ENSHAM
RESOURCES
PTY LIMITED

ABN 23 011 048 678

As Operator of the
Ensham Coal Project

Duckponds Road
via Emerald
PO Box 1565
Emerald QLD 4720
Australia

Telephone:
+61 7 4987 3601

Facsimile:
+61 7 4987 3622

Website:
www.ensham.com.au

The Ensham Coal Project is a joint venture of the following companies which are liable severally in the following proportions:

Bligh Coal Limited
ABN 20 010 186 393
47.5%

Idemitsu Australia Resources Pty Ltd
ABN 45 010 236 272
37.5%

Bowen Investment (Australia) Pty Ltd
ABN 12 002 806 831
15.0%

PROGRESSIVE REHABILITATON AND CLOSURE PLAN

Version 2

Mining Leases

7459, 7460, 70049, 70326, 70365, 70366, 70367

14 June 2021

Document ID number: EIMP.06.00.04

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

REHABILITATION PLANNING PART

This PRC Plan *Rehabilitation Planning* part includes information required by the EP Act and the guideline[1] under section 126C(1)(j) of the EP Act. It details how progressive rehabilitation and closure will be carried out over all the lands within relevant resource tenements at Ensham Mine.

Introduction

This a transitional Progressive Rehabilitation and Closure (PRC) Plan for the Ensham coal mine, located near Comet, 40 kilometres (km) northeast of Emerald in central Queensland. Ensham uses conventional open-cut strip-mining and underground bord and pillar mining methods to extract coal from the late Permian aged Rangal Coal Measures. Opencut mining commenced in 1993 and has disturbed an area of approximately 4,731.5 hectares (ha) to date. Underground mining commenced in 2012 and causes no discernible surface disturbance. At the end of 2020, Ensham had completed 1,554.2 ha of land rehabilitation. Most of that rehabilitation has a target post-mining land use (PMLU) of cattle grazing.

Ensham is operated on behalf of joint venture partners by Ensham Resources Pty Limited, a wholly owned subsidiary of Idemitsu Australia Resources Pty Limited. The joint ventures partners (Idemitsu Australia Resources Pty Limited (IAR) 47.5%, Bligh Coal Limited 37.5% and Bowen Investment (Australia) Pty Limited 15%) hold the relevant environmental authority (EA) and seven associated mining lease (ML) tenements covering 12,642.4 ha.

This PRC Plan has been developed in accordance with relevant sections 126C and 126D of the Queensland *Environmental Protection Act 1994* (EP Act) to satisfy requirements in the Queensland Government's *Guideline–Progressive rehabilitation and closure plans* (the Guideline) (DES 2019). The main purpose of the PRC Plan is to-

- Demonstrate planning for rehabilitation, including how and where environmentally relevant activities will be carried out in way that maximises the progressive rehabilitation of land to a stable condition.
- Provide for the condition to which land must be rehabilitated prior to surrender of the EA.

All areas disturbed within the relevant mining tenures will be rehabilitated to a PMLU or managed as a non-use management area (NUMA). Any undisturbed land within the relevant mining tenures is also identified as a PMLU.

Transitional arrangements.

Ensham is an existing, mine operating under an existing site-specific EA. This is a transitional PRC Plan submitted pursuant to the transition notice issued on 13 August 2020. The, transitional provisions of the EP Act operate to preserve existing outcomes, which outcomes are reflected in this PRC Plan.[2]. Ensham has pre-approved non-use management areas (NUMAs) as detailed in land outcome document EA *EPML00732813*. As Pre-approved NUMAs are provided under the current EA, the following requirements do not apply to this PRC Plan -

- Justification of the NUMA.
- Evidence to support justification of the NUMA.

---

[1] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.0.*

[2] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00*, p47

- Public interest evaluation.
- Compliance with the prohibition of voids located within a flood plain having to be rehabilitated to a stable condition.

This PRC Plan outlines how Ensham will manage NUMAs to achieve best practice management and minimise risks to the environment.

Land outcome documents.

Land outcome documents are defined in section 750 of the EP Act. The following land outcome documents are relevant to this PRC Plan.

Legislative requirement	Land outcome documents
land outcome document, for land, means the following documents relating to the land—	
(a) an environmental authority for a resource activity on the land;	1. EA *EPML00732813,* dated 3/9/2020.
(b) a document made under a condition of an environmental authority mentioned in paragraph (a), if— (i) the document relates to the management of a void within the meaning of section 126D on the land, or the rehabilitation of the land; and (ii) the document was received by the administering authority before the assent date; and (iii) the administering authority has not, within 20 business days after the assent date, given notice to the holder of the environmental authority that the document is insufficient in a material particular relevant to a matter mentioned in subparagraph (i); and (iv) before the assent date, the document had not been superseded;	
(c) a document made under a condition of an environmental authority mentioned in paragraph (a), if— (i) the document relates to the management of a void within the meaning of section 126D on the land, or the rehabilitation of the land; and (ii) the environmental authority requires the document to be given to the administering authority on a stated day that is on or after the assent date, or does not state a day when the document must be given; and (iii) the document is received by the administering authority within 3 years after the assent date; and (iv) the administering authority does not, within 20 business days after receiving the document, give the holder of the environmental authority notice that the document is insufficient in a material particular relevant to a matter mentioned in subparagraph (i);	None.
(d) a report evaluating an EIS under the *State Development and Public Works Organisation Act 1971*, section 34D;	None.
(e) an EIS assessment report;	None.
(f) a written agreement between the holder of an environmental authority mentioned in paragraph (a) and the State that is in force on the assent date.	None.

Ensham notes that the land outcome document list is hierarchical. Where there is an inconsistency between these documents, on either the final outcome or details of the outcome, then the document appearing first in the list will prevail to the extent of the inconsistency[3].

Accuracy.

Mining lease spatial inaccuracies.

Mining lease polygons used in this PRC Plan were downloaded from *QSpatial – Queensland Spatial Catalogue* (see http://qldspatial.information.qld.gov.au/catalogue/custom/index.page). We note this spatial data has inaccuracies in areas (size and extent) and boundaries (points and lines) (Figure P0-1). Inaccuracies mean the sum of each mining lease area is greater than the total area when mining leases are presented together. In this PRCP, all spatial data presented is accurate on a per mining lease basis only and cumulative totals are the sum of each tenement.

Cartesian area versus spherical area.

The QSpatial attribute area data is based on the registered survey plan. The area for survey plans is calculated as a cartesian area, which assumes a flat plane. In contrast, this PRC Plan presents all polygons as spherical area. Spherical area takes account of the curvature of the surface of the earth.

The sizes of planned versus actual rehabilitation areas will vary with level of accuracy.

There are many challenging aspects of mined land rehabilitation that will result in unavoidable mismatches between the size of predicted rehabilitation polygons or areas and the size of actual rehabilitation areas. These include design tolerances, and assumptions made on material volume losses and gains in earthworks, and the cascading effect that changes to one area have on those surrounding it. Whilst this PRC Plan reports future rehabilitation areas with a high degree of accuracy i.e., up to two decimal places, this level of accuracy is not realistic in rehabilitation earthworks. The identified rehabilitation areas are therefore subject to the following levels of accuracy:

- For discrete rehabilitation or improvement areas, the hectares presented herein are accurate to ±15 %.
- For total areas of PMLUs and NUMAs, the hectares presented herein are accurate to ±5 %.

[3] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00, p48.*

Example of spatial data inaccuracies in QSpatial

1 PROJECT PLANNING

Legislative requirement	Compliance
In accordance with section 126C(1)(b) and (c)(ii) of the EP Act, the rehabilitation planning part of the PRC plan must include a description of:	
• each resource tenure, including the area of each tenure	Table 1-1
• the relevant activities to which the application relates	Table 1-3
• the likely duration of the relevant activities	Section 1.1
• how and where the relevant activities are to be carried out, including maps.	Section 1.1.1 & Figure 1-1

1.1 Project description

Ensham is an operating opencut and underground coal mine located 40 kilometres (km) northeast of Emerald, near Comet, in central Queensland (Figure 1-1). The opencut uses a single dragline to expose coal which is removed with excavators and trucks. The underground uses five continuous miner production units to extract coal and a coal clearance system to convey coal to surface stockpiles. Ensham produces a high energy, low ash thermal coal for export via Gladstone Port and domestic electricity generation at Gladstone Power Station. The mine has operated since 1993 and supports a workforce of approximately 600 employees and contractors.

There are seven relevant resource tenements (Table 1-1, Table 1-3, and Figure 1-2). The mining operation commenced at Yongala on ML 70049 in 1993 with other mining leases added since, totalling a combined area greater than 12,000 ha. The duration of mining as a whole is planned to cease in 2037 with the completion of rehabilitation in 2043, subject to the approval of mining lease renewal where required. Primary mine features at Ensham include open-cut pits and waste rock dumps, Underground infrastructure, rehabilitation, and Mine infrastructure (Figure 1-3). As this is a transitional PRC Plan, Ensham is not required to demonstrate how aspects of the mine site have been designed for closure for existing or approved disturbance.[4]

Table 1-1 Ensham mining leases

Mining lease (ML)	Authorised holder	Grant date	Expiry date	Registered survey (ha)
70049	Bligh Coal Ltd Idemitsu Australia Resources Pty Ltd Bowen Investment (Australia) Pty Ltd	28/01/1993	31/01/2028	1,648.0
7459	Bligh Coal Ltd Idemitsu Australia Resources Pty Ltd Bowen Investment (Australia) Pty Ltd	21/04/1994	31/01/2028	6,154.0
70367	Bligh Coal Ltd Idemitsu Australia Resources Pty Ltd Bowen Investment (Australia) Pty Ltd	21/04/1994	31/01/2028	1,004.0
7460	Bligh Coal Ltd Idemitsu Australia Resources Pty Ltd Bowen Investment (Australia) Pty Ltd	21/04/1994	31/01/2028	774.3
70326	Bligh Coal Ltd	15/09/2005	31/1/2028	25.7

[4] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00, p19.*

Mining lease (ML)	Authorised holder	Grant date	Expiry date	Registered survey (ha)
	Idemitsu Australia Resources Pty Ltd Bowen Investment (Australia) Pty Ltd			
70365	Bligh Coal Ltd Idemitsu Australia Resources Pty Ltd Bowen Investment (Australia) Pty Ltd	04/11/2010	31/01/2028	2,766.0
70366	Bligh Coal Ltd Idemitsu Australia Resources Pty Ltd Bowen Investment (Australia) Pty Ltd	04/11/2010	31/01/2028	254.3

Table 1-2 Ensham affected lands and landholders

Mining lease (ML)	Lot on Plan	Landholders
70049	Lot 3 CP911009 Lot 2 SP165518	MD, ME, EM, JD & SM Shaw RH & RJ Simmons
7459	Lot 31 CP864573 Lot 32 RP908643 Lot 30 CP864574 Lot 33 RP864576	Bligh Coal Ltd (47.5%) Idemitsu Australia Resources Pty Ltd (37.5%) Bowen Investment (Australia) Pty Ltd (15%)
70367	Lot 31 CP864573 Lot 32 RP908643	Bligh Coal Ltd (47.5%) Idemitsu Australia Resources Pty Ltd (37.5%) Bowen Investment (Australia) Pty Ltd (15%)
7460	Lot 31 CP864573 Lot 32 RP908643	Bligh Coal Ltd (47.5%) Idemitsu Australia Resources Pty Ltd (37.5%) Bowen Investment (Australia) Pty Ltd (15%)
70326	Lot 31 CP864573	Bligh Coal Ltd (47.5%) Idemitsu Australia Resources Pty Ltd (37.5%) Bowen Investment (Australia) Pty Ltd (15%)
70365	Lot 31 CP864573 Lot 32 RP908643	Bligh Coal Ltd (47.5%) Idemitsu Australia Resources Pty Ltd (37.5%) Bowen Investment (Australia) Pty Ltd (15%)
70366	Lot 30 CP864574	Bligh Coal Ltd (47.5%) Idemitsu Australia Resources Pty Ltd (37.5%) Bowen Investment (Australia) Pty Ltd (15%)

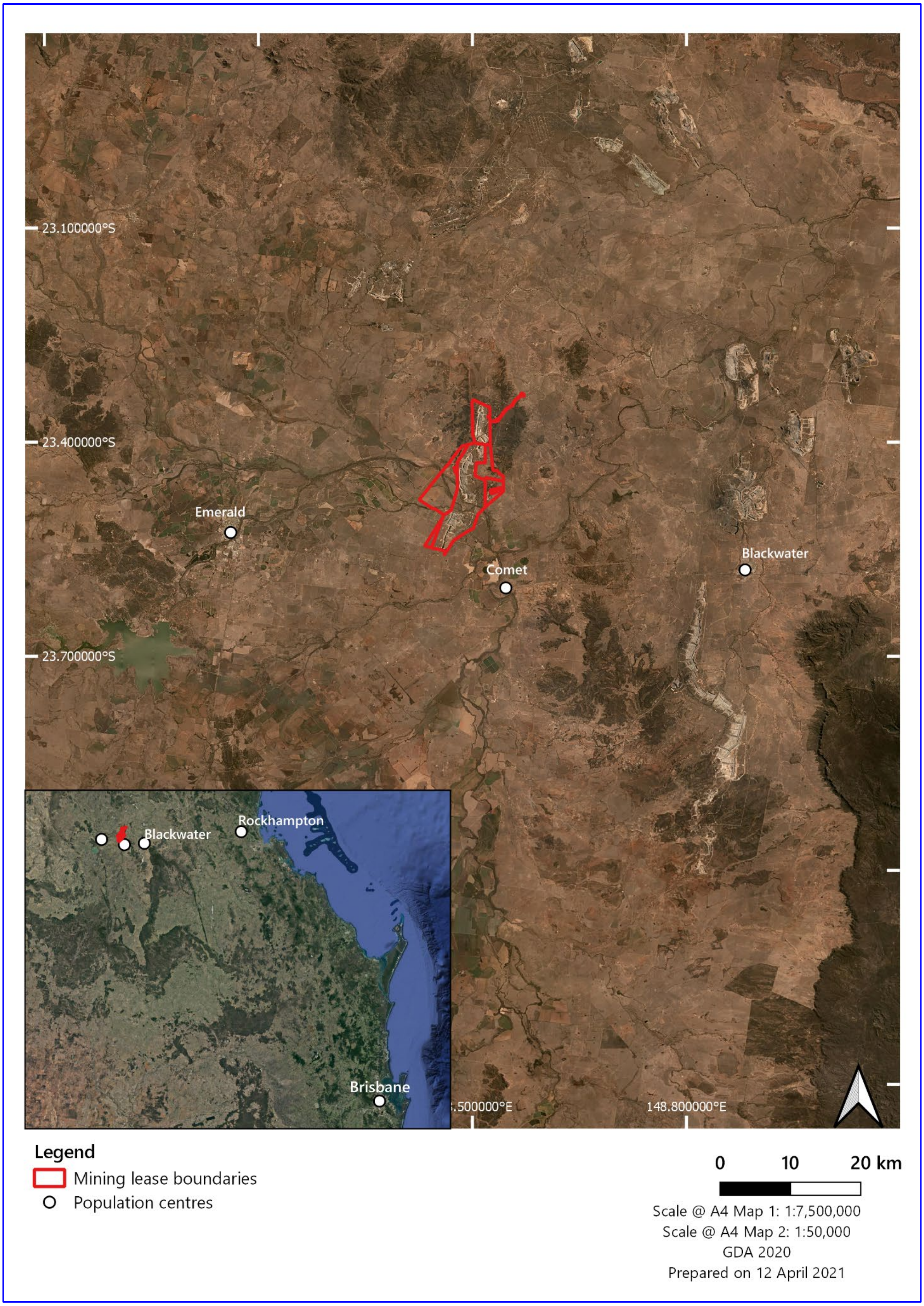


Figure 1-1 Ensham location in central Queensland

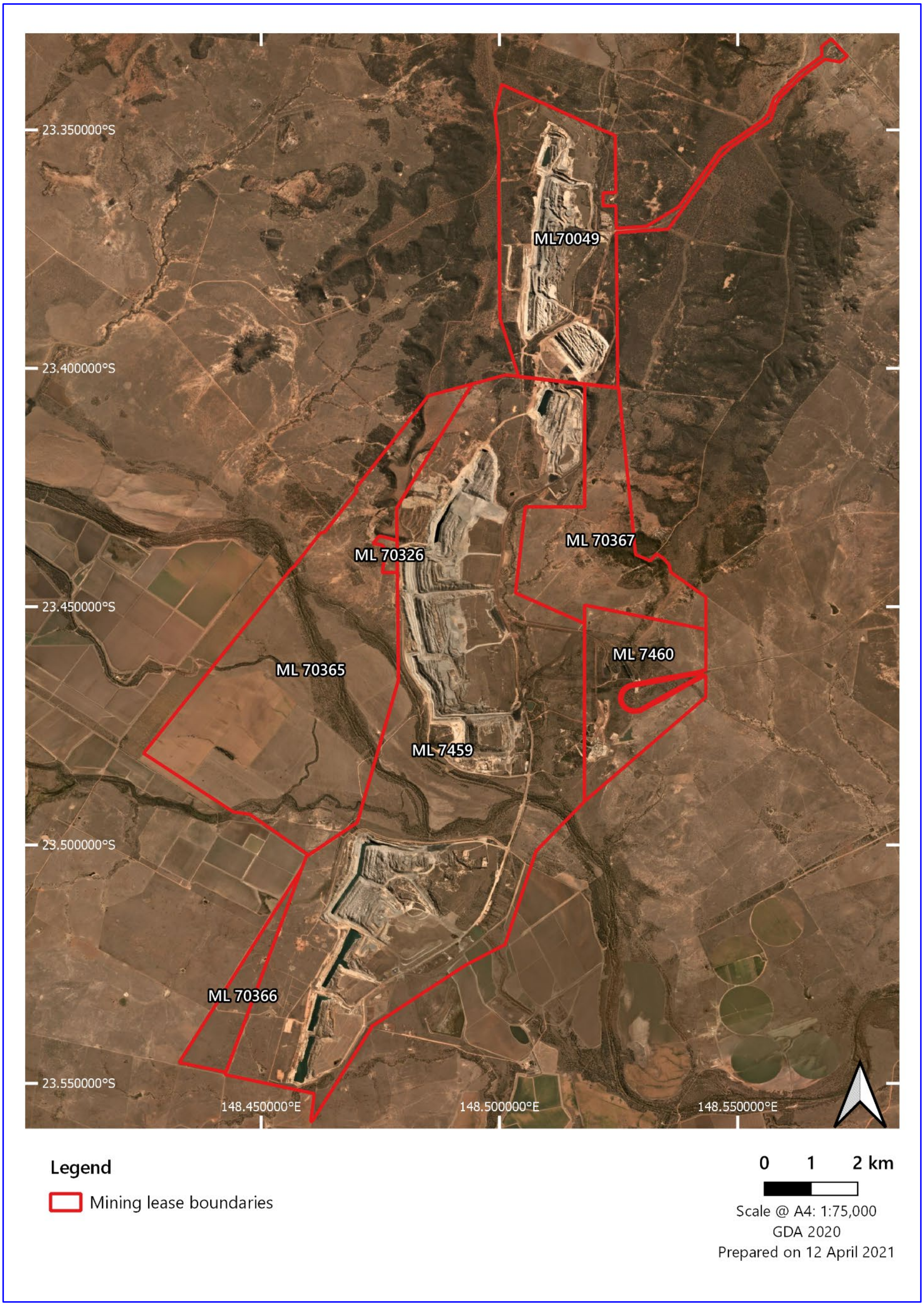


Figure 1-2 Ensham resource tenements (mining leases)

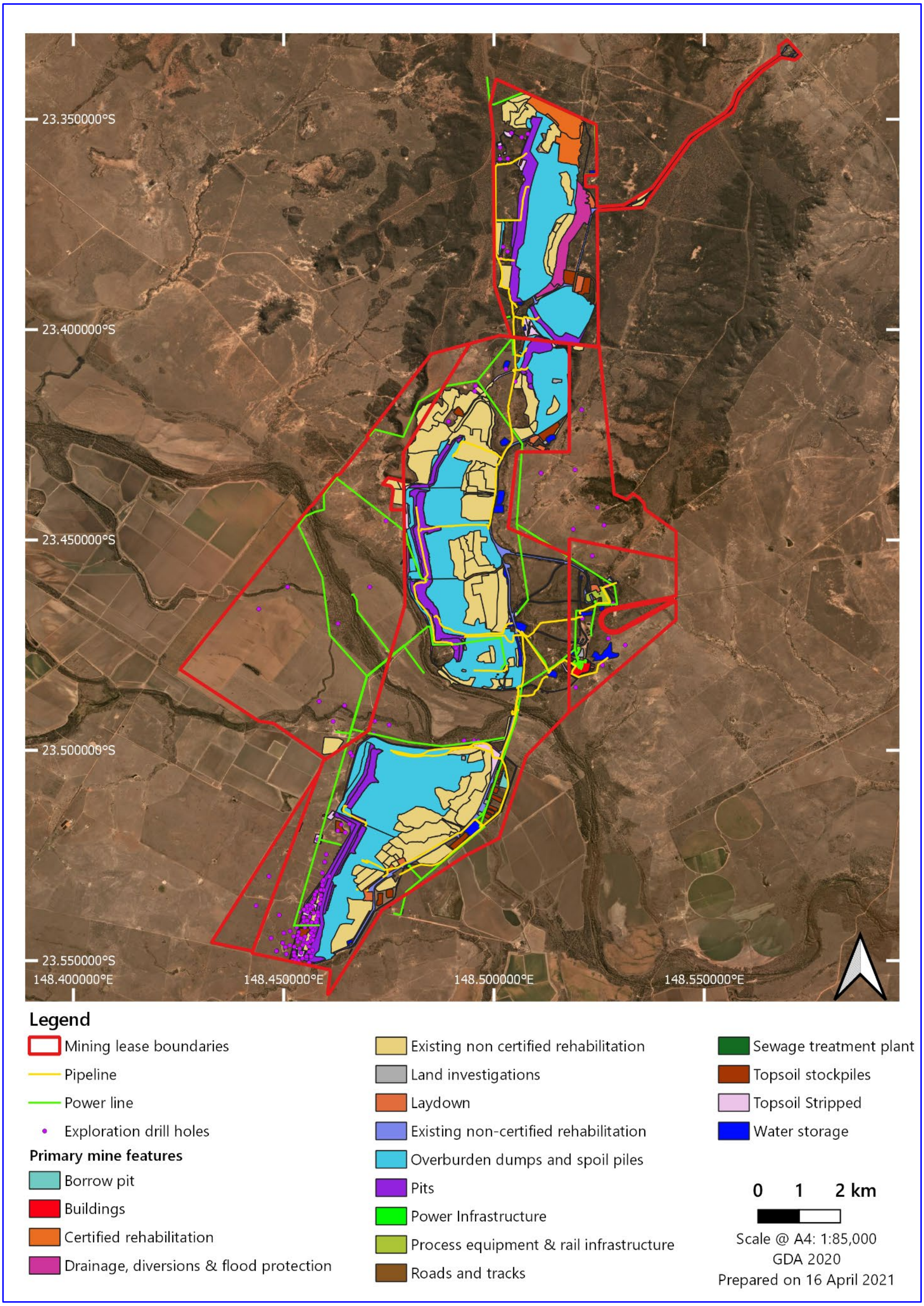


Figure 1-3 Ensham primary mine features

1.1.1 Environmentally Relevant Activities (ERA's)

Ensham's EA (EPML00732813) authorises the carrying out of the below listed ERA's. Not all ERA's currently occur in all mining leases despite that all ERA's are authorised for all mining leases. While open cut mining operations are downsizing, it is not possible to define the future commencement or locations of ERA's at Ensham specifically. A renewal is planned to be sought for all mining leases where required.

Table 1-3 Ensham environmentally relevant activities

Mining lease (ML)	Relevant activities	Start	Finish
70049	Mining black coal	1993	2028
	Extraction & screening	1993	2028
	Waste disposal	1993	2028
7459	Mining black coal	1994	2043
	Chemical storage	1994	2043
	Extraction & screening	1994	2043
	Regulated waste storage	1994	2043
	Waste disposal	1994	2043
	Sewage treatment	1994	2043
70367	Mining black coal	1994	2043
7460	Mining black coal	1994	2043
	Sewage treatment	1994	2043
70326	Mining black coal	2005	2043
70365	Mining black coal	2010	2043
70366	Mining black coal	2010	2043

It is noted that the below figure does not display the extent of ERA 13 – mining black coal, as it extent is variable in both open cut and underground operations across the mining leases. It is considered that black coal mining occurs across the mining leases as a whole.

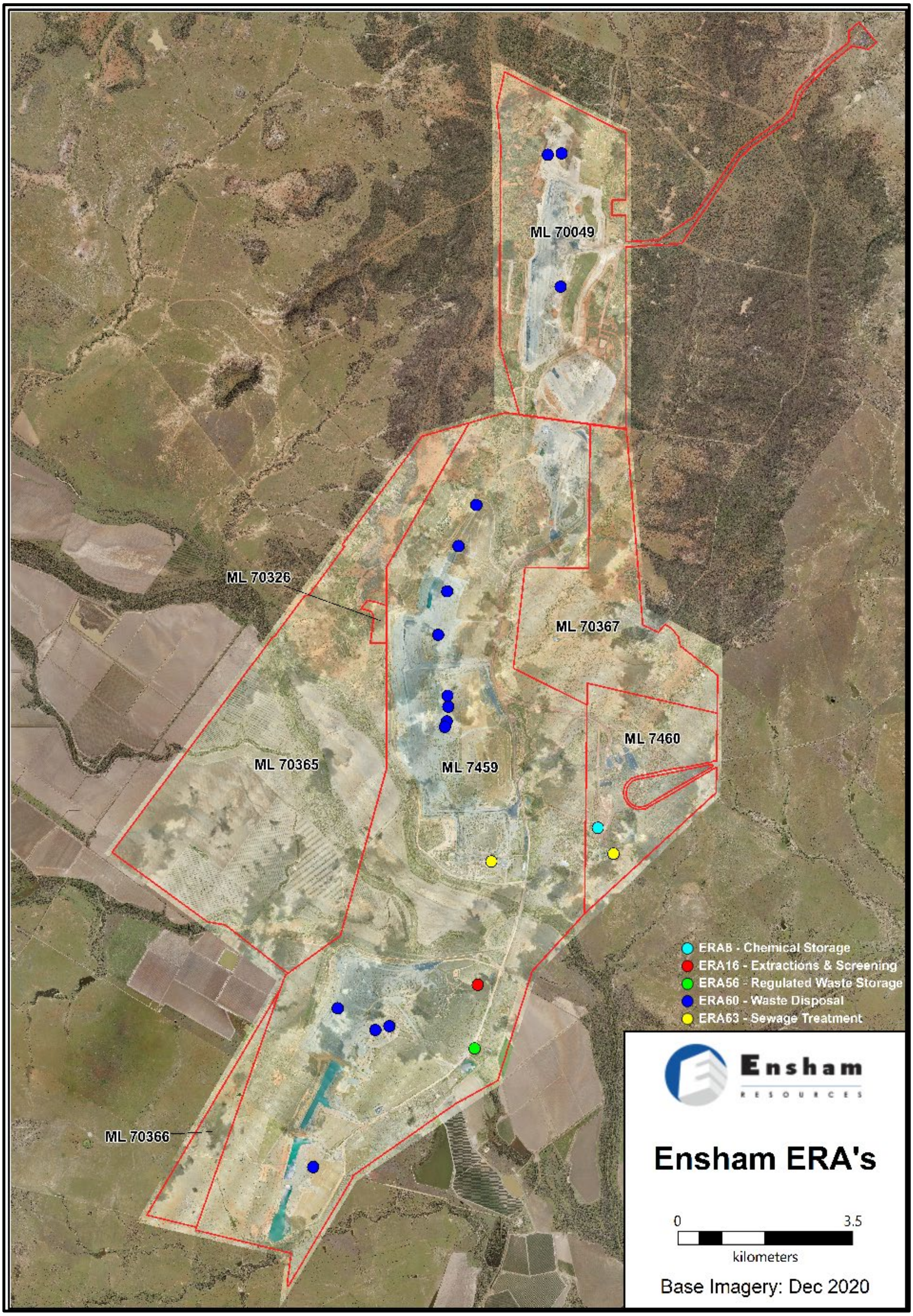


Figure 1-4 Environmentally relevant activities

1.2 Existing rehabilitation

Ensham has completed more than 1,550 ha of opencut mine rehabilitation since 2003 (Figure 1-5, Figure 1-6, Figure 1-7 and Figure 1-8). This equates to approximately one third of total mining disturbances. Most existing rehabilitation has a target PMLU of beef cattle grazing. Portions of existing rehabilitation have been applied for or approved as certified under the EP Act (Table 1-4). Following approval of the current application for certification of progressive rehabilitation in 2021, Ensham will have more certified rehabilitation than any other opencut coal mine in Queensland.

Table 1-4 Ensham existing rehabilitation

Status	Area (ha)
Certified (2018)	97.2
Application for certification (2021)	673.8
Not yet applied for or certified	783.2
TOTAL	**1554.1**

Figure 1-5 Existing rehabilitation at AB Pit (ML7459)

These areas are currently used for beef cattle grazing.

Figure 1-6 Existing rehabilitation at CDE Pit (ML7459)

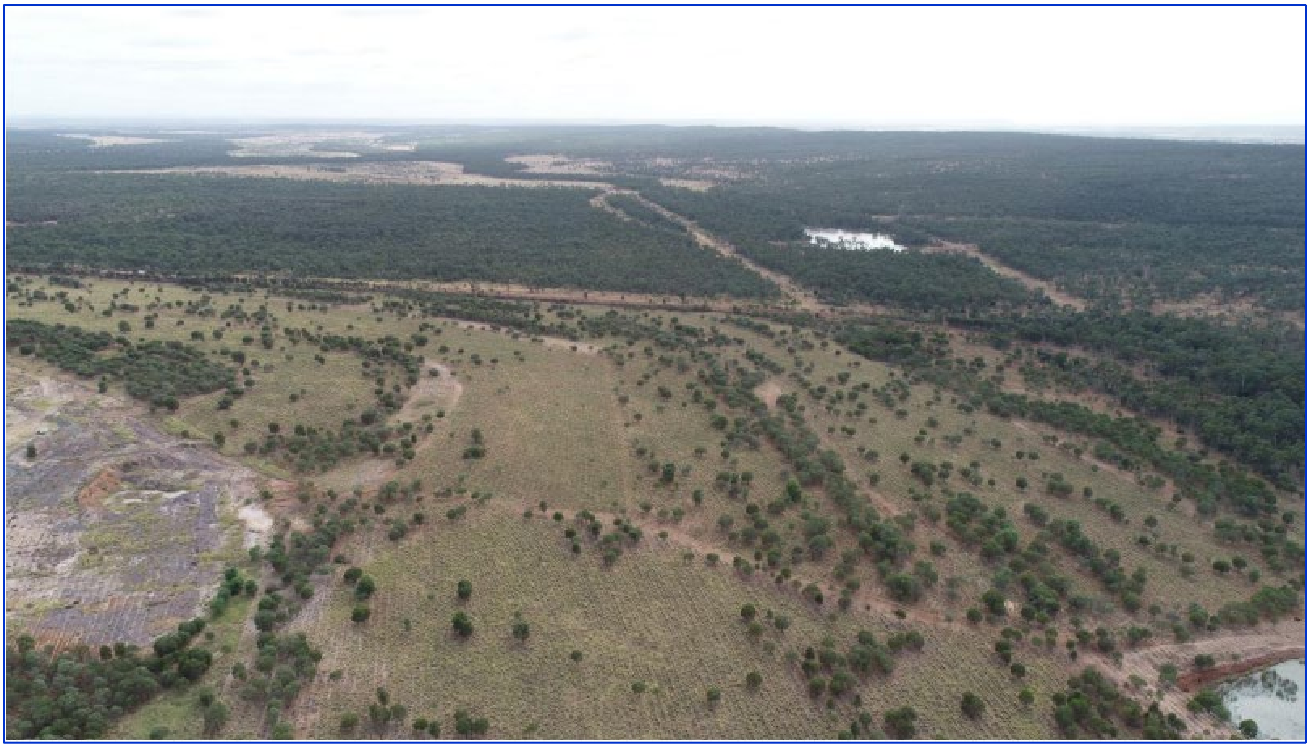


Figure 1-7 Existing rehabilitation at Y Pit (ML70049)

This area was certified in 2019 and is currently used for beef cattle grazing.

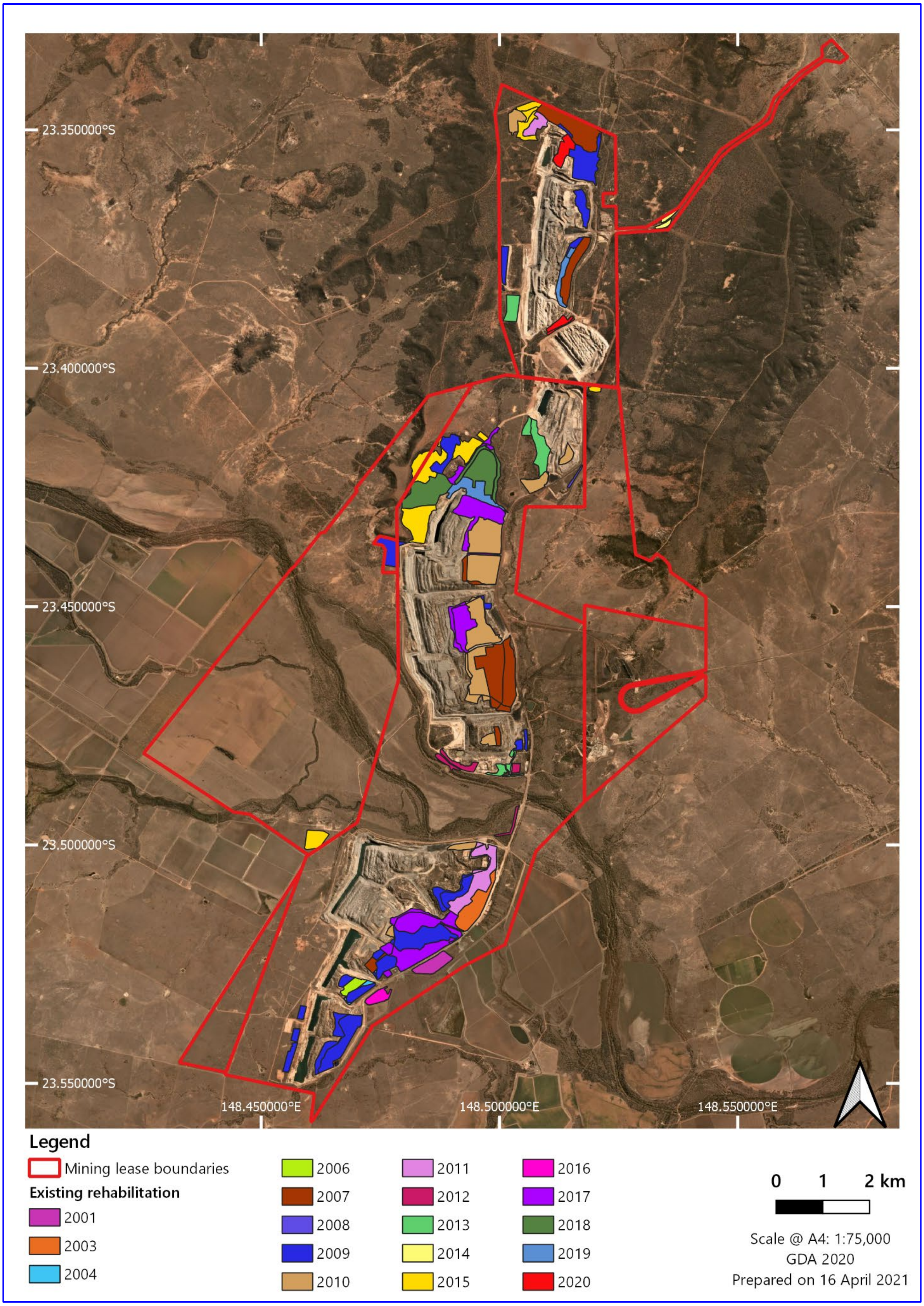


Figure 1-8 Ensham existing rehabilitation

1.3 Baseline Information

1.3.1 Site topography

The pre-mining topography at Ensham (Figure 1-9) is described as follows:

- Terrain in the northern half of the mine comprises mainly mildly dissected gently to moderately sloping and undulating lands, which form slopes and outwash plains flanking Boggy Creek. Erosion has occurred below the elevated plateau remnants that occur in the north. Plateau remnants feature steep escarpments, with sloes in the order of 33% to 66% gradient or more, with local relief up to 50 m between plateau crests and adjacent escarpment foot slopes.
- In the southern half, terrain is essentially gently sloping. This encompasses the extensive floodplain area of the Nogoa River and its major tributaries which flow through the area in a south-easterly direction within a broad alluvial tract approximately 4 km wide.

Key post-mining landform design parameters for rehabilitation are within the natural range of geometries of local landforms e.g., slope gradients and lengths.

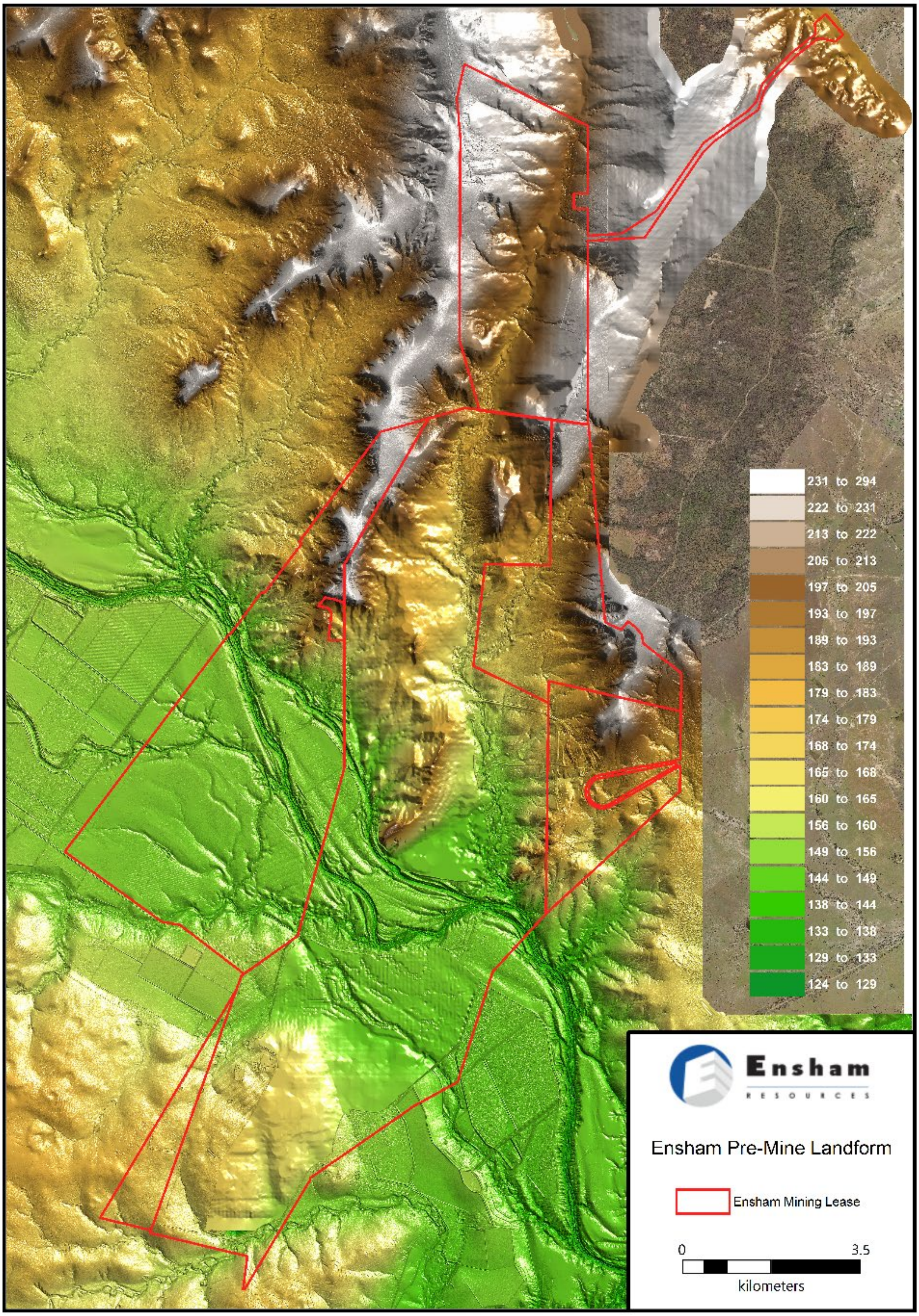


Figure 1-9 Ensham pre-mining topography

1.3.2 Climate

1.3.2.1 General

Ensham is in the Central Highlands Region which has a sub-tropical climate characterised by high variability in rainfall, temperature, and evaporation. Drought, flood, heatwaves, and frost are features of the climate. In general, winter days are warm and nights are cool, while summer days are hot and nights are warm. Rainfall summer dominant with almost half falling between December to February, often as high intensity thunderstorms.

According to CSIRO (2016), long term climatic modelling for Eastern Australia has predicted with very high confidence an increase in average minimum and maximum temperatures, the intensity of extreme rainfall events and the projection of droughts. A medium confidence prediction also indicates that there will be a decrease in average rainfall during winter and spring.

The closest Bureau of Meteorology (BoM) stations are Comet Post Office and Emerald Post Office.

1.3.2.2 Temperature, rainfall, and evaporation

December and January are the warmest months, reaching average high temperatures of 34.6 degrees Celsius (^{0}C) (Table 2-1). June and July are the coolest months. Humidity is fairly consistent throughout the year with morning ranging from 55 – 69 % and afternoons ranging from 33 – 47 %, with spring months drier than the rest of the year.

Average monthly rainfall approximately 17 mm in July to almost 90 mm in February. The average rainfall is received in about 60 rainy days. Almost half of annual rainfall occurs in summer, between December and February.

Table 1-5 Average temperatures rainfall and evaporation Emerald Airport from 1992 to 2020 (BoM 2020a)

Month	Temperature (°c)		Rainfall
	Min	Max	(mm)
January	22.3	34.6	84.2
February	22.1	33.8	87.6
March	20.5	32.8	59.7
April	17.0	30.0	28.9
May	13.1	26.4	18.0
June	10.3	23.4	30.4
July	9.1	23.4	17.2
August	10.0	25.5	20.3
September	13.6	29.2	25.6
October	17.1	31.8	44.2
November	19.5	33.5	50.4
December	21.4	34.5	81.5

Evaporation exceeds rainfall in all months (Table 1-6). Unremarkably, the highest deficits occur in the warmer months. The annual average moisture deficit is approximately 1,500 mm.

