
Silt 0.002-0.02mm	%	5.3	*	4.5	6.1	1.2	8	0.8	3.9	*	6.4	*	3.3	6.7
Clay <0.002mm	%	10.9	*	8.6	13.2	3.3	8	2.3	7.6	*	14.4	*	5.8	15.7
ADMC	%	2.5	*	1.6	3.4	1.3	8	0.9	1.2	*	3.9	*	1.1	4.8
Emerson Aggregate	Class		*				0			*		*	0.0	0.0
Phosphorus Buffer Index	mg/kg		*				0			*		*	0.0	0.0

Waste Rock Oxide

East West Enviroag Project Number: EW201484
Location: MBGM (MKR)
Landloch J/N: 3467.20a
Sample Collection Date: 27/11/2020
Sample Receival Date: 12/07/2020
Sample Analysis Date: 15/01/2021

	Lab No Sample ID Sample Depth (m) Field Texture	Mean		LCL 95%	UCL 95%	Std Dev	Count	CI 95% (+/-)	10%ile		90%ile		Min	Max
Analyses	**Unit**													
pH - Water	pH units	7.9	L.Alk	7.6	8.1	0.3	8	0.2	7.5	L.Alk	8.3	M.Alk	7.4	8.3
Electrical Conductivity	dS/m	0.33	M.Sal	0.12	0.53	0.29	8	0.20	0.07	VL.Sal	0.67	H.Sal	0.06	0.93
Chloride	mg/kg	238	L.Sal	100	375	199	8	138	38	VL.Sal	378	M.Sal	28	677
Total Nitrogen - Kjeldahl	mg/kg	422	VL	351	492	72	4	70	358	VL	490	VL	344	511
Total Phosphorus - Nitric/Perchloric	mg/kg	683	*	516	849	169	4	166	542	*	832	*	486	900
Phosphorus - Colwell extr	mg/kg	23	H	17	30	7	4	6	18	M	30	H	17	31
Potassium - Colwell ext	mg/kg	42	VL	30	53	12	4	11	30	VL	50	L	25	51
Sulphur - KCl	mg/kg	66.00	VH	24.53	107.47	42.31	4	41.47	28.91	VH	103.93	VH	28.10	106.00
Organic Carbon	%	0.18	EL	0.04	0.31	0.14	4	0.13	0.10	EL	0.30	EL	0.10	0.38
Copper	mg/kg	0.61	M	0.20	1.02	0.42	4	0.41	0.36	M	1.00	M	0.35	1.23
Iron	mg/kg	3	*	2	4	1	4	1	2	*	4	*	2	5
Manganese	mg/kg	1.65	L	0.44	2.86	1.24	4	1.21	0.79	VL	2.86	M	0.74	3.44
Zinc	mg/kg	4.87	M	0.53	9.20	4.43	4	4.34	1.03	M	9.11	H	0.83	9.92
Boron	mg/kg	0.33	VL	0.28	0.38	0.05	4	0.05	0.30	VL	0.38	VL	0.30	0.40
Cation Extraction Method	Rayment& Lyons	*	*	*	*	*	*	*	*	*	*	*	*	*
Cation Exchange Capacity	meq/100g	1.6	VL	0.8	2.4	1.2	8	0.8	1.0	VL	2.3	VL	1.0	4.6
Ex Calcium Percent	%	30.6	L	23.6	37.6	10.1	8	7.0	23.6	L	41.4	L	23.4	53.1
Ex Magnesium Percent	%	26.8	H	24.2	29.4	3.8	8	2.6	23.0	H	31.6	H	20.8	31.8
Ex Potassium Percent	%	16.2	H	13.3	19.1	4.2	8	2.9	12.7	H	19.9	H	9.1	24.2
Ex Sodium Percent	%	25.6	H.Sodic	21.0	30.1	6.6	8	4.6	19.8	H.Sodic	30.4	H.Sodic	10.2	30.5
Ex Aluminium Percent	%	0.9	VL	0.7	1.0	0.2	8	0.1	0.7	VL	1.1	VL	0.4	1.1
Exchangeable Calcium	mg/kg	117.7	*	13.6	221.8	150.2	8	104.1	53.5	*	212.6	*	47.8	488.0
Exchangeable Magnesium	mg/kg	51.9	*	24.0	79.8	40.3	8	27.9	31.3	*	79.7	*	30.7	150.0
Exchangeable Potassium	mg/kg	89.7	*	65.8	113.6	34.5	8	23.9	67.1	*	132.5	*	66.8	164.0
Exchangeable Sodium	mg/kg	79.1	*	69.5	88.7	13.8	8	9.6	67.6	*	94.0	*	64.7	108.0
Exchangeable Aluminium	mg/kg	1.1	*	0.9	1.3	0.2	8	0.2	1.0	*	1.2	*	1.0	1.7
Exchangeable Calcium	meq/100g	0.6	VL	0.1	1.1	0.8	8	0.5	0.3	VL	1.1	VL	0.2	2.4
Exchangeable Magnesium	meq/100g	0.4	L	0.2	0.7	0.3	8	0.2	0.3	VL	0.7	L	0.3	1.3
Exchangeable Potassium	meq/100g	0.2	L	0.2	0.3	0.1	8	0.1	0.2	VL	0.3	M	0.2	0.4
Exchangeable Sodium	meq/100g	0.3	M	0.3	0.4	0.1	8	0.0	0.3	L	0.4	M	0.3	0.5
Exchangeable Aluminium	meq/100g	0.0	H	0.0	0.0	0.0	8	0.0	0.0	H	0.0	H	0.0	0.0
Calcium/Magnesium Ratio	-	1.2	Low Ca	0.9	1.4	0.4	8	0.3	0.8	*	1.6	*	0.8	2.0
Gravel >2.0mm	%	37.0	*	31.7	42.2	7.6	8	5.2	30.9	*	43.5	*	20.8	45.4
Coarse Sand 0.2-2.0mm	%	23.3	*	20.5	26.2	4.1	8	2.8	18.6	*	26.8	*	16.7	29.0
Fine Sand 0.02-0.2mm	%	24.1	*	21.1	27.1	4.4	8	3.0	20.3	*	30.4	*	19.7	31.2
Silt 0.002-0.02mm	%	11.3	*	9.5	13.1	2.6	8	1.8	9.1	*	14.4	*	8.0	15.9
Clay <0.002mm	%	4.4	*	1.0	7.8	4.9	8	3.4	2.0	*	7.8	*	0.6	16.3
ADMC	%	4.5	*	3.4	5.6	1.6	8	1.1	3.1	*	6.0	*	2.7	8.0
Emerson Aggregate	Class	5.1	*	4.9	5.4	0.4	8	0.2	5.0	*	5.3	*	5.0	6.0
Phosphorus Buffer Index	mg/kg	35.0	*	31.5	38.5	3.6	4	3.5	32.8	*	38.3	*	32.5	40.3

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APPENDIX C: PHOTOGRAPHS OF MATERIAL TESTING

Photograph 13. Gravelly Topsoil test plot prior to rainfall simulation.

Photograph 14. Gravelly Topsoil test plot after receiving simulated rain at 125 mm/hr.

Photograph 15. Waste Rock Oxide test plot prior to rainfall simulation.

Photograph 16. Waste Rock Oxide test plot after receiving simulated rain at ~125 mm/hr..

Photograph 17. Gravelly Topsoil plot prior to being subjected to overland flows.

Photograph 18. Gravelly Topsoil plot tested to failure with overland flows.

Photograph 19. Waste Rock Oxide plot prior to being subjected to overland flows.

Photograph 20. Waste Rock Oxide plot tested to failure with overland flows.

