Brolga Project

Tenure number: ML5866 and ML5864

Environmental Authority: EMPL01624913

Progressive Rehabilitation and Closure Plan

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Terms and Abbreviations

°C	Degrees Celsius
AEP	Average Exceedance Probability
ANC	Acid Neutralising Capacity
AMD	Acid Mine Drainage
ANZECC and ARMCANZ	Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ)
ARD	Acid Rock Drainage
ASLP	Australian Standard Leaching Procedure
BGL	Below Ground Level
BPA	State Biodiversity Planning Assessment
BoM	Bureau of Meteorology
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
DAF	Queensland Department of Agriculture and Fisheries
DEHP	Queensland Department of Environment and Heritage Protection (former)
DEM	Digital Elevation Model
DES	Queensland Department of Environment and Science
EA	Environmental Authority
EC	Electrical conductivity
EFA	Ecosystem Function Analysis
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EP Act	Queensland *Environmental Protection Act 1994*
EP Regulation	Queensland Environmental Protection Regulation 2019
EVNT	Endangered, Vulnerable or Near Threatened taxa
GBR	Great Barrier Reef
GNP	Gladstone Nickel Project
IPCC	The Intergovernmental Panel on Climate Change
LGO	Low Grade Nickel Laterite Ore
LOX	Line of Oxidation
MERFP Act	Queensland *Mineral and Energy Resources (Financial Provisioning) Act 2018*
Mg/L	Milligrams per Litre
ML	Mining Lease
MNES	Matters of National Environmental Significance
MPA	Maximum Potential Acidity
MSES	Matters of State Environmental Significance
NAPP	Net Acid Producing Potential
NC Act	Queensland *Nature Conservation Act 1999*
NAG	Net acid generation
NAF	Non-acid forming

PMLU	Post Mining Land Use
PRC	Progression Rehabilitation and Closure
PRCP	Progression Rehabilitation and Closure Plan
PRCP Guideline	Department of Environment and Science, Progressive Rehabilitation and Closure Plan Guideline (ESR/2019/4964)
PVC	Polyvinyl Chloride
Qld	Queensland
QNI	QNI Resources Pty Ltd and QNI Metals Pty Ltd
RA	Rehabilitation Area
RAB	Reverse Area Blast
RM	Rehabilitation Milestone
RE	Regional Ecosystem
ROM	Run of Mine
RT	Rehabilitation Trial
SQP	Suitably Qualified Person
SEIS	Supplementary Environmental Impact Assessment
The Project or the Brolga Project	ML5866and ML5864, which operate under Environmental Authority EMPL01624913
WQOs	Water Quality Objectives
Yabulu Refinery	The Palmer Nickel and Cobalt Refinery in Yabulu, Townsville, Queensland

1 Introduction

The Brolga Project is owned by QNI Resources Pty Ltd and QNI Metals Pty Ltd (collectively referred to as 'QNI').

The Project is located about 55 kilometres north of Rockhampton, along the Bruce Highway (see Figure 1-1 to Figure 1-3).

The Project includes two mining leases (MLs), ML5866 (Brolga, or the Brolga ML) and ML5864 (Canoona, or the Canoona ML) which operate under Environmental Authority (EA) EMPL01624913. Collectively, the two MLs are referred to as 'the Brolga Project', or 'the Project'. The Project formerly supplied nickel to the Palmer Nickel and Cobalt Refinery in Yabulu (the Yabulu refinery), Townsville, Queensland. However, both MLs are currently in 'Care and Maintenance' as a result of the suspension of nickel refining at the Yabulu refinery.

Mining operations at the Brolga Project were relatively simple: at ML5866 nickel-oxide ore was mined from the lateritic regolith, overburden was stockpiled, the ore was screened to remove large rocks, then hauled to the nearby Glen Geddes railway siding and transported via rail to the Yabulu refinery.

ML5864 Canoona has been explored and drilled but no extraction of ore has occurred.



Figure 1-1. Location Map ML5866 and ML5864

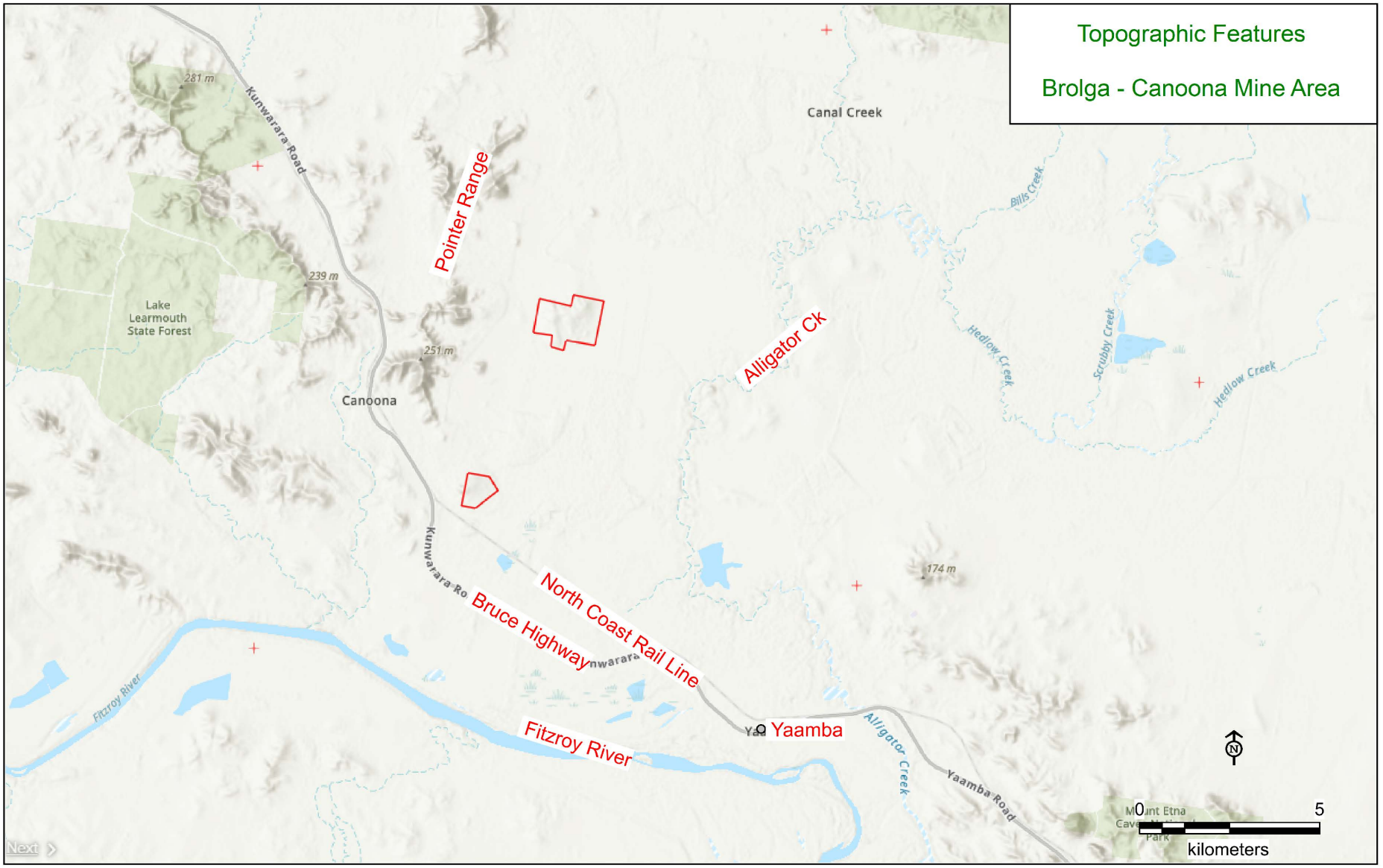


Figure 1-2. Brolga Canoona Topographic Features



Figure 1-3. Brolga Canoona Satellite Image

1.1 Purpose and Scope

This document sets out the rehabilitation activities that will take place on the Brolga Project. This Progressive Rehabilitation and Closure Plan (PRCP) has been prepared with reference to requirements for the preparation of a PRCP as set out in the Queensland Department of Environment and Science's Progressive Rehabilitation and Closure Plan (PRCP) Guideline (ESR/2019/4964) (PCRP guideline) (DES 2021) effective from 17 March 2021. As per the PRCP Guidelines, the PRCP consists of two parts:

- Rehabilitation planning part – this report
- PRCP schedule - Appendix 1 of this report.

As required by the PRCP Application Form, the structure of this report (i.e. the Rehabilitation planning part) is set out according to the formatting/structural requirements listed in Appendix 1 of the PRCP Application form (ESR/2019/4957).

1.2 Regulatory Context

An Environmental Authority (EA) with number EPML01624913, issued under the *Environmental Protection Act 1994,* for the Brolga Project was approved on 7 November 2013 for Schedule 3 Environmentally Relevant Activity, 15 - mining nickel ore (site specific). The current version of EA EPML01624913 is effective from 23 June 2021[1]. Obligations within the EA also apply to the progressive rehabilitation activities.

Mining operations, including rehabilitation, are regulated under the *Queensland Environmental Protection Act 1994* (EP Act) and *Environmental Protection Regulation 2019* (EP Regulation). As a result of the passing of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act), the EP Act was amended such that all new and existing EA holders for a mining activity relating to a mining lease approved through a site-specific activity must prepare a PRCP after receiving a Notice from the Department of Environment and Science (DES). The MERFP Act includes transitional provisions for the application of the PRCP requirement concerning existing mines such as the Brolga Project.

For existing mines, the transitional provisions mean that existing 'land outcomes' (which are Post Mine Land Uses (PMLUs) and associated completion criteria) secured in a 'land outcome document' received by DES (and not rejected) before December 2018 can be carried forward (and do not need community consultation or stakeholder agreement). According to Section 750 of the EP Act a 'land outcome document' can be:

a. an Environmental Authority (EA) for a resource activity
b. a document made under a condition of an EA that:
    - relates to the management of a void or rehabilitation of land (e.g. rehabilitation and closure plan or residual void management plan), and
    - was provided to the administering authority, and had not been superseded, before 30 November 2018, and

[1] Prior to this date the EA included another ML - ML 7048 – this was an infrastructure lease, was not mined or explored, and has since been relinquished.

- before 15 January 2019, the administering authority had not notified the EA holder that the document was insufficient.

a. a document made under a condition of an EA that:
   - relates to the management of a void or rehabilitation of land (e.g. rehabilitation and closure plan or residual void management plan) and
   - was provided to the administering authority between 20 November 2019 and 30 November 2021; and
   - within 20 business days after receiving the document, the administering authority had not notified the EA holder that the document was insufficient.

b. a report evaluating an EIS under section 34D of the State Development and Public Works Organisation Act 1971

c. an EIS assessment report

d. a written agreement between the EA holder and the State that is in force on 30 November 2018.

The PCRP guideline specifies that the land outcome document list is hierarchical and if there are inconsistencies between these documents on either the final outcomes or details of the outcome, then the document appearing first in the above list will prevail to the extent of the inconsistency.

For the Brolga Project, the relevant documents are:

- The EA - EMPL01624913 (see Appendix 2)
- The 'Brolga Rehabilitation Management Standard (QN-BR-STD-012)' (see Appendix 3).

The Brolga Rehabilitation Management Standard was prepared to satisfy conditions G1 – G9 (Land and Rehabilitation) of the EA (EMPL01624913). The document was approved on 28 May 2014 and was the rehabilitation management plan being utilised prior to the enactment of the *Mineral and Energy Resources (Financial Provisioning) Act 201*8 (MERFP Act) which brought about the requirement to submit this PRCP. The Brolga Rehabilitation Management Standard specifies a post mine land use of grazing.

2 Project Planning

2.1 Site Location

Environmental Authority EMPL01624913 is located near Glen Geddes, about 55 kilometres north of Rockhampton, along the Bruce Highway (see Figure 1-2). It contains two mining leases, ML5864 Canoona and ML5866 Brolga, which are located about five kilometres apart, and near the Bruce Highway. Both are located in the Livingstone Shire Council in the Rockhampton Mining District. The small township of Yaamba is located approximately 13 km south east of the project. The Glen Geddes rail siding is located approximately 5 km to the west of the Brolga ML adjacent to the North Coast rail line.

2.2 Project Description

2.2.1 Mining Tenements

The Brolga Project consists of two granted MLs, ML5864 Canoona and ML5866 Brolga which operate under EA EMPL01624913. Obligations within the EA also form part of the progressive rehabilitation activities. For example, for the Brolga ML, maintenance of levees and dams to control sediment and runoff is also fundamental to rehabilitation activities and to control the quality of water on the site.

ML5864 was initially granted on 13 June 1991 with a commencement date of 1 July 1991 and expiry date of 30 June 2031. ML5866 was initially granted on 20 July 1989 with a commencement date of 1 August 1989 and expiry date of 31 July 2020. A renewal application has been duly submitted for ML5866. Both MLs have been held by QNI Resources Pty Ltd (80%) and QNI Metals Pty Ltd (20%) since 27 March 1995. ML5864 Canoona covers a surface area of 64.49 hectares and ML5866 Brolga covers a surface area of 202.69 hectares.

2.2.2 Primary features /infrastructure

The primary features of the mine at the Brolga ML are described below and in Table 2-1. Figure 2-1 gives the location of each of the primary features.

There are three pits currently open which cover a total area of 11.3 hectares. Two of these pits have been excavated into the slope of the Brolga hill (Pit 8 and Pit 2 Extension). The elevation of the deepest part of Pit 8 is 19.9 metres, compared with its pre-mining, natural elevation of 34.1 metres. The deepest elevation of Pit 2 Extension is 20.5 metres, compared with its pre-mining, natural elevation of 42.5 metres. Pit 1 was excavated from the top of the hill. Its current deepest elevation is 47.6 metres, compared with its pre-mining, natural elevation of 67.3 metres.

All other pits are either back-filled or have had substantial backfilling, and became areas for mining operations such as screening or stockpiling (eg. ROM, Screening Stockpile, Go Line Pad). All other pits were also cut into the side of the hill. The landform that results from the back-filling is of a terraced form, rather than the sloping form that was previously the surface shape.

Most of the pits are more or less contiguous at the surface, and located on the eastern side of the hill, the exception being Pit 1, located at the top of the hill.

Most other mine features are out-of-pit dumps. Each of these has been formed into gently sloping terraced landforms, as a result of the knowledge that the post-mining land use would be grazing, and as a strategy to ensure stability. They were built as gently sloping areas that drained towards

areas that were unlikely to be degraded by erosion. These pads have batters that were made mainly from the large rocks that were gained by the screening process. This was a measure against the probability of erosion. Some were used as pads for mining operations (Go Line Pad, Top Pad and Front Pad). One was used exclusively for waste rock/overburden dump (Waste Rock Dump).

Large high spoil dumps with long steep slopes were never made. The existing back-filled pits have been designed to slope gently, drain so as to minimise erosional scouring and be easily converted to pasture areas.

There is one mine feature that was not formed into a flat or terraced landform – the Nontronite Stockpile. It is a stockpile on the Go Line Pad with a volume of 50,000 cubic metres that was managed as ore, but was downgraded to waste as a result of refining challenges. Proposed rehabilitation activity for this feature includes flattening it to a terraced landform.

There are five small pits that were used for refining tests with a total area of 0.5 hectare (the test pits).

Existing rehabilitation, all as back-filling of mined-out pits and associated bunding, covers an area of 19.5 hectares, and other historical rehabilitation areas are described in Section 2.7.

The only other mine features are the Haul Road and Bath-house Area.

Table 2-1 below gives a brief description of each mine feature and Figure 2-1 gives the locations.

Table 2-1. Summary description of current Brolga ML features

Mine Feature	Description
Test Pits	Five small pits that were used for refining tests.
Pit 1	A mined void excavated from the top of the hill. Its deepest elevation is 47.6 metres, compared with its pre-mining, natural elevation of 67.3 metres.
Pit 2	A mined void. Pit 2 has already been back-filled.
Pit 3/Oversized Dump	A mined void. Pit 3/Oversized Dump has been 70% back-filled.
Pit 4	A mined void. Pit 4 has already been back-filled.
Pit 5 North	A mined void.
Pit 5 South	A mined void.
Pit 8	A mined void excavated into the slope of the Brolga hill. The elevation of the deepest part of Pit 8 is 19.9 metres, compared with its pre-mining, natural elevation of 34.1 metres.
Topsoil Dump 2 & Topsoil Dump 3	Topsoil stockpile areas.
Nontronite Stockpile	Stockpile of ore that is high in nickel, but also in nontronite (an iron rich type of smectite clay) and cannot, at this stage, be economically extracted. Located on the Go Line Pad.
Top Pad	Out-of-pit dump for waste formed into pad for mine operations. Used as a parking, turn-around and pit exit point.
Go Line Pad	Out-of-pit dump for waste formed into pad for mine operations. Became an area used for parking of machinery and the location of the Nontronite Stockpile.
ROM	Ex pit that has had substantial backfilling, and became an area for run of mine (ROM) mining operations (where ore was stockpiled for screening and loading).
Screening Stockpile	Ex pit that has had substantial backfilling and is a stockpile for excavated low-grade ore ready for screening.
Pit 2 Extension	A mined void excavated into the slope of the Brolga hill. The deepest elevation of Pit 2 Extension is 20.5 metres, compared with its pre-mining, natural elevation of 42.5 metres.

Mine Feature	Description
Waste Rock Dump	Out-of-pit dump for waste. Comprised exclusively of Waste Rock.
Front Pad	Out-of-pit dump for low grade ore formed into pad for mine operations. Used for stockpiling and parking of machinery.
Topsoil Dumps 1, 4, 5, 6, 7	Topsoil stockpile areas.
Haul Road	The Haul Road network contains 2.82 kilometres of compacted tracks. They are unsealed formed roads built using overburden from the upper red-brown lateritic layer, an ideal road-base material.
Bath-house Area	The bath-house includes two adjacent demountable structures (shower and toilet block) with a septic tank, rainwater tank, underground PVC pipe to the rainwater tank, and some concrete paths and pads, all contained in a single clearing area.
Dam 4	Dam 4 is located on the eastern boundary of ML5866.

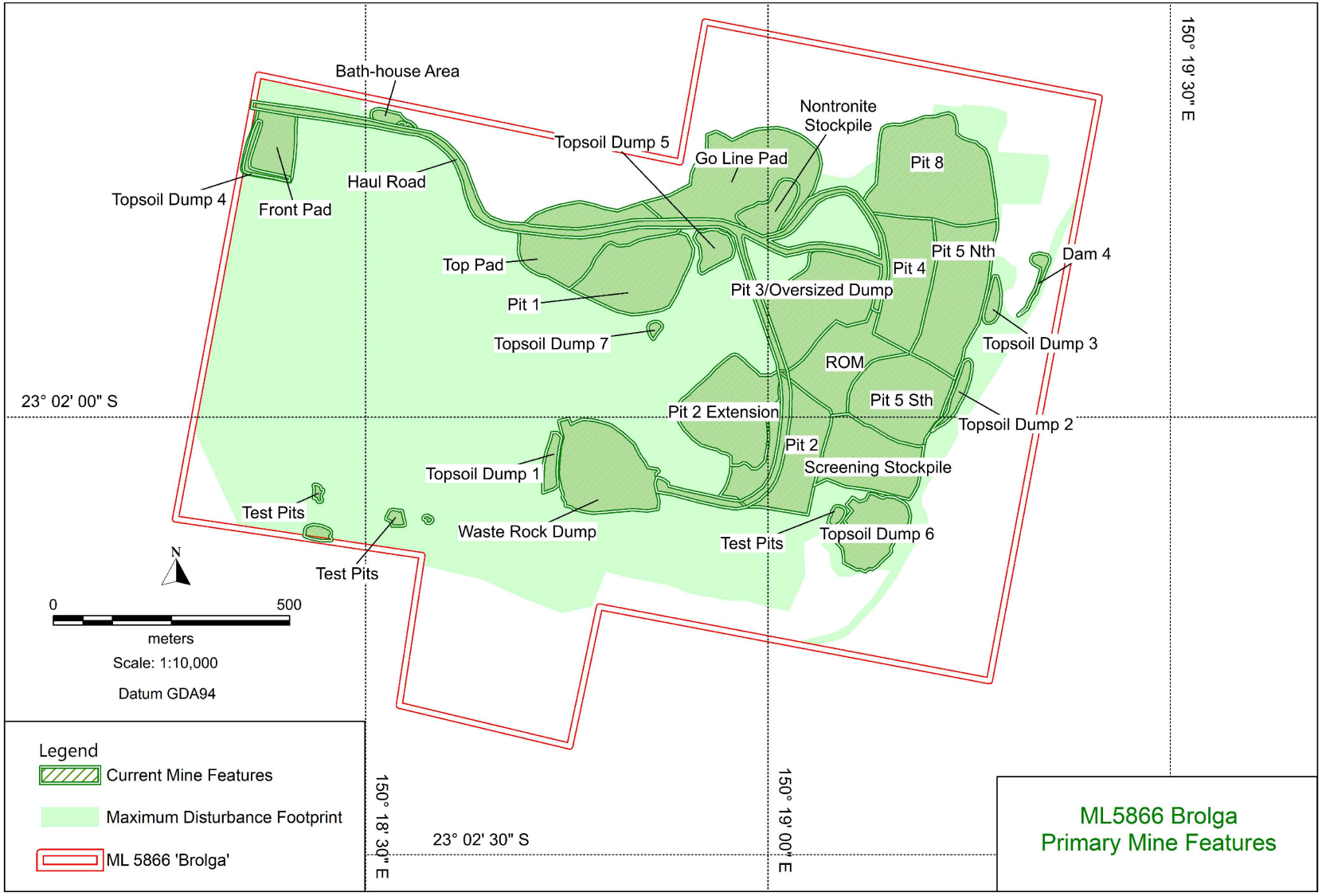


Figure 2-1. Current Brolga ML features

2.2.3 Type of mining operation

2.2.3.1 Background

Mining has occurred on ML5866 Brolga only. No mining activity, other than exploration, has taken place on ML5864 Canoona.

ML5866 Brolga area was mined during 1993-95, under a different tenement holder, but mining records from that period are not held by QNI. Consequently, some areas of ML5866 have already been mined, back-filled and rehabilitated (see Section 2.7.1 for a description of the former rehabilitation), but these areas were not known or recognised by QNI until new excavations revealed them.

Mining re-commenced under QNI on ML5866 Brolga in 2012 and continued until 2016. The mine has not operated since 2016 and is currently in care and maintenance as a result of the suspension of nickel refining at the Yabulu refinery. Current rehabilitation, in the form of back-filling in mined-out pits and associated bunding, covers an area of 19.5 hectares (see Section 2.7.2 for a description of the existing QNI rehabilitation).

2.2.3.2 QNI mining method at Brolga ML

Between 2012 and 2016, nickel ore was mined from ML5866 Brolga in a simple shallow open-cut mine operation.

Several metres (usually four to six) of overburden, consisting of red-brown laterite rock, were removed from the surface to expose the ore directly beneath. The ore is a pale-coloured saprolitic rock containing nickel-oxides and nickel-bearing silicates (smectite clays). Blasting was not used as excavators were capable of digging the ground to the depths required.

The areas that are referred to as ‘Pits’ in this document are basically a continuous arrangement of adjacent orebodies, rather than distinctive and separate excavations. The Life-of-mine Schedule from the time (QNI, 2014) refers to pits of about half a hectare to two hectares, which are frequently contiguous with, or very close to, other pits. Pit depths are about 20 metres deeper than surrounding topography. The depths of overburden removal have varied from two metres to about ten metres at the deepest, but was typically between four and six metres.

Mining on ML5866 under QNI commenced in 2012 at Pit 1 and Pit 2. Overburden waste rock was dumped to form the Waste Rock Dump and the Go Line Pad. Ore was first stockpiled on the Go Line Pad, which was at that time, the Run-of-Mine pad. That ore is now called the Nontronite Stockpile (see below).

Mining continued progressively to Pits 3, 4 and 5 by 2015, and most recently, Pit 8 by 2016. Overburden from Pits 3, 4 and 5 was dumped at the Front Pad to be pushed-out to make a versatile pad for various uses including parking of machinery and stockpiling of ore. Other overburden was dumped in mined-out pits.

The ore was stockpiled and screened at the mine, then trucked to the nearby Glen Geddes railway siding for loading on to trains and transport to the Yabulu refinery in Townsville. The only on-site beneficiation process was the screening to remove large rocks.

Processing challenges at the Yabulu refinery resulted in the recognition that some ore was high in iron content and contained nickel which could not be extracted economically. This ore is termed ‘Nontronite’ (after the relevant mineral) and was excluded from mining reserves. Consequently, the

original mining plan was modified. Existing nontronite-bearing rock remains on ML5864. The nontronite-bearing stockpile will be rehabilitated in a manner that makes it easily accessible should a revised processing method be identified in the future.

2.2.3.3 Exploration on Canoona ML

Mining has not occurred on ML 5864 Canoona; however, the site has had several exploration holes drilled as part of two phases of exploration. The first was under Authority to Prospect (ATP) 294M in the 1970's; the second under mining lease ML5866 during 1994 – 1996.

Exploration reports detail 109 holes drilled in Canoona between 1970 and 1972, nine of which were large-diameter (one-metre) holes. The drilling method for the majority of these holes was 'reverse air blast' (RAB - diameter 100 mm) - a routine drilling method at that time. Shallow RAB holes required no pit, and were all vertical so no additional clearing other than the track was required to accommodate the rig. Holes of these depths (less than 30 metres) were spaced about 75 metres apart and each would have been completed in a few hours. The size of the rig truck was probably about 10 metres long to mount the Mayhew-1000 rig. Sufficient air pressure for these shallow holes would have been supplied by the air-compressor mounted on the drilling truck, so no other trucks would have been required.

The nine large-diameter drill sites required more machinery and a larger clearing. The deepest of the large-diameter holes was 25 metres. One of them had a trench dug adjacent it, with a maximum depth of ten metres, and 40 metres in length.

Follow-up exploration drilling occurred during 1995. By that time, the industry standard transformed to a drilling technique known as reverse-circulation drilling, a method that has less sampling error. Drilling access tracks of the previously disturbed area were upgraded to provide access for this program. This phase of drilling affected approximately three-quarters of the previously disturbed area. No exploration or any sampling activity has occurred in Canoona since that time.

2.2.4 Proposed Duration of Operation

The current life-of-mine plan includes rehabilitation works only.

The previous life-of-mine plan that was in place prior to the suspension of the Yabulu refinery included a schedule to continue nickel ore mining on ML5866 for at least two years, and then commence mining on ML5864 for a further two years.

Currently, there is no other refinery to which the ore can be sent to maintain the economic viability for the mine. For this reason, the previous life-of-mine plan became redundant and was replaced with a plan which includes rehabilitation works only.

Rehabilitation works are planned to commence in 2024 and continue in an active state until 2028, after which monitoring of the rehabilitated areas will continue until 2031. If a stable final landform and post-mining land use is achieved by that time, an application to surrender the Environmental Authority may be made.

Should the Yabulu refinery recommence activities during the proposed PRCP period, a new life-of mine plan will be developed and appropriate amendments to the PRCP sought to enable mining and rehabilitation under a revised schedule.

2.3 Baseline Information

The following sections provide baseline information relevant to the land covered by EA EMPL01624913. The sections are consistent with the recommended topics listed in the PRCP Guidelines but follow the structure specified in Appendix 1 of the PRCP Application Form (ESR/2019/4957).

2.3.1 Site topography

Orthophotos and topographic data acquired in 2020 show the current features of land within ML5866 (Figure 2-2, Figure 2-3 and Figure 2-4). Satellite imagery from GeoResGlobe is provided for ML5864 in Figure 2-5, Figure 2-6 and Figure 2-7.

2.3.1.1 Brolga

The Brolga ML is situated on a topographically elevated feature that is surrounded by Quaternary alluvial sediment. It is a lateritised remnant of serpentinite on the south-eastern periphery of the Princhester Serpentinite, in the geological province known as the 'Marlborough Block'.

The Brolga ML ranges from around 20 to 70 metres above sea level, with the highest elevation near the northern side of the mining lease boundary. On the surrounding land, elevations are approximately 20 metres above sea level on the east, west and south sides, and between 20 and 50 on the north side (see Figure 2-2). Most of the surrounding relief is quite flat, gradually descending eastward to Alligator Creek.

Two kilometres west of Brolga is the Pointer Range, also part of the Princhester Serpentinite. Four kilometres east of Brolga is Alligator Creek, which meanders southward to the Fitzroy River.

2.3.1.2 Canoona

The Canoona mining lease is also situated on a topographically elevated feature surrounded by Quaternary alluvial sediment. It is also a lateritised remnant of serpentinite on the south-eastern periphery of the Princhester Serpentinite, also part of the 'Marlborough Block'.

The highest elevations on Canoona are about 75 metres above sea level, near the western mining lease boundary. The elevations are between 20 and 25 metres above sea level on the southern and eastern boundary, and 25 to 35 metres above sea level on the northern boundary. On most of the surrounding land elevations are approximately 20 metres above sea level (see Figure 2-6). Most of the surrounding relief is quite flat except for some other low remnant hills of the serpentinite, gradually descending eastward to Alligator Creek.

Run-off from the Canoona area flows into the surrounding Quaternary alluvium, and south and south-eastward to Alligator Creek and the Fitzroy River.

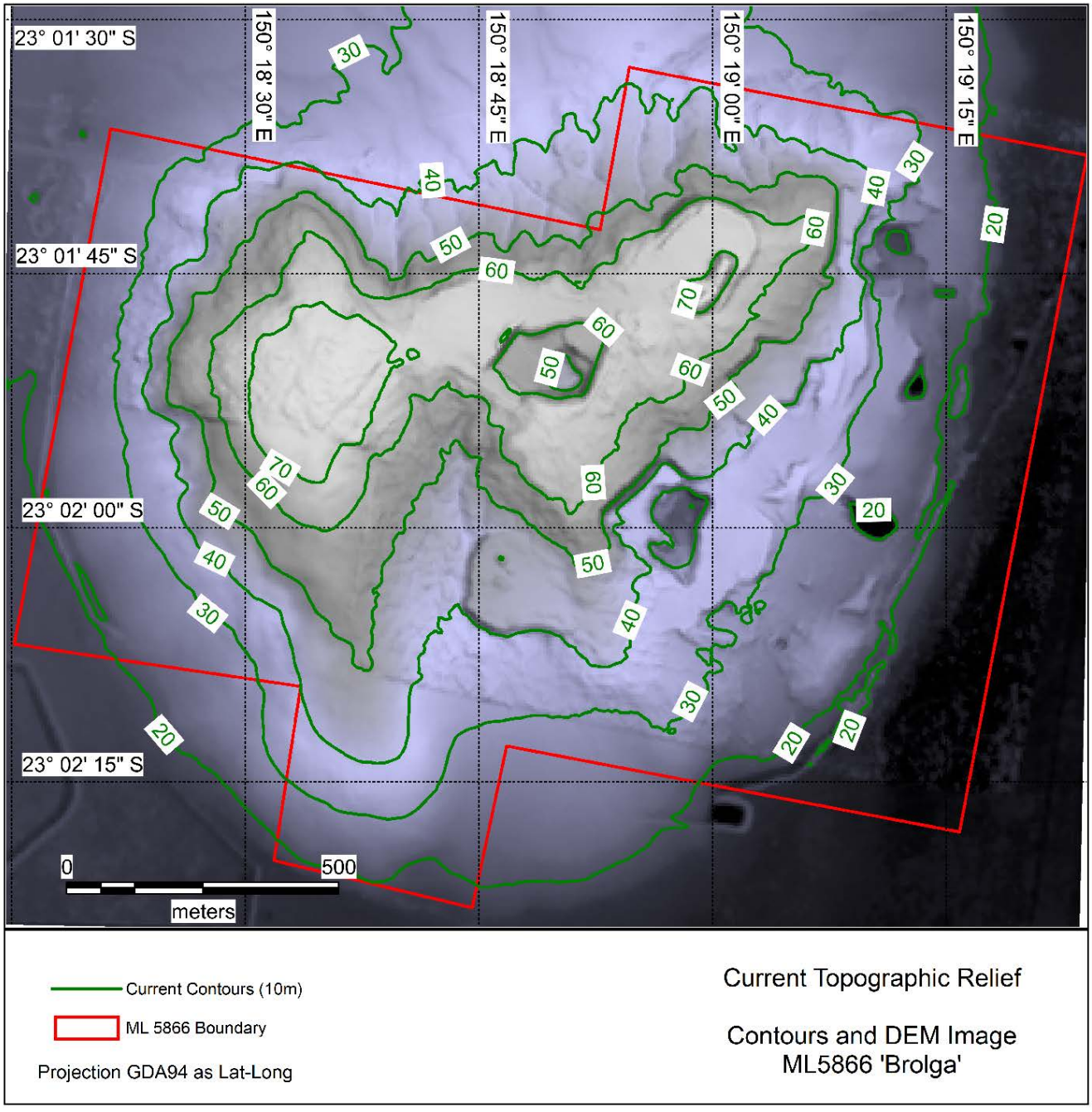


Figure 2-2. ML5866 Brolga Current Topographic Relief

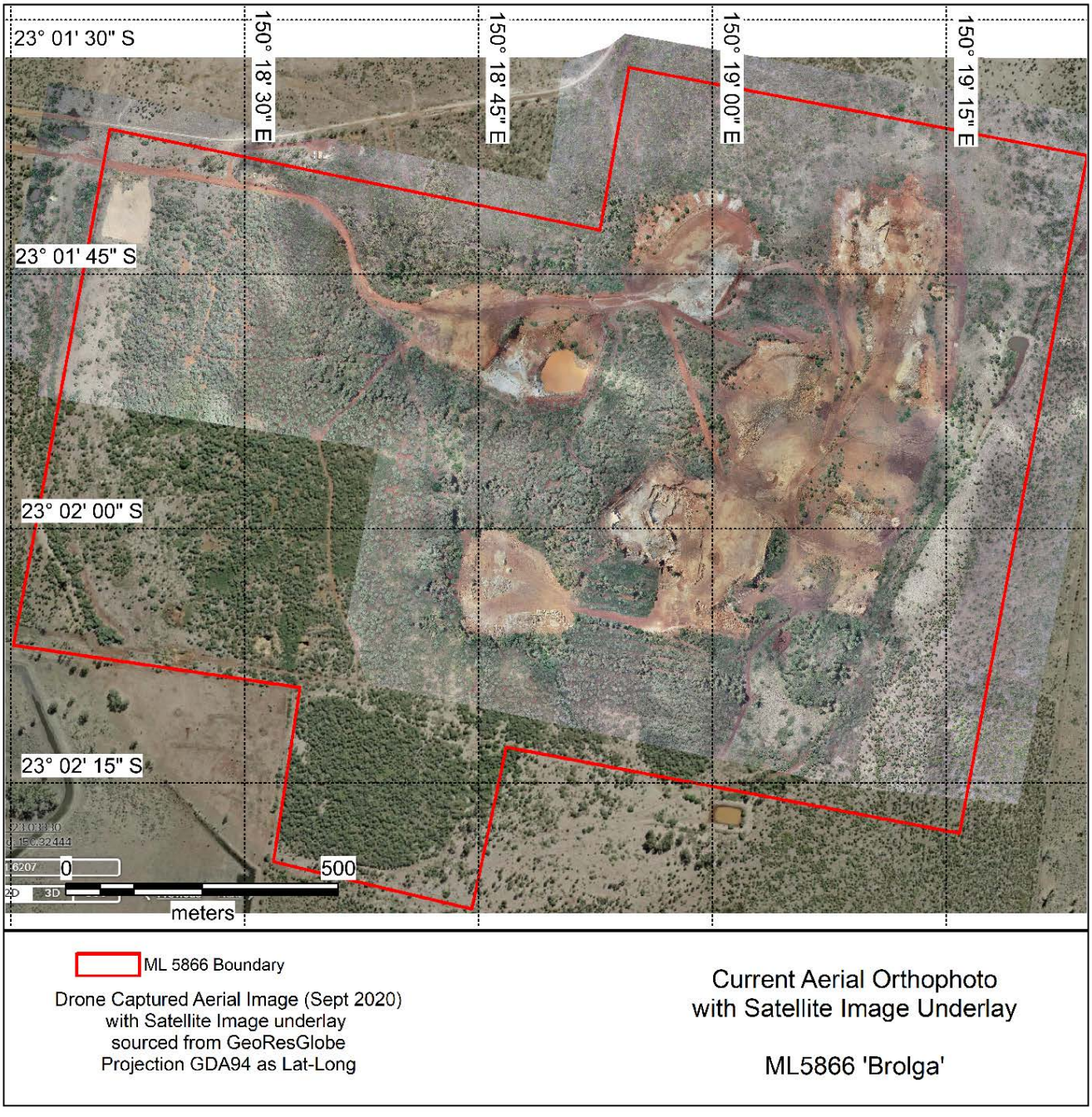


Figure 2-3. ML5866 Brolga Current Aerial Orthophoto

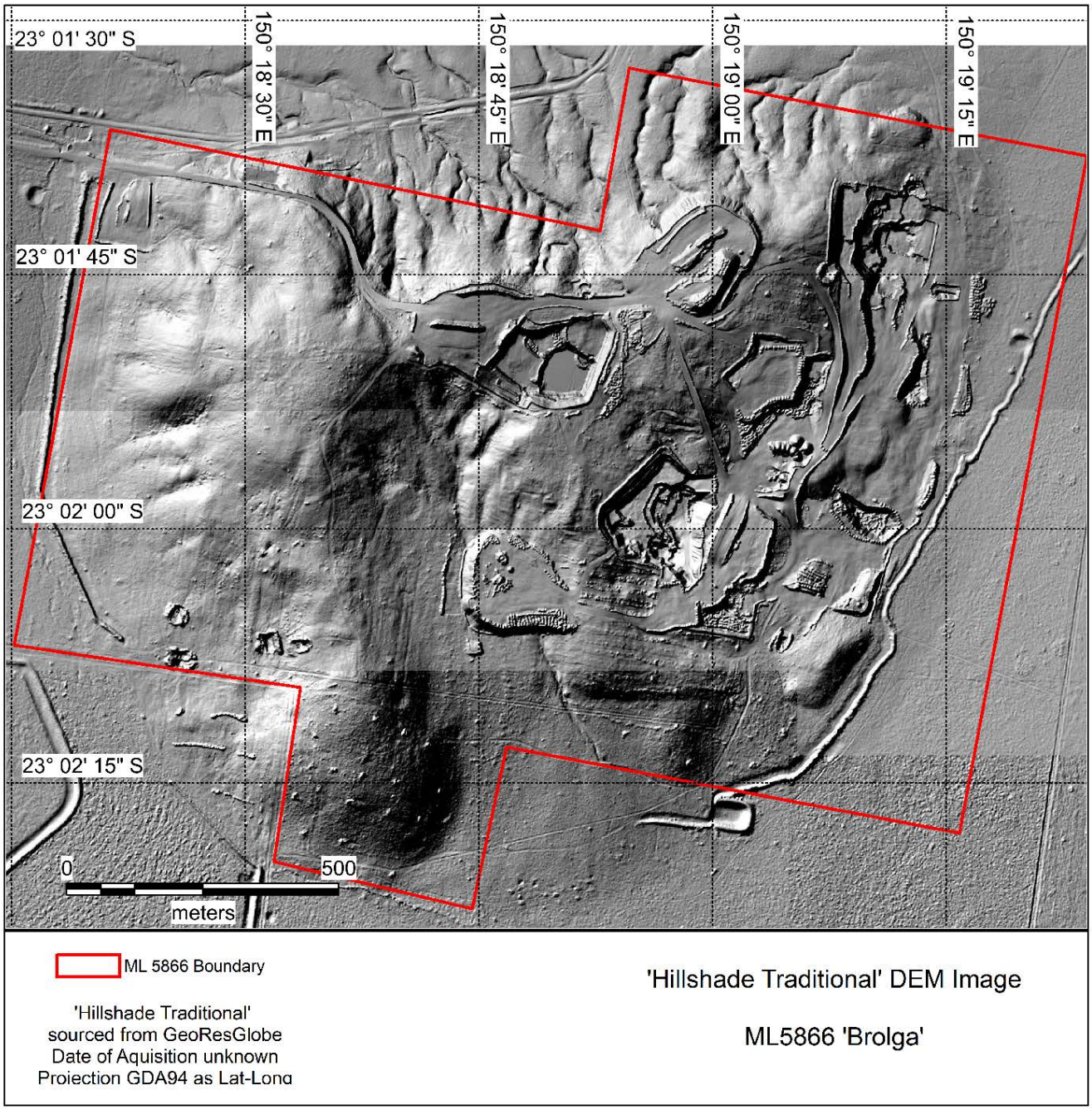


Figure 2-4. ML5866 Brolga Digital Elevation Image

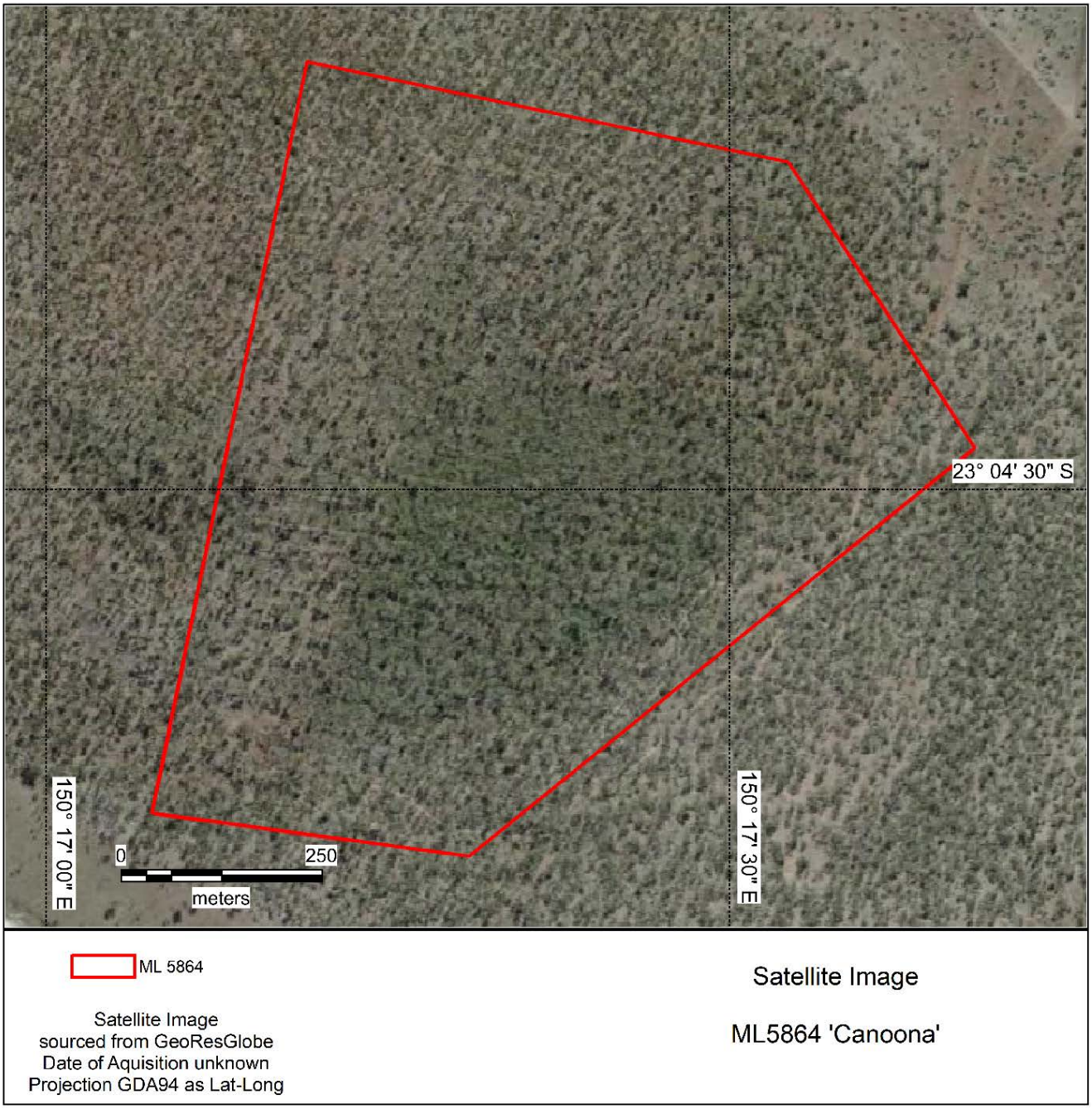


Figure 2-5. ML5864 Canoona Satellite Image

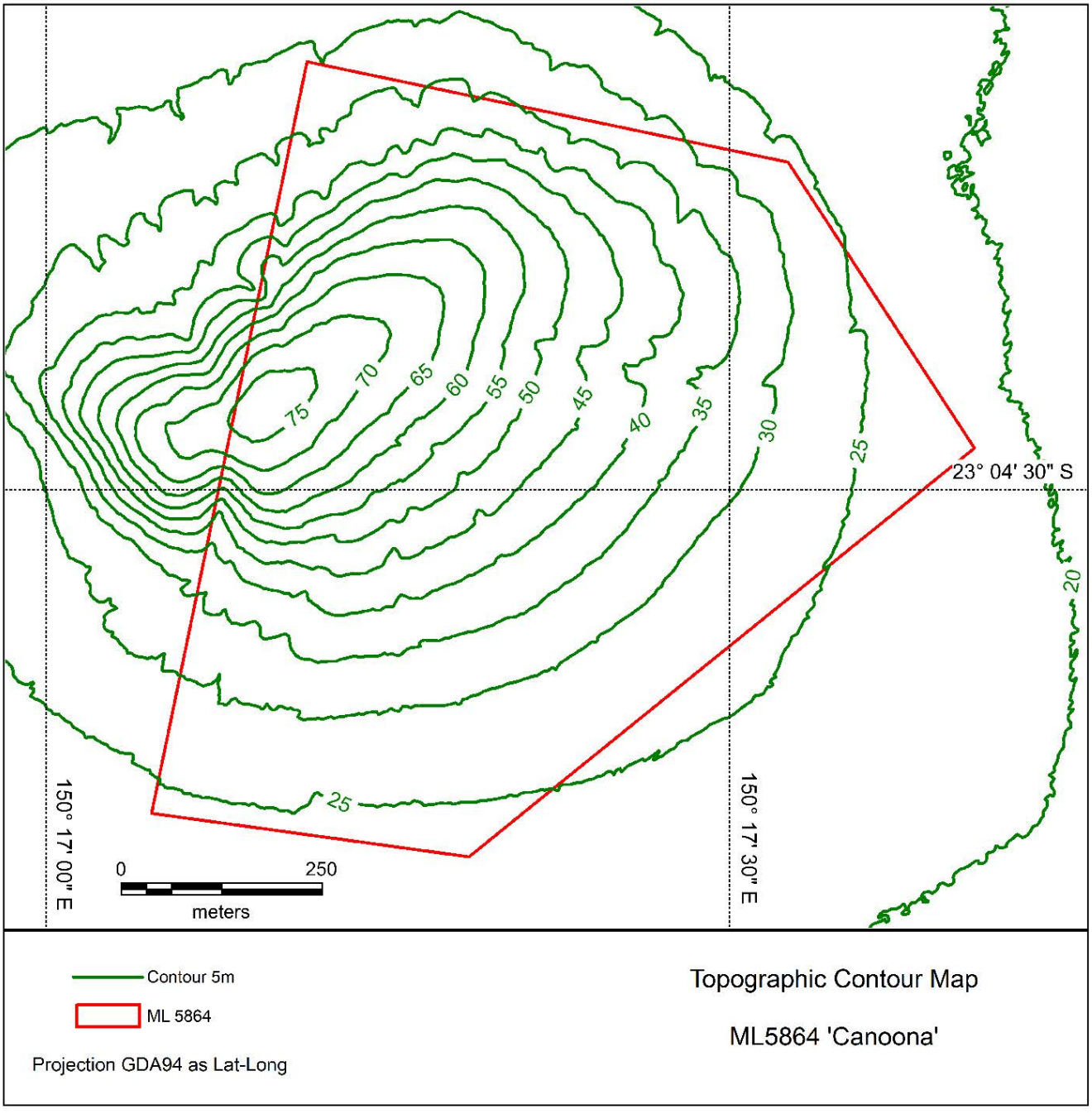


Figure 2-6. ML5864 Canoona Topographic Contours

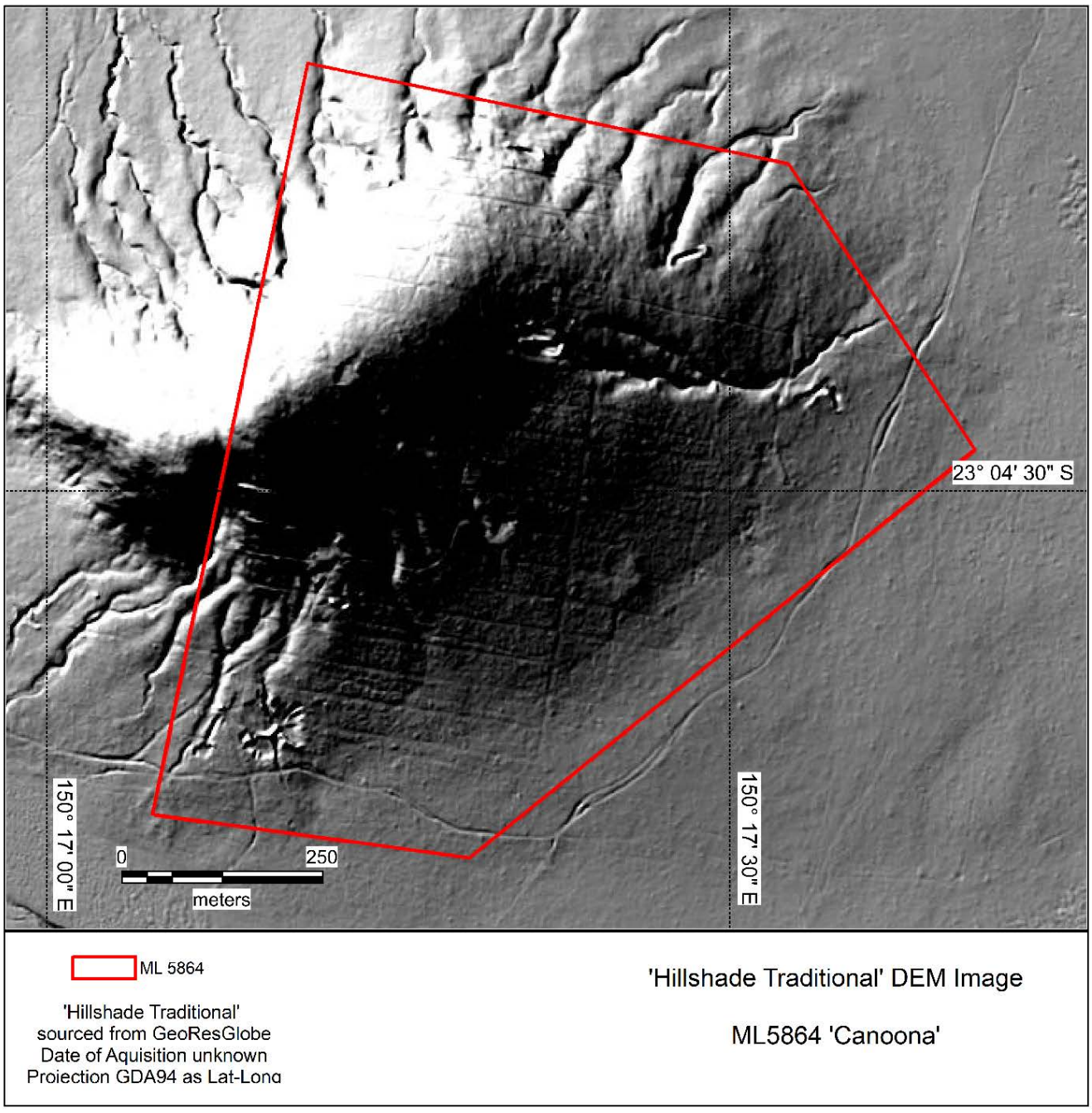


Figure 2-7. ML5864 Canoona Digital Elevation Image

2.3.2 Current landform

ML5866 Brolga contains several pits, some are open on ore, others are open for backfilling (see Figure 2-3). Some pits have been mined-out, backfilled and prepared for other uses such as the run-of-mine stockpiling (ROM) and screening of newly mined rock. There is one overburden dump and several pads that have been built using overburden material, variously used for parking and stockpiling. A network of haul roads links all the pits, general use and stockpile areas, and exploration and access tracks provided access to most other areas during the original exploration campaign and early mining activity.

The mine area also includes several topsoil stockpiles and bulk-sample pits. A water tank, septic system and showers are located near the entrance to the mine. Contour banks and dams control water run-off, storage and use.

The western part of ML5866 was cleared of vegetation in the 1990's and some parts of it were mined during that time under a former tenement holder. This western area has since been back-filled and revegetated.

The current landform of the Brolga ML is described in more detail in Section 2.2.2, and the features shown on Figure 2-1 and Figure 2-3.

ML5864 has not been subject to any mining activity. Numerous holes were drilled within it and those drill sites are linked by the remnants of the tracks that were made for that purpose. No other infrastructure is within ML5864 and no work has been done there since the 1990's.

2.3.3 Climate

The climate is classified as subtropical, within the south-east trade wind belt. Being close to the Tropic of Capricorn, the monsoonal influence is diminished. Similarly, the influence of high latitude cold fronts is diminished. Winds are predominantly from the south-east, with some north-east sea breezes in spring and summer. Some general trends from the area are:

- A distinct wet season during the months of December, January and February, with monthly rainfall averages greater than 100 mm.
- A distinct dry season between the months April through October with less than 50 mm mean monthly rainfall between these months.
- Evaporation rates that are highest during the summer months, and lowest mid-year. In any given month, the average evaporation is greater than the average rainfall.

2.3.3.1 Rain

Rainfall data indicates distinct wet and dry seasons. Mean monthly rainfall (calculated from the long-term rainfall data at Yaamba [BoM Station 33076]) averages are greater than 100 mm during the wet summer season, while in winter, dry season rainfall averages are less than 50 mm monthly.

The area is within the cyclone risk zone and is subject to summer thunderstorms.

Table 2-2. Monthly Rainfall (mm) (BoM Yaamba Station - 33076)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	143.5	154.4	109.1	57.5	43.2	42.7	35.1	22.4	24.2	43.3	61.8	110.9	842.1
Lowest	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	292.4
Highest	910.2	880.3	507.0	539.2	335.8	234.1	363.6	137.0	170.0	229.9	228.9	727.2	2002.4

2.3.3.2 Evaporation

The mean monthly evaporation (Rockhampton Aero, BoM Station 039083) ranges from a maximum of around 220 mm/month in the summer months to a minimum of around 118 mm/month in the winter months. Total average annual evaporation (around 2,120 mm) is considerably higher than average annual rainfall, and on average evaporation rates exceed rainfall rates in every month of the year.

Table 2-3. Mean monthly evaporation (mm) (BoM Rockhampton Aero Station 39083)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
229	189	195	159	130	105	112	136	174	214	228	242	2119

2.3.3.3 Temperature

Temperatures in the Project region are characteristic of a sub-tropical climate, with cool winters and hot summers. Data from Rockhampton is consistent with this trend with air temperatures low in the winter months and progressively increasing into spring.

The coolest temperatures are typically recorded in July and the warmest in December and January. Mean minimum and maximum temperatures range from lows in winter of 9.7°C to 11.1°C and highs in summer of 31.4°C to 32.2°C (BoM Rockhampton Aero Station 039083).

Table 2-4. Mean maximum and minimum temperature (°C) (BoM Rockhampton Aero Station 39083)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	32.0	31.4	30.6	28.8	26.1	23.6	23.3	24.9	27.5	29.7	31.3	32.2
Min	22.2	22.2	20.9	18.0	14.3	11.1	9.7	10.8	13.8	17.2	19.6	21.3

2.3.3.4 Long term projections

The Intergovernmental Panel on Climate Change (IPCC) technical definition of climate change is: 'any change in climate over time, whether due to natural variability or because of human activity' (IPCC 2014). Temperatures are predicted to rise, and climate extremes are predicted to amplify with the continued release of GHGs in Australia (CSIRO 2016). The projections are discussed in more detail below.

The preparedness of the Project for climate change depends on adaptation planning for a range of climate change effects including severe droughts, conflict over water use, heatwaves and intense rainfall.

Temperature

There is very high confidence that temperatures in Queensland will rise over the next century (CSIRO 2015). On average, Queensland temperatures have risen by approximately 1°C higher than they were 100 years ago and it is anticipated that temperatures could rise anywhere between 2.9 to 3.9°C by 2070 under a high emissions scenario.

By 2030 the annually averaged warming is projected to be between 0.4 and 1.5°C above the climate of 1986–2005 in Central Queensland. In 2070 under a high emissions scenario, temperature in the Central Queensland region is projected to rise by 2.9°C (1.8 to 3.8°C). By late in the century (2090), the average projected warming in the East Coast cluster (Natural Resource Management regions in the central part of the eastern seaboard of Australia) is 2.7 to 4.7 °C for a high emission scenario, or 1.3 to 2.5 °C under an intermediate emission scenario (CSIRO 2015). There is likely to be a substantial increase in the temperature reached on the hottest days, and an increase in the

frequency of hot days and the duration of warm spells. There is very high confidence that there will be up to two to three times the average number of days above 35°C under intermediate emission scenarios by late in the century (CSIRO 2015).

Rainfall

Australia has been experiencing an increase in extreme rainy days (greater than the 90th percentile for 24 hour rainfall) since the 1970s. However, by 2030, annual rainfall is projected to decrease by up to 3% under a high emission scenario. By 2050, under the high emissions scenario, annual rainfall is expected to decrease by 7% (-59 mm). Rainfall projections for 2070 show little change or a decrease, particularly in winter and spring. The frequency or intensity of high rainfall events is likely to increase (CSIRO, 2015).

Winds and Cyclones

It is projected that there will be a southern shift in the primary region of cyclone activity. Given the location of the Project, greater cyclonic impacts may be experienced. Wind predictions for the Project location estimates an annual increase in wind intensity of 2 to 5% (CSIRO, 2015).

2.3.4 Geological Setting

2.3.4.1 Regional Geology

Regional geology is shown in Figure 2-8. The area is highly mineralised with the nickel/cobalt ore body associated with the Brolga and Canoona sites shown in green, and the Canoona Gold Field in blue splitting the deposit. Magnesite mines are located to the east with a chrysoprase mine located in the west of the ore body.

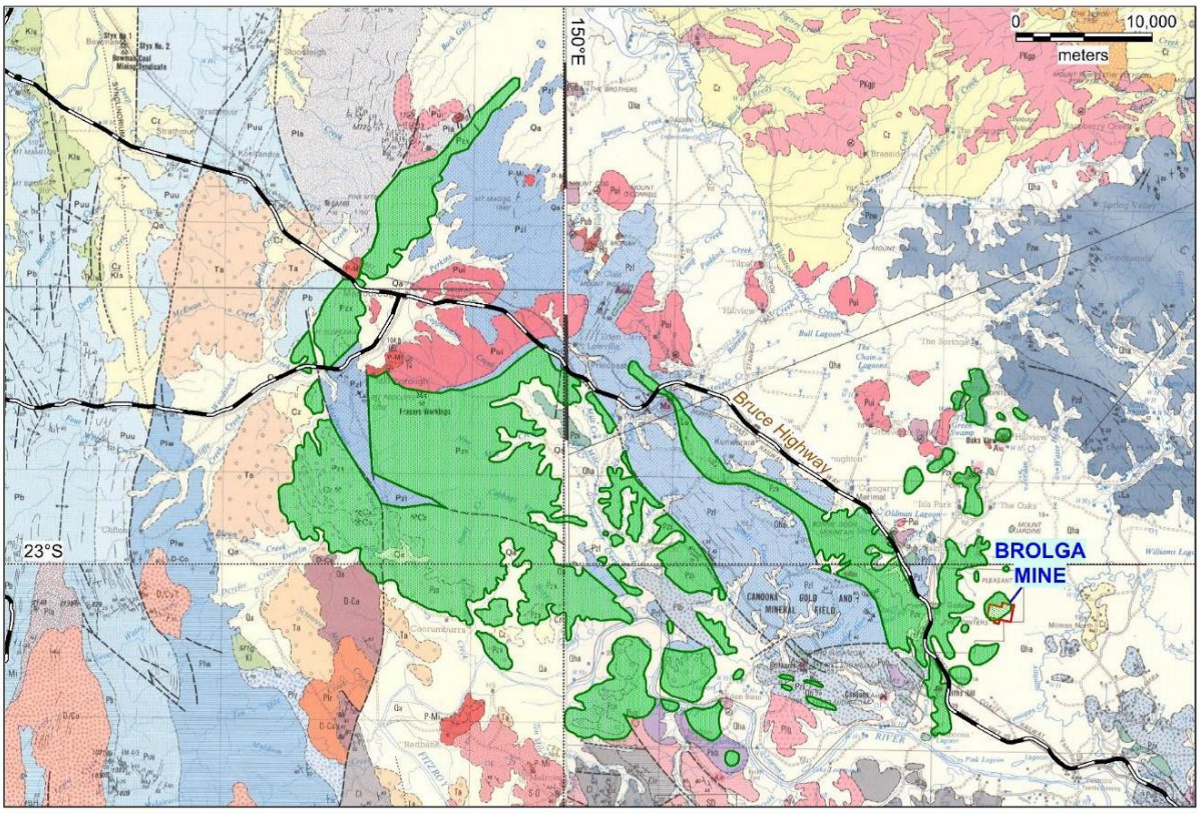


Figure 2-8. Geological Map of the Princhester Serpentinite

The Marlborough Block is a sliver (approximately 3 km thick) of serpentinised harzburgite ophiolite that dominates the landscape of the Marlborough district, forming a series of raised ridgelines with the surrounding granites and volcanics as flat low valleys (Bruce et al. 1998, Korsch et al. 1997).

The rock is now covered by a thick weathering profile containing economic enrichments of nickel, cobalt and chrysoprase. Chrysoprase is a semiprecious quartz rich gemstone being mined by Gumigil Pty Ltd. for jewellery and other items. The groundwaters that flow out of the serpentinite hills are supersaturated with magnesium.

A nickel-cobalt laterite is a weathered rock or soil that has been enriched in nickel and cobalt by the actions of leaching and re-precipitation. Nearly all laterites are of rusty-red coloration, because of high iron oxide content. They develop by intensive and prolonged weathering of the underlying parent rock (Parianos 2017).

2.3.4.2 Brolga (ML5866)

The Brolga deposit is a nickel enriched laterite, formed on the serpentinised peridotites of the Marlborough Block. Nickel laterite deposits are formed by groundwater leaching soluble minerals and elements from the peridotite, then re-precipitating them elsewhere, usually lower, in the rock mass. The nickel-sulphide of the serpentinite is dissolved from the red-brown upper layer of laterite, and is re-precipitated beneath it in the pale-coloured saprolitic laterite layer. The nickel re-precipitates as a nickel-oxide or nickel-silicate. Silica and magnesium also dissolve and re-precipitate in this manner. The extent of the serpentinite and the Marlborough Block are illustrated in Figure 2-9.

2.3.4.3 Canoona (ML5864)

The Canoona site comprises a direct extension from the nearby Pointer Range serpentinite, comprising serpentinised harzburgite and minor dunite; minor lherzolite, pyroxenite, altered gabbro and dolerite, chromitite. Surficial geology is similar to the Brolga site, comprising laterite and silica cap rock and rubble, along with serpentinite and saprolite.

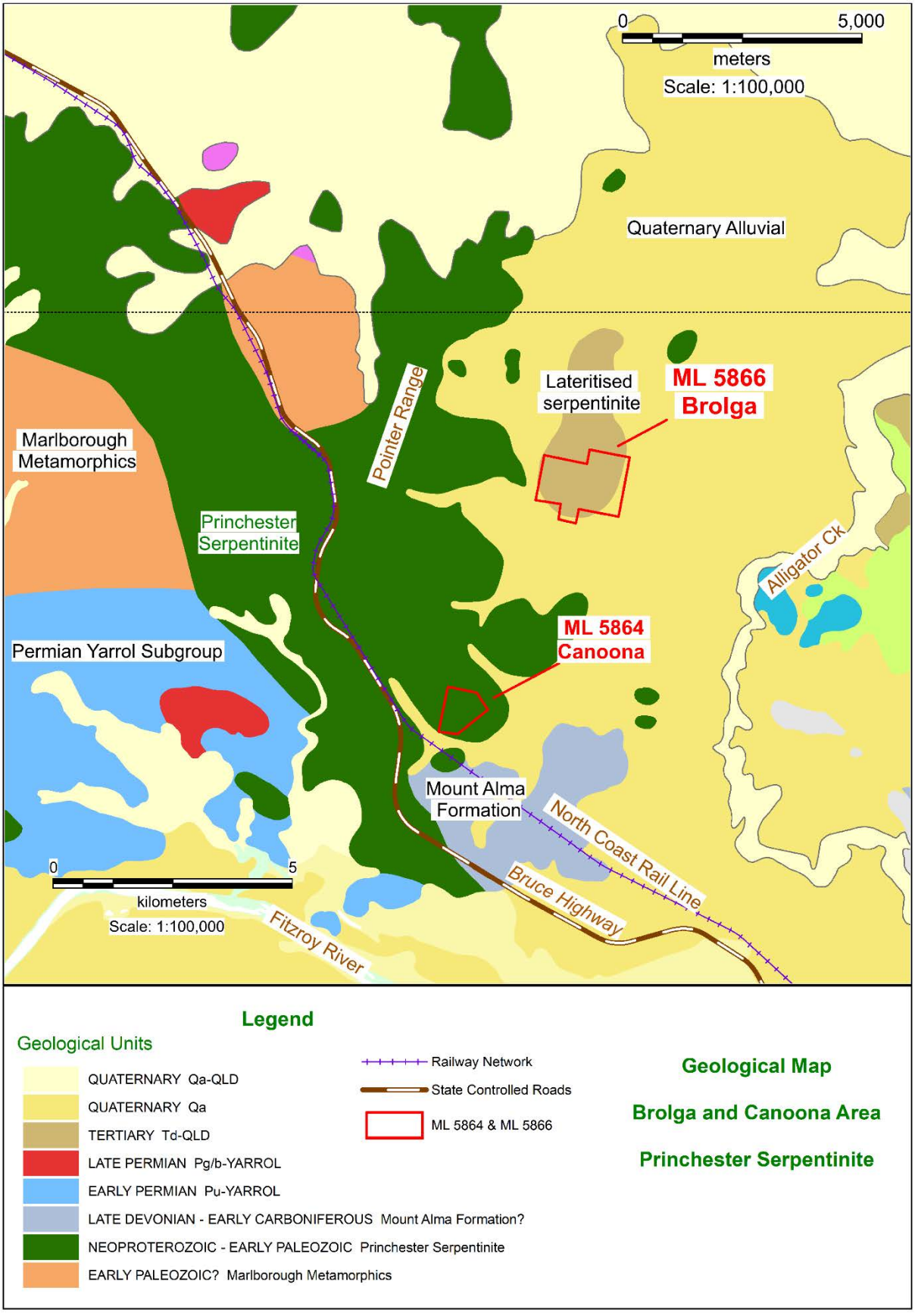


Figure 2-9. Brolga and Canoona Region Geological Map

2.3.5 Water Resources

2.3.5.1 Site Hydrology and Fluvial Networks

The EA is located within the Fitzroy River sub-basin (eastern tributaries) in the Fitzroy River catchment (Figure 2-10). Both MLs are on low hills surrounded by flat Quaternary alluvial plains, and drainage generally radiates from the centre of each site to the perimeter.

The long term yearly mean rainfall is 842 mm (Yaamba Station 33076), and mean annual evaporation rate 2,120 mm (Rockhampton Aero Station 39083). Evaporation rate at both sites is probably marginally higher than this figure, due to the increased distance from the coastline and consequently lower humidity. Long term yearly mean runoff is 122 mm (Figure 2-11), although rainfall and runoff are highly variable. Despite most years having small to moderate runoffs, a significant number of years have high runoff rates - over 200 mm in very wet years.

Brolga (ML5866)

At the Brolga mine site (ML5866) contour banks constructed by the mine and neighbouring farmers – both in the lease and in off lease areas - direct water to dams around the lease area. Run-off from the nearby Pointer Range drains eastward along waterways located immediately south of the Brolga hill, to the low country east of Brolga, designated as stream order 1, 2 and (immediately south of the ML) order 3 streams, mapped as un-named 'Minor', 'Non-perennial' watercourses. These have been modified by the construction of agricultural contour banks and dams. Due to these contour banks and impoundments and limited flow throughout the year, no continuous watercourse is identified from the ML to Alligator Creek to the east.

The local pattern of drainage is shown in Figure 2-12.

The site has four water dams (Dams 1 – 4), of which Dam 4 is the only one located within the ML. Dams 1 and 2 are located near the entrance to the property in the east, Dam 3 is near the south-eastern corner and Dam 4 is near the north-eastern corner. Dam 1 formerly supplied the mining operations water requirements. Dams 3 and 4 function as sediment control structures in association with existing stormwater diversion drains / banks. These structures will be maintained in order to capture and control sediment movement from the site. All four dams have been assessed as having a hazard category of 'low consequence category for failure to contain' in accordance with the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM365).

Anecdotally, the only open pit to hold water is Pit 1, which is confirmed by satellite imagery over the past several years. Catchment areas shown in Figure 2-12 show that only Dam 4 has significant disturbed areas in its catchment. Dam 3 has relatively minor cleared areas, while the other 2 dams are largely vegetated.

Canoona (ML5864)

Run-off from the Canoona site (ML5864) generally radiates from the centre to the perimeter and appears to soak into the surrounding Quaternary alluvium. Gullies are formed in the base of the hill, but not in the surrounding plains. As for the Brolga site, no defined channels are mapped or observed from the site towards any of the surrounding perennial watercourses.

The local drainage is shown in Figure 2-13.

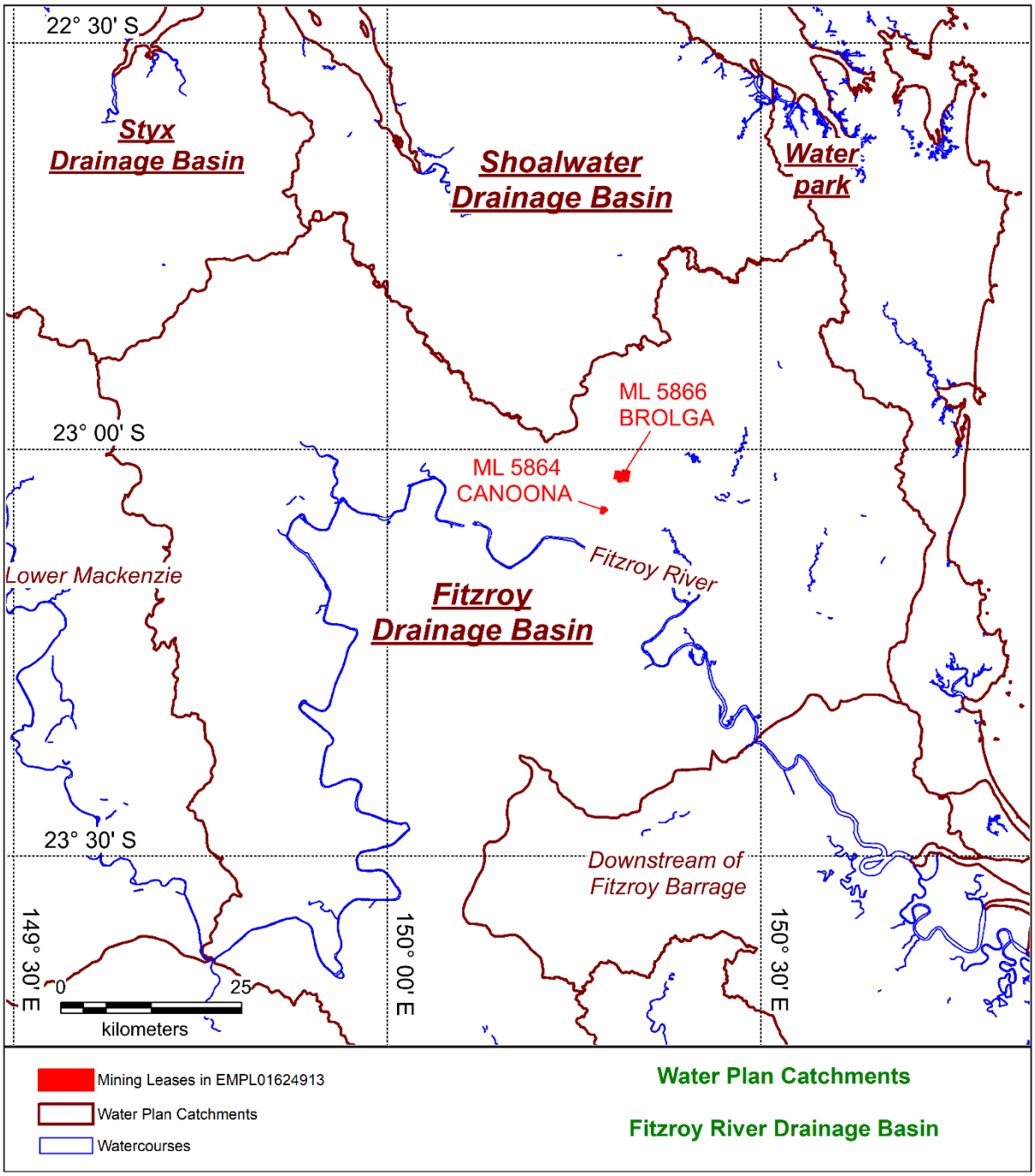


Figure 2-10. Fitzroy Sub-basin

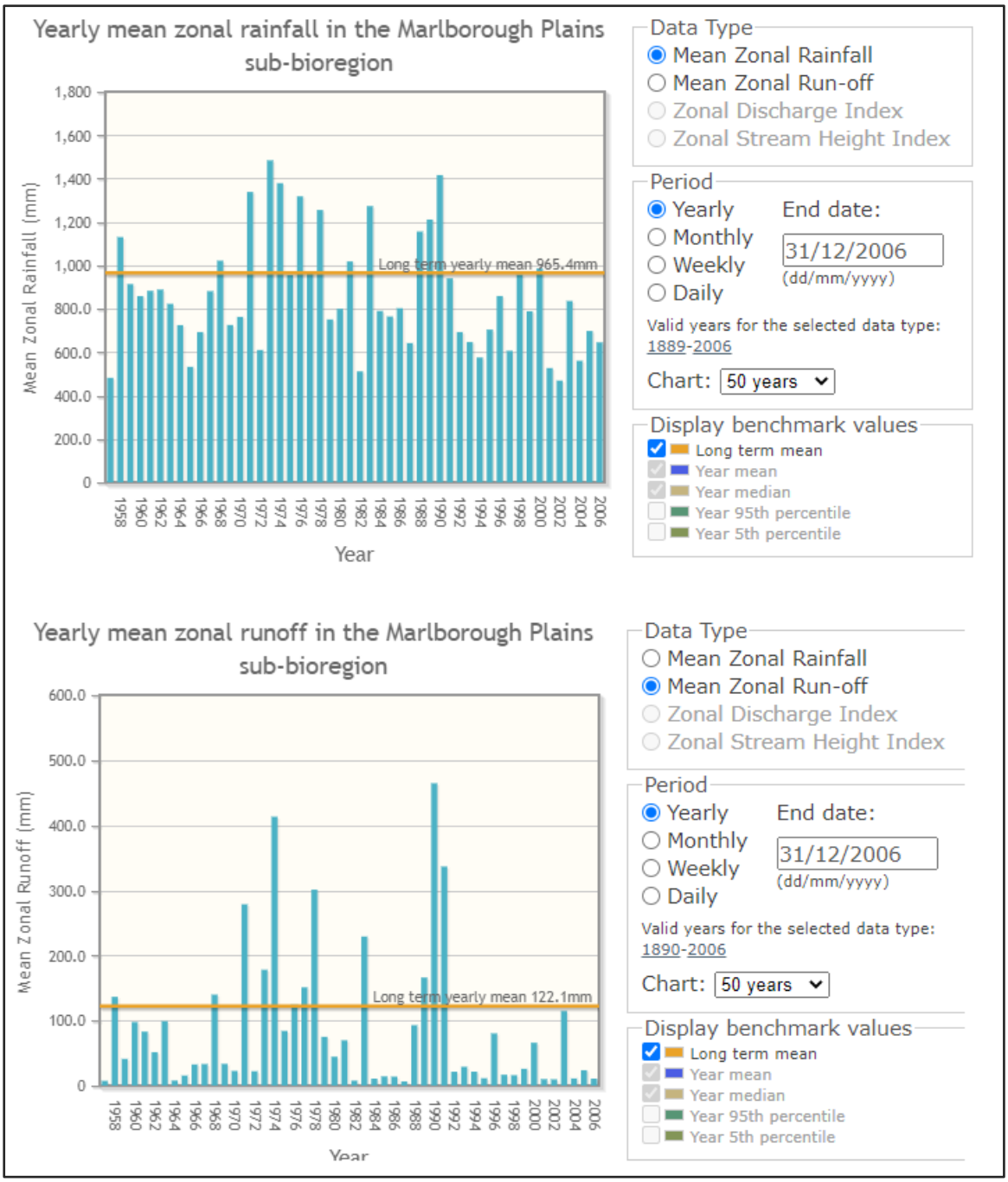


Figure 2-11. Yearly mean zonal rainfall and runoff in the Marlborough Plains sub-bioregion

Source: https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/biogeographic-subregion-marlborough-plains/

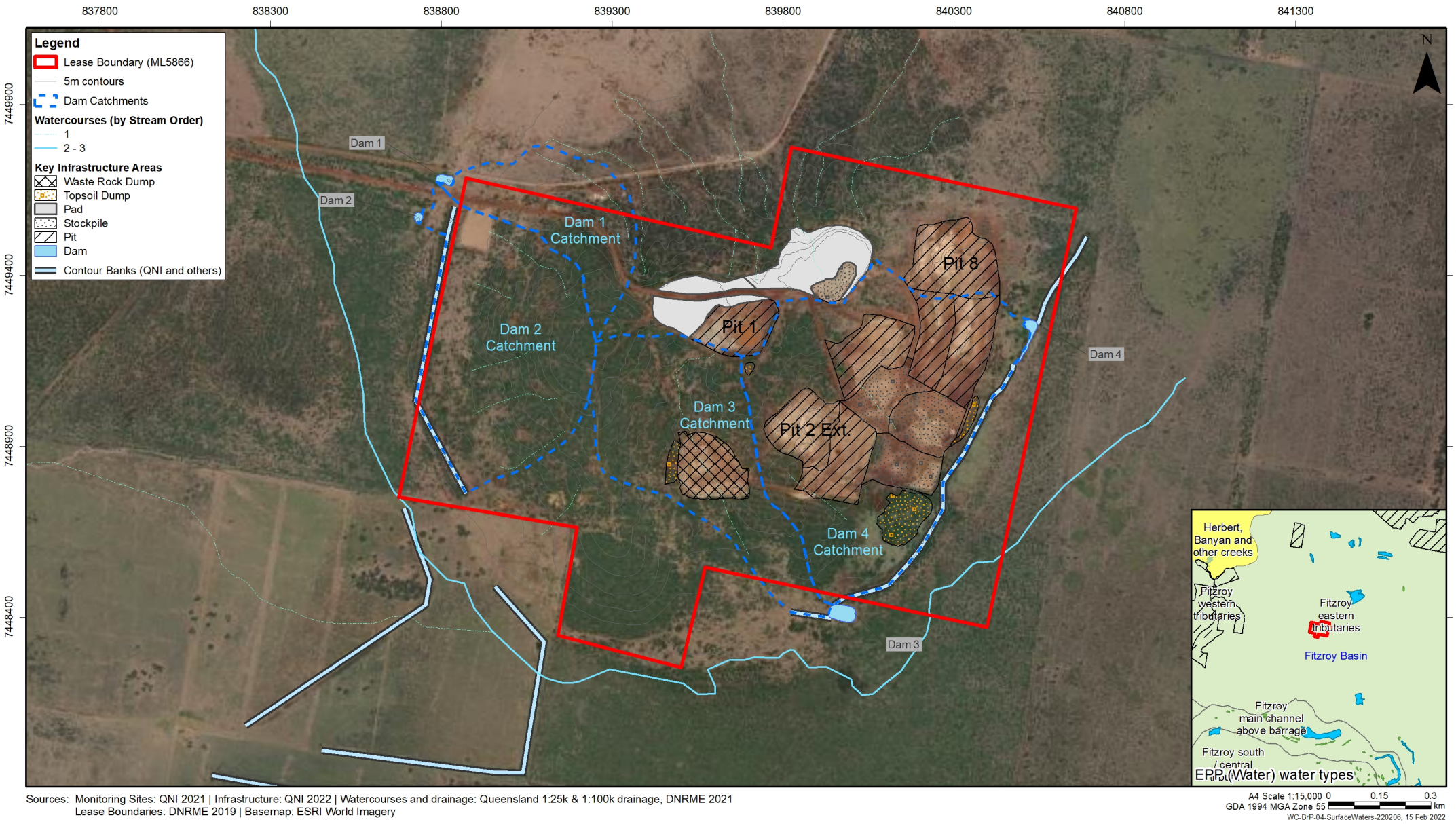


Figure 2-12. Local Drainage Pattern ML5866 Brolga

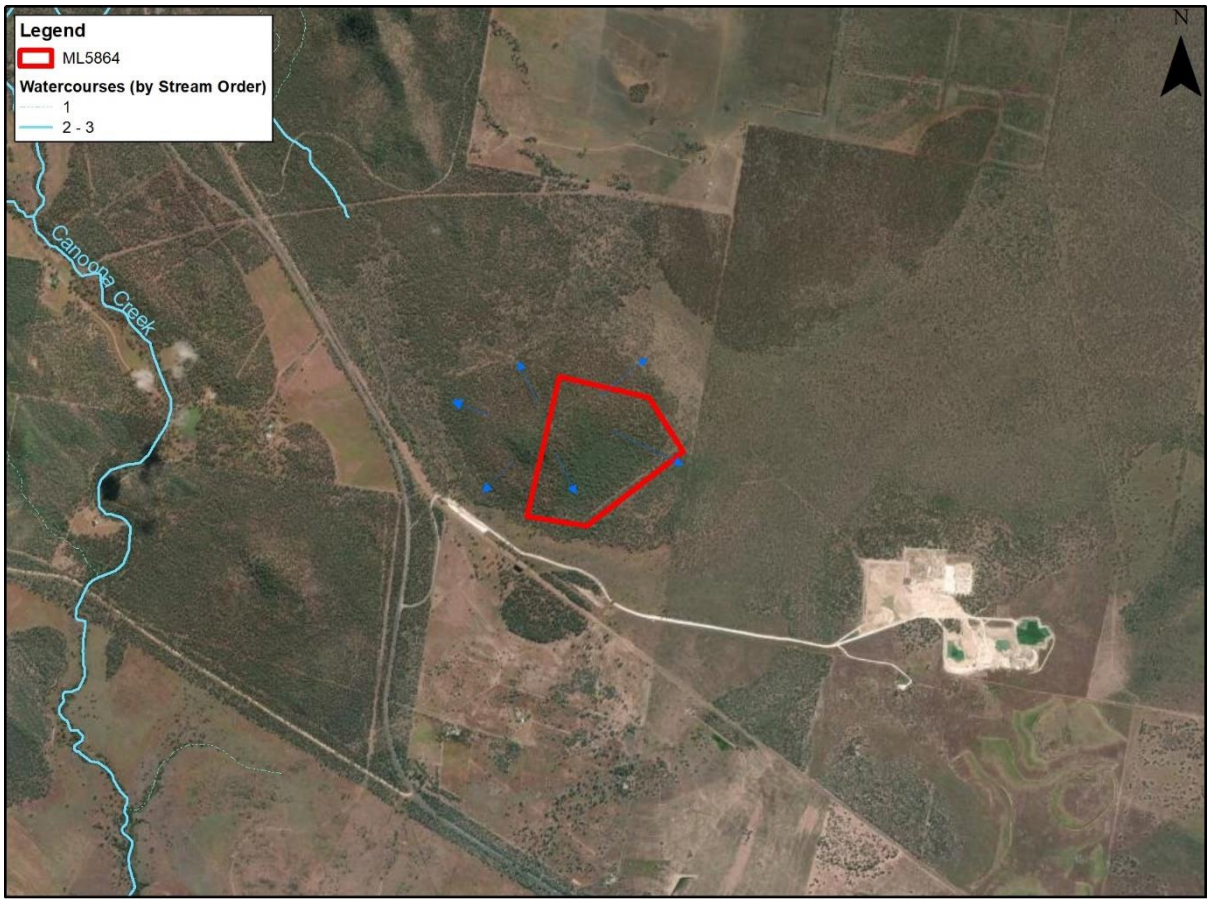


Figure 2-13. Local Drainage Pattern ML5864 Canoona

2.3.5.2 Flooding

The April 2017 Fitzroy River flood peaked at 16.1 metres at Yaamba. The extents of this flood event are shown in Figure 2-14 and are available from the Queensland Government QSpatial website (Flood extent polygon - April 2017 - Connors Fitzroy Isaac and Mackenzie Rivers).

Other major flood events of the Fitzroy River since January 1918 are listed in Table 2-5 with the flood peak levels from Yaamba. Six have exceeded 'Major flood level' (16.0 metres).

Table 2-5. Flood Events measured at Yaamba since 1859

Flood Event	Yaamba (m)
Jan-1918	17.32
Feb-1954	16.59
Feb-1978	14.75
May-1983	14.97
Jan-1991	16.65
Jan-2008	14.25
Mar-2010	10.73
Jan-2011	16.55
Mar-2012	13.50
Feb-2013	15.70
Apr-2017	16.10

Sources: http://www.bom.gov.au/qld/flood/brochures/fitzroy/fitzroy.shtml; https://riverhealth.org.au/report_card/additional-info/floods#site-fitzroy

Basin Level Flood Modelling mapping from the Queensland Government 'floodcheck' website[2] show that the 1% AEP reaches the base of the Brolga hill, flooding the low flat areas around Brolga, but does not intrude into any of the site infrastructure or pit areas (Figure 2-15). The extreme flood event is mapped over the low areas of the Brolga mine, including Pit 8, Pit 5, the Screening Stockpile and Topsoil Dumps 2, 3 and 6 (Figure 2-16). The 1% AEP event is outside of the Canoona ML boundary, flooding the surrounding low lying areas (Figure 2-15), and intrudes into the southern and eastern sides of the ML in the extreme flood event (Figure 2-16), although no infrastructure exists on the site.

The flood levels demonstrate that in major flood events, flooding is likely to occur on the peripheries of ML5866 and ML5864. The lowest parts of ML5866 and ML5864 are approximately 18 metres above sea level. Flood levels would have to exceed approximately 22 metres at Yaamba to enter any pit void that may be open in the Brolga ML.

While the extreme flood event modelled (based on probable maximum precipitation) does not represent the 0.1% AEP event (defining a floodplain for the purposes of a PRCP under the EP Regulation, s41C), and the basin level modelling is necessarily coarse scaled, it has been presumed that Pits 5 and 8 would be situated in the floodplain (as defined by the EP Regulation). In accordance with section 126D(3) of the EP Act, if land which is 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. Section 6.3.3 explains the assessment that has been undertaken to demonstrate that the final voids will be stable. Note that post-rehabilitation, no topsoil dumps would remain, and the Screening Stockpile would be rehabilitated, and would not form a void.

[2] https://floodcheck.information.qld.gov.au/mobile.html

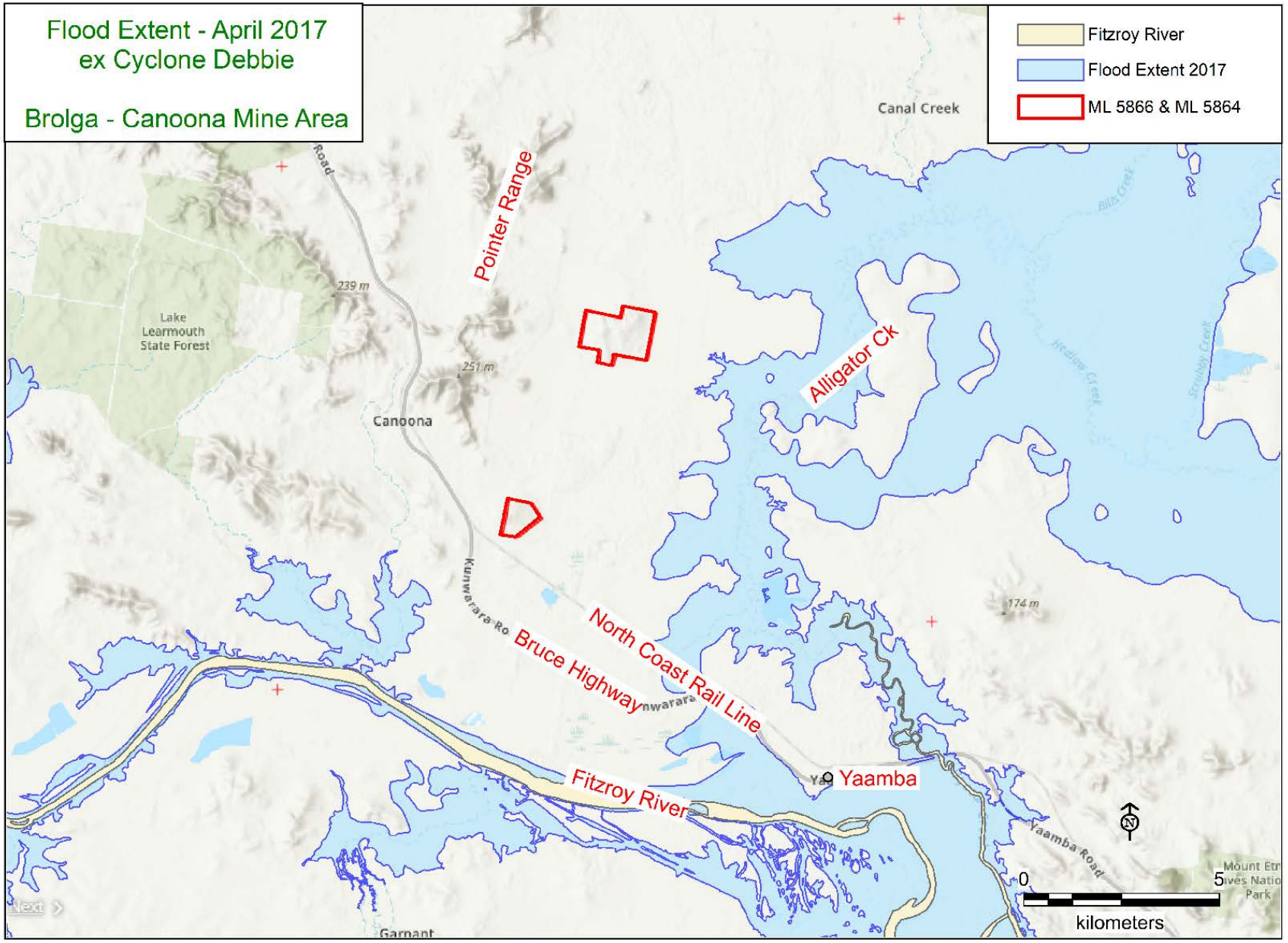
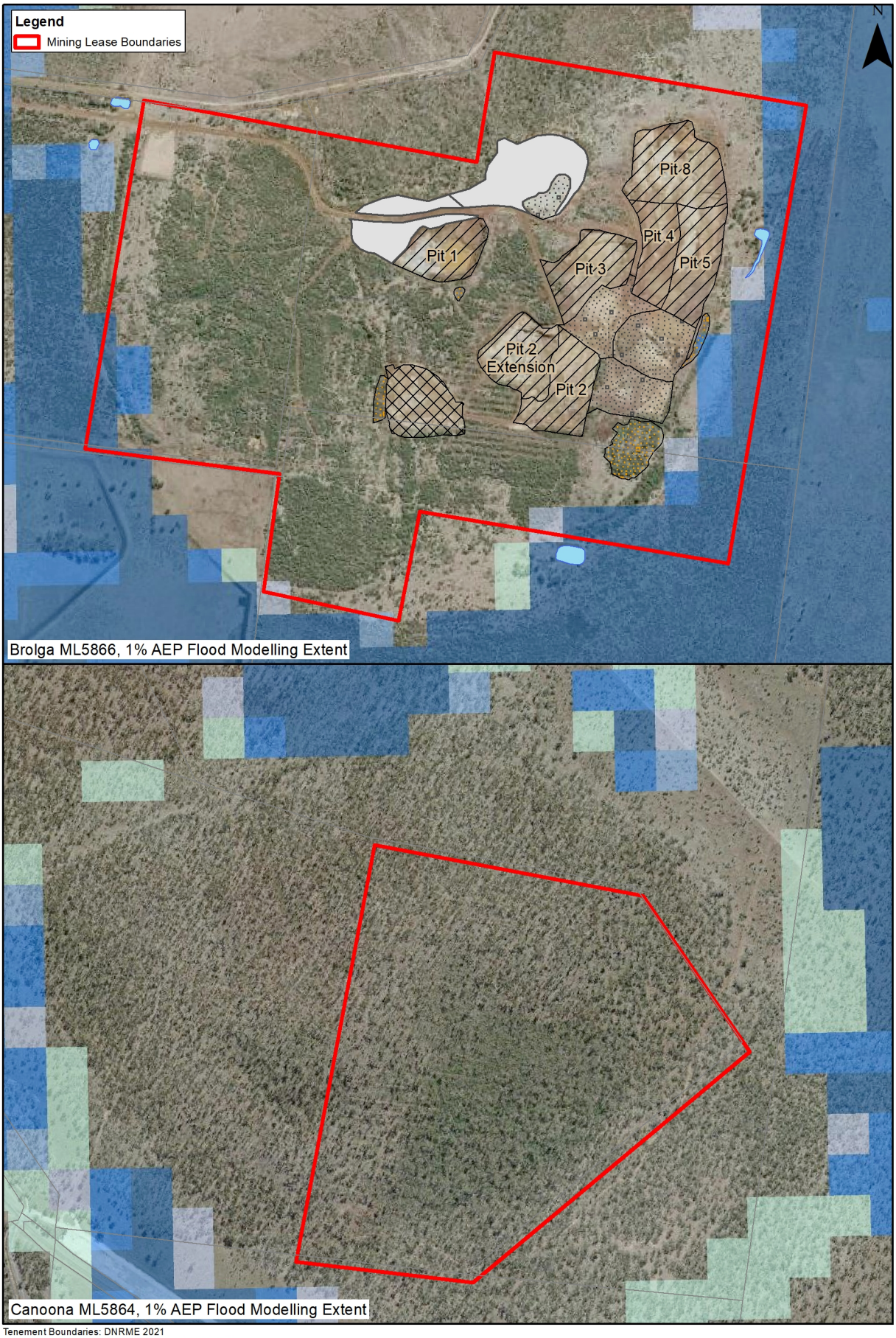


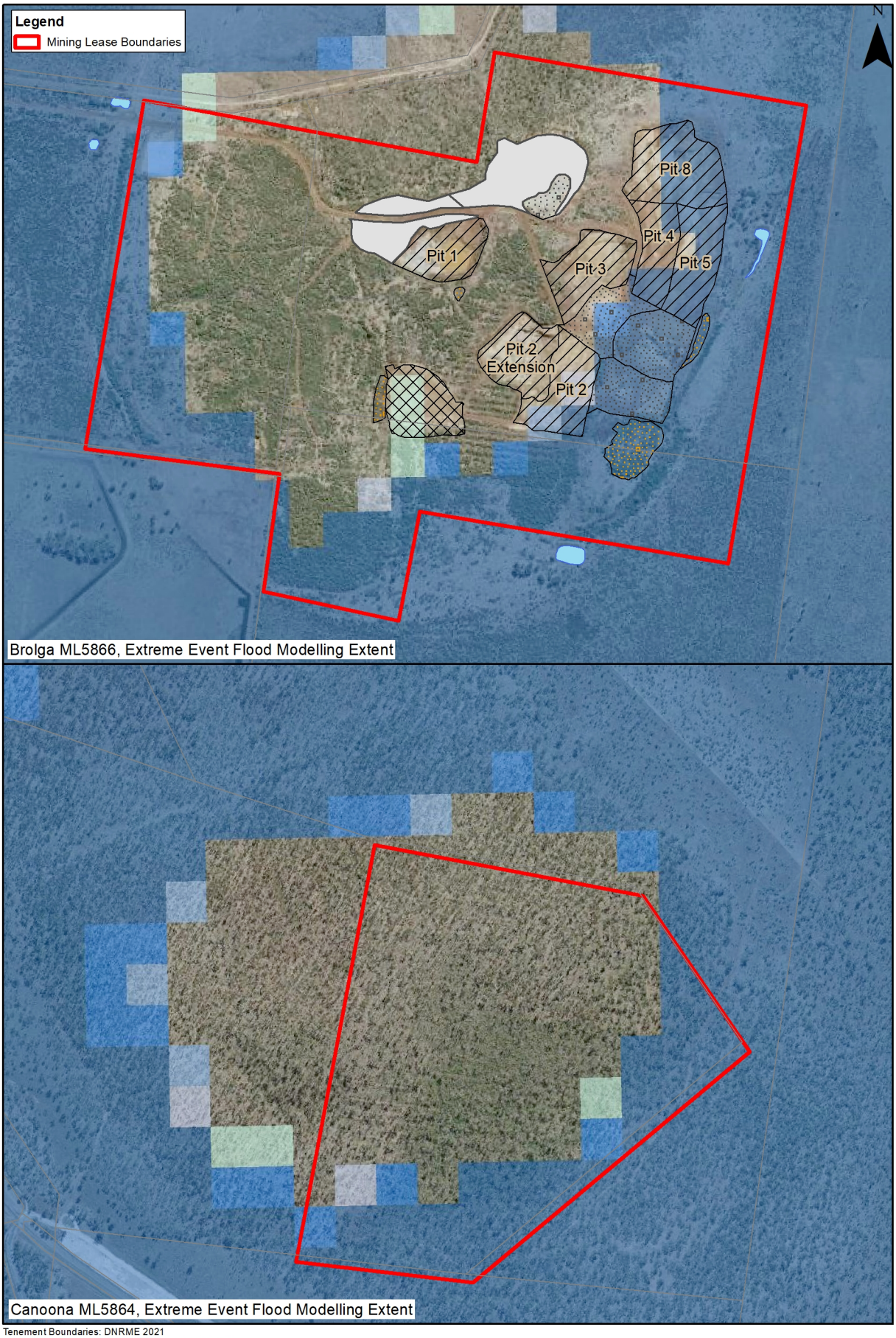
Figure 2-14. Flood Maximum Extent 2017



Tenement Boundaries: DNRME 2021
Flood Mapping, Basemap: Floodcheck Qld Feb 2022

QNI-BrP-05-Flood1pc-220209, 9 Feb 2022

Figure 2-15. Fitzroy Basin Flood Modelling – 1% AEP



Tenement Boundaries: DNRME 2021
Flood Mapping, Basemap: Floodcheck Qld Feb 2022

QNI-BrP-05-FloodPMF-220209, 9 Feb 2022

Figure 2-16. Fitzroy Basin Flood Modelling –Extreme Event

2.3.5.3 Groundwater

The MLs are located within the Prospect-Fitzroy groundwater zone (scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 – DEHP, 2013). However, newer draft groundwater chemistry zones have been developed (McNeil et al, 2018), which maps the MLs occurring over three groundwater systems:

- Fitzroy Serpentinite Belt Alluvium
- Eastern Weathered Cainozoic Remnants, and
- Serpentinite Belt Fractured Rock.

No groundwater dependent ecosystems are mapped in the vicinity of either site.

Brolga (ML5866)

The Brolga site (ML5866) has four groundwater bores installed, with two in operation for some time (Bore 1 and 2), and two more (QNWB4 and 5) installed in December 2021 (refer Figure 2-17). An investigation into the groundwater systems on the site was undertaken, including the installation of these latter two bores, an assessment of groundwater location and availability, and a water quality assessment (refer Appendix 4). This found groundwater at approximately 14mAHD, with a slight (~0.4%) grade to the east, well below the mining areas on the site (~50m below Pit 1 and 10m below Pit 2). No groundwater was identified in the upper laterite but was identified in lower fractured rock systems.

Based on the geology and observations during drilling, as well as from mining operations, groundwater is confirmed to be below all infrastructure areas and pits, but some lateral interflow appears to occur related to recent rainfall through the upper laterite layers where pits intersect these areas.

A simplified conceptual model is shown in Figure 2-18 , identifying the above key features.

Groundwater is not expected to recharge to any surface water features either on or off-site. Rainfall falling on the laterite areas is likely to either drain away as surface drainage or soak in, to drain laterally towards the Quaternary alluvial plains. Where pits intercept this layer, this interflow may end up in open pits. Since Pit 1 holds water (more or less permanently), while the others do not, it is considered likely there is some leakage from at least some of the pits into the underlying geology where cracks and fissures exist. However, the evidence suggests this would also flow laterally at boundaries to lower permeability rock, and downward recharge is likely to be, at best, very slow.

Canoona (ML5864)

No groundwater bores are located on the Canoona site (ML5864), and the geology is mapped as the Princhester Serpentinite (a continuous feature with nearby Pointer Range), rather than the ferricrete type structure for Brolga. However, given the proximity of the sites, and the nature of the geology (both serpentinite related ores), groundwater would be expected to be similar, existing in fractured rock systems. The nearest bores – RN91314, RN111135 and RN111596 on the floodplain north and south of the site – place the groundwater within serpentinite at around 10m depth, similar to that found at the Brolga site.

As no pits or other structures are situated on the Canoona site (ML5864), and the site is essentially fully vegetated, no groundwater interactions are likely to occur, and limited, if any, recharge would occur over the hill itself. No discharge locations or springs are anticipated, with any lateral throughflow translated into the surrounding floodplain groundwater systems.

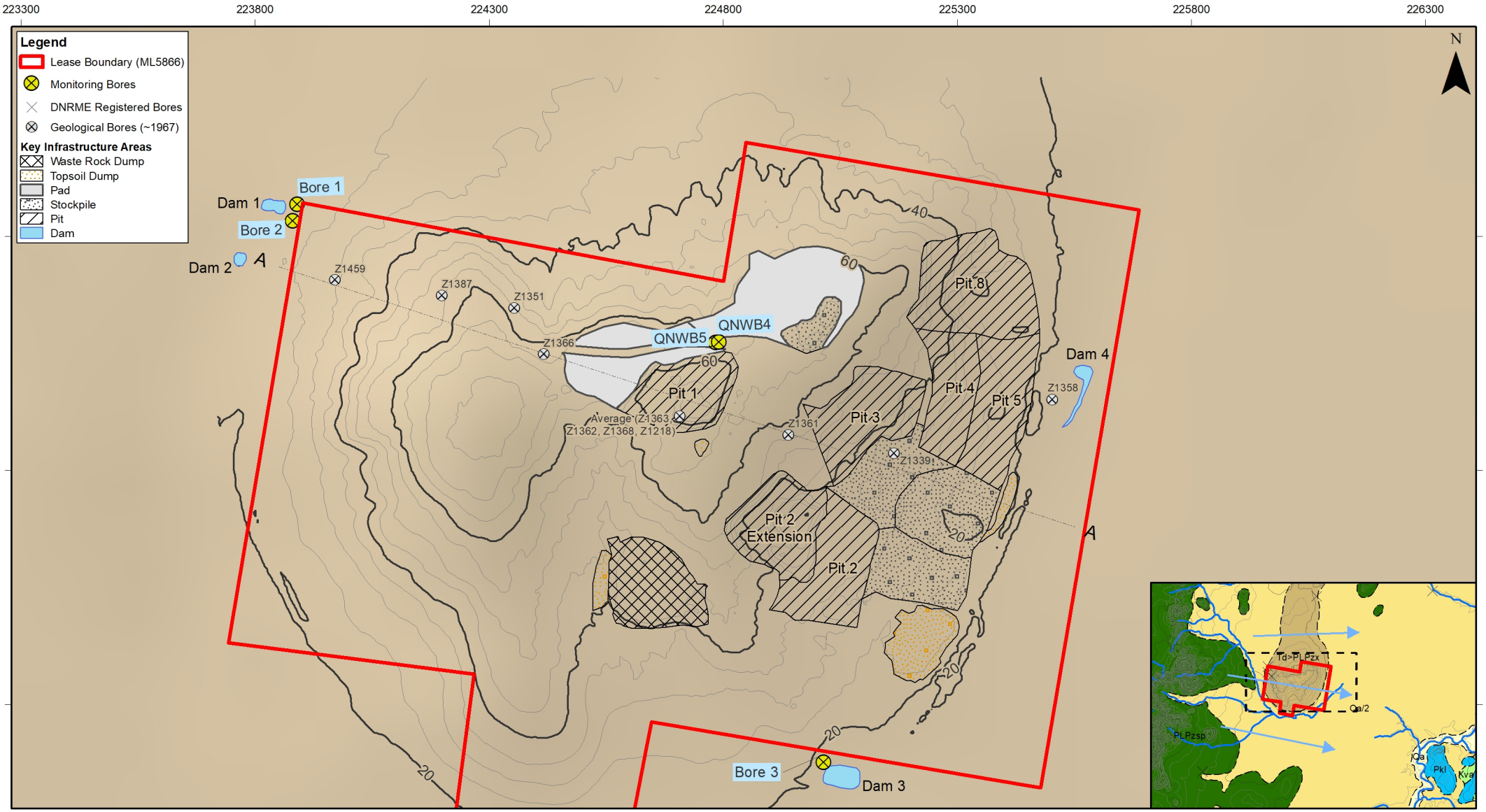


Figure 2-17. Groundwater Bores

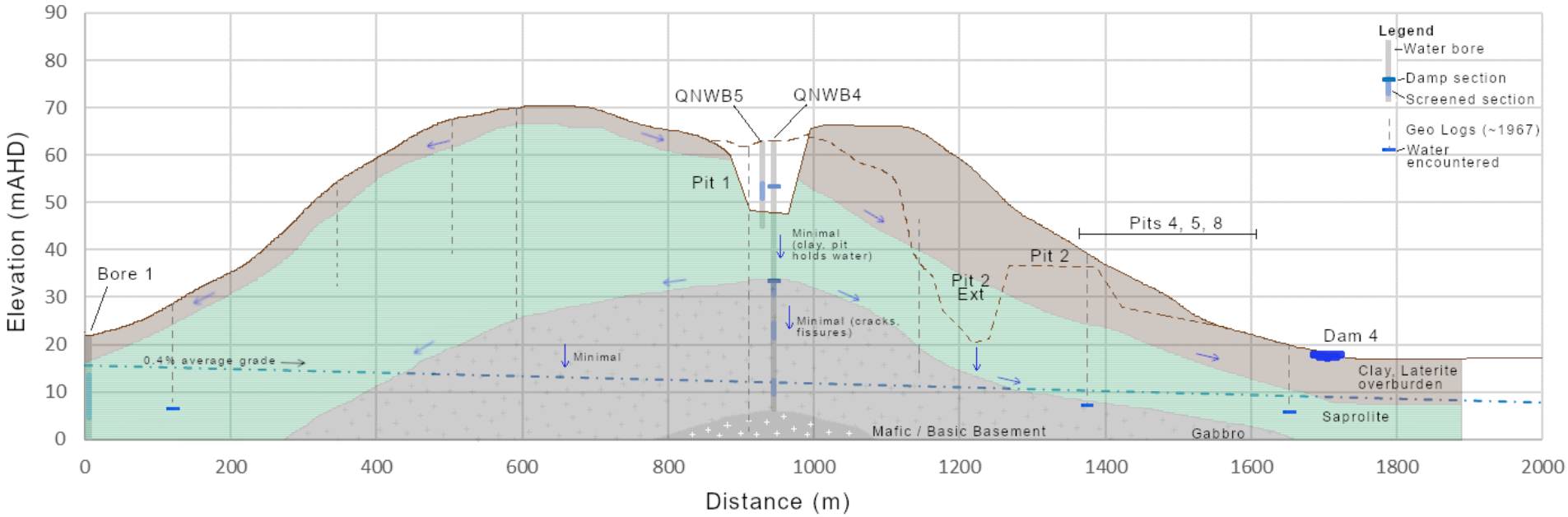


Figure 2-18. Simplified groundwater conceptual model (refer section A-A in Figure 2-17)

2.3.5.4 Water Quality

Canoona (ML5864)

No water quality information is available for the Canoona site (ML5864), although results for the nearby RN111135 bore (located south of the site in the floodplain) are similar to Bore 1 / Bore 2 results from the Brolga site (ML5866), indicating a similar groundwater quality. No surface water structures are in place at the site.

Brolga (ML5866)

As discussed in the water assessment in Appendix 4, the water quality is substantially influenced by the natural geology of the site, with groundwater moderately saline, and surface waters generally fresh. Both surface and groundwaters were dominated by bicarbonate, magnesium and sodium ions, with a neutral pH range, moderate to high hardness, and nitrogen and ammonia were elevated. Metals concentrations reflect the ore body, being enriched in nickel and the associated metals chromium, cobalt and manganese, as well as iron and aluminium. Other studies in the area have found similar associations, indicating these are natural features of the region rather than being an impact from mining activities.

Water quality in the dams meets the water quality criteria set out in Table F2 of the EA. Pit 1 meets the EA water quality criteria for all analytes other than an exceedance for nickel, however the results show that removal of some of the suspended load would reduce levels to within the criteria, and this is expected to occur as the catchment becomes vegetated and stabilised – see below. Groundwater similarly meets the EA criteria for surface waters, with the exception of nickel at QNWB4 (although the EA criteria do not apply to groundwaters).

In general, water for potable or other farm uses may not be ideal (based on salinity, metals concentrations and the potential for precipitates to be deposited over time, resulting in some scaling). The waters all were generally suitable for livestock watering, with some waters (Pit 1 and bore QNWB4) potentially requiring some settlement prior to use (although as noted below, Pit 1 would be expected to improve with stabilisation and revegetation in the catchment). Waters were also moderately suitable for irrigation, although again some waters may require settlement to reduce metals concentrations, with some potential for clogging of irrigation equipment due to iron and manganese (QNWB4, Pit 1).

Groundwater was generally within the draft Water Quality Objectives (WQOs) (McNeil et al, 2018), and given the mineralogy of the area, it is considered likely that groundwater would be naturally affected by the ore deposit (itself formed by dissolution and precipitation reactions within groundwater and geological structures) rather than mining activities.

Exceedances against the WQOs for slightly to moderately disturbed systems (DEHP, 2013) were identified for site dams and Pit 1 water for a number of analytes, including ammonia and total nitrogen, and dissolved metals (arsenic, chromium, cobalt and nickel), although metals exceedances are substantially reduced when receiving water conditions (hardness and background metals concentrations) and the nature of receiving catchments (more highly disturbed, agricultural areas) are taken into account. In particular, serpentinite soils and rocks are known to have elevated concentrations of heavy metals. A study of water quality and metals in sediments within the nearby Marlborough Creek system (Duivenvoorden et al, 2017) showed that the stream sediments were enriched with concentrations of nickel, chromium, cobalt and zinc up to 35, 21, 10 and 2 times the world average for shallow sediments, respectively. Concentrations for nickel and chromium were up

to 60 and 16 times those of the relevant sediment quality guidelines, respectively (Duivenvoorden et al, 2017).

Results for total and dissolved metals show that the bulk of the metals within the surface waters (and groundwater) are bound to suspended solids. Looking at the surface water structures, Dams 3 and 4 and Pit 1 generally have the higher total metals loads. Reference to Figure 2-12 shows that Pit 1, followed by Dam 4, then Dam 3, have the highest disturbed areas of the four dams. Given that the bulk of the metals are bound to sediments in the water column, it is considered very likely that stabilisation and sealing of the catchments would reduce inflow of solids, reducing the overall metals contents in these locations to those more alike to Dams 1 and 2 – i.e. increased vegetation would, unsurprisingly, improve water quality within the site impoundments.

Based on the above, and with the appropriate rehabilitation measures and monitoring, surface waters proposed to remain after rehabilitation would be suitable to support the intended post mining land use of grazing. Groundwaters appear consistent with regional levels, and local enrichment appears consistent with the serpentinite geology of the area. As no groundwater is intercepted and water tables are deep, ongoing management of groundwater during and post rehabilitation is not anticipated to be needed.

2.3.6 Soil Types, Properties and Productivity

In the Land Systems Capricornia (ZDD3) map, both mining leases in EMPL01624913 are within the soil map code ‘Tm’ (Tungamulli) on the Agricultural Land Class ‘C2’, meaning ‘Pasture Land – Native pastures’ (Figure 2-19 and Figure 2-20). Tungamulli is described as ‘Shallow, stony black, uniform clays or shallow, stony red, structured gradational clay loams and uniform clays formed on rolling low hills and undulating rises on serpentinite; Eucalypt woodland.’. The dominant ‘Soil Order’ in the immediate area is mapped as ‘Vertosol’.

Lateritic soils are residual soils, the remnants left after weathering has dissolved and removed other mineral and chemical constituents. The mineralogical composition of the soil is mainly iron- and aluminium-oxides, iron- and aluminium hydroxides, quartz, kaolinite and chalcedony. Some peds associated with the lower topographic areas appear to contain a minor proportion of smectite clay.

The topsoil contains a dark red-brown mixture of small stony fragments, quartz and chalcedony with a variable clay content. The degree to which these soils bind into clods, pisolites, aggregates and concretions varies depending upon the moisture and clay contents, which in turn is often a result of its origin in the topographic sense. The soil from the higher topographic areas contains proportionally less clay, while soils taken from lower areas contain a higher proportion of clay, presumably as a result of sediment transport during rain.

Being located on a lateritic regolith profile, the upper soil horizons are not distinguishable. There is no distinctive A0 Horizon or any significant organic enrichment. The ‘A’ soil horizon, which is the laterite ferricrete layer, is usually thick and highly variable in thickness, up to about three metres.

The stony fragments in the soil are concretions of iron- and aluminium-oxides (haematite, goethite, gibbsite), with grains of quartz and chalcedony also bound in the concretions.

The manner in which the soil binds is mainly due to the proportions of the various minerals and the moisture content. Moisture content greatly affects lateritic soil’s ability to form concretions and aggregate lumps. Clay also affects this tendency to aggregate.

The moisture content has a substantial effect on the soil binding properties. The moist soil has pre-existing concretions with weaker binding strength, due to the binding minerals becoming somewhat dissolved by the additional moisture. Dry soil, especially where there is a low clay content, aggregates into relatively strong concretions, which are not readily pulverized by machinery or hand.

The soil from the higher topographic areas contains proportionally less clay, resulting in it having a tendency to aggregate into the hard concretions typical of laterites. This occurs due to the dissolution and re-precipitation of iron- and aluminium-hydroxides, which bind the particles of quartz, chalcedony and existing iron- and aluminium-oxides into pisolites and irregularly shaped concretions.

Kaolinite is known to inhibit the binding/concretion process. The soil found on the lower slopes contains a higher proportion of clay (kaolinite) within which some fine concretions can be felt. Where the soil contains a significant kaolinite content, the binding processes that result in a visibly 'gravelly' soil are less likely to occur.

Although most of this clay on the lower areas is probably kaolinite, some of it must be smectite clay, because these soils have a distinctive plasticity. Kaolinite, although a clay, does not have exceptional plasticity, whereas smectite has a high plasticity. Despite the clay content, the soil does not tend to crack after drying.

A Livingstone Shire cadastral survey plan, dated 7th February 1913, of the land parcels where the Brolga Mine is located, noted soil on the mine area as "Brown gravelly soil", "gravelly Ironstone soil", "Rich red soil", "soil gravelly in places", "Red brown soil but rather stony" and "Rich chocolate soil."

The topsoil reflects the mineralisation of the area and has maintained the surrounding natural vegetation and pastures. The local flora is specialised as a vegetation community specific to soils formed on a serpentinite parent rock, adapted to the local mineralized environment.

The graders and bulldozers that scraped the topsoil attempted to scrape about 10 centimetres from the top of the soil profile. The irregular surface and variable soil properties resulted in a variable thickness of topsoil that was gathered to the topsoil dumps. It is estimated that the topsoil dumps include between 5 – 15 centimetres of soil that was scraped from the surface prior to overburden excavation. Assessments to ascertain any amelioration requirements of the stockpiled topsoil will be undertaken prior to use in rehabilitation activities.

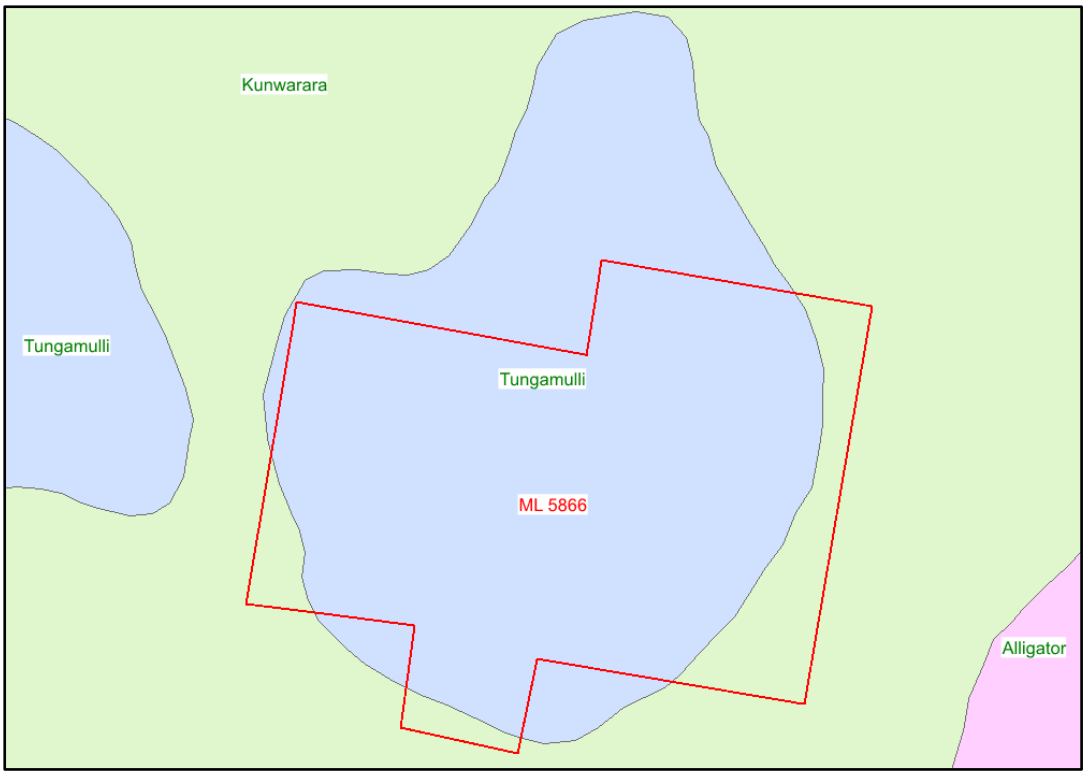


Figure 2-19. Soil Mapping ML 5866

Source: the Queensland Spatial Catalogue

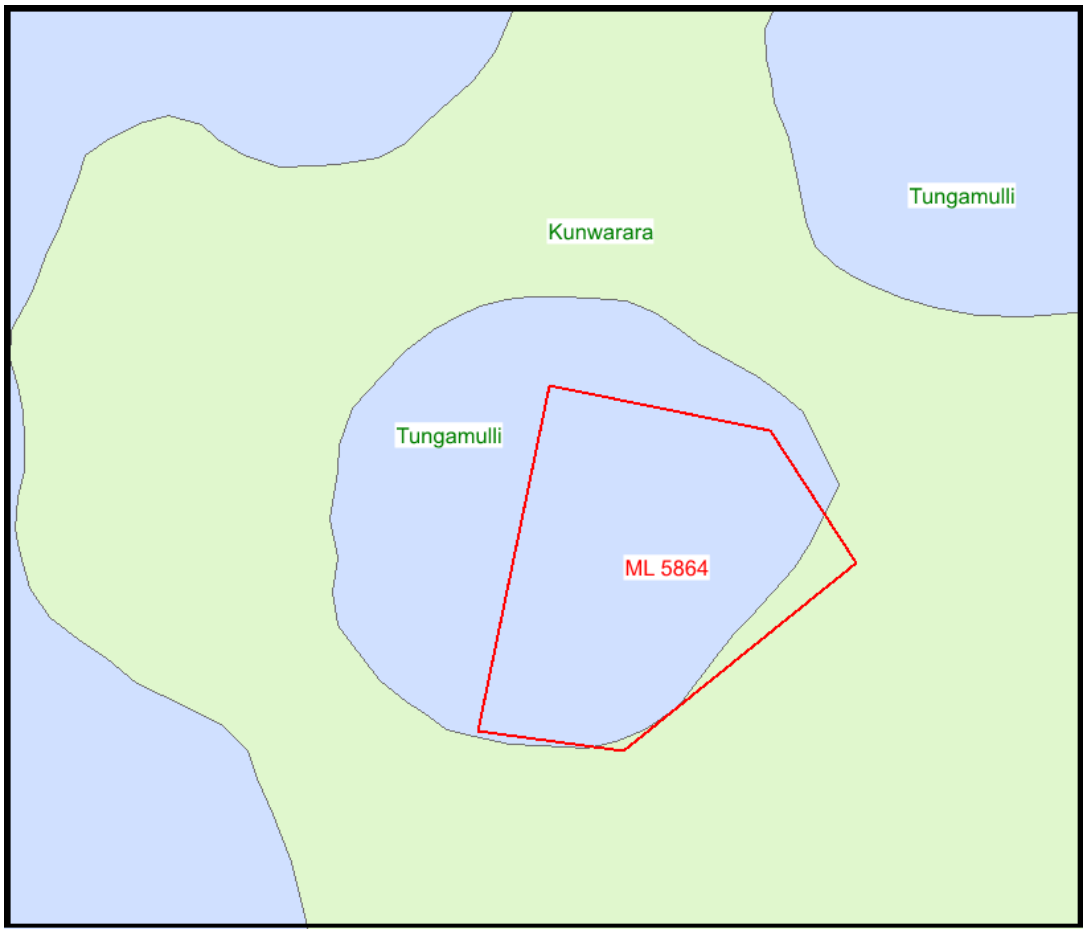


Figure 2-20. Soil Mapping ML 5864

2.3.7 Residue Geochemical Characteristics

The region's geology, ore body formation, Gladstone Nickel Project SEIS static testing (see below), regional water quality data and site rehabilitation performance following 28 years of mining on Brolga have been used to understand the geochemical characteristics of the residual material, in particular, with a view to understanding whether Acid Rock Drainage (ARD) is present. ARD typically limits plant growth due to the low pH and high salinity generated by the oxidation of pyritic mine waste, so it is critical to rehabilitation activities to understand whether it is present. A full explanation of the analyses is given below.

The Gladstone Nickel Project (GNP) consists of a proposed Nickel refinery with supporting facilities to be located at Gladstone, Queensland. The refinery will process ores from a nickel laterite mine which is part of the Ni/Co ore body that contains the Brolga mine and its resources, together with nickel laterite ores imported from the south-west Pacific region. Therefore, the Geochemical Characterisation Assessment undertaken for the GNP is directly relevant to the Brolga Project, and has been used to inform assessments of geochemistry. Figure 2-21 shows the location of Brolga Project in relation to the GNP and the Ni/Co ore body.

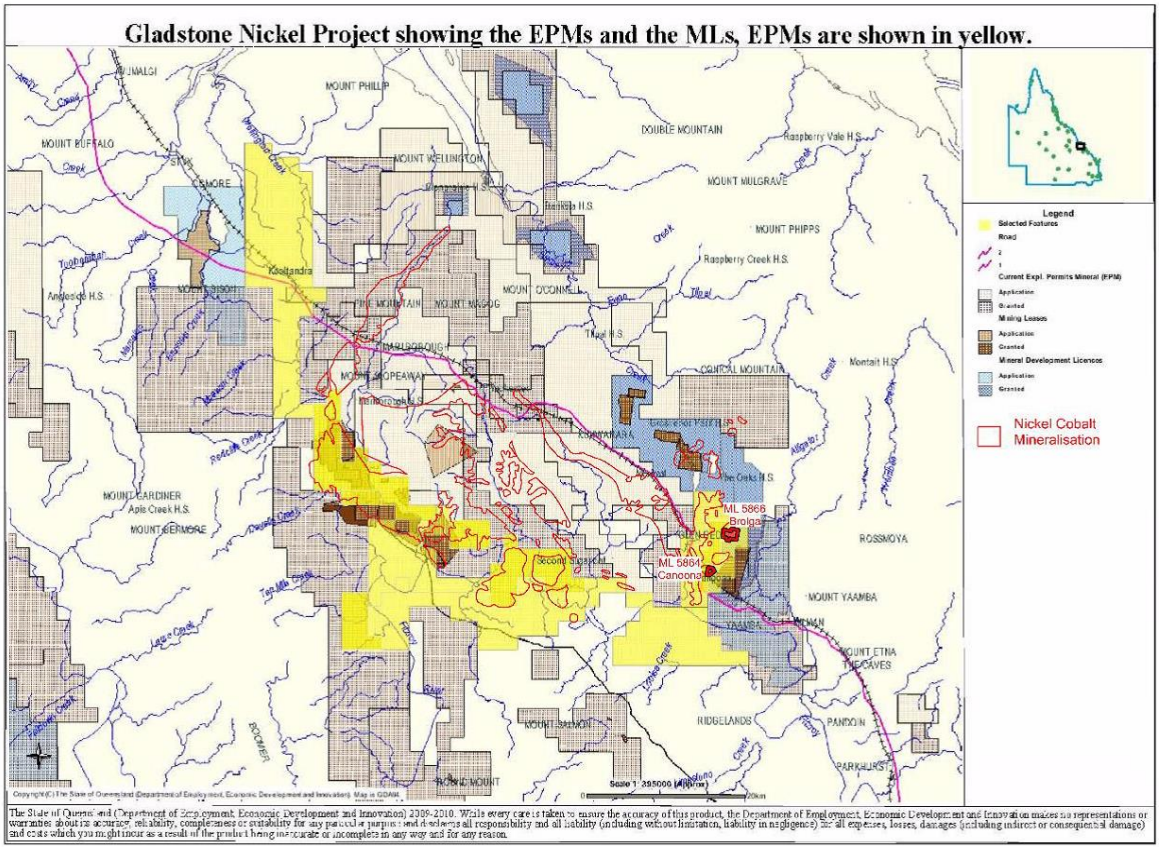


Figure 2-21. Location of Brolga Project relative to the Gladstone Pacific Nickel Project tenements

Laboratory analyses of leachate from the Waste Rock Dump and the Nontronite Stockpile using the Australian Standard Leaching Procedure (ASLP) water leach are shown in Table 2-6, below. Twenty sites were sampled in the Nontronite Stockpile and the Waste Rock Dump. The profile from 0 to 50 cm was collected and samples combined in a drum and mixed to make a representative sample. This was then poured through the site's splitter box until the desired shipping weight was obtained.

The electrical conductivity (EC) and salinity are representative of low salinity soils (Qld Government Salinity Management Handbook, Chapter 9 - Soils) and the pH is representative of the regional

alkaline sodic soils. The Gladstone Nickel Project SEIS Residue Geochemical Characterisation Assessment (Attached as Appendix 9 of this PRCP) states that the ore body has a pH of 7.6 and an electrical conductivity (µS/cm) of 650. This is consistent with the recorded EC for the leachate - refer to Appendix 10 to see the full set of results.

Table 2-6. Leachate from Waste Rock Dump and Nontronite Stockpile - Acid Rock Drainage Potential

Analyte	Unit	Nontronite Ore	Waste Rock
Al	mg/L	1.54	0.12
As	mg/L	<0.01	<0.01
B	mg/L	0.3	0.2
Cd	mg/L	<0.005	<0.005
Cr	mg/L	0.62	0.43
Co	mg/L	0.05	0.07
Cu	mg/L	<0.01	<0.01
Pb	mg/L	<0.01	<0.01
Ni	mg/L	2.97	2.71
Se	mg/L	<0.01	<0.01
Zn	mg/L	0.19	0.12
Mb	mg/L	0.01	<0.01
Hg	mg/L	<0.0001	<0.0001
Electrical Conductivity @ 25°C	µS/cm	150	60
Total Dissolved Solids @180°C	mg/L	123	59
Salinity	g/kg	0.07	0.03
Hydroxide Alkalinity as CaCO3	mg/L	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	13	21
Total Alkalinity as CaCO3	mg/L	13	21
Sulfate as SO4 - Turbidimetric	mg/L	3	1
Chloride	mg/L	38	6
Calcium	mg/L	<1	1
Magnesium	mg/L	1	5
Sodium	mg/L	30	7
Potassium	mg/L	<1	<1
Total Anions	meq/L	1.39	0.61
Total Cations	meq/L	1.39	0.76
Fluoride	mg/L	0.2	0.2
Final pH	pH Unit	7.8	8.5

Geology, scientific literature, site data and site rehabilitation performance are reviewed to quantify the risk of ARD. ARD is only a risk if mining occurs below the Line of Oxidation (LOX). Above this line, oxidation and leaching of the overburden has occurred. The groundwater table is considered a proxy for the LOX line. ARD can be observed in mine waste within 12 months of exposure to oxygen and water. ARD typically limits plant growth due to the low pH and high salinity generated by the oxidation of pyritic mine waste.

The region's geology, ore body formation, Gladstone Nickel EIS static testing, regional water quality data and site rehabilitation performance following 28 years of mining on the mining lease all demonstrate that ARD is not present in the mining horizon or a potential threat with mining. In fact,

the ore has a high Acid Neutralising Capacity (ANC) and is capable of being used to neutralise ARD in other waste (see Section 2.3.7.2 below).

Further explanation of the geochemistry with reference to these factors is given below.

2.3.7.1 Geology

As noted in Section 2.3.4, the regional area is highly mineralised with the Marlborough Block. A sliver (approximately 3 km thick) of serpentinised harzburgite ophiolite that dominates the landscape of the Marlborough district, covered by a thick weathering profile containing economic enrichments of nickel, cobalt and chrysoprase. The groundwaters that flow out of the serpentinite hills are supersaturated with magnesium.

A nickel-cobalt laterite is a weathered rock or soil that has been enriched in nickel and cobalt by the actions of leaching and re-precipitation. Nearly all laterites are of rusty-red coloration, because of high iron oxide content. They develop by intensive and prolonged weathering of the underlying parent rock (Parianos, 2017).

2.3.7.2 Low-grade nickel laterite ores used to treat Acid Mine Drainage

Limestone has been the traditional treatment media used in passive treatment of Acid Mine Drainage (AMD). However, due to some disadvantages, other alternatives of alkaline-generating materials, like serpentinite (Bernier, 2005; Kamal and Sulaiman, 2014) and low-grade nickel laterite ore (Turingan et al, 2020) have been investigated to neutralize AMD.

Turingan et al, 2020 used low grade nickel laterite ores (LGO) characterised by having less than 1.4% Ni to investigate its performance as media for AMD neutralization. Although the performance of LGO as AMD neutraliser in comparison with other materials analysed (limestone, fly ash, and cement waste) was not optimal, it was found that LGO in combination with other materials could help to treat AMD at mine sites.

The sole purpose of including nickel laterite ores and serpentinite ores as alternatives to treat Acid Mine Drainage in different studies around the globe demonstrates that these materials do not pose any risk of having and/or increasing the Acid Mine Drainage at any site.

Brolga mine considered any material with less than 0.8% nickel as waste. This locates Brolga mine inside the low grade nickel laterite ores (LGO) investigated by Turingan et al, 2020. In addition, Serpentinite - which is the type of rock studied by Bernier, 2005 and Kamal and Sulaiman, 2014 - is the ultramafic parent rock of the Marlborough Nickel Laterite deposits and therefore the Brolga Deposit (Foster & Eggleton, 2002).

2.3.7.3 Site data and observations

Since mining commenced in 1993, water quality on site is consistently above neutral, with surface waters (Dams 1 – 4) at around pH 8.0, and groundwaters pH 7.5. Site rehabilitation has been successful with natural colonisation of local species occurring in all disturbed areas with time. No visual evidence has been observed of hostile spoil limiting plant growth on site. Hostile spoil is defined as spoil with low pH, high salinity and/or poor physical characteristics.

2.3.7.4 Geochemical characteristics of ore (from Gladstone Nickel Project Supplementary EIS)

As part of the Supplementary Environmental Impact Statement for the GNP, a geochemical characterisation of the waste material and the ore of the Marlborough ore body was completed (this is included as Appendix 9 of this PRCP).

Table 2-7 shows the results of the geochemical (acid-base) testing of the ores evaluated. Results for the Marlborough ore are summarised below.

- The Marlborough ore sample has a pH (1:5) of 7.6 and have no detectable alkalinity.
- The EC for the Marlborough Ore is 650 uS/cm being classified as non-saline.
- Total sulphur concentration for the Marlborough Ore is low 0.01% with all the sulphur present as sulphate, indicating that almost no sulphur is present in the sulphidic (unoxidised) form.
- The low concentration of oxidisable sulphur in the Marlborough Ore (<0.01%) indicates that the samples are barren and can only generate an insignificant Maximum Potential Acidity (MPA) of approximately 0.3 kg H_2SO_4/t.
- Acid Neutralising Capacity (ANC) of Marlborough Ore is 25 kg H_2SO_4/t.
- As the ANC significantly exceeds the MPA, the Net Acid Producing Potential (NAPP) is strongly negative (-25.2 kg H_2SO_4/t) for Marlborough Ore.
- The Net Acid Generation (NAG) capacity for Marlborough Ore is <0.1 kg H_2SO_4/t with a NAG pH value of 8.3.

The Marlborough ore was classified as Non-Acid Forming (NAF) due to the lack of oxidisable sulphur, a negative NAPP, and NAG pH values above 4.5.

Table 2-7. Geochemical characteristics of the ore

	Units	Laboratory Detection Limit	Residue[6]	Marlborough Ore	New Caledonia Ore
pH[1]	pH units	0.1	7.4	7.6	5.3
Electrical Conductivity (EC)[1]	uS/cm	1	8,630	650	76
Alkalinity (to pH 5.5)[2]	kg H_2SO_4/t	0.0001	0.0021	<0.0001	<0.0001
Acidity (to pH 8.3)[2]	kg H_2SO_4/t	0.0001	0.00012	<0.0001	0.0026
Total Sulfur (as S)	%	0.01	7.66	0.01	0.28
Sulfate Sulfur (as S)[2]	%	0.01	7.34	0.01	0.28
Total Oxidisable Sulfur (TOS)[3]	%	0.01	0.32	<0.01	<0.01
Total Organic Carbon (TOC)	%	0.02	0.08	n/a	n/a
Maximum Potential Acidity (MPA)[4]	kg H_2SO_4/t	0.1	9.7	0.3	0.3
Acid Neutralising Capacity (ANC)	kg H_2SO_4/t	0.5	54.4	25.2	0.6
Net Acid Producing Potential (NAPP)	kg H_2SO_4/t	0.1	-44.7	-25	-0.3
Net Acid Generation (NAG)	kg H_2SO_4/t	0.1	<0.1	<0.1	<0.1
NAGpH	pH units	0.1	8.1	8.3	5.9
Sample Classification[5]			**Non-Acid Forming**	**Non-Acid Forming**	**Non-Acid Forming**

Notes:
1. Natural pH and EC provided for 1:5 sample:water extracts
2. Alkalinity and Acidity converted from meq/kg as $CaCO_3$ to kg H_2SO_4/t. Sulfate sulfur converted from mg/kg SO_4 to % S.
3. TOS concentration is calculated from the difference between total S and sulfate sulfur concentrations. It is assumed that the organic S concentration is negligible.
4. MPA calculated using TOS.
5. Sample has low TOS content, negative NAPP and NAGpH > 4.5 and is therefore classified as Non-Acid Forming (NAF).
6. Residue sample G200 NRS

2.3.8 Land Stability

Land stability is used to refer to larger scale ground movements and the formation of unstable soil or rock masses through either human activity or natural processes. Land instability can lead to damage to built infrastructure, vegetation, natural landforms and farmland and loss of land function.

Both mining leases are situated on topographically elevated features surrounded by Quaternary alluvial sediment. The Brolga site is a lateritised remnant of serpentinite on the south-eastern periphery of the Princhester Serpentinite. During the intense weathering the weathered profiles

became indurated due to the accumulation of secondary minerals within the profile. These characteristics help to stabilise the land and the slopes usually found in these types of rocks.

Based on airphoto research the area in its pre-mining state was used for grazing. The lower slopes and the soils appeared to have favoured the areas for this activity. The same analysis shows that the land in the area is stable in its original form. No signs of ground movements or gully erosion was visually found.

The Livingstone Shire Planning Scheme (2018) OM18 – Landslide Hazard Area mapping identifies both the Brolga and Canoona MLs occupying land where there is no identified landslide hazard (See Figure 2-22).

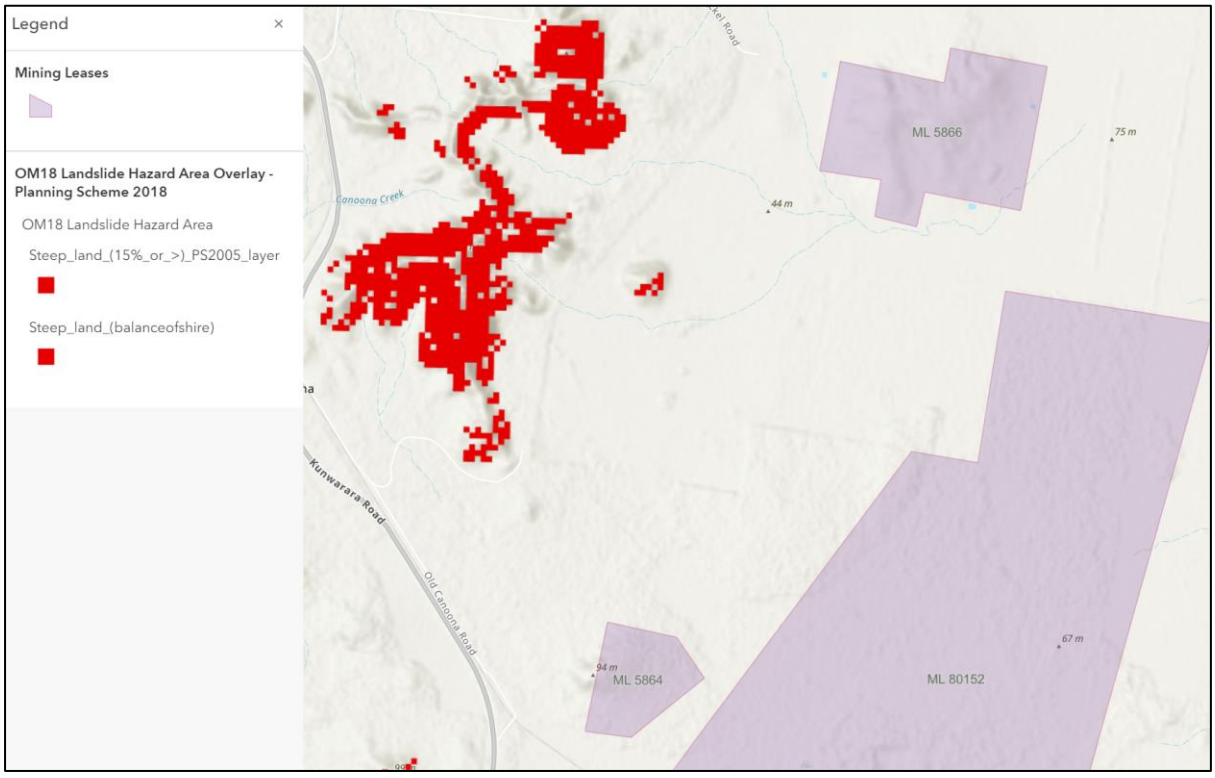


Figure 2-22: Livingstone Shire Landslide Hazard Mapping

2.3.9 Vegetation Communities and Ecological Data

EMPL01624913 is entirely within the 'Brigalow Belt' Bioregion, within Biogeographic subregion 'Marlborough Plains' (Code 11.14). It is within the Fitzroy Basin, Fitzroy River Sub-basin, on the 100K Map Tile 89-51 'Ridgelands' and the 250K Map Tile SF56-13 'Rockhampton'.

The Broad Vegetation Group over both mining leases is "Eucalypt woodlands to open forests".

ML5866 Brolga is mapped under the DES Regional Ecosystem (RE) mapping as containing entirely non-remnant vegetation. ML5864 Canoona is mapped as containing entirely remnant Regional Ecosystem vegetation (Figure 2-23 and Figure 2-24). The vegetation mapping is explained further in Section 2.3.9.1 below.

2.3.9.1 Regional Ecosystems

Brolga

Brolga is mapped as non-remnant vegetation. Its former vegetation is shown on the DES Pre-clearing RE mapping, which identifies the original extent of vegetation communities before anthropogenic

clearing occurred. The mapping identifies the pre-clearing vegetation of Brolga as predominantly RE 11.11.7x1. However, RE 11.3.38/11.3.38a (80/20%) occupied the flat areas surrounding the ML, as well as a small part of the Brolga ML itself, around the southern edges (Figure 2-25; see also Appendix 5 for the full details of the DES mapping).