Table 1-6 Evaporation and moisture deficits (BoM 2020b)

Month	Rainfall (mm)	Evaporation (mm)	Moisture deficit (mm)
January	124.8	229.5	104.7
February	161.8	182	20.2
March	45.4	180.2	134.8
April	6.6	162.8	156.2
May	9.8	121	111.2
June	17.2	102.2	85
July	11.8	104.9	93.1
August	13.6	152.8	139.2
September	6.2	162.7	156.5
October	89	206.2	117.2
November	38.4	249.5	211.1
December	42.6	223.9	181.3
Total	**567.2**	**2077.7**	**1510.5**

1.3.3 Geological setting

Ensham mine is located within the western Bowen Basin. The stratigraphic sequence across the mining lease is comprised of unconsolidated Quaternary sediments overlying consolidated Permian and Triassic materials (Table 1-7). The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular (Ensham Resources 2018).

The coal deposits targeted for mining are located within the Rangal Coal Measures, the uppermost Permian unit (Figure 1-10). The Rangal Coal Measures are 100 m thick, and subcrop over a strike length of approximately 80 km around the northern and eastern limits of the mine. The coal seams which occur at Ensham include the following:

- The Aries seam (A1),
- The Aries 2-Castor seam (A2C), 4.3m thick,
- The Castor Seam Lower Split (C22), between 0.2 and 0.4 m thick, and
- The Pollux Seam, present 6 to 12 m below the C22 Seam (Figure 1-11).

Table 1-7 Ensham stratigraphic summary

Age	Unit	Description
Quaternary	-	Alluvium, comprising soil, silt, clay, sand, and gravel.
Tertiary	Emerald Formation	Mudstone, sandstone, conglomerate, siltstone sediments, weekly consolidated in parts. Tertiary volcanics (basalt) are also mapped as being present over 10 km to the west of the mine.
Triassic	Rewan Group	Mudstone with lithic sandstone interbeds.
Permian	Rangal Coal Measures	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams. Coal seams include the Aries, Castor, Pollux and Orion seams. The main economic seams at Ensham are the Aries 2 and Castor seams.
	Burngrove Formation	Sandstones, siltstones and mudstones, and banded coal seams frequently interbedded with tuff and tuffaceous mudstones - coal seams include the Virgo and Leo seams.

Fair Hill Formation	Lithic and feldspathic labile sandstone, siltstone, mudstone and conglomerate.
Macmillian Formation	Lithic and feldspathic sublabile mudstone, siltstone and sandstone.

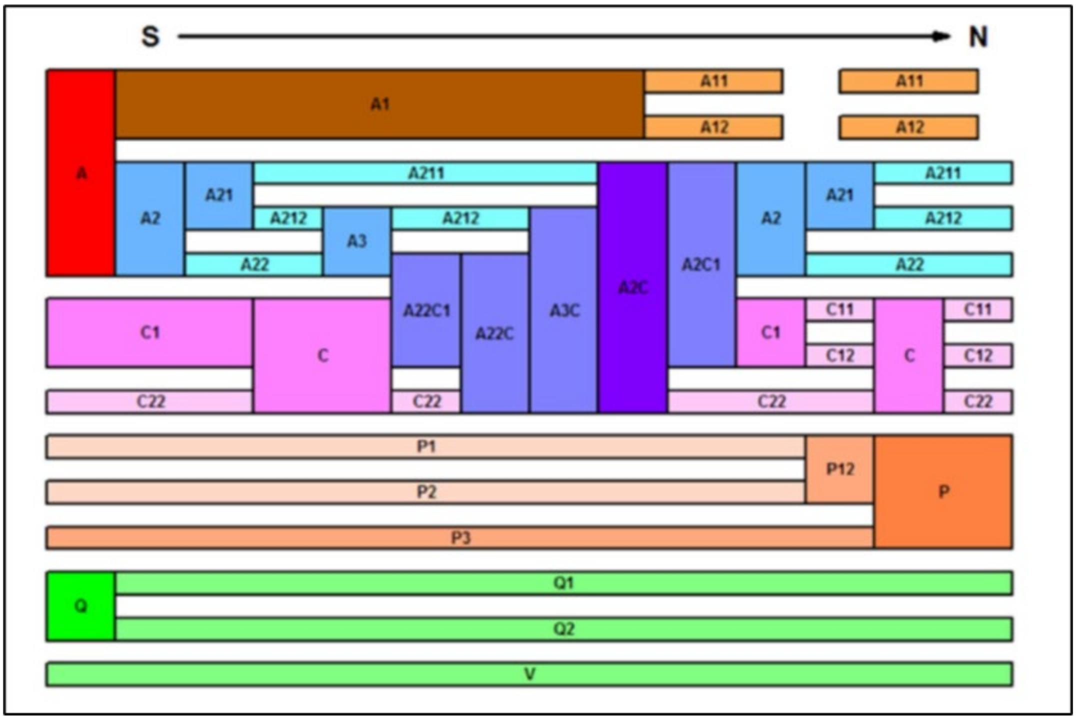


Figure 1-10 Rangal coal measures at Ensham

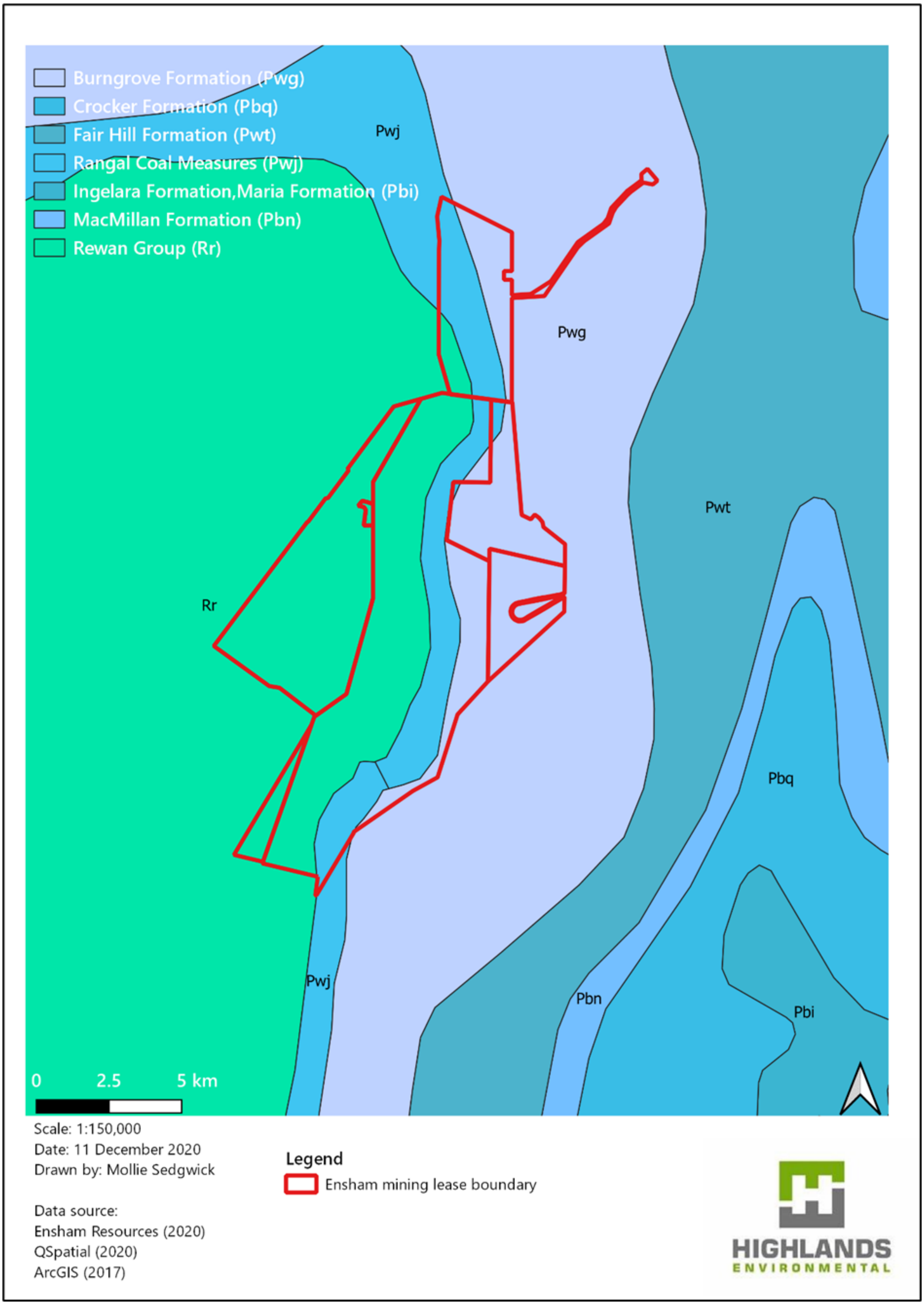


Figure 1-11 Geological units at Ensham

1.3.4 Site hydrology and fluvial units

Ensham is located approximately 10 km upstream of the confluence of the Nogoa and Comet Rivers and encompasses parts of the northern and southern floodplains of the Nogoa River. Boggy Creek is a smaller ephemeral tributary of the river which flows from the north, parallel to the exiting mine. Winton Creek is another ephemeral tributary which traverses the mine site on the south side of the river.

The Nogoa River forms part of the headwaters of the Fitzroy River Basin and includes the major tributary of Theresa Creek. The Nogoa and Comet Rivers combine to form the McKenzie River, which further downstream joins the Dawson River to become the Fitzroy River. The Fitzroy River flows to the Coral Sea at Rockhampton and is one of eastern Australia’s largest river catchment systems.

Key features of fluvial networks at Ensham are as follows:

- The Nogoa River dissects the mine (Figure 1-12). The flood plain has been temporarily restricted to 1,600 m width by flood protection levees. Mine Domain 7 – Flood Protection Landform will ultimately re-establish a minimum floodplain width of 2,000 m.
- Ephemeral tributaries of the Nogoa River that flow across the mining leases are Boggy, Winton and Mosquito Creeks.
- Corkscrew Creek, an ephemeral tributary of the Comet River, flows through the southern corner of ML 7459.
- A licenced diversion exists on Boggy Creek. Rehabilitation of this diversion to re-establish comparative up- and down-stream geomorphological characteristics commenced in 2020 and will be completed in 2021. This is Mine Domain – 3 Boggy Creek Diversion.

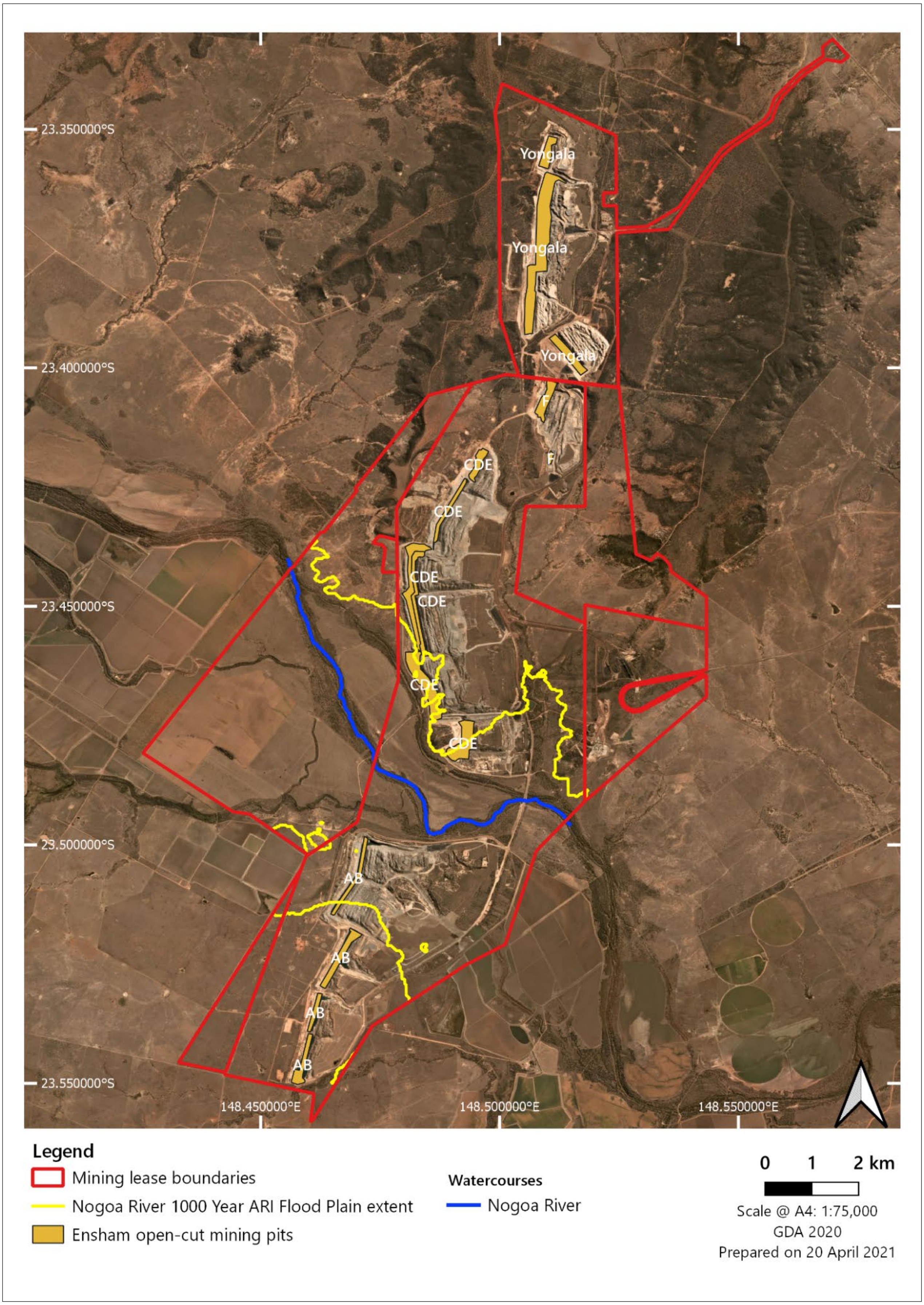


Figure 1-12 Nogoa River pre-mining floodplain extents

1.3.5 Groundwater

There are two main groundwater bearing units at Ensham, viz. the shallow alluvium (Quaternary aged sediments) association with the Nogoa River floodplain and the much deeper Permian aged Rangal Coal Measures. These units are not hydraulically connected and are separated by a low permeability unit.

The alluvium is an unconfined system recharged by rainfall and irrigation practices. Its water is saline and unsuitable for uses such as stock watering or irrigation. The alluvium is not well connected with the Nogoa River (Figure 1-13). Notwithstanding, groundwater monitoring by Ensham indicates standing water levels are influenced by rainfall and large flooding events (Figure 1-14).

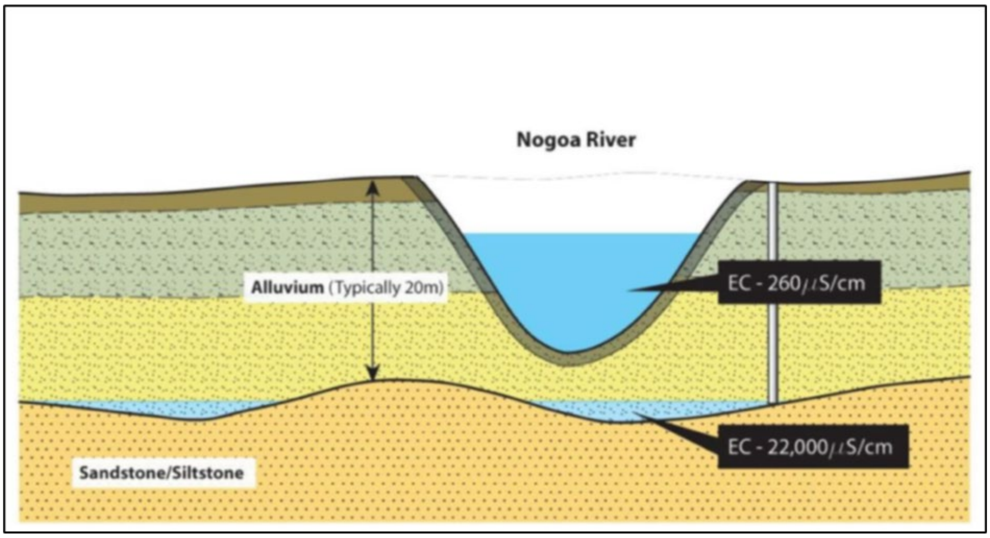


Figure 1-13 Conceptual cross-section of the Nogoa River floodplain and Quaternary alluvium aquifer (AGE 2006)

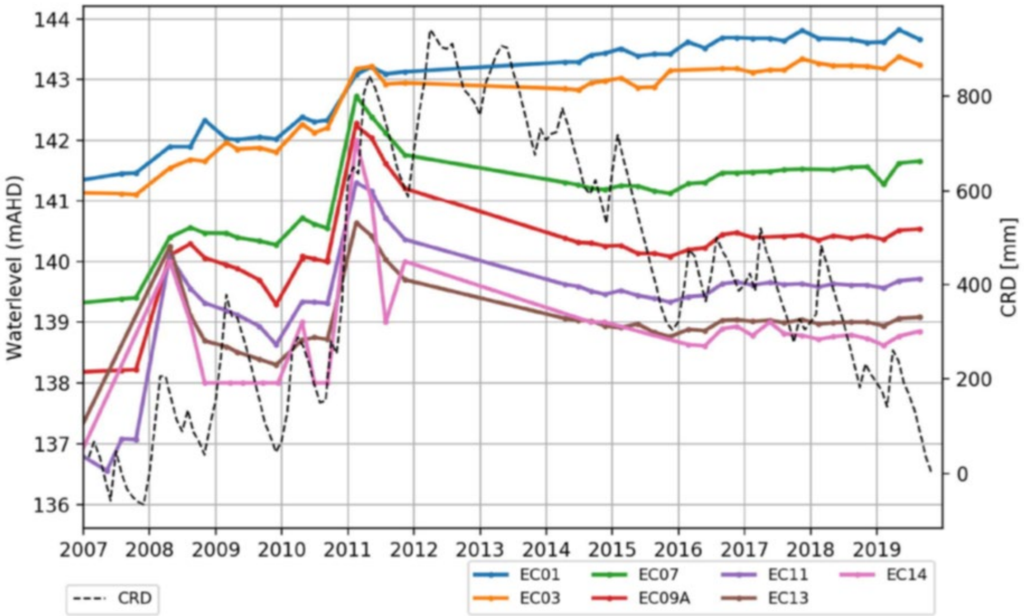


Figure 1-14 Standing water levels in Quaternary alluvium monitoring bores and cumulative rainfall departure (CRD) (SLR Consulting 2020)

Groundwater in the coal seams is also saline and not suitable for stock water supply or irrigation. These aquifers are confined to overlying and underlying shale and mudstones and exhibit relatively low transmissivity and recharge rates. Storage and movement of groundwater occurs within the coal seams, primarily along cleats and fissures and occasionally within minor fault zones. Groundwater quality is variable but typically very poor within this aquifer due to high salinity.

1.3.6 Soils

Story *et al.* (1967) describe several land systems and associated soil groups at Ensham (Table 1-8 and Figure 1-15). There are six major soil groups present, each with one or more soil type variants (Table 1-9). Soils are generally highly weathered and chemically and physically poor, with salinity and sodicity limiting productivity at depth i.e., saline and sodic subsoils.

Table 1-8 Land systems at Ensham

Land system	Description	Approximate area within mining lease boundaries (ha)
Humboldt	Blackbutt and brigalow on weathered clay plains occurring in most parts of the area; texture contrast and cracking clay soils.	3208.8
Monteagle	Lowlands with box and texture-contrast soils on undissected Tertiary land surface throughout the area except in the extreme south and north-east.	1308.7
Blackwater	Characterized by brigalow plains and cracking clay soils on weathered tertiary clay and older rocks along the central axis of the area.	1923.6
Comet	Alluvial plains with brigalow and cracking clay soils, often flooded, along major streams.	3834.4

Durandella	Hills with lancewood and narrow-leaved ironbark on weathered Tertiary and Permian rocks in the north-west, center, and south-east; shallow rocky soils.	1922.9
Girrah	Lowlands with downs and brigalow and cracking clay soils on unweathered Permian shale and lithic sandstone in the north and center.	414.7

Table 1-9 Soil groups at Ensham (from Hansen 2006)

Major soil group	Soil type	Soil classification	Soil description
1 - Shallow Rocky Soils	1	Leptic Rudosols	Soil type 1 occurs on low rocky hills and steep escarpment slopes and eroded plateau remnants. These soils are shallow (<0.5m), exhibit very little profile development and contain gravel and rock cobbles from various geological formations.
2 – Moderately Shallow Gravelly Sands, Loams or Clay Soils	2.1	Colluvic Clastic Rudosols	This soil group occurs on eroded middle and lower slopes and broad low gravelly rises. These soils are shallow to medium depth and comprise uniform or weakly gradational sands, loamy sands or sandy loams, loams or clayey soils with varying amounts of ferrundinous and siliceous gravel or stone. These soils exhibit low soil fertility and water storage capacity.
	2.2	Regolithic Chemic Tenosols	
	2.3	Acidic Brown Clastic-Leptic Rudosols	
3 – Gradational Red and Yellow Earth Soils	3.1	Petroferric Red Kandosols-Tenosols	These soils area present on the elevated dissected and eroded Tertiary plateau remnants and undulating plains associated with the Tertiary Emerald Formation. These soils include sandy, sandy loam or loamy surface soils grading to red, reddish brown or yellowish-brown sandy loam to light to medium massive or structured clay subsoils often with appreciable amounts of ferruginous gravel.
	3.2	Acidic Mesotrophic Red Kandosols	
	3.3	Haplic Mesotrophic Red Ferrosols	
4 – Texture Contrast (Duplex) Soils	4.1	Subnatric Brown Sodosol	Group 4 soil types have formed on Permo- Triassic sedimentary rocks, on gently inclined slopes, dissection slope interfluves, broad low rises and plains and on alluvial terraces and drainage flats. These soils are sandy, silty or loamy on the surface with a clear to abrupt change to a clayey subsoil horizon.
	4.2	Eutrophic Mesonatric Brown Sodosols	
	4.3	Eutrophic Subnatric Yellow Sodosols	
5 – Uniform Fine-textured (Non-cracking) Clay Soils	5.1	Sodic Pedaric Brown Dermosols	These soil types are present on erosional plains, levees and high terraces along stream systems, undulating alluvial plains and associated with cracking clays of Soil Group 6. These soils exhibit uniform profiles or weakly gradational profiles where clay content may increase slightly with depth.
	5.2	Sodic Pedaric Brown Dermosols	
	5.3	Sodic Pedaric Brown Dermosols	

6 – Cracking Clay Soils	6.1	Epipedal Black, Grey or Black Vertosols	Group 6 soil types form the dominant soil type within the alluvial plains associated with the Nogoa River and its tributaries. These soils have uniform medium to high clay content, pronounced swelling and shrinkage properties and commonly feature gilgai.
	6.2	Endohypersodic, Epipedal Black, Grey or Brown Vertisols	

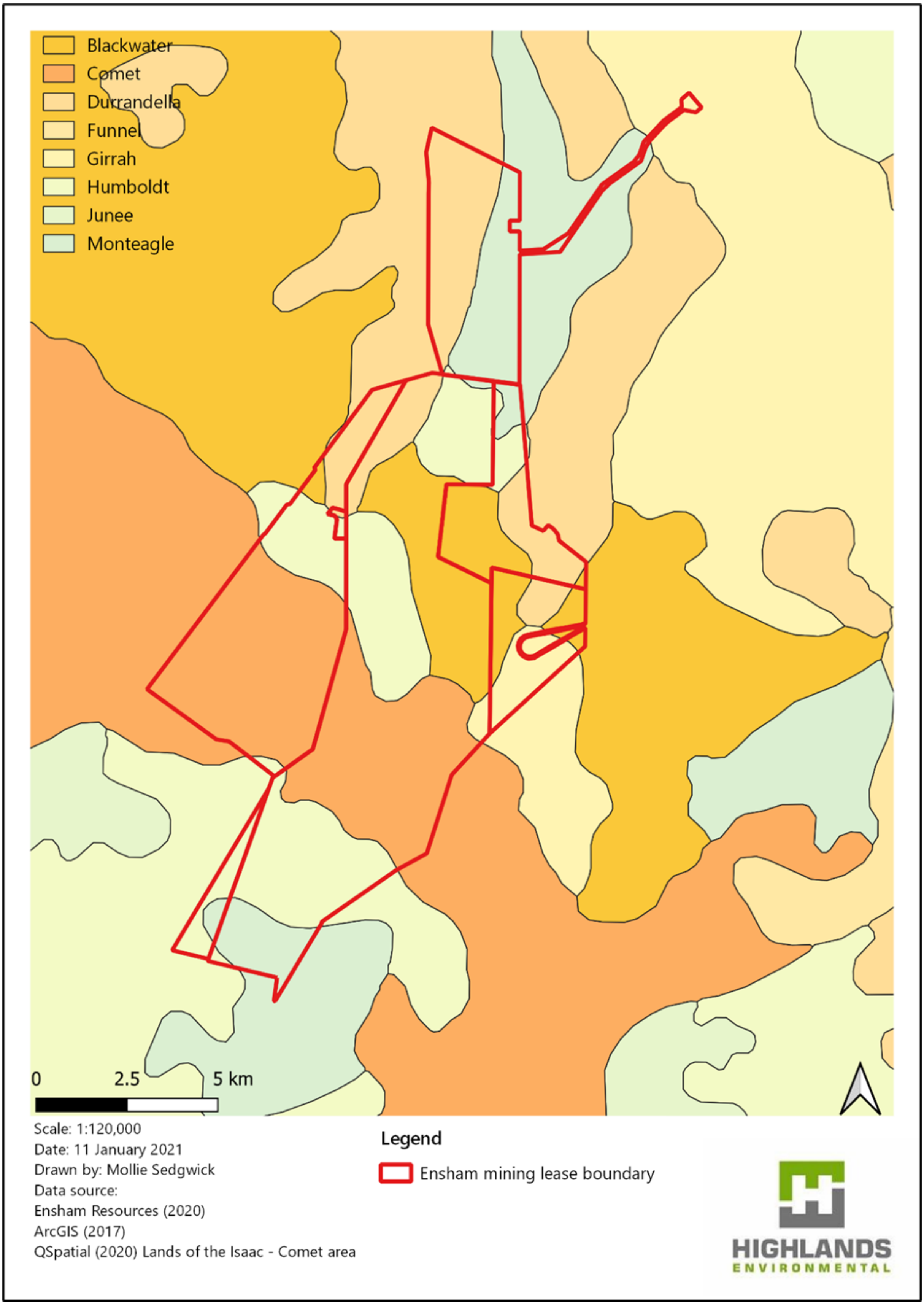


Figure 1-15 Land systems at Ensham

1.3.7 Land stability

Many land systems and associated soils at Ensham have moderate to high erosion potential and are unsuitable for clearing and agricultural development. The initial EIS found soil stability was variable (Hollingswoth, Dames and Moore (1990) and noted the following:

> *"Overall, the Yongala property, which comprises the major part of the study area, is currently in a moderately to in places severely degraded condition.....those areas which are potential susceptible to degradation due to landform, soil type and drainage conditions, already reflect a substantial level of degradation.*
>
> *In places, very deep erosion gullies have developed in many of the depressional drainageways within the property…The size and severity of gullying is attributable to the generally dispersive nature of the soils and substrate materials within those land units and uncontrolled surface water runoff."*

A more recent assessment found soils were variably affected by an accumulation of salts which affected structural stability (Hansen 2006). For example, major soil groups 2, 4, 5 and 6 are moderately to highly saline (refer to Table 1-9). This study concluded that due to accumulated salts, soils will generally have low infiltration and hydraulic conductivity and be prone to dispersion and excessive erosion if exposed to runoff.

1.3.8 Vegetation

Much of the land at Ensham had been cleared of vegetation for agricultural development prior to mining. Vegetation mapping shows there are 13 regional ecosystems within the mining leases (Table 1-10 and Figure 1-16). There are four Threatened Ecological Communities identified as potentially occurring (Table 1-11).

Table 1-10 Regional ecosystems at Ensham

Regional ecosystem	Description	Biodiversity status	VM Act class[1]
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Endangered
11.3.25e	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Of concern	Least concern
11.4.9a	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Endangered	Endangered
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern	Of concern
11.7.1	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust	Of concern	Least concern
11.7.2	*Acacia spp*. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	No concern at present	Least concern
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Endangered	Endangered
11.7.4	*Eucalyptus decorticans* and/or *Eucalyptus spp*., *Corymbia* spp., *Acacia spp*., *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust	No concern at present	Least concern

Regional ecosystem	Description	Biodiversity status	VM Act class[1]
11.5.9b	*Eucalyptus crebra* and other *Eucalyptus spp*. and *Corymbia spp*. woodland on Cainozoic sand plains and/or remnant surfaces	No concern at present	Least concern
11.7.1/11.7.2	*Acacia harpophyylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duicrust and *Acacia spp*. woodland on Cainozoic lateritic duricrust. Scarp retreat zone.	Of concern/least concern	Least concern
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland on fine-grained sedimentary rocks	No concern at present	Least concern
11.7.4/11.7.2	*Eucalyptus decorticans* and/or *Eucalyptus spp., Corymbia spp., Acacia spp., Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust and *Acacia spp*. woodland on Cainozoic lateritic duricrust. Scarp retreat zone.	No Concern/no concern	Least concern
11.3.1/11.3.25	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains and *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.	Endangered/of concern	Endangered
11.3.25e/11.3.3	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines and *Eucalyptus coolabah* woodland on alluvial plains.	Of concern/of concern	Least concern
11.3.1/11.3.3/ 11.3.37/11.3.2	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains, *Eucalyptus coolabah* woodland on alluvial plains, *Eucalyptus coolabah* fringing woodland on alluvial plains and *Eucalyptus populnea* woodland on alluvial plains.	Endangered/of concern/ no concern/of concern	Endangered
11.3.25/11.3.3/ 11.3.3c	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines and *Eucalyptus coolabah* woodland on alluvial plains	Of concern/of concern	Least concern
11.7.2/11.7.4	*Acacia spp*. woodland on Cainozoic lateritic duricrust. Scarp retreat zone and *Eucalyptus decorticans* and/or *Eucalyptus spp., Corymbia spp., Acacia spp., Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust.	No concern/ no concern	Least concern
11.7.2/11.7.1	*Acacia spp*. woodland on Cainzoic lateriic duricrust. Scarp retreat zone and *Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slope on Cainozoic lateritic duricrust.	No concern / least concern	Least concern
11.4.9/11.4.9b/ 11.4.8	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains and *Eucalyptus cambageana* woodland to open forest *with Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.	Endangered/endangered	Endangered

Regional ecosystem	Description	Biodiversity status	VM Act class[1]
11.9.2/11.9.1	*Eucalyptus melanophloia +/- E. orgadophila* woodland on fine-grained sedimentary rocks and *Acacia harpophylla-Eucalyptus cambageana* woodland to open forest on fine-grained sedimentary rocks	No concern/endangered	Least concern

Table 1-11 Threatened ecological communities potentially occurring at Ensham (DAWE 2021)

Name	Status	Type of presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural grasslands of the Queensland Central Highlands and norther Fitzroy Basin	Endangered	Community likely to occur within area
Poplar Box grassy woodland on Alluvial plains	Endangered	Community likely to occur within area
Weeping Myall woodlands	Endangered	Community likely to occur within area

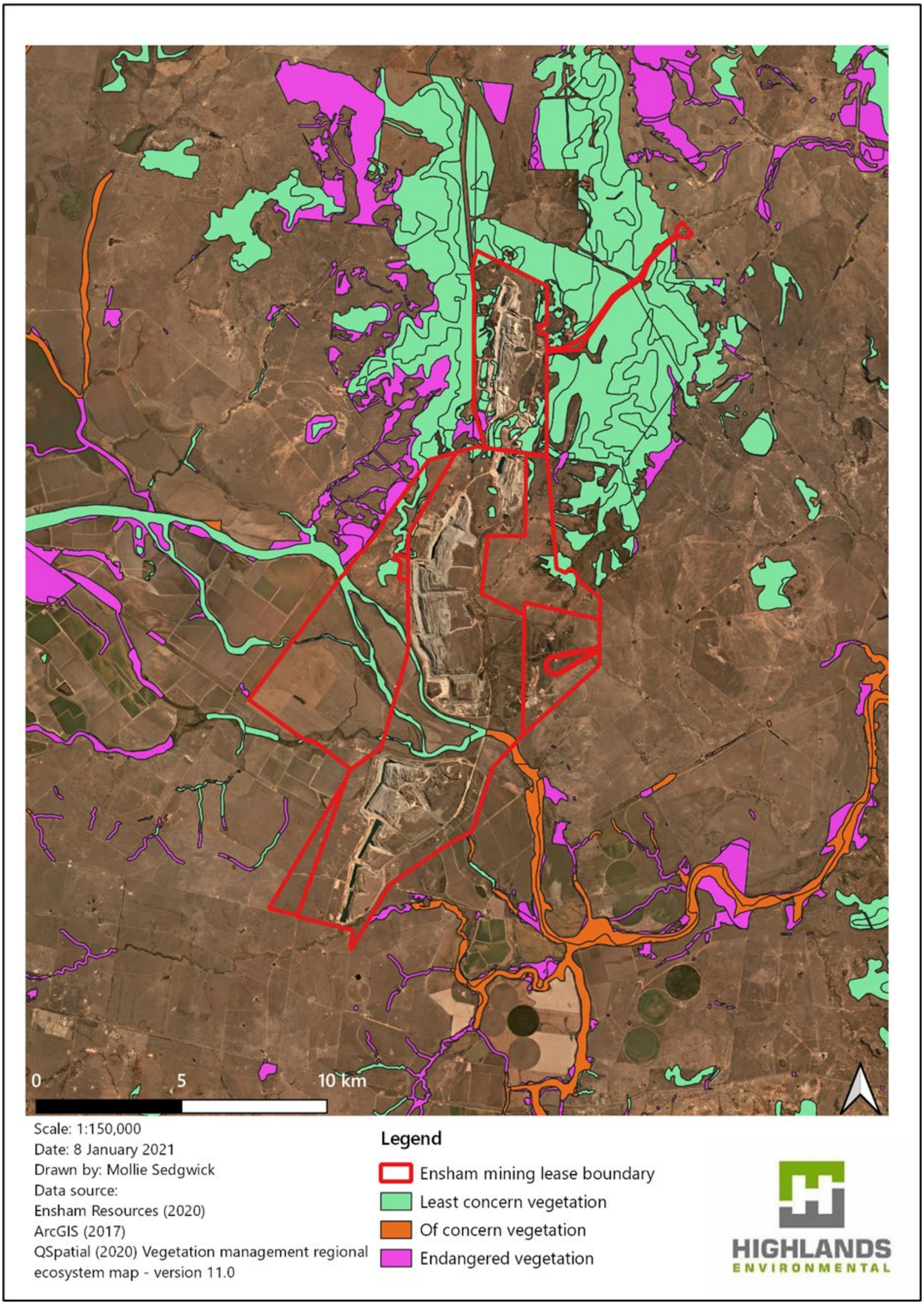


Figure 1-16 Regional ecosystems mapped at Ensham

1.3.9 Fauna

Desktop review indicates that 504 species have been recorded within a 50 km radius of Ensham (Queensland Government 2021). The species includes 22 amphibians, 103 reptiles, 27 ray-finned fish, 69 mammals, 14 insects and 269 birds. Of these, 23 species are identified as Matters of National Environmental Significance (MNES) as threatened species (Table 1-12). Field surveys conducted by Hansen Consulting (2006) recorded 193 terrestrial vertebrate species were recorded during two survey, including 22 mammals, 140 birds, 21 reptiles, and 10 amphibian species. None of the macroinvertebrates or fish species recorded are of conservation significance.

Table 1-12 Threatened species potentially occurring within 50 km of Ensham

Species name	EPBC Act 1999 listing status
Birds	
Calidris ferruginea Curlew sandpiper	Critically endangered
Erythrotriorchis radiatus red goshawk	Vulnerable
Falco hypoleucos Grey falcon	Vulnerable
Geophaps scripta scripta Squatter pigeon (southern)	Vulnerable
Grantiella picta Painted honeyeater	Vulnerable
Neochmia ruficauda ruficauda Star finch (eastern, Star finch (southern)	Endangered
Poephila cincta cincta Southern black-throated finch	Endangered
Rostratula australis (Australian painted snipe)	Endangered
Mammals	
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat	Vulnerable
Dasyurus hallucatus Northern quoll	Endangered
Macroderma gigas Ghost bat	Vulnerable
Nyctophilus corbeni Corbens's long-eared bat	Vulnerable
Onychogalea fraenata Bridled nail-tail wallaby	Endangered
Petauroides volans Greater glider	Vulnerable
Phascolarctos cinereus Koala	Vulnerable
Pteropus poliocephalus Grey-headed flying fox	Vulnerable
Reptiles	
Delma torquata Adorned delma	Vulnerable
Denisonia maculate Ornamental snake	Vulnerable
Egernia rugosa Yakka skink	Vulnerable
Elseya albagula Southern snapping turtle	Critically endangered
Furina dunmalli Dunmall's snake	Vulnerable
Lerista allanae Allan's Lerista	Endangered

Rheodytes leukops Fitzroy River turtle	Vulnerable

1.3.10 Pre-mining land uses

Prior to mining, the land was used for agricultural purposes, predominantly cattle grazing, but also irrigated and non-irrigated farming. Cultivation was restricted to land within the floodplain of the Nogoa River, most of which has not been disturbed by opencut mining.

The 1992 Environmental Management Overview Strategy (EMOS) for the Yongala property, the first granted mining lease at Ensham Mine (ML70049), described the property by noting the following comments:

> *"The only current land use within the study area is beef cattle grazing on predominantly native pastures of low to moderate productivity with some areas of introduced pasture species, mainly Buffel grass. The Yongala property which comprises the major part of the area of interest for the mining project is currently in a moderately to severely degraded condition. The rating of "Erosion Status" in Table A3.1 in Appendix 3 largely reflects the current condition of the land in that those areas which are potentially susceptible to land degradation due to the existing soil types and drainage conditions, are already in a substantially degraded condition.*
>
> *In places deep erosion gullies have developed along many of the gently inclined natural drainage ways (see Figure 6) within the property. The size and severity of gullying is largely attributable to the occurrence and generally dispersive nature of the surficial soils and substrate materials in those areas, exacerbated by the effects of uncontrolled surface water runoff resulting from high intensity storms. Quite commonly the initiation of these "badlands" type of erosion features can result from overgrazing by stock and other animals, or may be due to local soil/drainage effects. Whatever the cause, once developed to an advanced state, these types of erosion features are difficult and expensive to contain and rehabilitate successfully.*
>
> *Elsewhere on the property, mainly on the gently inclined mid-slopes below the red (lateritic) soil crestal plains, frequent small to locally quite extensive occurrences of surface scalding (bare areas) are evident. These areas may also reflect local soil/drainage effects, such as downslope subsurface drainage discharge zones with possible increased salinity or even higher nutrient levels which pre-dispose those areas to concentrated grazing by cattle. Irrespective of the origin of these features, once the areas become devoid of surface vegetative cover they are susceptible initially to sheet erosion and to the subsequent development of increasing levels of gully erosion."*

Whereas, the 1993 EMOS for the addition of ML7459, ML70367 and ML7460 notes:

> *"The area has been used for farming for many years and at least 90 percent of the lease area has been cleared including the land over the sites of the mine pits and the industrial area. The former owner of the Ensham property used it for beef cattle grazing, mainly on natural pastures but with some areas improved by deep ploughing and seeding with Buffel grass. The Duckponds property was mainly used for agricultural purposes, grain production, on the flood plain areas. The southern end of the lease was used primarily for improved pastures for beef cattle grazing."*

As per the above commentary, the pre-mining land condition varied across what is now Ensham Mine. Pre-mining imagery is displayed in Figure 1-17 below. The topography of this area (pre-mining) has been previously displayed in Section 1.3.1 (Figure 1-9).

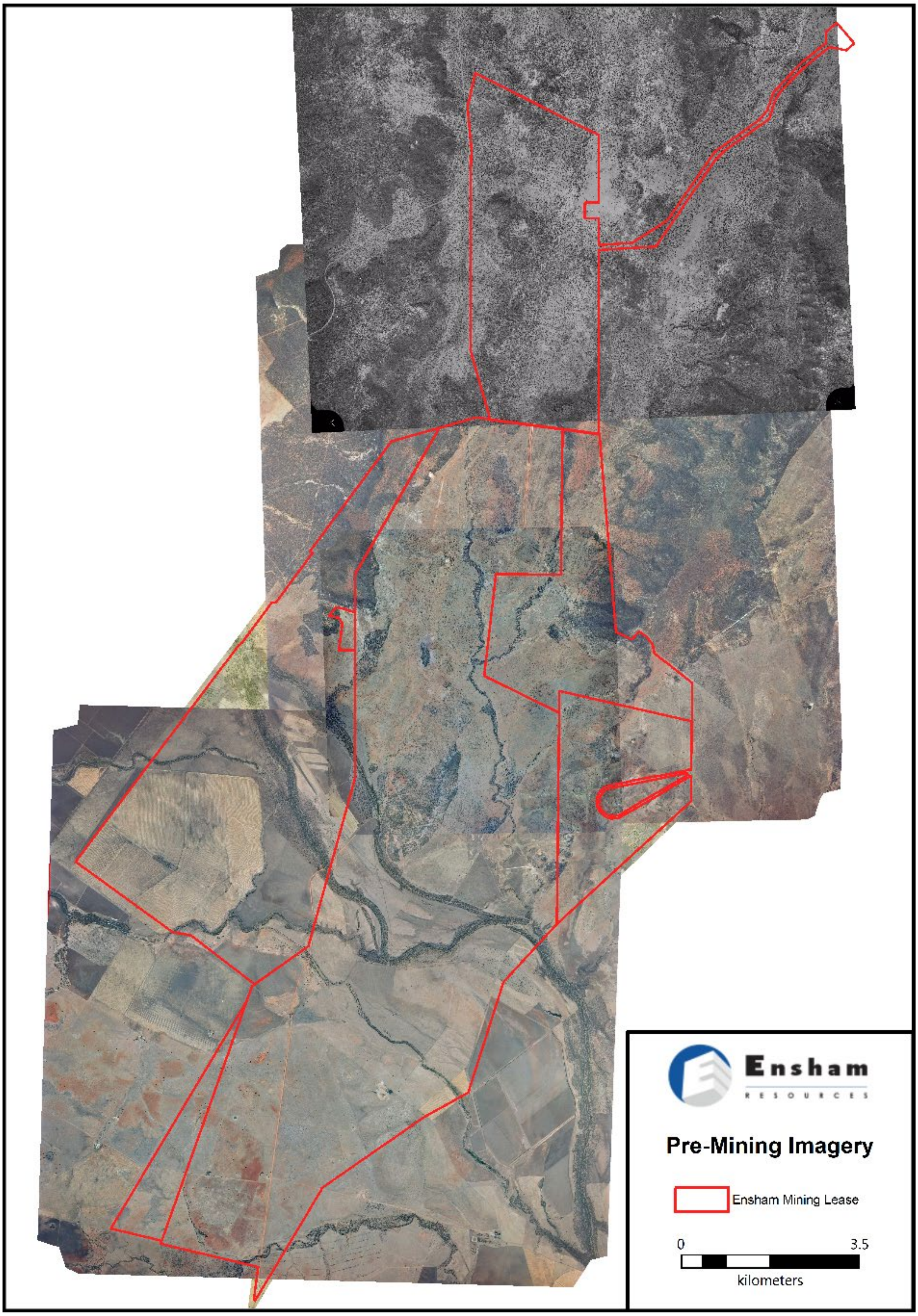


Figure 1-17 Ensham Pre-Mining Land Condition

1.3.11 Underlying landholders

Underlying landholders have been identified in Table 1-2 in the Section 1.1 of this report.