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Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation

Review of Existing Soil Data and Preliminary Screening Sampling and Analysis Plan

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Client: Manuka Resources Ltd

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Draft A	Lyndon McGrath	Simon Buchanan	11 Nov 2020
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CONTENTS

1 INTRODUCTION

Manuka Resources engaged Landloch to provide technical design support in regard to rehabilitation of the closure of Mount Boppy Gold Mine (the Mine). Specifically, the design of landforms for a stable waste rock emplacement (WRE) and tailings dam that will be capable of supporting vegetation and post mining land uses.

To ensure the constructed landforms are sufficiently resilient to erosion, the erodibility of soils used as capping material needs to be considered. Batter shapes, profiles and slopes must be designed to ensure gradients and slope lengths restrict erosion to a tolerable rate. In situations where these key properties cannot be altered, then alternative controls will be considered and recommended. As well, the growth media quality of materials placed near the surface of the landforms needs to be assessed for suitability to support the vegetation required to meet the pos- mining land use.

This Preliminary Screening Sampling and Analysis Plan (SAP) reviews the existing data and determines the data gaps. It provides details of the field and sample collection requirements for further characterisation of materials, to ensure there is sufficient data to support a robust design.

1.1 Project Description

Mount Boppy Resources Pty Ltd, a wholly owned subsidiary of Manuka Resources Ltd, took control of the Mine in 2019. The mining complex at Mount Boppy has grown through a process of expansions and acquisitions since underground mining initially commenced in 1901. Open-cut mining activities, including the current open-cut void commenced at the Mine in 2002 (R.W Corkery & Co, 2020).

The general arrangement of the mine is provided in Figure A1 (Appendix A).

1.2 Scope of Work

The scope of work for preparation of this SAP relates to Task 1 in Landloch's proposal to Manuka Resources (dated November 2020) titled *Mount Boppy Closure – Landform Design, Material Characterisation and Rehabilitation.*

It involves the following tasks:

i. Reviewing previous soils and land assessments undertaken at the Mine.

ii. Conducting data gap analysis to determine information required to:

   - Develop an inventory of materials available for landform construction and rehabilitation;
   - Assess the suitability of materials as a plant growth media; and
   - Develop design rules for rehabilitated landforms.

iii. Preparing a sampling and analysis plan for fieldworks.

2 DESKTOP REVIEW

The Mine is located near Canbelego in western New South Wales. Most of the land within the mining tenement is Crown Land with a small area located over privately owned freehold land.

2.1 Climate

The Study Area is situated in a persistently dry semi-arid climatic zone with hot summers and cool to mild winters.

Average monthly maximum temperatures tend in winter to range from 13°C to 20°C, and between 28°C to 39°C in summer. Summer temperatures can exceed 40°C for short periods.

Average monthly minimum temperatures range from 2°C to 8°C in winter to 14°C to 24°C in summer (BoM, 2020). Frosts are frequent through the winter (NSW National Parks and Wildlife Service, 2003).

Rainfall is relatively uniformly distributed throughout the year, with a median annual rainfall for Cobar of 390 mm. However, rainfall can be extremely variable in late spring and early summer when the highest observed falls have been more than 200 mm in any one month.

Average evaporation exceeds the average rainfall throughout the year (NSW National Parks and Wildlife Service, 2003)

2.2 Topography

The mine site is located within the Barwon-Darling River catchment. The Mine and surrounding area are characterised by poorly defined ephemeral drainage lines. These flow only immediately after rain and drain to Mulga Creek in the east or Yanda Creek in the southeast.

The surrounding land consists of gently undulating landforms with low ridges and occasionally prominent ridges and ranges. The most prominent topographical feature in the vicinity is Mount Boppy to the northeast with an elevation of 406 m.

Total natural relief across the mining lease is 30 m, with elevations ranging from 275 m in the northeast to 305 m in the low rises to the west (Figure 1). Previous mining activities have influenced the local topography with the deepest points of the Southern and Northern pits ranging from 209 m to 215 m or approximately 71 m and 65 m below the natural surface.

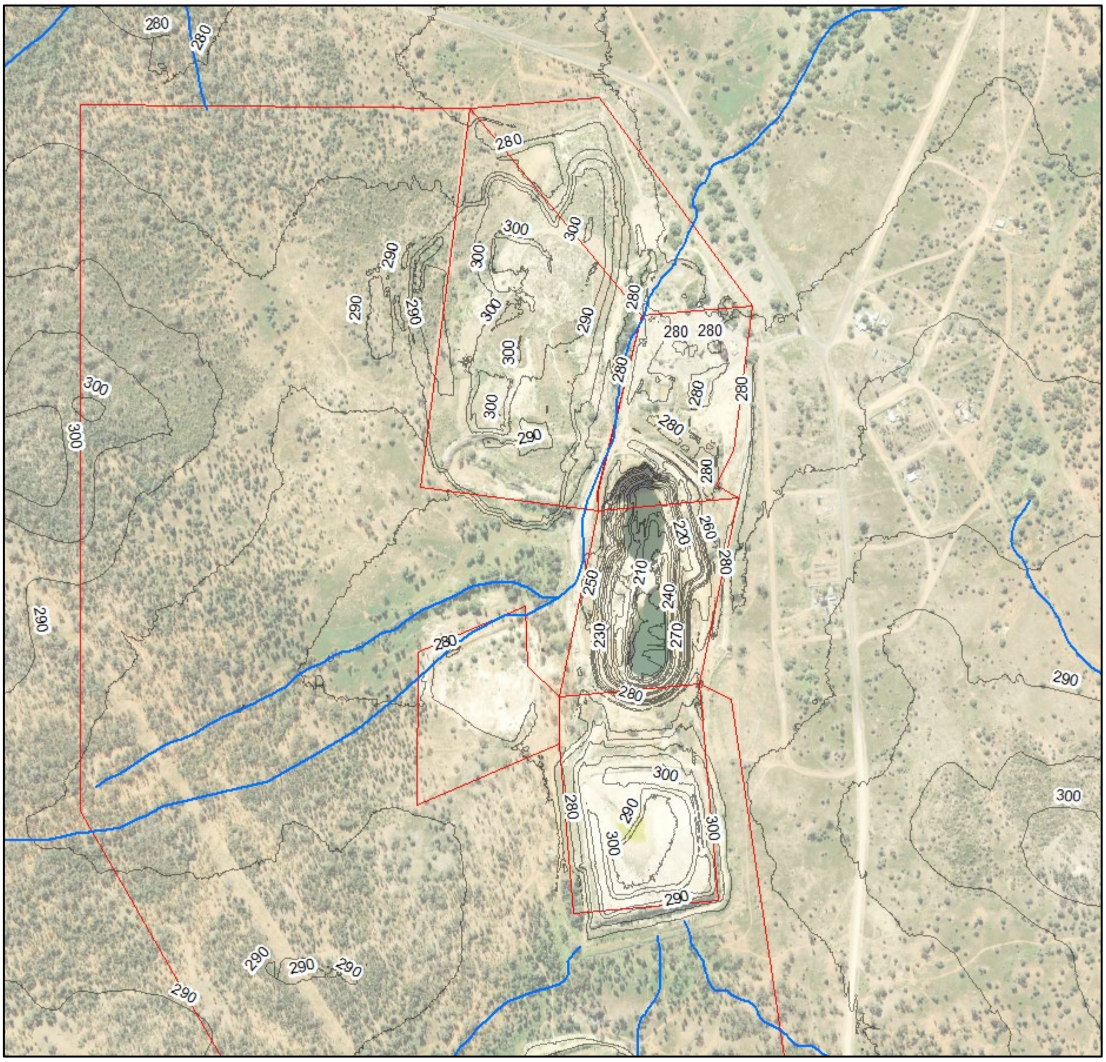

Figure 1. Topography the Study Area.

The gradients of the areas adjacent to the mining operations are typically less than 3% on the undulating plain, increasing to between 3 to 10 % on the residual rises. Within the Mine the existing batters on the WRE and TD are generally between 10–33%. The gradients of benches and plateaus of these structures are generally less than 10% (Figure 2).