Canoona

ML5864 Canoona is mapped as being wholly within RE 11.11.7 (Figure 2-26). An ecological assessment undertaken on Canoona in December 2021 found that this RE mapping was correct (see Appendix 6).

Regional Ecosystem descriptions

RE 11.11.7

The short description of RE 11.11.7 is *"Eucalyptus fibrosa subsp. fibrosa, Corymbia xanthope* woodland on serpentinite*"*. It is categorised as "Least Concern" under the *Vegetation Management Act 1999*, and has a Biodiversity Status of "Of concern" and a 'Sparse' Structure category.

Its description was transcribed from the following link;

https://apps.des.qld.gov.au/regional-ecosystems/details/?re=11.11.7

"Complex of vegetation on serpentinite hills and adjacent undulating colluvial aprons dominated by Eucalyptus fibrosa subsp. fibrosa +/- Corymbia xanthope +/- Corymbia spp. A variable shrub layer includes Acacia leptostachya, Hakea trineura, Xanthorrhoea spp. and Macrozamia serpentina. Occurs on steep mountains, undulating low hills and rises and colluvial aprons formed from Permian ultramafic rocks (serpentinite) including remnant lateritised surfaces in more elevated areas. Associated soils are shallow to moderately deep dark stony clays to clay loams. (BVG1M: 13c)"

RE 11.11.7x1

RE 11.11,7x1 is a subcategory of RE 11.11.7 that differs slightly from the main RE. This vegetation community is mapped as the pre-clearing community on the Brolga ML. The description is *"Eucalyptus fibrosa subsp. fibrosa +/- Corymbia spp. tall woodland with rainforest elements in the understorey.*

RE 11.3.38/11.3.38a (80/20%)

The short description of 11.3.38 is *Eucalyptus tereticornis, Melaleuca viridiflora, Corymbia tessellaris* and *Eucalyptus fibrosa* subsp. *fibrosa* woodland with a grassy ground layer on alluvial plains and broad drainage lines derived from serpentinite.

It is categorised as "Least Concern" under the *Vegetation Management Act 1999*, and has a Biodiversity Status of "Endangered". Structure category is 'Sparse'.

Its description was transcribed from the following link;

https://apps.des.qld.gov.au/regional-ecosystems/details/?re=11.3.38

Eucalyptus tereticornis, Corymbia tessellaris, C. dallachiana +/- E. fibrosa subsp. fibrosa, +/- Melaleuca spp. woodland to open forest. Includes areas dominated by Melaleuca bracteata low woodland. The grassy ground layer includes Arundinella nepalensis and Themeda triandra. Occurs on alluvial plains and broad drainage lines overlying magnetite deposits derived from serpentinite. (BVG1M: 16c).

On a small part of, and adjacent to, the Brolga ML, this RE is comprised of a mixed polygon of 80% RE 11.3.38 and 20% RE 11.11.38a. RE 11.3.38a is a subcategory within RE11.3.38 and is described as *"Melaleuca bracteata low woodland. Riverine."*

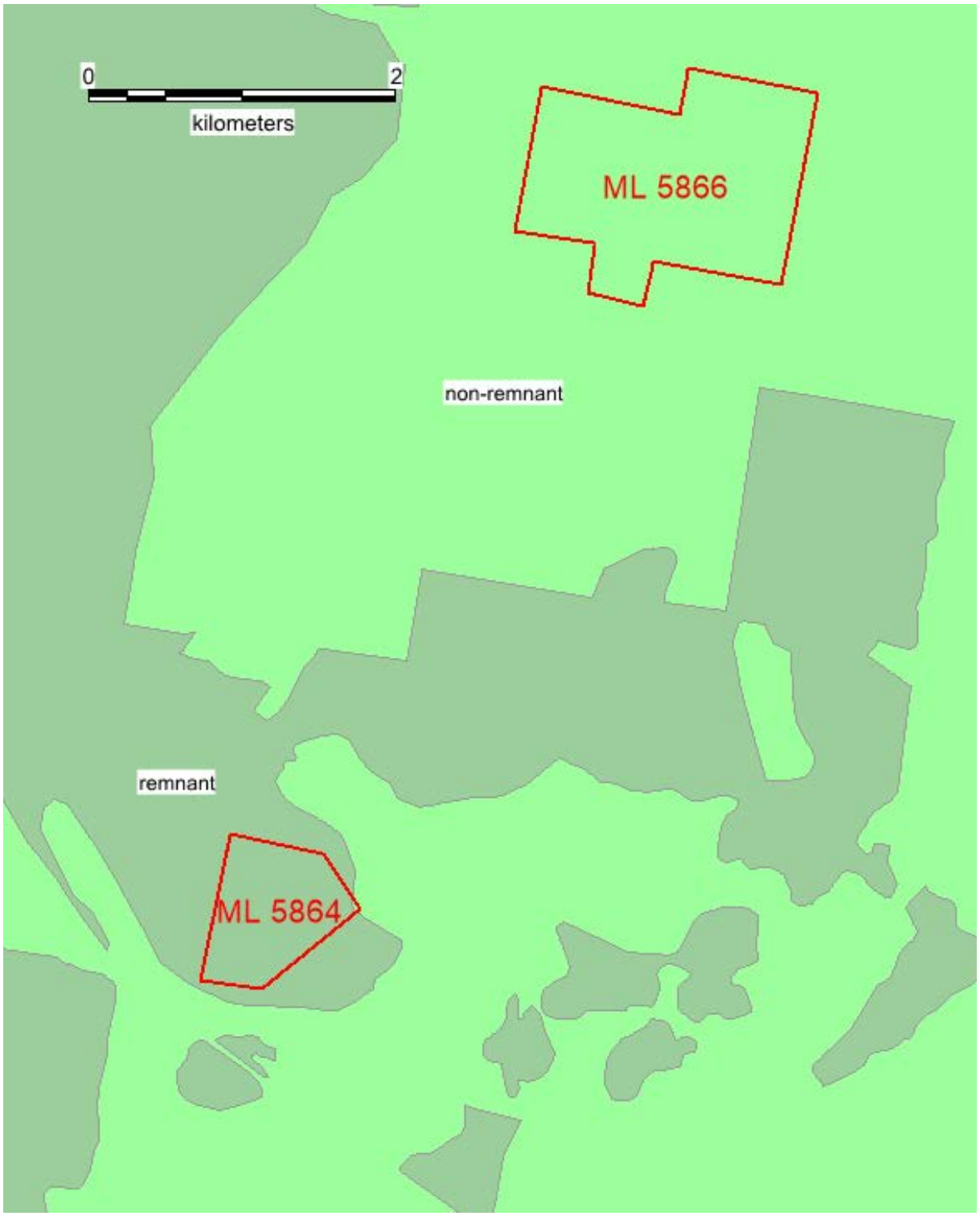


Figure 2-23. Extent of Remnant and non-remnant Vegetation

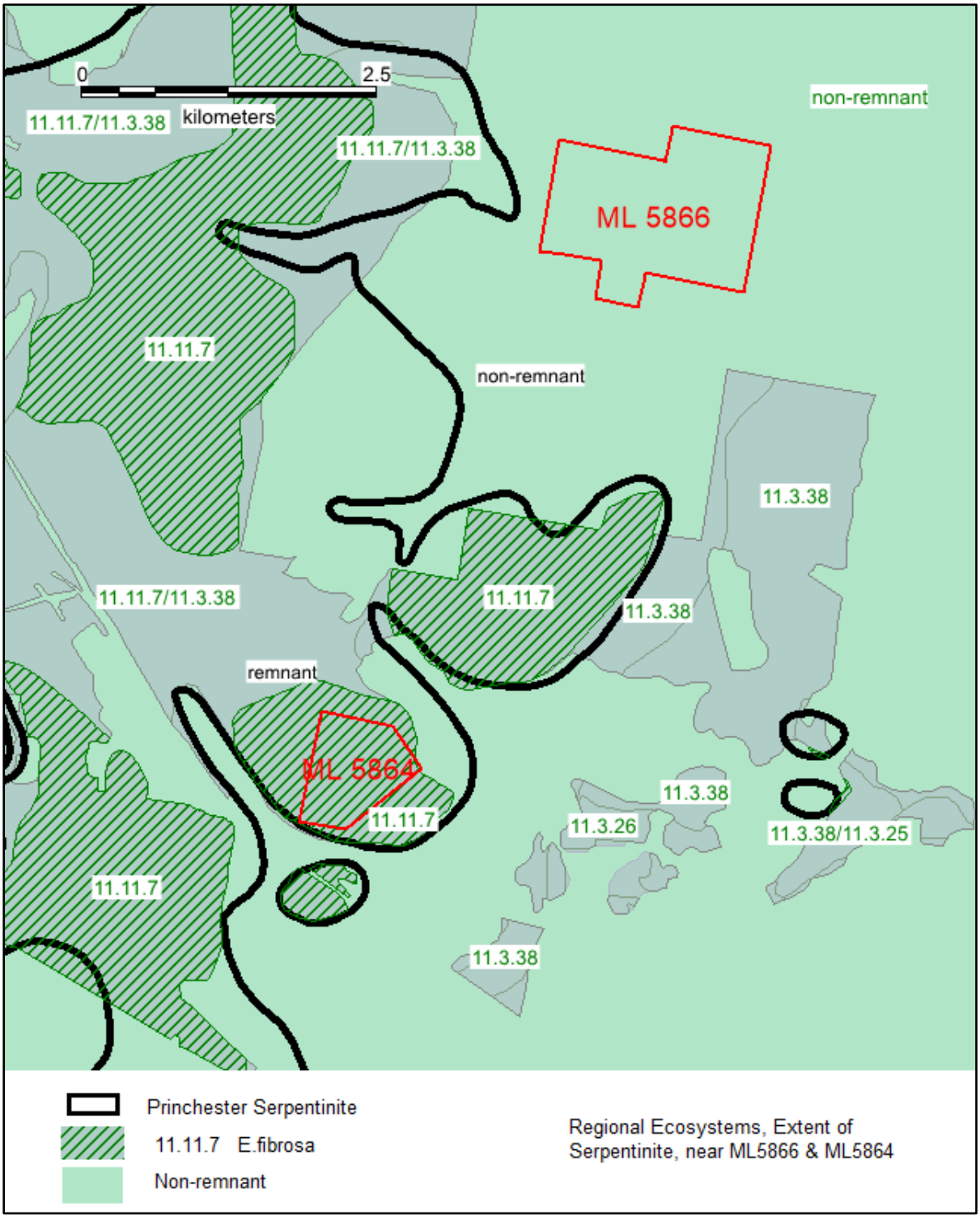


Figure 2-24. Regional Ecosystems and the Princhester Serpentinite

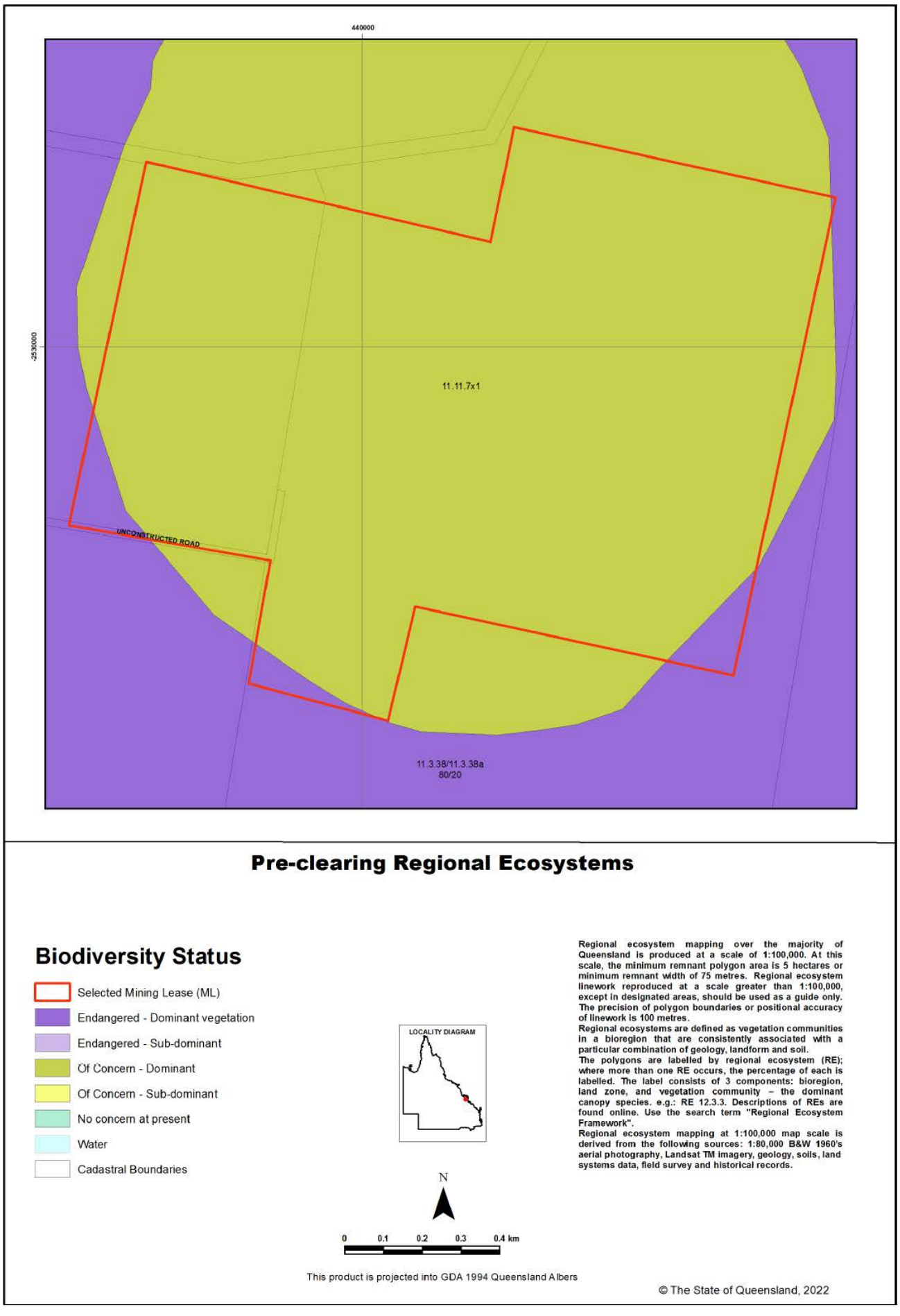


Figure 2-25. Brolga (ML5866) Pre-clearing Regional Ecosystems

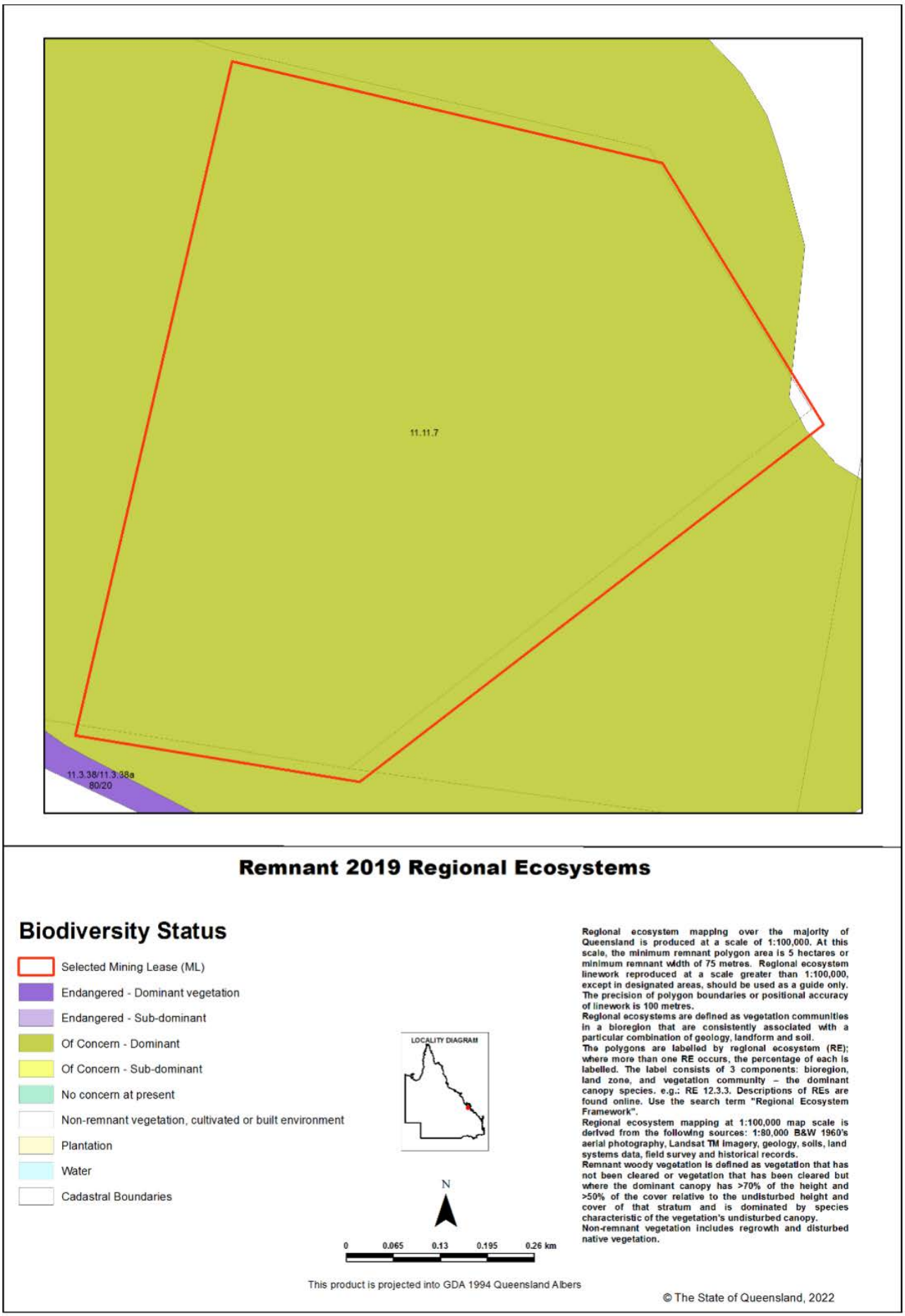


Figure 2-26. Canoona (ML5864) Remnant Regional Ecosystem

2.3.9.2 Biodiversity Significance

The DES attributes biodiversity significance on a bioregional scale through a Biodiversity Planning Assessment (BPA). For areas identified as having biodiversity values, the BPA assigns three levels of overall biodiversity significance: State, Regional or Local and/or other values.

Brolga

Other than a very small area (0.22 ha) on the edge of the Brolga ML mapped as having local, or other values, the Brolga ML is not mapped as having any Biodiversity Significance under the BPA (see Figure 2-27 with the full details in Appendix 5).

Canoona

The Canoona ML is mapped as having a State level of Biodiversity Significance. Within this categorisation, half of the site is further identified as State Habitat for Endangered, Vulnerable or Near Threatened (EVNT) taxa (see Figure 2-28, with the full details in Appendix 5).

2.3.9.3 Wildlife Corridors

Both MLs are mapped as State Wildlife Corridors.

2.3.9.4 Aquatic conservation significance (riverine wetlands)

Both MLs and surrounds are mapped as having a high aquatic conservation significance (riverine wetlands).

2.3.9.5 Regulated Vegetation – Essential Habitat

Essential Habitat is Regulated Vegetation in which a species that is Endangered or Vulnerable under the *Nature Conservation Act 1992* (NC Act) has been known to occur. Essential habitat is compiled from a combination of species habitat models and buffered records of conservation significant species. Essential habitat for protected wildlife includes suitable habitat on the lot, or where a species has been known to occur up to one kilometre from a lot on which there is assessable vegetation.

Brolga

Thirty-nine percent (79.92 ha) of the Brolga ML is mapped as essential habitat (see Figure 2-29). The species for which it is essential habitat are discussed below in Section 2.3.9.5. These areas will not be adversely affected by the rehabilitation activities, and the rehabilitation of the adjoining areas will enhance habitat values for fauna. The planting list for the forest areas of the site contain threatened locally endemic species, such as *Corymbia xanthope.*

Canoona

Fifty percent (32.64 ha) of the Canoona ML is mapped as regulated vegetation – essential habitat (see Figure 2-30). The species for which it is essential habitat are discussed below in Section 2.3.9.5. The habitat values of the Canoona ML will not be adversely affected. Enhanced weed control and fire management practices (described in Section 6.1.9 and Section 8.1) will enhance habitat values for conservation significant species.

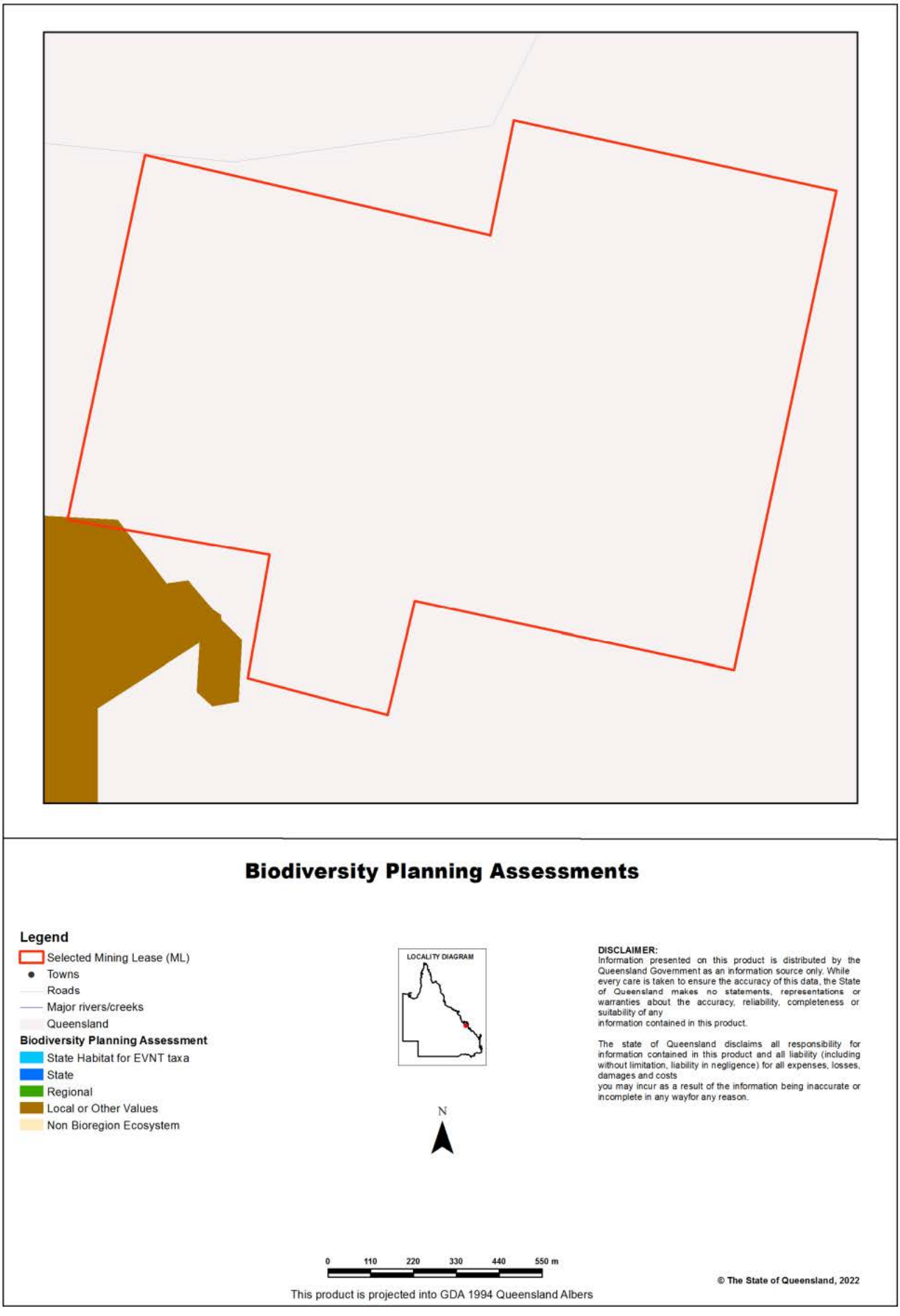


Figure 2-27. Brolga ML Biodiversity Significance

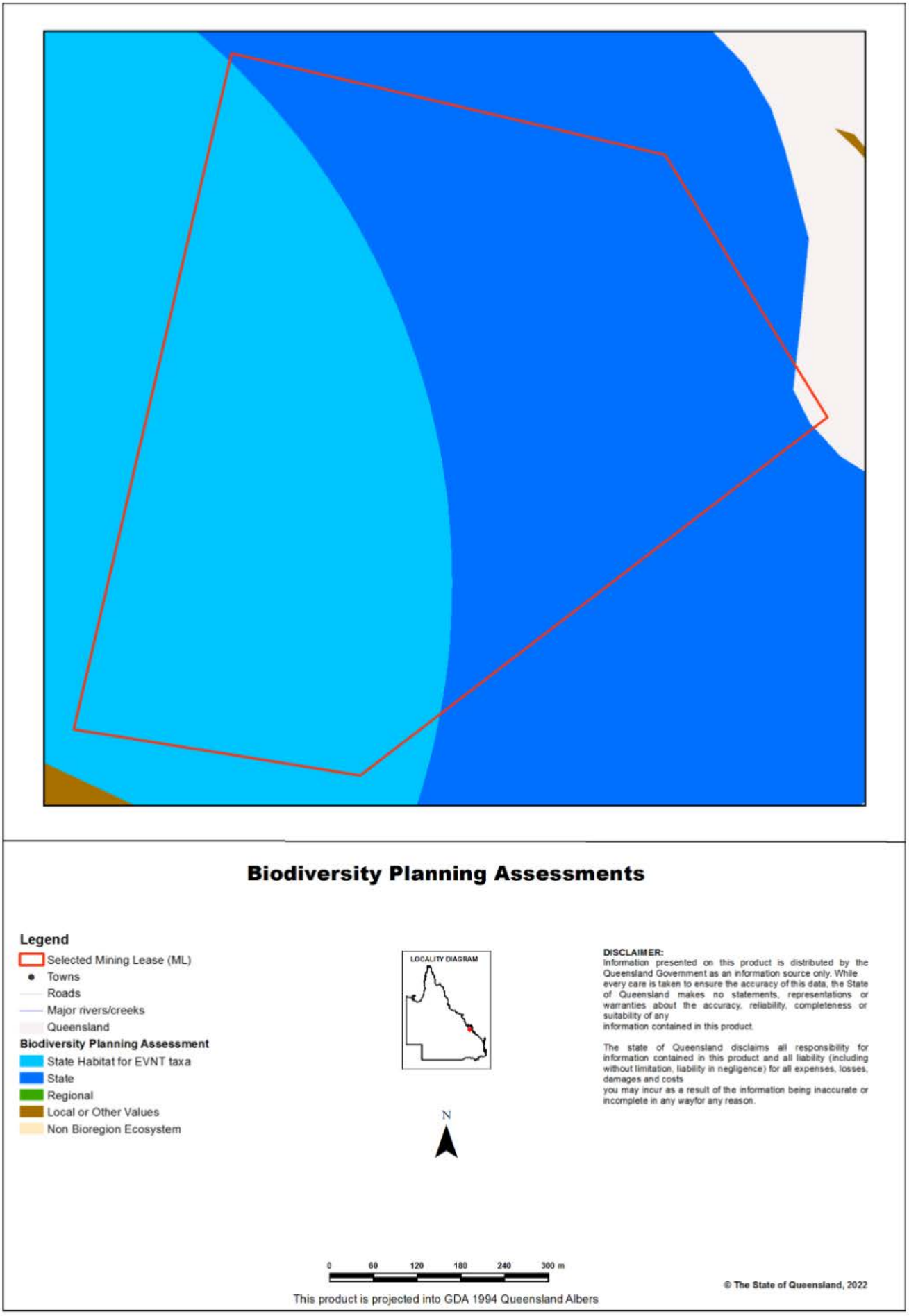


Figure 2-28. Canoona ML Biodiversity Significance

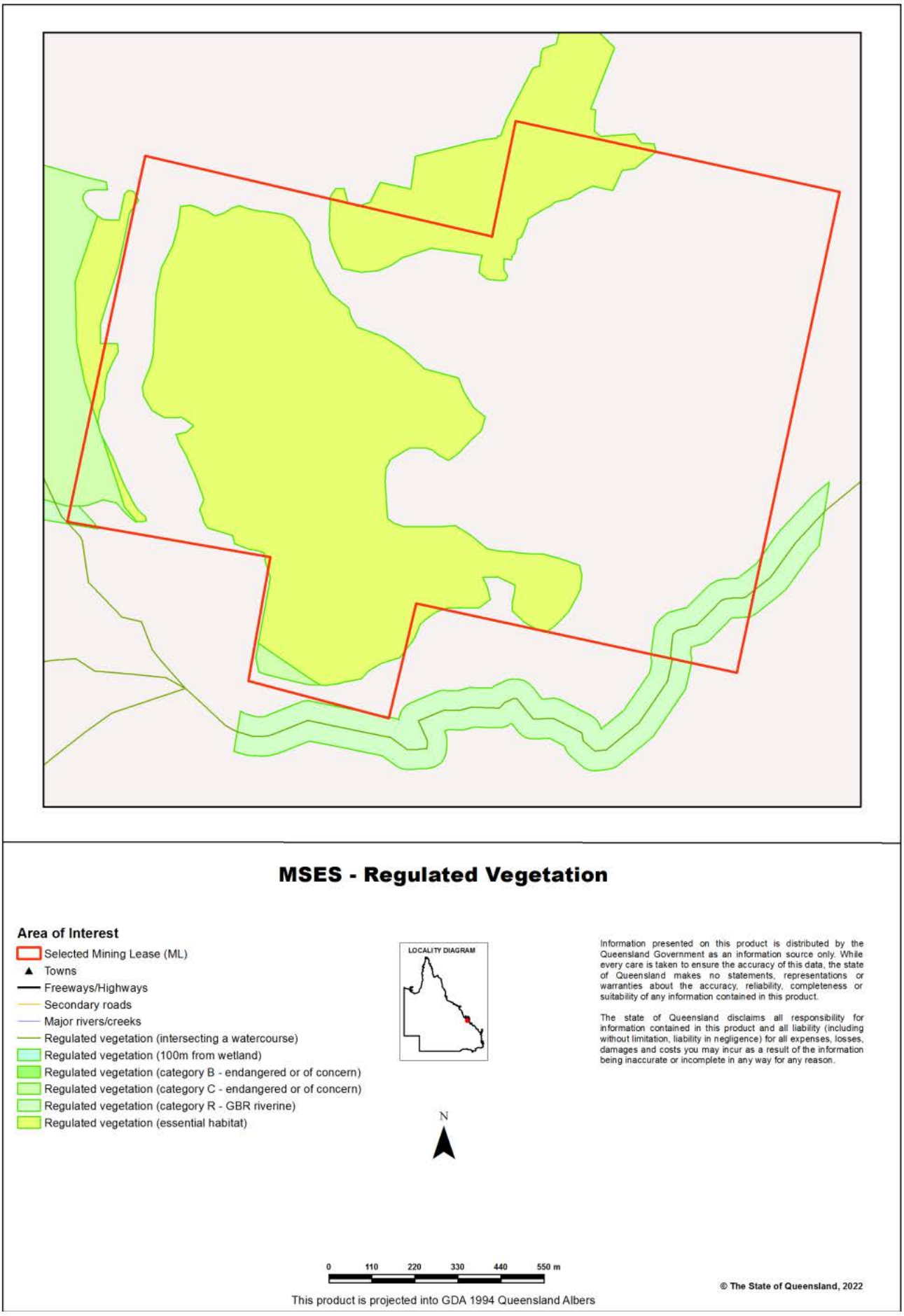


Figure 2-29. Brolga ML Regulated Vegetation

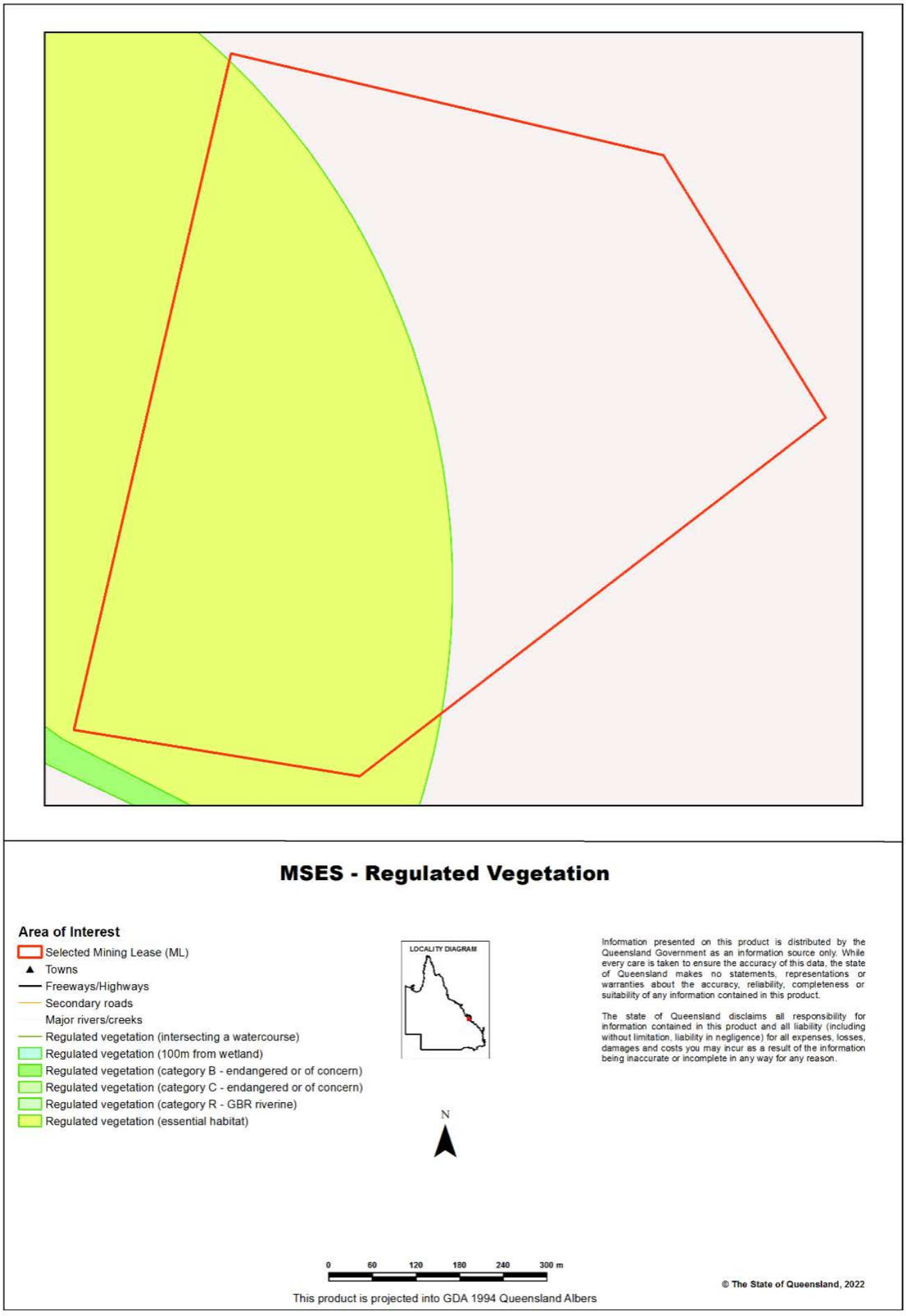


Figure 2-30. Canoona ML Regulated Vegetation

2.3.9.6 Other Regulated Vegetation

Small instances of the following MSES are mapped on the boundaries of the Brolga ML (see Figure 2-29). These areas have not been mined and will not be adversely affected by the rehabilitation activities.

- 2.35 ha of Endangered/Of Concern regrowth (Category C)
- 3.34 ha of Great Barrier Reef catchmnet riverine regrowth (Category R)
- 0.3 ha of vegetation management watercourse is mapped as present.

2.3.10 Flora and Fauna presence and populations

A Biodiversity and Conservation Values report and a Conservation Significant Species List was generated for each ML via the DES environmental reports online tool (see Appendix 5). The reports give the conservation significant species, recorded on, or within 4 km, and 1 km of the area of MLs, respectively. The results for the Brolga ML are given in Table 2-8 and for the Canoona ML in Table 2-9. Species recorded within 1 km are denoted in bold. In addition, 62.5% of the Canoona ML is mapped as having wildlife habitat for endangered or vulnerable fauna (see Figure 2-31). An ecological assessment of the Canoona ML, conducted in December 2021, confirmed the presence of *Corymbia xanthope, Macrozamia serpentina* and *Marsdenia brevifolia.*

Table 2-8. Conservation Significant Species, recorded on, or within 4 km of the Brolga ML

Species	Common Name	NC Act status	EPBC status	Back on Track rank
Bursaria reevesii		V		Medium
Capparis thozetiana		V	V	Medium
Corymbia xanthope	Glen Geddes bloodwood	V	V	Low
Hakea trineura		V	V	High
Macrozamia serpentina		E		Critical
Marsdenia brevifolia		v	V	High
Neoroepera buxifolia		V	V	Medium
Pimelea leptospermoides		NT	V	
Pimelea leptospermoides* subsp. *Leptospermoides		NT		Medium

Table 2-9. Conservation Significant Species, recorded on, or within 4 km of the Canoona ML

Species	Common Name	NC Act status	EPBC status	Back on Track rank
Capparis thozetiana		V	V	Medium
Corymbia xanthope	Glen Geddes bloodwood	V	V	Low
Geophaps scripta scripta	**squatter pigeon (southern subspecies)**	V	V	Medium
Hakea trineura		V	V	High
Macrozamia serpentina		E		Critical
Marsdenia brevifolia		V	V	High
Neoroepera buxifolia		V	V	Medium
Rhipidura rufifrons	**rufous fantail**	SLC		Low
Pimelea leptospermoides* subsp. *Leptospermoides		NT		Medium
Pultenaea setulosa		V	V	Medium
Stackhousia tryonii		NT		Medium

2.3.10.1 Weeds

Brolga

Past weed surveys on the Brolga ML identified the declared weed species lantana (*Lantana camara*), and giant rats-tail grass (*Sporobolus pyramidalis*). The environmental weeds snakeweed (*Stachytarpheta jamaicensis*), Guinea grass (*Megathyrsus maximus* var *maximus*) and buffel grass (*Cenchrus ciliaris*) were also recorded.

Canoona

Praxelis (*Praxelis clematidea*), stinking passionfruit (*Passiflora suberosa*), red Natal grass (*Melinus repens*) lantana (*Lantana camara*) and American rat's tail grass (*Sporobolus jaquemontia*) are present and generally restricted to the actual disturbance footprint (mostly the old drilling tracks) or within 10 m of the footprint, and have not spread into surrounding woodland to any substantial extent. However, approximately eight hectares is heavily infested with dense, continuous clumps of lantana, with instances of praxelis and stinking passionfruit evident in this zone.

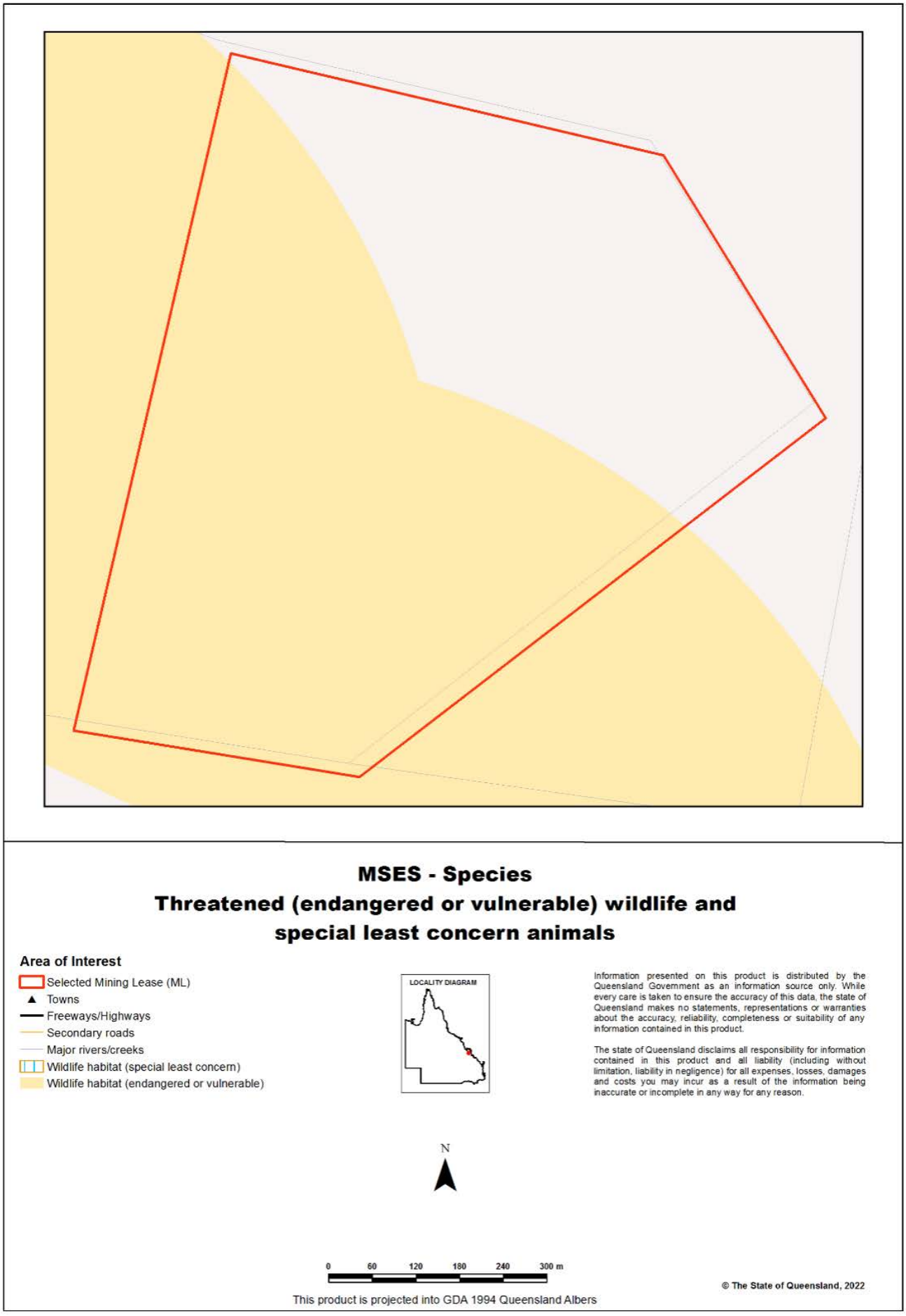


Figure 2-31. Canoona ML Endangered or Vulnerable Wildlife Habitat

2.3.11 Pre-mining land use

2.3.11.1 Brolga

Historic land use prior to exploration and mining appears to be mainly grazing. Within and near ML5866, some paddocks of forested areas were cleared of trees and probably improved by tillage, seeding and irrigation. To identify the pre-mining landscape, air photos from 1952 and 1979 were downloaded from Qimagery and georeferenced.

One paddock in the 1952 Brolga air photo (Figure 2-32) along the western boundary of ML5866 appears to have been prepared for cultivation along the lower slopes. The soil along these lower slopes has a significant clay content, giving it considerable plasticity with moisture and nutrient retaining characteristics, attractive for cropping. One field on the western lease boundary appears to have been tilled ready for sowing, and a nearby milking shed exists to this day. All other cleared areas in the 1952 photo are pasture areas.

The ML5866 Brolga 1979 air photo (Figure 2-33) shows that exploration drilling was being conducted by that time with regrowth of forest in previously cleared paddocks well established. Cultivation or cropping is not evident, and no contour banks or dams are in the area. Access tracks for exploration trucks caused considerable disturbance, and a pit appears to have been dug in the north-east corner of the future mining lease area. The pit was probably for fossicking for the semi-precious mineral chrysoprase, an activity popular in the area; the other possibility is that it might have been a bulk-sampling pit for nickel exploration.

The ML5866 Brolga 1994 and 1995 air photos (Figure 2-39 and Figure 2-40) show that substantial clearing had taken place for exploration and mining. It is not clear whether any pits had been dug at that time. It is interesting to compare it with the recent imagery in Figure 2-3 that shows the regrowth on the western side of the mining lease area.

2.3.11.2 Canoona

The ML5864 Canoona 1952 air photo (Figure 2-34) shows that the Canoona hill was still forested at that time. Some of the flat areas in the district were cleared, likely for cattle or sheep grazing. The Bruce Highway did not traverse this district at that time, although the railway line did, and probably facilitated rural development in the area. Some buildings are present near the Canoona rail siding at the apex of the railway line. Subsequent air photos have been viewed and confirm the area of Canoona has never been cleared of forest vegetation.

2.3.12 Early Mining Activity and Rehabilitation

A previous tenement holder conducted nickel mining within the ML5866 area in the early 1990's, and later, rehabilitation. Section 2.7.1 provides a description of the former tenement holder mining and rehabilitation activities.

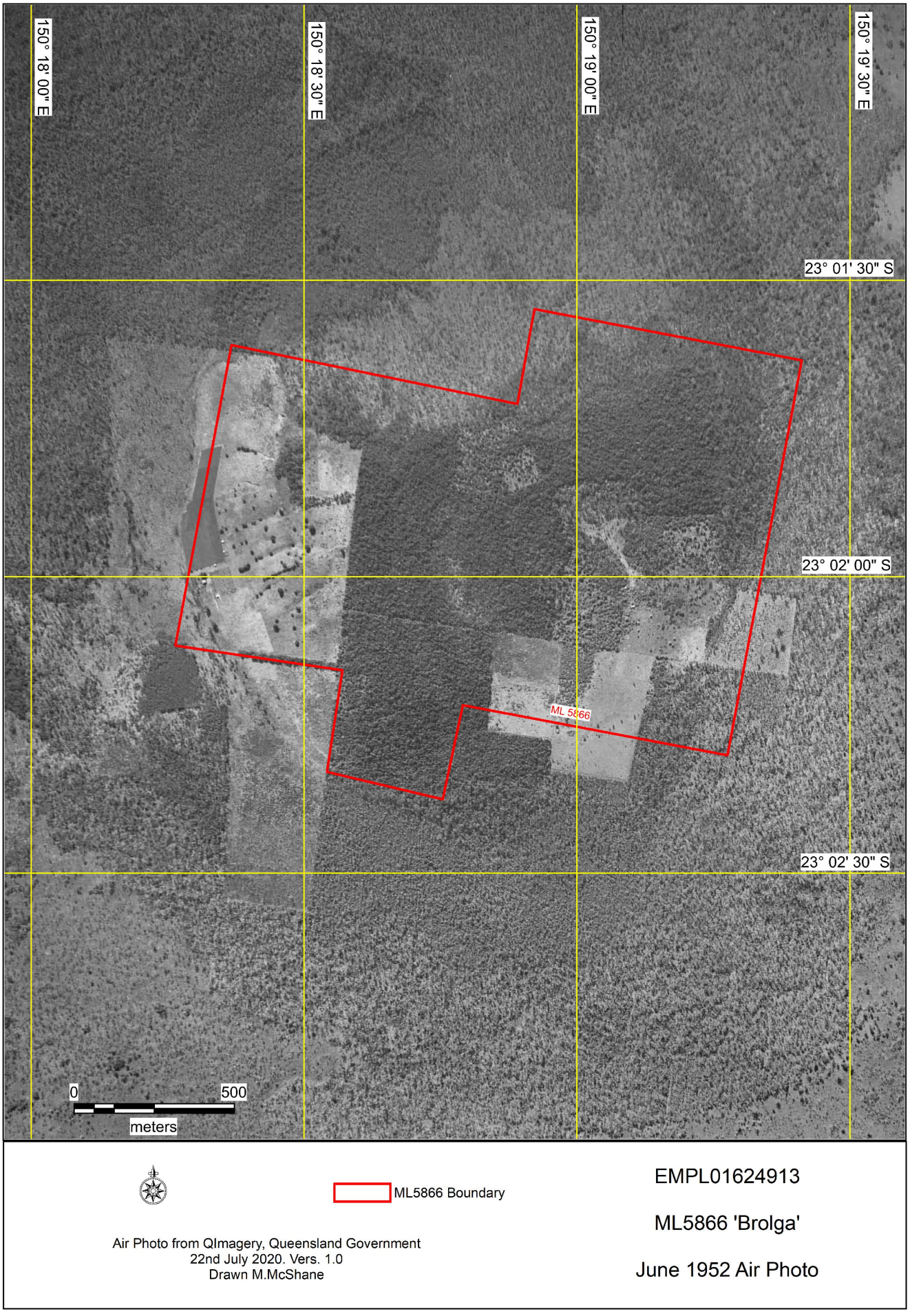


Figure 2-32. June 1952 Air Photo ML5866 Brolga

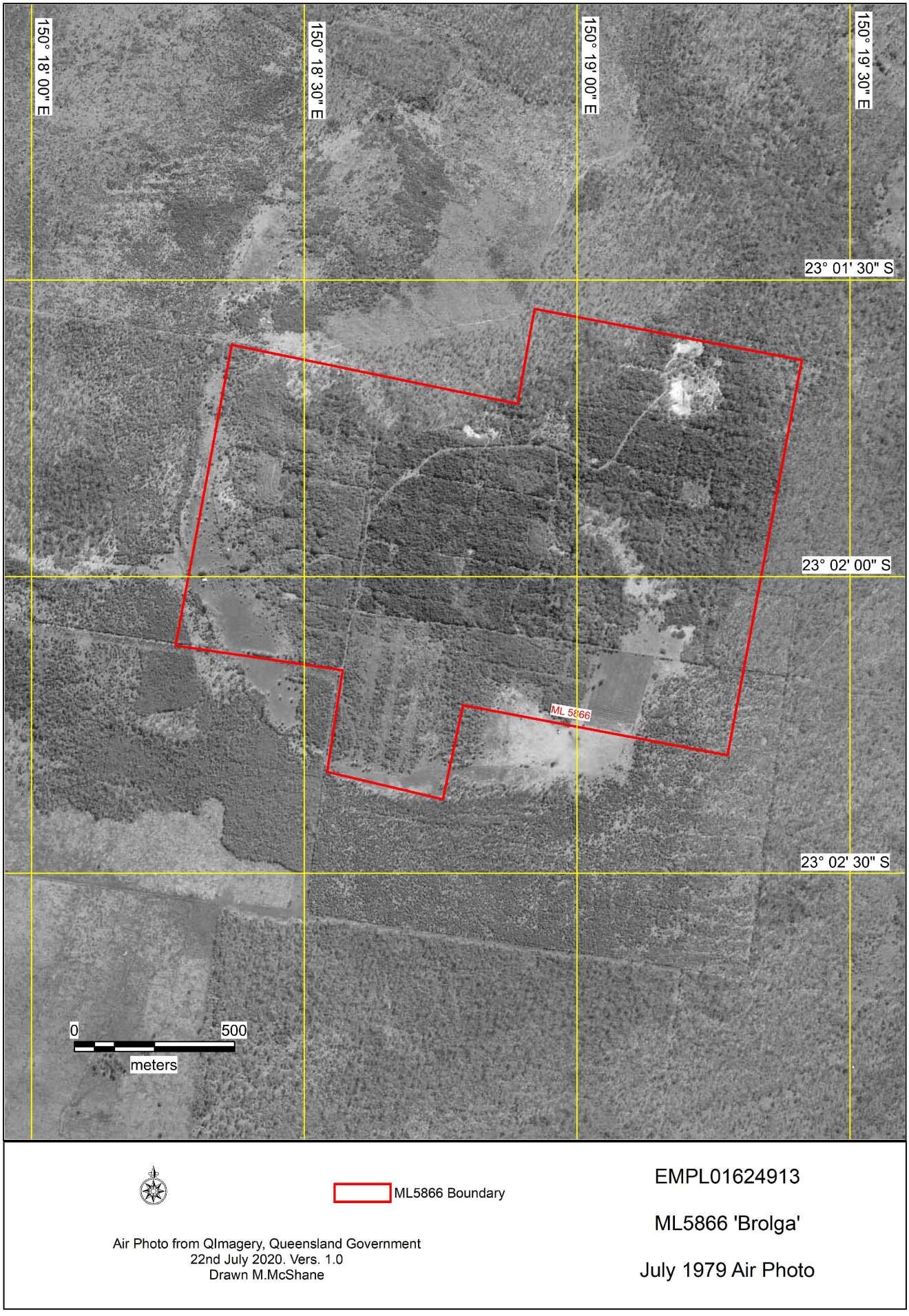


Figure 2-33. July 1979 Air Photo ML5866 Brolga

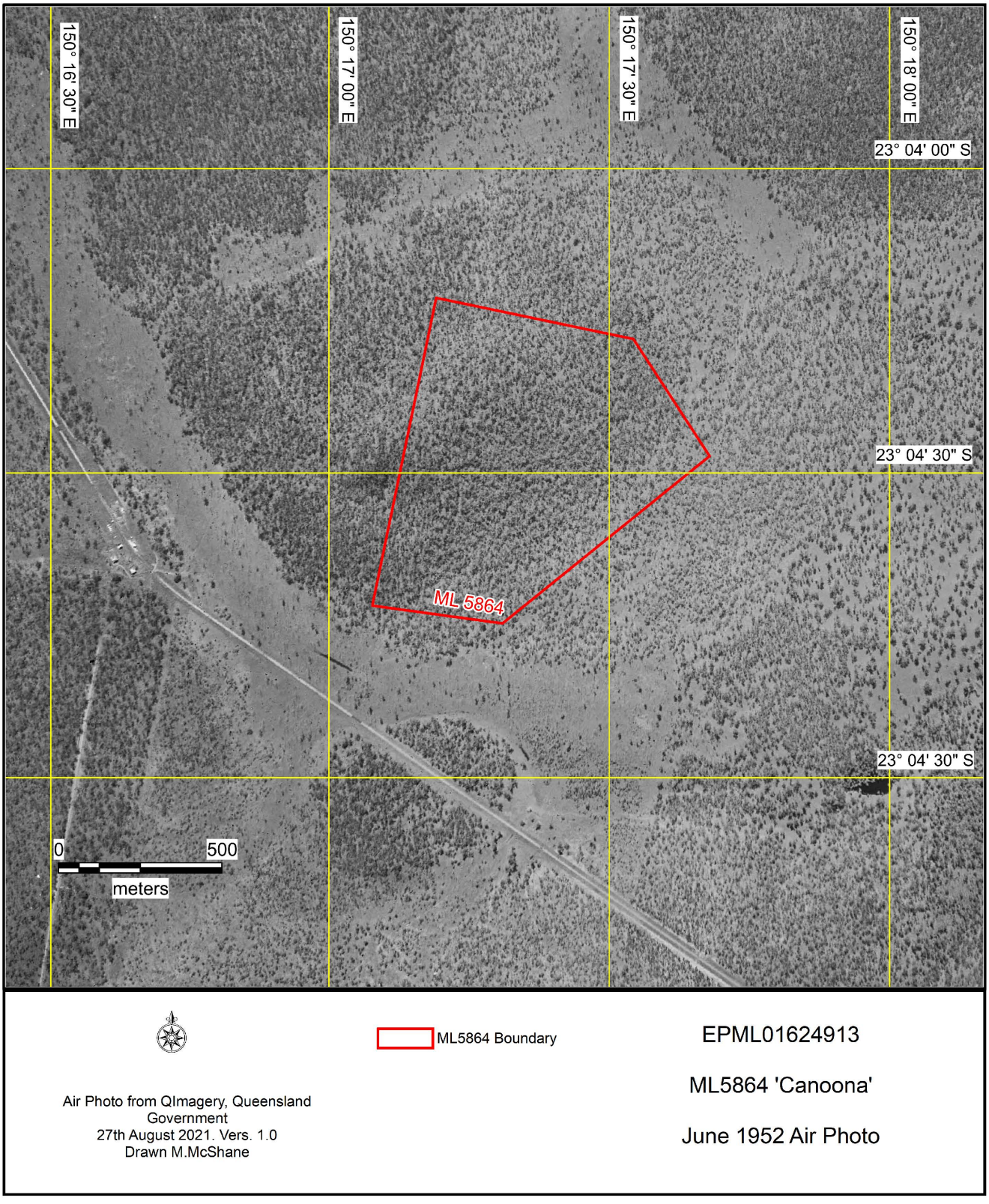


Figure 2-34. June 1952 Air Photo ML5864 Canoona

2.3.13 Surrounding Land Uses

The Livingstone Regional Council's Planning Scheme 2018 as depicted on its web service mapping tool (Figure 2-35) shows that the zoning in the area of the EA and the surrounding area is almost entirely 'Rural'.

The surrounding land uses are shown in Figure 2-36. Surrounding land uses are mainly cattle grazing, cereal crop cultivation, magnesite mining and forestry. A major highway (Bruce Highway) and railway (Northern Line) are less than five kilometres from Brolga and one kilometre from Canoona. Magnesite mining is carried out immediately east of Canoona. The nearest township, Yaamba, is eleven kilometres south-east.

Land use on the immediately surrounding properties is almost entirely cattle grazing. Most surrounding pastures have been improved for the purposes of grazing by the construction of contour banks, access tracks, dams, fences and stock watering facilities, the clearing of forest vegetation, and introduction of pasture grasses. Grazing and cropping intensity varies with soil quality and water availability.

Substantial areas of cropping and cultivation are located to the east along the floodplain soil of Alligator Creek, and to the south on areas of low topographic relief on floodplain soil along the Fitzroy River.

2.3.14 Underlying Landholders

All land parcels within the mining leases ML5866 and ML5864 are owned by QNI Resources Pty Ltd and QNI Metals Pty Ltd. All are in the Livingstone Shire Council Local Government Area.

Table 2-10. Underlying Landholders

Owner	Lot	Plan	Tenure
QNI Resources Pty Ltd and QNI Metals Pty Ltd (ML5866)	1	SP322712	FH
QNI Resources Pty Ltd and QNI Metals Pty Ltd (ML5866)	176	LN473	FH
QNI Resources Pty Ltd and QNI Metals Pty Ltd (ML5864)	1	RP620757	FH

2.3.15 Adjoining landholders

Sensitive Receptors are shown on Figure 2-37. The majority of receptors are grazing farm-houses and associated farm buildings. One is a rest area along the Bruce Highway, and one is the infrastructure associated with the nearby magnesite mine.

No rehabilitation work is required on ML5864, where most sensitive receptors are located. The nearest receptors to the Brolga ML (i.e. where the works will take place) are rural residences located 1.5 kilometres north of the site and 2.5 kilometres to the south-west of the site (see Figure 2-37).

There will be no operations at night on either mining lease, so it is unlikely that noise will become an issue with any of the occupants. The potential for dust and weed movement are issues of concern for some neighbours (see Section 3), and management and mitigation measures have been included as part of this PRCP (see Sections 8.1.6 and 8.1.7).

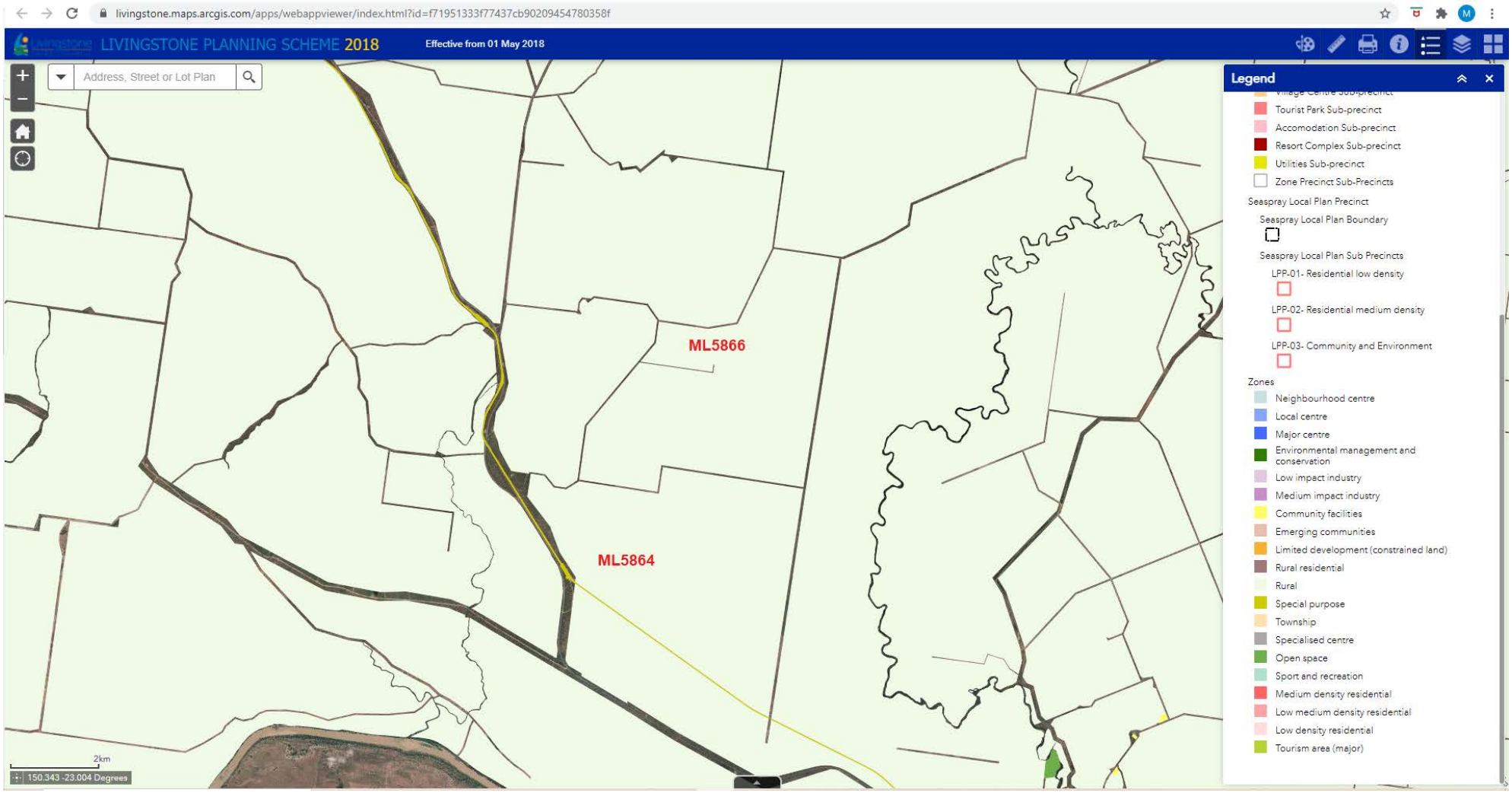


Figure 2-35. Local planning scheme zoning

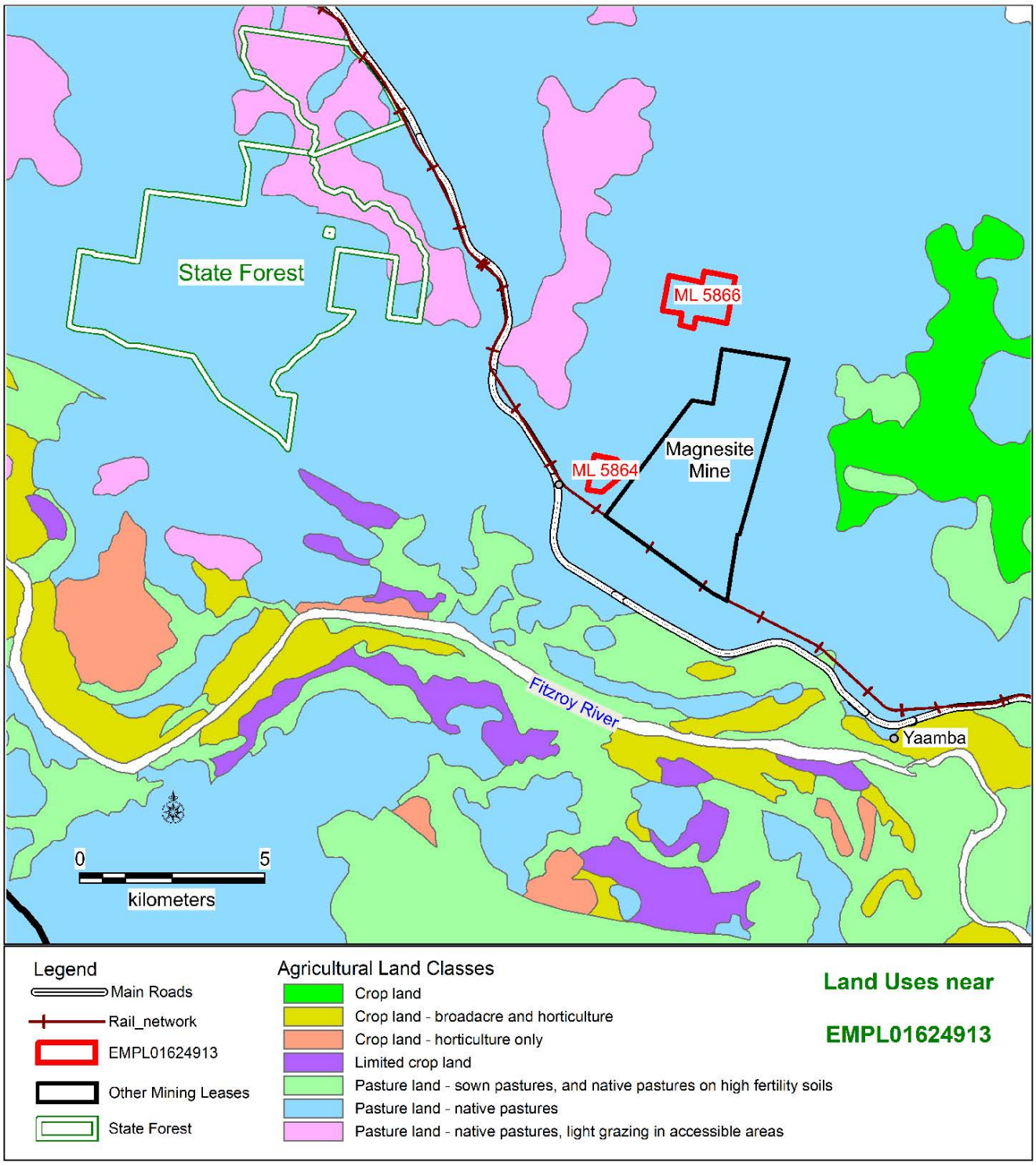


Figure 2-36. Surrounding land uses

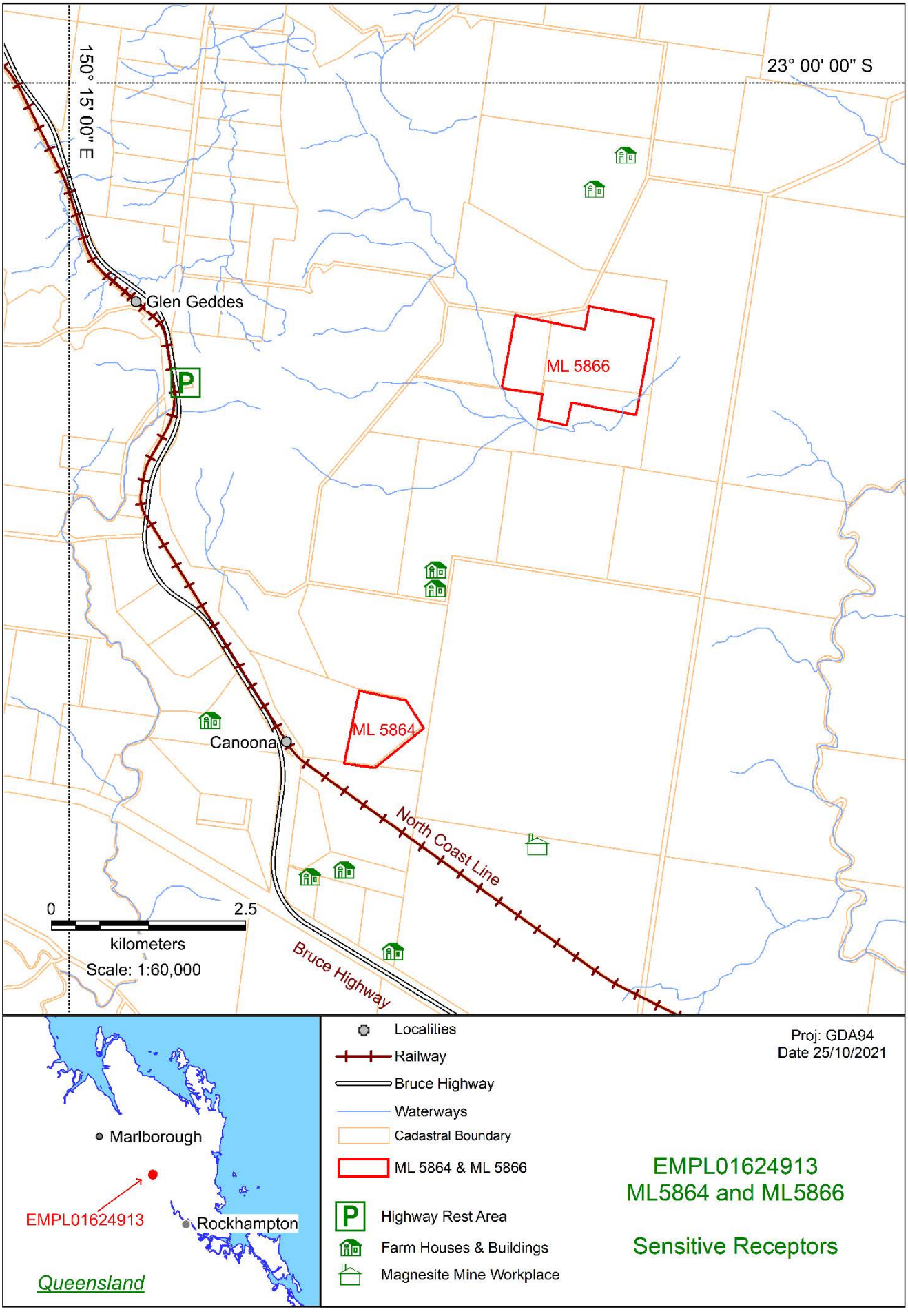


Figure 2-37. Sensitive Receptors

2.4 Design for Closure

The PRCP Guidelines specify that, to demonstrate that rehabilitation will be maximised for the mine site, the rehabilitation planning part of the PRCP for new or expanding sites must include a description of how a number of aspects of the mine have been designed for closure.

The Brolga Project is not new or expanding so 'design for closure' is not relevant to this PRCP.

2.5 Rehabilitation/improvement planning

The PRCP Guidelines state that the administering authority has the expectation that all disturbed land, which is available for rehabilitation or improvement, should be progressively rehabilitated throughout the operation of the mine. Progressive rehabilitation must be maximised by commencing and completing rehabilitation as soon as practicable after land becomes available. As the mine is no longer operational, all areas of land are available for rehabilitation.

ML5866 Brolga is 204.3 hectares in total area. As the mine is no longer operational, the mining activity is currently at its maximum disturbance footprint, of 52.4 hectares.

Mining has occurred on ML5866 Brolga only. No mining activity, other than exploration, has taken place on ML5864 Canoona.

The Area of Disturbance for Brolga is shown at Schedule 1 of the Environmental Authority EPML01624913 – this figure is replicated at Figure 2-38 of this document. All remaining activities under the current mine plan include only rehabilitation works. Proposed rehabilitation activities cover the entire maximum footprint.

2.5.1 Progressive rehabilitatation

Given that the current mine plan includes rehabilitation only, progressive rehabilitation can be applied to several mine features at once. The Planning Process and Design for Closure has considered the risks of attempting to rehabilitate too many features in unison, which would create an unacceptable risk of failing.

2.6 Spatial Information

Spatial information as a Shapefiles has been submitted to the Department along with the submission of this PRC Plan. As per the requirements of Attachment 1 of the PRCP Application Form, shapefiles detailing the following information have been submitted:

- the location and maximum extent of disturbance footprint for the mine life
- the PMLU for the area within the resource tenures
- the rehabilitation areas within the resource tenures
- any sensitive receptors
- extent of a floodplain.



Figure 2-38. Brolga and Canoona Area of Disturbance – Schedule 1 EA EPML01624913

2.7 Existing rehabilitation

2.7.1 Pre QNI mining rehabilitation

A previous holder of the tenement conducted nickel mining within the ML5866 area from 1993 until 1995. Plans from that earlier stage of mining are not available to QNI, so exact details can not be given. However, the extent of operations at that time may be gauged from Figure 2-39 and Figure 2-40, which are a series of air photos from that period and illustrate the extent of disturbance that occurred around that time – pits can be seen in the western part of ML5866 (Figure 2-39).

Rehabilitation progress is illustrated by Figure 2-41, an air photo taken in 2004. A recent aerial image (Figure 2-3) shows that some of the areas that were mined or cleared in the 1990's have recovered to forest. The regrown forested areas are now primarily *Acacia* woodlands. A large area of land on the western side of ML5866 was revegetated during the late 1990's. That area has since become included as a Matter of State Environmental Significance, Regulated Vegetation – Essential Habitat (Figure 2-29).



Figure 2-39. Brolga Air Photo March 1994

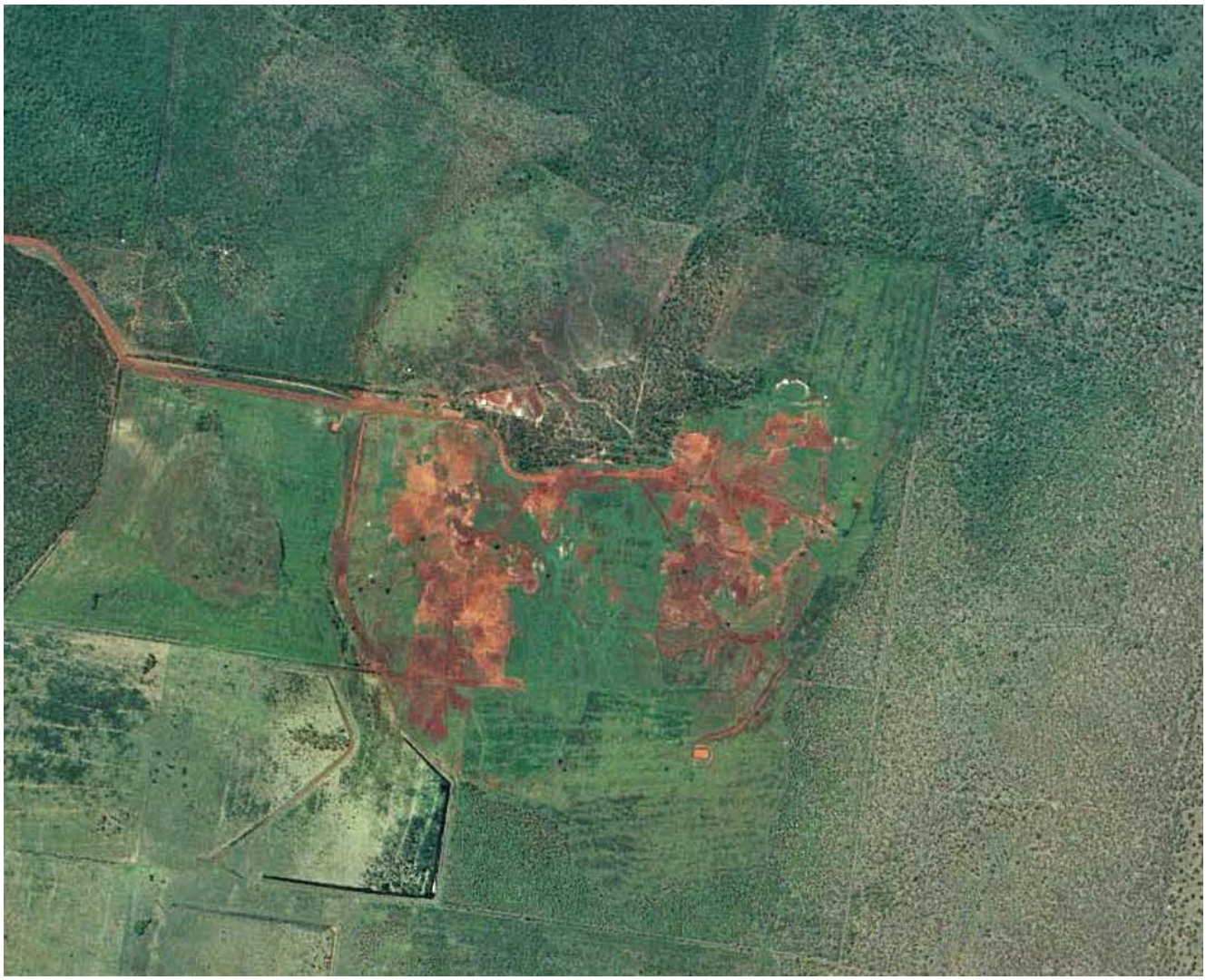


Figure 2-40. Brolga Air Photo December 1995



Figure 2-41. Brolga Air Photo July 2004

In terms of the method of rehabilitation activity, the area was selectively ripped in July 1999 and grass species planted. By 2002, previously mined areas had been re-contoured, topsoiled and, along with the cleared areas, seeded with green panic, silk sorghum, and Rhodes grass. Drill holes had been rehabilitated and areas which were slow to revegetate were re-ripped and seeded.

Site inspections to monitor the progress of rehabilitation at the site were completed in 2002, 2003, 2006, 2009 and 2011.

CQG Consulting were commissioned by QNI in 2012 to undertake an assessment of the rehabilitation status of the site at the time. A CQG ecologist and environmental scientist performed an Ecosystem Function Analysis (EFA) across six transects within the Brolga ML to provide a description of the functionality of the biogeochemical processes of the landscape through use of rapid assessable field indicators. The study investigated soil quality, vegetation structure, erosion, weeds and other environmentally relevant issues. Transects were positioned with a focus on areas of historic mine workings with accompanying reference transects placed outside of these areas (but within the mining lease) as controls. The EFA was performed in accordance with the CSIRO Landscape Function Analysis Manual (Tongway and Hindley, 2004). The key findings were:

- Ground cover across the study site was above 50 percent, indicating that revegetation had had a visible positive impact
- Some small areas, particularly those disturbed by historic mine workings and tracks, did contain bare dispersive soil with potential for erosion
- Vegetation and grass patches contributed greatly to the stability, infiltration and nutrient cycling of ML5866
- Low indices for transects 001, 002 (historic mine workings) indicated that follow-up revegetation may be required in these specific areas
- The ecosystems on ML5866 are functioning successfully, although it was recorded that work would be required to address the monoculture effect caused by the prevalence of lantana and *Acacia* spp.
- Weed control strategies were recommended to control both lantana and giant rats tail grass within the mining lease.
- It was recommended that the removal of lantana, which at the time was contributing to soil stability and nutrient cycling, should be conducted in concert with revegetation activities such as planting of native seedlings and grasses to prevent the backtracking of the land condition
- Weed control practices that did not involve the removal of the plant matter (i.e. herbicide spraying) were recommended to allow the remaining dead plant material to provide some soil erosion protection
- The condition of ML5866 – Brolga was considered largely suitable for its target end use as grazing land.

2.7.2 QNI rehabilitation

The CQG report commissioned by QNI was utilised in the development of the 'Brolga Rehabilitation Management Standard', which was developed to satisfy conditions G1 – G9 (Land and Rehabilitation) of the Environmental Authority (EMPL01624913).

The main features of the progressive rehabilitation process set out in the 'Brolga Rehabilitation Management Standard' include the following:

- construction of a stable final landform with minimal ponding of water within waste dump/backfilled areas
- progressive construction of the final landform design as part of normal mining operations, such that minimal reshaping is required at the end of mining
- use of suitable topsoil, which will either be stockpiled until suitable rehabilitation areas are available, or re-spread immediately across available rehabilitation areas
- deep ripping (as an erosion control measure and to facilitate seed propagation), seeding and (if required) fertiliser application preferably prior to the commencement of the wet season to maximise the benefits of subsequent rainfall
- treatment of declared weed species, when necessary, and
- minimisation of the final void area to reduce the potential for collection of water from direct rainfall and runoff from the rehabilitated landform.

Mining recommenced at Brolga in 2014 and continued until 2017. To date, QNI has undertaken the following rehabilitation measures and practices at the Brolga ML.

- stockpiling of topsoil
- back-filling of mined-out pits and respective bunding, covering an area of 19.5 hectares, comprising
  - Pit 1 – 20 % back-filled, in 2014 – 2015
  - Pit 2 – 100% back-filled, in 2014 – 2016
  - Pit 3/Oversized Dump – back-filled to 70% of its volume, during 2015 – 2016
  - Pit 4 – back-filled to 80% of its volume, during 2015 – 2016
  - Pit 5 North – 80% back-filled, during 2015 – 2017. About 14,000 cubic metres of fill are required to completely back-fill Pit 5 North.
  - Pit 5 South – 80% back-filled, during 2015 – 2017. About 29,000 cubic metres of fill are required to completely back-fill Pit 5 South.
- Monitoring for, and treatment of, declared weed species.

These works occurred progressively during mining operations. They have not been applied for to be progressively certified under the EP Act.

The other lease covered by the EA is ML5864, referred to as ‘Canoona’. It is 64.6 hectares in total area. ML5864 has had no mining activity and remains covered by remnant vegetation (RE 11.11.7 *Eucalyptus fibrosa*). Small areas of disturbance have occurred as a result of exploration, but natural revegetation of the disturbed areas has occurred and as such, the site requires no rehabilitation activity (any attempt to undertake rehabilitation would create more damage than benefit). The only rehabilitation related activities that have occurred on the Canoona ML are the building of a fence and weed maintenance.

3 Community Consultation

3.1.1 Background and purpose

This section describes the community and stakeholder consultation that has been undertaken to inform the development of this PRCP (consultation register), and the consultation that will be undertaken throughout the implementation of the PRCP (consultation plan).

As noted in Section 2.1, the Project is located in a sparsely populated area off the Bruce Highway approximately 55 km north of Rockhampton. The land directly surrounding the ML's is characterised by cattle grazing and sparse settlement on the various properties. QNI Resources Pty Ltd and QNI Metals Pty Ltd are the owners of the land, and there are three landholders directly adjacent to the sites. The nearest towns or townships are Marlborough located 52 km to the north-east and Yaamba approximately 11 km to the south-west. The project is located within the Livingstone Shire Council Local Government Area.

The mine is in care and maintenance with very limited activities taking place on site, and as such the move to rehabilitation is unlikely to cause any noticeable impacts on nearby communities.

3.1.1.1 Stakeholders

As a starting point for the consultation process a stakeholder identification process was undertaken, seeking to identify stakeholders that would potentially be impacted by the project or who had an interest in it. For the purpose of this plan, and due to the very limited anticipated impact of the project, the three private landholders adjacent to the sites, the two occupied properties along the access road (Nickel Road), as well as the local council were considered pertinent stakeholders for inclusion in the consultation process[3].

The stakeholder identification is presented in Table 3-1 below. Note that individual names have been removed to protect the privacy of individual stakeholders, where landholders are companies or government entities names have been revealed.

Figure 3-1 shows the sites and adjacent landholders.

[3] No community groups have been identified relevant to the area, and a search of the National Native Title Tribunal's registers identified no claims or determinations over the ML's.

Table 3-1. Stakeholder Identification

Category	Stakeholder
Underlying landholder (QNI Resources Pty Ltd and QNI Metals Pty Ltd)	Landholder of Lot 176 on LN473 and Lot 1 on SP322712 (Brolga) and Lot 1 on RP620757 (Canoona)
Adjacent landholders of ML5866	Landholders of Lot 178 on LN604 (Landholder 1)
	Landholders of Lot 183 on LN91 (Landholder 1)
	QMCH Pty Ltd & QMC (Kunwarara) Pty Ltd (Lot 629 on LIV40156) (Landholder 2)
	Yeppoon Grazing Pty Ltd (Lot 173 on LN393) (Landholder 3)
	Yeppoon Grazing Pty Ltd (Lot 175 on LN473) (Landholder 3)
Adjacent landholders of ML5864	QMCH Pty Ltd and QMC [Kunwarara] Pty Ltd) (Lot 3 on RP620757) (Landholder 2)
	QMCH Pty Ltd and QMC [Kunwarara] Pty Ltd) (Lot 1 on RP601266) (Landholder 2)
	Qld Dept of Transport and Main Roads (Lot 172 on SP108274)
	QNI Resources Pty Ltd and QNI Metals Pty Ltd (ML owner)
Occupied properties adjacent to access road	Landholders of Lot 1 on RP889900 (Landholder 4)
	Landholders of Lot 2 on RP889900 (Landholder 5)
Local government	Livingstone Shire Council
Community	Marlborough / Raspberry Creek Community

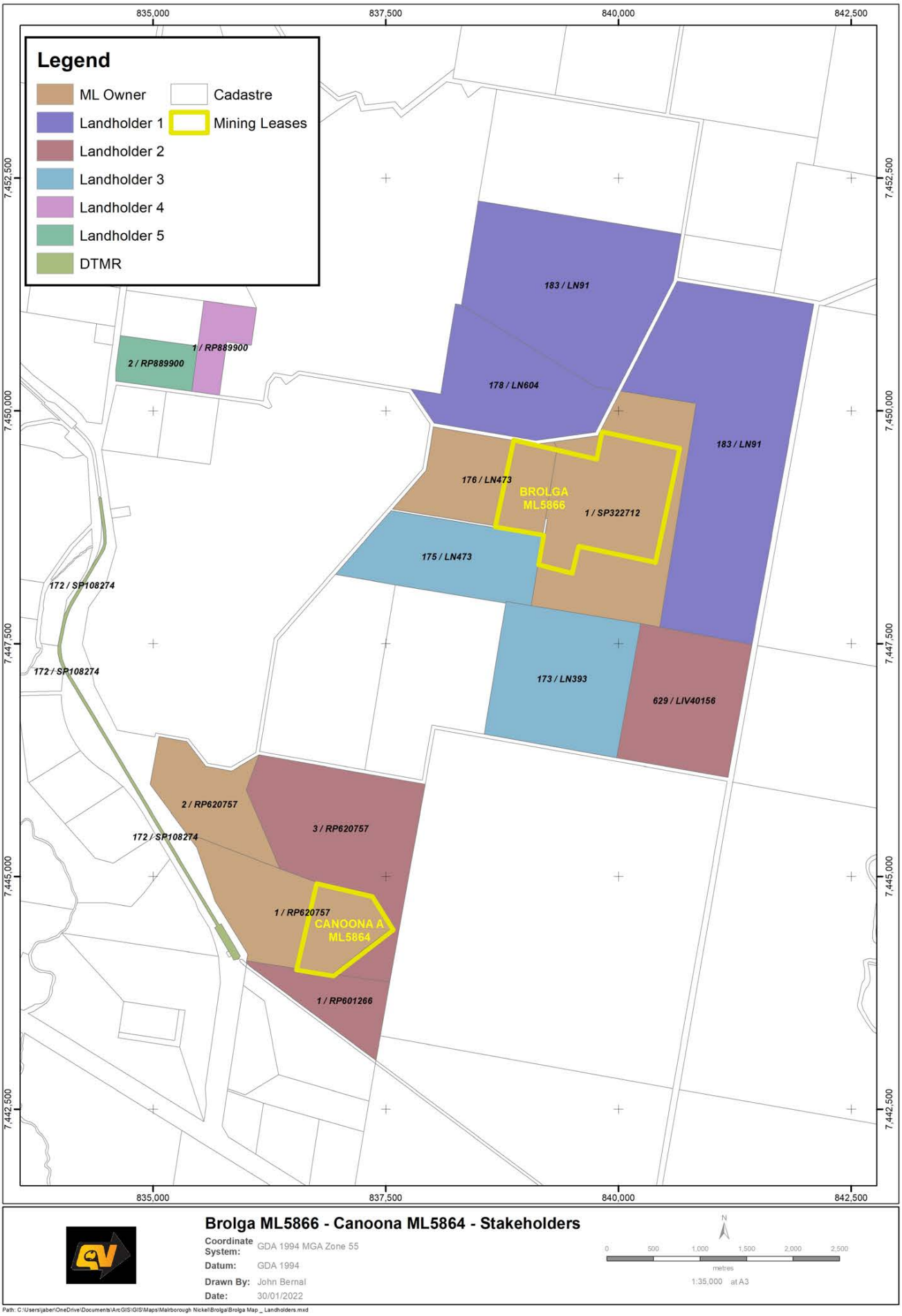


Figure 3-1. Adjacent landholders

3.1.2 Consultation Register

Informal consultation has occurred with the adjacent landholders over the life of the mine, including when it has been under care and maintenance.

The Mine Manager, who had main responsibility of the mining operations on site, and will be responsible for the rehabilitation and closure works, is a local and lives in the nearby community of Marlborough. As such, the Mine Manager has engaged with local stakeholders via a variety of methods, including face to face meetings and briefings at different opportunities with people from town, business owners, and adjacent landholder to share information about the status of the mine and the rehabilitation. Although these meetings have not been recorded, valuable information has been extracted from them and applied in this PRCP.

Specifically for this PRCP, the following formal consultation has occurred:

1. A letter with key content of the plan was sent to the five relevant private landholders on 23 December 2021 and council in January 2022 (a copy of the letter is provided in Appendix 7).
2. The proponent directly sought to contact these via phone or email in January 2022 to follow up on the letter and offer a face to face meeting or phone consultation.
3. Three of the landholders and council accepted the offer and face to face or phone consultation meetings were subsequently held with these. A consultation protocol was developed for these meetings to guide the discussion, seeking to elicit any concerns, expectations for ongoing consultation, and views on the proposed post mining land use and final landform.

One landholder near the access road (Landholder 5) was unable to be contacted via phone as the property had recently been sold and contact details were not readily available.

Table 3-2 below provides the community consultation register.

3.1.3 Consultation plan

In light of the limited impact of the project, and relatively low level of interest from most stakeholders, a targeted consultation program has been developed with the objectives of:

- *informing* adjacent landholders about key events during the implementation of the plan, particularly events which may impact them.
- providing them with an opportunity to *raise any issues* during the implementation of the plan.
- *informing* adjacent landholders and council when the plan is completed.

Table 3-3 below outlines the consultation activities currently planned during the implementation of the plan. As there was a relatively low level of interest in scheduled communication other than at relevant events, no regular information provision (such as annual updates) is planned.

Table 3-2. Consultation register

Consultation Date	Community member	Consultation type	Information provided	Summary of discussion / issues raised	How issues were considered	Decisions /outcomes	Commitments
18/01/22	Landholder 1	Face to Face meeting	Letter provided in Appendix 7. Figures showing final land form and post mining land use.	• Confirmed letter had been received • Discussed weed control • Discussed run off from block • Discussed post mining land use.	• Landholder (LH) is concerned with a perceived inactivity on weed control, specifically Giant Rats Tail Grass. We were treating this specific weed with control agent when the landholder arrived for meeting. • Run off from the block is also an issue. This was more about actual water flowing off the side of the hill and not Mine runoff. • LH was happy with post mining land use as low impact grazing rather than perceived feral animal haven if returned to native habitat.	• Improve weed control	• Increase frequency of weed control – see Section 8.1.6
20/01/22	Landholder 4	Phone Meeting	Letter provided in Appendix 7. Figures showing final land form and post mining land use.	• Confirmed letter had been received. • Discussed weed control and potential for dust. • Discussed post mining land use.	• Giant Rats Tail Grass is a concern for the landholder. How to ensure limit of spread was discussed. Confirmed weed control would be investigated. • The potential for an increase in dust if increased traffic levels was also raised. Informed the landholder minimal traffic was expected unless mining resumed which is not currently planned • The Landholder was happy with post mine land use as grazing.	• Improve weed control	• Increase frequency of weed control – see Section 8.1.6
21/1/22	Landholder 3	Phone meeting	Letter provided in Appendix 7. Figures showing final land form and post mining land use.	• Confirmed that letter had been received. • Discussed run off and potential for weed spread. • Discussed dust monitoring and communication during rehabilitation works.	• Landholder noted the letter had been in the weather and a bit damaged. Electronic copy was emailed to LH after meeting. • The landholder was concerned about water runoff from the mine property on the northern side of their property, and the potential for that to spread weeds. • The landholder was also interested in dust monitoring during rehabilitation works. • The landholder would like a meeting with QNI to discuss works potentially affecting their property prior to them commencing. Committed to meeting as requested	• Improve weed control. • Consult with LH prior to relevant works	• Increase frequency of weed control see Section 8.1.6 • Meet with LH prior to activities which may affect them in accordance with

				• Discussed post mining land use.			consultation plan. • Implement dust control in accordance with section 8.1.7 of this plan.
4/2/22	Landholder 2	Email	Letter provided in Appendix 7. Figures showing final land form and post mining land use.	• The Landholder had no issues with the proposed plan and had no further comments.	• N/A	• N/A	• N/A
7/2/22	Livingstone Shire Council NRM officers	Teams	Letter provided in Appendix 7. Selected content from ecological assessment and draft PRCP, particularly relating to proposed revegetation species and post mining land use	• Post mining land use • Species selection, timing for seeding, seed acquisition. • Ongoing engagement with council • Species selection, seed acquisition and timing for seeding was discussed.	• Council officer noted they operated a community nursery with plants endemic to the serpentinite region. • Officer noted that low intensity grazing was an acceptable post mining land use but cautioned about impacts of too high intensity grazing. • Discussed which species would be suitable, as well advisable time and method for seeding. Council officer noted the proposed timing in the plan might not be suitable. Discussed that trials would be useful to understand optimal timing. • Council officers also noted challenges about acquiring seeds, and mentioned that if seeds were purchased from the community nursery they would like advance notice and a small upfront payment.	• Continue to engage with council around revegetation efforts throughout the completion and implementation of the plan. • Sent ecological assessment to council officers. • Species selection described in Section 6.1.8 expanded using council information.	• Engage with council again prior to completion of plan in accordance with consultation plan.

Table 3-3. Planned consultation activities

Objective	Engagement type	Proposed consultation frequency	Released information	How feedback / comments are considered
Inform all landholders about commencement of activities.	Letter, email or phone as per their preference.	One off – on commencement of activities, currently scheduled for April 2024.	Letter confirming the activities, location and schedule.	Consider in schedule and execution plan.
Inform landholder about works that may affect them.	Phone or face to face meeting.	One off – on commencement of activities in area adjacent to Yeppoon Grazing Pty Ltd's property, currently scheduled for 2024 (the rehabilitation trials -RA1).	Schedule, nature and location of relevant activities.	Consider in schedule and execution plan.
Inform all landholders about unanticipated material change in schedule or methodology.	Letter, email or phone as per their preference.	One off – should unanticipated material change in schedule or methodology occur	Nature of unanticipated change.	To be determined depending on the nature of change.
Consult with council about final species selection and methodologies.	Teams or face to face meeting. Site visit.	One off and potentially ongoing during implementation.	Relevant aspects of plan.	Confirm species selection and seeding methodologies.
Inform all landholders about completion of activities.	Letter, email or phone as per their preference.	One off – on completion of the plan, currently scheduled for April 2033.	April 2033.	Inform all landholders and council via letter / email / phone as per their preference.
Enable all landholders to *raise concerns.*	Provide phone number and email address to all landholders.	Reactive.	Contact phone number and email.	To be determined depending on the nature of concerns raised.

4 Post-mining Land Use

The post-mining land use (PMLU) for both Brolga and Canoona, in both disturbed and non-disturbed areas, will be low-intensity grazing. The Area of Disturbance for the Brolga Project is detailed in Schedule 1 of the Environmental Authority EPML01624913, which is replicated in this document as Figure 2-38. The unshaded area shown in Figure 2-38 in the north part of the Mining Lease is a Conservation Area, which was designated (in the land outcome document 'Brolga Rehabilitation Management Standard' [Appendix 3]) to be undisturbed by rehabilitation activities, other than weed control and fencing to ensure protection from excessive grazing.

4.1 ML5866 Brolga

4.1.1 Consistency with Land Outcome Document

The PMLU of low-intensity grazing set out in this PRCP was previously addressed in the land outcome document 'Brolga Rehabilitation Management Standard' (Appendix 3). This document was prepared to satisfy condition G3 of the Environmental Authority (EMPL01624913) which required that, "All areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover in accordance with the submitted rehabilitation management plan". The document was approved on 28 May 2014 and was the rehabilitation management standard being utilised prior to the enactment of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (MERFP Act) which brought about the requirement to submit this PRCP.

4.1.2 Consistency with past land use, surrounding land uses and stakeholder preferences

The main land use in the areas surrounding the MLs is grazing – more specifically, Pasture Land - Native Pastures. Figure 2-36 shows the land uses in the area. As such, the PMLU of low-intensity grazing is consistent with the surrounding land uses, soil types and stakeholder preferences (no stakeholder has raised any objection to the proposed PMLU of low-intensity grazing). Both MLs have been grazed in the past.

4.1.3 Environmental Considerations

Whilst the final PMLU is grazing, the environmental values of the sites and surrounds have been considered.

The post-mining rehabilitated land on Brolga will provide some ecological values. Although some introduced grasses will be planted, and are already established, native grasses and forest species will be included.

Rehabilitation plans include the planting of substantial areas of trees and shrubs in the 'forest' and 'sparse woodland' areas. Seeds will be sown from seed collected from healthy plants growing near to the Brolga ML, and in similar environmental conditions (such as the Canoona ML). This will ensure the plants are better adapted to the local environment which gives the best chance of survival and provides for conservation of local genetic variations.

The forest and sparse woodland revegetation strategy provides shade for stock, windbreaks, habitat for a greater range of fauna, particularly avian fauna; an increase in organic material in soil, increased protection against soil erosion and ultimately a self-sustaining vegetation community.

Careful selection of species will be made to ensure those selected are suitable for primary and secondary succession stages of regrowth in the intended areas. For example, slopes and the edges of overburden dumps will be sown with *Acacia* species (among others). *Acacia* is a fast-growing shrub which is an ideal pioneer species, and grows well on rocky surfaces. Livingstone Shire Council revegetation specialists (who are very familiar with revegetation in serpentine landscapes) will be consulted in the finalisation of species lists.

The final voids are designed for closure as dams. The relevant pits are Pit 1, Pit 2 Extension and Pit 8. The existing dam on the eastern boundary (Dam 4) will remain. All open pits currently have exit ramps which will be preserved in the final landform design. The gradients of the final landform are illustrated in Figure 6-3.

The design has had consideration the direction of drainage. The majority of the rainfall landing on site will be captured on site in existing impoundments to provide for the PMLU of grazing (see Figure 2-12). This will also provide for protection surrounding properties and environmental values during the rehabilitation activities prior to revegetation when water run off is expected to contain more sediment.

The final landform will provide visual amenity that is reasonable for the surrounding area.

4.1.4 Remaining Infrastructure

Existing dams, concrete pads and tracks will be preserved post-mining for use in grazing practices and to assist with sediment and runoff control (see Section 6.6 below). The landholders, QNI, have provided a statement that they will accept responsibility for the infrastructure once mining has ceased (see Appendix 8).

The aforementioned infrastructure will be retained as it is consistent with the low-intensity grazing PMLU. The toilets and showers within the bath-house will be useful for future landholders. The roads will allow for access around the site for management of weeds, fire and cattle. The water infrastructure will allow the water captured on the site to be utilised for pasture irrigation and cattle watering. As demonstrated in Section 2.3.5.4, the quality of the water in these impoundments will be suitable for stock watering and irrigation.

4.2 ML5864 Canoona

ML5864 has had no mining activity other than exploration drill holes. ML 5864 is covered by remnant vegetation (RE 11.11.7 *Eucalyptus fibro*sa) and requires no rehabilitation activity other than fire and weed management. The site has never been cleared but has had some low intensity cattle grazing. Therefore, the PMLU is consistent with how the land was used before the mining activity was carried out on the land. Provided the cattle grazing is kept to a low level, and weed monitoring and management is carried out (particularly for weeds that cattle may spread), the PMLU will deliver a beneficial environmental outcome, as the Canoona ML contains threatened flora and provides habitat values for a range of native species.

No surface or groundwater features are located on the site requiring ongoing management.

The Canoona ML has been verified by an independent ecologist (see Appendix 6) to be successfully rehabilitating on its own and does not require any human intervention other than weed control and fire management. Therefore, the land is in stable condition, no environmental harm is being caused by anything on or in the land, and the land can sustain the PMLU.

4.3 Rehabilitation Areas

A rehabilitation area is defined in the EP Regulation as an area of land in the PMLU to which a rehabilitation milestone for the post-mining use relates. Rehabilitation areas and improvement areas must be based on the proposed rehabilitation or management methodology applicable to the PMLU.

Accordingly, 24 Rehabilitation Areas (RAs) have been defined (see Table 4-1), based upon the methodology described in Section 6.1 and 6.3. Figure 4-1 and Figure 4-2 show the distribution of the RA's.

4.4 Timing of Rehabilitation Activities

The rehabilitation activities (described in Section 6.1 and 6.3) to be applied to each Rehabilitation Area will occur in four stages commencing in 2024. Prior to active rehabilitation, rehabilitation trials will occur for two years (see Section 7.1).

1. The first rehabilitation stage, commencing in 2024, involves undertaking site inspections and confirming removal of infrastructure not being retained, and undertaking contaminated site investigations. Rehabilitation trials (RA1) also commence in 2024.
2. The second rehabilitation stage, commencing in 2024 with surface preparation completed in 2025, is to rehabilitate all pits that have already been partially or fully back-filled (RA2, 3, 4, 5 6 and 7). Their scheduling will allow a large area of land to be rehabilitated without requiring extensive earthworks. Their early establishment will further serve as indicators (in addition to the rehabilitation trials) of the success of the rehabilitation and revegetation methods.
3. The start of the third rehabilitation stage will coincide with the second stage for initial earthworks, commencing in 2025, to start landforming in areas that require time to compact (RA8, 9 and 10 - the Nontronite Stockpile and Go Line Pad). These areas will then be actively rehabilitated from 2027.
4. The fourth rehabilitation stage, commencing in 2028, is to rehabilitate all other areas, including the three pits that are currently open and will become dams (RAs 11, 12, and 15 – Pit 1, Pit 2 Extension and Pit 8) as well as the remaining operational areas (RAs 13, 14, 16, 17 - ROM, Screening Stockpile, Waste Rock Dump and Front Pad) and Dam 4 (expected to be minimal but some stabilisation and revegetation works may be required on or near banks).

A more detailed description of the activities to occur in each rehabilitation area is given in Section 4.5.2 below with reference to the rehabilitation milestones described below in Section 4.5.1. A summary table of the start and finish date for each Rehabilitation Area is included in Table 4-2.

The PRCP Schedule is detailed in Appendix 1.

Table 4-1. Rehabilitation Areas (RAs)

Rehabilitation Area (RA)	RA Name
RA1	Test Pits
RA2	Pit 2
RA3	Pit 3/Oversized Dump
RA4	Pit 4
RA5	Pit 5 North
RA6	Pit 5 South
RA7	Topsoil Dump 2 and Topsoil Dump 3
RA8	Nontronite Stockpile
RA9	Top Pad
RA10	Go Line Pad
RA11	Pit 1
RA12	Pit 8
RA13	ROM
RA14	Screening Stockpile
RA15	Pit 2 Extension
RA16	Waste Rock Dump
RA17	Front Pad
RA18	Topsoil Dumps 1, 4, 5, 6, 7
RA19	Haul Road
RA20	Bath-house Area
RA21	Dam 4
RA22	Brolga
RA23	Canoona
RA24	Water bores

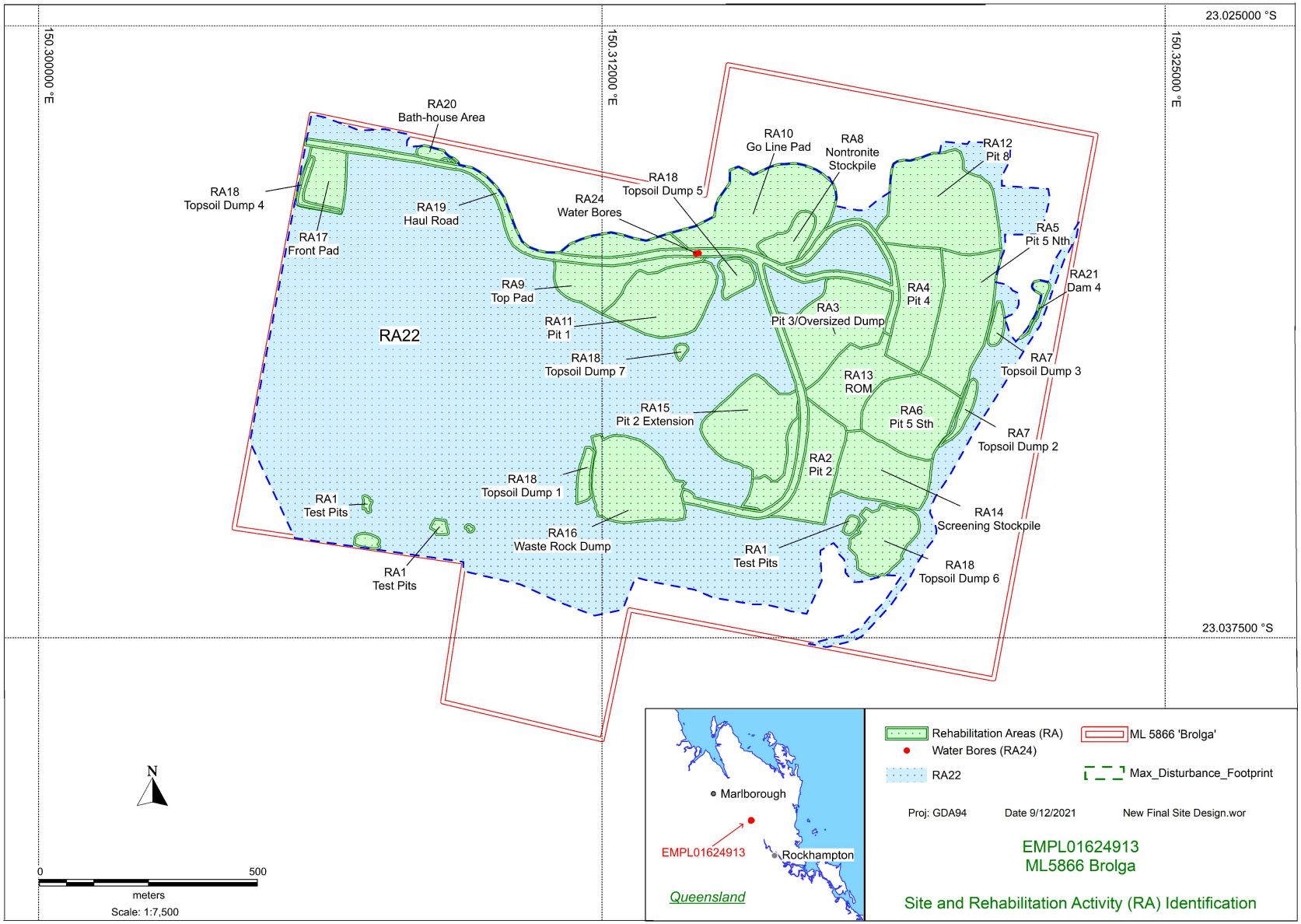


Figure 4-1. Brolga Rehabilitation Areas

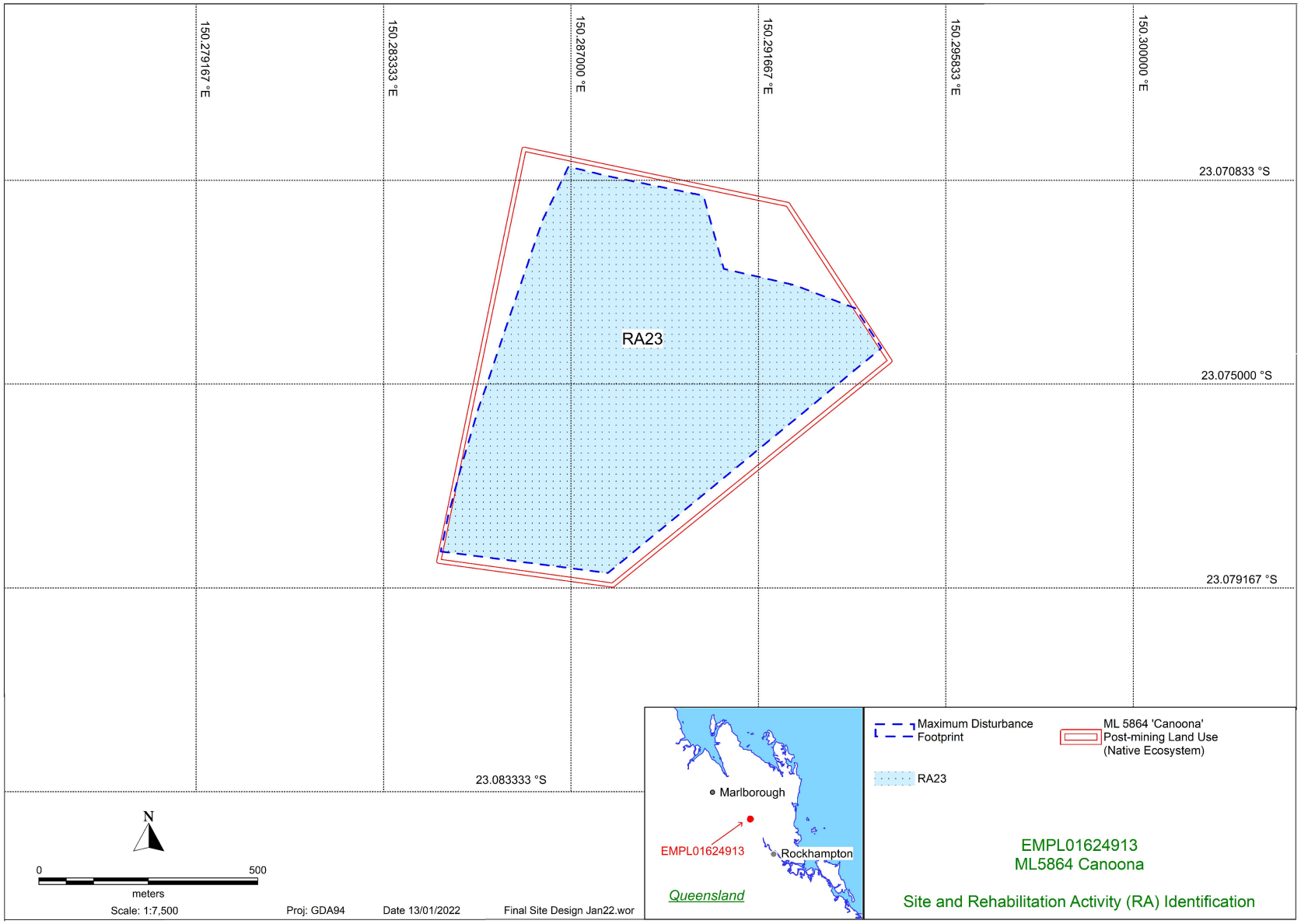


Figure 4-2. Canoona Rehabilitation Area

Table 4-2. Start and Finish Dates for Rehabilitation Areas

Rehabilitation Area (RA)	RA Name	Area (Ha)	Activity Start	Activity Finish
RA1	Test pits	0.45	Feb 2024	Dec 2028[1]
RA2	Pit 2	3.56	Feb 2024	Dec 2029
RA3	Pit 3/Oversized Dump	3.56	Feb 2024	Dec 2029
RA4	Pit 4	2.73	Feb 2024	Dec 2029
RA5	Pit 5 North	3.57	Feb 2024	Dec 2029
RA6	Pit 5 South	3.06	Feb 2024	Dec 2029
RA7	Topsoil Dump 2 and Topsoil Dump 3	0.55	Feb 2024	Dec 2029
RA8	Nontronite Stockpile	0.82	May 2024	Dec 2031
RA9	Top Pad	2.84	May 2024	Dec 2031
RA10	Go Line Pad	4.45	May 2024	Dec 2031
RA11	Pit 1	2.98	May 2024	Dec 2033
RA12	Pit 8	4.92	May 2024	Dec 2033
RA13	ROM	2.43	May 2024	Dec 2033
RA14	Screening Stockpile	2.66	May 2024	Dec 2033
RA15	Pit 2 Extension	3.36	May 2024	Dec 2033
RA16	Waste Rock Dump	3.32	May 2024	Dec 2033
RA17	Front Pad	1.36	May 2024	Dec 2033
RA18	Topsoil Dumps 1, 4, 5, 6, 7	2.88	May 2024	Dec 2033
RA19	Haul Road	4.47	May 2024	Dec 2031
RA20	Bath-house Area	0.19	May 2024	Dec 2031
RA21	Dam 4	0.17	May 2024	Dec 2032
RA22	Brolga	92.97	May 2024	Dec 2028
RA23	Canoona	52.38	May 2024	Dec 2027
RA24	Water bores	0.001	Jan 2030	Dec 2032

1 Note that revegetation will have occurred and establishment will be completed when landforming starts in some of the other areas (RA2-RA7), and vegetation will be established once other areas have started. To allow better understanding of long term effects, RA1 will continue to be monitored until the end of monitoring in all areas (i.e. Dec 2033).

4.5 Rehabilitation Milestones and Criteria

In accordance with the PRCP guideline, milestones, milestone criteria and PMLU completion criteria have been developed that are SMART:

- Specific
- Measurable
- Achievable
- Relevant, and
- Time bound.

4.5.1 Milestones

Each of the Milestones are applied to most of the Rehabilitation Areas. There a few exceptions - the Haul Road (RA19), Bath-house Area (RA20), and the balance of Brolga and Canoona (RA22 and RA23 respectively) which do not require earthworks or revegetation (earthworks for the haul road may be required but would be minor). All other rehabilitation areas require all eight Rehabilitation Milestones to be accomplished, although rehabilitation of the water bores simplifies the final two milestones into one, given their very small area.

The Milestones are described below in Table 4-3.

Milestone completion criteria, rehabilitation indicators and the justification of their relevance are given in Table 4-4 in Section 4.5.2.

Table 4-3. Rehabilitation Milestones

Rehabilitation Milestone	Milestone description	Milestone activities
RM1 Area available for rehabilitation free from contaminants	This RM seeks to ensure that the area available for rehabilitation is not contaminated, and that all infrastructure not being retained has been removed from the area.	• a visual inspection of the area to confirm the removal of all equipment and infrastructure not being retained on-site, and to document the condition of any infrastructure to remain. As part of this phase, an infrastructure management plan will be prepared detailing all infrastructure to remain on the site after rehabilitation, and the management and maintenance requirements until handover of the site. • A contaminated site investigation prepared by a suitably qualified person and certified by an approved auditor, to contain: - a site investigation report, assessing and making a determination as to whether contamination exists - where contamination is identified, and following remediation of the site, a validation report, describing works undertaken to remediate any contamination found, results of validation testing, and confirmation that contamination is removed or suitably treated or controlled - a site suitability statement, stating that the land is suitable for the intended post-mine land use. • As part of this process, remediation works may be required, which will be undertaken prior to any rehabilitation works commencing in the area. • An assessment shall also be made of the sediment within surface water impoundments, to determine whether these sediments may put meeting the water quality targets at risk. Where this is the case, remediation will be required, which may involve removal (dredging or other removal), and on or off-site disposal and encapsulation, or on or off-site treatment. An assessment report shall be prepared by a suitably qualified person, along with certification of the suitability of the impoundments to support the water quality targets, based on the sediment assessment, results of validation testing (if required), and water quality testing. Surface and groundwater testing shall commence from this phase and continue throughout the rehabilitation process.
RM2 Re-shaping landform complete	This RM involves land shaping and earthworks activities, including detailed design works, undertaking the works, and ensuring that landforms meet the final	• Finalise engineering and design plans • Install bunds and other erosion and sediment control system • Bulk earthworks to achieve required landform and slopes

Rehabilitation Milestone	Milestone description	Milestone activities
	landform design requirements. It does not include topsoiling. All instances of this RM occur in the dry season, by the end of August.	• General reshaping and pushing/ trimming to achieve final landform • Fill in all voids except for Pit 1 (RA11), Pit 8 (RA12) and Pit 2 Extension (RA15)
RM3 Surface preparation completed	This RM is surface preparation including surface ripping to relieve soil compaction that could restrict root growth, encourage water infiltration and reduce the risk of erosion; assessment of soil availability and quality; application of subsoil (where required) and topsoils; soil amelioration based on the soil quality assessment, and continued monitoring for erosion and land stability. All instances of this RM occur in the dry season and are completed by the end of August or September. Most Rehabilitation Activities require topsoiling immediately after the earthworks. One Rehabilitation Area, the Nontronite Stockpile (RA8) is not topsoiled until two years after earthworks, to allow for compaction of the newly spread rock material.	• Undertake assessments of soil quantity and quality, application requirements • Trim, rock rake and deep rip where required • Spread subsoils where required and topsoil • Soil amelioration as nominated in the assessment above (e.g. fertiliser) • continued monitoring for erosion and land stability • Undertake a check on the recent earthworks and surface preparation works for instability, erosion or other failures • Remediate any erosion or subsidence • Conduct water quality testing to ascertain compliance with trigger limits
RM4 Revegetation	This RM simply refers to the seeding of the area. All seeding (and all instances of this RM) is scheduled in September or October, when spring rain is expected.	• Direct seeding and fertiliser application • Seeds raked in • Application of mulch and fertiliser into sparse woodland revegetation areas • Firebreak maintenance • Continued monitoring for erosion and land stability
RM5 Vegetation is established	This RM refers to a check on the germination success of the most recent seeding. All instances of this RM occur by May-June in the calendar year following	• Monitoring to determine whether vegetation has established suitably in the revegetation areas

Rehabilitation Milestone	Milestone description	Milestone activities
	seeding. This allows one full wet season for sown seed to germinate, grow and begin to drop leaves. This RM includes assessment of vegetation cover and stem density, along with weed surveys and assessment for bare unvegetated patches, to confirm the success of vegetation establishment, and remediate any issues that are identified. Firebreak management and monitoring for erosion and land instability is continued.	• Monitoring to determine whether target species diversity and density meets required criteria • Weed management • Remediation of any identified shortfalls against the targets • Firebreak maintenance and continued monitoring for erosion and land stability
RM6 Final sustainable landform achieved	Required to determine whether the vegetation regrowth has grown vigorously enough to be grazed, is likely to self-seed in the future, and is mature enough and pervasive enough to prevent erosion of the area, with the objective of confirming that the rehabilitation area has achieved a stable and sustainable condition and achieves the purpose of the post-mining land use.	Collect evidence to show that the land is safe, structurally stable, does not cause environmental harm and is able to sustain the PMLU. This will include: • An assessment of the carrying capacity of grazing lands • An assessment of land suitability class to provide a final confirmation that the land can be considered to have met the PMLU requirement of low intensity grazing lands. • An assessment of vegetation cover • An assessment of surface water impoundment water quality against targets, and groundwater against the target of no change from baseline • Continued monitoring for erosion and land stability, and monitoring and management of weeds Any rectification activities identified will also be actioned and monitored for success.

4.5.2 Milestone Completion Criteria, Rehabilitation Indicators and Justification

Table 4-4. Milestone completion criteria, rehabilitation indicators and justification

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
RM1 Area available for rehabilitation free from contaminants	All areas	• Confirm all equipment and infrastructure not being retained for post-mine use has been removed	• Documented visual inspection (including photographs) to confirm all buildings, equipment, machinery and plant not to be retained have been removed	• Site must not contain infrastructure or equipment that requires management or remediation after rehabilitation completed • Only the infrastructure / buildings able to support the post mining land use are to be retained
		• Contamination absent, or suitably encapsulated and controlled	• Contaminated site investigation report prepared by a suitably qualified person and: • Site suitability statement, stating that area is not contaminated and is suitable for the post-mine land-use of low intensity grazing, OR • Following any required remediation / control works, site management plan completed stating the area is suitable for the post-mine land-use of low intensity grazing	• To ensure a safe and non-polluting site, contamination should be absent or suitably controlled, so that there is no ongoing pollution, safety issues, or contamination of surface or groundwaters
		• Sediment in water impoundments suitable to support long term water quality targets	• Investigation report from a suitably qualified person that: • Sediments in water impoundments are not contaminated, OR • Sediments have been remediated or removed and disposed of lawfully	• To support long term water quality targets, sediments should not be capable of causing water quality deterioration (outside of water quality targets) or present a long-term contamination source
RM2 Re-shaping	RA2, RA3, RA5, RA6,	• Bulk earthworks completed to final landform design plans	• Evidence of completion to design plans, including photographs, confirmation survey, and confirmation by suitably	• To establish a stable condition for land, the final site design specifications must

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
landform complete	RA8 RA11-18	• No voids / impoundments remaining other than Pit 1, Pit 2 extension, Pit 8 and Dam 4	qualified person that all final site design specifications met	be met to demonstrate final landform stability • All voids should be filled unless planned to be retained in the final landform design
		• Landform geotechnically stable - All embankment slopes ≤15%, or otherwise certified as stable with FoS≥1.5 by appropriately qualified geotechnical engineer - Compaction requirements of final design plan a	• Certification from a suitably qualified geotechnical engineer that: - slopes, including graded banks and waterways, are safe and stable. - material has been suitably compacted, based on an appropriate number of test sites in the field - Predictions / risk assessment completed confirming future long term stability and safety of landform	• Required to confirm the post-mining landform is safe and stable. An existing assessment of slope stability has been conducted (AMEC 2021), which will be confirmed in this phase of the works.
		• Drainage system installed to final landform design plans, confirmed by survey • No active rill, gully or sheet erosion visible within the rehabilitation area	• Site confirmation survey • Certification from a suitably qualified engineer that drainage systems have been appropriately reinstated • Records of visual inspections that no active rill, gully or sheet erosion is visible in the area	• A long term, stable drainage system has been installed, and no significant erosion is occurring, confirming the suitability of the landform and drainage system. Long term erosion to be controlled after surface preparation and revegetation
		• Confirmation that safety fencing and signage is in place above all slopes determined to be a potential safety risk to humans or cattle	• Certification from a suitably qualified person that all slopes do not present a safety risk based on the slope and/or exclusion fencing	• Slopes should be safe and stable, and where potential for fall injury is present, fenced off with appropriate signage installed. This should be undertaken in this milestone stage to protect the safety of personnel working to rehabilitate the site as well as long term site users.

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
RM3 Surface preparation completed	All areas except RA19, RA20, RA22, RA23	• Suitable soil resources are available to complete surface capping and soil establishment	• Assessment report detailing volumetric assessments of available vs required soil volumes, and sources for any makeup volume required	• Confirm that the amount of soil available is suitable to support the proposed works. Note that topsoil application will approximately match the amount of topsoil already removed and stockpiled, and more than sufficient subsoil material is available on-site, and so no soil shortfalls are anticipated.
		• Ripping to minimum 600-750mm at ripper spacing of approximately 1.2m across rehabilitation areas	• Records of visual inspections that surfaces have been appropriately ripped, including photographs	• The ripping and topsoils applications are those set out in the approved land outcome document (Brolga Rehabilitation Management Standard, 2014) • Ripping may be required to encourage root development to a depth that is suitable for vegetation to stabilise soils, minimise erosion and encourage keying in of different soil layers
		• Minimum 500mm subsoil across all rehabilitation areas	• Certification from suitably qualified person that the minimum subsoil depth has been reinstated, or exists prior to topsoiling	• Subsoil and topsoil should be applied at depths that will support plant growth, are practical for application by machinery, and be stable long term (will not blow or wash away)
		• Minimum 100mm topsoil across all rehabilitation areas	• Certification from suitably qualified person that the minimum topsoil depth has been reinstated	
		• Soil health and suitability assessment confirms topsoil is suitable for seeding	• A soil health and suitability assessment report prepared by a suitably qualified person to confirm soil is suitable for target vegetation establishment • Documented confirmation from a suitably qualified person that all requirements of the soil health and suitability assessment implemented	• Soil fertility assessments to confirm whether soils are suitable for establishment of target vegetation and to specify any requirements for topsoil amelioration prior to (or during) seeding

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
		• Erosion controls in place to minimise erosion of sub- and topsoils	• Records of visual inspections, including photographs and confirmation that erosion control plans have been implemented	• No active rill, gully or sheet erosion should be visible prior to seeding and revegetation activities • No environmental harm or nuisance should occur due to dust generation • Continued check that the landform and drainage system remains stable and suitable to prevent significant erosion. • Erosion controls in place to protect prepared surfaces
		• No active rill, gully or sheet erosion visible within the rehabilitation area	• Visual inspection (weekly, or as required) by a suitably qualified person to confirm there is no active rill, gully, or sheet erosion • No visible dust leaving site that may cause environmental harm or nuisance.	
		• Surface water quality in impoundments meets water quality targets OR shows no deterioration. Targets as follows (from the EA): - pH >4.0 – 9.0 pH units - Electrical Conductivity (EC) 5970 µS/cm - Sulfate as SO4 1000 mg/L - Fluoride 2mg/L - Total Arsenic 0.5 mg/L - Total Cadmium 0.01 mg/L - Total Chromium 1 mg/L - Total Cobalt 1 mg/L - Total Nickel 1 mg/L	• Records of water quality monitoring for target indicators • Report by suitably qualified person: - confirming water quality meets water quality targets, OR - confirms no worsening of water quality within site impoundments OR - advising of remediation requirements to meet water quality targets by end of rehabilitation works	• Surface water in monitoring locations meets post mining land use water quality targets. However, water quality within impoundments with unvegetated catchments may not reach water quality targets until the catchment is vegetated
		• Groundwater quality shows no deterioration from baseline conditions	• Records of water quality monitoring at established bores for target indicators • Report by suitably qualified person confirming no negative changes to groundwater quality	• Groundwater in monitoring locations remains within expected water quality monitoring limits

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
RM4 Revegetation	All areas other than RA19, RA20, RA21, RA22, RA23	• Application of fertiliser at rate of 100 kg/ha for pasture areas, or as otherwise recommended by the soil health and suitability assessment report (RM3)	• Records of fertiliser purchases and use retained, confirming required application rate	• Rates used for rehabilitation of pasture in the local area recommended at 150kg/ha. To be reduced to 100 kg/ha due to the presence of smectite clay in the Brolga soil, as this retains fertiliser much more readily than most grazing soils. Modified, if necessary, by soil health assessment.
		• Revegetation of pasture areas with the pasture grasses *Chloris gayana* (Rhodes grass), *Sorghum sp., Bothriochloa insculpta* (bisset bluegrass), *Heteropogan contortus* (black speargrass) and *Themeda triandra* (native kangaroo grass) at a rate of 3 kg/ha with 1 kg/ha of Seka seed	• Documented visual inspections (including photographs) of revegetation works (weekly, then as required) by a suitably qualified person during seeding works	• Seeding rate based on local experience • Inclusion of a legume in a pasture species is recommended by DAF to support establishment of native pastures
		• Revegetation of forest areas with the nitrogen fixing species *Stackhousia tryonii*, *Acacia leptostachya* and Allocasuarina species (e.g. *Allocasuarina cunninghamiana* and *A. torulosa*); other species to be used include *Corymbia xanthope* and *Eucalyptus fibrosa* (a suitable species list will be developed in consultation with Livingstone Shire Council – see Section 6.1.9.2).	• Documented species to be used, methods of application and rates of seed application • Documented visual inspections (including photographs) of revegetation works (weekly, then as required) by a suitably qualified person during seeding works	• Livingstone Shire Council operate a nursery producing native plants of local provenance and have undertaken several restoration projects in serpentine landscapes. Discussions have already been held with them regarding their involvement in the rehabilitation. • Species types, rates and methods of application will be based on most recent local experience of Livingstone Shire Council (based on experience in serpentinite landscapes) and local seed availability

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
		• Seeding rates to be governed by seed availability and collectability		
		• Revegetation of sparse woodland areas with Acacia and suitable forbs (a suitable species list will be developed in consultation with Livingstone Shire Council – see Section 6.1.9.3) at a rate to be governed by seed availability and collectability	• Documented visual inspections (including photographs) of revegetation works (weekly, then as required) by a suitably qualified person during seeding works	• Species types, rates and methods of application to be based on local experience (i.e. Livingstone Shire Council experience in serpentinite landscapes) and local seed availability
		• Timing of seeding to coincide with optimal soil and climatic conditions	• Documented advice from suitably qualified and experienced persons familiar with revegetation in local area, confirming best timing and conditions for sowing	• Seed failure is a key risk regarding establishment of vegetation by seed. Engagement with local (e.g. local Council) revegetation experts with experience in revegetation in the local area to maximise potential for success. This will need to coincide with rainfall and/or wet soil to improve germination success, but avoid heavy rains that will wash away sown seeds or seedlings.
		• Seeds to be raked in to achieve optimal cover following broadcasting	• Documented weekly visual inspections by a suitably qualified person during sowing	• Avoids desiccation of seeds or predation by birds
		• Application of mulch and fertiliser into the sparse woodland revegetation areas	• Documented visual inspections (including photographs) confirming appropriate application achieved	• The soil in the rocky slopes where the sparse woodland will be revegetated will benefit from amelioration by adding some mulch and fertiliser into and over the soil

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
		• No active rill, gully or sheet erosion visible within the rehabilitation area	• Visual inspection (weekly, or as required) by a suitably qualified person to confirm there is no active rill, gully, or sheet erosion	• Erosion may wash away seeds or seedlings, or otherwise damage topsoils
		• Firebreaks maintained until rehabilitation is complete	• Visual inspections of firebreak by a suitably qualified person on a monthly basis	• Firebreaks required as fire could damage re-establishing vegetation
		• Weeds at a maximum of 10% of groundcover	• Visual inspections for presence of weeds in revegetation areas	• Weed control and management is an important component of successful rehabilitation as weeds can be a major source of failure of rehabilitation efforts.
RM5 Vegetation is established	All areas other than RA19, RA20, RA21	• Vegetation cover to exceed 50th percentile of reference sites in pasture areas	• Documented assessment of reference and test sites, measured and recorded by a suitably qualified person	• Establishment of target species as defined in the revegetation section of the PRCP (Section 6.1.9)
		• Stem density to exceed the 50th percentile for target species in pasture areas		
		• Forest areas and sparse woodland areas contain seedlings or suckers (<2m in height) of target woody species at rate exceeding 50th percentile of reference sites		
		• Weeds at a maximum of 10% of groundcover	• Percent cover in 10 x 50m plot	• Weed control and management is an important component of successful rehabilitation as weeds can be a major source of failure of rehabilitation efforts
		• No presence of giant ratstail grass or lantana		
		• No exposed topsoil with less than 5% ground cover without seeding in any pasture area	• Documented visual inspection (monthly, or as required) by a suitably qualified person	• To minimise the potential for erosion

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
		• No patches of bare exposed soil (<5% cover of organic litter) exceeding 25m2 in any pasture area		• To minimise the potential for erosion
		• No active rill, gully or sheet erosion visible within the rehabilitation area		• Potential for erosion should be minimised
		• Firebreaks maintained until rehabilitation is complete	• Visual inspections of firebreak by a suitably qualified person on a monthly basis	• Firebreaks required as fire could damage re-establishing vegetation
RM6 Final sustainable landform achieved	All areas	• Carrying capacity able to support a sustainable level of grazing	• Documented assessment of carrying capacity by suitably qualified person, supports low intensity grazing land use	• Confirms that the pasture growth is sufficient to support the PMLU of low intensity grazing
		• Revegetation cover to exceed the 70th percentile among reference sites	• Documented assessment of reference and test sites, measured and recorded by a suitably qualified person.	• Confirms that vegetation growth is suitably dense, while allowing for patterns of growth that compare favourably to nearby reference sites
		• Land suitability class to meet requirements for final land use of low intensity grazing (Class 4 or better) – at 3 years post revegetation	• Land suitability class measured and certified by suitably qualified person	• Confirms that the land in general is sufficient to support the PMLU of low intensity grazing
		• Surface water quality in impoundments meets water quality targets from the EA: - pH >4.0 – 9.0 pH units - Electrical Conductivity (EC) 5970 µS/cm - Sulfate as SO4 1000 mg/L - Fluoride 2mg/L - Total Arsenic 0.5 mg/L	• Records of water quality monitoring for target indicators (identified in conditions of EA) • Report by suitably qualified person confirming water quality meets targets	• Surface water in monitoring locations meets post mining land use water quality targets for low intensity grazing (i.e. livestock watering)

Rehabilitation Milestone	Relevant RAs	Completion Criteria	Rehabilitation Indicators	Justification
		- Total Cadmium 0.01 mg/L - Total Chromium 1 mg/L - Total Cobalt 1 mg/L - Total Nickel 1 mg/L		
		• Groundwater quality shows no deterioration, compared to baseline data (as required in conditions of the EA) – at 3 years post revegetation	• Records of water quality monitoring at established bores for target indicators (identified in conditions of EA) • Report by suitably qualified person confirming water quality meets targets	• Groundwater in monitoring locations confirms no deterioration compared to baseline data (as required under EA conditions)
		• No active rill, gully or sheet erosion visible within the rehabilitation area, and all rill or gully erosive features rectified – at 3 years post revegetation	• Documented visual inspection (including photographs) confirming no rill, gully or sheet erosion features - active or unrectified	• Potential for erosion should be minimised
		• Weeds at a maximum of 10% of groundcover	• Percent cover in 10 x 50m plot.	• Weed control and management is an important component of successful rehabilitation as weeds can be a major source of failure of rehabilitation efforts.
		• No presence of giant ratstail grass or lantana		

4.6 Description of Rehabilitation Activities for each Rehabilitation Area

This section provides a brief description of the rehabilitation activities that will take place in each RA with reference to the rehabilitation milestones described above.

Table 4-5. Description of rehabilitation activities for each rehabilitation area

RA	RA Name	Rehabilitation Activities
Rehabilitation Areas Commencing 2024		
All Areas		A site inspection will be undertaken to confirm removal of all infrastructure and equipment from the site, and confirmation of that to remain. A generalised check of the infrastructure to remain will include preparation of an infrastructure management plan, detailing management, monitoring and maintenance activities to be undertaken for each item. A contaminated site investigation will also be conducted of all areas, to allow for remediation if required prior to rehabilitation works being commenced.
RA1	Test Pits	Rehabilitation and revegetation of the test pits as part of a rehabilitation trial will be conducted during 2024, with revegetation completed in mid-2025, and monitoring for establishment, weeds and erosion/drainage issues continuing throughout 2025. Following vegetation establishment, final monitoring of the achievement of sustainable landforms will continue until the end of rehabilitation – nominally by 2027 for this area, but continuing throughout to ascertain any issues that may arise after longer time periods.
Rehabilitation Areas Commencing 2025		
RA2 - 4	Pit 2 Pit 3 / Oversized Dump Pit 4	Pit 2, Pit 3 / Oversized Dump and Pit 4 have already been backfilled. Some earthworks are required, namely: • Pit 2 (RA2) - to build a road connection between the Waste Rock Dump (RA16) and the other sections of Haul Road, and to undertake maintenance of the bunds on the eastern and western sides of RA2 • Pit 3 / Oversized Dump (RA3) - to reduce the slope of the eastern wall of the dump to the geotechnical specialist's recommendations, which are a slope of 1.0 vertical on 3.0 horizontal (18 degrees) (AMEC, 2021 – Appendix 11). The existing bund at the top of this eastern wall also requires final reforming. • Pit 4 (RA4) - the existing bunds may require maintenance All these earthworks are to be carried out in the dry season. Surface preparation and topsoiling can follow immediately after checking the stability of the earthworks. Use Topsoil Dumps 2, 3 (RA7) or Topsoil Dump 6 (RA18). Seeding is scheduled for spring, following checks on erosion and stability of the land surface. Germination success and landform stability can be checked during and after the wet season. Monitoring of the area continues until a sustainable post-mining land use is achieved.
RA5, RA6	Pit 5 North Pit 5 South	Pit 5 North and Pit 5 South require some back-filling. Back-fill material can be borrowed from the nearby Screening Stockpile (RA14), the ROM (RA13) or the Waste Rock Dump (RA16). All these earthworks are to be carried out in the dry season. Surface preparation and topsoiling can

RA	RA Name	Rehabilitation Activities
		follow immediately after checking the stability of the earthworks. Use Topsoil Dumps 2 and 3 (RA7). Additional topsoil can be taken from any other topsoil dump. Seeding is scheduled for spring, following checks on erosion and stability of the land surface. Germination success and landform stability can be checked during and after the wet season. Monitoring of the area continues until a sustainable post-mining land use is achieved.
RA7	Topsoil Dump 2 and Topsoil Dump 3	After the topsoiling of RAs 2, 3, 4, 5 and 6, the topsoil remaining on Topsoil Dumps 2 and 3 can be spread over these topsoil dumps in preparation for seeding in the dry season, following a check on the stability of the landform. Seeding is scheduled for spring, following checks on erosion and stability of the land surface. Germination success and landform stability can be checked during and after the wet season. Monitoring of the area continues until a sustainable post-mining land use is achieved expected by May 2028.
RA8, RA10	Nontronite Stockpile Go Line Pad	In preparation for rehabilitation works in these areas, initial landforming will be undertaken, to allow for time to settle and compact, before beginning surface preparation and topsoiling works (refer next phase below). Pushing down of the Nontronite Stockpile can be carried out in the dry season. There is an estimated 50,000 cubic metres of stockpiled material to be pushed out over the Go Line Pad (RA10), and some of this material may be used in topping up of subsoil in other areas of the site as required. The objective of the final landform is to form RA10, the Go Line Pad, in a fashion that will make rainwater run-off towards Pit 1. At the Haul Road, a culvert will eventually be installed to preserve this formed road. In the interim, the run-off is to flow across the road, in doing so, ensuring that the culvert is installed in the optimum location. Bunding maintenance may be required along the Haul Road to ensure run-off does not flow northward. It was estimated that if the northern, western and eastern edges of the Go Line Pad have three metres of Nontronite pushed to them, then it would be a simple task to form the remainder of the Nontronite into a gentle slope that will flow to the Haul Road then to Pit 1. If there is too much Nontronite, some can be placed in Pit1 (RA11).
RA22	Brolga	RA22 comprises the balance of areas at Brolga, relating to historical rehabilitation activities. While appearing to be fully rehabilitated, RA22 will be subject to assessments to confirm vegetation is appropriately established over the entire area, followed by monitoring to confirm a sustainable post-mining land use is achieved coinciding with the completion of the remainder of the site. Should rectification works be required as part of the assessment, additional rectification and monitoring works will be conducted, with checks for stability and regrowth vigour scheduled to the end of the wet season.
RA23	Canoona	RA23 comprises the total Canoona site area, which has not been mined and therefore does not require earthworks, topsoiling or revegetation works. Monitoring will be conducted to confirm the final sustainable landform and vegetation is achieved, including weed control works and any rectification of revegetation required, with final monitoring to confirm a sustainable post-mining land use is achieved.
Rehabilitation Areas Commencing 2027		
RA8, RA10	Nontronite Stockpile, Go Line Pad	As noted above, the nontronite stockpile will have been pushed out over RA10, the Go Line Pad, early enough to allow time for the material to settle. Following settlement, and confirmation of stability, some earthworks may be required to attain the final landform shape. The interim drainage pattern described above (flow across the road into Pit 1) will remain until rehabilitation of the Haul Road (RA19).

RA	RA Name	Rehabilitation Activities
		Surface preparation and topsoiling may then be undertaken, using topsoil from Topsoil Dump 5. Seeding is scheduled for spring as pasture, with sloping areas planted with *Acacia* species and forbs, following checks on erosion and stability of the land surface. A fence line is planned for near the crest along the perimeter of the Go Line Pad so livestock do not traverse the slope. Germination success and landform stability can be checked during and after the wet season. Monitoring of the area continues until a sustainable post-mining land use is achieved.
RA9	Top Pad	The only earthworks required for the Top Pad are a renovation of the existing bunding. This includes bunding adjacent to Pit 1. Surface preparation and topsoiling can follow immediately after checking the stability of the earthworks. Topsoil is to be taken from the nearby Topsoil Dump 5 (RA18). Seeding is scheduled for spring, following checks on erosion and stability of the land surface. Germination success and landform stability can be checked during and after the wet season. Monitoring of the area continues until a sustainable post-mining land use is achieved.
Rehabilitation Areas Commencing 2028		
RA11 - RA17	Pit 1 Pit 8 ROM Screening Stockpile Pit 2 Extension Waste Rock Dump Front Pad	Rehabilitation activity on commences in the dry season, with the following works to be completed: • Pit 1 (RA11) - walls on the southern and eastern side are to be re-shaped to conform to a slope of 1.5 horizontal to 1.0 vertical (AMEC, 2021 – Appendix 11). The cut material can be placed in the void at the base of the new batter. A safety bund is to be built at the top of these walls to the specifications recommended in the geotechnical assessment (AMEC, 2021 – Appendix 11). Any spoil piles that remain are to be flattened. Large rocks are to be placed on the north-east corner area, and will become rip-rap to temper the flow energy of run-off from the Go Line Pad. • Pit 8 (RA12) – a check of any instability in the pit walls will identify earthworks requirements, and spoil piles can be flattened, and a safety bund is to be built along the perimeter above the uppermost batter. Back-filling of a small excavation located in the south-east corner of the Pit 8 is required. • ROM (RA13) - some reshaping may be required but this may have already been done when the nearby pits were back-filled (RA'S 4, 5 & 6). • Screening Stockpile (RA14) – Some reshaping may be required but this may have already been done when the nearby pits were back-filled (RA'S 4, 5 & 6). • Pit 2 Extension (RA15) – a check of any instability in the pit walls will identify earthworks requirements, and spoil piles can be flattened, and a safety bund is to be built along the perimeter above the uppermost batter. • Waste Rock Dump (RA16) - The batters are to be worked to a 1.0 vertical on 3.0 horizontal. A berm is to be formed from the existing rock material along the perimeter above the batter. It is important to maintain the gentle slope to the east that exists on the top of the Waste Rock Dump, so run-off flows to the east, rather than towards the berm and batters. • Front Pad (RA17) - Some reshaping of a few spoil piles will be required. Surface preparation and topsoiling can follow immediately after checking the stability of the earthworks. Topsoil is to be taken from the nearby Topsoil Dumps 1, 5, 6 and 7 (RA18).