2 COMMUNITY CONSULTATION

Legislative requirement	Compliance
In accordance with section 126C(1)(c)(iii) and (iv) of the EP Act, the rehabilitation planning part of the PRC plan must include:	
• details of the consultation undertaken by the applicant in developing the proposed PRC plan, and	Section 2.2
• details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan	Section 2.3

2.1 Engaging the community

Ensham has a long history of meaningful engagement with the community on all matters, including progressive rehabilitation. The enduring objectives of community consultation are to:

1. Identify stakeholders and their issues regarding rehabilitation and closure of the mine,
2. Ensure that Ensham addresses and responds to stakeholder issues and keeps the community informed on progressive rehabilitation and steps towards mine closure.

Community consultation was undertaken for the land outcome in the RVP including a Social Impact Assessment (SIA) of the outcome for the voids. The SIA involved an assessment of the social impacts of the proposed landform designs including flood related and water quality impacts on the health and community wellbeing. As identified in the SIA, the retention of levees and the associated flood protection for downstream landholders was a significant issue in determining the final landform design. In addition to the consultation with the community and the administering authority, a further informal notification to members of the public in respect of the proposed landforms was undertaken pursuant to section 316Q of the Environmental Protection Act 1994. As a result of this process, the most suitable outcome for the residual voids was assessed consistently with the outcome of the consultation. In order to return the width of the flood plain more toward pre-mine levels, but still protecting downstream landholders, the widening of the existing flood plain will happen on the northern side as defined in Appendix 5 of the EA. This outcome was deemed acceptable in the EA amendment which outcome has been adopted in this PRCP.

Additionally:

- Ensham is a 30-year-old coal mine that has engaged with the community for 3 decades.
- Nominated PMLUs are transitioned from land outcome document EA *EPML00732813*.
- The largest PMLU in rehabilitation at Ensham is beef cattle grazing, which is:
  - Re-establishing the pre-mining land use; and
  - For the most part, consistent with surrounding land uses.
- Ensham is in the process of applying for certification of 673.8 ha of rehabilitation with a beef cattle grazing PMLU.

2.2 Stakeholder consultations – PMLU & NUMA

Ensham has conducted considerable stakeholder consultations about rehabilitation over the past 30 years. Over these years, formal stakeholder consultations have been undertaken inclusive of the following.

2.2.1 Environmental Impact Statements (EIS) (1990, 2009 & underway)

Stakeholder consultation programs for EIS' have engaged with neighbouring landholders, local, state and federal governments, industry bodies, community groups and other interested parties. These programs identified a wide range of stakeholder issues, including mined land rehabilitation, that were subsequently addressed in EIS processes.

a) Ensham Coal Project, impact assessment study (Hollingsworth et al. 1990).

b) Revised Ensham Central Project, environmental impact statement including the outcomes of stakeholder engagements (Hansen Consulting 2006).

c) Ensham Life of Mine Extension Project, environmental and social impact assessments are currently underway.

2.2.2 Ensham Residual Void (RV) Project (2017-2020)

The focus of this project was to provide a platform to discuss rehabilitation options and rehabilitation success criteria for residual voids at the Ensham mine. The RV Project was primarily concerned with the location, extent, and potential environmental and social impacts of final voids, which are comprised in part of NUMAs, i.e., Domain 5 – groundwater daylighting water areas and Mine Domain 6 – Highwalls. As part of the RV project, the following engagement occurred:

2.2.2.1 Community Reference Group.

In the early phases of the Project (November 2017), a Community Reference Group (CRG) was established to work with the company and its relevant consultants in relation to the Project. The CRG consists of 11 members, including an independent Chair, that includes representation from nearby neighbours (3), mining area landholder (1), Central Highlands Council (2), CCHRUP (1), Fitzroy Partnership for River Health (1), Sunwater (1), Cotton Growers and Irrigators Association (1) and community (1).

The CRG has been established to:

- Establish good working relationships and promote information sharing between Ensham Mine, the local community and stakeholder groups on the Ensham RVP.
- Allow community members, and or their representatives, to seek information from Ensham Mine and provide feedback on the study to assist with the delivery of balanced social, environmental and economic outcomes for the community.
- Enable Ensham Mine representatives to keep the community informed about the project.
- Allow Ensham Mine to seek community views on the study and respond to matters raised by the community.
- Discuss the RV Project and raise any concerns associated with the Preferred Options and Final Option.
- Review the reports and studies undertaken for the RV Project.

- Provide comments on the reports and studies undertaken for the RV Project.
- Discuss community concerns with the RV Project, Preferred Options and Final Option.

CRG members were provided with all technical reports for review and comment and were briefed on the SIA approach and stakeholders to be engaged as part of the SIA program.

i. Social impact assessment (Umwelt 2019)
ii. Hydrology (Hydro Engineering and Consulting Pty Ltd 2019).
iii. Groundwater (Hydrosimulations 2019).
iv. Geochemistry (RGS 2019).
v. Water solute and balance (Hydro Engineering and Consulting Pty Ltd 2019b).
vi. Geotechnical stability (WSP 2019).
vii. Geomorphology (WRM 2019).
viii. Ecology (Umwelt 2019b).

2.2.2.2 Social impact report (Umwelt 2019).

This social impact assessment engaged with 48 stakeholders including neighbouring landholders, water catchment groups, local government, indigenous (Traditional Owners) groups and industry and business.

During the SIA engagement process there were five key themes that were identified by stakeholders across the three options presented. These included: Flood, Water Quality, Option Management, Community Use and Landform Design.

This section provides further detail on the social impact themes identified drawing, where relevant, on engagement and social baseline data collected in the profiling and scoping phases of the SIA.

2.2.2.2.1 Flood

Flood was repeatedly identified by stakeholders as an impact across the options being assessed and is directly related to the Ensham Mine site being located on a flood plain of the Nogoa River. In 2008 and 2010 major flood events occurred in the region. The 2008 flood event saw the Ensham Mine inundated with water because of a levee failure and flood water flowing into the operational pits. The failure of the levee, and the perceived ramifications for nearby neighbours and community, required the resulted in reengineering and construction of levees to protect it from a flood, with an average recurrence interval of 1000 years in the Nogoa River (Queensland Floods Commission of Inquiry, 2012); subsequently approved by the Coordinator-General in 2009. These relatively recent flood events have raised serious concerns in the community regarding the management of existing voids, given imminent closure, and subsequent impacts on upstream and downstream landholders. The Ensham Mine is surrounded by cotton farmers both upstream and downstream of the site and more broadly the Central Highlands region is heavily populated by farmers reliant on the availability of quality water to support their crops. As such, flood events have an intrinsic effect on the livelihoods of farmers; with some farmers reliant on smaller more regular flood events to maintain water security in the region. Conversely, large flood events pose the risk of negatively impacting farmers by damaging property, destroying crops and reducing yield. For example, in 2010-11, floods destroyed cotton crops in central Queensland with water logging reducing yield by approximately 10-15 per cent, resulting in significant financial implications for cotton growers (Australian Government, 2011). In 2013 Agforce estimated that about 30% of the Emerald cotton crop was inundated with a loss of 62,000 bales and a value in the order of $31m (Regional Australia Institute, 2013). These effects were reflected by landholders and other key stakeholders in the comments and concerns that arose during the engagement phases of the SIA. The ability to mitigate against major flood events has the potential to protect the economic and infrastructure strengths that exist in the CHRC area. Major flood events have the added risk of affecting the health and wellbeing of residents, particularly psychosocial impacts such as stress. Adults of working age and residents of regional and remote areas in Queensland were more likely to report emotional impacts caused by the 2010 floods such as distress, feeling terrified, helplessness or hopelessness, and stresses associated with having reduced incomes. Mental health issues were the largest impact of the floods in 2010 with an estimated lifetime cost of approximately $5.9 billion (Australian Business Roundtable (ABR), 2016). Mental health-related behaviours such as substance use (alcohol and smoking) have been documented following natural disasters (ABR 2016), in Emerald there was anecdotal evidence of a significant increase in alcohol related problems and domestic violence post the 2010 flood event (QCOSS, 2011). It is reasonable to expect that the mental health of residents in Emerald and its surrounding regions was affected having experienced major flood events in both 2008 and 2010. With Ensham Mine being located on a flood plain in proximity to the Nogoa River, Comet River and Winton Creek, there is a perception in the community that there is a high risk of contamination should seepage occur, with effects likely to be felt broadly across the Central Highlands region. Scientific studies show that seepage will not be an issue to either the river or groundwater. The angst among stakeholders regarding the potential for seepage to the river system was evident during the SIA engagement process. In 2013 farmers told the ABC that the Dee River was an unnatural shade of blue-green and that birds and fish were dying with contamination anecdotally reported to be occurring 55kms downstream from the Mount Morgan Mine. The high profile nature of the problems at Mount Morgan, in relation to groundwater seepage and contamination of the waterways, contributes to the level of concern in the Emerald and Comet communities given their heavy reliance on water for a range of purposes. The sentiment was further exacerbated by the breeching of the levees that occurred in the 2008 flood event.

2.2.2.2.2 Water Quality

Water security is critical to support industry and liveability of communities in the Fitzroy Basin. As with many parts of Australia, in the Fitzroy Basin there are multiple users of water, the coal industry and the agricultural industry are the two largest industries, raising concerns for: security of water supply; flood and drought impacts; the management of surface and underground water; and environmental flow and water quality (KPMG, 2018). The Central Highlands region has extensive water infrastructure, serviced by the Fairbairn Dam, a number of smaller weirs and a comprehensive irrigation network. Generally, water security is considered relatively strong; however, minimising water loss, unlocking future capacity and optimising water use and flexibility are ongoing challenges for the Central Highlands (KPMG, 2017). Agriculture is the major industry across the Central Highlands region accounting for approximately 12 per cent of all employment in the region. Surrounding the Ensham Mine are primarily cropping farms (mostly cotton) and some cattle grazing, including Nogoa Pastoral that runs cattle within the boundaries of the land owned by the Ensham Joint Venture. Nogoa Pastoral Company covers the majority of the land on which ML 7459 (6,154 ha) and ML 70365 (2,763 ha) is situated. Approximately half of the land is utilised for mining operations and the other half pastoral activities. As at 31 July 2018 there were 1,971 head of cattle comprising 787 steers, 1,127 females and 37 bulls. In addition, the Nogoa River runs between Pit B and Pit C, connecting to the Fairbairn Dam and an intricate water system that provides water to farmers and to the townships of Comet and Emerald and the region more broadly. As previously noted, water quality in the Central Highlands region is paramount to ensure it is usable for cropping and to support the current agricultural industry, as well as regional economic growth aspirations. Mining activities taking place on and around a flood plain, with the perception that there is potential for seepage to the river system, creates what is perceived to be a high risk scenario for the Central Highlands Region. With Mount Morgan, also situated in the Fitzroy catchment, the fear of contamination from groundwater seepage is evident amongst stakeholders concerned for their livelihoods and the safety of their community. The largest social risk identified by participants related to water quality, as a result of the Ensham Mine, relates to salinity, or salt content and the effects that this would have on landholders and the agricultural industry. The stronger the conductivity levels of water, the higher the salt content. Table 7.2 shows the conductivity of water levels mapped to the salinity class for irrigation water. Option 2 Beneficial Use involves rapid filling of the rehabilitated landforms that adjoin the floodplain using cast in situ culverts design to enable flows > 17,000ML/ day in the Nogoa River. The modelling conducted by Hydro Engineering & Consulting in 2018 (Rev 1) indicates that "with management of inflow and outflow, salt concentrations in the void should be able to be maintained at levels consistent with water quality guidelines for irrigation". There are vulnerabilities identified in the CHRC area that would be addressed by the availability of water for irrigation and other beneficial uses. Water security in the Central Highlands is of particular concern as is the dependence on mining. As the Central Highlands has an established agricultural industry, access to a secure water supply provides the opportunity to further diversify the economy and support the economic growth plans of the Central Highlands Economic Master Plan (CHEMP) to 2047. Securing a quality water source has the added benefit of potentially strengthening the well-established agricultural sector.

2.2.2.2.3 Option Management

Management refers to the ongoing maintenance and management of land, levees and/or any infrastructure post relinquishment and the aspects of ongoing management and maintenance may vary for each Option. The Queensland Government's Financial Assurance Framework, combined with the proposed new Better Mine Rehabilitation for Queensland policy mechanisms, as detailed in Section 3.0, provide a framework and standard for the ongoing maintenance of rehabilitated land under the residual risk payment post relinquishment. The largest management related perceived social risks for this project include the impacts on landholders and the local residents in the event of future levee failures (particularly if levees are not properly maintained); employment opportunities for the broader community associated with rehabilitation; and the associated cost to Ensham, and the company's ability to continue investing in mining in the region. The ability to support ongoing mining, through the provision of additional employment opportunities associated with rehabilitation, will further strengthen the economic outcomes for the Central Highlands region.

2.2.2.2.4 Community Use

Increasing the availability of land for future grazing and or cropping would be deemed as high value in a region such as the Central Highlands. Comet, where the Ensham Mine site is located near, has agriculture as the largest employer making the potential for use of the land a valuable asset. The use of any rehabilitated land would not be able to occur until the rehabilitated areas are deemed safe, stable and non-polluting and able to sustain appropriate land use after rehabilitation (Queensland Government, 2014), a process which may take an extended period of time. Consultation with the community and key stakeholders, as well as a review of relevant literature, has identified a range of potential uses for the stored water post mining for consideration by the operator of the reservoir. These include:

- Water storage for irrigation – allowing for water to be pumped to farms for crops, pastures, and urban landscapes (parks, school yards, residential lots and golf courses)
- Recreation and tourism – for swimming, skiing, boating, recreational fishing or diving
- Industrial uses – cooling, boiler feed, wash down, dust suppression, and firefighting
- Ecological values – permanent wetlands habitats
- Education – rehabilitation of mine sites and Aboriginal and/or Torres Strait Islander cultural practice (Doupé & Lymbery, 2005).

The broad range of potential community uses provides the opportunity to leverage their strengths in the growing tourism industry and further supplement reasonably diverse infrastructure. The largest perceived social risks relating to community use for this project relate to water quality and the potential impacts on landholders in the event they cannot farm the land, as well as the broader communities' ability to access and use the land suitably. Each of the options provides the opportunity to improve employment locally and contribute to the local economy. Given the CHRC is vulnerable to an over reliance on mining for employment, the more jobs created in other industries by delivery of an option, the greater the benefit to the community. The more industries that are able to benefit from the land available post mining the greater the opportunity to strengthen the economy and create sustainable employment.

2.2.2.2.5 Landform Design

Design refers to the impacts that directly relate to the landform design features of each of the options. A number of design changes have been made between round one and two SIA engagement phases. The most significant changes were made to Preferred Option 1 – Landform Levee, as a result of community feedback and preliminary findings from scientific studies. This resulted in a decision being made to: maintain landform to a 1:1000 level, negating the need to realign the anabranch; raise the floor of the pits to minimise groundwater interactions; and introduce a biodiversity corridor (treed corridor) along the high walls of all pits. Preferred Option 2 Flood Mitigation and Beneficial Use and Preferred Option 3 Backfill to PMF also saw changes to design with landform redesign to minimise geomorphological risks and the inclusion of the biodiversity corridor (treed corridor) along the western aspect of the rehabilitated landform between Corkscrew Creek and the Nogoa River. This would add to existing values in the natural landscape of the CHRC area that already contribute to a range of features and services that attract tourists to the region. The largest design related social risks for this project relate to the potential visual impacts of the voids for those living in the vicinity of the mine site.

Across all stakeholder groups consulted (key stakeholders, local and regional community residents and Ensham employees), Preferred Option 2 emerged as the key option preference (92), followed by Preferred Option 3 (29) and Preferred Option 1 (12). Key stakeholders consulted were more divided in their option preferences between Preferred Option 2 – Beneficial Use (16) and Preferred Option 3 – Backfill to PMF (19); whereas, both local and regional community residents (42) and Ensham employees (34) were more likely to demonstrate a clear preference for Preferred Option 2.

Option 2 was not supported by DES and the ultimate outcome was a modified Option 1 with potential for future beneficial use and water storage.

2.2.3 Background landholder/s

Ensham meets and communicates frequently with the background landholders to ML 70049 covering Lot 3 CP911009 and Lot 2 SP165518. These meetings have including detailed discussions about rehabilitation practices and outcomes at the Yongala properties and Boggy Creek diversion.

2.2.4 DES Interactions

The following key communications were made with the administering authority during the community consultation process.

- Staged meetings with the Administering Authority, which included submission and discussion of the technical studies and the outcomes of stakeholder consultation.
- Application for amendment of EA EPML00732813 to include outcomes of the RV Project.

2.3 Community consultation plan

A community consultation plan has been developed to detail Ensham's community engagement. This plan here on referenced as the Stakeholder Engagement Plan and is included as an attached reference document for the PRC plan.

2.4 Community consultation register

Ensham maintains a community consultation register that complies with section 126C(1)(c)(iii) of the EP Act. The details of all engagements with key stakeholders are recorded in the register. An extract of this register in included within a Figure in the Stakeholder Engagement Plan mentioned above.

3 POST MINING LAND USE

Legislative requirement	Compliance
In accordance with section 126C(1)(d) of the EP Act, the rehabilitation planning part of the PRC plan must state the extent to which each post-mining land use for land identified in the PRCP schedule for the plan is consistent with:	
a) the outcome of consultation with the community in developing the plan, and	Section 2.2
b) any strategies or plans for the land of a local government, the State or the Commonwealth.	Section 3.2

3.1 Ensham PMLUs

Following are summary descriptions of rehabilitation PMLUs at Ensham. These PMLUs are translated into this transitional PRC Plan from and are consistent with land outcome document EA *EPML00732813*, meaning that determination and justifications of PMLU's are not required for this PRCP. For consistency, mine domain numbering in this PRC Plan is paired to that in EA *EPML00732813*. Each listed PMLU can be rehabilitated to a stable condition[5], whereby:

- The land is safe and structurally stable, and
- There is no environmental harm being caused by anything on or in the land, and
- The land can sustain a PMLU.

As this is a transitional PRC Plan, Ensham is not required to complete the information requirements under section 126C(1)(j) of the EP Act[6].

3.1.1 Mine domain 1 – Cattle grazing on overburden / infrastructure areas

Beef cattle grazing is the largest land use in the Fitzroy Natural Resource Management (NRM) Region (ABARES 2015) occupying 12 million ha or 78 % of the total area. There are major beef cattle breeding, growing, and finishing operations and sale and processing facilities in the NRM region. It is also the largest PMLU at Ensham and will occupy 5580 ha or 92.2 % of all PMLUs (Figure 3-2).

Rehabilitation that will be used for beef cattle grazing will have slope gradients not greater than 25 % in accordance with Table A1-11 and will be sown to a mix of 3P (perennial, palatable and persistent) grasses and legumes. This rehabilitation will be land suitability class 1 (suitable) to class 4 (marginally suitable) according to the 2013 guidelines for agricultural land evaluation in Queensland (Queensland Government 2013b). Though not a criterion in land suitability assessment, cattle have grazed rehabilitated pastures at Ensham since 2012 and currently have access to about 600 ha of rehabilitated land.

The Supplementary Landform Report (p 20):

> *The design of the grazing domain with deliver a significantly better post mining land suitability for grazing than pre-mining for this area. This is supported by land mapping completed prior to mining in 1992 and undertaken as part of the Ensham Mine Environmental Management Overview Strategy (EMOS). This mapping shows significant amounts of the northern mining areas as being Land Suitability Class 5. Land*

[5] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00, p21.*
[6] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.0, p19.*

Suitability Class 5 describes land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner eg grazing (Guidelines for Agricultural Land Evaluation in Queensland 2013). The Completion Criteria contained in the submitted Rehabilitation Management Plan identifies that the areas that were Class 5 areas will now be equal to or greater than Class 4 (as defined in Appendix A: Land use limitation subclass threshold limits of the submitted Rehabilitation Management Plan) .

The reinstatement of the grazing PMLU for the inward facing low wall slopes in the rehabilitated open cut mining areas is consistent with the pre mining land use (Hollingsworth, Dames and Moore ECP IAS 1990 p92) and aligned with Hierarchy no: 4 - reinstate previous land use (e.g. grazing or cropping). Additionally, the inclusion of the 675ha's into the grazing domain connects the grazing areas lower in the rehabilitated open cut mining areas with the grazing areas on the upper and outward facing slopes. This complements the existing approved grazing domain area currently approved in the Ensham Mine Environmental Authority, delivering additional income producing land for the landowner which would assist with maintenance and upkeep of the rehabilitated land. Grazing has been, and continues to remain, a key industry for the Central Highlands (Central Highlands Economic Master Plan, 2017).

According to land outcome document EA *EPML00732813*, this PMLU will incorporate the following characteristics.

- All outward facing overburden slopes would achieve 0 to 10% slopes for tertiary materials, and 0 to 15% slopes for Permian materials.
- At least 90% of the inward facing slopes within Domain 1 would achieve 0 to 10% slopes for tertiary materials, and 0 to 15% slopes for Permian materials.
- Up to 10% of the of inward facing slopes may exist between 15% to 25%, and would be fully contained within the areas of 0 to 15% slopes.
- Minimum factor of safety of 1.5.

These slopes would be topsoiled and seeded, hay mulched or other suitable treatment to further reduce erosion risk potential. Benches within the spoil rehabilitation are not topsoiled to allow germination of tree seed as part of cattle shelterbelts and visual amenity.

Rehabilitated spoil with up to 10% of slopes at between 15% and 25% will be comparable with the slopes in some of the adjoining current grazing paddocks.

The below table and figure details the slope percentages seen in existing cattle grazing paddocks surrounding Ensham's mining and rehabilitation areas. Table 3-1 describes the percentage of area categorised within each slope percentage interval, eg. 63% of the area of No Man's Land Paddock has a slope of between 0-10%.

Table 3-1 Slope of existing grazing paddocks

Paddock	Area (ha)	0 – 10%	10 – 15%	15 – 20%	20 – 25%	25 – 100%	>100%
No Mans Land Paddock (part)	544	63%	17.6%	8.1%	4.1%	7.6%	0.1%

Boundary Paddock	207	51.4%	23.8%	12.4%	5.8%	6.4%	0.1%
Annabranch Paddock	895	57.9%	17.3%	8.7%	4.7%	11.2%	0.2%
Long Paddock	347	98.7%	0.9%	0.3%	0.1%	0.1%	0%
Boggy Creek Paddock	329	94.7%	2.4%	1.2%	0.7%	1.1%	0%
Adrians Paddock	356	84.9%	9.5%	2.7%	1.3%	1.6%	0%

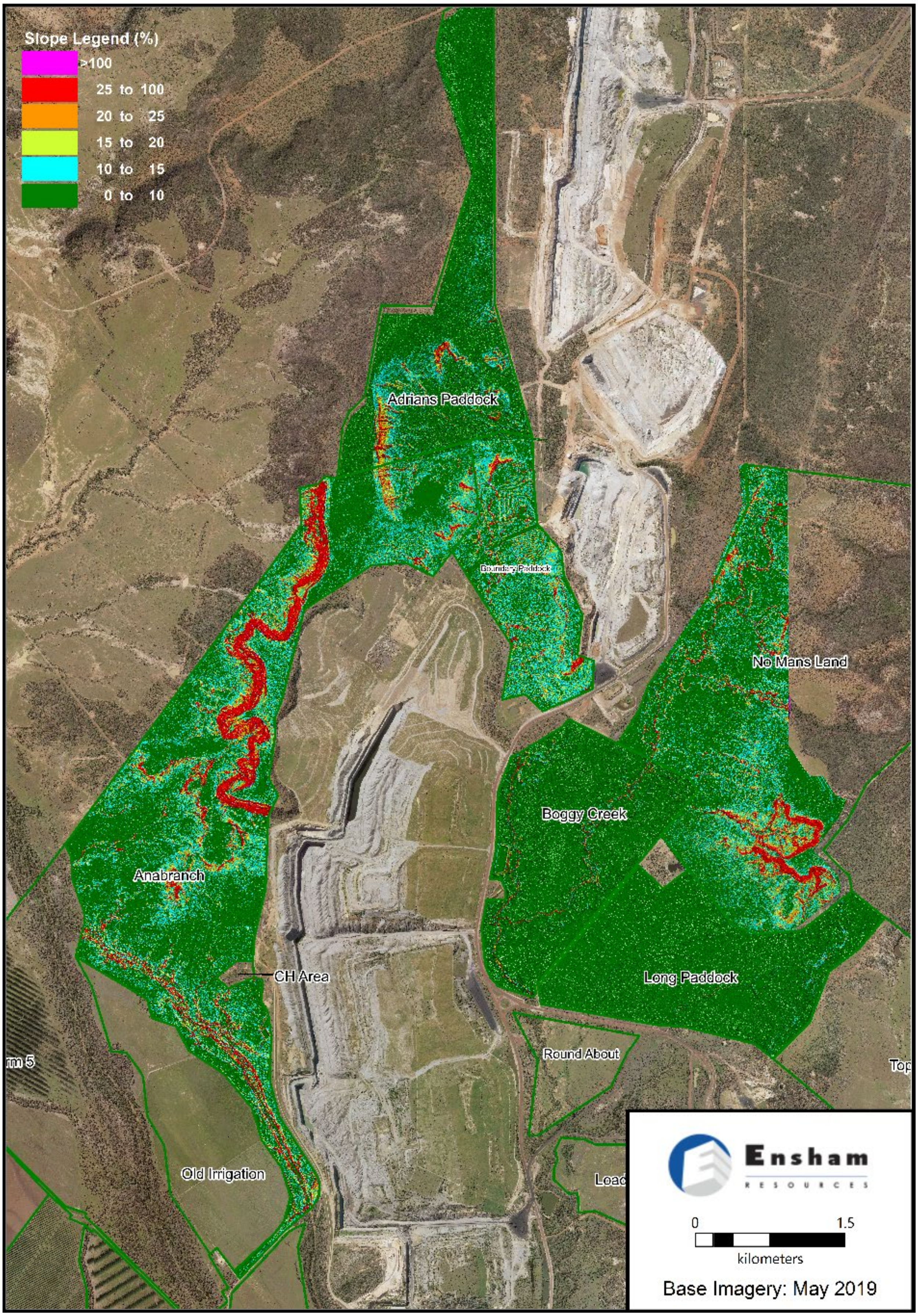


Figure 3-1 Slopes of existing grazing paddocks

3.1.2 Mine domain 2 – Landholder retained infrastructure

As per the written agreements, some mining infrastructure will be retained by the background landholders. This includes roads, dams, pipelines, bridges and electrical reticulation to assist in meeting ongoing land management requirements. Though important to facilitating other PMLUs, landholder retained infrastructure will be a minor component of rehabilitation at Ensham of all PMLUs at the mine.

Landholder retained infrastructure will include the following.

- The main power supply line into the mine is also used for power supply to a rural switchyard which then provides power to the homestead and property infrastructure such as a river pump and a bore. The 66KV line to the rural switchyard and lines to property infrastructure are to be retained.
- Water is pumped from the river using a Water Licence allocation to 2 dams, Clear Water Dam and Sailors Dam. It is pumped firstly to Clear Water Dam and then pumped again to Sailors Dam. The water from both dams is used within the mining operation. Water from Sailors Dam is further pumped as part of the grazing property infrastructure to tanks and troughs. Currently Sailors Dam is the only permanent water supply to the eastern grazing paddocks. The dams and accompanying pipelines are to be retained as part of the grazing infrastructure.
- The access road commences from the gazetted road into Currimundi property. It is the main access used for transport of stock arriving or departing from the main cattle yards by road train. Access across to the northern side of the river is achieved via the main access road, which is capable of transporting heavy machinery such as dozers used for fire breaks and vegetation management. In the event of flooding a light vehicle bridge provides access to the northern portion of the property.
- The access road continues north of the river and provides access to the stock watering infrastructure at Sailors Dam. It is proposed to retain this infrastructure as part of the grazing operation.

- Boundary paddock has been used as part of the cattle grazing operation of Duckponds for at least the last 5 years. A sediment dam was installed when out of pit spoil was being rehabilitated within this paddock. The rehabilitation is well established but the sediment dam has been left as a valuable stock watering point. It is proposed to be retained in its current configuration as it provides permanent stock water.
- The section of Yongala Haul Road existing over the Simmon's property "Boggy Creek" has been requested to be retained as is.

3.1.3 Mine domain 3 – Boggy Creek diversion

Rehabilitation of the Boggy Creek diversion will be completed in 2021. This rehabilitation will re-establish required geomorphological functionality to the watercourse, including suitable riparian vegetation. Like Mine domain 4 – native bushland corridor, this PMLU provides important habitat and ecosystem services, and links upstream and downstream remnant regional ecosystems, including those associated with the Nogoa River. This is a relatively minor PMLU that will occupy approximately 84 ha or 1.4 % of PMLUs at Ensham.

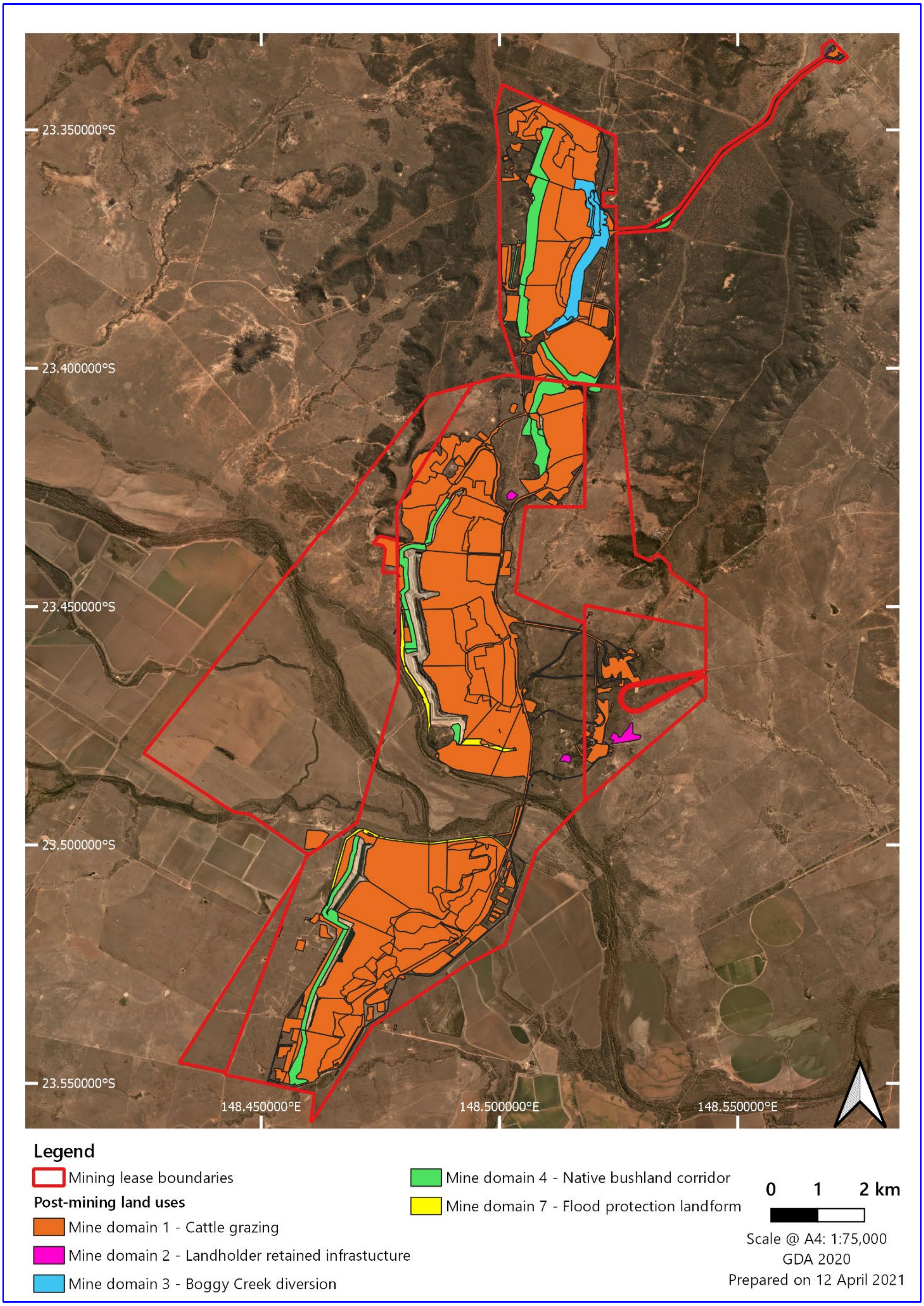


Figure 3-2 Locations and extents of PMLUs

3.1.4 Mine domain 4 – Native bushland corridor

Regional ecosystems in the Brigalow Belt Bioregion have been extensively cleared for agriculture and within the Fitzroy NRM Region protected, conservation and minimum use areas occupy just 7.8 % of land (ABARES 2015). Native bushland corridor rehabilitation at Ensham will provide important habitat for a variety of native animals and plants, with linkages to existing remnant regional ecosystems associated with the Nogoa River. This is a relatively minor PMLU that will occupy approximately 295 ha or 4.9 % of PMLUs at Ensham.

Native Bushland Corridor PMLU is located on the western side of the rehabilitated open cut mining areas, connecting Corkscrew Creek with the Nogoa River floodplain and the escarpment country. The corridor also connects with Boggy Creek.

According to land outcome document EA *EPML00732813*, this PMLU will incorporate the following characteristics.

- ≥50% established and persistent vegetative groundcover for all slopes from 0-20%.
- ≥80% established and persistent cover (vegetative and/or rock mulch if required) for slopes from 20% to 25%.
- Species richness ≥ 2 tree species, ≥ 3 shrub species, ≥ 5 groundcover species.
- Maximum 25% slope
- Areas >15% to be certified by a suitably qualified person as being stable long term, with rock mulch applied as required.

This PMLU has three broad functions, viz.

- It will provide corridors which will increase the available vegetation cover and associated foraging opportunities in the locality and is anticipated to be beneficial for a variety of native fauna species as well as increasing fauna movement opportunities in this landscape.
- It will also prohibit vehicle access onto the rehabilitated highwall slopes. This sustainable control is seen as better practice than the conventional practice that includes constructing a berm and fencing of the highwall.
- It will also reduce any visual impacts that may be associated with the rehabilitated opencut mining areas. The rehabilitated open cut mining areas are designed to be consistent with, and blend with, the regional escarpment landscape. As such, the rehabilitated open cut mining areas are not expected to have any significant impact on the visual amenity of the area. The selection of the flora species will be determined closer to time of rehabilitation, utilizing tree shrub, and groundcover BioCondition benchmarks for relevant regional ecosystems.

3.1.5 Mine domain 7 – Flood protection landform

The purpose of this rehabilitation is to prevent flood inundation of other rehabilitation domains. This PMLU replaces existing flood protection levees. Therefore, a key indicator is the design level of the landform crest, which must be at least 1 m above the estimated 1 in 1,000-year annual recurrence interval (ARI) flood event. This is a relatively minor PMLU that will occupy approximately 56 ha or 0.9 % of PMLUs at Ensham.

3.1.6 PMLU summaries

The total area and locations of each PMLU are provided (Table 3-2). Beef cattle grazing is the PMLU of greatest extent and is for the large part, re-establishing the pre-mining land use at Ensham.

Table 3-2 Location and extent of PMLUs at Ensham

PMLU	ML7459	ML7460	ML70365	ML70366	ML70367	ML70049	ML70326
Cattle grazing	2,949.8	95.9	30.5		1.3	875.1	19.4
Landholder retained infrastructure	16.0	15.9				6.7	
Native bushland corridor	192.7				4.7	144.4	
Boggy creek diversion						90.6	
Flood protection landform	65.3						

3.2 Relevant strategies and plans of the local, and State or Commonwealth governments

To the extent relevant, Ensham is on land affected by the following government plans.

1) Central Highlands Regional Council (CHRC)

    a) *Central Highlands Regional Council Planning Scheme 2016* (CHRC 2016).

2) Queensland Government

    a) *Central Queensland Regional Plan* (Queensland Government 2013).

3.2.1 CHRC planning scheme 2016

The *Central Highlands Regional Council Planning Scheme 2016*, adopted by Council on 24 February 2016, superseded the four Planning Schemes and associated planning scheme policies of the former Emerald, Duaringa, Bauhinia and Peak Downs Shires. Under the planning scheme, the Ensham mine is located in the rural zone. The following highlighted provisions are from *Part 3 Strategic Framework* and show the PMLUs at Ensham are strongly aligned with the planning scheme.

3.5 Natural resources and landscape theme

3.5.1 Strategic outcomes

The strategic outcomes for the natural resources and landscape theme are the following:

b. *Natural and rural landscape features are appropriately managed, utilised and protected to ensure that the Central Highlands maintains its unique character and identity whilst also allowing its natural resources, such as mineral and agricultural assets, to be sustainably used and managed.*

c. *Management and development practices reflect best practice methods for the sustainable use of the rich deposits of natural resources within the region, while encouraging new renewable and cleaner natural resources development.*

d. *Key natural resources including biological, energy, extractive, land, air and water resources are protected and sustainably managed to allow communities to meet present needs while not compromising the ability of future generations to meet their needs.*

e. Use of land and its natural resources is undertaken in a way that does not cause an adverse impact on the environment.

f. Natural ecosystems and water resources are protected and conserved as critical elements to the sustainability of all activities in the Central Highlands region.

g. Development in and adjacent to natural resource areas within Central Highlands is managed to facilitate co-existence between traditional rural and agricultural pursuits and resource activities and avoid or otherwise mitigate negative impacts on the continued and future use of these resource areas.

3.5.3 Element 2 – Natural resource management

3.5.3.1 Specific outcomes

Mineral and extractive resources

d. The economic benefits of extracting deposits of non-renewable resources and minerals from within the region are balanced against:

i. socio-economic and environmental impacts; and

ii. the long-term sustainable use of the land for non-extractive renewable activities and agricultural or pastoral uses.

e. Development within the Bowen Basin, as identified on Strategic Framework Map SFM-003, is appropriately designed and located to maximise opportunities for co-existence between mineral, petroleum and coal resource development and other land uses and sensitive environments.

3.2.2 Central Queensland Regional Plan 2013

The purpose of this plan is to identify the State's interests in land use planning in the central Queensland region. The plan sites Ensham in a priority agricultural area. Protecting priority agricultural land uses while supporting co-existence opportunities for the resource sector is a key regional policy (Figure B2-3). Cattle current graze on rehabilitated land at Ensham and rehabilitation is heavily skewed towards this beef cattle grazing as a PMLU, demonstrating rehabilitation is strongly aligned with the plan.

Regional outcome

Agriculture and resources industries within the Central Queensland region continue to grow with certainty and investor confidence.

Regional policy 1

Protect Priority Agricultural Land Uses within Priority Agricultural Areas.

Regional policy 2

Maximise opportunities for co-existence of resource and agricultural land uses within Priority Agricultural Areas.

Figure 3-3 Regional outcome for priority agricultural land (from Queensland Government 2013)

4 NON-USE MANAGEMENT AREAS

Legislative requirement	Compliance
In accordance with sections 126C(1)(d), (g) and (h) of the EP Act, for each proposed non-use management area, the rehabilitation planning part of the PRC plan must:	
• state the reasons the applicant considers the area cannot be rehabilitated to a stable condition	s126C(1)(g) of the EP Act is not applicable to this transitional PRC Plan
• include copies of reports or other evidence relied on by the applicant for each proposed non-use management area	S126(1)(h) of the EP Act is not applicable to this transitional PRC Plan
• state the extent to which the proposed non-use management area is consistent with the outcome of consultation with the community in developing the plan, and	Section 2.2
• state the extent to which the non-use management area is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.	Section 4.2

4.1 Ensham NUMAs

Following are summary descriptions of rehabilitation NUMAs at Ensham. These pre-approved NUMAs are translated into this transitional PRC Plan from land outcome documents EA *EPML00732813*. On this basis, Ensham is not required to:

- Justify NUMAs.
- Provide evidence to support the justification of NUMAs.
- Go through the public interest evaluation process.
- Comply with the prohibition of voids located within a flood plain having to be rehabilitated to a stable condition.

For consistency, *mine domain* numbering in this PRC Plan is paired to that contained in EA *EPML00732813*.

The land outcome document (EA) sets out the criteria to be met for the high walls and groundwater daylighting water areas are to be safe stable and non-polluting. They do not have a land use.

4.1.1 Mine domain 5 – Groundwater daylighting water areas

Regionally significant water storages, dams and reservoirs occupy less than 1.5 % of land within the NRM region (ABARES 2015). At a local level, minor water storages are important for stock and domestic supplies and assist native animals, particularly in times of drought. Groundwater daylighting water areas will be a minor component of rehabilitation at Ensham, occupying about 146 ha or 62.7 % of NUMAs at Ensham (Figure 4-1 and Table 4-1). This domain will be fenced either prior to relinquishment, or, when water daylights (whichever is the sooner) to prevent cattle accessing these areas. It is anticipated that aquatic bird life will reside in these areas similar to current site water bodies which support large numbers of aquatic bird life that would not exist on site otherwise.

Table 4-1 Predicted final water levels, volumes and areas

Pit	Surface water level	Regional groundwater level	Water storage volume (GL)	Water area (ha)	Approximate time for groundwater to daylight	Approximate year of equilibrium
A south	Groundwater does not daylight					
A central	133	144	0.5	3	50 years	2140
A north	133	144	1.2	16		
B	123	142	3.1	33	55 years	2200
C	125	142	22.1	65		
D				75		
E	Groundwater does not daylight					
F						
Y						
Total			**26.9**	**192**		

4.1.2 Mine domain 6 – Highwalls

Highwalls is a relatively minor component of the rehabilitated landscape at Ensham, occupying about 87 ha or 37.3 % of NUMAs at Ensham (Figure 4-1). Highwalls will have sufficient improvements to ensure safety, structural stability, and minimisation of environmental harm.

1) Improvements for safety.
   a) Safety bund constructed at ≥2 m high, base width of ≥5 m and crest width of ≤2 m.
   b) Safety bund positioned a distance not less than the total of the width of the *potentially unstable pit edge zone* plus an additional 10 m away from the existing pit edge. The width of the potentially unstable pit edge zone is defined by the distance between the existing pit edge and a point on the ground surface representing the intercept of a 45° plane projected from the slope toe.
   c) Fencing erected along extent of former highwalls.
   d) Fence position to be an additional 10 m away from the bund (in a direction away from the highwall edge).
   e) Warning signage posted every 500 m of the animal exclusion fence.
2) Improvements for structural stability.
   a) Slope gradients achieved as follows-
      i) Maximum of 275 % slopes for competent high walls.
      ii) Maximum of 50 % slopes for incompetent material
      iii) A south pit, F Pits and Y Pits highwall must be reshaped to a maximum of 25 % slopes.

iv) Northern Endwall of B Pit maximum 15 % slope

b) Landforms are assessed as geotechnically stable with a factor of safety ≥1.5.

c) Water run-off from above the highwall is channelled to the groundwater daylighting water areas PMLU through design pathways.