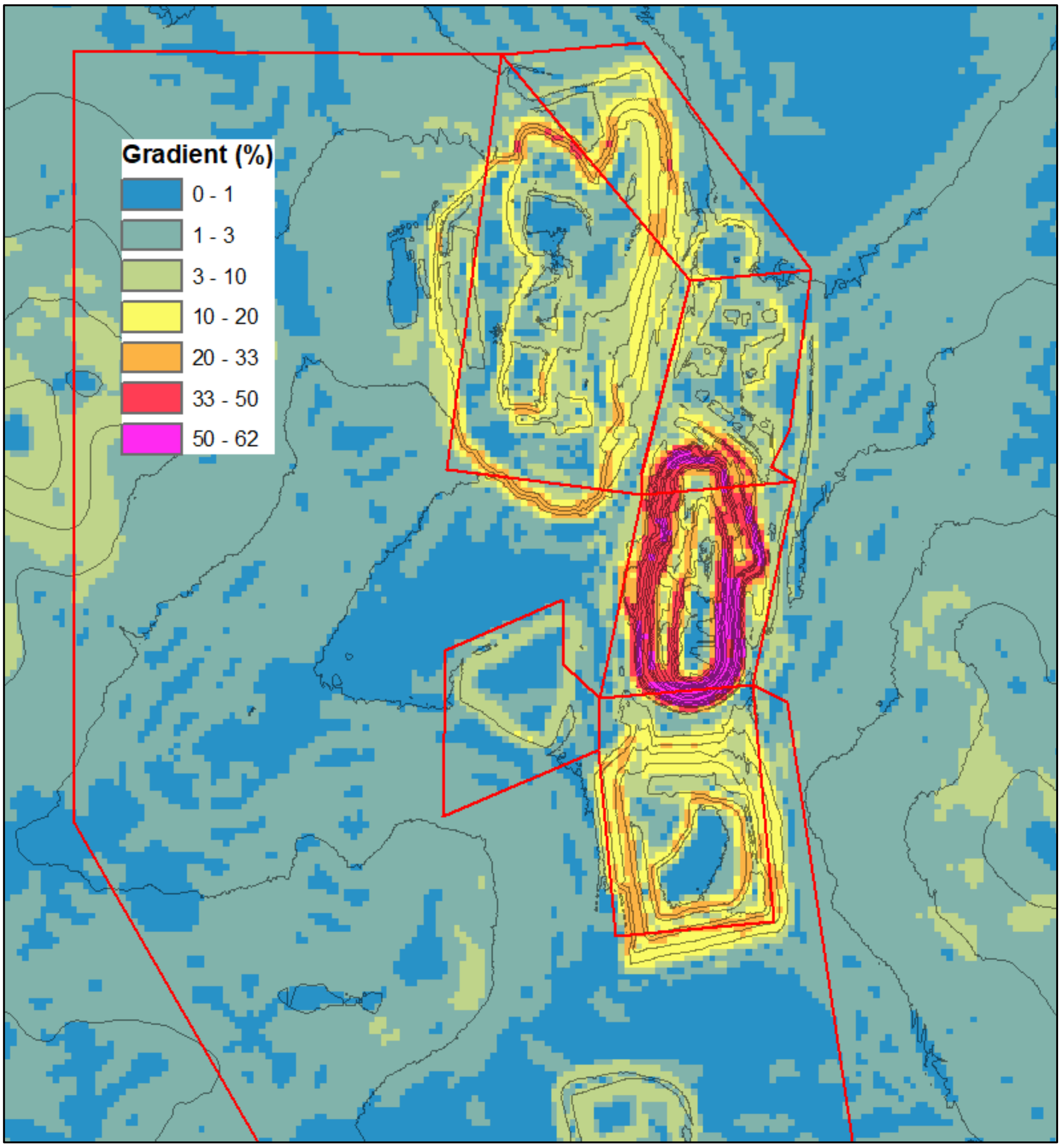

Figure 2. Existing lopes of the Study Area.

2.3 Geology and Soils

The Canbelego Regional Geology 1:100 000 mapping indicates there are four main broad geological units in the Study Area (Felton E.A., Brown R.E. and Fail A.P., 1985). The distribution of geological units are are provided in (Figure 3) and Table 1

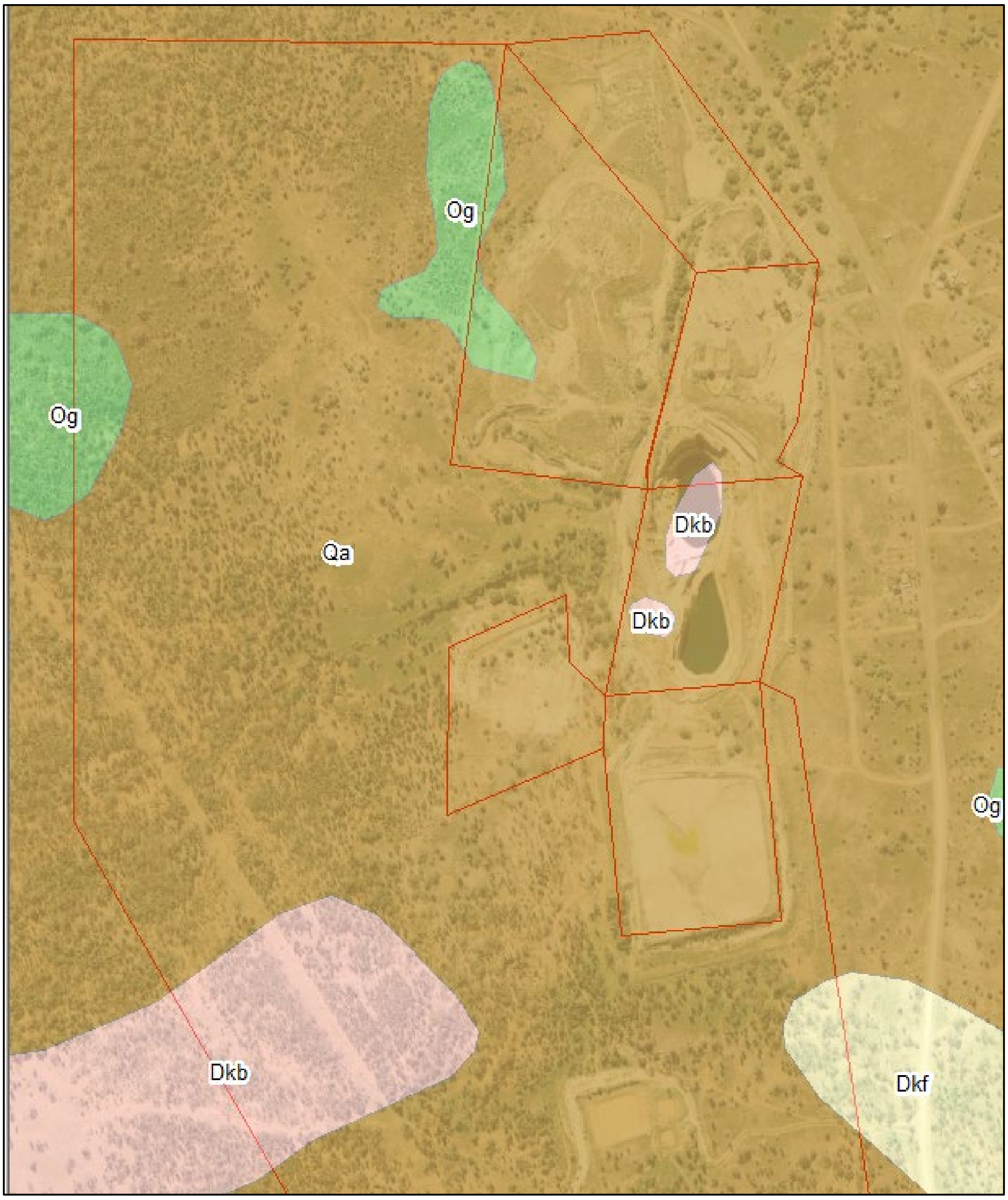

Figure 3. The geology units of the Study Area include Baledmund Formation (Dkb), Quaternary Alluvium (Qa), and Girilambone Group (Og), and Florida Volcanics (Dkf).