RA	RA Name	Rehabilitation Activities
		Seeding is scheduled for spring, following checks on erosion and stability of the land surface. Germination success and landform stability can be checked during and after the wet season. Monitoring of the area continues until a sustainable post-mining land use is achieved.
RA18	Topsoil Dumps 1, 5, 6 and 7 (RA18) -	Rehabilitation activity on the Topsoil Dumps commences in the dry season, after all the earthworks on the other Rehabilitation Areas has been carried out. Some drainage patterns may have been affected by the borrowing from the topsoil dumps, so a careful landform assessment is required. Any necessary reforming can be done next followed by surface preparation and spreading of the remaining topsoil. Seeding is scheduled for spring, following checks on erosion and stability of the land surface. Germination success and landform stability can be checked during and after the wet season. Monitoring of the area continues until a sustainable post-mining land use is achieved.
RA21	Dam 4	An initial assessment of Dam 4 conducted during 2024 will be combined with another assessment for stability at the start of this phase, to determine any stabilisation works required, such as for banks and verges. Any areas required to be rectified and revegetated will be undertaken, with revegetation undertaken after monitoring of erosion and stability of the land surface. Ongoing monitoring of stability and vegetative growth (where relevant) is conducted, with final sustainable post-mining land use achieved. This will be confirmed by concurrent water quality monitoring, started in 2024 and continued throughout the rehabilitation process.
Rehabilitation Areas Commencing 2030		
RA19	Haul Road	Rehabilitation Activity on the Haul Road commences in the dry season, timed to allow for other major earthworks and drainage systems associated with other Rehabilitation Areas to be completed, and revegetation underway. The path of drainage from the Go Line Pad to Pit 1 will be known by that time, so the exact location for installation of the culvert will also be known. Rip-rap will be in place at the corner area of Pit 1, to stem the flow of water. No revegetation is required. Monitoring for its sustainability continues until the end of rehabilitation works on the site.
RA20	Bath House Area	Following the initial assessment in 2024 of the management and maintenance requirements for RA20, ongoing maintenance as specified in the infrastructure management plan will have been followed, and the site will be assessed for meeting the sustainable post-mining land use status by the end of rehabilitation works on the site.
RA24	Water bores	Water bores will remain in place during the rehabilitation works to support groundwater monitoring, only being rehabilitated once major works are completed – timed to begin in 2030 and allowing for a year of stabilisation monitoring after rehabilitation. Closure and rehabilitation will involve grouting and removal / cutting off of the casing and capping to ground level. Any disturbed area around the bore will be revegetated by with completion by the end of rehabilitation works on the site.

5 Non-Use Management Area

No non-use management areas (NUMAs) are proposed for either ML.

6 Rehabilitation Management Methodology

6.1 General Rehabilitation Practices

6.1.1 Hydrogeology

As stated in Section 2.3.5.3, groundwaters appear consistent with regional water quality and levels, and local enrichment appears consistent with the serpentinite geology of the area. As no groundwater is intercepted and water tables are deep, ongoing management of groundwater during and post rehabilitation is not anticipated to be needed.

Monitoring will continue throughout the rehabilitation process to confirm that works are not impacting groundwater, with the wells closed and rehabilitated at the end of the works.

6.1.2 Flooding

Flooding in the regional area is likely to occur during the summer months in the local tropical climate. For this reason, earthworks are all proposed for the dry season. Within the mine site, flooding is most likely to be of the 'flash-flooding' kind, where large flows of water could scour areas with inappropriate drainage and/or that have not been stabilised sufficiently.

Strategies to mitigate the effects of flooding include the use of bunds that redirect water flows and drainage design that seeks to minimise flow speed and direct flows to existing stable areas and settlement dams.

The 1% AEP flood extent would not intrude into either ML area. However, extreme event flooding may inundate the final void, Pit 8 (RA12). In such a rain event, Pit 8 will probably be full, providing some mitigation effects for the wider basin. Further discussion of the management of this final void is provided in Section 6.3, with particular reference to flooding in Section 6.3.3.1.

6.1.3 Soil and capping material assessment

6.1.3.1 Quality assessments

An assessment will be undertaken of the suitability of the material contained at the screening stockpile (RA14), the ROM (RA13) and the waste rock dump (RA16) with reference to its use (under the topsoil) to achieve the PMLU vegetation communities of pasture, forest and sparse woodland.

A topsoil assessment must be carried out to determine its suitability to achieve the PMLU vegetation community of grassland, forest and sparse woodland. Considering that the PMLU is that which was previously on the site, it is likely that the quality of the topsoil will be suitable to achieve the PMLU of grazing as well as achieve the forest and sparse woodland areas. Nevertheless, the quality of the topsoil will be assessed to determine the required amounts of ameliorants and fertilisers.

6.1.3.2 Quantity assessments

Topsoil

An inventory of the existing topsoil stockpiles on the Brolga ML was made in 2020, using the drone elevation survey data to confirm volumes, with the results shown in Table 6-1. A total of 66,000 bank cubic metres (bcm) of topsoil is available for use across the site. Figure 6-1 shows the rehabilitation areas of the Brolga ML in terms of their topsoiling requirements, which is also included in Table 6-1. As can be seen, the available topsoil is sufficient to provide for 100mm of topsoil over all required areas of the site.

Note that topsoil to rehabilitate the water bores in RA24 will be stockpiled closed to these areas pending final rehabilitation (since other areas will be rehabilitated prior to this area being initiated), with topsoil likely obtained from the nearby Topsoil Dump 5.

Topsoil is not required for the Canoona ML, as no mining activity other than exploration drill holes has occurred on the site.

Table 6-1. Topsoil Inventory

Topsoil Stockpile	Estimated Volume (bcm)
1	4,900
2	1,600
3	4,300
4	3,800
5	11,200
6	39,000
7	1,200
subTotal	***66,000***

Rehabilitation Area Type	Area (m^2)	Depth Required (m)	Volume Required (m^3)
Bathhouse to be retained - topsoil not required	1,896	0	0
Historical disturbance - No topsoil required	928,125	0	0
Haul road to be retained - topsoil not required	44,763	0	0
Dams - topsoil not required. Allow 20% for banks	80,745	0.02 (20% allowance for banks)	1,615
Areas Requiring Topsoiling	408,795	0.1	40,879
	1,464,324		***42,494***
		Net Available	***+23,506***

Subsoil

An assessment of the filling requirements for the pits and other disturbance areas was undertaken in 2020 alongside the topsoil assessment, determining that excess material is present on the site. Available material is described in more detail in Sections 6.1.4 and 6.1.5 below, but equates to approximately 530,000 m^3 of available material, none of which requires treatment in terms of ARD.

An assessment of the site was undertaken based on the drone footage from 2020 and field assessment of available subsoil depths in 2021. The subsoil requirements across the site are shown in Figure 6-2 and summarised in Table 6-2. Note that subsoil will be obtained directly from these areas, or ameliorated prior to use, based on the soil health and suitability assessment.

Table 6-2. Subsoil requirements

Rehabilitation Area Type	Area (m^2)	Depth Required (m)	Volume Required (m^3)
Bathhouse, Dams - no additional subsoil required	82,641	0	0
Haul road to be retained - subsoil not required	44,763	0	0
Historical disturbance - no subsoil required	928,125	0	0
Disturbance areas - sufficient depth of subsoil in-situ	316,239	20% allowance = 0.1	31,624
Areas Requiring Additional Subsoil	92,556	0.5	46,278
subTotal	***1,464,324***		***77,902***

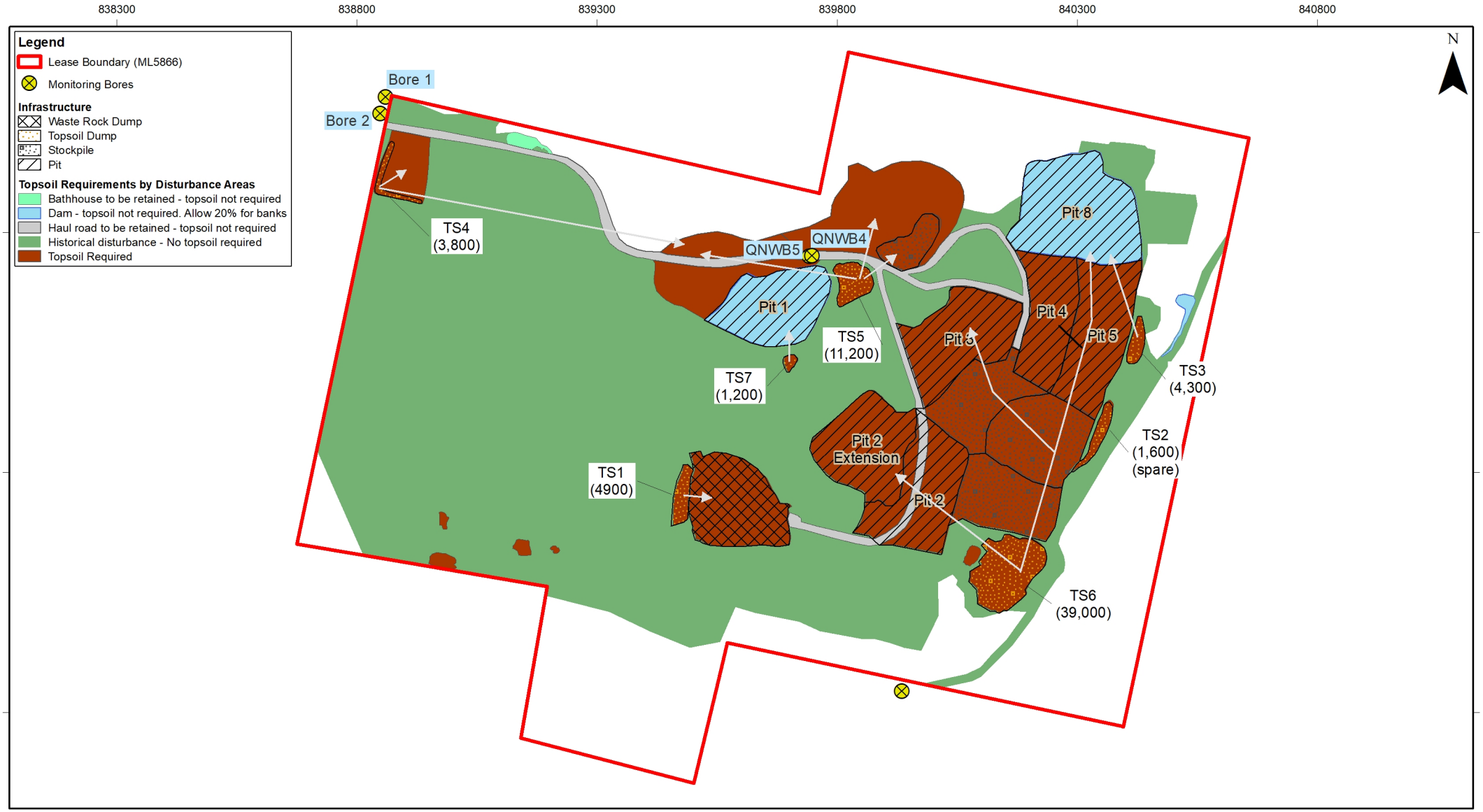


Figure 6-1. Topsoiling requirements, Brolga (ML5866)

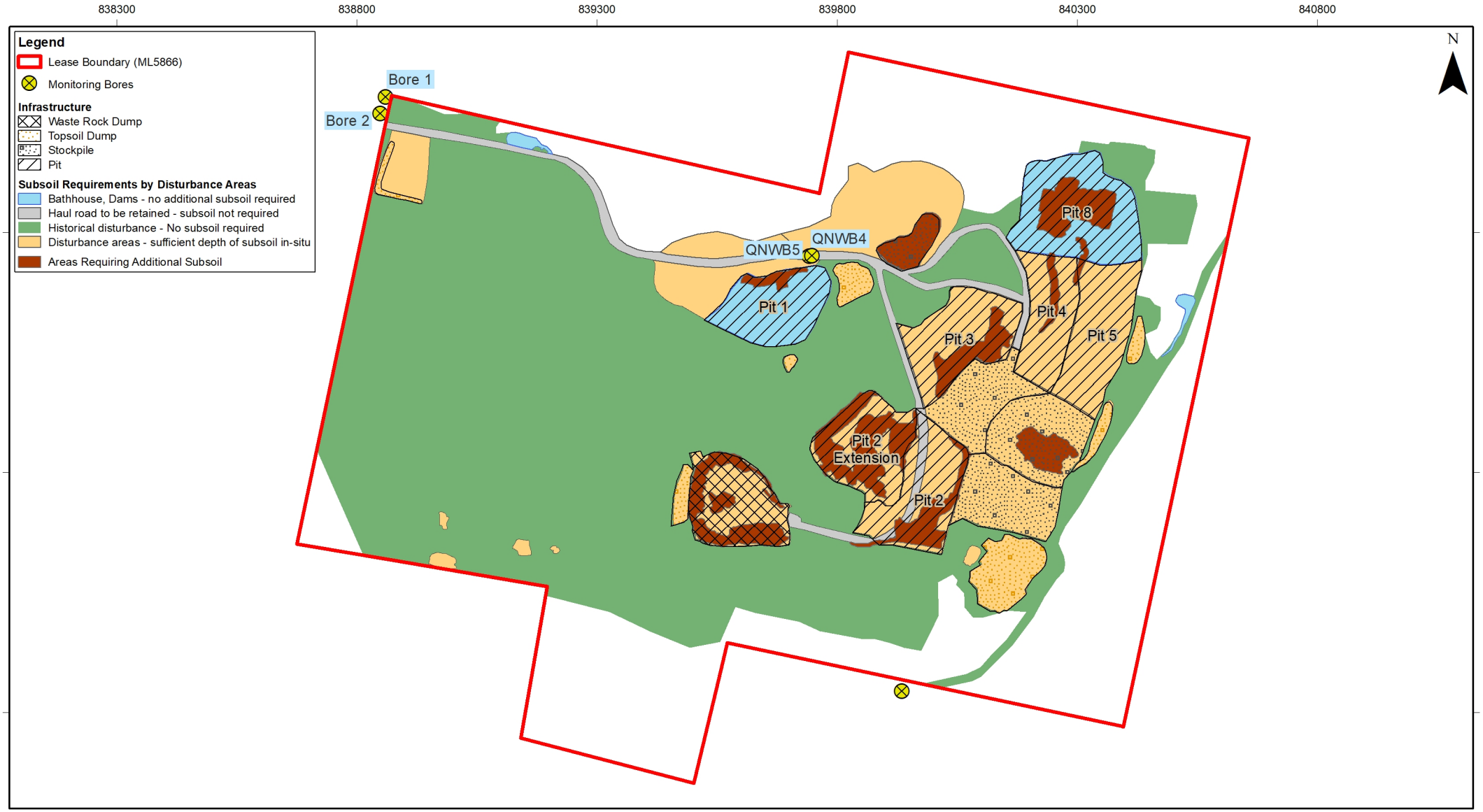


Figure 6-2. Subsoil requirements, Brolga (ML5866)

The subsoil requirements equate to around 15% of the 530,000m^3 available, and the 20% allowance for disturbed areas is conservative, since most of these areas incorporate or are made of the available waste material, which is to be reformed, leaving well in excess of the 0.5m depth required in most areas.

An additional assessment stage has been included to provide final confirmation of fill material volumes to fine tune the movement of material, particularly topsoil, across the site to achieve the required 100mm minimum topsoiling depth.

The depth of topsoil used needs to be suitable for the adequate establishment of the target vegetation. In general, a depth of between 150 mm and 300 mm is acceptable (DME 1995), however, shallower depths, such as the 100 mm proposed for the Brolga ML, are adequate where soils are expected to have good water holding capacity and inherent fertility - pre-existing topsoils were approximately 100mm deep.

6.1.4 Waste and other materials characterisation

The various overburden and ore dumps are comprised of material that can be considered to be either Waste, Ore, Low-grade Ore or Nontronite. Table 6-3 below itemises each structure's material. Waste Rock Dump, Top Pad and Go-Line Pad are Waste. The Nontronite stockpile is considered to be Waste in this context. The Front Pad is Low-grade Ore. The ROM and Screening Stockpile are Ore.

Table 6-3. Origin of Excavated Material

Structure	Category	Comments
Screening stockpile	Low-grade Ore	Excavated ore ready for screening
ROM	Ore	Where ore is stockpiled for screening and loading
Waste Rock Dump	Waste	Exclusively Waste Rock
Nontronite stockpile	Nontronite	High nickel content which cannot be refined. Stockpiled on the Go-Line Pad.
Top pad	Waste	Parking, turn-around and pit exit point.
Go-Line Pad	Waste	Area used for parking and the Nontronite Stockpile
Front pad	Low-grade Ore	An area originally used for stockpiling and parking of machinery

6.1.4.1 Low-Grade Ore

Because the nickel content of the ore from the Brolga Mine is quite low (by world standards), highly variable in content and transitional in grade within the deposit, a substantial volume of 'ore' is considered to be low-grade. The low-grade ore is neither worthless nor valuable. However, it was given a much lower priority for transport to the refinery. For this reason, it was stockpiled separately and used when higher grade ore could not be mined or was blended with high grade screened ore.

6.1.4.2 Waste Rock Dump

The Waste Rock Dump (WRD1) is a structure built using waste material (overburden) extracted from mainly Pit 1 and Pit 2. This overburden to the ore was comprised of the upper two layers of the lateritic profile (the ferricrete, and transitional 'Limonite' Zone). These upper zones of the lateritic profile that were extracted to form Waste Rock Dump (WRD1).

The description of this material is:

- Ferricrete; the surface layer, is the uppermost lateritic layer. It has been depleted of nickel, magnesium and cobalt. It is typically red-brown and variable in thickness. It is a residuum of oxidised serpentinite. Its typical mineral composition is iron-oxides (haematite and goethite), silica (as quartz, chalcedony and chrysoprase) and kaolinite clay. The iron-oxides occur as pisolites, nodules, mineral coatings and concretions. It is always treated as waste material.
- Transitional 'limonite' which is the zone that contains intercalations of the yellowish-brown zone and pale-cream-coloured parts of the siliceous zone. It contains mainly light brown to brown stained silica, limonite, and some kaolinite clay, greatly enriched in silica minerals. It is typically a brown to yellowish-brown colour. It is always treated as waste material.

Fragment sizes and shapes in Waste Rock Dump (WRD1) are highly variable, from clay-sized particles to naturally cemented aggregates up to 50 cm across. Mineralogically, it contains a mixture of iron and aluminium oxides and hydroxides, clay, and silica as quartz and chalcedony. The material is invariably highly weathered, having been extracted from the lateritic layers that form as a result of deep tropical climate weathering.

6.1.4.3 Go Line Pad

The Go-Line Pad is essentially the same material as that in the Waste Rock Dump (WRD1), being a mixture of the upper lateritic ferruginous layer and the top part of the next lateritic layer, where it transitions to the pale brown limonitic layer and cream a yellowish-brown siliceous zone. The Go Line Pad has compacted well, but suffers from erosional scouring on its slopes, therefore requires some pushing down of areas at the perimeter and vegetating to reduce the probability of generating sediment-charged run-off water. At its maximum height, the Go Line Pad is ten metres thick.

6.1.4.4 Top Pad

The Top Pad is also a mixture of the upper lateritic layers, mainly the ferricrete zone but with some of the paler limonitic zone. Much of the Top Pad is exposed ferruginous laterite that has been flattened and pushed northwards and outwards to the flanks of the pre-existing landform by dozers and graders to form a relatively flat area. The remainder and majority of the Top Pad area is 'cut and smoothed' from the pre-existing landform.

6.1.4.5 Nontronite Stockpile

The Nontronite Stockpile is entirely comprised of rock mined from the saprolitic laterite layer, and has a nickel content similar to the ore grade. Most of the nickel in this stockpile is in the smectite clay mineral known as nontronite, with a smaller proportion within nickel-oxides. Mine product that had a high proportion of nontronite was found to yield much less nickel during the refinery process, and so this type of product was stockpiled until a modified refining process could be devised, or the planned Gladstone Pacific Nickel Refinery was developed. The area called the Go Line Pad has been used to stockpile this 'potential ore' (it is not a low-grade ore).

The nontronite stockpile has been screened to pass 200 mm screens, and it has a highly variable proportion and range of grain sizes. Although a proportion is clay material, the majority of the material is rock aggregates cemented by silica, with aggregate sizes to 200 mm. It includes substantial proportions of silica (as chert and chalcedony), kaolinite and nontronite.

6.1.4.6 Geochemical analysis

The region's geology, ore body formation, GNP SEIS static testing (refer Appendix 9), regional water quality data and site rehabilitation performance following 28 years of mining on the mining lease all demonstrate that ARD is not present in the mining horizon or a potential threat with mining. The ore has a high ANC and is capable of being used to neutralize ARD in other waste. This is explained in Section 2.3.7.

The Marlborough ore was classified as Non-Acid Forming (NAF) due to the lack of oxidisable sulphur, a negative NAPP, and NAG pH values above 4.5.

6.1.5 Landform design

6.1.5.1 Brolga (ML5866)

The final landform design was determined using the continuation of strategies that have been used since mining recommenced in 2014. The former land reshaping, which occurred during the mining stages of the Project, was undertaken with the PMLU of grazing in mind. As such, the spoil dumps were formed into gently sloping terraced landforms to be suitable for grazing, and as a strategy to ensure stability. All open pits currently have ramps, which will be preserved in the proposed final landform.

The final landform design seeks to build on the former land reshaping, using the following criteria:

- Existing backfilling of pits is carried out with a view to creating a terraced landform. This suits the post-mining land use, while also mitigating vulnerability to erosion.
- Direct flows away from vulnerable slopes. This strategy has been built into the proposed rehabilitation works of the Go Line Pad (RA10), Waste Rock Dump (RA16) and by the installation of existing and proposed bunding.
- Conversion of final voids into dams for the post-mining land use. The strategy adopted for the final voids results in a water storage system that is unlikely to become depleted, but also avoids reliance upon a single, large dam whose stability might be compromised by its size. It also prevents the degradation and erosion that may eventuate from having a single dam overused by the daily visits of livestock.
- Use of local vegetation species that are adapted to the soil type, and pasture species that are successful in the local area.

The final landform design is shown in Figure 6-3 and Figure 6-4.

Geotechnical considerations

The post mining landform design has incorporated the following geotechnical criteria. These criteria are based upon the recommendations of a geotechnical specialist, which are documented in the report 'Geotechnical Assessment of the Brolga Project, QNI Resources Pty Ltd' (AMEC, 2021) - Appendix 11 of this PRCP.

- Integrate waste dumps and back-filled pits with the surrounding landform
- Waste dump batters maximum slope 1.0 vertical on 3.0 horizontal
- Contour banks installed on waste dump batters when the slope length is greater than 30m
- Residual void batters to be laid back to 25° maximum slope where possible, unless a geotechnical expert advises that the angle can be greater.

Geotechnical factors of disturbance features were assessed in consideration of stability. The disturbance features assessed included particular inspection of the three final voids (Pit 1, Pit 2 Extension and Pit 8) and the structures built from overburden and other waste rock (Go Line Pad, Nontronite Stockpile, Waste Rock Dump, Front Pad and Top Pad. As mentioned above, a geotechnical specialist provided an independent assessment and recommendations (AMEC, 2021). The outcome of these assessments and inspections are discussed below.

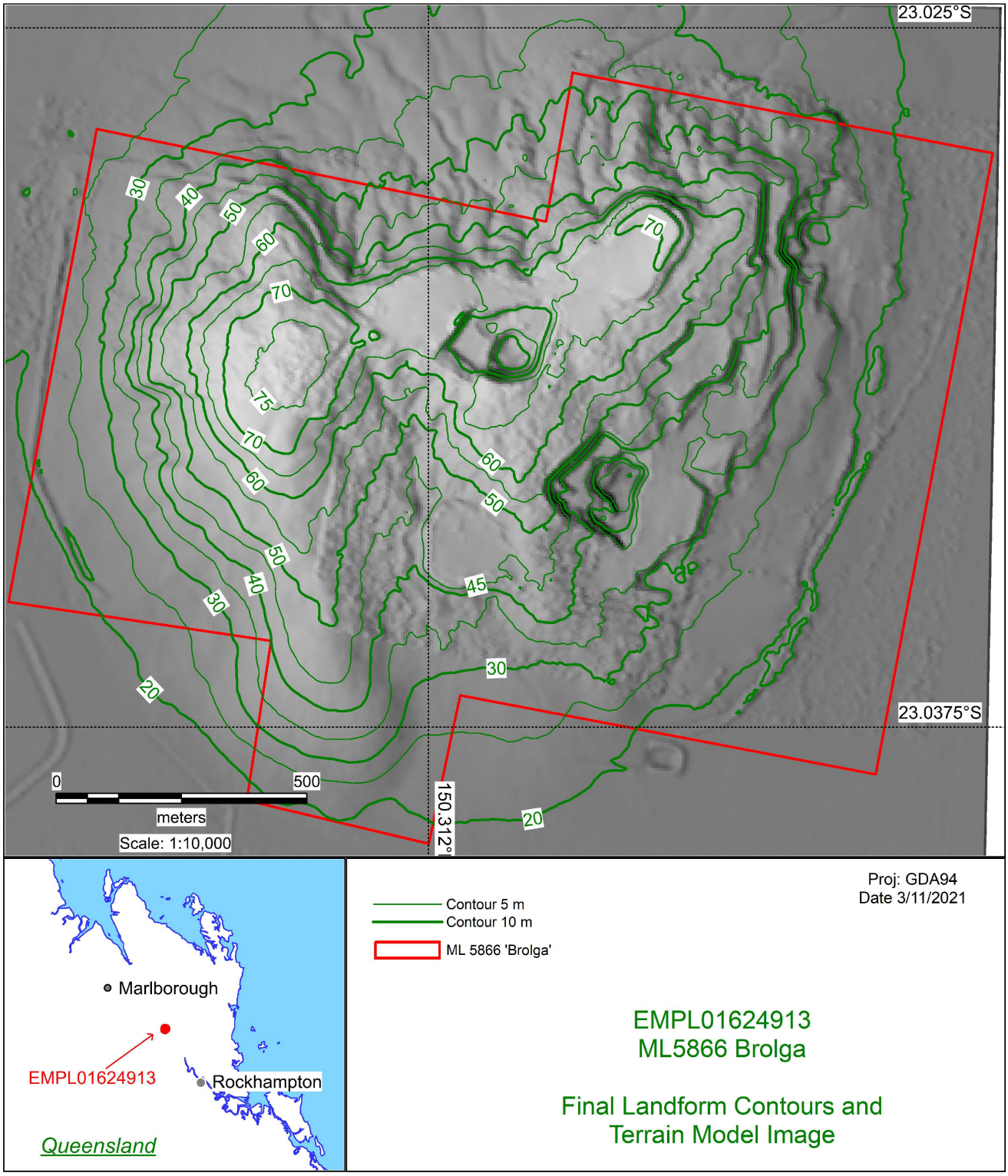


Figure 6-3. Final Landform Contour Map – Brolga (ML5866)

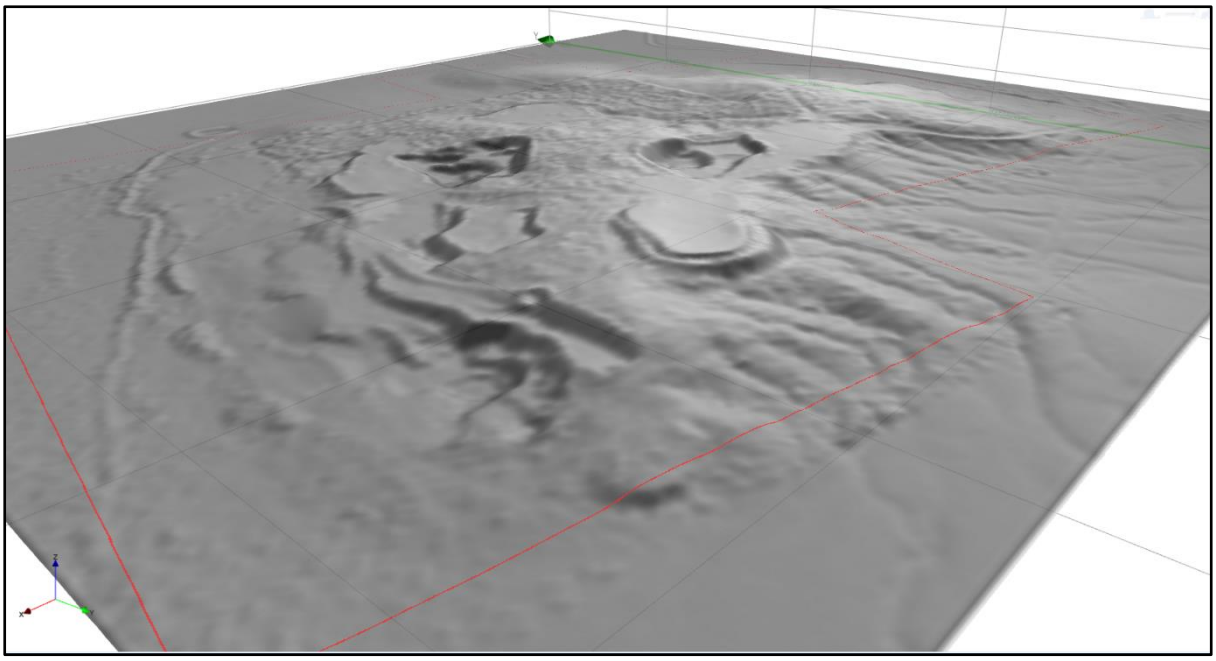


Figure 6-4. Final Landform Perspective view from the north-east – Brolga (ML5866)

Pit 2 Extension (RA15) and Pit 8 (RA12)

The exposed pit walls in Pit 2 Extension are comprised of strong rock and do not contain any swelling clay or soft rock, nor show any signs of mass wasting or failure of any kind. Geotechnical specialist's advice for Pit 2 Extension (RA15) determined that the pit walls are strong and stable, and included recommendations that a safety berm be installed along the top of the pit walls, and in-pit spoil piles be flattened. These recommendations have been incorporated into the rehabilitation works for RA15.

Pit 1 (RA11)

There are two walls of Pit 1 that require additional earthworks to ensure their stability. These are the eastern and southern walls of Pit 1. Geotechnical specialist's recommendations are that these pit walls must be modified to a constant slope ratio of 1.0 vertical on 1.5 horizontal. These recommendations have been incorporated into the rehabilitation works.

There is a considerable proportion of smectite clay in the walls of Pit 1, which causes them to swell and erode into the pit. Currently they are benched, and there is an apparent gradual accumulation of wasted material along the berms.

The cut material from the benching is to be placed at the base of the walls, in the void. The current topography immediately adjacent to these two walls will be modified by the installation of a safety berm built ten metres away from the pit crest. This will ensure that rainwater run-off continues to flow away from the pit, and minimise the amount of water that enters the pit causing the clay to swell.

The western and northern walls have already been graded back and have a large amount of back-fill at their bases to ensure their stability.

Waste Rock Dump (RA16)

The Waste Rock Dump was built using overburden waste rock. The geotechnical specialist's recommendation was that the batters are reshaped to a slope of 1.0 vertical on 3.0 horizontal. These recommendations have been incorporated into the rehabilitation works.

Pit 3/Oversized Dump (RA13)

Pit 3/Oversized Dump was built by back-filling Pit 3 with waste rock screened from run-of-mine ore. The geotechnical specialist's recommendation was that the batters be reshaped to a slope of 1.0 vertical on 3.0 horizontal; and that a safety berm be built along the crest. These recommendations have been incorporated into the rehabilitation works.

Materials Available

Bulk fill material is proposed to be taken from the screening stockpile (RA14), the ROM (RA13) and the waste rock dump (RA16). Table 6-4 below lists the volume of the material in each dump structure. No treatment is required in terms of ARD (see Section 6.1.4).

Table 6-4. Overburden and Ore Dump Volumes

Disturbance	Volume (m3)	Volume (t)
Screening Stockpile	19,940	25,900
ROM	29,700	38,620
Waste Rock Dump	196,800	255,800
Nontronite Stockpile	51,425	66,800
Top Pad	1,200	1,560
Go line Pad	231,300	300,700
Front Pad	1,620	2,100
subTotal	***531,985***	***691,480***

6.1.5.2 Canoona (ML5864)

The current layout at the Canoona site will not require alteration as part of finalising the rehabilitation works. As such, the final landform will be the same as the existing landform, as shown in Figure 2-6 and Figure 2-7.

6.1.6 Cover design

Soils assessments will be undertaken prior to application to ensure the proposed material and soils are suitable to achieve the PMLU.

Subsoils (and other secondary growth media) will then be spread across the scarified profiled landform at a nominal depth of around 500 mm. Topsoil (and other suitable primary growth mediums if identified as being required) will then be spread over the subsoil to a nominal depth of 100 mm. Fertiliser and/or hay mulch will also be applied, as necessary. Section 6.1.9 gives more details.

6.1.7 Water management

The mine area contains no rock minerals or introduced substances that are likely to contaminate the receiving environment (refer to Section 6.1.4 which presents the geochemical characteristic of the rock). Catchments and waterways of the proposed final landform are illustrated in Figure 6-5.

As described in Section 2.3.5.3, groundwater is not intercepted on the site, and the only locations that may hold water will be retained as dams. Given there are no other excavations proposed, no

dewatering will be required. Catchments and sub-catchments that flow to the final voids are also limited in size, further limiting the potential for any overflows, which can be controlled by use of the water in irrigation and livestock use, and which are directed and captured in any case by downstream dams.

The high water holding capacity of the upper layers of soils will also benefit revegetation efforts, and limits problems related to seepage, which is also partly due to the tempering of flow rates through the low permeability rocks. The high strength of the saprolitic layer's rocks is not compromised by the water seepage. Some problems have occurred where there is a high smectite clay content, for example in the walls of Pit 1, which have been addressed in the final design (refer Section 6.1.5).

Surface water diversions have been included into the designs of existing back-filling operations, in the form of bunding that directs water along the contour, rather than down. This has resulted in slow run-off velocities and the settlement of sediment from the slowly flowing water. This practice is continued in the proposed design of the final landform.

The existing backfilling has resulted in a terraced landform, which further reduces run-off velocity. The haul road includes bunds wherever sediment was seen to leave the road in volumes and rates too high.

In the final landform, Pit 1 will receive run-off from the catchment shown in Figure 6-5. The catchment includes only the Go Line Pad and some of the Top Pad and adjacent haul road. Run-off from the Go Line Pad will pass through a culvert that is to be installed. In the final landform, any outflow from Pit 1 (minimal if at all) would flow across established vegetation, southward along a natural gully, into Dam 3. Water quality would be consistent with that in the surrounding farm dams (including Dams 1, 2 and 3), which meets the water quality targets for this PRCP [and as specified in the EA] – refer Section 2.3.5.4).

Go Line Pad (RA10) and the Nontronite Stockpile (RA8)

Rehabilitation works for the Nontronite Stockpile include pushing this stockpile down, across the Go Line Pad. The final landform has been designed to force run-off to flow from the newly fashioned Go Line Pad to the haul road near Pit 1. This is to prevent run-off scouring the walls of the Go Line Pad. It also adds a modest catchment area to the watershed of Pit 1, which will become a dam for the post-mining land use. The extent of the catchment is illustrated in Figure 6-5. A berm has already been installed along the haul road to prevent run-off from this area flowing northward.

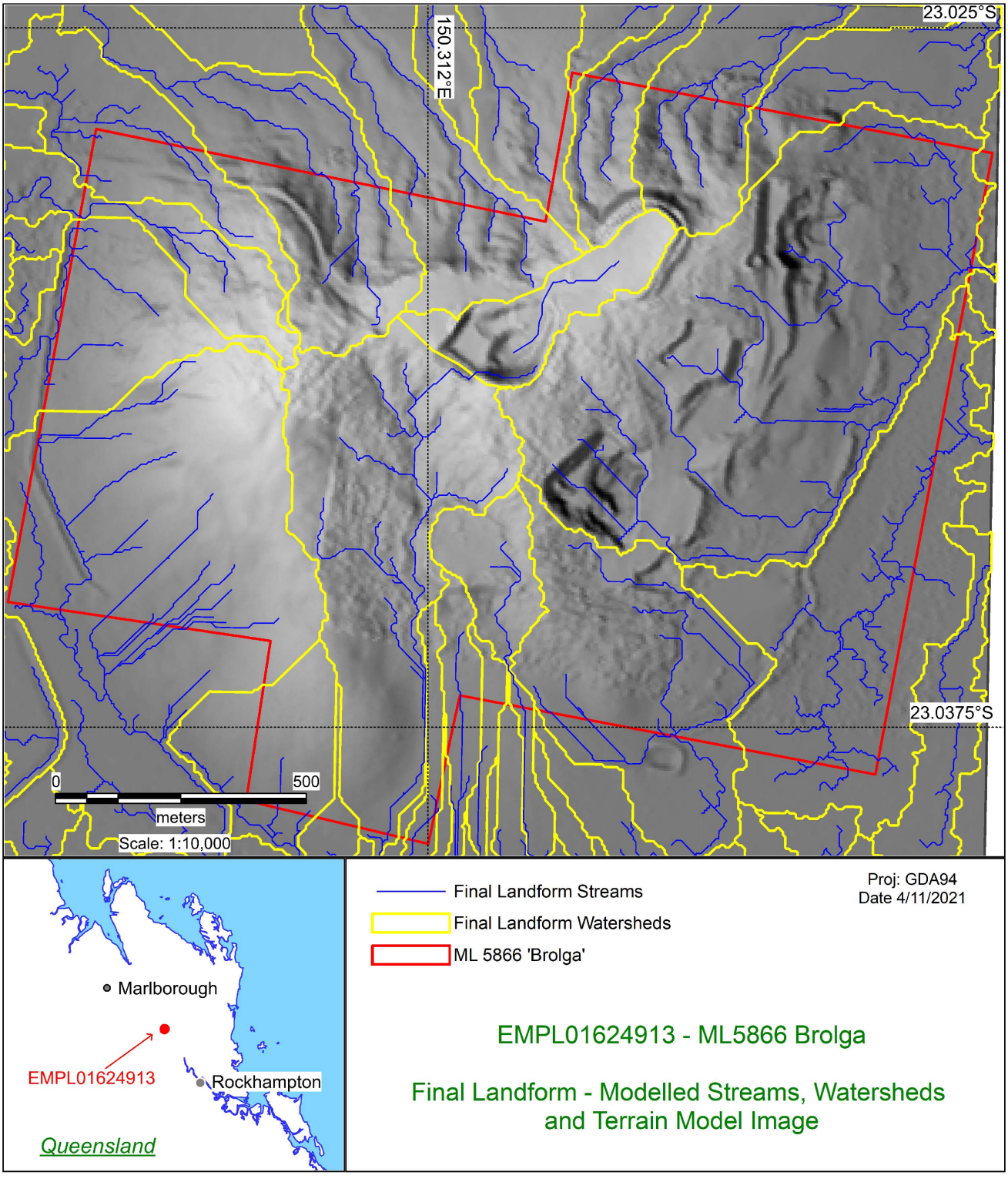


Figure 6-5. Final Landform, Watersheds and Waterways

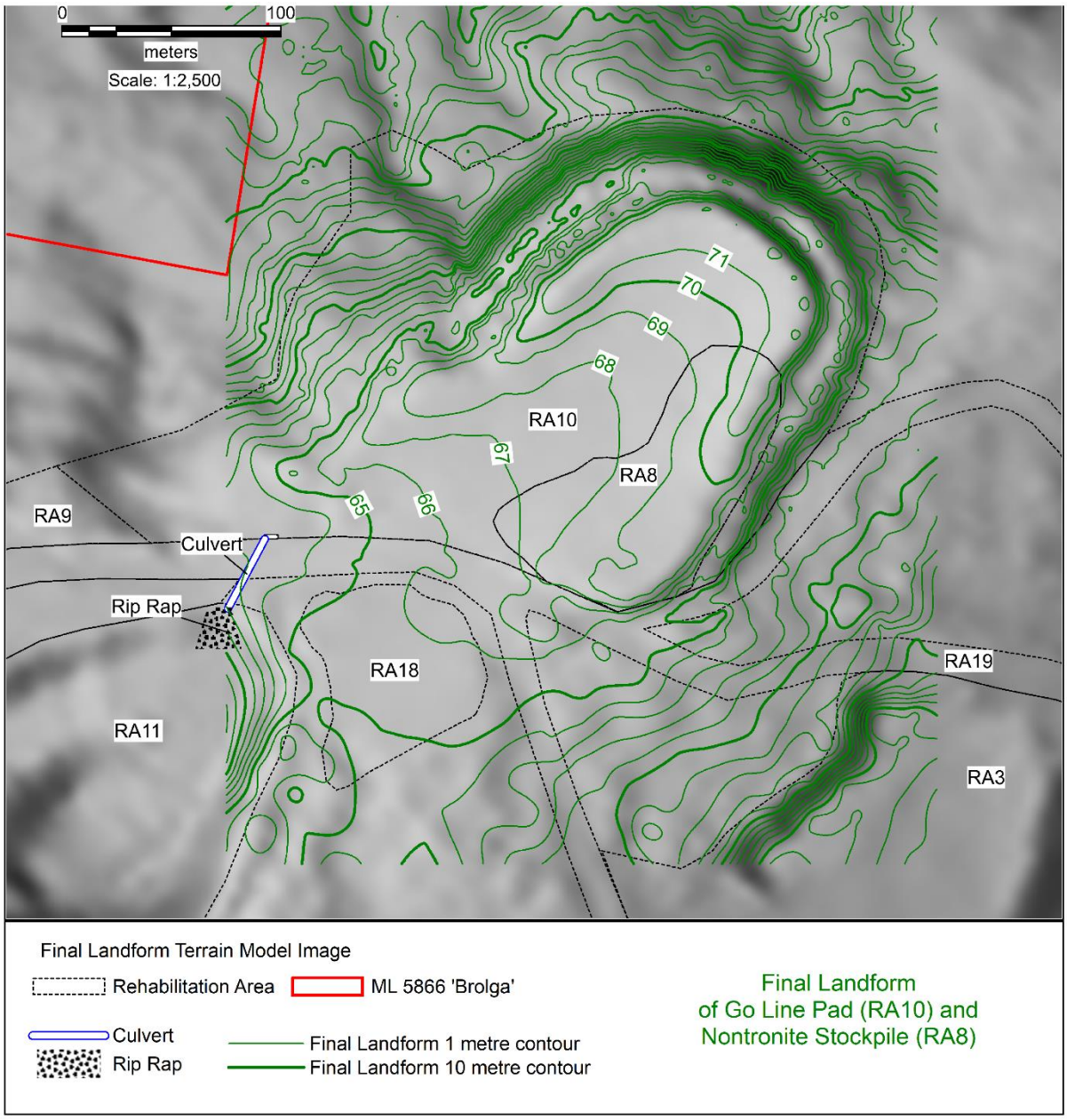


Figure 6-6. Final Landform – Go Line Pad (RA10)

6.1.8 Erosion and Sediment, Dust Control

6.1.8.1 Erosion and Sediment Control

An erosion and sediment control plan will be developed as part of the detailed engineering design plans. Measures will include the following:

- ripping and contouring to reduce runoff / enhance infiltration
- drainage control to divert runoff into pits for settlement of sediment
- undertaking works in the dry season, with revegetation before the wet season to protect soils from rain drop dispersion and surface erosion.

Additional (small) silt traps may also be constructed where considered necessary to reduce sediment inflows to dams or other areas, routinely emptied to maintain sediment trapping capacity. The

existing dams are part of sediment and erosion control measures under the EA, and form part of an existing Site Water Management Plan (under the EA).

6.1.8.2 Dust Control

The specific activities that have the potential to generate particulate emissions during rehabilitation activities are:

- Backfilling and Contouring
- Ripping
- Topsoil spreading
- Wheel generated dust from other vehicles on unpaved road
- Vehicle exhausts.

Dust emissions may vary according to the following factors:

- Overburden and topsoil stockpile and properties (location, moisture content, extent of stockpile)
- The earthmoving activities occurring
- Prevailing meteorological conditions
- The amount of the site vegetated.

The nearest receptors to the mine site are rural residences located 1.5 kilometres north of the site and 2.5 kilometres to the south-west of the site. Air emissions from rehabilitation activities at the Brolga ML are not expected to create any public nuisance or health concerns. It is acknowledged that there is, however, potential for there to be minor impacts on local visual amenity in times of low rainfall and higher wind speed where airborne particulate matter travels further. As such, the rehabilitation activities will have reference to the dust control initiatives set out in the Brolga Environmental Management Plan. These initiatives are tailored to address the higher risk periods, with greater focus on watering of haul roads and the use of dust suppression controls on stockpiles, and include the following control strategies:

- Haul roads and other unsealed roads will be watered, as appropriate
- Planning in advance of bulk earthworks to minimise handling, drop heights and wind erosion, where practicable
- Minimise the area of land disturbed at any one time
- Vehicles will travel in accordance with set speed limits
- Ongoing maintenance of roads will be undertaken to ensure they are in good condition
- Implementation of a dust monitoring program to monitor dust deposition at the lease boundary
- Appropriate awareness training for relevant personnel.

6.1.9 Revegetation

With the PMLU being grazing, three types of seeding mix (pasture, forest and woodland) will be used to revegetate the rehabilitation areas. A PMLU of grazing requires both pasture and forest. Livestock utilise forest as a means of protection from weather, especially wind, and as a protection from perceived predators. Cattle also commonly retreat to forested areas (if available) in the later part of the day to ruminate. Sparse woodland is the forest type that is planned for some pit walls and rocky batters because pasture and forest are not suitable to these landforms.

Pasture species will be sown on the gentle slopes and terraces; forest species will be used on moderate slopes and in groves considered to be in ideal locations for livestock shelter. Particular use of *Acacia* species will be used to revegetate rocky slopes and batters to a sparse woodland forest type. Early revegetation trials will determine whether the topsoil reserves still contain a range of viable seed.

6.1.9.1 Pasture Areas

Seed mixes for the pasture will include the pasture grasses *Chloris gayana* (Rhodes grass), *Sorghum* sp., *Bothriochloa insculpta* (bisset bluegrass), *Heteropogan contortus* (black speargrass) and *Themeda triandra* (native kangaroo grass). Inclusion of a legume in pasture mixes is recommended by the Queensland Department of Agriculture and Fisheries (DAF). Seka is considered to be a good choice for the Brolga area. It is commonly used in central Queensland, and will provide high quality protein forage during winter, when the grasses are stressed.

For the pastures, three kilograms of total grass seed per hectare is recommended, with one kilogram of Seka seed. Fertiliser rates are commonly recommended at around 150 kilograms per hectare, but with the presence of smectite clay in the Brolga soil, this fertiliser rate should be reduced to about 100 kg/ha, as it retains fertiliser much more readily than most grazing soils. Subsoil and topsoil assessments will be undertaken to determine the required amounts of ameliorants and fertilisers.

6.1.9.2 Forest Areas

For the forest species, some seed is likely to be preserved in the existing topsoil reserves. Additional seed can be sourced from established regrowth elsewhere on the mine site, and from remnant forest that is common in the immediate area.

'Eucalyptus fibrosa subsp. fibrosa, Corymbia xanthope woodland on serpentinite forest' (RE 11.11.7 - see Section 2.3.9) is the vegetation community chosen for the eventual forested areas. Its particular adaption to the serpentine soil type cannot be overlooked in consideration of alternatives. This soil type supports a number of serpentine endemics (Batianoff and Singh, 2001).

Suitable species for revegetation include the nitrogen fixing species *Stackhousia tryonii, Acacia leptostachya* and *Allocasuarina* species (e.g. *Allocasuarina cunninghamiana* and *A. torulosa*). These will help to improve the soil. Other species to be used include *Corymbia xanthope* and *Eucalyptus fibrosa.* A suitable species list will be developed in consultation with Livingstone Shire Council (who operate a nursery producing native plants of local provenance, and have undertaken several restoration projects in serpentine landscapes [pers. comm, P. Delalande & L. Childs, LSC, February 2022]).

Seeding rates for this vegetation type are not proposed in this report. Seeding rates will be governed by seed availability and collectability from forests on neighbouring properties. Hundreds of seeds are in even a few grams of gum nuts, however availability can differ from species to species, and year to year, so collection should be commenced as soon as possible.

6.1.9.3 Sparse Woodland

Rocky slopes, like the walls of overburden dumps and some pit walls, will be revegetated by sowing *Acacia* species and any forb that is collectable from nearby forest, into soil cast over scattered areas. Some grass seed is to be included to retain soil, but the intention is not to make pasture on these slopes. The soil in these areas will benefit from amelioration by adding some mulch and fertiliser into and over the soil. *Acacia* is a robust enough seedling to penetrate mulch. It already colonises the rocky slopes in the Brolga mine area. The mulch is required to prevent the soil drying out as the

rocks create a hot micro-habitat. Water seepage will maintain moisture availability during the wet season.

6.1.9.4 Soil Spreading and Seeding Practices

The characteristics of the soil are discussed in Section 2.3.6 of this PRCP. As specified in that Section, between 10 and 15 cm of topsoil was scraped, implying that there is an average of 100 mm of topsoil available to applied to all areas. A minimum topsoil depth of 100 mm will be applied, overlying a minimum 0.5m of subsoil, either in-situ or topped up to achieve the minimum 0.5m, to reinstate the former land surface. A soils assessment will be conducted of each stockpile prior to use to confirm the fertiliser and other amelioration requirements. The topsoil assessments will also confirm whether the soil resources available are sufficient for the revegetation.

Spreading of regolith and then topsoil will take place during the dry season, in winter (from May to August) in all RA's, in accordance with the Rehabilitation Schedule. This practice will allow time for it to settle and make apparent any erosion or instability that may eventuate. Precipitation events during the dry season, if any, are unlikely to be stormy or high rainfall events.

Monitoring of landform stability and revegetation success will be ongoing, but concentrated in the summer months. All rehabilitation activities will follow this seasonal temporal pattern in the Rehabilitation Schedule.

Seeding will be carried out in spring, September and October, to increase chance of seedling success from the seasonal rainfall. Ideally, seeding will be carried out after at least one spring rain event, and after that rain has had some time to evaporate and infiltrate, to leave an ideal soil moisture content for seed germination. Consideration must be given to moisture content so that sown seed does not become embedded in the concretions that are likely to form after rain, a characteristic of this soil type.

Monitoring of 'La Nina' weather conditions is a reliable forecasting technique in the timing for seed sowing. 'La Nina' conditions are an indicator that rain will fall during the coming year. They are predicted using oceanic surface temperature in the eastern Pacific Ocean. When a cool ocean surface exists, the consequent easterly wind across the Pacific Ocean is stronger and denser than normal, resulting in increased severity and frequency of rain events in the western Pacific regions. If a 'La Nina' year is predicted, sowing can be scheduled earlier because early spring rain is likely.

The conservation area which was designated in the Land Outcome document 'Brolga Rehabilitation Management Standard' (Appendix 3) has been undisturbed and therefore no rehabilitation is necessary (however checks will be performed to verify that the condition of the vegetation is consistent with that specified in this PRCP). A study undertaken in 2012 (see Appendix 12) demonstrated that, at that time, rehabilitation was well under way, with ground cover across the site above 50%. The weed control practices previously undertaken will continue in this area.

6.1.9.5 Soil Amelioration

The growth media does not necessarily require amelioration, as it usually contains sufficient smectite clay to retain moisture and nutrient, is friable enough when moist to facilitate germination, and provides sufficient seed-soil contact to promote seedling growth. However, amelioration of soil will be used in pasture grass sowing in the form of low-moderate fertiliser rates, and on the steep rocky slopes in the form of some mulch for sowing of *Acacia* spp.

A modest degree of topsoil amelioration by the addition of mulched plant material and a small amount of fertiliser is proposed for areas that have little or no friable regolith, like batters, berms

and other rocky ground. This is likely to increase seedling survival on the rocky ground which would otherwise dry out soil which is not ameliorated.

Amelioration of the soil by mulch is not proposed for the pasture areas (on terraced and gently sloping landforms).

Soils assessments will be undertaken prior to application to verify, or amend as required, the proposed amelioration measures to ensure that the proposed material and soils are suitable to achieve the PMLU.

6.1.9.6 Batters, Berms and Pit Walls

Along batters, berms and pit walls, topsoil spreading will not be pervasively or evenly spread. It is impractical to do this. Seeding will consist primarily of shrubs and forbs collected from neighbouring forests, plus any remnant seed bank which may persist in the topsoil reserves. Pioneer species like *Acacia* have already colonised and grown vigorously on existing pit walls, batters and berms.

6.1.9.7 Terraced landforms

Terraced landforms and gently sloping land will have three kilograms per hectare of grass seed added, and one kilogram of Seka, with a view to the post-mining land use, grazing. Soil will be spread relatively uniformly in these areas. Some groves of forest will also be sown.

6.1.9.8 Weed management

Weed control and management is an important component of successful rehabilitation as weeds can be a major source of failure of rehabilitation efforts. As such, it is critical that any new weed infestations are prevented and/or controlled at the earliest possible opportunity.

In addition, QNI is obliged under the *Biosecurity Act 2014* to prevent the spread of declared weeds. Three species observed on the MLs are declared category 3 weeds under this Act - American rat's tail grass (*Sporobolus jacquemontia*), giant rat's tail grass (*Sporobolus pyramidalis)* and lantana (*Lantana camara*). The Act requires everyone to take all reasonable and practical measures to minimise the biosecurity risks associated with invasive plants under their control. Some non-declared weeds can also severely impair the successful development of rehabilitation. It is therefore important to identify and prioritise the weed species of concern and set out their management requirements.

Priority will be given to management of weed species that have the highest risk of severely impairing the success of rehabilitation. Currently, of the weed species identified at the Brolga mine, giant rat's tail grass is the highest priority species for management. Lantana has been identified as the second highest priority weed species for management. Priorities should be reviewed annually, and be informed by monitoring.

Management should have reference to the management practices set out in the factsheets – rat's tail grasses (DAF, 2021) and lantana (DAF, 202) and other governmental factsheets relevant to other weed species identified.

6.1.9.9 Fire management

Brolga

Bushfires need to be excluded from the Brolga ML site to allow the success of pasture as the final land cover for grazing post-mining. The bushfire risk has two main sources: neighbouring properties; and activities on site.

Fire controls such as firebreaks will be maintained along fence lines where there is a high fuel load to protect the property from any neighbouring fires.

Activities on-site will be risk-managed so that if a fire risk is identified the activity can be modified or controlled in an appropriate way to avoid fire ignition.

The site has an Emergency Response Plan (QN-PLN-002) which is applicable to the Brolga ML.

Canoona

Canoona is intended for very low intensity grazing in a manner that preserves the structure and condition of the Regional Ecosystem on site.

For Canoona the fire management guidelines for RE 11.11.7 should be followed. These guidelines are given as part of the Regional Ecosystem description for that RE type (DES, 2022) and are as follows:

- SEASON: Burn early dry season when there is good soil moisture, with some later fires in the early storm season or after good spring rains.
- INTENSITY: Various.
- INTERVAL: Most intervals between five to ten years, with no shrubby woodlands receiving two consecutive intervals of < six years.
- STRATEGY: Once boundaries of the planned burning area are secure, ignite across the landscape in a patchwork, rather than continuous ignition strips. Use topographical features to help create a patchily burnt landscape. Where shrubby woodlands occur within a broader grassy landscape, attempt to burn the shrubby woodland during every second fire rotation in the grassy woodland, by burning early breaks around the shrubby areas. In sites with a history of wildfires recurring within 5 years, patchy burning in a few small strategic locations at three or four year intervals may reduce the incidence of extensive wildfires, while ensuring most shrubby woodland areas remain unburnt for > 5 years.
- ISSUES: Shrubby woodlands require longer fire intervals than grassy woodlands, because of the presence of fire-killed shrubs and the time required for post-fire regrowth to return to a mature structure. The seedlings of many fire-killed shrubs (such as some wattles) require fire years or more before they mature. The creation of a fine-scale patchy mosaic can be more difficult to achieve in shrubby compared to grassy woodlands. Ensure seedlings of fire-killed shrubs mature and persist in the woodland; ensure several years of mature shrubby woodland structure before the subsequent fire.

6.1.10 Water Bore Rehabilitation

Water bores will remain in place during the rehabilitation works to support groundwater monitoring, only being rehabilitated once major works are completed. Closure and rehabilitation will involve grouting and removal / cutting off of the casing, and capping to ground level. Any disturbed area around the bore will be revegetated, although given their location this will be minimal.

6.2 Tailings Storage Facilities

No tailings of any kind have ever been generated at this mine site.

6.3 Voids

6.3.1 Brolga

Three residual voids are in the closure design for ML5866: Pit 1, Pit 2 Extension and Pit 8.

All open pits currently have ramps, which will be preserved in the proposed final landform. All open pits are in the closure design as dams for the post-mining land use, grazing (Figure 6-7). The disturbance feature 'Pit 8' (RA12) is topographically the lowest final void in the closure design.

The dimensions of the voids are given in Table 6-5 and Table 6-6.

Table 6-5. Residual void dimensions

Final Void	Depth	Length	Width
Pit 1	22	204	192
Pit 2 Extension	36	226	194
Pit 8	25	270	225

Table 6-6. Residual void maximum slope angles

Final Void	High Wall	Low Wall	End Walls
Pit 1	33°	27°	34°
Pit 2 Extension	40°	40°	40°
Pit 8	40°	20°	30°

Advice regarding the long-term stability of each of the three final voids was sought from a geotechnical specialist. The consequent recommendations are discussed in Appendix 11.

The final void that requires major modification to the pit walls is Pit 1 (RA11). Pit 1 currently has instability in its walls. The wall design is as a series of berms and batters. The lateritic layers contain a greater proportion of smectite clay in this pit, which swells upon wetting, resulting in instability. There is a noticeable accumulation of wasted regolith along the berms of Pit 1.

It was recommended that the walls of Pit 1 be flattened to a slope of 1.5 horizontal to 1.0 vertical for long term stability. This has been included in the proposed rehabilitation works for Pit 1. The western and northern walls have already been graded back and have a large amount of back-fill at their bases to ensure their stability.

In the final landform, Pit 1 will receive run-off from the catchment shown in Figure 6-5. The catchment includes only the Go Line Pad and some of the Top Pad and adjacent haul road. Run-off from the Go Line Pad will pass through a culvert that is to be installed. The water management system – comprised of diversion bunds, dams and other drainage systems has been designed to keep water on site. Water quality would be consistent with that in the surrounding farm dams (including Dams 1, 2 and 3) which meet the water quality targets.

The other final voids (Pit 8 and Pit 2 Extension) have strong rock throughout their walls. Geotechnical advice recommended no changes to the geometry of these existing walls. All three final voids require safety bunds to be installed at the top of the steep slopes.

All areas with potentially unsafe slopes and drops will be fenced off with appropriate signage installed to exclude both cattle and humans from accessing these areas.

6.3.2 Canoona

As a result of the exploration activities described in Section 2.2.3.3, two very minor voids exist on Canoona (the EP Act defines a void as 'an area of land…excavated in the carrying out of a mining activity'). These are shallow (less than 2 m deep), less than 100 m^2 and roughly rectangular in shape. The side walls have slumped and the ends are gently sloping, allowing easy access and egress. They do not pose any environmental or safety risk. Vegetation is regrowing naturally in and around them, and any efforts to rehabilitate them would result in greater environmental damage than any benefit given the amount of vegetation clearing that would be required to access them and undertake earthworks.

6.3.3 Voids in Floodplains

6.3.3.1 Brolga

The entire area of ML5866 Brolga is mapped within the Fitzroy River, Fitzroy sub-basin Floodplain Assessment Overlay.

The land encircling ML5866 is at elevations of around 20 metres, gradually sloping towards Alligator Creek five kilometres to the east. It is geologically mapped as Quaternary Holocence Alluvium. The Palaeozoic Serpentinite rises above the floodplain.

The majority of ML5866 is topographically higher than the surrounding land, on a distinctive rise above the Quaternary floodplain. Most of ML5866 is above elevation 20 metres, to a maximum elevation of about 70 metres above sea level.

Three residual voids are in the closure design for ML5866: Pit 1, Pit 2 Extension and Pit 8. They are above the geological floodplain as demarcated by the Quaternary sediment that surrounds the Brolga mine. All are in the closure design as dams for the post-mining land use, grazing. The disturbance feature 'Pit 8' (RA12) is topographically the lowest final void in the closure design.

Flood modelling was not carried out. 'FloodCheckMap' was used to qualify the risk of inundation on final voids in ML5866 (refer to Section 2.3.5.2). The 1% AEP and extreme flood extents near the EA are shown in Figure 2-15 and Figure 2-16 of the Baseline Information section of this report.

Peak water level at a flood event of 1% AEP shows that floodwater would intrude ML5866 near its perimeter, but not enter any final void. Peak water level at 'extreme event' indicates that floodwater would enter a final void, Pit 8. As a result, an examination was undertaken to examine whether Pit 8 will be stable enough to endure extreme event flooding.

Inspection of Pit 8 by geologists and an independent geotechnical specialist determined that the rocks of the pit walls within Pit 8 are exceptionally strong, not reactive to moisture and not susceptible to erosion. The rocks are very high in silica content, non-friable and have very low permeability and low porosity. During an extreme flood event, it is probable that Pit 8 would already be full, and mitigate flow energy that may result from regional flooding. These observations concluded that Pit 8 will remain stable during a 0.1% AEP extreme flood event, and not intensify any scouring, erosion or sedimentation.

Water contained in Pit 8 will be suitable to support the intended post mining land use of grazing. As such, should any flooding of Pit 8 occur in an extreme event, it would not be expected to cause any impacts to downstream environments (see Section 2.3.5.4 and Appendix 4).

6.3.3.2 Canoona

There are no voids in the floodplain at the Canoona ML. The majority of ML5864 sits above the floodplain, however a small part of Canoona is mapped within the Floodplain Assessment Area. None of the areas that were formerly explored lie within the 1% AEP flood extent. Two former drillpads/boreholes (number 4 and 9) lie at the very edge of the Peak water level at 'extreme event' flood level.

Given there are no voids in floodplains, and the fact that Canoona will not be significantly disturbed during rehabilitation activities (only weed and fire management are required), it is therefore considered that there would not be any risk to any environmental value on, or in proximity to the Canoona ML as a result of flooding.

6.4 Dams

Pit 1 (RA11), Pit 2 Extension (RA4) and Pit 8 (RA12) are all final voids that will be modified to become dams. (Pit 1) currently contains water more or less permanently, and the other voids are expected to contain water for shorter periods during the wet season. Dam 4 is located on the eastern boundary of ML5866.

This water infrastructure will allow the water captured on the site to be utilised for pasture irrigation and cattle watering, consistent with the PLMU. As demonstrated in Section 2.3.5.4, the quality of the water in these impoundments will be suitable for stock watering and irrigation.

Management and maintenance of the pits is described in Section 6.3. Regarding water dams, in general management and maintenance will include the following activities:

- Initial assessment of sediment contamination within water impoundments
- Geotechnical assessment and stability works for banks and walls
- Revegetation (where necessary) of banks and adjoining areas
- Water quality monitoring, to identify issues within the dam or catchment, and collect sufficient data to confirm the quality meets the water quality targets
- Ongoing visual inspections for stability and water quality (e.g. surface slicks and scums, algal blooms).

6.5 Underground mining

No underground mining of any kind has ever been undertaken at this mine site.

6.6 Built Infrastructure

The mine has been in Care and Maintenance since 2016 and all mine equipment has been removed from the site.

Specifically, the only remaining infrastructure on site is as listed below:

- The network of haul roads
- The network of access tracks
- The bath-house infrastructure.

These will remain as post-mine infrastructure in support of the PMLU. A further description of each of these features is given below and their location is depicted on Figure 6-7.

The landholders, QNI Resources Pty Ltd and QNI Metals Pty Ltd, have provided a statement that they will accept responsibility for the infrastructure once mining has ceased (see Appendix 8).

The aforementioned infrastructure will be retained as it is consistent with, and will support, the PMLU of low-intensity grazing. In addition, one culvert will be installed to drain water from the Go Line to Pit 1. The toilets and showers within the bathhouse will be useful for future workers on the property. The roads will allow for access around the site for management of weeds, fire and cattle.

6.6.1 Haul Road

The Haul Road (RA19) network contains 2.82 kilometres of compacted tracks. They are unsealed formed roads built using overburden from the upper red-brown lateritic layer, an ideal road-base material. The haul road network will be utilised throughout rehabilitation works, and will be maintained to support these works, with final reshaping, drainage and surfacing works conducted prior to completion of rehabilitation where needed. General maintenance works will include:

- Maintenance of road geometry and drainage systems, through reworking and recompaction where required
- Installation, inspection and maintenance of the culvert and other drainage structures (e.g. erosion, damage / cracking of structures, etc.)
- Grading where corrugation, rutting, and/or potholes form
- Dust suppression (i.e. water carts) to control dust emissions where required from traffic.

6.6.2 Access Tracks

The network of access tracks includes 5.7 kilometres (total length) of pushed track. Management and maintenance will be similar to, but of a much lower magnitude, to the haul road, with works including vegetation management and trimming and general track management.

6.6.3 Bath-house

The bathhouse includes two adjacent demountable structures (shower and toilet block) with a septic tank, rainwater tank, underground PVC pipe to the rainwater tank, and some concrete paths and pads, all contained in a clearing approximately 1,700 square metres in area. Ongoing maintenance of these structures will include:

- Inspections for general wear and tear, and the need for repairs to maintain quality (e.g. cracks in walls, paths, maintaining working order for doors, windows, etc.)
- Plumbing and electrical inspection, and replacement / refitting where required
- Pump out of septic tank (once at the start of rehabilitation, and generally 5 yearly thereafter depending on use).

6.6.4 Culvert

The culvert is yet to be installed. It will drain water across the Haul Road (RA19) from the Go Line area to Pit 1. It is required to prevent erosion of the Haul Road from water run-off.

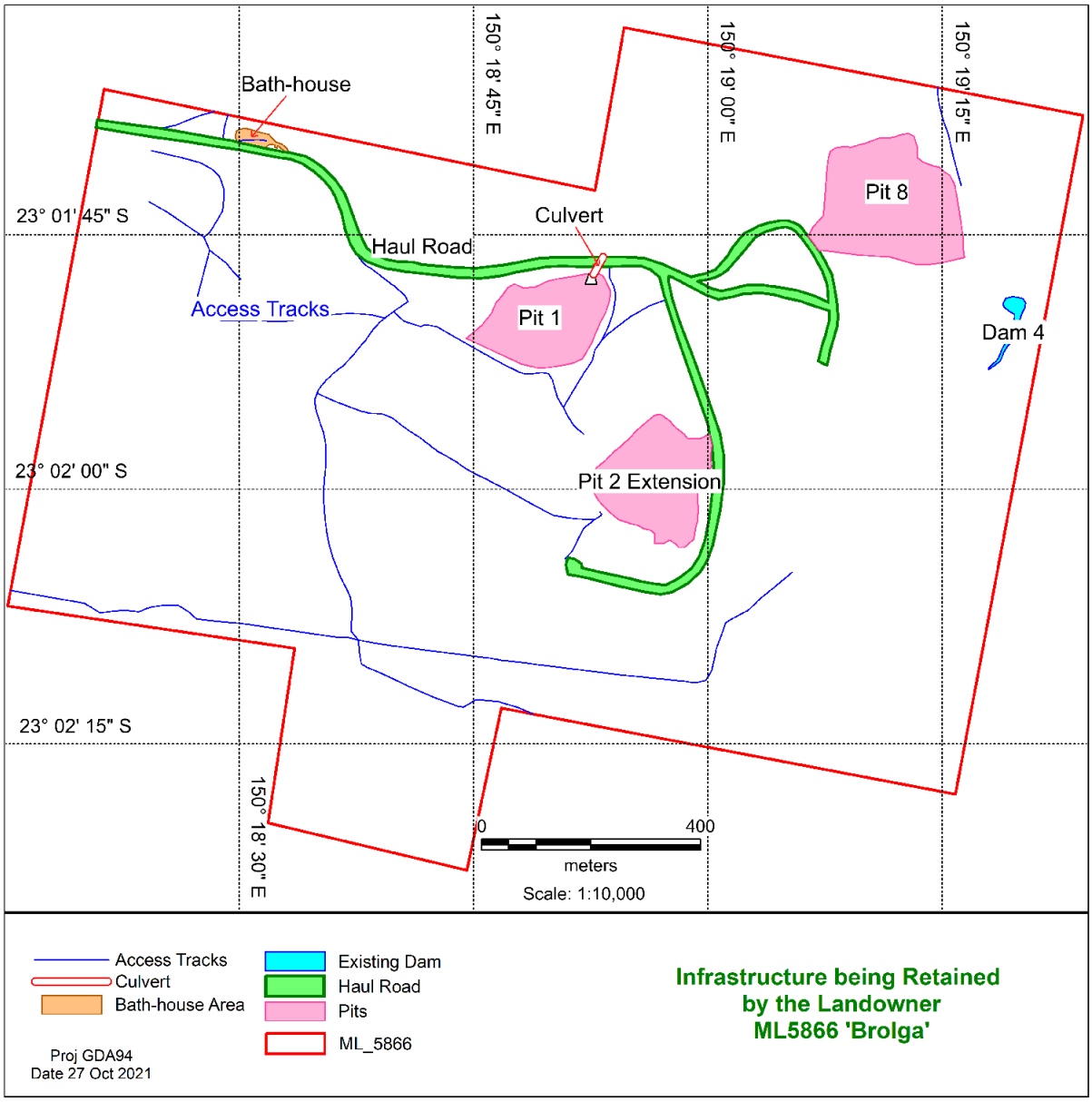


Figure 6-7. Infrastructure being Retained by the Landowner

6.7 Final Site Design

Figure 6-8 and Figure 6-9 show the final site design for both MLs, including:

- the maximum disturbance footprint
- resource tenure boundaries
- PMLU for the land within the MLs
- flood plain extent.

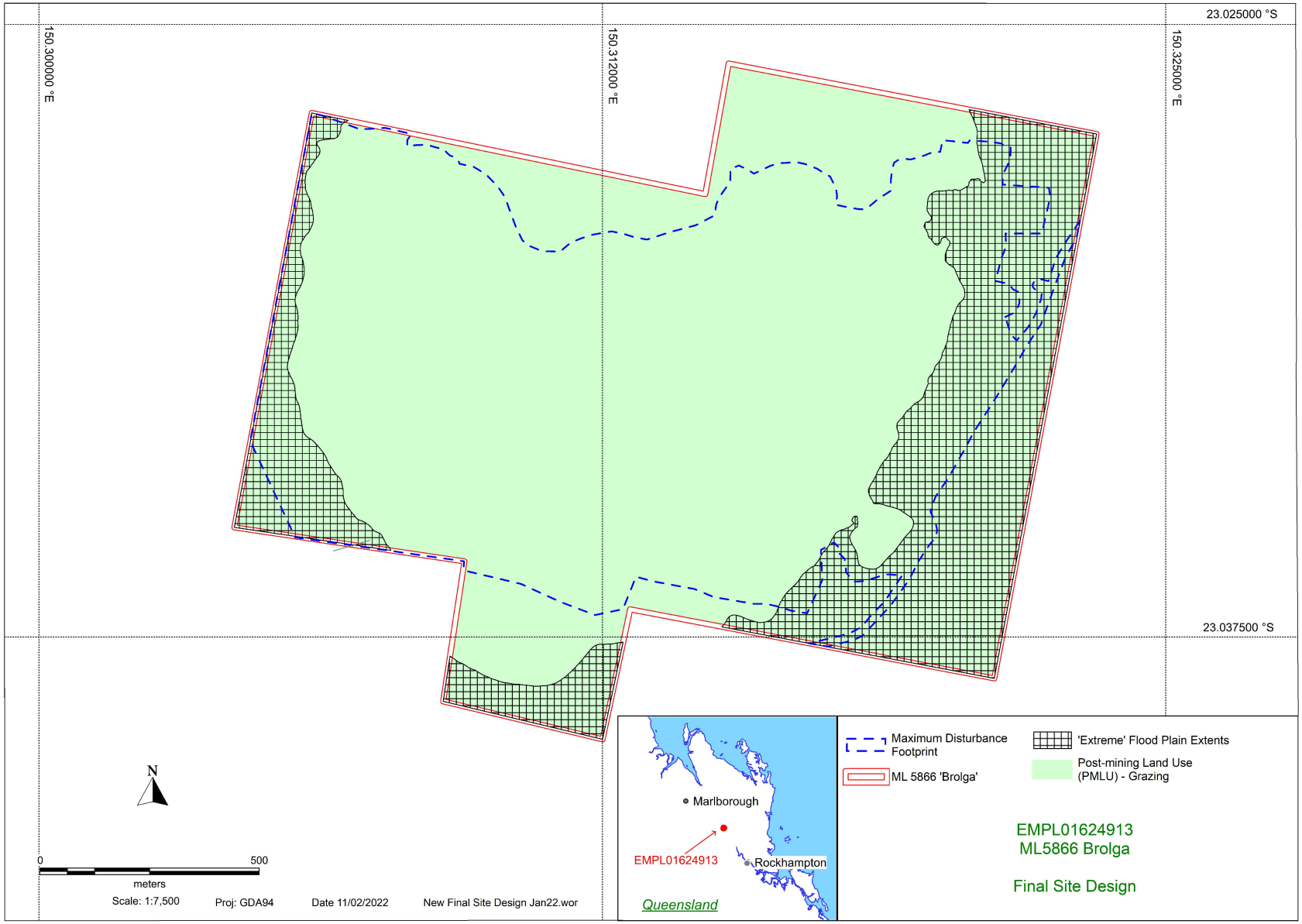


Figure 6-8. Brolga ML final site design

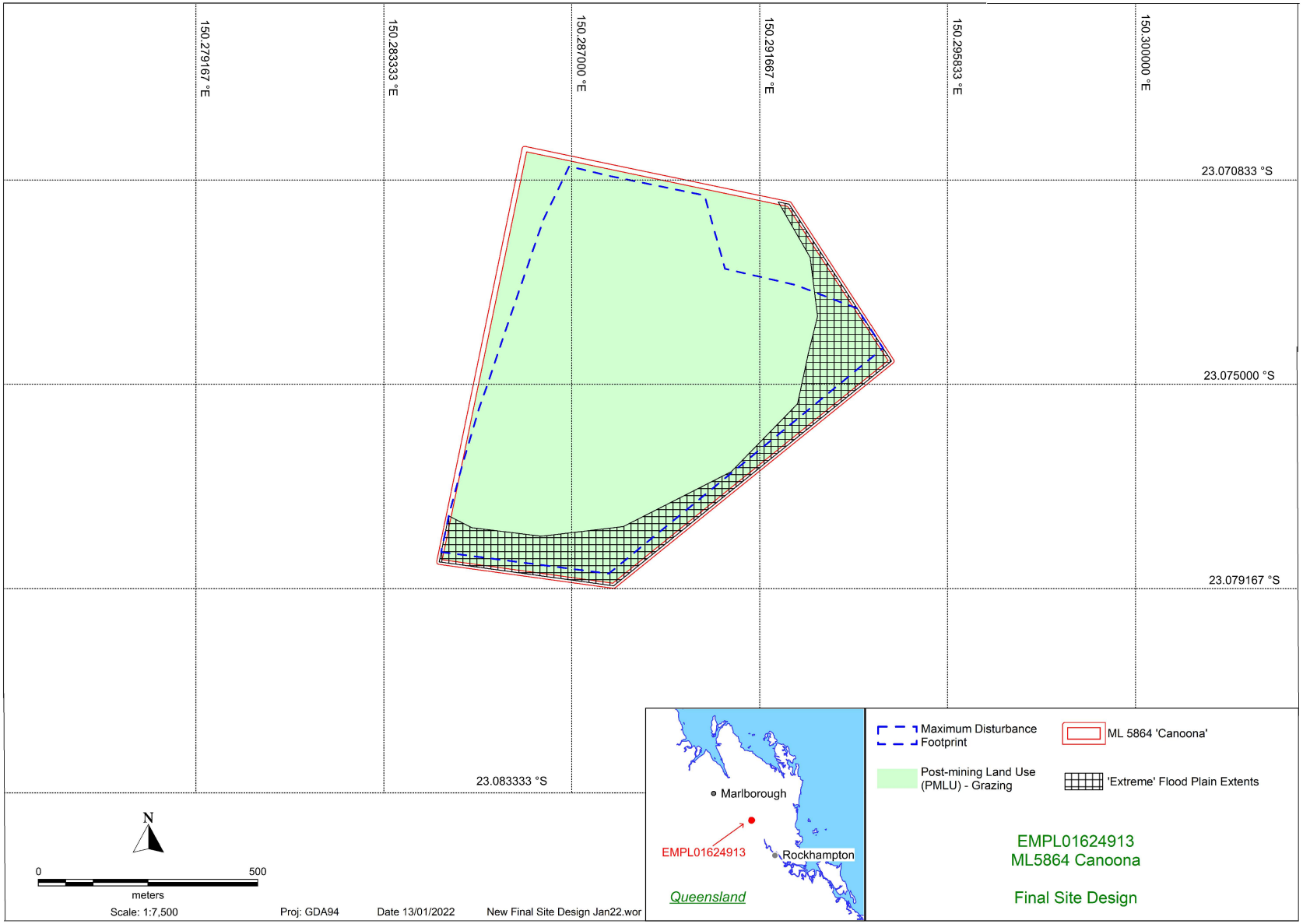


Figure 6-9. Canoona ML final site design

6.8 Management System

Management of rehabilitation works will be undertaken within a health, safety, environment and quality management system (HSEQ System), based on a continuous improvement and risk-based model already in place at QNI. The key elements supporting this PRCP include:

Incorporating the PRCP Requirements into the HSEQ System

The existing QNI HSEQ System will refer to and report on progress with the PRCP as one of its fundamental components, and adopt objectives and targets relevant to safe completion of the PRCP.

Non-Conformance and Corrective Action

Any rectification or requirements for further action identified in any monitoring or assessment program (or opportunistic observation) will be added to the existing QNI incident register recording at least the following details:

- Area located, including link to spatial database location, by whom and date of observation / finding
- Description of the issue
- Detail of the rectification or follow up actions required
- Responsible party for action
- Required timing for completion
- Where relevant, evidence required for completion (refer to milestone monitoring, Section 8.1.9 where relevant).

Roles, Responsibilities and Training

The QNI HSEQ System will be used to include specification of roles and responsibilities, and an assessment of training needs, along with tracking of training conducted.

Communication, Supplier and Sub-contractor Management

The QNI HSEQ System will also further address communication needs and requirements at Brolga and Canoona, including both internal and external communications, and the management of suppliers and subcontractors.

Documentation and Records

The existing QNI system will be used to manage and maintain documents, ensure quality control (e.g. the latest documents are in use), and to retain appropriate records.

7 Risk Assessment

Section 3.7 of the Guideline – Progressive Rehabilitation and Closure Plans - specifies that a PRCP must include a risk assessment, one which identifies "the risks of a stable condition not being achieved and how the applicant intends to manage or minimise the identified risks." This section of the proposed PRCP contains the results of the risk assessments that were carried out during the PRC planning process.

The risk assessment process demonstrated to the applicant that, although a variety of risks will be encountered during and after remediation works, many of the identified risks are common across multiple features in the disturbed area. Therefore, the identified risks and proposed mitigation measures are generally the same across the entire area.

The analyses include a tabulation of the identified risks and proposed controls common across multiple features in the disturbed area (Table 7-2) and the controls that mitigate them.

Below are some relevant facts:

1. The mine has not operated since early 2017, and in that time no mass failure of pit walls or out-of-pit spoil structures has occurred
2. The disturbed area includes multiple pits, some back-filled partially or wholly, and some out-of-pit dumps that are maintained as either waste rock dumps or out-of-pit dumps modified for use in mine operations (stockpiling, parking)
3. Previous rehabilitation of completely barren areas, back-filled pits and spoil dumps within ML5866 was successful (Section 2.7.1)
4. There is a large topsoil reserve retained within ML5866
5. There are large areas within and near ML5866 available for seed collection
6. There has never been any chemical treatment of ore on site
7. The only beneficiation of ore on site has been screening
8. There are no acid generating minerals exposed by the mining operation
9. The local climate has distinctive wet and dry seasons.

The main risk groups that were identified were: failure of slopes; poor vegetation regrowth; unsuitability of revegetation; over-topping of dams; erosion/scouring and sedimentation of drainage paths.

To control these risks, the following measures were introduced to the rehabilitation planning and design process:

- Geotechnical consultant to design residual void and out-of-pit dump slopes
- Minimise catchment areas for all dams
- Drainage paths for potentially overtopping dams to be controlled by berms and areas already revegetated
- Nontronite stockpile to be pushed down
- Revegetation trial to be conducted early in the rehabilitation plan, on a small area (Test-Pits) (see Section 7.1 below)
- Back-filling to maintain gentle slopes with terraced landforms
- Plant species known to grow locally, pasture and forest types

- Conduct earthworks during dry season
- Conduct seeding during spring
- Install bunds to control drainage paths and diminish flow speed
- Install fences where necessary to control livestock movement.

Both inherent risks (risks without control) and residual risks (risks with control) are identified and assessed for each hazard. Risks are scored based on definitions in Table 7-1.

Table 7-1. Scoring system used to assess risks

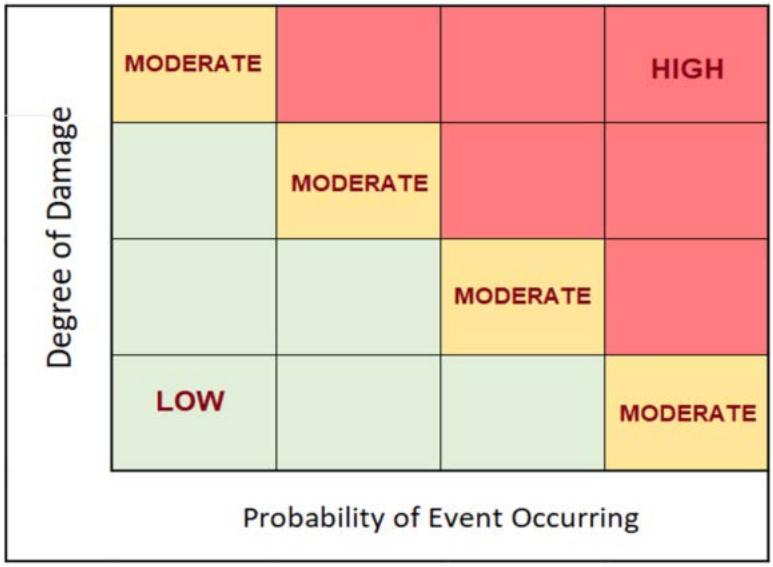
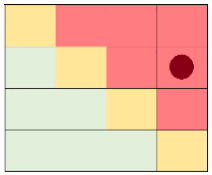
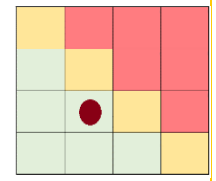
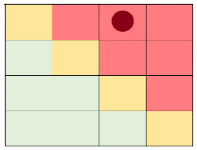
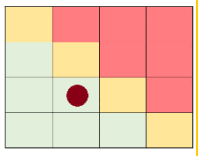
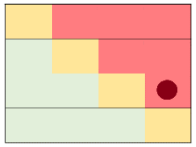
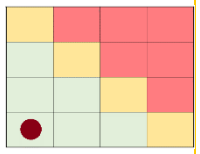
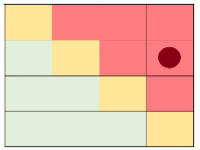
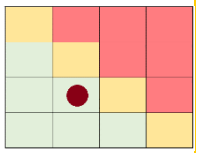
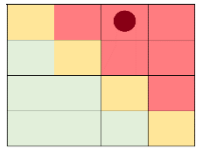
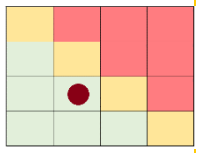
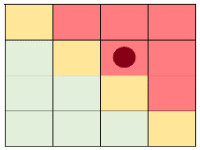
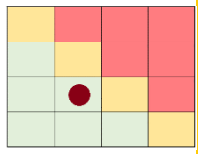
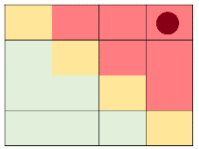
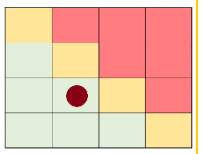
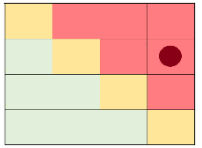
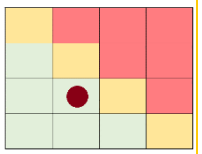
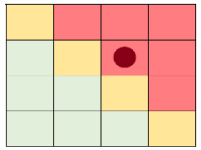
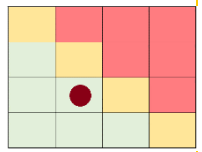
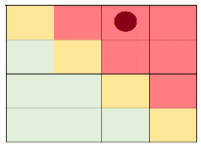
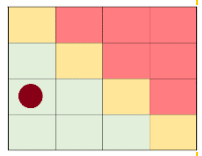
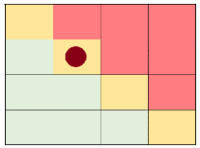
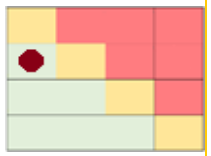
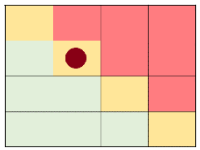
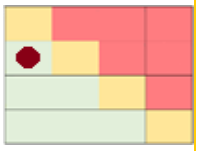
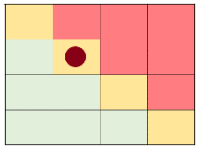
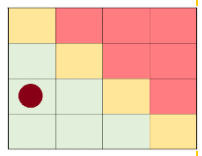
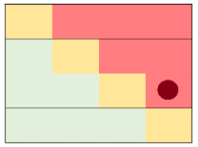
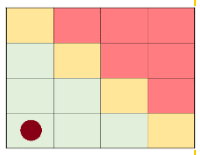
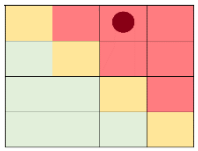
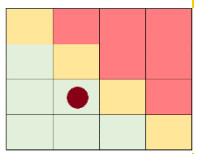
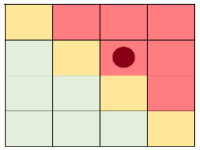
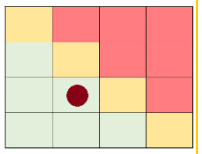


Table 7-2. Risk Assessment Summary

Identified Risk	Potential Consequences	Relevant Disturbance Feature Types	Features Affected by this Risk	Controls (1)	Controls (2)	Controls (3)	Risk without Controls	Risk with Controls
Walls of residual voids unstable	Possible mass-wasting and/or gradual attrition of wall rock, causing additional wall instability, erosion and downstream sedimentation	All voids and all pit walls that have not been fully backfilled	Pit 1, Pit 2 Extension, Pit 3, Pit 8	Use of a geotechnical consultant to assess stability and recommend mitigation measures	Minimise catchment area to reduce infiltration of water. Direct water run-off away from walls	Bench back walls and reduce pit wall angles where necessary		
Over-topping of residual voids	Overland flow causing loss of vegetation, erosion of soil and downstream sedimentation	Residual voids	Pit 1, Pit 2 Extension and Pit 8	Ensure catchment areas are small	Reform landform to direct possible outflows across low-risk areas	Ensure voids/dams are large but shallow. Evaporation rate is 700 mm / year in this region		
Final Landform of non-residual pit walls unstable	Possible mass-wasting and/or gradual attrition of wall rock, causing additional wall instability, erosion and downstream sedimentation	All pits that are not fully backfilled	Pit 4, Pit 5, Pit 5 South	Fully back-fill all these to landform of surrounding area	Conduct earthworks during dry season, Winter and Spring months	Conduct topsoiling and seeding promptly after earthworks		
Instability of Spoil Pile Walls, Pad walls, Overburden Dumps	Mass failure creating an unstable landform, resulting in severe sedimentation downstream	Waste rock dumps and other spoil piles and pads	Pit 2 backfill, Pit 3 backfill, Waste Rock Dump 1 (WRD1), Go Line Pad, Top Pad	Use of a geotechnical consultant to assess stability and recommend mitigation measures	Minimise catchment area to reduce infiltration of water. Direct water run-off away from walls	Bench back and reduce spoil pile edge angles where necessary		

Identified Risk	Potential Consequences	Relevant Disturbance Feature Types	Features Affected by this Risk	Controls (1)	Controls (2)	Controls (3)	Risk without Controls	Risk with Controls
Instability of Stockpiles	Possible mass-wasting and/or gradual attrition of stockpile, causing additional wall instability, erosion and downstream sedimentation	Any stockpile	Nontronite Stockpile, ROM Stockpile, Low-grade Stockpile and Unscreened Low-grade Stockpile	Use these stockpiles for back-filling operations	Push down any remaining stockpile	Use any remaining stockpiles to make a final landform that drains away from sensitive areas		
Erosion / scouring due to high slope angles	Possible sedimentation of downstream waterways	Slopes of pit walls, spoil piles, back-filled pits	Pit 1, Pit 2 Extension, Pit 8, Waste Rock Dump (WRD1), Go Line Pad	Use of a geotechnical consultant to assess stability and recommend mitigation measures	Minimise catchment areas and manage run-off in/near high slope domains	Prompt topsoiling and revegetation after earthworks using mainly local *Acacia* species		
Erosion / scouring of any surface	Possible sedimentation and scouring of downstream waterways	All Disturbance Features		Revegetate using local species (especially fast growing *Acacia* spp.) and other species known to grow well in the area.	Redirect run-off using appropriate landform design	Minimise catchment areas where risk is considered to be high		
Instability of slopes, spoil piles and pit walls	Possible sedimentation of downstream waterways,	Slopes of pit walls, spoil piles, back-filled pits	Pit 1, Pit 2 Extension, Pit 8, Waste Rock Dump (WRD1), Go Line Pad, Nontronite Stockpile	Schedule earthworks during Winter and Spring months, when disturbance features are low in moisture content	Use of a geotechnical consultant to assess stability and recommend mitigation measures			

Identified Risk	Potential Consequences	Relevant Disturbance Feature Types	Features Affected by this Risk	Controls (1)	Controls (2)	Controls (3)	Risk without Controls	Risk with Controls
Erosion / scouring during rehabilitation operations	Loss of topsoil stock; mass wall failure; possibility of severe downstream sedimentation;	All Disturbance Features		Conduct earthworks during Dry season, Winter and Spring months	Conduct topsoiling and seeding soon after earthworks	Utilise appropriate erosion and sediment controls		
Loss of recently top-soiled and seeded areas due to torrential rain	Loss of topsoil stock; possible downstream sedimentation; necessity to re-schedule rehabilitation works	All Disturbance Features		Schedule topsoiling and revegetation in late Spring, before heavy rain but when soil moisture is moderate	Conduct earthworks during Dry season	Monitor predicted La Nina events to anticipate ideal timing of topsoiling and seeding		
Water quality in dams to be retained does not meet water quality targets	Water cannot be used to support the PMLU	Dams / residual voids	Pit 1, Pit 2 Extension, Pit 8, Dam 4	Assess and if necessary remediate sediment within water storages	Rehabilitate receiving catchments	Monitor water quality, and remediate pollutant sources		
Groundwater quality indicates decline in water quality	Potential impacts off-site	Likely features associated with residual voids, chemical/fuel storage areas, water bores		Continue to monitor water quality to provide early warning of potential issues	Based on the monitoring, assess site for potential sources causing the change			
Final Landform suitability for cattle grazing	Loss of land value; Loss of potential land use	All Disturbance Features		Final landform design to have low gradient wherever reasonably possible.	Back-filling to a terraced landform	Retention of some voids for water storage		

Identified Risk	Potential Consequences	Relevant Disturbance Feature Types	Features Affected by this Risk	Controls (1)	Controls (2)	Controls (3)	Risk without Controls	Risk with Controls
Revegetation suitability for cattle grazing	Risk that the rehabilitation does not suit the post-mining land use	All Disturbance Features		Revegetation species to include known pasture grasses suitable for the climate (green panic, silk sorghum, rhodes grass) with some forest species (local *Acacia* species + *Eucalyptus fibrosa*) and *Corymbia xanthope*	Retention of access roads and voids that are suitable for dams	Weed control [Giant Rats Tail grass - *Sporobolus pyramidali* and Lantana – *Lantana camara*		
Revegetation self-sustaining	Denudation of vegetation resulting in erosion and loss of post-mining land use suitability	All Disturbance Features		The grass species are proven sustainable pasture grasses suitable for the area. Forest species will be local only.	After establishment of vegetation, bird life is likely to facilitate introduction of other local species			
Revegetation regrowth rate poor	Erosion of soil, scouring and sedimentation of downstream drainage	All Disturbance Features		Conduct regrowth trial on small area (Test Pits) first	Use local species, known to grow nearby	Sow seed in spring		

7.1 Rehabilitation Trial (Test Pits - RA1)

A Rehabilitation Trial is planned on the 'Test Pits (RA1)' as a risk control measure. The Test Pits comprise five discrete bulk sampling pits and their associated overburden waste rock. The combined area of these five bulk-sampling pits is 0.447 hectares. The purpose of the trial is to evaluate, and modify if required, the proposed rehabilitation methodology associated with final landform design. The trial is planned to commence in April 2024 and conclude in April 2030.

As per the Progressive Rehabilitation and Closure Plans Guideline, rehabilitation trials will not result in the delay of rehabilitation and will take place in locations that have already been disturbed as part of earlier mining operations.

The Rehabilitation Trial commences in winter 2024. Seeding will take place in spring, 2024. This allows for at least a year of establishment prior to the earliest scheduled revegetation of the (RAs) (RA2 – RA7) and more than two years before the remaining areas. The success of this revegetation exercise will determine whether the backfilling, topsoiling and revegetation methods are appropriate. Amendments will be made to the PRCP planning part as required to reflect changes to revegetation species, timing or techniques. Milestones will also be reviewed and amended accordingly. This will provide confidence for the larger areas scheduled for rehabilitation afterwards. Any seed-bank that may still exist in the topsoil will also be assessed during the Rehabilitation Trial.

It should be noted that there is a high degree of confidence that the proposed rehabilitation measures will be successful, based upon the prior successful rehabilitation of the Brolga site under a previous mining tenure by a previous tenement holder.

7.1.1 RA1 - Milestones

As the PRCP is an adaptive document, any required modifications to rehabilitation activities elucidated during the trial will be used to improve on the final design.

The Rehabilitation Activities for the Test Pits begins in the dry season, 2024. The Rehabilitation Milestones (RMs) for the trial are the same as those listed for all the other Rehabilitation Activities (Section 4.5). The Rehabilitation Milestones for the trials on the Test Pits are as follows.

After a contaminated land assessment (RM1) the Test Pits will be backfilled using the overburden stockpiles that are adjacent to each pit (RM2). Additional fill can be taken from the nearby Waste Rock Dump. Topsoiling assessments to determine the fertility, and suitability, of the topsoil for the PMLU will be undertaken prior to spreading. After checking the stability of the earthworks (RM2), any amelioration required will be undertaken and then topsoiling will follow after back-filling (RM3).

Topsoil can be taken from the Topsoil Dump 1 (near the Waste Rock Dump) or Topsoil Dump 6. All earthworks and topsoiling will take place in the dry season, 2024, following checks on erosion and stability of the land surface.

Seeding is to be carried out in the spring months following the backfilling and surface preparation works. Germination success and landform stability can be checked during and after the wet season of 2024/25. Monitoring of the area continues until a sustainable post-mining land use is achieved (RM6) expected by the end of 2027. However, monitoring will continue annually until the end of full site rehabilitation, to identify any issues that may arise over the long term. As such, the final Milestone monitoring stage will proceed over five years. Adjustments to optimise methods and

timing of seeding can be made if success rates are lower than expected, and reassessed after each wet season.

As the PRCP is an adaptive document, any required modifications to rehabilitation activities elucidated during the trial will be used to improve on the final design.

8 Monitoring and Maintenance

This section describes the monitoring and maintenance practices to be undertaken to ensure and demonstrate that the milestones and milestone criteria have been achieved.

A Monitoring and Maintenance Program will be implemented by QNI to monitor the rehabilitation activities and outcomes. The overarching objective of the monitoring program is to evaluate the progress of the rehabilitation activities. Regular maintenance and monitoring will allow for the identification of any discrepancies between the planned objectives and targets and the actual rehabilitation, and, if required, for corrective actions to be implemented in a timely manner. The monitoring program will:

- compare monitoring results against the planned rehabilitation objectives and targets
- assess and monitor stability of landscape in accordance with reference milestones
- assess effectiveness of environmental controls implemented
- where necessary, identify modifications required for the monitoring program and/or rehabilitation practices
- compare flora species present against original seed mix
- assess vegetation health.

The main activities within the monitoring will be to check that the actual rehabilitation accords with the planned design; check for erosive scouring and other degradation; quantify the success of revegetation (when it is carried out); monitor water quality and conduct and weed surveys. Regular checks are already made for weed species, and this will continue under the PRCP monitoring program. Monitoring will be particularly frequent after seeding. Most monitoring for erosion will be carried out during the summer wet seasons, when the site is the most susceptible to instability.

8.1 General Monitoring and Maintenance Practices

8.1.1 Visual Inspections

Visual inspections will be required of various elements of the rehabilitation works. The general requirements for these visual inspections are as follows:

- All inspections required under the monitoring program are to be documented and maintained in an electronic format available to site and company management, and authorised officers on request
- The documentation must include notes and photographs confirming the findings and outcomes of the inspection
- Any shortfalls or rectification works required must include:
  - Required actions
  - Responsible person to ensure the actions are completed
  - Timing for completion of the action.

As part of confirming the removal of all equipment and infrastructure not being retained for post-mine use and in addition to the above, a decommissioning checklist will be completed. This will include confirmation that all services, pipelines, buildings, equipment and other ancillary infrastructure has been removed or is absent from the area investigated, and that all rubbish has

been removed. For infrastructure to remain, this will be detailed on the decommissioning checklist (location, condition, ongoing maintenance and general management requirements).

In general, weekly visual inspections are to be conducted during on site works for Milestones RM1 to RM3 and RM4. Additional opportunistic inspections should be undertaken, with any observations written in the site manager's logbook.

8.1.2 Surface Water Monitoring Program

A surface water monitoring program is currently being undertaken on the site, including Pit 1 and Dam 4, plus the Dams 1 – 3 which sit on the Brolga property, but outside of the mining lease boundary. This program is to be continued to support ongoing assessment of water quality and site suitability, with the data used to inform achievement of impoundment water quality targets in Milestone RM6. As such, monitoring will:

- Be conducted Quarterly, following the initial assessment in Milestone RM1 of impoundment sediment and water quality
- Continue until Milestone RM6:
  - Should water quality meet the water quality targets, this may be reduced to six-monthly until Milestone RM6 is completed. Cease monitoring thereafter.
  - Should the water quality not meet the water quality targets, continue quarterly monitoring until the targets are reached, and continue quarterly monitoring until Milestone RM6 is completed. Cease monitoring thereafter.

Monitoring locations are a site for each impoundment representative of the water quality within the following impoundments (refer Figure 2-12):

- Pit 1
- Pit 2 extension
- Pit 8
- Dam 4.

Water quality monitoring will also be undertaken within Dams 1, 2 and 3, which receive runoff from the site, and which will also act as reference sites for quality particularly within the Pits and Dam 4.

The EA for the site requires compliance with surface water quality targets, related to livestock watering criteria from Volume 3 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000). As such, the EA targets for surface water impoundments are adopted as the final water quality targets.

Monitoring will include the parameters in Table 8-1. The relevant impoundment water quality targets for Milestone RM6 are also shown in Table 8-1.

Table 8-1. Surface water monitoring water quality targets

Parameter	Units	Water Quality Target	Source
pH	pH units	>4.0 – 9.0	1
Electrical Conductivity (EC)	µS/cm	5970	1
Total Dissolved Solids	mg/L	Monitoring only	3
Major cations, alkalinity	mg/L	Monitoring only	3
Sulfate as SO_4	mg/L	1000	1
Chloride	mg/L	Monitoring only	3
Fluoride	mg/L	2	1
Total Arsenic	mg/L	0.5	1
Total Cadmium	mg/L	0.01	1
Total Chromium	mg/L	1	2
Total Cobalt	mg/L	1	1
Total Nickel	mg/L	1	1

Table notes:
1 Environmental Authority EPML01624913, Table F2
2 Contaminant limit based on ANZECC & ARMCANZ (2000) stock water quality guidelines
3 Added as supporting information

8.1.3 Groundwater Monitoring

Monitoring of depth to standing water level and quality in groundwater wells will be undertaken on a six-monthly basis throughout the rehabilitation program, until completion in the final Milestone. Monitoring will be conducted within one of the bores required to be monitored under the EA for the site, plus the two new bores installed in late 2021 and the bore located off-lease adjacent to Dam 3, namely:

- Bore 1 (existing long term bore, named site BB1 in the EA)
- QNWB4 (new deep well adjacent to Pit 1
- QNWB5 (new shallow well adjacent to Pit 1)
- Bore 3 (existing unregistered bore adjacent to Dam 3.

Note that no water has been identified within bore QNWB5, and this may continue to be the case. However, continued monitoring should still be conducted to test for any temporary water tables in the vicinity, and their interactions with Pit 1.

Monitoring of these wells will include depth to standing water level – as a depth (in metres) from the top of casing, and a reduced level as metres below ground level – and water quality. Water quality parameters are shown in Table 8-2.

Table 8-2. Groundwater monitoring water quality targets

Table 8-3. pH	pH units	Bore 1 - no change from baseline[3]	1
Electrical Conductivity (EC)	µS/cm	No change from baseline[3]	1
Total Dissolved Solids	mg/L	No change from baseline[3]	1
Calcium	mg/L	No change from baseline[3]	1
Magnesium	mg/L	No change from baseline[3]	1
Sodium	mg/L	No change from baseline[3]	1
Bicarbonate Alkalinity (as $CaCO_3$)	mg/L	No change from baseline[3]	1
Other major cations (K), alkalinity (CO_3, OH^-, Total)	mg/L	Monitoring only	2
Sulfate as SO_4	mg/L	No change from baseline[3]	1
Chloride	mg/L	Monitoring only	2
Fluoride	mg/L	Monitoring only	2
Total Arsenic	mg/L	Monitoring only	2
Total Cadmium	mg/L	Monitoring only	2
Total Chromium	mg/L	Monitoring only	2
Total Cobalt	mg/L	Monitoring only	2
Total Nickel	mg/L	Monitoring only	2

Table notes:
1 Environmental Authority EPML01624913, Table E2
2 Added to allow for comparison between surface and groundwaters
3 No change from baseline conditions in Bore 1

8.1.4 Spatial Database

A spatial database will be maintained for the duration of the rehabilitation works, and for a minimum of 10 years post-rehabilitation. The spatial database shall contain the following information:

- Site features and layout (existing)
- Post-mining final design landform, as digital elevation model (and contours)
- Rehabilitation areas
- Location of surface and groundwater monitoring sites
- Location of any encapsulation areas, areas to be managed or subject to any constraint as identified in the contaminated site assessment in Milestone RM1
- Survey and digital elevation model (and contours) prepared during Milestone RM2, with updated data when these are updated (maintain copies of all prior survey / DEM data)
- Polygons (derived from the above rehabilitation areas) defining different soil application areas, linked to the register of soil attributes and conditioning
- Polygons (derived from the above soil areas) defining different revegetation areas, linked to the register of revegetation practices and application.

8.1.5 Vegetation Monitoring

Groundcover density and species dominance is to be assessed by a suitably qualified person using a recognised, and appropriate method. The method should be such that it allows for a confident estimate of percentage ground cover, and the dominance of each species type within each RA (high pasture productivity may not be sustained in the long term if the pasture comprises one or few

species). For RAs that include more than one type of vegetation (i.e. pasture, forest, woodland), each vegetation type within the RA should be assessed.

The method recommended is the BioCondition monitoring methodology described by the Queensland Herbarium (Eyre et al, 2015).

8.1.6 Weeds

Weed control and management is an important component of successful rehabilitation as weeds can be a major source of failure of rehabilitation efforts. As such, it is critical that any new weed infestations are prevented and/or controlled at the earliest possible opportunity.

In addition, QNI is obliged under the *Biosecurity Act 2014* (Qld) to prevent the spread of declared weeds. Some non-declared weeds can also severely impair the successful development of rehabilitation. It is therefore important to identify and prioritise the weed species of concern and set out their management requirements.

Priority will be given to management of weed species that have the highest risk of severely impairing the success of rehabilitation. Priorities should be reviewed annually, and be informed by monitoring.

Weed monitoring will be undertaken by suitably qualified and experienced persons, comprising representative sample plots in the revegetation areas at a nominal 10 x 50 m area, with weed identification and percent ground cover determined. Regular weed monitoring to allow the early detection and treatment of new weed infestations will be undertaken during stockpile assessments, soil stockpiling works, surface preparation and planting activities, since weed risk is highest during these activities. After planting, weed monitoring will be undertaken on an annual basis until rehabilitation works are completed.

Weed management practices to be undertaken for maintenance are detailed in Section 6.1.9.8.

8.1.7 Dust Monitoring

In general, dust monitoring will be visual, inspecting for the presence of dust plumes moving off-site, particularly towards sensitive receptors (where present). Should potential for environmental harm or nuisance be identified, dust deposition gauges can be utilised to measure the daily average dust deposited (averaged over a month) near to sensitive receptors, in accordance with AS/NZS 3580.10.1 - Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter - Gravimetric method.

8.1.8 Fire management

Firebreaks on Brolga must be maintained until rehabilitation is complete. Visual inspections of firebreak by a suitably qualified person will be conducted on a monthly basis, reduced later in the rehabilitation works as appropriate.

For Canoona visual inspections should be undertaken to ascertain the timing and frequency of burns on a yearly basis.

Firebreak maintenance and fire management practices to be undertaken (for maintenance on Canoona) are detailed in Section 6.1.9.9.

8.1.9 Monitoring of remaining infrastructure

An annual inspection of the bath house, roads/tracks, and culverts will be carried out by a suitably qualified person. An infrastructure management plan detailing monitoring, management and maintenance for each item identified on the decommissioning checklist (refer to Section 8.1.1) to remain will be developed. The monitoring will generally comprise a visual inspection of each item, undertaking any specific maintenance required by the infrastructure management plan. Any rectification works identified in each inspection will be entered into the incident/remediation register for follow up action.

8.1.10 Audits and Reporting

Internal Audits

QNI will utilise its existing internal auditing system to assess the progress of rehabilitation on a six-monthly basis prior to site stabilisation (i.e. vegetation establishment), and yearly thereafter until completion of rehabilitation.

The internal audit will:

- assess progress against the milestones and milestone criteria
- determine whether evidence meets the requirements of the PRCP (i.e. is it suitable to support the completion of Milestones)
- identify remediation requirements, including works and resources required and timing,
- be prepared for site and company management.

External Audits

As required by section 285 of the EP Act, all holders of a PRCP schedule must commission a rehabilitation auditor to carry out an audit of the PRCP schedule every three years.

The purpose of the audit is to assess for the audit period:

- The progress towards achieving milestones
- whether the all the conditions imposed on the PRCP schedule have been complied with
- the accuracy of the information that has been provided to the administering authority, and
- whether the PMLU is likely to be achieved, with reference to the rehabilitation that has and will be carried out.

As part of the adaptive management of rehabilitation at the Project, these audit reports will also be used to assess rehabilitation performance and provide an early warning of necessary corrective actions and will be prepared by a person that meets the requirements under the relevant guideline approved by the chief executive.

Progress Reporting

A summary of the progress against the rehabilitation milestones, key activities undertaken, and any issues and remediation required (along with required actions, timing and responsible persons) is to be completed monthly while works are being undertaken on the site. This may be reduced to quarterly prior to and including vegetation establishment where limited active works are being completed on the site, and six-monthly after vegetation is established.

Annual Return

In addition to the annual return requirements that relate to the Brolga EA, in accordance with section 316J(3) of the *Environmental Protection Act 1994*, the EA annual return must also include an evaluation of the effectiveness of the PRCP schedule, including the environmental management carried out under the schedule, for the year to which the annual return relates.

This evaluation must include:

- whether any milestones to be completed under the PRC Plan schedule during the year have been met, and
- whether the conditions imposed on the PRC Plan schedule have been complied with.

Records

All documentation, inspection reports and checklists, etc., are to be retained in electronic form available to site and company management and other relevant personnel, and to authorised officers on request. Hard copy versions of these should be retained (where originally in hard copy format) in a location accessible to site personnel requiring such access (i.e. site management).

8.2 Reference Sites

The Brolga Rehabilitation Management Standard (refer Appendix C) was prepared to satisfy conditions G1 – G9 (Land and Rehabilitation) of the EA (EMPL01624913). This document was the rehabilitation management plan being utilised prior to the enactment of the *Mineral and Energy Resources (Financial Provisioning) Act 2018* which brought about the requirement to submit this PRCP.

The Rehabilitation Management Standard refers to three reference sites to be established – two for grazing lands and one for the Conservation Area. The Conservation Area (shown as the unshaded area on Figure 2-38) was not (i.e. in the Rehabilitation Management Standard document), and is not, proposed to be disturbed by rehabilitation activities, other than weed control and fencing to ensure protection from excessive grazing. As such, it is not a Rehabilitation Area as per the PRCP guidelines and so does not need to be monitored via a Reference Site.

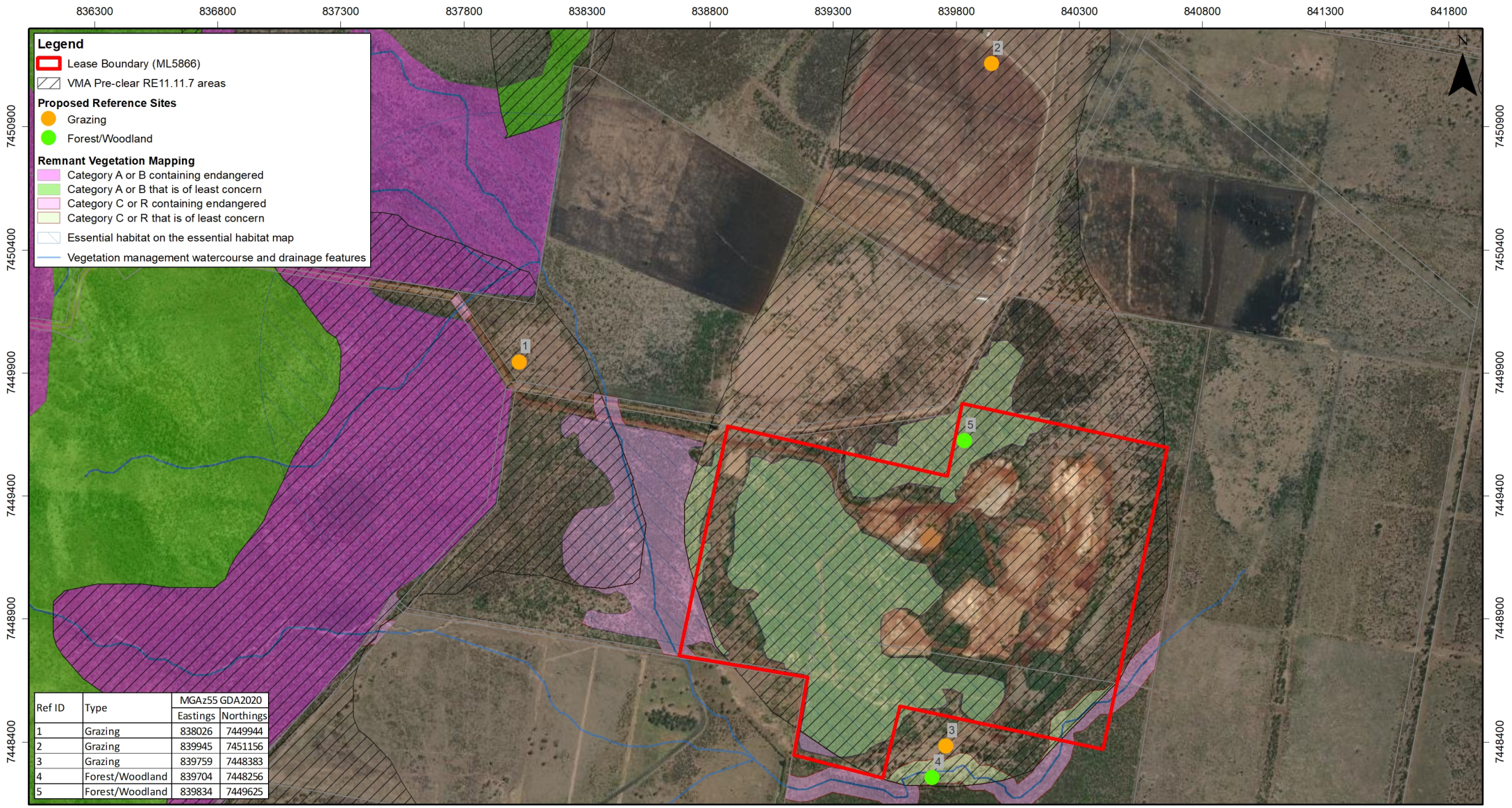
The PMLU for the Brolga ML is low-intensity grazing, consisting of a mix of 'pasture', 'forest' and 'sparse woodland' (see Section 6.1.9). Five reference sites have been identified for the Brolga ML – their location is shown on Figure 8-1, and described in Table 8-4. Sites have been chosen to be representative of 'pasture' and 'forest'. To ensure the reference sites have the same geology, landform and soil as the Brolga ML, the 'pasture' reference sites have been situated on grazing land that is identified as pre-clearing Regional Ecosystem 11.11.7, which is the pre-clearing Regional Ecosystem on the Brolga ML. Similarly, the two 'forest' reference sites are situated on grazing land mapped as regrowth of RE 11.11.7. Within the mix of grazing habitats, 'sparse woodland' is specific only to rocky slopes, like the walls of overburden dumps and some pit walls. These rocky slopes are proposed to be revegetated by sowing Acacia species and any forb that is collectable from nearby forest, into soil cast over scattered areas. As such, within the five reference sites established for 'pasture' and 'forest', the presence, density and diversity of Acacia and forb species will be used as references for the success of the establishment of 'sparse woodland'.

In accordance with the Qld Biocondition Assessment Manual (Eyre et al, 2015) the reference sites have been sized at 100 x 50 m.

It is not proposed to utilise reference sites for the Canoona ML, as it has had no mining activity other than exploration drill holes. Canoona is covered by remnant vegetation (RE 11.11.7 Eucalyptus fibrosa) and requires no rehabilitation activity other than ongoing fire and low level weed management. As such, reference sites are not required for this ML.

Table 8-4. Reference site locations

ID	Description	GCA2020 zone 55	
		Eastings	Northings
R1	Grazing land, west of ML	790487	7458552
R2	Grazing land, north of ML	791779	7457261
R3	Grazing land, immediately south of ML	790852	7458646
R4	Forest/Woodland, regrowth RE11.11.7, adjacent R3	790539	7458924
R5	Forest/Woodland, regrowth RE11.11.7	791315	7458472



Ref ID	Type	MGAz55 GDA2020	
		Eastings	Northings
1	Grazing	838026	7449944
2	Grazing	839945	7451156
3	Grazing	839759	7448383
4	Forest/Woodland	839704	7448256
5	Forest/Woodland	839834	7449625

Sources: Monitoring Sites: QNI 2021 | Rehabilitation Areas: QNI 2022
Lease Boundaries: DNRME 2019 | Basemap: ESRI World Imagery

A4 Scale 1:21,330 0 0.2 0.4 km
GDA2020 MGA Zone 55
WC-BrP-05-RefSites-221004, 4 Oct 2022

Figure 8-1. Proposed Reference Sites

8.3 Milestone Monitoring

Eight rehabilitation milestones are set out in section 8.5 (i.e. within the PRCP schedule in Section 8).

Milestones will be used to demonstrate the completion of progressive rehabilitation and improvement steps and events, and will act as completion criteria for the achievement of the PMLU of low-intensity grazing.

A milestone monitoring programme has been developed to set out the methods and techniques to monitor progress towards, and completion of, the rehabilitation milestones. The programme is described below in Table 8-5 with respect to each of their rehabilitation milestones listed. Note that not all milestones are relevant to all rehabilitation areas.

Table 8-5. Milestone monitoring programme

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
RM1 Area available for rehabilitation free from contaminants	All areas	A visual inspection to confirm that all equipment and infrastructure not being retained for post-mine use has been removed.	A visual inspection of the site to be undertaken, with a decommissioning checklist (refer Visual Inspections, Section 8.1) completed. Should any items remain outstanding, identify remediation requirements and complete.	Prior to land disturbance	• Decommissioning checklist
		A contaminated land investigation report is to be prepared by a suitably qualified person (SQP), to confirm the site is suitable for the intended post mine land-use of low intensity grazing, or that remediation works have been completed satisfactorily, and the site is suitable for the intended post-mine land-use of low intensity grazing.	A contaminated land investigation report is to be prepared by an SQP. In order to meet the requirements of the EP Act an SQP must be engaged to: • conduct a site investigation to assess whether contamination exists • prepare a validation report describing any contamination remediation works required, and • if remediation works are not required, or, if required, upon completion of any remediation works, prepare a site suitability statement, stating that land is not contaminated and is suitable for the post-mine land-use of low intensity grazing.		• Reports prepared by a suitably qualified person: - Contaminated site investigation report - Validation report (if needed) - Site Suitability Statement
		Sediment within impoundments will be assessed for the potential to negatively affect long term water quality, and validated if necessary post remediation	An assessment of each of the impoundments on the site is to be undertaken to determine the effect of any *in-situ* sediment on long term water quality. An investigation report is to be prepared, based on sampling of sediments and water quality confirming that: • The impoundment is suitable to remain without remediation, or		• Investigation report from SQP • Statement of suitability for each of the impoundments

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
			• Remediation is required, and detailing the remediation and validation testing to be undertaken. In both cases, a statement from an SQP confirming that the impoundment is suitable to support the long-term achievement of water quality targets is to be completed.		
RM2 Re-shaping landform complete	RA2, RA3, RA5, RA6, RA8 RA11-18	Visual inspections during the works	Ongoing visual inspections (refer Visual Inspections in Section 8.1) must be undertaken during the works to confirm that: • they are proceeding in accordance with the final design plans • erosion controls are in place, and erosion is suitably controlled during the works • no visible dust moving off-site that could cause environmental harm or nuisance • remediation requirements are identified and actioned as and when required.	Weekly during site works	• Visual inspection sheets, photographs
		Post-completion survey ('as-constructed' plan) and preparation of digital elevation model	Survey of completed area(s) to produce a digital elevation model of the site. This may be completed at different times for different areas, and so surveys must be able to be compiled into a progressive 3D Digital Elevation Model (DEM). The DEM is to be used to produce 'as-constructed' plans, highlighting any discrepancies between the approved designs and actual construction.	At completion of earthworks, but prior to certification	• Digital Elevation Model (DEM) electronic file • 'As-constructed' plans • A database of 'approved design' and 'as-constructed' plans for any engineering works associated with the mine rehabilitation is to be maintained.
		Certification that final landform is 'generally in accordance' with final land design plans	A site inspection and assessment of as constructed documentation and plans is to be undertaken by a suitably qualified and	At completion of earthworks	• Certification from suitably qualified and experienced engineer to confirm the final

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
			experienced engineer. Certification from this person is required to confirm the final landform is generally in accordance' with final land design plans.		landform is generally in accordance' with final land design plans.
		Site inspection and testing, and certification that the site is geotechnically stable	Based on the final design plan and earthworks planning, a geotechnical testing program is required to be developed by a suitably qualified and experienced geotechnical engineer. During site works, in particular, during significant earthworks, and final shaping and compaction, geotechnical inspections and testing are required to be undertaken to confirm that the works meet the geotechnical and stability requirements of the final design plan. Following completion of works, certification from a suitably qualified and experienced geotechnical engineer is required confirming the site meets the Milestone requirements for geotechnical stability, including slope angles, all berms, slopes and embankments.	Inspections and testing during earthworks Inspection and final certification at completion of earthworks	• Certification from suitably qualified and experienced geotechnical engineer to confirm the landform is geotechnically stable
		Site inspection and certification that the drainage network has been installed and is appropriate to manage stormwater on the site, and that no significant erosion is occurring	Site inspection and certification by an SQP that the final drainage network meets both the final design plan requirements, and that the drainage network is suitably designed and built to convey stormwater without significant erosion, and in a manner that will support long term landform stability.	At completion of drainage works	• Certification from suitably qualified and experienced engineer to confirm the drainage network is suitable for the intended post mining landuse
		Site inspection and certification that site slopes are safe.	Following completion of landforming, a site assessment will be conducted to identify any slopes that still pose a fall risk to cattle and/or humans. Fencing and signage will then be installed, and a final site assessment to confirm	At completion of earthworks	• Certification from suitably qualified and experienced person to confirm slopes are

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
			the satisfactory installation of both fencing and signage will be undertaken, with signoff and certification of such by a suitably qualified person.		safe and suitable fencing and signage is installed.
RM3 Surface preparation completed	All areas except RA19, RA20, RA22, RA23	Visual inspections during the works	Visual inspections of the works area while works are being completed to confirm: • Works are proceeding according to the planned design, including installation and maintenance of appropriate erosion and sediment controls and surface ripping • No significant erosion features present • No visible dust moving off-site that could cause environmental harm or nuisance.	Weekly during site works	• Visual inspection sheets, photographs
		A volumetric assessment of available soil resources for surface preparation works.	A volumetric assessment is to be completed (by survey or other similarly suitable method) of all soil stockpiles, along with confirmatory testing of all rehabilitation areas, confirming required subsoil application depth (if any) and quantities of subsoil and topsoil required. Following this, an assessment of the required volumes and source for any makeup volume required is to be determined and documented within the assessment report, along with haulage routes.	Prior to any works in RM3 commencing	• Electronic records of the volumes, timing and soil particulars maintained • GIS files recording the location of relevant soil stockpiles and spreading, and test sites • Topsoil Report prepared
		Soil health and suitability assessment of topsoil stockpiles prior to spreading.	A soil health and suitability assessment report prepared by a suitably qualified person to confirm soil is suitable for target vegetation establishment. This will include assessment of topsoil and subsoil stockpiles prior to placement, along with remediation requirements; field testing of soil placement locations to confirm	Soil stockpile assessments within six months prior to spreading Soil testing one month	• Soil health and suitability assessment report(s)

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
			the depth of subsoil required to be added (if any); and follow up validation assessment of in-situ soils after placement.	following soil placement (and confirmation of appropriate depths, amelioration)	
		Visual inspections to confirm surface ripping and preparation completed	Visual inspections, including photographs, of all areas prior to soil addition, to provide confirmation that surface preparation works have been completed as required, including ripping of surfaces.	During ripping and surface preparation	• Visual inspection sheets, photographs
		Tracking of soil volumes, application and amelioration	Details of testing, movement and spreading of soils are to be made and retained, including: • Remaining soil stockpile quantities, to track volumes and ensure deficits do not occur • The area and dates where soil has been applied • Results of testing to confirm applied depths of soils meet the design plans, including photographs and locations of test sites • Quantity and type of mulch and/or fertiliser applied, and the location of the application (i.e. soil areas above).	During / following soil application	• Electronic records of inspections, photographs, fertiliser, mulch etc. application rates and types • GIS files of area of application, stockpile locations • Electronic register of source and destination for all soils, linked to GIS files
		Weed monitoring	Regular weed monitoring to allow the early detection and treatment of new weed infestations during stockpile assessments and surface preparation works.	Monthly during site works	• Weed monitoring report
		Visual inspections after completion of earthworks	Visual inspection of all earthworks areas after completion for any instances of degradation, erosion or earthworks failure. Inspection to include presence of sediment plumes and	On completion of earthworks and monthly thereafter	• Visual inspection records, including photographs

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
			evidence of accumulation of sediment within drainage lines or impoundments. Inspect site for visible dust moving off-site that could cause environmental harm or nuisance.	(until completion of RM)	• Records of maintenance to ensure as constructed landform complies with approved designs.
		Water quality monitoring in surface water impoundments	Continue water quality monitoring started in Milestone RM1 of ponded water within impoundments and assess against water quality targets. If water quality does not meet water quality targets, provide an assessment of the progress towards meeting targets, and determine whether current site conditions are contributing to water quality failure – determine remediation requirements. Action any remediation requirements and maintain documented evidence that these have been completed.	Quarterly	• Surface water quality database • Assessment report by suitably qualified person
		Groundwater monitoring in nominated groundwater monitoring bores	Continue monitoring of water level and water quality in nominated water bores. Report to be prepared by an SQP that groundwater shows no deterioration from baseline conditions		• Groundwater quality and quantity database • Assessment report by suitably qualified person
RM4 Revegetation	All areas other than RA19, RA20, RA21, RA22, RA23	Visual inspections of revegetation works	Visual inspections and retention of records must be undertaken during the revegetation works confirming the works are proceeding as planned. This will include confirmation that the following requirements are met: • Fertiliser application rate, as specified in the soil health and suitability assessment report (RM3) • Rate of seed application (kg/ha) for each seed type and mix of seeds applied	Weekly during sowing	• Visual inspection sheets, photographs

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
			• Timing of seed application (i.e. date, season, climatic conditions) • Seed application method and any cover requirements • Mulching of sparse woodland areas • No active significant erosion occurring.		
		Weed monitoring	Regular weed monitoring of revegetation areas to allow the early detection and treatment of new weed infestations during planting activities.	Monthly during site works	• Weed monitoring report
		Monitoring of firebreaks	The site should contain suitable firebreaks to control for fire and the risk of damage to the revegetation works. Ongoing visual monitoring of firebreaks, coupled with remediation where required (clearing etc.) is required to maintain firebreaks in an optimal condition.	6-monthly	• Visual inspection sheets, photographs • Entry of any identified issues into incident/remediation register
		Tracking of revegetation practices and successes / remediation works	Tracking of information obtained from visual inspections and records detailed above.	Updated as each revegetation area is completed	• GIS files of area of application, test locations, outcomes, linked to register above • A register of: - applied fertiliser and seed (type and amount) - date of application - area of application (link to areas in spatial database)
RM5 Vegetation is established	All areas other than RA19,	Assessment of reference and test sites.	A documented report by an SQP detailing the assessment of a representative number of test quadrats within transects in both test (i.e.	6-months after revegetation is completed in an area	• Groundcover density and species dominance report prepared by an SQP

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
	RA20, RA21		revegetation areas) and reference sites. This sampling is to identify: • Groundcover density and species dominance. • Stem density of target species • For forest and sparse woodland areas, presence and number of target woody species.		
		Weed monitoring	Weed monitoring of revegetated areas to allow the early detection and treatment of new weed infestations.	Annually	• Weed monitoring report
		Visual inspections for erosion features and signs of land degradation or instability, areas of bare exposed soil	Visual inspections must be conducted to check: • for the presence of erosion features - active rill, gully or sheet erosion • Drainage is following appropriate drainage paths • For areas of exposed soil. Should any of these be identified, rectification works must be initiated to ensure the success of revegetation and to avoid instability and deterioration of land surfaces.	6-monthly	• Visual inspection sheets, photographs • Entry of any identified issues into incident/remediation register
		Monitoring of firebreaks	The site should contain suitable firebreaks to control for fire and the risk of damage to the revegetation works. Ongoing visual monitoring of firebreaks, coupled with remediation where required (clearing etc.) is required to maintain firebreaks in an optimal condition.	6-monthly	• Visual inspection sheets, photographs • Entry of any identified issues into incident/remediation register
RM6 Final sustainable	All areas	Assessment of carrying capacity of final landform	An assessment by a suitably qualified and experienced person, taking into account the pasture type and density, pasture mass available	3 years after revegetation is	• Assessment report by a SQP

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
landform achieved			and landform, of the sustainable carrying capacity for low intensity cattle grazing on the site.	completed in an area	
		Assessment of reference and test sites	A documented report by an SQP detailing the assessment of a representative number of test quadrats within transects in both test (i.e. revegetation areas) and reference sites. This sampling is to identify: • Groundcover density and species dominance. • For forest and sparse woodland areas, presence and number of target woody species.		• Groundcover density and species dominance report prepared by an SQP
		Assessment of land suitability class	An assessment by an SQP to measure and determine the land suitability class of the rehabilitated site, to meet the requirements for low intensity grazing land.	3 years after revegetation is completed in an area	• Assessment report by a SQP
		Weed monitoring	Weed monitoring of revegetated areas to allow the early detection and treatment of new weed infestations.	Annually	• Weed monitoring report
		Water quality monitoring in surface water impoundments	Final assessment report by a SQP to detail whether water quality meets the water quality targets. Determine remediation requirements where not met.	3 years after revegetation is completed in an area. Where remediation is required, quarterly for 2 years after achievement of water quality	• Surface water quality database • Assessment report by suitably qualified person

Rehabilitation Milestone	Areas to be monitored	Monitoring Element	Description of Monitoring	Timing	Milestone records
				targets or as otherwise recommended by the report	
		Groundwater monitoring in nominated groundwater monitoring bores	Final assessment report to be prepared by a SQP that groundwater shows no deterioration from baseline conditions.	3 years after revegetation is completed in an area. Where target not achieved, quarterly for 2 years after achievement of water quality targets or as otherwise recommended by the report	• Groundwater quality and quantity database • Assessment report by suitably qualified person
		Visual inspections for erosion features and signs of land degradation or instability, areas of bare exposed soil	Visual inspections must be conducted to check: • for the presence of erosion features - active rill, gully or sheet erosion • Drainage is following appropriate drainage paths • For areas of exposed soil. Should any of these be identified, rectification works must be initiated to ensure the success of revegetation and to avoid instability and deterioration of land surfaces.	3 years after revegetation is completed in an area. Where target not achieved, annually for 2 years after achievement of target	• Visual inspection sheets, photographs • Entry of any identified issues into incident/remediation register

8.4 Surrender

8.4.1 Final Rehabilitation Report

A final rehabilitation report is to be prepared when applying to surrender the EA. The purpose of this final rehabilitation report is to demonstrate that the conditions of the EA have been complied with, and that rehabilitation of disturbed land has been carried out satisfactorily. The requirements of the final rehabilitation report are listed in section 269A of the *Environmental Protection Act 1994*.

9 References

10 ANZECC and ARMCANZ (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3 Primary Industries - Rationale and Background Information (Irrigation and general water uses, stock drinking water, aquaculture and human consumers of aquatic foods).* Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, October 2000.

Australian Mining Engineering Consultants – AMEC (2021) *Geotechnical Assessment of the Brolga Project, QNI Resources Pty Ltd*. November 2021. Internal Report.

Australian Government, Bureau of Meteorology, 2021. Flood Warning System for the Fitzroy River. http://www.bom.gov.au/qld/flood/brochures/fitzroy/fitzroy.shtml

Batianoff, G.N. and Singh, S. (2001). Central Queensland serpentine landforms, plant ecology and endemism. *South African Journal of Science* 97, November/December 2001.

Bernier L.R. (2005) The potential use of serpentinite in the passive treatment of acid mine drainage: Batch experiments. *Environmental Geology*, 47 (5), pp 670 - 684.

Brolga Environmental Management Plan (2013). Internal report.

Bruce M., Niu Y., Harbourt T. and Holcombe R (1998) Geochemistry and Geochronology of the Marlborough ophiolite: Implications for the tectonic history of the Northern New England Fold Belt. *Geological Society of Australia Abstracts* 49, p. 58.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2015) Climate Change in Australia: Projections for Australia's NRM Regions. Available from: https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms_page_media/168/CCIA_2015_NRM_TechnicalReport_WEB.pdf

Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2016) State of the Climate 2016, Australian Government, Bureau of Meteorology. Available from: http://www.bom.gov.au/state-of-the-climate/State-of-the-Climate-2016.pdf

Department of Agriculture and Fisheries (2020) Lantana. Available from: https://www.daf.qld.gov.au/__data/assets/pdf_file/0009/62010/lantana.pdf

Department of Agriculture and Fisheries (2020) Rat's tail grasses. Available from: https://www.daf.qld.gov.au/__data/assets/pdf_file/0010/69616/rats-tail-grasses.pdf

Department of Environment and Heritage Protection (DEHP) (2013). Environmental Protection (Water) Policy 2009 Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Fitzroy River Sub-basin. Environmental Policy and Planning, Department of Environment and Heritage Protection. September 2011, republished in July 2013. Department of Environment and Science (2018); Land systems – Lands of the Dawson Fitzroy area – Queensland – ZDD3. https://www.qld.gov.au/environment/land/soil/

Drinking Water Quality Management Plan. Rockhampton Regional Council – from: https://www.rockhamptonregion.qld.gov.au/CouncilServices/Fitzroy-River-Water/Water-treatment-and-supply/Providing-quality-drinking-water

Department of Minerals and Energy (DME) (1995) *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland.* Department of Minerals and Energy.

Duivenvoorden, L.J., Roberts, D.T. and Tucker, G.M. (2017) Serpentine geology links to water quality and heavy metals in sediments of a stream system in central Queensland, Australia. *Environ Earth Sci* **76**, 320. https://doi.org/10.1007/s12665-017-6615-8

Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015). *BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2*. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane.

Fitzroy Partnership for River Health, 2021. https://riverhealth.org.au/resources/fitzroy-basin-boundary-map/

Fitzroy Partnership for River Health, 2021. https://riverhealth.org.au/report_card/additional-info/floods#site-fitzroy

Foster L. and Eggleton R. (2002) The Marlborough Nickel Laterite Deposits. In Roach I.C. ed 2002. *Regolith and Landscapes in Eastern Australia*, pp 33 – 36.

URS (2007). Gladstone Nickel Project Environmental Impact Statement Supplement, Appendix B: Residue Geochemical Characterisation. Prepared for Gladstone Pacific Nickel Ltd, December 2007. Accessed 19 June 2022 from https://eisdocs.dsdip.qld.gov.au/Gladstone%20Nickel/seis/vol-2-appendices-a-g/app-b-residue-geochemical-characterisation.pdf

IMC (2013). Marlborough Leases Nontronite and Haul Road Study. Internal report.

IMC (2013b). Review of Fe and Nontronite at Marlborough. March 2013. Internal report.

Intergovernmental Panel on Climate Change (IPCC) (2014) *Climate Change (2014): Impacts, Adaptation and Vulnerability*, Part B: Regional Aspects, Working Group II Contribution the Fifth Assessment Report of the IPCC, Cambridge University Press, UK and USA.

Intergovernmental Panel on Climate Change (IPCC) (2014) *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Kamal N. and Sulaiman S. (2014) Bench-scale study of acid mine drainage treatment using local neutralisation agents. *Malaysian Journal of Fundamental and Applied Sciences*, 10 (3), pp 150-153.

Korsch R.J., Johnstone D.W. and Wake-Dyster K.D. (1997). Crustal Architecture of the New England Orogen Based on Deep Seismic Profiling. In: Flood P.G. & Ashley P.M. eds. Tectonics and Metallogenesis of the New England Fold Belt. *Geological Society of Australia*, Sydney, 29-51.

Livingstone Shire Council Interactive Mapping. https://livingstone.maps.arcgis.com/home/index.html

McNeil, V.H., Thames, D., Vaca, F., Bennett, L. and McGregor, G.B. (2018). Regional groundwater chemistry zones: Fitzroy-Capricorn-Curtis Coast and Burdekin-Haughton-Don regions: Summary and results. Draft for consultation. Water Planning Ecology: Department of Environment and Science, Queensland Government.

Marsh E. and Anderson E. (2011) Ni-Co Laterites – A Deposit Model: U.S. Geological Survey. Open-File report 2011 – 1159, 9p.

Parianos J. (2017) Types and Distribution of Ni/Co Laterite Profiles – (Unpublished Powerpoint Presentation).

QNI Resources Pty Ltd (2014) Brolga Life of Mine Schedule – Technical Report. October 2014.

QNI Resources Pty Ltd (2020) Brolga Project – Explanatory notes – Estimated Rehabilitation costs. November 2020.

QNI Resources Pty Ltd (2021) Brolga Project – Response – Information Request 18/12/2020 – May 2021.

Queensland Government, Department of Environment and Science, 2021 WetlandInfo, Facts and Maps, Marlborough Plains biogeographic subregion. https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/biogeographic-subregion-marlborough-plains/

Queensland Government, Department of Environment and Science, 2021. Land systems - land systems of the Capricornia coast - CCL3. https://www.qld.gov.au/environment/land/soil/

Queensland Government, Department of Environment and Science, 2021. Dominant soil orders of Queensland. https://www.qld.gov.au/environment/land/soil/

Queensland Government, Department of Environment and Science, 2021. Matters of state environmental significance. https://environment.des.qld.gov.au/management/planning-guidelines/method-mapping-mses

Queensland Government, 2021. FloodCheck Queensland. https://floodcheck.information.qld.gov.au/mobile.html

Queensland Government, 2021. GeoResGlobe. https://georesglobe.information.qld.gov.au/

Queensland Government, 2021. QImagery. https://qimagery.information.qld.gov.au/

Queensland Government, 2021. Regional Ecosystem Descriptions. Regional ecosystem details for 11.11.7. https://apps.des.qld.gov.au/regional-ecosystems/details/?re=11.11.7

Queensland Government, 2021. Regional Ecosystem Descriptions. Regional ecosystem details for 11.3.38. https://apps.des.qld.gov.au/regional-ecosystems/details/?re=11.3.38

Queensland Government, 2021. State of the Environment Report 2020. https://www.stateoftheenvironment.des.qld.gov.au/climate/climate-observations/evaporation-rate

Queensland Government, Department of Science Information Technology Innovation and the Arts (DSITIA) (2016) Wildlife Online Extract. Access date: 14 December 2016. Available from: https://apps.des.qld.gov.au/report-request/species-list

Survey Office Queensland (1913). Livingstone Shire Council cadastral survey plan. Portion 174 – 177, Parish of Yaamba, County of Livingstone, District of Rockhampton.

C. Turingan, G. Singson, B. Melchor, R. Alorro, A. Beltran and A. Orbecido (2020). A comparison of the acid mine drainage (AMD) neutralization potential of low grade nickel laterite and other alkaline-generating materials. I*OP Conference series: Materials Science and engineering*, 778 012142

C. Turingan, G. Singson, B. Melchor, R. Alorro, A. Beltran and A. Orbecido

Tongway, D J. and Hindley, N, L. (2004). Landscape Function Analysis Manual: Procedures for Monitoring and Assesssing Landscapes with Special Reference to Minesites and Rangelands. In: *Canberra: CSIRO Sustainable Ecosystems;* 2004. Available from: http://hdl.handle.net/102.100.100/186491?index=1

Appendix 1

PRCP Schedule

Appendix 2

Environmental Authority EPML0162913

Appendix 3

Brolga Rehabilitation Management Standard

Appendix 4

Water Assessment

Appendix 5

DES Environmental Reports

Appendix 6

Site condition report for ML5864 (Canoona)

Appendix 7

Consultation - LSC and Landholder letter

Appendix 8

Landholder acceptance of responsibility for remaining infrastructure

Appendix 9

GNP SEIS Appendix B – Residue Geochemical Characterisation

Appendix 10

Ore Waste Rock Analyses

Appendix 11

Geotechnical Assessment of the Brolga Project

Appendix 12

Ecosystem Function Analysis (EFA) for ML5866 (Brolga)

Permit

Environmental Protection Act 1994

Environmental authority EPML01624913

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: EPML01624913

Environmental authority takes effect on 23 June 2021

Environmental authority holder(s)

Name(s)	Registered address
QNI RESOURCES PTY. LTD.	1 Greenvale Street YABULU QLD 4818
QNI METALS PTY LTD	Level 17 240 Queen Street BRISBANE CITY QLD 4000 Australia

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Schedule 3 15: Mining nickel ore	ML5864
Schedule 3 15: Mining nickel ore	ML5866

Additional information for applicants

Environmentally relevant activities

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

ABN 46 640 294 485

Queensland Government

Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days);

that is causing, or is reasonably likely to cause, serious or material environmental harm.