3) Improvements to ensure minimisation of environmental harm.

a) Regional groundwater aquifers maintain their current water quality and groundwater monitoring bores do not exceed the water quality limits detailed in Table C11 – Groundwater quality limits in the relevant EA as a result of mining activities.

4.1.3 NUMA summaries

The total area and locations of each NUMA are provided for each mining tenement (Table 4-2).

Table 4-2 Location and extent of NUMAs at Ensham

NUMA	ML7459	ML7460	ML70365	ML70366	ML70367	ML70049	ML70326
Highwalls	86.1	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater daylighting water areas	145.7	0.0	0.0	0.0	0.0	0.0	0.0

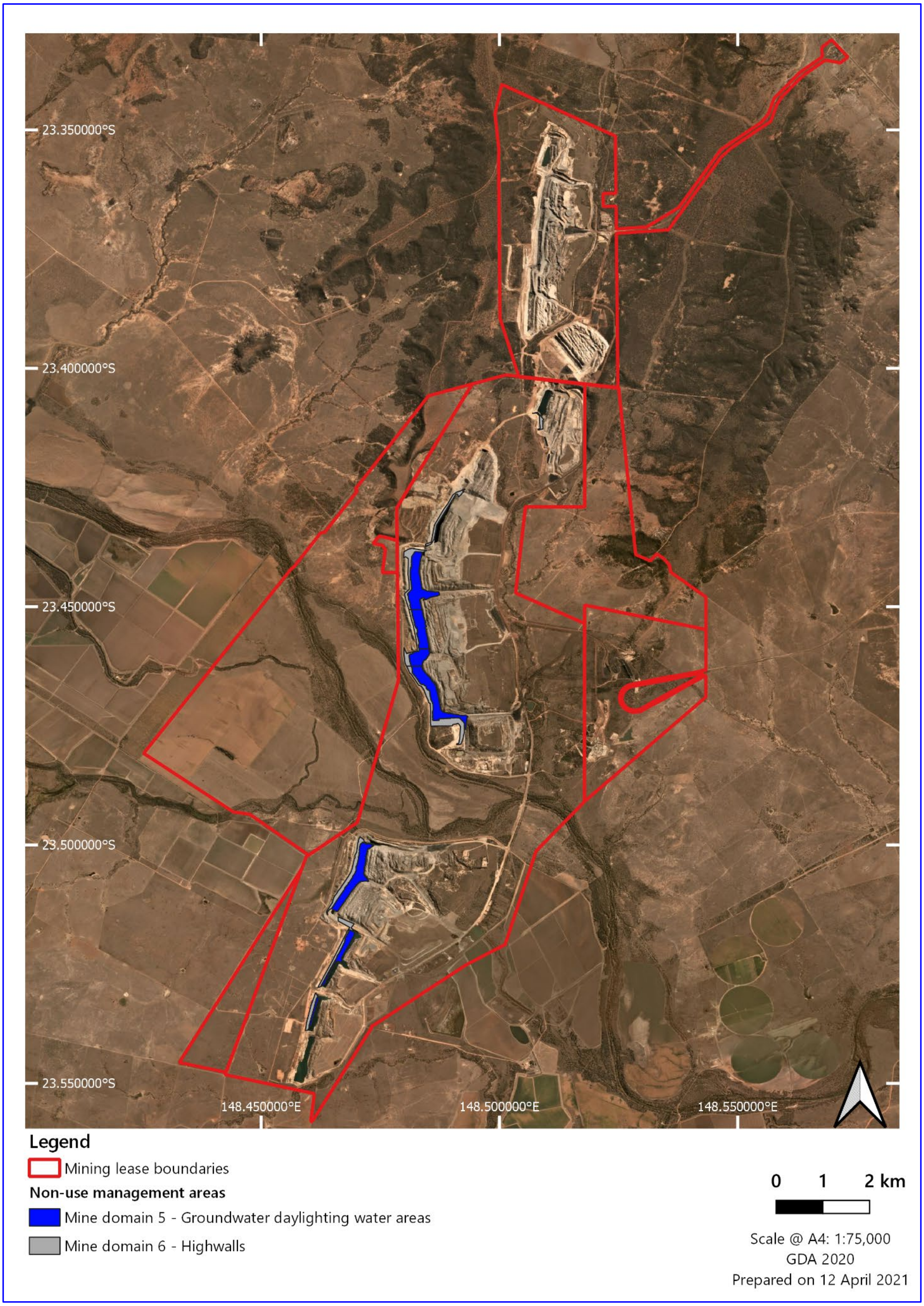


Figure 4-1 Location and extent of NUMAs

4.2 Relevant strategies and plans of the local, and State or Commonwealth governments

The existence of NUMAs in the post-mining landscape at Ensham is an inevitable consequence of the approved mining activities. Despite being pre-approved in land outcome documents, the area of NUMAs has been minimised and represents less than 5 % of all disturbed lands. The strategic outcome of protecting natural resources is supported by minimising the area of groundwater daylighting and the design which means that the residual areas are groundwater sinks not sources. Conversely, Ensham has sought to maximise the area of PMLUs in the post-mining landscape. Therefore, to the extent possible, Ensham has complied with the local (CHRC 2016) and regional (Queensland Government 2013) planning instruments, particularly as these relate to resource and agricultural land use co-existence and sustainability.

4.3 Voids in floodplains

Legislative requirement	Compliance
In accordance with section 126D(3) of the EP Act, if land the subject of the proposed PRCP schedule will contain a void situated wholly or partly in a flood plain, the schedule must provide for the rehabilitation of the land to a stable condition.	

As NUMAs at Ensham have already been identified in a land outcome document, i.e., EA *EPML00732813*, this PRC Plan is not required to comply with sections 126C(1)(g) or (h) or 126(D)(2) or (3) of the EP Act.[7]

As the pre-approved NUMA locations have been specified in the EA and are shown in Figure 4-1, Ensham is not required to undertake floodplain modelling as part of this plan.

[7] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.0, p23.*

[8] DES (2019), *Guideline–Progressive rehabilitation and closure plans (PRC plans), ESR/2019/4964, Version 2.00, p26*

5 REHABILITATION MANAGEMENT METHODOLOGY

Legislative requirement	Compliance
In accordance with section 126C(1)(e) and (i), the rehabilitation planning part of the PRC plan must:	
• For each proposed post-mining land use for land, state the proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRCP schedule.	Sections 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.10, 5.11 & 5.12
• For each proposed non-use management area, state the proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRCP schedule for the area.	Sections 5.1 and 5.9.

Following is a general description of the proven rehabilitation practices at Ensham and the significant drivers that have shaped development of those practices. General rehabilitation practices at Ensham are efficient and effective. To date, most rehabilitation has focussed on inter-ramp, outward facing slopes of 10 – 15 % gradient for cattle grazing PMLU.

5.1 Hydrogeology

The Bowen Basin is the largest productive coal basin in the country. The Bowen Basin stretches from Townsville to south of the Queensland-New South Wales border in a north to south direction. In the southern parts, the extent of the Bowen Basin and the hydrogeological Great Artesian Basin (GAB) overlap. The Rewan Formation is recognised as the base aquitard of the GAB (Habermehl, 1980 and 1998). An aquitard is defined as a geologic formation or stratum that lies adjacent to an aquifer and that allows only a small amount of liquid to pass. In the study area, the Rewan Group is present at subcrop. The Clematis Sandstone, an aquifer of the GAB is not present. The closest intake area (i.e. outcrop of the Clematis Sandstone) is located 50 km southeast of the mine area.

The surface geology of the Project Area is dominated by the Nogoa River alluvium to the south and the Tertiary Sediment to the south and the north.

The stratigraphic sequence comprises unconsolidated Quaternary aged sediments unconformably overlying consolidated Permian and Triassic aged sequences. The alluvial sequence comprises silt and clay underlain by a basal unit of sand and gravel. The alluvium is itself overlain by a deep clay-rich black soil, which tends to be highly absorbent during rainfall events. The alluvial sequence varies in thickness, with a maximum observed depth of 25 m. Tertiary formations include the duricrusted paleosols on top of deep weathering profiles and the Emerald Formation. The Emerald Formation primarily consists of fluviatile and lacustrine claystone, siltstone, sandstone and mudstone, all deeply weathered in outcrop.

The Triassic age Rewan Group overlies the Permian coal measures and occurs as in-fill material, thickening to the west with the dip of the coal measures and thin to the east The Rewan Group has a distinct greenish tint (non-marine deposits containing glauconite) in colour and is composed of siltstone and mudstone, with interbeds of lithic and volcanic sandstones.

The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular.

The coal deposits mined at Ensham Mine are found within the Rangal Coal Measures, which is the uppermost Permian unit. The Rangal Coal Measures consist of interbedded sandstone, siltstone, mudstone, and coal with tuff (towards the base) and have a thickness of up to 100 m.

A detailed hydrogeological assessment has been undertaken (Hydrosimulations 2020). According to Cote (2020), this study comprised description and modelling of water flow through:

- The two main groundwater bearing units: the alluvium (quaternary sediments) and the Permian aged Rangal Coal Measures. The alluvium is an unconfined system recharged by rainfall and irrigation practices. Its water is saline and unsuitable for uses such as stock watering or irrigation. The alluvium is not well connected with the Nogoa River. The most permeable lithological units are the coal seams, which form aquifers with low transmissivities that are confined by overlying and underlying shales and mudstones. Groundwater in the coal seams is also saline and not suitable for stock water supply or irrigation. These groundwater bearing units are referred to as the "regional groundwater system".
- The underground workings: groundwater flow direction in the Rangal Coal Measures is not well defined but data indicates that groundwater from the seams flows primarily towards underground workings. When underground workings are in close proximity to rehabilitated open cut mining areas, there can also be pathways with relatively high hydraulic conductivity that convey water from the rehabilitated open cut mining areas to the underground workings. This will impact on the water levels in the rehabilitated open cut mining areas, which will only stabilise once the underground workings have filled with water. Groundwater levels in the regional system are always higher than the underground workings so there cannot be flow from the underground workings to the regional groundwater system. There can only be flow between the rehabilitated open cut mining areas and the underground workings.
- Waste material: as opencut operations progress, pits are backfilled with waste material. This creates a porous medium through which water can flow. This water is treated as groundwater. Similar to an aquifer, the waste material is assigned hydraulic properties to simulate the interaction with water in the pit.

Additional groundwater monitoring bores (SLR 2021) have been proposed to monitor the impact of mining and rehabilitation of the mining pits and are scheduled to be included into the monitoring program

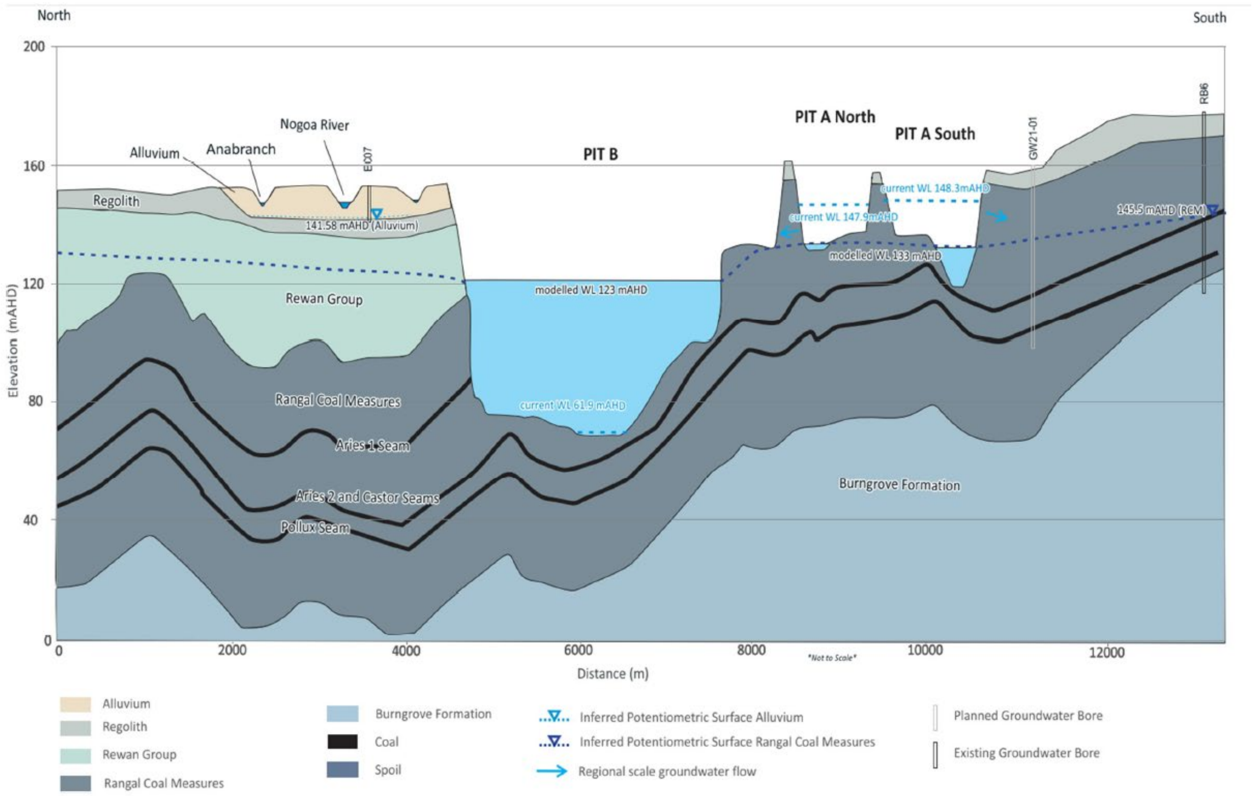


Figure 5-1 Cross section of Nogoa River and Pits A and B (north to south)

5.1.1 Water quality

The majority of bores screened in the alluvium are of sodium-chloride (Na-Cl) water type dominance. Alluvium bores show a wide range in salinity with recorded values from approximately 1,000 µS/cm to 30,000 µS/cm. Water pH is neutral with a median value of 7.1. Most of the alluvium is hydraulically isolated from the Nogoa River, resulting in brackish to highly saline conditions. Slow infiltration recharge and evapotranspiration are likely to be the dominant processes resulting in salinisation of the alluvium.

Bores screened in the Rewan Group (Winton Creek Bore and Jamar Bore) are all Na-Cl dominant. EC is variable with recorded values ranging from approximately 1,300 µS/cm to 8,300 µS/cm. Water pH is neutral with a median value of 7.7. Though sourced from only two locations, this data shows a relatively small range of values, with the majority of samples clustered tightly. Three samples show varied ionic ratios at Jamar bore and these may represent samples significantly affected by abstraction within the sampling period. Overall, little trend in groundwater chemistry change over time illustrates the low degree of groundwater flow within this aquifer as chemistry values are relatively stable.
Bores monitoring the Rangal Coal Measures are Na-Cl dominant. Electrical conductivity ranges within the Rangal Coal Measures are variable, with values measured from approximately 2,000 µS/cm to 4,000 µS/cm (Karanga bore and RB1) and approximately 7,000 µS/cm to 13,000µS/cm (all other bores). Water pH is neutral with a median value of 7.7. Karanga bore may indicate that this bore monitors an area that receives higher recharge and where groundwater is younger.

Water infiltrating through the spoil material will trigger a range of chemical reactions that will lead to various solutes or metals being exported to the rehabilitated open cut mining areas and will contribute to final water quality. There are many geochemical processes that can impact on water quality and the geochemical characteristics of the spoil determine which processes are likely to be the most prevalent. These cannot be represented in detail as they are too complex. A simplified approach was adopted, based on a methodology provided by SRK (2020) supported by some test results (RGS, 2019).

Overburden characterisation by RGS (2019) indicated that the key geochemical processes are dissolution and transport of salts (total dissolved solids, calcium, chloride, magnesium, potassium, and sodium) and oxidation of sulphide minerals.

Salts are immediately soluble and will be mobilised by water flow. Leaching tests performed by RGS (2019) showed that salt concentrations in the leachate from the spoil material declines over time, with a solute concentration reduction of about 50% for each pore water volume displacement.

5.1.2 Modelled results

Cote (2020) determined that modelling results show that some of the rehabilitated open cut mining areas will maintain a permanent water body with a water level that will fluctuate around a steady state 'equilibrium' level in response to climate variations. Equilibrium level is predicted to be reached after 50 years at A Pit, 100 years for the B Pit area, 150 years for the CD Pits rehabilitated open cut mining areas. These results are detailed in HEC (2020).

All predicted long-term average water levels are below the external "spill" level, the level at which water would overflow out of the rehabilitated open cut mining area. There will be no export of water from the rehabilitated open cut mining areas to surface water in the receiving environment. Further, all predicted water levels in the rehabilitated open cut mining areas are beneath the regional groundwater levels. Groundwater will flow from the regional system to the rehabilitated open cut mining areas. There will be no flow from the rehabilitated open cut mining areas to the regional groundwater system.

Regarding salt and long-term water quality, in the rehabilitated opencut mining area at A Pit, concentrations reach an equilibrium of approximately 12,500 µS/cm after about 20 years. This is because there is flow through the porous medium from A Pit to B Pit. There is a balance between the inputs and outputs of solutes so that concentrations remain around a stable value.

For rehabilitated open-cut mining areas at AB Pits, and CD Pits, concentrations are predicted to keep increasing. This is because the only outflow from these areas is via evaporation, which does not contain solutes. There is no output of solutes and concentrations increase with time. Given that the water held in the rehabilitated open cut mining areas does not reach levels that result in overflow to surface water or groundwater, this does not pose a threat to the receiving environment. In addition, it is not proposed to use the water for any PMLU. For these reasons, Cote (2020) concluded that all rehabilitated open cut mining areas are predicted to be non-polluting.

5.2 Flooding

Ensham extends to the south and north of the Nogoa River floodplain. The following discussion about flooding summarises the analysis in WRM (2019) unless otherwise cited.

The river consists of a well-defined 10 m deep channel that is carved through a relatively flat floodplain. Flood slopes vary from 0.03 % to 0.05 %. The floodplain varies in width from about 4 km at the location of the mine (currently narrowed to 1.5 km by the mine levees) to about 13 km near the Crinum Creek confluence. The floodplain consists of quaternary alluvium and lacustrine deposits of a mix of sand, silt, clay and gravel.

Hansen Consulting (2006) characterised the alluvium as a strongly structured alkaline heavy (cracking) clay soil classified as a grey or brown Vertosol soil.

Several anabranch flood channels cross the floodplain, the most prominent is located adjacent to C Pit. The anabranch receives flow every year on average and conveys 36 % of the 10 % AEP event. Other flood channels receive Nogoa River floodwater only for larger floods but convey a greater proportion of the flow during these large flood events. These channels may be parts of decaying or developing anabranch channels, varying through time. B Pit has been constructed across one of the flood channels called Old Winton Creek. Prior to mining, Old Winton Creek conveyed 6 % of the 10 % AEP flow and 34% of the 1% AEP flow.

Flood modelling of pre-mining conditions shows flood velocities are generally low with median channel velocities between 1.1 m/s and 1.3 m/s. Overbank velocities in the flood channels are much lower with median values between 0.2 m/s and 0.8 m/s. Observations of the Nogoa River channel and floodplain taken after the January 2008 and January 2010 floods, which were both very large events, found that the soils and vegetation characteristics at the time were capable of resisting channel bank and overbank sheet erosion, although some minor localised erosion was encountered. On the basis of these observations, minimal erosion or channel movement is expected for the range of modelled pre-mine velocities and shear stresses for events up to at least the 1% AEP event. Whilst acknowledging that anabranching systems are inherently not stable in the long term, this suggests that the pre-mining Nogoa River channel and floodplain are stable in the short term and medium term.

The final landform design at Ensham includes a Mine Domain 7 - flood protection landform PMLU. This landform prevents floodwater from inundating residual voids on the former floodplain, providing flood immunity up to the 0.1 % or 1 in 1,000 annual exceedance probability (AEP) flood event plus 0.5 m. It will permanently confine the floodplain to a minimum of 2 km width between the northern section of B Pit and the southern section of C Pit, as defined in land outcome document EA *EPML00732813*. This will have an insignificant impact on flooding characteristics because flood modelling of the current levee alignment, which restricts the floodplain at Ensham to 1.5 km width, shows that compared to pre-mining conditions:

- There would be no change in peak velocities and shear stresses from pre-mine conditions for the 10% AEP flood;
- The differences between pre-mine and current flood velocities and shear stresses for the 1% AEP event are minor;
- Where increases from pre-mine conditions occur for the 1% AEP event, the predicted velocities and shear stresses are no greater than pre-mine velocities and shear stress along the upstream reach of the river for the same event; and
- the extreme event (adopted as 1.5 x the 0.1% AEP event) would increase velocities and shear stresses along the Nogoa River channel and the adjacent floodplain for about 7 km. Again, the increased velocities and shear stresses are no greater than pre-mine velocities and shear stress along the upstream reach of the river for the same event.

For each of these reasons, rehabilitation at Ensham is not expected to have a significant impact on the morphology of the Nogoa River in the long term.

5.3 Soil Assessment

Natural soils have horizons or layers, approximately parallel to the land surface, with morphological properties different from layers below and/or above it (National Committee on Soil and Terrain 2009). Horizon notation is deduced from profile descriptions, usually colour and texture, and sometimes laboratory data. Typical horizon notations are A horizons of darker, organic rich surface materials, B horizons of mineral soil layers with distinct colours, and C horizons of partly weathered parent materials beneath the solum (AB profile).

Most rehabilitation at Ensham requires creation of new soil profiles with A, B and C horizons. These new soil profiles are called Anthroposols (Isbell and National Committee on Soil and Terrain, 2016). To date, most rehabilitation at Ensham has been completed by placing a thin A horizon of topsoil over B and C horizons of overburden –

- A horizon (0 – 15 cm depth) of topsoil
- B horizon (15 – 90 cm depth) of overburden
- C horizon (>90 cm depth) of overburden.

The new solum i.e., A and B horizons, has an assumed depth of 90 cm as most plant roots, plant-available nutrients and accessible water, and other plant-soil interactions and soil fauna, are contained within this depth limit.

5.3.1 Topsoil

5.3.1.1 Soil groups

Soils at Ensham have been comprehensively characterised, e.g., see Hanson (2006). Essentially, there are 6 major soil groups on site, viz.

Soil Group (1) – Shallow Rocky Soils (Rudosols) that occur on low rocky hills and steep escarpment slopes and eroded plateau remnants. These soils are shallow (<0.5m), exhibit very little profile development and contain gravel and rock cobbles from various geological formations.

Soil Group (2) – Moderately Shallow Gravelly Sands, Loams and Clay Soils (Rudosols and Tenosols) that occur on eroded middle and lower slopes and broad low gravelly rises. These soils are shallow to medium depth and comprise uniform or weakly gradational sands, loamy sands or sandy loams, loams or clayey soils with varying amounts of ferruginous and siliceous gravel or stone. These soils exhibit low soil fertility and water storage capacity.

Soil Group (3) – Gradational Red and Yellow Earth Soils (Kandosols-Tenosols, Kandosols and Ferrosols) present on the elevated dissected and eroded Tertiary plateau remnants and undulating plains associated with the Tertiary Emerald Formation. These soils include sandy, sandy loam or loamy surface soils grading to red, reddish brown or yellowish-brown sandy loam to light to medium massive or structured clay subsoils often with appreciable amounts of ferruginous gravel.

Soil Group (4) – Texture Contrast (Duplex) Soils (Sodosols) that have formed on Permo- Triassic sedimentary rocks, on gently inclined slopes, dissection slope interfluves, broad low rises and plains and on alluvial terraces and drainage flats. These soils are sandy, silty or loamy on the surface with a clear to abrupt change to a clayey subsoil horizon.

Soil Group (5) – Uniform Fine-textured (non-cracking) Clay Soils (Dermosols) present on erosional plains, levees and high terraces along stream systems, undulating alluvial plains and associated with cracking clays of Soil Group 6. These soils exhibit uniform profiles or weakly gradational profiles where clay content may increase slightly with depth.

Soil Group (6) – Cracking Clay Soils (Vertosols) that form the dominant soil type within the alluvial plains associated with the Nogoa River and its tributaries. These soils have uniform medium to high clay content, pronounced swelling and shrinkage properties and commonly feature gilgai.

Most soils are highly weathered, chemically, and physically poor, and can be saline and sodic at depth.

5.3.1.2 Topsoil management and suitability as A horizon

Ensham has currently accumulated approximately 3.0 million cubic metres (Mm^3) of topsoil in stockpiles for future rehabilitation works. Soil stockpiles are strategically located across the site (Table 5-1). Limited knowledge exists of the suitability of all stockpiles.

Table 5-1 Topsoil haul distances derived by the Spry Model

Topsoil Location	Volume of Topsoil Required	Volume of Topsoil Transported to or Within	Haul Distance
A Pit	467,261.99	468,382.06	>1000 m to <=1500 m
B Pit	738,746.74	739,365.72	>3000 m to <=4000 m
C Pit	611,353.83	523,364.92	>5000 m to <=6000 m
D Pit	419,692.87	297,929.85	> 6000 m
E Pit	131,845.26	129,719.31	>3000 m to <=4000 m
F Pit South	241,620.67	189,431.99	>1500 m to <=2000 m
F Pit North	300,377.43	252,384.05	>1000 m to <=1500 m
Y Pit	552,365.93	409,731.70	>1500 m to <=2000 m
TOTAL	3,463,264.72	3,010,309.61	

The haul distances described above and within the ERC are derived utilising the Spry Model, in conjunction to various site-based inputs. In identifying the haul distances, the model also schedules the hauling of topsoil. The Spry model contains a set of destination topsoil solids - that is, areas that need to have topsoil placed onto them. The model also contains source solids, representing the existing topsoil stockpiles. As part of the scheduling process, the Spry model simulates hauling topsoil from the purple stockpiles to the green destination solids, recording information about the haulage including truck hours, total haul distance, etc. The Spry model uses a set of defined haul paths, and chooses the best route - the third picture below shows some of the potential haul routes used in the Spry model. By identifying the best route, this therefore identifies the haul distances for the topsoil.

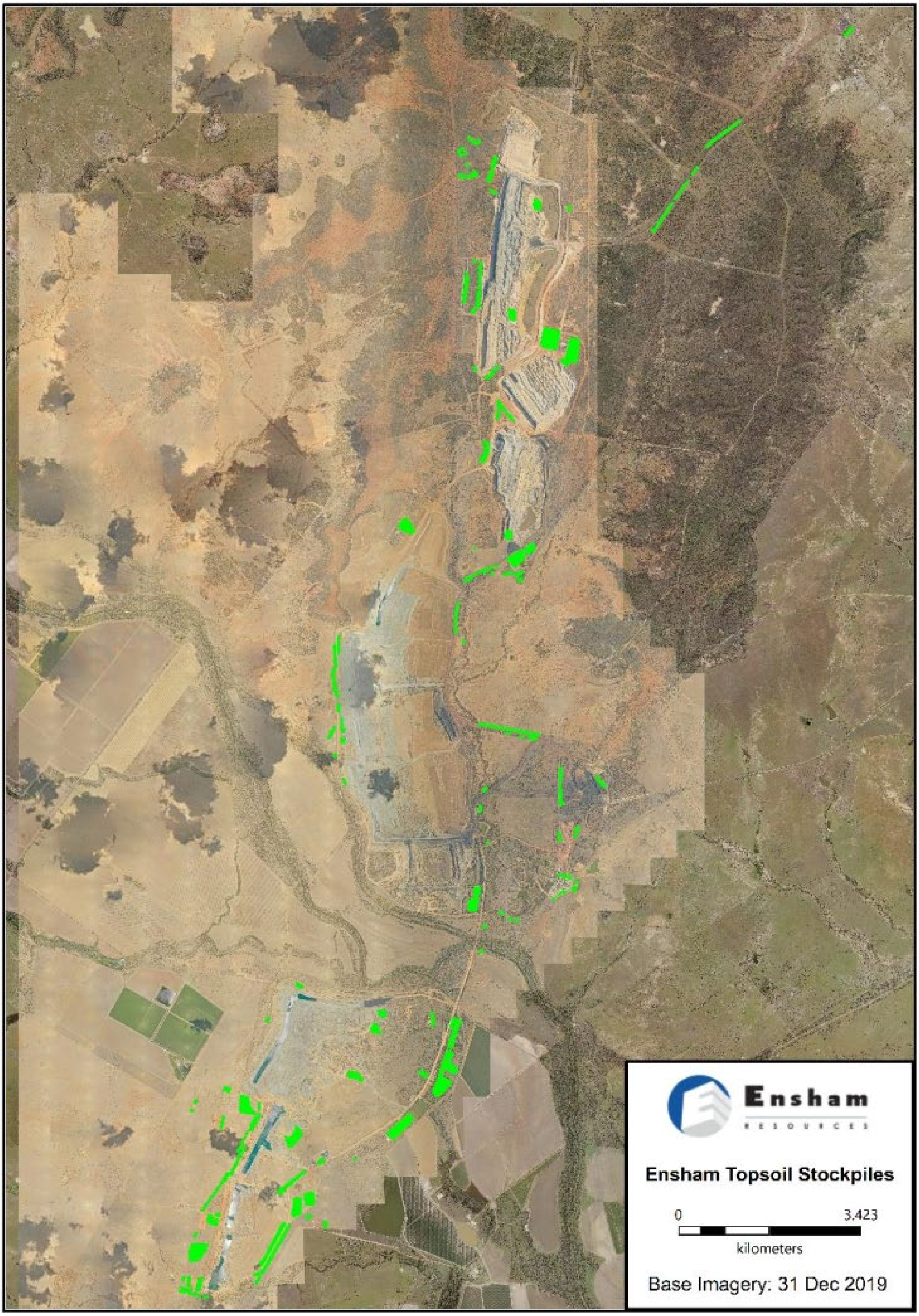


Figure 5-2 Locations of soil stockpiles at Ensham

5.3.1.2.1 Soil pH

Soil acidity/alkalinity affects the availability of various nutrients, toxic elements and chemical species present in soil solution and available to plant roots (Hazelton and Murphy 2007). Strong soil alkalinity reduces the plant-availability of both macro- and micro-nutrients in soils regardless of total concentration (Table 5-2). In very strongly alkaline conditions, where pH ≥ 9.0, the availability of 8 of the 13 essential plant nutrients is reduced.

Table 5-2 Influence of soil pH on nutrient availability (from Hazelton and Murphy 2007)

Nutrient		pH_{WATER} at which nutrient availability is reduced
Macro-	N	>9.0
	P	>8.5
Micro-	Ca	>9.0
	Mg	>9.0
	Mn	>8.0
	B	>7.5
	Cu	>8.0
	Zn	>8.0

The availability of soil nutrients is a major limitation to plant production in central Queensland (Shields and Williams 1991) and P deficiency is widespread. Unlike soil N, which can be 'fixed' from the atmosphere by rhizobium bacteria in symbiotic relationships with plant roots, all soil P is derived from soil parent materials and fertilisers, if applied. Plants require relatively large amounts of available P for normal, productive growth. The yield of buffel grass, for example, is halved if available soil P is reduced from 20 to 10 mg/kg (Campbell *et al.* 2012).

As the availability of P reduces when soil pH exceeds 8.5, this is a useful starting threshold when deciding soil suitability for use in rehabilitation. However, soil available for use in rehabilitation in central Queensland are inherently strongly alkaline and therefore, a practical approach is proposed to decide soil suitability based on pH (Table 5-3). Marginally suitable soils, pH 8.5 – 8.9, should only be used if no suitable alternative soil resources are available.

Table 5-3 Soil suitability based on alkalinity as pH

Soil pH	Suitability
<8.5	Suitable
8.5 – 8.9	Marginally suitable
≥9.0	Not suitable

5.3.1.2.2 Salinity

Soil salinity is the concentration of dissolved salts in soil solution. These are mainly Na^+ but also K^+, Ca^{2+} and Mg^{2+} which may be chlorides, sulphates or carbonates. Excess salt in soil solution, i.e. high salinity, inhibits osmotic processes whereby plant roots absorb soil moisture. Salinity is measured as electrical conductivity (EC) in a 1:5 soil/water suspension ($EC_{1:5}$ or EC_{WATER} dS/m). This is converted to saturated EC (EC_{SAT} dS/m) by accounting for the moisture holding capacity of the soil, i.e. clay content. EC_{SAT} is preferred as it better approximates the salinity of soil solutions experienced by plant roots.

For mined land rehabilitation in central Queensland, topsoil with an EC_{SAT} ≤4 dS/m is considered suitable. The growth of most plants is affected at higher salinities (Hazelton and Murphy 2007).

5.3.1.2.3 Sodicity

Sodicity occurs when the exchangeable Na^+ on the cation exchange complex leads to clay dispersion in soil. Sodic soils have the following issues.

- Surface crusting
- Low infiltration and hydraulic conductivity
- Hard, dense subsoils
- Tunnel and gully erosion.

The level of exchangeable Na^+ is determined by measuring the concentration of all the exchangeable cations in the soil and expressing the amount of exchangeable sodium as a proportion of the sum of all the exchangeable cations, known as the cation exchange capacity (CEC) (Hazelton and Murphy 2007). This proportion is called the exchangeable sodium percentage (ESP). Topsoils with low sodicity are preferred for mined land rehabilitation in central Queensland. Generally, topsoils with an ESP <6 % are suitable, while topsoils with ESP >6 -14 % are marginally suitable and typically require amelioration with gypsum to ensure aggregate stability.

5.3.1.3 Ensham topsoil reserves

Suitable topsoils for rehabilitation will have the following characteristics.

- pH <8.5 preferably and 8.5 – 9.0 if no other soil resources are available.
- EC_{SAT} ≤4 dS/m and
- ESP <6 preferably and ESP ≤14 % with amelioration if no other soil resources are available.

On this basis, Ensham has approximately 2.2 Mm^3 of good / very good topsoil stockpiled on site. Ensham has a deficit of good quality topsoil of 1.2 Mm^3. This is calculated based on future rehabilitation requiring ≥0.15 m depth of soil respread across 2,309 ha of disturbances (Table 5-4). Ensham is working on several initiatives to address this deficit, including amelioration of poor and marginal topsoils and/or amelioration of spoil to create a suitable growth media (refer to Section 6.2).

Table 5-4 Approximate area requiring topsoil respread to ≥15 cm depth

Mining disturbance	Area (ha)
Spoil emplacement	1,852
Access tracks	66
Borrow pits	6
Cleared and topsoil stripped	108
Camp	13
Laydown area	75
Water storages	12
Process plant	15

Mining disturbance	Area (ha)
Process water storage	27
Haul road	134
TOTAL	2,309

5.3.2 Overburden material

New B horizons (15-90 cm depth) provide anchorage for plants and contribute to soil nutrition; however the principal role of subsoil is to store moisture for plant use. Understanding spoil characteristics and potential subsoil limitations that restrict root proliferation and access to stored water is essential in achieving satisfactory rehabilitation. Common limitations at Ensham are subsoil salinity and sodicity.

5.3.2.1 Waste characterisation

Spoils at Ensham have been comprehensively characterised. To determine appropriate rehabilitated area design parameters for rehabilitation, it is crucial to understand material characteristics. Several reports have described materials at Ensham to varying extents, e.g., Loch (2015), URS (2005), URS (2015) and CMLR (2005), and each contain some useful information. Reports demonstrate that spoils and soils are typically sodic and saline, and non-acid forming (RGS, 2018).

A and B Pits were combined and are modelled as comprising 79 M m3 of Permian over/interburden, 0.7M m3 of Tertiary overburden and 19M m3 of Quaternary sediments. B Pit is modelled as containing 171 Mm3 of Permian material, 9,395 m3 of Tertiary material and 18 Mm3 of Quaternary material. Cenozoic sediments are approximately 50 m deep in the south of A Pit, becoming shallower to the north. The model of A and B Pit extends to the bottom of the Aries 1 seam, approximately 90 – 100 m below ground level (bgl). The Aries seam dips westward at approximately 3° – 4° and this dip and dip direction is roughly consistent through the rest of the A and B Pit model.

C, D and E Pits combined are modelled to contain 564 M m3 of Permian material, 137,522 m3 of Tertiary material and 135 M m3 of Quaternary material. Cenozoic sediments are approximately 20 m deep and logged as primarily soil in C and southern D Pits and clay in the north of D Pit and E Pit. The model of the C, D and E lithology extends to the base of the Castor seam roughly 125 m bgl. Generally, strata are westward dipping at approximately 2°.

F Pit is modelled to comprise 28 M m3 of Permian material, 5,448 m3 of Tertiary material and 6 M m3 of Quaternary material. Cenozoic sediments in F Pit are very shallow in the south (approximately 2 m bgl), deepening in the north (approximately 16 m bgl). These sediments are primarily clay with a thin soil covering. Marker beds in the model are dipping westward approximately 5 – 6° in the south of F Pit and 2 – 4° in the north. The model is approximately 55 m deep and extends to the base of the Pollux seam. The Y Pit model contains 137M m3 of Permian material, 32,824 m3 of Tertiary material and 33 M m3 of Quaternary material. The Cenozoic sediments in Y Pit are mostly clay with minor soil in the south and clay in the north. The sediments deepen from approximately 5 m in the south to 20 m in the north. The model extends to the base of the Pollux seam, 60 – 70 m below ground level for most of the model, thickening to 80 – 100 m in the north. There is a vertical offset of 11 m between coal beds logged in drill holes in the central east of the model. Drill hole X5057 is the only hole that shows an offset of this magnitude and coal beds logged in drill holes to the north and south become marginally deeper. This feature is interpreted to be an anticline, shallowly plunging southwest. Marker beds tend towards a western dip, bedding in the northern and southern ends of the model are near-flat (0 - 1°), with steeper angles modelled in the centre around the anticline (up to 12°).

Total metal/metalloid concentrations in the overburden and potential coal reject materials were low compared to unmineralised soil materials. Leachate from these mining materials was generally pH neutral to slightly alkaline and had low levels of salinity. Dissolved metal/metalloid concentrations were all below applied water quality guideline concentrations apart from molybdenum in a minor proportion of potential coal reject materials. The depositional environment of the coal in the Ensham stratigraphic sequence was an alluvial environment with negligible marine influences at a regional level, therefore the magnitude of any potential for AMD generation is expected to be limited, compared to coal formed in marine influenced strata

Surface water quality monitoring data collected over the past decade (2010 – 2021) is well aligned with the groundwater data and overall statistics show that at surface water quality is typically pH neutral with low concentrations of dissolved parameters such as metals/metalloids. Salinity in surface runoff collected from rehabilitated areas is also low and generally reflects predicted levels in pits and dams containing unrehabilitated spoil runoff and water pumped from underground (RGS 2021).

CMLR (2005) provides a simple and practical classification of overburdens based on geology and measured physical and chemical parameters. Four distinct spoils were identified, described and mapped throughout the mine (Table 5-5). The geochemistry of these spoils is well understood and salinity and sodicity are the principal limitations to plant growth and stability in rehabilitation.

Soil salinity is the concentration of dissolved salts in soil solution. These are mainly Na+ but also K+, Ca^{2+} and Mg^{2+} which may be chlorides, sulphates, or carbonates. Excess salt in soil solution, i.e., high salinity, inhibits osmotic processes that enable plant roots to absorb soil moisture. Salinity is measured as electrical conductivity (EC) in a 1:5 soil/water suspension ($EC_{1:5}$ or EC_{WATER} dS/m). This is converted to saturated EC (EC_{SAT} dS/m) by accounting for the moisture holding capacity of the soil, i.e., clay content. EC_{SAT} is preferred as it better approximates the salinity of soil solutions experienced by plant roots.

Table 5-5 Spoil types and distributions at Ensham (adapted from CMLR 2005)

<table>
<tr><th rowspan="2">Era</th><th rowspan="2">Period</th><th rowspan="2">Group</th><th rowspan="2">Description</th><th colspan="7">Ensham pit</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>Y</th></tr>
<tr><td rowspan="3">Cainozoic</td><td>Quaternary</td><td>n/a</td><td>Alluvial sands, silt gravel</td><td colspan="3">Q</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Tertiary</td><td rowspan="2">n/a</td><td rowspan="2">Sandstone, siltstone, claystone</td><td></td><td colspan="2">T2</td><td></td><td></td><td colspan="2">T2</td></tr>
<tr><td colspan="7">T1</td></tr>
<tr><td rowspan="2">Palaeozoic</td><td rowspan="2">Upper Permian</td><td rowspan="2">Blackwater</td><td rowspan="2">Rangal coal measures</td><td colspan="7">P</td></tr>
<tr><td colspan="7">COAL</td></tr>
</table>

Sodicity occurs when the exchangeable Na^{+} on the cation exchange complex leads to clay dispersion in soil. Sodic soils have the following issues.

- Surface crusting,
- Low infiltration and hydraulic conductivity,
- Hard, dense subsoils, and
- Tunnel and gully erosion.

The level of exchangeable Na^+ is determined by measuring the concentration of all the exchangeable cations in the soil and expressing the amount of exchangeable sodium as a proportion of the sum of all the exchangeable cations, known as the cation exchange capacity (CEC) (Hazelton and Murphy 2007). This proportion is called the exchangeable sodium percentage (ESP).

A description of each of the four spoils at Ensham follows.

5.3.2.1.1 Quaternary spoil (Q)

Pale brown to yellow alluvial sands and gravels (Figure 5-3). Low clay content means material has little water or nutrient holding capacity. Non-saline but sodic with low surface cohesion, this overburden is highly dispersive and prone to excessive erosive when exposed to rainfall.

Figure 5-3 Quaternary spoil in B Pit is screened for gravel and sand for use around site (left) and erosion in situ Quaternary spoil in B Pit endwall (right)

5.3.2.1.2 Tertiary spoil (T2)

This overburden is Tertiary age material that appears above T1 overburden in B, C, F and Y pits. It is distinguishable from T1 by its darker colour but is otherwise physically and chemically similar.

5.3.2.1.3 Tertiary spoil (T1)

Overlying the Permian overburden, this material is derived from Tertiary age alluvium or colluvium (Figure 5-4). It is consistently saline to extremely saline, with chloride levels toxic to plants at Y Pit, and consistently sodic to extremely sodic. This material is extremely dispersive.

Figure 5-4 Tertiary spoil overlying Permian spoil in Y Pit (left) and F Pit (right)

5.3.2.1.4 Permian spoil (P)

Easily distinguished by its bluish grey colour, consisting of rapidly weathering mudstones and siltstones, with orange/yellow resistant sandstone fragments (Figure 5-5). Derived from Permian sedimentary rocks of the Blackwater Group, it is generally non-saline to saline and sodic.