A description of the geological units is provided in Table 1. The Florida Volcanics are believed to be the source of gold at Mount Boppy.

Table 1. Primary geological units relevant to the Study Area (Felton E.A., Brown R.E. and Fail A.P., 1985).

Geological unit	Map code	Description
Quaternary Alluvium	Qa	Consists of layers of gravel, sand, silt and clay sediments.
Baledmund Formation	Dkb	Thinly laminated, commonly ferruginous, occasionally calcareous, siltstone and minor interbedded, well-sorted fine-grained lithic-quartz sandstone. Boulder to granule polymictic conglomerate and sedimentary breccia are variably developed at the base.
Girilambone Group	Og	Deformed and metamorphosed, micaceous, quartzose and quartz-lithic sandstone, pelite, chert; minor intercalations of polymictic conglomerate, siltstone, quartzite, and mafic and intermediate volcanics; black shale.
Florida Volcanics	Dkf	Rhyolitic and rhyodacitic lithic-crystal tuff and volcanic breccia, rhyolite lava, flow-foliated porphyritic dacite and minor siltstone

2.3.1 Land systems

Land systems are areas or groups of areas throughout which there is a recurring pattern of topography, soils and vegetation. They reflect variations in soil type, geology, landform, drainage and vegetation. The Study Area is situated within the Cobar Land System that is described as (P.J. Walker, 1991).:

- Slightly undulating rounded ridges and higher residuals of Sulurian and Ordovician sedimentary and metamorphic rocks with overlying residual and colluvial gravel and quartz.
- General undulating relief is 10 m and 20m on residual hills.
- Well defined dendritic drainage lines of Quaternary alluvium ranging from 10 m to 1,000 m wide.

Other land systems in the region that will remain undisturbed by the Mine include Mineshaft, Boppy and Wynwood.

Relevant details of the landforms of the Cobar Land System are provided in Table 2.

Table 2. Summary details of the landforms in the Cobar Land System (P.J. Walker, 1991).

Landforms	Soil Groups	Vegetation
Residual rises/ low hills. Slopes to 20 % and 300 m long; relief to 20 m. Small areas of Mineshaft land system also included.	Earthy or sandy lithosols with variable outcropping rock and surface stone, some gravelly red earths.	Dense to scattered mulga (*Acacia aneura*), green mallee (*Eucalyptus viridis*), and red box (*E. intertexta*); dense silver cassia (*Cassia artemisioides*), lobe-leaf hopbush (*Dodonaea lobulata*), budda (*Eremophila mitchellii*), emu bush (E. longifolia), and green fuchsia-bush (*E. serrulata*); abundant variable speargrass (Stipa variabilis), purple burr-daisy (*Calotis cuneifolia*), rock fern (*Cheilanthes tenuifolia*), long greybeard grass (*Amphipogon caricinus*), grey copperburr (*Sclerolaena diacantha*), and No. 9 wire grass (*Aristida jerichoensis*).
Ridge crests and upper slopes. Slopes to 5 % and 500 m long; relief to 10 m.	Lithosols of loamy or sandy loam texture, with shallow acid red earths; plentiful surface quartz gravel and rock fragments, slight ferruginous gravel.	Moderate to dense red box, mulga, green mallee and white cypress pine (*Callitris columellaris*); dense to moderate budda, silver cassia, punty bush (*Cassia eremophila*) and turpentine (*Eremophila sturtii*); sparse No. 9 wire grass, variable speargrass, other grasses and forbs.
Lower slopes and very low ridges. Slopes to 2 %, to 1km long; relief to 5 m.	Moderately deep red earths and calcareous red earths usually within hardpan; earthy lithosols.	Moderate bimble box (*Eucalyptus populnea*), mulga, white cypress pine and red box; moderate to dense budda, turpentine, punty bush and emu bush; sparse to moderate No. 9 wire grass, variable speargrass, grey copperburr, purple love crass (Eragrostis lacunaria), purple burr-daisy and forbs.
Smaller drainage lines. Level to 2 % slope, relief to 3 m; 10 m to 200 m wide.	Deep to moderately deep red earths with loam to clay loam surface texture over hard pan; slight gravel.	Dense to moderate bimble box, white cypress pine, mulga, red box and wilga (*Geijera parviflora*); dense budda, turpentine, punty bush and broad-leaf hopbush (*Dodonaea viscosa*); sparse to abundant No. 9 wire grass, variable speargrass, other grasses and forbs.
Larger drainage lines. Level, 200 m to 1 km wide; formed by merger of smaller drainage lines.	Deep calcareous and neutral red earths with loamy, silty and clay loam surface texture over hardpan; slight if any gravel.	Dense (except where cleared) bimble box, white cypress pine, mulga, yarran (*Acacia homalophylla*) and ironwood (*A. excelsa*); dense to moderate punty bush, budda, turpentine, broad-leaf hopbush and dogwood (*Myoporum deserti*); sparse to abundant No. 9 wire grass, variable speargrass, other grasses and forbs.

In broad terms, the topsoil materials of the Cobar Land System are generally *sandy* or *loamy* textured with clay content of less than 15 % and 15–35 %, respectively. Considering this is dominant across the mining lease, it can be expected that the topsoil materials recovered by Manuka Resources for use as growth media in rehabilitation works will mainly be sandy or loamy in texture. Little difference is expected in the subsoil material.

The locality and distribution of land systems units are presented in Figure 3.