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority-on the nominated day; or

b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or

c) otherwise-on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Sustainable Planning Act 2009* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

Rebecca McAuley
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Date issued: 23 June 2021

Enquiries:
Mineral Business Centre
Department of Environment and Science
Phone: 07 42225352
Email: ESCairns@des.qld.gov.au

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Conditions of environmental authority

Department interest: General	
Condition number	**Condition**
A1	This environmental authority authorises environmental harm referred to in the conditions. Where there is no condition or this environmental authority is silent on a matter, the lack of a condition or silence does not authorise environmental harm.
A2	In carrying out the mining activity authorised by this environmental authority, the holder of this environmental authority must comply with **Schedule 1— Figure 1: Brolga and Canoona Project Area of Disturbance**.
A3	The holder of this environmental authority must: a) install all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority; b) maintain such measures, plant and equipment in a proper and efficient condition; c) operate such measures, plant and equipment in a proper and efficient manner; d) ensure all instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority are properly calibrated.
Monitoring	
A4	Except where specified otherwise in another condition of this authority, all monitoring records or reports required by this environmental authority must be kept for a period of not less than 5 years.
Financial assurance	
A5	Provide to the administering authority financial assurance for the amount and in the form acceptable to the administering authority in accordance with the most recent edition of the administering authority's: *Guideline—Calculating financial assurance for mining projects*, before the proposed mining activities can commence.
A6	The amount of financial assurance must be reviewed by the holder of this environmental authority when a plan of operations is amended or replaced or the authority is amended.
Risk management	
A7	The holder of this environmental authority must develop and implement an environmental management system for mining activities which mirrors the content requirement of the Standard for Environmental Management (IS014001 :2004), or the latest edition of an Australian standard for environmental management, by 3 months from the issue of this EA

Notification of emergencies, incidents and exceptions	
A8	The holder of this environmental authority must notify the administering authority by written notification within twenty four (24) hours, after becoming aware of any emergency or incident which results in the release of contaminants not in apcordance, or reasonably expected to be not in accordance with the conditions of this environmental authority.
A9	Within ten (10) business days following the initial notification of an emergency or incident, or receipt of monitoring results, whichever is the latter, further written advice must be provided to the administering authority, including the following: a) results and interpretation of any samples taken and analysed; b) outcomes of actions taken at the time to prevent or minimise unlawful environmental harm; and c) proposed actions to prevent a recurrence of the emergency or incident.
Complaints	
A10	The holder of this environmental authority must record all environmental complaints received about the mining activities including: a) name, address and contact number for of the complainant; b) time and date of complaint; c) reasons for the complaint; d) investigations undertaken; e) conclusions formed; f) actions taken to resolve the complaint; g) any abatement measures implemented; and h) person responsible for resolving the complaint.
A11	The holder of this environmental authority must, when requested by the administering authority, undertake relevant specified monitoring within a reasonable timeframe nominated or agreed to by the administering authority to investigate any complaint of environmental harm. The results of the investigation (including an analysis and interpretation of the monitoring results) and abatement measures, where implemented, must be provided to the administering authority within ten (10) business days of completion of the investigation, or no later than ten (10) business days after the end of the timeframe nominated by the administering authority to undertake the investigation.

Third-party reporting	
A12	The holder of this environmental authority must: a) within 1 year of the commencement of this authority, obtain from a suitably qualified and experienced third party a report on compliance with the conditions of this environmental authority; b) obtain further such reports at regular intervals not exceeding 3 years from the completion of the report referred to above; and c) provide each report to the administering authority within 90 days of its completion.
A13	Where a condition of this environmental authority requires compliance with a standard, policy or guideline published externally to this environmental authority and the standard is amended or changed subsequent to the issue of this environmental authority the holder of this environmental authority must: a) comply with the amended or changed standard, policy or guideline within 2 years of the amendment or change being made, unless a different period is specified in the amended standard or relevant legislation; and b) until compliance with the amended or changed standard, policy or guideline is achieved, continue to remain in compliance with the corresponding provision that was current immediately prior to the relevant amendment or change.

Department interest: Air	
Condition number	**Condition**
Dust Nuisance	
B1	Dust and particulate matter must not exceed the following levels when measured at any sensitive or commercial place: a) Dust deposition of 120 milligrams per square metre per day, averaged over 1 month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter — Gravimetric method. b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of either: i. Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air Determination of suspended particulate matter—PM10 high volume sampler with size-selective inlet — Gravimetric method, or ii. Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air— Determination of suspended particulate matter—PM10 low volume sampler—Gravimetric method. c) A concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres (PM2.5) suspended in the atmosphere of 25 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.10 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM (sub) 2.5(/sub) low volume sampler—Gravimetric method. d) A concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a 1 year averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—Total suspended particulate matter (TSP)— High volume sampler gravimetric method.

Department interest: Waste management	
Condition number	**Condition**
C1	Unless otherwise permitted by the conditions of this environmental authority or with prior approval from the administering authority and in accordance with a relevant standard operating procedure, waste must not be burnt.
C2	The holder of this environmental authority may burn vegetation cleared in the course of carrying out extraction activities provided the activity does not cause environmental harm at any sensitive place or commercial place.

Department interest: Noise	
Condition number	**Condition**
D1	The holder of this environmental authority must ensure that noise generated by the mining activities does not cause the criteria in **Table D1 - Noise Limits** to be exceeded at a sensitive place or commercial place.

Schedule D, Table 1 — Noise limits

Noise level dB(A)	Monday to Sunday (including public holidays)		
	7am - 6pm	6pm - 10pm	10pm - 7am
	Noise measured at a 'sensitive'		
$L_{A10,\ adj,\ 10\ mins}$	B/g + 5	B/g + 5	B/g + 3
$L_{A1,\ adj,\ 10\ mins}$	B/g + 10	B/g + 10	B/g + 8
	Noise measured at a 'commercial place'		
$L_{A10,\ adj,\ 10\ mins}$	B/g + 10	B/g + 10	B/g + 5
$L_{A1,\ adj,\ 10\ mins}$	B/g + 15	B/g + 15	B/g + 10

Note: B/g means Background.

D3	Noise monitoring and recording must include the following descriptor characteristics and matters: a) LAN, T (where N equals the statistical levels of 1, 10 and 90 and T = 15 mins); b) background noise LA90; c) the level and frequency of occurrence of impulsive or tonal noise and any adjustment and penalties to statistical levels; d) atmospheric conditions including temperature, relative humidity and wind speed and directions; e) effects due to any extraneous factors such as traffic noise; f) location, date and time of monitoring; and g) if the complaint concerns low frequency noise, Max LpLIN,T and one third octave band measurements in dB(LIN) for centre frequencies in the 10 — 200 Hz range.

Department interest: Groundwater Water	
Condition number	**Condition**
E1	The holder of the environmental authority must develop and implement a groundwater monitoring program within twelve (12) months of the grant of this environmental authority. The program must be able to detect a significant change in groundwater quality values (consistent with the current suitability of the groundwater for agricultural and industrial use) due to activities that are part of this mining project.

Table E1 - Groundwater monitoring locations and frequency

Monitoring Point	Easting (GDA 94)	Northing (GDA 94)	Monitoring Frequency
BB1	150.306077	-23.026933	Samples collected and analysed monthly for the initial 12 months of baseline data collection and following that, quarterly.
BB2	150.305884	-23.027177	Samples collected and analysed monthly for the initial 12 months of baseline data collection and following that, quarterly.

E2	If the groundwater containment trigger levels defined **Table E2: Groundwater Contaminant Trigger Values** are exceeded then the environmental authority holder must complete an investigation into the potential for environmental harm and notify the administering authority within twenty-eight (28) days of receiving the analysis report.

Table E2: Groundwater Contaminant Trigger Values

Water Quality Indicator	Unit	Trigger Values
Calcium	µg/L	To be provided as per condition E5
Dissolved Solids (Total)	µg/L	To be provided as per condition E5
Electrical Conductivity	µS/cm	To be provided as per condition E5
HCO_3	µg/L	To be provided as per condition E5
Magnesium	µg/L	To be provided as per condition E5
pH	pH Units	To be provided as per condition E5
SO_4	µg/L	To be provided as per condition E5
Sodium	µg/L	To be provided as per condition E5

E3	A background groundwater monitoring program must be developed to include bore(s) that are located an appropriate distance from potential sources of impact from mining activities to provide the following: a) representative groundwater samples from the aquifers potentially affected by mining activities; b) at least twelve (12) sampling events (monthly sampling) to determine background groundwater quality as far as practicable; and c) the final groundwater contaminant parameters and trigger levels required for each bore type must be provided according to condition E5.
E4	The groundwater monitoring data must be reviewed on an annual basis. The review must include the assessment of groundwater quality data and the suitability of the monitoring network. The assessment must be submitted to the administering authority within twenty-eight (28) days of receiving the report.
E5	Groundwater containment trigger levels as per **Table E2: Groundwater Containment Trigger Values** must be finalised based on background groundwater monitoring program defined in condition E3 and be submitted to the administering authority by 12 months after the issue of this environmental authority.
E6	The following information must be recorded in relation to all groundwater water sampling: a) the date on which the sample was taken; b) the time at which the sample was taken; c) the monitoring point at which the sample was taken; and d) the results of all monitoring.
Bore construction and maintenance and decommissioning	
E9	The construction, maintenance and management of groundwater bores (including groundwater monitoring bores) must be undertaken in a manner that prevents or minimises impacts to the environment and ensures the integrity of the bores to obtain accurate monitoring

Department interest: Water	
Condition number	**Condition**
Contaminant release	
F1	Mine affected water must not be released directly or indirectly to any waters as a result of the authorised mining activities, except as permitted under the conditions of this environmental authority.
Monitoring of water storage quality	
F2	Water storages stated in **Table F1 - Water storage monitoring** which are associated with the release points must be monitored for the water quality characteristics specified in **Table F2 – Onsite water storage contaminant limits** at the monitoring locations and at the monitoring frequency specified in **Table F1 - Water storage monitoring**.

Table F1 - Water storage monitoring

Water Storage Description	Latitude (decimal degree, GDA94)	Longitude (decimal degree, GDA94)	Monitoring Location	Frequency of monitoring
Dam 1	-23.0268	150.3054	Grab sample taken at dam spillway	Quarterly
Dam 2	-23.0279	150.3047	Grab sample taken at dam spillway	Quarterly
Dam 3	-23.0380	150.3171	Grab sample taken at dam spillway	Quarterly
Dam 4	-23.0303	150.3222	Grab sample taken at dam spillway	Quarterly

Table F2 - Onsite water storage contaminant limits

Quality Characteristic	Test Value	Containment Level
pH (pH unit)	Range	Greater than 4, less than 9[2]
EC (μS/cm)	Maximum	5970[1]
Sulphate (mg/L)	Maximum	1000[1]
Fluoride (mg/L)	Maximum	2[1]
Arsenic (mg/L)	Maximum	0.5[1]
Cadmium (mg/L)	Maximum	0.01[1]
Cobalt (mg/L)	Maximum	1[1]
Nickel (mg/L)	Maximum	1[1]

Note:

[1] Contaminant limit based on ANZECC & ARMCANZ (2000) stock water quality guidelines.

[2] Page 4.2—15 of ANZECC & ARMCANZ (2000) 'Soil and animal health will not generally be affected by water with pH in the range of 4—9'.

Note: Total measurements (unfiltered) must be taken and analysed

F3	In the event that waters storages defined in **Table F1 - Water storage monitoring** exceed the contaminant limits defined in **Table F2 - Onsite water storage contaminant limits**, the holder of the environmental authority must implement measures, where practicable, to prevent access to waters by all livestock.
F4	All determinations of water quality and biological monitoring must be performed by an appropriately qualified person.
Water reuse	
F5	Mine affected water may be piped or trucked or transferred by some other means that does not contravene the conditions of this environmental authority and deposited into artificial water storage structures, such as farm dams or tanks, or used directly at properties owned by the environmental authority holder or a third party (with the consent of the third party).
Temporary interference with waterways	
F6	Temporarily destroying native vegetation, excavating, or placing fill in a watercourse, lake or spring necessary for and associated with mining operations must be undertaken in accordance with Department of Environment and Heritage Protection *Guideline - Activities in a Watercourse, Lake or Spring Associated with Mining Activities*.

Water management plan	
F7	A Water Management Plan must be developed by an appropriately qualified person and implemented within six (6) months of the date of issue of this Environmental Authority.
Stormwater and water sediment controls	
F8	An Erosion and Sediment Control Plan must be developed by an appropriately qualified person and implemented for all stages of the mining activities on the site to minimise erosion and the release of sediment to receiving waters and contamination of stormwater.
F9	Stormwater, other than mine affected water, is permitted to be released to waters from: a) erosion and sediment control structures that are installed and operated in accordance with the Erosion and Sediment Control Plan required by condition F8; and b) water management infrastructure that is installed and operated, in accordance with a Water Management Plan that complies with conditions F7, for the purpose of ensuring water does not become mine affected water.

Department interest: Land and rehabilitation	
Condition number	**Condition**
Topsoil	
G1	Topsoil must be strategically stripped ahead of mining in accordance with a topsoil management plan.
G2	A topsoil inventory which identifies the topsoil requirements and availability of suitable topsoil on site must be detailed in the Plan of Operations.
Rehabilitation landform criteria	
G3	All areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover in accordance with the submitted rehabilitation management plan.
G4	A Rehabilitation Management Plan must be developed by an appropriately qualified person and implemented within six (6) months of the date of issue of this Environmental Authority.

G5	The rehabilitation management plan must, at a minimum: a) map existing areas of rehabilitation; b) develop design objectives for rehabilitation of disturbed areas and post mining land uses across the mine; c) specify spoil characteristics, soil analysis, soil separation for use on rehabilitation; d) detail rehabilitation methods applied to areas; e) contain landform design criteria including end of mine design; f) detail how landform design will be consistent with the surrounding topography; g) identify success criteria for areas and itemise re-vegetation criteria; h) explain planned native vegetation rehabilitation areas and corridors; i) identify at least a minimum of three (3) reference and three (3) rehabilitation sites to be used to develop rehabilitation success criteria; j) describe rehabilitation indicators and the monitoring program to be used; k) develop a contingency plan for rehabilitation maintenance or redesign; l) describe end of mine landform design plan and post mining land uses across the mine; and m) include a cost benefit analysis / triple bottom line assessment (or an alternative assessment method) of the proposed final landform design criteria and alternatives.
G6	Rehabilitation must commence progressively in accordance with the Plan of Operations.
Residual void outcome	
G7	Residual voids must not cause any serious environmental harm to land, surface waters or any recognised groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority.
Contaminated land	
G8	Before applying for surrender of a mining lease, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the mining lease which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use.
G9	Before applying for progressive rehabilitation certification for an area, the holder must (if applicable) provide to the administering authority a site investigation report under the Act, in relation to any part of the area the subject of the application which has been used for notifiable activities or which the holder is aware is likely to be contaminated land, and also carry out any further work that is required as a result of that report to ensure that the land is suitable for its final land use under condition G1.

Department interest: Regulated Structures	
Condition number	**Condition**
Assessment of Hazard Category	
H1	The hazard category of any structure must be assessed by a suitably qualified and experienced person: a) in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (*EM365*); and b) in any of the following situations: i. prior to the design and construction of the structure; or ii. prior to any change in its purpose or the nature of its stored contents; and iii. in accordance with the *Manual for assessing Hazard Categories and Hydraulic Performance of Dams*.
H2	A hazard assessment report and certification must be prepared for any structure assessed and the report may include a hazard assessment for more than one structure.
H3	The holder must, on receipt of a hazard assessment report and certification, provide to the administering authority one paper copy and one electronic copy of the hazard assessment report and certification.
H4	Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635).*
H5	The holder must take reasonable and practical measures so that each dam associated with the mining activity is designed, constructed, operated and maintained in accordance with accepted engineering standards and is fit for the purpose for which it is intended.

Definitions

Words and phrases used throughout this environmental authority are defined below. Where a definition for a term used in this environmental authority is not provided within this environmental authority, but is provided in the EP Act 1994 or subordinate legislation, the definition in the EP Act or subordinate legislation must be used.

'Administering authority' means the Department of Environment and Heritage Protection or its successor.

'Annual exceedance probability' or 'AEP' means the probability that at least one event in excess of a particular magnitude will occur in any given year.

'appropriately qualified person' means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relating to the subject matter using the relevant protocols, standards, methods or literature.

'assessed' and 'assessment' by a suitably qualified and experienced person in relation to a hazard assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

a) exactly what has been assessed and the precise nature of that determination;

b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;

c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and

d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

'associated works' means in relation to a dam,

a) operations of any kind and all things constructed, erected or installed for that dam; and

b) any land used for those operations.

'**certification'** means assessment and approval must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by this manual, including design plans, 'as constructed' drawings and specifications, construction, operation or an annual report regarding regulated structures, undertaken in accordance with the Board of Professional Engineers of Queensland Policy Certification by RPEQs (ID: 1.4 (2A)).

'commercial place' means a workplace used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees' accommodation or public roads.

'construction' or 'constructed' in relation to a regulated structure includes building a new regulated structure and lifting or otherwise modifying an existing regulated structure, but does not include investigations and testing necessary for the purpose of preparing a design plan.

'**dam'** means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works. A dam does not mean a fabricated or manufactured tank or container, designed and constructed to an Australian Standard that deals with strength and structural integrity of that tank or container.

'design storage allowance' or 'DSA' means an available volume, estimated in accordance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* published by the administering authority, must be provided in a dam as at 1 November each year in order to prevent a discharge from that dam to an annual exceedance probability (AEP) specified in that manual.

'**designer**' for the purposes of a regulated dam, means the certifier of the design plan for the regulated dam.

'disturbance' of land includes:

a) compacting, removing, covering, exposing or stockpiling of earth;

b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion;

c) carrying out mining within a watercourse, waterway, wetland or lake;

d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls;

e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be removed after the mining activity has ceased; or

f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of 'disturbance':

a) areas off lease (e.g. roads or tracks which provide access to the mining lease);

b) areas previously disturbed which have achieved the rehabilitation outcomes;

c) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions);

d) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc) which is to be left by agreement with the landowner.

e) disturbance that pre-existed the grant of the tenure.

'**EC'** means electrical conductivity.

'emergency action plan' means documentation forming part of the operational plan held by the holder or a nominated responsible officer, that identifies emergency conditions that sets out procedures and actions that will be followed and taken by the dam owner and operating personnel in the event of an emergency. The actions are to minimise the risk and consequences of failure, and ensure timely warning to downstream communities and the implementation of protection measures. The plan must require dam owners to annually update contact details that are part of the plan, and to comprehensively review the plan at least every five years.

'Environmental authority' means environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994.*

'Environmental authority holder' means the holder of this environmental authority.

'Flowable substance' means matter or a mixture of materials which can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

'hazard' means in relation to a dam as defined, means the potential for environmental harm resulting from the collapse or failure of the dam to perform its primary purpose of containing, diverting or controlling flowable substances.

'hazard category' means a category, either low significant or high, into which a dam is assessed as a result of the application of tables and other criteria in 'Manual for Assessing Hazard Categories and Hydraulic Performance of Dams'.

'Holder' means any person who is the holder of, or is acting under, that environmental authority.

'hydraulic performance' means the capacity of a regulated dam to contain or safely pass flowable substances based on a probability (AEP) of performance failure specified for the relevant hazard category in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)*.

'infrastructure' means water storage dams, levees„ roads and tracks, buildings and other structures built for the purpose of the mining activity.

'**land**' in the 'land schedule' of this document means land excluding waters and the atmosphere, that is, the term has a different meaning from the term as defined in the *Environmental Protection Act 1994*. For the purposes of the *Acts Interpretation Act 1954*, it is expressly noted that the term 'land' in this environmental authority relates to physical land and not to interests in land.

'land use' —means the selected post mining use of the land, which is planned to occur after the cessation of mining operations.

'levee' means an embankment that only provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

'licensed place' means the mining activities carried out at the mining tenements detailed in Table # (page #) of this environmental authority.

'Low hazard dam' means any dam that is not a high or significant hazard category as assessed using the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635).

'm' means metres.

'mandatory reporting level' or 'MRL' means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* published by the administering authority.

'mine affected water':

a) means the following types of water:
   i. pit water, tailings dam water, processing plant water;
   ii. water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the *Environmental Protection Regulation 2008* if it had not formed part of the mining activity;
   iii. rainfall runoff which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated, excluding rainfall runoff discharging through release points associated with erosion and sediment control structures that have been installed in accordance with the standards and requirements of an Erosion and Sediment Control Plan to manage such runoff, provided that this water has not been mixed with pit water, tailings dam water, processing plant water or workshop water;
   iv. groundwater which has been in contact with any areas disturbed by mining activities which have not yet been rehabilitated;
   v. groundwater from the mine's dewatering activities;
   vi. a mix of mine affected water (under any of paragraphs i)-v) and other water.

b) does not include surface water runoff which, to the extent that it has been in contact with areas disturbed by mining activities that have not yet been completely rehabilitated, has only been in contact with:
   i. land that has been rehabilitated to a stable landform and either capped or revegetated in accordance with the acceptance criteria set out in the environmental authority but only still awaiting maintenance and monitoring of the rehabilitation over a specified period of time to demonstrate rehabilitation success; or
   ii. land that has partially been rehabilitated and monitoring demonstrates the relevant part of the landform with which the water has been in contact does not cause environmental harm to waters or groundwater, for example:
      (a) areas that are been capped and have monitoring data demonstrating hazardous material adequately contained with the site;

(b) evidence provided through monitoring that the relevant surface water would have met the water quality parameters for mine affected water release limits in this environmental authority, if those parameters had been applicable to the surface water runoff; or

iii. both.

'measures' includes any measures to prevent or minimise environmental impacts of the mining activity such as bunds, silt fences, diversion drains, capping, and containment systems.

'modification or modifying' (see definition of 'construction')

'natural flow' means the flow of water through waters caused by nature.

'non-polluting' means having no adverse impacts upon the receiving environment.

'Operational plan' for a dam means a document that amongst other things sets out procedures and criteria to be used for operating a dam during a particular time period. The operational plan as defined herein may form part of a plan of operations or plan otherwise required in legislation.

'Probable Maximum Flood (PMF)' means the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area.

'protected area' means — a protected area under the *Nature Conservation Act 1992*; or

a) a marine park under the *Marine Parks Act 1992*; or

b) a World Heritage Area.

'receiving environment' in relation to an activity that causes or may cause environmental harm, means the part of the environment to which the harm is, or may be, caused. The receiving environment includes (but is not limited to):

a) a watercourse;

b) groundwater; and

c) an area of land that is not specified in Schedule 1 — Figure 1 of this environmental authority.

'receiving waters' means the waters into which this environmental authority authorises releases of mine affected water.

'regulated dam' means any dam in the significant or high hazard category as assessed using the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (EM635)* published by the administering authority.

'**rehabilitation**' the process of reshaping and revegetating land to restore it to a stable landform

'release event' means a surface water discharge from mine affected water storages or contaminated areas on the licensed place.

'RL' means reduced level, relative to mean sea level as distinct from depths to water.

'representative' means a sample set which covers the variance in monitoring or other data either due to natural changes or operational phases of the mining activities.

'sensitive place' means:

a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or

b) a motel, hotel or hostel; or

c) an educational institution; or

d) a medical centre or hospital; or

e) a protected area under the Nature Conservation Act 1992, the Marine Parks Act 1992 or a World Heritage Area; or

f) a public park or gardens.

Note: *The definition of 'sensitive place' and 'commercial place' is based on Schedule 1 of EPP Noise. That is, a sensitive place is inside or outside on a dwelling, library & educational institution, childcare or kindergarten, school or playground, hospital, surgery or other medical institution, commercial & retail activity, protected area or an area identified under a conservation plan under Nature Conservation Act 1992 as a critical habitat or an area of major interest, marine park under Marine Parks Act 2004, park or garden that is outside of the mining lease and open to the public for the use other than for sport or organised entertainment. A commercial place is inside or outside a commercial or retail activity.*

A mining camp (i.e., accommodation and ancillary facilities for mine employees or contractors or both, associated with the mine the subject of the environmental authority) is not a sensitive place for that mine or mining project, whether or not the mining camp is located within a mining tenement that is part of the mining project the subject of the environmental authority. For example, the mining camp might be located on neighbouring land owned or leased by the same company as one of the holders of the environmental authority for the mining project, or a related company. Accommodation for mine employees or contractors is a sensitive place if the land is held by a mining company or related company, and if occupation is restricted to the employees, contractors and their families for the particular mine or mines which are held by the same company or a related company.

For example, a township (occupied by the mine employees, contractors and their families for multiple mines that are held by different companies) would be a sensitive place, even if part or all of the township is constructed on land owned by one or more of the companies.

'spillway' means a weir, channel, conduit, tunnel, gate or other structure designed to permit discharges form the dam, normally under flood conditions or in anticipation of flood conditions.

'suitably qualified and experienced person' in relation to regulated structures means a person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002*, and has demonstrated competency and relevant experience:

a) for regulated dams, an RPEQ who is a civil engineer with the required qualifications in dam safety and dam design.

b) for regulated levees, an RPEQ who is a civil engineer with the required qualifications in the design of flood protection embankments.

Note: *It is permissible that a suitably qualified and experienced person obtain subsidiary certification from an RPEQ who has demonstrated competence and relevant experience in geomechanics, hydraulic design or engineering hydrology.*

'structure' in relation to regulated structures means dam or levee.

'system design plan' means a plan that manages an integrated containment system that shares the required DSA volume across the integrated containment system.

'the Act' means the *Environmental Protection Act 1994*.

'*µ*S/cm' means micro siemens per centimetre.

'**Void**' means any constructed, open excavation in the ground.

'**watercourse**' has the same meaning given in the *Water Act 2000*.

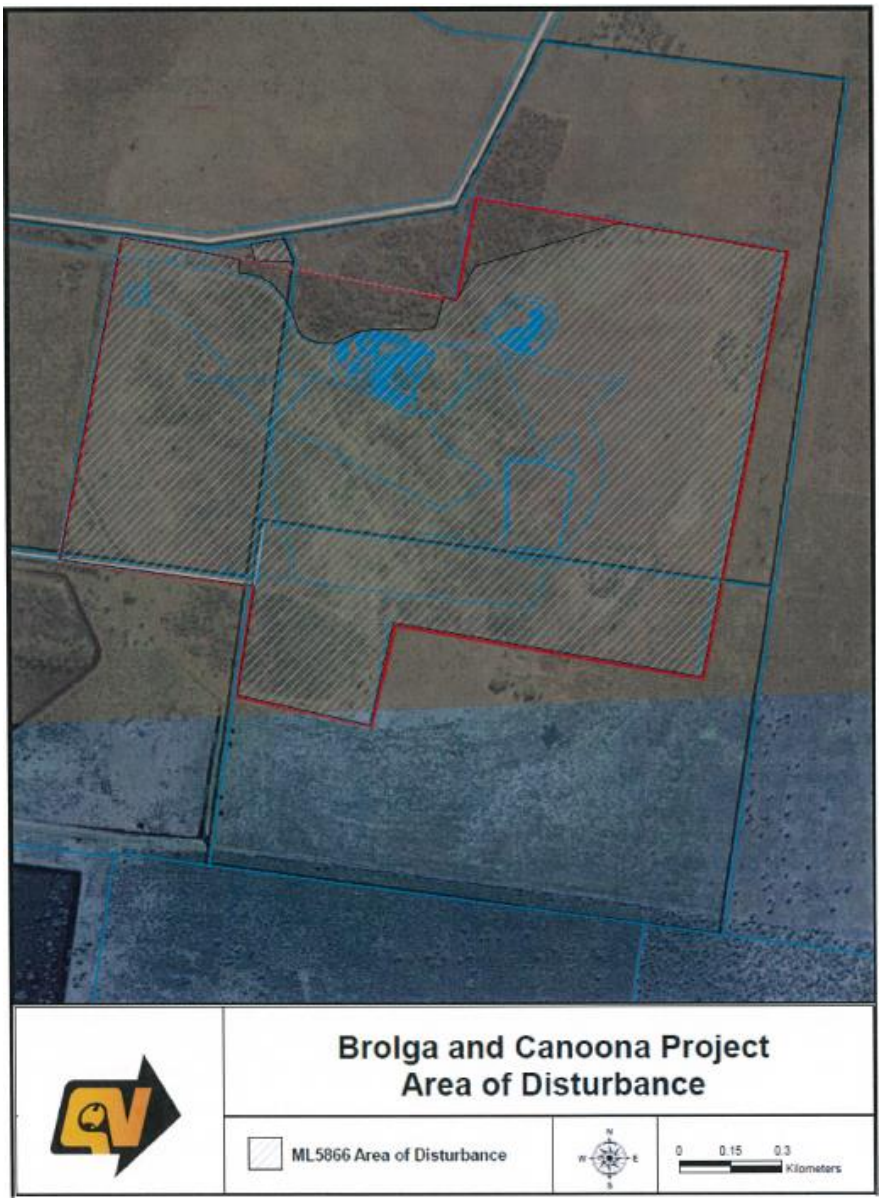
'water quality' means the chemical, physical and biological condition of water.

'**waters**' includes river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined natural or artificial watercourse, bed and bank of any waters, dams, non-tidal or tidal waters (including the sea), storm water channel, storm water drain, and groundwater and any part thereof.

END OF DEFINITIONS

Schedule 1 – Approved plans

Figure 1: Brolga and Canoona Project Area of Disturbance



END OF PERMIT

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DOCUMENT INFORMATION

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1. INTRODUCTION

1.1 Context

This standard has been developed to ensure that management of Brolga mine rehabilitation is sustainable and complies with environmental regulatory requirements.

1.2 Scope

The Brolga Project is a historic nickel ore mine situated approximately 55 kilometres north of Rockhampton, Queensland (Figure 1). The total area of the lease (ML5866) encompasses 203 hectares of undulating land positioned across Lots 174, 176 and 177 on Plan LN473 (Figure 2).

In late 2012, QNI Resources Pty Ltd (QNI) re-established a small scale mining operation and associated infrastructure at the Brolga site to extract approximately 30,000 tonnes per month of nickel ore. By June 2013 sufficient ore had been mined to complete processing trials at the Palmer Nickel and Cobalt Refinery in Townsville and mining activity at Brolga mine was put on hold.

In late 2013 QNI applied for, and were granted, an amendment to the site environmental authority (EA) for an expanded mining operation at the Brolga mine. The amended EA allows for an increased mining rate of up to 900,000 tonnes per annum of nickel ore product. In mid-2014 QNI recommenced mining operations at the Brolga mine at an increased rate of up to 60,000 tonnes of nickel ore per month.

This rehabilitation management plan has been developed in accordance with the amended site Environmental Authority (EPML01624913) requirements to provide a strategy for progressive rehabilitation of the site and achieve the desired post mining land use.

As mining operations at Brolga progress and the mine plan evolves, this Rehabilitation Management Plan will be reviewed and updated accordingly. Information gained through implementation and subsequent monitoring of rehabilitation at the Brolga site will also be incorporated into this document to allow for the continual improvement of rehabilitation activities at Brolga.

1.3 Background

The Brolga site was mined by a previous operator between 1993 and 1995 during which time approximately 600,000 tonnes of nickel ore was produced. The mine comprised two areas of mine workings, a haul road, a sediment retention bund and workshop and office facilities.

Active mining at the site ceased in approximately 1996 and, following closure of the mine, the site had been under the process of landform and vegetative rehabilitation to return it to its former land use as a low intensity grazing property.

In terms of rehabilitation activity, the area was selectively ripped in July 1999 and grass species planted. By 2002, previously mined areas had been re-contoured, topsoiled and, along with the cleared areas, seeded with green panic, silk sorghum, and Rhodes grass. Drill holes had been rehabilitated and areas which were slow to revegetate were re-ripped and seeded.

Site inspections to monitor the progress of rehabilitation at the site were completed in 2002, 2003, 2006, 2009 and 2011. In 2012, QNPL commissioned an ecosystem function analysis to determine success of rehabilitation efforts to date. Key findings of the assessment were:

- Ground cover throughout the site is generally well above 50 percent;
- The ecosystems are generally functioning successfully;
- The dominant species were Lantana and Acacia spp. which appeared to be limiting overall species richness;

- Stability, infiltration and nutrient cycling values were less in historic mine workings than in areas undisturbed by mining activities; and
- Areas of bare dispersive soil are present in isolated patches providing potential for erosion.

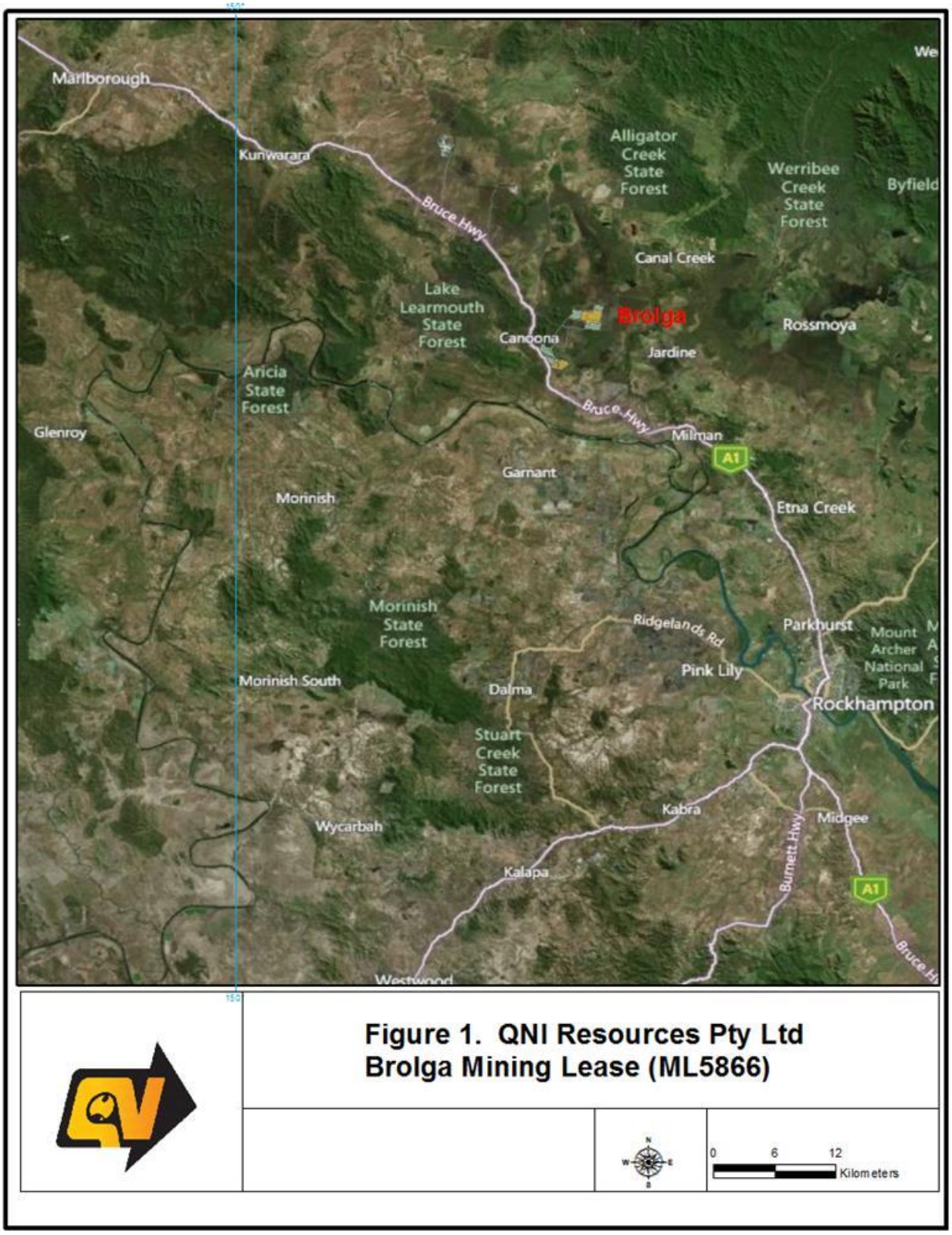


Figure 1. QNI Resources Pty Ltd Brolga Mining Lease (ML5866)

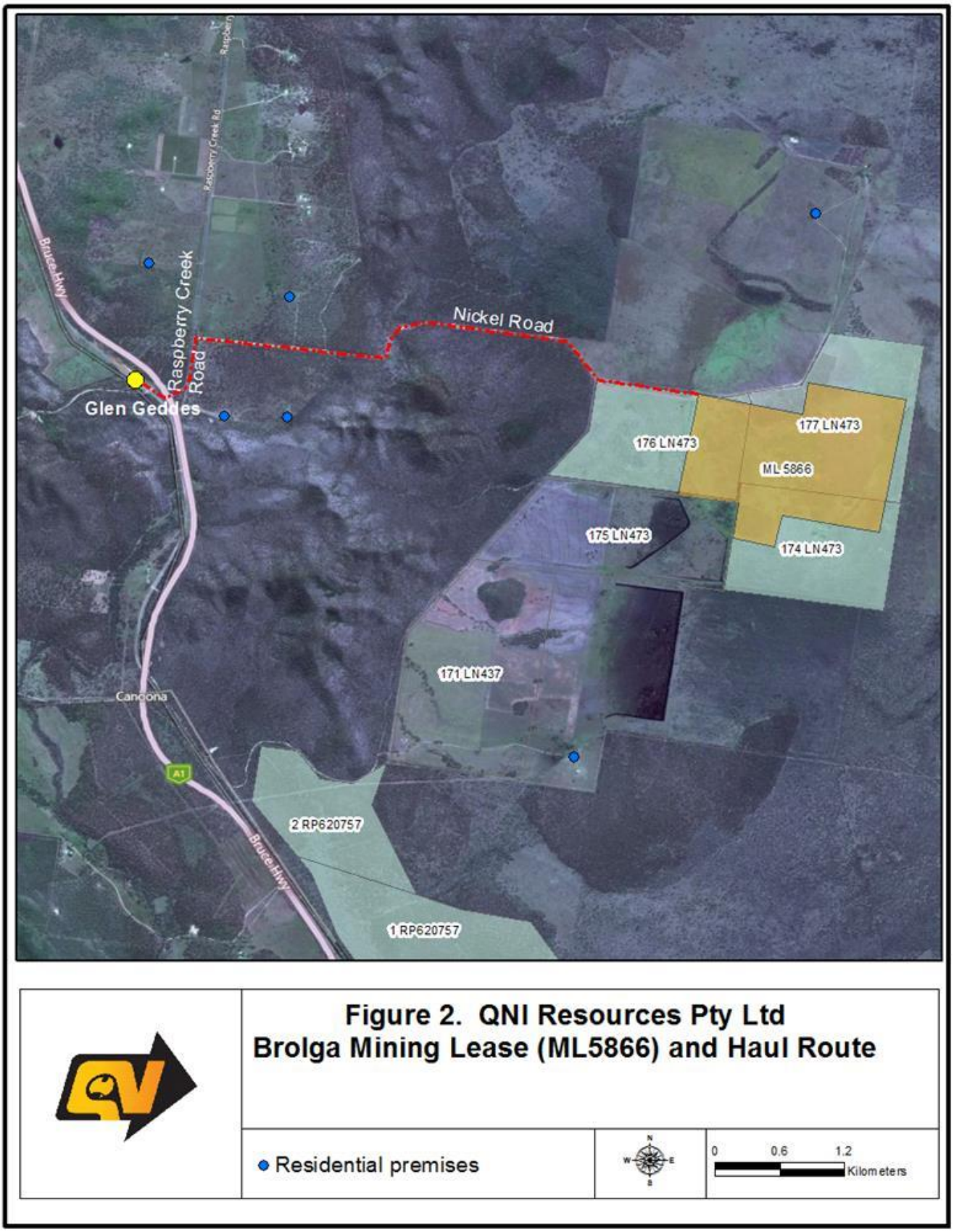


Figure 2. QNI Resources Pty Ltd Brolga Mining Lease (ML5866) and Haul Route

2. ACCOUNTABILITIES

- **Manager Environment**
  - Contact and communicate with external agencies as required.
  - Provide strategic and expert advice on the methods to achieve requirements.
  - Coordinate licence and regulatory requirements.
  - Ensure EMS standards are updated in line with associated Management Plans.
  - Coordinate the development and implementation of a Rehabilitation Management Plan for operations in consultation with key personnel and Managers.
  - Review and assess the rehabilitation monitoring data annually and recommendations on improvements to rehabilitation practices.

- **Mine Manager**
  - Notify the Environmental Manager prior to any action or operation that has the potential to cause a non-compliance with a requirement of this standard;
  - Schedule operational rehabilitation activities in accordance with the rehabilitation schedule;
  - Seek approval from the Environmental Manager prior to any planned works within rehabilitation areas, or works that may interfere with rehabilitation areas;
  - Assist with rehabilitation monitoring and maintenance activities as required.

- **All Personnel**
  - Duty of care to prevent environmental harm.

3. DEFINITIONS

TERM	DEFINITION
Land use	The selected post mining use of the land, which is planned to occur after the cessation of mining operations.
Rehabilitation	The process of reshaping and revegetating land to restore it to a stable landform.
Waters	Includes river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined natural or artificial watercourse, bed and bank of any waters, dams, non-tidal or tidal waters (including the sea), storm water channel, storm water drain, and groundwater and any part thereof.

4. REHABILITATION OBJECTIVES

Brolga mine has the following long-term objectives for rehabilitation:

- To ensure the mine site is safe for humans and animals now, and in the foreseeable future;
- To ensure water and soil quality on site is non-polluting and consistent with the requirements for the wellbeing of humans and agricultural use;
- To ensure land disturbed by mining activities is stable;
- Achieve a self-sustaining habitat for grazing and/or conservation land use, requiring minimal on-going maintenance.

The objectives will be achieved through implementation of short term and long term rehabilitation activities. Short term rehabilitation activities are focused on reshaping and stabilisation of spoil, erosion control and establishing revegetation. Key actions include:

- Minimising vegetation disturbance during mining operations;
- Reshaping and stabilising disturbed areas, earthworks and drainage lines as part of the mining process to minimise erosion and sedimentation;
- Applying topsoil, seeding and establishing the rehabilitation of stabilised areas upon their release from the active mining area;
- Control of pests including feral animals and noxious weeds;
- Implementing a fire plan and excluding cattle from the areas undergoing rehabilitation.

The long term actions to achieve rehabilitation objectives include:

- Establishing a low maintenance , geotechnically stable, safe and vegetated landform that is in accordance with the natural surrounding landscape and is acceptable to the stakeholders;
- To control pests including feral animals and noxious weeds;
- To monitor rehabilitation success in terms of physical and biological parameters that have been pre-determined;
- Decommissioning mine related infrastructure not required and maintaining infrastructure required for post-mine use;
- Establishing and meeting all closure criteria to enable relinquishment of the site.

5. REHABILITATION MANAGEMENT STRATEGY

All areas disturbed by mining activities, excluding some infrastructure, will be rehabilitated to a stable landform with a self-sustaining vegetation cover. Rehabilitation of disturbed land will generally proceed within two years of the areas becoming available for rehabilitation. However it is noted that in some situations, progressive rehabilitation within a two year timeframe may not be possible because the area may be operationally integrated with nearby areas that are unavailable for rehabilitation.

To achieve the rehabilitation objectives at the Brolga Mine a schedule will be developed for the progressive implementation of the following key rehabilitation stages:

- Area backfilled and/or re-contoured (reshaped to final grade);
- Area topsoiled;
- Area seeded (ripped and seeded, irrespective of germination success);
- Area established (vegetation established, although minor reseeding/erosion repairs may be necessary); and
- Area successfully rehabilitated (compliance with rehabilitation success criteria).

5.1 Mining Areas

Areas will be rehabilitated as they become available according to the mine plan. The mine plan has mapped 22 pits to be mined, an old pit to be backfilled and an external waste dump.

The mining area has been divided into three sections (see Figure 3):

1. Nontronite area
2. Eastern Anontronitic; and
3. Western Anontronitic.

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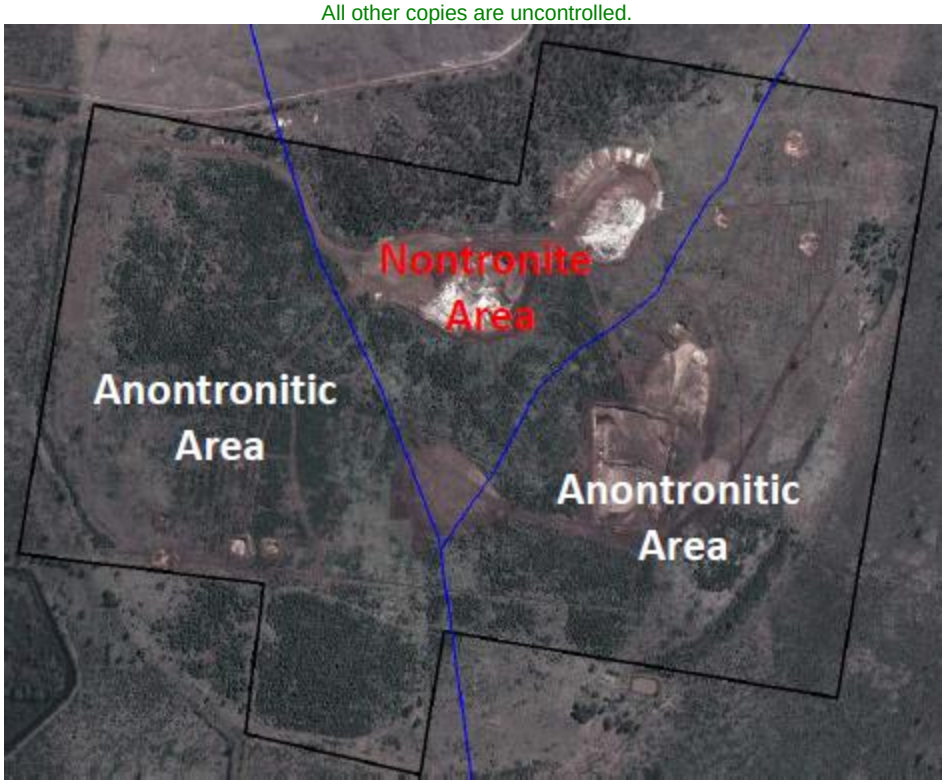


Figure 3. Mining areas within the ML

The Nontronite area is the central north area of the ML which covers much of the previously mined/disturbed areas and includes the external waste dump site, old pit and low grade stockpile. The Eastern Anontronitic area covers the current pit (pit 1) and planned pits 2 to 12. The Western Anontronitic area covers planned pits 22 to 30. Pit 21 is assumed to be mined out (see Figure 4).

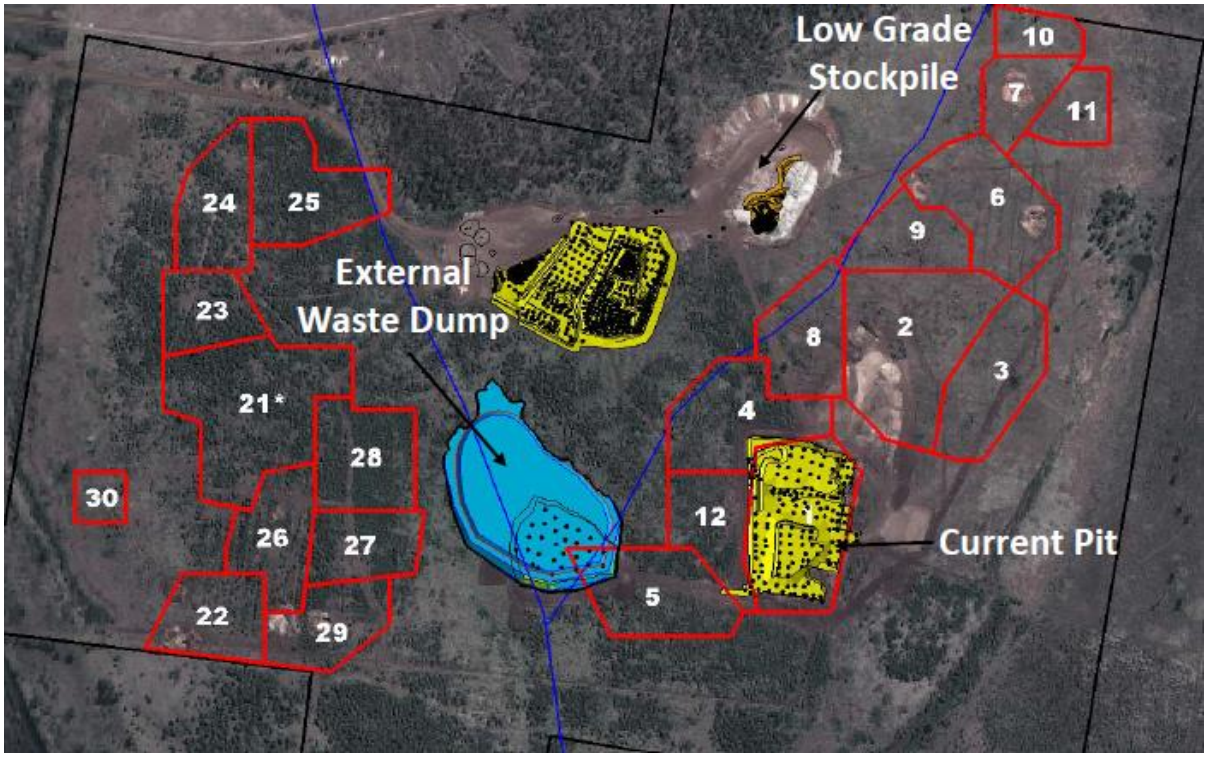


Figure 4. Existing and planned pits, dump site and stockpile locations.

Other disturbed areas include (see Figure 5):

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- Site office, ablution facilities, car parking, and any other amenities;
- Roads;
- Rail Siding Infrastructure; and
- Dams

The above mining infrastructure is required until mining is complete, and much of the infrastructure will be retained indefinitely for post-mining use. This includes the concrete slabs, main roads, rail siding infrastructure and the dams. The dams, which function as sediment retention ponds will be scheduled for a clean out of excess sediment post-mining, as well as water quality monitoring to ensure suitability for use by livestock.

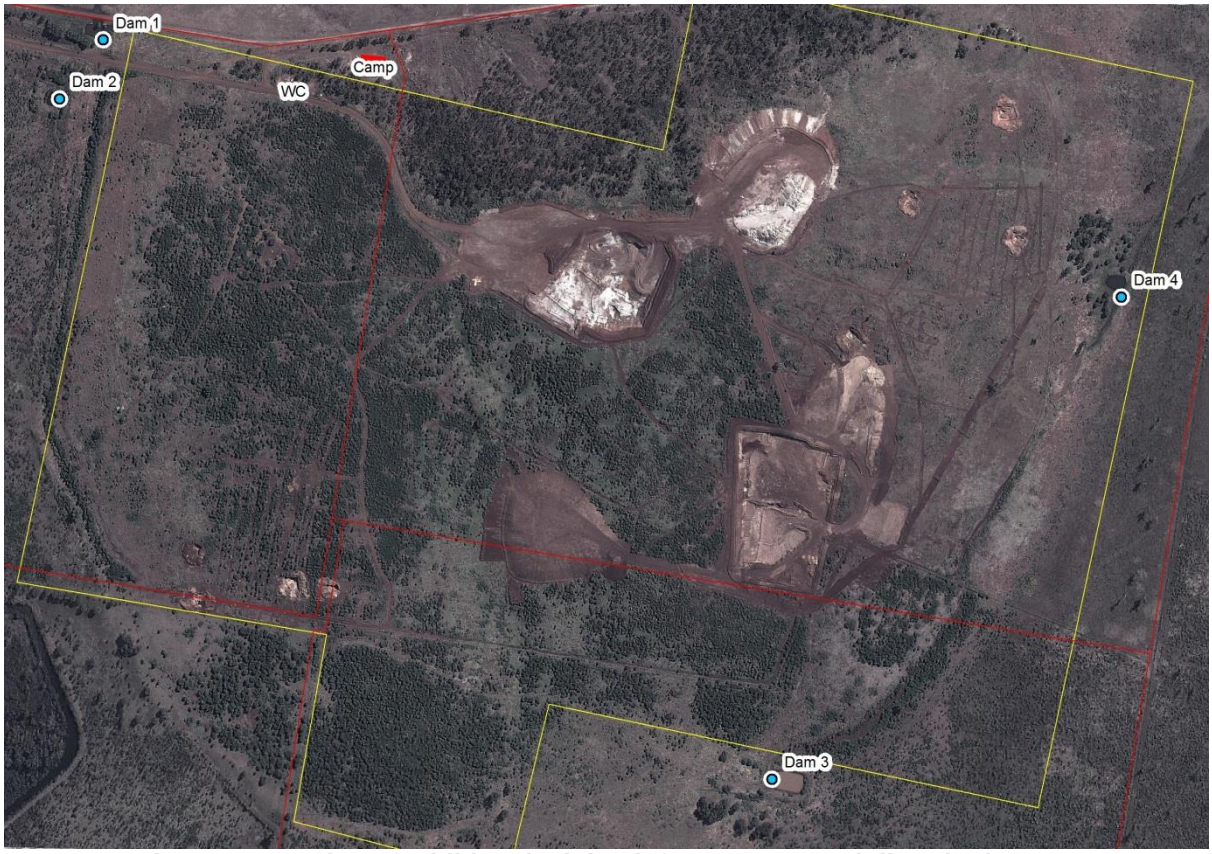


Figure 5. Location of additional mining infrastructure and disturbed areas.

5.2 Rehabilitation Domains

The mining areas can be divided into 3 domains for rehabilitation. There is an additional domain for a conservation area adjacent to the mining area. The domains are described below:

Domain 1 – Nontronite area

Domain 2 – Eastern and Western anontronitic areas

Domain 3 – Other areas disturbed by mining

Domain 4 – Conservation area

5.3 Rehabilitation Schedule

Rehabilitation of areas will follow the backfilling and waste dumping schedule. For pits not scheduled for backfilling/waste dumping, the mining schedule is referenced. Rehabilitation activities are scheduled to occur in the quarter following completion of backfilling, waste dumping or mining. The backfilling schedule is summarised in Table

1 below, all schedules are available in the Brolga Pit Optimisation and Mine Planning Review (IMC, 2014).

Table 1. Pit backfilling schedule

Backfilling Area (Ha)

Sum of area	Period												
Backfill	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Q3 2015	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Grand Total
bf_pitiv	1.8			2.3									4.1
bf_pit22		3.3	1.0										4.3
bf_2											2.3		2.3
bf_3								0.1	1.3	1.1	0.0		2.5
bf_4								1.0	2.0				2.9
bf_12										1.1	0.1	0.3	1.5
bf_22								2.1					2.1
bf_23									1.4	0.1			1.5
bf_24											1.7	0.4	2.2
bf_25												0.8	0.8
bf_26						2.4							2.4
bf_27					-	0.5	0.9						1.3
bf_28							1.9						1.9
bf_29												0.3	0.3
bf_30								0.5					0.5
Grand Total	**1.8**	**3.3**	**1.0**	**2.3**	**-**	**2.9**	**2.7**	**3.7**	**4.7**	**2.3**	**4.1**	**1.9**	**30.6**

The rehabilitation schedule for disturbed areas is outlined in Table 2. The following sections of this plan will outline how rehabilitation objectives will be achieved.

Table 2. Rehabilitation Schedule

LOCATION	DISTURBED AREA (Ha)	AREA AVAILABLE FOR REHABILITATION	COMMENT
Pit 1	4.2	Q2 2015	Backfilled
Pit 2	4.8	Q2 2017	Backfilled
Pit 3	2.5	Q2 2017	Backfilled
Pit 4	2.9	Q4 2016	Backfilled
Pit 5	2.0	Q1 2017	No backfilling
Pit 6	3.6	Q3 2017	No backfilling
Pit 7	1.1	Q3 2016	No backfilling
Pit 8	1.2	Q3 2017	No backfilling
Pit 9	1.1	Q3 2017	No backfilling
Pit 10	0.5	Q3 2017	No backfilling
Pit 11	0.5	Q3 2017	No backfilling
Pit 12	1.5	Q3 2017	Backfilled
Pit 22	2.1	Q3 2016	Backfilled
Pit 23	1.5	Q1 2017	Backfilled
Pit 24	2.2	Q3 2017	Backfilled
Pit 25	2.8	Q3 2017	Backfilled
Pit 26	2.4	Q1 2016	Backfilled
Pit 27	1.3	Q2 2016	Backfilled
Pit 28	1.9	Q2 2016	Backfilled
Pit 29	2.0	Q3 2017	Backfilled
Pit 30	0.5	Q3 2016	Backfilled
External dump	6.8	Q2 2016	Backfilled/waste dump
Old pit (pit iv) & dumps	14.8	Q3 2015	Backfilled
Roads/ROM/Hardstand and other infrastructure	9	Q3 2017	Some infrastructure to remain post-mining
Total	73.4		

5.4 Rehabilitation Assessment and Completion Criteria

Rehabilitation assessment and completion criteria will be based on the short and long term objectives outlined in section 4 above. The completion criteria are defined in Section 6. The Department of Environment and Heritage Protection will need to be satisfied that the criteria have been met before the Environmental Authority/Mining Lease may be surrendered and financial assurance released.

6. REHABILITATION ACTIONS

6.1 Progressive Rehabilitation

The main features of the progressive rehabilitation process for disturbed land include the following:

- construction of a stable final landform with minimal ponding of water within waste dump/backfilled areas;
- progressive construction of the final landform design as part of normal mining operations, such that minimal reshaping is required at the end of mining;
- use of suitable topsoil, which will either be stockpiled until suitable rehabilitation areas are available, or re-spread immediately across available rehabilitation areas;
- deep ripping (as an erosion control measure and to facilitate seed propagation), seeding and (if required) fertiliser application preferably prior to the commencement of the wet season to maximise the benefits of subsequent rainfall;
- treatment of declared weed species, when necessary; and
- minimisation of the final void area to reduce the potential for collection of water from direct rainfall and runoff from the rehabilitated landform.

Within the mining lease and adjacent freehold title area, there are two zones subject to active rehabilitation and conservation as part of this rehabilitation plan. Figure 6 maps the area of disturbance to be rehabilitated to pasture for grazing (zone 1), and the area zoned for conservation (zone 2) which will require minimal rehabilitation.

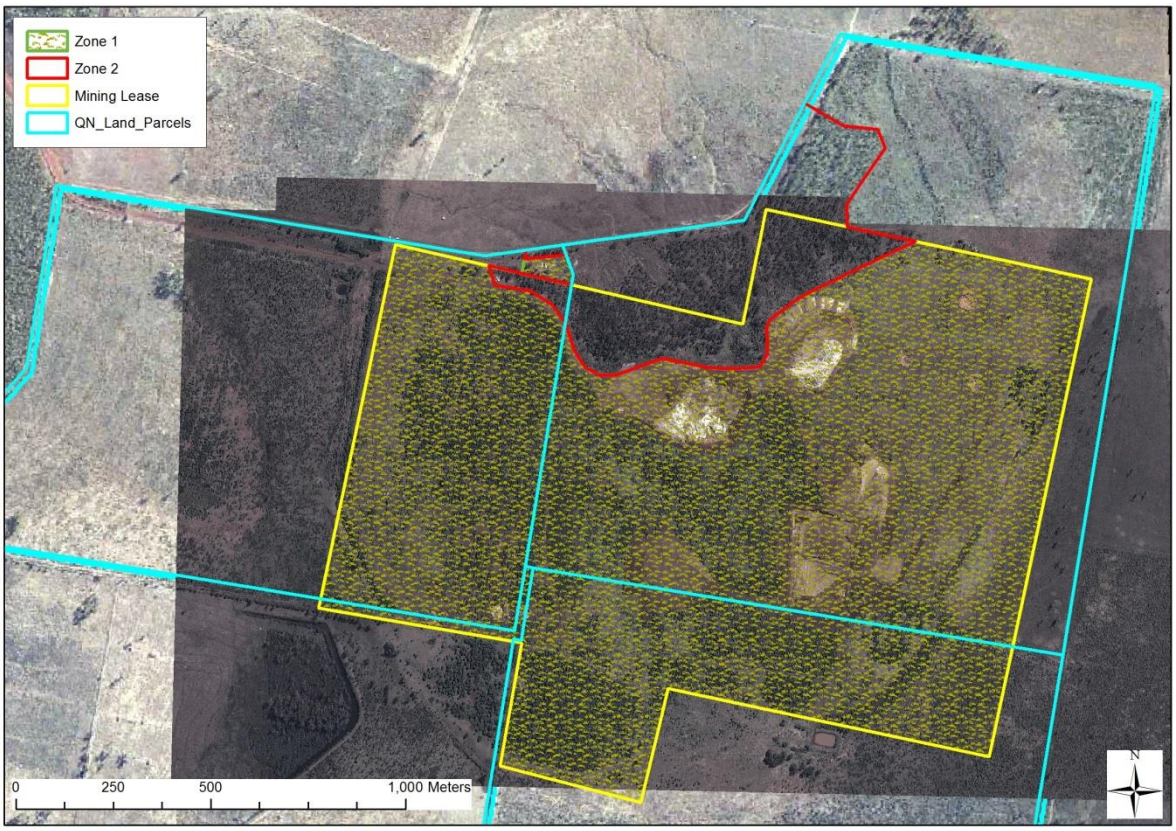


Figure 6. Rehabilitation zones

6.2 Rehabilitation Methods

6.2.1 Zone 1 – Grazing Area

Zone 1 covers much of the mining lease and includes all of the areas disturbed by mining activities. Domains 1, 2 and 3 are all within Zone 1 and will be rehabilitated to pasture for low intensity grazing activities.

As mining pits are backfilled and other disturbed areas (eg. waste dumps) are made available for rehabilitation (see rehabilitation schedule in Table 2), various earthmoving equipment will shape the area to create a self-sustaining land form which emulates the surrounding landscape and requires minimal on-going maintenance. This will be achieved through:

- post mining landform design,
- timely rehabilitation of exposed spoil areas;
- management of stormwater flows and
- control of declared weeds.

The post mining landform design will incorporate the following criteria;

- Integrate waste dumps with the surrounding landform;
- Waste dump batters 14° maximum slope;
- Waste dump height maximum 10m above surrounding landform;
- Contour banks installed on waste dump batters when slope length is greater than 30m;
- Minimise residual voids;

- Residual void batters to be laid back to 25° maximum slope where possible;
- For sections of residual void batters that cannot be reshaped, a maximum inter-bench angle of 63°, provided it is stable;

Following land re-contouring, disturbed areas will be covered with topsoil to a depth of no less than 100mm. Deep ripping of the spoil/topsoil will occur to a depth of 60-75cm at a ripper spacing of approximately 1.2m. The rip lines are oriented across the slope at a gradient of 0.5% (1h:200v) off the contour. Ripping is used to improve rainfall/runoff infiltration and reduce erosion.

Seeding (and fertiliser application where required) will occur in conjunction with ripping, and application rates will be determined in accordance with the supplier recommendations and local conditions. Where possible ripping/seeding should occur in the months leading up to the wet season (e.g. October-November) to increase chance of seedling success from the seasonal rainfall.

Zone 1 areas will be seeded with a local seeding mix composed of native and pasture grasses, native trees and shrubs. Cattle will be excluded from the property for all of the mining operational period and from rehabilitated areas until established. All areas still under rehabilitation will be fenced from cattle. A weed management program will be implemented to ensure areas maintain the intended species composition.

For mining pits backfilled, there is no requirement for re-establishment of a subsoil profile, due to the relative good quality of spoil used for backfill.

6.2.2 Zone 2 – Conservation Area

The conservation area will be undisturbed and not subject to top-soiling, seeding or planting of tubestock. The area therefore needs protection from mining activities and excessive future grazing, as well as ongoing weed control. Actions required in this area include fencing to exclude stock and weed management.

6.3 Spoil and Soil Management

6.3.1 Spoil Management

Spoil quality is generally good due to the relatively shallow depth from which it is mined (i.e. 20m or less). There is limited stockpiling of spoil planned, rather spoil will be placed at the external dump site, or used as backfill to fill mining pits as mining is completed. All spoil will be used to re-contour the land as part of rehabilitation.

6.3.2 Top Soil Management Plan

Where significant disturbance of an area is scheduled to occur, topsoil is removed for later placement on the final rehabilitation surface. Topsoil stripping, stockpiling and replacement on rehabilitation areas are undertaken using a variety of heavy equipment including dozers, loaders, excavators and trucks. Where possible, topsoil is reused immediately in preference to stockpiling. Where this is not possible, topsoil stockpiles will be established in predetermined locations and stabilised to prevent erosion. The locations of existing topsoil stockpiles at Brolga are shown in Figure 7.

To ensure all topsoil is retained for rehabilitation, ground-truthing of each mining area will be undertaken to establish the depth of the topsoil layer, and therefore the depth to be stripped and retained prior to mining. The topsoil inventory will be updated as depths are established.

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Figure 7. Topsoil stockpile locations

6.3.3 Top Soil Inventory

The current 2014 topsoil inventory for the Brolga mine is shown in Table 3 below.

Table 3. Brolga Mine topsoil inventory.

CLASSIFICATION	VOLUME	
Topsoil currently stockpiled	22,250	m^3
Topsoil Stockpiled from future disturbance	55,575	m^3
Total topsoil available for life of mine	77,825	m^3
Topsoil required for current disturbance	22,250	m^3
Topsoil required for future disturbance	55,575	m^3
Total topsoil requirement	77,825	m^3
Estimated topsoil surplus to end of mine life	0	m^3

6.4 Weed and Pest Management

Pest plants at the Brolga mine are currently managed in accordance with Brolga Mine Weed Management Plan included at Appendix 1. The document 'Brolga Mine Weed Control Requirements' outlines the legal requirements for weed and pest control, and guides the Management Plan.

6.5 Controlling Access

Access to the site is restricted to authorised personnel who have been inducted and understand the safety and environmental aspects of the site, including restricted areas such as those under rehabilitation. All visitors to the site must report to the main office and be accompanied by authorised personnel during their visit.

Rehabilitation sites will be clearly signed to control access, and where required fenced to exclude cattle.

6.6 Bushfire Management

Bushfires need to be excluded from site to allow the success of pasture as the final land cover for grazing post-mining. The bushfire risk has two main sources: neighbouring properties; and activities on site.

Fire controls such as firebreaks will be maintained along fence lines where there is a high fuel load to protect the property from any neighbouring fires. During mine operations resources will be available to help manage any fires.

Activities on-site will be risk-managed so that if a fire risk is identified the activity can be modified or controlled in an appropriate way to avoid fire ignition.

The site has an Emergency Response Plan (QN-PLN-002) which is applicable to the Brolga mine site.

7. COMPLETION CRITERIA

The long-term objectives for rehabilitation of the Brolga mine site are detailed in Section 4. These objectives address the overarching rehabilitation goals and are aligned with the criteria detailed in the Department of Environment and Heritage Protection (EHP) Guideline *Rehabilitation requirements for mining resource activities*:

- Safe to humans and wildlife;
- Non-polluting;
- Stable landform; and
- Sustains agreed post-mining land use.

The rehabilitation completion criteria (refer Table 5) have been developed to assess the performance of rehabilitation activities at the Brolga mine site against the post-mining land use objectives detailed in Table 4.

Table 4. Rehabilitation domains and post-mine land use

DOMAIN	MINING/LAND USE TYPE	POST MINE LAND DESCRIPTION
1	Old pit	Pasture grasses/native grasses/shrub mix
	External waste dump	Pasture grasses/native grasses/shrub mix
	Low grade stock pile	Pasture grasses/native grasses/shrub mix
	Ore crushing/screening /stockpiling	Pasture grasses/native grasses/shrub mix
2	Active pits	Pasture grasses/native grasses/shrub mix
3	Offices and other buildings	Concrete pads retained post mining. Pasture grasses/native grasses /shrub mix in other areas
	Roads	Main access roads retained post mining. Pasture grasses/native grasses /shrub mix for minor tracks.
	Dams	Dams to be retained post mining for livestock.
	Rail infrastructure	Rail infrastructure to be retained post mining for other operations
4	Conservation area	Conservation area

7.1 Domain 1

Domain 1 incorporates most of the pre-2014 mining disturbed areas including the old pit, and the planned external waste dump. Ore crushing, screening and stockpiling has occurred, and will continue to occur, in this area. The area will require significant filling and re-contouring of voids and dumps to emulate the surrounding landform and revegetate to a pasture of grasses and shrubs with some trees for grazing of livestock. Table 5 outlines the goals, objectives, indicators and proposed completion criteria for Domain 1.

7.2 Domain 2

Domain 2 incorporates the planned mining pits (2014 to 2017). Most pits will be backfilled and rehabilitated to a pasture of grasses and shrubs with some trees for grazing of livestock. Some may remain as shallow voids, but similarly rehabilitated for grazing. Domain 2 shares the rehabilitation goals and objectives of Domain 1, and therefore mirrors the Domain 1 completion criteria. Table 5 outlines the goals, objectives, indicators and proposed completion criteria for Domain 2.

Table 5. Brolga completion criteria for rehabilitation of disturbed lands in Domain 1 and Domain 2

Goal	Objective	Parameter/Indicator	Completion Criteria
Safe	The area is safe for humans and animals	Safety assessment of slopes	Confirmation in rehabilitation report that slopes, including graded banks are safe. Predictions/ risk assessment to be made about future safety.
		Technical design of landform	Landform designed, construction and maintained to specified geotechnical design performance.
		No toxic substances/contamination	Confirmation in rehabilitation report that soil, spoil and other cover materials are safe, including an assessment of any predicted future changes.
		Site security	Evidence of secure gates and fences to manage access to site.
Non-polluting	Hazardous materials and contaminated spoil/soil removed	Results of site contaminated land assessment report, if required.	Contaminated sites (if any) remediated and removed from EHP Environmental Management Register or Contaminated Land Register.
	No contaminated downstream waters	Surface and groundwater monitoring	Water quality of retained dams complies with Environmental Authority and/or ANZECC (livestock) guidelines

Goal	Objective	Parameter/Indicator	Completion Criteria
Stable landform	No landform slumping	Records of slope failure/slumping	Evidence that appropriate risk assessment was undertaken and control measures are in place to prevent recurrence
		Compliance with final landform design	Documented evidence that landform outcomes comply with landform designs
	Landform design minimises erosion	Records of erosion	Evidence of appropriate risk assessment and the measures taken to address and prevent further erosion
		Compliance with final landform design	Documented evidence that landform outcomes comply with landform designs
	Vegetation cover minimises erosion	Vegetation cover	Evidence that vegetation cover is 50% or greater
		Leaf litter, humus, depth of growing medium	Evidence of litter breakdown and humus formation
Sustainable land use	Self-sustaining vegetation suitable for grazing	Key species presence	Presence of key pasture and native grasses, shrubs, trees as per seed mix used
		Native species recruitment	Evidence of second generation recruitment of shrub/trees
		Absence of weeds species	Successful control / eradication of Class 2 weeds including Giant Rats tail Grass, Bellyache Bush and Lantana Compliance with weed management program
		Fauna presence	Evidence of active use of rehabilitated sites by native fauna (e.g. birds/nests, scats etc.)
	Soil properties support and will continue to support grazing land	Chemical properties of topsoil and other subsoil/growth medium for vegetation	Evidence in rehabilitation reporting that topsoil and spoil chemistry satisfies the following: • Soil salinity content is <800 dS/m with the aim of attaining <400 dS/m; • Soil pH is between 5.5 and 9; • Soil Exchangeable Sodium Percentage (ESP) is <15%.

Goal	Objective	Parameter/Indicator	Completion Criteria
		Physical properties of topsoil and other subsoil/growth medium for vegetation	Topsoil strips returned to a depth of 100 mm on spoil dumps. Surface ripped before revegetated where appropriate. Physical properties to be achieved to within 2 standard deviations of that in reference sites and determined by soil testing.
		Biological properties of topsoil and other subsoil/growth medium for vegetation	Evidence that nutrient accumulation and recycling processes are occurring by the presence and decomposition of a litter layer.
	Land use is established with comparable management requirements to similarly used un-mined land.	Achieves agreed stocking capacity/capability on agreed areas (potential for erosion/damage to slopes which may be fenced off).	Use of rehabilitated land meets specified yield.

7.3 Domain 3

Domain 3 incorporates all other mining disturbed areas. Most of the buildings will be removed, however other infrastructure such as the dams and some roads will remain for post-mine use. Disturbed areas not in use will be rehabilitated to a pasture of grasses and shrubs with some trees for grazing of livestock. Table 6 outlines the goals, objectives, indicators and proposed completion criteria for Domain 3.

Table 6. Brolga completion criteria for rehabilitation of disturbed lands in domain

Goal	Objective	Parameter/Indicator	Completion Criteria
Safe	The area is safe for humans and animals	List of equipment/infrastructure expected to remain post-mining	All equipment/ infrastructure not required for post mining use removed from site
		No toxic substances/contamination	Confirmation in rehabilitation report that soil, spoil and other cover materials are safe with details of predicted future changes.
		Safety assessment of dams	Confirmation in rehabilitation report that dams are safe. Predictions/ risk assessment to be made about future safety.
		Site security	Evidence of secure gates and fences to manage access to site.
Non-polluting	Hazardous materials and contaminated spoil/soil removed	Results of site contaminated land assessment report, if	Contaminated sites (if any) remediated and removed from EHP

Goal	Objective	Parameter/Indicator	Completion Criteria
		required.	Environmental Management Register or Contaminated Land Register.
	No contaminated downstream waters	Surface and groundwater monitoring	Water quality complies with Environmental Authority and/or ANZECC (livestock) guidelines
Stable landform	Vegetation cover minimises erosion	Vegetation cover	Evidence that vegetation cover is 50% or greater
		Leaf litter, humus, depth of growing medium	Evidence of litter breakdown and humus formation
Sustainable land use	Self-sustaining vegetation suitable for grazing	Key species presence	Presence of key pasture and native grasses, shrubs, trees as per seed mix used
		Native species recruitment	Evidence of second generation recruitment of shrub/trees
		Absence of weeds species	Successful control / eradication of Class 2 weeds including Giant Rats tail Grass, Bellyache Bush and Lantana Compliance with weed management program
		Fauna presence	Evidence of active use of rehabilitated sites by native fauna (e.g. birds/nests, scats etc.)
	Soil properties support and will continue to support grazing land	Chemical properties of topsoil and other subsoil/growth medium for vegetation	Evidence in rehabilitation reporting that topsoil and spoil chemistry satisfies the following: • Soil salinity content is <800 dS/m with the aim of attaining <400 dS/m; • Soil pH is between 5.5 and 9; • Soil Exchangeable Sodium Percentage (ESP) is <15%.
		Physical properties of topsoil and other subsoil/growth medium for vegetation	Topsoil strips returned to a depth of 100 mm on spoil dumps. Surface ripped before revegetated where appropriate. Physical properties to be achieved to within 2 standard deviations of that in reference sites and determined by soil testing.
		Biological properties of topsoil and other subsoil/growth medium for vegetation	Evidence that nutrient accumulation and recycling processes are occurring by the presence and decomposition of a

Goal	Objective	Parameter/Indicator	Completion Criteria
			litter layer.
	Dams suitable for livestock and wildlife use	Animal presence/use of dams	Evidence of active use of dams by livestock
	Land use is established with comparable management requirements to similarly used un-mined land.	Achieves agreed stocking capacity/capability on agreed areas (potential for erosion/damage to slopes which may be fenced off).	Use of rehabilitated land meets specified yield.

7.4 Domain 4

Domain 4 is the conservation area, which has not been directly disturbed by mining activities. The zone will remain protected and conservation values enhanced or maintained, therefore completion criteria will only relate to sustainable land use. Table 7 outlines the goals, objectives, indicators and proposed completion criteria for Domain 4.

Table 7. Brolga completion criteria for enhancement/maintenance of Domain 4

Goal	Objective	Parameter/Indicator	Completion Criteria
Sustainable land use	Enhancement/maintenance of environmental values	Key species presence	Species presence and composition compared to reference area
		Absence of weed species	Successful control/eradication of class 2 weeds and Lantana
		Fauna presence	Evidence of active use of rehabilitated sites by native fauna (e.g. birds/nests, scats etc.)
		Absence of livestock	Evidence of secure fencing to exclude livestock

8. REHABILITATION MONITORING

Rehabilitation of the Brolga site is not due to commence until late 2015 when areas become available after mining. Therefore rehabilitation monitoring objectives and indicators are proposed below, however the monitoring program is to be finalised closer to the commencement of rehabilitation activities.

8.1 Objectives of monitoring program

Draft objectives for the rehabilitated grazing areas (Domains 1, 2 & 3) are focused on vegetation cover and composition, substrate quality and seedling success:

- To measure ground cover and suitable pasture yield;
- To assess the relative success of sown species by comparing seeding mixes with on-ground outcomes;
- To seek relation patterns between the successful establishment of sown species and the substrate and sowing conditions.

Draft objectives for the conservation area (Domain 4) are based on species richness and biodiversity relative to the local area:

- To measure the density and richness of overstory and understory woody species; and
- To assess the relative biodiversity value of the area.

8.2 Reference sites

To measure the success of rehabilitation within a relatively short timeframe, it is necessary to establish reference sites to compare to the rehabilitated areas. The references sites must fulfil the following criteria:

- Have not been impacted by mining activity;
- At least one site will be located outside the mining lease;
- Be in a similar ecological setting; and
- Be exposed to similar natural disturbances.

Three reference sites will be established for the areas to be rehabilitated to grazing land, and at least one reference site will be established for the conservation area. The references sites will be established prior to commencement of rehabilitation activities, and reference site monitoring will begin once the first rehabilitation works are commenced in 2015.

8.3 Rehabilitation indicators

Proposed indicators for grazing areas include:

- Species richness/composition;
- Vegetation cover
- Soil condition; and
- Erosion

Proposed indicators for the conservation area include:

- Species richness;
- Tree and shrub density; and
- Native fauna presence.

8.4 Monitoring program

Establishment of permanent transects in revegetation areas, conservation area and reference sites is recommended. Quadrants within the transects should be set at regular intervals to sample and record data including photographic evidence. Data sheets will be developed for recording observations and samples taken. Data collected at each transect will be statistically analysed for comparison with reference areas, and to test for impacts of various parameters on rehabilitation success.

9. POTENTIAL RISKS AND CONTINGENCY PLANNING

The potential impacts on the rehabilitated Brolga mine site may include:

- Erosion;
- Increased air emissions, in particular dust particulates;
- Potential land and water contamination;
- Changes to catchment hydrology;
- Changes to existing landform;
- Inadequate design for landform rehabilitation including voids and spoil; and
- Poor establishment of revegetated areas.

The potential impacts on post mine land use will result primarily from the removal of ore and subsequent creation of residual voids and spoil heaps. It is anticipated that the post mining capability of Brolga mine site will be similar to the pre-mining capability due to considerable landform shaping and terracing.

To deal with potential impacts a number of strategies have been adopted, these include:

- Decommissioning of mining related infrastructure with the exception of dams and roads that are to be used for agricultural purposes post mining;
- Landform design, where possible will emulate the natural drainage and slopes in the area;
- Landform morphology will be executed to determine an integrated final landform
- Contour banks where required will be constructed on re-contoured spoil to minimise erosion;
- Rehabilitation slopes will be graded in a manner to drain water from rain events to minimise erosion;
- Appropriate measures will be undertaken to dissipate energy of running water collected from banks during rainfall events;
- A final void plan will be undertaken prior to mine closure to determine safety to stock and persons;
- Ripping of topsoil in conjunction with seedlings will be done to minimise erosion;
- Revegetation will be surveyed and maintenance will be carried out on a as needs basis to meet success criteria;
- Rehabilitation will be carried out using seeds endemic to the area, if required tube stock may be used;
- A rehabilitation schedule will be both implemented and maintained;
- All mine related roads (apart from predetermined access roads to be retained post-mining) will be rehabilitated by removal of contaminated material (if any), ripping of compacted areas and topsoiling and seeding; and
- All mine traffic will be restricted to authorised access roads where possible.

10. COST BENEFIT ANALYSIS

The final landform design criteria have been based on rehabilitating the mine site to its former low density grazing land use. Alternatives to this final land use includes rehabilitate the entire site for conservation. A cost benefit analysis of the two final land use options clearly indicate that rehabilitating the land to grazing has greater economic potential.

The economic benefits from a return to low intensity grazing can be achieved by:

- Income generated from grazing cattle
- Reduced rehabilitation costs to re-establish pasture in an already established grazing landscape; rather than re-create the former serpentine woodland.

11. TRAINING

The Brolga and Yabulu Site inductions, and relevant TRACESS training modules provide the underpinning knowledge for this standard.

12. RECORDS

Records	Electronic Storage Location	Hard Copy Location	Retention Period (yrs)	Confidential Records
N/A				

The electronic version is current, or when printed and stamped with the green controlled document stamp.
All other copies are uncontrolled.

13. APPENDIXES

Appendix	Details
1	Brolga Mine Weed Management Plan

14. RELATED DOCUMENTS

Origin	Details
Queensland Nickel Yabulu	Brolga Pit Optimisation and Mine Planning Review (IMC, 2014).
	Brolga Mine Weed Control Requirements
	Emergency Response Plan QN-PLN-002
Queensland Government	EHP Guideline: Rehabilitation requirements for mining resource activities
Australia Government	

Brolga Project

Water Assessment, ML5866 (Brolga)

Waratah Coal

WC-BrP-RT001, Rev 0

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Terms and Abbreviations

As	Arsenic
Cr	chromium
EA	Environmental Authority
mAHD	metres Australian Height Datum
ML	Mining Lease
Water EPP	Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (Qld)

1 Introduction

The Brolga Project is a mining project comprising two mining leases (MLs) - ML5866 (Brolga) and ML5864 (Canoona), both of which are currently in 'Care and Maintenance' as a result of the suspension of nickel refining at the Yabulu Nickel Refinery in Townsville, Queensland. ML5866 Brolga was actively mined prior to the suspension of mining in 2016. ML5864 Canoona has been explored and drilled but no extraction of ore has occurred.

Both MLs are held by QNI Resources Pty Ltd (80%) and QNI Metals Pty Ltd (20%) (collectively referred to as QNI) under Environmental Authority (EA) EPML01624913.

This water assessment has been undertaken to understand the nature of surface and groundwater on the ML5866 Brolga ML remaining during rehabilitation, and following closure and handover, to assist in determining the requirements for rehabilitation of the site. To this end, this report:

- Provides a brief description of the historic mining operations
- Identifies the key topographical, geological and hydrological/hydrogeological characteristics of the site
- Assesses the available surface and groundwater quality data, and
- Summarises the key risks, constraints and opportunities in relation to rehabilitation and water resources on the site.

2 Background

2.1 Project Description

The Brolga ML was mined originally in 1993 – 1995 (under a different tenement holder), although there are limited records remaining from that time. In June 2012, QNI commenced mining, using a simple open-cut mine operation where 4 – 6 metres of red-brown lateritic overburden was removed to expose the pale-coloured saprolitic ore beneath it. Blasting was not used as excavators were capable of digging the ground to the depths required.

Weathering of the country rock is quite deep, and only weathered rock was excavated in the mining process. The nickel is contained within nickel-oxides and nickel-bearing silicates (smectite clays) that form a proportion of the pale-coloured saprolitic rock found beneath the red-brown surface lateritic layer. The parent rock of the laterite is called serpentinite, which is a rock considered to have once been a peridotite (an igneous rock similar in composition to a basalt) but which has undergone some degree of metamorphism.

Following removal of the laterite overburden, pits were progressively mined and back-filled. The ore was screened on-site to remove large rocks. The remainder was trucked to a nearby rail-siding and railed to the Yabulu Nickel Refinery.

2.2 Topography and Geology

The Brolga mining lease is situated on a low hill surrounded by flat grazing land comprising Quaternary alluvial sediments, with the hill being a lateritised remnant of serpentinite on the south-eastern periphery of the Princhester Serpentinite (Map Code Td>PLPzx, Figure 2-1). Elevations range from about 70mAHD within the ML, declining to about 20mAHD on the surrounding plains. The overall regional topography is flat and grades gradually east to Alligator Creek.

The Pointer range is located 2km west of the Brolga ML, also part of the Princhester Serpentinite.

Drilling for the construction of water bores identified four key zones within the profile through the deposit (from the top of the hill at QNWB4) (refer Figure 2-2):

- Surface weathered zone, comprising ferricrete, clays and laterite (down to ~13m depth)
- Saprolite – weathered bedrock - down to 26m
- An igneous, competent, low permeability gabbro from 26m to 56m, underlain by
- A mafic intrusive igneous basement rock.

The description of the profile for Bore 1 (RN161522) on the western side of the mine also finds a similar profile (refer Appendix C), although the bore only extended to 21.5m, and only encountered the laterite and saprolite layers. Historical bore logs (refer Appendix C) broadly confirm the above profile.

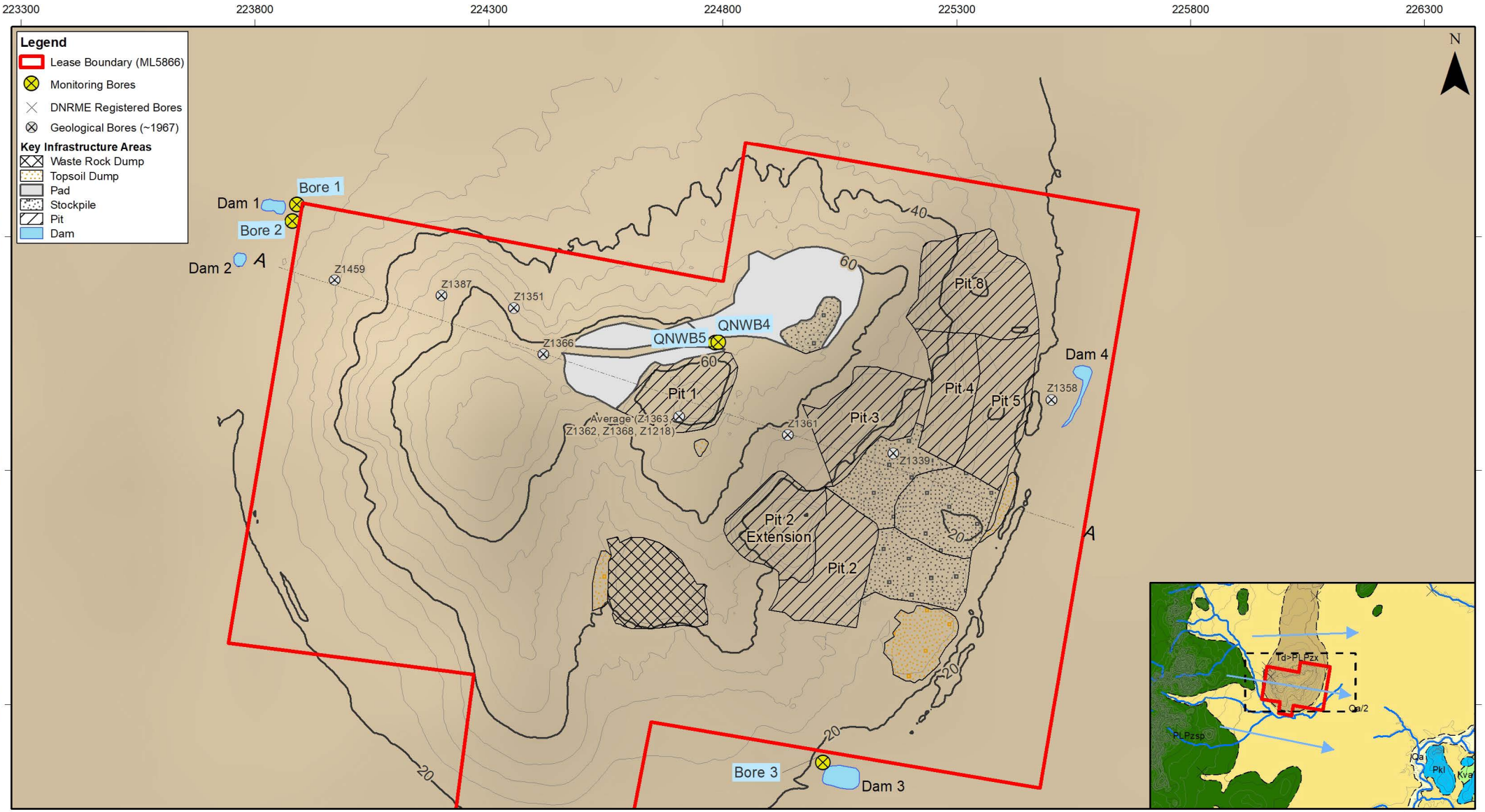


Figure 2-1. Topography, Geology and Groundwater

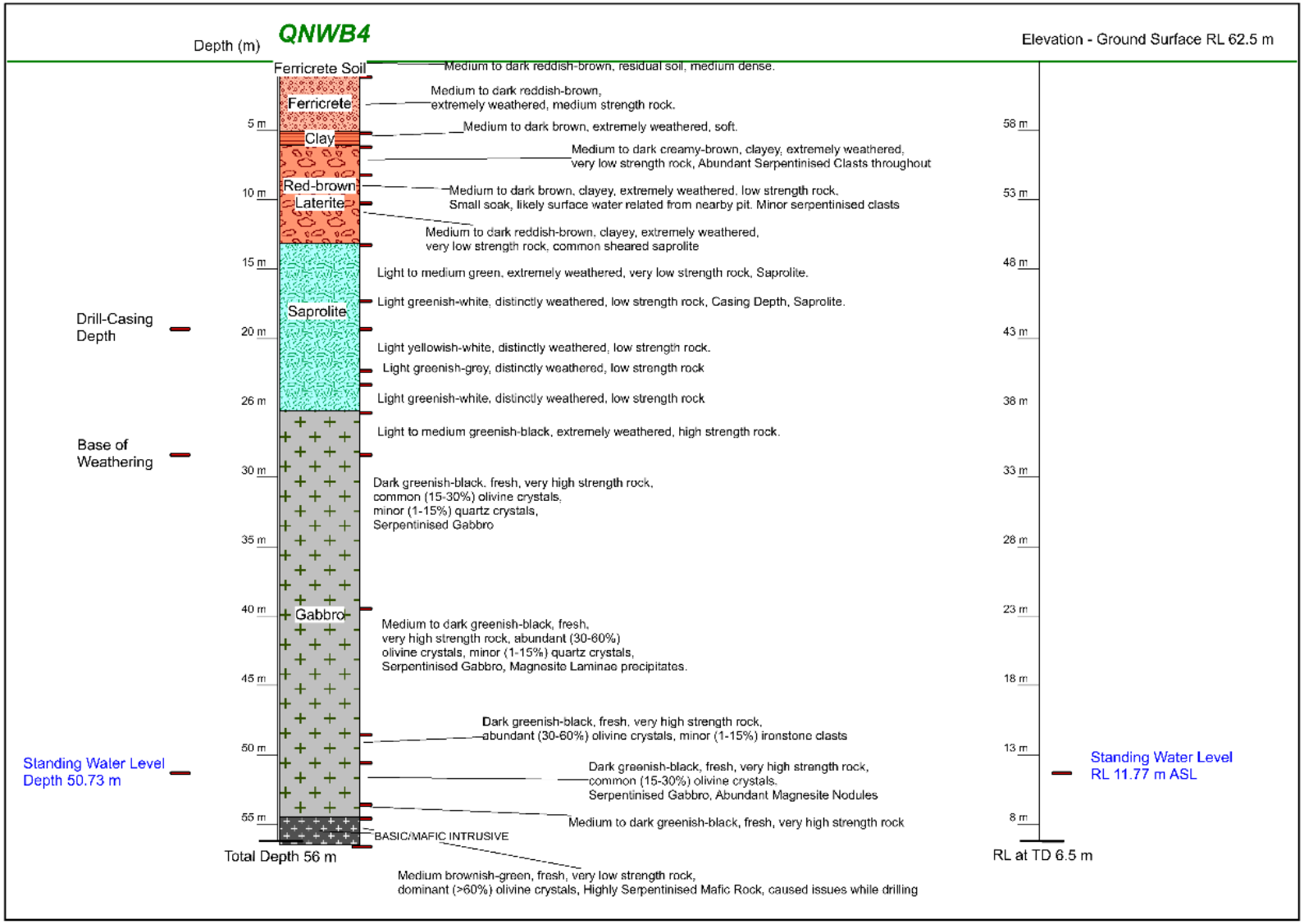


Figure 2-2. Geologic log of QNWB4 bore

2.3 Surface Waters

The site is located within the Fitzroy River sub-basin (eastern tributaries), within an area scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (Water (EPP)) (EHP, 2013). Being a relatively isolated elevated feature in the landscape, runoff is generally directed radially out from the elevated portions of the ML, and further directed by contour banks into farm and other mine dams. Site flows ultimately join drainage coming from the Pointer range to the west, and flow east (on the south side of the ML) towards the coast. Due to these contour banks and impoundments, no continuous watercourse is identified from the ML to Alligator Creek to the east.

The site has four water dams (Dams 1 – 4), of which Dam 4 is the only one located within the ML. Anecdotally, the only open pit to hold water is Pit 1, which is confirmed by satellite imagery over the past several years. Catchment areas shown in Figure 2-3 show that only Dam 4 has significant disturbed areas in its catchment. Dam 3 has relatively minor cleared areas, while the other 2 dams are largely vegetated. Water quality for the dams and Pit 1 are described further in Section 3.

2.4 Groundwater

The site is located within the Prospect-Fitzroy groundwater zone (scheduled under the Water (EPP) – EHP, 2013). However, newer draft groundwater chemistry zones have been developed (McNeil *et al*, 2018), which maps the site occurring over three groundwater systems:

- Fitzroy Serpentinite Belt Alluvium
- Eastern Weathered Cainozoic Remnants, and
- Serpentinite Belt Fractured Rock.

The site has four groundwater bores installed, with two in operation for some time (Bore 1 and 2), and two more (QNWB4 and 5) installed in December 2021 as part of this investigation (refer Appendix C for bore logs / installation notes). Groundwater was encountered in Bore 1 (west side of the deposit) and QNWB4 (near Pit 1, central to the deposit) at around the same level – approximately 14mAHD – but with a slight (~0.4%) grade to the east. The second new bore (QNWB5) was situated in the upper laterite above Pit 1, and no water was identified. Groundwater was identified within the saprolite zone in Bore 1, and within the igneous rock within the deposit - both fractured rock systems. Another bore (Bore 3), located adjacent to Dam 3, located groundwater at ~10mAHD, and historical logs from 1967 (refer Appendix C) identified a similar level, confirming groundwater as lying underneath the overall hill structure at around the same level.

Two ‘damp’ zones encountered in the QNWB4 and QNWB5 bores indicate potential short term impediments to downward movement – one within the clayey material in the upper layers, and the other at the top of the igneous rock / base of the saprolite. This indicates permeability is minimal and/or water has flowed away from this area relatively quickly. Discussions with QNI indicate that exploration drill holes and excavations at the mine site have not revealed any groundwater systems, and the saprolitic rock is described as largely impervious, due mainly to the silica cementation that is prolific within it. However, water has been described draining from the upper laterite layers in some exposed areas, appearing to be rainfall derived interflow.

Based on the geology and water levels encountered, a simplified conceptual model has been developed, as shown in Figure 2-4 (note that the underlying geology and flow patterns are simplified, and so absolute depths and thicknesses are estimates only).

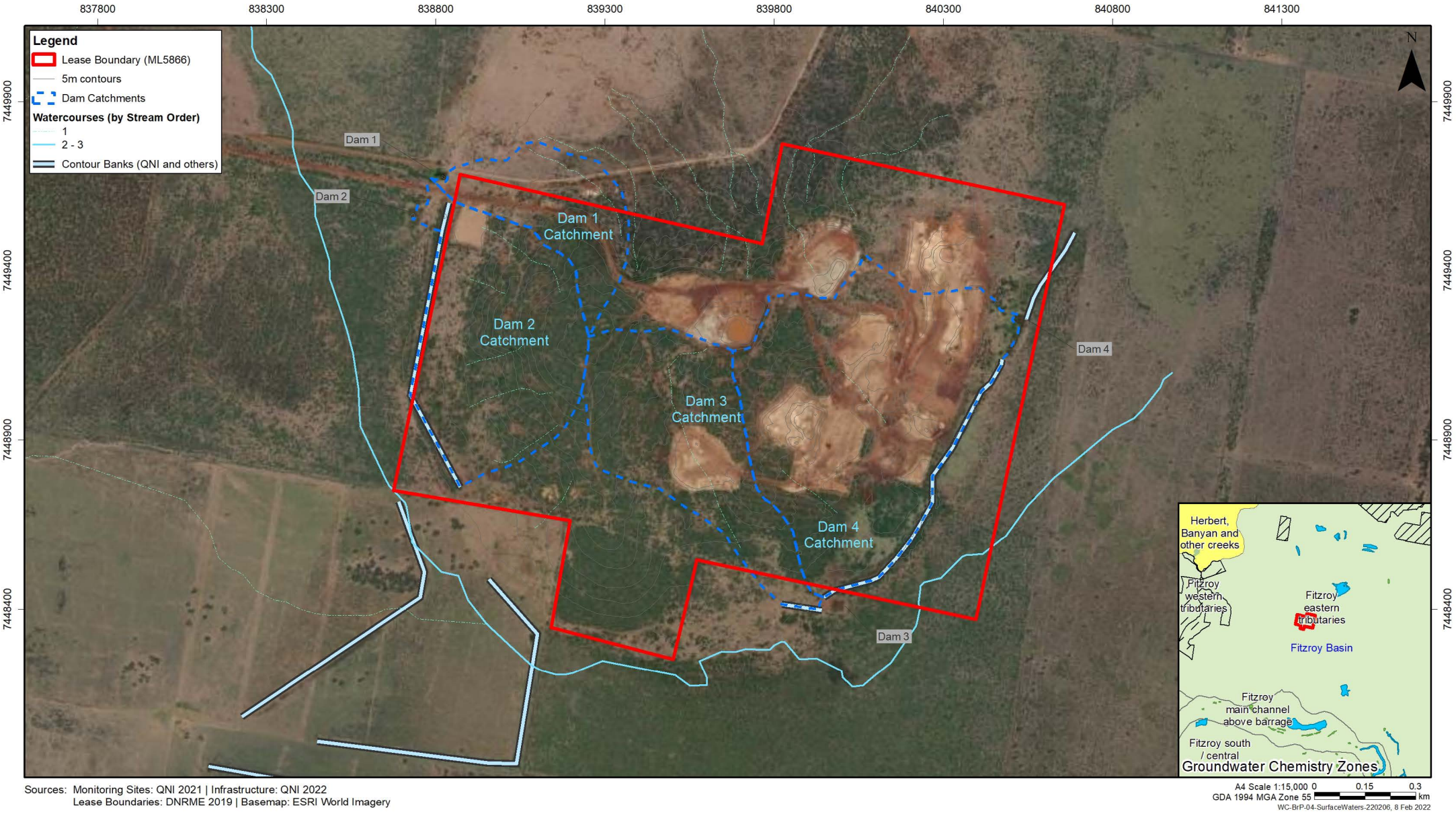


Figure 2-3. Surface waters on the Project site

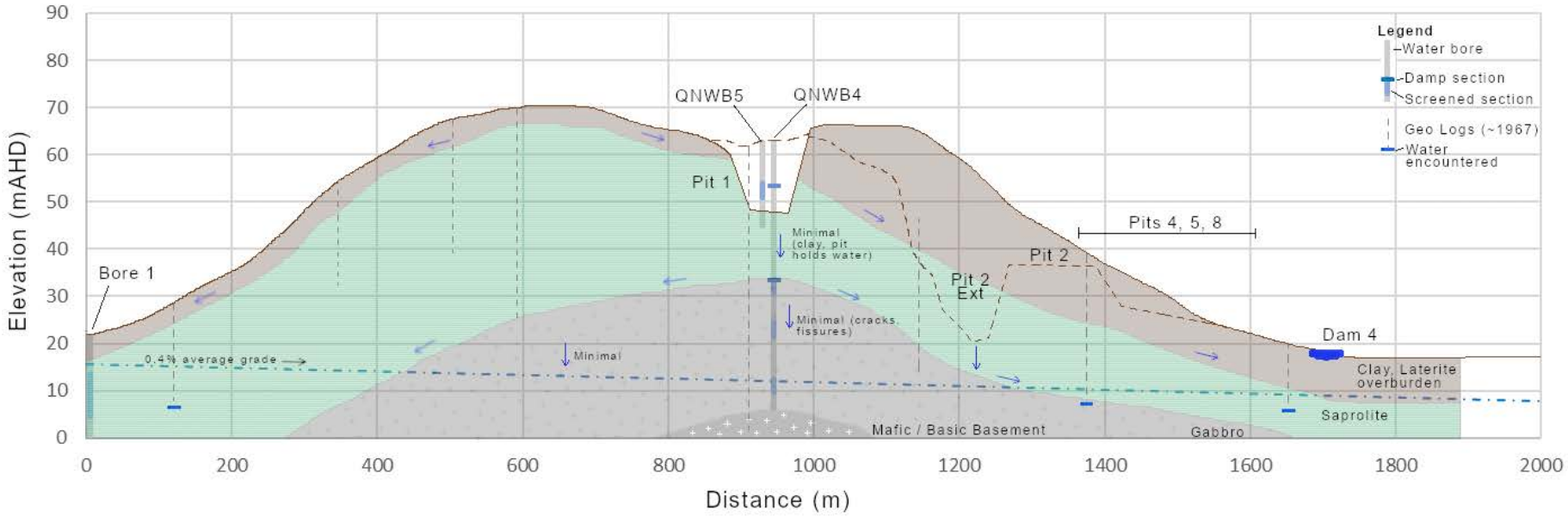


Figure 2-4. Simplified groundwater conceptual model (refer section A-A in Figure 2-1)

Groundwater is not expected to recharge to any surface water features either on or off-site. Rainfall falling on the laterite areas is likely to either drain away as surface drainage or soak in, to drain laterally towards the Quaternary alluvial plains. Where pits intercept this layer, this interflow may end up in open Pits. Since Pit 1 holds water (more or less permanently), while the others do not, it is considered likely there is some leakage from pits into the underlying structures where cracks and fissures exist. However, the evidence suggests this would also flow laterally at boundaries to lower permeability rock, and downward recharge is likely to be at best very slow.

As noted in Section 2.3, the regional topography grades gently to the east from the ranges located west of the Project, and so groundwater will also regionally flow east (refer Figure 2-1). Based on the groundwater systems identified above, and the geological makeup of the site, incident rainfall would be expected to permeate into the upper clay and laterite layers, but to be impeded in the downward direction, other than through cracks and fissures. Groundwater might then be expected to flow laterally along boundaries to more impervious zones towards the alluvial plains – this is supported by the identified damp zones at the peak elevation of the site. Local movement of permeated rainfall would occur within the upper laterite layers, with likely short term flow into open pits, although the laterite is described as acting like a sponge to soak up incident rainfall (within the structure rather than as groundwater lenses).

In a similar manner to surface water (refer Section 2.3), groundwater would be expected to generally flow radially outwards from the centre of the site towards the surrounding alluvial plains, other than where it permeates through cracks and fissures in the rock. No aquifers are identified above the lower levels of the site (around 14mAHD), indicating that much of the permeated groundwater would likely remain above the saprolite and make its way outwards to the alluvial plains around the site. Pit 1 holds water, likely due to clay impedance in its base, and/or inflow of permeated rainfall through the laterite layers. Conversely, other pits on the site do not hold water, indicating limited inflow of permeated water, and/or enhanced leakage into surrounding fractured rock systems.

No groundwater dependent ecosystems nor active or inactive spring systems are mapped in the vicinity of the site (Queensland Government Wetland Maps 2.0, accessed 8 February 2022[1]).

[1] https://wetlandinfo.des.qld.gov.au/wetlandmaps/?extent=135.393,-30.511,155.607,-8.739

3 Water Quality Assessment

3.1 Overview

Water quality monitoring is required under the EA for surface and groundwaters – namely for pH, salinity, cations, sulfate and bicarbonate (and also fluoride, arsenic, cadmium, cobalt and nickel for surface waters) – with data available from 2013 onwards. An additional two groundwater bores have been installed adjacent to Pit 1 on top of the deposit, and an additional two rounds of monitoring were conducted for the purpose of this assessment – one in December 2021 and the other in January 2022. This included an expanded range of analytes, including a total and dissolved metals scan, nutrients and hydrocarbons.

Historical data is provided in Appendix B to this report. A summary of the key data is tabulated in Appendix A, compared against livestock drinking water and the irrigation short and long term trigger values from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3 - Primary Industries (ANZECC & ARMCANZ 2000). In addition, the 80th (and where relevant 20th) percentile triggers from McNeil *et al* (2018) (for groundwater) and EHP (2013) (for surface water) are included for comparison, along with the Australian Drinking Water Guidelines (NHMRC & NRMMC 2021) where relevant.

3.2 Water Quality Results

In general, dam waters and Pit 1 were relatively fresh, with a neutral range of pH. Bore waters were a little more brackish (740 – 2200 mg/L total dissolved solids), and both surface and groundwaters had a similar makeup, dominated by bicarbonate, magnesium and sodium. Nitrogen and ammonia were elevated in dams, when compared to off-site surface receiving water criteria, although similar levels were found in groundwaters.

Bore waters in the centre of the site (bore QNWB4) were elevated in iron, manganese and zinc, with manganese being elevated in Bore 1, compared to the draft Water Quality Objectives (McNeil et al, 2018). In addition, elevated aluminium, chromium, cobalt and nickel were found at various surface and groundwater sites when compared to the other guideline/trigger values. Dissolved metal levels dropped significantly, indicating as anticipated that the bulk of the metals are bound to sediments in the waters.

All hydrocarbon results were non-detect, with the exception of a trace level detection at QNWB4 – this is likely to be either a residual of drilling, or otherwise unrelated to site operations, based on the depth of the bore / water table.

A comparison to the livestock, irrigation, drinking water and environmental (aquatic ecosystem protection and draft groundwater water quality objectives) is provided in Appendix A, and summarised below.

3.2.1 Livestock Watering

Exceedances of the relevant trigger values for livestock drinking water were identified for:

- Pit 1:
  - Aluminium (marginal), nickel
- Groundwater bore QNWB4:
  - Aluminium (marginal), chromium (marginal), nickel.

Less frequent exceedances also occurred for chromium in Dam 3 and 4, and nickel in Dam 4.

Elevated aluminium requires that the diet contains sufficient phosphorous to compensate for the effects of aluminium, and so this is not considered a strong limitation. Chromium, while marginally elevated, may not cause harm at these levels, although additional animal feeding trial information is required to confirm (ANZECC & ARMCANZ, 2000). Nickel, however, may potentially preclude Pit 1 and bore QNWB4 water use for livestock.

However, when the dissolved fractions are considered, no exceedances for livestock watering triggers were found. This means that the bulk of the metals in the water are bound into suspended sediments, and that settlement (and flocculation if required) of this water would render it suitable for livestock watering.

3.2.2 Irrigation Water Use

Chloride levels were elevated, and within the range identified as potentially problematic for short term (groundwater) and long term (Dam 1) irrigation. Total metals concentrations were above short term triggers for chromium (QNWB4 bore), cobalt, iron and nickel (Pit 1, QNWB4 bore), with long term triggers also exceeded for aluminium (Pit 1 and QNWB4), chromium (Dams 3, 4, Pit 1), iron (Dams 1- 4), manganese (Pit 1 and QNWB4) and nickel (Dam 3). Less frequent exceedances also occurred for chromium (Dams 1, 2, Bore 2), cobalt (Dams 3, 4), manganese (Dams 1 – 4, Bores 1, 2) and nickel (Dams 1, 2 and 4).

When the dissolved fractions are considered, there were no short term and only two long term trigger values exceeded – manganese and nickel at the QNWB4 bore.

Each of these metals is considered as follows:

- Chromium criteria are related to the chromium (VI) species, and investigations undertaken by QNI indicate that Cr (VI) only makes up <5% of the total (Cr III + VI)[2]. As such, chromium exceedances noted above are based on total amounts and would not equate to actual exceedances.
- Cobalt is only marginally exceeded, and only at Pit 1 and QNWB4. As such, cobalt is not anticipated to be an issue for irrigation, and can be reduced by some settlement of solids from these waters.
- For iron, the short term triggers relate to some reports of reduced plant growth, while long term triggers relate to the dissolved fraction in irrigation waters (ANZECC & ARMCANZ, 2000), which were all low. Only Pit 1 and QNWB4 had levels elevated above the short term triggers, which could be alleviated if needed by settlement of solids before use.
- Nickel levels are elevated, as would be expected for waters associated with the local geology, but regarding irrigation water use, only the Pit 1 and QNWB4 waters were above the short term triggers, and settlement and removal of suspended solids in these waters would reduce total metals loads low enough to have minimal impacts. The long term trigger was only marginally exceeded at Dam 3, and not at the other sites. As such and regarding nickel concentrations, it is likely that site waters would either be suitable for irrigation, or suitable following some settlement to reduce concentrations – namely in Pit 1 and QNWB4 waters.

[2] Up to 50% in Dam 1, however levels were lower and below trigger values

- Aluminium levels at Pit 1 and QNWB4 were only marginally above the long term trigger values. Phytotoxicity appears related to acid reactions in soils (ANZECC & ARMCANZ, 2000) and soil pH is not acidic. As such, issues related to aluminium are not considered likely to occur.
- The manganese exceedances (Pit 1 and QNWB4) both relate to the long term trigger value, which is relevant to dissolved manganese in irrigation waters, and protection from damage to irrigation infrastructure from clogging. Dissolved manganese was below the trigger values for Pit 1, but remained above for QNWB4, and these waters may be problematic depending on the irrigation method used.

As such, while some exceedances of the irrigation trigger values were identified, overall the site waters are considered moderately suitable for irrigation, with bore waters suited for moderately tolerant plants. Some waters (Pit 1, QNWB4) may require reduction in solids in the water, such as through settlement and/or flocculation, and some (QNWB4) may cause issues with clogging of irrigation equipment.

3.2.3 Drinking Water

The relevant criteria from the Australian Drinking Water Guidelines (NHMRC & NRMMC 2021) were compared to the data in Appendix A, finding that the waters exceeded chloride and total dissolved solids criteria and metals, with some metals exceedances still remaining in the dissolved fraction. This confirms that while the water may be suitable for livestock or irrigation water use (refer above comments), it would not be considered suitable for potable use. Consideration of metals and ionic composition of the water indicates that precipitation and scaling may be a problem with bore waters (as also identified by McNeil et al 2018).

3.2.4 Environmental Water

The site is located in the Fitzroy River Sub-basin fresh waters Comparison of the data against the EHP (2013) water quality objectives (WQOs) and the draft WQOs prepared by McNeil et al (2018) was undertaken, with the total metals considered for groundwater, and dissolved for stormwater. As recommended by ANZG (2018), the 95%ile for metals and metalloids was considered.

In selecting toxicant default guideline values to compare against, ordinarily the 95% (and 99% for analytes with the potential to bioaccumulate) is utilised for slightly-moderately disturbed systems, which may be suitable for Alligator Creek and the like further to the east. However, since the site discharges into local farm and mine dams, and any further discharge appears to terminate in local contoured channels and agricultural areas, a lower species protection level appropriate to more highly disturbed systems (80 – 90%) may be appropriate[3]. As such, the data are compared to the 95% (and 99% where appropriate) species protection levels for slightly-moderately disturbed systems, and comments made further below regarding how they relate to the 80-90% species protection level.

The assessment provided in Appendix A found:

- Dam 1: electrical conductivity was elevated compared to baseflow objectives for receiving waters (1300 VS 445µS/cm)

[3] Refer ANZG (2018), https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants#retrieval-of-default-guideline-values-for-fresh-and-marine-water; https://www.waterquality.gov.au/anz-guidelines/resources/key-concepts/level-of-protection#slightly-to-moderately-disturbed-systems

- Bores 1 and 2 (magnesium, 299, 300 vs 205mg/L) and Bore 2 (bicarbonate alkalinity, 758 vs 741mg/L) were a little elevated
- Ammonia (0.058 – 0.070 vs <0.020mg/L) and total nitrogen (0.7 – 1.1 vs <0.50mg/L) were elevated in Dams 1 – 4, and total phosphorous a little elevated in Dam 4 (0.06 vs <0.05mg/L)
- Total nitrogen was elevated in Bore 2 (4.2 vs 1.772mg/L)
- Groundwater total metals – elevated iron (0.05 – 69.7 vs 0.02mg/L) and manganese (0.23 – 3.05 vs 0.04mg/L), plus copper (0.042 vs 0.03mg/L) and zinc (0.209 vs 0.100mg/L) at QNWB4
- Surface water dissolved metals – elevated arsenic[4] (Dams 1, 2, 4), chromium (all sites), cobalt (dams), copper (Dam 3) and nickel (all sites other than Dam 1).

Regarding the surface water exceedances, reference to Duivenvoorden et al (2017) indicates a naturally high hardness and elevated metals for Marlborough Creek, located in the local area and draining similar geology. When hardness modified trigger values from ANZG (2018) are applied based on hardness in Marlborough Creek (~600mg/L), only arsenic, chromium and cobalt remain as exceedances (plus one marginal nickel result at Dam 2). Duivenvoorden et al (2017) found elevated cobalt at 0.01 – 0.02mg/L in creek waters which is above the levels identified in Appendix A, and arsenic is close to the limit for both species (AsIII, AsV), indicating it may not actually be in exceedance, or only marginally.

When compared to a lower species protection level (80 – 90%):

- no exceedances for arsenic or copper were identified, and
- no nickel exceedance for Dam 4 (only Dams 2, 3 and Pit 1).

[4] Although speciation may indicate that AsIII and AsV do not exceed the relevant default guideline values

4 Conclusions and Key Findings

Overall, the water quality is substantially influenced by the natural geology of the site, with groundwater moderately saline, and surface waters generally fresh. Both surface and groundwaters were dominated by bicarbonate, magnesium and sodium ions, with a neutral pH range, and nitrogen and ammonia were elevated. Metals concentrations reflect the ore body, being enriched in nickel (see for example relationship to serpentine rocks, ANZECC & ARMCANZ, 2000), and the associated metals chromium, cobalt and manganese, as well as iron and aluminium. Other studies in the area have found similar associations, with Duivenvoorden et al (2017) identifying elevated nickel, chromium, cobalt and zinc in stream sediments of the Marlborough Creek system.

In general, water for potable or other farm uses may not be ideal, based on salinity, metals concentrations and also the potential for precipitates to be deposited over time with some scaling. The waters all appeared generally suitable for livestock watering, with the exception of nickel in Pit 1 and bore QNWB4, which can be remedied by settlement of solids to remove the bulk of the total metal load. Waters were also moderately suitable for irrigation, although groundwaters would be confined to moderately tolerant crop types (i.e. the pasture grasses and vegetation proposed for rehabilitation works), and waters may require settlement to reduce metals concentrations, with some potential for clogging of irrigation equipment for some waters due to iron and manganese (QNWB4, Pit 1).

Groundwater was generally within the draft WQOs (McNeil et al, 2018), and given the minerology of the area, it is considered likely that groundwater would be naturally affected by the ore deposit (itself formed by dissolution and precipitation reactions within groundwater and geological structures) rather than mining activities.

Exceedances against the WQOs for slightly to moderately disturbed systems (EHP, 2013) were identified for site dams and Pit 1 water for a number of analytes, including ammonia and total nitrogen, and dissolved metals (arsenic, chromium, cobalt and nickel), although metals exceedances are substantially reduced when receiving water conditions (hardness and background metals concentrations) and the nature of receiving catchments are taken into account. Looking at the surface water structures, dams 3 and 4 and Pit 1 generally have the higher total metals loads. Reference to Figure 2-3 shows that Pit 1 followed by Dam 4 then Dam 3 have the highest disturbed areas of the four dams. Given that the bulk of the metals are bound to sediments in the water column (i.e. dissolved << total metals), it is considered very likely that stabilisation and sealing of the catchments would reduce inflow of solids, reducing the overall metals contents in these locations to those more alike to Dams 1 and 2. It is also likely that any overflows during high rainfall periods would reduce concentrations to negligible levels, consistent with the surrounding highly mineralised catchment.

Based on the above, and with appropriate rehabilitation measures and monitoring, surface waters proposed to remain after rehabilitation would be suitable to support the intended post mining land use of grazing. Groundwaters appear consistent with regional levels, and local enrichment appears consistent with the serpentinite geology of the area. As no groundwater is intercepted and water tables are deep, ongoing management of groundwater during and post rehabilitation is not anticipated to be needed.

5 References

AMEC (2022). Hydrogeological Assessment of the Brolga Project, QNI Resources Pty Ltd. Australian Mining Engineering Consultants, February 2022.

ANZECC & ARMCANZ (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3 Primary Industries - Rationale and Background Information (Irrigation and general water uses, stock drinking water, aquaculture and human consumers of aquatic foods). Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, October 2000.

ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.

Duivenvoorden, L.J., Roberts, D.T., Tucker, G.M. (2017). Serpentine geology links to water quality and heavy metals in sediments of a stream system in central Queensland, Australia. Environmental Earth Sciences, Vol. 76, Issue 8, pp1-14

EHP (2013). Environmental Protection (Water) Policy 2009 Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Fitzroy River Sub-basin. Environmental Policy and Planning, Department of Environment and Heritage Protection. September 2011, republished in July 2013.

INSEL (1968). Lateritic Nickel Investigations in Authority to Prospect No. 294M for the Year 1967. International Nickel Southern Exploration Limited. Accessed GSQ Open Data Portal (ID CR002506), Queensland Department of Natural Resources Mines and Energy, 6 February 2022, https://geoscience.data.qld.gov.au/report/cr002506

McNeil, V.H., Thames, D., Vaca, F., Bennett, L. & McGregor, G.B. (2018). Regional groundwater chemistry zones: Fitzroy-Capricorn-Curtis Coast and Burdekin-Haughton-Don regions: Summary and results. Draft for consultation. Water Planning Ecology: Department of Environment and Science, Queensland Government.

NHMRC & NRMMC (2021). Australian Drinking Water Guidelines 6, 2011, National Water Quality Management Strategy. Version 3.6 Updated March 2021, National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

Appendix A

Water Quality Summary

A1 – Key Parameter Boxplots

Note:

- Boxplots show 20th to 80th percentiles in the box, and the median (central line), plus min/max in the outer lines
- The blue numbers represent the number of results
- Criteria are shown as lines with annotation.

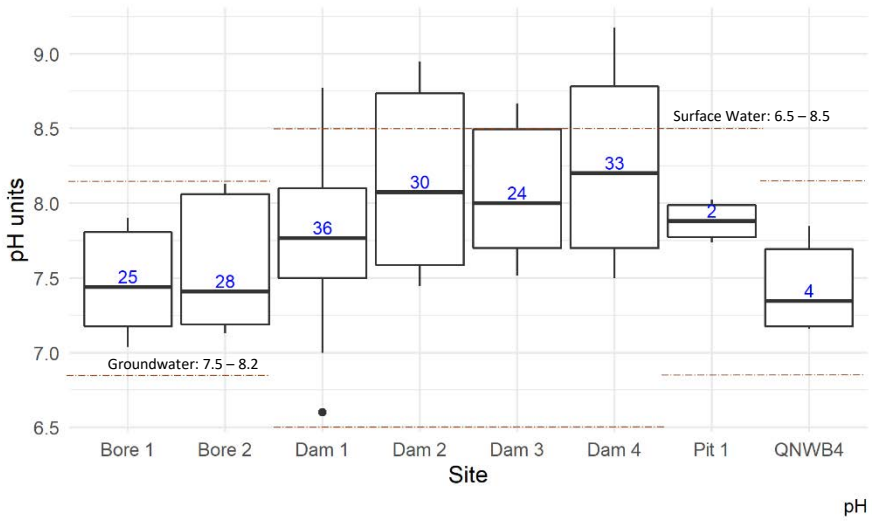


Figure A1. Boxplot of pH

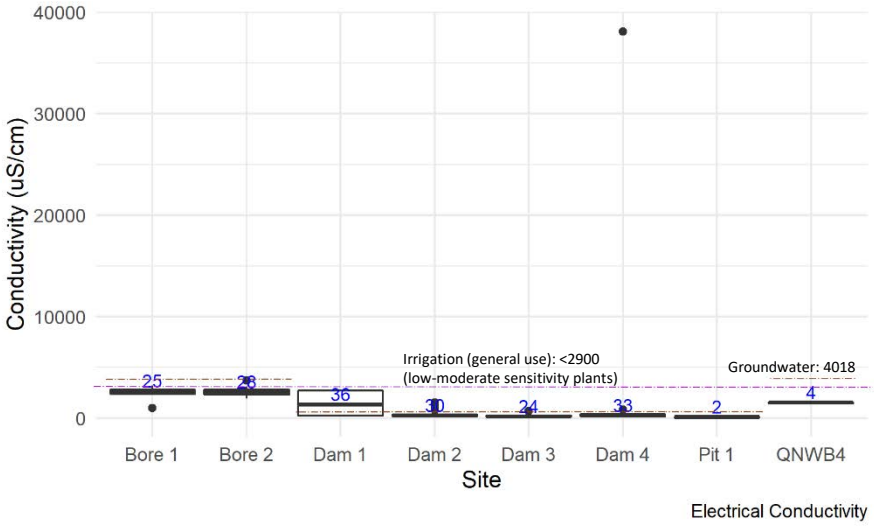


Figure A2. Boxplot of electrical conductivity

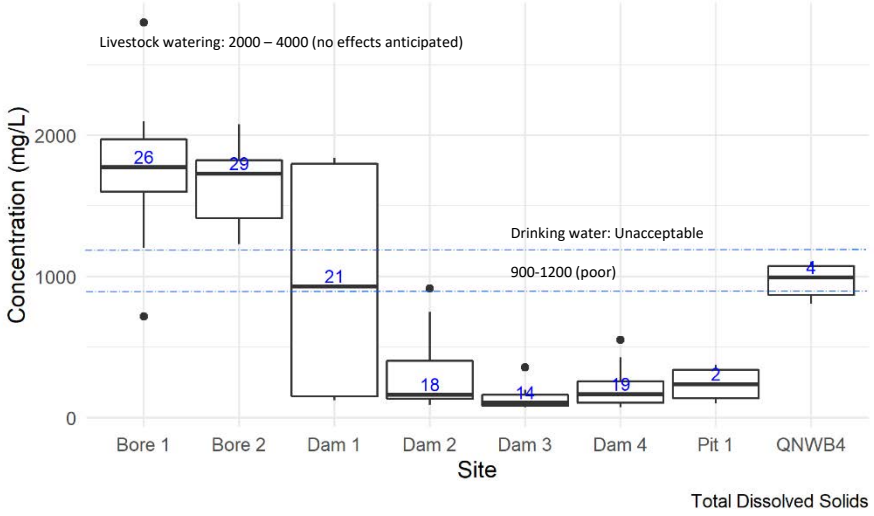


Figure A3. Boxplot of total dissolved solids

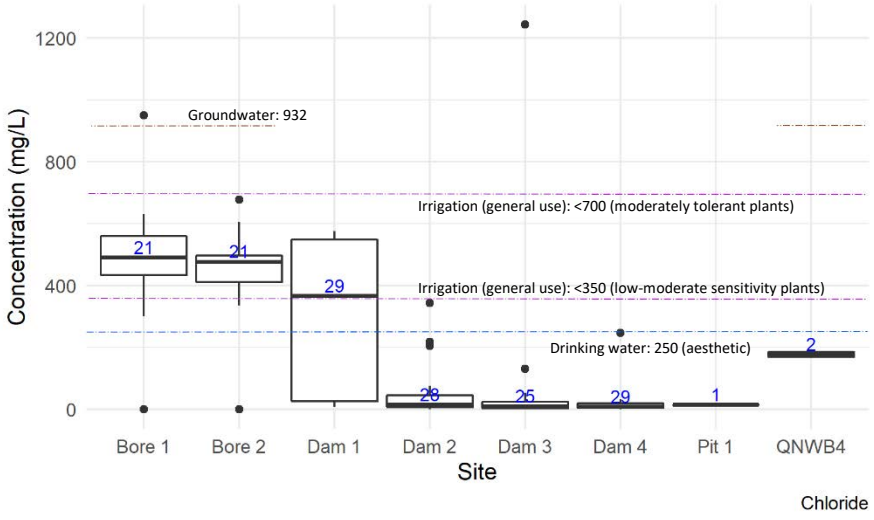


Figure A4. Boxplot of chloride

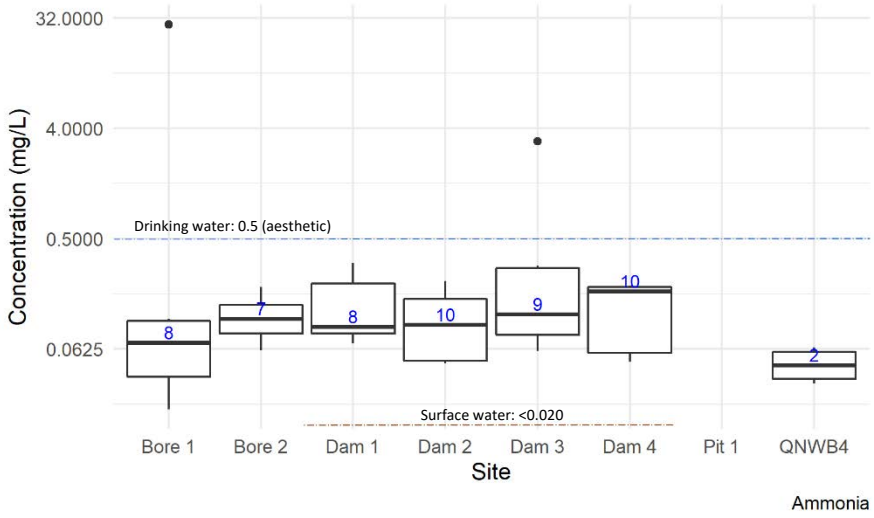


Figure A5. Boxplot of ammonia

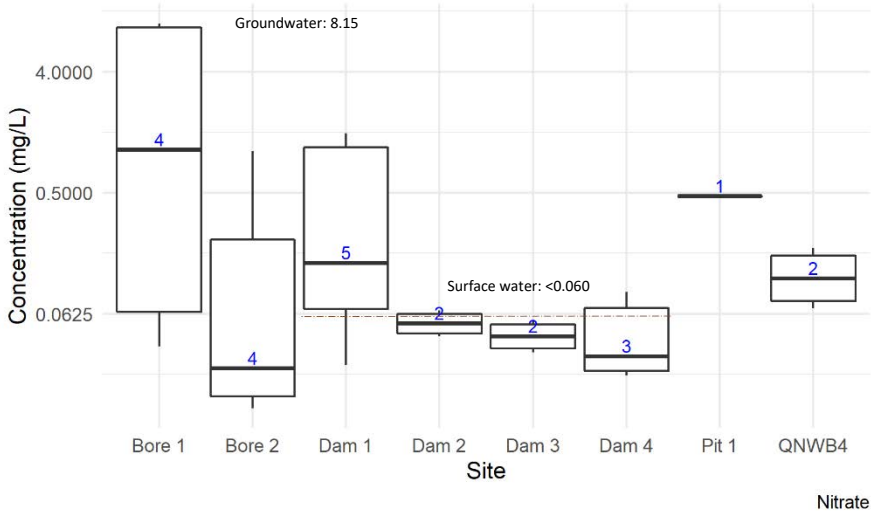


Figure A6. Boxplot of nitrate

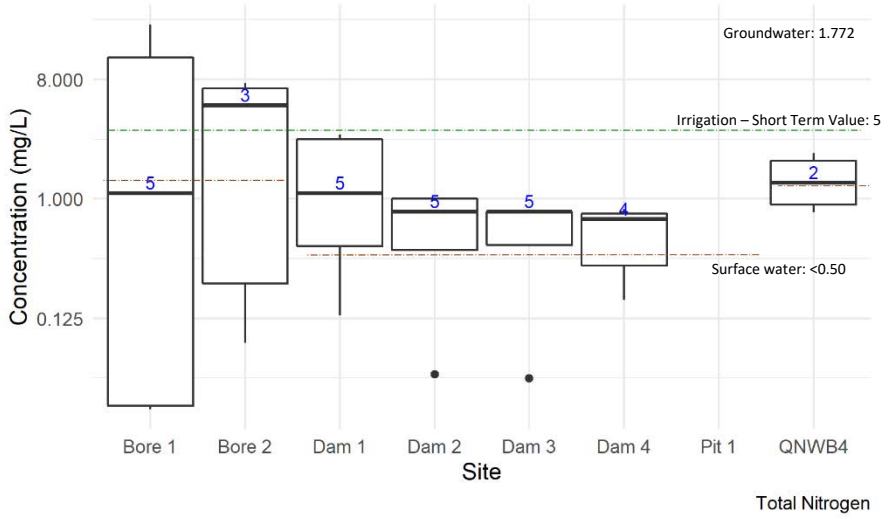


Figure A7. Boxplot of total nitrogen

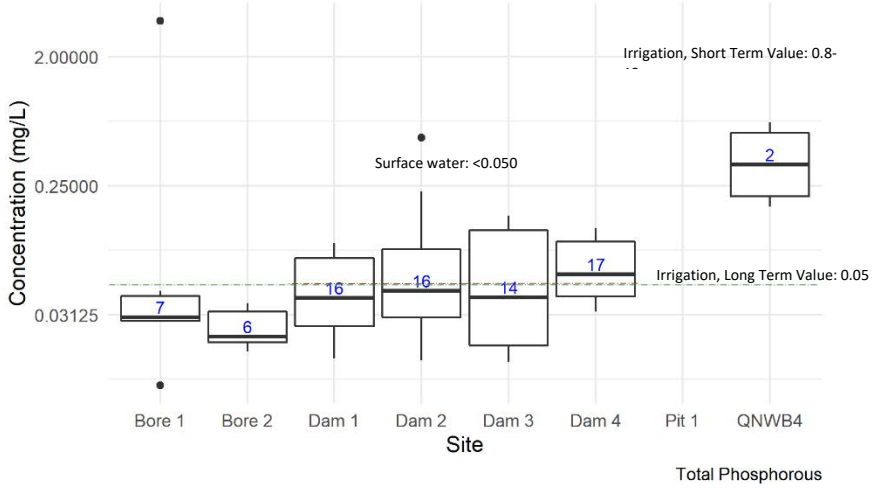


Figure A8. Boxplot of total phosphorous

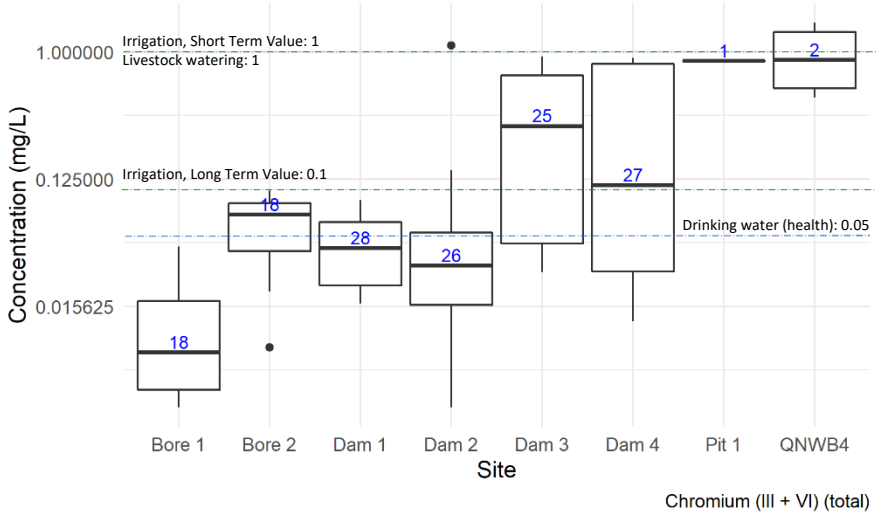


Figure A9. Boxplot of chromium (total)

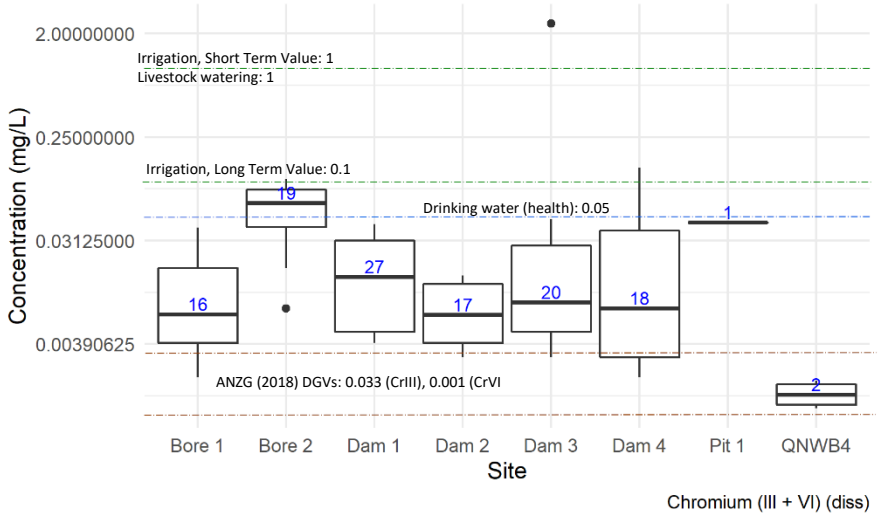


Figure A10. Boxplot of chromium (dissolved)

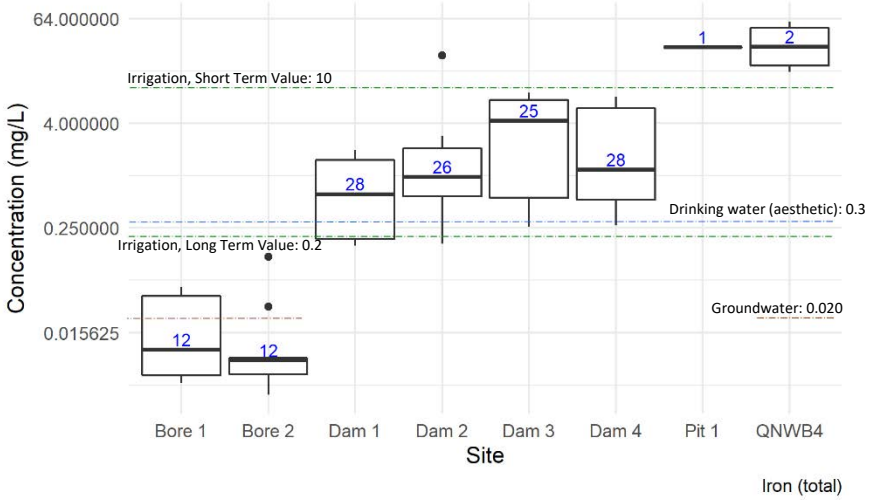


Figure A11. Boxplot of iron (total)

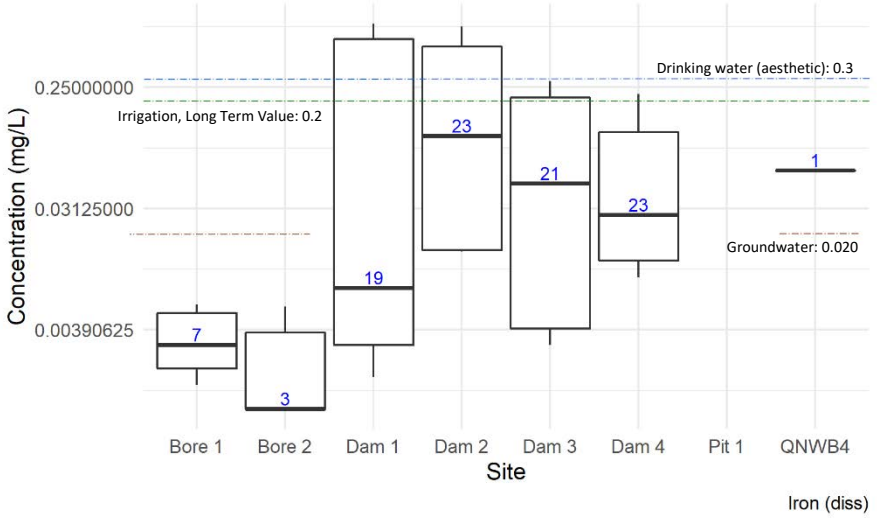


Figure A12. Boxplot of iron (dissolved)

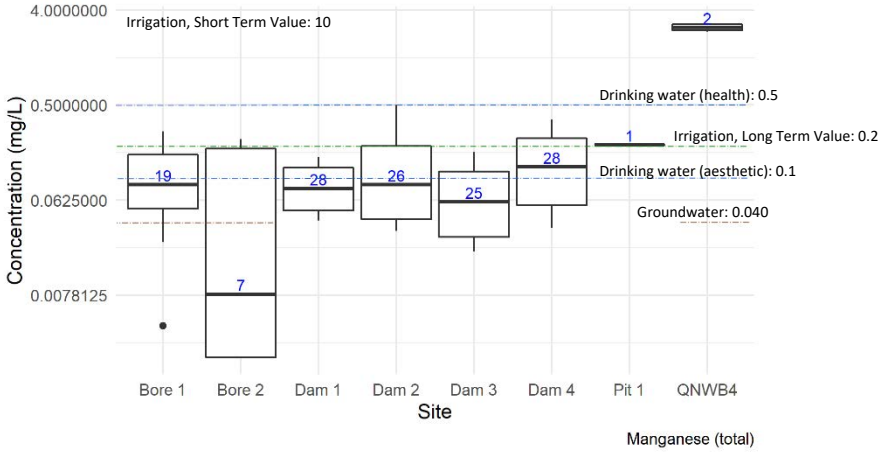


Figure A13. Boxplot of manganese (total)

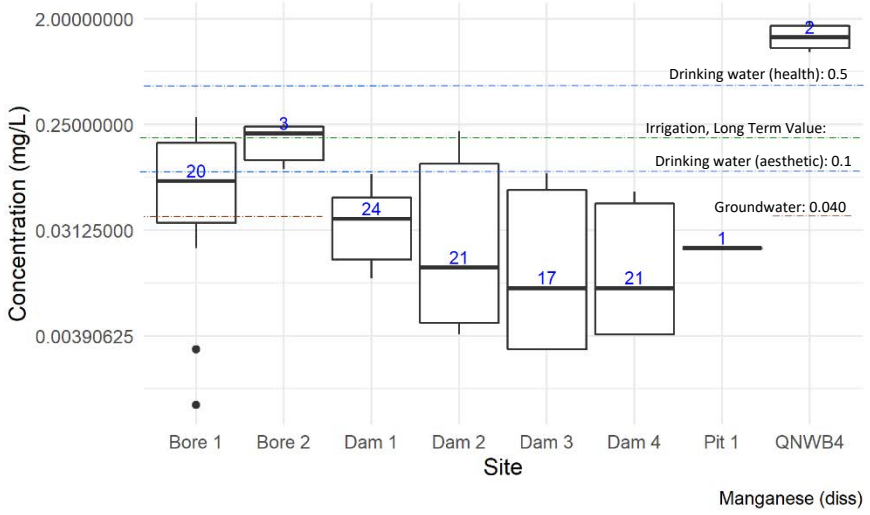


Figure A14. Boxplot of manganese (dissolved)

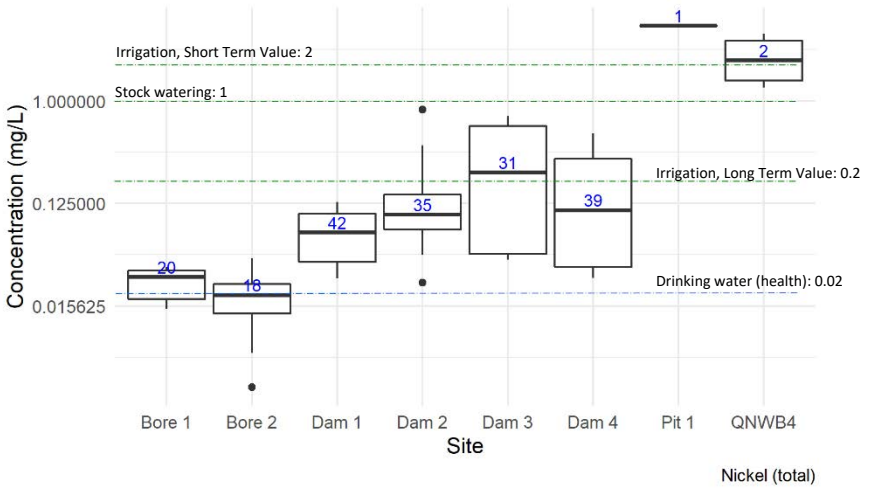


Figure A15. Boxplot of nickel (total)

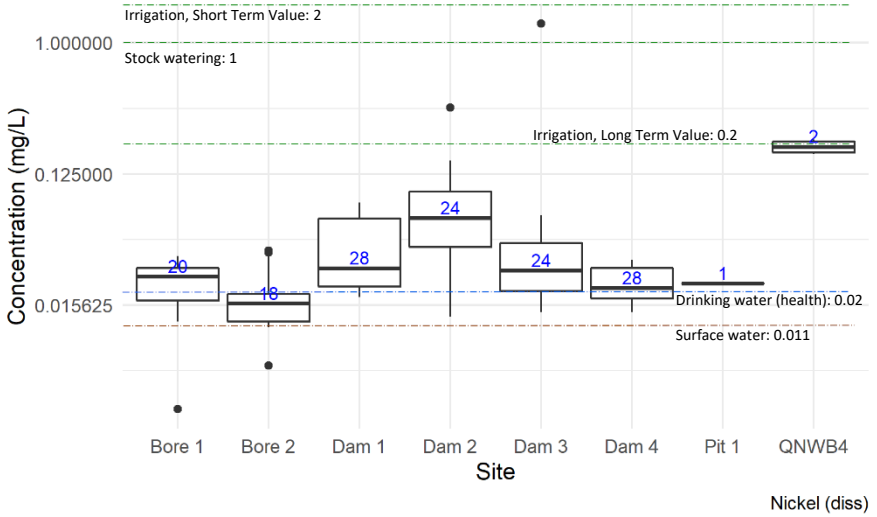


Figure A16. Boxplot of nickel (dissolved)