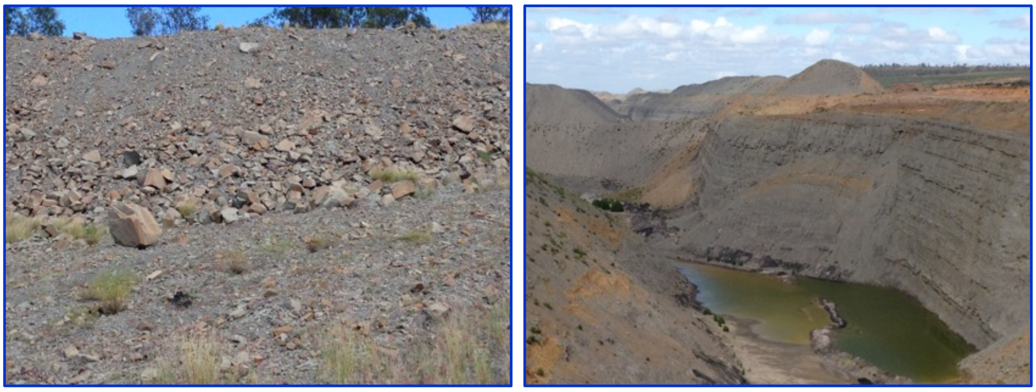


Figure 5-5 Permian spoil in D Pit emplacement (left) and E Pit highwall (right)

5.3.2.2 Spoil management and suitability for B horizons

5.3.2.2.1 Effects of sodicity and salinity

Salinity and sodicity are opposing forces in soil / overburden aggregate stability: salinity is aggregating while sodicity is dispersing. Salinity and sodicity often occur together and salt affected materials have historically been grouped as saline, non-saline and sodic, or saline and sodic, depending on the relative composition of the salts present. Using available data, Ensham overburdens and soils can be grouped into these categories (Figure 5-6 and Figure 5-7). Here, a saturated electrical conductivity (ECe) >4 (dS/m) and an exchangeable sodium percentage (ESP) >6 are the generally accepted threshold limits for salinity impacts on plants and sodicity impacts on soil structure. For regional context, the 32 central Queensland soils and overburdens assessed by (So et al. 1998) in ACARP Project C4011 are included.

However, for a given sodicity value, as EC increases soil dispersion decreases. Conversely, very low EC values mean that a soil may become dispersive where the ESP is very low, e.g., ESP of 2. The relationship between salinity and sodicity is the electrochemical stability index (ESI). ESI is determined by calculating the ratio of EC to ESP, i.e., ESI = EC1:5/ESP. The adopted critical ESI value for Australian soils is 0.05 (McKenzie 1998). Materials with an ESI less than the critical value will be prone to dispersion. Most of the Ensham overburdens and soils are highly dispersive.

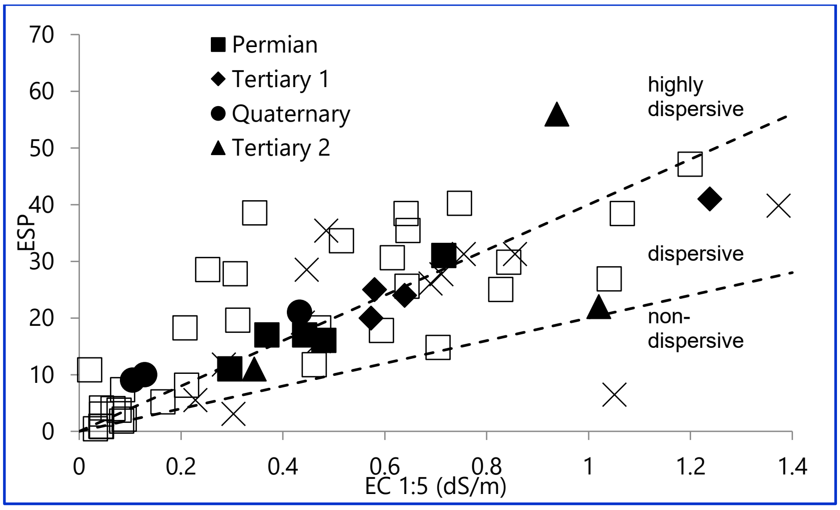


Figure 5-6 Classification of dispersive materials showing Ensham overburdens (after CMLR 2005), 16 central Queensland overburdens by ACARP C4011 (So et al 1998) and 40 central Queensland overburdens by ACARP C12031 (Henderson 2004)

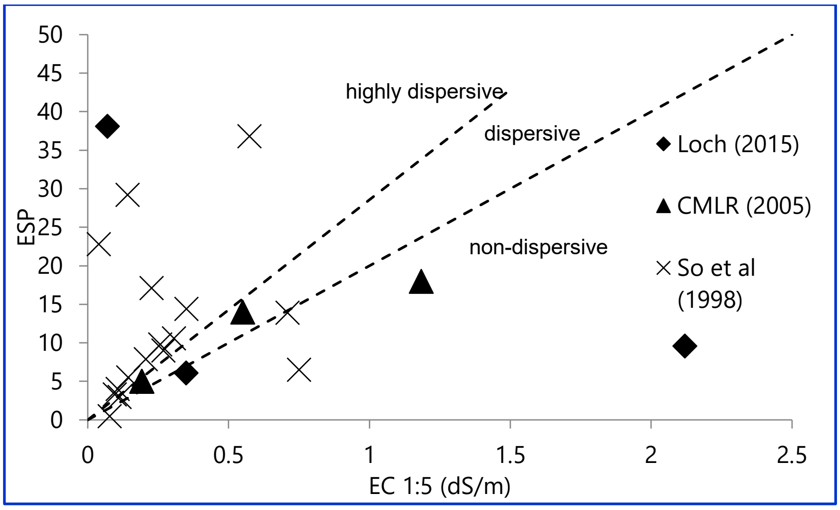
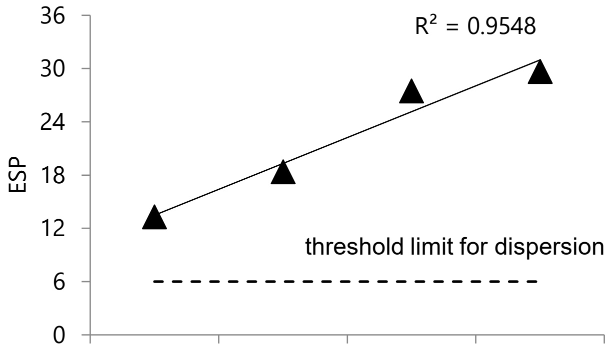


Figure 5-7 Classification of dispersive materials showing Ensham soils (after CMLR 2005 and Loch 2015) and 16 soils by ACARP C4011 (So et al 1998)

ESI explains the extremely dispersive nature of some overburdens, particularly Tertiary age materials. Although also highly saline, this salinity is insufficient to counter the effects of extreme sodicity, and the material disperses readily and is prone to excessive erosion. Ensham overburdens can be ranked in terms of salinity, sodicity and dispersivity (Figure 5-8).



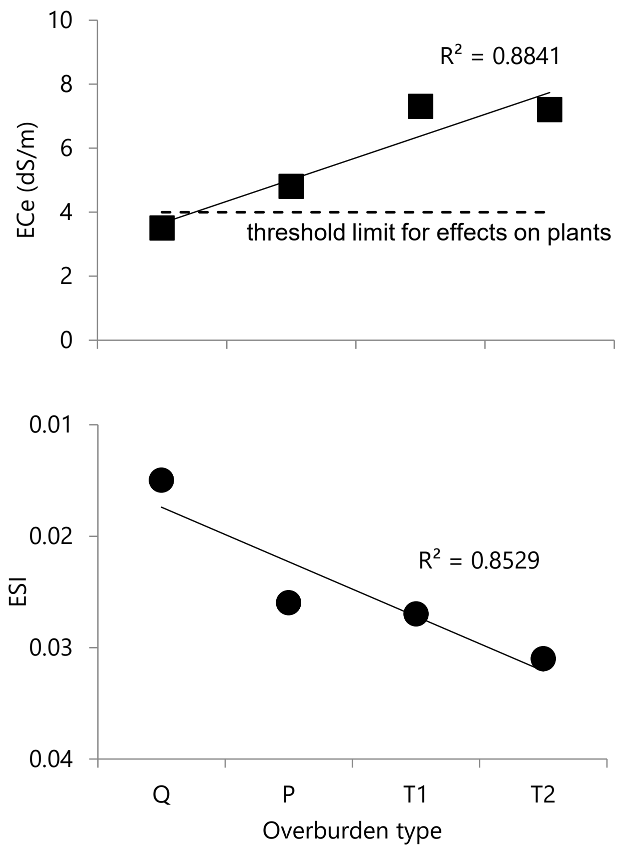


Figure 5-8 Relative salinity (a), sodicity (b) and dispersivity (c) of Ensham overburdens (after CMLR 2005)

This analysis shows that:

- Quaternary overburden is the most dispersive, but Tertiary overburdens are the most saline and most sodic;
- Tertiary overburdens are about twice as saline as Permian overburdens; and,
- All overburdens are highly dispersive.

5.3.2.2.2 Quaternary spoil (Q)

Quaternary overburden is the most dispersive and least cohesive overburden at Ensham, making it prone to excessive tunnel and gully erosion. This material will be selectively placed and buried beneath other material to ensure it does not present at or near the surface of final landforms. It is not suitable for topsoil application and rehabilitation.

5.3.2.2.3 Tertiary spoils (T1 and T2)

Tertiary overburdens are the most saline and sodic, are prone to excessive dispersion and erosion, and occur in every pit at Ensham. Common throughout central Queensland mines, Tertiary overburdens have been extensively studied by ACARP and other industry-led research.

For example, ACARP C12031 *Rehabilitation of Dispersive Tertiary Spoil in the Bowen Basin* by Henderson (2004) made the following recommendations in ascending order of risk of poor outcome, i.e., decreasing hazard control effectiveness.

- Bury under another spoil type.

- Cover with at least a metre of rocky spoil to create a 'store and release' cover system.
- Topsoil and grass cover at slope angles that avoid sliding failure along the soil/spoil interface when wet. Provide measures to assist erosion control until grass is established.

Practice at Ensham and other mines in central Queensland shows that conservative slope gradients are required to control erosion of Tertiary overburden. The common approach is to limit slope gradients to not more than 10%. Ensham can demonstrate appropriate hazard control effectiveness with respect to dispersion and erosion risks when:

- Slope gradients of Tertiary overburden do not exceed 10% maximum gradient;
- Slope lengths do not exceed 200 m;
- Contour banks and rock-lined waterways are not used; and,
- Hay mulch is applied at the time of sowing.

5.3.2.2.4 Permian spoil (P)

Permian overburden is about 50% less saline and 50% less sodic than Tertiary overburdens. Though similarly dispersive, the material is favoured for rehabilitation because it is:

- Less hostile to the establishment and growth of plants; and,
- More erosion resistant, due in part to its variable content of course sandstone fragments.

5.4 Landform design at Ensham

Landform design at Ensham is based on the following overarching principles of achieving a post-mining landscape that is (i) Erosionally stable with sustainable rates of soil loss, (ii) Inherently suitable for nominated PMLUs, and (iii) Feasible in terms of safety, engineering, and cost.

5.4.1 Achieving sustainable rates of soil loss (erosion)

Erosion is the greatest risk to any post-mining landscape in central Queensland. Though historical rates of soil loss up to 40 t/ha/y were considered acceptable, for example see Queensland Department of Mines and Energy (1995), the contemporary view is that erosion rates from rehabilitated landforms should be analogous to surrounding unmined areas. This would need to be demonstrated by monitoring of surrounding unmined areas, which is very difficult in practice. Williams (2000) summarised variously estimated soil losses and found for mixed pasture and woodlands, rates have a maximum of around 4 t/ha/y. Coincidently, Grigg *et al.* (2001) conclude the rate of soil loss in mine rehabilitation should not exceed the rate of soil renewal, which is less than 4 t/ha/y.

It is well established that high vegetation percentages reduce erosion in rehabilitation, even on steep slopes (Carroll *et al.* 2000; Loch 2000). So *et al.* (1998) studied erosion of 16 spoils and 16 soils from 15 coal mines throughout Queensland and found the potential impact of vegetation on erosion from rehabilitated soils was *"enormous"*. Under vegetation, infiltration capacities increase greatly, soil structure is improved, and erosion can be greatly reduced. So *et al.* (1998) suggest 30 to 40 % vegetation cover will be required to reduce erosion to acceptable levels.

For sloping rehabilitation, rates higher than 50 % were recommended by Grigg *et al.* (2001). Carroll *et al.* (2001) found rates of erosion from 10 % and 20 % gradient spoil rehabilitation were reduced to <1 t/ha/y with groundcover >50 %. Other research shows that high levels of vegetative cover reduce erosion to minimal levels, even on very steep slopes (Carroll *et al.* 2000; Carroll and Tucker 2000; Loch 2000). Loch (2000) studied erosion at Meandu mine and found, as simple rule of thumb, a level of 50 % vegetative cover was adequate to control erosion.

However, the period when soil is unvegetated and vulnerable to erosion and unsustainably high rates of soil loss presents a significant *window of erosion risk* for rehabilitation (Carroll *et al.* 2000; Carroll and Tucker 2000; Loch 2000). Carroll *et al.* (2001) studied runoff and erosion in field experiments at three central Queensland coal mines. That study demonstrated that groundcover takes longer to establish on steeper slopes (Figure 5-9), thus extending the window of erosion risk when the landform can fail.

So *et al.* (1998) measured the rate of erosion-derived sediment delivery from 32 bare soils and overburdens in central Queensland at slope gradients from 5 to 30%. Unremarkably, sediment delivery rates increased linearly with slope (Figure 5-10) and with slope length. The effect of increasing slope gradient from 5% to 30% was a 12-fold and 4-fold increase in sediment delivery rates for soils and spoils, respectively.

With consideration to material characteristics (see Section 5.3.2.1) and more than 40 years of industry-led research and practice, Ensham has determined the following typical design objectives for slopes.

1. Tertiary overburden slopes, regardless of soil type, will typically have:
    - Gradients ≤10%, and
    - Lengths ≤200m, variable depending on the size of the contributing upper catchment.

2. Permian overburden slopes, regardless of soil type, will typically have:
    - Gradients ≤15%, and
    - Lengths ≤100m, variable depending on the size of the contributing upper catchment.

There is of course considerable variation in the spoil composition with higher sandstone component spoils being more competent than those with higher mudstone / siltstone composition.

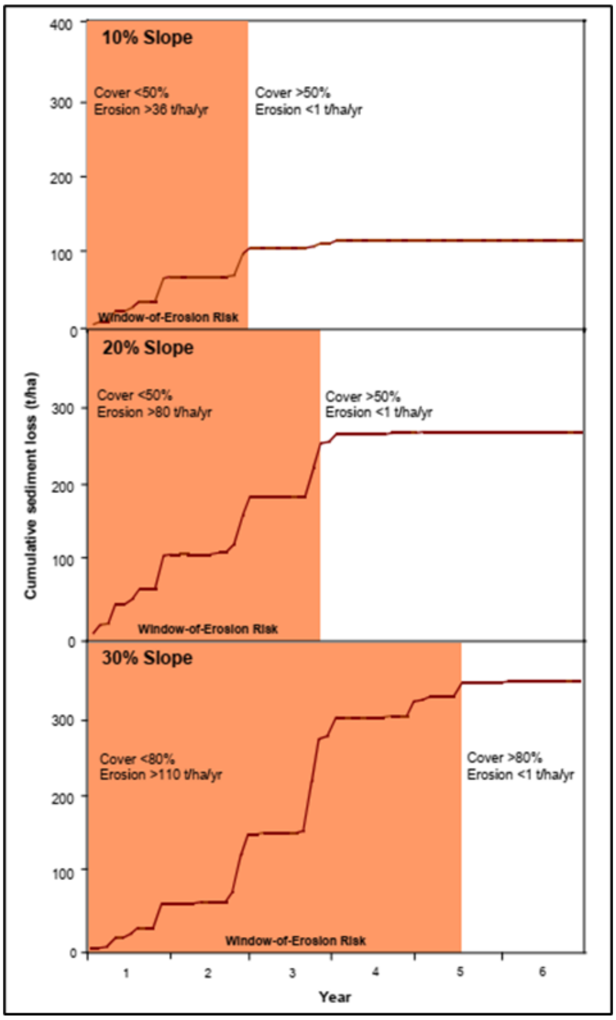


Figure 5-9 Window of erosion risk and cumulative soil loss for 10, 20 and 30 % slope gradients (from Carroll et al. 2001)

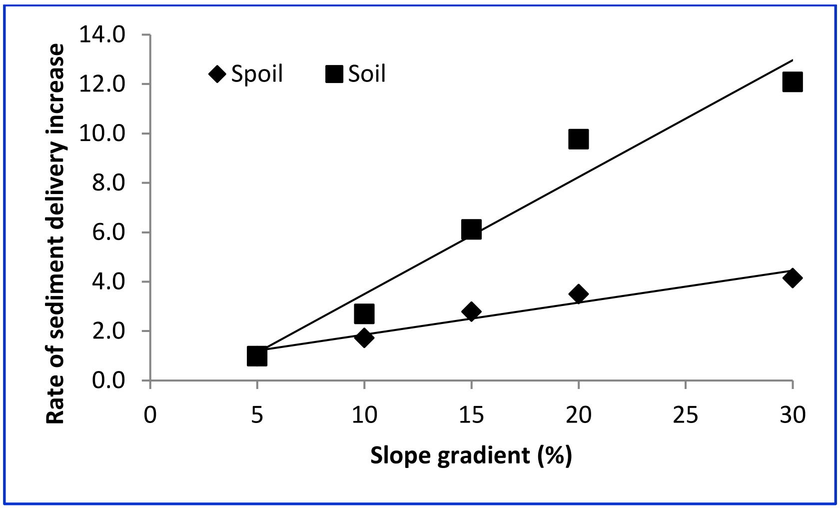


Figure 5-10 Effect of slope gradient on the rate of sediment delivery (So et al. 1998)

5.4.2 Land suitability requirements for beef cattle grazing in rehabilitation

More than 90 % of rehabilitation at Ensham has a target PMLU of beef cattle grazing. Determination of rehabilitation suitability requires evaluation of soil and landform attributes based on the requirements for beef cattle grazing using current technology and management.

Five land suitability classes are defined for use in Queensland, with land suitability decreasing progressively from class 1 to class 5. These classes are used to describe an area of land in terms of suitability for a particular land use which allows optimum, sustainable production using current technology, while minimising degradation to the land resource in the short, medium or long term.

Land is considered less suitable as the severity of limitations for a specified land use increase, reflecting:

- reduced potential for production.
- increased inputs required to achieve an acceptable level of production.
- increased inputs required to prepare the land for successful production.
- increased inputs required to prevent land degradation.

The five land suitability classes are summarised below and described in detail (Table 5-6).

Class 1 - Suitable land with negligible limitations.

Class 2 - Suitable land with minor limitations.

Class 3 - Suitable land with moderate limitations.

Class 4 - Marginally suitable land with severe limitations.

Class 5 - Unsuitable land with extreme limitations.

Table 5-6 Land suitability classes (from DNRM/DSITIA 2013)

Class	Suitability	Limitations	Description
1	Suitable	Negligible	Highly productive land that is well suited to the proposed use.
2	Suitable	Minor	Land with limitations that either constrain production, or require more than the simple management practices of class 1 land to maintain sustainable production.
3	Suitable	Moderate	Land with limitations that either further constrain production, or require significant inputs to ensure sustainable use.
4	Marginally suitable	Severe	Land which is marginally suited for a proposed use and would require major inputs to ensure sustainability; often the inputs required may not be justified in terms of the benefits to be gained from using the land for a proposed use and the land is considered presently unsuitable for that use.
5	Not suitable	Extreme	Land with extreme limitations that preclude any possibility of successful sustained use of the land in the proposed manner.

Classes 1 to 3 are considered suitable for a specified land use because the benefits from using the land (for that particular use) outweigh the inputs required to initiate and maintain production.

Class 4 is also used in situations where reducing the effect of a particular limitation may indicate production is possible, but additional studies are needed to determine the feasibility of such actions, e.g. fertilisation.

In contrast, there is no doubt regarding the long-term suitability of Class 1–3 lands or the unsuitability of Class 5 land. Class 5 land has limitations that in aggregate are so severe that the benefits do not justify the inputs required to initiate and maintain production. It would require a major change in economics, technology or management expertise before the land could be considered suitable for the land use being considered. Many Class 5 lands have physical characteristics that totally preclude any form of development, e.g. mountains, and will always remain unsuitable for agriculture.

5.4.2.1 Rehabilitation suitability for beef cattle grazing

Suitability classification evaluates rehabilitation in terms of the potential to graze and finish cattle on improved pastures. The evaluation is not discounted because the land is rehabilitated land. Rather, it applies a strict set of rules to determine suitability and is based on frameworks developed and applied previously to unmined land in the region, e.g., Shields and Williams (1991).

Typical grazing systems in inland central Queensland aim to produce young, finished, grass fed, export quality cattle without inputs other than pasture development. Most production is based around improved grass-legume pastures. Improved pasture development in many areas is dominated by buffel grass, although Rhodes grass, introduced bluegrasses (Indian bluegrass, creeping bluegrass), purple pigeon grass and panic species all have a role in certain situations. Legume establishment and species vary significantly depending on soil characteristics and microclimates. Commonly used legumes include shrubby stylos species, Desmanthus species, Wynn cassia (sandy soils), butterfly pea (clay soils), medics, siratro and leucaena (cropping soils). Though siratro and leucaena are no longer recommended in rehabilitation due to their propensity to become environmental weeds.

Considering descriptions provided in DNRM/DSITIA (2013) and DSITI/DNRM (2015), earlier work by Shields and Williams (1991) and typical grazing systems in central Queensland, land classes for grazing in rehabilitation at Ensham mine have been developed (Table 5-7).

Table 5-7 Suitability classes for beef cattle grazing PMLU at Ensham

Class	Suitability	Grazing system	Descriptions
1	Suitable	Fattening / finishing	Rehabilitation capable of attaining maximum grazing productivity, i.e. production of young, finished, grass fed, export quality cattle in most seasons.
2	Suitable	Growing	Rehabilitation on which younger cattle perform well but may be difficult to finish at a young age, depending on seasonal conditions.
3	Suitable	Year-round breeding	Rehabilitation able to carry breeding stock all year round depending on seasons.
4	Marginal	Seasonal breeding	Rehabilitation able to carry breeding stock only in better seasons or for short periods in conjunction with higher class country.
5	Unsuitable	Never	Rehabilitation that is not suitable for cattle grazing.

5.4.2.2 Beef cattle grazing land suitability rule set

There are certain land use requirements for beef cattle grazing. The inherent properties of the soil and landform that are used to assess land use requirements (and hence determine land suitability) are called land use limitations (shortened here to 'limitations'). According to DSITI/DNRM (2015), limitations can be regarded as land use requirements stated in a negative sense, e.g., rockiness, wetness, frost. Requirements, limitations and the effect of limitations on land uses are developed by precedent, i.e., earlier studies, and experience and consultation with other practitioners.

Limitation subclasses are used to develop rule sets that define suitability. The suitability rule set applicable to rehabilitation at Ensham was developed by Highlands Environmental, consulting soil scientists based in Emerald, following DSITI/DNRM (2015), DME (1995), Shields and Williams (1991) and McClurg (1999), plus extensive field testing and consultation with Mr George Bourne at DNRME, Emerald, and other practitioners (Table 5-8).

Table 5-8 Limitation rule-set for beef cattle grazing on coal mine rehabilitation

Limitation	Code	Indicator	Units	Class				
				1	2	3	4	5
Water availability	m	PAWC in ERD	mm/0.6m	>75	75-60	<60-45	<45-30	<30
Nutrient supply	nd	P in 0.1m	mg/kg 0.1m	>20	20-14	<14-8	<8-4	<4
	nr	pH in 0.1m	None	7.3 – 6.6	<6.6 – 6.0 >7.3 – 8.0	<6.0 – 5.5 >8.0 – 8.5	<5.5 – 5.0 >8.5-9.0	<5.0 or >9.0
Soil physical factors	p	Surface soil structure	variable	Fine (peds <10mm)	Coarse (peds >10mm)	Surface crust	Very hard setting	Massive
Salinity	sa	ECe in ERD	dS/m	<2	2-<4	4-<10	10-<16	≥16
Rockiness	r	Fragments on surface	%	<5	5-10	10-30	30-60	>60
Topography, slope and microrelief	ts	Gradient, surface	%	<5	5-<10	10-<15	15->20	≥20
	tm	Vertical interval, surface	m	Nil ripping furrows	Regular ripping furrows <0.2m	Regular ripping furrows 0.2-0.4m	Regular ripping furrows >0.4-0.6m	Regular ripping furrows >0.6m
Water erosion, surface soil	e	Slope, ESP<6	%	<5	5-8	>8-12	>12-18	>18
		Slope, ESP>6<14	%	<3	3-6	>6-10	>10-12	>12
		Slope, ESP>14	%	<1	1-2	>2-4	>4-6	>6
Subsoil erosion	es	ESP at 0.5m	%	<7	7-14	>14-23	>23-34	>34
Potentially acid forming materials	d	pH<4.5	none	Not likely to be present within 5m of surface	Not likely to be present within 3m of surface	Not likely to be present within 2m of surface	Present immediately below root zone, 0.9-0.6m	Present within root zone, 0.6m

This rule set describes in detail the soil and landform characteristics that more than 90 % of rehabilitation at Ensham will achieve. While this table prescribes the limitation rule set for the respective classes, there are variations to the indicators for the Ensham mine which have been assessed and approved under the EA with the relevant criteria designed specifically in line with the site specific conditions for example slopes up to 25% are authorised under the EA to achieve Class 4 gradient surface indicators.

5.4.3 Ensham final landform

Guided by the abovementioned principles and criteria, Ensham have designed a final landform in adherence to the objectives, domains and the indicative domain plan in the land outcome document. Development of the landform was undertaken through use of a modelling software that took into consideration limitations, criteria and rehabilitation strategies to enable the development of successful rehabilitation.

Key parameters were input into the modelling software, there are inclusive (but not limited to) the following:

- Identification of spoil type,
- Retaining maximum slope criteria for each spoil type dictated in the EA,
- Accounting for all disturbed material and land,
- Pertaining to the limitations dictated in the EA including, but not limited to:
  - Tertiary slopes 0-10%
  - Permian slopes 0-15% slopes
  - Maximum of 10% inward facing slopes in Domain 1 between 15-25% slopes (and encased by slopes 0-15%)
  - NBC maximum slope 25%
  - Maximum dimensions for groundwater daylighting areas
  - Competent highwalls maximum slope of 275%, incompetent maximum 50% slopes.
    - A South, F & Y pit ≤25%
    - B Pit Endwall ≤15%
  - Watercourse facing slopes ≤15%
  - Void facing slopes within Domain 7 reduced to ≤25% under exempt conditions.
- Installation of benches into rehabilitation slopes
- Minimum of 2km width in the floodplain (between B & C pit)
- Retain permanent flood structure 0.1%AEP
- Planned drainage, particularly from highwalls to groundwater daylighting areas
- Consideration that the final landform will be able meet success criteria (safe, stable, non-polluting, land use) and will not cause environmental harm.

The resulting final landform is displayed in the below 3D lidar figure. For reference, a pre-mining landform figure is located in Section 1.3.1.

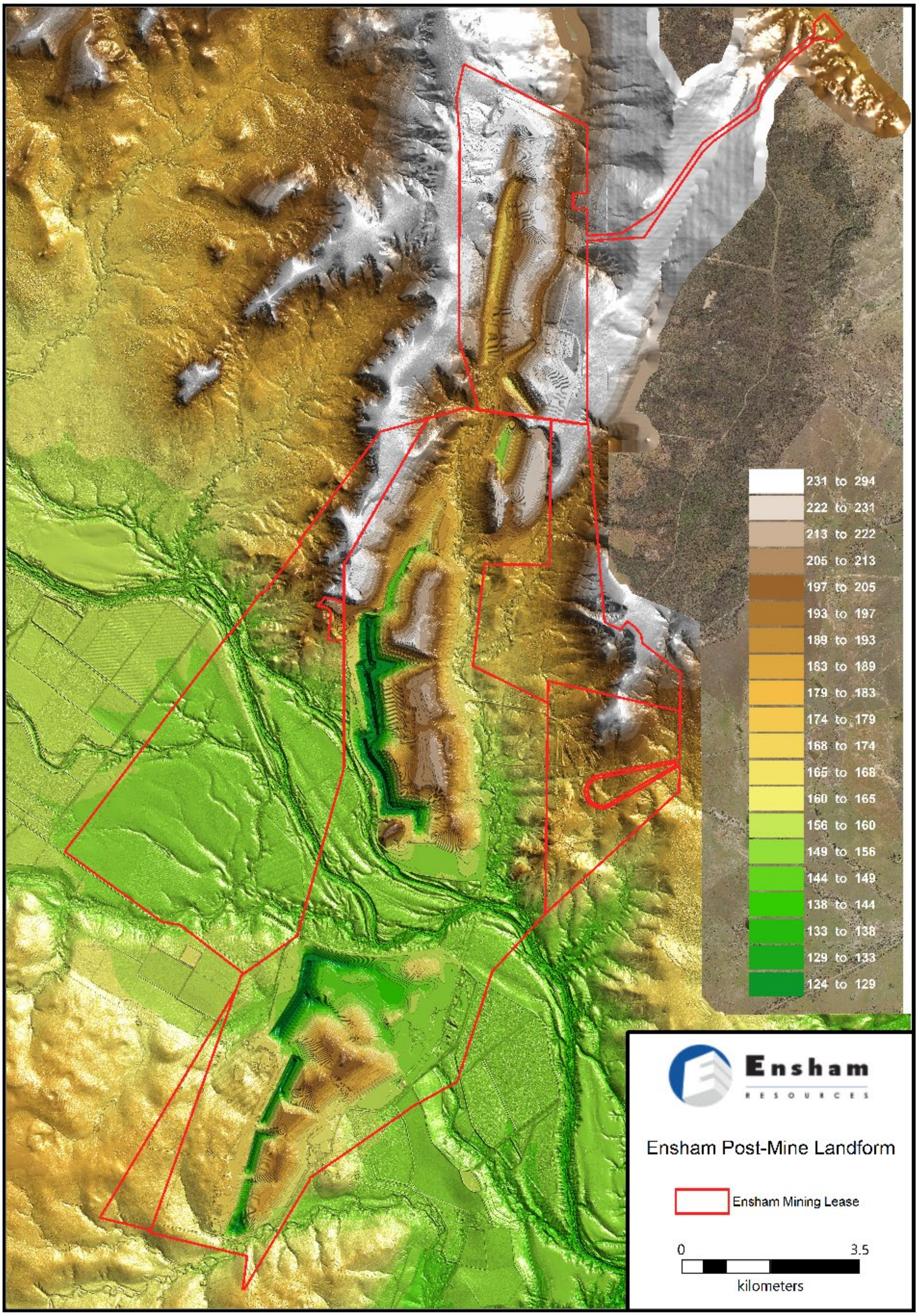


Figure 5-11 Ensham Final Landform

5.4.4 Water management

Post-mining landforms at Ensham are designed to not concentrate overland flow and therefore, do not require contour banks or rock-lined waterways to transport overland flow downslope and off rehabilitation. Rather, landform design is sympathetic to natural geo-fluvial processes. Slope lengths are broken by benches to slow runoff velocities without concentrating flow and to encourage infiltration and soil profile wetting. This limits the volume and velocity of runoff and encourages revegetation. The existing water management plan will continue to be the basis of water management across site until end of mine life.

5.4.4.1 Management of Mine Affected Water (MAW)

MAW is pumped from mining areas and stored on site in mine water storages and in certain mining pits. The storage water levels are maintained with sufficient freeboard to prevent overtopping in design rainfall events, and in most cases are not affected by external catchments. The mine water system is able to discharge waters in a controlled manner from a number of storages to the Nogoa River, in accordance with EA release conditions (which include minimum flow requirements and maximum salinity levels). The EA conditions detail a variety of contaminants required to be sampled to identify the risk they post to the environmental values of the receiving environment.

5.4.4.2 Management of Surface Water Runoff

In order to collect the suspended sediments entrained in runoff from disturbed areas, catch drains direct the runoff to sediment mitigation areas such as sediment dams. Sediments are settled out or deposited before reaching receiving waters. Deposited sediments are excavated periodically to maintain the capacity of the dams. Alongside this, rainfall runoff samples are collected rehabilitated areas to demonstrate the compliance of the surface water runoff to EA quality characteristics as part of the certification process.

5.4.4.3 Management of Runoff from Infrastructure Areas

Industrial Area runoff is also collected in catch drains and directed to sediment dams. Areas which are known to produce oil or chemical-affected runoff are bunded to separate contaminants from cleaner flows, and directed to storage dams, with the water being recycled for use in the process.

5.4.4.4 Management of Sewage Effluent

Sewage effluent is produced at the sewage treatment plant and is stored in large secure tanks. The effluent is sampled regularly to demonstrate compliance, then enabling the effluent to be irrigated through a series of pipework into a low traffic area of irrigated trees.

5.4.4.5 Drainage and Catchments

Ensham's Erosion and Sediment Control Plan details the specifics of Ensham's catchments and drainage strategies. As a summary, Ensham targets drainage to minimise the creation of MAW, whilst diverting the majority of runoff to sediment dams (or raw/stock water dams) where possible.

5.4.4.6 Surface Water Diversions

Ensham Mine has one surface water diversion existing within the mining tenures. The Boggy Creek Diversion (BCD) was established in 1993 to reroute water away from the planned mining areas. Following extensive planning and the appropriate regulatory approvals, the BCD commenced rehabilitation in 2019 and is scheduled to be completed in 2021. This diversion is a permanent diversion and will require minimal maintenance through its life.

5.4.4.7 Dewatering Requirements

In order to fulfil rehabilitation requirements at Ensham Mine, mine pits will require dewatering. This shall be done by:

- Use of the water for dust suppression
- Release into the Nogoa River
- Translocation to water storages underground
- Evaporation

Avenues for treatment and or sale of water can be explored should it be deemed necessary by the mine.

5.4.4.8 Water Monitoring

Regular water monitoring is undertaken at Ensham Mine to track the quality (and levels for groundwater) of MAW, runoff, groundwater and raw water, inclusive of upstream and downstream reaches of the Nogoa River.

Monitoring of the condition of water management structures, such as dams, sediment dams and levees is also incorporated into Ensham's scheduled monitoring. These inspections assess not only the condition, but also identifies any need for repair and recommendations for improvement.

5.5 Deep ripping

Deep ripping of newly created Anthroposols to the depth of the solum (90 cm) is essential for achieving satisfactory rehabilitation at Ensham. Deep ripping has several advantages for rehabilitation. The single greatest advantage is creation of macro-porosity that increases rainfall infiltration and furrows that reduce runoff and erosion (Gardner 2001; Koch 2007). Other benefits include the following:

- Reducing soil bulk density (Henderson 1989) caused by equipment compaction of subsoil (spoil) during landform construction.
- Increases profile recharge and plant available water (Kew et al. 2007).
- Facilitates deeper rooting by establishing vegetation, improves root architecture and increases use of deep subsoil moisture (Szota et al. 2007; Lardner and Tibbett 2013).
- Can be used to mechanically incorporate gypsum into subsoils (spoils), lessening the time required for gypsum to dissolve and react with the subsoil solid phase.
- Creates a surface seedbed for seed germination with good soil-seed contact (also provided by shallow ripping) (Lardner and Tibbett 2013).

Practice at Ensham is to use a single tine and rip at close intervals with overlapping track lines. To improve ripping outcomes and achieve greater tillage at depth, a wing-like structure is fitted to the shank of the tine directly behind the point. This action lifts and tills the soil profile across a broad front. Deep ripping is typically enough to create a friable seed bed into which seed is sown.

5.6 Revegetation

5.6.1 Revegetation objectives

Revegetation has two primary aims. Initial rapid vegetation establishment is required to achieve a transitional groundcover greater than 50 % to control soil loss by water erosion to sustainable levels. This may be achieved in some instances using a non-persistence cover crop such as annual millet, in addition to longer-lived grasses and forbs. In the longer term, establishment and persistence of specific species is needed to achieve specific completion criteria for each PMLUs.

Ensham has developed revegetation objectives for each PMLU (Table 5-9). Some of these are common, like rapid establishment for erosion hazard control effectiveness, while others are specific to PMLUs, e.g., 3P species for beef cattle grazing PMLU.

Table 5-9 Revegetation objectives for each PMLU at Ensham

PMLU	Revegetation objectives
Mine Domain 1 Beef cattle grazing	1. Rapid groundcover establishment to provide long-term erosion hazard control effectiveness. 2. ≥50% established and persistent vegetative groundcover for all slopes from 0-15%. 3. ≥80% established and persistent vegetative cover for slopes from 15% to 25%. 4. A persistent sward of 3P pasture species including legumes (perennial, palatable and persistent). 5. Weeds comprise less than 10 % of groundcover.
Mine Domain 2 Landholder retained infrastructure	There are no revegetation objectives for this PMLU.
Mine Domain 3 Native bushland corridor	1. Rapid groundcover establishment to provide long-term erosion hazard control effectiveness. 2. ≥50% established and persistent vegetative groundcover for all slopes from 0-20%. 3. ≥80% established and persistent cover (vegetative and/or rock mulch) for slopes from 20% to 25%. 4. Species richness ≥ 2 tree species, ≥ 3 shrub species, ≥ 5 groundcover species. 5. Weeds comprise less than 10 % of groundcover.
Mine Domain 4 Boggy Creek diversion	1. Rapid groundcover establishment to provide long-term erosion hazard control effectiveness. 2. Terrestrial vegetation communities should aim to resemble RE11.7.2/11.7.4 and RE11.7.1 3. Riparian vegetation communities should resemble RE11.3.25. 4. The revegetation outcome must achieve a long-term self-sustaining vegetation community.
Mine Domain 5 Flood protection landform	1. Rapid groundcover establishment to provide long-term erosion hazard control effectiveness.

	2. ≥50% established and persistent vegetative groundcover for all slopes from 0-20%.

5.6.2 Seed mixes

Key species representative of each PMLU for Domain 1 – beef cattle grazing and Domain 5 – flood protection landform are provided (Table 5-10). For revegetation of Domain 4 - Boggy Creek diversion, Alluvium (2018) recommend more than 60 suitable species. The species mix for Domain 3 – Native Bushland Corridor is yet to be decided. It will likely include species such as *Corymbia citriodora* and/or *Acacia shirleyi* (or *A. catenulate*) to ensure development of the appropriate floristic composition in accordance to the regional ecosystems described in the EA. Where possible, seed mixes will be locally sourced, or at minimum, aim to be sourced from suppliers that harvest from areas demonstrating similar environmental characteristics to that of Ensham Mine. In many cases, supply availability and historical seed success performance/quality will be the key factors driving seed sourcing.

Table 5-10 Key species for Domain 1 – beef cattle grazing and Domain 5 – flood protection landform

Scientific name	Common name	Sowing rate (kg/ha)
Chloris gayana	Reclaimer Rhodes	2.5
Chloris gayana	Katambora Rhodes	2.5
Chloris gayana	Callide Rhodes	2.5
Macroptilum bracteatum	Burgundy Bean	2.5
Stylosanthes spp.	Stylo Mix	2.5
Urochloa mosambicensis cv. Saraji	Sabi grass	5
Cynodon dactylon	Couch	2.5
	TOTAL	**20**

5.6.3 Establishing vegetation

Vegetation establishment in rehabilitation at Ensham is aided by attention to the following basic principles.

5.6.3.1 Growth medium

As described in section 5.3.1.2, Ensham have ~3.0 million cubic metres (Mm3) of topsoil available on site for rehabilitation. Laboratory analysis is the basis for ensuring the suitability (and need for addressing soil limitations where necessary) to ensure it is suitable to sustain the PMLU. Topsoil will be spread at a depth of 150mm. The outcomes of rehabilitation trials will determine the strategies to address the topsoil deficit (eg. amelioration of spoil).

5.6.3.2 Seedbed preparation

Ensham sows into well prepared seedbeds that are loose and friable, with many micro-niches to enable good contact between soil and seeds. This is essential for good germination. At Ensham, deep ripping is usually enough to create a good seedbed as this activity causes significant surface soil disturbance.

5.6.3.3 Sowing good quality seed

Ensham sows good quality seed. Whilst there are no established thresholds, the results of independent seed tests are used to compare quality and price of available seed. This includes purity (%), germination (%) and percentage of pure live seeds (purity % x germination %).

5.6.3.4 Sowing at the right time

Sowing at the right time and avoiding a false start is critical to revegetation. Ensham aims to sow in the warmer months of the year from September to March, and ideally November to January when the probability of rainfall is highest. Where possible, use of irrigation may be used to establish germination and pasture in rehabilitation areas, removing the need to sow at the "right time" suited to climatic conditions and rainfall.

5.6.3.5 Correcting soil limitations

Understanding and correcting soil limitations ensures revegetation success. Regular soil and spoil laboratory testing ensures the correct fertilisers and ameliorants are applied to promote revegetation success. Ensham will sample and test all materials used in future rehabilitation. Addressing soil limitations within Ensham soils has historically included the application of lime, gypsum, fertiliser and hay-mulch where needed.

5.6.3.6 Controlling weeds

Weed prevention is far better than weed control. Weed prevention in rehabilitation is achieved by not over-fertilising, controlling weeds around site generally, ensuring hay mulch is weed free, inspecting machinery before it enters site, sowing soon after seedbed preparation so that weeds do not get a head start. Ensham's weed management will operate in accordance to the Weed and Feral Animal Management Plan.

5.6.3.7 Managing grazing livestock

Livestock are excluded from establishing rehabilitation until monitoring demonstrates revegetation has been successful, including demonstrating a sustainable groundcover for erosion control. Once cattle are moved onto rehabilitation, best practice grazing management ensures rehabilitation is not overgrazed and the overall land condition is maintained or improved over time. This is done so in accordance to the Grazing Management Plan.

5.7 Erosion control

It is well established that high cover percentages, above 50 % groundcover, reduce erosion in rehabilitation, even on steep slopes, e.g., see Loch (2000) and Carroll (2000). However, the period when the soil is bare and vulnerable to erosion by surface runoff presents a significant window of erosion risk (Loch 2000; Carroll and Tucker 2000; Carroll *et al*. 2001). For typical rehabilitation with slope gradients ≤15 %, this window of erosion risk exists from the time of sowing until >50 % groundcover is established. It is during this period, which may be weeks or months depending on rainfall and other factors that affect plant establishment and growth, that you will need to actively control erosion to prevent unacceptable soil loss and potentially severe gully erosion and landscape failure.

Ensham applies hay mulch immediately after sowing to provide instant groundcover and close the window of erosion risk (Figure 5-12). Hay mulch applied at a minimum rate of 5 t/ha is a quick, cheap, and effective erosion hazard control. It also promotes germination and establishment of sown species by assisting to retain soil moisture through reducing evapotranspiration and lowering soil temperatures in the hotter months.

Figure 5-12 Spreading hay mulch for erosion control in rehabilitation at Ensham

5.8 Tailings Storage Facilities

Ensham does not operate a traditional coal handling and preparation plant (CHPP) to wash coal and therefore, does not generate fine tailings mineral waste. There are no tailings storage facilities (TSFs) at the mine.

5.9 Voids

Ensham's final landform has a pre-approved NUMA for Mine Domain 5 - Groundwater daylighting water areas. Pits A South, E, F & Y will be partially backfilled to support a final land use of grazing, therefore not considered a void. Pits A, Central, A North, B, C & D will also be partially backfilled but are predicted to have groundwater daylighting areas within them, resulting in a NUMA.