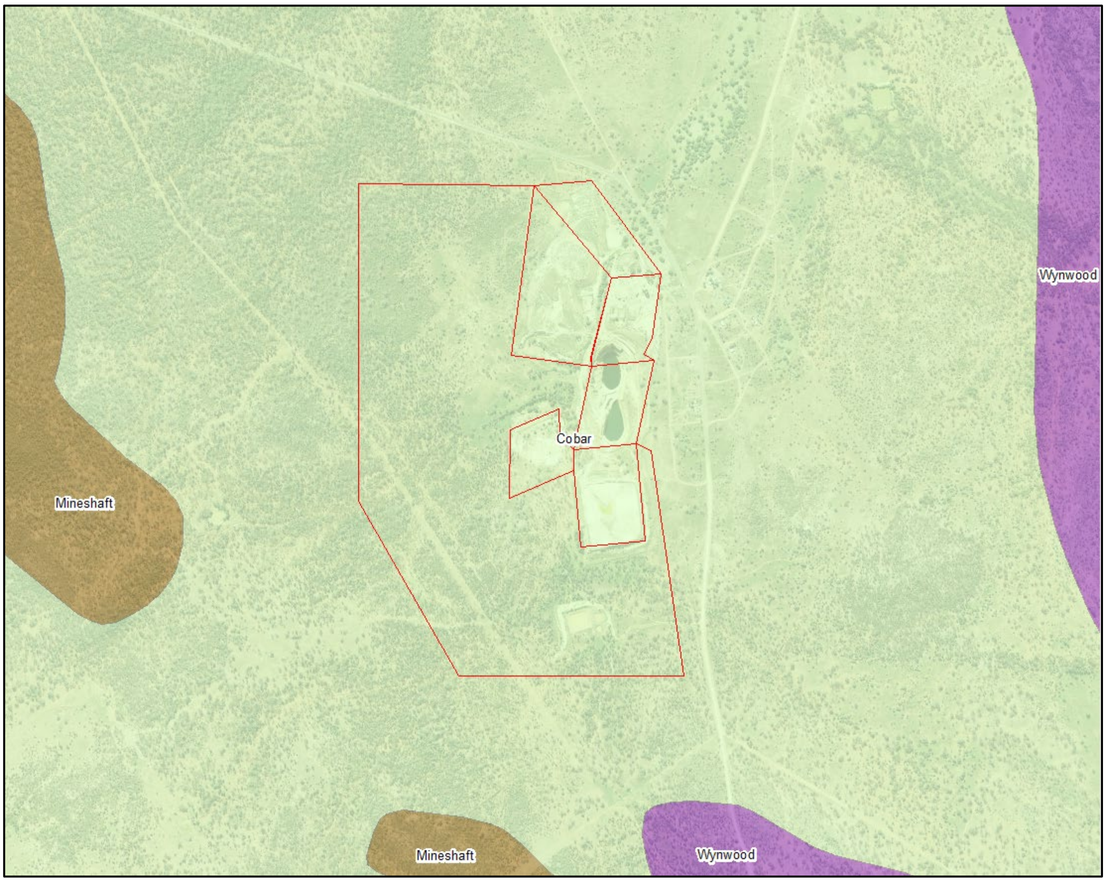

Figure 4. Land systems in the vicinity of the mine.

2.3.2 Recoverable soils

A soil assessment was undertaken as part of a previous environmental assessment for a proposed expansion circa 2011 (SEEC, 2011). A total of six test pits were excavated across the mine site (Appendix A). The dominant soil type identified within the survey area is loamy or sandy loam gravelly lithosols. The soil assessment report (SEEC, 2011) provides the following detail about the soil material:

- Shallow and gravelly (400 mm to 1,200 mm deep);
- Topsoil is non-saline but subsoils can be slightly to moderately saline (EC 0.28 dS/m to 0.4 dS/m);
- Low in organic matter;

- Slightly acidic to slightly alkaline; and
- Non-sodic

Topsoil fertility was not tested in the 2011 program.

The Mount Boppy Mine Operation Plan - MOP (R.W Corkery & Co, 2020) provides the following details about the soil materials.

- The soils are highly erodible but are relatively coarse grained and not dispersible.
- Although the soils are erodible, the low slope gradients and low rainfall erosivity mean the soil loss class is 'Very Low'.
- The soils are unlikely to respond well to artificial fertilisers as their base saturation is high. Soil improvement will be best achieved by incorporating organic matter and/or addition of soil ameliorants like gypsum.

A disturbance approval (DA 2011/LD-00070 – REV 1) is outlined in the *Soil and Water Management Plan* (SWMP) (R.W. Corkery & Co, 2016). The approval allows disturbance within the area identified as Catchment D5 (Figure 3) for the purpose of mine water storage and evaporation ponds. While the ponds are no longer required the most recent modification of the MOP provides for the recovery of up to 46,000 m^3 of topsoil and subsoil from this area.

This area can potentially be developed as a soil borrow pit. Soil will be stripped to a depth of 400 mm to 500 mm and separated into topsoil and overburden/regolith. A proportion of topsoil (50 mm) will be retained for respreading over the borrow pit area with the remainder available for rehabilitation works.

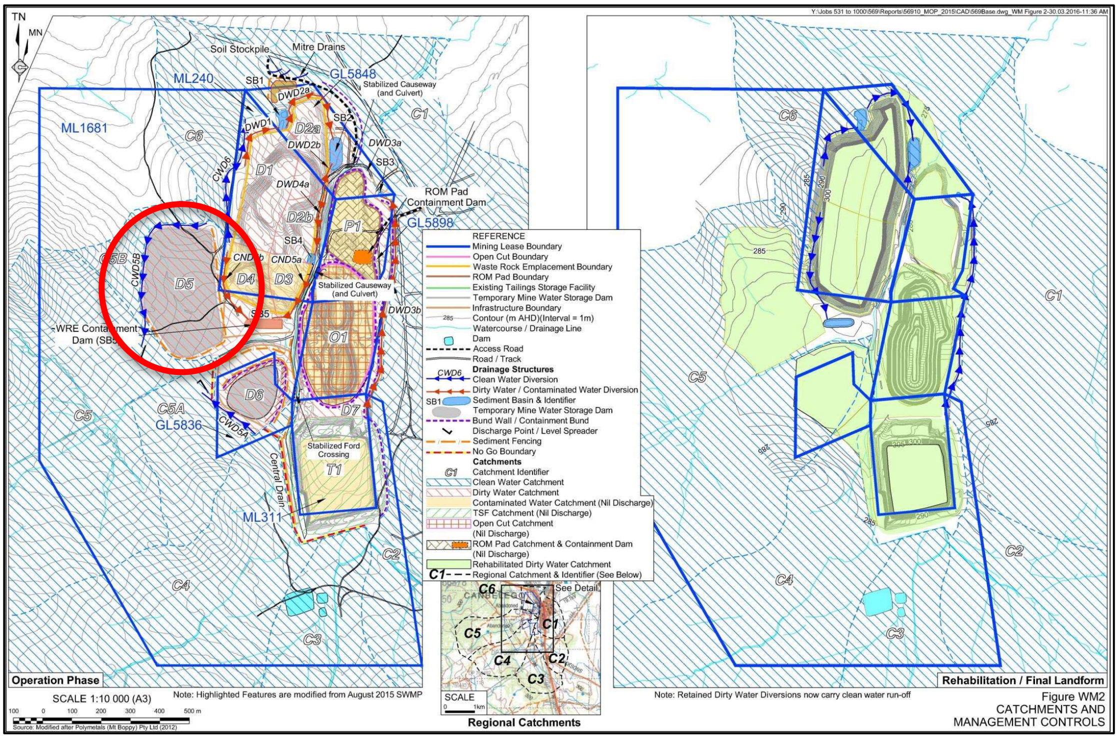

Figure 5. Potential borrow pit at Catchment D5 (red circle).

2.4 Stockpiles

A guide to available stockpiled materials, volumes and locations are provided in the MOP (R.W Corkery & Co, 2020) and SWMP (R.W. Corkery & Co, 2016). Summary details are provided in Table 3.

Table 3. Summary of details of stockpiled materials for rehabilitation reported in the MOP and SWMP.

Material	Location	Volume (m^3)	Comments
Soil	5 locations on western side of Mine (Figure A2 – Appendix A)	10,600	Previously extracted soil material.
Soil	North of WRE	6,000 to 7,000	Soil stripped for the Temporary Mine Water Storage Dam stockpiled north of the WRE.
Overburden	WRE	10,200	Stockpiled weathered overburden material. Recovered to potentially supplement the soil material as a growth medium.

The MOP (R.W Corkery & Co, 2020) outlines that stockpiled soil material and weathered overburden will provide sufficient material to apply a 50 mm depth of growth medium across the final WRE, capped TSF 3 and ROM pad (17,200 m^3). The remaining soil and weathered overburden (~3,600 m^3) will be spread across infrastructure areas and used to increase the soil depth across flatter areas of the WRE.

2.5 Overburden

The key non-ore sedimentary materials that make up the overburden are predominantly sedimentary breccia, succeeded by bedded quartz–lithic arenite and quartz pebble conglomerate with intercalated siltstone.

Overburden materials are likely to be strongly oxidised (weathered), non-acid forming, low in sulphur, contain little acid neutralising capacity and relatively benign (RGS, 2015). This material will be used as a capping layer above potential acid forming (PAF) material and potential growth medium (R.W Corkery & Co, 2020).