A2 – Summary of Water Quality Data

Table A1. Summary of water quality data – medians - comparison with guideline values – physico-chemical

Parameter	Phys-Chem			Cations/Anions										
	pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
Guideline/Trigger Values / Units	pH units	uS/cm	mg/L											
Livestock drinking water[1]	-	-	2000 - 4000	1000	-	-	-	-	-	-	-	1000	-	1 - 2
Irrigation – General[1]	6 - 8.5	<2900 (MT)		-	-	-	<230 (MS)	-	-	-	-	-	<350 (MS) <700 (MT)	-
Drinking Water[2] - Health / Aesthetic	6.5 - 8.5	-	- / <1200 (900-1200 = poor)	-	-	-	- / 180	-	-	-	-	- / 250	- / 250	1.5 / -
EHP (2013) - Surface Water[4]	6.5 - 8.5	BF: <445[3] HF <250	-	-	-	-	-	-	-	-	-	<15	-	-
McNeil et al (2018) -Groundwater[5]	7.5 – 8.2	4018	-	165	205	-	391	741	-	-	620	166	932	0.6
Site														
Dam 1	7.8	1300	930[p]	6	217	1	47	407	56	<1	188	9.5	**366**[Da,Ir(MS)]	<0.1
Dam 2	8.1	229	162	3	15	3	11	65	8	<1	74	1	16	<0.5
Dam 3	8.0	161	106	4	10	5	6	69	5	<1	46	2	10	<0.1
Dam 4	8.2	240	164	4	21	6	6	110	14	<1	93	2	9	0.1
Pit 1	7.9	103	236	1	6	1	13	14	<1	<1	14	9	15	0.2
Bore 1	7.4	2650	**1770**[Da]	7	299	1	63	706	19	<1	505	50	**488**[Da,Ir(MS)]	<0.1
Bore 2	7.4	2560	**1730**[Da]	6	300	<1	69	758	36	<1	562	54	**474**[Da,Ir(MS)]	<0.1
QNWB4	7.4	1510	1013[p]	13	190	2	43	665	<1	<1	655	35	178	0.1

Table notes:

* Red denotes exceedance of draft WQOs (McNeil *et al*, 2018 in groundwater, EHP, 2013 in surface water). Bold and symbols indicate exceedances of other guideline/trigger values: L = livestock, Ir = Irrigation; D = Drinking Water (a = aesthetic, h = health); for TDS, p = poor, though acceptable (900 - 1200)

EC = electrical conductivity; TDS = total dissolved solids; Ca = calcium; Mg = magnesium; K = potassium; Na = sodium; HCO_3^- = bicarbonate alkalinity (as $CaCO_3$); CO_3^- = carbonate alkalinity (as $CaCO_3$); OH^- = hydroxide alkalinity (as $CaCO_3$); Tot Alk = total alkalinity (as $CaCO_3$); SO_4 = sulfate (as SO_4); Cl = chloride; F = fluoride

1 ANZECC & ARMCANZ (2000): MT = suitable for moderately tolerant (or more tolerant) crops; MS = suitable for moderately sensitive (or more tolerant) crops

2 Australian Drinking Water Guidelines (NHMRC & NRMMC, 2021)

3 BF = Baseflow; HF = High flow

4 Fitzroy River Sub-basin fresh waters

5 9 - Serpentinite Belt

Table A2. Summary of water quality data – medians - comparison with guideline values – nutrients

-	Nutrients						
Guideline/Trigger Values Units	NH3	NO2	NO3	NOx	TKN	TN	TP
	mg/L						
Livestock drinking water[1]	-	30	400	-	-	-	-
Irrigation STVs[1]	-	-	-	-	-	25-125	0.8-12
Irrigation LTVs[1]	-	-	-	-	-	5	0.05
Drinking Water - Health / Aesthetic[2]	- / 0.5	3	50	-	-	-	-
EHP (2013) - Surface Water	<0.020	-	<0.060	-	-	<0.50	<0.050
McNeil et al (2018) -Groundwater[3]	-	-	8.15	-	-	1.772	-
Dam 1	0.058	0.03	<0.01	0.05	1.0	1.1	0.04
Dam 2	0.066	<0.01	<0.01	0.02	0.9	0.8	0.04
Dam 3	0.070	<0.01	<0.01	0.07	0.8	0.8	0.03
Dam 4	0.063	<0.01	<0.01	0.01	0.7	0.7	0.06[LT]
Pit 1	<0.010	<0.01	0.47	0.47	<1	<1	<0.1
Bore 1	0.035	<0.01	<0.01	0.11	13.5	1.1	0.03
Bore 2	0.040	0.01	<0.01	0.02	0.6	4.2	0.02
QNWB4	0.050	<0.01	0.14	0.14	1.5	1.6	0.49

Table notes:

* Red denotes exceedance of draft WQOs (McNeil *et al*, 2018 in groundwater, EHP, 2013 in surface water). Bold and symbols indicate exceedances of other guideline/trigger values: L = livestock, ST = Irrigation Short Term; LT = Irrigation Long Term (note that an exceedance of the short term TV is also an exceedance of the long term TV); D = Drinking Water (a = aesthetic, h = health)

1 ANZECC & ARMCANZ (2000), Volume 3

2 Australian Drinking Water Guidelines (NHMRC & NRMMC, 2021)

3 Zone 9 - Serpentinite Belt

4 Fitzroy eastern tributaries, fresh waters (EHP, 2013)

Table A3. Summary of water quality data – medians - comparison with guideline values – total metals

Parameter	Total Metals																
	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
Guideline/Trigger Values Units	mg/L																
Livestock drinking water[1]	5	0.5	5	0.01	1	1	0.5	-	0.1	-	0.002	0.15	1	-	<0.2	-	<20
Irrigation STVs[1]	20	2	<0.5	0.05	1	0.1	5	10	5	10	-	0.05	2	-	0.1	0.5	5
Irrigation LTVs[1]	5	0.1	0.5	0.01	0.1	0.05	0.2	0.2	2	0.2	-	0.01	0.2	-	0.01	0.1	2
Drinking Water - Health / Aesthetic[2]	- / 0.2	0.01 / -	4 / -	0.002 / -	0.05 / -	-	2 / 1	- / 0.3	0.01 / -	0.5 / 0.1	0.001 / -	0.05 / -	0.02 / -	-	0.017 / -	-	- / 3
McNeil et al (2018) – Groundwater[3]	-	-	-	-	-	-	0.030	0.020	-	0.040	-	-	-	-	-	-	0.100
Dam 1	<0.001	<0.006	0.08	<0.0002	0.041	0.005	0.002	**0.61**^{Da,LT}	0.001	0.081	<0.0001	<0.001	**0.070**^{Dh}	0.019	<0.001	<0.01	0.019
Dam 2	<0.001	<0.001	<0.05	<0.0002	0.031	0.005	0.003	**0.96**^{Da,LT}	<0.001	0.088	<0.0001	<0.001	**0.100**^{Dh}	0.018	<0.001	<0.01	0.009
Dam 3	<0.001	<0.006	<0.05	<0.0002	**0.297**^{Dh,LT}	0.013	0.003	**4.28**^{Da,LT}	<0.001	0.060	<0.0001	<0.001	**0.234**^{Dh,LT}	0.026	<0.001	<0.01	<0.005
Dam 4	<0.001	0.001	<0.05	<0.0002	**0.103**^{Dh,LT}	0.010	0.002	**1.18**^{Da,LT}	<0.001	**0.130**^{Da}	<0.0001	<0.001	**0.109**^{Dh}	0.018	<0.001	<0.01	0.010
Pit 1	**5.3**^{Da,L,LT}	<0.001	<0.05	<0.0001	**0.859**^{Dh,LT}	**0.105**ST	0.019	**30.0**^{Da,ST}	<0.001	**0.210**^{Da,LT}	<0.0001	<0.001	**4.61**^{Dh,L,ST}	0.012	<0.001	<0.01	0.053
Bore 1	0.020	0.001	0.11	0.0001	0.006	<0.001	<0.004	0.005	<0.001	0.088	<0.0001	<0.001	**0.028**^{Dh}	0.107	<0.001	<0.01	0.021
Bore 2	-	0.002	0.12	<0.0001	0.067	<0.001	<0.004	0.01	<0.001	<0.001	-	<0.001	0.019	-	-	<0.01	<0.005
QNWB4	**6.2**^{Da,L,LT}	0.002	0.10	0.0003	**1.14**^{Dh,L,ST}	**0.118**ST	0.027	**41.5**^{Da,ST}	0.008	**2.745**^{Dh,LT}	0.0001	<0.001	**2.82**^{Dh,L,ST}	0.097	0.004	0.02	0.138

Table notes:

* Red denotes exceedance of draft WQOs (McNeil *et al*, 2018) in groundwater. Bold and symbols indicate exceedances of other guideline/trigger values: L = livestock, ST = Irrigation Short Term; LT = Irrigation Long Term (note that an exceedance of the short term TV is also an exceedance of the long term TV); D = Drinking Water (a = aesthetic, h = health)

1 ANZECC & ARMCANZ (2000), Volume 3

2 Australian Drinking Water Guidelines (NHMRC & NRMMC, 2021)

3 Zone 9 - Serpentinite Belt

Table A4. Summary of water quality data – medians - comparison with guideline values – dissolved metals

Parameter	Dissolved Metals																
Guideline/Trigger Values Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
	mg/L																
Livestock drinking water[1]	5	0.5	5	0.01	1	1	0.5	-	0.1	-	0.002	0.15	1	-	<0.2	-	<20
Irrigation STVs[1]	20	2	<0.5	0.05	1	0.1	5	10	5	10	-	0.05	2	-	0.1	0.5	5
Irrigation LTVs[1]	5	0.1	0.5	0.01	0.1	0.05	0.2	0.2	2	0.2	-	0.01	0.2	-	0.01	0.1	2
Drinking Water - Health / Aesthetic[2]	- / 0.2	0.01 / -	4 / -	0.002 / -	0.05 / -	-	2 / 1	- / 0.3	0.01 / -	0.5 / 0.1	0.001 / -	0.05 / -	0.02 / -	-	0.017 / -	-	- / 3
McNeil et al (2018) – Groundwater[4]	-	-	-	-	-	-	0.030	0.020	-	0.040	-	-	-	-	-	-	0.100
AWQGs (ANZG, 2018)[3]	0.055	0.024 / 0.013	0.94	0.0002	0.0033 / 0.001	0.0014	0.0014	-	0.0034	1.9	0.00006	0.034	0.011	-	0.0005	0.006	0.008
Dam 1	<0.01	<0.006	0.07	<0.0001	0.015	<0.001	<0.004	0.004	<0.001	0.032	<0.0001	<0.001	**0.028^{Dh}**	0.029	<0.001	<0.01	<0.005
Dam 2	<0.01	0.002	<0.05	<0.0001	0.004	<0.001	<0.004	0.082	<0.001	0.009	<0.0001	<0.001	**0.062^{Dh}**	0.033	<0.001	<0.01	<0.005
Dam 3	<0.01	<0.006	<0.05	<0.0001	0.008	<0.001	0.002	0.028	<0.001	0.004	<0.0001	<0.001	**0.027^{Dh}**	0.015	<0.001	<0.01	<0.005
Dam 4	<0.01	<0.006	<0.05	<0.0001	0.003	<0.001	<0.004	0.022	<0.001	0.006	<0.0001	<0.001	**0.021^{Dh}**	0.012	<0.001	<0.01	<0.005
Pit 1	<0.01	<0.001	0.05	<0.0001	0.045	<0.001	0.002	<0.05	<0.001	0.022	<0.0001	<0.001	**0.022^{Dh}**	0.010	<0.001	<0.01	<0.005
Bore 1	<0.01	0.001	0.12	0.0001	0.005	<0.001	<0.004	<0.001	0.001	0.082	<0.0001	<0.001	**0.024^{Dh}**	0.088	<0.001	<0.01	0.015
Bore 2	-	0.001	0.12	<0.0001	0.065	<0.001	<0.004	<0.001	<0.001	<0.001	<0.0001	<0.001	0.016	<0.001	-	-	<0.01
QNWB4	<0.01	0.001	0.11	0.00015	0.002	0.036	0.005	0.060	<0.001	**1.491^{Dh,LT}**	<0.0001	0.001	**0.19^{Dh,LT}**	0.087	0.003	<0.01	0.025

Table notes:

Table notes:

* Red denotes exceedance of draft WQOs (McNeil *et al*, 2018 in groundwater; ANZG, 2018 in surface water). Bold and symbols indicate exceedances of other guideline/trigger values: L = livestock, ST = Irrigation Short Term; LT = Irrigation Long Term (note that an exceedance of the short term TV is also an exceedance of the long term TV); D = Drinking Water (a = aesthetic, h = health)

1 ANZECC & ARMCANZ (2000), Volume 3

2 Australian Drinking Water Guidelines (NHMRC & NRMMC, 2021)

3 Australian Water Quality Guidelines (AWQGs) (ANZG, 2018) – Arsenic default guideline values (DGVs) refer to As(III) / As (V); Chromium to Cr(III) / Cr(VI) – values for slightly-moderately disturbed systems

Table A5. Summary of water quality data – 95th percentiles - comparison with guideline values – total metals

Parameter	Total Metals																
	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
Guideline/Trigger Values Units	mg/L																
Livestock drinking water[1]	5	0.5	5	0.01	1	1	0.5	-	0.1	-	0.002	0.15	1	-	<0.2	-	<20
Irrigation STVs[1]	20	2	<0.5	0.05	1	0.1	5	10	5	10	-	0.05	2	-	0.1	0.5	5
Irrigation LTVs[1]	5	0.1	0.5	0.01	0.1	0.05	0.2	0.2	2	0.2	-	0.01	0.2	-	0.01	0.1	2
Drinking Water - Health / Aesthetic[2]	- / 0.2	0.01 / -	4 / -	0.002 / -	0.05 / -	-	2 / 1	- / 0.3	0.01 / -	0.5 / 0.1	0.001 / -	0.05 / -	0.02 / -	-	0.017 / -	-	- / 3
McNeil et al (2018) – Groundwater[3]	-	-	-	-	-	-	0.030	0.020	-	0.040	-	-	-	-	-	-	0.100
Dam 1	0.06	**0.012**^{Dh}	0.12	<0.0002	**0.112**^{Dh,LT}	0.016	0.010	**2.06**^{Da,LT}	0.001	**0.223**^{Da,LT}	<0.0001	<0.001	**0.15**^{Dh,LT}	0.019	<0.001	<0.01	0.019
Dam 2	**0.38**^{Da}	0.010	0.06	0.0003	**0.129**^{Dh,LT}	0.071	0.010	**2.76**^{Da,LT}	<0.001	**1.480**^{Dh,LT}	<0.0001	<0.001	**0.25**^{Dh,LT}	0.018	<0.001	<0.01	0.009
Dam 3	0.14	**0.011**^{Dh}	<0.09	<0.0002	**1.41**^{Dh,L,ST}	**0.100**^{LT}	0.011	**11.00**^{Da,ST}	<0.001	**0.346**^{Da,LT}	<0.0001	<0.001	**0.91**^{Dh,LT}	0.026	<0.001	<0.01	<0.005
Dam 4	**3.03**^{Da}	**0.016**^{Dh}	<0.09	<0.0002	**1.26**^{Dh,L,ST}	**0.071**^{LT}	0.007	**9.30**^{Da,LT}	<0.001	**0.397**^{Da,LT}	<0.0001	<0.001	**1.01**^{Dh,L,LT}	0.018	<0.001	<0.01	0.010
Pit 1	**5.29**^{Da,L,LT}	<0.001	<0.05	<0.0001	**0.859** ^{Dh,LT}	**0.105**ST	0.019	**30.00**^{Da,ST}	<0.001	**0.210**^{Da,LT}	<0.0001	<0.001	**4.61**^{Dh,L,ST}	0.012	<0.001	<0.01	0.053
Bore 1	0.02	**0.029**^{Dh}	0.13	0.0001	**0.052**^{Dh}	0.003	0.004	0.06	<0.001	**0.225**^{Da,LT}	<0.0001	<0.001	**0.037**^{Dh}	0.107	<0.001	<0.01	0.021
Bore 2	-	**0.041**^{Dh}	0.13	<0.0001	**0.101** ^{Dh,LT}	0.002	0.003	0.05	<0.001	**0.230**^{Da,LT}	-	<0.001	**0.038**^{Dh}	-	-	<0.01	<0.005
QNWB4	**10.2**^{Da,L,LT}	0.002	0.11	0.0004	**1.88**^{Dh,L,ST}	**0.156**ST	0.042	**69.70**^{Da,ST}	**0.012**^{Dh}	**3.05**^{Dh,LT}	0.0001	<0.001	**4.48**^{Dh,L,ST}	0.119	0.006	0.02	0.209

Table notes:

* Red denotes exceedance of draft WQOs (McNeil *et al*, 2018) in groundwater. Bold and symbols indicate exceedances of other guideline/trigger values: L = livestock, ST = Irrigation Short Term; LT = Irrigation Long Term (note that an exceedance of the short term TV is also an exceedance of the long term TV); D = Drinking Water (a = aesthetic, h = health)

1 ANZECC & ARMCANZ (2000), Volume 3

2 Australian Drinking Water Guidelines (NHMRC & NRMMC, 2021)

3 Zone 9 - Serpentinite Belt

Table A6. Summary of water quality data – 95th percentiles - comparison with guideline values – dissolved metals

Parameter	Dissolved Metals																
Guideline/Trigger Values Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
	mg/L																
Livestock drinking water[1]	5	0.5	5	0.01	1	1	0.5	-	0.1	-	0.002	0.15	1	-	<0.2	-	<20
Irrigation STVs[1]	20	2	<0.5	0.05	1	0.1	5	10	5	10	-	0.05	2	-	0.1	0.5	5
Irrigation LTVs[1]	5	0.1	0.5	0.01	0.1	0.05	0.2	0.2	2	0.2	-	0.01	0.2	-	0.01	0.1	2
Irrigation – General[1]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drinking Water - Health / Aesthetic[2]	- / 0.2	0.01 / -	4 / -	0.002 / -	0.05 / -	-	2 / 1	- / 0.3	0.01 / -	0.5 / 0.1	0.001 / -	0.05 / -	0.02 / -	-	0.017 / -	-	- / 3
McNeil et al (2018) – Groundwater[4]	-	-	-	-	-	-	0.030	0.020	-	0.040	-	-	-	-	-	-	0.100
AWQGs (ANZG, 2018)[3]	0.055	0.024 / 0.013	0.94	0.0002	0.0033 / 0.001	0.0014	0.0014	-	0.0034	1.9	0.00006	0.034	0.011	-	0.0005	0.006	0.008
Dam 1	<0.01	**0.015**^{Dh}	0.12	<0.0001	**0.051**^{Dh}	0.003	0.005[4]	**0.76**^{Da,LT}	<0.001	**0.110**^{Da}	<0.0001	<0.001	**0.088**[4] ^{Dh}	0.029	<0.001	<0.01	<0.010
Dam 2	<0.01	**0.024**^{Dh}	0.06	<0.0001	0.019	0.009	0.003[4]	**1.12**^{Da,LT}	<0.001	**0.360**^{Da,LT}	<0.0001	<0.001	**0.15**^{Dh,LT}	0.033	<0.001	<0.01	<0.010
Dam 3	<0.01	**0.012**^{Dh}	<0.09	<0.0001	0.048	0.008	0.004	**0.30**^{LT}	<0.001	**0.104**^{Da}	<0.0001	<0.001	**0.063**^{Dh}	0.015	<0.001	<0.01	0.005
Dam 4	<0.01	**0.014**^{Dh}	<0.09	<0.0001	**0.388** ^{Dh,LT}	0.005	0.004[4]	**0.28**^{LT}	<0.001	0.078	<0.0001	<0.001	**0.036**^{Dh}	0.012	<0.001	<0.01	<0.010
Pit 1	<0.01	<0.001	0.05	<0.0001	0.045	<0.001	0.002[4]	<0.05	<0.001	0.022	<0.0001	<0.001	**0.022**^{Dh}	0.010	<0.001	<0.01	<0.005
Bore 1	<0.01	**0.018**^{Dh}	0.15	0.0001	0.047	0.001	0.002	0.006	0.001	**0.216**^{Da,LT}	<0.0001	<0.001	**0.031**^{Dh}	0.088	<0.001	<0.01	0.015
Bore 2	-	**0.018**^{Dh}	0.12	<0.0001	**0.093**^{Dh}	0.004	<0.004	**0.026**^{LT}	<0.001	**0.217**^{Da,LT}	<0.0001	<0.001	**0.036**^{Dh}	<0.001	-	-	<0.01
QNWB4	<0.01	0.001	0.11	0.0002	0.002	0.039	0.008	0.060	<0.001	**2.010**^{Dh,LT}	<0.0001	0.001	**0.22**^{Dh,LT}	0.106	0.003	<0.01	0.035

Table notes:

* Red denotes exceedance of draft WQOs (McNeil *et al*, 2018 in groundwater; ANZG, 2018 in surface water). Bold and symbols indicate exceedances of other guideline/trigger values: L = livestock, ST = Irrigation Short Term; LT = Irrigation Long Term (note that an exceedance of the short term TV is also an exceedance of the long term TV); D = Drinking Water (a = aesthetic, h = health)

1 ANZECC & ARMCANZ (2000), Volume 3

2 Australian Drinking Water Guidelines (NHMRC & NRMMC, 2021)

3 Australian Water Quality Guidelines (AWQGs) (ANZG, 2018) – Arsenic default guideline values (DGVs) refer to As(III) / As (V); Chromium to Cr(III) / Cr(VI) – values for slightly-moderately disturbed systems

4 Not an exceedance, based on raised hardness modified default guideline values from ANZG (2018), and average water hardness of: Dam 1, 770mg/L; Dams 2-3, 65mg/L; Dam 4, 100mg/L; Pit 1, 30mg/L.

Appendix B

Water quality data

Table B1. Available water quality data – physico-chemical

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm						mg/L						
Site	Date														
Bore 1	04-Apr-13	7.64	2380	1340	5	262	<1	48	620	<1	<1	620	49	415	<0.1
	07-May-13			716	5	155	<1	40	315	<1	<1	315	29	300	<0.1
	09-Jul-14	7.44	2945	1973.15	11.9	277.9	0.964	61.4	456	69			54	490	
	18-Aug-14	7.43	2797	1873.99	8.4	291.8	0.888	58.2	450	38			50	462	
	15-Sep-14				5.8	306.3	0.671	55.4	731				45	555	
	15-Sep-14	7.07	2633	1764.11	5.8	306.3	0.671	55.4	731				45	555	
	13-Oct-14	7.02	2649	1774.83	6.3	309.6	0.679	54.1	685				43	560	
	21-Nov-14	7.08	2698	1807.66	6.5	304	0.825	62.7	805	92			31	485	
	15-Dec-14	7.83	2398	1606.66	10.5	254.6	1.462	65	605				46	439	
	12-Jan-15	7.36	2784	1865.28	7.9	392.2	0.996	77.3	572	65			50	565	
	18-Feb-15	7.36	2629	1761.43	6.6	323.5	0.733	66.2	786				63	509	
	13-Apr-15	6.91	2688	1800.96	6.2	0.034	319.4	0.023	0.632	0.037	0.027		1187	<0.001	
	19-May-15	7.55	2367	1610	6.4	285.9	0.658	50.1	696				32	435	
	15-Jun-15	7.33	2352	1599	6	271.2	0.642	49.8	717				31	530	
	13-Jul-15	7.5	2672	1817	7	324.5	0.78	56.8	758				51	522	
	18-Aug-15	7.44	2935	1996	6.2	307.8	<0.005	75.5	800				61	466	
	14-Sep-15	7.28	2960	2013	7	350.1	0.425	62.9	786				40	597	
	19-Oct-15	7.28	2370	1612	6.8	297.1	0.81	63.1	806				30	402	
	16-Nov-15	7.2	2610	1775	8.2	336	1.546	66.1	779				40	455	
	14-Dec-15	6.88	2340	1591	6.2	256.7	0.855	43.3	751				25	950	
	25-Aug-17	7.6	2300	1200	7.1	230		96	880				35		
	07-Apr-20	7.9	2700	1900	7.4	350	0.6	70	470				59		
	07-Aug-20	8.2	3200	2100	6	300	14	78	1100				75		

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm						mg/L						
	06-Jan-21	8	990	2800	16	350	<5	73	650				60		
	20-Apr-21	7.8	2300	1600	7.4	260	5.4	71	590				57		
	20-Dec-21	7.9	2800	1600	5.9	270	6.3	65	950				65		
	19-Jan-22	7.54	2900	1990	8	311	6	74	694	<1	<1	694	63	631	<0.1
Bore 2	04-Apr-13	7.87	2290	1260	5	241	<1	46	516	<1	<1	516	45	440	<0.1
	07-May-13			1100	5	266	<1	52	608	<1	<1	608	49	411	<0.1
	09-Jul-14	7.32	2871	1923.57	5.9	281.2	0.33	55	582	90			49	450	
	18-Aug-14	7.44	3094	2072.98	6.6	345.8	0.402	74.2	625	72			60	524	
	15-Sep-14				5.5	315.6	0.383	70.8	831				57	497	
	15-Sep-14	6.9	2678	1794.26	5.5	315.6	0.383	70.8	831				57	497	
	13-Oct-14	7.06	2584	1731.28	5.8	309.9	0.4	67.7	811				54	482	
	21-Nov-14	7.18	2792	1870.64	5.9	318.2		74.7	1243				54	439	
	15-Dec-14	7.5	2677	1793.59	6.1	327.1	0.493	77.7	911				59	490	
	12-Jan-15	7.44	2676	1792.92	6.9	378.4	0.447	84.8	831				60	492	
	18-Feb-15	7.3	2435	1631.45	6.8	333.4	0.749	59.9	751				61	577	
	17-Mar-15	7.29	2659	1781.53	6.1	329.8		72.1	689	149			54	477	
	13-Apr-15	6.96	2126	1424.42	4.9	<0.001	253.7	0.012	0.277	0.051	0.024		1243	<0.001	
	19-May-15	7.16	2103	1430	5.5	263.5	0.261	53.2	772				47	336	
	15-Jun-15	7.22	2186	1486	5.5	261.2	0.273	54.7	731				45	367	
	13-Jul-15	7.42	2494	1696	6	292.4	0.463	65.6	813				43	471	
	18-Aug-15	7.56	2537	1725	7.7	358.4	0.42	69.1	758				64	605	
	14-Sep-15	7.23	2540	1727	5.8	305.2	0.041	70.5	813				47	482	
	19-Oct-15	7.23	2540	1727	5.7	291.8	<0.005	69.8	800				50	430	
	16-Nov-15	7.2	2640	1795	6.5	333.8	0.536	78.7	779				57	398	
	14-Dec-15	7.16	2630	1788	6	304.5	0.417	64.1	805				50	678	

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm						mg/L						
	19-Dec-17	8.2	2200	1100	6.2	240	11	60	660				24		
	15-Jun-18	8.1	2300	1300	6.6	220	8.3	65	650				31		
	25-Sep-18	8.2	1900	1000	6	210	9.2	57	590				27		
	11-Mar-19	8	3000	2200	6.8	260	17	65	850				32		
	28-Jun-19	8.2	3700	1600	12	270	33	78	1300				6.5		
	16-Oct-19	8.1	2500	1600	6.6	310	3	90	750				70		
	07-Apr-20	7.5	2800	1400	6	280	5.1	75	740				57		
	07-Aug-20	8.1	3100	2100	7.7	360		69	600				62		
	06-Jan-21	7.4	2500	2200	5.3	300	<5	79	920				62		
Dam 1	04-Apr-13	8.24	1340	726	5	129	1	29	307	<1	<1	307	26	217	<0.1
	07-May-13			930	6	224	<1	45	430	58	<1	488	39	366	<0.1
	04-Jun-13	7	149.3	152	2	12	1	11	52	<1	<1	52	<1	13	0.1
	27-Nov-13	8.77	858	687	5.5	80.8	3.967	31.9	255	54			9	73	
	18-Dec-13				4.3	64.9	4.404	23.2	281				9	62	
	21-Jan-14				4.1	55.2	5.704	22.4	203				10	54	
	20-Feb-14				3.6	15.7	1.438	8.5	98				1	6	
	26-Mar-14				1.4	13.9	2.28	10.4	140				3	30	
	22-Apr-14				1.1	9.2	1.036	7.5	59				<1	22	
	28-May-14				1.1	12.7	1.396	8.1	133				<1	3	
	09-Jul-14	7.9	2274	1523.58	7.3	242.4	1.572	48.2	407				44	310	
	18-Aug-14	8.3	2300	1541	8.2	317.6	1.681	65.1	412	39			54	445	
	15-Sep-14	7.57	2778	1861.26	6.3	317	0.965	63.6	791				50	559	
	13-Oct-14	7.54	2687	1800.29	6.7	311.3	1.105	62.7	758				50	532	
	21-Nov-14	7.62	2790	1869.3	9.8	343.9	2.61	77.7	625	79			41	641	
	15-Dec-14	8.33	1597	1069.99	4	118	4.091	27.3	372				<10	166	

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm		mg/L										
	15-Jan-15	8.04	2338	1566.46	6.9	258.6	2.958	55.5	592				36	428	
	18-Feb-15	8.06	613	410.71	4.3	65.1	2.034	18.5	207				<10	852	
	17-Mar-15	7.34	2716	1819.72	6.9	326.1	1.227	72.2	710	108			54	459	
	14-Apr-15	7.31	2749	1841.83	6.6	0.054	318.5	0.059	0.956	0.065	0.041		1198	<0.001	
	19-May-15	7.86	2444		7.6	325.4	0.877	62	613	81			50	532	
	15-Jun-15	7.59	2558		8.2	319.6	1.333	63.5	551	88			48	651	
	13-Jul-15	7.77	2195		7.2	304.4	1.221	62.7	786				<10	476	
	18-Aug-15	7.76	2623		7.5	339.7	0.56	73.4	786				59	547	
	14-Sep-15	8.14	2810		6.9	338.1	0.651	68.9	806				66	551	
	19-Oct-15	8.47	2780		6.9	332.3	0.811	68.4	627	95			50	497	
	16-Nov-15	7.4	1270		4.1	106.4	4.567	24	221				16	165	
	14-Dec-15	7.89	2740		7.5	316.2	0.609	62.9	771				49	551	
	11-Jul-16	7.6	240										<5		<0.5
	14-Dec-16	8.1	240										12		<0.5
	25-Aug-17	8	250										<5		1.1
	19-Dec-17	7.7	280										8.9		<0.5
	15-Jun-18	7.7	200	122									<5		<0.5
	25-Sep-18	8	320	195.2	6	210	9.2	57					<5		<0.5
	11-Mar-19	8	200	122									<5		<0.5
	28-Jun-19	7.5	140	85.4									<5		<0.5
	16-Oct-19	8.1	2100	1281									7.1		0.8
	07-Apr-20	6.6	240	146.4									<5		<0.5
	07-Aug-20	7.9	380										<5		0.6
	06-Jan-21	7.1	320										<5		0.8
	20-Apr-21	7.5	210										<5		<0.5

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm		mg/L										
	20-Dec-21	7.5	110										< 5		< 0.5
	19-Jan-22	7.18	150	172	3	12	<1	10	70	<1	<1	70	2	9	<0.1
Dam 2	04-Apr-13	8.27	202	164	3	15	2	9	74	<1	<1	74	<1	9	<0.1
	07-May-13			104	2	14	2	9	73	<1	<1	73	2	9	<0.1
	04-Jun-13	7.13	138	179	2	11	1	10	49	<1	<1	49	<1	13	0.2
	27-Nov-13	9.62	358.8	213	4.4	14.9	2.782	25.9	31	14			5	51	
	18-Dec-13				3.3	16.6	5.101	25.5	56				16	77	
	21-Jan-14				4.2	21.4	10.012	20.8	34				91	37	
	20-Feb-14				3.6	15.3	1.555	8.4	83				<1	7	
	26-Mar-14				1.4	10.6	2.355	10.3	97	8			2	28	
	22-Apr-14				1.2	10.2	1.03	7.4	59				1	26	
	28-May-14				0.9	10.6	1.12	7.3	48	11			1	3	
	09-Jul-14	7.53	207	138.69	1.9	11.1	0.784	9.2	65	3			1	3	
	18-Aug-14	8.75	164	109.88	1.9	12.8	1.146	10	65	12			<1	9	
	15-Sep-14	9.25	196.3	131.521	1.6	14.2	0.827	11.2	53	18			<1	10	
	13-Oct-14	8.81	788	527.96	10.8	62.9	1.817	24.4	21	16			13	205	
	21-Nov-14	8.92	980	656.6	15.6	88.6	6.539	41.5	20				<10	344	
	15-Dec-14	6.97	1118	749.06	8.1	70.9	14.667	33.3	19				<10	218	
	18-Feb-15	7.97	242	162.14	4.6	22.9	2.707	12.4	114				<10	16	
	17-Mar-15	8.41	224	150.08	3.5	19.9	3.286	9.3	91	19			<10	5	
	14-Apr-15	7.83	308	206.36	3	0.194	20.3	0.185	3.029	0.113	0.041		176	0.016	
	14-Apr-15	8.13	134	89.78	2.3	0.051	8.8	0.417	3.584	0.278	0.02		85	0.024	
	19-May-15	7.9	216.7		3.3	19.3	2.567	11.1	109				<10	10	
	15-Jun-15	7.5	284		3.2	19.1	2.635	11.9	103				<10	19	
	13-Jul-15	7.66	188		3.2	18.9	2.874	12.7	113				49	8	

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm		mg/L										
	18-Aug-15	8.73	256.3		1.6	20.4	4.165	12.6	112					20	
	14-Sep-15	8.51	113.6		3.4	21.9	4.075	16.1	130					18	
	16-Nov-15	7.7	229		2.5	15.1	4.853	9.2	19				21	39	
	14-Dec-15	8.05	359		3.3	22.2	3.999	13	428				28	50	
	11-Jul-16	7.7	240										<5		<0.5
	14-Dec-16	8.1	260										<5		<0.5
	25-Aug-17	9.2	200										<5		0.7
	19-Dec-17	7.6	130										<5		<0.5
	15-Jun-18	8.1	220	134.2									<5		<0.5
	07-Apr-20	6.8	240	146.4									<5		<0.5
	26-Aug-20	8.3	1500	915									33		<0.5
	20-Apr-21	8.1	330										<5		<0.5
	20-Dec-21	7.6	150										< 5		< 0.5
	19-Jan-22	7.48	171	158	3	15	1	9	82	<1	<1	82	1	9	<0.1
Dam 3	03-Apr-13	8	109	72	4	4	6	5	39	<1	<1	39	<1	7	<0.1
	07-May-13			130	3	8	5	5	49	<1	<1	49	<1	6	<0.1
	04-Jun-13	7.9	128	92	3	8	5	5	50	<1	<1	50	<1	6	0.1
	27-Nov-13	8.4	707	357	15.6	43.5	15	20.5	229	22			7	44	
	18-Dec-13				7.9	25.9	12.575	11.1	140				22	16	
	21-Jan-14				5.8	17.1	10.803	9.9	105				19	16	
	20-Feb-14				1.7	4.2	3.755	4.8	42				1	4	
	26-Mar-14				1	4.2	4.579	4.7	77				4	14	
	22-Apr-14				0.7	5.2	3.758	4	42				1	<1	
	28-May-14				1.5	6.8	3.831	3.8	70	14			2	3	
	09-Jul-14	7.55	119	79.73	4.2	8.5	4.002	5.7	70				2	2	

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm						mg/L						
	18-Aug-14	8.02	107	71.69	3.3	9.9	4.73	5.1	50	10			2	5	
	15-Sep-14	8.04	172	115.24	3.9	13.5	5.347	5.9	106				2	4	
	13-Oct-14	8.53	212.3	142.241	5	15	6.249	6.4	126				1	6	
	21-Nov-14	8.78	296	198.32	9.3	26.7	10.331	10.1	180				<10	10	
	15-Dec-14	9.04	227	152.09	3.6	11.8	9.298	5.9	73				20	10	
	18-Feb-15	8.55	131	87.77	2.3	8	4.119	9.3	45				178	1244	
	17-Mar-15	7.86	144	96.48	2.2	7.8	3.717	6	159	47			<10	12	
	19-May-15	7.93	220		3.4	10.2	3.552	8.5	52				<10	11	
	15-Jun-15	8.47	192		3.8	11.6	3.96	9.1	65				<10	53	
	13-Jul-15	7.84	146		3.9	11.7	4.648	9.6	69				27	11	
	18-Aug-15	8.72	172.4		3.1	13.7	8.222	8.7	69				<10	22	
	16-Nov-15	7.5	138		4.2	20.3	8.483	4.7	64				10	34	
	14-Dec-15	8.01	339		7.8	26.2	10.597	11.1	126				25	131	
	11-Jul-16	7.7	150										<5		<0.5
	14-Dec-16	8.3	260										<5		<0.5
	25-Aug-17	8	180										5.1		0.8
	07-Apr-20	7.5	280	170.8									<5		<0.5
	20-Apr-21	7.7	120										<5		<0.5
	20-Dec-21	7.5	78										< 5		< 0.5
	19-Jan-22	7.95	92	83	2	8	4	4	43	<1	<1	43	2	4	<0.1
Dam 4	03-Apr-13	8.5	196	120	3	16	6	3	82	<1	<1	82	<1	4	<0.1
	07-May-13			122	4	22	6	4	104	<1	<1	104	2	6	<0.1
	04-Jun-13	7.84	232	238	4	23	6	4	110	<1	<1	110	<1	6	0.1
	27-Nov-13	9.68	466	224	9.1	41.4	5	10.9	133	48			2	10	
	18-Dec-13				6.3	18.1	3.98	12.4	119				2	12	

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm		mg/L										
	21-Jan-14				7.4	41.6	10.6	16.1	218				4	22	
	20-Feb-14				2.7	11.1	6.923	4.3	84				<1	6	
	26-Mar-14				2.5	14.8	7.88	5.7	919	83			4	20	
	22-Apr-14				1.2	11.5	4.835	4.1	28	19			1	23	
	28-May-14				2.4	16.1	5.037	4.1	91	35			2	5	
	09-Jul-14	9.52	225	150.75	4	21	5.07	6.2	77	14			<1	<1	
	18-Aug-14	8.75	251	168.17	4	25.6	6.182	5.8	123	13			<1	7	
	15-Sep-14	8.8	255.1	170.917	4.1	29.7	5.318	6.4	110	33			1	6	
	13-Oct-14	9.16	244.9	164.083	4.1	23.4	5.964	6.4	146				2	9	
	21-Nov-14	9.23	259	173.53	3.6	13.2	6.099	7.4	93				<10	12	
	15-Dec-14	7.75	186	124.62	2.9	11.5	7.339	4.4	73				<10	10	
	15-Jan-15	9.18	419	280.73	4.8	26.6	13.558	5.9	146				<10	20	
	18-Feb-15	8.75	636	426.12	4	14.7	6.168	7.2	86				<10	3	
	17-Mar-15	8.57	820	549.4	3.2	15.4	7.202	2.8	193	54			<10	3	
	14-Apr-15	8.22	570	381.9	4	0.222	21.2	0.13	7.954	0.236	0.045		181	0.016	
	19-May-15	7.7	240		4.5	24	7.155	6.1	131				<10	6	
	15-Jun-15	8.13	263		4.8	26.9	7.636	6.8	138				<10	15	
	13-Jul-15	7.12	309		4.9	28	8.448	7.2	159				<10	32	
	18-Aug-15	8.54	279.2		3.3	32.5	14.6	5.7	179				<10	16	
	14-Sep-15	8.99	38100		5.7	38.7	13.333	7.4	207					9	
	19-Oct-15	8.29	677		8.2	55.5	19.378	11.8	276				<10	21	
	16-Nov-15	7.5	183		2.9	16.2	5.449	6.6	60				11	30	
	14-Dec-15	7.96	205		3.1	16.9	3.678	8.4	73				10	248	
	11-Jul-16	7.7	150										<5		<0.5
	14-Dec-16	8.3	250										7.2		<0.5

	Parameter	Phys-Chem			Cations/Anions										
		pH	EC	TDS	Ca	Mg	K	Na	HCO_3^-	CO_3^-	OH^-	Tot Alk	SO_4	Cl	F
	Units	pH units	uS/cm	mg/L											
	25-Aug-17	8.3	240										5.6		0.8
	11-Mar-19	8.2	180	109.8									<5		<0.5
	28-Jun-19	7.9	150	91.5									<5		<0.5
	16-Oct-19	7.3	140	85.4									<5		0.6
	07-Apr-20	7.5	120	73.2									5.3		<0.5
	07-Aug-20	7.6	150										<5		<0.5
	06-Jan-21	7.4	200										6.9		0.7
	20-Apr-21	7.9	110										<5		0.9
	20-Dec-21	7.7	96										< 5		< 0.5
	19-Jan-22	7.83	99	93	1	7	2	8	46	<1	<1	46	2	7	0.1
Pit 1	05-Jan-22	7.7	109.7	66.917											
	19-Jan-22	8.06	96	406	1	6	1	13	14	<1	<1	14	9	15	0.2
QNWB4	20-Dec-21	8	1400	740	13	140	1	34	660				40		
	20-Dec-21	7.2	1450	1030	19	179	1	44	622	<1	<1	622	36	164	0.1
	05-Jan-22	7.14	1561	952.21											
	19-Jan-22	7.49	1600	1140	10	219	2	47	688	<1	<1	688	31	192	<0.1

Table B2. Available water quality data – nutrients

-		Nutrients						
	Units	NH3	NO2	NO3	NOx	TKN	TN	TP
		mg/L						
Site	Date							
Bore 1	04-Apr-13	-	<0.01	7.85	7.85	1	8.8LT	0.01
	07-May-13	-	-	-	0.93	0.2	1.1	0.03
	09-Jul-14	<0.1	-	-	-	-	-	0.029
	18-Aug-14	<0.1	-	-	-	-	0.028	-
	15-Sep-14	<0.1	-	-	-	-	0.024	-
	15-Sep-14	<0.1	-	-	-	-	-	-
	13-Oct-14	<0.1	-	-	-	-	-	-
	21-Nov-14	<0.1	0.02	<0.01	0.02	-	-	-
	15-Dec-14	<0.1	0.04	0.14	0.19	-	-	-
	12-Jan-15	<0.1	-	-	-	-	-	-
	18-Feb-15	0.07	-	-	-	-	-	-
	19-May-15	0.03	-	-	-	-	-	-
	15-Jun-15	0.11	-	-	-	-	-	-
	13-Jul-15	<0.02	-	-	-	-	-	<0.008
	18-Aug-15	0.07	0.01	<0.01	0.02	-	-	<0.008
	14-Sep-15	0.05	<0.01	<0.01	-	-	-	0.046
	19-Oct-15	<0.02	<0.01	0.02	0.02	-	-	0.028
	16-Nov-15	0.02	<0.01	<0.01	0.01	-	-	0.03
	14-Dec-15	0.1	<0.01	<0.01	-	-	-	<0.008
	19-Jan-22	28.3	0.31	9.79	10.1	26.9	37	3.56
Bore 2	04-Apr-13	-	0.06	4.6	4.66	0.4	5.1	0.02
	07-May-13	-	-	-	7.54	0.8	8.3	<0.01
	09-Jul-14	<0.1	-	-	-	-	-	0.015

-		Nutrients						
		NH3	NO2	NO3	NOx	TKN	TN	TP
	Units				mg/L			
	18-Aug-14	<0.1	-	-	-	-	0.029	-
	15-Sep-14	<0.1	-	-	-	-	-	-
	15-Sep-14	<0.1	-	-	-	-	-	-
	13-Oct-14	<0.1	-	-	-	-	-	-
	21-Nov-14	<0.1	<0.01	0.03	0.03	-	-	-
	15-Dec-14	<0.1	<0.01	<0.01	0.01	-	-	-
	12-Jan-15	<0.1	-	-	-	-	-	-
	18-Feb-15	0.12	-	-	-	-	-	-
	17-Mar-15	0.04	-	-	-	-	-	-
	19-May-15	<0.02	-	-	-	-	-	-
	15-Jun-15	0.1	-	-	-	-	-	-
	13-Jul-15	0.08	-	-	-	-	-	<0.008
	18-Aug-15	0.11	0.01	<0.01	0.01	-	-	0.033
	14-Sep-15	0.31	<0.01	0.02	0.02	-	-	0.043
	19-Oct-15	<0.02	0.05	<0.01	0.05	-	-	0.021
	16-Nov-15	<0.02	0.01	0.01	0.02	-	-	0.023
	14-Dec-15	0.15	0.01	<0.01	0.02	-	-	<0.008
Dam 1	04-Apr-13	-	0.03	1.77	1.8	1.5	3.3	0.06
	07-May-13	-	-	-	2.01	0.7	2.7	0.02
	04-Jun-13	-	-	-	<0.01	1.1	1.1	0.09
	27-Nov-13	-	-	-	-	-	-	0.115
	18-Dec-13	-	-	-	-	-	-	0.109
	21-Jan-14	-	-	-	-	-	-	0.078
	20-Feb-14	-	-	-	<8	-	-	0.03
	26-Mar-14	-	-	-	<8	-	-	0.041

-		Nutrients						
		NH3	NO2	NO3	NOx	TKN	TN	TP
Units		mg/L						
	22-Apr-14	-	-	-	77	-	-	0.026
	28-May-14	-	-	-	44	-	-	0.041
	09-Jul-14	<0.1	-	-	-	-	-	0.038
	18-Aug-14	<0.1	-	-	-	-	0.039	-
	15-Sep-14	<0.1	-	-	-	-	-	-
	13-Oct-14	<0.1	-	-	-	-	-	-
	21-Nov-14	0.3	0.02	<0.01	0.02	-	-	-
	15-Dec-14	<0.1	<0.01	<0.01	-	-	-	-
	15-Jan-15	<0.1	0.05	<0.01	0.04	-	-	-
	18-Feb-15	0.08	0.01	0.11	0.12	-	-	-
	17-Mar-15	0.05	0.07	0.97	1.04	-	-	-
	14-Apr-15	-	0.12	0.15	0	-	-	-
	19-May-15	<0.02	0.03	<0.01	0.03	-	-	-
	15-Jun-15	0.13	0.02	<0.01	0.03	-	-	-
	13-Jul-15	<0.02	0.03	<0.01	0.03	-	-	0.008
	18-Aug-15	0.1	0.04	<0.01	0.04	-	-	<0.008
	14-Sep-15	0.09	0.06	<0.01	0.06	-	-	0.048
	19-Oct-15	<0.02	0.04	<0.01	0.05	-	-	0.012
	16-Nov-15	<0.02	<0.01	<0.01	0	-	-	0.069
	14-Dec-15	0.36	0.06	<0.01	0.06	-	-	<0.008
	19-Jan-22	0.09	<0.01	0.01	0.01	0.8	0.8	0.04
Dam 2	04-Apr-13	-	<0.01	<0.01	<0.01	0.8	0.8	0.03
	07-May-13	-	-	-	<0.01	0.7	0.7	0.06
	04-Jun-13	-	-	-	<0.01	1	1	0.09
	27-Nov-13	-	-	-	-	-	-	0.227

-		Nutrients						
		NH3	NO2	NO3	NOx	TKN	TN	TP
	Units				mg/L			
	18-Dec-13	-	-	-	-	-	-	0.541
	21-Jan-14	-	-	-	-	-	-	0.119
	20-Feb-14	-	-	-	<8	-	-	0.018
	26-Mar-14	-	-	-	<8	-	-	0.03
	22-Apr-14	-	-	-	118	-	-	0.042
	28-May-14	-	-	-	30	-	-	0.015
	09-Jul-14	<0.1	-	-	-	-	-	0.033
	18-Aug-14	<0.1	-	-	-	-	0.047	-
	15-Sep-14	<0.1	-	-	-	-	-	-
	13-Oct-14	<0.1	-	-	-	-	-	-
	21-Nov-14	<0.1	<0.01	<0.01	-	-	-	-
	15-Dec-14	<0.1	0.03	<0.01	0.02	-	-	-
	18-Feb-15	0.42	<0.01	0.07	0.07	-	-	-
	17-Mar-15	0.05	<0.01	0.04	0.04	-	-	-
	14-Apr-15	-	<0.01	-	-	-	-	-
	14-Apr-15	-	<0.01	-	-	-	-	-
	19-May-15	0.15	<0.01	<0.01	-	-	-	-
	15-Jun-15	0.12	<0.01	<0.01	-	-	-	-
	13-Jul-15	0.05	<0.01	<0.01	-	-	-	0.03
	18-Aug-15	0.08	<0.01	<0.01	-	-	-	0.082
	14-Sep-15	0.06	<0.01	<0.01	-	-	-	0.05
	16-Nov-15	0.12	0.03	<0.01	0.03	-	-	0.028
	14-Dec-15	0.21	<0.01	<0.01	-	-	-	<0.008
	19-Jan-22	0.03	<0.01	<0.01	<0.01	1	1	0.07
Dam 3	03-Apr-13	-	<0.01	<0.01	<0.01	0.8	0.8	0.06

-		Nutrients						
		NH3	NO2	NO3	NOx	TKN	TN	TP
	Units				mg/L			
	07-May-13	-	-	-	0.09	0.7	0.8	0.12
	04-Jun-13	-	-	-	<0.01	0.8	0.8	0.09
	27-Nov-13	-	-	-	-	-	-	0.374
	18-Dec-13	-	-	-	-	-	-	0.124
	21-Jan-14	-	-	-	-	-	-	0.055
	20-Feb-14	-	-	-	12	-	-	0.02
	26-Mar-14	-	-	-	9	-	-	0.031
	22-Apr-14	-	-	-	84	-	-	0.019
	28-May-14	-	-	-	23	-	-	0.013
	09-Jul-14	0.3	-	-	-	-	-	0.019
	18-Aug-14	<0.1	-	-	-	-	0.044	-
	15-Sep-14	<0.1	-	-	-	-	-	-
	13-Oct-14	<0.1	-	-	-	-	-	-
	21-Nov-14	0.1	<0.01	<0.01	-	-	-	-
	15-Dec-14	<0.1	0.08	<0.01	0.07	-	-	-
	18-Feb-15	0.28	0.01	0.06	0.07	-	-	-
	17-Mar-15	0.06	<0.01	0.03	0.03	-	-	-
	19-May-15	<0.02	<0.01	<0.01	-	-	-	-
	15-Jun-15	0.12	<0.01	<0.01	-	-	-	-
	13-Jul-15	0.09	<0.01	<0.01	-	-	-	0.01
	18-Aug-15	0.07	<0.01	<0.01	-	-	-	<0.008
	16-Nov-15	3.14	0.05	<0.01	0.06	-	-	0.17
	14-Dec-15	0.17	<0.01	<0.01	-	-	-	<0.008
	19-Jan-22	<0.01	<0.01	<0.01	<0.01	0.8	0.8	0.02
Dam 4	03-Apr-13	-	<0.01	<0.01	<0.01	0.7	0.7	0.05

-		Nutrients						
		NH3	NO2	NO3	NOx	TKN	TN	TP
	Units				mg/L			
	07-May-13	-	-	-	<0.01	0.7	0.7	0.06
	04-Jun-13	-	-	-	<0.01	0.9	0.9	0.06
	27-Nov-13	-	-	-	-	-	-	0.104
	18-Dec-13	-	-	-	-	-	-	0.091
	21-Jan-14	-	-	-	-	-	-	0.064
	20-Feb-14	-	-	-	<8	-	-	0.034
	26-Mar-14	-	-	-	<8	-	-	0.041
	22-Apr-14	-	-	-	79	-	-	0.031
	28-May-14	-	-	-	21	-	-	0.142
	09-Jul-14	0.2	-	-	-	-	-	0.057
	18-Aug-14	<0.1	-	-	-	-	0.094	-
	15-Sep-14	<0.1	-	-	-	-	-	-
	13-Oct-14	<0.1	-	-	-	-	-	-
	21-Nov-14	<0.1	<0.01	<0.01	-	-	-	-
	15-Dec-14	<0.1	<0.01	<0.01	-	-	-	-
	15-Jan-15	<0.1	<0.01	<0.01	0.01	-	-	-
	18-Feb-15	0.07	0.01	<0.01	0.01	-	-	-
	17-Mar-15	0.27	<0.01	0.12	0.12	-	-	-
	14-Apr-15	-	0.01	0.03	-	-	-	-
	19-May-15	0.2	<0.01	<0.01	0.01	-	-	-
	15-Jun-15	0.2	0.01	<0.01	0.02	-	-	-
	13-Jul-15	<0.02	0.01	<0.01	0.01	-	-	0.025
	18-Aug-15	0.18	<0.01	<0.01	-	-	-	0.117
	14-Sep-15	0.06	<0.01	<0.01	0.01	-	-	0.071
	19-Oct-15	<0.02	<0.01	<0.01	0.01	-	-	0.253

-		Nutrients						
		NH3	NO2	NO3	NOx	TKN	TN	TP
	Units				mg/L			
	16-Nov-15	0.04	0.03	<0.01	0.03	-	-	0.046
	14-Dec-15	0.19	0.02	<0.01	0.02	-	-	<0.008
	19-Jan-22	0.05	<0.01	0.02	0.02	<0.5	<0.5	0.06
Pit 1	19-Jan-22	<0.01	<0.01	0.47	0.47	<1.0	<1.0	<0.10
QNWB4	20-Dec-21	0.03	<0.01	0.22	0.22	2.3	2.5	0.82
QNWB4	19-Jan-22	0.07	<0.01	0.06	0.06	0.6	0.7	0.15

Table B3. Available water quality data – total metals

Parameter		Total Metals																
		Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
Units		mg/L																
Site	Date																	
Bore 1	04-Apr-13		<0.001	0.12	<0.0001	0.045	<0.001	<0.001	<0.05	<0.001	0.004		<0.001	0.018			<0.01	<0.005
	07-May-13		<0.001	0.08		0.001	0.002	<0.001	<0.05		0.193			0.028				
	09-Jul-14		<0.006			0.012	0.002	0.009	0.019		0.088			0.032				
	18-Aug-14		0.013			<0.001	<0.001	<0.004	<0.001		0.158			0.028				
	15-Sep-14		<0.006			0.004	<0.001	<0.004	<0.001		0.086			0.032				
	13-Oct-14		<0.006			0.015	<0.001	<0.004	<0.001		0.103			0.029				
	21-Nov-14		<0.006			<0.001	<0.001	<0.004	0.005		0.186			0.024				
	15-Dec-14		<0.006			0.005	<0.001	<0.004	0.005		0.219			0.037				
	12-Jan-15		<0.006			0.017	0.003	<0.004	0.05		0.281			0.04				
	18-Feb-15		<0.006			0.04	<0.001	<0.004	0.053		0.128			0.032				
	19-May-15		<0.006			0.003	<0.001	<0.004	0.004		0.025			0.018				
	15-Jun-15		0.021			0.006	<0.001	<0.004	0.005		0.025			0.012				
	13-Jul-15		0.008			0.01	<0.001	<0.004	0.002		0.117			0.021				
	18-Aug-15		0.085			0.116	<0.001	<0.004	0.014		<0.001			0.022				
	14-Sep-15		0.023			0.017	<0.001	<0.004	<0.001		0.064			0.029				
	19-Oct-15		<0.006			0.003	<0.001	<0.004	0.007		0.053			0.015				
	16-Nov-15		<0.006			0.006	<0.001	<0.004	0.015		0.121			0.028				
	14-Dec-15		<0.006			0.004	<0.001	<0.004	0.121		0.052			0.012				
	19-Jan-22	0.02	<0.001	0.13	0.0001	0.009	0.006	0.003	<0.05	<0.001	0.052	<0.0001	<0.001	0.034	0.107	<0.001	<0.01	0.021
Bore 2	04-Apr-13		<0.001	0.1	<0.0001	0.02	0.004	<0.001	<0.05	<0.001	0.221		<0.001	0.037			<0.01	<0.005
	07-May-13		<0.001	0.13		0.036	<0.001	<0.001	<0.05		0.002			0.02				
	09-Jul-14		<0.006			0.043	<0.001	0.006	0.008		0.002			0.02				
	18-Aug-14		<0.006			0.057	<0.001	<0.004	0.003		<0.001			0.021				

	Parameter	Total Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
			mg/L															
	15-Sep-14		<0.006			0.073	<0.001	<0.004	<0.001		<0.001			0.02				
	15-Sep-14		<0.006			0.073	<0.001	<0.004	<0.001		<0.001			0.02				
	13-Oct-14		<0.006			0.086	<0.001	<0.004	<0.001		<0.001			0.018				
	21-Nov-14																	
	15-Dec-14		<0.006			0.09	<0.001	<0.004	0.007		<0.001			0.027				
	12-Jan-15		<0.006			0.082	<0.001	<0.004	0.006		<0.001			0.018				
	18-Feb-15		<0.006			0.008	<0.001	<0.004	0.008		0.264			0.036				
	17-Mar-15																	
	19-May-15		<0.006			0.057	<0.001	<0.004	0.031		0.002			0.014				
	15-Jun-15		0.008			0.067	<0.001	<0.004	0.116		0.008			0.013				
	13-Jul-15		0.031			0.082	<0.001	<0.004	0.005		<0.001			0.013				
	18-Aug-15		0.08			0.032	<0.001	<0.004	0.005		0.113			0.041				
	14-Sep-15		0.029			0.082	<0.001	<0.004	<0.001		<0.001			0.019				
	19-Oct-15		<0.006			0.1	<0.001	<0.004	0.008		<0.001			0.006				
	16-Nov-15		<0.006			0.103	<0.001	<0.004	0.006		<0.001			0.018				
	14-Dec-15		<0.006			0.063	<0.001	<0.004	0.008		<0.001			0.003				
Dam 1	04-Apr-13		<0.001	0.09	<0.0001	0.035	0.005	0.002	0.88	<0.001	0.192		<0.001	0.083			<0.01	<0.005
	07-May-13		<0.001	0.12		0.042	0.003	0.001	0.64		0.102			0.057				
	04-Jun-13		<0.01	<0.1		0.13	0.01	<0.01	3.81		0.24			0.28				
	27-Nov-13		<0.006			0.063	0.013	0.006	1.539		0.122			0.115				
	18-Dec-13		<0.006			0.06	0.01	0.006	1.267		0.09			0.102				
	21-Jan-14		<0.006			0.022	0.008	0.005	0.312		0.051			0.057				
	20-Feb-14		<0.006			0.025	0.018	0.006	1.968		0.13			0.149				
	26-Mar-14		0.006			0.015	0.007	0.011	1.097		0.095			0.088				
	22-Apr-14		<0.006			0.017	0.017	0.004	1.496		0.069			0.093				

	Parameter	Total Metals																
		Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
	Units	mg/L																
	28-May-14		<0.006			0.076	0.008	0.015	2.095		0.147			0.124				
	09-Jul-14		<0.006			0.023	0.003	0.008	0.29		0.074			0.051				
	18-Aug-14		0.006			0.022	<0.001	<0.004	0.157		0.049			0.039				
	15-Sep-14		<0.006			0.046	<0.001	<0.004	0.193		0.068			0.035				
	13-Oct-14		<0.006			0.105	0.005	<0.004	1.059		0.085			0.094				
	21-Nov-14		<0.006			0.012	0.002	<0.004	0.184		0.092			0.039				
	15-Dec-14		<0.006			0.039	0.003	<0.004	0.582		0.076			0.097				
	15-Jan-15		<0.006			0.036	0.003	<0.004	0.384		0.073			0.049				
	18-Feb-15		<0.006			0.044	0.007	<0.004	1.52		0.122			0.12				
	17-Mar-15		<0.006			0.116	<0.001	<0.004	0.659		0.046			0.073				
	19-May-15		<0.006			0.039	<0.001	<0.004	0.332		0.029			0.035				
	15-Jun-15		0.011			0.022	<0.001	<0.004	0.148		0.064			0.022				
	13-Jul-15		0.006			0.045	<0.001	<0.004	0.205		0.044			0.026				
	18-Aug-15		0.016			0.082	<0.001	<0.004	0.3		0.077			0.038				
	14-Sep-15		0.023			0.049	<0.001	<0.004	0.126		0.024			0.027				
	19-Oct-15		<0.006			0.046	<0.001	<0.004	0.152		0.099			0.016				
	16-Nov-15		<0.006			0.057	0.005	0.009	0.851		0.137			0.084				
	14-Dec-15		<0.006			0.012	<0.001	<0.004	0.169		0.032			0.03				
	11-Jul-16	<0.001	<0.001		<0.0002		0.009							0.23				
	14-Dec-16	<0.001	<0.001		<0.0002		0.004							0.093				
	25-Aug-17	<0.001			<0.0002		0.005							0.09				
	19-Dec-17	<0.001			<0.0002		0.004							0.065				
	15-Jun-18		<0.001		<0.0002		0.004							0.063				
	25-Sep-18		<0.001		<0.0002		0.004							0.066				
	11-Mar-19		<0.001		<0.0002		0.004							0.049				

	Parameter	Total Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
		mg/L																
	28-Jun-19		<0.001		<0.0002		0.001							0.024				
	16-Oct-19		0.002		<0.0002		0.016							0.13				
	07-Apr-20		<0.001		<0.0002		0.008							0.091				
	07-Aug-20	<0.001			<0.0002		0.005							0.079				
	06-Jan-21	0.001			<0.0002		0.007							0.063				
	20-Apr-21	<0.001			<0.0002		0.011							0.098				
	20-Dec-21		< 0.001		< 0.0002		0.006							0.14				
	19-Jan-22	0.09	<0.001	<0.05	<0.0001	0.02	0.005	0.008	2	0.001	0.275	<0.0001	<0.001	0.06	0.019	<0.001	<0.01	0.019
Dam 2	04-Apr-13		<0.001	<0.05	<0.0001	0.017	0.003	0.002	0.93	<0.001	0.147		<0.001	0.096			<0.01	<0.005
	07-May-13		<0.001	<0.05		0.017	0.003	0.002	0.6		0.098			0.082				
	04-Jun-13		<0.01	<0.1		0.04	<0.01	<0.01	1.49		0.09			0.14				
	27-Nov-13		<0.006			0.052	0.014	0.005	2.049		0.251			0.125				
	18-Dec-13		0.007			1.104	0.16	0.015	24.058		1.771			0.84				
	21-Jan-14		<0.006			0.084	0.061	0.005	0.999		1.948			0.406				
	20-Feb-14		<0.006			0.017	0.02	<0.004	1.319		0.182			0.155				
	26-Mar-14		0.01			0.003	0.003	0.009	0.236		0.03			0.091				
	22-Apr-14		<0.006			0.021	0.02	<0.004	2.444		0.163			0.115				
	28-May-14		<0.006			0.016	0.003	0.008	0.647		0.041			0.074				
	09-Jul-14		<0.006			0.033	0.004	0.01	0.778		0.034			0.081				
	18-Aug-14		<0.006			0.013	0.025	<0.004	0.58		0.062			0.071				
	15-Sep-14		<0.006			0.036	0.006	<0.004	1.184		0.068			0.083				
	13-Oct-14		0.006			0.029	0.003	<0.004	0.705		0.064			0.053				
	21-Nov-14		0.01			0.007	0.002	<0.004	0.517		0.101			0.044				
	15-Dec-14		<0.006			0.007	<0.001	<0.004	0.165		0.074			0.11				
	18-Feb-15		<0.006			0.012	0.013	<0.004	2.259		0.405			0.165				

	Parameter	Total Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
		mg/L																
	17-Mar-15		<0.006			0.04	0.025	<0.004	2.205		0.627			0.187				
	19-May-15		<0.006			0.05	0.006	<0.004	1.07		0.086			0.105				
	15-Jun-15		0.008			0.068	0.004	<0.004	1.548		0.09			0.106				
	13-Jul-15		0.017			0.032	<0.001	<0.004	0.682		0.04			0.063				
	18-Aug-15		<0.006			0.045	0.003	<0.004	0.926		0.079			0.075				
	14-Sep-15		0.007			0.028	0.004	<0.004	0.525		0.043			0.055				
	16-Nov-15		<0.006			0.144	0.005	<0.004	1.661		0.016			0.097				
	14-Dec-15		<0.006			0.026	<0.001	<0.004	0.251		0.006			0.025				
	11-Jul-16	<0.001	<0.001		<0.0002		0.003							0.15				
	14-Dec-16	<0.001	0.001		<0.0002		0.007							0.18				
	25-Aug-17	<0.001			<0.0002		0.002							0.047				
	19-Dec-17	<0.001			0.0003		0.023							0.15				
	15-Jun-18		<0.001		<0.0002		0.006							0.076				
	07-Apr-20		<0.001		<0.0002		0.007							0.1				
	26-Aug-20		<0.001		<0.0002		0.01							0.1				
	20-Apr-21	0.002			<0.0002		0.093							0.14				
	20-Dec-21		< 0.001		< 0.0002		0.005							0.12				
	19-Jan-22	0.5	<0.001	0.06	<0.0001	0.082	0.009	0.005	2.87	<0.001	0.204	<0.0001	<0.001	0.146	0.018	<0.001	<0.01	0.009
Dam 3	03-Apr-13		<0.001	<0.05	<0.0001	0.045	0.008	0.002	5.8	<0.001	0.105		<0.001	0.168			<0.01	<0.005
	07-May-13		<0.001	<0.05		0.229	0.012	0.005	7.83		0.051			0.737				
	04-Jun-13		<0.01	<0.1		0.37	0.02	<0.01	11.4		0.06			0.81				
	27-Nov-13		<0.006			0.331	0.044	0.009	6.372		0.822			0.378				
	18-Dec-13		<0.006			0.603	0.051	0.011	8.343		0.144			0.505				
	21-Jan-14		<0.006			0.358	0.03	0.006	7.301		0.028			0.234				
	20-Feb-14		<0.006			0.671	0.046	0.007	4.01		0.208			0.485				

	Parameter	Total Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
		mg/L																
	26-Mar-14		<0.006			0.075	0.007	0.008	0.905		0.044			0.079				
	22-Apr-14		<0.006			0.094	0.007	<0.004	1.019		0.019			0.083				
	28-May-14		<0.006			0.039	<0.001	0.01	0.276		0.007			0.048				
	09-Jul-14		<0.006			0.015	0.002	0.01	0.086		0.007			0.033				
	18-Aug-14		<0.006			0.02	0.003	<0.004	0.172		0.023			0.035				
	15-Sep-14		<0.006			0.027	0.002	<0.004	0.271		0.027			0.045				
	13-Oct-14		<0.006			0.028	<0.001	<0.004	0.251		0.04			0.04				
	21-Nov-14		<0.006			0.207	0.013	<0.004	1.644		0.09			0.177				
	15-Dec-14		<0.006			0.297	0.02	<0.004	4.28		0.03			0.243				
	18-Feb-15		<0.006			0.939	0.031	<0.004	4.584		0.114			0.544				
	17-Mar-15		<0.006			0.718	0.029	<0.004	5.178		0.126			0.496				
	19-May-15		<0.006			0.646	0.031	<0.004	4.345		0.064			0.509				
	15-Jun-15		0.015			0.396	0.028	<0.004	3.231		0.06			0.6				
	13-Jul-15		0.02			0.91	0.034	<0.004	5.742		0.082			0.622				
	18-Aug-15		<0.006			1.529	0.047	0.005	9.404		0.076			1.003				
	16-Nov-15		<0.006			4.451	0.295	0.022	59.658		0.381			3.696				
	14-Dec-15		<0.006			0.15	0.009	0.004	1.841		0.038			0.125				
	11-Jul-16		<0.001		<0.0002		0.15							0.63				
	14-Dec-16	<0.001	<0.001		<0.0002		0.003							0.033				
	25-Aug-17	<0.001			<0.0002		0.004							0.045				
	07-Apr-20		0.001		<0.0002		0.036							0.2				
	20-Apr-21	<0.001			<0.0002		0.002							0.045				
	20-Dec-21		< 0.001		< 0.0002		0.009							0.27				
	19-Jan-22	0.17	<0.001	<0.05	<0.0001	0.047	0.003	0.002	0.66	<0.001	0.046	<0.0001	<0.001	0.071	0.026	<0.001	<0.01	<0.005
Dam 4	03-Apr-13		0.001	<0.05	<0.0001	0.027	0.002	0.002	0.8	<0.001	0.09		<0.001	0.035			<0.01	<0.005

	Parameter	Total Metals																
		Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
	Units	mg/L																
	07-May-13		<0.001	<0.05		0.014	0.002	<0.001	0.29		0.082			0.025				
	04-Jun-13		<0.01	<0.1		0.05	<0.01	<0.01	0.82		0.08			0.04				
	27-Nov-13		0.009			0.148	0.011	0.004	1.875		0.122			0.054				
	18-Dec-13		<0.006			0.084	0.005	0.007	0.977		0.02			0.033				
	21-Jan-14		<0.006			0.092	0.013	<0.004	1.044		0.035			0.054				
	20-Feb-14		<0.006			0.043	0.01	0.005	0.922		0.079			0.057				
	26-Mar-14		0.013			0.003	0.002	0.012	0.169		0.056			0.026				
	22-Apr-14		<0.006			<0.001	0.004	<0.004	0.53		0.032			0.025				
	28-May-14		<0.006			0.061	0.007	0.007	1.051		0.313			0.046				
	09-Jul-14		<0.006			0.006	0.003	0.006	0.163		0.057			0.022				
	18-Aug-14		0.008			0.03	0.005	<0.004	0.682		0.144			0.037				
	15-Sep-14		0.006			0.01	0.003	<0.004	0.388		0.191			0.029				
	13-Oct-14		<0.006			0.043	0.002	<0.004	0.529		0.069			0.035				
	21-Nov-14		<0.006			0.016	0.002	<0.004	0.223		0.026			0.028				
	15-Dec-14		<0.006			0.861	0.069	<0.004	7.842		0.256			0.971				
	15-Jan-15		<0.006			0.113	0.009	<0.004	1.308		0.161			0.072				
	18-Feb-15		<0.006			0.9	0.032	<0.004	6.496		0.148			0.348				
	17-Mar-15		<0.006			0.677	0.026	<0.004	6.132		0.18			0.243				
	19-May-15		<0.006			0.33	0.016	<0.004	3.066		0.112			0.137				
	15-Jun-15		0.012			0.22	0.01	<0.004	2.58		0.137			0.121				
	13-Jul-15		0.013			0.232	0.011	<0.004	2.214		0.223			0.109				
	18-Aug-15		0.021			0.566	0.026	0.004	5.608		0.37			0.258				
	14-Sep-15		0.037			0.435	0.024	<0.004	4.186		0.412			0.209				
	19-Oct-15		<0.006			0.902	0.047	0.005	8.747		0.556			0.494				
	16-Nov-15		<0.006			2.89	0.09	0.004	11.226		0.362			1.334				

Parameter		Total Metals																
		Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
Units		mg/L																
	14-Dec-15		<0.006			0.872	0.015	<0.004	2.069		0.052			0.242				
	11-Jul-16	<0.001			<0.0002		0.034							0.63				
	14-Dec-16	0.001	0.001		<0.0002		0.008							0.11				
	25-Aug-17	<0.001			<0.0002		0.003							0.032				
	11-Mar-19		0.001		<0.0002		0.036							0.3				
	28-Jun-19		<0.001		<0.0002		0.013							0.21				
	16-Oct-19		0.003		<0.0002		0.15							2.9				
	07-Apr-20		<0.001		<0.0002		0.009							0.094				
	07-Aug-20	<0.001			<0.0002		0.017							0.21				
	06-Jan-21	<0.001			<0.0002		0.01							0.09				
	20-Apr-21	<0.001			<0.0002		0.005							0.11				
	20-Dec-21		< 0.001		< 0.0002		0.016							0.32				
	19-Jan-22	4.33	0.002	<0.05	<0.0001	1.45	0.022	0.004	9.52	<0.001	0.138	<0.0001	<0.001	0.467	0.018	<0.001	<0.01	0.01
Pit 1	19-Jan-22	5.29	<0.001	<0.05	<0.0001	0.859	0.105	0.019	30	<0.001	0.21	<0.0001	<0.001	4.61	0.012	<0.001	<0.01	0.053
QNWB4	20-Dec-21	10.2	0.001	0.09	0.0004	1.88	0.156	0.042	69.7	0.012	2.44	0.0001	<0.001	4.48	0.119	0.006	0.02	0.209
	19-Jan-22	2.24	0.002	0.11	0.0002	0.406	0.08	0.011	13.2	0.003	3.05	<0.0001	<0.001	1.15	0.075	0.001	<0.01	0.067

Table B4. Available water quality data – dissolved metals

Parameter		Dissolved Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
		mg/L																
Site	Date																	
Bore 1	04-Apr-13		<0.001	0.15	<0.0001	0.042	<0.001	<0.001	<0.05	0.001	0.003	<0.0001	<0.001	0.018	<0.001			<0.01
	07-May-13		<0.001	0.09		0.001	0.001	<0.001	<0.05		0.173			0.023				
	09-Jul-14		<0.006			0.011	<0.001	<0.004	<0.001		0.046			0.017				
	18-Aug-14		0.01			0.002	<0.001	<0.004	0.006		0.177			0.031				
	15-Sep-14		<0.006			<0.001	<0.001	<0.004	<0.001		0.082			0.026				
	13-Oct-14		<0.006			0.018	<0.001	<0.004	<0.001		0.103			0.028				
	21-Nov-14		<0.006			<0.001	<0.001	<0.004	<0.001		0.208			0.025				
	15-Dec-14		<0.006			0.005	<0.001	<0.004	<0.001		0.186			0.028				
	12-Jan-15		<0.006			0.015	<0.001	<0.004	<0.001		0.29			0.034				
	18-Feb-15		<0.006			0.039	<0.001	<0.004	0.002		0.129			0.028				
	19-May-15		<0.006			0.004	<0.001	<0.004	<0.001		0.022			0.016				
	15-Jun-15		<0.006			0.005	<0.001	<0.004	0.006		0.022			0.017				
	13-Jul-15		0.006			0.01	<0.001	<0.004	<0.001		0.114			0.023				
	18-Aug-15		<0.006			0.094	<0.001	<0.004	0.001		0.001			0.014				
	14-Sep-15		0.032			0.018	<0.001	<0.004	<0.001		0.068			0.025				
	19-Oct-15		0.007			0.002	<0.001	<0.004	0.003		0.048			0.012				
	16-Nov-15		0.015			0.005	<0.001	<0.004	0.003		0.119			0.026				
	14-Dec-15		<0.006			<0.001	<0.001	<0.004	0.002		0.047			0.003				
	19-Jan-22	<0.01	<0.001	0.14	0.0001	0.005	0.005	0.002	<0.05	<0.001	0.041	<0.0001	<0.001	0.024	0.088	<0.001	<0.01	0.015
Bore 2	04-Apr-13		<0.001	0.12	<0.0001	0.018	0.004	<0.001	<0.05	<0.001	0.209	<0.0001	<0.001	0.035	<0.001			<0.01
	07-May-13		<0.001	0.12		0.034	<0.001	<0.001	<0.05		<0.001			0.018				
	09-Jul-14		<0.006			0.046	<0.001	<0.004	<0.001		<0.001			0.011				
	18-Aug-14		<0.006			0.057	<0.001	<0.004	<0.001		<0.001			0.016				

	Parameter	Dissolved Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
								mg/L										
	15-Sep-14		<0.006			0.066	<0.001	<0.004	<0.001		<0.001			0.016				
	15-Sep-14		<0.006			0.066	<0.001	<0.004	<0.001		<0.001			0.016				
	13-Oct-14		<0.006			0.087	<0.001	<0.004	<0.001		<0.001			0.016				
	21-Nov-14		<0.006			0.074	<0.001	<0.004	<0.001		<0.001			0.015				
	15-Dec-14		<0.006			0.075	<0.001	<0.004	<0.001		<0.001			0.017				
	12-Jan-15		<0.006			0.091	<0.001	<0.004	<0.001		<0.001			0.019				
	18-Feb-15		<0.006			0.008	<0.001	<0.004	0.001		0.265			0.037				
	19-May-15		<0.006			0.056	<0.001	<0.004	<0.001		<0.001			0.012				
	15-Jun-15		<0.006			0.057	<0.001	<0.004	<0.001		<0.001			0.012				
	13-Jul-15		0.015			0.078	<0.001	<0.004	<0.001		<0.001			0.011				
	18-Aug-15		0.015			0.025	<0.001	<0.004	0.009		0.087			0.036				
	14-Sep-15		0.034			0.087	<0.001	<0.004	<0.001		<0.001			0.017				
	19-Oct-15		<0.006			0.091	<0.001	<0.004	<0.001		<0.001			0.006				
	16-Nov-15		0.007			0.107	<0.001	<0.004	<0.001		<0.001			0.018				
	14-Dec-15		<0.006			0.064	<0.001	<0.004	0.001		<0.001			<0.003				
Dam 1	04-Apr-13		<0.001	0.07	<0.0001	0.009	<0.001	0.001	0.12	<0.001	0.033	<0.0001	<0.001	0.05	<0.001			<0.01
	07-May-13		<0.001	0.13		0.016	<0.001	0.001	<0.05		0.005			0.026				
	04-Jun-13		<0.01	<0.1		0.02	<0.01	<0.01	0.34		0.17			0.09				
	27-Nov-13		<0.006			0.004	<0.001	<0.004	<0.001		<0.001			0.036				
	18-Dec-13		<0.006			0.004	<0.001	<0.004	0.01		<0.001			0.038				
	21-Jan-14		<0.006			0.005	<0.001	<0.004	<0.001		<0.001			0.034				
	20-Feb-14		<0.006			0.016	0.004	<0.004	0.97		0.102			0.106				
	26-Mar-14		0.007			<0.001	<0.001	<0.004	0.559		0.058			0.077				
	22-Apr-14		<0.006			0.005	<0.001	<0.004	0.592		0.036			0.073				
	28-May-14		<0.006			0.015	0.002	0.02	0.768		0.061			0.071				

	Parameter	Dissolved Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
		mg/L																
	09-Jul-14		<0.006			0.012	<0.001	<0.004	<0.001		0.023			0.027				
	18-Aug-14		0.006			0.014	<0.001	<0.004	<0.001		0.011			0.026				
	15-Sep-14		<0.006			0.028	<0.001	<0.004	0.015		0.02			0.022				
	13-Oct-14		<0.006			0.047	<0.001	<0.004	<0.001		0.05			0.026				
	21-Nov-14		<0.006			0.001	<0.001	<0.004	<0.001		0.079			0.023				
	15-Dec-14		<0.006			0.011	<0.001	<0.004	0.008		0.042			0.04				
	15-Jan-15		<0.006			0.012	<0.001	<0.004	0.001		0.031			0.021				
	18-Feb-15		<0.006			0.011	0.002	<0.004	0.741		0.018			0.085				
	17-Mar-15		<0.006			0.069	<0.001	<0.004	0.002		0.017			0.029				
	19-May-15		<0.006			0.021	<0.001	<0.004	0.003		0.003			0.02				
	15-Jun-15		<0.006			0.015	<0.001	<0.004	0.003		0.044			0.022				
	13-Jul-15		0.006			0.032	<0.001	<0.004	<0.001		0.015			0.015				
	18-Aug-15		0.018			0.053	<0.001	<0.004	0.004		0.045			0.019				
	14-Sep-15		0.038			0.041	<0.001	<0.004	0.001		<0.001			0.021				
	19-Oct-15		<0.006			0.033	<0.001	<0.004	0.007		0.052			0.009				
	16-Nov-15		<0.006			0.017	<0.001	<0.004	0.008		0.057			0.029				
	14-Dec-15		<0.006			0.005	<0.001	<0.004	0.004		0.019			0.014				
	19-Jan-22	<0.01	<0.001	0.06	<0.0001	0.003	0.002	0.003	<0.05	<0.001	0.115	<0.0001	<0.001	0.05	0.029	<0.001	<0.01	<0.005
Dam 2	04-Apr-13		<0.001	<0.05	<0.0001	0.006	<0.001	0.002	0.49	<0.001	0.035	<0.0001	<0.001	0.076	<0.001			<0.01
	07-May-13		<0.001	<0.05		0.004	<0.001	0.001	0.14		0.019			0.062				
	04-Jun-13		<0.01	<0.1		0.02	<0.01	<0.01	0.51		0.07			0.11				
	21-Jan-14		<0.006			0.01	0.046	0.004	0.015		1.839			0.359				
	20-Feb-14		<0.006			0.013	0.004	<0.004	0.727		0.138			0.131				
	26-Mar-14		0.007			<0.001	<0.001	<0.004	0.129		0.007			0.085				
	22-Apr-14		<0.006			0.004	<0.001	<0.004	0.631		0.004			0.068				

	Parameter	Dissolved Metals															
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
		mg/L																
	28-May-14		<0.006			0.007	<0.001	<0.004	0.289		0.009			0.062				
	09-Jul-14		<0.006			0.003	<0.001	<0.004	0.055		0.004			0.058				
	18-Aug-14		<0.006			<0.001	<0.001	<0.004	0.124		0.015			0.052				
	15-Sep-14		0.008			<0.001	0.003	<0.004	0.108		0.004			0.041				
	13-Oct-14		0.012			0.007	<0.001	<0.004	0.031		0.004			0.028				
	21-Nov-14		0.006			<0.001	0.002	<0.004	0.281		0.115			0.084				
	15-Dec-14		<0.006			0.002	<0.001	<0.004	0.022		0.066			0.077				
	18-Feb-15		<0.006			0.006	0.01	<0.004	1.791		0.385			0.154				
	17-Mar-15		<0.006			0.013	0.004	<0.004	1.187		0.219			0.135				
	19-May-15		<0.006			<0.001	<0.001	<0.004	0.023		0.008			0.071				
	15-Jun-15		0.006			<0.001	<0.001	<0.004	0.016		0.007			0.057				
	13-Jul-15		<0.006			<0.001	<0.001	<0.004	0.015		<0.001			0.044				
	18-Aug-15		0.026			0.008	<0.001	<0.004	0.027		0.005			0.04				
	14-Sep-15		0.033			0.004	<0.001	<0.004	0.015		<0.001			0.034				
	16-Nov-15		0.008			0.043	<0.001	<0.004	0.005		0.006			0.03				
	14-Dec-15		<0.006			0.013	<0.001	<0.004	0.006		<0.001			0.013				
	19-Jan-22	<0.01	<0.001	0.06	<0.0001	0.003	0.001	0.002	<0.05	<0.001	0.111	<0.0001	<0.001	0.038	0.033	<0.001	<0.01	<0.005
Dam 3	03-Apr-13		<0.001	<0.05	<0.0001	0.005	0.003	0.002	0.19	<0.001	0.072	<0.0001	<0.001	0.047	<0.001			<0.01
	07-May-13		<0.001	<0.05		0.009	<0.001	0.002	0.21		0.007			0.045				
	04-Jun-13		<0.01	<0.1		<0.01	<0.01	<0.01	0.22		0.01			0.04				
	27-Nov-13		<0.006			0.003	<0.001	0.004	<0.001		0.003			0.035				
	21-Jan-14		<0.006			0.009	<0.001	<0.004	<0.001		0.01			0.024				
	20-Feb-14		<0.006			0.028	0.007	<0.004	0.066		0.127			0.052				
	26-Mar-14		0.037			0.004	<0.001	<0.004	0.086		0.028			0.026				
	22-Apr-14		<0.006			0.048	<0.001	<0.004	0.277		0.004			0.033				

	Parameter	Dissolved Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
		mg/L																
	28-May-14		<0.006			0.03	<0.001	0.004	0.133		0.003			0.031				
	09-Jul-14		<0.006			0.006	<0.001	<0.004	0.003		<0.001			0.018				
	18-Aug-14		0.008			0.005	<0.001	<0.004	0.003		<0.001			0.016				
	15-Sep-14		<0.006			<0.001	<0.001	<0.004	0.003		<0.001			0.014				
	13-Oct-14		<0.006			0.008	<0.001	<0.004	0.004		<0.001			0.014				
	21-Nov-14		<0.006			<0.001	<0.001	<0.004	0.001		0.003			0.025				
	15-Dec-14		<0.006			0.012	<0.001	<0.004	0.054		<0.001			0.025				
	18-Feb-15		<0.006			0.012	<0.001	<0.004	0.016		0.057			0.034				
	17-Mar-15		<0.006			0.048	<0.001	<0.004	0.3		0.089			0.065				
	19-May-15		<0.006			0.005	<0.001	<0.004	0.026		0.01			0.028				
	15-Jun-15		<0.006			0.008	<0.001	<0.004	0.048		0.002			0.025				
	13-Jul-15		<0.006			0.008	<0.001	<0.004	0.029		<0.001			0.02				
	18-Aug-15		0.013			0.016	<0.001	<0.004	0.016		<0.001			0.019				
	16-Nov-15		<0.006			2.453	0.094	0.009	23.289		0.107			1.356				
	14-Dec-15		<0.006			<0.001	<0.001	<0.004	0.011		0.003			0.031				
	19-Jan-22	<0.01	<0.001	<0.05	<0.0001	0.015	<0.001	0.002	<0.05	<0.001	0.013	<0.0001	<0.001	0.024	0.015	<0.001	<0.01	0.005
Dam 4	03-Apr-13		<0.001	<0.05	<0.0001	0.008	0.001	0.004	0.31	<0.001	0.033	<0.0001	<0.001	0.024	<0.001			<0.01
	07-May-13		<0.001	<0.05		0.002	<0.001	<0.001	<0.05		0.002			0.02				
	04-Jun-13		<0.01	<0.1		<0.01	<0.01	<0.01	<0.05		<0.01			0.02				
	27-Nov-13		<0.006			0.003	<0.001	<0.004	<0.001		<0.001			0.012				
	18-Dec-13		<0.006			0.041	<0.001	<0.004	0.023		<0.001			0.031				
	21-Jan-14		0.015			0.004	<0.001	<0.004	<0.001		0.004			0.019				
	20-Feb-14		<0.006			0.029	<0.001	<0.004	0.449		0.056			0.032				
	26-Mar-14		0.027			<0.001	<0.001	<0.004	0.042		0.004			0.029				
	22-Apr-14		<0.006			<0.001	<0.001	<0.004	0.199		0.001			0.015				

	Parameter	Dissolved Metals																
	Units	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Sr	U	V	Zn
		mg/L																
	28-May-14		<0.006			0.003	<0.001	<0.004	0.075		0.007			0.017				
	09-Jul-14		<0.006			<0.001	<0.001	<0.004	0.032		0.004			0.018				
	18-Aug-14		0.007			<0.001	<0.001	<0.004	0.055		0.025			0.024				
	15-Sep-14		<0.006			<0.001	<0.001	<0.004	0.015		0.005			0.02				
	13-Oct-14		<0.006			0.008	<0.001	<0.004	0.017		<0.001			0.016				
	21-Nov-14		<0.006			<0.001	<0.001	<0.004	0.014		<0.001			0.011				
	15-Dec-14		<0.006			0.074	0.003	<0.004	0.229		0.084			0.038				
	15-Jan-15		<0.006			0.006	<0.001	<0.004	0.014		0.01			0.021				
	18-Feb-15		<0.006			0.002	<0.001	<0.004	0.061		0.007			0.025				
	17-Mar-15		<0.006			0.018	<0.001	<0.004	0.156		0.067			0.027				
	19-May-15		<0.006			<0.001	<0.001	<0.004	0.012		0.013			0.026				
	15-Jun-15		<0.006			<0.001	<0.001	<0.004	0.009		0.004			0.019				
	13-Jul-15		<0.006			<0.001	<0.001	<0.004	0.006		<0.001			0.018				
	18-Aug-15		<0.006			0.009	<0.001	<0.004	0.012		0.01			0.022				
	14-Sep-15		0.011			0.004	<0.001	<0.004	0.003		<0.001			0.025				
	19-Oct-15		<0.006			0.001	<0.001	<0.004	0.028		0.053			0.032				
	16-Nov-15		<0.006			0.979	0.011	<0.004	0.065		0.234			0.049				
	14-Dec-15		<0.006			0.557	<0.001	<0.004	0.02		0.015			0.012				
	19-Jan-22	<0.01	<0.001	<0.05	<0.0001	0.034	<0.001	0.001	<0.05	<0.001	0.02	<0.0001	<0.001	0.02	0.012	<0.001	<0.01	<0.005
Pit 1	19-Jan-22	<0.01	<0.001	0.05	<0.0001	0.045	<0.001	0.002	<0.05	<0.001	0.022	<0.0001	<0.001	0.022	0.01	<0.001	<0.01	<0.005
QNWB4	20-Dec-21	<0.01	<0.001	0.1	0.0002	0.002	0.032	0.008	<0.05	<0.001	0.971	<0.0001	0.001	0.166	0.106	0.003	<0.01	0.035
	19-Jan-22	<0.01	0.001	0.11	0.0001	0.001	0.039	0.001	0.06	<0.001	2.01	<0.0001	<0.001	0.222	0.067	<0.001	<0.01	0.014

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2137201**	Page	: 1 of 7
Amendment	: **1**		
Client	: **WARATAH COAL**	Laboratory	: Environmental Division Brisbane
Contact	: JOHN BERNAL	Contact	: Customer Services EB
Address	: Level 17, 240 Queen St, Brisbane, 4000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3532 3842	Telephone	: +61-7-3243 7222
Project	: Queensland Nickel	Date Samples Received	: 20-Dec-2021 20:41
Order number	: ----	Date Analysis Commenced	: 21-Dec-2021
C-O-C number	: ----	Issue Date	: 12-Jan-2022 14:45
Sampler	: BILL STACEY		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 1		
No. of samples analysed	: 1		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) . However, the difference is within experimental variation of the methods.
- Amendment (12/1/22): This report has been amended to alter the project reference . All analysis results are as per the previous report.
- EG035T (Total Mercury): Positive mercury results have been confirmed by re-extraction and re-analysis.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	QN-W4	----	----	----	----
				Sampling date / time	20-Dec-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2137201-001	--------	--------	--------	--------
					Result	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**1450**	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**1030**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**622**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**622**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**36**	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**164**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**19**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**179**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**44**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**1**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Dysprosium	7429-91-6	0.001	mg/L		<0.001	----	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Bismuth	7440-69-9	0.001	mg/L		<0.001	----	----	----	----
Erbium	7440-52-0	0.001	mg/L		<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.10**	----	----	----	----
Europium	7440-53-1	0.001	mg/L		<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.106**	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.078**	----	----	----	----
Gadolinium	7440-54-2	0.001	mg/L		<0.001	----	----	----	----
Titanium	7440-32-6	0.01	mg/L		<0.01	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Gallium	7440-55-3	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		**0.0002**	----	----	----	----
Hafnium	7440-58-6	0.01	mg/L		<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	QN-W4	----	----	----	----
				Sampling date / time	20-Dec-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2137201-001	--------	--------	--------	--------	
				Result	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS - Continued									
Tellurium	22541-49-7	0.005	mg/L	<0.005	----	----	----	----	
Cobalt	7440-48-4	0.001	mg/L	**0.032**	----	----	----	----	
Holmium	7440-60-0	0.001	mg/L	<0.001	----	----	----	----	
Uranium	7440-61-1	0.001	mg/L	**0.003**	----	----	----	----	
Caesium	7440-46-2	0.001	mg/L	<0.001	----	----	----	----	
Chromium	7440-47-3	0.001	mg/L	**0.002**	----	----	----	----	
Indium	7440-74-6	0.001	mg/L	<0.001	----	----	----	----	
Copper	7440-50-8	0.001	mg/L	**0.008**	----	----	----	----	
Lanthanum	7439-91-0	0.001	mg/L	<0.001	----	----	----	----	
Rubidium	7440-17-7	0.001	mg/L	**0.002**	----	----	----	----	
Lithium	7439-93-2	0.001	mg/L	**0.008**	----	----	----	----	
Lutetium	7439-94-3	0.001	mg/L	<0.001	----	----	----	----	
Thorium	7440-29-1	0.001	mg/L	<0.001	----	----	----	----	
Cerium	7440-45-1	0.001	mg/L	<0.001	----	----	----	----	
Manganese	7439-96-5	0.001	mg/L	**0.971**	----	----	----	----	
Neodymium	7440-00-8	0.001	mg/L	<0.001	----	----	----	----	
Molybdenum	7439-98-7	0.001	mg/L	**0.001**	----	----	----	----	
Praseodymium	7440-10-0	0.001	mg/L	<0.001	----	----	----	----	
Nickel	7440-02-0	0.001	mg/L	**0.166**	----	----	----	----	
Samarium	7440-19-9	0.001	mg/L	<0.001	----	----	----	----	
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	
Terbium	7440-27-9	0.001	mg/L	<0.001	----	----	----	----	
Antimony	7440-36-0	0.001	mg/L	**0.001**	----	----	----	----	
Thulium	7440-30-4	0.001	mg/L	<0.001	----	----	----	----	
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	
Ytterbium	7440-64-4	0.001	mg/L	<0.001	----	----	----	----	
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	----	----	
Yttrium	7440-65-5	0.001	mg/L	<0.001	----	----	----	----	
Thallium	7440-28-0	0.001	mg/L	<0.001	----	----	----	----	
Zirconium	7440-67-7	0.005	mg/L	<0.005	----	----	----	----	
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----	
Zinc	7440-66-6	0.005	mg/L	**0.035**	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----	
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	**10.2**	----	----	----	----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	QN-W4	----	----	----	----
				Sampling date / time	20-Dec-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2137201-001	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Dysprosium	7429-91-6	0.001	mg/L		<0.001	----	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.001**	----	----	----	----
Bismuth	7440-69-9	0.001	mg/L		<0.001	----	----	----	----
Erbium	7440-52-0	0.001	mg/L		<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.09**	----	----	----	----
Europium	7440-53-1	0.001	mg/L		<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.119**	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.119**	----	----	----	----
Gadolinium	7440-54-2	0.001	mg/L		<0.001	----	----	----	----
Titanium	7440-32-6	0.01	mg/L		**0.25**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Gallium	7440-55-3	0.001	mg/L		**0.003**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		**0.0004**	----	----	----	----
Hafnium	7440-58-6	0.01	mg/L		<0.01	----	----	----	----
Tellurium	22541-49-7	0.005	mg/L		<0.005	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.156**	----	----	----	----
Holmium	7440-60-0	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		**0.006**	----	----	----	----
Caesium	7440-46-2	0.001	mg/L		<0.001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		**1.88**	----	----	----	----
Indium	7440-74-6	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.042**	----	----	----	----
Lanthanum	7439-91-0	0.001	mg/L		**0.003**	----	----	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.006**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L		**0.012**	----	----	----	----
Lutetium	7439-94-3	0.001	mg/L		<0.001	----	----	----	----
Thorium	7440-29-1	0.001	mg/L		**0.002**	----	----	----	----
Cerium	7440-45-1	0.001	mg/L		**0.010**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**2.44**	----	----	----	----
Neodymium	7440-00-8	0.001	mg/L		**0.003**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Praseodymium	7440-10-0	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**4.48**	----	----	----	----
Samarium	7440-19-9	0.001	mg/L		<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	QN-W4	----	----	----	----
				Sampling date / time	20-Dec-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2137201-001	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Lead	7439-92-1	0.001	mg/L		**0.012**	----	----	----	----
Terbium	7440-27-9	0.001	mg/L		<0.001	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	----	----	----	----
Thulium	7440-30-4	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Ytterbium	7440-64-4	0.001	mg/L		<0.001	----	----	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	----	----	----	----
Yttrium	7440-65-5	0.001	mg/L		**0.003**	----	----	----	----
Thallium	7440-28-0	0.001	mg/L		<0.001	----	----	----	----
Zirconium	7440-67-7	0.005	mg/L		**0.006**	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		**0.02**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.209**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		**69.7**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		**0.0001**	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.22**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.22**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**2.3**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**2.5**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.82**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Sample ID	QN-W4	----	----	----	----
				Sampling date / time	20-Dec-2021 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2137201-001	--------	--------	--------	--------
					Result	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**17.8**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**17.6**	----	----	----	----
ø **Ionic Balance**	----	0.01	%		**0.52**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2201420**	Page	: 1 of 13
Client	: **WARATAH COAL**	Laboratory	: Environmental Division Brisbane
Contact	: JOHN BERNAL	Contact	: Customer Services EB
Address	: C/- ALS EMERALD 9 FOUNDRY RD EMERALD 4720	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3532 3842	Telephone	: +61-7-3243 7222
Project	: Queensland Nickel	Date Samples Received	: 20-Jan-2022 11:15
Order number	: BN290-18	Date Analysis Commenced	: 21-Jan-2022
C-O-C number	: ----	Issue Date	: 28-Jan-2022 12:45
Sampler	: BILL STACEY		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Thomas Donovan	Senior Organic Chemist - PFAS	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK061G (Total Kjeldahl Nitrogen as N) / EK067G (Total Phosphorus as P): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- It has been noted that EK055G (Ammonia as N) is greater than EK061G (Total Kjeldahl Nitrogen as N) for sample EB2201420_001 (Bore 1), however this difference is within the limits of experimental variation.
- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- EG020-F (Dissolved Metals by ICP-MS) were found to be higher than EG020-T (Total Metals by ICP-MS) for some samples. This was confirmed by re-digestion and re-analysis.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Bore 1	Dam 1	Dam 2	Dam 3	Dam 4
			Sampling date / time	19-Jan-2022 08:40	19-Jan-2022 08:10	19-Jan-2022 08:25	19-Jan-2022 10:10	19-Jan-2022 09:30
Compound	CAS Number	LOR	Unit	EB2201420-001	EB2201420-002	EB2201420-003	EB2201420-004	EB2201420-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**2900**	**150**	**171**	**92**	**99**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**1990**	**172**	**158**	**83**	**93**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**694**	**70**	**82**	**43**	**46**
Total Alkalinity as CaCO3	----	1	mg/L	**694**	**70**	**82**	**43**	**46**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**63**	**2**	**1**	**2**	**2**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**631**	**9**	**9**	**4**	**7**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**8**	**3**	**3**	**2**	**1**
Magnesium	7439-95-4	1	mg/L	**311**	**12**	**15**	**8**	**7**
Sodium	7440-23-5	1	mg/L	**74**	**10**	**9**	**4**	**8**
Potassium	7440-09-7	1	mg/L	**6**	<1	**1**	**4**	**2**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	**0.14**	**0.06**	**0.06**	<0.05	<0.05
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	**0.088**	**0.033**	**0.029**	**0.015**	**0.012**
Barium	7440-39-3	0.001	mg/L	**0.018**	**0.016**	**0.015**	**0.011**	**0.009**
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	<0.0001	<0.0001	<0.0001	<0.0001
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Bore 1	Dam 1	Dam 2	Dam 3	Dam 4
				Sampling date / time	19-Jan-2022 08:40	19-Jan-2022 08:10	19-Jan-2022 08:25	19-Jan-2022 10:10	19-Jan-2022 09:30
Compound	CAS Number	LOR	Unit		EB2201420-001	EB2201420-002	EB2201420-003	EB2201420-004	EB2201420-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L		**0.005**	**0.001**	**0.002**	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		**0.005**	**0.003**	**0.003**	**0.015**	**0.034**
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.002**	**0.003**	**0.002**	**0.001**
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.005**	<0.001	<0.001	**0.002**	**0.001**
Lithium	7439-93-2	0.001	mg/L		**0.003**	<0.001	<0.001	<0.001	<0.001
Lutetium	7439-94-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.041**	**0.111**	**0.115**	**0.013**	**0.020**
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		**0.024**	**0.038**	**0.050**	**0.024**	**0.020**
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.015**	<0.005	<0.005	**0.005**	<0.005
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	**0.09**	**0.50**	**0.17**	**4.33**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	Bore 1	Dam 1	Dam 2	Dam 3	Dam 4
				Sampling date / time	19-Jan-2022 08:40	19-Jan-2022 08:10	19-Jan-2022 08:25	19-Jan-2022 10:10	19-Jan-2022 09:30
					EB2201420-001	EB2201420-002	EB2201420-003	EB2201420-004	EB2201420-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L		**0.13**	<0.05	**0.06**	<0.05	<0.05
Europium	7440-53-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.107**	**0.019**	**0.018**	**0.026**	**0.018**
Barium	7440-39-3	0.001	mg/L		**0.011**	**0.007**	**0.008**	**0.004**	**0.020**
Gadolinium	7440-54-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	**0.17**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		**0.0001**	<0.0001	<0.0001	<0.0001	<0.0001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L		**0.006**	**0.005**	**0.009**	**0.003**	**0.022**
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		**0.009**	**0.020**	**0.082**	**0.047**	**1.45**
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.003**	**0.008**	**0.005**	**0.002**	**0.004**
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.001**
Rubidium	7440-17-7	0.001	mg/L		**0.006**	<0.001	**0.002**	**0.003**	**0.004**
Lithium	7439-93-2	0.001	mg/L		**0.003**	<0.001	<0.001	<0.001	<0.001
Lutetium	7439-94-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Manganese	7439-96-5	0.001	mg/L		**0.052**	**0.275**	**0.204**	**0.046**	**0.138**
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		**0.034**	**0.060**	**0.146**	**0.071**	**0.467**
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Bore 1	Dam 1	Dam 2	Dam 3	Dam 4
				Sampling date / time	19-Jan-2022 08:40	19-Jan-2022 08:10	19-Jan-2022 08:25	19-Jan-2022 10:10	19-Jan-2022 09:30
Compound	CAS Number	LOR	Unit		EB2201420-001	EB2201420-002	EB2201420-003	EB2201420-004	EB2201420-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Lead	7439-92-1	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	<0.001
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.021**	**0.019**	**0.009**	<0.005	**0.010**
Iron	7439-89-6	0.05	mg/L		<0.05	**2.00**	**2.87**	**0.66**	**9.52**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	**0.1**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**28.3**	**0.09**	**0.03**	<0.01	**0.05**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.31**	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**9.79**	**0.01**	<0.01	<0.01	**0.02**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**10.1**	**0.01**	<0.01	<0.01	**0.02**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**26.9**	**0.8**	**1.0**	**0.8**	<0.5
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**37.0**	**0.8**	**1.0**	**0.8**	<0.5
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**3.56**	**0.04**	**0.07**	**0.02**	**0.06**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Bore 1	Dam 1	Dam 2	Dam 3	Dam 4
				Sampling date / time	19-Jan-2022 08:40	19-Jan-2022 08:10	19-Jan-2022 08:25	19-Jan-2022 10:10	19-Jan-2022 09:30
Compound	CAS Number	LOR	Unit		EB2201420-001	EB2201420-002	EB2201420-003	EB2201420-004	EB2201420-005
					Result	Result	Result	Result	Result
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**33.0**	**1.69**	**1.91**	**1.01**	**1.16**
ø **Total Cations**	----	0.01	meq/L		**29.4**	**1.57**	**1.80**	**1.03**	**1.02**
ø **Ionic Balance**	----	0.01	%		**5.79**	**----**	**----**	**----**	**----**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**98.2**	**101**	**99.0**	**99.2**	**97.2**
Toluene-D8	2037-26-5	2	%		**99.9**	**99.5**	**101**	**101**	**99.9**
4-Bromofluorobenzene	460-00-4	2	%		**113**	**110**	**114**	**110**	**110**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Pit 1	QN-W4	----	----	----
			Sampling date / time	19-Jan-2022 09:00	19-Jan-2022 09:15	----	----	----
Compound	CAS Number	LOR	Unit	EB2201420-006	EB2201420-007	--------	--------	--------
				Result	Result	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	96	1600	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	406	1140	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	14	688	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	14	688	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	9	31	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	15	192	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	1	10	----	----	----
Magnesium	7439-95-4	1	mg/L	6	219	----	----	----
Sodium	7440-23-5	1	mg/L	13	47	----	----	----
Potassium	7440-09-7	1	mg/L	1	2	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.001	----	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	----	----	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	----	----	----
Boron	7440-42-8	0.05	mg/L	0.05	0.11	----	----	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L	0.010	0.067	----	----	----
Barium	7440-39-3	0.001	mg/L	0.007	0.079	----	----	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	----	----	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.0001	----	----	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Pit 1	QN-W4	----	----	----
				Sampling date / time	19-Jan-2022 09:00	19-Jan-2022 09:15	----	----	----
Compound	CAS Number	LOR	Unit		EB2201420-006	EB2201420-007	--------	--------	--------
					Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.039**	----	----	----
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	----	----	----
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	----	----	----
Chromium	7440-47-3	0.001	mg/L		**0.045**	**0.001**	----	----	----
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.001**	----	----	----
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	----	----	----
Rubidium	7440-17-7	0.001	mg/L		<0.001	**0.003**	----	----	----
Lithium	7439-93-2	0.001	mg/L		<0.001	**0.006**	----	----	----
Lutetium	7439-94-3	0.001	mg/L		<0.001	<0.001	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	----	----	----
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.022**	**2.01**	----	----	----
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	----	----	----
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.022**	**0.222**	----	----	----
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	----	----	----
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	----	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	----	----	----
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	----	----	----
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	----	----	----
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.014**	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	**0.06**	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**5.29**	**2.24**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Pit 1	QN-W4	----	----	----
				Sampling date / time	19-Jan-2022 09:00	19-Jan-2022 09:15	----	----	----
Compound	CAS Number	LOR	Unit		EB2201420-006	EB2201420-007	--------	--------	--------
					Result	Result	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.002**	----	----	----
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	----	----	----
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	**0.11**	----	----	----
Europium	7440-53-1	0.001	mg/L		<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.012**	**0.075**	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.018**	**0.117**	----	----	----
Gadolinium	7440-54-2	0.001	mg/L		<0.001	<0.001	----	----	----
Titanium	7440-32-6	0.01	mg/L		**0.03**	**0.06**	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	**0.0002**	----	----	----
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	----	----	----
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.105**	**0.080**	----	----	----
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	**0.001**	----	----	----
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	----	----	----
Chromium	7440-47-3	0.001	mg/L		**0.859**	**0.406**	----	----	----
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.019**	**0.011**	----	----	----
Lanthanum	7439-91-0	0.001	mg/L		**0.001**	<0.001	----	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.002**	**0.003**	----	----	----
Lithium	7439-93-2	0.001	mg/L		<0.001	**0.007**	----	----	----
Lutetium	7439-94-3	0.001	mg/L		<0.001	<0.001	----	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	----	----	----
Cerium	7440-45-1	0.001	mg/L		**0.001**	**0.003**	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.210**	**3.05**	----	----	----
Neodymium	7440-00-8	0.001	mg/L		**0.001**	<0.001	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	----	----	----
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L		**4.61**	**1.15**	----	----	----
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Pit 1	QN-W4	----	----	----
				Sampling date / time	19-Jan-2022 09:00	19-Jan-2022 09:15	----	----	----
Compound	CAS Number	LOR	Unit		EB2201420-006	EB2201420-007	--------	--------	--------
					Result	Result	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Lead	7439-92-1	0.001	mg/L		<0.001	**0.003**	----	----	----
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	----	----	----
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	----	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	----	----	----
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	----	----	----
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	----	----	----
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.053**	**0.067**	----	----	----
Iron	7439-89-6	0.05	mg/L		**30.0**	**13.2**	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	<0.1	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	**0.07**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.47**	**0.06**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.47**	**0.06**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<1.0	**0.6**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<1.0	**0.7**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.10	**0.15**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Pit 1	QN-W4	----	----	----
				Sampling date / time	19-Jan-2022 09:00	19-Jan-2022 09:15	----	----	----
Compound	CAS Number	LOR	Unit		EB2201420-006	EB2201420-007	--------	--------	--------
					Result	Result	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**0.93**	----	----	----	----
ø **Total Anions**	----	0.01	meq/L		----	**19.8**	----	----	----
ø **Total Cations**	----	0.01	meq/L		**1.13**	**20.6**	----	----	----
ø **Ionic Balance**	----	0.01	%		----	**2.01**	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	**110**	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	**110**	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ **Total Xylenes**	----	2	µg/L		<2	<2	----	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**98.4**	**101**	----	----	----
Toluene-D8	2037-26-5	2	%		**99.8**	**101**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**110**	**113**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66	138
Toluene-D8	2037-26-5	79	120
4-Bromofluorobenzene	460-00-4	74	118

Appendix C

Bore Logs

C1 – On-site Water Bores

Bore Report

From Year:

Registered Number	Facility Type	Facility Status	Drilled Date	Office	Shire
161522	Sub-Artesian Facility	Existing	19/10/2012	Rockhampton	4530 - LIVINGSTONE SHIRE COUNCIL

Details

Description			
Parish	6000 - NO LONGER USED		
Original Name			
Driller Name	DART, GREGORY		
Drill Company	BURNETT & GLADSTONE DRILLING		
Const Method	ROTARY AIR		
Bore Line			
D/O File No		**Polygon**	
R/O File No		**Equipment**	
H/O File No		**RN of Bore Replaced**	
Log Received Date	16/09/2016	**Data Owner**	
Roles			

Location

Latitude	23-01-37	**Basin**	1300
Longitude	150-18-21	**Sub-area**	
GIS Latitude	-23.02686355	**Lot**	176
GIS Longitude	150.30593816	**Plan**	LN473
Easting	223892		
Northing	7450966	**Map Scale**	
Zone	56	**Map Series**	
Accuracy		**Map No**	
GPS Accuracy		**Map Name**	
Checked	Yes	**Prog Section**	

Casing

5 ***records for RN*** **161522**

Pipe	Date	Rec	Top (m)	Bottom (m)	Material Description	Mat Size (mm)	Size Desc	Outside Diameter (mm)
A	19/10/2012	1	0.00	17.00	Polyvinyl Chloride	9.000	WT - Wall Thickness	170
A	19/10/2012	2	8.00	17.00	Perforated or Slotted Casing	1.500	AP - Aperture Size	170
X	19/10/2012	3	0.00	6.00	Grout			250
X	19/10/2012	4	6.00	7.00	Cuttings or other fill between casing and hole wall			250
X	19/10/2012	5	7.00	17.00	Gravel Pack			250

Bore Report

From Year:

Strata Logs

3 *records for RN* **161522**

Rec	Top (m)	Bottom (m)	Strata Description
1	0.00	1.00	TOPSOIL
2	1.00	5.00	BROWN CLAY
3	5.00	21.50	BLUE GREEN YELLOW RED ROCK

Stratigraphies

0 *records for RN* **161522**

Aquifers

1 *records for RN* **161522**

Rec	Top (m)	Bottom (m)	Lithology	Date	SWL (m)	Flow	Quality	Yield (L/s)	Contr	Cond	Formation Name
1	7.00		XXXX - Unknown	19/10/2012	-5.80	N	EC 1300	8.84	Y	PS	PRINCHESTER SERPENTINITE

Pump Tests Part 1

1 *records for RN* **161522**

Pipe	Date	Rec	RN of Pumped Bore	Top (m)	Bottom (m)	Dist (m)	Meth	Test Types	Pump Type	Suction Set (m)	Q Prior to Test (l/s)	Dur of Q PR (mins)	Pres on Arriv (m)	Q on Arriv (l/s/)
A	19/10/2012	1	161522				PUM		AIR					

Pump Tests Part 2

1 *records for RN* **161522**

Pipe	Date	Rec	Test Dur (mins)	SWL(m)	Recov Time (mins)	Resid DD (m)	Max DD or P RED (m)	Q at Max DD (l/s)	Time to Max DD (mins)	Max Q (l/s)	Calc Stat HD (m)	Design Yield (l/s)	Design BP (m)	Suct. Set (m)	Tmsy (m2/Day)	Stor
A	19/10/2012	1	180	-5.80				8.84								

Bore Conditions

0 *records for RN* **161522**

Elevations

0 *records for RN* **161522**

Bore Report

From Year:

Water Analysis Part 1	**0**	*records for RN*	**161522**
Water Analysis Part 2	**0**	*records for RN*	**161522**
Water Levels	**0**	*records for RN*	**161522**
Wire Line Logs	**0**	*records for RN*	**161522**
Field Measurements	**0**	*records for RN*	**161522**
Special Water Analysis	**0**	*records for RN*	**161522**

Bore Report

From Year:

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Water bore drilling log

Authorisation details
Registered number ..... Development permit number ..... Works reference number QN-W4

2042358

SECTION A—LOCATION DETAILS
Name of landholder QUEENSLAND NICKEL Phone No. .....
Postal address CANOONA QLD Postcode 4702
Real property address ..... Postcode .....
Real property description Lot ..... Plan ..... or Bore location GPS. Latitude ..... Longitude ..... Datum .....
Easting 224784 Northing 7450668 Zone 56K

SECTION B BORE COMPLETION DETAILS
Date commenced 6/12/21
Date completed 7/12/21

SECTION C—DRILLING METHOD
☐ Rotary mud ☐ Cable tool
☐ Auger ☒ Rotary air
☐ Other

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
200	0	19
150	19	56

SECTION E CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
PVC	177	9	0	19
PVC	60	5	0	53.1

SECTION F—CENTRALISERS

Type	Location (metres) From	To
KWIK-ZIP 155 HT-C	29	32
"	38	41
"	50	53

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
SLOTS	60	0.5mm	29	32
"	"	"	38	41
"	"	"	50	53

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
2mm SAND	150	60	27.5	53

SECTION I—BORE PURPOSE
☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial
☐ Urban ☐ Industrial Other (please specify) MONITORING BORE

SECTION I—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed this(*)
0	5	FERRICRETE MEDIUM-DARK RED/BROWN	
5	13	EXTREMELY WEATHERED LIMONITE CREAMY/BROWN CLAYEY EXTREMELY WEATHERED LOW STRENGTH.	*
13	25	LATERITE - GREENISH WHITE - WEATHERED LOW STRENGTH.	
25	54	GABBRO - DARK GREENISH BLACK - MAGNESITE NODULES - HIGH STRENGTH.	
54	56	SERPENTINISED MAFIC ROCK - HIGHLY FRACTURED LOST CIRCULATION FURTHER DRILLING ABANDONED.	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Quality (e.g. potable, brackish, salty)
9m	—	—	DAMP
29m	—	—	DAMP

Conductivity (µS/cm) NO SAMPLE pH

SECTION L SUB ARTESIAN BORE ON COMPLETION

Depth to standing water level from ground level (metres)	Depth to pump suction or bottom of drill stem (metres)
50.20m	

Type of test used ☒ Air ☐ Bail ☐ Pump

Estimated supply (litres/second)	Duration of test (hours)	Drawdown level from surface (metres)
TO LOW TO MEASURE	30 MIN	

SECTION M—ARTESIAN BORE ON COMPLETION

Shut-in pressure (kPa)	Free flow (litres/second)	Temperature (°C)

SECTION N—REMARKS
THIS BORE DID NOT PRODUCE SUFFICIENT WATER TO MEASURE WHILE DRILLING.

SECTION O—CERTIFICATION
I hereby certify that the bore is drilled and constructed according to the conditions of my driller's licence and the information provided is true and accurate.

Driller C. WESTON Driller's licence no. 2730
Trainee driller JACK HAWKINS-BOYD Driller's licence no.
Signature of driller ..... Date 7/12/21
Contractor WARRTAH COAL

Department of Natural Resources and Mines

White — forward to the Department of Natural Resources and Mines Pink — provide to landholder Blue — Driller to retain

The information you are giving on this form will be used by this department for the purpose of processing your drill log form to record your water bore drilling activity under the Water Act 2000. Your personal details will be recorded in a register and may be accessed by authorised staff of this department and may be disclosed to any other third party without your consent except where required by law. For information on collection, use and disclosure of personal information, please see our Privacy Statement, please visit www.dnrm.qld.gov.au.

Water bore drilling log

2042657

Authorisation details
Registered number _____ Development permit number _____ Works reference number QN-WS

SECTION A—LOCATION DETAILS

Name of landholder QUEENSLAND NICKEL Phone No. _____

Postal address CANOONA Postcode 4702

Real property address _____ Postcode _____

Real property description Lot _____ Plan _____ or Bore location GPS. Latitude _____ Longitude _____ Datum _____

Easting 224784 Northing 7450668 Zone 56K

SECTION B—BORE COMPLETION DETAILS

Date commenced 7/12/21

Date completed 7/12/21

SECTION C—DRILLING METHOD

☐ Rotary mud ☐ Cable tool

☐ Auger ☒ Rotary air

☐ Other _____

SECTION D—HOLE SIZE

Diameter (mm)	Location (metres) From	To
250	0	1
150	0	18

SECTION E—CASING DETAILS

Type (PVC, steel etc)	Size O.D. (mm)	Wall thickness (mm)	Location (metres) From	To
PVC	60mm	5mm	0	17.62

SECTION F—CENTRALISERS

Type	Location (metres) From	To
NIL		

SECTION G—PERFORATIONS/ SLOTS/ SCREENS

Type	Size O.D. (mm)	Aperture (mm)	Location (metres) From	To
SLOTS	60	0.5	8.6	11.6

SECTION H—CEMENTING/GRAVEL PACK/ANNULAR FILL DETAILS

Type & material size	Hole diameter (mm)	Casing diameter (mm O.D.)	Location (metres) From	To
GRAVEL	150	60	7.5	17.6
BENTONITE	150	60	6.5	7.5
GROUT	150	60	0	6.5

SECTION I—BORE PURPOSE

☐ Domestic ☐ Stock ☐ Irrigation ☐ Commercial

☐ Urban ☐ Industrial Other (please specify) MONITORING.

SECTION J—PARTICULARS OF STRATA

From (metres)	To (metres)	Strata description (use more than one line if required)	Water bed thus(*)
0	5	FERRICRETE: MEDIUM DARK REDDISH/ BROWN - MEDIUM STRENGTH.	
5	13	LIMONITE; CREAMY/BROWN CLAYEY - EXTREMELY WEATHERED - VERY LOW STRENGTH	*
13	18	LATERITE - LIGHT TO MEDIUM GREEN - EXTREMELY WEATHERED - VERY LOW STRENGTH.	

SECTION K—WATER BEARING BEDS

Depth struck (metres)	Water rose to (metres)	Supply (litres/second)	Quality (e.g. potable, brackish, salty)
9m	—	—	DAMP.

Conductivity (µS/cm) NO SAMPLE pH

SECTION L—SUB ARTESIAN BORE ON COMPLETION

Depth to standing water level from ground level NO H_2O MEASURED (metres) Depth to pump suction or bottom of drill stem 8/12/21. (metres)

Type of test used ☒ Air ☐ Bail ☐ Pump

Estimated supply NIL (litres/second) Duration of test (hours) Drawdown level from surface (metres)

SECTION M—ARTESIAN BORE ON COMPLETION

Shut-in pressure (kPa) Free flow (litres/second) Temperature (°C)

SECTION N—REMARKS

ONLY A DAMP ZONE @ 9m SHOULD ANY TRACE OF H_2O

SECTION O—CERTIFICATION

I hereby certify that the bore is drilled and constructed according to the conditions of my driller's licence and the information provided is true and accurate.

Driller C. WESTON Driller's licence no. 2730

Trainee driller _____ Driller's licence no. _____

Signature of driller _____ Date 14/12/21

Contractor WARATAH COAL

Department of Natural Resources and Mines

White — foward to the Department of Natural Resources and Mines Pink — provide to landholder Blue — Driller to retain

The information being collected in this form will be used by this department for the purpose of processing your drill log form to record your water bore drilling activity under the authority of section 313 of the *Water Act 2000*. Your personal details will be accessed only by authorised officers within this department and will not be disclosed to any other third party without your consent except where required by law. The information collected will be retained as required by the *Public Records Act 2002 (Qld)* and may be stored in a departmental database. For more information on the department's privacy commitment, please visit www.dnrm.qld.gov.au.

CS983 03/15

C2 – Historical Logs

Note:

- Units are in feet, and locations on local coordinates
- Formation codes are:
  - A = Alluvium or surficial
  - L = laterite
  - S = saprolite
  - Q = Quartz
  - C = Clay
  - Other letters are degree of weathering, colouration, other descriptors.
- Logs are from INSEL (1968)

PROPERTY BROLGA, ROCKH PTON. **SAMPLE RECORD**

FIELD CO S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N112+50/E85	205.3'	95'					Failing CFD1.	Z-1218.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START – FINISH	SYSTEM
N 112+48.0	E 85+01.0	Vertical		19/5/67 19/5/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	MgO	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	0.08	0.008	28.0									Alluvium	E50854
10.0	5.0	0.13	0.011	40.0									Cb.Lb.	E50855
15.0	5.0	0.23	0.011	36.0									Cb.Lb.	E50856
20.0	5.0	0.23	0.009	42.0									Cb.Lb.	E50857
25.0	5.0	0.46	0.011	38.0									Cb.Lb.SA.	E50858
30.0	5.0	1.31	0.054	21.2									Cb.SA.	E50859
35.0	5.0	1.45	0.246	26.0									SA.	E50860
40.0	5.0	0.48	0.024	39.5			1.16	.128	22.5		34		SA.Cb.	E50861
45.0	5.0	1.41	0.237	26.2									SA.Cb.	E50862
50.0	5.0	1.78	0.139	25.5									SA,B.Cb.	E50863
55.0	5.0	1.02	0.060	16.0									SA,B.	E50864
60.0	5.0	0.54	0.030	9.5									SA,B.	E50865
65.0	5.0	0.74	0.031	10.8									SA,B.	E50866
70.0	5.0	1.05	0.028	12.5									SA,C.	E50867
75.0	5.0	0.56	0.020	11.0									SB,C.	E50868
80.0	5.0	0.30	0.017	9.2									SB,C.	E50869
85.0	5.0	0.24	0.014	8.2									SC.	E50870
90.0	5.0	0.26	0.014	9.8									SC.	E50871
95.0	5.0	0.24	0.014	8.2									SC,D.	E50872

Completed – Bedrock.
Drilling Time: 1¾ hours.
Drilled by W.L. Sides & Son.
Logged and Sampled by G.F. Davey.

G.A.W.

PROPERTY: ROLGA, ROCKHAMPTON

SAMPLE RECORD

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N110/E97+50	109.2'	85'					Falling CFDl.	Z-1339.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START	FINISH	SYSTEM
N 110+02.0	E 97+49.0	Vertical		21/8/67	21/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	MgO	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	0.51	0.038	15.8									A.	E63352
10.0	5.0	0.48	0.042	10.2									Qb,g,X.	E63353
15.0	5.0	0.99	0.178	12.8									Qb,X.Sl.	E63354
20.0	5.0	1.56	0.246	15.2									Qb,X.Sl.	E63355
25.0	5.0	1.29	0.193	18.0			1.22	.181	16.8		1.1		Qb,X.Sl.	E63356
30.0	5.0	1.13	0.149	17.0									Qb,X.Sl.	E63357
35.0	5.0	1.02	0.126	16.5									Qb,X.Sl.	E63358
40.0	5.0	0.59	0.007	14.5									Sl.Qb,S(mg)	E63359
45.0	5.0	0.69	0.101	15.8									Sl.Qb,S.(mg)	E63360
50.0	5.0	0.83	0.105	23.0									Sl.Qb,S.(mg)	E63361
55.0	5.0	0.68	0.083	19.2									Sl.Qb,S.(mg)	E63362
60.0	5.0	0.60	0.065	17.2									Sl.Qb,S.(mg)	E63363
65.0	5.0	0.71	0.066	22.5									Sl.Qb,S.(mg)	E63364
70.0	5.0	0.71	0.069	22.0									Sl.Qb,S.(mg)	E63365
75.0	5.0	0.46	0.034	11.8									Sl.Qb,S.	E63366
80.0	5.0	0.65	0.043	15.0									Sl.Qb(as)	E63367
85.0	5.0	0.67	0.042	15.8									Sl.Qb(as)	E63368

Hole abandoned due to water.
Very poor recovery from 50'-85'.
Using foam continuously.
Drilling Time: 5¼ hours.
Drilled by W.L.Sides & Son.
Logged and Sampled by B.S.Elks.

PROPERTY BROLGA, ROCKHAM TON. **SAMPLE RECORD**

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N115/E70	194.9'	65'					Falling CFDl.	Z-1351.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START – FINISH		SYSTEM
N 114+96.0	E 70+0.0	Vertical		20/8/67	20/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS					PROGRESSIVE TOTALS					LENGTH	FORMATION	SAMPLE No.
		Ni	Co.	Fe	SiO_2	MgO	Ni	Co.	Fe	SiO_2	MgO			
0.0														
5.0	5.0	0.72	0.025	9.5									S1.	E63237
10.0	5.0	0.61	0.019	7.8									S1,2.	E63238
15.0	5.0	0.42	0.015	6.8									S1,2,3.	E63239
20.0	5.0	0.33	0.013	6.0									S1,2,3.	E63240
25.0	5.0	0.30	0.012	6.0									S1,2,3.	E63241
30.0	5.0	0.28	0.013	5.8									S2,3,1.	E63242
35.0	5.0	0.27	0.013	6.0									S2,3,1.	E63243
40.0	5.0	0.26	0.013	6.2									S2,3,1.	E63244
45.0	5.0	0.20	0.010	5.2									S2,3,1.	E63245
50.0	5.0	0.22	0.011	4.8									S2,3.	E63246
55.0	5.0	0.22	0.010	4.8									S2,3.	E63247
60.0	5.0	0.21	0.010	4.5									S2,3.	E63248
65.0	5.0	0.20	0.010	4.5									S3,2.	E63249

Hole completed in hard Serpentine.
Drilling Time: ¾ hour.

Drilled by W.L.Sides & Son.
Logged and Sampled by Bert Wust.

G.S.W.

PROPERTY BROLGA, ROCKHAMPTO...

SAMPLE RECORD

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N115/E107+50	53.8'	35'					Failing CFDl.	Z-1358.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START - FINISH	SYSTEM
N 115+0.0	E 107+51.0	Vertical		22/8/67 22/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	MgO	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	0.18	0.020	10.2									Cr.Sl.	E66015
10.0	5.0	0.18	0.020	10.0									Cr.(mg)	E66016
15.0	5.0	0.33	0.034	9.8									Cr,P(mg)	E66017
20.0	5.0	0.35	0.022	10.8									Cr.(mg)	E66018
25.0	5.0	0.56	0.021	10.5									Sl.Cr,P.	E66019
30.0	5.0	0.47	0.019	9.2									Sl,2.	E66020
35.0	5.0	0.31	0.014	7.0									S2,1.	E66021

Hole abandoned due to water flow.
Drilling Time: 1 hour.
Drilled by W.L. Sides & Son.
Logged and Sampled by B.Wust.

G.&W.

PROPERTY BROLGA, ROCKHAMI N. **SAMPLE RECORD** 6

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N110/E90	151.3'	105'					Failing CFD1.	Z-1361.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START - FINISH	SYSTEM
N 110+01.0	E 90+09.0	Vertical		22/8/67 22/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	Mg●	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	0.37	0.047	33.8									A.	E63384
10.0	5.0	0.79	0.174	22.5									Qb,P.Sl(ga)	E63385
15.0	5.0	2.76	0.149	8.2	2.4%		2.52	1.50	8.5		10.5		Qb,S.Sl.	E63386
20.0	5.0	0.89	0.022	6.5									Qb,S.Sl.	E63387
25.0	5.0	0.55	0.026	6.2									Qb,S.Sl.	E63388
30.0	5.0	0.53	0.026	6.2									Qb,S.Sl.	E63389
35.0	5.0	0.44	0.018	5.5									Sl.Qb.	E63390
40.0	5.0	0.37	0.015	5.2									Sl.Qb.	E63391
45.0	5.0	0.33	0.011	4.2									Sl.(mg)	E63392
50.0	5.0	0.34	0.010	4.5									Sl.(mg)	E63393
55.0	5.0	0.41	0.010	4.5									Sl.(mg)	E63394
60.0	5.0	0.40	0.009	4.5									Sl.(mg)	E63395
65.0	5.0	0.31	0.009	3.8									Sl.(mg)	E63396
70.0	5.0	0.27	0.008	3.5									Sl.(mg)	E63397
75.0	5.0	0.23	0.008	3.0									Sl.(mg)	E63398
80.0	5.0	0.20	0.007	3.2									Sl.(mg)	E63399
85.0	5.0	0.23	0.008	3.2									Sl.(mg)	E63400
90.0	5.0	0.23	0.008	3.2									Sl.(mg)	E63401
95.0	5.0	0.20	0.007	3.0									Sl.(mg)	E63402
100.0	5.0	0.15	0.005	2.2									Sl.(mg)	E63403
105.0	5.0	0.15	0.005	2.0									Sl.(mg)	E63404

Hole completed in Magnesite and partly weathered Serpentine.
Poor recovery at 30'. Reaming & Casing time: 1½ hours.
Pulling Casing: ¼ hour. Drilling Time: 3 hours.
Drilled by W.L.Sides & Son.
Logged and Sampled by B.S.Elks.

G.S.W.

PROPERTY BROLGA, ROCKHAMPTON. **SAMPLE RECORD**

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N110/E85	200'	65'					Failing CFDl.	Z-1362.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START - FINISH	SYSTEM
N 110+01.0	E 85+04.5	Vertical		22/8/67 22/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	MgO	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	0.58	0.105	40.0									A.	E63405
10.0	5.0	1.55	0.282	16.5									S1.Qb,S.	E63406
15.0	5.0	1.00	0.082	11.2			1·16	·114	12·2		7·3		S1,2.Qb,S.	E63407
20.0	5.0	0.84	0.044	11.2									S1,2.Qb,S.	E63408
25.0	5.0	1.25	0.057	13.2									S1,2.Qb,S.	E63409
30.0	5.0	0.51	0.016	7.5									S1,2.	E63410
35.0	5.0	0.63	0.015	6.8									S1,2.	E63411
40.0	5.0	0.42	0.014	7.5									S2,1.	E63412
45.0	5.0	0.38	0.013	7.0									S2,1.	E63413
50.0	5.0	0.39	0.015	7.8									S2,1.	E63414
55.0	5.0	0.34	0.015	9.0									S2,3.	E63415
60.0	5.0	0.32	0.016	10.0									S3.	E63416
65.0	5.0	0.28	0.014	7.0									S3.	E63417

Hole completed in Bedrock.
Drilling Time: 30 minutes.
Drilled by W.L.Sides & Son.
Logged & Sampled by B.S.Elks.

PROPERTY BROLGA, ROCKHAMPTON. **SAMPLE RECORD**

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N110/E80	207.4'	65'					Falling CFDl.	Z-1363.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START – FINISH	SYSTEM
N 110+05.0	E 79+95.5	Vertical		22/8/67 22/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	Mg●	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	1.60	0.360	23.8									A.	E63418
10.0	5.0	1.47	0.186	14.5									S1.	E63419
15.0	5.0	1.70	0.186	16.5	1-44 / 20 (0)		1·49	·145	15·5		6·8		S1.Qb,S.	E63420
20.0	5.0	1.70	0.072	18.0									S1.	E63421
25.0	5.0	1.32	0.034	14.2									S1,2.	E63422
30.0	5.0	0.85	0.021	12.2									S1,2.	E63423
35.0	5.0	0.58	0.020	10.8									S1,2.	E63424
40.0	5.0	0.59	0.019	11.0									S1,2.	E63425
45.0	5.0	0.36	0.016	8.2									S2,3.	E63426
50.0	5.0	0.28	0.015	6.8									S3.	E63427
55.0	5.0	0.25	0.013	6.0									S3.	E63428
60.0	5.0	0.23	0.013	5.5									S3.	E63429
65.0	5.0	0.25	0.015	5.5									S3.	E63430

Hole completed in Bedrock.
Drilling Time: 25 minutes.
Drilled by W.L.Sides & Son.
Logged & Sampled by B.S.Elks.

G.a.W.

PROPERTY BROLGA, ROCKHAMI N. **SAMPLE RECORD** Sheet 1.

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N112+50/E72+50	223.1'	140'					Faiflng CFD1.	Z-1366.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START - FINISH	SYSTEM
N 112+51.5	E 72+57.0	Vertical		23/8/67 23/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	MgO	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	0.30	0.013	32.0									A.	E63469
10.0	5.0	1.27	0.450	12.2									S1.	E63470
15.0	5.0	0.65	0.037	8.0									S1.	E63471
20.0	5.0	0.74	0.043	9.5									S1.	E63472
25.0	5.0	0.63	0.025	8.5									S1.	E63473
30.0	5.0	0.62	0.023	8.2									S1.	E63474
35.0	5.0	0.60	0.020	8.2									S1.	E63475
40.0	5.0	0.49	0.017	7.5									S1.	E63476
45.0	5.0	1.06	0.051	17.0									S1.	E63477
50.0	5.0	1.09	0.055	19.0									S1.	E63478
55.0	5.0	1.10	0.056	18.2			1.03	.051	18.8		4.5		S1.	E63479
60.0	5.0	0.85	0.047	23.0									S1.	E63480
65.0	5.0	1.01	0.073	23.5									S1.	E63481
70.0	5.0	0.65	0.037	15.0									S1,2.	E63482
75.0	5.0	0.48	0.028	11.8									S1,2.	E63483
80.0	5.0	0.35	0.020	9.2									S1,2.	E63484
85.0	5.0	0.37	0.018	8.8									S1,2.	E63485
90.0	5.0	0.34	0.019	9.0									S1,2.	E63486
95.0	5.0	0.23	0.013	7.8									S1,2.	E63487
100.0	5.0	0.32	0.010	7.8									S1,2.	E63488
105.0	5.0	0.09	0.009	7.0									S1,2.	E63489
110.0	5.0	0.09	0.010	6.8									S2,1.	E63490
115.0	5.0	0.11	0.011	8.2									S2,3.	E63491
120.0	5.0	0.10	0.009	6.8									S2,3.	E63492
125.0	5.0	0.08	0.010	6.8									S2,3.	E63493
130.0	5.0	0.08	0.010	6.2									S3,2.	E63494
135.0	5.0	0.08	0.011	6.2									S3,2.	E63495
140.0	5.0	0.07	0.009	6.2									S3.	E63496
G.&W.														

PROPERTY BROLGA, ROCKHAMPTON. **SAMPLE RECORD** SHEET 2.

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N112+50/E72+50.	223.1'	140'					Failing CFD1	Z1366.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START – FINISH	SYSTEM
N 112+51.5	E 72+57.0	Vertical		23/8/67 23/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS					PROGRESSIVE TOTALS					LENGTH	FORMATION	SAMPLE No.
		Ni	Co.	Fe	SiO_2	MgO	Ni	Co.	Fe	SiO_2	MgO			

Hole completed in Bedrock.
Drilling Time: 1 hour.
Drilled by W.L.Sides & Son.
Logged & Sampled by B.S.Elks.

G.A.W.

PROPERTY BROLGA, ROCKHAMPTON. **SAMPLE RECORD**

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N112+50/E82+50.	214.75'	80'					Failing CFD1.	Z-1368.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START - FINISH	SYSTEM
N 112+50	E. 82+53.0	Vertical		23/8/67 23/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	MgO	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	0.16	0.016	41.5									A.	E66537
10.0	5.0	0.17	0.016	43.2									Lo.Qb,P.	E66538
15.0	5.0	0.33	0.019	42.5									Lo.Qb,X.	E66539
20.0	5.0	1.48	0.282	15.8									Sl.Qb.Cb.	E66540
25.0	5.0	1.60	0.073	15.8	1.40 / 25(5)								Sl,2.Qb.	E66541
30.0	5.0	1.53	0.044	15.2			1.41	.078	15.2		7.9		Sl,2.	E66542
35.0	5.0	1.31	0.035	15.8									Sl,2.	E66543
40.0	5.0	1.10	0.033	15.2									Sl,2.	E66544
45.0	5.0	0.55	0.023	9.0									Sl,2.	E66545
50.0	5.0	0.41	0.016	7.0									S2,3.	E66546
55.0	5.0	0.39	0.013	9.0									S2,3.	E66547
60.0	5.0	0.61	0.020	9.8									S2,3.	E66548
65.0	5.0	0.33	0.015	8.2									S3.	E66549
70.0	5.0	0.45	0.020	9.0									S3.	E66550
75.0	5.0	0.31	0.014	6.2									S3.	E66551
80.0	5.0	0.33	0.018	7.2									S3.	E66552

Hole completed in Bedrock.
Drilling Time: ¾ hour.
Drilled by W.L.Sides & Son.
Logged and Sampled by B.S.Elks.

G.S.W.

BROLGA, ROCKHAMP[illegible].

SAMPLE RECORD

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N115/E65	201.5'	95'					Fairing CFDl.	Z-1387.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START - FINISH	SYSTEM
N 114+99.0	E 64+93.0	Vertical		25/8/67 28/8/67	Feet.

DEPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	MgO	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	2.22	0.075	8.5									A.	E66668
10.0	5.0	2.46	0.054	8.5									Sl.Qb,S.	E66669
15.0	5.0	2.58	0.030	8.0									Sl.Qb,S.	E66670
20.0	5.0	2.34	0.022	7.0									Sl.Qb,S.	E66671
25.0	5.0	2.40	0.032	9.5									Sl.Qb,X.	E66672
30.0	5.0	1.38	0.032	10.0			1·72	·058	13·2		6·8		Sl.Qb,X.	E66673
35.0	5.0	1.43	0.033	10.0									Sl.Qb,X.	E66674
40.0	5.0	1.77	0.037	11.5									Sl.Qb,X.	E66675
45.0	5.0	1.71	0.060	10.0									Sl.Qb,X.	E66676
50.0	5.0	1.24	0.127	18.0									Sl.Qb,X.	E66677
55.0	5.0	1.06	0.114	18.0									Sl.Qb,X.	E66678
60.0	5.0	1.03	0.120	17.0									Sl.Qb,X.	E66679
65.0	5.0	0.54	0.056	12.0									Sl.Qb,X.	E66680
70.0	5.0	0.67	0.111	14.0									Sl.Qb,X.	E66681
75.0	5.0	0.81	0.121	15.5									Sl.Qb,X.	E66682
80.0	5.0	0.75	0.102	15.5									Sl.Qb,X.	E66683
85.0	5.0	0.55	0.052	10.5									Sl.Qb,X.	E66684
90.0	5.0	0.52	0.053	11.5									Sl.Qb,X.	E66685
95.0	5.0	0.50	0.041	9.0									Sl.Qb,X.	E66686
													Abandoned.	

Hole abandoned due to excessive caving.
Foam used continuously from 15'.
Drilling Time: 6 hours.
Drilled by W.L.Sides & Son.
Logged and Sampled by B.S.Elks.

ORIGINAL COMPONENT IN POOR CONDITION

PROPERT. BROLGA, ROCKHAMPTC

SAMPLE RECORD

FIELD CO-ORD'S	ELEVATION	DEPTH	AREA	OF	INFLUENCE	AREA CODE	TYPE	HOLE NO.
N115/E57+50.	116.1'	95'					Falling CFDl.	Z-1459.

FINAL CO-ORD'S		DIP.	AZIMUTH	DATE: START - FINISH	SYSTEM
N 114+89.0	E 57+55.0	Vertical		29.9.67 29 9.67	Feet.

EPTH	SAMPLE LENGTH	ANALYSIS Ni	Co.	Fe	SiO_2	MgO	PROGRESSIVE TOTALS Ni	Co.	Fe	SiO_2	MgO	LENGTH	FORMATION	SAMPLE No.
0.0														
5.0	5.0	1.02	0.025	12.5	1·02		0·89	·024	11·0		3·44		A.	E76824
10.0	5.0	0.46	0.016	8.2									S1,2(mg)	E76825
15.0	5.0	0.21	0.014	7.0									S1,2(mg)	E76826
20.0	5.0	0.20	0.012	5.2									S1,2(mg)	E76827
25.0	5.0	0.23	0.013	5.2									S1,2(mg)	E76828
30.0	5.0	0.18	0.013	6.2									S1,2(mg)	E76829
35.0	5.0	0.17	0.011	5.2									S1,2(mg)	E76830
40.0	5.0	0.24	0.016	8.2									S1,2(mg)	E76831
45.0	5.0	0.20	0.012	7.0									S1,2(mg)	E76832
50.0	5.0	0.21	0.011	6.5									S1,2(mg)	E76833
55.0	5.0	0.22	0.011	6.2									S1,2(mg)	E76834
60.0	5.0	0.20	0.012	6.0									S1,2(mg)(as)	E76835
65.0	5.0	0.23	0.015	7.0									S1,2(mg)(as)	E76836
70.0	5.0	0.22	0.014	7.0									S1,2,3(mg)(as)	E76837
75.0	5.0	0.19	0.013	7.0									S1,2,3(mg)(as)	E76838
80.0	5.0	0.19	0.013	6.2									S1,2,3(mg)(as)	E76839
85.0	5.0	0.19	0.011	5.0									S2,1(mg)Qb.	E76840
90.0	5.0	0.18	0.013	6.2									S2,1(mg)(as)	E76841
95.0	5.0	0.17	0.012	6.0									S2,3,1(mg)	E76842
													Abandoned.	

Hole abandoned due to water.
Drilling Time: 1¾ hours.
Drilled by W.L. Sides & Son.
Logged and Sampled by B.S.Elks.

G2

Queensland Government

Department of Environment and Science

Environmental Reports

Biodiversity and Conservation Values

Biodiversity Planning Assessments and Aquatic Conservation Assessments

For the selected area of interest
ml: 5866

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or Area of Interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending from 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: biodiversity.planning@des.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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Summary Information

Tables 1 to 8 provide an overview of the AOI with respect to selected topographic and environmental values.

Table 1: Area of interest details: ml: 5866

Size (ha)	203.82
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

The following table identifies available Biodiversity Planning Assessments (BPAs) and Aquatic Conservation Assessments (ACAs) with respect to the AOI.