5.9.1 Highwall stability

Regarding long-term stability of highwalls, a recent geotechnical assessment by (WSP 2018), including slope stability analysis to assess overall factor of safety, determined the following:

- Tertiary-aged materials should be regraded to a slope gradient ≤1(V):3(H), which is numerically equivalent to grade of 33.3 % or angle of 18.4 degrees, to improve stability to an acceptable standard.
- Weathered Permian-aged materials should be regraded to a slope gradient of 1(V):2(H), equivalent to a grade of 50 % or angle of 26.6 degrees.
- Fresh Permian-aged materials should be regraded to a slope gradient of 1(V):1(H), equivalent to a grade of 100 % or angle of 45 degrees.
- If recommended slope geometries cannot be achieved, partially backfilling of voids to buttress walls with spoil could be considered.

5.9.2 Hydrogeology

Void hydrogeology, addressing the long-term water balance and water levels within voids and potential to overtop, has been detailed previously in this PRC Plan (see Section 5.1).

5.10 Underground mining

Underground mining at Ensham has negligible surface impacts because, unlike longwall mining, bord and pillar mining does not cause surface subsidence. The underground workings are accessed from a section of B Pit highwall (Figure 5-13).

Figure 5-13 Entrances to the existing Ensham underground mine.

The areas above underground mining panels will be subject to short term surface disturbance. The requirement to drill bore holes for geotechnical, coal quality, gas extraction, mine inertisation, groundwater monitoring and service holes will continue for the life of the mine. Once the drill hole is finished with, the bore and the areas disturbed by these activities are rehabilitated and returned to previous land use of cattle grazing consistent with the rehabilitation milestones under the PRCP schedule for the relevant rehabilitation areas.

Exploration and underground service holes are not included in future disturbance or rehabilitation planning. These holes are temporary in nature and rehabilitated upon closure of the hole. Planned disturbance for the drilling of these holes is unable to be identified as the drill locations are fluid based on a series of environmental and operational factors.

5.10.1 Geotechnical stability and surface subsidence

Bord and pillar mining at Ensham forms a regular array of stable coal pillars and roadways in each panel i.e., mining area, and does not cause large scale overburden fracturing or surface subsidence (Gordon 2020). In a recent geotechnical assessment, Gordon (2020) confirmed:

- The long-term stability of the mine layout with a minimum factor of safety of 1.6.
- Predicted surface subsidence of less than 40 mm vertical movement, because of elastic compression of the strata i.e., compression due to the additional load on the pillars after the coal is extracted.
- No surface cracking due to subsidence and associated strains and tilts.
- No surface topographical depressions that would cause ponding of incident rainfall and runoff water.

As underground mining does not cause any discernible surface impacts, no rehabilitation activities are necessary. The potential for measurable subsidence in the long-term is very low due to the stability of the overburden (Gordon 2020). The size and location of coal pillars is designed to ensure a very conservative long-term factor of safety is maintained i.e., a very low probability of coal pillars crushing out that would cause overburden instability and surface subsidence.

5.10.2 Groundwater

The hydrogeological setting comprises two groundwater bearing units, viz. the Quaternary aged alluvium and the Permian aged Rangal Coal Measures. The two are separated by a low permeability unit and neither aquifer is suitable for stock or domestic use due to salinity (SLR 2020). Underground mining causes aquifer drawdown of the Permian coal-aquifer during mining operations and recovers post-mining (SLR 2020). This will have no impact on rehabilitation at Ensham.

5.11 Built infrastructure

No equipment, hazardous materials or contamination will remain in the post-mining landscape at Ensham.

5.11.1 Infrastructure to be decommissioned

Ensham has commenced decommissioning and removal of built infrastructure. In 2019 – 2020 the former Yongala Camp facilities and workshop were decommissioned and removed to allow for Boggy Creek diversion rehabilitation. Remaining infrastructure to be progressively decommissioned and removed from site includes the following.

- Draglines, continuous miners and ancillary opencut and u/g mining equipment.
  All equipment will be de-oiled, isolated, and depressurised prior to sale for overhaul and reuse, or salvage and scrap value. All mobile equipment will be removed from site.
- Opencut and u/g administration, office, workshop and stores buildings, and camp facilities.
  All buildings will have services terminated prior to removal from site for sale or salvage and scrap value. Concrete foundations, driveways, pathways, and similar non-hazardous wastes will be disposed of in-pit and buried.
- ROM, crusher, coal stacking and reclaiming, and train loading infrastructure.
  All coal preparation infrastructure will be pull-down and removed from site for sale or salvage and scrap value. Concrete foundations, driveways, pathways, and similar non-hazardous wastes will be disposed of in-pit and buried. Coal will be disposed of in-pit and buried.
- Vehicle refuelling facilities.
  All fuel, oil and lubricants will be extracted for recycling or disposal. All infrastructures will be removed from site for sale or salvage and scrap value. Concrete foundations, driveways, pathways, and similar non-hazardous wastes will be disposed of in-pit and buried.
- Vehicle washdown facilities.
  All chemical agents will be extracted for recycling or disposal. All infrastructures will be removed from site for sale or salvage and scrap value. Concrete foundations, driveways, pathways, and similar non-hazardous wastes will be disposed of in-pit and buried.

Following the safe decommissioning and removal of infrastructure from site, a contaminated land investigation will be conducted. The investigation will be guided by the location of any environmentally relevant activities conducted on site.

5.11.2 Infrastructure to be retained post-mining

Built infrastructure that is proposed to be retained in the post-mining landscape is limited to items considered advantageous to on-going land management activities associated with the PMLUs. These items have been listed (see Section 3.1.2).

5.12 Methods to achieve a stable condition

Following is a summary of the proven rehabilitation methods used to deliver rehabilitated land in a stable condition at Ensham (Table 5-11). A stable condition is defined in section 111A of the EP Act as follows.

> *Land is in a stable condition if-*
>
> - *The land is safe and structurally stable, and*
> - *There is no environmental harm being caused by anything on or in the land, and*
> - *The land can sustain a PMLU.*

Table 5-11 Rehabilitation methods for each rehabilitation PMLU at Ensham

PMLU	Rehabilitation methods
Beef cattle grazing.	1. Remove infrastructure. 2. Spoil and soil laboratory testing. 3. Undertake a contaminated land assessment where required. 4. Reshape overburden as required to achieve landform design parameters paired to land suitability requirements and spoil types. 5. Apply gypsum if needed. 6. Respread topsoil to minimum 150 mm depth. 7. Deep rip profile to minimum 600 mm depth. 8. Apply seed and fertiliser. 9. Apply hay mulch at minimum rate of 5 t/ha. 10. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 11. Certification of progressive rehabilitation. 12. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.
Landholder retained infrastructure.	1. Identify infrastructure to be retained by land holder/s. 2. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 3. Certification of progressive rehabilitation. 4. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.

PMLU	Rehabilitation methods
Watercourse, bed and banks of the Boggy Creek diversion.	1. Remove infrastructure. 2. Spoil and soil laboratory testing. 3. Undertake a contaminated land assessment where required. 4. Reshape land as required to achieve landform design parameters per DRNM approved design. 5. Apply gypsum and/or lime if needed. 6. Respread topsoil to minimum 150 mm depth. 7. Deep rip profile to minimum 600 mm depth. 8. Apply seed and fertiliser. 9. Apply hay mulch at minimum rate of 5 t/ha. 10. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 11. Certification of progressive rehabilitation. 12. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.
Native bushland corridor	1. Remove infrastructure. 2. Spoil and soil laboratory testing. 3. Undertake a contaminated land assessment where required. 4. Apply gypsum if needed. 5. Respread topsoil to minimum 150 mm depth. 6. Deep rip profile to minimum 600 mm depth. 7. Apply seed and fertiliser. 8. Apply hay mulch at minimum rate of 5 t/ha. 9. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 10. Certification of progressive rehabilitation. 11. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.
Flood protection landform	1. Spoil and soil laboratory testing. 2. Reshape overburden as required to achieve landform design parameters. 3. Apply gypsum if needed. 4. Respread topsoil to minimum 150 mm depth. 5. Apply rock for erosion / scour protection as needed. 6. Deep rip profile to minimum 600 mm depth (where no rock is applied).

PMLU	Rehabilitation methods
	7. Apply seed and fertiliser. 8. Apply hay mulch at minimum rate of 5 t/ha. 9. Monitor and manage rehabilitation to achieve completion criteria, demonstrating the land is in a stable condition. 10. Certification of progressive rehabilitation. 11. Monitor, manage, and maintain the rehabilitated land in a stable condition until mine closure.

6 RISK ASSESSMENT

Legislative requirement	Compliance
In accordance with section 126C(1)(f) of the EP Act, the rehabilitation planning part of the PRC plan must identify the risks of a stable condition for land described as a post-mining land use not being achieved, and how the applicant intends to manage or minimise the risks.	

In accordance with section 126C(1)(f) of the EP Act, this section identifies the risks of a stable condition for land described as a PMLU not being achieved, and how Ensham intends to manage or minimise those risks. It also identifies the risks of the NUMA causing environmental harm and not being safe and structurally stable and details how Ensham intends to manage and minimise the identified risks.

6.1 Risk assessment of PMLUs and NUMAs and relevant milestones

A risk assessment workshop was convened on 14 December 2020 at Ensham mine. A detailed report of that workshop is provided below (Table 6-1). All risks associated with the achievement of rehabilitation milestones for PMLUs and management milestones for NUMAs were identified and evaluated using the Ensham risk matrix and risk acceptance threshold model. This tool includes likelihood and consequence tables, and a quantitative risk matrix. It recognises AS ISO 31000:2018 Risk Management – Guidelines (Standards Australia, 2018), Queensland coal mining safety and health legislation, and other standards.

Where additional risk treatments are proposed to ensure risks are as low as reasonably possible, then the risk treatment step in the risk assessment also highlights-

- The reasons for selecting the treatment option.
- Those responsible for the approval and implementation of the plan
- Proposed actions.
- Resource requirements.
- Performance measures and constraints.
- Reporting and monitoring requirements.
- Timing and scheduling.

There are no significant risks that will prevent Ensham from achieving this PRCP, including rehabilitation milestones and management milestones as stated in the schedule.

Table 6-1 Ensham PRCP risk assessment

Process Step	Hazard Type	Description of Unwanted Event	Consequence Type	Current Controls In Place	Control Type	Control Quality	Control Effectiveness	Maximum Reasonable Consequence	Likelihood (The likelihood of the MRC of the unwanted event occurring given the effectiveness of the controls)	Risk Score	Additional treatment options	Reason for selecting the treatment option	Responsibility for approval and implementation	Proposed actions	Resource requirements	Performance measures and constraints	Reporting and monitoring requirements	Timing and scheduling	Maximum Reasonable Consequence	Likelihood	Risk Score
RM1 Infrastructure decommissioning and removal	Other	Infrastructure decommissioning and removal takes longer than planned.	Legal & Regulatory	Asset register. As built drawings. Infrastructure maintenance. Experience in decommissioning of infrastructure on site.	Administrative	60-90%		Minor	Possible	Medium	*Infrastructure decommissioning and removal plan* to be developed and implemented.	A management plan is required to ensure that infrastructure decommissioning and removal is completed on time and budget.	GM Operations	Plan to include register of infrastructure, schedule, budget and responsible roles.	Time Budget Personnel	None	Monitor project milestones.	To be determined	Minor	Rare	Low
	Chemical	Discovery of unknown hazardous materials e.g. asbestos.	Safety	Asbestos register - 3rd party audited and verified.	Administrative	>90%		Insignificant	Rare	Low	None required.										
	Land	Spill of hazardous substance causes potential environmental harm.	Environment	Personnel spill training. Secondary containment. Spill clean up equipment. Removal of hazardous substances prior to decommissioning.	Elimination	>90%		Insignificant	Unlikely	Low	None required.										
RM2 Identification and remediation of contaminated land	Chemical	Previously unknown contamination discovered.	Environment	Site based history of contamination and sites that contain a risk.	Administrative	>90%		Insignificant	Unlikely	Low	None required.										
	Chemical	Previously unknown contamination discovered.	Financial	Site based history of contamination and sites that contain a risk.	Administrative	>90%		Insignificant	Unlikely	Low	None required.										
RM3 Final landform development	Other	Final landform development takes longer than planned.	Legal & Regulatory	Mine planning, scheduling and budgeting.	Administrative	>90%		Minor	Possible	Medium	None required.										
	Other	Unsuitable material for landform development.	Legal & Regulatory	Spoil cross-sections detailing composition. allowing spoil type identification. Landform design suited to material type. RMP.	Administrative	>90%		Minor	Possible	Medium	Final landform design to be reviewed by on site Technical Services Team.	Site technical services team have a wealth of local knowledge about past mining activities, including how dumps and landforms were constructed.	GM Operations	Develop a sign-off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time	None		To be determined	Minor	Rare	Low
	Other	Incorrect Slope for rehab in accordance to criteria.	Legal & Regulatory	Landform design suited to material type. Survey control and progression validation.	Administrative	>90%		Minor	Possible	Medium	Formalise rehabilitation progression signoff process.	Have relevant site personnel sign-off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Develop a sign-off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time			To be determined	Minor	Rare	Low
RM4 Seedbed preparation	Land	Unsuitable soil in accordance to specifications.	Environment	Topsoil mapping/register, placement as per plans. Amelioration strategy.	Administrative	>90%		Minor	Possible	Medium	None required.										
	Land	Topsoil depth not applied to minimum depth.	Environment	Survey, spot checks.	Administrative	>90%		Minor	Possible	Medium	Formalise topsoil application checks to be completed prior to ripping.	Ensuring topsoil is applied to the appropriate depths so there is sufficient topsoil to support vegetation.	Environmental Superintendent.	Develop a sign-off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time Budget	None		To be determined	Moderate	Rare	Medium
	Land	Unconventional topsoil depth does not support vegetation growth.	Environment	Land suitability criteria demonstrated in existing rehabilitation.	Engineering	60-90%		Major	Possible	Critical	Conduct management of change review for revised topsoil depth of 150mm.	Change management implications need to be considered to ensure rehabilitation achieves required land suitability class with less topsoil used.	Manager HSET Systems	Implement site standard for management of change.	Personnel Time Budget				Moderate	Unlikely	Medium
	Land	Incorrect ameliorant application applied.	Environment	Topsoil quality & ameliorant specifications	Administrative	>90%		Minor	Possible	Medium	Include step in rehab sign off process for ameliorant application.	Have relevant site personnel sign-off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Develop a sign-off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time	None		To be determined	Minor	Rare	Low
	Land	Deep Ripping depth and spacing not to specifications.	Environment	Site based procedure to achieve specifications.	Administrative	>90%		Minor	Unlikely	Low	Confirm deep ripping process is documented. Include in site rehabilitation process signoff.	Have relevant site personnel sign-off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Develop a sign-off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time	None		To be determined	Minor	Rare	Low
	Land	Unable to supply volume of rock to meet specifications.	Environment	Harvesting available rock. Utilising/recycling foundation work where possible. Offsite suppliers available to address shortfall.	Elimination	30-60%		Major	Possible	Critical	Investigate alternative landform to reduce rock mulch requirements.	Identification of alternative landforms viable with site materials to reduce the need to source rock from off site suppliers.	Environmental Superintendent.	Investigate alternative landforms to reduce the need for rock mulching.	Personnel Time Budget	None		To be determined	Minor	Rare	Low
RM5 Sowing	Land	Seed mix not to quality or specification.	Environment	Reputable supplier. Seed mix designed to meet specification.	Administrative	60-90%		Minor	Possible	Medium	Introduce Seed quality verification process.	A seed quality verification process will reduce the use poor quality seed mixes, therefore increasing likelihood of plant establishment.	Environmental Superintendent.	Develop a seed quality verification process.	Personnel Time Budget	None		To be determined	Minor	Rare	Low
	Land	Unable to source specific species of seed.	Environment	No current controls in place.	Administrative	<30%		Minor	Possible	Medium	Identify primary and secondary species lists for substitution purposes. Address seeding program in advance to engage with supplier to ensure supply. Investigate seed harvesting options.	Developing site specific primary and secondary species lists for PMLUs to provide to supplier to ensure supply when required.	Environmental Superintendent.	Develop primary and secondary species lists for relevant PMLUs.	Personnel Time Budget	None		To be determined	Minor	Rare	Low
	Land	Unable to source supply of hay sufficient to rehabilitation requirements	Environment	External source of hay mulch.	Administrative	60-90%		Minor	Possible	Medium	Consider options to grow product on site on Ensham owned farming land.	Growing a suitable crop to use as hay mulching on site will reduce costs and ensure supply.	Environmental Superintendent.	Investigate feasibility of growing mulch hay on site.	Personnel Time Budget	None		To be determined	Minor	Unlikely	Low
	Land	Hay mulch not applied to specification.	Environment	Rate of application defined.	Administrative	>90%		Minor	Unlikely	Low	Rehabilitation sign off process - coverage .	Have relevant site personnel sign-off critical stages of the rehabilitation procedure to ensure specifications are followed to complete satisfactory rehabilitation.	Manager HSET Systems	Develop a sign-off procedure to ensure relevant site personnel are involved at critical stages in the rehabilitation process, e.g. similar to BHP WorkPack system.	Personnel Time	None		To be determined	Minor	Rare	Low
RM6 Vegetation established	Land	Vegetation does not satisfy completion criteria.	Environment	RMP, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%		Moderate	Rare	Medium	None required.										
	Land	Groundcover does not satisfy completion criteria.	Environment	RMP, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%		Moderate	Rare	Medium	None required.										
	Land	Weeds species in groundcover is >10%.	Environment	RMP, Grazing Management Plan, Annual Rehabilitation Monitoring.	Administrative	>90%		Moderate	Rare	Medium	None required.										
RM7 Achievement of a stable condition (beef cattle grazing PMLU)	Land	The Rehabilitation Area contains significantly more hazards than the surrounding unmined landscape.	Safety	Rehabilitation design & signoff.	Administrative	>90%		Moderate	Unlikely	Medium	None required.										
	Land	The Rehabilitation Area surface water runoff does not comply with completion criteria and causes environmental harm.	Legal & Regulatory	Mine Waste Management Plan, Water Management Plan (includes monitoring).	Administrative	>90%		Moderate	Unlikely	Medium	None required.										
	Land	The Rehabilitation Area does not achieve a land suitability class between 2 and 4.	Legal & Regulatory	Material characterisation, selective placement (design plan).	Administrative	>90%		Moderate	Possible	High	Material testing prior to use.	Testing materials prior to use to ensure suitable materials are used in rehabilitation.	Environmental Superintendent.	Develop a material testing procedure to ensure suitable materials are used in rehabilitation.	Personnel Time Budget	None	Review Rehabilitation Management Plan	To be determined	Minor	Rare	Low

6.2 Rehabilitation trials

Rehabilitation is well understood at Ensham and no rehabilitation trials are proposed as a method to manage or minimise a risk of a stable condition not being achieved. Notwithstanding, rehabilitation trials may be conducted from time to time as a component of continuous improvement. Rehabilitation trials have been and will continue to be conducted at Ensham from time to time as a component of continuous improvement.

6.2.1 NEDO Trial

The earlier of Ensham's trials, the NEDO trial, was aimed to establish a high capacity carbon sink in a short period time by trialling methods of afforestation. This trial expanded from 2001 to 2005 and studied various treatments and conditions (inclusive of soil additives/fertilisers, fungi presence, watering regimes, and groundcover variability) against 2 tree species. The findings from this trial provided a foundation of data for Ensham to understand the growth of trees in rehabilitation, particularly with respect to measurable carbon fixation.

6.2.2 Yongala Grazing Trial

In Dec 2015 to Apr 2016, a grazing trial was conducted at Ensham. This trial was undertaken at Yongala and aimed to provide evidence that demonstrates the ability of rehabilitated mine spoil to meet an end land use of a grazing rangeland system. The priorities of the grazing trial were to;

- demonstrate the rehabilitated areas can support a carrying capacity of similar land types and conditions of grazing areas in the surrounding district; and
- that rehabilitation remains a safe and stable landform prior to and following the grazing trial; and
- to ensure established rehabilitation pasture species remain viable following the grazing trail.

Whilst not directly analysed in the assessment, condition and performance of the cattle was considered following removal from the rehabilitation area.

Pre and post grazing assessments were completed in the trial areas, collating data on the following parameters:

- Ground cover (%)
- Soil condition rating (1-5)
- Pasture condition rating (1-4)
- Dry matter (DM) yield (kg/ha)
- Yield unpalatable (%)

Assessment of these, alongside consideration of the condition and performance of the cattle within the area enabled the following conclusions to be drawn.

- Dry matter yield decreased with grazing
- % of unpalatable forage decreased significantly (attributed to cattle compacting and mulching rank unpalatable material, whilst promoting new growth through disturbance and rainfall) – this increased the pasture condition rating.
- Slight decrease in groundcover post grazing.

- Soil condition unchanged with the presence of grazing

The native woodland reference site experienced similar conditions, but however did not see as significant of a fluctuation in dry matter yield post grazing.

Overall, the results from the grazing trial indicate that grazing on rehabilitation at Ensham is sustainable to stocking rates comparable to the surrounding district without risk of deterioration in landform stability and viability of pasture species, therefore aiding in developing rehabilitation strategies moving forward.

6.2.3 BCS Growth Trials

BCS Consortium (Cammel Consulting, Innovate Enviro and SoilCyclers Pty Ltd) are currently undertaking growth trials at Ensham using ameliorated and remediated overburden as a growth media as part of a project jointly funded by METS Ignited and Idemitsu. The aim of the trial is to be able to identify strategies to improve spoil and topsoil for use in rehabilitation/ Laboratory results of the ameliorated material have shown results to be equal to or better than a typical site topsoil. SoilCyclers sampled overburden from across the site and they have developed and costed an amelioration strategy to turn overburden into a growth media to address the topsoil shortfall. Two samples of typical Tertiary and Permian spoil material were chosen for onsite amelioration trials which commenced in December 2020. BCS Consortium are confident that ameliorating overburden to a growth media is a proven solution to meet rehabilitation needs as required.

7 MONITORING AND MAINTENANCE

7.1 Milestone monitoring

A monitoring program has been developed and is aligned to the eleven Rehabilitation Milestones described in Section 9.1.2.2

7.1.1 Monitoring of RM1 – Infrastructure decommissioning and removal

Where relevant, this RM is the initial step in the rehabilitation process. Achievement of this milestone will be determined by completion of a checklist and formal signoff by relevant Ensham personnel. This may include formal confirmation of the following:

- Have all services been disconnected?
- Have all road materials been removed?
- Have all pipelines been removed?
- Have all buildings and foundations been removed?
- Has all machinery and equipment been removed?
- Has all scrap been removed?
- Has all general and regulated waste been removed?

A report will be compiled of the infrastructure removed and disposal process.

7.1.2 Monitoring of RM2 – Identification and remediation of contaminated land

This RM is relevant to rehabilitation areas that were previously used for an *environmentally relevant activity* e.g., fuel storage, sewage treatment. Where such activities were conducted, the following process will apply:

- Engage a suitably qualified person.
- Site investigation report, to determine if contamination exists.
- Validation report, describing works conducted to remediate any contaminated land.
- Site suitability statement, indicating the land is not contaminated.

The above listed documentation will demonstrate achievement of this RM.

7.1.3 Monitoring of RM3 – final landform development

Achievement of this RM will be determined by ground and aerial survey, and generation of 'as constructed' digital terrain models and/or plans. These will be signed off by relevant Ensham personnel, including technical and operation functions at the mine, confirming design specifications have been achieved within acceptable engineering tolerances.

7.1.4 Monitoring of RM4 – Seedbed preparation

Seedbed preparation will generally require the spreading of topsoil and tillage to create loose, friable surface with plenty of micro-niches for seed/soil contact. Achievement of this RM will be demonstrated as follows:

- Laboratory soil testing to determine material suitability for use as a growth media.
- Amelioration and fertilisation to overcome plant growth limitations identified by soil laboratory testing.
- Survey control and mapping of the extent and depth of topsoil replacement, where topsoil is used.
- The date of topsoil replacement and subsequent treatments e.g., deep ripping, sowing.

7.1.5 Monitoring of RM5 - Sowing

Achievement of this RM will be documented in the site GIS, including the following information:

- The extent (boundaries) of each area sown.
- The seed mix sown.
- Date of sowing.
- Sowing methods.
- Seed quality records.

7.1.6 Monitoring of RM6 – Vegetation establishment

Vegetation establishment will be monitored as:

- Percentage groundcover, using ground methods which may be supplemented with remote sensing methods.
- Prevalence of weeds.

Field assessments are conducted by competent technical personnel, and data review and reporting by an appropriately qualified person.

7.1.6.1 Groundcover monitoring

Specifically, groundcover monitoring consists of visual observations using a transect or quadrat to delineate a representative groundcover measurement for the rehabilitation area. Observations on the type of cover are made for the assessment area alongside biomass, diversity/species presence and weed infestations.

Groundcover assessments are subsequently also paired with erosion monitoring of the associated rehabilitation areas.

7.1.6.2 Erosion Monitoring

In-field visual observations shall constitute erosion monitoring in rehabilitation areas. This assessment will note the presence of any erosion within the rehabilitation, its severity and any recommended actions where deemed necessary. This monitoring can also be paired with drainage and runoff assessments with the aim to identify and rectify converging flow paths.

7.1.7 Monitoring of RM7 – Achievement of a stable condition (beef cattle grazing PMLU)

7.1.7.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO13000:2009) to demonstrate each rehabilitation is safe, relative to unmined lands used for the same purpose e.g., cattle grazing.

7.1.7.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is causing environmental harm. This will include monitoring for the following parameters:

- pH
- Salinity, as electrical conductivity (EC)
- Total suspended solids
- Arsenic
- Molybdenum
- Selenium
- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the EA. Any instances of seepage from rehabilitation areas will be sampled.

7.1.7.3 PMLU

Agricultural land resource evaluation and land suitability assessment will be used to determine if rehabilitation areas can sustain a PMLU of cattle grazing. Details of this land evaluation methodology have been provided (refer to Section 5.4.2). Alongside this, pasture productivity assessment will be conducted to identity its suitability for cattle grazing (eg. 3P grasses).

7.1.8 Monitoring of RM8 - Achievement of a stable condition (landholder retained infrastructure PMLU)

7.1.8.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO13000:2009) to demonstrate each rehabilitation area is safe, relative to unmined lands used for the same purpose.

7.1.8.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is causing environmental harm. This will include monitoring for the following parameters:

- pH
- Salinity, as EC
- Total suspended solids
- Arsenic
- Molybdenum
- Selenium
- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the EA. Any instances of seepage from rehabilitation areas will be sampled.

7.1.8.3 PMLU

This PMLU will be demonstrated by formal agreement between the underlying landholders and Ensham.

7.1.9 Monitoring of RM9 - Achievement of a stable condition (Boggy Creek diversion PMLU)

7.1.9.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO13000:2009) to demonstrate each rehabilitation is safe, relative to unmined lands used for the same purpose e.g., cattle grazing.

7.1.9.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is causing environmental harm. This will include monitoring for the following parameters:

- pH
- Salinity, as EC
- Total suspended solids
- Arsenic
- Molybdenum
- Selenium
- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the EA. Any instances of seepage from rehabilitation areas will be sampled.

7.1.9.3 PMLU

This PMLU will be demonstrated by application of diversion monitoring methods outlined in Criteria for functioning river landscape units in mining and post-mining landscapes (ACARP Project C20017). Specifically, this will require assessment of riparian vegetation to determine an index of diversion condition (IDC) score. IDC is designed specifically for Bowen Basin diversions and provides rapid assessment of channel condition and flags potential management issues.

7.1.10 Monitoring of RM10 - Achievement of a stable condition (native bushland corridor PMLU)

7.1.10.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO13000:2009) to demonstrate each rehabilitation is safe, relative to unmined lands used for the same purpose e.g., cattle grazing.

7.1.10.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is causing environmental harm. This will include monitoring for the following parameters:

- pH
- Salinity, as EC

- Total suspended solids
- Arsenic
- Molybdenum
- Selenium
- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the EA. Any instances of seepage from rehabilitation areas will be sampled.

7.1.10.3 PMLU

To monitoring native bushland rehabilitation areas, Ensham will establish permanent transects and adapt the BioCondition methodology by Eyre et al. (2015). This may include:

- Transects.
- Canopy cover.
- Stem counts, grouped into type (tree, shrub) and genus (Eucalypt, Acacia).
- Groundcover.
- Species richness.

7.1.11 Monitoring of RM11 - Achievement of a stable condition (flood protection landform PMLU)

7.1.11.1 The rehabilitation area is safe

Ensham will use formal hazard assessment methods aligned to Australian Standard for risk management (AS/NZS ISO13000:2009) to demonstrate each rehabilitation is safe, relative to unmined lands used for the same purpose e.g., cattle grazing.

7.1.11.2 Rehabilitation does not cause environmental harm

Surface water monitoring shall be used to demonstrate nothing on or in rehabilitation areas is causing environmental harm. This will include monitoring for the following parameters:

- pH
- Salinity, as EC
- Total suspended solids
- Arsenic
- Molybdenum
- Selenium
- Sulphate.

Rainfall runoff will be sampled to ensure rehabilitation areas are in compliance with the criterion outlined in the EA. Any instances of seepage from rehabilitation areas will be sampled.

7.1.11.3 PMLU

Survey monitoring and generation of 'as constructed' digital terrain models and/or plans. These will be signed off by relevant personnel, including technical and operation functions at the mine, confirming design specifications have been achieved within acceptable engineering tolerances.

8 REFERENCES

ABARES (2015) *Catchment Scale Land Use of Australia - Update March 2015*, Department of Environment 2015, Natural Resource Management (NRM) Boundaries 2015, viewed on 11 December 2020 at Land Use and Management Information for Australia - Fitzroy NRM Region - Queensland (daff.gov.au)

Australasian Groundwater and Environmental (2006) Ensham Central Project – EIA, groundwater impact assessment, Australasian Groundwater and Environmental, Brisbane.

Bureau of Meteorology (2020a) Climate statistics for Australian locations, Emerald Airport, accessed on 10 December 2020, from http://www.bom.gov.au/climate/averages/tables/cw_035264_All.shtml#other

Bureau of Meteorology (2020b) Evapotranspiration calculations, Emerald Airport, accessed on 10 December 2020, from http://www.bom.gov.au/watl/eto/tables/qld/emerald_airport/emerald_airport.shtml

Carroll C, Merton L and Burger P (2000) Impact of vegetative cover and slope on runoff, erosion, and water quality for field plots on a range of soil and spoil materials on central Queensland coal mines, Australian Journal of Soil Research 38:313-327.

Carroll C and Tucker A (2000) Effects of pasture cover on soil erosion and water quality on central Queensland coal mine rehabilitation, Tropical Grasslands 34:254-262.

Carroll C, Tucker A, Merton L, Burger P and Pink L (2001) Sustainability Indicators for Coal Mine Rehabilitation, ACARP project C7006, Queensland Department of Natural Mines and Resources, Brisbane.

CHRC (2016) *Central Highlands Regional Council Planning Scheme,* viewed on 11 December 2020 at Central Highlands Regional Council Planning Scheme 2016 - Central Highlands Regional Council

CMLR (2005) *'Ensham coal mine, rehabilitation resource survey'*, Centre for Mined Land Rehabilitation, The University of Queensland, Brisbane.

Cote C (2020) *Ensham Residual Void Study, Summary of Water Studies,* Sustainable Minerals Institute, The University of Queensland, 2020.

CSIRO (2016) Climate change in Australia, projections for Australia's NRM regions, accessed on 10 December 2020, from https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/super-clusters/?current=ESC&tooltip=true&popup=true

DAWE (2021) *EPBC Act protected matters report*, Commonwealth of Australia Department of Agriculture, Water and the Environment, Canberra.

Ensham Resources (2017) *Ensham Residual Void Study Community Reference Group Charter,* Ensham Resources, Brisbane.

Ensham Resources Pty Limited. (1992). *Environmental Management Overview Strategy November 1992 - Ensham Coal Project - Yongala Mine.*

Ensham Resources Pty Limited. (1993). *Environmental Management Overview Strategy July 1993 - Ensham Coal Project - Ensham Operations.*

Gordon N (2020) *Subsidence report for the Ensham life of mine extension project,* a report prepared for AECOM Australia Pty Ltd on behalf of Ensham Resources Pty Ltd by Gordon Geotechniques Pty Ltd.

Grigg AH, Emmerton BR and Callum NJ (2001) The development of draft completion criteria for ungrazed rehabilitation pastures after opencut coal mining in central Queensland, ACARP project C8038, The University of Queensland, Brisbane.

Hollingsworth, Dames and Moore (1990) Ensham coal project, Impact assessment study, Hollingsworth, Dames and Moore, Brisbane.

Hansen (2006) *Terrain, soils and land capability assessment,* Ensham Central Project, Hansen Consulting, Brisbane.

Hansen Consulting (2006) *Revised Ensham Central Project, environmental impact statement*, Hansen Consulting, Brisbane.

Hazelton P and Murphy b (2007) *Interpreting soil test results, what do all the numbers mean?* CSIRO Publishing, Melbourne.

Kew G, Mengler F and Gilkes F (2007) *Regolith Strength, Water Retention, and Implications for Ripping and Plant Root Growth in Bauxite Mine Restoration*, Restoration Ecology, Vol 15, Issue s4, pp 54-64.

Koch, J.M. (2007) Alcoa's mining and restoration process in South Western Australia, Restoration Ecology, Vol. 15, pp. s11–s16.

Lardner, T.D. and Tibbett, M. (2013) Chapter: Deep ripping after topsoil return affects root proliferation and floristic diversity in a restored biodiverse forest after bauxite mining, Publisher: Australian Centre for Geomechanics, Editors: Mark Tibbett, Andy Fourie, Caroline Digby, pp.363-376.

Loch R (2000) *Effects of vegetation cover on runoff and erosion under simulated rain and overland flow on a rehabilitated site on the Meandu Mine, Tarong, Queensland,* Australian Journal of Soil Research (2000), vol 38, pp 299-312.

Loch R (2004) *Standards for the supply and application of hydromulch products, stage 1 critical shear testing.* Prepared for Qld Department of Main Roads, October 2004.

Queensland Department of Mines and Energy (1995) Technical Guidelines Index, Queensland Government via Department of Mines and Energy, Brisbane.

Queensland Government (2013) Central Queensland Regional Plan, Queensland Government via Department of State Development, Infrastructure and Planning, Brisbane.

Queensland Government (2013b) Guidelines for agricultural land evaluation in Queensland, Queensland Government via Department of Science, Information Technology and Innovation (DSITI) and Department of Natural Resources and Mines (DNRM), Brisbane.

RGS (2018) Material Characterization and source term development for the Ensham Coal Mine Final Void Plan, September 2018. RGS (2019) Final technical report, material characterisation and source term development for the Ensham coal mine final void plan, RGS, Brisbane.

RGS (2021) Mining Waste Management Plan, RGS, Brisbane.

SLR (2020) *Ensham life of mine extension project, groundwater impact assessment,* prepared for AECOM Australia Pty Ltd by SLR Consulting Australia Pty Ltd.

SLR Consulting (2020) Ensham Life of Mine Extension Project, Groundwater impact assessment, SLR Consulting, Brisbane.

SLR (2021) Residual void groundwater monitoring design, SLR, Brisbane

So HB, Sheridan GJ, Loch RJ, Carroll C, Willgoose G, Short M and Grabski A (1998) Post Mining Landscape Parameters for Erosion and Water Quality Control, ACARP project C4011, The University of Queensland, Brisbane.

SRK (2020) *Project Memorandum: Sulphide and Metal/Metalloid Source Depletion Estimates*. Prepared for Ensham Resources Pty Ltd.

Story R, Galloway R W and Gunn R H (1967) *Land systems of the Isaac-Comet area*, CSIRO, Melbourne.

Szota C, Veneklass E, Koch J and Lambers H (2007) *Root Architecture of Jarrah (Eucalyptus marginata) Trees in Relation to Post-Mining Deep Ripping in Western Australia,* Restoration Ecology, Vol 15, Issue s4, pp s65-s73.

Umwelt (2019) *Social impact assessment, Ensham Residual Void Project,* Final – Confidential, prepared by Umwelt (Australia) Pty Ltd for Idemitsu Australia Resources Pty Ltd, Newcastle.

URS (2005) *'Geochemical characterisation and assessment of overburden and potential coal reject material at the Ensham Central Project'*, a report prepared for Ensham Resources by URS Australia, Brisbane.

URS (2015), *'Geochemical characterisation of overburden and potential rejects'*, a report prepared for Ensham Resources by URS Australia, Brisbane.

Umwelt (2019b) *Stage 3 ecological assessment report confidential*, Umwelt, Newcastle.

Williams DJ (2000) Assessment of Embankment Parameters, Pages 275-284 in W. A. Hustrulid, M. K. McCarter, and D. J. A. V. Zyl, editors. Slopestability in Surface Mining. Society for Mining, Metallurgy, and Exploration, Inc, Littleton, Colorado.

WRM (2019) *Ensham mine residual void study, Geomorphic impact assessment of options, Stage 3*, WRM, Brisbane.

WSP (2018) Stage 3 geotechnical assessment, WSP, Brisbane.

9 APPENDICES & ATTACHMENTS

9.1 PRCP schedule & supporting information

Legislative requirement	Compliance
In accordance with section 126D(1) of the EP Act, the PRCP schedule in the PRC plan must:	
a) describe the area of each resource tenure either a post-mining land use or non-use management area, and	Section 9.1.1
b) for each post-mining land use state: i. each rehabilitation milestone required to achieve a stable condition, and ii. when each rehabilitation milestone is to be achieved, and	Section 9.1.2 & Section 9.1.4
c) for each non-use management area state: i. each management milestone, and ii. when each management milestone is to be achieved, and	Section 9.1.3 & Section 9.1.5
d) include maps showing the land mentioned in (a), (b) and (c).	Figure 9-1 to Figure 9-14 (inclusive)

9.1.1 Land use categorisation

All lands within the relevant mining lease tenements, including undisturbed lands, have been provided with either a PMLU or a NUMA (Figure 9-1, Figure 9-2, Figure 9-3, Figure 9-4, Figure 9-5, Figure 9-6 & Figure 9-7 and Table 9-1, Table 9-2, Table 9-3, Table 9-4, Table 9-5, Table 9-6 & Table 9-7). There are seven mining lease tenements, which combined cover 12,642.4 ha of land.

Table 9-1 ML7459 land use categories

Land use categorisations			Area (ha)
Undisturbed	PMLU	Cattle grazing	1,505.0
		Cultivation for cropping	417.3
		Native bushland and watercourses	783.6
		Landholder retained infrastructure	2.1
		Subtotal	**2,708.0**
Disturbed by mining activities	PMLU	Cattle grazing	2949.8
		Landholder retained infrastructure	16.0
		Native bushland corridor	192.7
		Boggy Creek diversion	
		Flood protection landform	65.3
		Subtotal	**3,223.8**
	NUMA	Groundwater daylighting water areas	145.7
		Highwalls	86.1
		Subtotal	**231.8**
TOTAL			**6,163.6**
Registered survey (QSpatial)			6,154.0

Table 9-2 ML7460 land use categories

Land use categorisations			Area (ha)
Undisturbed	PMLU	Cattle grazing	464.5
		Cultivation for cropping	
		Native bushland and watercourses	199.0
		Landholder retained infrastructure	
		Subtotal	**663.5**
Disturbed by mining activities	PMLU	Cattle grazing	95.9
		Landholder retained infrastructure	15.9
		Native bushland corridor	
		Boggy Creek diversion	
		Flood protection landform	
		Subtotal	**111.8**
	NUMA	Groundwater daylighting water areas	0.0
		Highwalls	0.0
		Subtotal	**0.0**
TOTAL			**775.3**
Registered survey (QSpatial)			774.3

Table 9-3 ML70049 land use categories

Land use categorisations			Area (ha)
Undisturbed	PMLU	Cattle grazing	20.5
		Cultivation for cropping	
		Native bushland and watercourses	511.4
		Landholder retained infrastructure	
		Subtotal	**531.9**
Disturbed by mining activities	PMLU	Cattle grazing	875.1
		Landholder retained infrastructure	6.7
		Native bushland corridor	144.4
		Boggy Creek diversion	90.6
		Flood protection landform	
		Subtotal	**1,116.8**
	NUMA	Groundwater daylighting water areas	0.0
		Highwalls	0.0
		Subtotal	**0.0**
		TOTAL	**1,648.7**
		Registered survey (QSpatial)	1,648.0

Table 9-4 ML70326 land use categories

Land use categorisations			Area (ha)
Undisturbed	PMLU	Cattle grazing	5.6
		Cultivation for cropping	
		Native bushland and watercourses	0.7
		Landholder retained infrastructure	
		Subtotal	**6.3**
Disturbed by mining activities	PMLU	Cattle grazing	19.4
		Landholder retained infrastructure	0.0
		Native bushland corridor	0.0
		Boggy Creek diversion	0.0
		Flood protection landform	0.0
		Subtotal	**19.4**
	NUMA	Groundwater daylighting water areas	0.0
		Highwalls	0.0
		Subtotal	**0.0**
		TOTAL	**25.7**
		Registered survey (QSpatial)	25.7

Table 9-5 ML70365 land use categories

Land use categorisations			Area (ha)
Undisturbed	PMLU	Cattle grazing	553.7
		Cultivation for cropping	1,483.1
		Native bushland and watercourses	699.8
		Landholder retained infrastructure	2.2
		Subtotal	**2,738.8**
Disturbed by mining activities	PMLU	Cattle grazing	30.5
		Landholder retained infrastructure	
		Native bushland corridor	
		Boggy Creek diversion	
		Flood protection landform	
		Subtotal	**30.5**
	NUMA	Groundwater daylighting water areas	0.0
		Highwalls	0.0
		Subtotal	**0.0**
		TOTAL	**2,769.3**
		Registered survey (QSpatial)	2,766.0

Table 9-6 ML70366 land use categories

Land use categorisations			Area (ha)
Undisturbed	PMLU	Cattle grazing	254.5
		Cultivation for cropping	0.1
		Native bushland and watercourses	
		Landholder retained infrastructure	
		Subtotal	**254.6**
Disturbed by mining activities	PMLU	Cattle grazing	0.0
		Landholder retained infrastructure	0.0
		Native bushland corridor	0.0
		Boggy Creek diversion	0.0
		Flood protection landform	0.0
		Subtotal	**0.0**
	NUMA	Groundwater daylighting water areas	0.0
		Highwalls	0.0
		Subtotal	**0.0**
		TOTAL	**254.6**
		Registered survey (QSpatial)	254.3

Table 9-7 ML70367 land use categories

Land use categorisations			Area (ha)
Undisturbed	PMLU	Cattle grazing	640.4
		Cultivation for cropping	
		Native bushland and watercourses	358.5
		Landholder retained infrastructure	
		Subtotal	**998.9**
Disturbed by mining activities	PMLU	Cattle grazing	1.3
		Landholder retained infrastructure	0.0
		Native bushland corridor	4.7
		Boggy Creek diversion	0.0
		Flood protection landform	0.0
		Subtotal	**6.0**
	NUMA	Groundwater daylighting water areas	0.0
		Highwalls	0.0
		Subtotal	**0.0**
TOTAL			**1,004.9**
Registered survey (QSpatial)			**1,004.0**

Table 9-8 All tenements land use categories

Land use categorisations			Area (ha)
Undisturbed	PMLU	Cattle grazing	3,444.2
		Cultivation for cropping	1,900.5
		Native bushland and watercourses	2,553
		Landholder retained infrastructure	4.3
		Subtotal	**7,902.3**
Disturbed by mining activities	PMLU	Cattle grazing	3,972.0
		Landholder retained infrastructure	38.6
		Native bushland corridor	341.8
		Boggy Creek diversion	90.6
		Flood protection landform	65.3
		Subtotal	**4,508.3**
	NUMA	Groundwater daylighting water areas	145.7
		Highwalls	86.1
		Subtotal	**231.8**
TOTAL			**12,642.4**
Registered survey (QSpatial)			12,626.3

- For discrete rehabilitation or improvement areas, the hectares presented herein are accurate to ±15 %.
- For total areas of PMLUs and NUMAs, the hectares presented herein are accurate to ±5 %.