'Increased Risk' potential acid forming materials (> 1 % total sulfur) are estimated to comprise ~50,000 m^3 of overburden recovered from 50 m to 165 m below ground level . These materials will be placed within the existing TSF 3 structure prior to capping. The remaining 'moderate risk' PAF material with a total sulfur content between 0.3 % and 1 % (~150,000 m^3) will be placed within the WRE (Mt Boppy Resources, 2020).

2.6 Post Mining Landforms

The final landform and drainage design at Mount Boppy aims to provide a stable and non-polluting landform that is compatible with the surrounding landscape and is detailed in the Mount Boppy MOP. The constructed landform should be suitable for the proposed final land use and blend, as far as practicable, with the adjacent topography. The final landform will also include any drainage structures needed for the area (R.W Corkery & Co, 2020).

The MOP provides final landform details for the six rehabilitation domains at the Mine. The four relevant rehabilitation domains for the assessment include:

- Domain 2 – Tailings Storage Facility;
- Domain 3 – Water Management Area; and
- Domain 4 – Overburden Emplacement Areas.

Final landform details for each domain are summarised in the Table 4.

Table 4. Summary of landform details provided in the MOP for relevant domains.

Domain	Final Landform Details
2	Tailings Storage Facility PAF material will be paddock dumped over the existing tailings surface in piles approximately 3 m high. These will be pushed out by a bulldozer to compact and push into the tailings surface and lime added at a conservative rate of 30 t/ha. A clay liner will then be compacted over the PAF material to a minimum depth of 0.9 m and with a permeability of 1×10^{-9} m/s. NAF material will then be paddock dumped and dozer profiled to create a minimum 2 m thick store and release cover. The profiled surface will be free-draining with appropriate water management structures.
3	Water Management Area After dewatering, the material excavated to create the dams will then be pushed back into the dams and profiled using a bulldozer to create a free draining landform.
4	Overburden Emplacement Areas The WRE will be progressively constructed through paddock dumping of NAF material and profiling using a bulldozer. Specially designed PAF encapsulation areas within the WRE will be similarly formed through paddock dumping of a base layer of NAF material to a minimum thickness of 3 m. The NAF material will be selected to provide good drainage beneath the WRE such that the PAF material is not subject wetting and drying cycles. PAF material will be built up in lifts to a maximum of approximately 15 m thickness with NAF material used to form the batters of the WRE. The areas of PAF encapsulation will be progressively limed, clay capped and covered with NAF.

2.7 Post Mining Land Uses

Post-mining land uses will predominantly be native vegetation communities suitable for intermittent and very low intensity grazing (Rural Land Capability Class VI). The batters of the WRE and TSF will be rehabilitated with native vegetation and have a land use of passive nature conservation (Rural Land Capability Class VII) (R.W Corkery & Co, 2020).

Of relevant to post mining land uses

- Rural Land Capability Class (RLCC) VI requires slopes < 33% and a soil depth of >250mm. This may be achievable with 50mm of TS placed on NAF waste provided the overburden can support vegetation and does not contain hazards to plant growth (e.g. extreme acidity/alkalinity, salts, etc)
- RLCC VII requires slopes < 50%. This is a potential conflict with the 10 m upper lift on the WRE currently planned to be RLCC VII. Currently the gradients of the conceptual WRE landform are to be ~80% (R.W Corkery & Co, 2020).

2.8 Rehabilitation

Growth medium will be development by placing oxidised overburden, subsoil and available topsoil on the final landform to prepare the surface for revegetation. Soil preparation may include ameliorant application (e.g. gypsum / lime) and ripping or scarifying the surface. Use of non-persistent cover crops will be used to stabilise the soil surface.

Rehabilitation trials and monitoring completed to date indicates that planting of tube stock at the Mine has limited success. Therefore, revegetation will be undertaken by either direct or mechanical seeding. Seeding will be completed as soon as practicable after placement of soil material / growth medium and before the surface forms a crust to achieve an optimal surface microhabitat (R.W Corkery & Co, 2020).

Direct seeding lines for tree species will be spaced a minimum of 6 m apart on flat areas and 8 m on slopes to provide sufficient space for establishment and maintenance of groundcover species. Seeding rates will need to be high due to potential impact of grazing animals and will be approximately 1.5 kg/ha (R.W Corkery & Co, 2020).

An alternate seeding option which maximises water where the seed is placed would be to seed directly into contour lines where moisture will be captured (Knop, 2009).

Rehabilitation species mixes are provided in Appendix B.

3 FORWARD PROGRAM

Detailed characterisation of potential growth media will target the following materials for use in the landform design process:

1. Topsoil materials;
2. Subsoil materials;
3. NAF waste rock overburden; and
4. Soil fertility of analogue sites.

All material for use as growth media will need to be characterised in terms of basic chemical and physical fertility properties.

Any materials that may potentially be placed at the surface for use as topsoil / primary growth media will require detailed fertility assessment and detailed erodibility characterisation to determine suitability for slopes.

3.1 Sampling Plan

The sampling plan is provided in Table 5. Additional samples will be collected whilst on site. If the initial rounds of tested reveals materials are more variable than expected, then these additional samples may be tested.

Table 5. Sampling plan for preliminary screening program.

ID	Material	Location	Samples to Collect	Samples Analysed Initially
Reference (analogue) sites	Topsoil	Natural ground (minimally disturbed) (Sites from SEEC 2011)	6	6
	Subsoil		12	12
Stockpile - Topsoil	Topsoil	unknown	20	10
Stockpile - Overburden	NAF overburden	WRE	16	8
		Tailings Dam	8	4
Potential Borrow Pit	Topsoil	Catchment D5	3	6
	Subsoil		6	6
Total			**71**	**52**

3.2 Sample Collection

Samples for chemical analysis will be placed into separate bags. All samples will be identified using the project name, unique profile number and depth range from where the sample was taken.

Surface samples will be composites obtained by combining at least five sub-samples taken at random within a 10 m radius. Subsurface samples collected will be discrete grab samples.

The mass of samples will be 5 kg for soil/non-rocky materials and 10–15 kg for rocky materials (coarse fragments greater than 50 %).

Data to be recorded at each site includes:

- unique identification;
- geospatial location;
- nature of exposure;
- current land use and/or land cover;
- current surface condition;
- slope gradient description;
- presence or erosion;
- rock outcrops/ coarse fragment cover; and

- photographs of site and profile.

3.3 Laboratory Analysis

Laboratory analysis will be undertaken by a National Association of Testing Authorities (NATA) or Australian Soil and Plant Analysis Council (ASPAC) accredited laboratory. It will focus on defining plant growth potential of the samples, as well as assisting in defining appropriate bulk sampling locations for subsequent erodibility studies.

Testing will occur in two phases. Suite 1 (initial) testing will be conducted on all samples. Those determined to be likely suitable for use near a rehabilitated surface will be subjected to Suite 2 testing to consider their fertility and other key physical properties of importance.

3.3.1 Suite 1

Suite 1 testing will include assessment of the fine fraction (less than 2 mm) of all samples (approximately 34) for:

- $pH_{1:5}$ (water);
- Electrical Conductivity ($EC_{1:5}$), Chloride;
- Exchangeable cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Al^{3+}) with calculations of exchangeable sodium percent (ESP), effective cation exchange capacity (ECEC), and Ca:Mg ratio; and
- Field texture.

3.3.2 Suite 2

Suite 2 testing will target fertility of materials that will potentially be used as a primary growth media (topsoil) that have demonstrated suitable pH, EC, and dispersion potential in the Phase 1 testing.

Soil fractions < 2 mm will be tested for:

- Total N and Total P;
- Available (Cowell) P, K, and (KCl) S;
- Organic C;
- Extractable trace elements (Cu, Zn, Mn, Fe and B); and
- Particle size analysis (clay <2 µm, silt 2-20 µm, very fine sand (20-100 µm), fine sand 100-200 µm, coarse sand 200-2,000 µm, gravel >2,000 µm); and
- Emerson Dispersion Class.