Table 2: Available Biodiversity Planning and Aquatic Conservation Assessments

Assessment Type	Assessment Area and Version
Biodiversity Planning Assessment(s)	Brigalow Belt v2.1
Aquatic Conservation Assessment(s) (riverine)	Great Barrier Reef Catchments v1.1
Aquatic Conservation Assessment(s) (non-riverine)	Great Barrier Reef Catchments v1.3

Table 3: Remnant regional ecosystems within the AOI as per the Qld Herbarium's 'biodiversity status'

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0

The following table identifies the extent and proportion of the user specified area of interest (AOI) which is mapped as being of "State", "Regional" or "Local" significance via application of the Queensland Department of Environment and Science's *Biodiversity Assessment and Mapping Methodology* (BAMM).

Table 4: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
State Habitat for EVNT taxa	0.0	0.0
State	0.0	0.0
Regional	0.0	0.0
Local or Other Values	0.22	0.11

Table 5: Non-riverine wetlands intersecting the AOI

Non-riverine wetland types intersecting the area of interest	#
(No Records)	

NB. The figures presented in the table above are derived from the relevant non-riverine Aquatic Conservation Assessment(s). Later releases of wetland mapping produced via the Queensland Wetland Mapping Program may provide more recent

information in regards to wetland extent.

Table 6: Named waterways intersecting the AOI

(no results)

Refer to **Map 1** for general locality information.

The following two tables identify the extent and proportion of the user specified AOI which is mapped as being of "Very High", "High", "Medium", "Low", or "Very Low" aquatic conservation value for riverine and non-riverine wetlands via application of the Queensland Department of Environment and Science's *Aquatic Biodiversity Assessment and Mapping Method* (AquaBAMM).

Table 7: Summary table, aquatic conservation significance (riverine)

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	203.82	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

Table 8: Summary table, aquatic conservation significance (non-riverine)

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

Biodiversity Planning Assessments

Introduction

The Department of Environment and Science (DES) attributes biodiversity significance on a bioregional scale through a Biodiversity Planning Assessment (BPA). A BPA involves the integration of ecological criteria using the *Biodiversity assessment and Mapping Methodology* (BAMM) and is developed in two stages: 1) **diagnostic criteria**, and 2) **expert panel criteria**. The diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion, while the expert panel criteria allows for the refinement of the mapped information from the diagnostic output by incorporating local knowledge and expert opinion.

The BAMM methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes. While natural resource values such as dryland salinity, soil erosion potential or land capability are not dealt with explicitly, they are included to some extent within the biodiversity status of regional ecosystems recognised by the DES.

Biodiversity Planning Assessments (BPAs) assign three levels of overall biodiversity significance.

- **State significance** - areas assessed as being significant for biodiversity at the bioregional or state scales. They also include areas assessed by other studies/processes as being significant at national or international scales. In addition, areas flagged as being of State significance due to the presence of endangered, vulnerable and/or near threatened taxa, are identified as "State Habitat for EVNT taxa".
- **Regional significance** - areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.
- **Local significance and/or other values** - areas assessed as not being significant for biodiversity at state or regional scales. Local values are of significance at the local government scale.

For further information on released BPAs and a copy of the underlying methodology, go to:

http://www.qld.gov.au/environment/plants-animals/biodiversity/planning/

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

The following table identifies the extent and proportion of the user specified AOI which is mapped as being of "State", "Regional" or "Local" significance via application of the BAMM.

Table 9: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
State Habitat for EVNT taxa	0.0	0.0
State	0.0	0.0
Regional	0.0	0.0
Local or Other Values	0.22	0.11

Refer to **Map 2** for further information.

Diagnostic Criteria

Diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion. These criteria are diagnostic in that they are used to filter the available data and provide a "first-cut" or initial determination of biodiversity significance. This initial assessment is then combined through a second group of other essential criteria.

A description of the individual diagnostic criteria is provided in the following sections.

Criteria A. Habitat for EVNT taxa: Classifies areas according to their significance based on the presence of endangered, vulnerable and/or rare (EVNT) taxa. EVNT taxa are those scheduled under the *Nature Conservation Act 1992* and/or the

Environment Protection and Biodiversity Conservation Act 1999. It excludes highly mobile fauna taxa which are instead considered in Criterion H and brings together information on EVNT taxa using buffering of recorded sites or habitat suitability models (HSM) where available.

Criteria B. Ecosystem value: Classifies on the basis of biodiversity status of regional ecosystems, their extent in protected areas (presence of poorly conserved regional ecosystems), the presence of significant wetlands; and areas of national importance such as the presence of Threatened Ecological Communities, World Heritage areas and Ramsar sites. Ecosystem value is applied at a bioregional (**B1**) and regional (**B2**) scale.

Criteria C. Tract size: Measures the relative size of tracts of vegetation in the landscape. The size of any tract is a major indicator of ecological significance, and is also strongly correlated with the long-term viability of biodiversity values. Larger tracts are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller tracts.

Criteria D. Relative size of regional ecosystems: Classifies the relative size of each regional ecosystem unit within its bioregion (**D1**) and its subregion (**D2**). Remnant units are compared with all other occurrences with the same regional ecosystem. Large examples of a regional ecosystem are more significant than smaller examples of the same regional ecosystem because they are more representative of the biodiversity values particular to the regional ecosystem, are more resilient to the effects of disturbance, and constitute a significant proportion of the total area of the regional ecosystem.

Criteria F. Ecosystem diversity: Is an indicator of the number of regional ecosystems occurring within an area. An area with high ecosystem diversity will have many regional ecosystems and ecotones relative to other areas within the bioregion.

Criteria G. Context and connection: Represents the extent to which a remnant unit incorporates, borders or buffers areas such as significant wetlands, endangered ecosystems; and the degree to which it is connected to other vegetation.

A summary of the biodiversity status based upon the diagnostic criteria is provided in the following table.

Table 10: Summary of biodiversity significance based upon diagnostic criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
Local or Other Values	Refer to diagnostic data for additional information	0.22	0.11

Assessment of diagnostic criteria with respect to the AOI

The following table reflects an assessment of the individual diagnostic criteria noted above in regards to the AOI.

Table 11: Assessment of individual diagnostic criteria with respect to the AOI

Diagnostic Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
A: Habitat for EVNT Taxa					0.22	0.1		
B1: Ecosystem Value (Bioregion)								
B2: Ecosystem Value (Subregion)								
C: Tract Size								
D1: Relative RE Size (Bioregion)								
D2: Relative RE Size (Subregion)								
F: Ecosystem Diversity								
G: Context and Connection								

Other Essential Criteria

Other essential criteria (also known as expert panel criteria) are based on non-uniform information sources and which may rely more upon expert opinion than on quantitative data. These criteria are used to provide a "second-cut" determination of biodiversity significance, which is then combined with the diagnostic criteria for an overall assessment of relative biodiversity significance. A summary of the biodiversity status based upon the other essential criteria is provided in the following table.

Table 12: Summary of biodiversity significance based upon other essential criteria with respect to the AOI

(No Records)

A description of each of the other essential criteria and associated assessment in regards to the AOI is provided in the following sections.

Criteria H. Essential and general habitat for priority taxa: Priority taxa are those which are at risk or of management concern, taxa of scientific interest as relictual (ancient or primitive), endemic taxa or locally significant populations (such as a flying fox camp or heronry), highly specialised taxa whose habitat requirements are complex and distributions are not well

correlated with any particular regional ecosystem, taxa important for maintaining genetic diversity (such as complex spatial patterns of genetic variation, geographic range limits, highly disjunct populations), taxa critical for management or monitoring of biodiversity (functionally important or ecological indicators), or economic and culturally important taxa.

Criteria I. Special biodiversity values: areas with special biodiversity values are important because they contain multiple taxa in a unique ecological and often highly biodiverse environment. Areas with special biodiversity values can include the following:

- Ia - centres of endemism - areas where concentrations of taxa are endemic to a bioregion or subregion are found.
- Ib - wildlife refugia (Morton *et al*. 1995), for example, islands, mound springs, caves, wetlands, gorges, mountain ranges and topographic isolates, ecological refuges, refuges from exotic animals, and refuges from clearing. The latter may include large areas that are not suitable for clearing because of land suitability/capability.
- Ic - areas with concentrations of disjunct populations.
- Id - areas with concentrations of taxa at the limits of their geographic ranges.
- Ie - areas with high species richness.
- If - areas with concentrations of relictual populations (ancient and primitive taxa).
- Ig - areas containing REs with distinct variation in species composition associated with geomorphology and other environmental variables.
- Ih - an artificial waterbody or managed/manipulated wetland considered by the panel/s to be of ecological significance.
- Ii - areas with a high density of hollow-bearing trees that provide habitat for animals.
- Ij - breeding or roosting sites used by a significant number of individuals.
- Ik - climate change refuge.

The following table identifies the value and extent area of the Other Essential Criteria H and I within the AOI.

Table 13: Relative importance of expert panel criteria (H and I) used to access overall biodiversity significance with respect to the AOI

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
H: Core Habitat Priority Taxa								
Ia: Centres of Endemism								
Ib: Wildlife Refugia								
Ic: Disjunct Populations								
Id: Limits of Geographic Ranges								
Ie: High Species Richness								
If: Relictual Populations								
Ig: Variation in Species Composition								
Ih: Artificial Wetland								
Ii: Hollow Bearing Trees								

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
Ij: Breeding or Roosting Site								
Ik: Climate Refugia								

NB. Whilst biodiversity values associated with Criteria I may be present within the site (refer to tables 12 and 15), for the New England Tableland and Central Queensland Coast BPAs, area and % area figures associated with Criteria Ia through to Ij cannot be listed in the table above (due to slight variations in data formats between BPAs).

Criteria J. Corridors: areas identified under this criterion qualify either because they are existing vegetated corridors important for contiguity, or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and "stepping stones".

Bioregional and subregional conservation corridors have been identified in the more developed bioregions of Queensland through the BPAs, using an intensive process involving expert panels. Map 3 displays the location of corridors as identified under the Statewide Corridor network. The Statewide Corridor network incorporates BPA derived corridors and for bioregions where no BPA has been assessed yet, corridors derived under other planning processes. *Note: as a result of updating and developing a statewide network, the alignment of corridors may differ slightly in some instances when compared to those used in individual BPAs.*

The functions of these corridors are:

- **Terrestrial** Bioregional corridors, in conjunction with large tracts of remnant vegetation, maintain ecological and evolutionary processes at a landscape scale, by:

  • Maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations of species over long periods of time;

  • Maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change;

  • Maintaining large scale seasonal/migratory species processes and movement of fauna;

  • Maximising connectivity between large tracts/patches of remnant vegetation;

  • Identifying key areas for rehabilitation and offsets; and

- **Riparian** Bioregional Corridors also maintain and encourage connectivity of riparian and associated ecosystems.

The location of the corridors is determined by the following principles:

- Terrestrial

  • Complement riparian landscape corridors (i.e. minimise overlap and maximise connectivity);

  • Follow major watershed/catchment and/or coastal boundaries;

  • Incorporate major altitudinal/geological/climatic gradients;

  • Include and maximise connectivity between large tracts/patches of remnant vegetation;

  • Include and maximise connectivity between remnant vegetation in good condition; and

- Riparian

  • Located on the major river or creek systems within the bioregion in question.

The total extent of remnant vegetation triggered as being of "State", "Regional" or "Local" significance due to the presence of an overlying BPA derived terrestrial or riparian corridor within the AOI, is provided in the following table. For further information on how remnant vegetation is triggered due to the presence of an overlying BPA derived corridor, refer to the relevant landscape BPA expert panel report(s).

Table 14: Extent of triggered remnant vegetation due to the presence of BPA derived corridors with respect to the AOI

Biodiversity Significance	Area (Ha)	% of AOI
State	0.0	0.0

Biodiversity Significance	Area (Ha)	% of AOI
Regional	0.0	0.0
Local	0.0	0.0

NB: area figures associated with the extent of corridor triggered remnant vegetation are only available for those bioregions where a BPA has been undertaken.

Refer to **Map 3** for further information.

Threatening process/condition (Criteria K) - areas identified by experts under this criterion may be used to amend (upgrade or downgrade) biodiversity significance arising from the "first-cut" analysis. The condition of remnant vegetation is affected by threatening processes such as weeds, ferals, grazing and burning regime, selective timber harvesting/removal, salinity, soil erosion, and climate change.

Assessment of Criteria K with respect to the AOI is not currently included in the "Biodiversity and Conservation Values" report, as it has not been applied to the majority of Queensland due to data/information limitations and availability.

Special Area Decisions

Expert panel derived "Special Area Decisions" are used to assign values to Other Essential Criteria. The specific decisions which relate to the AOI in question are listed in the table below.

Table 15: Expert panel decisions for assigning levels of biodiversity significance with respect to the AOI

(No Records)

Expert panel decision descriptions:

(No Records)

Aquatic Conservation Assessments

Introduction

The Aquatic Biodiversity Assessment and Mapping Method or AquaBAMM (Clayton *et al.* 2006), was developed to assess conservation values of wetlands in queensland, and may also have application in broader geographical contexts. It is a comprehensive method that uses available data, including data resulting from expert opinion, to identify relative wetland conservation/ecological values within a specified study area (usually a catchment). The product of applying this method is an Aquatic Conservation Assessment (ACA) for the study area.

An ACA using AquaBAMM is non-social, non-economic and identifies the conservation/ecological values of wetlands at a user-defined scale. It provides a robust and objective conservation assessment using criteria, indicators and measures that are founded upon a large body of national and international literature. The criteria, each of which may have variable numbers of indicators and measures, are naturalness (aquatic), naturalness (catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. An ACA using AquaBAMM is a powerful decision support tool that is easily updated and simply interrogated through a geographic information system (GIS).

Where they have been conducted, ACAs can provide a source of baseline wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered (i.e. an early input to broader 'triple-bottom-line' decision-making processes). An ACA can have application in:

- determining priorities for protection, regulation or rehabilitation of wetlands and other aquatic ecosystems
- on-ground investment in wetlands and other aquatic ecosystems
- contributing to impact assessment of large-scale development (e.g. dams)
- water resource and strategic regional planning prcesses

For a detailed explanation of the methodology please refer to the summary and expert panel reports relevant to the ACA utilised in this assessment. These reports can be accessed at Wetland *Info*:

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

Explanation of Criteria

Under the AquaBAMM, eight criteria are assessed to derive an overall conservation value. Similar to the Biodiversity Assessment and Mapping Methodology, the criteria may be primarily diagnostic (quantitative) or primarily expert opinion (qualitative) in nature. The following sections provide a brief description of each of the 8 criteria.

Criteria 1. Naturalness - Aquatic: This attribute reflects the extent to which a wetland's (riverine, non-riverine, estuarine) aquatic state of naturalness is affected through relevant influencing indicators which include: presence of exotic flora and fauna; presence of aquatic communities; degree of habitat modification and degree of hydrological modification.

Criteria 2. Naturalness - Catchment: The naturalness of the terrestrial systems of a catchment can have an influence on many wetland characteristics including: natural ecological processes e.g. nutrient cycling, riparian vegetation, water chemistry, and flow. The indicators utilised to assess this criterion include: presence of exotic flora and/or fauna; riparian, catchment and flow modification.

Criteria 3. Naturalness - Diversity and Richness: This criterion is common to many ecological assessment methods and can include both physical and biological features. It includes such indicators as species richness, riparian ecosystem richness and geomorphological diversity.

Criteria 4. Threatened Species and Ecosystems: This criterion evaluates ecological rarity characteristics of a wetland. This includes both species rarity and rarity of communities / assemblages. The communities and assemblages are best represented by regional ecosystems. Species rarity is determined by NCA and EPBC status with Endangered, Vulnerable or Near-threatened species being included in the evaluation. Ecosystem rarity is determined by regional ecosystem biodiversity status i.e. Endangered, Of Concern, or Not of Concern.

Criteria 5. Priority Species and Ecosystems: Priority flora and fauna species lists are expert panel derived. These are aquatic, semi-aquatic and riparian species which exhibit at least 1 particular trait in order to be eligible for consideration. For

flora species the traits included:

- It forms significant macrophyte beds (in shallow or deep water).
- It is an important food source.
- It is important/critical habitat.
- It is implicated in spawning or reproduction for other fauna and/or flora species.
- It is at its distributional limit or is a disjunct population.
- It provides stream bank or bed stabilisation or has soil binding properties.
- It is a small population and subject to threatening processes.

Fauna species are included if they meet at least one of the following traits:

- It is endemic to the study area (>75 per cent of its distribution is in the study area/catchment).
- It has experienced, or is suspected of experiencing, a serious population decline.
- It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area/catchment.
- It is currently a small population and threatened by loss of habitat.
- It is a significant disjunct population.
- It is a migratory species (other than birds).
- A significant proportion of the breeding population (>one per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).
- Limit of species range.

See the individual expert panel reports for the priority species traits specific to an ACA.

Criteria 6. Special Features: Special features are areas identified by flora, fauna and ecology expert panels which exhibit characteristics beyond those identified in other criteria and which the expert panels consider to be of the highest ecological importance. Special feature traits can relate to, but are not solely restricted to geomorphic features, unique ecological processes, presence of unique or distinct habitat, presence of unique or special hydrological regimes e.g. spring-fed streams. Special features are rated on a 1 - 4 scale (4 being the highest).

Criteria 7. Connectivity: This criterion is based on the concept that appropriately connected aquatic ecosystems are healthy and resilient, with maximum potential biodiversity and delivery of ecosystem services.

Criteria 8. Representativeness: This criterion applies primarily to non-riverine assessments, evaluates the rarity and uniqueness of a wetland type in relation to specific geographic areas. Rarity is determined by the degree of wetland protection within "protected Areas" estate or within an area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995*, or *Marine Parks Act 2004*. Wetland uniqueness evaluates the relative abundance and size of a wetland or wetland management group within geographic areas such as catchment and subcatchment.

Riverine Wetlands

Riverine wetlands are all wetlands and deepwater habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water. AquaBAMM, when applied to riverine wetlands uses a discrete spatial unit termed subsections. A subsection can be considered as an area which encompasses discrete homogeneous stream sections in terms of their natural attributes (i.e. physical, chemical, biological and utilitarian values) and natural resources. Thus in an ACA, an aquatic conservation significance score is calculated for each subsection and applies to all streams within a subsection, rather than individual streams as such.

Please note, the area figures provided in Tables 16 and 17, are derived using the extent of riverine subsections within the AOI. Refer to **Map 5** for further information. A summary of the conservation significance of riverine wetlands within the AOI is provided in the following table.

Table 16: Overall level/s of riverine aquatic conservation significance

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
High	203.82	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

The individual aquatic conservation criteria ratings for riverine wetlands within the AOI are listed below.

Table 17: Level/s of riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
1. Naturalness aquatic	203.82	100.0						
2. Naturalness catchment			203.82	100.0				
3. Diversity and richness			203.82	100.0				
4. Threatened species and ecosystems	203.82	100.0						
5. Priority species and ecosystems	203.82	100.0						
6. Special features								
7. Connectivity			203.82	100.0				
8. Representative-ness								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to riverine wetlands within the AOI.

Table 18: Expert panel decisions for assigning overall levels of riverine aquatic conservation significance

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
fi_r_fl_03	Regional ecosystem 11.3.38	Fitzroy	5.2.1	4

4 is the highest rating/value

Expert panel decision descriptions:

fi_r_fl_03

This regional ecosystem is a serpentinite ecosystem known to contain a number of rare and threatened species.

Non-riverine Wetlands

Non-riverine wetlands include both lacustrine and palustrine wetlands, however, do not currently incorporate estuarine, marine or subterranean wetland types. A summary of the conservation significance of non-riverine wetlands within the AOI is provided in the following table. Refer to **Map 6** for further information.

Table 19: Overall level/s of non-riverine aquatic conservation significance

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

The following table provides an assessment of non-riverine wetlands within the AOI and associated aquatic conservation criteria values.

Table 20: Level/s of non-riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to non-riverine wetlands within the AOI.

Table 21: Expert panel decisions for assigning overall levels of non-riverine aquatic conservation significance.

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Threatened and Priority Species

Introduction

This chapter contains a list of threatened and priority flora and/or fauna species that have been recorded on, or within 4km of the Assessment Area.

The information presented in this chapter with respect to species presence is derived from compiled databases developed primarily for the purpose of BPAs and ACAs. Data is collated from a number of sources and is updated periodically.

It is important to note that the list of species provided in this report, may differ when compared to other reports generated from other sources such as the State government's WildNet, Herbrecs or the federal government's EPBC database for a number of reasons.

Records for threatened and priority species are filtered and checked based on a number of rules including:

- Taxonomic nomenclature - current scientific names and status,
- Location - cross-check co-ordinates with location description,
- Taxon by location - requires good knowledge of the taxon and history of the record,
- Duplicate records - identify and remove,
- Expert panels - check records and provide new records,
- Flora cultivated records excluded,
- Use precise records less than or equal to 2000m,
- Use recent records greater than or equal to 1975 animals, greater than or equal to 1950 plants.

Threatened Species

Threatened species are those species classified as "Endangered" or "Vulnerable" under the *Environment Protection and Biodiversity Conservation Act 1999* or "Endangered", "Vulnerable" or "Near threatened" under the *Nature Conservation Act 1992*.

The following threatened species have been recorded on, or within approximately 4km of the AOI.

Table 22: Threatened species recorded on, or within 4km of the AOI

Species	Common name	NCA status	EPBC status	Back on Track rank	Migratory species*	Wetland species**	Identified flora/fauna
Bursaria reevesii		V		Medium			FL
Capparis thozetiana		V	V	Medium			FL
Corymbia xanthope	Glen Geddes bloodwood	V	V	Low			FL
Hakea trineura		V	V	High			FL
Macrozamia serpentina		E		Critical			FL
Marsdenia brevifolia		V	V	High			FL
Neoroepera buxifolia		V	V	Medium			FL
Pimelea leptospermoides		NT	V	Low			FL
Pimelea leptospermoides subsp. leptospermoides		NT					FL

NB. Please note that the threatened species listed in this section are based upon the most recently compiled DES internal state-wide threatened species dataset. This dataset may contain additional records that were not originally available for inclusion in the relevant individual BPAs and ACAs.

**JAMBA - Japan-Australia Migratory Bird Agreement; CAMBA - China-Australia Migratory Bird Agreement; ROKAMBA - Republic of Korea-Australia Migratory Bird Agreement; CMS - Convention on the Conservation of Migratory Species*.

***I - wetland indicator species; D - wetland dependent species*.

BPA Priority Species

A list of BPA priority species that have been recorded on, or within approximately 4km of the AOI is contained in the following table.

Table 23: Priority species recorded on, or within 4km of the AOI

(no results)

NB. Please note that the list of priority species is based on those species identified in the BPAs, however records for these species may be more recent than the originals used. furthermore, the BPA priority species databases are updated from time to time. At each update, the taxonomic details for all species are amended as necessary to reflect current taxonomic name and/or status changes.

ACA Priority Species

A list of ACA priority species used in riverine and non-riverine ACAs that have been recorded on, or within approximately 4km of the AOI are contained in the following tables.

Table 24: Priority species recorded on, or within 4 km of the AOI - riverine

(no results)

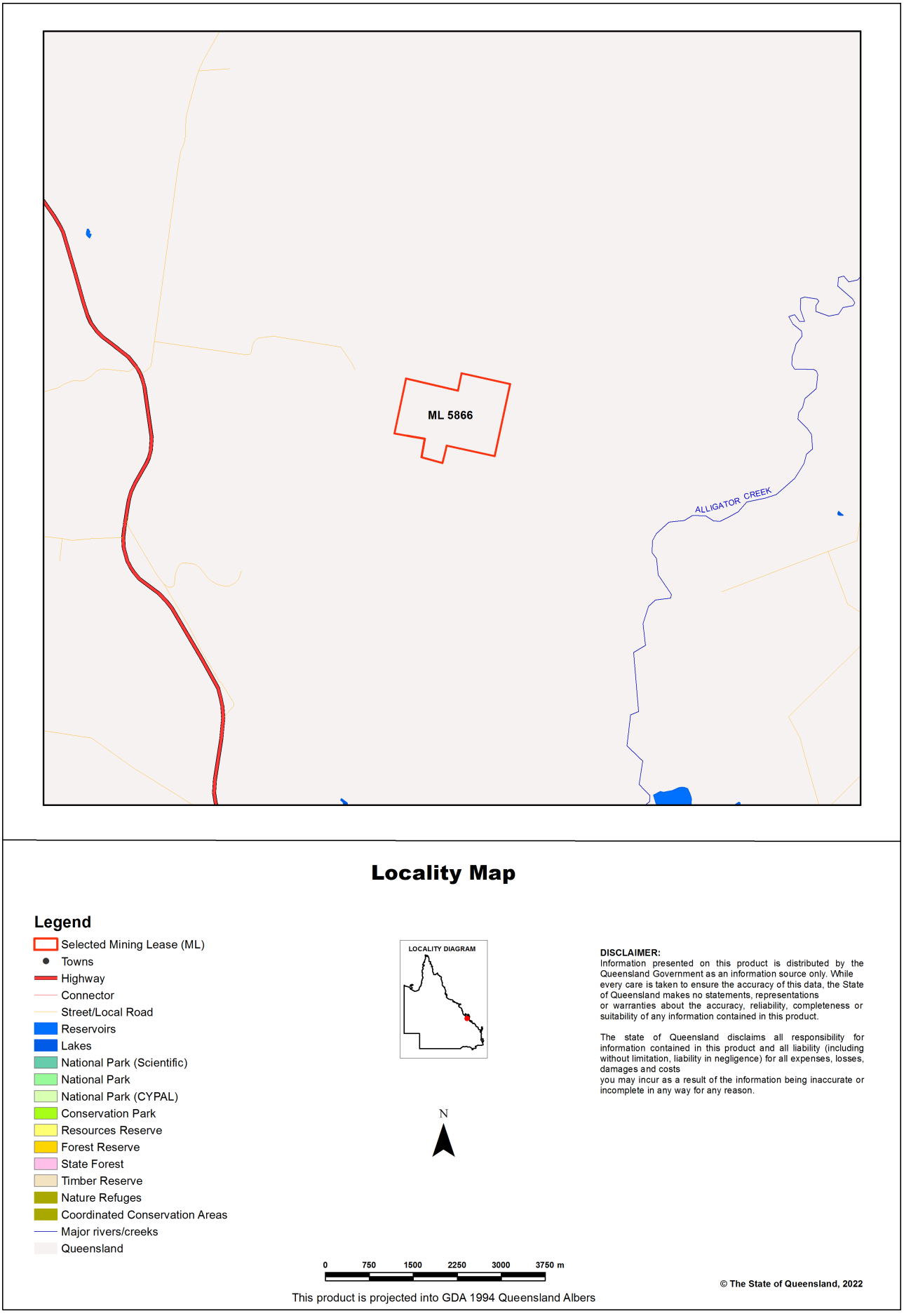
Table 25: Priority species recorded on, or within 4 km of the AOI - non-riverine

(no results)

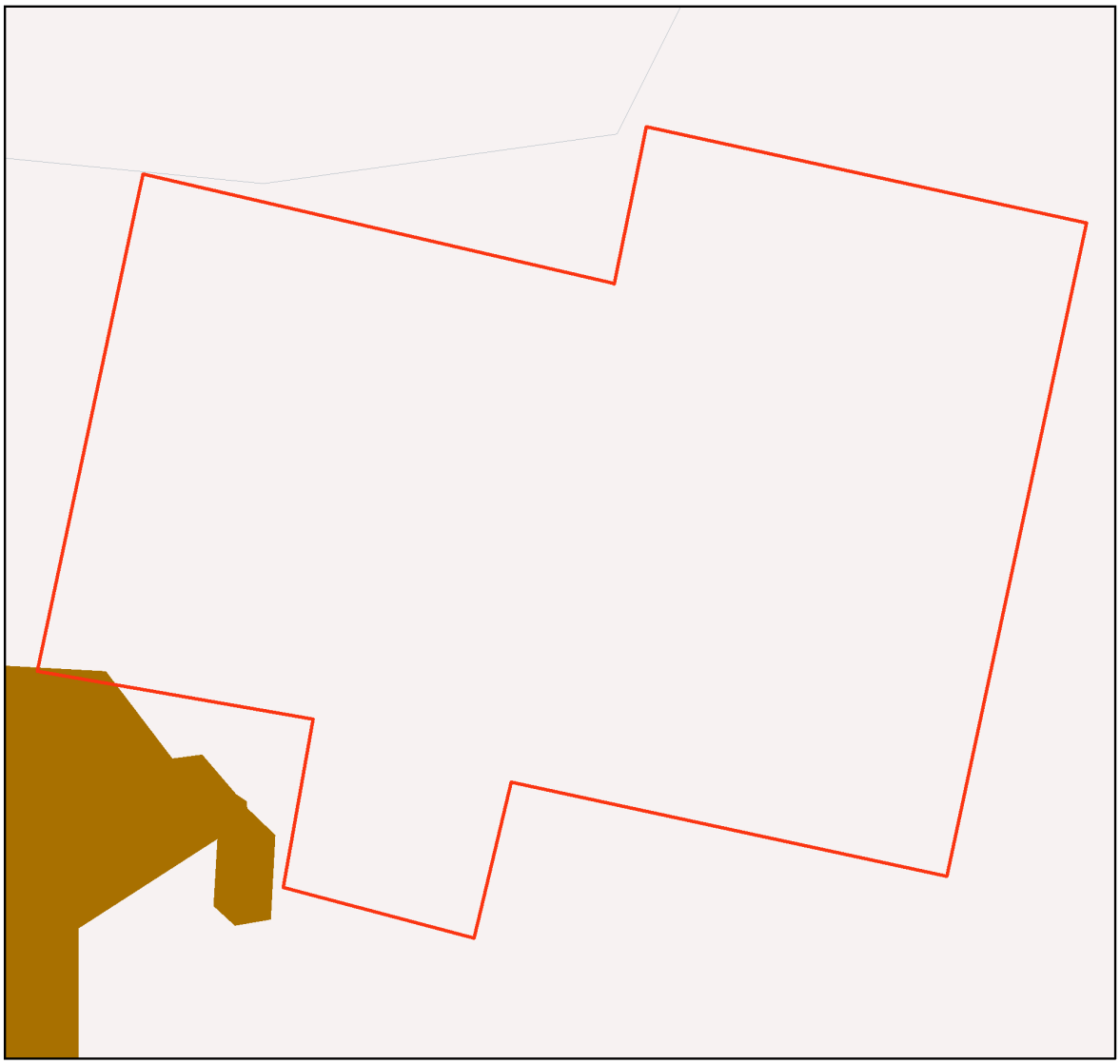
NB. Please note that the priority species records used in the above two tables are comprised of those adopted for the released individual ACAs. The ACA riverine and non-riverine priority species databases are updated from time to time to reflect new release of ACAs. At each update, the taxonomic details for all ACAs records are amended as necessary to reflect current taxonomic name and/or status changes.

Maps

Map 1 - Locality Map



Map 2 - Biodiversity Planning Assessment (BPA)



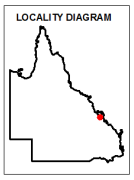
Biodiversity Planning Assessments

Legend

- Selected Mining Lease (ML)
- Towns
- Roads
- Major rivers/creeks
- Queensland

Biodiversity Planning Assessment

- State Habitat for EVNT taxa
- State
- Regional
- Local or Other Values
- Non Bioregion Ecosystem





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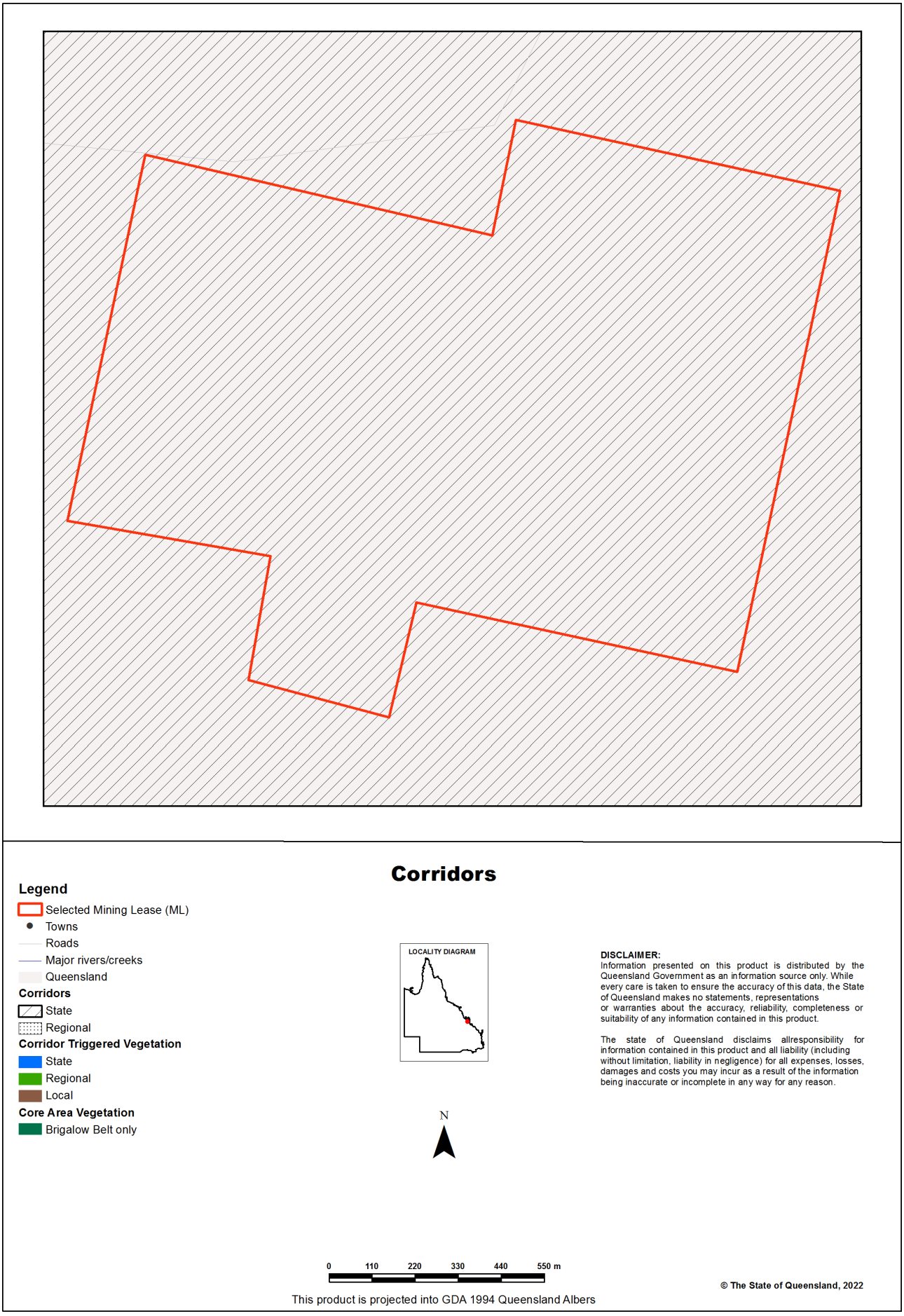
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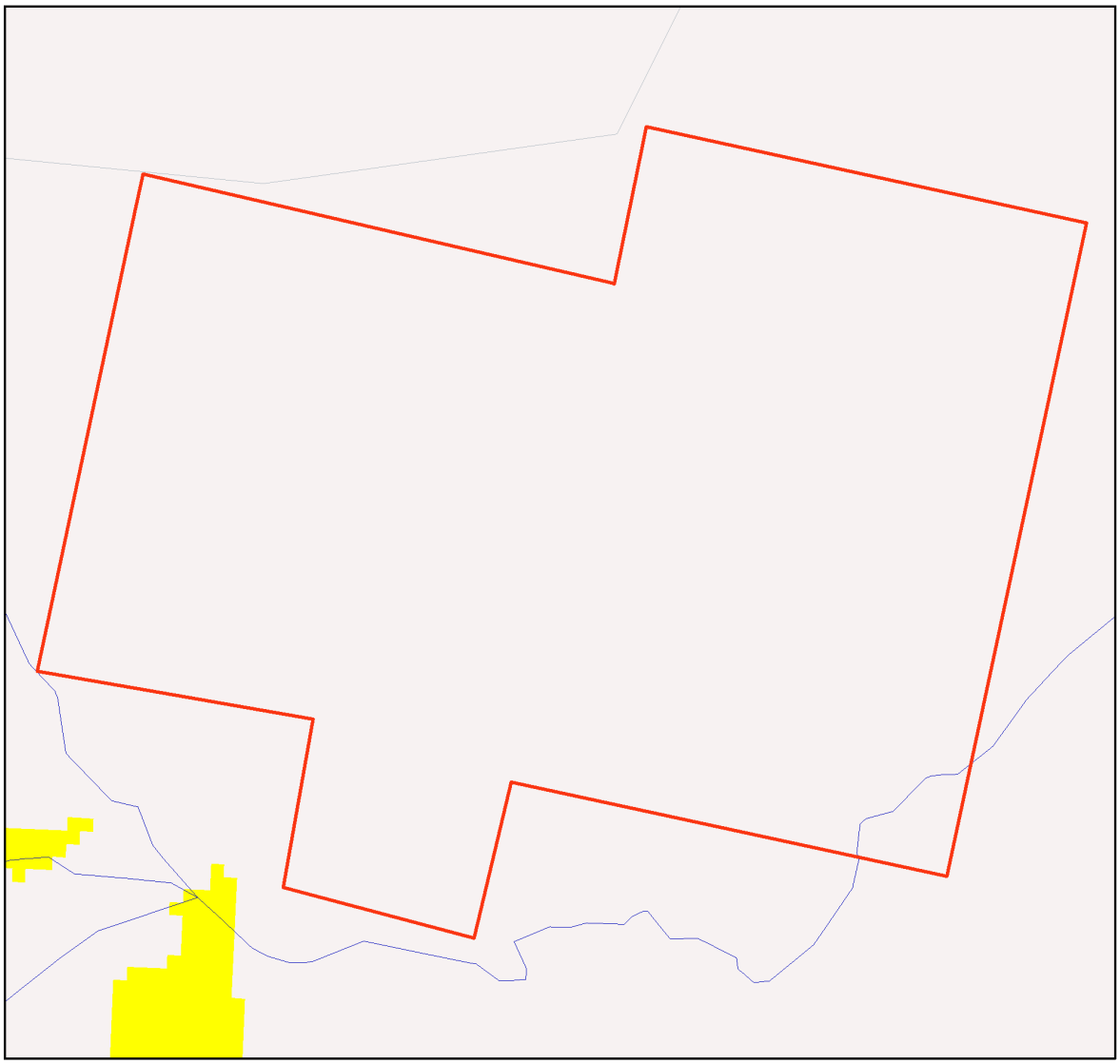
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Map 3 - Corridors



Map 4 - Wetlands and waterways



Wetlands and Waterways

Legend

- Selected Mining Lease (ML)
- Towns
- Roads
- Springs
- Rivers/Creeks
- Directory of Important Wetlands
- Ramsar Sites - QLD
- Queensland

Wetland Type

- Marine Waterbodies
- Estuarine Waterbodies
- Riverine Waterbodies
- Lacustrine Waterbodies
- Palustrine Waterbodies
- Marine RE
- Estuarine RE
- Riverine RE
- Lacustrine RE
- Palustrine RE
- RE 51-80% wetland (mosaic units)
- RE 1-50% wetland (mosaic units)

LOCALITY DIAGRAM

N

0 110 220 330 440 550 m

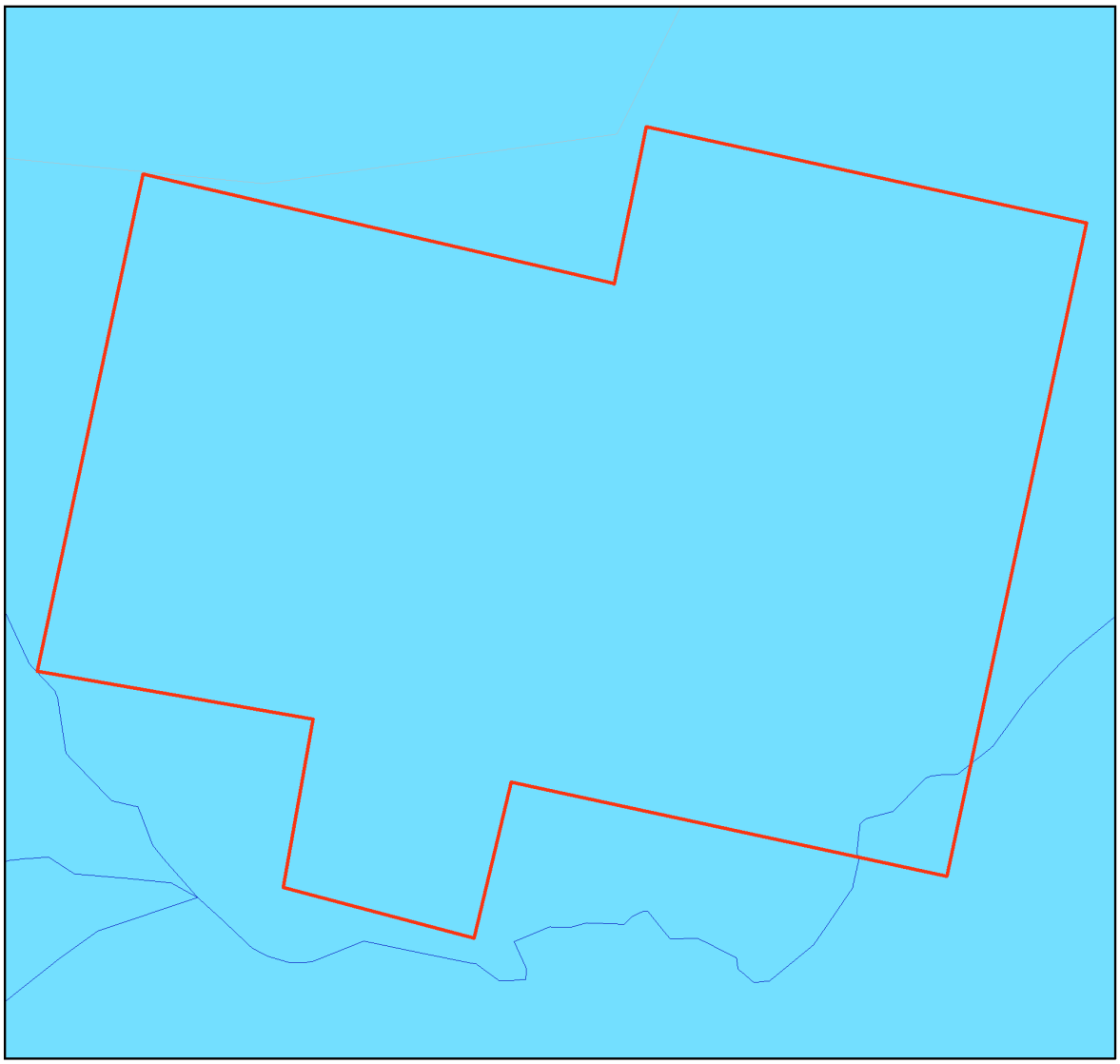
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Map 5 - Aquatic Conservation Assessment (ACA) - riverine



Aquatic Conservation Assessment (ACA) - riverine

Legend

- Selected Mining Lease (ML)
- Towns
- Roads
- Rivers/Creeks
- Queensland

ACA Riverine - Subcatchment Significance

- Very High
- High
- Medium
- Low
- Very Low

LOCALITY DIAGRAM

N

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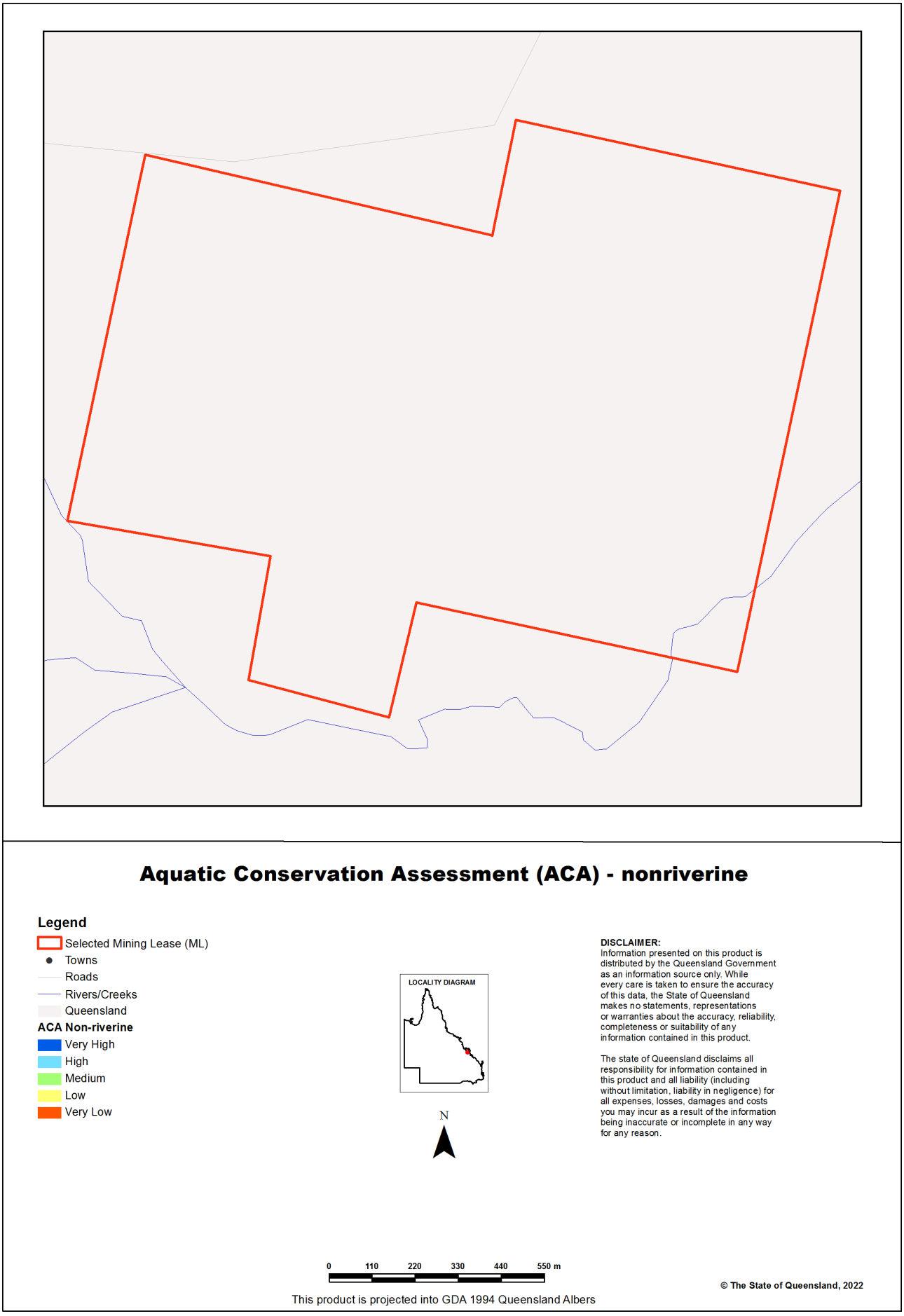
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0 110 220 330 440 550 m

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Map 6 - Aquatic Conservation Assessment (ACA) - non-riverine



References

Clayton, P.D., Fielder, D.F., Howell, S. and Hill, C.J. (2006) *Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment.* Published by the Environmental Protection Agency, Brisbane. ISBN 1-90928-07-3. Available at

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca/

Environmental Protection Agency (2002) *Biodiversity Assessment and Mapping Methodology. Version 2.1, July 2002.* (Environmental Protection Agency, Brisbane).

Morton, S. R., Short, J. and Barker, R. D. with an Appendix by G.F. Griffin and G. Pearce (1995). *Refugia for Biological Diversity in Arid and Semi-arid Australia. Biodiversity Series* , Paper No. 4, Biodiversity Unit, Environment Australia.

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

Theme	Datasets
Aquatic Conservation Assessments Non-riverine*	Combination of the following datasets: Cape York Peninsula Non-riverine v1.1 Eastern Gulf of Carpentaria v1.1 Great Barrier Reef Catchment Non-riverine v1.3 Lake Eyre and Bulloo Basins v1.1 QMDB Non-riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Non-riverine ACA v1.1 Southern Gulf Catchments Non-riverine ACA v1.1
Aquatic Conservation Assessments Riverine*	Combination of the following datasets: Cape York Peninsula Riverine v1.1 Eastern Gulf of Carpentaria v1.1 Great Barrier Reef Catchment Riverine v1.1 Lake Eyre and Bulloo Basins v1.1 QMDB Riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Riverine ACA v1.1 Southern Gulf Catchments Riverine ACA v1.1
Biodiversity Planning Assessments*	Combination of the following datasets: Brigalow Belt BPA v2.1 Cape York Peninsula BPA v1.1 Central Queensland Coast BPA v1.3 Channel Country BPA v1.1 Desert Uplands BPA v1.3 Einasleigh Uplands BPA v1.1 Gulf Plains BPA v1.1 Mitchell Grass Downs BPA v1.1 Mulga Lands BPA v1.4 New England Tableland v2.3 Northwest Highlands v1.1 Southeast Queensland v4.1 Wet Tropics v1.1
Statewide BPA Corridors*	Statewide corridors v1.6
Threatened Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
BPA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
ACA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.

***These datasets are available at:**

http://dds.information.qld.gov.au/DDS

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
ACA	- Aquatic Conservation Assessment
AQUABAMM	- Aquatic Biodiversity Assessment and Mapping Methodology
BAMM	- Biodiversity Assessment and Mapping Methodology
BoT	- Back on Track
BPA	- Biodiversity Planning Assessment
CAMBA	- China-Australia Migratory Bird Agreement
DES	- Department of Environment and Science
EPBC	- *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	- Endangered, Vulnerable, Near Threatened
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
JAMBA	- Japan-Australia Migratory Bird Agreement
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
ROKAMBA	- Republic of Korea-Australia Migratory Bird Agreement

Queensland Government

Department of Environment and Science

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest
ml: 5866

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

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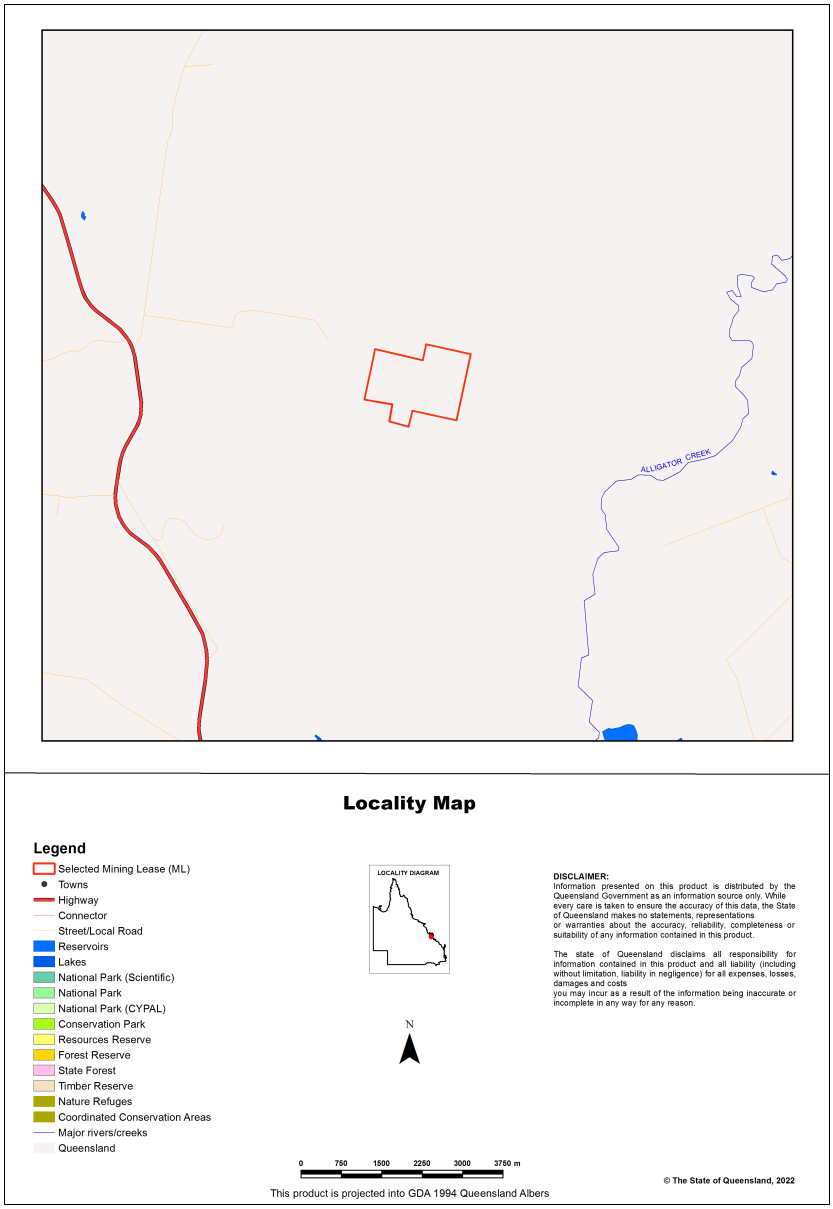
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI ml: 5866

Size (ha)	203.82
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992* ;

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004* ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

    • Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;

    • Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;

    • Category R areas on the regulated vegetation management map;

    • Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;

    • Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Queensland Wetland Environmental Values under the Environment Protection Regulation 2019;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;

- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
1c Protected Areas- special wildlife reserves	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	0.0 ha	0.0 %
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7a Threatened (endangered or vulnerable) wildlife	0.01 ha	0.0%
7b Special least concern animals	0.0 ha	0.0 %
7c i Koala habitat area - core (SEQ)	0.0 ha	0.0 %
7c ii Koala habitat area - locally refined (SEQ)	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0.0 ha	0.0 %
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	2.35 ha	1.2%
8c Regulated Vegetation - Category R (GBR riverine regrowth)	3.34 ha	1.6%
8d Regulated Vegetation - Essential habitat	79.92 ha	39.2%
8e Regulated Vegetation - intersecting a watercourse **	0.3 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0.0 ha	0.0 %
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(no results)

1b. Protected Areas - nature refuges

(no results)

1c. Protected Areas - special wildlife reserves

(no results)

2. State Marine Parks - highly protected zones

(no results)

3. Fish habitat areas (A and B areas)

(no results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(no results)

5. High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values

(no results)

6a. Wetlands in High Ecological Value (HEV) waters

(no results)

6b. Waterways in High Ecological Value (HEV) waters

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7a. Threatened (endangered or vulnerable) wildlife

Values are present

7b. Special least concern animals

Not applicable

7c i. Koala habitat area - core (SEQ)

Not applicable

7c ii. Koala habitat area - locally refined (SEQ)

Not applicable

Threatened (endangered or vulnerable) wildlife habitat suitability models

Species	Common name	NCA status	Presence
Boronia keysii		V	None
Calyptorhynchus lathami	Glossy black cockatoo	V	None
Casuarius casuarius johnsonii	Sthn population cassowary	E	None
Crinia tinnula	Wallum froglet	V	None
Denisonia maculata	Ornamental snake	V	None
Litoria freycineti	Wallum rocketfrog	V	None
Litoria olongburensis	Wallum sedgefrog	V	None
Melaleuca irbyana		E	None
Petaurus gracilis	Mahogany Glider	E	None
Petrogale persephone	Proserpine rock-wallaby	E	None
Phascolarctos cinereus	Koala - outside SEQ*	V	None
Pezoporus wallicus wallicus	Eastern ground parrot	V	None
Taudactylus pleione	Kroombit tinkerfrog	E	None
Xeromys myoides	Water Mouse	V	None

**For koala model, this includes areas outside SEQ. Check 7c SEQ koala habitat for presence/absence.*

Threatened (endangered or vulnerable) wildlife species records

Scientific name	Common name	NCA status	EPBC status	Migratory status
Macrozamia serpentina		E		

Special least concern animal species records

(no results)

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

Migratory status (M) - China and Australia Migratory Bird Agreement (C), Japan and Australia Migratory Bird Agreement (J), Republic of Korea and Australia Migratory Bird Agreement (R), Bonn Migratory Convention (B), Eastern Flyway (E)

To request a species list for an area, or search for a species profile, access Wildlife Online at:

https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals** and **Map 3b - MSES - Species - Koala habitat area (SEQ)** for an overview of the relevant MSES.

MSES - Regulated Vegetation

For further information relating to regional ecosystems in general, go to:
https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/
For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:
https://environment.ehp.qld.gov.au/regional-ecosystems/

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Regional ecosystem	Vegetation management polygon	Vegetation management status
11.3.38/11.3.38a	E-dom	hvr_end

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Regulated vegetation map category	Map number
R	8951

8d. Regulated Vegetation - Essential habitat

Values are present

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

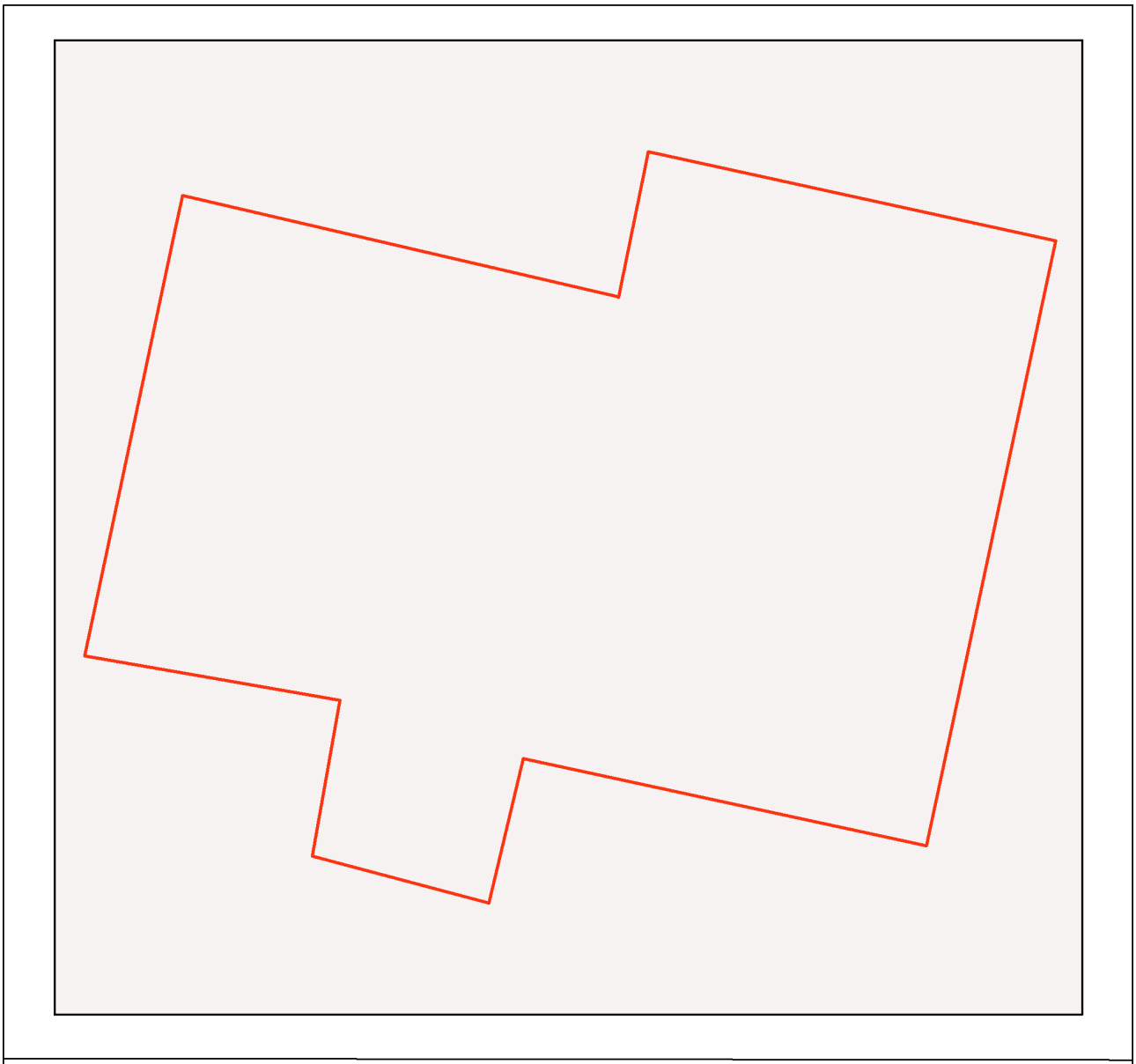
(no results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

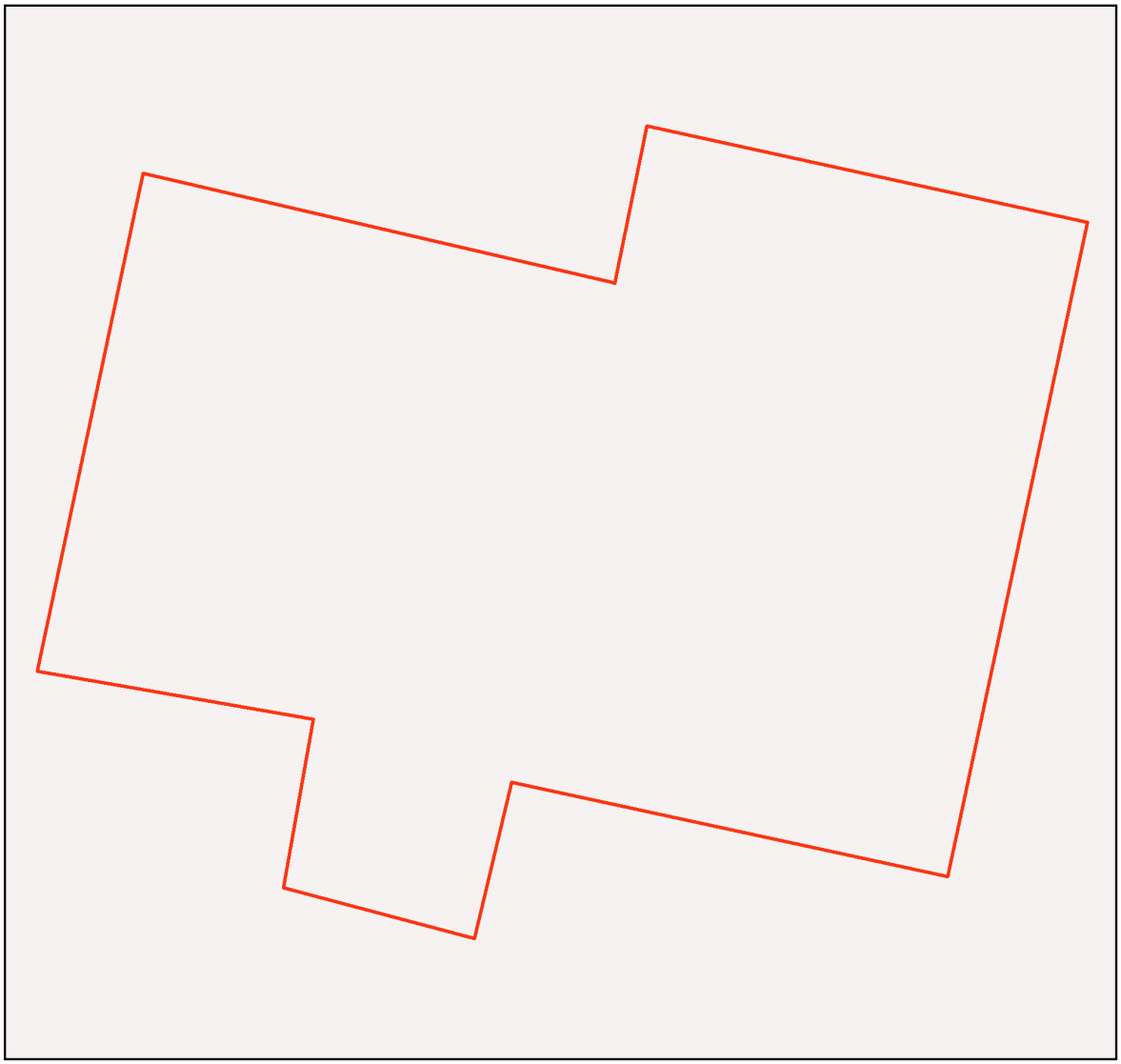
(no results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

Map 1 - MSES - State Conservation Areas



Map 2 - MSES - Wetlands and Waterways

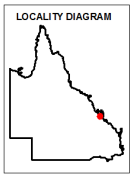


MSES - Wetlands and Waterways

Area of Interest

- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Declared high ecological value waters (watercourse)
- Strategic environmental area (designated precinct)
- Declared high ecological value waters (wetland)
- High ecological significance wetlands

LOCALITY DIAGRAM



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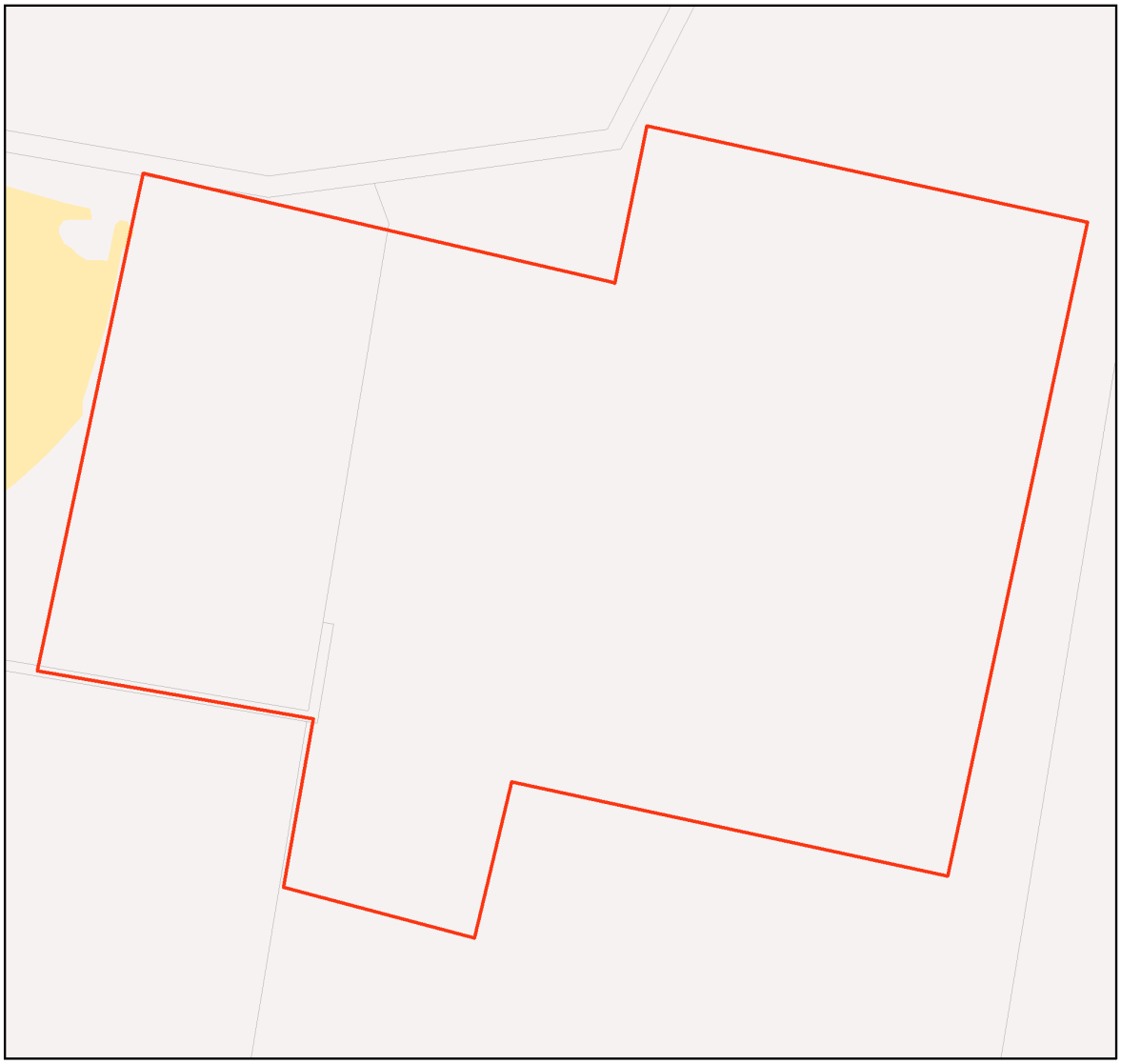
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Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals

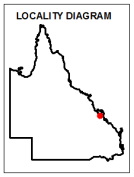


MSES - Species
Threatened (endangered or vulnerable) wildlife and special least concern animals

Area of Interest

- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Wildlife habitat (special least concern)
- Wildlife habitat (endangered or vulnerable)

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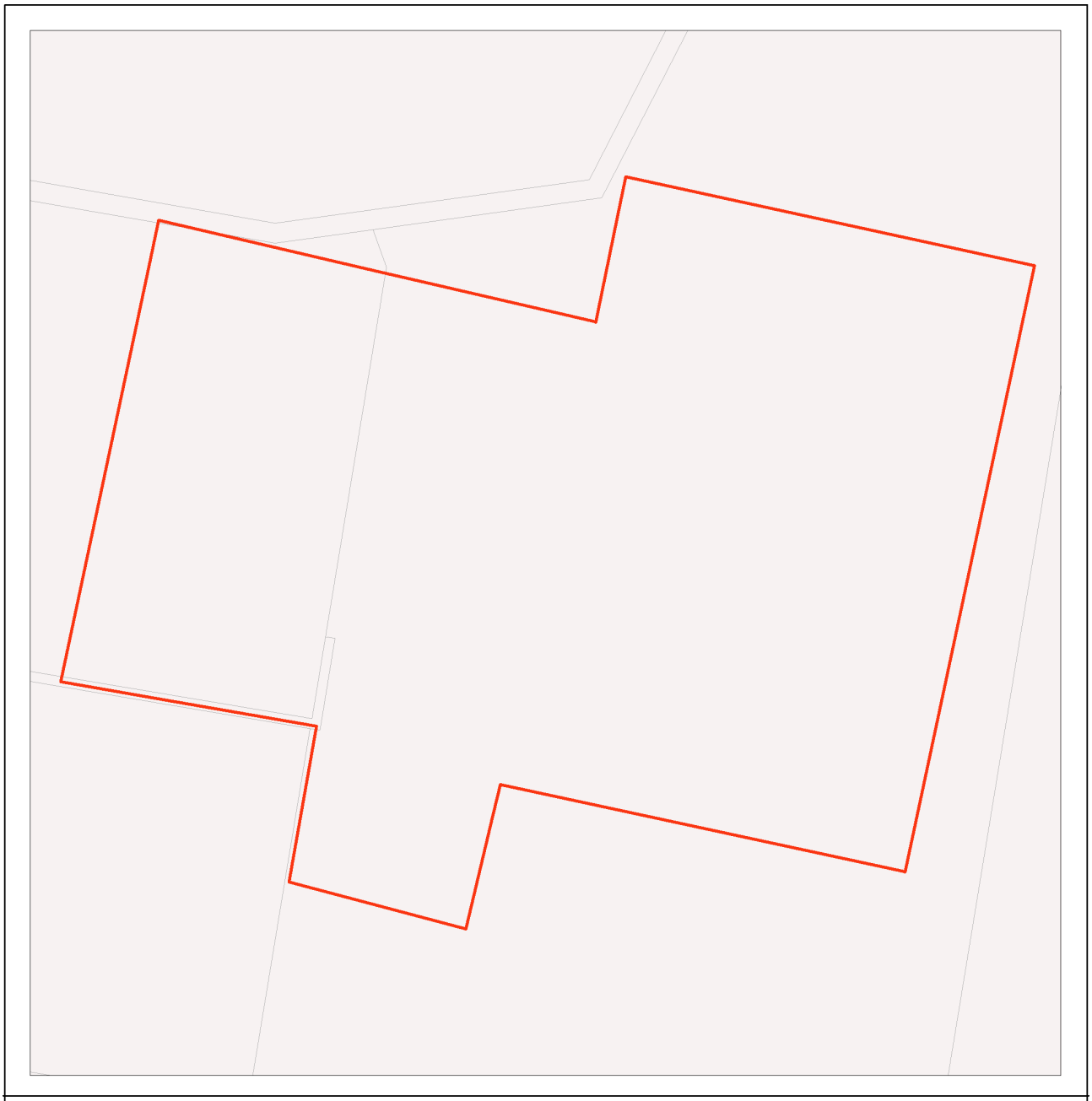
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0 110 220 330 440 550 m

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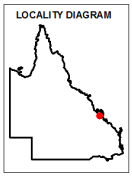
Map 3b - MSES - Species - Koala habitat area (SEQ)



MSES - Species
Koala habitat area (SEQ)

Area of Interest
- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Koala habitat area (core)
- Koala habitat area (locally refined)

LOCALITY DIAGRAM



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The represented layers for SEQ 'koala habitat area-core' and 'koala habitat area- locally refined' in MSES are sourced directly from the regulatory mapping under the Nature Conservation (Koala) Conservation Plan 2017. Whilst every effort is made to ensure the information remains current, there may be delays between updating versions. Please refer to the original mapping for the most recent version. See https://environment.des.qld.gov.au/wildlife/animals/living-with/koalas/mapping

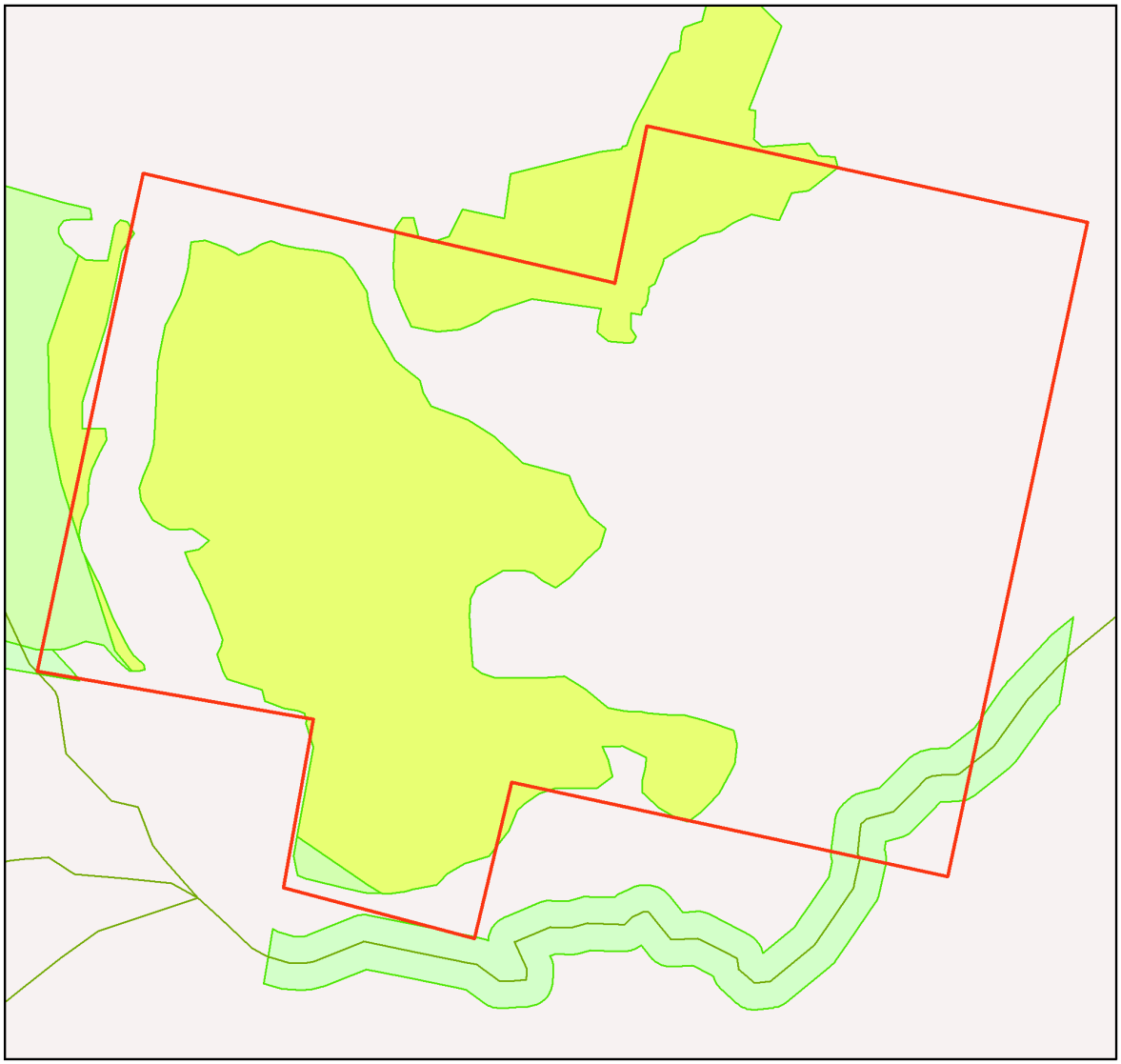
The koala habitat mapping within South East Queensland uses regional ecosystem linework compiled at a scale varying from 1:25,000 to 1:100,000. Linework should be used as a guide only. The positional accuracy of regional ecosystem data mapped at a scale of 1:100,000 is +/- 100 metres.

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Map 4 - MSES - Regulated Vegetation

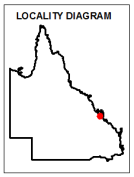


MSES - Regulated Vegetation

Area of Interest

- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Regulated vegetation (intersecting a watercourse)
- Regulated vegetation (100m from wetland)
- Regulated vegetation (category B - endangered or of concern)
- Regulated vegetation (category C - endangered or of concern)
- Regulated vegetation (category R - GBR riverine)
- Regulated vegetation (essential habitat)

LOCALITY DIAGRAM



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0 110 220 330 440 550 m

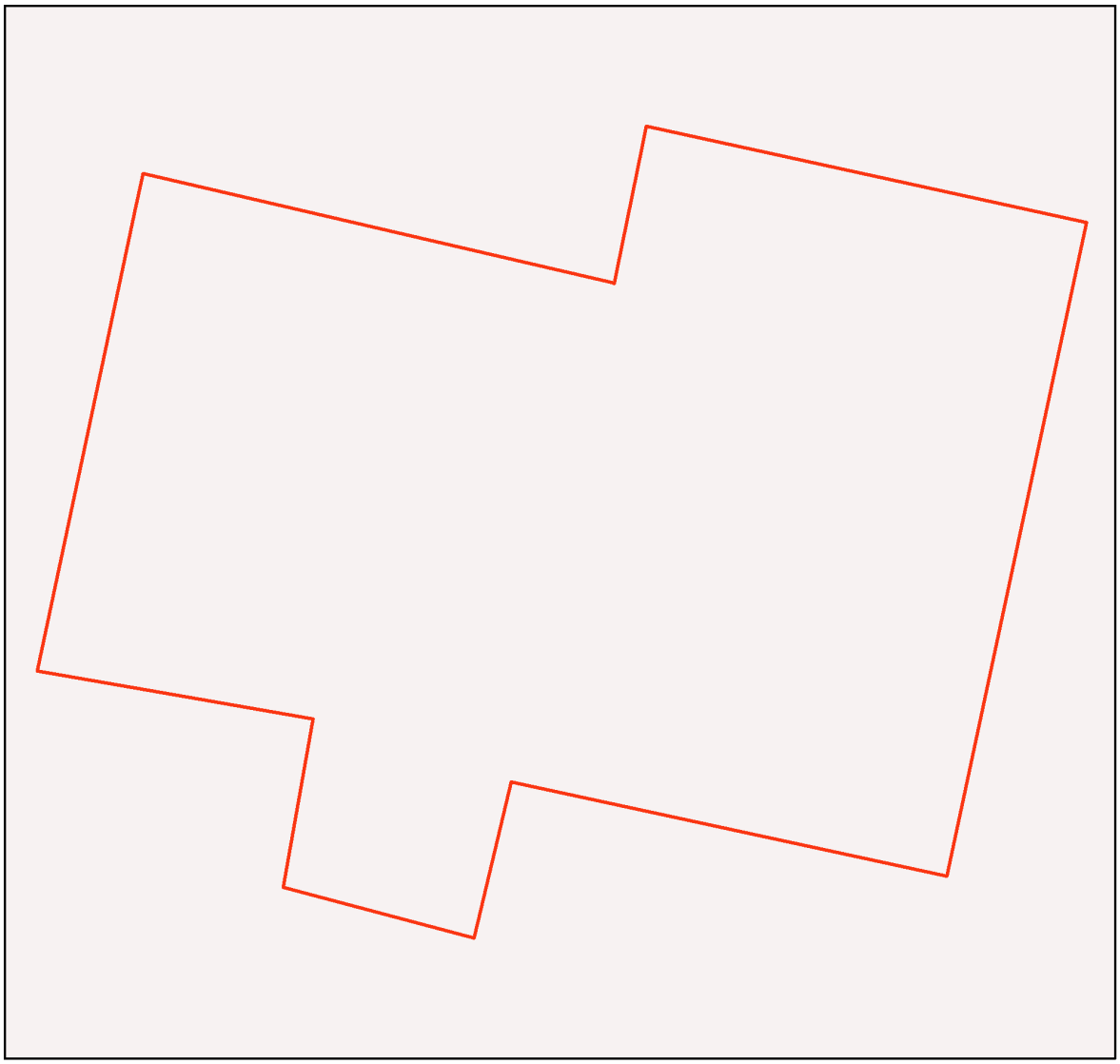
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Map 5 - MSES - Offset Areas

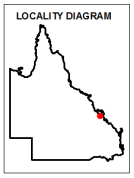


MSES - Offsets

Area of Interest

- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Legally secured offset area (offset register)
- Legally secured offset area (vegetation offsets)

LOCALITY DIAGRAM



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Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). The compiled MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The Queensland Government's "Method for mapping - matters of state environmental significance for use in land use planning and development assessment" can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.information.qld.gov.au)**
Protected Areas-Estates, Nature Refuges, Special Wildlife Reserves	- Protected areas of Queensland - Nature Refuges - Queensland - Special Wildlife Reserves- Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Queensland Wetland Environmental Values
Wetlands in HEV waters	HEV waters: - EPP Water intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 5) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000)
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various) - SEQ koala habitat areas under the Koala Conservation Plan 2019
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map
VMA Essential Habitat	Vegetation management - essential habitat map
VMA Wetlands	Vegetation management wetlands map
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DES	- Department of Environment and Science
EP Act	- *Environmental Protection Act 1994*
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Science

Environmental Reports

Regional Ecosystems

Biodiversity Status

For the selected area of interest
ml: 5866

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no matters of interest have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the classes used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Resources website https://www.dnrme.qld.gov.au/

Please direct queries about these reports to: Queensland.Herbarium@qld.gov.au

Disclaimer

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Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Area of interest details: ml: 5866

Size (ha)	203.82
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" regional ecosystems classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with particular combinations of geology, landform and soil (Sattler and Williams 1999). Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem classification and descriptions are reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and are usually distinguished by differences in dominant species, frequently in the shrub or ground layers and are denoted by a letter following the regional ecosystem code (e.g. a, b, c). Vegetation communities and regional ecosystems are amalgamated into a higher level classification of broad vegetation groups (BVGs).

A published methodology for survey and mapping of regional ecosystems across Queensland (Neldner et al 2020) provides further details on regional ecosystem concepts and terminology.

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium's Regional Ecosystem Mapping, and not the regulated mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Resources website.

https://www.dnrme.qld.gov.au/

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (1000 ha); or patch size (100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

*****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.*

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI and provides their short descriptions, Biodiversity Status, and remnant extent within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
non-remnant	None	None	203.82	100.0

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before clearing.

Table 4 provides further information in regards to the remnant regional ecosystems present within the AOI. Specifically, the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
non-remnant	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

The distribution of mapped wetland systems within the area of interest is displayed in **Map 6**.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
non-remnant	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional) scales.

A comprehensive description of BVGs is available at:

https://publications.qld.gov.au/dataset/redd/resource/

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	203.82	100.0

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant extent (hectares) of each vegetation community derived from the regional ecosystem mapping data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Technical descriptions include data on canopy height, canopy cover and native plant species composition of the predominant layer, which are attributes relevant to assessment of the remnant status of vegetation under the *Vegetation Management Act 1999*. However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used for remnant assessment where possible (Neldner et al. 2020 (PDF)* section 3.3 of:

https://publications.qld.gov.au/dataset/redd/resource/

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community.

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

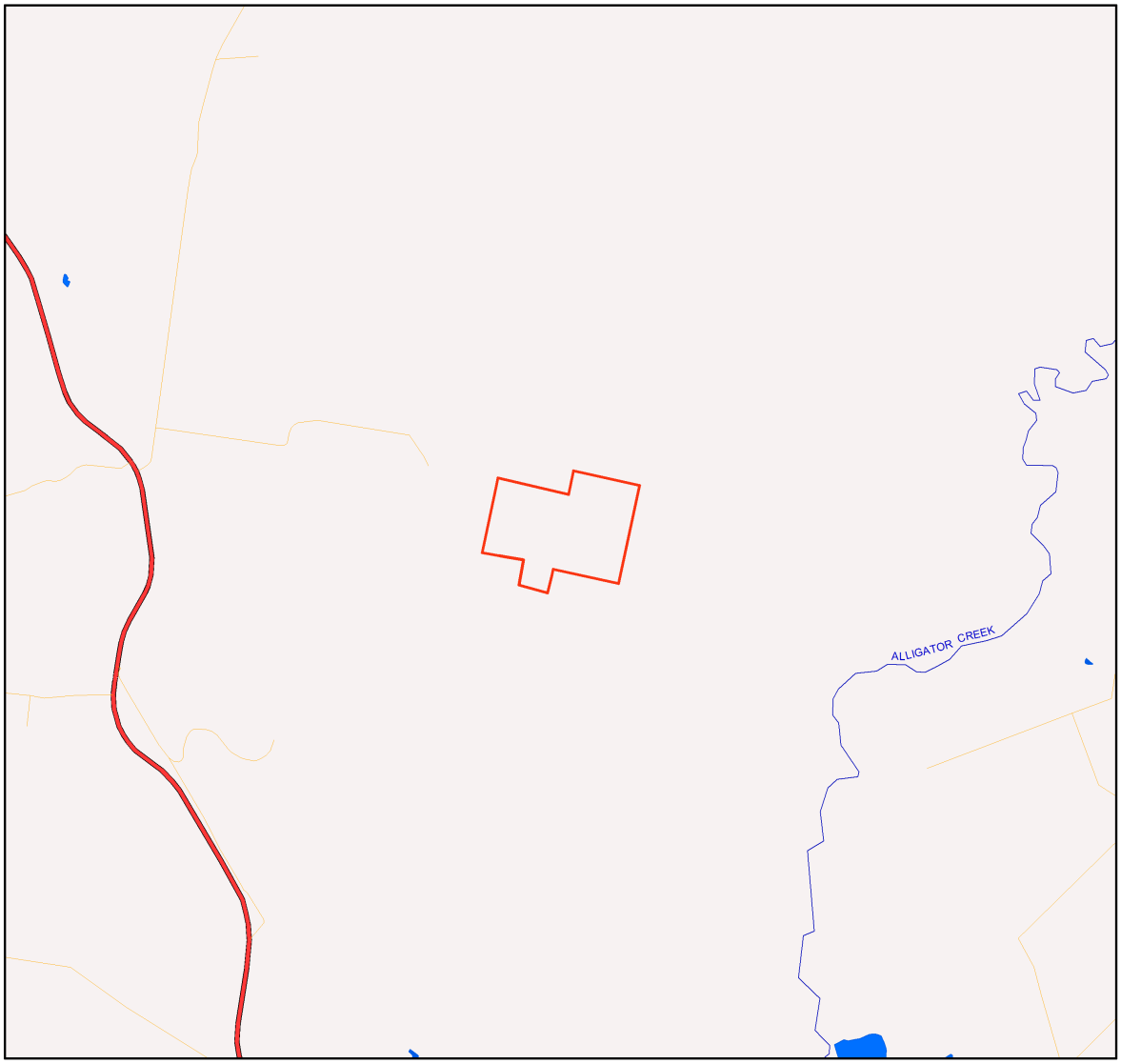
Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
non-remnant	Not currently available	Not currently available

Maps

Map 1 - Location



Locality Map

Legend

- Selected Mining Lease (ML)
- Towns
- Highway
- Connector
- Street/Local Road
- Reservoirs
- Lakes
- National Park (Scientific)
- National Park
- National Park (CYPAL)
- Conservation Park
- Resources Reserve
- Forest Reserve
- State Forest
- Timber Reserve
- Nature Refuges
- Coordinated Conservation Areas
- Major rivers/creeks
- Queensland



N

0 750 1500 2250 3000 3750 m

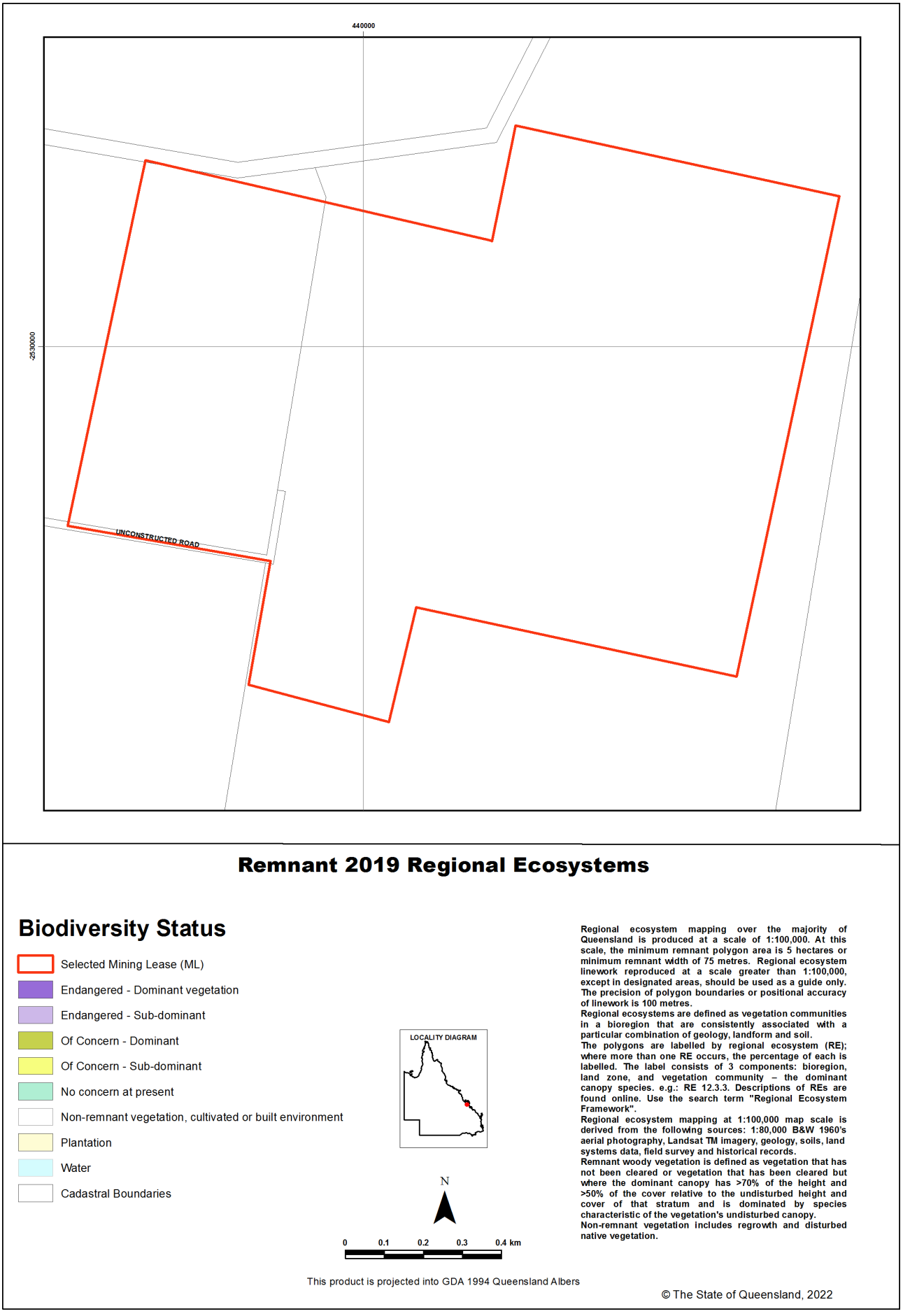
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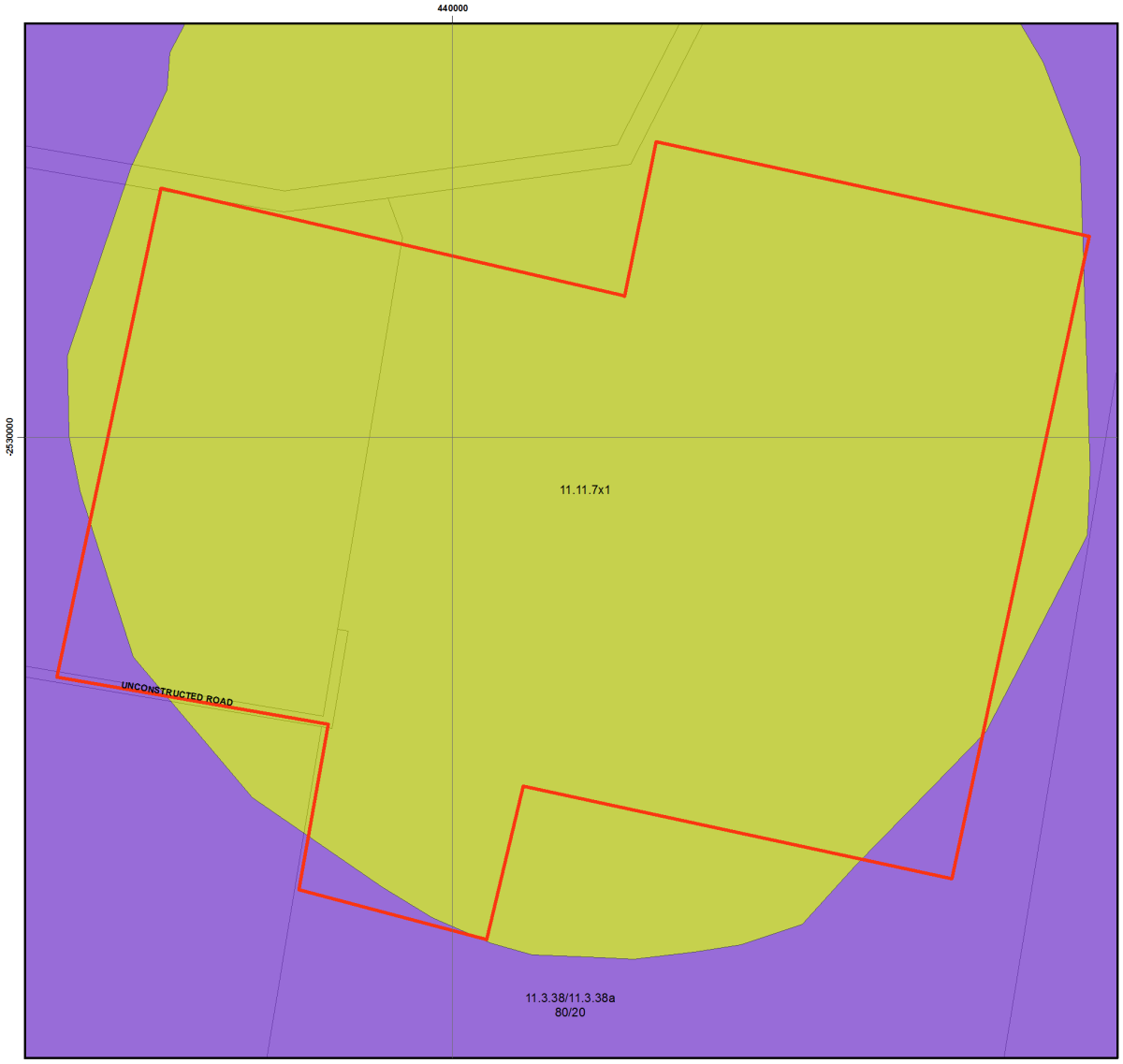
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Map 2 - Remnant 2019 regional ecosystems



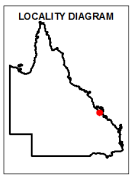
Map 3 - Pre-clearing regional ecosystems

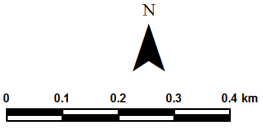


Pre-clearing Regional Ecosystems

Biodiversity Status

- Selected Mining Lease (ML)
- Endangered - Dominant vegetation
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- No concern at present
- Water
- Cadastral Boundaries



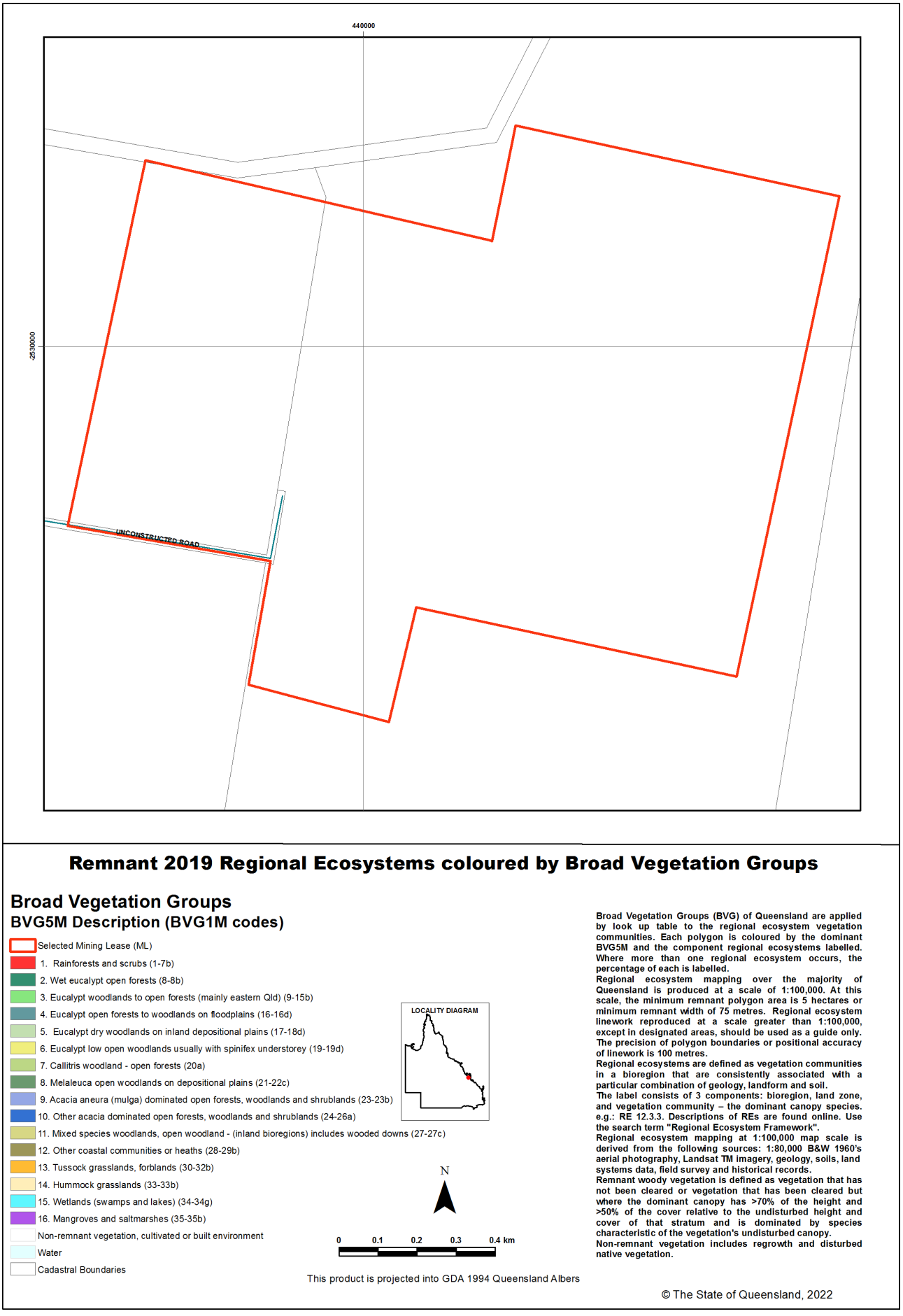


This product is projected into GDA 1994 Queensland Albers

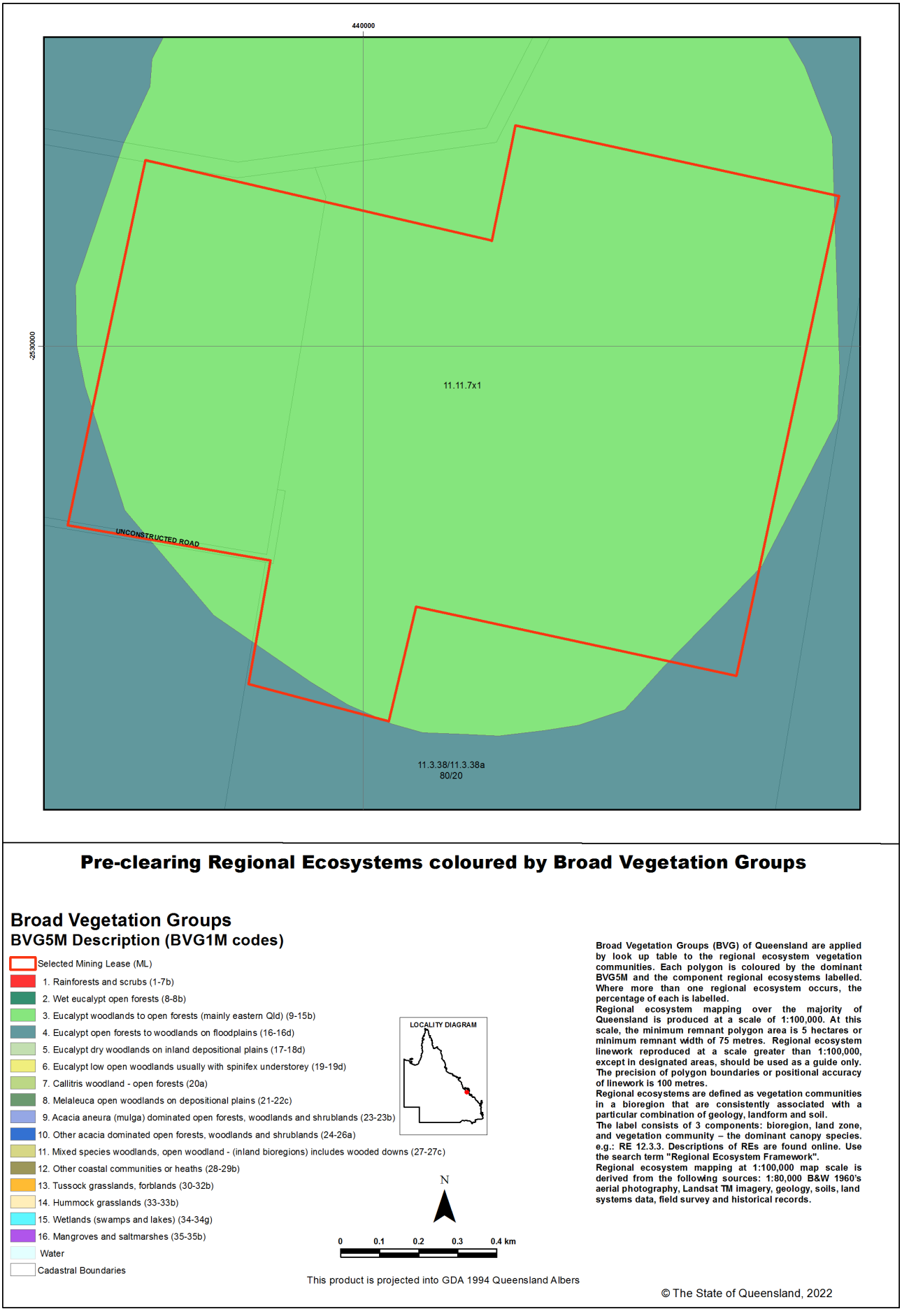
Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.
Regional ecosystems are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.
The polygons are labelled by regional ecosystem (RE); where more than one RE occurs, the percentage of each is labelled. The label consists of 3 components: bioregion, land zone, and vegetation community – the dominant canopy species. e.g.: RE 12.3.3. Descriptions of REs are found online. Use the search term "Regional Ecosystem Framework".
Regional ecosystem mapping at 1:100,000 map scale is derived from the following sources: 1:80,000 B&W 1960's aerial photography, Landsat TM imagery, geology, soils, land systems data, field survey and historical records.

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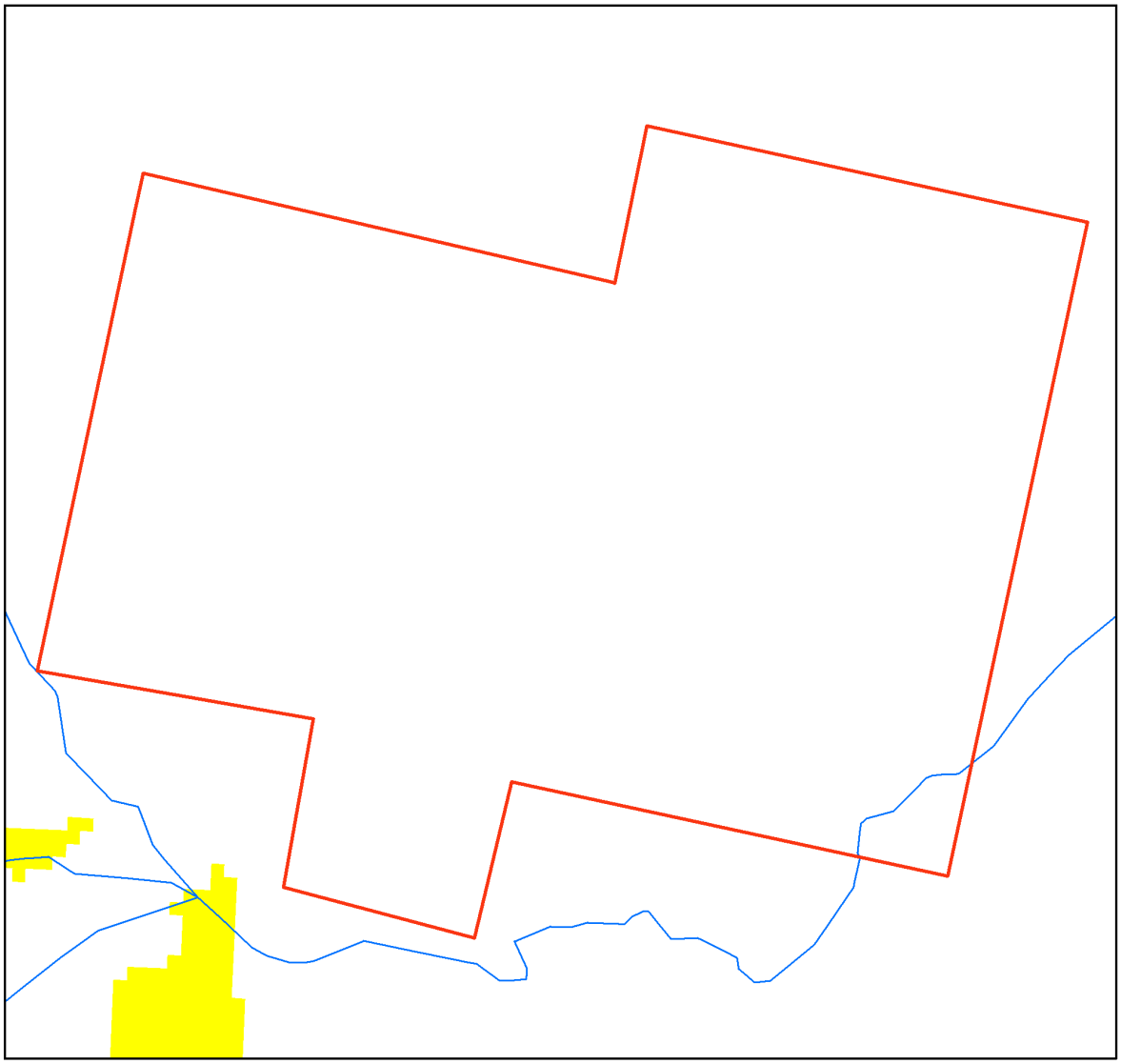
Map 4 - Remnant 2019 regional ecosystems by BVG (5M)



Map 5 - Pre-clearing regional ecosystems by BVG (5M)



Map 6 - Wetlands and waterways



Queensland Wetland Data

Legend

- Selected Mining Lease (ML)
- Towns

Queensland Wetland Data

- Riverine Drainage Lines
- Springs

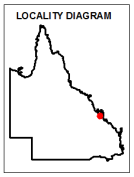
Wetland System - Water Bodies

- Marine Waterbodies
- Estuarine Waterbodies
- Riverine Waterbodies
- Lacustrine Waterbodies
- Palustrine Waterbodies

Wetland System - Regional Ecosystems

- Marine RE
- Estuarine RE
- Riverine RE
- Lacustrine RE
- Palustrine RE
- RE 51-80% wetland (mosaic units)
- RE 1-50% wetland (mosaic units)

LOCALITY DIAGRAM



N

0 110 220 330 440 550 m

Accuracy information: The positional accuracy of wetland data mapped at a scale of 1:100,000 is +/-100m with a minimum polygon size of 5ha or 75m wide for linear features, except for areas along the east coa st which are mapped at the 1:50,000 scale with a positional accuracy of +/-50m, with a minimum polygon size of 1ha or 35m wide for linear features. Wetlands smaller than 1ha are not delineated on the wetland data. Consideration of the effects of mapped scale is necessary when interpret ing data at a larger scale, e.g. 1:25,000. For property assessment, digital linework should be used as a guide only. The extent of wetlands depicted on this map is based on rectified 2013 Landsat ETM+ imagery supplied by Statewide Landcover and Trees Study (SLATS), Department of Environment and Science. The extent of water bodies is based on the maximum extent of inundation derived from available Landsat imagery up to and including the 2013 imagery.

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This product is projected into GDA 1994 Queensland Albers

Links and Other Information Sources

The Department of Environment and Science's Website -

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

The methodology for mapping regional ecosystems can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

Technical descriptions for regional ecosystems can be obtained from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

Benchmarks can be obtained from:

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

For further information associated with the remnant regional ecosystem dataset used by this report, refer to the metadata associated with the Biodiversity status of pre-clearing and Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) which is available through the Queensland Government Information System portal,

http://dds.information.qld.gov.au/dds/

The Queensland Globe is a mapping and data application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link:

http://www.dnrm.qld.gov.au/mapping-data/queensland-globe

References

Neldner, V.J., Niehus, R.E., Wilson, B.A., McDonald, W.J.F., Ford, A.J. and Accad, A. (2019). The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 4.0. Queensland Herbarium, Department of Environment and Science.

(https://publications.qld.gov.au/dataset/redd/resource/78209e74-c7f2-4589-90c1-c33188359086)

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Addicott, E.P. and Appelman, C.N. (2020). Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 5.1. Updated March 2020. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

(https://publications.qld.gov.au/dataset/redd/resource/6dee78ab-c12c-4692-9842-b7257c2511e4)

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

The dataset listed below is available for download from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/

- Regional Ecosystem Description Database

The datasets listed below are available for download from:

http://dds.information.qld.gov.au/dds/

- Biodiversity status of pre-clearing and 2019 remnant regional ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
VMA	- *Vegetation Management Act 1999*

WildNet Records
Conservation Significant Species List



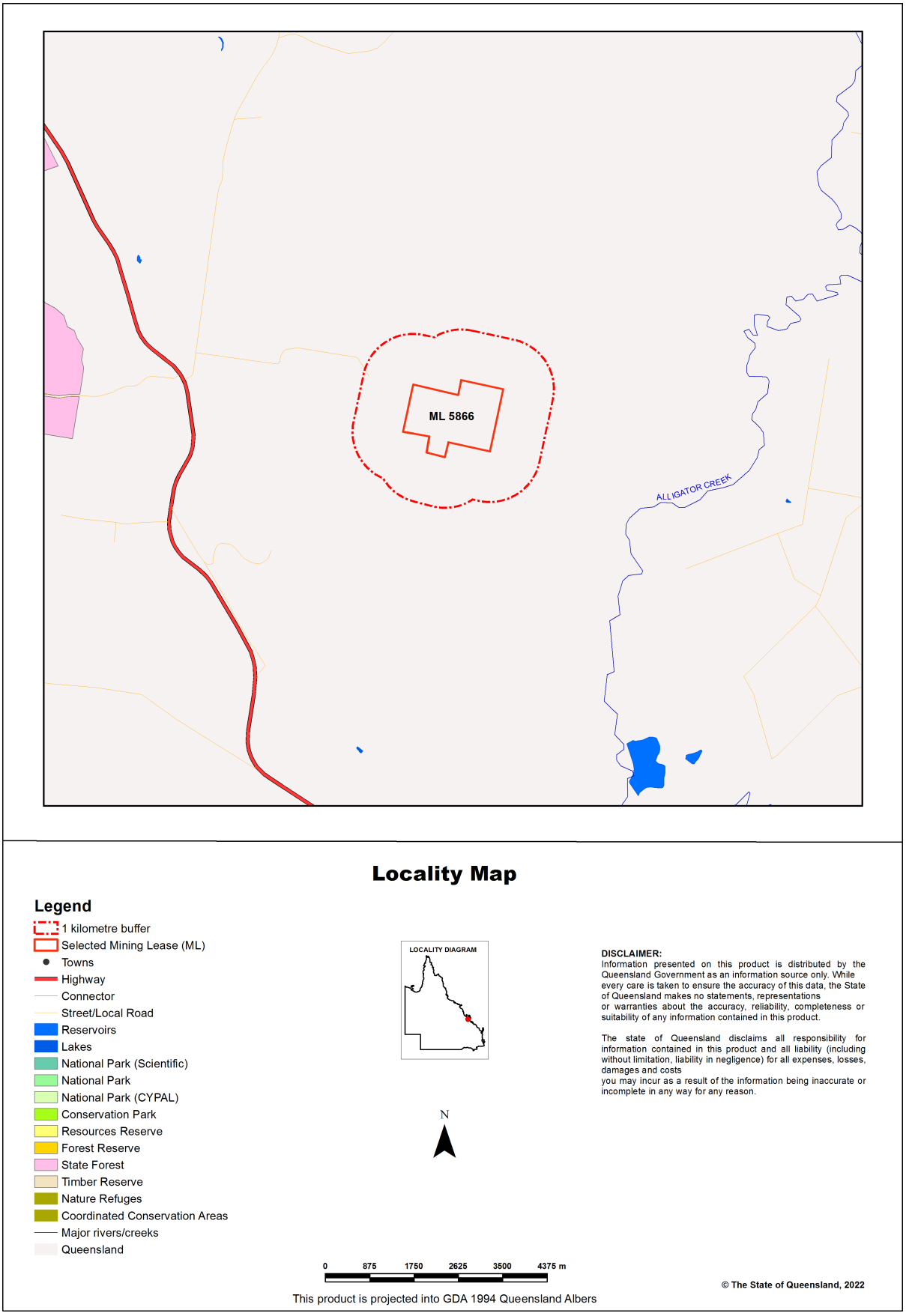
For the selected area of interest 203.82ha ml: 5866

Current as at 02/02/2022

WildNetCSSpeciesList

Queensland Government

Map 1. Locality Map



Summary Information

The following table provides an overview of the area of interest ml: 5866.

Table 1. Area of interest details

Size (ha)	203.82
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

Protected Area(s)
No estates or reserves are located within the area of interest.

World Heritage Area(s)
No World Heritage Areas are located within the area of interest.

Ramsar Area(s)
No Ramsar Areas are located within the area of interest.

Conservation Significant Species List

Introduction

This report is derived from a spatial layer generated from the WildNet database managed by the Department of Environment and Science. The layer which is generated weekly contains the WildNet wildlife records that are not classed as erroneous or duplicate, that have a location precision equal to or less than 10000 metres and do not have a count of zero.

Conservation significant species are species listed:

- as threatened or near threatened under the Nature Conservation Act 1992;
- as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* or
- migratory species protected under the following international agreements:
  - Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
  - China-Australia Migratory Bird Agreement
  - Japan-Australia Migratory Bird Agreement
  - Republic of Korea-Australia Migratory Bird Agreement

The WildNet dataset is constantly being enhanced and the taxonomic and status information revised. If a species is not listed in this report, it does not mean it doesn't occur there and listed species may also no longer inhabit the area. It is recommended that you also access other internal and external data sources for species information in your area of interest (Refer Links and Support).

Table 2 lists the species recorded within the area of interest and its one kilometre buffer.

Table 2. Conservation significant species recorded within the area of interest and its one kilometre buffer

Taxon Id	Kingdom	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
36429	Plantae	Equisetopsida	Thymelaeaceae	*Pimelea leptospermoides subsp. leptospermoides*	None	NT	None	6	6	22/08/2012
27445	Plantae	Equisetopsida	Zamiaceae	*Macrozamia serpentina*	None	E	None	1	1	30/11/2004

Taxon Id: Unique identifier of the taxon from the WildNet database.

NCA: Queensland conservation status of the taxon under the *Nature Conservation Act 1992* (Least Concern (C), Critically Endangered (CR), Endangered (E), Extinct (EX), Near Threatened (NT), Extinct in the Wild (PE), Special Least Concern (SL), and Vulnerable (V)).

EPBC: Australian conservation status of the taxon under the *Environment Protection and Biodiversity Conservation Act 1999* (Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Vulnerable (V), and Extinct in the Wild (XW)).

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Links and Support

Other sites that deliver species information from the WildNet database include:

- Species profile search - access species information approved for publication including species names, statuses, notes, images, distribution maps and records
- Species lists - generate species lists for Queensland protected areas, forestry areas, local governments and areas defined using coordinates
- Biomaps - view biodiversity information, including WildNet records approved for publication, and generate reports
- Queensland Globe - view spatial information, including WildNet records approved for publication
- Qld wildlife data API - access WildNet species information approved for publication such as notes, images and records etc.
- Wetland*Maps* - view species records, survey locations etc. approved for publication
- Wetland*Summary* - view wildlife statistics, species lists for a range of area types, and access WildNet species profiles
- WildNet wildlife records - published - Queensland - spatial layer of WildNet records approved for publication generated weekly
- Generalised distribution and densities of Queensland wildlife - Queensland species distributions and densities generalised to a 10 km grid resolution
- Conservation status of Queensland wildlife - access current lists of priority species for Queensland including nomenclature and status information
- Queensland Confidential Species - the list of species flagged as confidential in the WildNet database.

Please direct queries about this report to the WildNet Team.

Other useful sites for accessing Queensland biodiversity data include:

- Useful wildlife resources
- Queensland Government Data
- Atlas of Living Australia (ALA)
- Online Zoological Collections of Australian Museums (OZCAM)
- Australia's Virtual Herbarium (AVH)
- Protected Matters Search Tool

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WildNet Records
Pest List



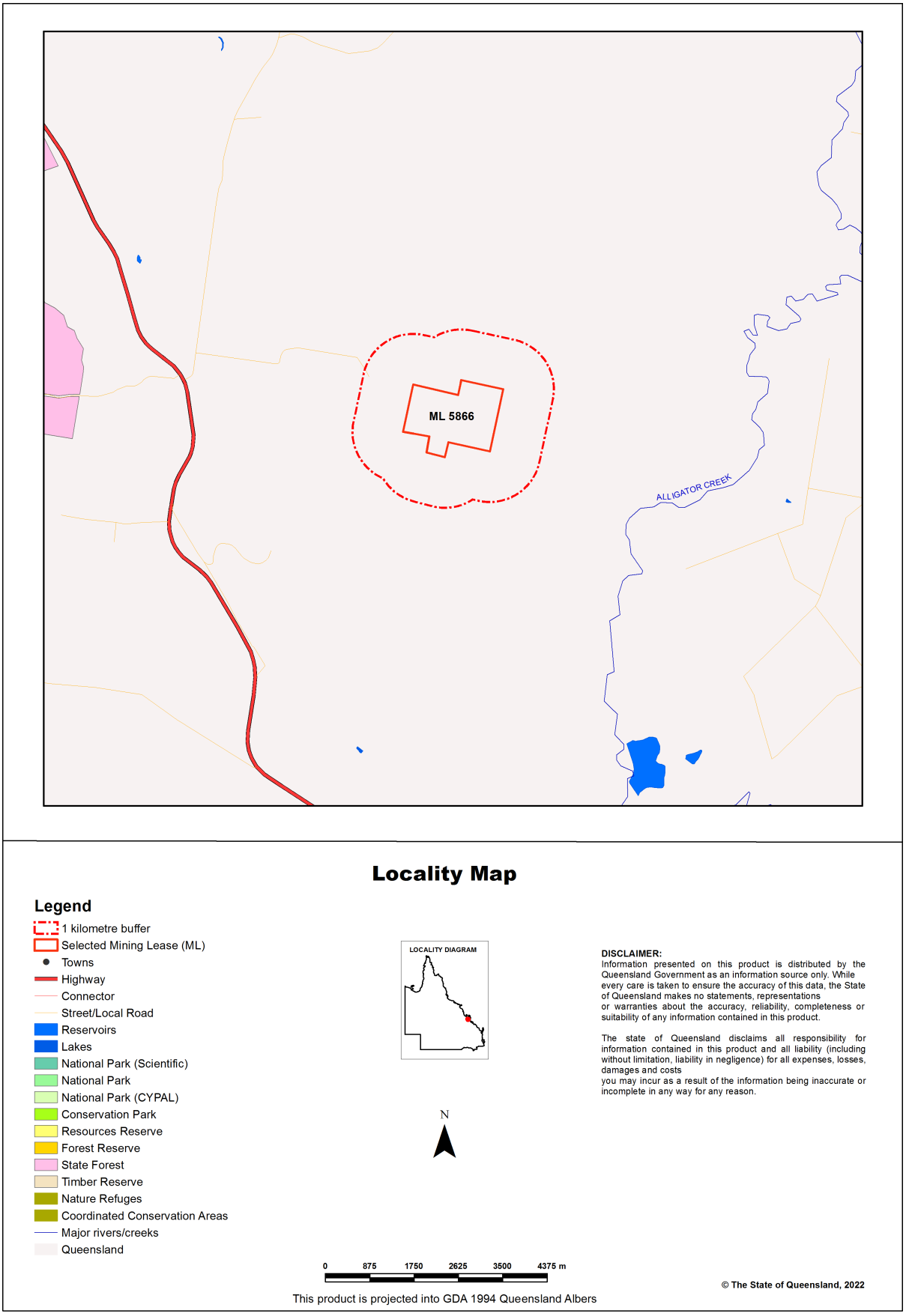
For the selected area of interest 203.82ha ml: 5866

Current as at 02/02/2022

WildNetPestList

Queensland Government

Map 1. Locality Map



Summary Information

The following table provides an overview of the area of interest ml: 5866.

Table 1. Area of interest details

Size (ha)	203.82
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

Protected Area(s)

No estates or reserves are located within the area of interest.

World Heritage Area(s)

No World Heritage Areas are located within the area of interest.

Ramsar Area(s)

No Ramsar Areas are located within the area of interest.

Pest List

Introduction

This report is derived from a spatial layer generated from the WildNet database managed by the Department of Environment and Science. The layer which is generated weekly contains the WildNet wildlife records that are not classed as erroneous or duplicate, that have a location precision equal to or less than 10000 metres and do not have a count of zero.

The WildNet dataset is constantly being enhanced and the taxonomic and status information revised. If a species is not listed in this report, it does not mean it doesn't occur there and listed species may also no longer inhabit the area. It is recommended that you also access other internal and external data sources for species information in your area of interest (Refer Links and Support).

Species Data

Contextual location information is presented in Map 1.

A summary of the pests recorded within the area of interest and its one kilometre buffer is presented in Table 2.

Table 2. Pests recorded within the area of interest and its one kilometre buffer

Taxon Id	Kingdom	Class	Family	Scientific Name	Common Name	Specimens	Records	Last record	Endemicity
15479	Plantae	Equisetopsida	Apocynaceae	*Cryptostegia grandiflora*	rubber vine	1	1	30/11/2004	IU
36076	Plantae	Equisetopsida	Passifloraceae	*Passiflora pallida*	None	1	1	09/12/1998	IU
16302	Plantae	Equisetopsida	Petiveriaceae	*Rivina humilis*	None	1	1	19/05/1993	IU
16479	Plantae	Equisetopsida	Phytolaccaceae	*Phytolacca octandra*	inkweed	1	1	19/05/1993	IU
16475	Plantae	Equisetopsida	Solanaceae	*Physalis ixocarpa*	annual ground cherry	1	1	19/05/1993	IU
16157	Plantae	Equisetopsida	Solanaceae	*Solanum americanum*	None	1	1	19/05/1993	IU
19905	Plantae	Equisetopsida	Verbenaceae	*Lantana camara*	lantana	1	1	03/07/2003	IU

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Endemicity: The endemicity code for the taxon (Introduced (Intranational) (IA), Introduced (International) (II), Introduced (Unknown), Exotic (Intranational) (XA), Exotic (International) (XI) and Exotic (Unknown) (XU)).

Links and Support

Other sites that deliver species information from the WildNet database include:

- Species profile search - access species information approved for publication including species names, statuses, notes, images, distribution maps and records
- Species lists - generate species lists for Queensland protected areas, forestry areas, local governments and areas defined using coordinates
- Biomaps - view biodiversity information, including WildNet records approved for publication, and generate reports
- Queensland Globe - view spatial information, including WildNet records approved for publication
- Qld wildlife data API - access WildNet species information approved for publication such as notes, images and records etc.
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WildNet Records
Species List



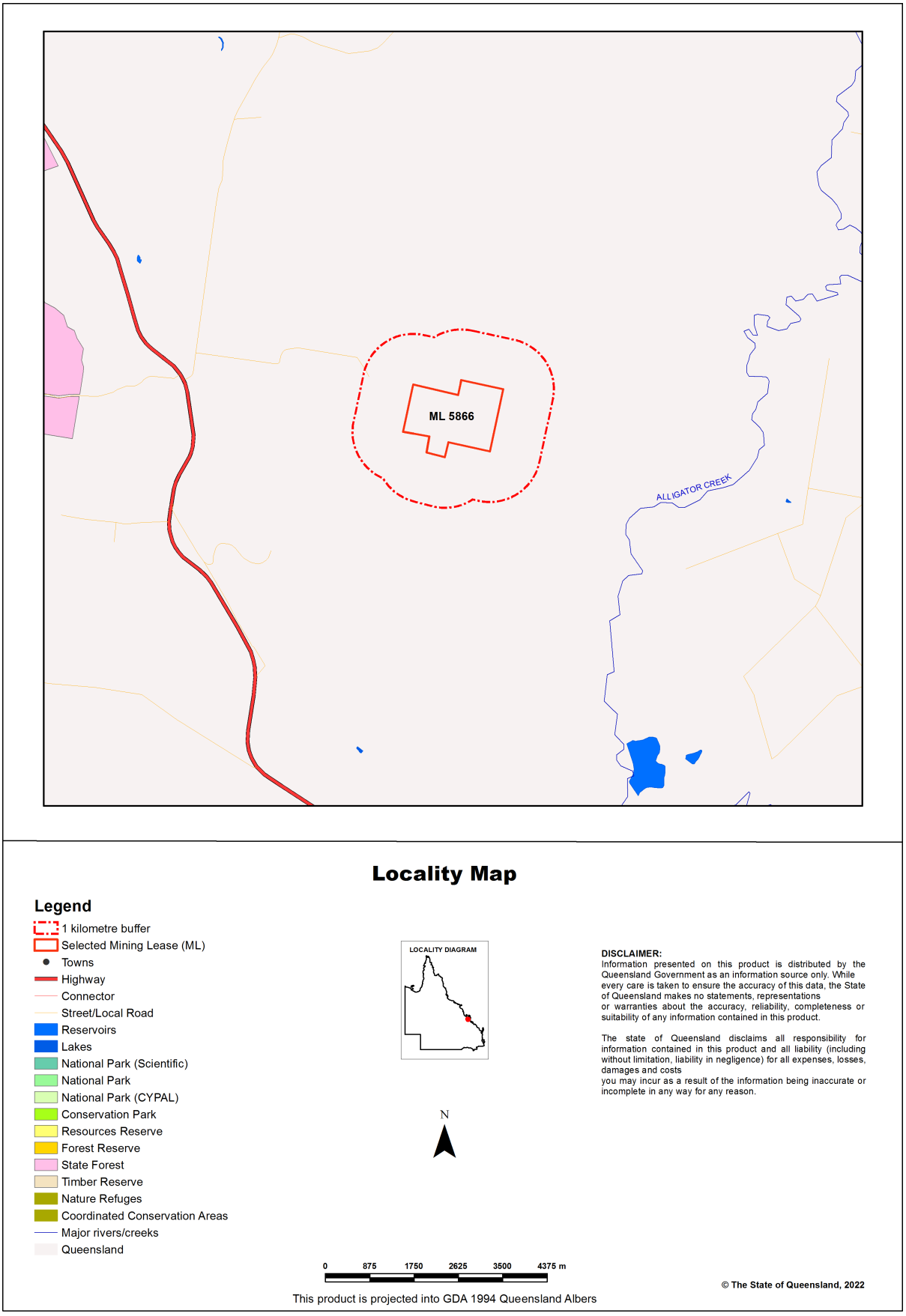
For the selected area of interest 203.82ha ml: 5866

Current as at 02/02/2022

WildNetSpeciesList

Queensland Government

Map 1. Locality Map



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Catchment(s)	Fitzroy

Protected Area(s)
No estates or reserves are located within the area of interest.

World Heritage Area(s)
No World Heritage Areas are located within the area of interest.

Ramsar Area(s)
No Ramsar Areas are located within the area of interest.

Species List

Introduction
This report is derived from a spatial layer generated from the WildNet database managed by the Department of Environment and Science. The layer which is generated weekly contains the WildNet wildlife records that are not classed as erroneous or duplicate, that have a location precision equal to or less than 10000 metres and do not have a count of zero.

The WildNet dataset is constantly being enhanced and the taxonomic and status information revised. If a species is not listed in this report, it does not mean it doesn't occur there and listed species may also no longer inhabit the area. It is recommended that you also access other internal and external data sources for species information in your area of interest (Refer Links and Support).

Table 2 lists the animals recorded within the area of interest and its one kilometre buffer.

Table 3 lists the plants recorded within the area of interest and its one kilometre buffer.

Table 4 lists the fungi recorded within the area of interest and its one kilometre buffer.

Table 5 lists the protists recorded within the area of interest and its one kilometre buffer.

Table 2. Animals recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Table 3. Plants recorded within the area of interest and its one kilometre buffer

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
5869	Equisetopsida	Acanthaceae	*Harnieria hygrophiloides*	white karambal	C	None	1	1	19/05/1993
16424	Equisetopsida	Anacardiaceae	*Pleiogynium timorense*	Burdekin plum	C	None	1	1	19/05/1993
8144	Equisetopsida	Annonaceae	*Melodorum leichhardtii*	None	C	None	1	1	19/05/1993
9698	Equisetopsida	Apocynaceae	*Carissa ovata*	currantbush	C	None	2	2	09/12/1998
15479	Equisetopsida	Apocynaceae	*Cryptostegia grandiflora*	rubber vine	None	None	1	1	30/11/2004
41644	Equisetopsida	Apocynaceae	*Leichhardtia viridiflora subsp. viridiflora*	None	C	None	1	1	19/05/1993
8462	Equisetopsida	Araliaceae	*Polyscias elegans*	celery wood	C	None	1	1	19/05/1993

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
33810	Equisetopsida	Chenopodiaceae	*Dysphania carinata*	None	C	None	1	1	19/05/1993
16028	Equisetopsida	Combretaceae	*Terminalia porphyrocarpa*	None	C	None	1	1	19/05/1993
16220	Equisetopsida	Cyperaceae	*Scleria brownii*	None	C	None	1	1	19/05/1993
17438	Equisetopsida	Dioscoreaceae	*Dioscorea transversa*	native yam	C	None	1	1	19/05/1993
17445	Equisetopsida	Ebenaceae	*Diospyros humilis*	small-leaved ebony	C	None	2	2	09/12/1998
18091	Equisetopsida	Euphorbiaceae	*Acalypha eremorum*	soft acalypha	C	None	1	1	19/05/1993
6716	Equisetopsida	Euphorbiaceae	*Adriana tomentosa var. tomentosa*	None	C	None	2	2	30/11/2004
31860	Equisetopsida	Euphorbiaceae	*Claoxylon tenerifolium subsp. tenerifolium*	None	C	None	1	1	19/05/1993
17561	Equisetopsida	Euphorbiaceae	*Croton insularis*	Queensland cascarilla	C	None	1	1	19/05/1993
17179	Equisetopsida	Euphorbiaceae	*Excoecaria dallachyana*	scrub poison tree	C	None	2	2	19/05/1993
15964	Equisetopsida	Lamiaceae	*Vitex melicopea*	None	C	None	1	1	19/05/1993
11794	Equisetopsida	Lauraceae	*Neolitsea brassii*	None	C	None	1	1	26/10/1991
15827	Equisetopsida	Leguminosae	*Acacia aulacocarpa*	None	C	None	1	1	19/05/1993
15789	Equisetopsida	Leguminosae	*Acacia complanata*	flatstem wattle	C	None	1	1	19/05/1993
21915	Equisetopsida	Leguminosae	*Acacia disparrima subsp. disparrima*	None	C	None	1	1	09/12/1998
21784	Equisetopsida	Leguminosae	*Acacia fodinalis*	None	C	None	1	1	15/04/2008
14066	Equisetopsida	Leguminosae	*Acacia leiocalyx subsp. leiocalyx*	None	C	None	1	1	09/12/1998
32294	Equisetopsida	Leguminosae	*Acacia sp. (Canoona S.T.Blake 15321)*	None	C	None	1	1	09/12/1998
18175	Equisetopsida	Leguminosae	*Austrosteenisia blackii var. blackii*	None	C	None	1	1	19/05/1993
15555	Equisetopsida	Leguminosae	*Cajanus confertiflorus*	None	C	None	1	1	30/11/2004
7462	Equisetopsida	Loganiaceae	*Strychnos psilosperma*	strychnine tree	C	None	1	1	19/05/1993
17988	Equisetopsida	Loranthaceae	*Amyema congener subsp. rotundifolia*	None	C	None	1	1	19/05/1993
16661	Equisetopsida	Meliaceae	*Melia azedarach*	white cedar	C	None	1	1	19/05/1993
16559	Equisetopsida	Meliaceae	*Owenia venosa*	crow's apple	C	None	2	2	19/05/1993
15987	Equisetopsida	Meliaceae	*Turraea pubescens*	native honeysuckle	C	None	1	1	19/05/1993
22365	Equisetopsida	Moraceae	*Ficus rubiginosa forma glabrescens*	None	C	None	1	1	19/05/1993
6402	Equisetopsida	Moraceae	*Trophis scandens subsp. scandens*	None	C	None	1	1	19/05/1993
27383	Equisetopsida	Myrtaceae	*Gossia bidwillii*	None	C	None	1	1	19/05/1993
16840	Equisetopsida	Oleaceae	*Jasminum simplicifolium subsp. australiense*	None	C	None	1	1	19/05/1993
36076	Equisetopsida	Passifloraceae	*Passiflora pallida*	None	None	None	1	1	09/12/1998
16302	Equisetopsida	Petiveriaceae	*Rivina humilis*	None	None	None	1	1	19/05/1993
17810	Equisetopsida	Phyllanthaceae	*Bridelia leichhardtii*	None	C	None	1	1	19/05/1993

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
16479	Equisetopsida	Phytolaccaceae	*Phytolacca octandra*	inkweed	None	None	1	1	19/05/1993
16505	Equisetopsida	Picrodendraceae	*Petalostigma pubescens*	quinine tree	C	None	2	2	15/04/2008
22387	Equisetopsida	Pittosporaceae	*Pittosporum spinescens*	None	C	None	1	1	19/05/1993
11121	Equisetopsida	Poaceae	*Aristida gracilipes*	None	C	None	1	1	19/05/1993
15411	Equisetopsida	Poaceae	*Entolasia stricta*	wiry panic	C	None	1	1	19/05/1993
17033	Equisetopsida	Proteaceae	*Grevillea helmsiae*	None	C	None	1	1	19/05/1993
16538	Equisetopsida	Rubiaceae	*Pavetta australiensis var. australiensis*	None	C	None	1	1	19/05/1993
29828	Equisetopsida	Rubiaceae	*Psydrax lamprophylla forma lamprophylla*	None	C	None	1	1	19/05/1993
2399	Equisetopsida	Rubiaceae	*Psydrax odorata*	None	C	None	1	1	09/12/1998
15871	Equisetopsida	Rutaceae	*Acronychia laevis*	glossy acronychia	C	None	1	1	19/05/1993
11300	Equisetopsida	Rutaceae	*Flindersia australis*	crow's ash	C	None	1	1	19/05/1993
13638	Equisetopsida	Sapindaceae	*Cupaniopsis wadsworthii*	None	C	None	1	1	19/05/1993
17339	Equisetopsida	Sapindaceae	*Elattostachys xylocarpa*	white tamarind	C	None	1	1	19/05/1993
16475	Equisetopsida	Solanaceae	*Physalis ixocarpa*	annual ground cherry	None	None	1	1	19/05/1993
16157	Equisetopsida	Solanaceae	*Solanum americanum*	None	None	None	1	1	19/05/1993
16165	Equisetopsida	Solanaceae	*Solanum ellipticum*	potato bush	C	None	1	1	19/05/1993
16103	Equisetopsida	Sterculiaceae	*Sterculia quadrifida*	peanut tree	C	None	1	1	19/05/1993
36429	Equisetopsida	Thymelaeaceae	*Pimelea leptospermoides subsp. leptospermoides*	None	NT	None	6	6	22/08/2012
31416	Equisetopsida	Ulmaceae	*Trema tomentosa var. aspera*	None	C	None	1	1	09/12/1998
19905	Equisetopsida	Verbenaceae	*Lantana camara*	lantana	None	None	1	1	03/07/2003
17648	Equisetopsida	Vitaceae	*Cissus oblonga*	None	C	None	1	1	19/05/1993
27445	Equisetopsida	Zamiaceae	*Macrozamia serpentina*	None	E	None	1	1	30/11/2004

Table 4. Fungi recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Table 5. Protists recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

NCA: Queensland conservation status of the taxon under the *Nature Conservation Act 1992* (Least Concern (C), Critically Endangered (CR), Endangered (E), Extinct (EX), Near Threatened (NT), Extinct in the Wild (PE), Special Least Concern (SL), and Vulnerable (V)).

EPBC: Australian conservation status of the taxon under the *Environment Protection and Biodiversity Conservation Act 1999* (Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Vulnerable (V), and Extinct in the Wild (XW)).

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Links and Support

Other sites that deliver species information from the WildNet database include:

- Species profile search - access species information approved for publication including species names, statuses, notes, images, distribution maps and records
- Species lists - generate species lists for Queensland protected areas, forestry areas, local governments and areas defined using coordinates
- Biomaps - view biodiversity information, including WildNet records approved for publication, and generate reports
- Queensland Globe - view spatial information, including WildNet records approved for publication
- Qld wildlife data API - access WildNet species information approved for publication such as notes, images and records etc.
- Wetland*Maps* - view species records, survey locations etc. approved for publication
- Wetland*Summary* - view wildlife statistics, species lists for a range of area types, and access WildNet species profiles
- WildNet wildlife records - published - Queensland - spatial layer of WildNet records approved for publication generated weekly
- Generalised distribution and densities of Queensland wildlife - Queensland species distributions and densities generalised to a 10 km grid resolution
- Conservation status of Queensland wildlife - access current lists of priority species for Queensland including nomenclature and status information
- Queensland Confidential Species - the list of species flagged as confidential in the WildNet database.

Please direct queries about this report to the WildNet Team.