9.1.2 Post-mining land uses

PMLUs at Ensham are listed in the land outcome document EA *EPML00732813* and reproduced here as follows.

- Mine Domain 1 - Cattle grazing on overburden and infrastructure areas.
- Mine Domain 2 - Landholder retained infrastructure.
- Mine Domain 3 - Boggy Creek diversion.
- Mine Domain 4 - Native bushland corridor.
- Mine Domain 7 - Flood protection landform.

A description of each PMLU is provided in the planning part of this PRCP (see Section 2.4). These PMLUs account for approximately 95 % of mining disturbance in the post-mining landscape at Ensham.

9.1.2.1 Rehabilitation areas

A total of 26 rehabilitation areas (RAs) have been identified at Ensham (Figure 9-8, Figure 9-9., Figure 9-10, Figure 9-11, Figure 9-12 and Figure 9-13). This includes 5 areas of existing rehabilitation, RA1 to RA5, and 21 areas of future rehabilitation, RA6 to RA26 (Table 9-10). A schedule of future RA availability for rehabilitation is provided (Table 9-10). This schedule is cognisant of mining activities and infrastructure requirements, particularly as these relate to underground mining operations, and the feasibility of completing rehabilitation. Feasibility of completing rehabilitation includes considerations of timing and management complexity, and safety, cost, and engineering requirements for each RA.

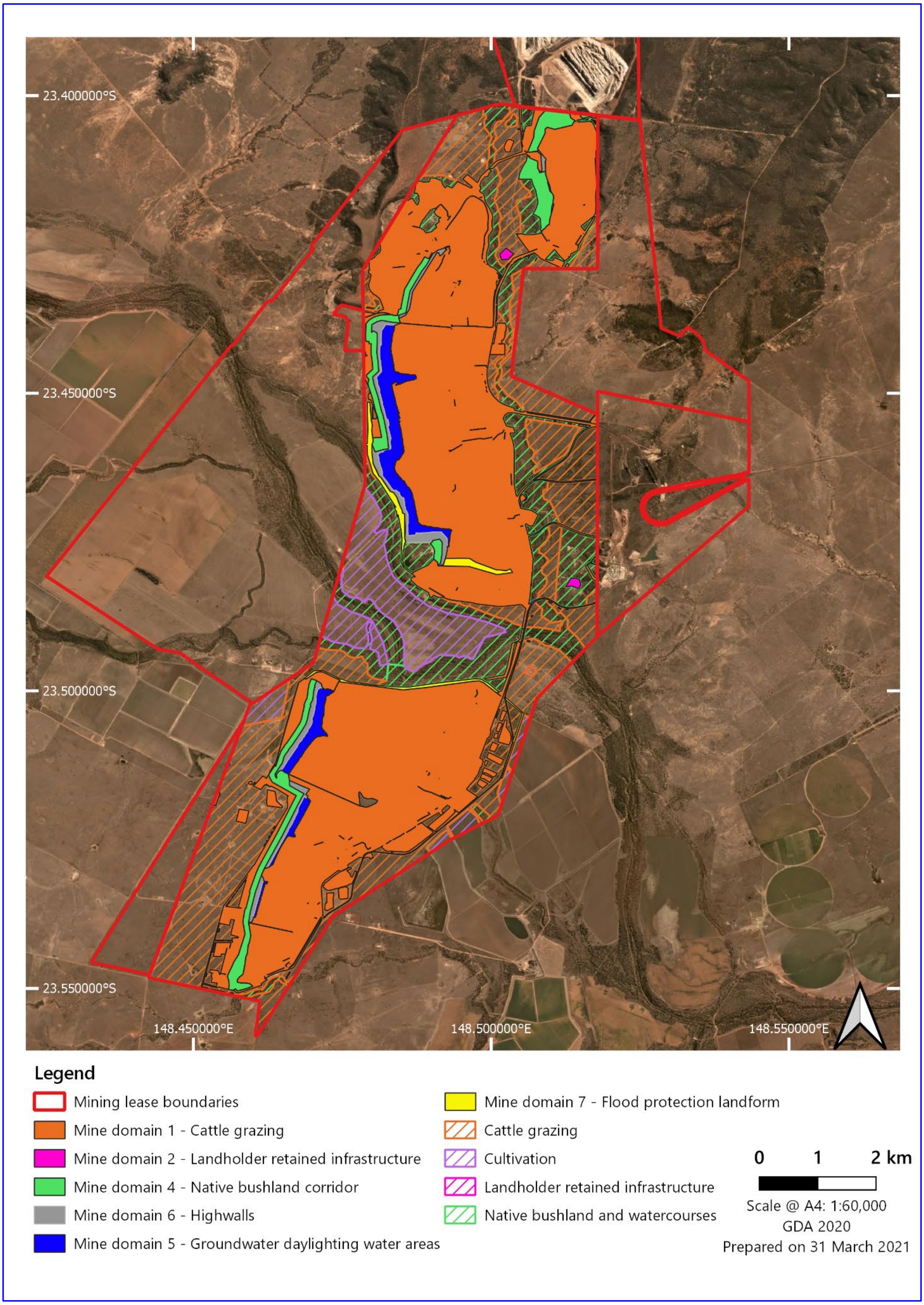


Figure 9-1 ML7459 land use categories

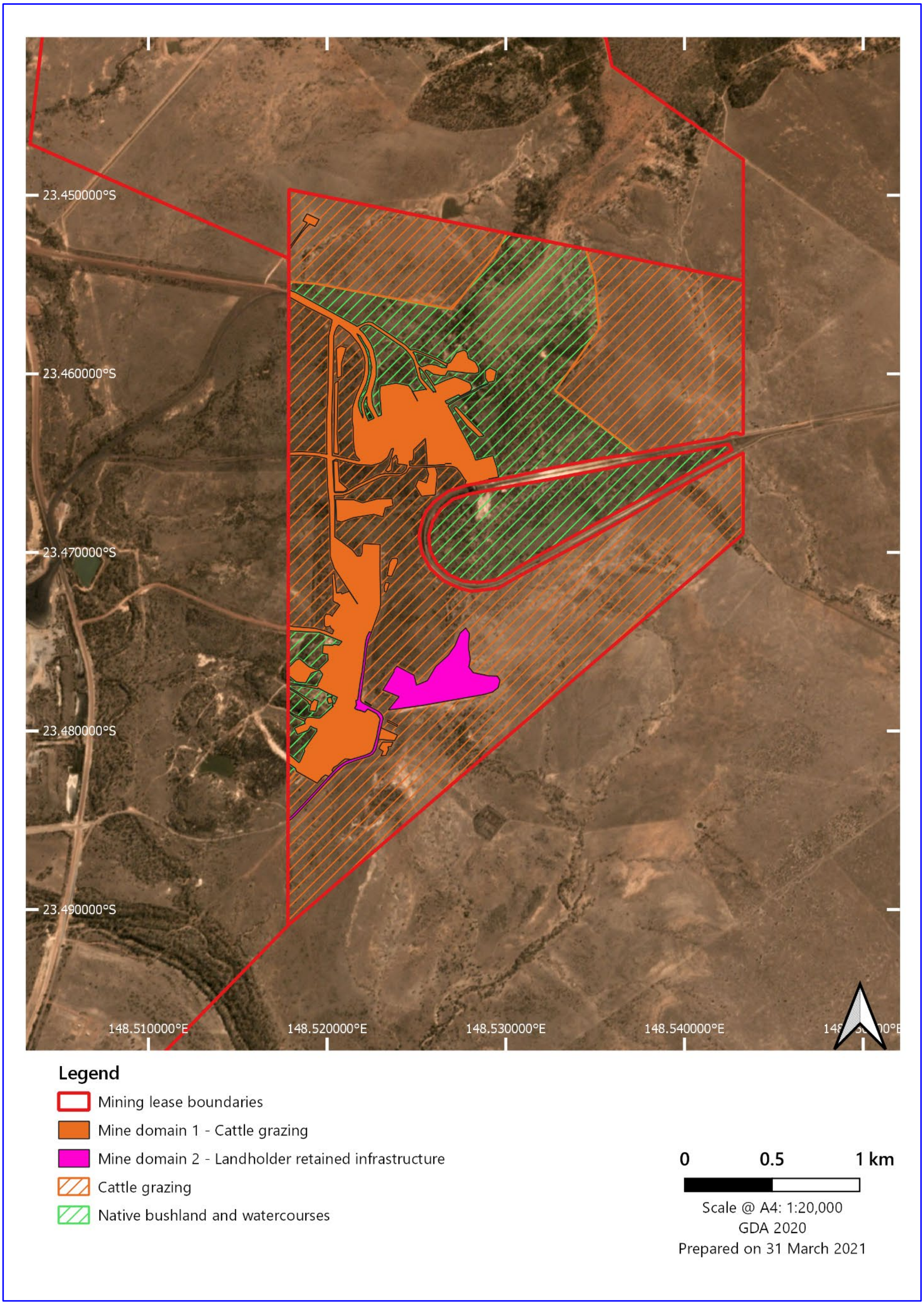


Figure 9-2 ML7460 land use categories

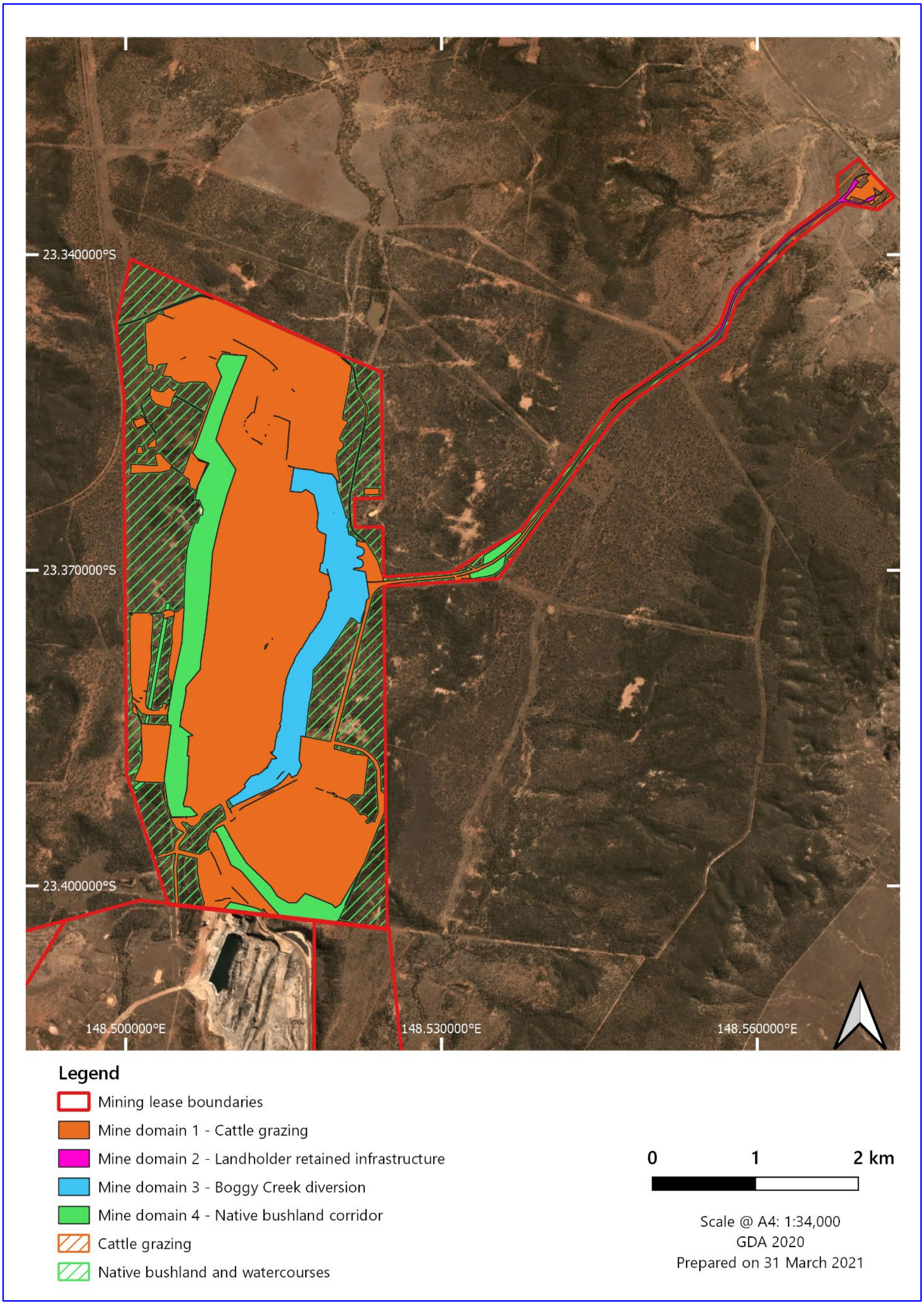


Figure 9-3 ML70049 land use categories

Figure 9-4 ML70326 land use categories

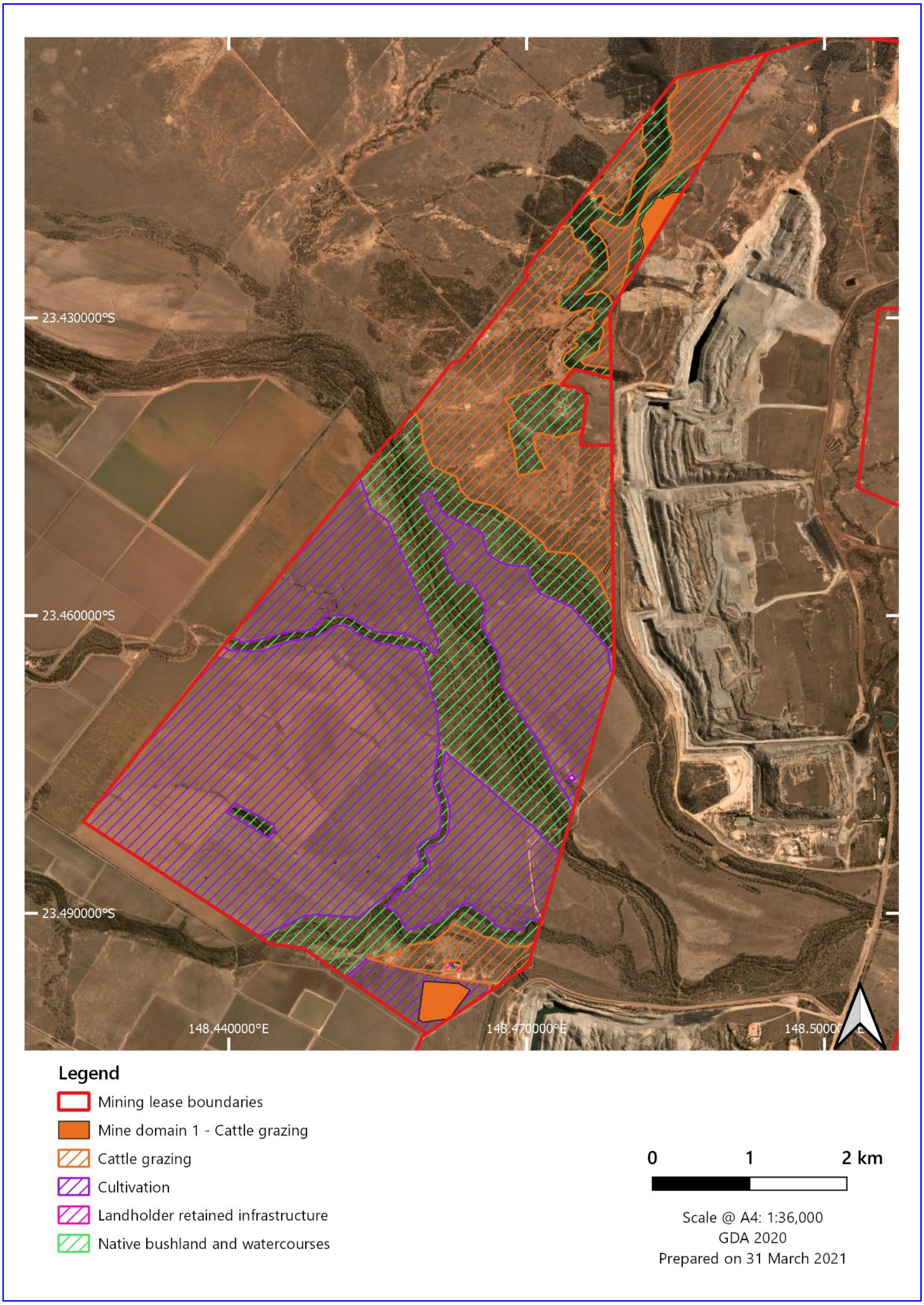


Figure 9-5 ML70365 land use categories

Figure 9-6 ML70366 land use categories

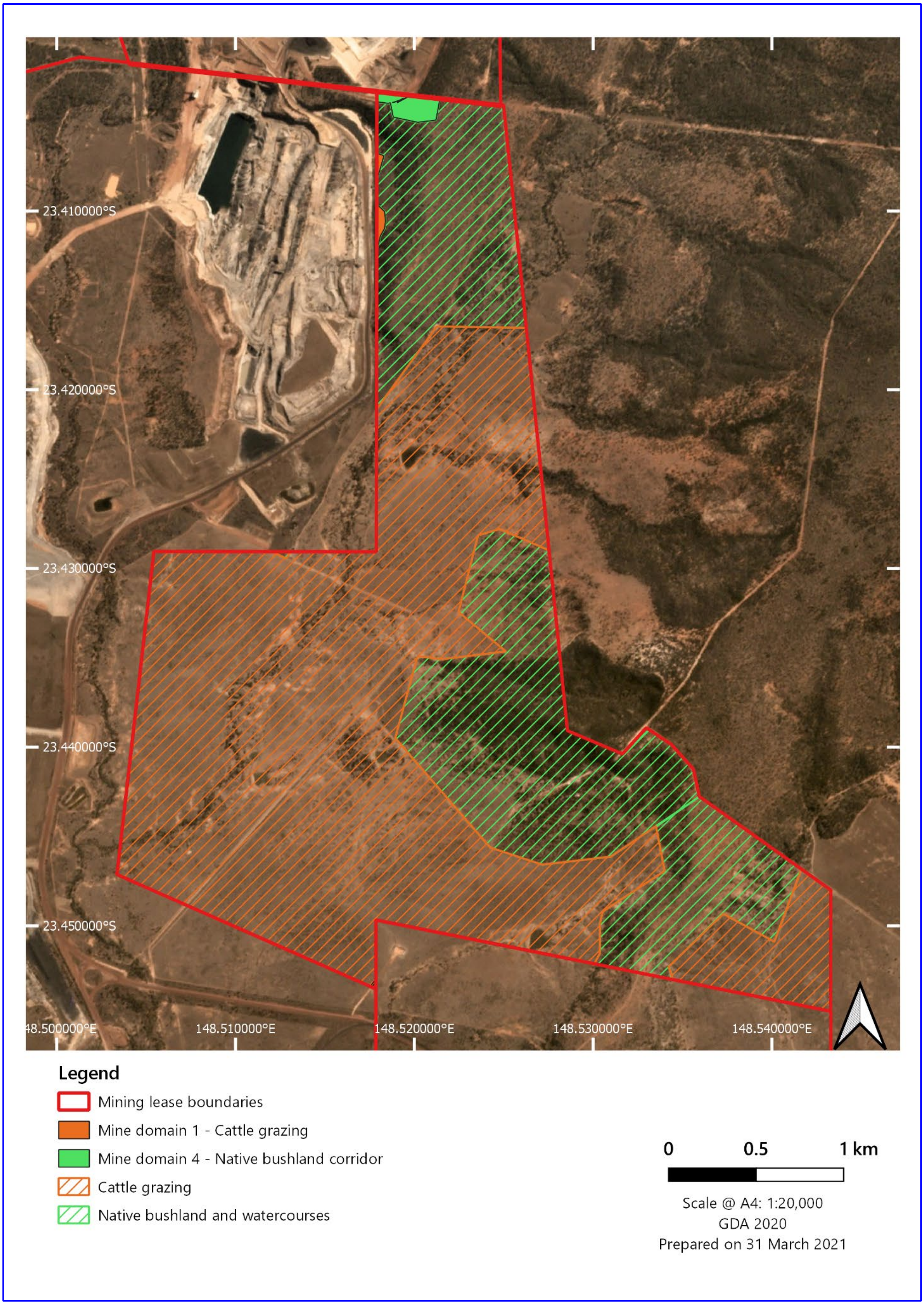


Figure 9-7 ML70367 land use categories

Table 9-9 Rehabilitation Areas and descriptions

RA #	PMLU	Area (ha)	Comment
1	Domain 1 - Cattle grazing	97.2	Existing rehabilitation, certified in 2019
2	Domain 1 - Cattle grazing	673.8	Existing rehabilitation, application for certification in 2021
3	Domain 1 – Cattle grazing	731.2	Existing rehabilitation
4	Domain 4 – Native bushland corridor	44.1	Existing rehabilitation
5	Domain 3 – Boggy Creek diversion	7.8	Existing rehabilitation
	Subtotal	**1554.1**	**Existing rehabilitation at Ensham**
6	Domain 3 – Boggy Creek diversion	82.8	Scheduled rehabilitation
7	Domain 1 – Cattle grazing	97.6	Scheduled rehabilitation
8	Domain 4 – Native bushland corridor	24.2	Scheduled rehabilitation
9	Domain 1 – Cattle grazing	81.1	Scheduled rehabilitation
10	Domain 1 – Cattle grazing	107.1	Scheduled rehabilitation
11	Domain 4 – Native bushland corridor	85.2	Scheduled rehabilitation
12	Domain 1 – Cattle grazing	58.1	Scheduled rehabilitation
13	Domain 1 – Cattle grazing	532.8	Scheduled rehabilitation
14	Domain 4 – Native bushland corridor	28.2	Scheduled rehabilitation
15	Domain 7 – Flood protection landform	3.0	Scheduled rehabilitation
16	Domain 4 – Native bushland corridor	29.4	Scheduled rehabilitation
17	Domain 1 – Cattle grazing	529.4	Scheduled rehabilitation
18	Domain 7 – Flood protection landform	6.9	Scheduled rehabilitation
19	Domain 4 – Native bushland corridor	85.6	Scheduled rehabilitation
20	Domain 7 – Flood protection landform	12.2	Scheduled rehabilitation
21	Domain 1 – Cattle grazing	871.7	Scheduled rehabilitation
22	Domain 4 – Native bushland corridor	45.2	Scheduled rehabilitation
23	Domain 7 – Flood protection landform	8.5	Scheduled rehabilitation
24	Domain 7 – Flood protection landform	34.7	Scheduled rehabilitation
25	Domain 1 – Cattle grazing	425.1	Scheduled rehabilitation
26	Domain 2 – Landholder retained infrastructure	38.5	Scheduled rehabilitation
	Subtotal	**3187.2**	**Scheduled rehabilitation at Ensham**
	TOTAL	**4741.3**	**Rehabilitation at Ensham**

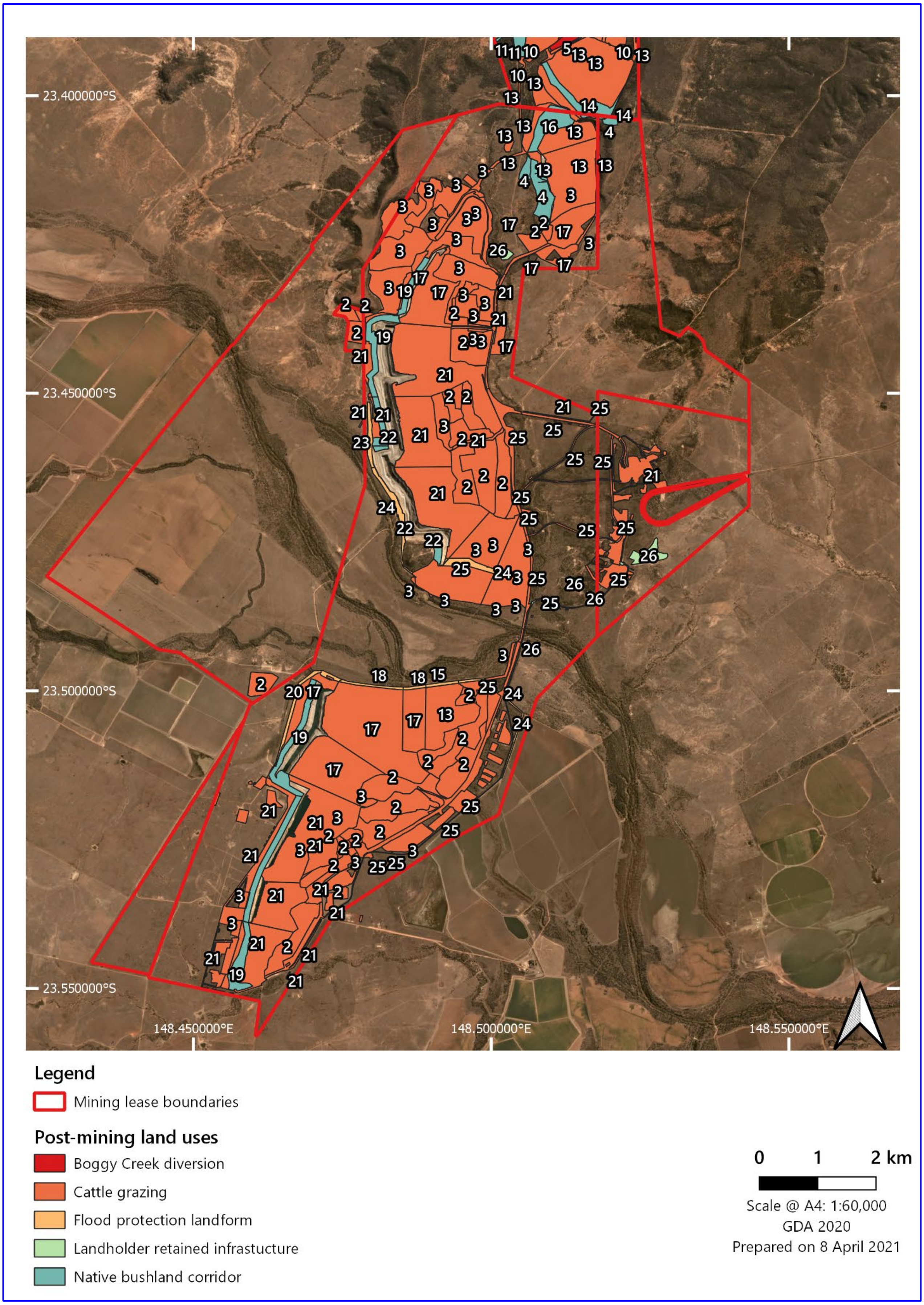


Figure 9-8 ML7459 Rehabilitation Areas (by RA number)

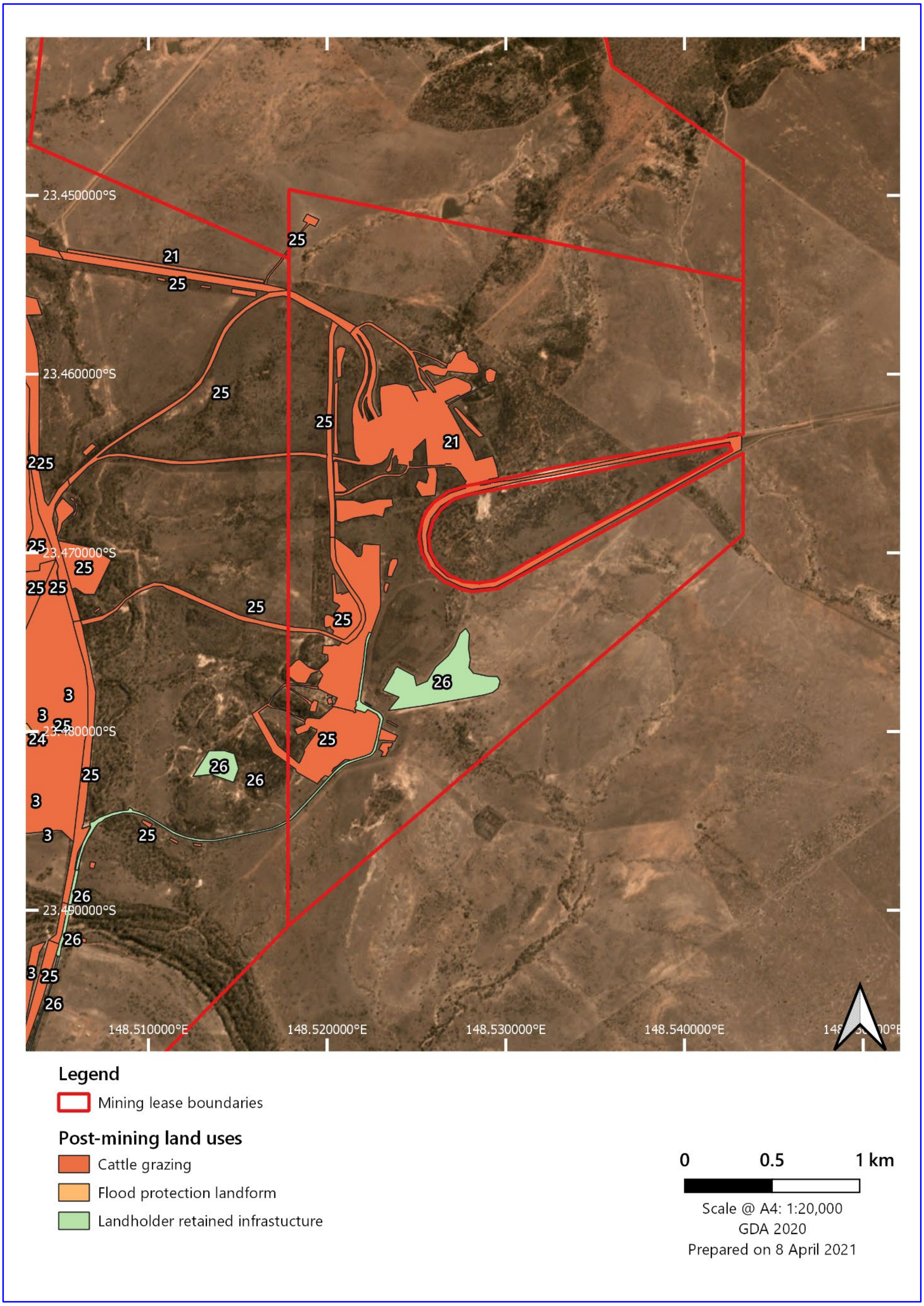


Figure 9-9 ML7460 Rehabilitation Areas (by RA numbers)

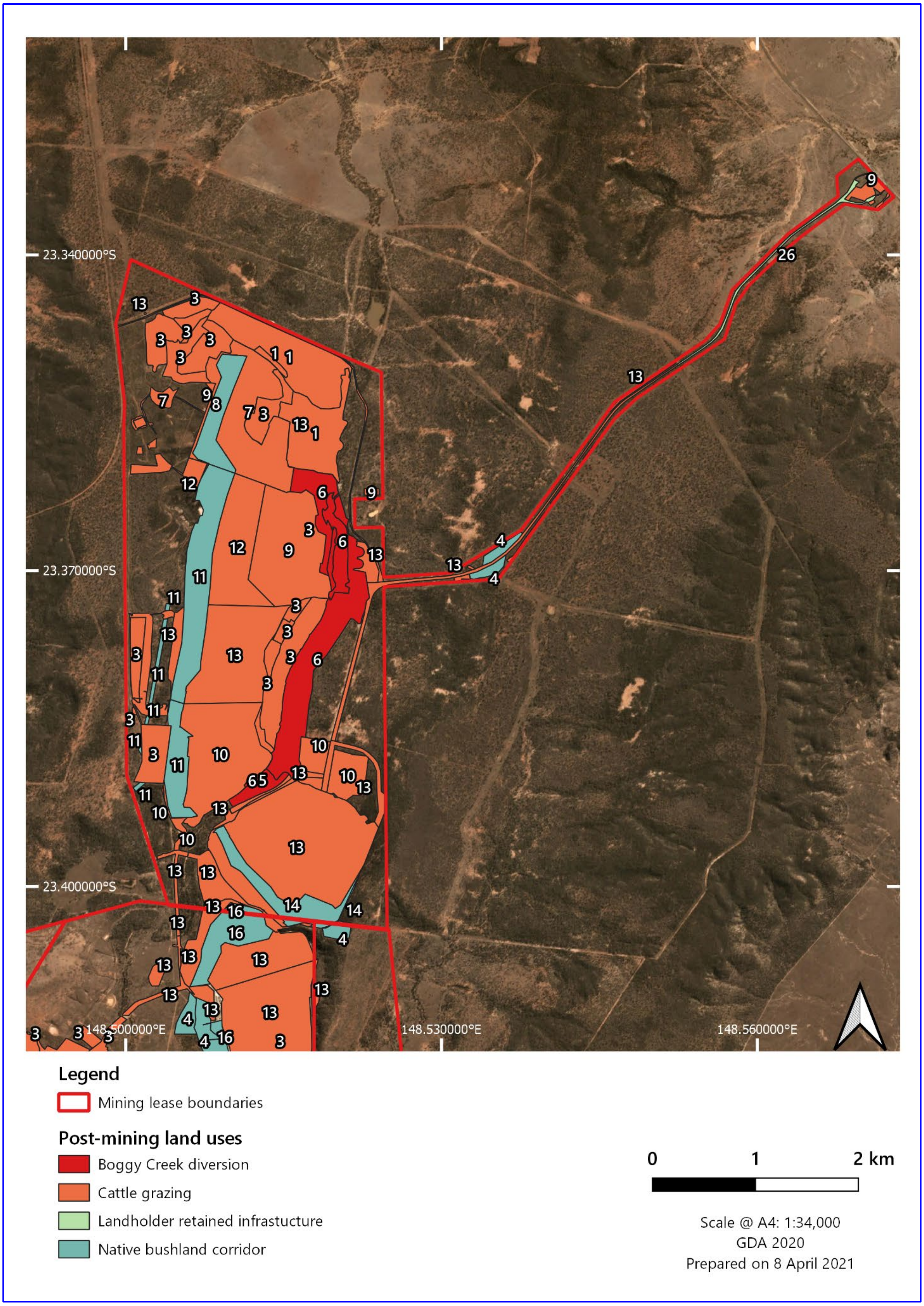


Figure 9-10 ML70049 Rehabilitation Areas (by RA numbers)

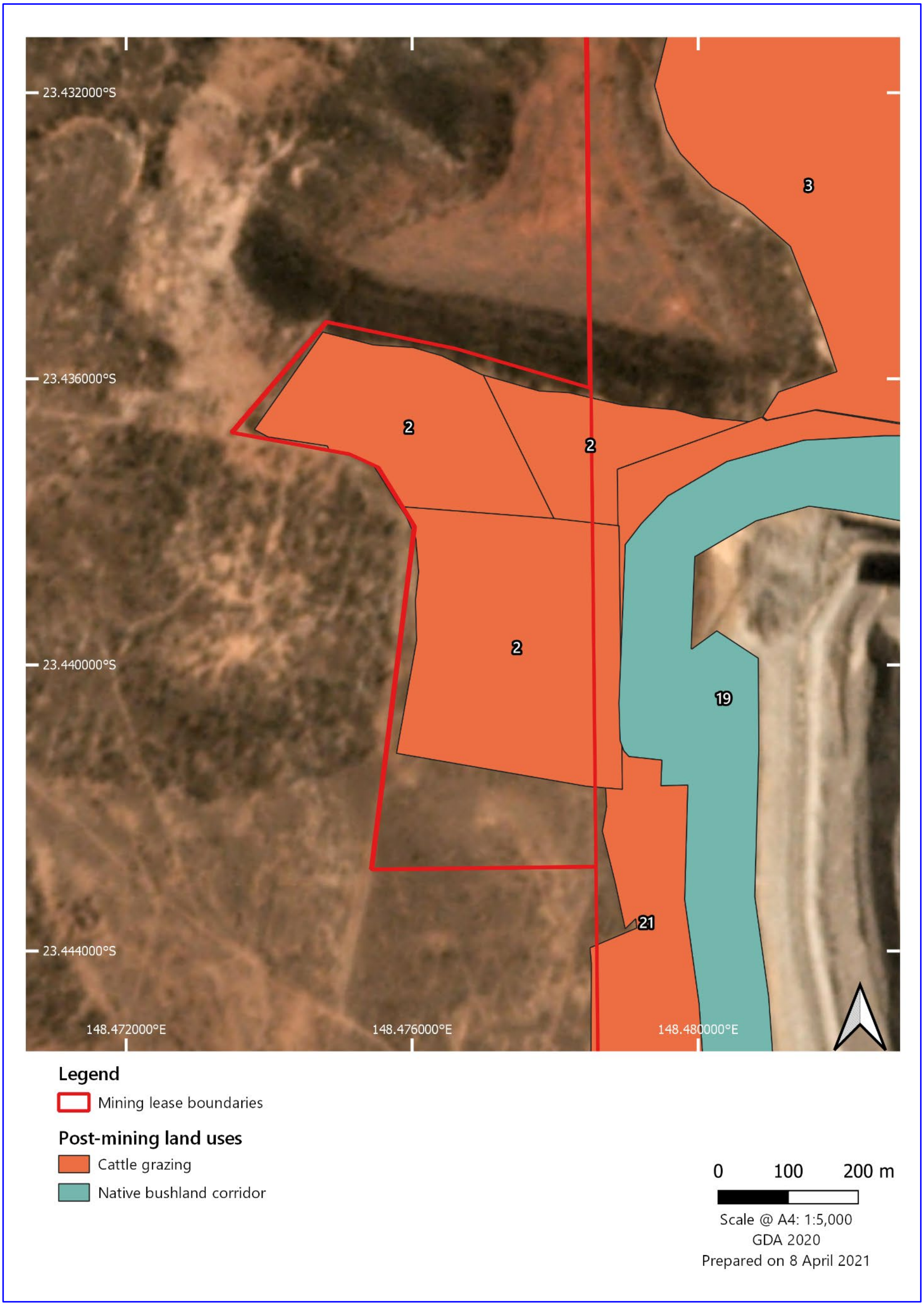


Figure 9-11 ML70326 Rehabilitation Areas (by RA numbers)

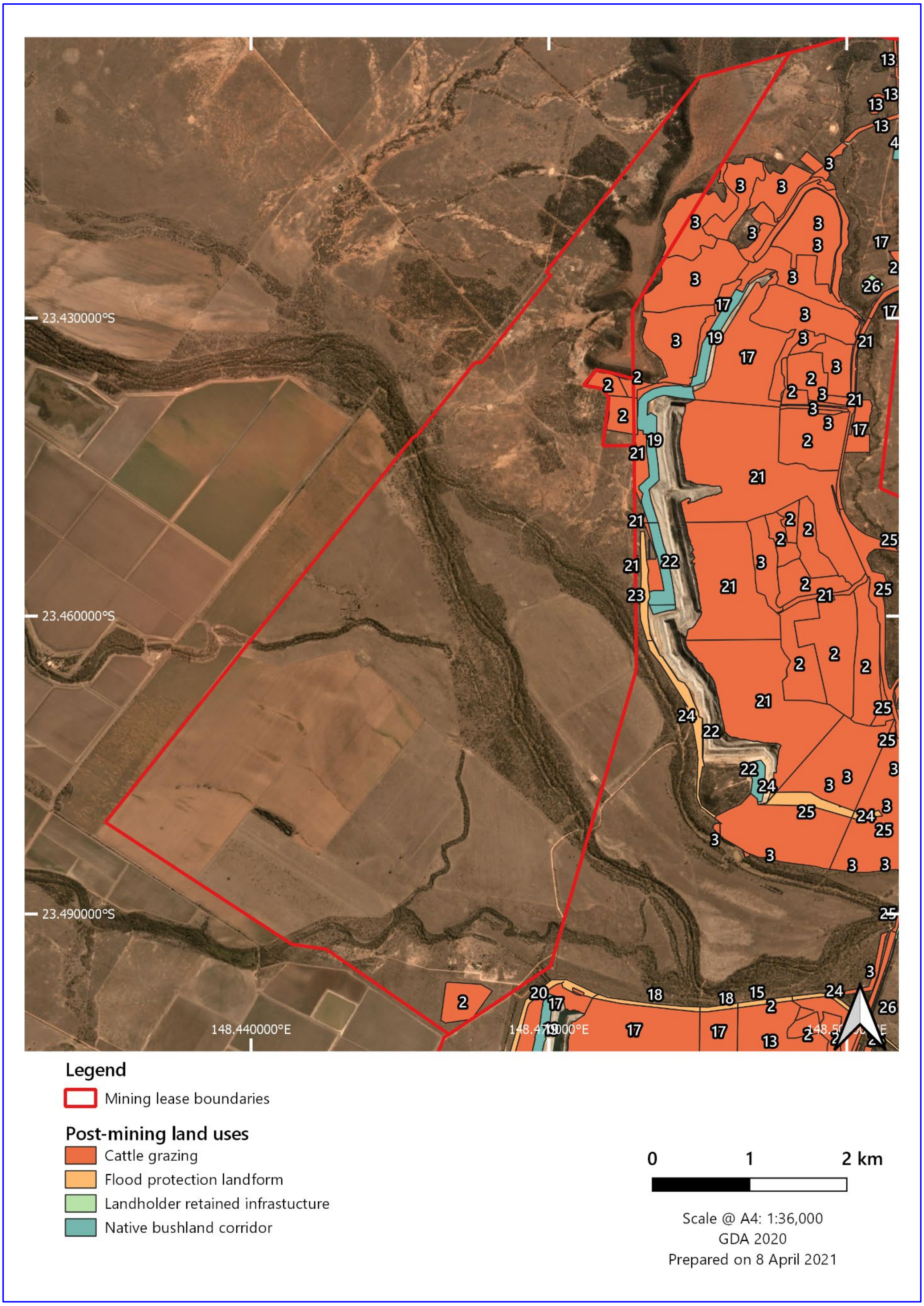


Figure 9-12 ML70365 Rehabilitation Areas (by RA numbers)