The coarse fraction (greater than 25 mm) of any rocky wastes (maximum of 10 samples) will be assessed for:

- Slake soundness;
- Rock particle density;

- Water absorption; and
- Particle size distribution using scaled digital images (four photographs in total, two per rocky waste sample).

3.4 Data Analysis and Progress Reporting

Field and laboratory data will be assessed to define materials that are suitable for use near the surface of rehabilitated landforms.

Possible amendments will be identified, including amelioration of structural instability and fertility issues.

Any existing analytical data for soils and wastes will be included (where possible) in the assessment.

Suitable materials for bulk sampling will be identified, including possible locations from where these materials could be sourced.

Reporting will consist of a brief letter report to Manuka Resources.

4 REFERENCES

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APPENDIX A: MAPS AND FIGURES

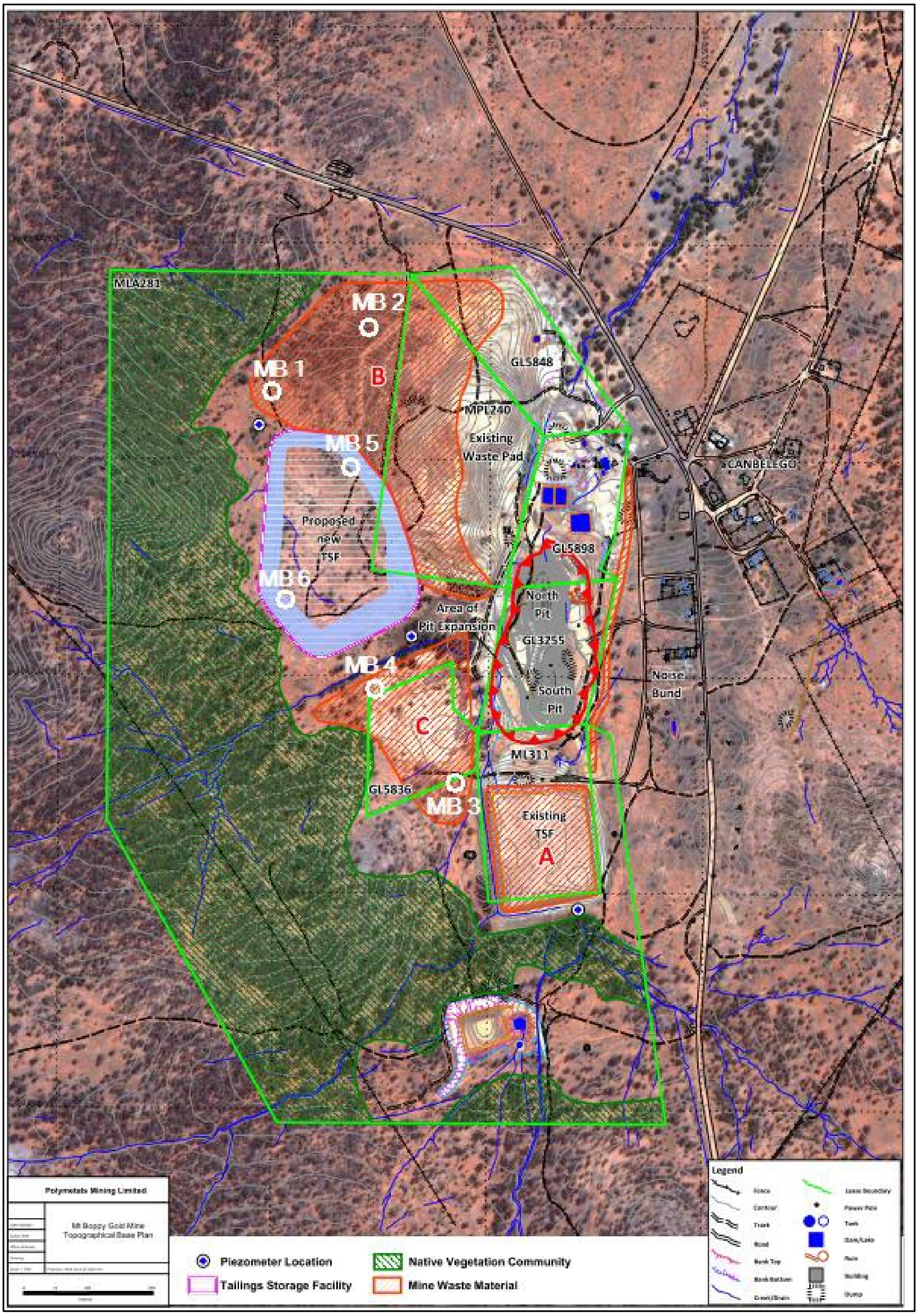

Figure A1. General arrangement and locations of test pit locations for the previous soils assessment (SEEC, 2011).

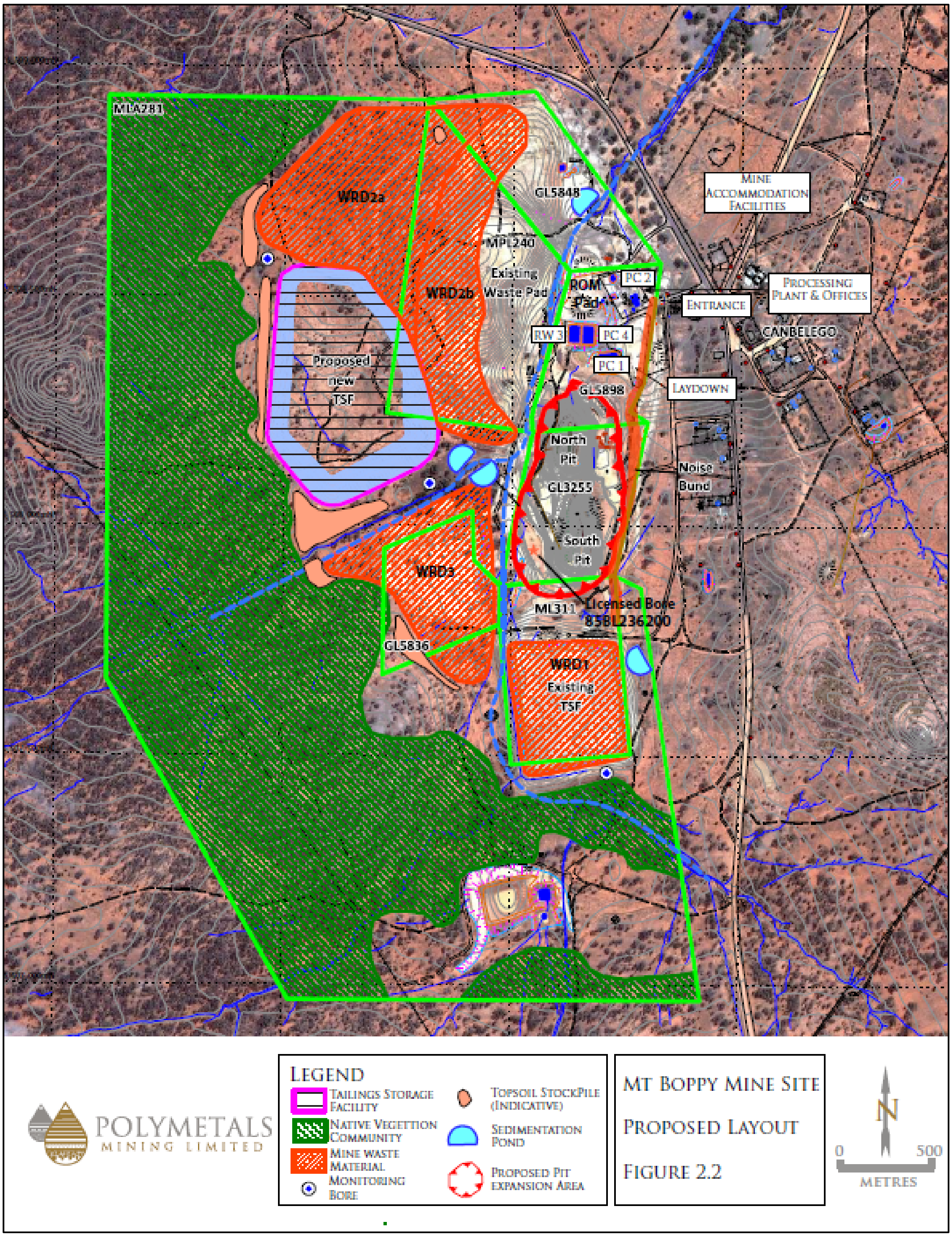

Figure A2. Indicative topsoil sampling locations (Polymetals (Mt Boppy) Pty Ltd, 2011).