Other useful sites for accessing Queensland biodiversity data include:

- Useful wildlife resources
- Queensland Government Data
- Atlas of Living Australia (ALA)
- Online Zoological Collections of Australian Museums (OZCAM)
- Australia's Virtual Herbarium (AVH)
- Protected Matters Search Tool

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government, to the maximum extent permitted by law, makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



WildNet Records
Weed List



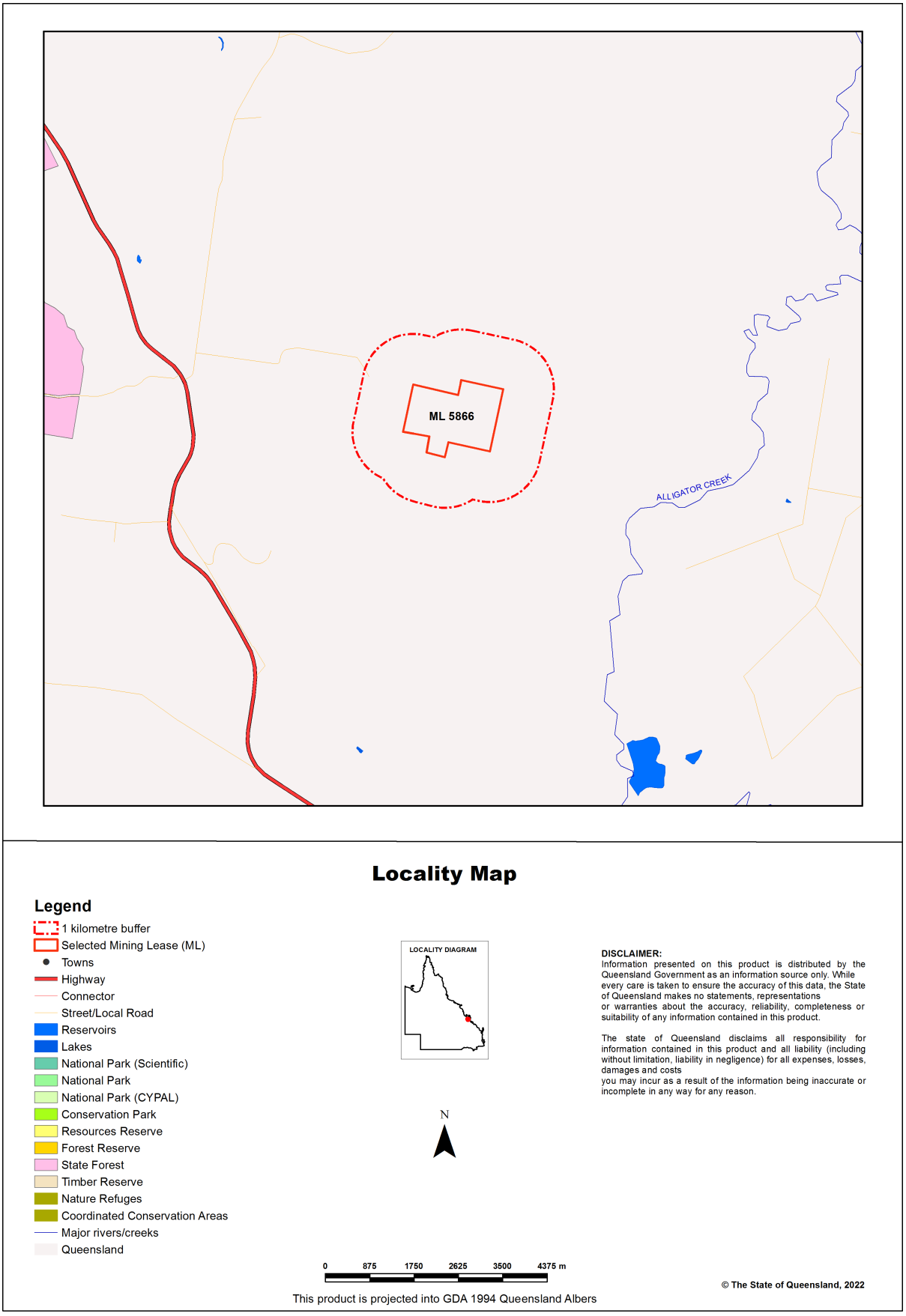
For the selected area of interest 203.82ha ml: 5866

Current as at 02/02/2022

WildNetWeedList

Queensland Government

Map 1. Locality Map



Summary Information

The following table provides an overview of the area of interest ml: 5866.

Table 1. Area of interest details

Size (ha)	203.82
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

Protected Area(s)
No estates or reserves are located within the area of interest.

World Heritage Area(s)
No World Heritage Areas are located within the area of interest.

Ramsar Area(s)
No Ramsar Areas are located within the area of interest.

Weed List

Introduction

This report is derived from a spatial layer generated from the WildNet database managed by the Department of Environment and Science. The layer which is generated weekly contains the WildNet wildlife records that are not classed as erroneous or duplicate, that have a location precision equal to or less than 10000 metres and do not have a count of zero.

The WildNet dataset is constantly being enhanced and the taxonomic and status information revised. If a species is not listed in this report, it does not mean it doesn't occur there and listed species may also no longer inhabit the area. It is recommended that you also access other internal and external data sources for species information in your area of interest (Refer Links and Support).

Species Data

Contextual location information is presented in Map 1.

A summary of the weeds recorded within the area of interest and its one kilometre buffer is presented in Table 2.

Table 2. Weeds recorded within the area of interest and its one kilometre buffer

Taxon Id	Family	Scientific Name	Common Name	Specimens	Records	Last record	Endemicity
15479	Apocynaceae	*Cryptostegia grandiflora*	rubber vine	1	1	30/11/2004	IU
36076	Passifloraceae	*Passiflora pallida*	None	1	1	09/12/1998	IU
16302	Petiveriaceae	*Rivina humilis*	None	1	1	19/05/1993	IU
16479	Phytolaccaceae	*Phytolacca octandra*	inkweed	1	1	19/05/1993	IU
16475	Solanaceae	*Physalis ixocarpa*	annual ground cherry	1	1	19/05/1993	IU
16157	Solanaceae	*Solanum americanum*	None	1	1	19/05/1993	IU
19905	Verbenaceae	*Lantana camara*	lantana	1	1	03/07/2003	IU

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Endemicity: The endemicity code for the taxon (Introduced (Intranational) (IA), Introduced (International) (II), Introduced (Unknown), Exotic (Intranational) (XA), Exotic (International) (XI) and Exotic (Unknown) (XU)).

Links and Support

Other sites that deliver species information from the WildNet database include:

- Species profile search - access species information approved for publication including species names, statuses, notes, images, distribution maps and records
- Species lists - generate species lists for Queensland protected areas, forestry areas, local governments and areas defined using coordinates
- Biomaps - view biodiversity information, including WildNet records approved for publication, and generate reports
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- Qld wildlife data API - access WildNet species information approved for publication such as notes, images and records etc.
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Queensland Government

Department of Environment and Science

Environmental Reports

Biodiversity and Conservation Values

Biodiversity Planning Assessments and Aquatic Conservation Assessments

For the selected area of interest
ml: 5864

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or Area of Interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending from 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: biodiversity.planning@des.qld.gov.au

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Summary Information

Tables 1 to 8 provide an overview of the AOI with respect to selected topographic and environmental values.

Table 1: Area of interest details: ml: 5864

Size (ha)	64.49
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

The following table identifies available Biodiversity Planning Assessments (BPAs) and Aquatic Conservation Assessments (ACAs) with respect to the AOI.

Table 2: Available Biodiversity Planning and Aquatic Conservation Assessments

Assessment Type	Assessment Area and Version
Biodiversity Planning Assessment(s)	Brigalow Belt v2.1
Aquatic Conservation Assessment(s) (riverine)	Great Barrier Reef Catchments v1.1
Aquatic Conservation Assessment(s) (non-riverine)	Great Barrier Reef Catchments v1.3

Table 3: Remnant regional ecosystems within the AOI as per the Qld Herbarium's 'biodiversity status'

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	64.33	99.76
No concern at present	0.0	0.0

The following table identifies the extent and proportion of the user specified area of interest (AOI) which is mapped as being of "State", "Regional" or "Local" significance via application of the Queensland Department of Environment and Science's *Biodiversity Assessment and Mapping Methodology* (BAMM).

Table 4: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
State Habitat for EVNT taxa	32.5	50.4
State	31.83	49.36
Regional	0.0	0.0
Local or Other Values	0.0	0.0

Table 5: Non-riverine wetlands intersecting the AOI

Non-riverine wetland types intersecting the area of interest	#
(No Records)	

NB. The figures presented in the table above are derived from the relevant non-riverine Aquatic Conservation Assessment(s). Later releases of wetland mapping produced via the Queensland Wetland Mapping Program may provide more recent

information in regards to wetland extent.

Table 6: Named waterways intersecting the AOI

(no results)

Refer to **Map 1** for general locality information.

The following two tables identify the extent and proportion of the user specified AOI which is mapped as being of "Very High", "High", "Medium", "Low", or "Very Low" aquatic conservation value for riverine and non-riverine wetlands via application of the Queensland Department of Environment and Science's *Aquatic Biodiversity Assessment and Mapping Method* (AquaBAMM).

Table 7: Summary table, aquatic conservation significance (riverine)

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	64.49	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

Table 8: Summary table, aquatic conservation significance (non-riverine)

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

Biodiversity Planning Assessments

Introduction

The Department of Environment and Science (DES) attributes biodiversity significance on a bioregional scale through a Biodiversity Planning Assessment (BPA). A BPA involves the integration of ecological criteria using the *Biodiversity assessment and Mapping Methodology* (BAMM) and is developed in two stages: 1) **diagnostic criteria**, and 2) **expert panel criteria**. The diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion, while the expert panel criteria allows for the refinement of the mapped information from the diagnostic output by incorporating local knowledge and expert opinion.

The BAMM methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes. While natural resource values such as dryland salinity, soil erosion potential or land capability are not dealt with explicitly, they are included to some extent within the biodiversity status of regional ecosystems recognised by the DES.

Biodiversity Planning Assessments (BPAs) assign three levels of overall biodiversity significance.

- **State significance** - areas assessed as being significant for biodiversity at the bioregional or state scales. They also include areas assessed by other studies/processes as being significant at national or international scales. In addition, areas flagged as being of State significance due to the presence of endangered, vulnerable and/or near threatened taxa, are identified as "State Habitat for EVNT taxa".
- **Regional significance** - areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.
- **Local significance and/or other values** - areas assessed as not being significant for biodiversity at state or regional scales. Local values are of significance at the local government scale.

For further information on released BPAs and a copy of the underlying methodology, go to:

http://www.qld.gov.au/environment/plants-animals/biodiversity/planning/

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

The following table identifies the extent and proportion of the user specified AOI which is mapped as being of "State", "Regional" or "Local" significance via application of the BAMM.

Table 9: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
State Habitat for EVNT taxa	32.5	50.4
State	31.83	49.36
Regional	0.0	0.0
Local or Other Values	0.0	0.0

Refer to **Map 2** for further information.

Diagnostic Criteria

Diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion. These criteria are diagnostic in that they are used to filter the available data and provide a "first-cut" or initial determination of biodiversity significance. This initial assessment is then combined through a second group of other essential criteria.

A description of the individual diagnostic criteria is provided in the following sections.

Criteria A. Habitat for EVNT taxa: Classifies areas according to their significance based on the presence of endangered, vulnerable and/or rare (EVNT) taxa. EVNT taxa are those scheduled under the *Nature Conservation Act 1992* and/or the

Environment Protection and Biodiversity Conservation Act 1999. It excludes highly mobile fauna taxa which are instead considered in Criterion H and brings together information on EVNT taxa using buffering of recorded sites or habitat suitability models (HSM) where available.

Criteria B. Ecosystem value: Classifies on the basis of biodiversity status of regional ecosystems, their extent in protected areas (presence of poorly conserved regional ecosystems), the presence of significant wetlands; and areas of national importance such as the presence of Threatened Ecological Communities, World Heritage areas and Ramsar sites. Ecosystem value is applied at a bioregional (**B1**) and regional (**B2**) scale.

Criteria C. Tract size: Measures the relative size of tracts of vegetation in the landscape. The size of any tract is a major indicator of ecological significance, and is also strongly correlated with the long-term viability of biodiversity values. Larger tracts are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller tracts.

Criteria D. Relative size of regional ecosystems: Classifies the relative size of each regional ecosystem unit within its bioregion (**D1**) and its subregion (**D2**). Remnant units are compared with all other occurrences with the same regional ecosystem. Large examples of a regional ecosystem are more significant than smaller examples of the same regional ecosystem because they are more representative of the biodiversity values particular to the regional ecosystem, are more resilient to the effects of disturbance, and constitute a significant proportion of the total area of the regional ecosystem.

Criteria F. Ecosystem diversity: Is an indicator of the number of regional ecosystems occurring within an area. An area with high ecosystem diversity will have many regional ecosystems and ecotones relative to other areas within the bioregion.

Criteria G. Context and connection: Represents the extent to which a remnant unit incorporates, borders or buffers areas such as significant wetlands, endangered ecosystems; and the degree to which it is connected to other vegetation.

A summary of the biodiversity status based upon the diagnostic criteria is provided in the following table.

Table 10: Summary of biodiversity significance based upon diagnostic criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
State	Remnant contains at least 1 Endangered or 2 Vulnerable or Near Threatened species (A)	32.5	50.4
Regional	Remnant contains at least one Of Concern RE (B1)	31.83	49.36

Assessment of diagnostic criteria with respect to the AOI

The following table reflects an assessment of the individual diagnostic criteria noted above in regards to the AOI.

Table 11: Assessment of individual diagnostic criteria with respect to the AOI

Diagnostic Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
A: Habitat for EVNT Taxa	32.5	50.4			31.83	49.4		
B1: Ecosystem Value (Bioregion)			64.33	99.8				
B2: Ecosystem Value (Subregion)					64.33	99.8		
C: Tract Size	64.33	99.8						
D1: Relative RE Size (Bioregion)							64.33	99.8
D2: Relative RE Size (Subregion)							64.33	99.8
F: Ecosystem Diversity					64.33	99.8		
G: Context and Connection	5.01	7.8			59.32	92.0		

Other Essential Criteria

Other essential criteria (also known as expert panel criteria) are based on non-uniform information sources and which may rely more upon expert opinion than on quantitative data. These criteria are used to provide a "second-cut" determination of biodiversity significance, which is then combined with the diagnostic criteria for an overall assessment of relative biodiversity significance. A summary of the biodiversity status based upon the other essential criteria is provided in the following table.

Table 12: Summary of biodiversity significance based upon other essential criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
State	Remnant contains Special Biodiversity Values (view Expert Panel data for further information) (I) & Remnant forms part of a bioregional corridor (J)	64.33	99.75

A description of each of the other essential criteria and associated assessment in regards to the AOI is provided in the following sections.

Criteria H. Essential and general habitat for priority taxa: Priority taxa are those which are at risk or of management concern, taxa of scientific interest as relictual (ancient or primitive), endemic taxa or locally significant populations (such as a flying fox camp or heronry), highly specialised taxa whose habitat requirements are complex and distributions are not well correlated with any particular regional ecosystem, taxa important for maintaining genetic diversity (such as complex spatial patterns of genetic variation, geographic range limits, highly disjunct populations), taxa critical for management or monitoring of biodiversity (functionally important or ecological indicators), or economic and culturally important taxa.

Criteria I. Special biodiversity values: areas with special biodiversity values are important because they contain multiple taxa in a unique ecological and often highly biodiverse environment. Areas with special biodiversity values can include the following:

- Ia - centres of endemism - areas where concentrations of taxa are endemic to a bioregion or subregion are found.
- Ib - wildlife refugia (Morton *et al*. 1995), for example, islands, mound springs, caves, wetlands, gorges, mountain ranges and topographic isolates, ecological refuges, refuges from exotic animals, and refuges from clearing. The latter may include large areas that are not suitable for clearing because of land suitability/capability.
- Ic - areas with concentrations of disjunct populations.
- Id - areas with concentrations of taxa at the limits of their geographic ranges.
- Ie - areas with high species richness.
- If - areas with concentrations of relictual populations (ancient and primitive taxa).
- Ig - areas containing REs with distinct variation in species composition associated with geomorphology and other environmental variables.
- Ih - an artificial waterbody or managed/manipulated wetland considered by the panel/s to be of ecological significance.
- Ii - areas with a high density of hollow-bearing trees that provide habitat for animals.
- Ij - breeding or roosting sites used by a significant number of individuals.
- Ik - climate change refuge.

The following table identifies the value and extent area of the Other Essential Criteria H and I within the AOI.

Table 13: Relative importance of expert panel criteria (H and I) used to access overall biodiversity significance with respect to the AOI

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
H: Core Habitat Priority Taxa								
Ia: Centres of Endemism	64.33	99.8						
Ib: Wildlife Refugia								
Ic: Disjunct Populations								
Id: Limits of Geographic Ranges								
Ie: High Species Richness								
If: Relictual Populations			64.33	99.8				

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
Ig: Variation in Species Composition	64.33	99.8						
Ih: Artificial Wetland								
Ii: Hollow Bearing Trees								
Ij: Breeding or Roosting Site								
Ik: Climate Refugia								

NB. Whilst biodiversity values associated with Criteria I may be present within the site (refer to tables 12 and 15), for the New England Tableland and Central Queensland Coast BPAs, area and % area figures associated with Criteria Ia through to Ij cannot be listed in the table above (due to slight variations in data formats between BPAs).

Criteria J. Corridors: areas identified under this criterion qualify either because they are existing vegetated corridors important for contiguity, or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and "stepping stones".

Bioregional and subregional conservation corridors have been identified in the more developed bioregions of Queensland through the BPAs, using an intensive process involving expert panels. Map 3 displays the location of corridors as identified under the Statewide Corridor network. The Statewide Corridor network incorporates BPA derived corridors and for bioregions where no BPA has been assessed yet, corridors derived under other planning processes. *Note: as a result of updating and developing a statewide network, the alignment of corridors may differ slightly in some instances when compared to those used in individual BPAs.*

The functions of these corridors are:

- **Terrestrial** Bioregional corridors, in conjunction with large tracts of remnant vegetation, maintain ecological and evolutionary processes at a landscape scale, by:

  • Maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations of species over long periods of time;

  • Maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change;

  • Maintaining large scale seasonal/migratory species processes and movement of fauna;

  • Maximising connectivity between large tracts/patches of remnant vegetation;

  • Identifying key areas for rehabilitation and offsets; and

- **Riparian** Bioregional Corridors also maintain and encourage connectivity of riparian and associated ecosystems.

The location of the corridors is determined by the following principles:

- Terrestrial

  • Complement riparian landscape corridors (i.e. minimise overlap and maximise connectivity);

  • Follow major watershed/catchment and/or coastal boundaries;

  • Incorporate major altitudinal/geological/climatic gradients;

  • Include and maximise connectivity between large tracts/patches of remnant vegetation;

  • Include and maximise connectivity between remnant vegetation in good condition; and

- Riparian

  • Located on the major river or creek systems within the bioregion in question.

The total extent of remnant vegetation triggered as being of "State", "Regional" or "Local" significance due to the presence of an overlying BPA derived terrestrial or riparian corridor within the AOI, is provided in the following table. For further information on how remnant vegetation is triggered due to the presence of an overlying BPA derived corridor, refer to the relevant landscape BPA expert panel report(s).

Table 14: Extent of triggered remnant vegetation due to the presence of BPA derived corridors with respect to the AOI

Biodiversity Significance	Area (Ha)	% of AOI
State	64.33	99.75
Regional	0.0	0.0
Local	0.0	0.0

NB: area figures associated with the extent of corridor triggered remnant vegetation are only available for those bioregions where a BPA has been undertaken.

Refer to **Map 3** for further information.

Threatening process/condition (Criteria K) - areas identified by experts under this criterion may be used to amend (upgrade or downgrade) biodiversity significance arising from the "first-cut" analysis. The condition of remnant vegetation is affected by threatening processes such as weeds, ferals, grazing and burning regime, selective timber harvesting/removal, salinity, soil erosion, and climate change.

Assessment of Criteria K with respect to the AOI is not currently included in the "Biodiversity and Conservation Values" report, as it has not been applied to the majority of Queensland due to data/information limitations and availability.

Special Area Decisions

Expert panel derived "Special Area Decisions" are used to assign values to Other Essential Criteria. The specific decisions which relate to the AOI in question are listed in the table below.

Table 15: Expert panel decisions for assigning levels of biodiversity significance with respect to the AOI

Decision Number	Description	Panel Recommended Significance	Criteria Values
brbn_fl_03	Remnant vegetation on serpentinite	State	Ia (endemic richness): VH; If (relictual taxa): H; Ig (ecosystem variation): VH
brbn_l_17a	None	None	None

Expert panel decision descriptions:

brbn_fl_03

Remnant vegetation communities situated on serpentinite geology often exhibit distinct ecosystem variation in terms of floristics and vegetation structure in comparison to similar communities situated on other geology types. These communities tend to contain a number of narrow range endemics many of which are also classified as threatened (**Bursaria reevesii**, **Capparis thozetiana** and **Cycas ophiolitica**). Some species are only found on this geology in QLD, including **Macrozamia serpentina**, **Olearia macdonnellensis**, **Neoroepera buxifolia** and **Euphorbia ophiolitica**.

brbn_l_17a

None

Aquatic Conservation Assessments

Introduction

The Aquatic Biodiversity Assessment and Mapping Method or AquaBAMM (Clayton *et al.* 2006), was developed to assess conservation values of wetlands in queensland, and may also have application in broader geographical contexts. It is a comprehensive method that uses available data, including data resulting from expert opinion, to identify relative wetland conservation/ecological values within a specified study area (usually a catchment). The product of applying this method is an Aquatic Conservation Assessment (ACA) for the study area.

An ACA using AquaBAMM is non-social, non-economic and identifies the conservation/ecological values of wetlands at a user-defined scale. It provides a robust and objective conservation assessment using criteria, indicators and measures that are founded upon a large body of national and international literature. The criteria, each of which may have variable numbers of indicators and measures, are naturalness (aquatic), naturalness (catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. An ACA using AquaBAMM is a powerful decision support tool that is easily updated and simply interrogated through a geographic information system (GIS).

Where they have been conducted, ACAs can provide a source of baseline wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered (i.e. an early input to broader 'triple-bottom-line' decision-making processes). An ACA can have application in:

- determining priorities for protection, regulation or rehabilitation of wetlands and other aquatic ecosystems
- on-ground investment in wetlands and other aquatic ecosystems
- contributing to impact assessment of large-scale development (e.g. dams)
- water resource and strategic regional planning prcesses

For a detailed explanation of the methodology please refer to the summary and expert panel reports relevant to the ACA utilised in this assessment. These reports can be accessed at Wetland *Info*:

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

Explanation of Criteria

Under the AquaBAMM, eight criteria are assessed to derive an overall conservation value. Similar to the Biodiversity Assessment and Mapping Methodology, the criteria may be primarily diagnostic (quantitative) or primarily expert opinion (qualitative) in nature. The following sections provide a brief description of each of the 8 criteria.

Criteria 1. Naturalness - Aquatic: This attribute reflects the extent to which a wetland's (riverine, non-riverine, estuarine) aquatic state of naturalness is affected through relevant influencing indicators which include: presence of exotic flora and fauna; presence of aquatic communities; degree of habitat modification and degree of hydrological modification.

Criteria 2. Naturalness - Catchment: The naturalness of the terrestrial systems of a catchment can have an influence on many wetland characteristics including: natural ecological processes e.g. nutrient cycling, riparian vegetation, water chemistry, and flow. The indicators utilised to assess this criterion include: presence of exotic flora and/or fauna; riparian, catchment and flow modification.

Criteria 3. Naturalness - Diversity and Richness: This criterion is common to many ecological assessment methods and can include both physical and biological features. It includes such indicators as species richness, riparian ecosystem richness and geomorphological diversity.

Criteria 4. Threatened Species and Ecosystems: This criterion evaluates ecological rarity characteristics of a wetland. This includes both species rarity and rarity of communities / assemblages. The communities and assemblages are best represented by regional ecosystems. Species rarity is determined by NCA and EPBC status with Endangered, Vulnerable or Near-threatened species being included in the evaluation. Ecosystem rarity is determined by regional ecosystem biodiversity status i.e. Endangered, Of Concern, or Not of Concern.

Criteria 5. Priority Species and Ecosystems: Priority flora and fauna species lists are expert panel derived. These are aquatic, semi-aquatic and riparian species which exhibit at least 1 particular trait in order to be eligible for consideration. For

flora species the traits included:

- It forms significant macrophyte beds (in shallow or deep water).
- It is an important food source.
- It is important/critical habitat.
- It is implicated in spawning or reproduction for other fauna and/or flora species.
- It is at its distributional limit or is a disjunct population.
- It provides stream bank or bed stabilisation or has soil binding properties.
- It is a small population and subject to threatening processes.

Fauna species are included if they meet at least one of the following traits:

- It is endemic to the study area (>75 per cent of its distribution is in the study area/catchment).
- It has experienced, or is suspected of experiencing, a serious population decline.
- It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area/catchment.
- It is currently a small population and threatened by loss of habitat.
- It is a significant disjunct population.
- It is a migratory species (other than birds).
- A significant proportion of the breeding population (>one per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).
- Limit of species range.

See the individual expert panel reports for the priority species traits specific to an ACA.

Criteria 6. Special Features: Special features are areas identified by flora, fauna and ecology expert panels which exhibit characteristics beyond those identified in other criteria and which the expert panels consider to be of the highest ecological importance. Special feature traits can relate to, but are not solely restricted to geomorphic features, unique ecological processes, presence of unique or distinct habitat, presence of unique or special hydrological regimes e.g. spring-fed streams. Special features are rated on a 1 - 4 scale (4 being the highest).

Criteria 7. Connectivity: This criterion is based on the concept that appropriately connected aquatic ecosystems are healthy and resilient, with maximum potential biodiversity and delivery of ecosystem services.

Criteria 8. Representativeness: This criterion applies primarily to non-riverine assessments, evaluates the rarity and uniqueness of a wetland type in relation to specific geographic areas. Rarity is determined by the degree of wetland protection within "protected Areas" estate or within an area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995*, or *Marine Parks Act 2004*. Wetland uniqueness evaluates the relative abundance and size of a wetland or wetland management group within geographic areas such as catchment and subcatchment.

Riverine Wetlands

Riverine wetlands are all wetlands and deepwater habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water. AquaBAMM, when applied to riverine wetlands uses a discrete spatial unit termed subsections. A subsection can be considered as an area which encompasses discrete homogeneous stream sections in terms of their natural attributes (i.e. physical, chemical, biological and utilitarian values) and natural resources. Thus in an ACA, an aquatic conservation significance score is calculated for each subsection and applies to all streams within a subsection, rather than individual streams as such.

Please note, the area figures provided in Tables 16 and 17, are derived using the extent of riverine subsections within the AOI. Refer to **Map 5** for further information. A summary of the conservation significance of riverine wetlands within the AOI is provided in the following table.

Table 16: Overall level/s of riverine aquatic conservation significance

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
High	64.49	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

The individual aquatic conservation criteria ratings for riverine wetlands within the AOI are listed below.

Table 17: Level/s of riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
1. Naturalness aquatic	42.16	65.4	22.33	34.6				
2. Naturalness catchment			64.49	100.0				
3. Diversity and richness			42.16	65.4	22.33	34.6		
4. Threatened species and ecosystems	42.16	65.4	22.33	34.6				
5. Priority species and ecosystems	64.49	100.0						
6. Special features								
7. Connectivity	22.33	34.6	42.16	65.4				
8. Representative-ness								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to riverine wetlands within the AOI.

Table 18: Expert panel decisions for assigning overall levels of riverine aquatic conservation significance

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
fi_r_fl_03	Regional ecosystem 11.3.38	Fitzroy	5.2.1	4

4 is the highest rating/value

Expert panel decision descriptions:

fi_r_fl_03

This regional ecosystem is a serpentinite ecosystem known to contain a number of rare and threatened species.

Non-riverine Wetlands

Non-riverine wetlands include both lacustrine and palustrine wetlands, however, do not currently incorporate estuarine, marine or subterranean wetland types. A summary of the conservation significance of non-riverine wetlands within the AOI is provided in the following table. Refer to **Map 6** for further information.

Table 19: Overall level/s of non-riverine aquatic conservation significance

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

The following table provides an assessment of non-riverine wetlands within the AOI and associated aquatic conservation criteria values.

Table 20: Level/s of non-riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to non-riverine wetlands within the AOI.

Table 21: Expert panel decisions for assigning overall levels of non-riverine aquatic conservation significance.

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Threatened and Priority Species

Introduction

This chapter contains a list of threatened and priority flora and/or fauna species that have been recorded on, or within 4km of the Assessment Area.

The information presented in this chapter with respect to species presence is derived from compiled databases developed primarily for the purpose of BPAs and ACAs. Data is collated from a number of sources and is updated periodically.

It is important to note that the list of species provided in this report, may differ when compared to other reports generated from other sources such as the State government's WildNet, Herbrecs or the federal government's EPBC database for a number of reasons.

Records for threatened and priority species are filtered and checked based on a number of rules including:

- Taxonomic nomenclature - current scientific names and status,
- Location - cross-check co-ordinates with location description,
- Taxon by location - requires good knowledge of the taxon and history of the record,
- Duplicate records - identify and remove,
- Expert panels - check records and provide new records,
- Flora cultivated records excluded,
- Use precise records less than or equal to 2000m,
- Use recent records greater than or equal to 1975 animals, greater than or equal to 1950 plants.

Threatened Species

Threatened species are those species classified as "Endangered" or "Vulnerable" under the *Environment Protection and Biodiversity Conservation Act 1999* or "Endangered", "Vulnerable" or "Near threatened" under the *Nature Conservation Act 1992*.

The following threatened species have been recorded on, or within approximately 4km of the AOI.

Table 22: Threatened species recorded on, or within 4km of the AOI

Species	Common name	NCA status	EPBC status	Back on Track rank	Migratory species*	Wetland species**	Identified flora/fauna
Capparis thozetiana		V	V	Medium			FL
Corymbia xanthope	Glen Geddes bloodwood	V	V	Low			FL
Geophaps scripta scripta	squatter pigeon (southern subspecies)	V	V	Medium			FA
Hakea trineura		V	V	High			FL
Macrozamia serpentina		E		Critical			FL
Marsdenia brevifolia		V	V	High			FL
Neoroepera buxifolia		V	V	Medium			FL
Pimelea leptospermoides subsp. leptospermoides		NT					FL
Pultenaea setulosa		V	V	Medium			FL
Stackhousia tryonii		NT		Medium			FL

NB. Please note that the threatened species listed in this section are based upon the most recently compiled DES internal state-wide threatened species dataset. This dataset may contain additional records that were not originally available for inclusion in the relevant individual BPAs and ACAs.

**JAMBA - Japan-Australia Migratory Bird Agreement; CAMBA - China-Australia Migratory Bird Agreement; ROKAMBA - Republic of Korea-Australia Migratory Bird Agreement; CMS - Convention on the Conservation of Migratory Species*.

***I - wetland indicator species; D - wetland dependent species*.

BPA Priority Species

A list of BPA priority species that have been recorded on, or within approximately 4km of the AOI is contained in the following table.

Table 23: Priority species recorded on, or within 4km of the AOI

(no results)

NB. Please note that the list of priority species is based on those species identified in the BPAs, however records for these species may be more recent than the originals used. furthermore, the BPA priority species databases are updated from time to time. At each update, the taxonomic details for all species are amended as necessary to reflect current taxonomic name and/or status changes.

ACA Priority Species

A list of ACA priority species used in riverine and non-riverine ACAs that have been recorded on, or within approximately 4km of the AOI are contained in the following tables.

Table 24: Priority species recorded on, or within 4 km of the AOI - riverine

(no results)

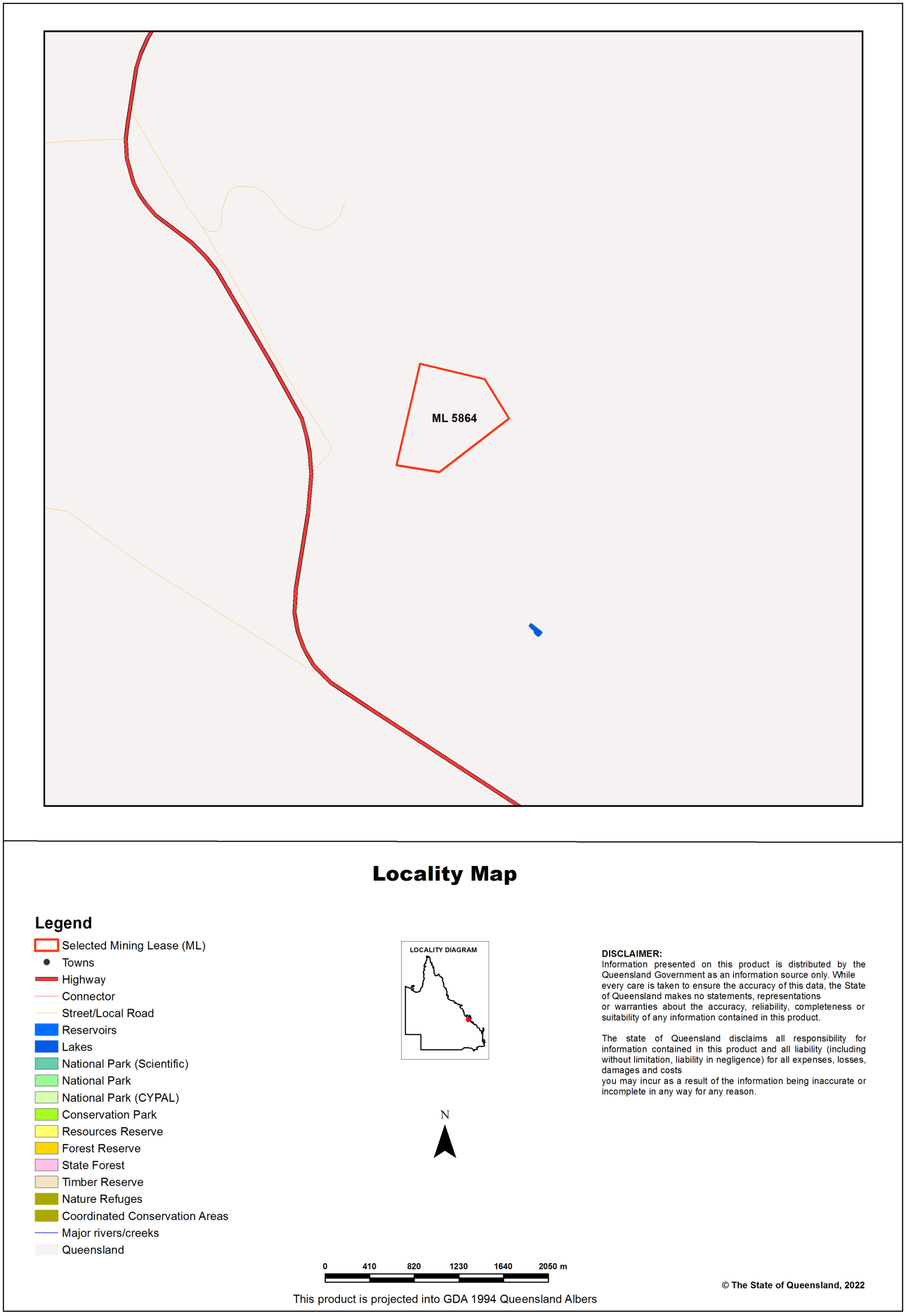
Table 25: Priority species recorded on, or within 4 km of the AOI - non-riverine

(no results)

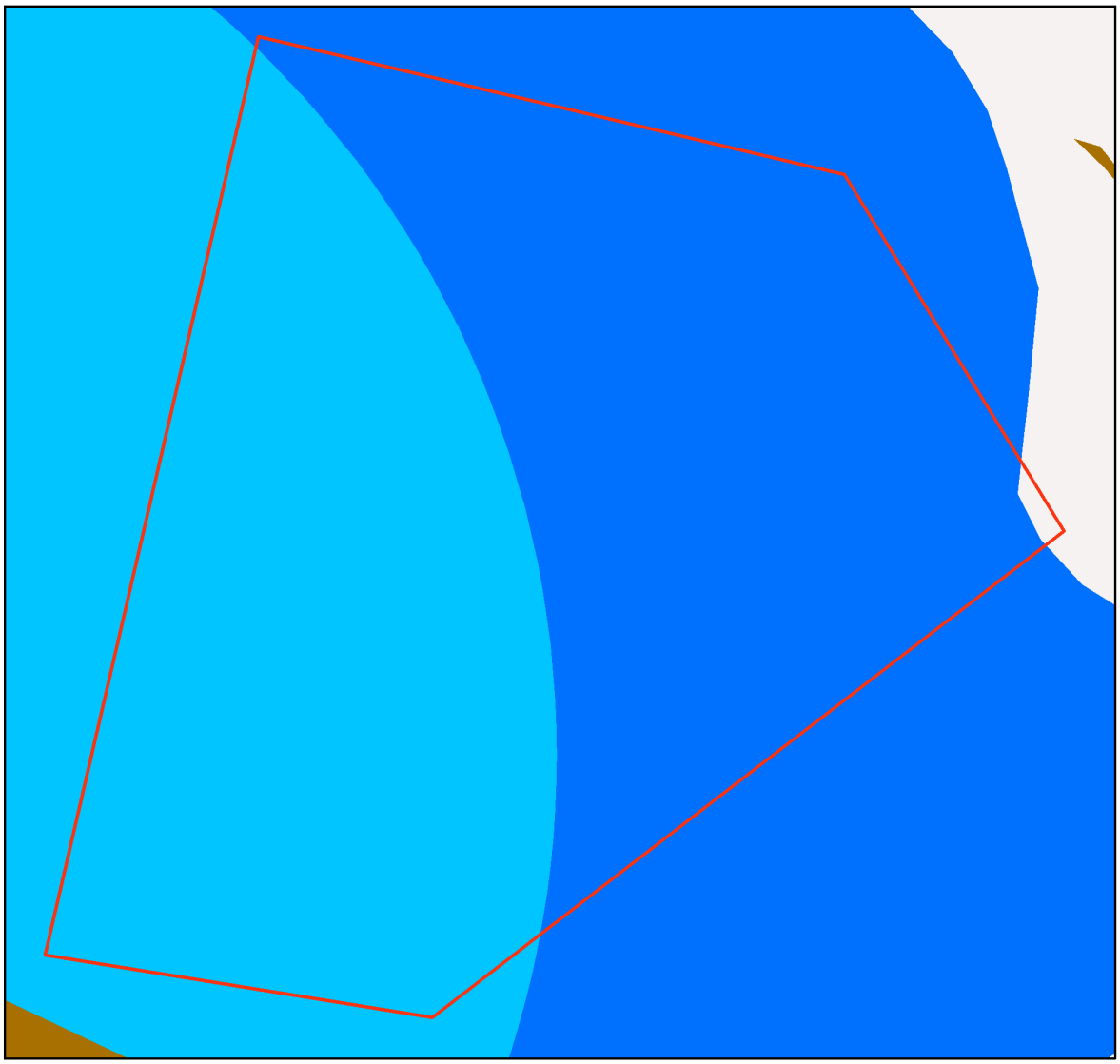
NB. Please note that the priority species records used in the above two tables are comprised of those adopted for the released individual ACAs. The ACA riverine and non-riverine priority species databases are updated from time to time to reflect new release of ACAs. At each update, the taxonomic details for all ACAs records are amended as necessary to reflect current taxonomic name and/or status changes.

Maps

Map 1 - Locality Map



Map 2 - Biodiversity Planning Assessment (BPA)



Biodiversity Planning Assessments

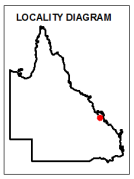
Legend

- Selected Mining Lease (ML)
- Towns
- Roads
- Major rivers/creeks
- Queensland

Biodiversity Planning Assessment

- State Habitat for EVNT taxa
- State
- Regional
- Local or Other Values
- Non Bioregion Ecosystem

LOCALITY DIAGRAM



N

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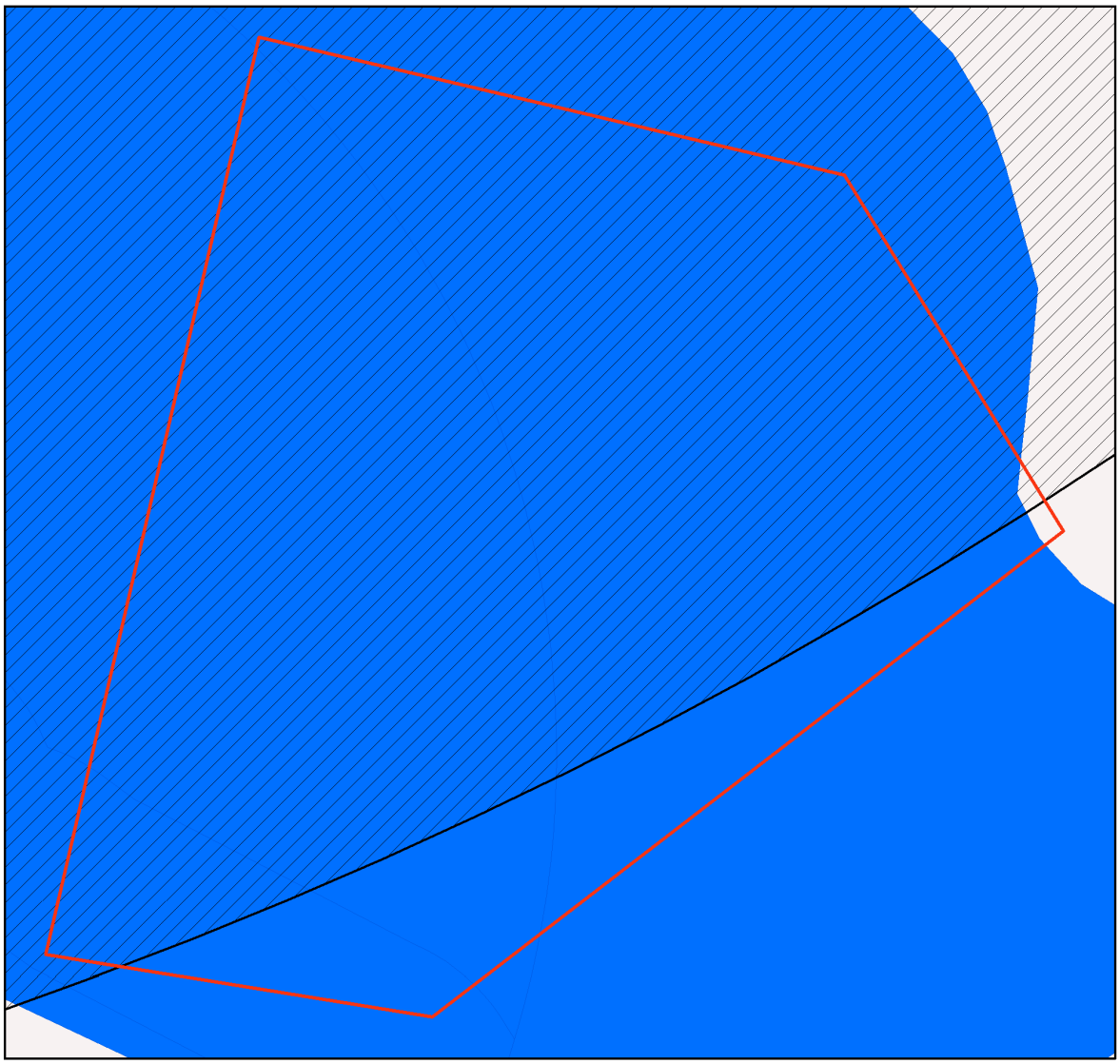
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Map 3 - Corridors



Corridors

Legend

- Selected Mining Lease (ML)
- Towns
- Roads
- Major rivers/creeks
- Queensland

Corridors

- State
- Regional

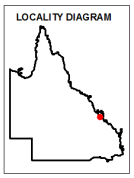
Corridor Triggered Vegetation

- State
- Regional
- Local

Core Area Vegetation

- Brigalow Belt only

LOCALITY DIAGRAM



N

0 60 120 180 240 300 m

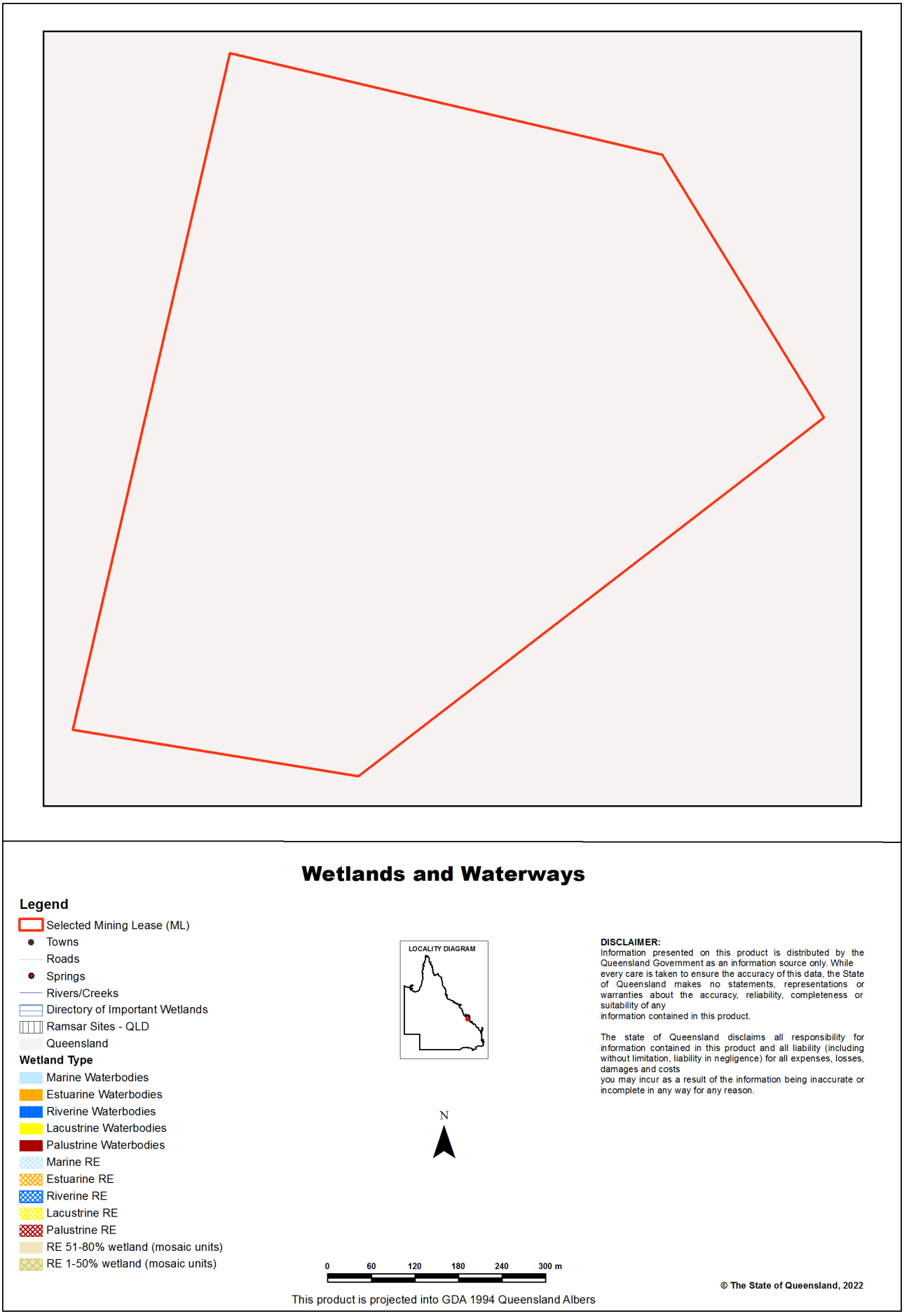
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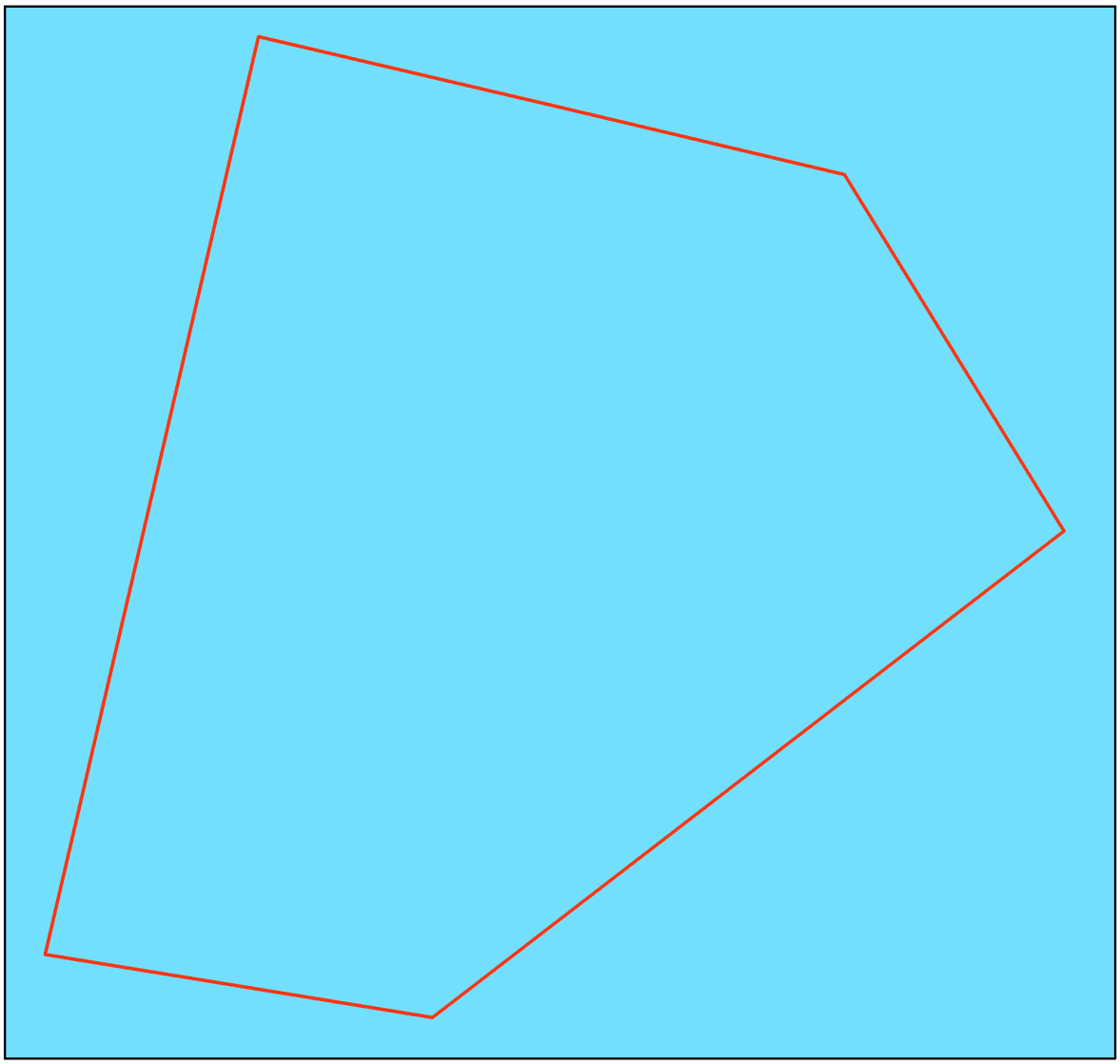
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Map 4 - Wetlands and waterways



Map 5 - Aquatic Conservation Assessment (ACA) - riverine



Aquatic Conservation Assessment (ACA) - riverine

Legend

- Selected Mining Lease (ML)
- Towns
- Roads
- Rivers/Creeks
- Queensland

ACA Riverine - Subcatchment Significance

- Very High
- High
- Medium
- Low
- Very Low

LOCALITY DIAGRAM

N

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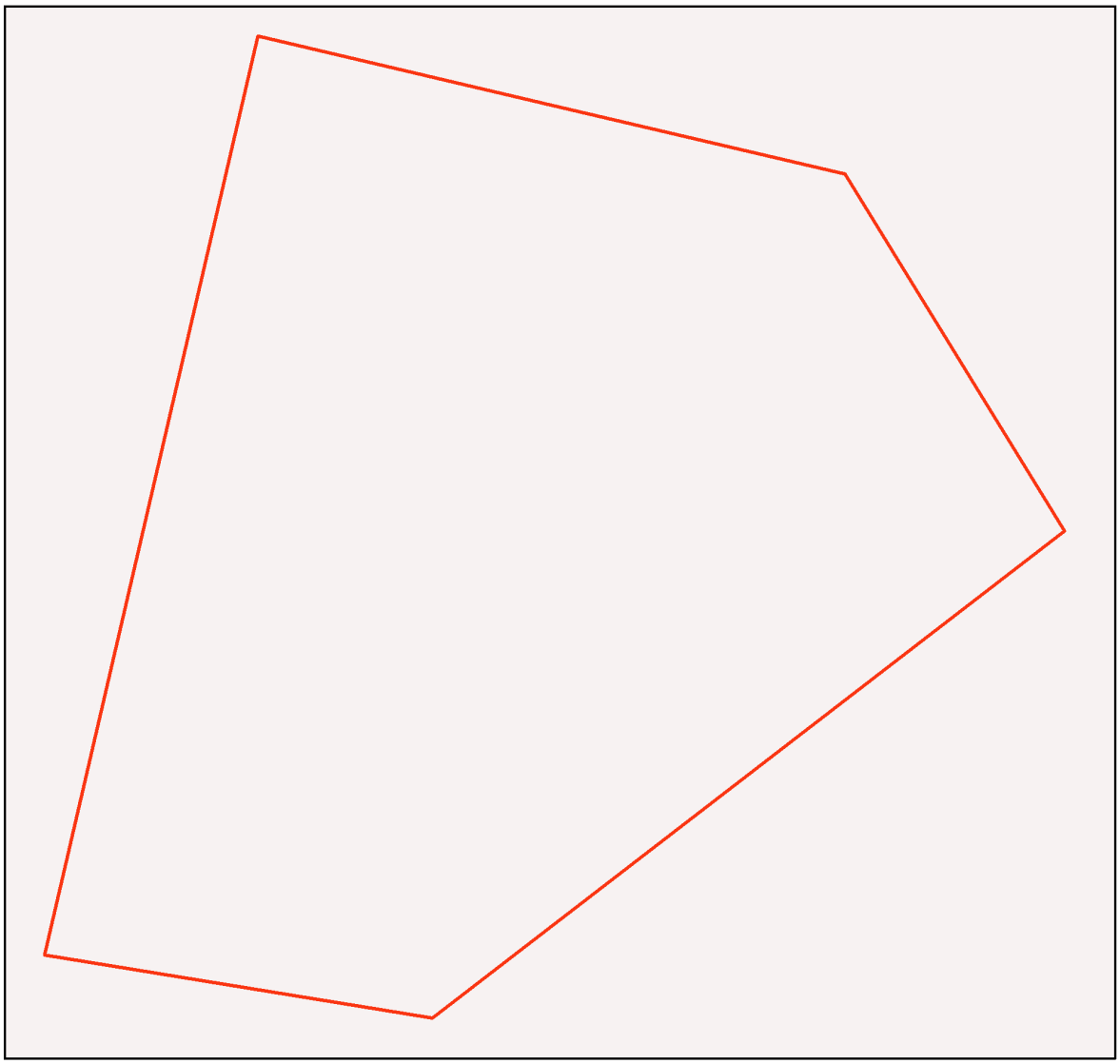
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Map 6 - Aquatic Conservation Assessment (ACA) - non-riverine



Aquatic Conservation Assessment (ACA) - nonriverine

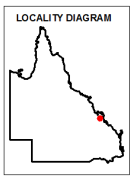
Legend

- Selected Mining Lease (ML)
- Towns
- Roads
- Rivers/Creeks
- Queensland

ACA Non-riverine

- Very High
- High
- Medium
- Low
- Very Low

LOCALITY DIAGRAM



N

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0 60 120 180 240 300 m

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References

Clayton, P.D., Fielder, D.F., Howell, S. and Hill, C.J. (2006) *Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment.* Published by the Environmental Protection Agency, Brisbane. ISBN 1-90928-07-3. Available at

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca/

Environmental Protection Agency (2002) *Biodiversity Assessment and Mapping Methodology. Version 2.1, July 2002.* (Environmental Protection Agency, Brisbane).

Morton, S. R., Short, J. and Barker, R. D. with an Appendix by G.F. Griffin and G. Pearce (1995). *Refugia for Biological Diversity in Arid and Semi-arid Australia. Biodiversity Series* , Paper No. 4, Biodiversity Unit, Environment Australia.

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

Theme	Datasets
Aquatic Conservation Assessments Non-riverine*	Combination of the following datasets: Cape York Peninsula Non-riverine v1.1 Eastern Gulf of Carpentaria v1.1 Great Barrier Reef Catchment Non-riverine v1.3 Lake Eyre and Bulloo Basins v1.1 QMDB Non-riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Non-riverine ACA v1.1 Southern Gulf Catchments Non-riverine ACA v1.1
Aquatic Conservation Assessments Riverine*	Combination of the following datasets: Cape York Peninsula Riverine v1.1 Eastern Gulf of Carpentaria v1.1 Great Barrier Reef Catchment Riverine v1.1 Lake Eyre and Bulloo Basins v1.1 QMDB Riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Riverine ACA v1.1 Southern Gulf Catchments Riverine ACA v1.1
Biodiversity Planning Assessments*	Combination of the following datasets: Brigalow Belt BPA v2.1 Cape York Peninsula BPA v1.1 Central Queensland Coast BPA v1.3 Channel Country BPA v1.1 Desert Uplands BPA v1.3 Einasleigh Uplands BPA v1.1 Gulf Plains BPA v1.1 Mitchell Grass Downs BPA v1.1 Mulga Lands BPA v1.4 New England Tableland v2.3 Northwest Highlands v1.1 Southeast Queensland v4.1 Wet Tropics v1.1
Statewide BPA Corridors*	Statewide corridors v1.6
Threatened Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
BPA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
ACA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.

***These datasets are available at:**

http://dds.information.qld.gov.au/DDS

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
ACA	- Aquatic Conservation Assessment
AQUABAMM	- Aquatic Biodiversity Assessment and Mapping Methodology
BAMM	- Biodiversity Assessment and Mapping Methodology
BoT	- Back on Track
BPA	- Biodiversity Planning Assessment
CAMBA	- China-Australia Migratory Bird Agreement
DES	- Department of Environment and Science
EPBC	- *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	- Endangered, Vulnerable, Near Threatened
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
JAMBA	- Japan-Australia Migratory Bird Agreement
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
ROKAMBA	- Republic of Korea-Australia Migratory Bird Agreement

Queensland Government

Department of Environment and Science

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest
ml: 5864

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

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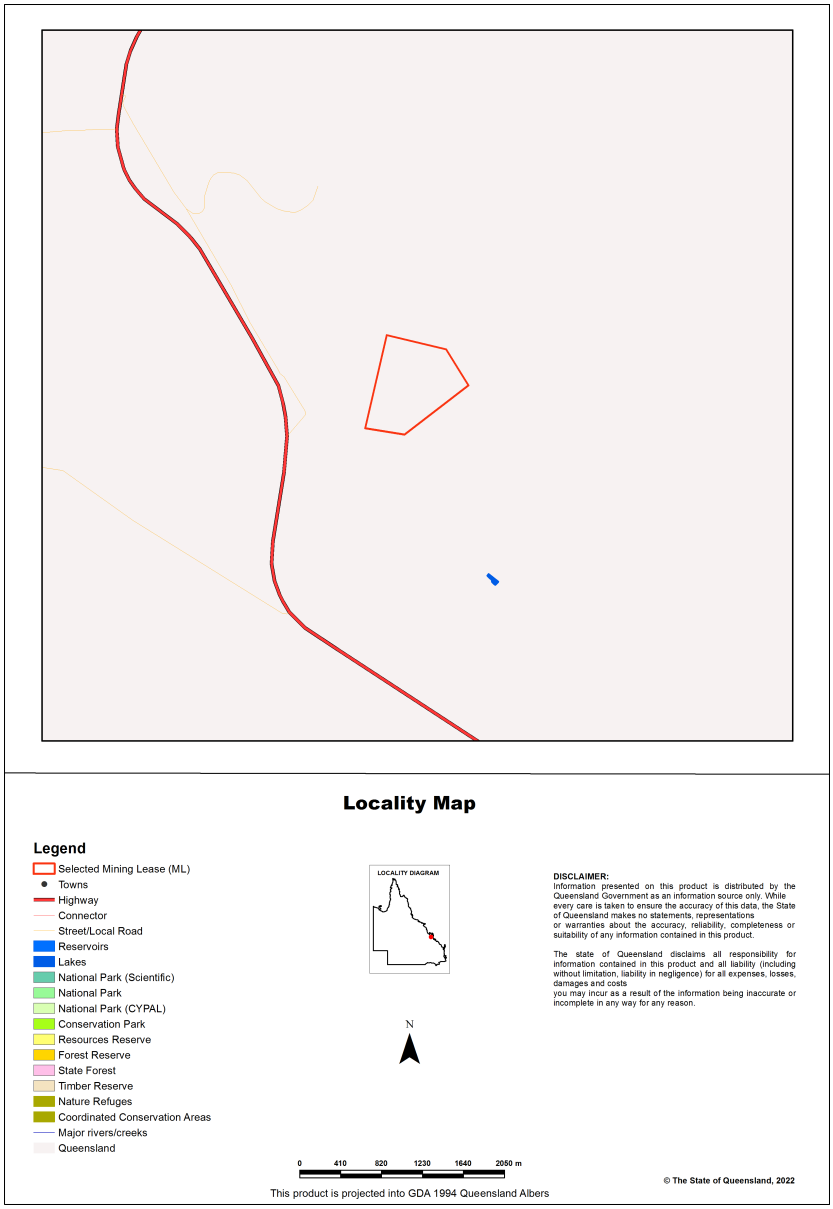
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI ml: 5864

Size (ha)	64.49
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992* ;

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004* ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

    • Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;

    • Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;

    • Category R areas on the regulated vegetation management map;

    • Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;

    • Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Queensland Wetland Environmental Values under the Environment Protection Regulation 2019;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;

- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
1c Protected Areas- special wildlife reserves	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	0.0 ha	0.0 %
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7a Threatened (endangered or vulnerable) wildlife	40.28 ha	62.5%
7b Special least concern animals	0.0 ha	0.0 %
7c i Koala habitat area - core (SEQ)	0.0 ha	0.0 %
7c ii Koala habitat area - locally refined (SEQ)	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0.0 ha	0.0 %
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0.0 ha	0.0 %
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0.0 ha	0.0 %
8d Regulated Vegetation - Essential habitat	32.64 ha	50.6%
8e Regulated Vegetation - intersecting a watercourse **	0.0 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0.0 ha	0.0 %
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(no results)

1b. Protected Areas - nature refuges

(no results)

1c. Protected Areas - special wildlife reserves

(no results)

2. State Marine Parks - highly protected zones

(no results)

3. Fish habitat areas (A and B areas)

(no results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(no results)

5. High Ecological Significance wetlands on the Map of Queensland Wetland Environmental Values

(no results)

6a. Wetlands in High Ecological Value (HEV) waters

(no results)

6b. Waterways in High Ecological Value (HEV) waters

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7a. Threatened (endangered or vulnerable) wildlife

Values are present

7b. Special least concern animals

Not applicable

7c i. Koala habitat area - core (SEQ)

Not applicable

7c ii. Koala habitat area - locally refined (SEQ)

Not applicable

Threatened (endangered or vulnerable) wildlife habitat suitability models

Species	Common name	NCA status	Presence
Boronia keysii		V	None
Calyptorhynchus lathami	Glossy black cockatoo	V	None
Casuarius casuarius johnsonii	Sthn population cassowary	E	None
Crinia tinnula	Wallum froglet	V	None
Denisonia maculata	Ornamental snake	V	None
Litoria freycineti	Wallum rocketfrog	V	None
Litoria olongburensis	Wallum sedgefrog	V	None
Melaleuca irbyana		E	None
Petaurus gracilis	Mahogany Glider	E	None
Petrogale persephone	Proserpine rock-wallaby	E	None
Phascolarctos cinereus	Koala - outside SEQ*	V	None
Pezoporus wallicus wallicus	Eastern ground parrot	V	None
Taudactylus pleione	Kroombit tinkerfrog	E	None
Xeromys myoides	Water Mouse	V	None

**For koala model, this includes areas outside SEQ. Check 7c SEQ koala habitat for presence/absence.*

Threatened (endangered or vulnerable) wildlife species records

Scientific name	Common name	NCA status	EPBC status	Migratory status
Geophaps scripta scripta	squatter pigeon (southern subspecies)	V	V	
Corymbia xanthope	Glen Geddes bloodwood	V	V	
Marsdenia brevifolia		V	V	

Special least concern animal species records

(no results)

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

Migratory status (M) - China and Australia Migratory Bird Agreement (C), Japan and Australia Migratory Bird Agreement (J), Republic of Korea and Australia Migratory Bird Agreement (R), Bonn Migratory Convention (B), Eastern Flyway (E)

To request a species list for an area, or search for a species profile, access Wildlife Online at:
https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals** and **Map 3b - MSES - Species - Koala habitat area (SEQ)** for an overview of the relevant MSES.

MSES - Regulated Vegetation

For further information relating to regional ecosystems in general, go to:
https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/
For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:
https://environment.ehp.qld.gov.au/regional-ecosystems/

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Not applicable

8d. Regulated Vegetation - Essential habitat

Values are present

8e. Regulated Vegetation - intersecting a watercourse**

(no results)

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

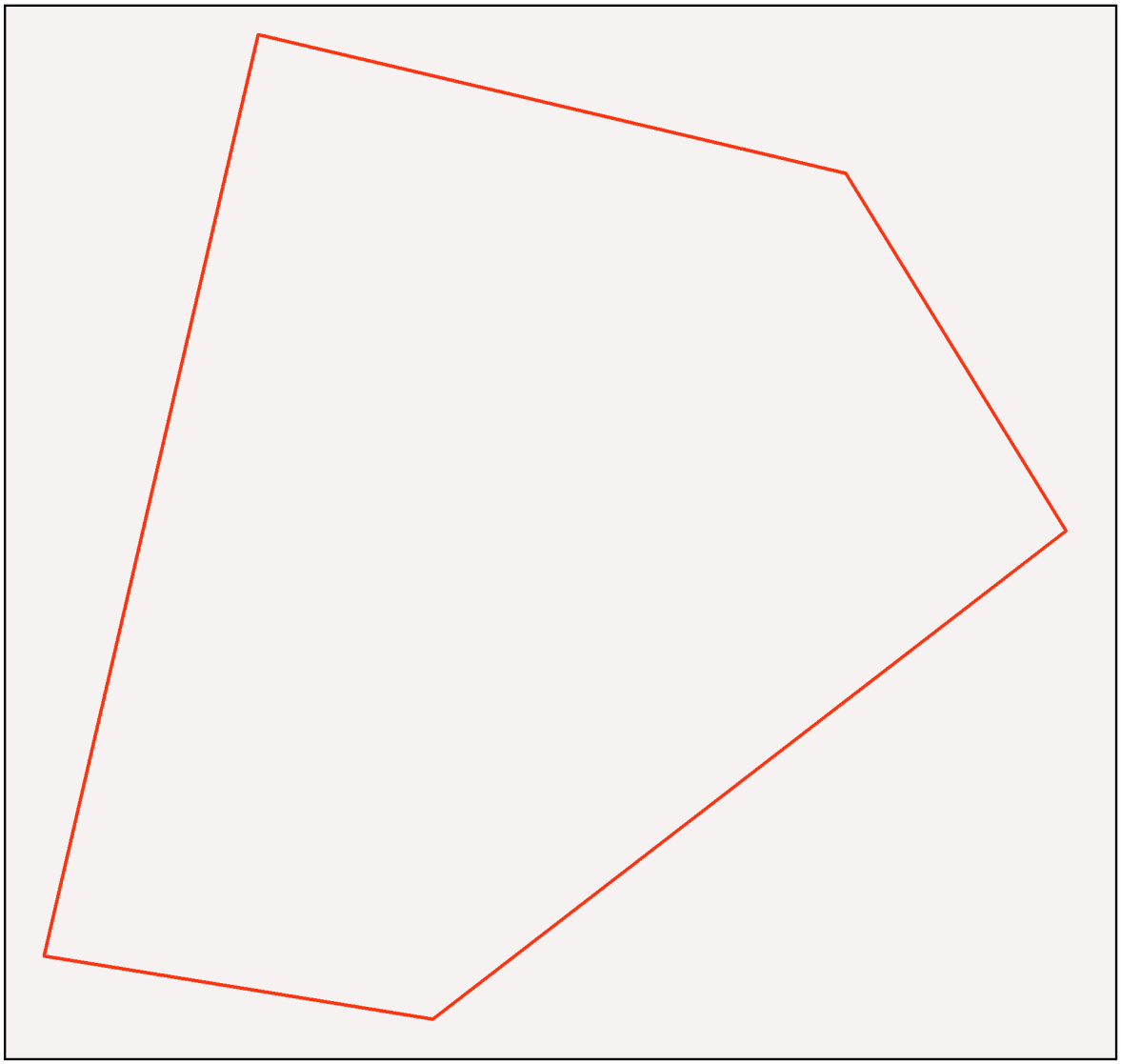
(no results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

(no results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

Map 1 - MSES - State Conservation Areas

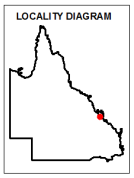


MSES - State Conservation Areas

Area of Interest

- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Protected area (estates, nature refuges, special wildlife reserves)
- Declared fish habitat area (A and B areas)
- Marine park (highly protected)

LOCALITY DIAGRAM



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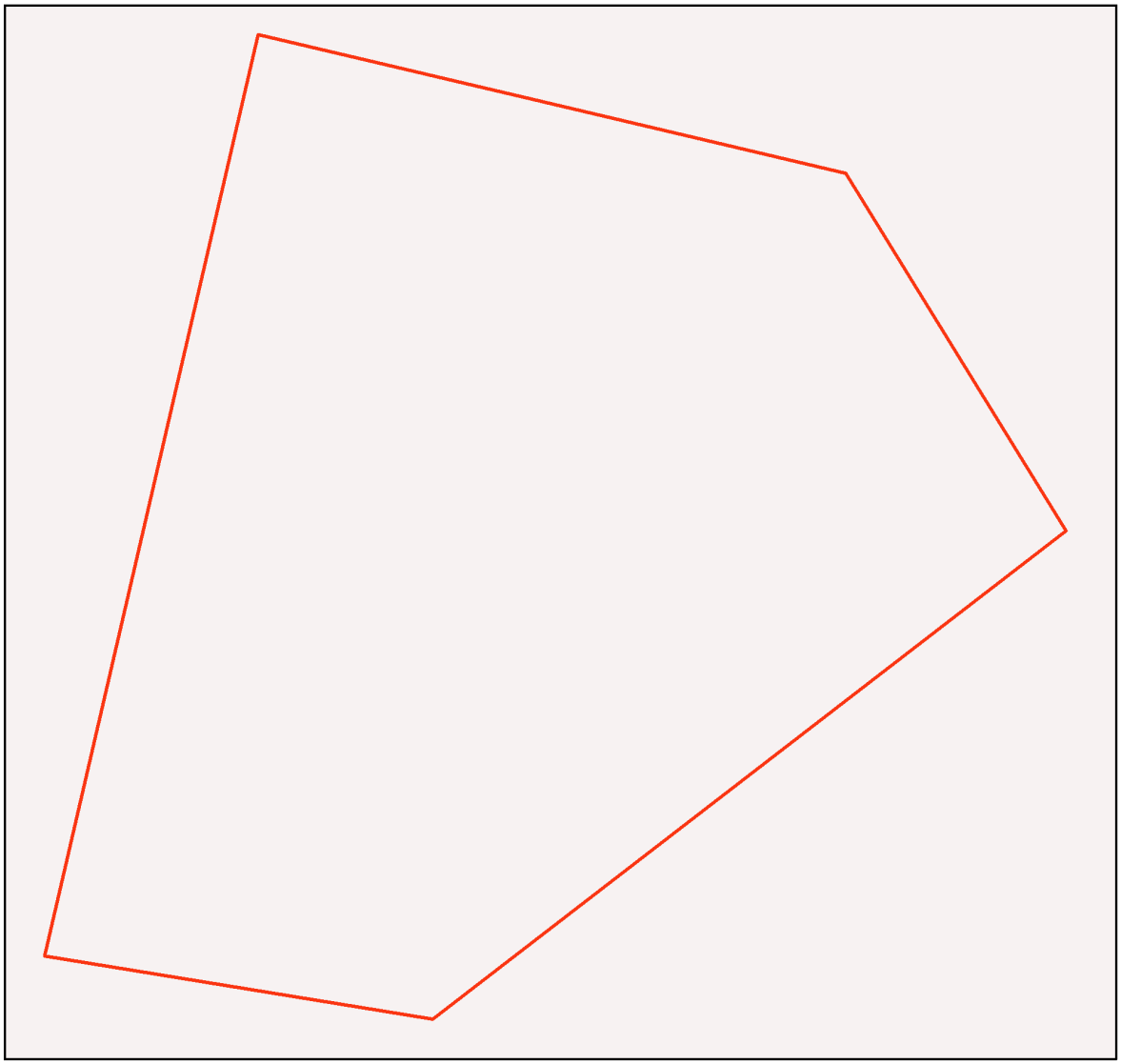
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Map 2 - MSES - Wetlands and Waterways

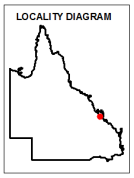


MSES - Wetlands and Waterways

Area of Interest

- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Declared high ecological value waters (watercourse)
- Strategic environmental area (designated precinct)
- Declared high ecological value waters (wetland)
- High ecological significance wetlands

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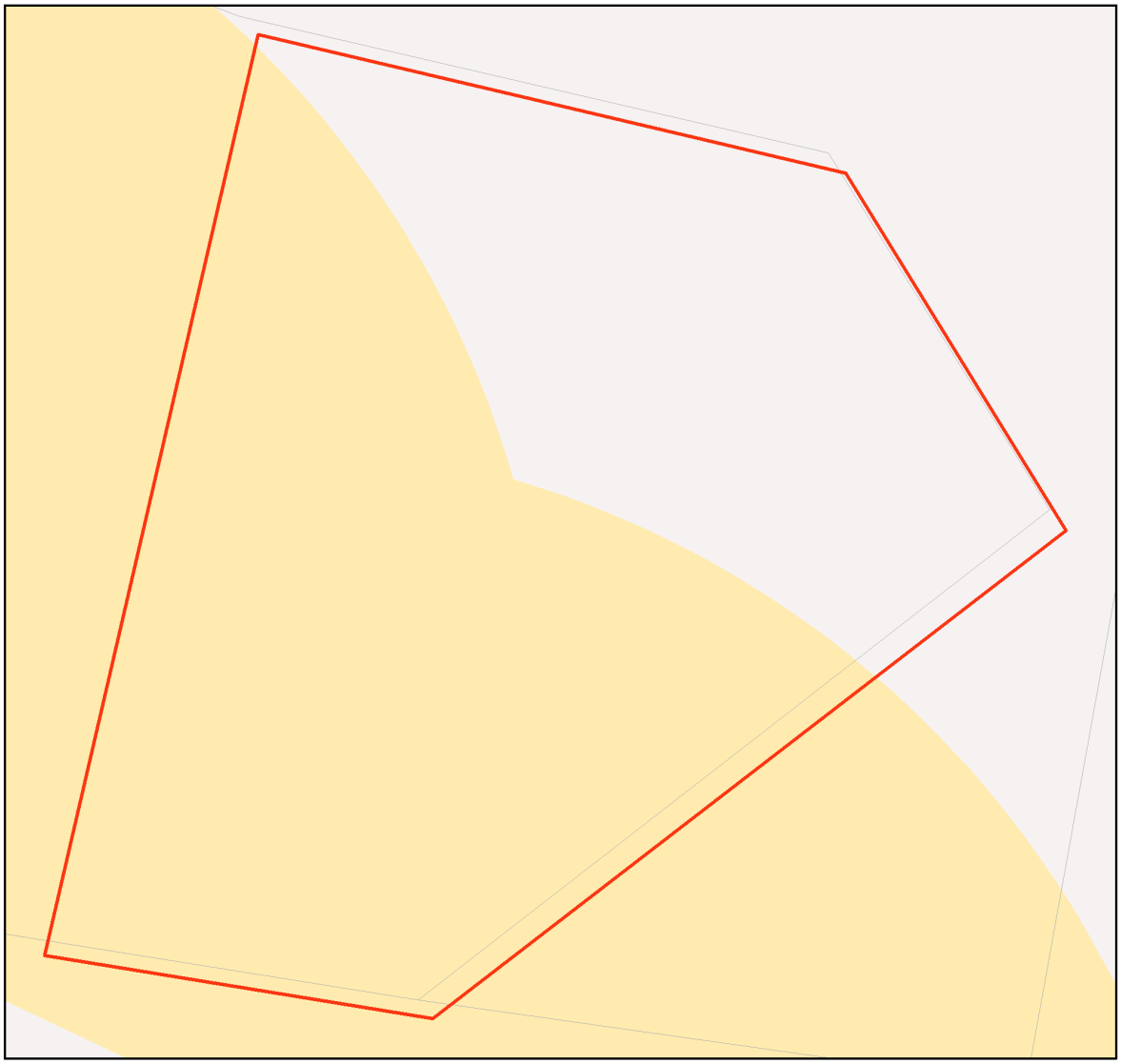
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Map 3a - MSES - Species - Threatened (endangered or vulnerable) wildlife and special least concern animals

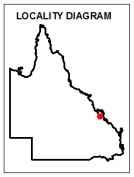


MSES - Species
Threatened (endangered or vulnerable) wildlife and special least concern animals

Area of Interest

- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Wildlife habitat (special least concern)
- Wildlife habitat (endangered or vulnerable)

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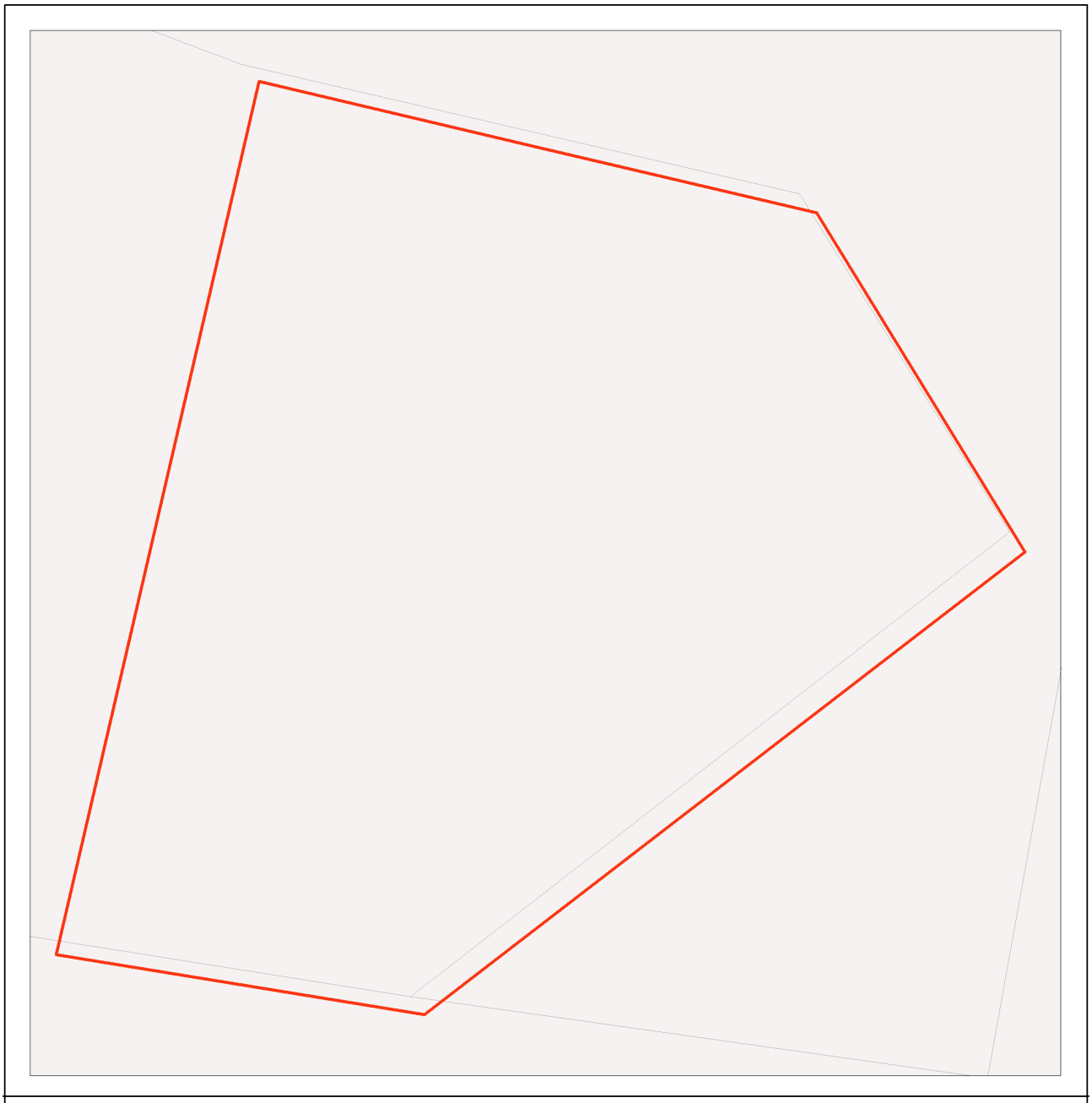
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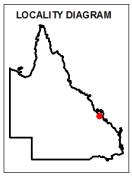
Map 3b - MSES - Species - Koala habitat area (SEQ)



MSES - Species
Koala habitat area (SEQ)

Area of Interest
- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Koala habitat area (core)
- Koala habitat area (locally refined)

LOCALITY DIAGRAM



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The represented layers for SEQ 'koala habitat area-core' and 'koala habitat area- locally refined' in MSES are sourced directly from the regulatory mapping under the Nature Conservation (Koala) Conservation Plan 2017. Whilst every effort is made to ensure the information remains current, there may be delays between updating versions. Please refer to the original mapping for the most recent version. See https://environment.des.qld.gov.au/wildlife/animals/living-with/koalas/mapping

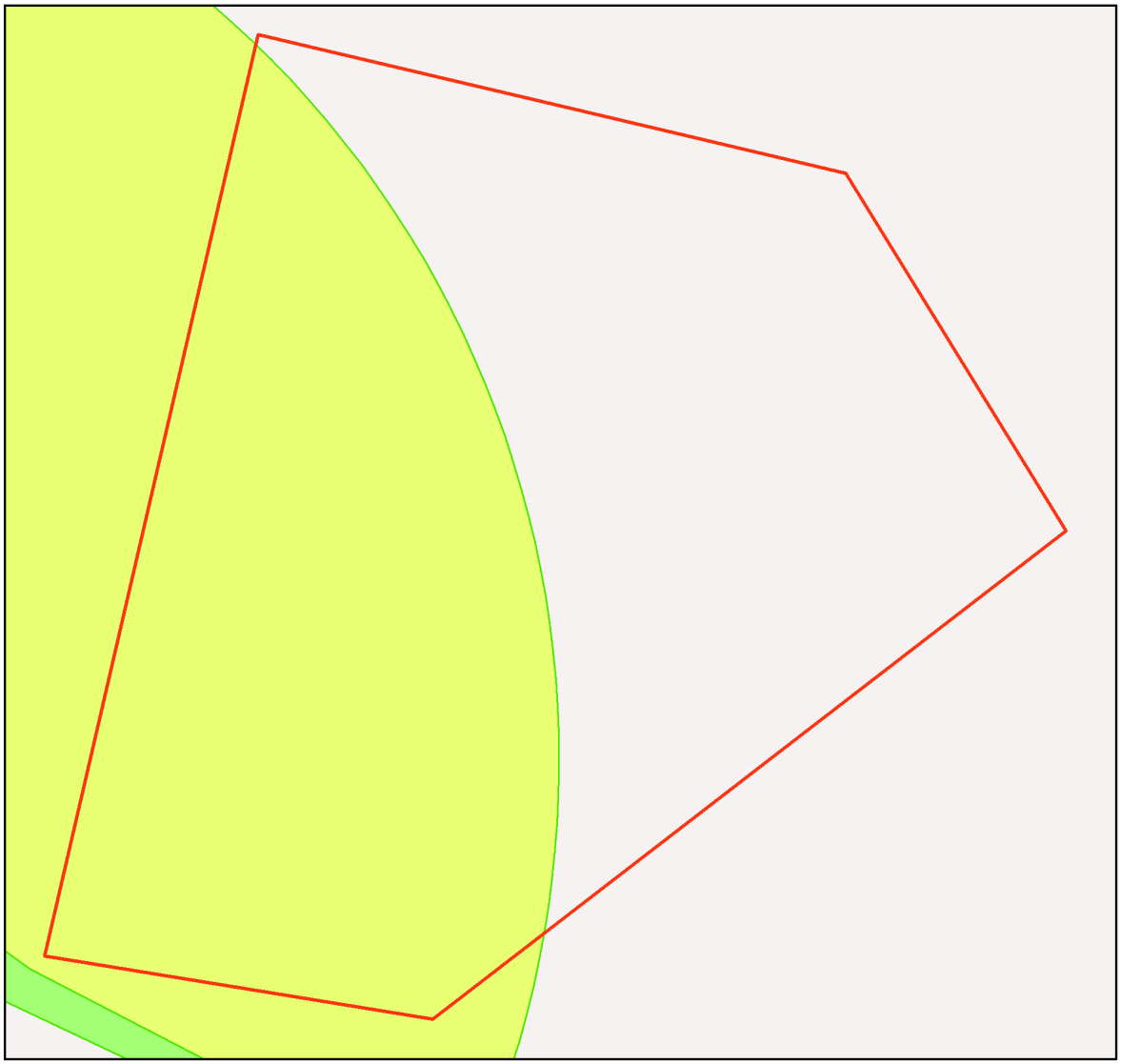
The koala habitat mapping within South East Queensland uses regional ecosystem linework compiled at a scale varying from 1:25,000 to 1:100,000. Linework should be used as a guide only. The positional accuracy of regional ecosystem data mapped at a scale of 1:100,000 is +/- 100 metres.

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0 50 100 150 200 250 m

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Map 4 - MSES - Regulated Vegetation

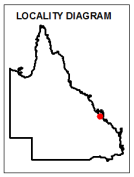


MSES - Regulated Vegetation

Area of Interest

- Selected Mining Lease (ML)
- Towns
- Freeways/Highways
- Secondary roads
- Major rivers/creeks
- Regulated vegetation (intersecting a watercourse)
- Regulated vegetation (100m from wetland)
- Regulated vegetation (category B - endangered or of concern)
- Regulated vegetation (category C - endangered or of concern)
- Regulated vegetation (category R - GBR riverine)
- Regulated vegetation (essential habitat)

LOCALITY DIAGRAM



N

0 60 120 180 240 300 m

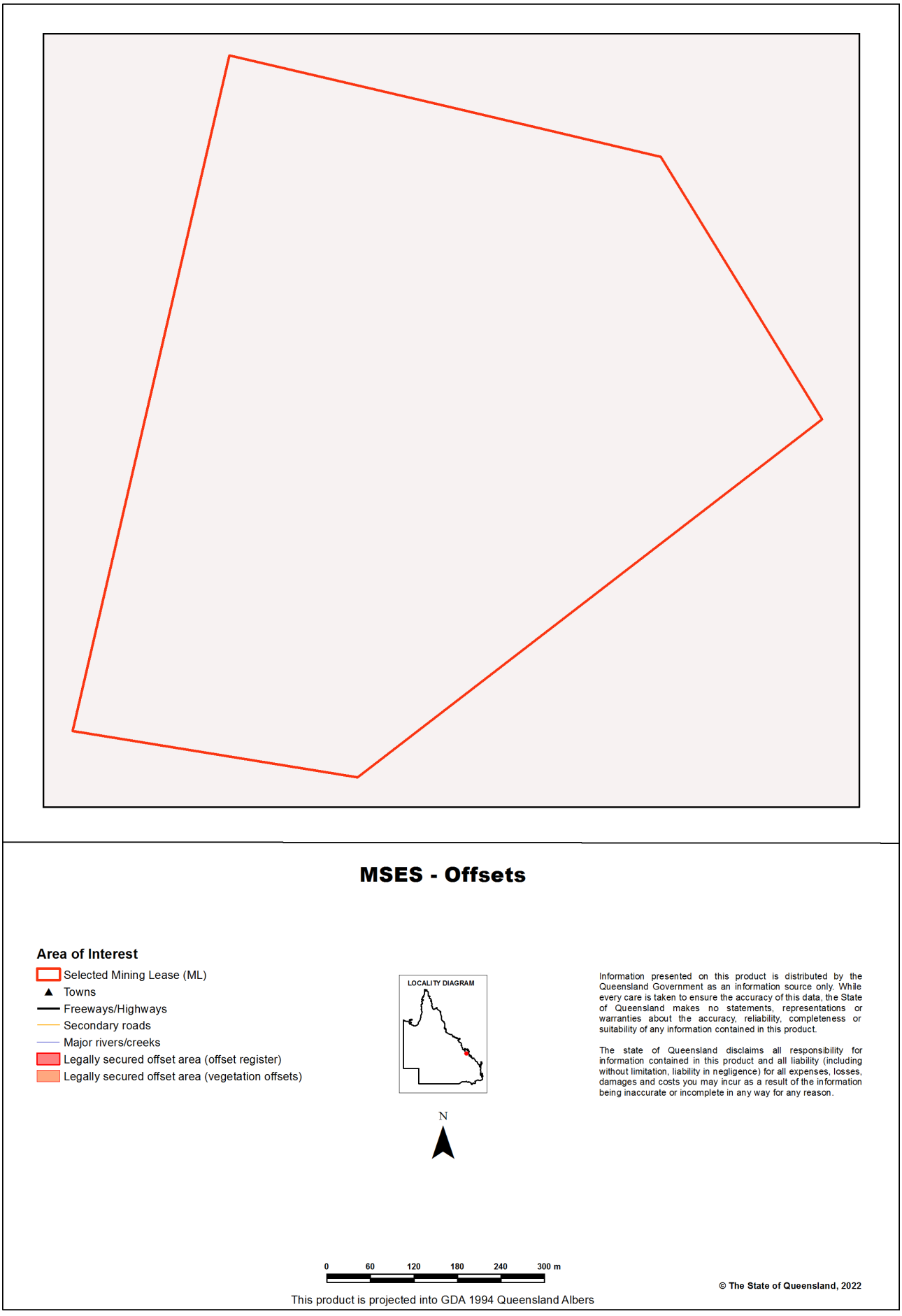
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Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). The compiled MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The Queensland Government's "Method for mapping - matters of state environmental significance for use in land use planning and development assessment" can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.information.qld.gov.au)**
Protected Areas-Estates, Nature Refuges, Special Wildlife Reserves	- Protected areas of Queensland - Nature Refuges - Queensland - Special Wildlife Reserves- Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Queensland Wetland Environmental Values
Wetlands in HEV waters	HEV waters: - EPP Water intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 5) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000)
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various) - SEQ koala habitat areas under the Koala Conservation Plan 2019
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map
VMA Essential Habitat	Vegetation management - essential habitat map
VMA Wetlands	Vegetation management wetlands map
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DES	- Department of Environment and Science
EP Act	- *Environmental Protection Act 1994*
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Science

Environmental Reports

Regional Ecosystems

Biodiversity Status

For the selected area of interest
ml: 5864

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no matters of interest have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the classes used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Resources website https://www.dnrme.qld.gov.au/

Please direct queries about these reports to: Queensland.Herbarium@qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Area of interest details: ml: 5864

Size (ha)	64.49
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" regional ecosystems classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	64.33	99.76
No concern at present	0.0	0.0
Total remnant vegetation	64.33	99.76

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with particular combinations of geology, landform and soil (Sattler and Williams 1999). Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem classification and descriptions are reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and are usually distinguished by differences in dominant species, frequently in the shrub or ground layers and are denoted by a letter following the regional ecosystem code (e.g. a, b, c). Vegetation communities and regional ecosystems are amalgamated into a higher level classification of broad vegetation groups (BVGs).

A published methodology for survey and mapping of regional ecosystems across Queensland (Neldner et al 2020) provides further details on regional ecosystem concepts and terminology.

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium's Regional Ecosystem Mapping, and not the regulated mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Resources website.

https://www.dnrme.qld.gov.au/

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (1000 ha); or patch size (100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

*****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.*

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI and provides their short descriptions, Biodiversity Status, and remnant extent within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
11.11.7	Eucalyptus fibrosa subsp. fibrosa, Corymbia xanthope woodland on serpentinite	Of concern	64.33	99.76
non-remnant	None	None	0.16	0.25

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before clearing.

Table 4 provides further information in regards to the remnant regional ecosystems present within the AOI. Specifically, the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
11.11.7	Pre-clearing 62000 ha; Remnant 2019 51000 ha	13c	Not a Wetland	Low
non-remnant	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

The distribution of mapped wetland systems within the area of interest is displayed in **Map 6**.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
11.11.7	Habitat for threatened flora species including Cycas ophiolitica, Capparis humistrata, Macrozamia serpentina, Corymbia xanthope, Hakea trineura, Capparis thozetiana, Neoroepera buxifolia, Pultenaea setulosa, Marsdenia brevifolia, Bursaria reevesii and the near threatened species Pimelea leptospermoides and Stackhousia tryonii.
non-remnant	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional) scales.

A comprehensive description of BVGs is available at:

https://publications.qld.gov.au/dataset/redd/resource/

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	0.16	0.25
13c	Woodlands of Eucalyptus crebra (sens. lat.) (narrow-leaved red ironbark), E. drepanophylla (grey ironbark), E. fibrosa (dusky-leaved ironbark), E. shirleyi (shirley's silver-leaved ironbark) on granitic and metamorphic ranges (land zones 12, 11, 9, [5]) (BRB, EIU, SEQ, NET, CQC)	64.33	99.76

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant extent (hectares) of each vegetation community derived from the regional ecosystem mapping data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Technical descriptions include data on canopy height, canopy cover and native plant species composition of the predominant layer, which are attributes relevant to assessment of the remnant status of vegetation under the *Vegetation Management Act 1999*. However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used for remnant assessment where possible (Neldner et al. 2020 (PDF)* section 3.3 of:

https://publications.qld.gov.au/dataset/redd/resource/

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community.

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

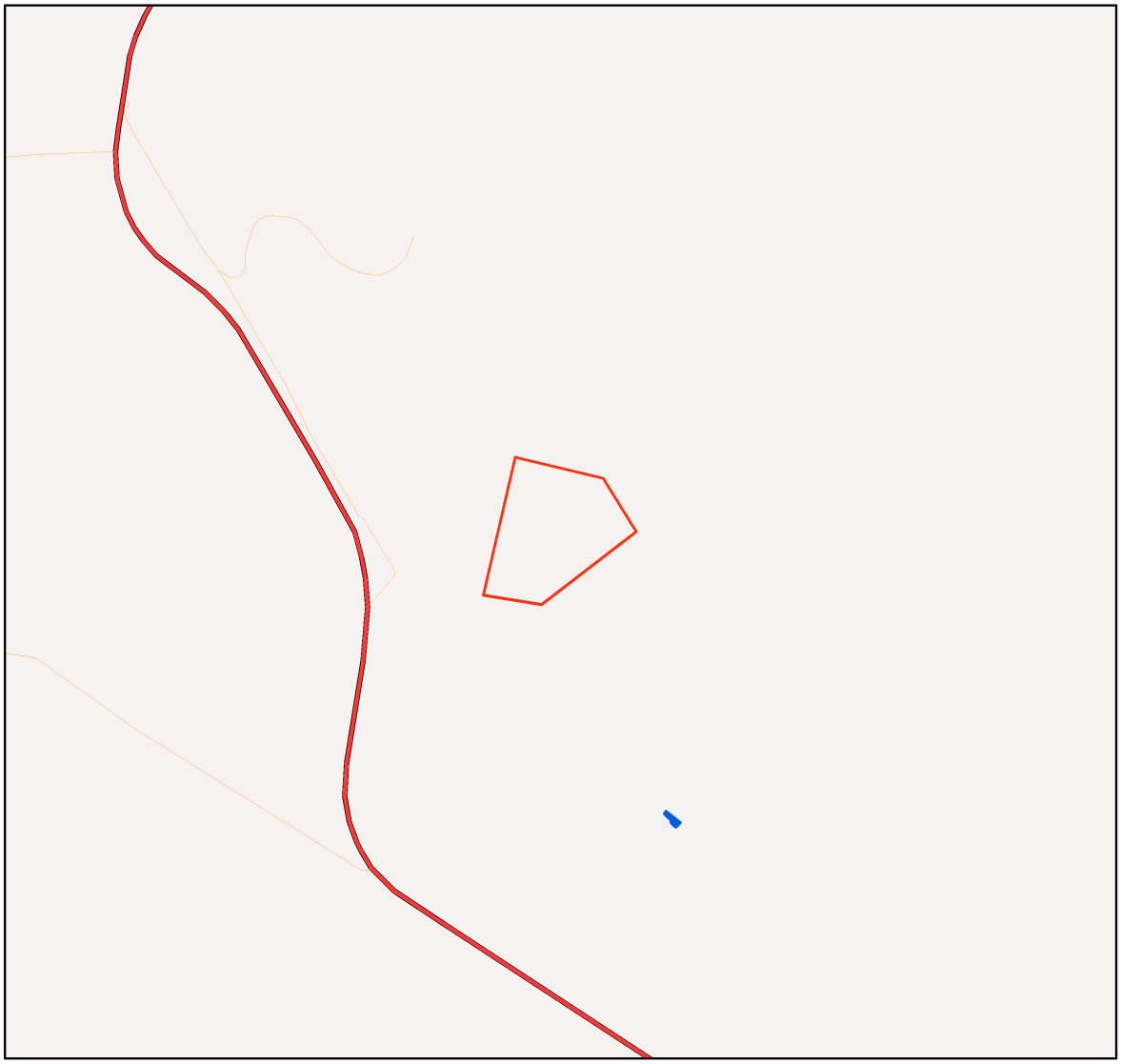
Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
11.11.7	Available	Available
non-remnant	Not currently available	Not currently available

Maps

Map 1 - Location



Locality Map

Legend

- Selected Mining Lease (ML)
- Towns
- Highway
- Connector
- Street/Local Road
- Reservoirs
- Lakes
- National Park (Scientific)
- National Park
- National Park (CYPAL)
- Conservation Park
- Resources Reserve
- Forest Reserve
- State Forest
- Timber Reserve
- Nature Refuges
- Coordinated Conservation Areas
- Major rivers/creeks
- Queensland



N

0 410 820 1230 1640 2050 m

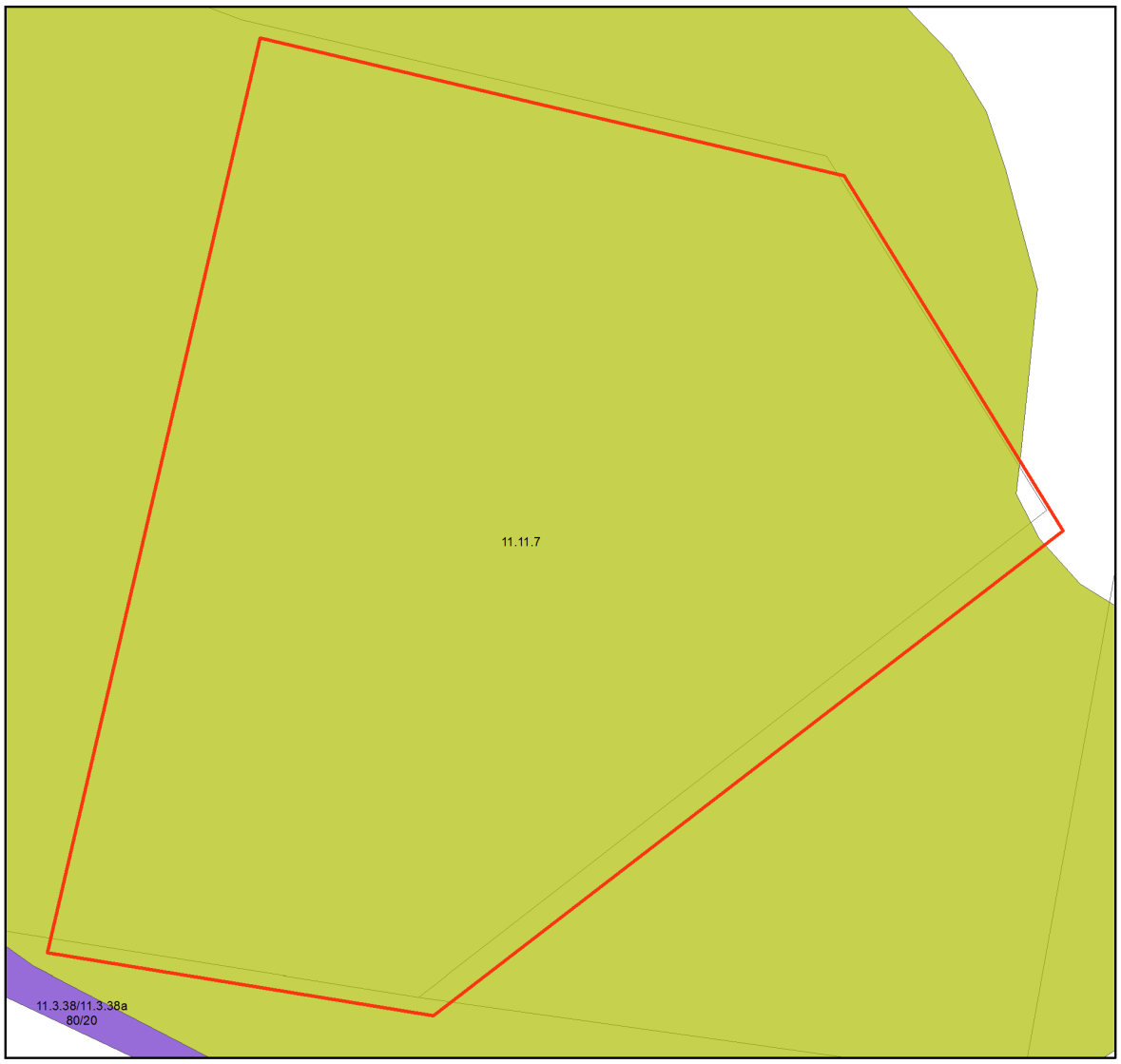
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Map 2 - Remnant 2019 regional ecosystems

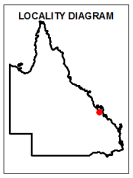


Remnant 2019 Regional Ecosystems

Biodiversity Status

- Selected Mining Lease (ML)
- Endangered - Dominant vegetation
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- No concern at present
- Non-remnant vegetation, cultivated or built environment
- Plantation
- Water
- Cadastral Boundaries

LOCALITY DIAGRAM



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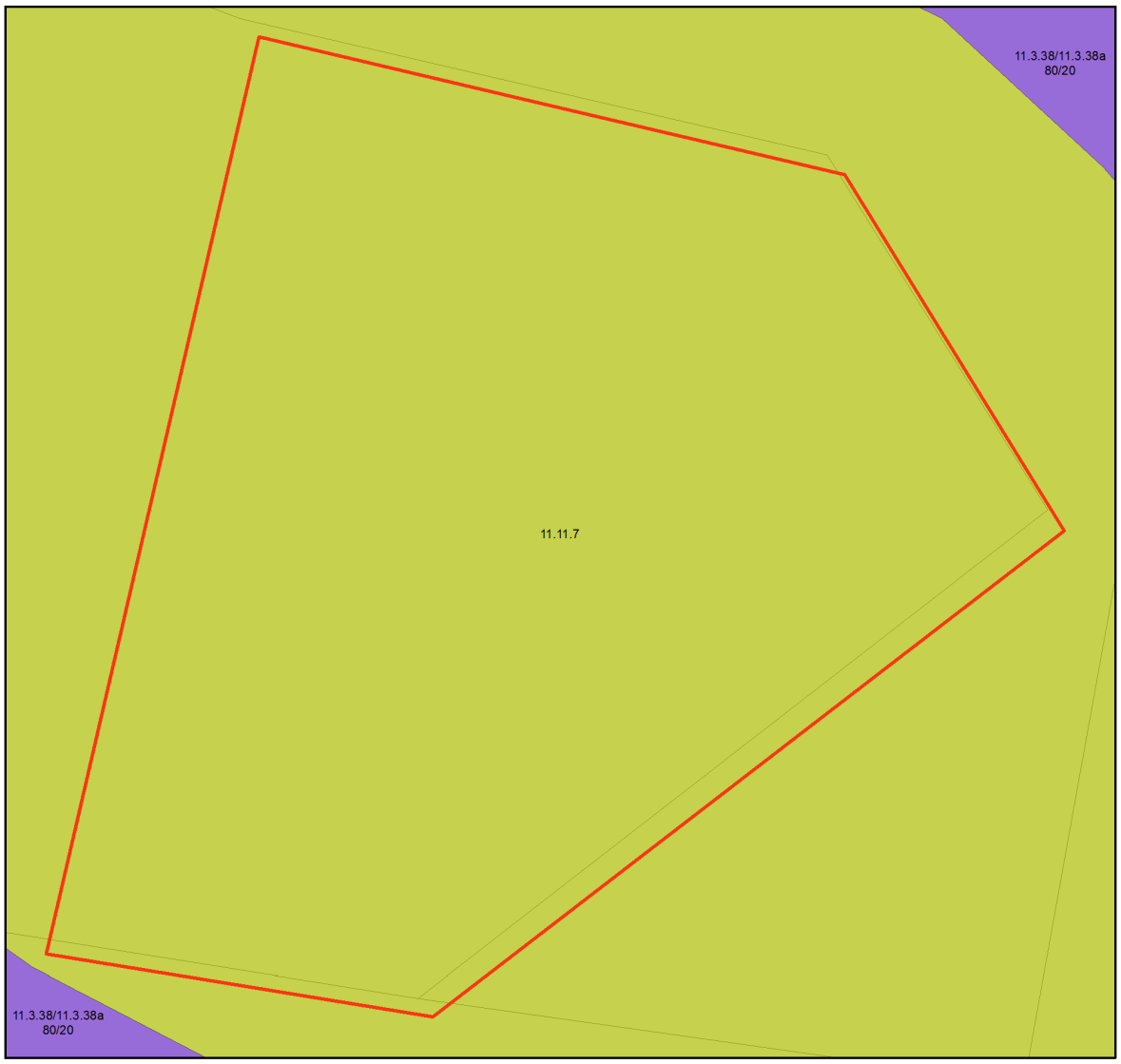
0 0.065 0.13 0.195 0.26 km

This product is projected into GDA 1994 Queensland Albers

Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.
Regional ecosystems are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.
The polygons are labelled by regional ecosystem (RE); where more than one RE occurs, the percentage of each is labelled. The label consists of 3 components: bioregion, land zone, and vegetation community – the dominant canopy species. e.g.: RE 12.3.3. Descriptions of REs are found online. Use the search term "Regional Ecosystem Framework".
Regional ecosystem mapping at 1:100,000 map scale is derived from the following sources: 1:80,000 B&W 1960's aerial photography, Landsat TM imagery, geology, soils, land systems data, field survey and historical records.
Remnant woody vegetation is defined as vegetation that has not been cleared or vegetation that has been cleared but where the dominant canopy has >70% of the height and >50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy.
Non-remnant vegetation includes regrowth and disturbed native vegetation.

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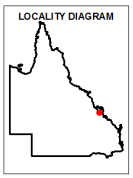
Map 3 - Pre-clearing regional ecosystems

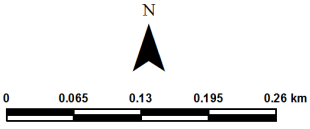


Pre-clearing Regional Ecosystems

Biodiversity Status

- Selected Mining Lease (ML)
- Endangered - Dominant vegetation
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- No concern at present
- Water
- Cadastral Boundaries





This product is projected into GDA 1994 Queensland Albers

Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.
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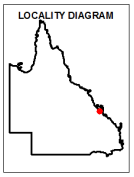
Map 4 - Remnant 2019 regional ecosystems by BVG (5M)



Remnant 2019 Regional Ecosystems coloured by Broad Vegetation Groups

Broad Vegetation Groups
BVG5M Description (BVG1M codes)

- Selected Mining Lease (ML)
- 1. Rainforests and scrubs (1-7b)
- 2. Wet eucalypt open forests (8-8b)
- 3. Eucalypt woodlands to open forests (mainly eastern Qld) (9-15b)
- 4. Eucalypt open forests to woodlands on floodplains (16-16d)
- 5. Eucalypt dry woodlands on inland depositional plains (17-18d)
- 6. Eucalypt low open woodlands usually with spinifex understorey (19-19d)
- 7. Callitris woodland - open forests (20a)
- 8. Melaleuca open woodlands on depositional plains (21-22c)
- 9. Acacia aneura (mulga) dominated open forests, woodlands and shrublands (23-23b)
- 10. Other acacia dominated open forests, woodlands and shrublands (24-26a)
- 11. Mixed species woodlands, open woodland - (inland bioregions) includes wooded downs (27-27c)
- 12. Other coastal communities or heaths (28-29b)
- 13. Tussock grasslands, forblands (30-32b)
- 14. Hummock grasslands (33-33b)
- 15. Wetlands (swamps and lakes) (34-34g)
- 16. Mangroves and saltmarshes (35-35b)
- Non-remnant vegetation, cultivated or built environment
- Water
- Cadastral Boundaries



N

0 0.065 0.13 0.195 0.26 km

This product is projected into GDA 1994 Queensland Albers

Broad Vegetation Groups (BVG) of Queensland are applied by look up table to the regional ecosystem vegetation communities. Each polygon is coloured by the dominant BVG5M and the component regional ecosystems labelled. Where more than one regional ecosystem occurs, the percentage of each is labelled.
Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.
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Non-remnant vegetation includes regrowth and disturbed native vegetation.

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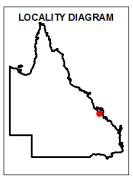
Map 5 - Pre-clearing regional ecosystems by BVG (5M)



Pre-clearing Regional Ecosystems coloured by Broad Vegetation Groups

Broad Vegetation Groups
BVG5M Description (BVG1M codes)

- Selected Mining Lease (ML)
- 1. Rainforests and scrubs (1-7b)
- 2. Wet eucalypt open forests (8-8b)
- 3. Eucalypt woodlands to open forests (mainly eastern Qld) (9-15b)
- 4. Eucalypt open forests to woodlands on floodplains (16-16d)
- 5. Eucalypt dry woodlands on inland depositional plains (17-18d)
- 6. Eucalypt low open woodlands usually with spinifex understorey (19-19d)
- 7. Callitris woodland - open forests (20a)
- 8. Melaleuca open woodlands on depositional plains (21-22c)
- 9. Acacia aneura (mulga) dominated open forests, woodlands and shrublands (23-23b)
- 10. Other acacia dominated open forests, woodlands and shrublands (24-26a)
- 11. Mixed species woodlands, open woodland - (inland bioregions) includes wooded downs (27-27c)
- 12. Other coastal communities or heaths (28-29b)
- 13. Tussock grasslands, forblands (30-32b)
- 14. Hummock grasslands (33-33b)
- 15. Wetlands (swamps and lakes) (34-34g)
- 16. Mangroves and saltmarshes (35-35b)
- Water
- Cadastral Boundaries



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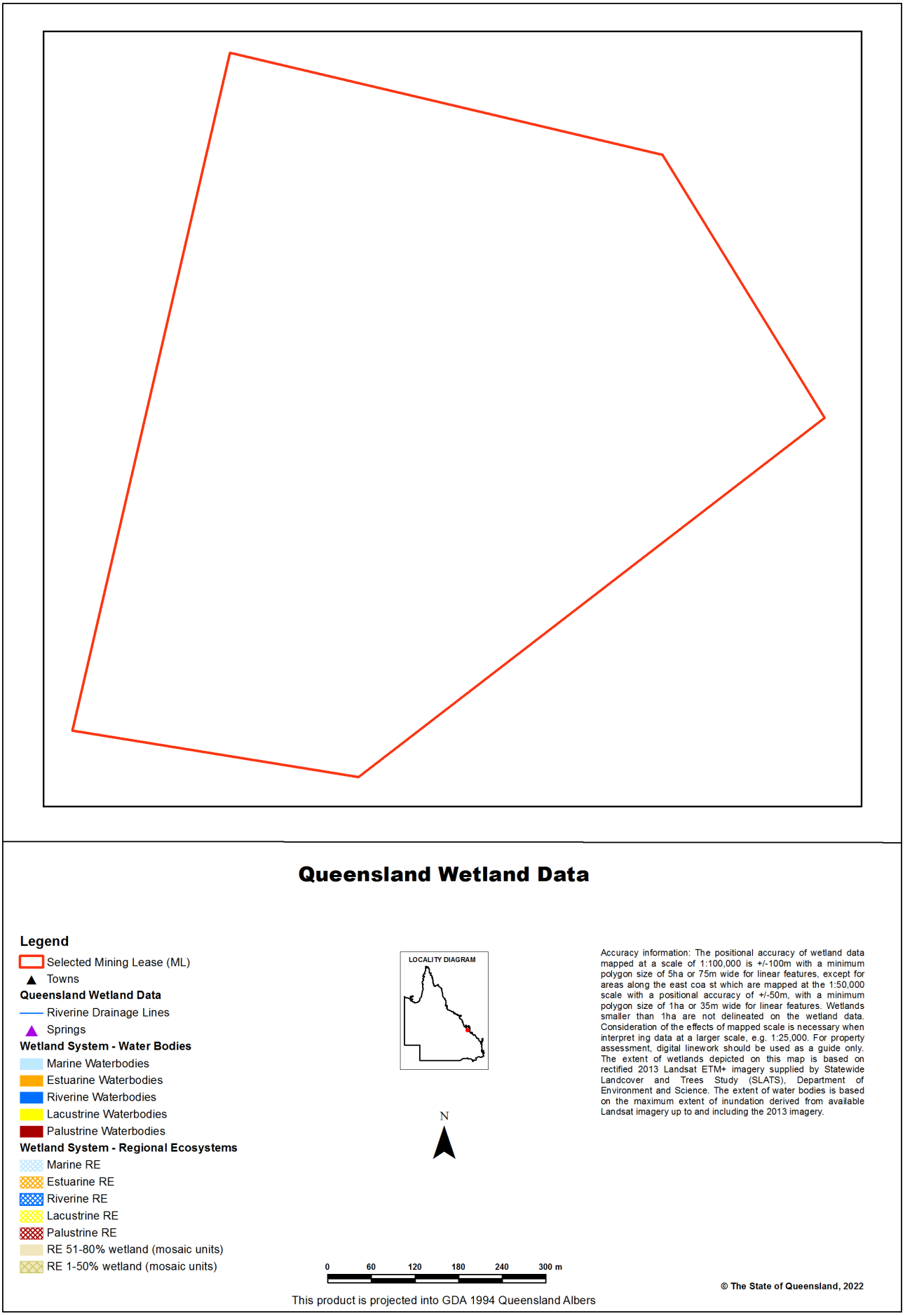
0 0.065 0.13 0.195 0.26 km

This product is projected into GDA 1994 Queensland Albers

Broad Vegetation Groups (BVG) of Queensland are applied by look up table to the regional ecosystem vegetation communities. Each polygon is coloured by the dominant BVG5M and the component regional ecosystems labelled. Where more than one regional ecosystem occurs, the percentage of each is labelled.
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Regional ecosystems are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.
The label consists of 3 components: bioregion, land zone, and vegetation community – the dominant canopy species. e.g.: RE 12.3.3. Descriptions of REs are found online. Use the search term "Regional Ecosystem Framework".
Regional ecosystem mapping at 1:100,000 map scale is derived from the following sources: 1:80,000 B&W 1960's aerial photography, Landsat TM imagery, geology, soils, land systems data, field survey and historical records.

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Map 6 - Wetlands and waterways



Links and Other Information Sources

The Department of Environment and Science's Website -

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

The methodology for mapping regional ecosystems can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

Technical descriptions for regional ecosystems can be obtained from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

Benchmarks can be obtained from:

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

For further information associated with the remnant regional ecosystem dataset used by this report, refer to the metadata associated with the Biodiversity status of pre-clearing and Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) which is available through the Queensland Government Information System portal,

http://dds.information.qld.gov.au/dds/

The Queensland Globe is a mapping and data application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link:

http://www.dnrm.qld.gov.au/mapping-data/queensland-globe

References

Neldner, V.J., Niehus, R.E., Wilson, B.A., McDonald, W.J.F., Ford, A.J. and Accad, A. (2019). The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 4.0. Queensland Herbarium, Department of Environment and Science.

(https://publications.qld.gov.au/dataset/redd/resource/78209e74-c7f2-4589-90c1-c33188359086)

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Addicott, E.P. and Appelman, C.N. (2020). Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 5.1. Updated March 2020. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

(https://publications.qld.gov.au/dataset/redd/resource/6dee78ab-c12c-4692-9842-b7257c2511e4)

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

The dataset listed below is available for download from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/

- Regional Ecosystem Description Database

The datasets listed below are available for download from:

http://dds.information.qld.gov.au/dds/

- Biodiversity status of pre-clearing and 2019 remnant regional ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
VMA	- *Vegetation Management Act 1999*

WildNet Records
Conservation Significant Species List



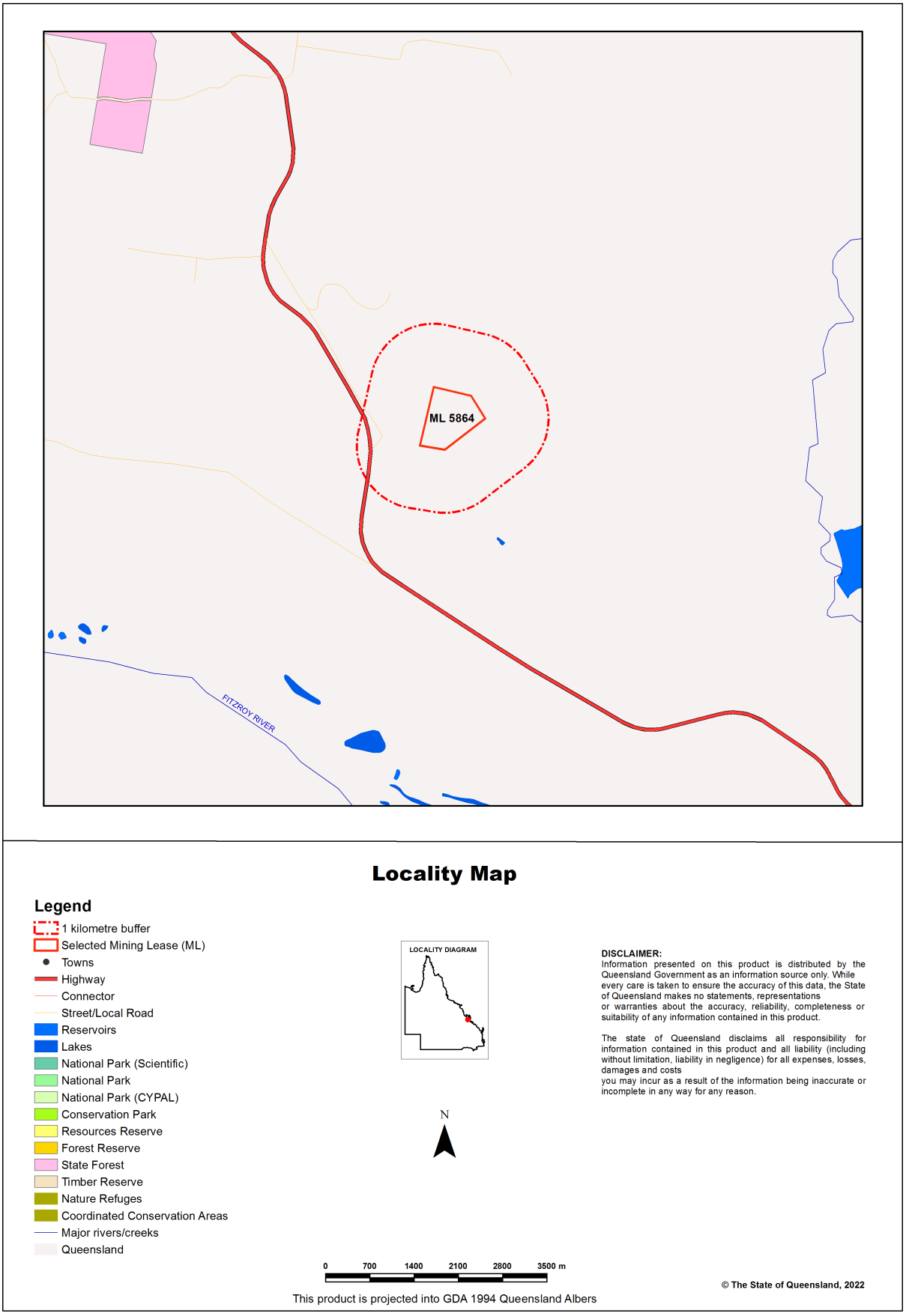
For the selected area of interest 64.49ha ml: 5864

Current as at 02/02/2022

WildNetCSSpeciesList

Queensland Government

Map 1. Locality Map



Summary Information

The following table provides an overview of the area of interest ml: 5864.

Table 1. Area of interest details

Size (ha)	64.49
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

Protected Area(s)
No estates or reserves are located within the area of interest.

World Heritage Area(s)
No World Heritage Areas are located within the area of interest.

Ramsar Area(s)
No Ramsar Areas are located within the area of interest.

Conservation Significant Species List

Introduction

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Conservation significant species are species listed:

- as threatened or near threatened under the Nature Conservation Act 1992;
- as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* or
- migratory species protected under the following international agreements:
  - Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
  - China-Australia Migratory Bird Agreement
  - Japan-Australia Migratory Bird Agreement
  - Republic of Korea-Australia Migratory Bird Agreement

The WildNet dataset is constantly being enhanced and the taxonomic and status information revised. If a species is not listed in this report, it does not mean it doesn't occur there and listed species may also no longer inhabit the area. It is recommended that you also access other internal and external data sources for species information in your area of interest (Refer Links and Support).

Table 2 lists the species recorded within the area of interest and its one kilometre buffer.

Table 2. Conservation significant species recorded within the area of interest and its one kilometre buffer

Taxon Id	Kingdom	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
1785	Animalia	Aves	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)	V	V	0	1	13/03/2013
1578	Animalia	Aves	Rhipiduridae	*Rhipidura rufifrons*	rufous fantail	SL	None	0	1	13/03/2013
13744	Plantae	Equisetopsida	Stackhousiaceae	*Stackhousia tryonii*	None	NT	None	1	1	01/04/1983

Taxon Id	Kingdom	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
36429	Plantae	Equisetopsida	Thymelaeaceae	*Pimelea leptospermoides subsp. leptospermoides*	None	NT	None	1	1	22/09/1943

Taxon Id: Unique identifier of the taxon from the WildNet database.

NCA: Queensland conservation status of the taxon under the *Nature Conservation Act 1992* (Least Concern (C), Critically Endangered (CR), Endangered (E), Extinct (EX), Near Threatened (NT), Extinct in the Wild (PE), Special Least Concern (SL), and Vulnerable (V)).

EPBC: Australian conservation status of the taxon under the *Environment Protection and Biodiversity Conservation Act 1999* (Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Vulnerable (V), and Extinct in the Wild (XW)).

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Links and Support

Other sites that deliver species information from the WildNet database include:

- Species profile search - access species information approved for publication including species names, statuses, notes, images, distribution maps and records
- Species lists - generate species lists for Queensland protected areas, forestry areas, local governments and areas defined using coordinates
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Please direct queries about this report to the WildNet Team.

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WildNet Records
Pest List



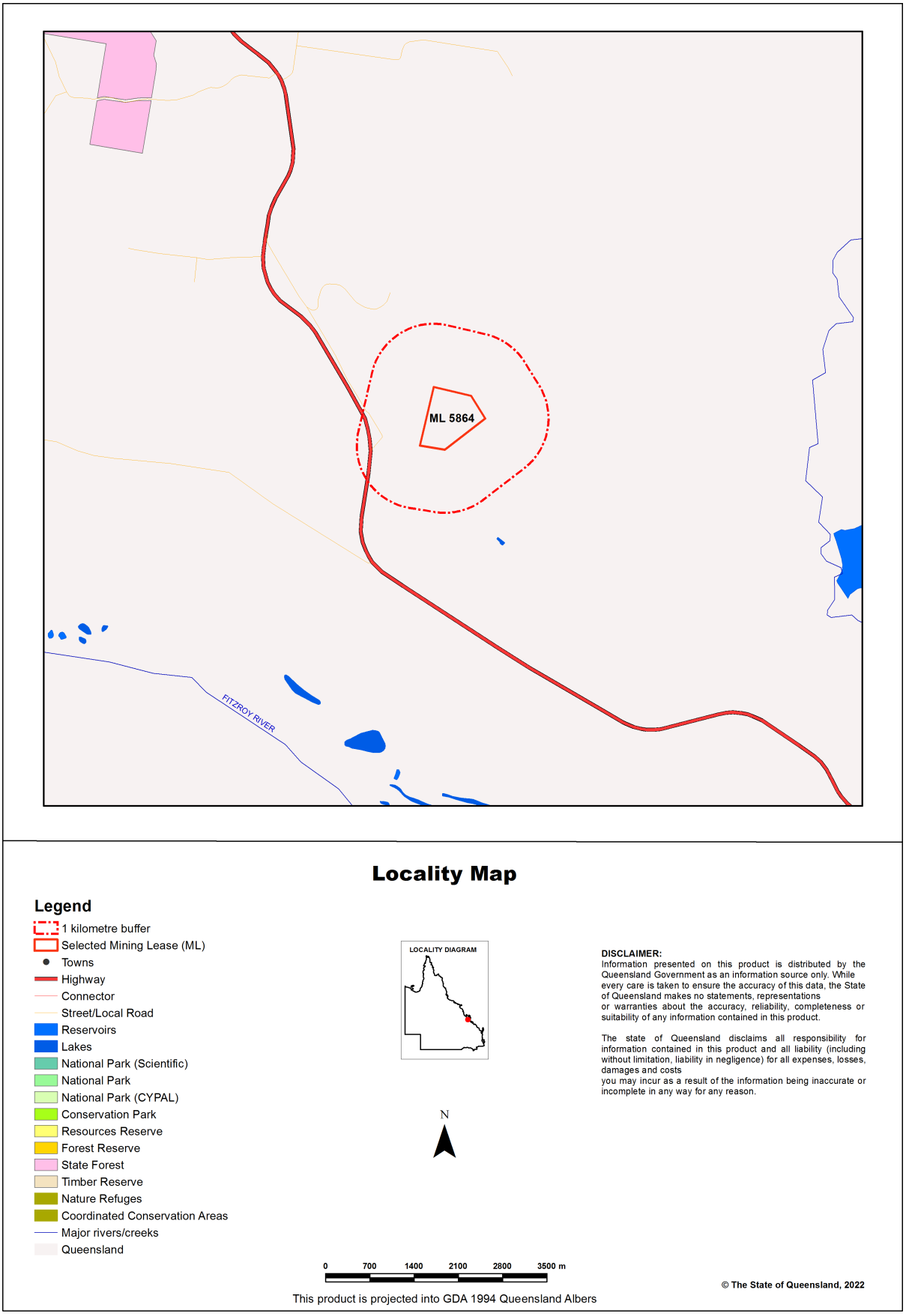
For the selected area of interest 64.49ha ml: 5864

Current as at 02/02/2022

WildNetPestList

Queensland Government

Map 1. Locality Map



Summary Information

The following table provides an overview of the area of interest ml: 5864.

Table 1. Area of interest details

Size (ha)	64.49
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

Protected Area(s)

No estates or reserves are located within the area of interest.

World Heritage Area(s)

No World Heritage Areas are located within the area of interest.

Ramsar Area(s)

No Ramsar Areas are located within the area of interest.

Pest List

Introduction

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Species Data

Contextual location information is presented in Map 1.

A summary of the pests recorded within the area of interest and its one kilometre buffer is presented in Table 2.

Table 2. Pests recorded within the area of interest and its one kilometre buffer

No pests found within the area of interest and its one kilometre buffer.

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Endemicity: The endemicity code for the taxon (Introduced (Intranational) (IA), Introduced (International) (II), Introduced (Unknown), Exotic (Intranational) (XA), Exotic (International) (XI) and Exotic (Unknown) (XU)).

Links and Support

Other sites that deliver species information from the WildNet database include:

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WildNet Records
Species List



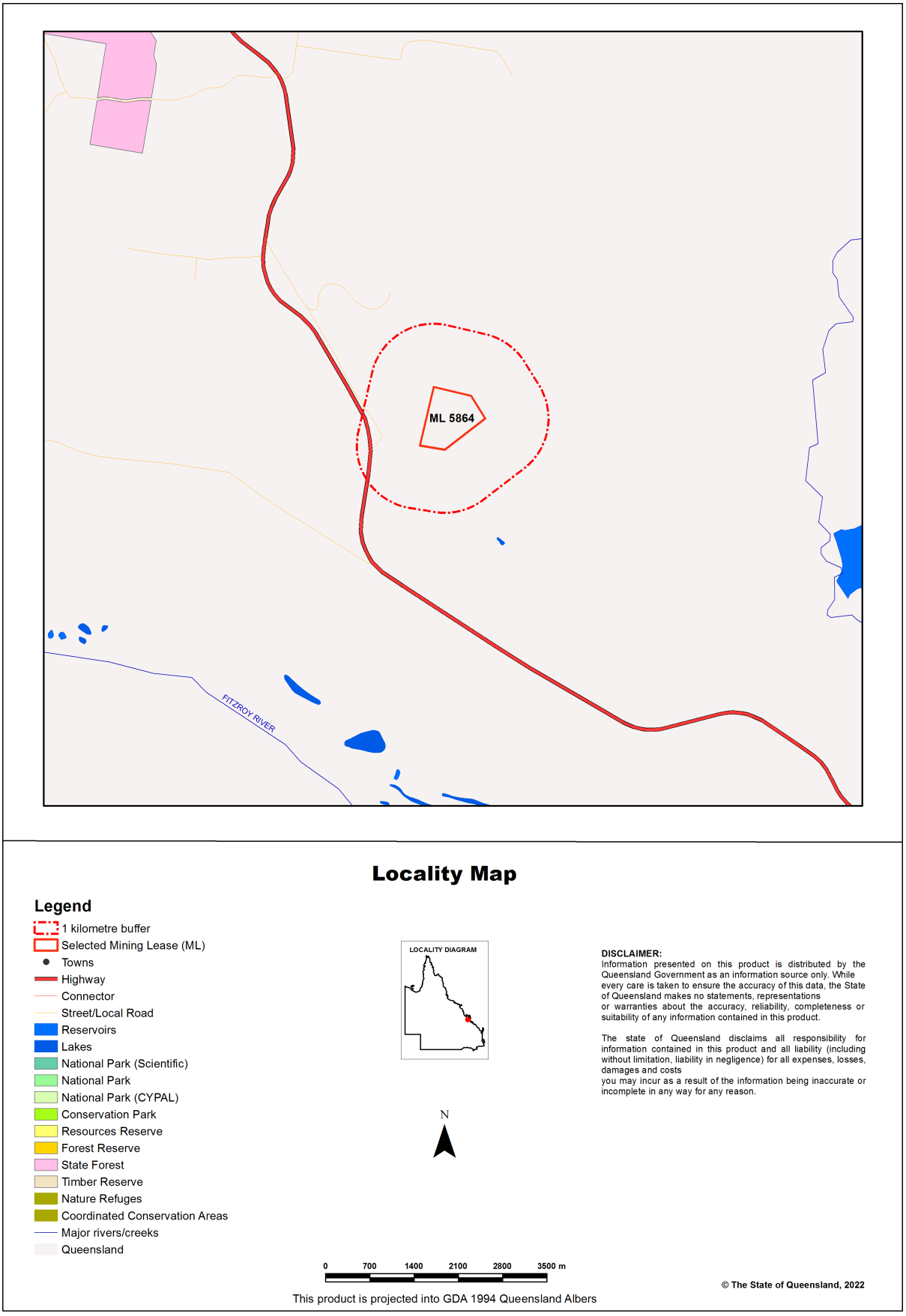
For the selected area of interest 64.49ha ml: 5864

Current as at 02/02/2022

WildNetSpeciesList

Queensland Government

Map 1. Locality Map



Summary Information

The following table provides an overview of the area of interest ml: 5864.

Table 1. Area of interest details

Size (ha)	64.49
Local Government(s)	Livingstone Shire
Bioregion(s)	Brigalow Belt
Subregion(s)	Marlborough Plains
Catchment(s)	Fitzroy

Protected Area(s)
No estates or reserves are located within the area of interest.

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Ramsar Area(s)
No Ramsar Areas are located within the area of interest.

Species List

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Table 2 lists the animals recorded within the area of interest and its one kilometre buffer.

Table 3 lists the plants recorded within the area of interest and its one kilometre buffer.

Table 4 lists the fungi recorded within the area of interest and its one kilometre buffer.

Table 5 lists the protists recorded within the area of interest and its one kilometre buffer.

Table 2. Animals recorded within the area of interest and its one kilometre buffer

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
1785	Aves	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)	V	V	0	1	13/03/2013
1767	Aves	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra	C	None	0	1	28/09/2001
1578	Aves	Rhipiduridae	*Rhipidura rufifrons*	rufous fantail	SL	None	0	1	13/03/2013

Table 3. Plants recorded within the area of interest and its one kilometre buffer

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
7558	Equisetopsida	Leguminosae	*Acacia julifera subsp. julifera*	None	C	None	1	1	25/06/1962

Taxon Id	Class	Family	Scientific Name	Common Name	NCA	EPBC	Specimens	Records	Last record
32294	Equisetopsida	Leguminosae	*Acacia sp. (Canoona S.T.Blake 15321)*	None	C	None	1	1	01/09/1975
12500	Equisetopsida	Myrtaceae	*Eucalyptus fibrosa subsp. fibrosa*	None	C	None	1	1	23/05/1989
17376	Equisetopsida	Sapindaceae	*Dodonaea lanceolata var. subsessilifolia*	None	C	None	2	2	30/07/1978
13744	Equisetopsida	Stackhousiaceae	*Stackhousia tryonii*	None	NT	None	1	1	01/04/1983
36429	Equisetopsida	Thymelaeaceae	*Pimelea leptospermoides subsp. leptospermoides*	None	NT	None	1	1	22/09/1943

Table 4. Fungi recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Table 5. Protists recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

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EPBC: Australian conservation status of the taxon under the *Environment Protection and Biodiversity Conservation Act 1999* (Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Vulnerable (V), and Extinct in the Wild (XW)).

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WildNet Records
Weed List



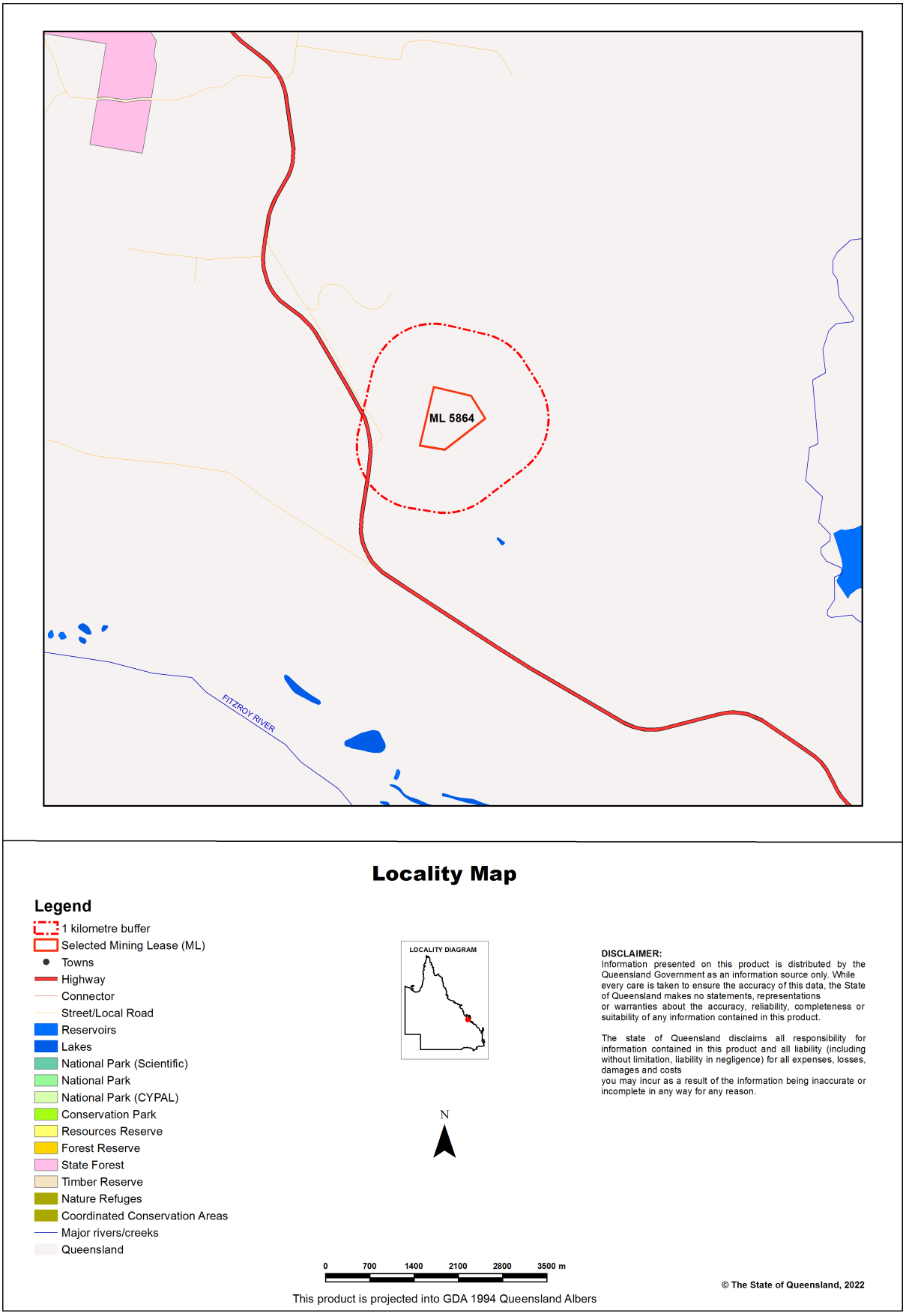
For the selected area of interest 64.49ha ml: 5864

Current as at 02/02/2022

WildNetWeedList

Queensland Government

Map 1. Locality Map



Summary Information

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Protected Area(s)
No estates or reserves are located within the area of interest.

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Weed List

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Species Data

Contextual location information is presented in Map 1.

A summary of the weeds recorded within the area of interest and its one kilometre buffer is presented in Table 2.

Table 2. Weeds recorded within the area of interest and its one kilometre buffer

No weeds found within the area of interest and its one kilometre buffer.

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Endemicity: The endemicity code for the taxon (Introduced (Intranational) (IA), Introduced (International) (II), Introduced (Unknown), Exotic (Intranational) (XA), Exotic (International) (XI) and Exotic (Unknown) (XU)).

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TECHNICAL MEMO

From: Simon Danielsen, Astrebla Ecological Services

To: Natasha Macintosh

Date: 10 January, 2022

Subject: Site condition report and recommendations for rehabilitation of mining lease ML5864, Old Canoona Rd, Yaamba

---

QNI Resources Pty Ltd plan to rehabilitate an inactive mining lease (ML5864) located on Old Canoona Rd approximately 11.5 km north west of Yaamba (which is 30 km north of Rockhampton) (see Figure 1). In order to develop a rehabilitation plan for ML5864, Astrebla Ecological Services was commissioned to inspect the site, provide a report on the ecological condition as present in December 2021, and make recommendations in relation to ecological rehabilitation. Consequently, the site was surveyed by Simon Danielsen on 29 December, 2021. It should be noted that the site survey and this memo cover ecological issues only - other environmental concerns were not addressed.

Legislative background

In compiling this memo and making recommendations, the general environmental outcomes for closure of mining leases outlined in the *Guideline - Progressive rehabilitation and closure plans (PRC plans)* (Department of Environment and Science, 2021) have been considered. The *Environmental Protection Act 1994* (the EP Act) requires areas disturbed within a mining tenure to be rehabilitated to a post-mining land use (PMLU) (or be managed as a non-use management area, which is not applicable in this case). Post-mining land uses include habitat and ecosystem services, native ecosystem, forestry, cropping and grazing, among others.

For a proposed PMLU to be accepted by the government, it must be demonstrated that the land can be rehabilitated to a stable condition, which is defined in s.111A of the EP Act as:

> Land is in a stable condition if –
>
> a. the land is safe and structurally stable, and
> b. there is no environmental harm being caused by anything on or in the land, and
> c. the land can sustain a PMLU.

The PMLU chosen for the closure of ML5864 will determine how the land is to be rehabilitated. Recommendations are made in this memo as to appropriate PMLUs and the rehabilitation steps appropriate to each.

Site history

Mining lease ML5864 was granted to QNI Resources on 13 June, 1991. Based on historical aerial photography available on the QImagery site (Queensland government, 2022), clearing of tracks and drill pads for exploration of the site appears to have occurred between March 1994 and December 1995 (see Figure 2). Since then, the site has not been utilised for any purpose associated with mining. Until a fence was erected in 2021 cattle from the neighbouring property could access the site, and some grazing may have consequently occurred. There is no built infrastructure on the site.

There are two minor voids present (the EP Act defines a void as 'an area of land…excavated in the carrying out of a mining activity'). These are shallow (less than 2 m deep), less than 100 m^2 and roughly rectangular in shape. The side walls have slumped somewhat and the ends are gently sloping, allowing easy access and egress. They are both in the process of revegetating naturally. They do not represent a hazard to wildlife, the public or grazing animals.

Staff responsible for maintaining the site informed me that all borehole linings have been removed and the only work that has occurred on the site since the drilling program was to construct the new fence along the northern, eastern and southern boundaries.

Site description

The site (ML5864) is 64.49 ha in area with a pentagonal boundary (see Figure 2), and is situated on the eastern slope of a gently to moderately inclined low hill between 30 and 80 m elevation in the Fitzroy River catchment. In general, slopes within the site ranged between 0-2% along the apron slope in the east, 5-10% on the mid-slopes and 10-25% near the hill crest.

Land systems mapping for the Capricornia coast (Department of Environment and Science, 2020) identifies the majority of the site (59 ha) within the 'Tungamulli' land system, which is described as:

> Shallow, stony black, uniform clays or shallow, stony red, structured gradational clay loams and uniform clays formed on rolling low hills and undulating rises on serpentinite; eucalypt woodland.