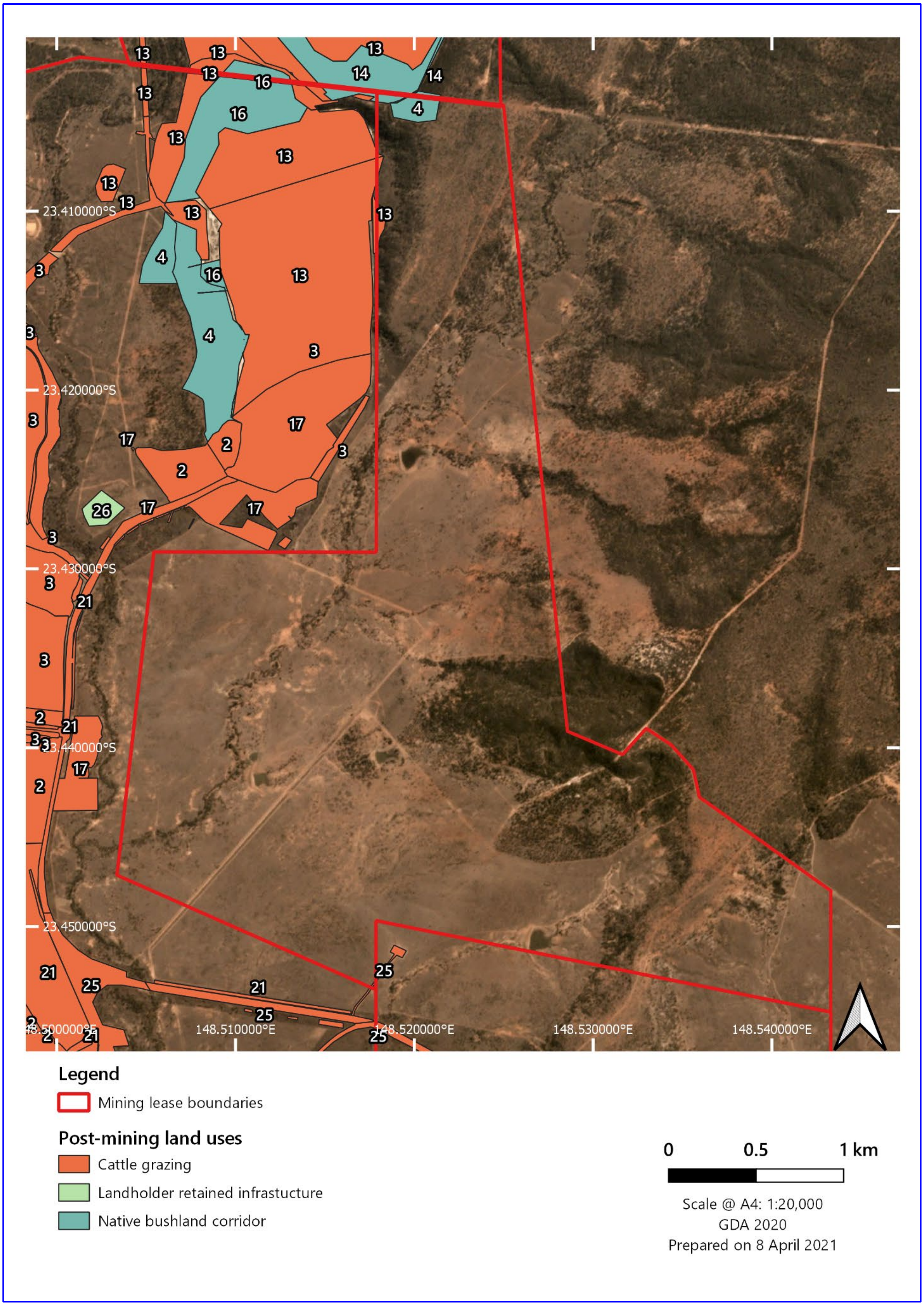


Figure 9-13 ML70367 Rehabilitation Areas (by RA numbers)

Table 9-10 Schedule of PMLU land availability for rehabilitation

RA	Mine	2001-2020 (ha)	2021 (ha)	2022 (ha)	2023 (ha)	2024 (ha)	2025 (ha)	2026 (ha)	2027 (ha)	2028 (ha)	2029 (ha)	2030 (ha)	2031 (ha)	2032 (ha)	2033 (ha)	2034 (ha)	2035 (ha)	2036 (ha)	2037 (ha)	2038 (ha)	2039 (ha)	2040 (ha)	2041 (ha)	2042 (ha)	2043 (ha)	Cumm. total (ha)
Existing Rehabilitation Losses			-0.2	-5	-16.2	-2.9		-4.6		-15.4		-4.9	-6.3	-7.3	-6.8		-5.3	-10.6	-13.9	-9	-25	-34.5	-31.4	-20.6		-219.9
1	1	97.2																								-122.7
2	1	673.8																								551.1
3	1	731.2																								1282.3
4	4	44.1																								1326.4
5	3	7.8																								1334.2
6	3		82.8																							1417.0
7	1		17.1	80.6																						1514.7
8	4			24.2																						1538.9
9	1				81.6																					1620.5
10	1					107.1																				1727.6
11	4					85.2																				1812.8
12	1						58.1																			1870.9
13	1							90.5	205.7	71.7	60.6	104.3														2403.7
14	4								28.2																	2431.9
15	7									3.0																2434.9
16	4											27.7	1.6													2464.2
17	1													84.5	219.1	106.1	25.3	94.5								2993.7

RA	Mine	2001-2020 (ha)	2021 (ha)	2022 (ha)	2023 (ha)	2024 (ha)	2025 (ha)	2026 (ha)	2027 (ha)	2028 (ha)	2029 (ha)	2030 (ha)	2031 (ha)	2032 (ha)	2033 (ha)	2034 (ha)	2035 (ha)	2036 (ha)	2037 (ha)	2038 (ha)	2039 (ha)	2040 (ha)	2041 (ha)	2042 (ha)	2043 (ha)	Cumm. total (ha)
18	7													2.1	4.8											3000.6
19	4															29.4	12.0	44.1								3086.1
20	7															12.2										3098.3
21	1																	105.8	190.0	164.8	178.4	232.6				3969.9
22	4																			13.9	25.0	6.4				4015.2
23	7																			8.5						4023.7
24	7																					14.2	11.0	5.1	4.4	4058.4
25	1																						142.2	101.9	182.3	4484.8
26	2									6.7															38.5	4523.3
Total by year (ha)		1554.1	99.7	99.8	65.4	189.4	58.1	85.9	233.9	59.3	60.6	127.1	-4.7	79.3	217.1	147.7	32	233.8	176.1	178.2	178.4	218.7	121.8	86.4	225.2	
Cumm. total (ha)		1554.1	1653.8	1753.6	1819	2008.4	2066.5	2152.4	2386.3	2445.6	2506.2	2633.3	2628.6	2707.9	2925	3072.7	3104.7	3338.5	3514.6	3692.8	3871.2	4089.9	4211.7	4298.1	4523.3	

- For discrete rehabilitation or improvement areas, the hectares presented herein are accurate to ±15 %.
- For total areas of PMLUs and NUMAs, the hectares presented herein are accurate to ±5 %.

9.1.2.2 Rehabilitation milestones and criteria

Rehabilitation milestones and criteria have been developed for all rehabilitation areas that have a PMLU (Table 9-11). These milestones are SMART, meaning they are:

Specific – is it clear what must be done.

Measurable - it is possible to know when it is achieved.

Achievable - it is capable of being achieved.

Reasonable – there is a clear connection between the milestone and the desired rehabilitation outcome.

Timely – it is clear when the milestone will be completed.

Table 9-11 Rehabilitation milestones

ID	Rehabilitation milestone	Milestone criteria
RM1	Infrastructure decommissioning and removal	1.1 All services disconnected, except that to be retained by landholder by formal agreement. 1.2 All buildings and infrastructure removed from RA, except that to be retained by landholder by formal agreement. 1.3 All plant and equipment removed from RA, except that to be retained by the landholder by formal agreement.
RM2	Identification and remediation of contaminated land	2.1 Contaminated land assessment by SQP. 2.2 Remediation or management of identified contaminated land. 2.3 Removal of land from Contaminated Land Register. 2.4 Removal of land from Environmental Management Land Register if feasible.
RM3	Final landform development	<u>Beef cattle grazing PMLU</u> • All outward facing overburden slopes to achieve 0-10% slopes for Tertiary materials and 0-15% slopes for Permian materials. • 90% of the inward facing slopes achieving 0-10% slopes for Tertiary materials and 0-15% slopes for Permian materials. • Up to 10% of the inward facing slopes may include slopes between 15% to 25%, subject to these areas being fully contained within areas of 0-15% slopes. • Landforms are assessed as being geotechnically stable with a factor of safety ≥1.5. <u>Native bushland corridor PMLU</u> • Maximum 25% slope • Areas >15% to be certified by a suitably qualified person as being stable long term, with rock mulch applied as required.. <u>Flood protection landform PMLU</u> • Watercourse facing slopes ≤15%. • Void facing slopes ≤15%, except where constrained by proximity to void regrade, batters can be reduced to ≤25%. • Bench of 10m to separate inward toe embankment from adjacent edge of void stabilisation regrade. • Landform – 0.1%AEP +0.5m freeboard. • Line the river facing embankments at sharp changes in alignment where turbulence could occur with hard, durable rock rip rap. • Must be fenced to exclude stock and permanent fencing in place post construction and maintained. <u>Boggy Creek Diversion PMLU</u>

ID	Rehabilitation milestone	Milestone criteria
		• Geotechnically stable with a factor of safety ≥1.5 • As constructed drawings submitted to Department of Regional Development, Manufacturing and Water
RM4	Seedbed preparation	4.1 Topsoil is replaced to 150mm depth on all areas to be revegetated. 4.2 Soil ameliorants and fertilisers are applied as needed to address soil limitations.
RM5	Sowing	5.1 Seed sown at appropriate rates for each PMLU- <u>Beef cattle grazing PMLU</u> • 3P pasture species mix sown. <u>Native bushland corridor PMLU</u> • > Native tree and shrub species mix sown. <u>Flood protection landform PMLU</u> • > Native tree and shrub species mix sown. • > Grass species sown. 5.2 Hay mulch applied as required.
RM6	Vegetation establishment	6.1 Vegetation has established and satisfies rehabilitation completion criteria for each PMLU- <u>Beef cattle grazing PMLU</u> • ≥50% established and persistent vegetative groundcover for all slopes from 0-15%. • ≥80% established and persistent vegetative cover for slopes from 15% to 25%. <u>Native bushland corridor PMLU</u> • ≥50% established and persistent vegetative groundcover for all slopes from 0-20%. • ≥80% established and persistent cover (vegetative and/or rock mulch) for slopes from 20% to 25%. • Species richness ≥ 2 tree species, ≥ 3 shrub species, ≥ 5 groundcover species.
RM7	Achievement of a stable condition (beef cattle grazing PMLU)	7.1 The RA is safe. • Safety hazards in rehabilitation are similar to surrounding unmined landscapes. 7.2 There is no environmental harm being caused by anything on or in the RA. • Surface water runoff is non-polluting to receiving waters and complies with the following- pH 7.1 – 8.2 EC (salinity) <403 µs/cm Total Suspended Solids (TSS) (sediment loss) <405 mg/L Arsenic ≤13 µg/L Molybdenum ≤34 µg/L Selenium ≤5 µg/L Sulphate (SO_4^{2+}) <16.34 mg/L 7.3 The RA can sustain a PMLU. • Rehabilitation is suitable for sustainable cattle grazing and is land suitability class 2 to 4 as defined in the Guidelines for Agricultural Land Evaluation in Queensland (State Department of Queensland 2013).

ID	Rehabilitation milestone	Milestone criteria
RM8	Achievement of a stable condition (landholder retained infrastructure)	8.1 The RA is safe. • Safety hazards in rehabilitation are similar to surrounding unmined landscapes. 8.2 There is no environmental harm being caused by anything on or in the RA. • Surface water runoff is non-polluting to receiving waters and complies with the following- pH 7.1 – 8.2 EC (salinity) <403 µs/cm Total Suspended Solids (TSS) (sediment loss) <405 mg/L Arsenic ≤13 µg/L Molybdenum ≤34 µg/L Selenium ≤5 µg/L Sulphate (SO_4^{2+}) <16.34 mg/L • 8.3 Landholder formally accepts infrastructure for his/her ongoing beneficial use.
RM9	Achievement of a stable condition (Boggy Creek diversion)	9.1 The RA is safe. • Safety hazards in rehabilitation are similar to surrounding unmined landscapes. 9.2 There is no environmental harm being caused by anything on or in the RA. • Surface water runoff is non-polluting to receiving waters and complies with the following- pH 7.1 – 8.2 EC (salinity) <403 µs/cm Total Suspended Solids (TSS) (sediment loss) <405 mg/L Arsenic ≤13 µg/L Molybdenum ≤34 µg/L Selenium ≤5 µg/L Sulphate (SO_4^{2+}) <16.34 mg/L • 9.3 Riparian vegetation is suitable for conservation of rehabilitated creek diversion areas and has an IDC score >10 as defined in Criteria for functioning river landscape units in mining and post-mining landscapes (ACARP Project number C20017).
RM10	Achievement of a stable condition (Native bushland corridor)	10.1 The RA is safe. • Safety hazards in rehabilitation are similar to surrounding unmined landscapes. 10.2 There is no environmental harm being caused by anything on or in the RA. • Surface water runoff is non-polluting to receiving waters and complies with the following- pH 7.1 – 8.2 EC (salinity) <403 µs/cm Total Suspended Solids (TSS) (sediment loss) <405 mg/L Arsenic ≤13 µg/L Molybdenum ≤34 µg/L Selenium ≤5 µg/L Sulphate (SO_4^{2+}) <16.34 mg/L 10.3 The RA can sustain a PMLU. • Rehabilitation has some native species and some native bushland characteristics, including: ≥2 tree species at relevant benchmark density

ID	Rehabilitation milestone	Milestone criteria
		≥3 shrub species at relevant benchmark density ≥5 groundcover species at relevant benchmark density as per relevant Regional Ecosystem BioCondition Benchmark = 11.10.1 and/or 11.10.3)
RM11	Achievement of a stable condition (Flood protection landform)	11.1 The RA is safe. • Safety hazards in rehabilitation are similar to surrounding unmined landscapes. 11.2 There is no environmental harm being caused by anything on or in the RA. • Surface water runoff complies with the following- pH 7.1 – 8.2 EC (salinity) <403 µs/cm Total Suspended Solids (TSS) (sediment loss) <405 mg/L Arsenic ≤13 µg/L Molybdenum ≤34 µg/L Selenium ≤5 µg/L Sulphate (SO_4^{2+}) <16.34 mg/L 11.3 Constructed as per certified designs provided under condition H11 of the EA, and certified by a suitably qualified and experienced person.

9.1.3 Non-use management areas

There are two pre-approved NUMAs at Ensham. These are shown in land outcome document EA *EPML00732813* and reproduced here as follows.

- Mine Domain 5 - Groundwater daylighting water areas.
- Mine Domain 6 - Highwalls.

9.1.3.1 Improvement areas

A total of 12 improvement areas have been identified at Ensham (Figure 9-14). A schedule of improvement area availability for management is provided (Table 9-12). This schedule is cognisant of mining activities and infrastructure requirements, particularly as these relate to underground mining operations, and the feasibility of completing rehabilitation. Feasibility includes considerations of timing and management complexity, and safety, cost, and engineering requirements.

Table 9-12 Schedule of NUMA land availability for improvement

IA	Mine domain	2021 (ha)	2022 (ha)	2023 (ha)	2024 (ha)	2025 (ha)	2026 (ha)	2027 (ha)	2028 (ha)	2029 (ha)	2030 (ha)	2031 (ha)	2032 (ha)	2033 (ha)	2034 (ha)	2035 (ha)	2036 (ha)	2037 (ha)	2038 (ha)	2039 (ha)	2040 (ha)	2041 (ha)	2042 (ha)	2043 (ha)	Cumulative total[1] (ha)
1	6										3.0														3.0
2	6														18.9										21.9
3	5														30.6										52.5
4	6															7.7									60.2
5	6																11.9								72.1
6	5																35.0								107.1
7	6																		8.6						115.7
8	5																		32.4						148.2
9	6																			12.9					161.1
10	5																			14.3					175.3
11	6																				23.1				198.4
12	5																				33.4				231.8
Total by year (ha)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	49.5	7.7	46.9	0.0	41.1	27.2	56.5	0.0	0.0	0.0	
Cumm. total (ha)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	3.0	52.5	60.2	107.1	107.1	148.2	175.3	231.8	231.8	231.8	231.8	

9.1.3.2 Improvement area milestones

Improvement area milestones and criteria have been developed for all improvement areas that have a NUMA (Table 9-13). These milestones are SMART, meaning they are:

Specific – is it clear what must be done.

Measurable - it is possible to know when it is achieved.

Achievable - it is capable of being achieved.

Reasonable – there is a clear connection between the milestone and the desired rehabilitation outcome.

Timely – it is clear when the milestone will be completed.

Table 9-13 Improvement area milestones

ID	Management milestone	Milestone criteria
MM1	Sufficient improvements to ensure structural stability	1.1 Slope gradients achieved as follows for NUMAs- • Maximum of 275% slopes for competent high walls. • Maximum of 50% slopes for incompetent material • A south pit, F Pits and Y Pits highwall must be reshaped to a maximum of 25% slopes. • Northern Endwall of B Pit maximum 15% slope 1.2 Landforms are assessed as geotechnically and erosionally stable with a factor of safety ≥1.5 1.3 Water run-off from above the highwall is channelled to the groundwater daylighting water areas PMLU through design pathways.
MM2	Sufficient improvements to ensure safety and minimisation of environmental harm	2.1 The NUMA is safe. • All areas to be certified by suitably qualified person as being safe long-term. • Bunded, fenced and signed to exclude humans and stock 2.2 There is no environmental harm being caused by anything on or in the NUMA. The existence of the highwalls themselves does not constitute environmental harm. • Regional groundwater aquifers maintain their current water quality and groundwater monitoring bores do not exceed the water quality limits detailed in Table C11 – Groundwater quality limits in the relevant EA as a result of mining activities. 2.3 Groundwater daylighting water areas Maximum dimensions: • A Central – Surface Water Level -133mAHD, Water storage Volume -0.5GL, and Water Area – 3ha • A North – Surface Water Level – 133mAHD, Water storage volume – 1.2GL, and Water Area – 16ha • B – Surface Water Level – 123mAHD, Water Storage Volume – 3.1GL and Water Area – 33ha • C and D – Surface Water Level – 125mAHD, Water Storage Volume – 22.1GL and Water Areas – 65ha for C and 75ha for D

The milestones will be achieved by:

- Inspection and assessment by suitably qualified person for each highwall to determine the boundaries of competent and incompetent materials.
- Design of construction process for slope of incompetent material.
- Design and construction process for reshaping A South, F & Y pit highwalls to < 25% slopes.
- Backfill northern endwall of B pit to < 15% using suitably sourced material.
- Monitor the groundwater aquifers and investigate any emerging trends.

Figure 9-14 Improvement Areas

9.1.4 Rehabilitation areas schedule

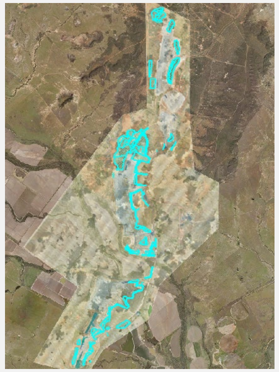
Following are schedules with key dates and milestones for all RAs at Ensham that have not yet achieved Certification.

The location of each RA is shown in Figure 9-8, Figure 9-9, Figure 9-10, Figure 9-11, Figure 9-12 & Figure 9-13 and with the provided spatial files.

9.1.4.1 RA 02

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA2 (2021 certification application area)									
Relevant activities	Mine domain 1 - Cattle grazing									
Total rehabilitation area size (ha)	673.8									
Commencement of first milestone: RM7	30/06/2021									
PMLU	Mine domain 1 - Cattle grazing									
Date area is available	30/06/21	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	673.8									
Milestone completed by	30/06/26	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM7	673.8									

9.1.4.2 RA 03

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA3 (existing rehabilitation)									
Relevant activities	Mine domain 1 - Cattle grazing									
Total rehabilitation area size (ha)	731.2									
Commencement of first milestone: RM7	30/06/2021									
PMLU	Mine domain 1 - Cattle grazing									
Date area is available	30/06/21	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	731.2									
Milestone completed by	30/06/26	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM7	731.2									

9.1.4.3 RA 04

Post-mining land uses (PMLU)										
Rehabilitation area (description)				RA4 (existing rehabilitation)						
Relevant activities				Mine domain 4 - Native bushland corridor						
Total rehabilitation area size (ha)				44.1						
Commencement of first milestone: RM10				30/06/2021						
PMLU				Mine domain 4 - Native bushland corridor						
Date area is available	30/06/21	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	44.1									
Milestone completed by	30/06/31	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM10	44.1									

9.1.4.4 RA 05

Post-mining land uses (PMLU)										
Rehabilitation area (description)				RA5 (existing rehabilitation)						
Relevant activities				Mine domain 3 - Boggy Creek diversion						
Total rehabilitation area size (ha)				7.8						
Commencement of first milestone: RM9				30/06/2021						
PMLU				Mine domain 3 - Boggy Creek diversion						
Date area is available	30/06/21	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	7.8									
Milestone completed by	30/06/31	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM9	7.8									

9.1.4.5 RA 06

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA6 (Boggy Creek Diversion)									
Relevant activities	Mine domain 3 - Boggy Creek diversion									
Total rehabilitation area size (ha)	82.8									
Commencement of first milestone: RM1	1/01/2021									
PMLU	Mine domain 3 - Boggy Creek diversion									
Date area is available	1/01/21	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	82.8									
Milestone completed by	30/12/21	30/12/22	30/12/25	30/12/34			xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM1	82.8									
RM3	82.8									
RM4		82.8								
RM5		82.8								
RM6			82.8							
RM9				82.8						

9.1.4.6 RA 07

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA7 (Ramp 10 & borrow pits)									
Relevant activities	Mine domain 1 - Cattle grazing									
Total rehabilitation area size (ha)	97.6									
Commencement of first milestone: RM1	30/06/2021									
PMLU	Mine domain 1 - Cattle grazing									
Date area is available	30/06/21	30/06/22	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	17.1	97.6								
Milestone completed by	30/12/21	30/12/22	30/12/23	30/12/24	30/12/25	30/12/29	30/12/30		xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM1		80.5								
RM3	17.1	97.6								
RM4		17.1	97.6							
RM5		17.1	97.6							
RM6				17.1	97.6					
RM7						17.1	97.6			

9.1.4.7 RA 08

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA8 (Ramp 10)									
Relevant activities	Mine domain 4 - Native bushland corridor									
Total rehabilitation area size (ha)	24.2									
Commencement of first milestone: RM3	30/06/2022									
PMLU	Mine domain 4 - Native bushland corridor									
Date area is available	30/06/22	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	24.2									
Milestone completed by	30/12/22	30/12/23	30/12/26	30/12/36		xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM3	24.2									
RM4		24.2								
RM5		24.2								
RM6			24.2							
RM10				24.2						

9.1.4.8 RA 09

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA9 (Ramp 9 & Yongala TLO)									
Relevant activities	Mine domain 1 - Cattle grazing									
Total rehabilitation area size (ha)	81.2									
Commencement of first milestone: RM3	30/06/2023									
PMLU	Mine domain 1 - Cattle grazing									
Date area is available	30/06/23	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	81.2									
Milestone completed by	30/12/23	30/12/24	30/12/26	30/12/31	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM3	81.2									
RM4		81.2								
RM5		81.2								
RM6			81.2							
RM7				81.2						

9.1.4.9 RA 10

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA10 (Ramp 8 South & Laydown)									
Relevant activities	Mine domain 1 - Cattle grazing									
Total rehabilitation area size (ha)	107.1									
Commencement of first milestone: RM3	30/06/2024									
PMLU	Mine domain 1 - Cattle grazing									
Date area is available	30/06/24	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	107.1									
Milestone completed by	30/12/24	30/12/25	30/12/27	30/12/32	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM3	107.1									
RM4		107.1								
RM5		107.1								
RM6			107.1							
RM7				107.1						

9.1.4.10 RA 11

Post-mining land uses (PMLU)										
Rehabilitation area (description)				RA11 (Ramp 8 & 9 NBC)						
Relevant activities				Mine domain 4 - Native bushland corridor						
Total rehabilitation area size (ha)				85.2						
Commencement of first milestone: RM3				30/06/2024						
PMLU				Mine domain 4 - Native bushland corridor						
Date area is available	30/06/24	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	85.2									
Milestone completed by	30/12/24	30/12/25	30/12/27	30/12/32	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM3	85.2									
RM4		85.2								
RM5		85.2								
RM6			85.2							
RM10				85.2						

9.1.4.11 RA 12

Post-mining land uses (PMLU)										
Rehabilitation area (description)				RA12 (Ramp 9)						
Relevant activities				Mine domain 1 - Cattle grazing						
Total rehabilitation area size (ha)				58.1						
Commencement of first milestone: RM3				30/06/2025						
PMLU				Mine domain 1 - Cattle grazing						
Date area is available	30/06/25	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	58.1									
Milestone completed by	30/12/25	30/12/26	20/12/28	30/12/33	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM3	58.1									
RM4		58.1								
RM5		58.1								
RM6			58.1							
RM7				58.1						

9.1.4.12 RA 13

Post-mining land uses (PMLU)													
Rehabilitation area (description)	RA13 (Ramp 8, Ramp 84, Ramp 83, Ramp 24 East & Yongala Infrastructure)												
Relevant activities	Mine domain 1 - Cattle grazing												
Total rehabilitation area size (ha)	532.8												
Commencement of first milestone: RM3	30/06/2026												
PMLU	Mine domain 1 - Cattle grazing												
Date area is available	30/06/26	30/06/27	30/06/28	30/06/29	30/06/30	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx				10/12/xxxx
Cumulative area available (ha)	90.5	296.2	367.9	428.5	532.8								
Milestone completed by	30/12/26	30/12/27	30/12/28	30/12/29	30/12/30	30/12/31	30/12/32	30/12/33	30/12/34	30/12/34	30/12/35	30/12/36	30/12/37
Milestone Reference	**Cumulative area achieved (ha)**												
RM3	90.5	296.2	367.9	428.5	532.8								
RM4		90.5	296.2	367.9	428.5	532.8							
RM5		90.5	296.2	367.9	428.5	532.8							
RM6				90.5	296.2	367.9	428.5	532.8					
RM7									90.5	296.2	367.9	428.5	532.8

9.1.4.13 RA 14

Post-mining land uses (PMLU)										
Rehabilitation area (description)				RA14 (Ramp 84 NBC)						
Relevant activities				Mine domain 4 - Native bushland corridor						
Total rehabilitation area size (ha)				28.2						
Commencement of first milestone: RM3				30/06/2027						
PMLU				Mine domain 4 - Native bushland corridor						
Date area is available	30/06/27	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	28.2									
Milestone completed by	30/12/27	30/12/28	30/12/30	30/12/40	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM3	28.2									
RM4		28.2								
RM5		28.2								
RM6			28.2							
RM10				28.2						

9.1.4.14 RA 15

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA15 (Southern Flood Protection Landform)									
Relevant activities	Mine domain 7 - Flood protection landform									
Total rehabilitation area size (ha)	3.0									
Commencement of first milestone: RM3	30/06/2028									
PMLU	Mine domain 7 - Flood protection landform									
Date area is available	30/06/28	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	3.0									
Milestone completed by	30/12/28	30/12/29	30/12/31	30/12/36	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM3	3.0									
RM4		3.0								
RM5		3.0								
RM6			3.0							
RM11				3.0						

9.1.4.15 RA 16

Post-mining land uses (PMLU)										
Rehabilitation area (description)				RA16 (Ramp 83 NBC)						
Relevant activities				Mine domain 4 - Native bushland corridor						
Total rehabilitation area size (ha)				29.4						
Commencement of first milestone: RM3				30/06/2030						
PMLU				Mine domain 4 - Native bushland corridor						
Date area is available	30/06/30	30/06/31	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	27.7	29.4								
Milestone completed by	30/12/30	30/12/31	30/12/32	30/12/33	30/12/34	30/12/43	30/12/44		xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM3	27.7	29.4								
RM4		27.7	29.4							
RM5		27.7	29.4							
RM6				27.7	29.4					
RM10						27.7	29.4			

9.1.4.16 RA 17

Post-mining land uses (PMLU)													
Rehabilitation area (description)	RA17 (Ramp 83 Infrastructure, Ramp 7 & Ramp 24)												
Relevant activities	Mine domain 1 - Cattle grazing												
Total rehabilitation area size (ha)	529.4												
Commencement of first milestone: RM3	30/06/2031												
PMLU	Mine domain 1- Cattle grazing												
Date area is available	30/06/31	30/06/32	30/06/33	30/06/34	30/06/35	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx			
Cumulative area available (ha)	84.5	303.6	409.7	434.9	529.4								
Milestone completed by	30/12/31	30/12/32	30/12/33	30/12/34	30/12/35	30/12/36	30/12/37	30/12/38	30/12/39	30/12/40	30/12/41	30/12/42	31/12/43
Milestone Reference	**Cumulative area achieved (ha)**												
RM3	84.5	303.6	409.7	434.9	529.4	529.4							
RM4		84.5	303.6	409.7	434.9	529.4							
RM5		84.5	303.6	409.7	434.9	529.4							
RM6				84.5	303.6	409.7	434.9	529.4					
RM7									84.5	303.6	409.7	434.9	529.4

9.1.4.17 RA 18

Post-mining land uses (PMLU)										
Rehabilitation area (description)				RA18 (Southern Flood Protection Landform)						
Relevant activities				Mine domain 7 - Flood protection landform						
Total rehabilitation area size (ha)				6.9						
Commencement of first milestone: RM3				30/06/2032						
PMLU				Mine domain 7 - Flood protection landform						
Date area is available	30/06/32	30/06/33	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	2.1	6.9								
Milestone completed by	30/12/32	30/12/33	30/12/34	30/12/35	30/12/36	30/12/45	30/12/46	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM3	2.1	6.9								
RM4		2.1	6.9							
RM5		2.1	6.9							
RM6				2.1	6.9					
RM11						2.1	6.9			

9.1.4.18 RA 19

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA19 (Ramp 7, Ramp 24 and Ramp 20 NBC)									
Relevant activities	Mine domain 4 - Native bushland corridor									
Total rehabilitation area size (ha)	85.6									
Commencement of first milestone: RM3	30/06/2034									
PMLU	Mine domain 4 - Native bushland corridor									
Date area is available	30/06/34	30/06/35	30/06/36	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	29.4	41.4	85.6							
Milestone completed by	30/12/34	30/12/35	30/12/36	30/12/37	30/12/38	30/12/39	30/12/42	30/12/43	30/12/44	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM3	29.4	41.4	85.6							
RM4		29.4	41.4	85.6						
RM5		29.4	41.4	85.6						
RM6				29.4	41.4	85.6				
RM10							29.4	41.4	85.6	

9.1.4.19 RA 20

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA20 (Southern Flood Protection Landform)									
Relevant activities	Mine domain 7 - Flood protection landform									
Total rehabilitation area size (ha)	12.2									
Commencement of first milestone: RM3	30/06/2034									
PMLU	Mine domain 7 - Flood protection landform									
Date area is available	30/06/34	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	12.2									
Milestone completed by	30/12/34	30/12/35	30/12/37	30/12/47	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM3	12.2									
RM4		12.2								
RM5		12.2								
RM6			12.2							
RM11				12.2						

9.1.4.20 RA 21

Post-mining land uses (PMLU)		
Rehabilitation area (description)	RA21 (A Pit, D Pit & TLO Infrastructure)	
Relevant activities	Mine domain 1 - Cattle grazing	
Total rehabilitation area size (ha)	871.7	
Commencement of first milestone: RM3	30/06/2036	
PMLU	Mine domain 1 - Cattle grazing	

Date area is available	30/06/36	30/06/37	30/06/38	30/06/39	30/06/40	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx				10/12/xxxx
Cumulative area available (ha)	105.8	295.8	460.6	639.0	871.7								
Milestone completed by	30/12/36	30/12/37	30/12/38	30/12/39	30/12/40	30/12/41	30/12/43	30/12/44	30/12/45	30/12/46	30/12/47	30/12/48	30/12/49
Milestone Reference	**Cumulative area achieved (ha)**												
RM3	105.8	295.8	460.6	639.0	871.7								
RM4		105.8	295.8	460.6	639.0	871.7							
RM5		105.8	295.8	460.6	639.0	871.7							
RM6				105.8	295.8	460.6	639.0	871.7					
RM7									105.8	295.8	460.6	639.0	871.7

9.1.4.21 RA 22

Post-mining land uses (PMLU)										
Rehabilitation area (description)				RA22 (A Pit & D Pit NBC)						
Relevant activities				Mine domain 4 - Native bushland corridor						
Total rehabilitation area size (ha)				45.2						
Commencement of first milestone: RM3				30/06/2038						
PMLU				Mine domain 4 - Native bushland corridor						
Date area is available	30/06/38	30/06/39	30/06/40	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	13.9	38.9	45.2							
Milestone completed by	30/12/38	30/12/39	30/12/40	30/12/41	30/12/42	30/12/43	30/12/50			xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM3	13.9	38.9	45.2							
RM4		13.9	38.9	45.2						
RM5		13.9	38.9	45.2						
RM6				13.9	38.9	45.2				
RM10							45.2			

9.1.4.22 RA 23

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA23 (Northern Flood Protection Landform)									
Relevant activities	Mine domain 7 - Flood protection landform									
Total rehabilitation area size (ha)	8.5									
Commencement of first milestone: RM3	30/06/2038									
PMLU	Mine domain 7 - Flood protection landform									
Date area is available	30/06/38	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	8.5									
Milestone completed by	30/12/38	30/12/39	30/12/41	30/12/50	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	Cumulative area achieved (ha)									
RM3	8.5									
RM4		8.5								
RM5		8.5								
RM6			8.5							
RM11				8.5						

9.1.4.23 RA 24

Post-mining land uses (PMLU)											
Rehabilitation area (description)				RA24 (Flood Protection Landform)							
Relevant activities				Mine domain 7 - Flood protection landform							
Total rehabilitation area size (ha)				34.7							
Commencement of first milestone: RM3				30/06/2040							
PMLU				Mine domain 7 - Flood protection landform							
Date area is available	30/06/40	30/06/41	30/06/42	30/06/43	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx		10/12/xxxx
Cumulative area available (ha)	14.2	25.1	30.2	34.7							
Milestone completed by	30/12/40	30/12/41	30/12/42	30/12/43	30/12/44	30/12/45	30/12/46	30/12/50			
Milestone Reference	**Cumulative area achieved (ha)**										
RM3	14.2	25.1	30.2	34.7							
RM4		14.2	25.1	30.2	34.7						
RM5		14.2	25.1	30.2	34.7						
RM6				14.2	25.1	30.2	34.7				
RM11								34.7			

9.1.4.24 RA 25

Post-mining land uses (PMLU)										
Rehabilitation area (description)	RA25 (C Pit & Mine Infrastructure Areas)									
Relevant activities	Mine domain 1 - Cattle grazing									
Total rehabilitation area size (ha)	425.1									
Commencement of first milestone: RM3	30/06/2041									
PMLU	Mine domain 1 - Cattle grazing									
Date area is available	30/06/41	30/06/42	30/06/43	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	142.2	242.8	425.1							
Milestone completed by	30/12/41	30/12/42	30/12/43	30/12/44	30/12/45	30/12/46	30/12/49	30/12/50		
Milestone Reference	Cumulative area achieved (ha)									
RM3	142.2	242.8	425.1							
RM4		142.2	242.8	425.1						
RM5		142.2	242.8	425.1						
RM6				142.2	242.8	425.1				
RM7							142.2	425.1		

9.1.4.25 RA 26

Post-mining land uses (PMLU)		
Rehabilitation area (description)	RA26 (Nogoa Pastoral and Simmons Infrastructure)	
Relevant activities	Mine domain 2 - Landholder retained infrastructure	
Total rehabilitation area size (ha)	38.5	
Commencement of first milestone: RM1	31/01/2028	
PMLU	Mine domain 2 - Landholder retained infrastructure	

Date area is available	31/01/28	30/12/43	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	6.7	38.5								
Milestone completed by	31/01/28	30/12/43	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx	xx/xx/xxxx
Milestone Reference	**Cumulative area achieved (ha)**									
RM1	6.7	38.5								

9.1.5 Improvement areas schedule

Following are schedules with key dates and milestones for all future IAs at Ensham.

The location of each IA is shown in Figure 9-14 and with the provided spatial files.

9.1.5.1 IA 1

<table>
<tr><th colspan="11">Non-use management area (NUMA)</th></tr>
<tr><td colspan="4">Improvement area (description)</td><td colspan="4">IA1
(Ramp 83)</td><td colspan="3" rowspan="5"></td></tr>
<tr><td colspan="4">Relevant activities</td><td colspan="4">Mine domain 6 - Highwalls</td></tr>
<tr><td colspan="4">Total size (ha)</td><td colspan="4">3.0</td></tr>
<tr><td colspan="4">Commencement of first milestone: MM1</td><td colspan="4">30/06/2030</td></tr>
<tr><td colspan="4">NUMA</td><td colspan="4">Mine domain 6 - Highwalls</td></tr>
<tr><td>Date area is available</td><td>30/06/30</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cumulative area available (ha)</td><td>3.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Milestone completed by</td><td>30/06/32</td><td>30/06/37</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Milestone Reference</td><th colspan="10">Cumulative area achieved (ha)</th></tr>
<tr><td>MM1</td><td>3.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>MM2</td><td></td><td>3.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

9.1.5.2 IA 2

Non-use management area (NUMA)										
Improvement area (description)	IA2 (Ramp 24)									
Relevant activities	Mine domain 6 - Highwalls									
Total size (ha)	18.89									
Commencement of first milestone: MM1	30/06/2034									
NUMA	Mine domain 6 - Highwalls									
Date area is available	30/06/34									
Cumulative area available (ha)	18.89									
Milestone completed by	30/06/36	30/06/42								
Milestone Reference	Cumulative area achieved (ha)									
MM1	18.89									
MM2		18.89								

9.1.5.3 IA 3

Non-use management area (NUMA)										
Improvement area (description)				IA3 (Ramp 24)						
Relevant activities				Mine domain 5 - Groundwater daylighting water areas						
Total size (ha)				30.65						
Commencement of first milestone: MM1				30/06/2034						
NUMA				Mine domain 5 - Groundwater daylighting water areas						
Date area is available	30/06/34									
Cumulative area available (ha)	30.65									
Milestone completed by	30/06/36	30/06/42								
Milestone Reference	**Cumulative area achieved (ha)**									
MM1	30.65									
MM2		30.65								

9.1.5.4 IA 4

Non-use management area (NUMA)										
Improvement area (description)				IA4 (Ramp 7)						
Relevant activities				Mine domain 6 - Highwalls						
Total size (ha)				7.69						
Commencement of first milestone: MM1				30/06/2035						
NUMA				Mine domain 6 - Highwalls						
Date area is available	30/06/35									
Cumulative area available (ha)	7.69									
Milestone completed by	30/06/37	30/06/42								
Milestone Reference	**Cumulative area achieved (ha)**									
MM1	7.69									
MM2		7.69								

9.1.5.5 IA 5

Non-use management area (NUMA)										
Improvement area (description)	IA5 (Ramp 6)									
Relevant activities	Mine domain 6 - Highwalls									
Total size (ha)	11.9									
Commencement of first milestone: MM1	30/06/2036									
NUMA	Mine domain 6 - Highwalls									
Date area is available	30/06/36									
Cumulative area available (ha)	11.9									
Milestone completed by	30/06/38	30/06/43								
Milestone Reference	Cumulative area achieved (ha)									
MM1	11.9									
MM2		11.9								

9.1.5.6 IA 6

Non-use management area (NUMA)										
Improvement area (description)				IA6 (Ramp 6)						
Relevant activities				Mine domain 5 - Groundwater daylighting water areas						
Total size (ha)				34.98						
Commencement of first milestone: MM1				30/06/2036						
NUMA				Mine domain 5 - Groundwater daylighting water areas						
Date area is available	30/06/36		10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	34.98									
Milestone completed by	30/06/38	30/06/43								
Milestone Reference	Cumulative area achieved (ha)									
MM1	34.98									
MM2		34.98								

9.1.5.7 IA 7

Non-use management area (NUMA)										
Improvement area (description)	IA7 (Ramp 5)									
Relevant activities	Mine domain 6 - Highwalls									
Total size (ha)	8.63									
Commencement of first milestone: MM1	30/06/2038									
NUMA	Mine domain 6 - Highwalls									
Date area is available	30/06/38		10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	8.63									
Milestone completed by	30/06/40	30/06/45								
Milestone Reference	Cumulative area achieved (ha)									
MM1	8.63									
MM2		8.63								

9.1.5.8 IA 8

Non-use management area (NUMA)										
Improvement area (description)				IA8 (Ramp 5)						
Relevant activities				Mine domain 5 - Groundwater daylighting water areas						
Total size (ha)				32.42						
Commencement of first milestone: MM1				30/06/2038						
NUMA				Mine domain 5 - Groundwater daylighting water areas						
Date area is available	30/06/38		10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	32.42									
Milestone completed by	30/06/40	30/06/45								
Milestone Reference	**Cumulative area achieved (ha)**									
MM1	32.42									
MM2		32.42								

9.1.5.9 IA 9

Non-use management area (NUMA)										
Improvement area (description)				IA9 (A Pit)						
Relevant activities				Mine domain 6 - Highwalls						
Total size (ha)				12.91						
Commencement of first milestone: MM1				30/06/2039						
NUMA				Mine domain 6 - Highwalls						
Date area is available	30/06/39		10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	12.91									
Milestone completed by	30/06/41	30/06/46								
Milestone Reference	**Cumulative area achieved (ha)**									
MM1	12.91									
MM2		12.91								

9.1.5.10 IA 10

Non-use management area (NUMA)										
Improvement area (description)	IA10 (A Pit)									
Relevant activities	Mine domain 5 - Groundwater daylighting water areas									
Total size (ha)	14.25									
Commencement of first milestone: MM1	30/06/2039									
NUMA	Mine domain 5 - Groundwater daylighting water areas									
Date area is available	30/06/39		10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	14.25									
Milestone completed by	30/06/41	30/06/46								
Milestone Reference	**Cumulative area achieved (ha)**									
MM1	14.25									
MM2		14.25								

9.1.5.11 IA 11

Non-use management area (NUMA)										
Improvement area (description)	IA11 (Ramp 3 & 4)									
Relevant activities	Mine domain 6 - Highwalls									
Total size (ha)	23.08									
Commencement of first milestone: MM1	30/06/2040									
NUMA	Mine domain 6 - Highwalls									
Date area is available	30/06/40		10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	23.08									
Milestone completed by	30/06/42	30/06/47								
Milestone Reference	**Cumulative area achieved (ha)**									
MM1	23.08									
MM2		23.08								

9.1.5.12 IA 12

Non-use management area (NUMA)										
Improvement area (description)				IA12 (Ramp 4)						
Relevant activities				Mine domain 5 - Groundwater daylighting water areas						
Total size (ha)				33.44						
Commencement of first milestone: MM1				30/06/2040						
NUMA				Mine domain 5 - Groundwater daylighting water areas						
Date area is available	30/06/40		10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx	10/12/xxxx
Cumulative area available (ha)	33.44									
Milestone completed by	30/06/42	30/06/47								
Milestone Reference	**Cumulative area achieved (ha)**									
MM1	33.44									
MM2		33.44								