APPENDIX B: REVEGETATION SPECIES

Table 16
Revegetation Species List

Genus	Species	Common Name	Comments
Trees			
Brachychiton	*populneus*	Kurrajong	Local to Mine Site
Eucalyptus	*microcarpa*	Grey Box	Local to Mine Site
Eucalyptus	*populnea*	Bimble Box	Local to Mine Site
Eucalyptus	*viridis*	Green Mallee	Locally occurring on shallow / rocky soils
Allocasuarina	*luehmannii*	Buloke	Regionally occurring on a variety of soils
Callitris	*glaucophylla*	White Cypress Pine	Indigenous to Mine Site
Callitris	*endlicheri*	Black Cypress Pine	Locally occurring on shallow / rocky soils
Eucalyptus	*dwyeri*	Dwyer's Red Gum	Locally occurring on shallow / rocky soils
Eucalyptus	*vicina*	Hill Red Gum	Locally occurring on shallow / rocky soils
Eucalyptus	*morrisii*	Grey Mallee	Locally occurring on shallow / rocky soils
Eucalyptus	*intertexta*	Coolibah	Indigenous to Mine Site
Shrubs			
Acacia	*brachystachya*	Umbrella Mulga	Locally occurring on shallow / rocky soils. Seedlings very susceptible to grazing.
Acacia	*colletioides*	Wait-a-while	Locally occurring in Box Woodlands.
Acacia	*deanei*	Dean's Wattle	Locally occurring in Box Woodlands. Susceptible to grazing when young.
Acacia	*decora*	Western Golden Wattle	Locally occurring in Box Woodlands. Very susceptible to grazing.
Acacia	*hakeoides*	Hakea Wattle	Locally occurring in Box Woodlands. Very susceptible to grazing.
Acacia	*triptera*	Spur-wing Wattle	Locally occurring in Mallee / Box Woodlands.
Senna	*artemisioides*	Silver Cassia	Locally occurring in Box Woodlands.
Dodonaea	*truncatiales*	Propellor Hopbush	Locally occurring on shallow / rocky soils.
Geijera	*parviflora*	Wilga	-
Acacia	*aneura*	Mulga	Indigenous to mine site area
Acacia	*excelsa*	Ironwood	Indigenous to mine site
Acacia	*doratoxylon*	Currawang	Locally occurring on shallow / rocky soils
Acacia	*difformis*	Drooping Wattle	Regionally occurring on shallow soils
Acacia	*lineata*	Streaked Wattle	Locally occurring on shallow or rocky soils
Acacia	*montana*	Mallee Wattle	Regionally occurring on shallow or rocky soils
Exocarpos	*aphyllus*	Leafless Cherry	Locally occurring on shallow / rocky soils
Pandorea	*pandorana*	Wonga Vine	Locally occurring on shallow / rocky soils
Pittosporum	*angustifolium*	Butterbush	Regionally occurring on a variety of soils
Pultenaea	*microphylla*	Spreading Bush-pea	Locally occurring on shallow or rocky soils
Santalum	*acuminatum*	Quandong	Regionally occurring on a variety of soils
Groundcover			
Poaceae	*Aristida ramosa*	-	Locally occurring.
Poaceae	*Austrodanthonia caespitosa*	White-Top	Locally occurring.
Poaceae	*Austrostipa scabra*	-	Locally occurring.
Poaceae	*Chloris truncata*	Windmill Grass	Locally occurring.
Poaceae	*Digitaria brownii*	Cotton Panic Grass	Locally occurring.
Poaceae	*Themeda australis*	Kangaroo Grass	Locally occurring.
Chenopodiacae	*Einadia nutans*	Climbing Saltbush	Locally occurring.
Chenopodiacae	*Enchylaena tomentosa*	Ruby Saltbush	Locally occurring.
-	-	Sterile Millet	Temporary stabilisation only – non persistent.
-	-	Perennial Ryegrass	Temporary stabilisation only – non persistent.
Source: Knop (2011) & OzArk			

APPENDIX C: RECORD OF CLIENT SUPPLIED DATA

Table C1. Record of Client Supplied Data

Title	Comments
Geotechnical Assessment of Mine Waste Materials – Mt. Boppy Gold Mine (RGS, 2015)	Lab analysis for some waste material including weathered overburden. Includes volumes of PAF and NAF material for landforms.
Targeted Assessment Program – Soils and Materials Management (NSW Resources Regulator, October 2020)	Audited against progressive rehabilitation obligation in the MOP and, in addition, how soils were being managed on site. Not adequately identified soil risks. Characterisation of soils to identify constraints to rehabilitation is required.
Proposed Redevelopment – Mt Boppy Gold Mine (Response to submissions DA 2011/LD-00070)	Some useful information on rehabilitation and stockpiles.
Soils Assessment for Proposed expansion of Mt Boppy Gold Mine Canbelego, NSW (SEEC, 2011)	Useful. Soils information for soil types and management across the My Boppy site. Includes data Lad data for 6 test pits.
Mt Boppy Gold Mine Proposed Redevelopment Project - Environmental Impact Statement (EIS) (Polymetals (Mt Boppy) Pty Ltd, 2011)	Useful. Topsoil stripping information including indicative stockpile locations. Soils information is from the SEEC soils report. No other soils data provided Information on landforms and rehabilitation domains.
Soil and Water Management Plan for the Mt Boppy Gold Mine (R.W. Corkery & Co, 2016)	Useful. Soils data provided by the SEEC report. Information on available soil resources for rehabilitation and the soil monitoring program.
Remediation and validation report (Envirowest Consulting, 2016)	Contaminated land assessment. Minor soils data but not relevant to assessment.
Mt Boppy Gold Mine Canbelego NSW – Revegetation Strategy 2009/2010 (Knop, 2009)	Strategies for vegetation establishment on landforms. Two methods proposed. Direct seeding contour lines or spot seeding.
Rehabilitation Report 1 February 2019 to 31 January 2020 (Manuka Resources, 2020)	Rehabilitation trials information and rehabilitation domains. No soils data.
Operations Environmental Management Plan – Mt Boppy Gold Mine (v4) (Black Oak Minerals Limited, 2015)	Includes details on rehabilitation, soil and water management plan and performance criteria.
Mount Boppy Mining Operations Plan (R.W Corkery & Co, 2020)	Rehabilitation requirements for Mount Boppy. Details rehabilitation objectives and proposed post mining landform.

Title	Comments
	The proposed Post-mining land uses will predominantly be native vegetation communities suitable for intermittent and very low intensity grazing
Historical Heritage Assessment, (Ozark Environmental and Heritage Management, September 2011)	Provides some topography and geology information. Includes no relevant soil data.
Statement of Environmental Effects for the Mt Boppy Gold Mine (R.W. Corkery & Co. Pty. Ltd., 2015)	Geology and resource information. Waste rock management Minor soil and land capability information. Useful in describing rehabilitation landforms, land uses and objectives.