The Tungamulli land system is classed as suitable for 'pasture land-native pastures', with an agricultural land suitability rating of C2, indicating it is appropriate for cattle or sheep breeding (but not cropping of any kind) (Department of Environment and Science, 2020; DSITI & DNRM, 2015). Just under 5 ha along the eastern boundary of the site (the lowest elevations) is mapped as the 'Kunwarara' land system, which is described as:

> Black and brown, alkaline cracking clays or black, self-mulching magnesic cracking clays formed on broad alluvial plains and swamps on fine textured alluvium derived from serpentinite and overlying magnesite; moderate melonhole; blue gum woodland and black teatree open forest.

The Kunwarara land system is also classed as suitable for 'pasture land-native pastures', with an agricultural land suitability rating of C2 (Department of Environment and Science, 2020). The site survey found that the DES 2020 mapping is slightly incorrect as this land system is present just to the east of the eastern boundary, and does not occur within the site boundary itself.

The hill on which the site is located is mapped in the Queensland 1:100, 000 geological mapping as Princhester Serpentinite (Queensland Globe, 2022), and protruding bedrock is common, with abundant loose rock present on the surface (generally cobble to stone sized i.e. 6-60 cm diameter). Vegetation on the site is mapped as the least concern regional ecosystem (RE) 11.11.7, which is described as (Queensland Herbarium, 2021):

> Complex of vegetation on serpentinite hills and adjacent undulating colluvial aprons dominated by *Eucalyptus fibrosa* subsp. *fibrosa* +/- *Corymbia xanthope* +/- *Corymbia* spp. A variable shrub layer includes *Acacia leptostachya, Hakea trineura, Xanthorrhoea* spp. and *Macrozamia serpentina*. Occurs on steep mountains, undulating low hills and rises and colluvial aprons formed from Permian ultramafic rocks (serpentinite) including remnant lateritised surfaces in more elevated areas. Associated soils are shallow to moderately deep dark stony clays to clay loams.

The site survey found this RE mapping was correct. On the drier slopes in the north, west and south-west the predominant vegetation is woodland and open forest with a median height of approximately 16-18 m dominated by *E. fibrosa* subsp. *fibrosa,* with *C. erythrophloia* present as a sub-dominant element in some places. The vulnerable species *C. xanthope* is present as an associate only (i.e. its contribution to overall canopy biomass is minor) (see Plate 1). The shrub layer is generally sparse to very sparse, and is dominated by *Alphitonia excelsa* and the wattles *Acacia leptostachya* and *Acacia disparrima* (and possibly an unnamed wattle collected from Canoona previously about which there is no published information – *Acacia* sp. (Canoona S.T. Blake15321)) (AVH, 2022). *Macrozamia serpentina* is a common component, and the ground layer is comprised of a diverse range of grasses and herbs, most commonly *Panicum effusum, Aristida* spp., *Heteropogon contortus, Cymbopogon refractus, Chrysopogon fallax, Dichanthium sericeum, Desmodium rhytidophyllum* and *Lomandra confertifolia*.

Mid and lower slopes with an easterly aspect were characterised by open forest with a wider range of canopy species, including *Eucalyptus crebra, Eucalyputs tereticornis, E. fibrosa* subsp. *fibrosa, Corymbia tessellaris* and *Corymbia dallachiana* (see Plate 2). In addition to *Alphitonia excelsa* and *Acacia leiocalyx,* the lower tree and shrub layer was characterised by a number of non—sclerophyllous species including *Psychotria daphnoides* var. *angustifolia, Trema tomentosa* var. *aspera, Dyrpetes deplanchei, Euroschinus falcatus* and *Psydrax odorata* subsp. *australiana. Gahnia aspera* frequently dominated the ground layer.

This corresponds to the sub-unit 11.11.7a (which as a sub-component of RE 11.11.7 is also least concern), which is described as (Queensland Herbarium, 2021):

> *Eucalyptus fibrosa* subsp. *fibrosa* +/- *Corymbia* spp. +/- *Eucalyptus* spp. woodland with a diverse shrub layer including several endemic species. Occurring on undulating low hills and colluvial aprons.



Plate 1: Woodland dominated by *Eucalyptus fibrosa,* with *Corymbia xanthope* in foreground



Plate 2: Woodland in the eastern section of the site with a higher diversity of canopy species

Special ecological values

During the survey, it was noted that the site contains a number of special ecological values associated with its location on serpentinite. The Central Queensland serpentine flora is comprised of communities of plants occurring on serpentine geological formations located between Marlborough and Balragowan (approximately 20 km south east of Rockhampton), and has high levels of species richness and endemism, including a number of species listed as threatened in Queensland or Commonwealth legislation. It is the most diverse serpentine flora in Australia. The site is located at the southern tip of the Glen Geddes occurrence serpentinite formation (Batianoff and Singh, 2001).

A search of the Queensland government Wildnet database for threatened flora species previously recorded in the vicinity returned seven species found within a 2 km radius of the centre of the site. Utilising opportunistic survey methods only (i.e. no targeted surveys were conducted), three of these species were found to be present:

- *Corymbia xanthope* (Glen Geddes bloodwood) is a tree (visible in the centre of Plate 2 as a tree with fire-blackened trunk) listed as vulnerable under the Queensland NC Act (*Nature Conservation Act 1992*) and the Commonwealth EPBC Act (*Environment Protection and Biodiversity Conservation Act 1999*). It is present as an occasional component of the canopy and sub-canopy (estimated at approximately 5/ha), and has been identified as a serpentine-endemic species (Batianoff and Singh, 2001), being restricted to the Byfield State Forest-Marlborough-Yeppoon area (AVH, 2022).
- *Leichhardtia brevifolia* (formerly *Marsdenia brevifolia*) is a sub-shrub growing to 1 m high (see Plate 3) listed as vulnerable under the NC Act and the EPBC Act. It is found on a variety of soils in three clusters (Townsville/Paluma, Springsure and Rockhampton/Marlborough) and is not endemic to serpentinite. It was present across most of the site in low densities (estimated at approximately 20/ha).
- *Macrozamia serpentina* is a cycad with an underground trunk (only the crown is visible above the ground) (see Plate 4) listed as endangered under the NC Act (it is not listed under the EPBC Act). This species was present across the entire site, with an abundance varying from very occasional (i.e. present as scattered individuals, estimated at approximately 1-5/ha) to sparse (estimated at up to 50/ha). *Macrozamia serpentina* is recognised as endemic to serpentinite (Batianoff and Singh, 2001).

In addition, the site is comprised of 64.49 ha of woodland and open forest that is contiguous with remnant vegetation in the Pointer Range that extends over 10 km to the north (including the Canoona Creek riparian corridor), and with remnant vegetation extending to the east (including the Alligator Creek riparian corridor). Consequently, it is likely to provide suitable habitat for threatened fauna species that utilise woodlands and open forest, in particular koala (*Phascolarctos cinereus*) and greater glider (*Petauroides volans*), both of which are known to occur in the wider region (Atlas of Living Australia, 2022).



Plate 3: *Leichhardtia brevifolia*



Plate 4: *Macrozamia serpentina*

Ecological condition

In order to describe ecological condition, the site has been divided into three zones with consistent condition characteristics (see Figure 3). These zones are described in the sections below.

Good condition

Ecological condition is rated as 'good' across most of the site (approximately 40 ha – see Figure 3). This zone has a northerly, westerly or southerly aspect, appears drier and better drained and is generally characterised by *E. fibrosa* subsp. *fibrosa* woodland/open forest. The old drilling tracks and pads mapped in Figure 2 are generally difficult or impossible to discern (except for physical evidence such as cuttings or spoil heaps/earth piles) and are gradually reverting to the original ecological condition (see Plate 5 and Plate 6).

The main weed present is praxelis (*Praxelis clematidea**), with minor occurrences of stinking passionfruit (*Passiflora suberosa**), red Natal grass (*Melinus repens**) and lantana (*Lantana camara**). These weeds are generally restricted to the actual disturbance footprint (mostly the old drilling tracks) or within 10 m of the footprint, and have not spread into surrounding woodland to any substantial extent.



Plate 5: Drill pad 3 (left) and drill pad 1 (right), both in the zone mapped as in good condition



Plate 6: Track rehabilitation in the zone mapped as in good condition

Moderate condition

Approximately 16 ha of the site is mapped as being in moderate ecological condition (see Figure 3). This zone is located on the lower colluvial apron of the low hill that dominates the site, with level to very gently inclined slopes with a south-easterly aspect. It is characterised by a greater species diversity in the canopy (*E. fibrosa, E. tereticornis, C. tessellaris, C. dallachiana, E. crebra*) and the vegetation community corresponds to the sub-RE 11.11.7a.

Tracks and pads in this area (see Figure 2) are re-establishing themselves well and are in many cases difficult or impossible to discern (see Plate 7). However, in this zone weed incursion and spread has been more substantial, and lantana in particular is present in dense clumps (see Plate 8). These clumps are as yet isolated from each other and movement within this zone is still relatively easy.

Weeds are also common along the eastern section of the boundary track (see Figure 2), in particular praxelis and American rat's tail grass (*Sporobolus jaquemontia**).



Plate 7: Drill pad 9 (left) and track rehabilitation in the zone mapped as in moderate condition



Plate 8: Examples of the incursion of lantana in the zone mapped as in moderate condition

Poor condition

Approximately 8 ha of the site is in poor ecological condition (see Figure 3). Native vegetation is re-establishing in the former disturbance footprint mapped in Figure 2, however the area is heavily infested with dense, continuous clumps of lantana (see Plate 9). Praxelis and stinking passionfruit are other notable weeds in this zone. Extensive canopy die-back is also evident in this area (which has a positive feedback effect on the lantana infestation) (see Plate 10). This die-back is easily seen in aerial imagery dating from 2017 onwards (see Figure 2), but is not evident in the most recent pre-2017 aerial imagery available from the QImagery site, which dates to July 2004 (Queensland government, 2022).

The Rockhampton region experienced two periods of drought (where rainfall was categorised by the Bureau of Meteorology as 'very much below average') in the period from 1997 to 2021 (Bureau of Meteorology, 2022). It is known that ironbarks (such as the two dominant species in this zone, *E. crebra* and *E. fibrosa*) die-back much faster than other eucalypts in drought (Rice, Matzner, Byer and Brown, 2004), and it is possible that die-back in this zone has resulted from these periods of drought.



Plate 9: Dense infestations of lantana are present in the zone mapped as in poor ecological condition (left) and praxelis is present in places (right)

Weeds and feral pests

For the purpose of this memo, any exotic plant is considered a weed, although it should be noted that only two of the exotic species recorded on the site are declared restricted invasive plants under the *Biosecurity Act 2014*. Weeds recorded on the site were:

- American rat's tail grass (*Sporobolus jacquemontia**) – a declared category 3 restricted invasive plant under the Biosecurity Act, this was only observed in patches along the eastern boundary track, where the soil is more moist and of a higher quality. This species is frequently associated with vehicle movements, and is easily spread via machinery.
- Lantana (*Lantana camara**) – a declared category 3 restricted invasive plant under the Biosecurity Act, this species is the most widespread weed on the site, occupying an area of at least 8 ha. Of all the weed species observed on the site, it has the highest capacity to degrade the ecological values of the site.

- Praxelis (*Praxelis clematidea**) – similar to blue top (*Ageratum houstonianum**) and often referred to under this name. This species is a weed of unattended sites and crops, often in wetter areas, and spreads primarily via an airborne seed. It is present in low densities along and beside tracks on this site.
- Red Natal grass (*Melinus repens**) – a common weed in bushland, this grass spreads via an airborne seed, but may also be spread by machinery and via the movements of mammals (i.e. on clothing and fur coats). It is present in low densities along and beside tracks on this site.
- Stinking passionfruit (*Passiflora suberosa**) – a common sprawling and climbing vine with a small black fruit eaten by birds, which spread the seed. This weed is present in low densities in association with tracks and disturbed areas, and is more common where lantana is prevalent.

In addition, signs of feral pigs (*Sus scrofa*) were noted across the site, but most frequently in the zone of poor condition, where they are likely to utilise lantana thickets for shelter.



Plate 10: Canopy dieback of ironbark trees in the zone mapped as in poor ecological condition

Recommendations for rehabilitation

Recommendations are discussed below, with all recommendations highlighted.

Appropriate post-mining land use for the site

As outlined in the Legislative background section, how rehabilitation is to be achieved and measured will depend on the PMLU adopted for the closure.

Given the high ecological values present and moderate to good condition of the majority of the site, it is recommended that the most appropriate PMLU is native ecosystem – that is, the site be maintained and managed as a native ecosystem, for its habitat value to threatened flora and fauna.

A secondary suitable PMLU is grazing – the agricultural land suitability class for the site and surrounds is C2, indicating it is appropriate for cattle breeding/grazing.

Given the high ecological values present on this site, and the existing presence of lantana infestations in the centre (which grazing is likely to exacerbate) a grazing PMLU is considered marginally suitable – that is, not preferable.

Rehabilitation of previous disturbance

The entire site (including the area mapped as being in poor condition) displays abundant evidence of re-establishing native vegetation – saplings and small trees of the dominant canopy species (primarily *E. fibrosa*) have colonised old tracks and drill pads (Plates 5-7), and pioneering shrub species such as wattles and red ash are common. Disturbance from exploration activities in the 1990s was selective and left the main elements of the natural ecosystem on the site substantially intact and in good condition. These plants are now providing the seedstock and biotic factors necessary for full rehabilitation to original, remnant condition.

Therefore, it is recommended that because the site has achieved a level of advanced rehabilitation entirely on its own, a revegetation program is not necessary.

Prior earthworks on the site were minor and restricted to excavation of drill pads, shallow water storage pits or scoops (classed as voids) beside drill pads, and the construction of tracks suitable for drilling rigs to negotiate. Since exploration activities ceased in the 1990s the voids have partially filled, and all are open on at least two sides (so do not pose a threat to wildlife, humans or cattle). To access these sites in order to reshape the land surface would do extensive damage to the existing re-establishing native vegetation and would set back rehabilitation progress by many years.

Given the advanced stage of native vegetation re-establishment already evident on the site, and the minor nature of these tracks, voids and associated spoil heaps (the latter a few metres at most high), it is recommended that the most appropriate course of action from an ecological viewpoint is to leave the landscape to continue settling.

Therefore, it is recommended that because prior earthworks were minor, present no risk to users of the site or animals, and are already extensively revegetating without outside intervention, no further action in relation to these earthworks is required.

Removal of weeds

The major weed of concern on the site is lantana, which is generally absent from the zone of good ecological condition mapped in Figure 3, but prevalent in the 8 ha zone of poor ecological condition and becoming prevalent in sections of the 16 ha zone of moderate ecological condition. Dieback (most likely as a result of drought) in the zone of poor ecological condition has exacerbated its spread. It is likely that, if left unattended, lantana will progressively invade the eastern and south-eastern sections of the site (the damper areas with better soils), degrading the site by restricting movement for native fauna, providing habitat for feral pigs, and degrading habitat for threatened flora species.

Therefore, it is recommended that to safeguard the natural values of the site, steps be taken to control and (ideally) to remove lantana from the site. This could involve a combination of chemical control (using splatter gun spraying from a mobile hand-held unit), biological controls and a cool-burn fire regime.

It is also recommended that American rat's tail grass be controlled along the eastern boundary track, as ongoing vehicle movements will continue to spread seed.

Establishment of an ecologically appropriate fire regime

Establishing an ecologically appropriate fire regime would maximise the ecological values of the site for threatened flora and fauna species, and would be an important management tool if the PMLU is to be native ecosystem. It would also assist in the control of lantana, when undertaken in association with other treatment methods.

The Queensland Herbarium has published recommendations for fire regimes that are ecologically appropriate for every RE, including 11.11.7. For this RE, it is recommended to undertake patchwork burns in the early dry season when there is good soil moisture, with some later fires in the early storm season or after good spring rains. Interval between fire would ideally be between 6-10 years to ensure wattles can complete their life-cycles (Queensland Herbarium, 2021).

Therefore, it is recommended that the vegetation on site be subjected to a planned fire management regime in accordance with Queensland Herbarium recommendations for the RE 11.11.7.

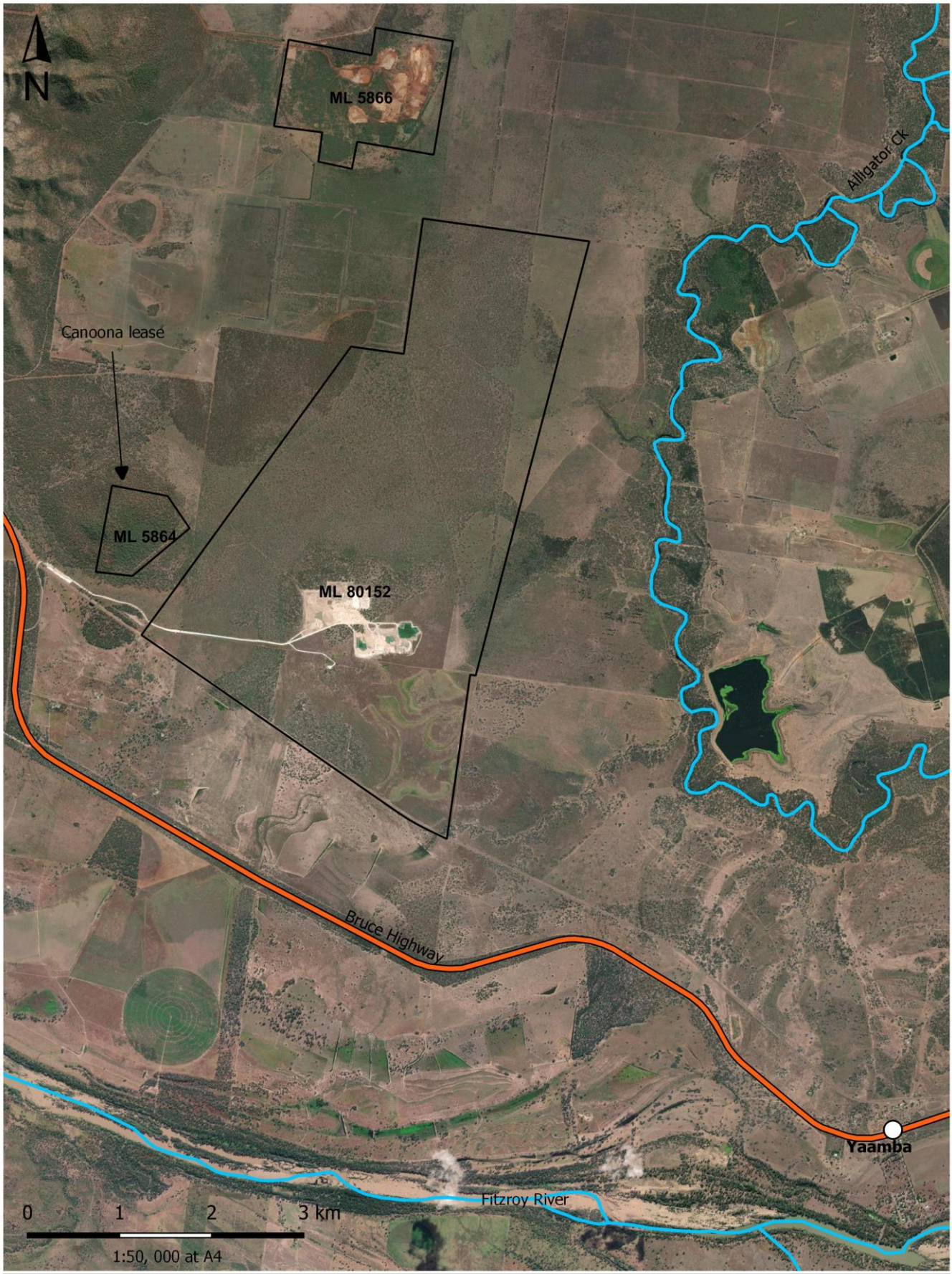


Figure 1 Location of ML5864 (Canoona lease)

Imagery © ESRI Satellite (5/1/2022)
ML Permit Granted layer © Dept Resources, Qld (5/1/2022)
GIS by Simon Danielsen, Astrebla Ecological Services, 5 January, 2022

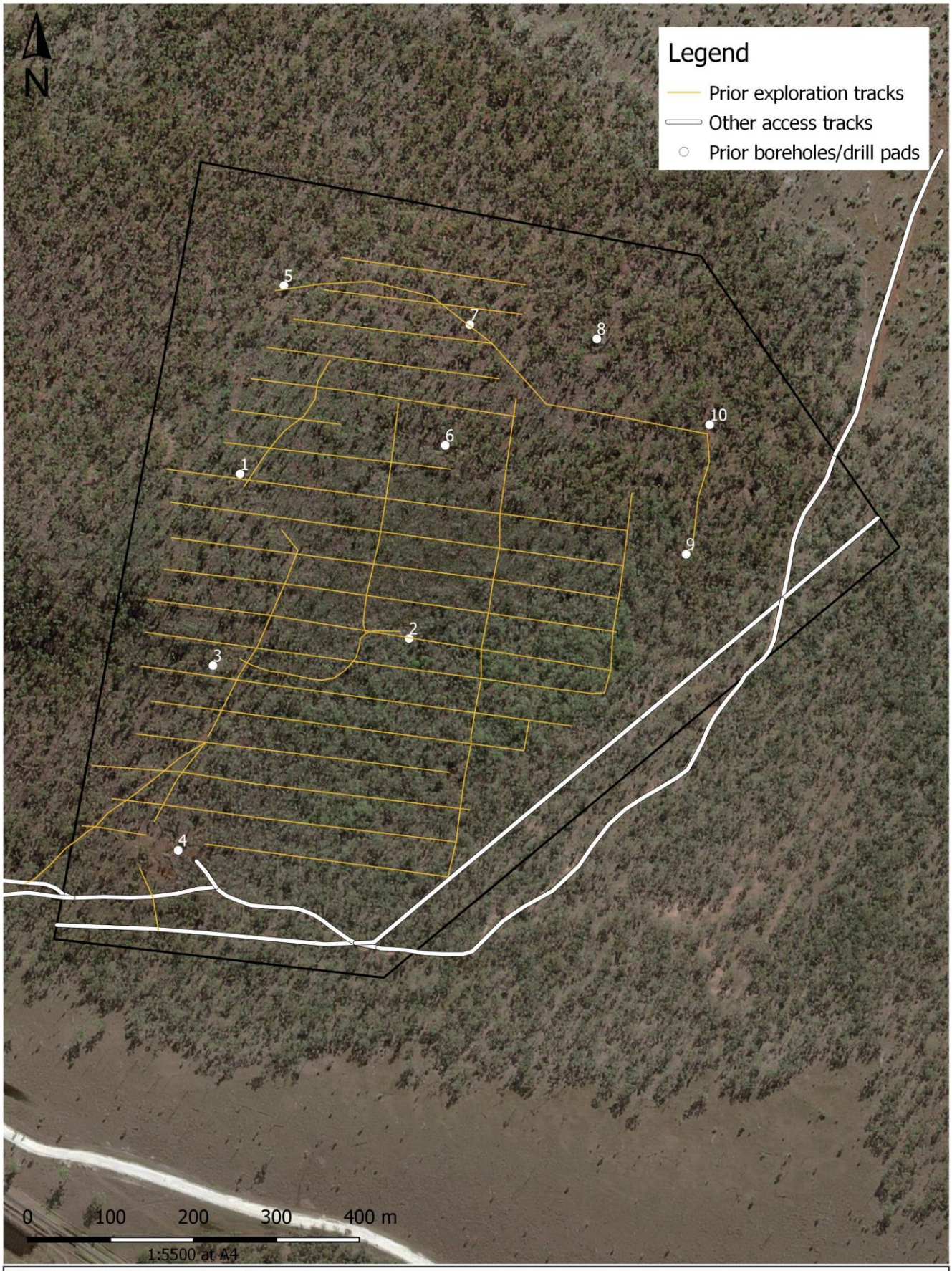


Figure 2 Previous exploration activity

Imagery © ESRI Satellite (5/1/2022)
ML Permit Granted layer © Dept Resources, Qld (5/1/2022)
Tracks and bore hole layers provided by QNI Resources P/L
GIS by Simon Danielsen, Astrebla Ecological Services, 5 January, 2022

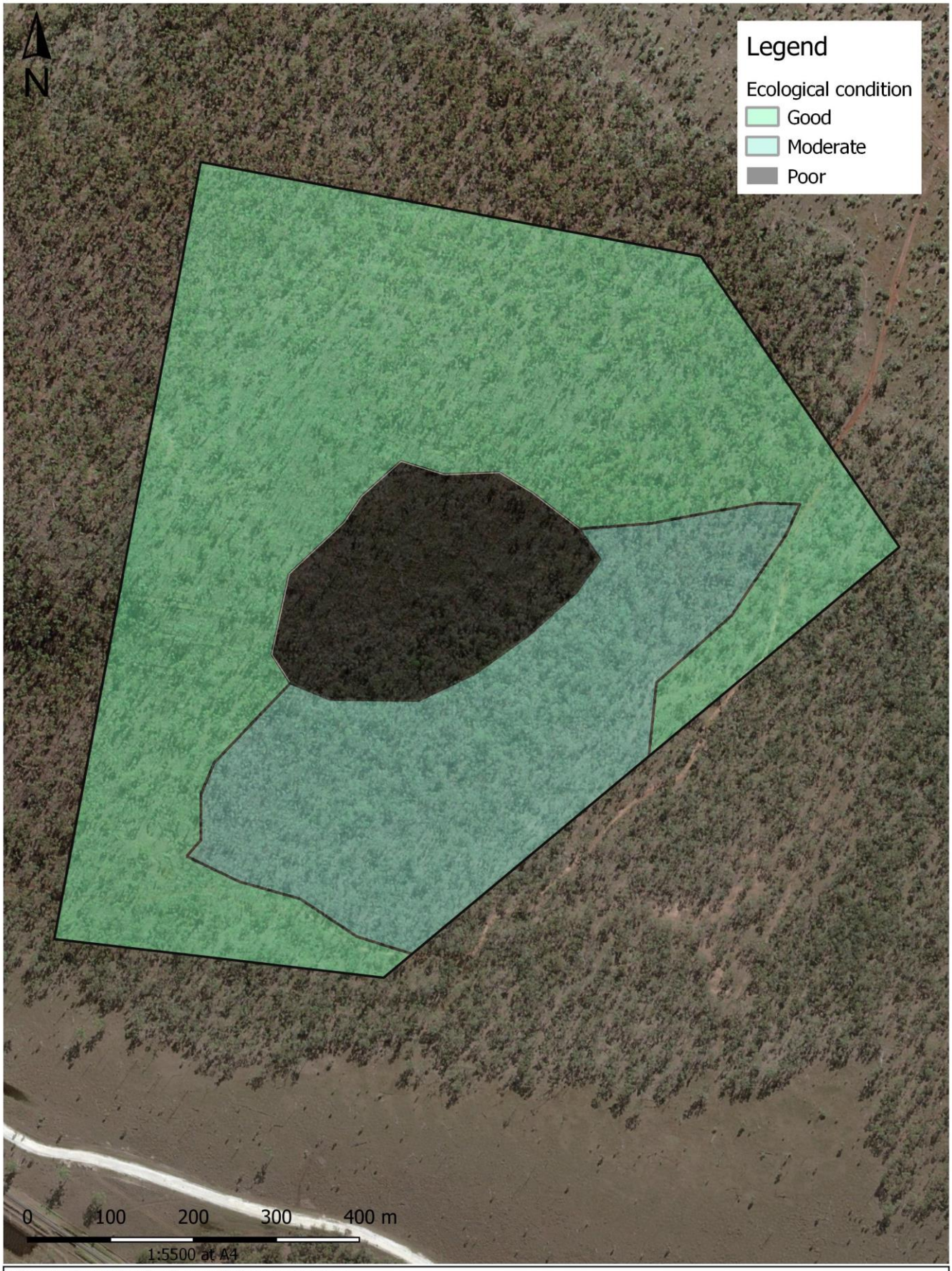


Figure 3 Ecological condition mapping

Imagery © ESRI Satellite (5/1/2022)
ML Permit Granted layer © Dept Resources, Qld (5/1/2022)
Ecological condition mapping by Astrebla
GIS by Simon Danielsen, Astrebla Ecological Services, 5 January, 2022

References

Atlas of Living Australia, 2022, website at http://www.ala.org.au, accessed 5 January, 2022.

AVH, 2022, *Australia's Virtual Herbarium,* Council of Heads of Australasian Herbaria. Available online at http://avh.chah.org.au/, accessed 5 January, 2022.

Bationoff, G.A. and Singh, S., 2001, Central Queensland serpentine landforms, plant ecology and endemism, *South African Journal of Science* 97: 496-500.

Bureau of Meteorology, 2022, *Previous droughts*, webpage available at http://www.bom.gov.au/climate/drought/knowledge-centre/previous-droughts.shtml, accessed 5 January, 2022.

Department of Environment and Science, 2020, *Land systems – land systems of the Capricornia coast – CCL3*. Queensland government, Brisbane. Digital mapping available from https://www.qld.gov.au/environment/land/soil/. Accessed 5 January, 2022.

Department of Environment and Science, 2021, *Guideline – Progressive rehabilitation and closure plans (PRC plans).* Version 2.00. Department of Environment and Science, Queensland government, Brisbane.

DSITI & DNRM, 2015, *Guidelines for agricultural land evaluation in Queensland.* 2nd edition. Queensland government, Brisbane.

Queensland Globe, 2022, Geology, 1:100k, Detailed surface geology. Online resource provided by Queensland government, available from https://qldglobe.information.qld.gov.au/.

Queensland government, 2022, QImagery, historical aerial imagery available online from https://qimagery.information.qld.gov.au/. Accessed 5 January, 2022.

Queensland Herbarium, 2021, *Regional Ecosystem Description Database (REDD).* Version 12 (March 2021). Department of Environment and Science, Brisbane.

Rice, K.J., Matzner, S.L., Byer, W. and Brown, J.R., 2004, Patterns of tree dieback in Queensland, Australia: the importance of drought stress and the role of resistance to cavitation, *Oecologia* 139 (2): 190-198.

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QNI Metals Pty Ltd
ABN 56 066 656 175

Level 17, 240 Queen Street
Brisbane QLD 4000
GPO BOX 1538, Brisbane, QLD, 4001

To the Landholder

22 of December 2021

Dear Landholder

Subject: BROLGA MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN: COMMUNITY CONSULTATION

QNI Resources Pty ltd and QNI Metals Pty Ltd are currently preparing a Progressive Rehabilitation and Closure Plan (PRC Plan) for the Brolga Project.

It is a requirement of the PRC Plan process that affected stakeholders, such as landholders and adjoining landholders, are consulted and the consultation should be used to inform the outcomes stated in the PRC Plan. The purpose of this letter is to give you an overview of the works that will be undertaken and offer you an opportunity to comment on those works.

Background

The Brolga Mine (Environmental Authority EMPL01624913) includes two mining leases, ML5866 (Brolga) and ML5864 (Canoona) (collectively known as 'the Brolga Project' or 'the Brolga Mine'), both of which are currently on 'Care and Maintenance' as a result of the suspension of nickel refining at the Yabulu Nickel Refinery in Townsville, Queensland. ML5866 'Brolga' was actively mined prior to the suspension of mining. ML5864 'Canoona' has been explored and drilled but no extraction of ore has occurred there.

Mining operations were relatively simple; nickel-oxide ore was mined, overburden was stockpiled, the ore was screened to remove large rocks, then hauled to the railways siding at Glen Geddes and transported via rail to the Yabulu Nickel Refinery.

Given that mining has been suspended indefinitely, Queensland Nickel are now preparing a PRC Plan in accordance with the new 'progressive rehabilitation and closure plan requirements for resource activities' that took effect in Queensland from 1 November 2019. These new requirements give the holders of existing Environmental Authorities three years to transition their existing rehabilitation and closure plans over to the new PRC Plan framework.

Your opportunity to comment

As an adjoining landholder, you are being given the opportunity to comment on the proposed rehabilitation and closure works for the Brolga Project, and provide any comments to be considered in the final PRC Plan.

If you wish to provide input or have any questions we encourage you to review the proposed works described in the appendix to this letter and get in touch with us via b.stacey@waratahcoal.com / 0400 665 930 before the 25 January 2022. Bill Stacey - Site Manager will also seek to contact you in person early next year to answer any questions and take on any feedback, if you wish to provide any. Your input will be incorporated in summary form in the plan however names or features that can identify you will be removed to protect respondents' anonymity.

We look forward to your response.

Yours sincerely,



Nui Harris
Manager

APPENDIX: SUMMARY OF PROPOSED WORKS

Rehabilitation practices

Rehabilitation practices to be undertaken are simple and comprise the following:

- The land form will be 'smoothed out' by integrating the waste rock dumps and back-filled pits with the surrounding landform
    - Waste dump batters will have a maximum slope of 1.0 vertical on 3.0 horizontal
    - Contour banks will be installed on waste dump batters when the slope length is greater than 30m
    - Residual void batters will be laid back to 25° maximum slope where possible, unless a geotechnical expert advises that the angle can be greater
- Following land re-contouring, disturbed areas will be covered with topsoil.
    - Shallow ripping will occur at a ripper spacing of approximately 1.2m
    - The rip lines are to be oriented across the slope to improve rainfall infiltration and reduce erosion
- All land re-contouring and earthworks will be carried out during the dry season, winter, from May to August
- All seeding will take place in spring, September and October
    - Seed mixes for the pasture will include the pasture grasses *Chloris gayana* (Rhodes grass), *Sorghum* sp., *Bothriochloa insculpta* (Bisset Bluegrass), *Heteropogan contortus* (black speargrass) and *Themeda australis* (Native Kangaroo grass) and the legume seka which will provide high quality protein forage during winter, when the grasses are stressed.
- Monitoring of landform stability and revegetation success will be ongoing, but concentrated in the summer months

Final Landform

The post-mining land use (PMLU) for the area is intended to be for low-intensity cattle grazing. Some of the existing mine infrastructure that will improve the ability of the property to be grazed will be retained: access tracks, versatile demountable structures, rain-water tanks and a septic system. Three final voids will become dams and increase water storage capacity; the terraced landforms that were once open cut pits will be graded to be more suitable for cattle grazing and pasture improvement; existing and new contour banks will direct water to dams.

As three final voids will be kept, the land will have a large water storage capacity, which will allow the soil to be used to its full potential and possibly provide water sources to mitigate drought on neighbouring farms through gravity feed.

Rehabilitation plans also include the planting of substantial areas of trees and shrubs. This provides shade for stock, windbreaks, habitat for a greater range of fauna, particularly avian fauna; an increase in organic material in soil, increased protection against soil erosion and ultimately a self-sustaining vegetation community.

Slopes and the edges of overburden dumps will be sown with *Acacia* species. *Acacia* is a fast-growing shrub which is an ideal pioneer species, and grows well even on rocky surfaces.

Rehabilitation Schedule

The rehabilitation and re-vegetation process will commence in 2024 in small, isolated areas where the seeds will be tested before being applied in the main areas of the Project. Rehabilitation will follow the schedule showed in the below table.

Rehabilitation Area	Activity Start	Activity Finish
Bath-house Area	30/04/24	1/09/26
Dam 4	30/04/24	1/09/28
Pit 2; Pit 3/Oversized Dump; Pit 4; Pit 5 North: Pit 5 South; Topsoil Dump 2 and Topsoil Dump 3	30/04/26	30/04/30
Top Pad	30/04/28	30/04/31
Nontronite Stockpile	30/04/28	30/04/33
Haul Road	30/04/30	1/09/32
Go Line Pad; Pit 1; Pit 8; ROM; Screening Stockpile; Pit 2 Extension; Waste Rock Dump; Front Pad; Topsoil Dumps 1, 4, 5, 6, 7	30/04/30	30/04/33

Final Site layout

The attached figures show the final layout for the Project and its cadastral boundaries.

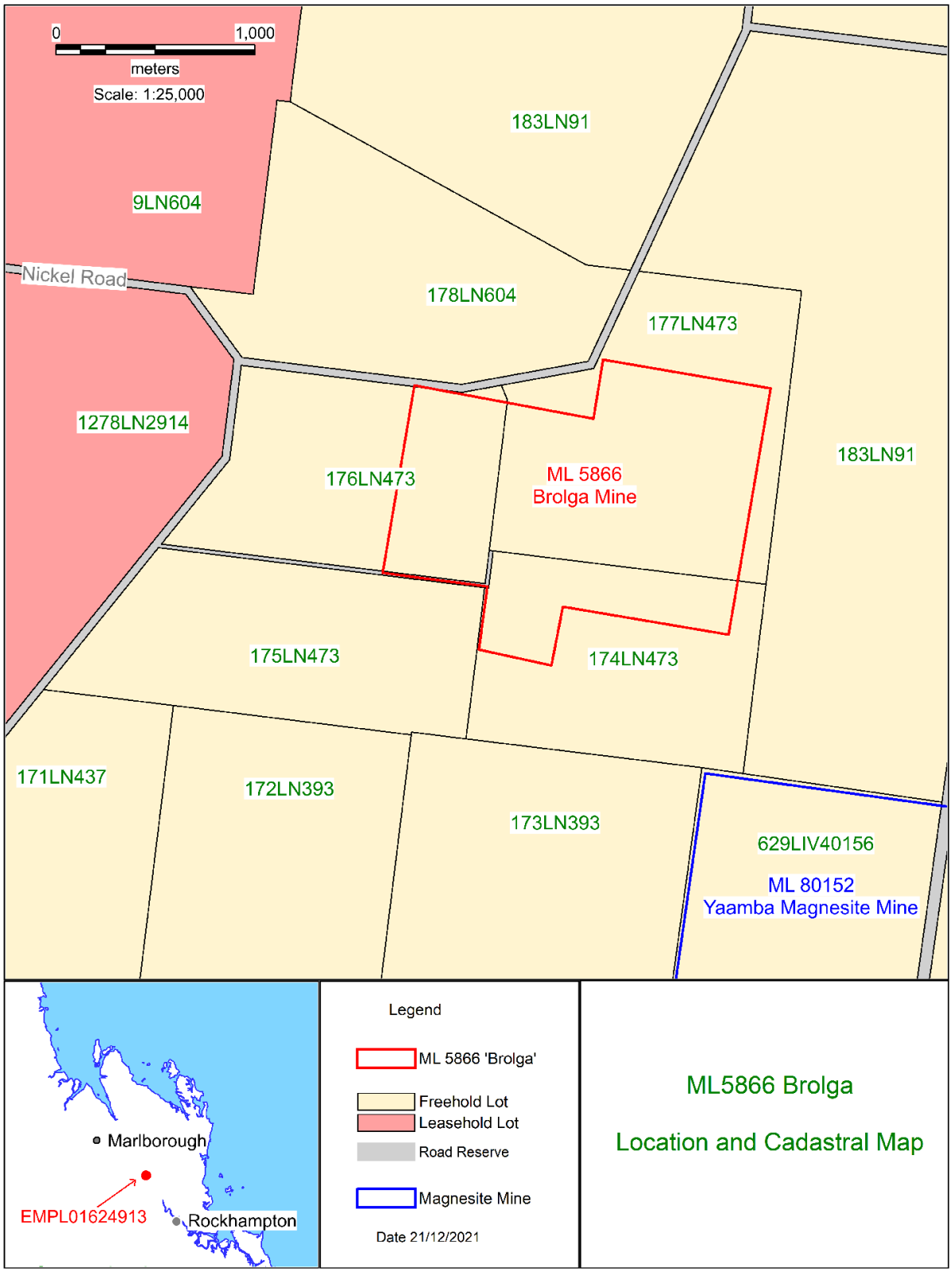


Figure 1 – ML 5866 – Brolga Location and cadastral map

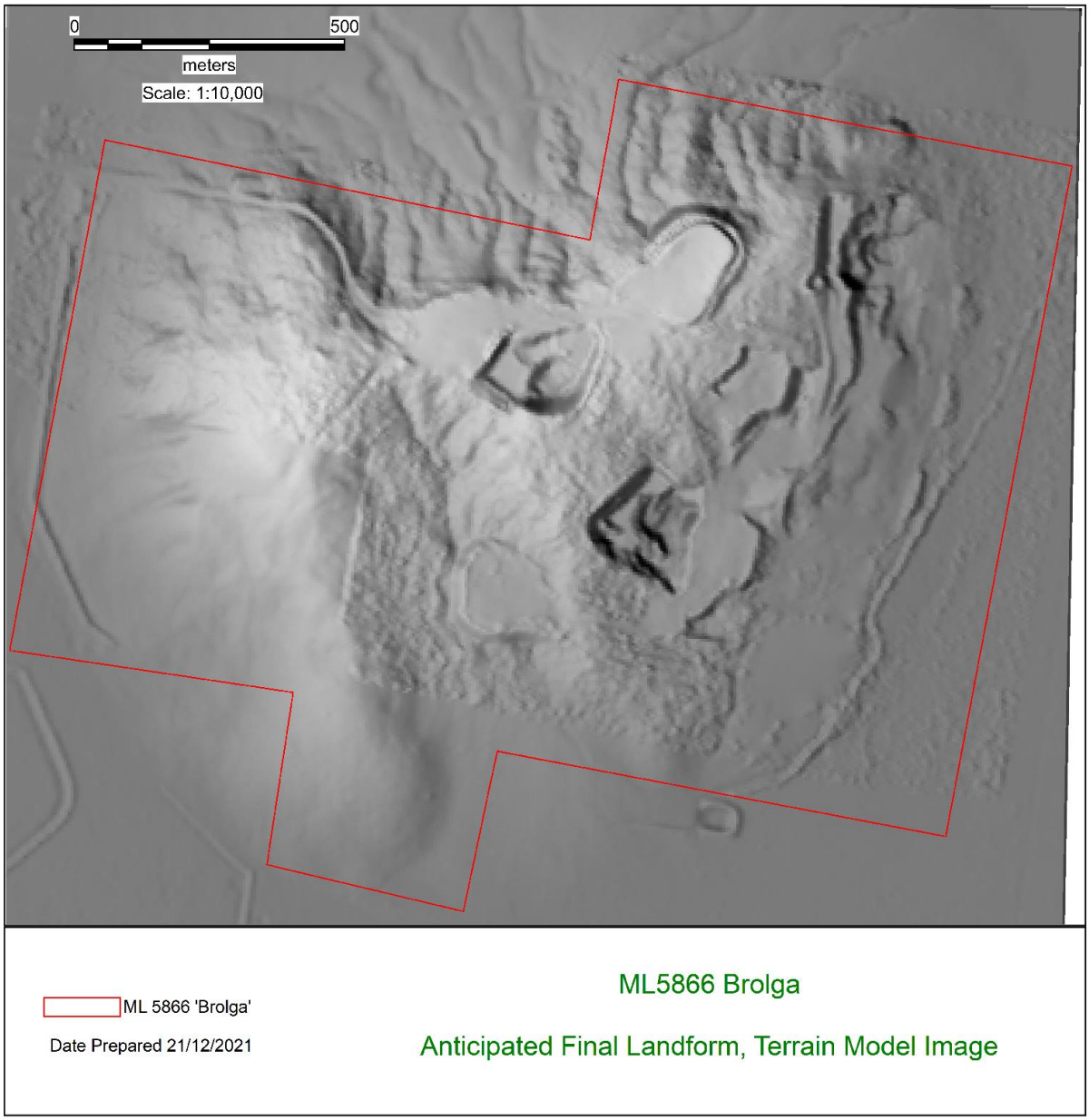


Figure 2 – ML 5866 – Brolga final landform

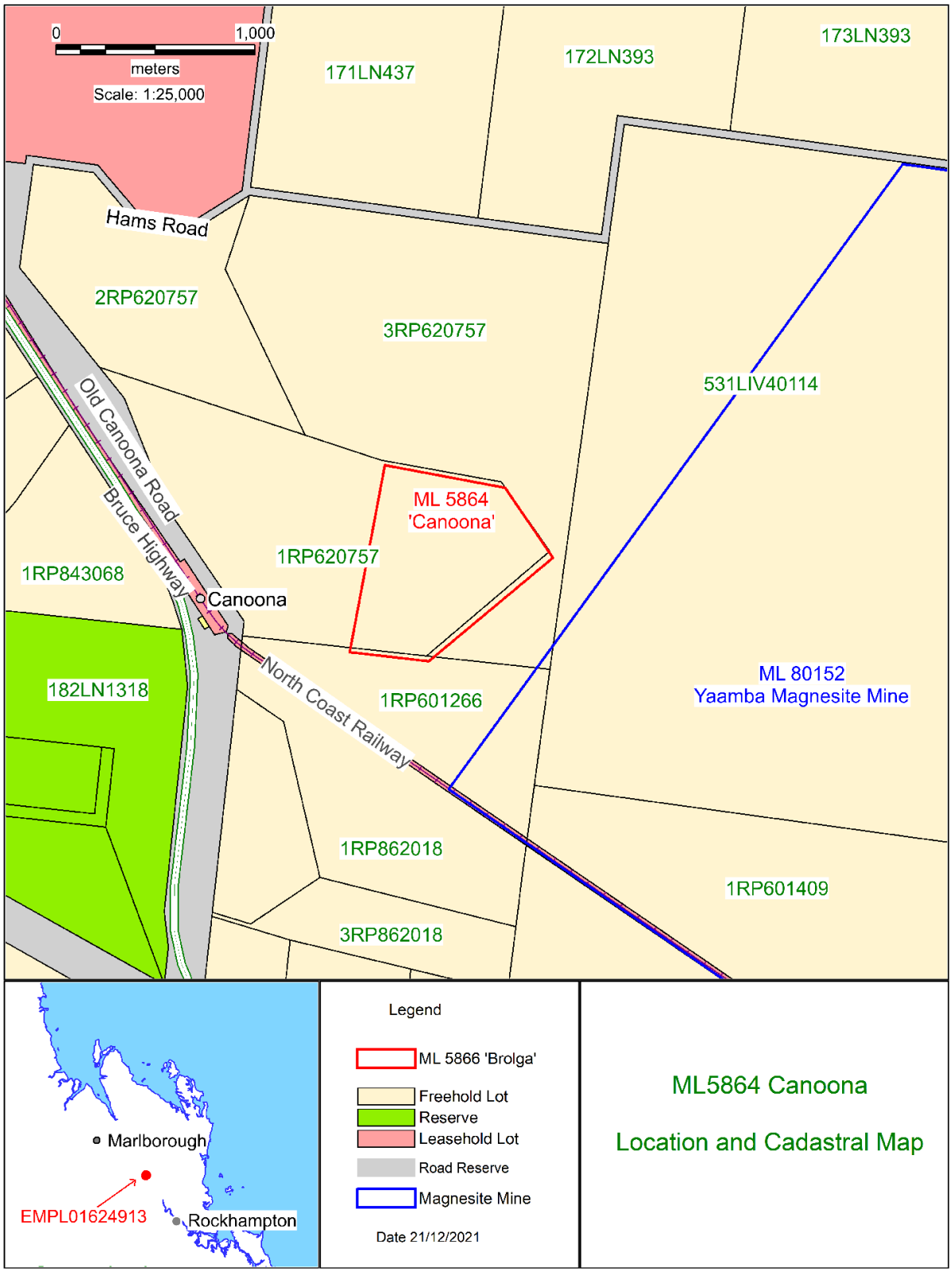


Figure 3 – ML 5864 – Canoona Location and cadastral map

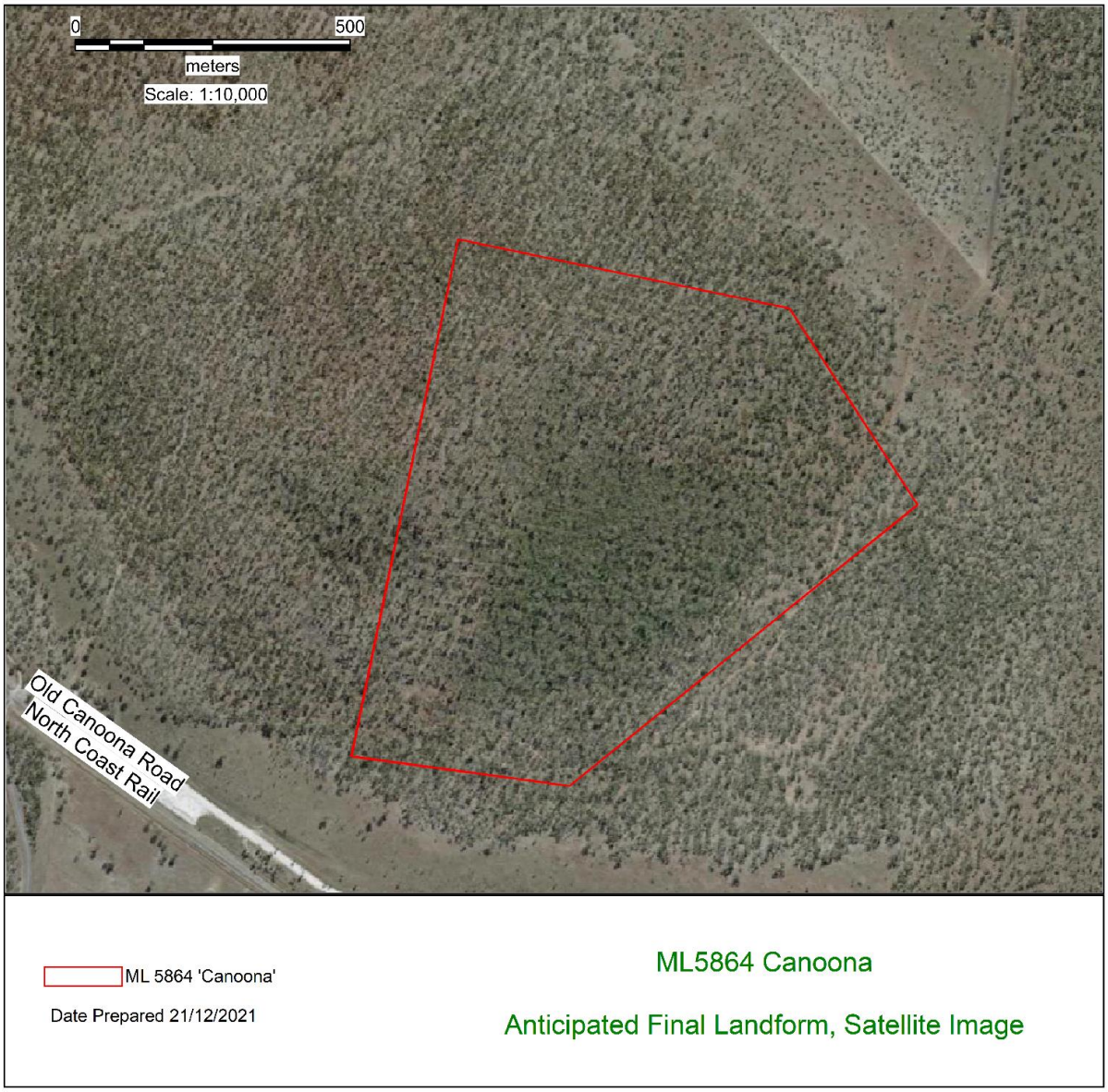


Figure 4 – ML 5864 – Canoona final land form

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Level 17, 240 Queen Street
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11 of January 2022

Livingstone Shire Council
Attention: Cale Dendle, Chief Executive Officer
Via email: enquiries@livingstone.qld.gov.au

Dear Mr Dendle

BROLGA MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN: COMMUNITY CONSULTATION

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It is a requirement of the PRC Plan process that affected stakeholders, such as landholders and adjoining landholders and councils, are consulted and the consultation should be used to inform the outcomes stated in the PRC Plan. The purpose of this letter is to give you an overview of the works that will be undertaken and offer you an opportunity to comment on those works.

Background

The Brolga Mine (Environmental Authority EMPL01624913) includes two mining leases, ML5866 (Brolga) and ML5864 (Canoona) (collectively known as 'the Brolga Project' or 'the Brolga Mine'), both of which are currently on 'Care and Maintenance' as a result of the suspension of nickel refining at the Yabulu Nickel Refinery in Townsville, Queensland. ML5866 'Brolga' was actively mined prior to the suspension of mining. ML5864 'Canoona' has been explored and drilled but no extraction of ore has occurred there.

Mining operations were relatively simple; nickel-oxide ore was mined, overburden was stockpiled, the ore was screened to remove large rocks, then hauled to the railways siding at Glen Geddes and transported via rail to the Yabulu Nickel Refinery.

Given that mining has been suspended indefinitely, Queensland Nickel are now preparing a PRC Plan in accordance with the new 'progressive rehabilitation and closure plan requirements for resource activities' that took effect in Queensland from 1 November 2019. These new requirements give the holders of existing Environmental Authorities three years to transition their existing rehabilitation and closure plans over to the new PRC Plan framework.

Your opportunity to comment

As the relevant local council, Livingstone Shire Council is being given the opportunity to comment on the proposed rehabilitation and closure works for the Brolga Project, and to have any comments considered in the final PRC Plan.

If council wishes to provide input or have any questions we encourage you to review the proposed works described in appendix to this letter and get in touch with us via email to our site manager Bill Stacey (b.stacey@waratahcoal.com) before the 25 January 2022.

We look forward to your response.

Yours sincerely,

Nui Harris
Manager

APPENDIX: SUMMARY OF PROPOSED WORKS

Rehabilitation practices

Rehabilitation practices to be undertaken are simple and comprise the following:

- The land form will be 'smoothed out' by integrating the waste rock dumps and back-filled pits with the surrounding landform
    - Waste dump batters will have a maximum slope of 1.0 vertical on 3.0 horizontal
    - Contour banks will be installed on waste dump batters when the slope length is greater than 30m
    - Residual void batters will be laid back to 25° maximum slope where possible, unless a geotechnical expert advises that the angle can be greater
- Following land re-contouring, disturbed areas will be covered with topsoil.
    - Shallow ripping will occur at a ripper spacing of approximately 1.2m
    - The rip lines are to be oriented across the slope to improve rainfall infiltration and reduce erosion
- All land re-contouring and earthworks will be carried out during the dry season, winter, from May to August
- All seeding will take place in spring, September and October
    - Seed mixes for the pasture will include the pasture grasses *Chloris gayana* (Rhodes grass), *Sorghum* sp., *Bothriochloa insculpta* (Bisset Bluegrass), *Heteropogan contortus* (black speargrass) and *Themeda australis* (Native Kangaroo grass) and the legume seka which will provide high quality protein forage during winter, when the grasses are stressed.
- Monitoring of landform stability and revegetation success will be ongoing, but concentrated in the summer months

Final Landform

The post-mining land use (PMLU) for the area is intended to be for low-intensity cattle grazing. Some of the existing mine infrastructure that will improve the ability of the property to be grazed will be retained: access tracks, versatile demountable structures, rain-water tanks and a septic system. Three final voids will become dams and increase water storage capacity; the terraced landforms that were once open cut pits will be graded to be more suitable for cattle grazing and pasture improvement; existing and new contour banks will direct water to dams.

As three final voids will be kept, the land will have a large water storage capacity, which will allow the soil to be used to its full potential and possibly provide water sources to mitigate drought on neighbouring farms through gravity feed.

Rehabilitation plans also include the planting of substantial areas of trees and shrubs. This provides shade for stock, windbreaks, habitat for a greater range of fauna, particularly avian fauna; an increase in organic material in soil, increased protection against soil erosion and ultimately a self-sustaining vegetation community.

Slopes and the edges of overburden dumps will be sown with *Acacia* species. *Acacia* is a fast-growing shrub which is an ideal pioneer species, and grows well even on rocky surfaces.

Rehabilitation Schedule

The rehabilitation and re-vegetation process will commence in 2024 in small, isolated areas where the seeds will be tested before being applied in the main areas of the Project. Rehabilitation will follow the schedule showed in the below table.

Rehabilitation Area	Activity Start	Activity Finish
Bath-house Area	30/04/24	1/09/26
Dam 4	30/04/24	1/09/28
Pit 2; Pit 3/Oversized Dump; Pit 4; Pit 5 North: Pit 5 South; Topsoil Dump 2 and Topsoil Dump 3	30/04/26	30/04/30
Top Pad	30/04/28	30/04/31
Nontronite Stockpile	30/04/28	30/04/33
Haul Road	30/04/30	1/09/32
Go Line Pad; Pit 1; Pit 8; ROM; Screening Stockpile; Pit 2 Extension; Waste Rock Dump; Front Pad; Topsoil Dumps 1, 4, 5, 6, 7	30/04/30	30/04/33

Final Site layout

The attached figures show the final layout for the Project and its cadastral boundaries.

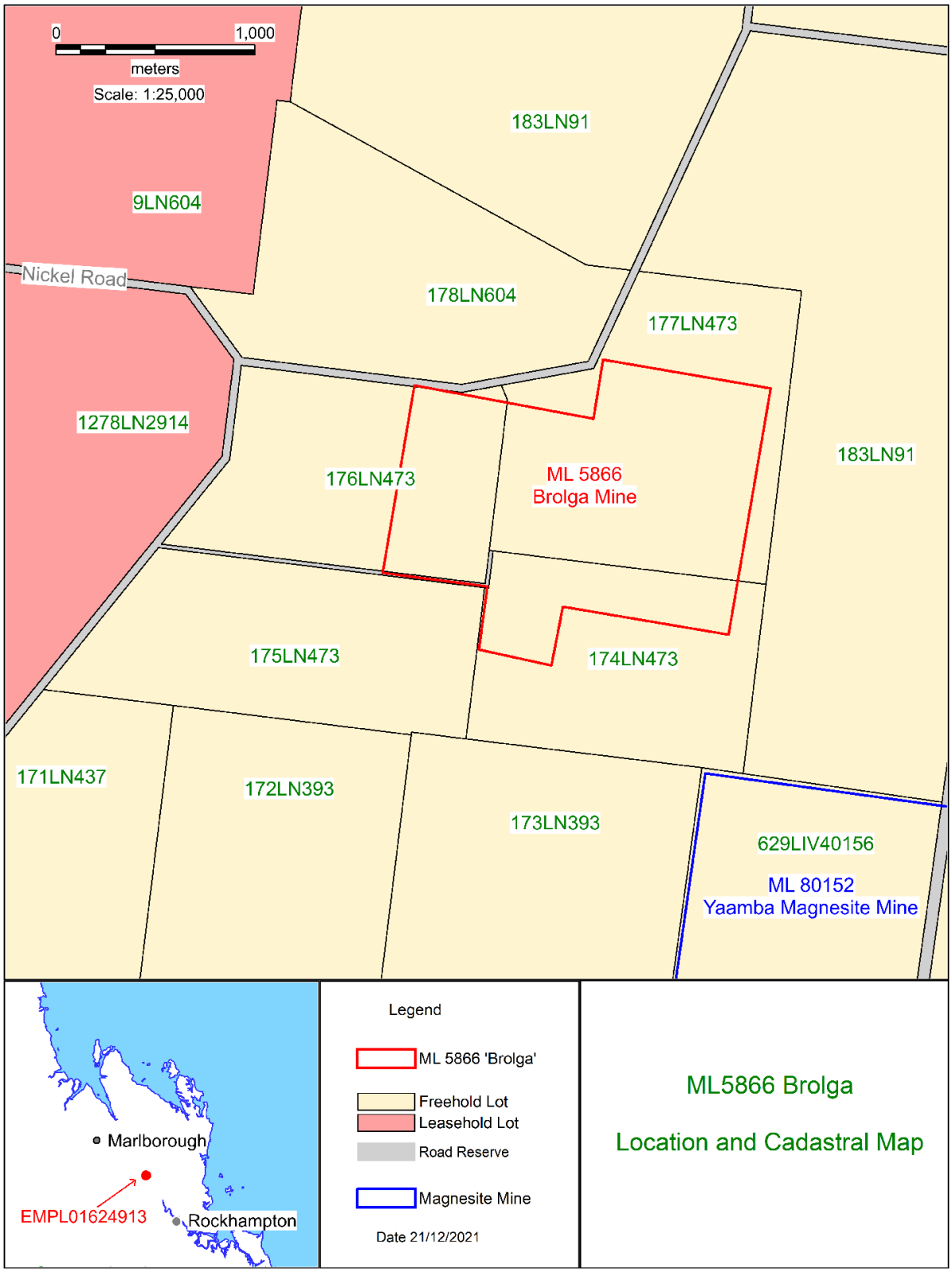


Figure 1 – ML 5866 – Brolga Location and cadastral map

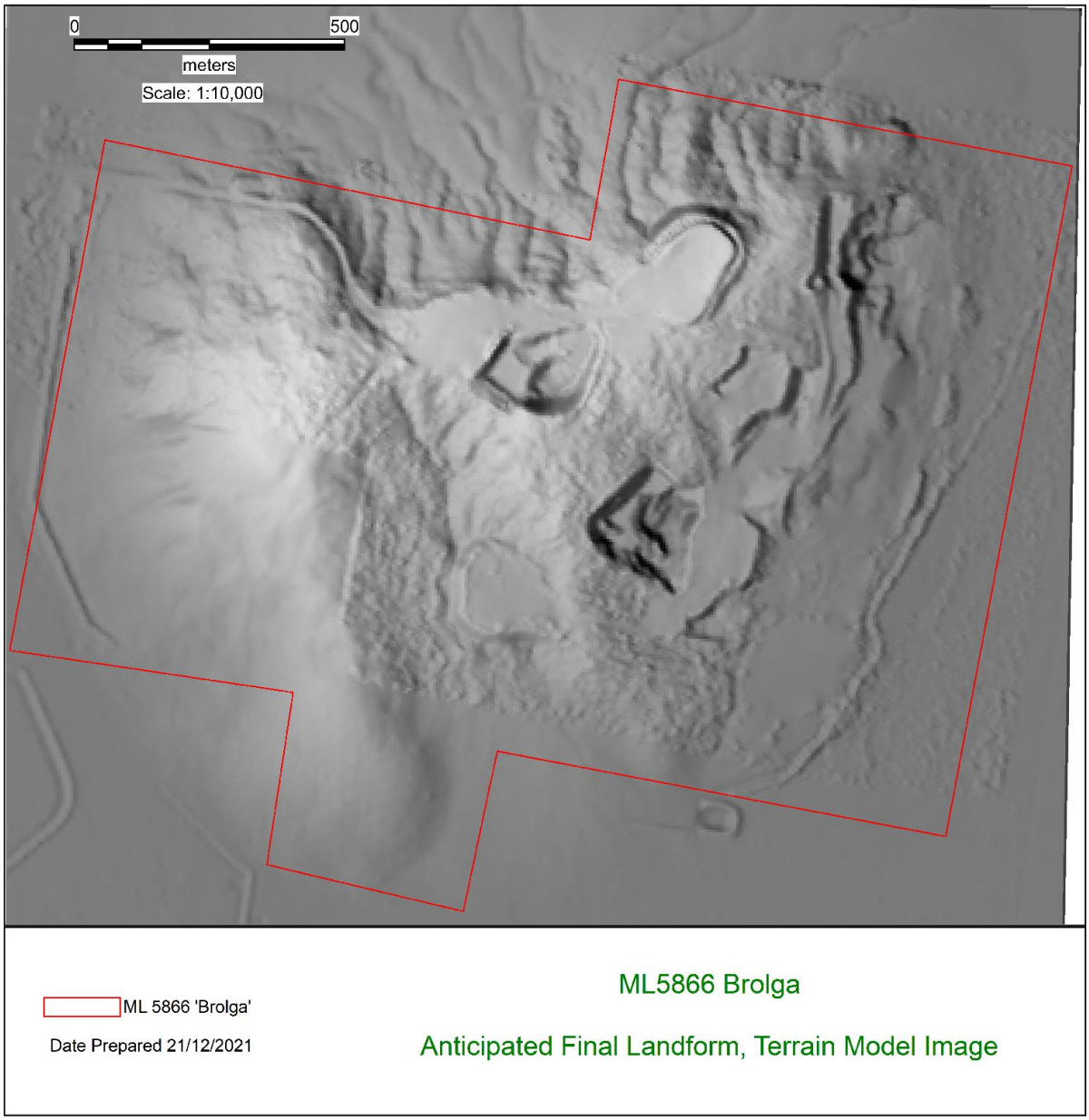


Figure 2 – ML 5866 – Brolga final landform

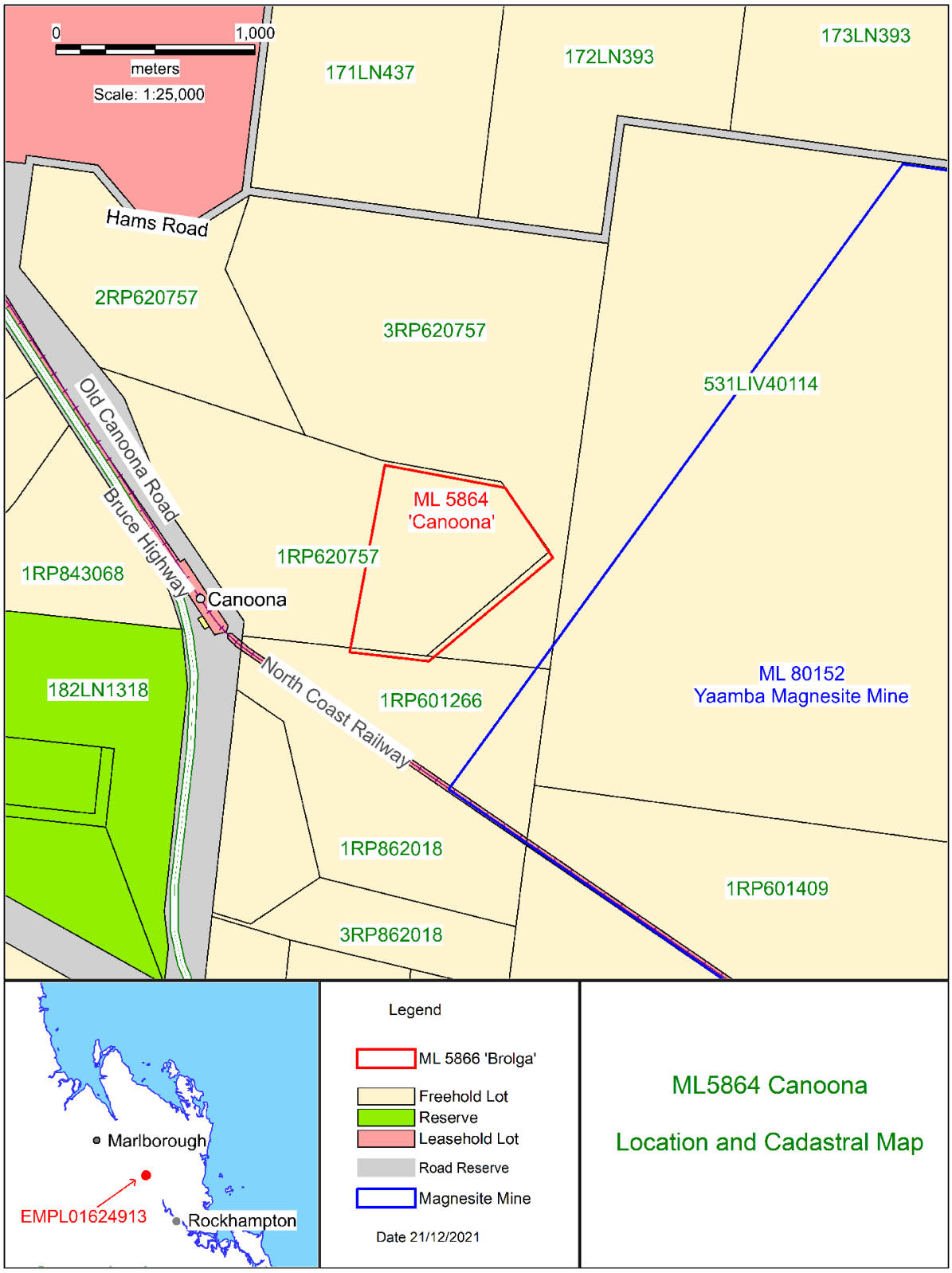


Figure 3 – ML 5864 – Canoona Location and cadastral map

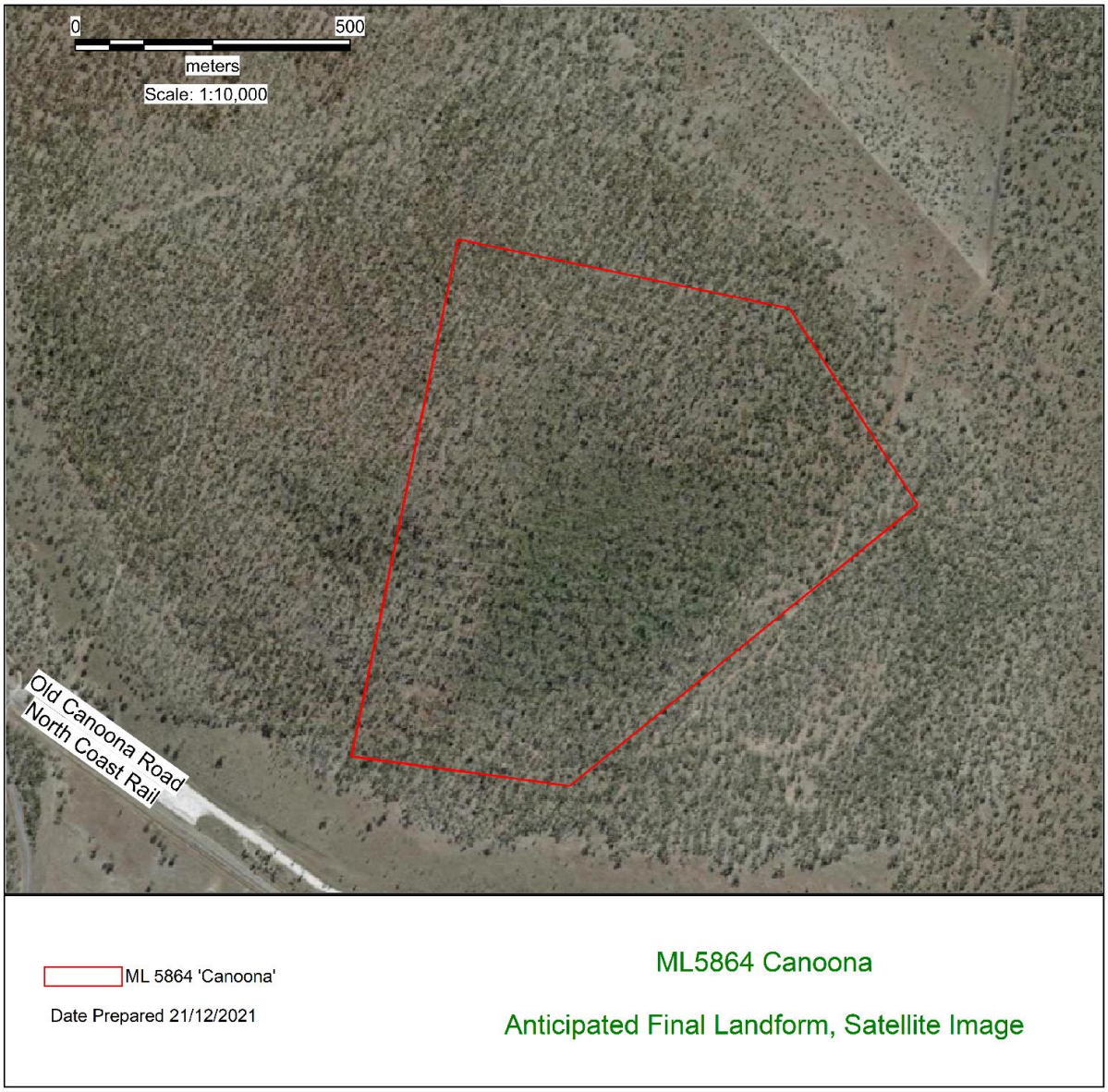


Figure 4 – ML 5864 – Canoona final land form

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4 November 2021

LANDHOLDER STATEMENT

QUEENSLAND DEPARTMENT OF ENVIRONMENT AND SCIENCE

PROGRESSIVE CLOSURE AND REHABILITATION PLAN (PRCP)

ML5866 - INFRASTRUCTURE TO BE RETAINED

With reference to the PRCP process for the Brolga Mine on ML5866, QNI Resources Pty Ltd accepts the retention of the following infrastructure:

- the network of haul roads
- the network of access tracks
- the bath-house infrastructure
- the culvert (yet to be installed) which will drain water from the Go Line to Pit 1
- Dam 4
- Pit 1, Pit 2 Extension and Pit 8, as final voids (dams)

If you require anything further, please do not hesitate to contact me.

Yours sincerely,

Ian M. Ferguson

Director
QNI Resources Pty Ltd

GLADSTONE NICKEL PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

Residue Geochemical Characterisation

B



URS

Gladstone Pacific Nickel LTD

Appendix B Residue and Ore Geochemical Characterisation

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Appendix B Residue and Ore Geochemical Characterisation

B.1 Background

B.1.1 Residue Treatment

All material to be placed within the RSF will undergo initial treatment in the final neutralisation circuit. In this process, the pH is raised to 7.0[1], allowing most of the heavy metals to be precipitated. Limestone will be added as a reactant to the first stage, raising the pH of the slurry to approximately 5.5[1]. Lime slurry will be added as reactant to the second stage, raising the pH of the final slurry to 7.0. The neutralised slurry containing residues from ore and other process inputs, in addition to gypsum generated during neutralisation, will be pumped to the RSF thickeners located at the RSF.

B.2 Testing

A bulk residue sample was provided by GPN and geochemically tested in September 2007 by Australian Laboratory Services Pty Ltd (ALS). The residue sample analysed had been pre-neutralised to a pH of 7.0, in order to replicate the pH of residue material discharged to the RSF. The residue sample was derived from a pilot process utilising combined ore from Marlborough (Qld) and New Caledonia, and is representative of the final process.

In addition, an ore sample from Marlborough and an ore sample from New Caledonia (New Cal) also underwent geochemical testing by ALS in November 2007

B.2.1 Acid Generation and Prediction

Acid generation from the process residue is caused by the exposure of sulphide minerals, most commonly pyrite (FeS_2), to atmospheric oxygen and water. Sulphur assay results are used to calculate the maximum potential acid (MPA) that could be generated by the residue, either directly from pyritic sulphur content, or by assuming that all sulphur not present as sulphate occurs as pyrite. Pyrite oxidises to generate acid according to the following overall reaction:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \text{ ---> } Fe(OH)_3 + 2\ H_2SO_4$$

The chemical components of the acid generation process consist of the above sulphide oxidation reaction and acid neutralisation, which is mainly provided by inherent carbonates and to a lesser extent silicate materials. The amount and rate of acid generation is determined by the interaction and overall balance of the acid generation and neutralisation components.

The net acid producing potential (NAPP) is used as an indicator of materials that may be of concern with respect to acid generation and represents the balance between the MPA and the acid neutralising capacity (ANC) of the material, which is determined experimentally. By convention, the NAPP result is expressed in units of kg H_2SO_4/t sample. If the ANC exceeds the MPA, then the NAPP of the material is negative. Conversely, if the MPA exceeds the ANC, the NAPP of the material is positive.

The net acid generation (NAG) test involves direct hydrogen peroxide oxidation of a sample of a material to oxidise reactive sulphide, then measurement of pH and titration of any net acidity produced by the acid generation and neutralisation reactions occurring in the sample. A final NAGpH < 4 can confirm that the sample is Potentially Acid Forming (PAF), and a final NAGpH ≥ 4 can confirm that the sample is Non-Acid Forming (NAF).

[1] Lisa Park (GPN) personal communication, July 2006.

Appendix B Residue and Ore Geochemical Characterisation

B.2.2 Assessment of Element Enrichment and Solubility

Multi-element scans were carried out to identify any elements (particularly metals) that are present in the residue and ore at concentrations that may be of environmental concern with respect to surface water quality and revegetation. The assay result for each element is compared to relevant environmental investigation levels to determine any concerns related to the residue storage facility (RSF) operation and final rehabilitation. The assay result for ore is also compared to relevant environmental investigation levels to determine any concerns related to stockpiling of this material. Elements identified as enriched may not necessarily be a concern for revegetation, drainage water quality, or public health but their significance should be evaluated. Similarly, because an element is not enriched does not mean it will never be a concern, because under some conditions (*e.g.* low pH) the geochemical behaviour of common environmentally important elements such as Al, Cu, Cd, Fe and Zn increases.

Water extracts are used to determine the immediate solubility and potential mobility of elements under existing pH conditions. Soluble element concentrations have been compared with those recommended in relevant surface water and groundwater guidelines in order to determine their environmental significance.

The general water extract method involves mixing a 10g solid sample with 50 g of deionised water in a 100 mL bottle, tumbling end-over-end for 1 hour, then filtering the liquid to 0.45µm and analysing the filtrate. Soluble trace metals were analysed by ICP-AES. Soluble Hg was analysed by FIMS and soluble Cr VI was analysed by Discrete Analyser. Cr III is the calculated difference between Total Cr and Cr VI.

Total concentration in residue solids

There are no specific guidelines and/or regulatory criteria specifically related to total metal concentrations in process residue materials, apart from those associated with Queensland EPA acceptance criteria for hazardous dams (EPA, 2006). In the absence of directly relevant criteria, and to provide relevant context, the total concentration of each element reported in residue solids has been compared to QLD EPA (1998) environmental investigation levels (for soils) and NEPC (1999) health-based investigation levels (HILs) for parks and recreation (open spaces). The EPA (1998) guidelines are primarily aimed at soil investigations and provide a suitable guideline for an industrial facility, such as the RSF. The NEPC (1999) guidelines for 'open spaces' are less stringent than the EPA guidelines, however their applicability stems from the potential final land use of the RSF following closure (*e.g.* grass cover and low intensity livestock grazing). Geochemical results are also compared to EPA acceptance criteria for hazardous dams to provide additional context.

The total metals concentration for individual elements in residue materials can be relevant for revegetation activities and/or where the potential exists for human contact (*e.g.* if the material was to be used off-site). Of more relevance is the potential for residue material to leach soluble metals or metalloids at concentrations that may impact the environment or human health. The leaching tests go some way to addressing this issue.

Total concentration in ore solids

Similar to residue solids, there are no specific guidelines and/or regulatory criteria specifically related to total metal concentrations in ore materials. In the absence of directly relevant criteria, and to provide relevant context, the total concentration of each element reported in ore solids has been compared to QLD EPA (1998) environmental investigation levels (for soils) and NEPC (1999) health-based investigation levels (HILs) for parks and recreation (open spaces). Geochemical results are also compared to EPA acceptance criteria for hazardous dams to provide additional context.

The total metals concentration for individual elements in ore materials can be relevant for general stockpiling activities (or should some of this material report as waste) and/or where the potential exists for human contact (*e.g.* if the material was to be used off-site). Of more relevance is the potential for ore material to leach soluble metals or metalloids at concentrations that may impact the environment or human health. The water-extract tests go some way to addressing this issue, by providing an indication of the initial solubility of metals and metalloids.

Appendix B Residue and Ore Geochemical Characterisation

Soluble concentration in residue liquor

The key regulatory tool for determining the water quality hazard criteria for dams (including tailing storage facilities) is the EPA acceptance criteria for hazardous dams (EPA, 2006). In addition to the solid residue (as stated above), the acceptance criterion also applies to the liquid contents in a dam generally available to the environment (for example, water available to birds and animals). As such, the concentration of elements and compounds in the residue liquor is compared to the acceptance criteria for determining dams containing hazardous waste (EPA, 2006). In addition, the concentration of elements and compounds in the residue liquor is also compared to ANZECC (2000) livestock drinking water guidelines.

Soluble concentration in residue leachate

Leaching tests are used to quantify solubility and potential mobility of elements and compounds under existing pH conditions. There are several leaching tests commonly used, depending on the waste type being tested and the likely disposal method and environment of disposal, *e.g.* municipal landfill waste, monofill industrial waste, *etc*. The leach test employed for the GNP process residue is the Australian Standard (AS4439.3-1997), "*Wastes, sediments and contaminated soils. Part 3: Preparation of leachates – Bottle leaching procedure*" (Standards Australia, 1997a). The water leachate used was de-ionised water. This leach method (and the selection of de-ionised water as the leaching fluid) is applicable for use with industrial solid waste proposed for monofil disposal. The general method for this test procedure is to combine a portion of process residue solid with de-ionised water in a 1:20 mass ratio (solid:water). The solution, within an enclosed 2 litre glass bottle, is mechanically tumbled end-over-end for 18 hours at room temperature. The fluid is then pressure filtered, and the filtrate analysed.

There are no specific Queensland guidelines and regulatory criteria specifically related to seepage from residue facilities, apart from those associated with EPA acceptance criteria for hazardous dams (EPA, 2006), however the applicability of various guidelines to seepage chemistry is related to the surrounding environment of the residue facility. The beneficial use of groundwater in the vicinity of the RSF is stock and domestic use. Therefore, to provide relevant context, the soluble concentrations of elements and compounds in the leachate have been compared to four key water quality references:

- NHMRC/ARMCANZ (1996) Australian Drinking Water Guidelines;
- ANZECC (2000) Livestock Drinking Water Guidelines;
- ANZECC (2000) Water Quality for Irrigation and General Use (Short- and Long-term trigger values); and
- Baseline groundwater quality from beneath the proposed RSF site and surrounding area.

Soluble concentration in water extracts from ore materials

Water extract tests are used to determine the immediate initial solubility of elements under existing pH conditions. Soluble element concentrations are compared with those listed in relevant marine water guideline criteria in order to determine their environmental significance.

There are no guidelines and regulatory criteria specifically related to seepage from ore materials since guidelines (and regulatory criteria) will depend upon the end-use and receiving environment of the seepage. Ore will only be handled, used or stored at the port facility and nearby processing plant, therefore, to provide relevant context, URS has compared the soluble concentration of each element extracted from ore materials to ANZECC (2000) Marine water quality guidelines.

B.2.3 Sodicity and Dispersion

The relative proportion of the various exchangeable cations (*e.g.* calcium, magnesium, potassium and sodium) in a material can have a significant effect on the physical properties of that material. Potential

effects can be indicated by assessment of material sodicity, as measured by the Exchangeable Sodium Percentage (ESP[2]). ESP is calculated from the effective cation exchange capacity (eCEC) of the material. When the ESP is high or the calcium/magnesium ratio is low, the material is more likely to disperse upon wetting. As the percentage of sodium in the material increases, the tendency for dispersion increases, resulting in crusting, reduced infiltration and consequent reduced plant growth, high runoff and erosion. In general terms, ESP values of less than 6 indicate that a material has a low risk of dispersion and ESP values greater than 12 indicate that a material has a higher risk of dispersion. The effect of ESP on dispersion is also influenced by other soil properties such as organic matter content, clay mineralogy, cation composition, and particularly electrolyte concentration of the soil and of any applied irrigation water (Isbell, 2002). Materials with a high risk of dispersion generally require management strategies to be put in place to ensure that slopes are stabilised against erosion.

The structural stability of a soil aggregate upon wetting can have significant implications on the infiltration rate, hydraulic conductivity and soil strength of that particular material. Potential effects can be indicated by assessment of aggregate cohesion, as measured by the Emerson Class Number Test (Standards Australia, 1997b). Soils are generally divided into six classes on the basis of their coherence in water. The lower the Emerson Class Number, the greater the likelihood that the soil will readily disperse in water, resulting in crusting, reduced infiltration and consequent reduced plant growth, high runoff and erosion. The higher the Emerson Class number, the greater the likelihood that the soil will not disperse in water. Materials with a high risk of dispersion (*e.g.* ECN 1 or 2) generally require management strategies to be put in place to ensure that slopes are stabilised against erosion.

B.2.4 Organic Carbon and Nutrients

Total organic carbon in soil comprises a variety of carbonaceous materials including humus, soil micro-organisms, plant and animal residues, coal, charcoal, coke and graphite, and carbonate minerals such as calcite and dolomite. Australian soils generally contain less than 5% organic carbon but higher levels are common in some surface soils. The total organic carbon content of a soil (taken in context and in conjunction with a variety of other parameters) can provide an indication of its potential suitability as a growth medium.

Soil nutrients include nitrogen and phosphorous and deficiencies in these elements can also present a potential plant-growth issue, which may have implications for reduced vegetative cover, reduced plant species variability and erosion. Nitrogen and phosphorous deficiencies can generally be overcome in soils by fertiliser addition; however other soil characteristics (*e.g.* pH, salinity, sodicity, and metals) can impact soil fertility.

B.3 Geochemical Characteristics of Solid Residue

B.3.1 Acid Forming Potential

The results of the geochemical (acid-base) testing of the residue sample are provided in Table 1.3.1 and summarised below.

- The residue sample has a $pH_{(1:5)}$ of 7.4 and has a net alkalinity equivalent to 0.0021 kg H_2SO_4/t.
- The current Electrical Conductivity$_{(1:5)}$ (EC) of the sample is high (8,630 µS/cm) and the sample is classified as saline.
- Total sulphur concentration is relatively high (7.66%) and sulphate sulphur concentration is similarly high (7.34%) indicating that only a small amount of sulphur is present in the sulphidic (unoxidised)

[2] ESP can be defined as the proportion of sodium adsorbed onto a material surface as a proportion of the total cation exchange capacity.

form. The relatively high sulphate sulphur concentration is likely due to the presence of gypsum in the final neutralised sample.

- The relatively low concentration of oxidisable sulphur (0.32%) within the residue material generates a Maximum Potential Acidity (MPA) of 9.7 kg H_2SO_4/t. Taking into account the high Acid Neutralising Capacity (ANC) of 54.4 kg H2SO4/t indicates that the material is unlikely to generate any significant amount of acidity.
- As the ANC significantly exceeds the MPA, the Net Acid Producing Potential (NAPP) for the sample is strongly negative (-44.7 kg H_2SO_4/t).
- The Net Acid Generation (NAG) capacity of the process residue sample is <0.1 kg H2SO4/t, with a NAGpH value of 8.1.

On the basis of these results the process residue material can be classified as Non-Acid Forming (NAF).

B.3.2 Multi-element Composition

Total metal and metalloid concentrations are generally within the applied EPA (1998) environmental investigation levels (EILs), NEPC (1999) health-based investigation levels (HILs) and EPA hazardous dam acceptance criteria. Exceptions are total nickel, manganese and sulphate concentrations.

- The total nickel concentration (182 mg/kg) is elevated compared to the EPA (1998) EILs (60 mg/L).
- The total manganese concentration (4,510 mg/kg) is elevated compared to the EPA (1998) EILs (500 mg/kg) and NEPC (1999) HILs (3,000 mg/kg). No EPA hazardous dam acceptance criteria exist for total manganese concentration.
- The total chromium concentration (3,100 mg/kg) is highly elevated compared to the EPA (1998) EILs (50 mg/kg) and NEPC (1999) HILs (200 mg/kg). No EPA hazardous dam acceptance criteria exist for total chromium concentration.

The total sulphate concentration (220,000 mg.kg) is highly elevated compared to the EPA (1998) EILs (2,000 mg/kg), most likely as a result of the gypsum present in the process residue. No NEPC (1999) HILs or EPA hazardous dam acceptance criteria exist for total sulphate concentration.

B.3.3 Cation Exchange Capacity, Sodicity, Organic Carbon and Nutrients

The results of the cation exchange capacity, sodicity, organic carbon and nutrient testing of the process residue sample are provided in Table 1.3.2 and summarised below.

- The effective CEC (eCEC) of the residue sample is moderate (52 meq/100g).
- The Exchangeable Sodium Percentage (ESP) of the residue sample is 7.3 %. This result indicates that the sodicity of the residue sample is marginally elevated (*i.e.* > 6 %).
- The Emerson Class Number of the sample is 6 (in distilled water). This indicates that the material is unlikely to disperse in water.
- The Total Organic Carbon (TOC) concentration in the process residue sample is low (0.08%).
- The total nitrogen concentration in the residue sample is low (30 mg/kg).
- The bicarbonate extractable phosphorus (extractable P) concentration in residue material is low (<2 mg/kg).

Appendix B Residue and Ore Geochemical Characterisation

B.4 Geochemical Characteristics of Solid Ore

B.4.1 Acid Forming Potential

The results of the geochemical (acid-base) testing of the ore samples are provided in Table 1.3.1 and summarised below.

- The Marlborough ore sample has a $pH_{(1:5)}$ of 7.6 and the New Cal ore sample has a $pH_{(1:5)}$ of 5.3. Both samples have no detectable alkalinity.
- The current Electrical Conductivity$_{(1:5)}$ (EC) of both samples is low (650 and 76 µS/cm for Marlborough and New Cal, respectively) and the samples are classified as non-saline.
- Total sulphur concentration is generally low (0.01 and 0.28% for Marlborough and New Cal, respectively), with all of the sulphur present as sulphate, indicating that almost no sulphur is present in the sulphidic (unoxidised) form.
- The low concentration of oxidisable sulphur (<0.01% for both samples) indicates that both ore samples are barren and can only generate an insignificant Maximum Potential Acidity (MPA) of approximately 0.3 kg H_2SO_4/t. The Marlborough ore sample has a moderate Acid Neutralising Capacity (ANC) of 25 kg H_2SO_4/t, whereas the New Cal ore sample has a low ANC of less than 1 kg H_2SO_4/t.
- As the ANC exceeds the MPA, the Net Acid Producing Potential (NAPP) for both samples is negative, more-so for the Marlborough ore due to a greater ANC.
- The Net Acid Generation (NAG) capacity of the ore samples is <0.1 kg H_2SO_4/t, with a NAGpH value of 8.3 for the Marlborough ore and 5.9 for the New Cal ore.

On the basis of the lack of oxidisable sulphur, negative NAPP and NAGpH values above 4.5, both ore samples can be classified as Non-Acid Forming (NAF).

B.4.2 Multi-element Composition

The results of the total metal concentrations in ore samples are provided in Table 1.3.2. Total metal and metalloid concentrations are elevated with respect to the applied EPA (1998) environmental investigation levels (EILs), NEPC (1999) health-based investigation levels (HILs) and EPA hazardous dam acceptance criteria for total chromium, cobalt, manganese, nickel and sulphate concentrations. This is to be expected, given that this is ore material and is supposed to be mineralised, particularly with respect to nickel.

B.5 Geochemical Characteristics of Residue Liquor

B.5.1 General Chemical Characteristics

Process residue liquor is pH neutral (pH 6.8), has moderate alkalinity (61 mg/L) and is highly saline. The total dissolved solids content of the liquor is 136,000 mg/L - approximately 4 times seawater concentration and significantly greater than the ANZECC (2000) livestock drinking water guidelines. Suspended solids content is 110 mg/L. Magnesium and sodium are the dominant cations (19,800 and 15,300 mg/L, respectively) and sulphate and chloride are the dominant anions (74,100 and 33,100 mg/L, respectively). The soluble sulphate and chloride concentrations were highly elevated with respect to the EPA hazardous dam acceptance criteria (and ANZECC livestock drinking water guidelines for sulphate), due to the highly saline nature of the process residue liquor.

Appendix B Residue and Ore Geochemical Characterisation

B.5.2 Multi-element Composition

Soluble metal and metalloid concentrations are generally within the applied EPA hazardous dam acceptance criteria and ANZECC (2000) livestock drinking water guidelines. Exceptions are soluble nickel, cadmium and fluoride concentrations.

The soluble nickel and cadmium concentrations (1.92 mg/L and 0.198 mg/L, respectively) are elevated compared to the applied criteria of 1 mg/L and 0.01 mg/L, respectively.

The soluble fluoride concentration (3.3 mg/L) is elevated compared to the applied criteria of 2 mg/L.

B.5.3 Organic Carbon, Oxygen Demand and Nutrients

The results of the total organic carbon, chemical oxygen demand and nutrient testing of the process residue liquor are provided in Table 1.3.3 and summarised below.

- The Chemical Oxygen Demand (COD) of the residue liquor is 794 mg/L.
- The Total Organic Carbon (TOC) concentration in the residue liquor is 9%.
- The total nitrite and nitrate concentrations in the residue liquor are 0.044 and 1.39 mg/L, respectively and are below the applied criteria.
- The ammonia concentration in the residue liquor is 1.15 mg/L.

The total phosphorus concentration in residue liquor is 0.28 mg/L.

B.6 Leachate Characteristics of Residue Solid

The results of the leaching test of the process residue solid sample are provided in Table 1.3.4 and summarised below:

- Leachate is pH-neutral (7.22), brackish (3,170 mg/L TDS) with low alkalinity (16 mg/L).
- Dominant major soluble ions are calcium and sulphate, indicative of the gysum in the process residue solid.
- Leachate is generally low in soluble metals and metalloids.

The leachate results in Table 1.3.4 are compared to relevant applied guideline values and local groundwater quality results as follows:

- The salinity of the leachate is significantly elevated with respect to the Australian Drinking Water guideline value of 500 mg/L, and is almost twice the total dissolved solids concentration of local groundwater.
- Calcium and magnesium concentrations in leachate are greater than in local groundwater, but do not exceed applied water quality guideline values. Sulphate concentration in leachate exceeds all applied guideline sulphate values and local groundwater sulphate concentrations.
- With respect to metals and metalloids, leachate was:
    - marginally elevated in chromium and nickel compared to local groundwater; and
    - significantly elevated in manganese compared to local groundwater, the Australian drinking water guideline value and the irrigation (long-term) trigger value.

Appendix B Residue and Ore Geochemical Characterisation

B.7 Multi-element Solubility in Water Extracts from Ore Solid

The results of the water-extract test of the ore solid samples are provided in Table 1.3.5 and summarised below:

- Leachate is pH-neutral (7.6) from Marlborough ore and slightly acidic (pH 5.3) from New Cal ore. Both ore samples are non-saline.
- Dominant major soluble ions are sodium and sulphate, although concentrations are low.
- Water extracts from both ore types is generally low in soluble metals and metalloids.

The water extract results in Table 1.3.5 are compared to relevant applied ANZECC Marine Water guideline values. The results indicate that despite the highly elevated total metal concentrations of some metals (Cr, Co, Mn and Ni) the initial solubility of these and other metals is generally low, as follows:

- Only soluble aluminium, chromium, nickel and sulphur were detectable (i.e. above the laboratory reporting limits (LOR)) in the water extract solutions from both ores. All other metals (excluding major cations) had soluble concentrations in water extracts below the LOR;
- Hexavalent chromium (Cr^{VI}) concentrations in both the Marlborough ore (0.26 mg/L) and New Caledonia ore (0.08 mg/L) were elevated with respect to the ANZECC Marine water quality guideline value of 0.0044 mg/L. Trivalent chromium (Cr III) concentrations in both ore samples were below applied guideline values;
- Cobalt, nickel and manganese concentrations, which were elevated in solid ore samples, were all less than the laboratory LOR in the water extracts.

The concentration of soluble metals in 1:5 water extracts from ore materials is likely to be greater than would be seen in leachate produced naturally from stockpile runoff. This is due to the agitation used in the water extract method and the greater dilution that would be seen with natural rainfall runoff.

B.8 Conclusions

Geochemical test results for process residue material likely to report to the RSF, and ore material, indicate that:

- The residue sample has a low TOS content, negative NAPP and NAGpH of 8.1; and is therefore classified as Non-Acid Forming (NAF). The ore samples also have a very low TOS content, negative NAPP and NAGpH greater than 4.5, and are therefore also classified as NAF.
- The concentration of metals in the residue sample solids is generally within applied environmental and health based investigation guideline levels for soils. However, elevated concentrations of chromium, manganese and nickel in solids are indicated. The concentration of some metals in ore solids (Ni, Mn, Co, Cr) is elevated, as expected in mineralised material.
- Leachate derived from residue is moderately saline and approximately double the salinity (TDS) of local groundwater. Water extract from ore material is non-saline.
- The concentrations of metals in leachate derived from residue solid are generally low and, with the exception of manganese, are comparable to or less than metals concentrations in local groundwater. Nickel and chromium concentrations in leachate are marginally above local groundwater concentrations, but below applied guideline values.
- The concentrations of metals in water extracts derived from ore solids are also low, despite the elevated total metals concentrations in the solid. Only hexavalent chromium (Cr VI) concentration in the water extract from both ore types is greater than the applied marine water quality guideline values, particularly in the Marlborough ore.

Appendix B Residue and Ore Geochemical Characterisation

- The concentration of soluble metals in the residue liquor is generally low and within EPA hazardous dam acceptance criteria and ANZECC (2000) livestock drinking water criteria. However, the elevated concentrations of soluble cadmium, fluoride and nickel are indicated. The concentration of soluble salts in the residue liquor solution is generally high. The soluble sulphate concentration exceeds both the applied guideline criteria. Soluble chloride also exceeds the applied hazardous dam acceptance criteria.
- The residue solid has a moderate ESP indicating that the material is marginally sodic. However, the Emerson Class Test indicates that the material is generally cohesive and unlikely to disperse.
- The residue solid and the residue liquor contain low levels of total organic carbon, total extractable phosphorous and total nitrogen.

B.9 Summary and Recommendations

- The geochemical results indicate that the process residue material (following treatment in the final neutralisation circuit) is likely to be NAF. The source material (Marlborough ore and New Caledonia ore) is also NAF.
- The residue solids may contain elevated concentrations of chromium, manganese and nickel compared to applied guideline criteria. The ore solids are expected to contain elevated concentrations of chromium, manganese and nickel compared to applied guideline criteria.
- The salinity, soluble cadmium and nickel, and soluble sulphate and fluoride concentrations in the residue liquor are likely to be elevated compared to applied guideline criteria.
- The initial solubility of ore materials is unlikely to present a significant environmental hazard with respect to the applied ANZECC marine water quality guidelines, however hexavalent chromium concentration in both the Marlborough and New Caledonia ores is elevated with respect to the marine water quality guidelines. Therefore, ore material will need to be managed to minimise environmental release.
- The initial geochemical assessment results indicate that direct revegetation of the process residue material in the RSF (as part of final rehabilitation) is unlikely to be appropriate due to high salinity levels and low nutrient concentrations. Hence, a cover system may be required for final rehabilitation.
- It is recommended that GPN commence kinetic leach column testing of process residue material to confirm initial findings and investigate any potential issues associated with ongoing leachate quality. This will provide an indication of the timing and extent of any soluble metal/salt release, provide an indication of ongoing leachate quality, and facilitate optimisation of any required seepage monitoring program.

B.10 References

ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality: Livestock Drinking Water. Australian and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). Canberra, ACT.

ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Marine water quality guidelines (95% trigger values). Australian and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). Canberra, ACT.

ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality: Water Quality for Irrigation and General Use. Australian and New Zealand Environment Conservation

Appendix B Residue and Ore Geochemical Characterisation

Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). Canberra, ACT.

EPA (1998). Queensland Government. Department of Environment. Draft guidelines for the assessment & management of contaminated land in Queensland. May 1998.

EPA (2006). Queensland Government - Environment Protection Agency. Determining dams containing hazardous waste. Information sheet 0302.

Isbell, R.F. (2002). The Australian Soil Classification (revised edition). CSIRO Publishing. Victoria.

NEPC (1999). National Environment Protection Council. National Environmental Protection (Assessment of Site Contamination) Measure. Guideline on investigation levels for soil and groundwater. HIL(E); parks, recreation open space and playing fields.

NHMRC/ARMCANZ (1996). National Health and Medical Research Council / Agriculture and Resource Management Council of Australia and New Zealand. Australian Drinking Water Guidelines. Canberra, ACT.

Standards Australia (1997a). AS4439.3-1997 Wastes, sediments and contaminated soils. Part 3: Preparation of leachates – Bottle leaching procedure. Homebush, NSW.

Standards Australia (1997b). AS1289.3.8.1-1997 Methods of testing soils for engineering purposes. Method 3.8.1 – Soil classification tests – Dispersion – Determination of Emerson class number of a soil. Homebush, NSW.

URS (2007). Supplement to EIS Groundwater Investigations for Gladstone Pacific Nickel RSF and Plant Sites. Unpublished report to Gladstone Pacific Nickel.

Tables

Table 1.3.1 Acid-base chemistry of process residue neutralised solids and ore

	Units	Laboratory Detection Limit	Residue[6]	Marlborough Ore	New Caledonia Ore
pH[1]	pH units	0.1	7.4	7.6	5.3
Electrical Conductivity (EC)[1]	uS/cm	1	8,630	650	76
Alkalinity (to pH 5.5)[2]	kg H_2SO_4/t	0.0001	0.0021	<0.0001	<0.0001
Acidity (to pH 8.3)[2]	kg H_2SO_4/t	0.0001	0.00012	<0.0001	0.0026
Total Sulfur (as S)	%	0.01	7.66	0.01	0.28
Sulfate Sulfur (as S)[2]	%	0.01	7.34	0.01	0.28
Total Oxidisable Sulfur (TOS)[3]	%	0.01	0.32	<0.01	<0.01
Total Organic Carbon (TOC)	%	0.02	0.08	n/a	n/a
Maximum Potential Acidity (MPA)[4]	kg H_2SO_4/t	0.1	9.7	0.3	0.3
Acid Neutralising Capacity (ANC)	kg H_2SO_4/t	0.5	54.4	25.2	0.6
Net Acid Producing Potential (NAPP)	kg H_2SO_4/t	0.1	-44.7	-25	-0.3
Net Acid Generation (NAG)	kg H_2SO_4/t	0.1	<0.1	<0.1	<0.1
NAGpH	pH units	0.1	8.1	8.3	5.9
Sample Classification[5]			**Non-Acid Forming**	**Non-Acid Forming**	**Non-Acid Forming**

Notes:

1. Natural pH and EC provided for 1:5 sample:water extracts
2. Alkalinity and Acidity converted from meq/kg as $CaCO_3$ to kg H_2SO_4/t. Sulfate sulfur converted from mg/kg SO_4 to % S.
3. TOS concentration is calculated from the difference between total S and sulfate sulfur concentrations. It is assumed that the organic S concentration is negligible.
4. MPA calculated using TOS.
5. Sample has low TOS content, negative NAPP and NAGpH > 4.5 and is therefore classified as Non-Acid Forming (NAF).
6. Residue sample G200 NRS

Table 1.3.2 Chemistry of process residue neutralised solid and ore

Parameters	Laboratory detection limit	QLD-EPA[1] Environmnetal Investigation Level	NEPC[2] Health-Based Investigation Level	QLD-EPA Hazardous dam criteria[3]	Total concentrations in Residue Solid	Total concentrations in Marlborough Ore	Total concentrations in New Caledonia Ore
Elements and Major Ions	**mg/kg (unless indicated)**						
Aluminium (Al)	50	-	-	-	4,280	10,700	13,300
Antimony (Sb)	5	20	-	-	<5	<5	14
Arsenic (As)	5	20	200 (total)	500	<5	<5	<5
Barium (Ba)	10	-	-	-	-	450	60
Beryllium (Be)	1	-	40	-	<1	<1	<1
Boron (B)	50	-	6,000	15,000	<50	<50	<50
Cadmium (Cd)	1	3	40	100	2	<1	3
Calcium (Ca)	10	-	-	-	78,200	210	40
Chromium (Cr) (Total)	2	50[4]	200	-	3,100	1,340	4,070
Cobalt (Co)	2	-	200	500	26	577	1,160
Copper (Cu)	5	60	2,000	5,000	6	57	24
Fluoride (F)	40	-	-	-	<40	-	-
Iron (Fe)	50	-	-	-	110,000	92,500	298,000
Lead (Pb)	5	300	600	1,500	<5	<5	<5
Magnesium (Mg)	10	-	-	-	16,500	36,700	1,160
Manganese (Mn)	5	500	3,000	-	4,510	3,650	7,240
Mercury (Hg)	0.1	1	30 (inorganic)	75	<0.1	<0.1	0.1
Molybdenum (Mo)	2	-	-	-	<2	<2	<2
Nickel (Ni)	2	60	600	3,000	182	9,000	8,300
Phosphorus (P)	50	-	-	-	-	<50	<50
Potassium (K)	10	-	-	-	930	160	70
Sulphur (as S)	50	-	-	-	-	140	1,460
Selenium (Se)	5	-	-	-	<5	<5	<5
Silica (Si)	0.01%	-	-	-	13.9%	-	-
Silver (Ag)	2	-	-	-	<2	<2	<2
Sodium (Na)	10	-	-	-	8,220	1,580	70
Strontium (Sr)	2	-	-	-	66	14	9
Sulphate (SO_4)	100	2000	-	-	220,000	650	9,620
Thallium (Tl)	5	-	-	-	<5	<5	<5
Tin (Sn)	5	50	-	-	<5	<5	<5
Titanium (Ti)	10	-	-	-	-	80	30
Uranium (U)	0.1	-	-	-	0.2	-	-
Vanadium (V)	5	-	-	-	-	36	23
Zinc (Zn)	5	200	14,000	35,000	14	98	164
Exchangeable Cations & Emerson Class	meq/100g (except ESP)						
Exch. Calcium	0.1	-	-	-	39.1	-	-
Exch. Magnesium	0.1	-	-	-	8.9	-	-
Exch. Potassium	0.1	-	-	-	0.2	-	-
Exch. Sodium	0.1	-	-	-	3.8	-	-
Cation Exchange Capacity	0.1	-	-	-	52.0	-	-
Exchangeable Sodium Percentage	0.1%	-	-	-	7.3%	-	-
Emerson Class Number	-	-	-	-	6	-	-
Nutrients	mg/kg (unless indicated)						
Nitrite + Nitrate as N (sol.)	0.1	-	-	-	0.6	-	-
Total Kjeldahl Nitrogen as N	20	-	-	-	30	-	-
Total Nitrogen as N	20	-	-	-	30	-	-
Bicarbonate Extractable P (Colwell)	2	-	-	-	<2	-	-
Total Organic Carbon (TOC)	0.02%	-	-	-	0.08%	-	-

Notes:

< indicates less than the analytical detection limit.

Shaded cells indicate values which exceed one or more applied guideline values and/or hazardous dam acceptance criteria.

1. Queensland Government. Department of Environment. Draft Guidelines for the Assessment & Management of Contaminated Land in Queensland. May 1998.

2. NEPC (1999). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM). Guideline on investigation levels for soil and groundwater. HIL(E); parks, recreation open space and playing fields.

3. Queensland Government - Environment Protection Agency. Determining dams containing hazardous waste. Information sheet 0302. Criteria for total solids.

4. Cr(III). No background or QLD-EPA EIL's available for Cr Total.

Table 1.3.3 Chemistry of process residue liquor

Parameters	Laboratory detection limit	QLD-EPA Hazardous dam criteria[1]	ANZECC Livestock drinking water (LDW) guideline levels[2]	Soluble concentrations in Residue Liquor
pH	0.01 pH unit	4 to 8	-	6.84
Electrical Conductivity	1 uS/cm	-	-	67,800
Total Dissolved Solids (TDS)	1 mg/L	-	4000 [3]	136,000
Suspended Solids (SS)	1 mg/L	-	-	110
Alkalinity as $CaCO_3$	1 mg/L	-	-	61
Acidity as $CaCO_3$	1 mg/L	-	-	61
Nutrients	mg/L			
Ammonia as N	0.010	-	-	1.15
Nitrite as N	0.010	-	30	0.044
Nitrate as N	0.010	-	400	1.39
Nitrite + Nitrate as N	0.010	-	-	1.44
Total Phosphorous as P	0.01	-	-	0.28
Total Organic Carbon	1	-	-	9
Chemical Oxygen Demand	5	-	-	794
Soluble Major Cations	mg/L			
Calcium (Ca)	1	-	1,000	528
Magnesium (Mg)	1	-	-	19,800
Sodium (Na)	1	-	-	15,300
Potassium (K)	1	-	-	476
Soluble Major Anions	mg/L			
Chloride (Cl)	1	2,500	-	33,100
Sulphate (SO_4)	1	1,000	1,000	74,100
Soluble Metals & Metalloids	mg/L			
Aluminium (Al)	0.01	-	5	<0.01
Antimony (Sb)	0.001	-	-	0.010
Arsenic (As)	0.001	1	0.5	0.023
Beryllium (Be)	0.001	-	-	<0.001
Boron (B)	0.1	5	5	2.8
Cadmium (Cd)	0.0001	0.01	0.01	0.198
Chromium (Cr)	0.001	-	1	0.166
Cobalt (Co)	0.001	1	1	0.421
Copper (Cu)	0.001	1	0.5	0.003
Fluoride (F)	0.1	2	2	3.3
Iron (Fe)	0.05	-	-	<0.05
Lead (Pb)	0.001	0.5	0.1	<0.001
Manganese (Mn)	0.001	-	-	800
Mercury (Hg)	0.0001	0.002	0.002	<0.0001
Molybdenum (Mo)	0.001	-	0.15	<0.001
Nickel (Ni)	0.001	1	1	1.92
Selenium (Se)	0.010	-	0.02	<0.010
Silica (Si)	0.1	-	-	32.1
Silver (Ag)	0.001	-	-	<0.001
Strontium (Sr)	0.001	-	-	6.55
Thallium (Tl)	0.001	-	-	<0.001
Tin (Sn)	0.001	-	-	<0.001
Uranium (U)	0.001	-	0.2	<0.001
Zinc (Zn)	0.005	20	20	0.021

Notes:

< indicates less than the analytical detection limit.

Shaded cells indicate values which exceed the applied guideline values and/or hazardous dam acceptance criteria.

1. Queensland Government - Environment Protection Agency. Determining dams containing hazardous waste. Information sheet 0302. Criteria for liquor.

2. ANZECC and ARMCANZ, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT (2000). Livestock drinking water (cattle).

3. TDS limit based on tolerance for beef cattle, sheep, horses and pigs.

Table 1.3.4 Chemistry of process residue leachate

		Water Quality Guidelines				Local Groundwater Quality [4]				
Parameters	**Laboratory detection limit for soluble analytes**	**NHMRC/ ARMCANZ Australian drinking water (ADW) guideline levels[1]**	**ANZECC Livestock drinking water (LDW) guideline levels[2]**	**ANZECC Irrigation water (LTV) guideline levels[3]**	**ANZECC Irrigation water (STV) guideline levels[3]**	**Groundwater bore RSF17[4] (alluvium)**	**Groundwater bore RSF14[4] (Mount Alma Fm quartzite + siltstones)**	**Groundwater bore RSF24[4] (Rockhampton Grp - Qzt siltstones)**	**Soluble concentrations in Residue leachate[5]**	**Exceedances***
pH (leachate)	0.01 pH unit	6.5 to 8.5 [6]	-	-	-	7.90	7.72	7.88	7.22	
Electrical Conductivity	1 uS/cm	-	-	crop dependent	crop dependent	3,150	1,980	2,380	3,710	local GW
Total Dissolved Solids (TDS)	1 mg/L	500 [6]	4000 [7]	crop dependent	crop dependent	1,920	1,520	1,430	3,170	ADW + local GW
Alkalinity as $CaCO_3$	1 mg/L	-	-	-	-	548	759	706	16	
Acidity as $CaCO_3$	1 mg/L	-	-	-	-	-	-	-	4	
Soluble Major Cations				mg/L						
Calcium (Ca)	1	-	1,000	-	-	86	102	71	556	local GW
Magnesium (Mg)	1	-	-	-	-	96	97	68	204	local GW
Sodium (Na)	1	180 [6]	-	crop dependent	crop dependent	432	236	352	153	
Potassium (K)	1	-	-	-	-	13	12	8	6	
Soluble Major Anions				mg/L						
Chloride (Cl)	1	250 [6]	-	crop dependent	crop dependent	627	272	338	240	
Sulphate (SO_4)	1	500	1,000	-	-	148	33	70	2,000	ADW + LDW + local GW
Soluble Metals & Metalloids				mg/L						
Aluminium (Al)	0.10	0.2 [6]	5	5	20	-	-	-	<0.10	
Antimony (Sb)	0.01	0.003	-	-	-	-	-	-	<0.01	
Arsenic (As)	0.01	0.007	0.5	0.1	2.0	0.001	0.002	0.002	<0.01	
Beryllium (Be)	0.01	-	-	0.1	0.5	<0.001	<0.001	<0.001	<0.01	
Boron (B)	0.1	0.3	5	0.5	crop dependent	-	-	-	<0.1	
Cadmium (Cd)	0.005	0.002	0.01	0.01	0.05	0.0003	<0.0001	<0.0001	<0.005	
Chromium (Cr)	0.01	0.05	1	0.1	1	0.001	<0.001	0.002	0.02	local GW
Cobalt (Co)	0.01	-	1	0.05	0.1	0.029	0.002	0.003	<0.01	
Copper (Cu)	0.01	2	0.5	0.2	5	0.013	<0.001	0.002	<0.01	
Fluoride (F)	0.1	1.5	2	1	42	-	-	-	0.5	
Iron (Fe)	0.05	0.3 [6]	-	0.2	10	-	-	-	<0.05	
Lead (Pb)	0.01	0.01	0.1	2	5	0.002	0.021	0.017	<0.01	
Manganese (Mn)	0.01	0.5	-	0.2	10	0.213	0.100	0.092	7.28	ADW + LTV + local GW
Mercury (Hg)	0.0001	0.001	0.002	0.002	0.002	<0.0001	<0.0001	<0.0001	<0.0001	
Molybdenum (Mo)	0.01	0.05	0.15	0.01	0.01	-	-	-	<0.01	
Nickel (Ni)	0.01	0.02	1	0.2	2	0.027	0.010	0.013	0.02	local GW
Selenium (Se)	0.01	0.01	0.02	0.02	0.05	-	-	-	<0.01	
Silica (Si)	0.1	-	-	-	-	-	-	-	20.7	
Silver (Ag)	0.01	0.1	-	-	-	-	-	-	<0.01	
Strontium (Sr)	0.1	-	-	-	-	-	-	-	0.6	
Thallium (Tl)	0.01	-	-	-	-	-	-	-	<0.01	
Tin (Sn)	0.01	-	-	-	-	-	-	-	<0.01	
Uranium (U)	0.001	-	0.2	0.01	0.1	-	-	-	<0.001	
Zinc (Zn)	0.01	3 [6]	20	2	5	0.041	0.010	0.042	<0.01	

Notes:

< indicates less than the analytical detection limit. * Result concentrations that exceed applied guideline values and/or local groundwater concentrations.

1. NHMRC & ARMCANZ, Australian Drinking Water Guidelines. National Health and Medical Research Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT (1996).
2. ANZECC and ARMCANZ, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT (2000). Livestock drinking water (cattle).
3. ANZECC and ARMCANZ. Water Quality for Irrigation and General Use. STV = short-term trigger value. LTV = long-term trigger value. STV assumes continuous irrigation for up to 20 years. LTV assumes 100 years of continuous irrigation.
4. Selected representative bores. Refer to URS report (2007) for full groundwater assessment.
5. Standards Australia (1997). AS4439.3-1997 Wastes, sediments and contaminated soils. Part 3: Preparation of leachates – Bottle leaching procedure. Homebush, NSW. Residue sample G200 NRS.
6. Aesthetic guideline value. No health-based guideline value.
7. TDS limit based on tolerance for beef cattle, sheep, horses and pigs.

Table 1.3.5 Multi-element solubility in water extracts from ore

Parameters	Laboratory detection limit for soluble analytes from Ore	ANZECC Marine water guideline levels (95%) [1]	Soluble concentrations in Marlborough Ore[2]	Soluble concentrations in New Caledonia Ore[2]
pH	0.01 pH unit	-	7.6	5.3
Electrical Conductivity	1 uS/cm	-	650	76
Total Dissolved Solids (TDS)	1 mg/L	-	-	-
Alkalinity as $CaCO_3$	1 mg/L	-	-	-
Acidity as $CaCO_3$	1 mg/L	-	-	-
Soluble Major Cations	mg/L			
Calcium (Ca)	2	-	<2	2
Magnesium (Mg)	2	-	6	2
Sodium (Na)	2	-	105	5
Potassium (K)	2	-	<2	<2
Soluble Major Anions	mg/L			
Chloride (Cl)	2	-	134	9
Sulphate (SO_4)	2	-	50	10
Soluble Metals & Metalloids	mg/L			
Aluminium (Al)	0.2	-	0.2	<0.2
Antimony (Sb)	0.02	-	<0.02	<0.02
Arsenic (As)	0.02	-	<0.02	<0.02
Barium (Ba)	0.2	-	<0.2	<0.2
Beryllium (Be)	0.02	-	<0.02	<0.02
Boron (B)	0.2	-	<0.2	<0.2
Cadmium (Cd)	0.02	0.0055	<0.02	<0.02
Chromium (Cr) (total soluble)	0.02	-	0.26	0.09
Chromium (Cr III)	0.02	0.0274	<0.02	<0.02
Chromium (Cr VI)	0.02	0.0044	0.26	0.08
Cobalt (Co)	0.02	0.001	<0.02	<0.02
Copper (Cu)	0.02	0.0013	<0.02	<0.02
Fluoride (F)	0.2	-	<0.2	<0.2
Iron (Fe)	0.2	-	<0.2	<0.2
Lead (Pb)	0.02	0.0044	<0.02	<0.02
Manganese (Mn)	0.02	-	<0.02	<0.02
Mercury (Hg)	0.0001	0.0004 (inorganic)	<0.0001	<0.0001
Molybdenum (Mo)	0.02	-	<0.02	<0.02
Nickel (Ni)	0.02	0.07	0.02	0.03
Phosphorous (P)	2	-	<2	<2
Sulphur (as S)	2	-	16	3
Selenium (Se)	0.02	-	<0.02	<0.02
Silver (Ag)	0.02	0.0014	<0.02	<0.02
Strontium (Sr)	0.2	-	<0.2	<0.2
Thallium (Tl)	0.2	-	<0.2	<0.2
Tin (Sn)	0.02	-	<0.02	<0.02
Titanium (Ti)	0.2	-	<0.2	<0.2
Vanadium (V)	0.02	0.1	<0.02	<0.02
Zinc (Zn)	0.02	0.015	<0.02	<0.02

Notes:

< indicates less than the analytical detection limit. Shaded cells indicate result concentrations that exceed applied guideline values.

1. ANZECC and ARMCANZ, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT. Marine water quality guidelines (95% trigger values).

2. 1:5 solid:water extracts

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1629843**	Page	: 1 of 4
Client	: **QUEENSLAND NICKEL SALES PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ROSS HULTGREN	Contact	: Customer Services EB
Address	: Queensland Nickel Sales Pty Ltd 1 Greenvale Street Yabulu Queensland 4818	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 4720 6783	Telephone	: +61-7-3243 7222
Project	: Brolga	Date Samples Received	: 19-Dec-2016 16:00
Order number	: ----	Date Analysis Commenced	: 21-Dec-2016
C-O-C number	: ----	Issue Date	: 10-Jan-2017 08:51
Sampler	: Bill stacy		
Site	: ----		
Quote number	: BNBQ/333/15		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

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Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: **ASLP LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	Nantronite Ore	Waste Rock	----	----	----
				Client sampling date / time	[19-Dec-2016]	[19-Dec-2016]	----	----	----
					EB1629843-001	EB1629843-002	--------	--------	--------
					Result	Result	----	----	----
EG005W: Water Leachable Metals by ICPAES									
Aluminium	7429-90-5	0.1	mg/L		**1.54**	**0.12**	----	----	----
Arsenic	7440-38-2	0.01	mg/L		<0.01	<0.01	----	----	----
Boron	7440-42-8	0.1	mg/L		**0.3**	**0.2**	----	----	----
Cadmium	7440-43-9	0.005	mg/L		<0.005	<0.005	----	----	----
Chromium	7440-47-3	0.01	mg/L		**0.62**	**0.43**	----	----	----
Cobalt	7440-48-4	0.01	mg/L		**0.05**	**0.07**	----	----	----
Copper	7440-50-8	0.01	mg/L		<0.01	<0.01	----	----	----
Lead	7439-92-1	0.01	mg/L		<0.01	<0.01	----	----	----
Nickel	7440-02-0	0.01	mg/L		**2.97**	**2.71**	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.01	mg/L		**0.19**	**0.12**	----	----	----
Molybdenum	7439-98-7	0.01	mg/L		**0.01**	<0.01	----	----	----
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	----	----	----

Analytical Results

Sub-Matrix: **ROCK** (Matrix: **SOIL**)			Client sample ID	**Nantronite Ore**	**Waste Rock**	**----**	**----**	**----**
			Client sampling date / time	[19-Dec-2016]	[19-Dec-2016]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1629843-001**	**EB1629843-002**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EN60: Bottle Leaching Procedure								
Final pH	----	0.1	pH Unit	**7.8**	**8.5**	**----**	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1629843**	Page	: 1 of 4
Client	: **QUEENSLAND NICKEL SALES PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ROSS HULTGREN	Contact	: Customer Services EB
Address	: Queensland Nickel Sales Pty Ltd 1 Greenvale Street Yabulu Queensland 4818	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 4720 6783	Telephone	: +61-7-3243 7222
Project	: Brolga	Date Samples Received	: 19-Dec-2016
Order number	: ----	Date Analysis Commenced	: 21-Dec-2016
C-O-C number	: ----	Issue Date	: 10-Jan-2017
Sampler	: Bill stacy		
Site	: ----		
Quote number	: BNBQ/333/15		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG005W: Water Leachable Metals by ICPAES (QC Lot: 703968)									
EB1629843-001	Nantronite Ore	EG005W: Cadmium	7440-43-9	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG005W: Arsenic	7440-38-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG005W: Chromium	7440-47-3	0.01	mg/L	0.62	0.63	1.80	0% - 20%
		EG005W: Cobalt	7440-48-4	0.01	mg/L	0.05	0.05	0.00	No Limit
		EG005W: Copper	7440-50-8	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG005W: Lead	7439-92-1	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG005W: Nickel	7440-02-0	0.01	mg/L	2.97	3.07	3.49	0% - 20%
		EG005W: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG005W: Zinc	7440-66-6	0.01	mg/L	0.19	0.19	0.00	0% - 50%
		EG005W: Molybdenum	7439-98-7	0.01	mg/L	0.01	<0.01	0.00	No Limit
		EG005W: Aluminium	7429-90-5	0.1	mg/L	1.54	1.57	2.26	0% - 50%
		EG005W: Boron	7440-42-8	0.1	mg/L	0.3	0.3	0.00	No Limit
EG035W: Water Leachable Mercury by FIMS (QC Lot: 703965)									
EB1629843-001	Nantronite Ore	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 705317)									
EB1630103-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	1.6	1.5	8.92	0% - 50%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005W: Water Leachable Metals by ICPAES (QCLot: 703968)								
EG005W: Aluminium	7429-90-5	0.1	mg/L	<0.10	----	----	----	----
EG005W: Arsenic	7440-38-2	0.01	mg/L	<0.01	0.1 mg/L	94.0	73	119
EG005W: Boron	7440-42-8	0.1	mg/L	<0.1	----	----	----	----
EG005W: Cadmium	7440-43-9	0.005	mg/L	<0.005	0.1 mg/L	95.1	87	111
EG005W: Chromium	7440-47-3	0.01	mg/L	<0.01	0.1 mg/L	100	88	112
EG005W: Cobalt	7440-48-4	0.01	mg/L	<0.01	0.1 mg/L	96.3	86	114
EG005W: Copper	7440-50-8	0.01	mg/L	<0.01	0.2 mg/L	96.9	87	115
EG005W: Lead	7439-92-1	0.01	mg/L	<0.01	0.1 mg/L	107	83	113
EG005W: Nickel	7440-02-0	0.01	mg/L	<0.01	0.1 mg/L	109	85	113
EG005W: Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----
EG005W: Zinc	7440-66-6	0.01	mg/L	<0.01	0.2 mg/L	97.1	84	111
EG005W: Molybdenum	7439-98-7	0.01	mg/L	<0.01	----	----	----	----
EG035W: Water Leachable Mercury by FIMS (QCLot: 703965)								
EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	94.1	83	117
EK040P: Fluoride by PC Titrator (QCLot: 705317)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	10 mg/L	95.8	80	117

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005W: Water Leachable Metals by ICPAES (QCLot: 703968)							
EB1629843-002	Waste Rock	EG005W: Arsenic	7440-38-2	1 mg/L	99.8	70	130
		EG005W: Cadmium	7440-43-9	0.5 mg/L	101	70	130
		EG005W: Chromium	7440-47-3	1 mg/L	101	70	130
		EG005W: Cobalt	7440-48-4	1 mg/L	102	70	130
		EG005W: Copper	7440-50-8	1 mg/L	102	70	130
		EG005W: Lead	7439-92-1	1 mg/L	94.6	70	130
		EG005W: Nickel	7440-02-0	1 mg/L	90.2	70	130
		EG005W: Zinc	7440-66-6	1 mg/L	101	70	130
EG035W: Water Leachable Mercury by FIMS (QCLot: 703965)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EG035W: Water Leachable Mercury by FIMS (QCLot: 703965) - continued							
EB1629843-002	Waste Rock	EG035W: Mercury	7439-97-6	0.01 mg/L	80.5	70	130
EK040P: Fluoride by PC Titrator (QCLot: 705317)							
EB1630103-002	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	91.0	70	130

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1700453**	Page	: 1 of 4
Client	: **QUEENSLAND NICKEL SALES PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ROSS HULTGREN	Contact	: Customer Services EB
Address	: Queensland Nickel Sales Pty Ltd 1 Greenvale Street Yabulu Queensland 4818	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 4720 6783	Telephone	: +61-7-3243 7222
Project	: Brolga	Date Samples Received	: 10-Jan-2017 12:09
Order number	: ----	Date Analysis Commenced	: 11-Jan-2017
C-O-C number	: ----	Issue Date	: 20-Jan-2017 09:37
Sampler	: BILL STACEY		
Site	: ----		
Quote number	: BNBQ/333/15		
No. of samples received	: 2		
No. of samples analysed	: 2		

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Accreditation No. 825
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^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)				Client sample ID	Nantronite Ore	Waste Rock	----	----	----
				Client sampling date / time	[19-Dec-2016]	[19-Dec-2016]	----	----	----
Compound	CAS Number	LOR	Unit		EB1700453-001	EB1700453-002	--------	--------	--------
					Result	Result	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		150	60	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		123	59	----	----	----
EA020EC: Salinity									
Salinity	----	0.01	g/kg		0.07	0.03	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		13	21	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		13	21	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		3	1	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		38	6	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	1	----	----	----
Magnesium	7439-95-4	1	mg/L		1	5	----	----	----
Sodium	7440-23-5	1	mg/L		30	7	----	----	----
Potassium	7440-09-7	1	mg/L		<1	<1	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		1.39	0.61	----	----	----
Total Cations	----	0.01	meq/L		1.39	0.76	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)	Client sample ID			Nantronite Ore	Waste Rock	----	----	----
	Client sampling date / time			[19-Dec-2016]	[19-Dec-2016]	----	----	----
Compound	CAS Number	LOR	Unit	EB1700453-001	EB1700453-002	--------	--------	--------
				Result	Result	----	----	----
EN60: Bottle Leaching Procedure								
Final pH	----	0.1	pH Unit	**8.5**	**8.6**	**----**	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1700453**	Page	: 1 of 3
Client	: **QUEENSLAND NICKEL SALES PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ROSS HULTGREN	Contact	: Customer Services EB
Address	: Queensland Nickel Sales Pty Ltd 1 Greenvale Street Yabulu Queensland 4818	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 4720 6783	Telephone	: +61-7-3243 7222
Project	: Brolga	Date Samples Received	: 10-Jan-2017
Order number	: ----	Date Analysis Commenced	: 11-Jan-2017
C-O-C number	: ----	Issue Date	: 20-Jan-2017
Sampler	: BILL STACEY		
Site	: ----		
Quote number	: BNBQ/333/15		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
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- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

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Signatories	*Position*	*Accreditation Category*
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD

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CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
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RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

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Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA010P: Conductivity by PC Titrator (QC Lot: 722379)									
EB1700453-002	Waste Rock	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	60	55	8.85	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 722380)									
EB1700453-001	Nantronite Ore	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	123	131	6.55	0% - 50%
ED037P: Alkalinity by PC Titrator (QC Lot: 722378)									
EB1700453-002	Waste Rock	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	21	21	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	21	21	0.00	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 723180)									
EB1700453-001	Nantronite Ore	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	3	3	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 723181)									
EB1700453-001	Nantronite Ore	ED045G: Chloride	16887-00-6	1	mg/L	38	39	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 722389)									
EB1700453-001	Nantronite Ore	ED093F: Calcium	7440-70-2	1	mg/L	<1	<1	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	1	<1	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	30	30	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA010P: Conductivity by PC Titrator (QCLot: 722379)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	4000 µS/cm	100	91	107
				<1	12890 µS/cm	100	91	107
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 722380)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	95.0	88	112
				<10	2000 mg/L	98.0	88	112
ED037P: Alkalinity by PC Titrator (QCLot: 722378)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	105	80	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 723180)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	107	85	118
				<1	100 mg/L	95.9	85	118
ED045G: Chloride by Discrete Analyser (QCLot: 723181)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	96.6	90	115
				<1	1000 mg/L	97.1	90	115
ED093F: Dissolved Major Cations (QCLot: 722389)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 723180)							
EB1700453-002	Waste Rock	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	105	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 723181)							
EB1700453-002	Waste Rock	ED045G: Chloride	16887-00-6	400 mg/L	102	70	130

GEOTECHNICAL ASSESSMENT OF THE BROLGA PROJECT, QNI RESOURCES PTY LTD

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November 2021

GEOTECHNICAL ASSESSMENT OF THE BROLGA PROJECT, QNI RESOURCES PTY LTD

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3.4 Pit 8 2
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FIGURE 4 : ASSESSED AREAS
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FIGURE 23 : PIT 8 LOOKING WEST (225 359 E, 7 450 752 N)

FIGURE 24 : WEST WALL BATTER, PIT 8 (225 316 E, 7 450 777 N)

FIGURE 25 : PIT 8 WEST BATTER LOOKING SOUTH (225 294 E, 7 450 747 N)

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APPENDICES

APPENDIX 1 : DESCRIPTIONS AND PHOTOGRAPHS OF SAMPLES

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GEOTECHNICAL ASSESSMENT OF THE BROLGA PROJECT, QNI RESOURCES PTY LTD

1.0 INTRODUCTION

The Brolga mining lease ML5866 is located about 45 km north northwest of Rockhampton and 50 km south east of Marlborough (Figure 1). Figure 2 is a site plan and Figure 3 is a contour plan. The following features are geotechnically assessed in this report.

- Pit 1,
- Pit 2 Extension,
- Pit 3 and Oversized Dump (OSD),
- Pit 8,
- Waste Rock Dump (WRD).

The following information is presented:-

- Final dimensions of voids and stockpiles,
- Geotechnical stability analyses of pits batters and stockpiles slopes,
- Recommended final slope angles for long term stability,
- Rehabilitation requirements and safety bunding.

2.0 GEOLOGICAL SETTING

The main material types at this site are brown laterite (Photograph 1 in Appendix 1) and grey, white, brown and greenish brown, variably indurated saprolite (Photographs 2 to 6 in Appendix 2). The laterite is about 3.0 m thick and consists of siliceous mineral particles, silt, clay and iron oxide nodules coated in haematite. This material is generally of low strength but becomes stronger where weakly cemented with haematite.

The saprolite layer is a compact mass of clay with siliceous particles. It is partially silicified and formed by chemical weathering. It is generally strong.

3.0 GEOTECHNICAL ASSESSMENT

The six sites assessed are shown in Figure 4. Geotechnical conditions are described and remedial measures are recommended.

3.1 Pit 1

Figure 5 is a plan of Pit 1 and Figure 6 shows cross sections. Typical brown laterite is shown in Photograph 1 of Appendix 1. Figures 7, 8, 9 and 10 show the pit walls which are steep and unstable, mainly consisting of laterite. Saprolite occurs on the western side of the south wall (Figures 7 and 10). Photograph 2 in Appendix 2 shows compact, grey saprolite.

It is recommended that the batters of the south and east walls are flattened to 1.5 (horizontal) to 1.0 (vertical) for long term stability (Figures 4 and 11). A safety bund is required following recutting (Figures 4 and 11). Site spoil piles in this area need to be flattened with 1.0 (vertical) on 3.0 (horizontal) final batters, then topsoiled and seeded.

3.2 Pit 2 Extension

Pit 2 Extension has a northwest and southwest wall as seen in Figures 12 and 13. Two strong samples of saprolite are shown in Photographs 3 and 4 of Appendix 1. Figure 14 shows the location of the strong saprolite sample in Photograph 4 of Appendix 2.

In Pit 2 Extension the batters are at an angle of 40° to 50°. There are generally three batters and two berms (Figures 14 to 18). All batters are stable and consist of strong saprolite.

It is recommended that a safety bund is constructed as shown in Figure 4. Design criteria are included in Appendix 2. Site stockpiles should be reshaped with final stable batters of 1.0 (vertical) on 3.0 (horizontal). These batters need to be topsoiled and seeded.

3.3 Pit 3 / Oversized Dump

Pit 3 was backfilled with oversized material forming a northeasterly trending batter (Figure 4) on the south east boundary of Pit 3. A sample of strong, greenish brown saprolite taken from the batter is in Photograph 8 of Appendix 1. The oversized dump has an average batter angle of 34° (Figure 19). The batters are stable with durable rock fragments (Figure 20).

For long term stability and facilitated rehabilitation, it is recommended that the batters are flattened to 1.0 (vertical) on 3.0 (horizontal), and then topsoiled and seeded.

A safety bund as described in Appendix 2 is required along the crest.

Spoil piles within this area need to be flattened to 1.0 (vertical) on 3.0 (horizontal), then topsoiled and seeded for long term stability.

3.4 Pit 8

The Pit 8 plan and cross sections are shown in Figures 21 and 22. There are four batters and three berms on the western wall (Figures 21 and 22). Batter details are shown in Figures 23 to 25.

Photographs 5 and 6 in Appendix 1 show strong saprolite from Pit 8. The batters in Figures 23 to 25 are sound and geotechnically stable. Average slope angle is 40°.

A safety bund as described in Appendix 2 is required above the uppermost batter (Figures 4 and 21). Spoil piles at this site need to be flattened to 1.0 (vertical) on 3.0 (horizontal) for long term stability, then topsoiled and seeded.

3.5 Waste Rock Dump

The Waste Rock Dump (WRD) is shown in Figures 26 and 27. The batters material types are included in Figures 28 and 29.

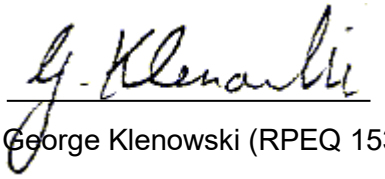
Fine clayey, gravelly silt which is the fine portion of the WRD, is included in Photograph 7 of Appendix 1. This material has an angle of repose of 30°. The material in Figures 28 and 29 has a repose angle of 32°. The coarse fraction comprises sound rock fragments.

It is recommended that the WRD batters are reshaped to be 1.0 (vertical) on 3.0 (horizontal) for long term stability and for subsequent topsoiling and seeding.

4.0 REGISTERED PROFESSIONAL ENGINEER OF QUEENSLAND SIGN OFF

This Registered Professional Engineer of Queensland (RPEQ) Report for the geotechnical assessment of the Brolga Project has been completed by George Klenowski (RPEQ 15332) according to the requirements of the Board of Professional Engineers of Queensland.

Yours sincerely,



November 2021

George Klenowski (RPEQ 15332)

FIGURES



FIGURE 1 : BROLGA MINING LEASE ML5866 LOCALITY PLAN



Brolga MLs - Geotechnical Report

Coordinate System:	GDA 1994 MGA Zone 56
Datum:	GDA 1994
Drawn By:	John Bernal
Date:	24/10/2021

N

0 100 200 300 400

metres

1:4,000 at A3

FIGURE 2 : SITE PLAN

Path: C:\Users\jaber\OneDrive\Documents\ArcGIS\GIS\Maps\Malrborough Nickel\Brolga\Brolga Map _ Geotech.mxd

224,500

225,000

7,451,000

7,450,500

7,450,000

Go Line Pad

Pit 8

Nontronite Stockpile

Top Pad

HR01

Top Pad

TS5

Pit 1

Pit 4

Pit 5

TS3

Pit 3

TS7

ROM

TS2

USLG Stockpile

Pit 2 Extension

Pit 2

Low Grade Screened Stockpile

TS1

WRD1

HR01

S_Pit_05_OB

Sample_Pit_05

TS6

LEGEND

Disturbed areas

Brolga 2m Contours

Brolga MLs - Geotechnical Report - 2m Contours

Coordinate System: GDA 1994 MGA Zone 56

Datum: GDA 1994

Drawn By: John Bernal

Date: 24/10/2021

N

0 100 200 300 400

metres

1:4,000 at A3

FIGURE 3 : CONTOUR PLAN

Path: C:\Users\jaber\OneDrive\Documents\ArcGIS\GIS\Maps\Malrborough Nickel\Brolga\Brolga Map _ Geotech.mxd

224,500
225,000
7,451,000
7,450,500
7,450,000
Safety Bund
4
Rehabilitate Spoil
Pit 8
Go Line Pad
Nontronite Stockpile
Top Pad
HR01
Rehabilitate Spoil
1
Top Pad
TS5
Pit 1
A
Recut and Safety Bund
A'
TS7
Rehabilitate Spoil
3
Pit 4
Pit 5
Pit 3
TS3
Safety Bund
OSD
Rehabilitate Batters
ROM
3
Safety Bund
2
TS2
USLG Stockpile
Pit 2 Extension
Rehabilitate Spoil
Rehabilitate Batters
TS1
WRD1
5
Pit 2
Low Grade Screened Stockpile
HR01
S_Pit_05_OB
Sample_Pit_05
TS6
LEGEND
Remedial Works
Disturbed areas
224,500
225,000

Brolga MLs - Geotechnical Report - Areas Assessed

Coordinate System:	GDA 1994 MGA Zone 56
Datum:	GDA 1994
Drawn By:	John Bernal
Date:	26/10/2021

N

0 100 200 300 400

metres

FIGURE 4 : ASSESSED AREAS

1:4,000 at A3

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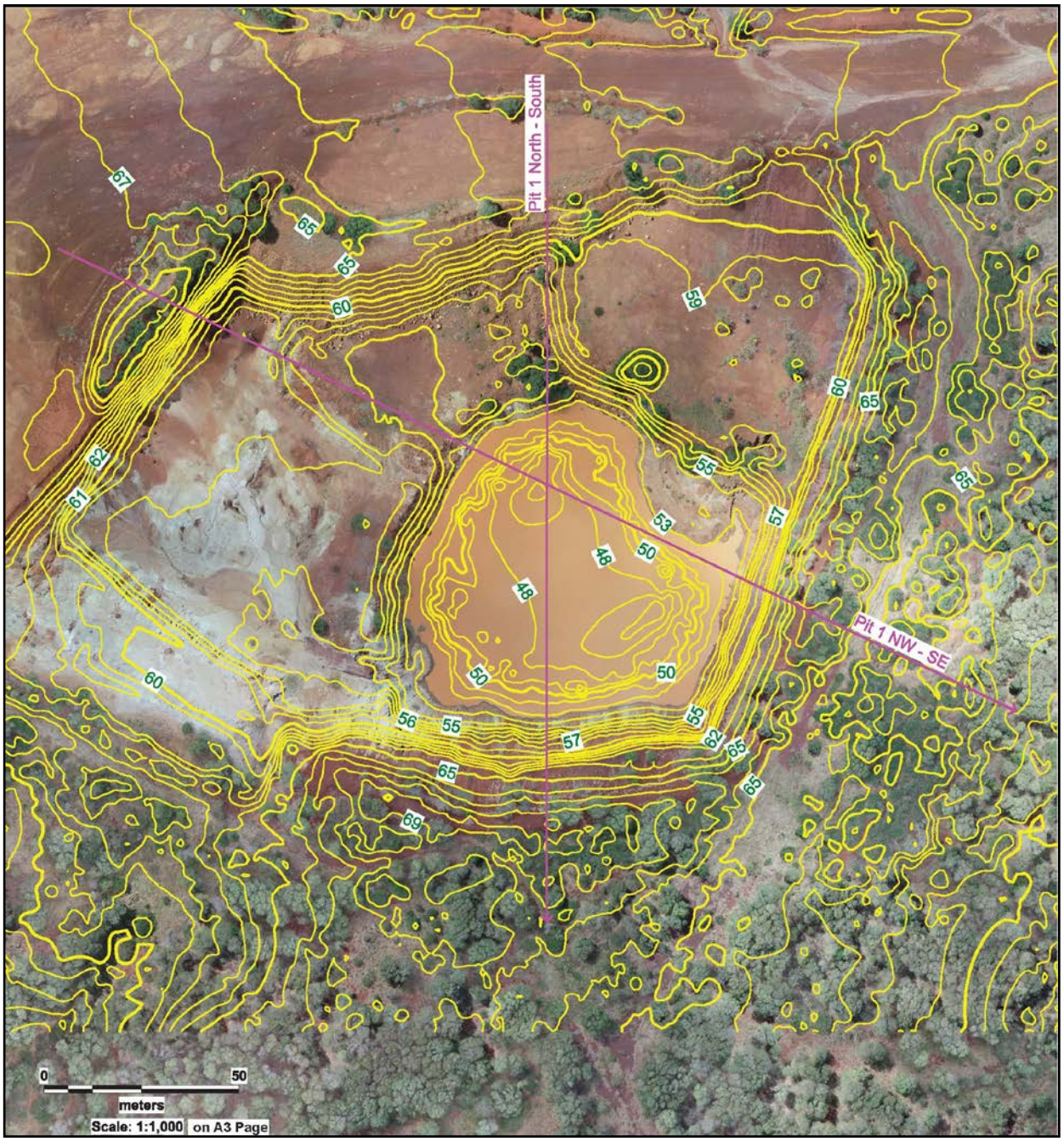
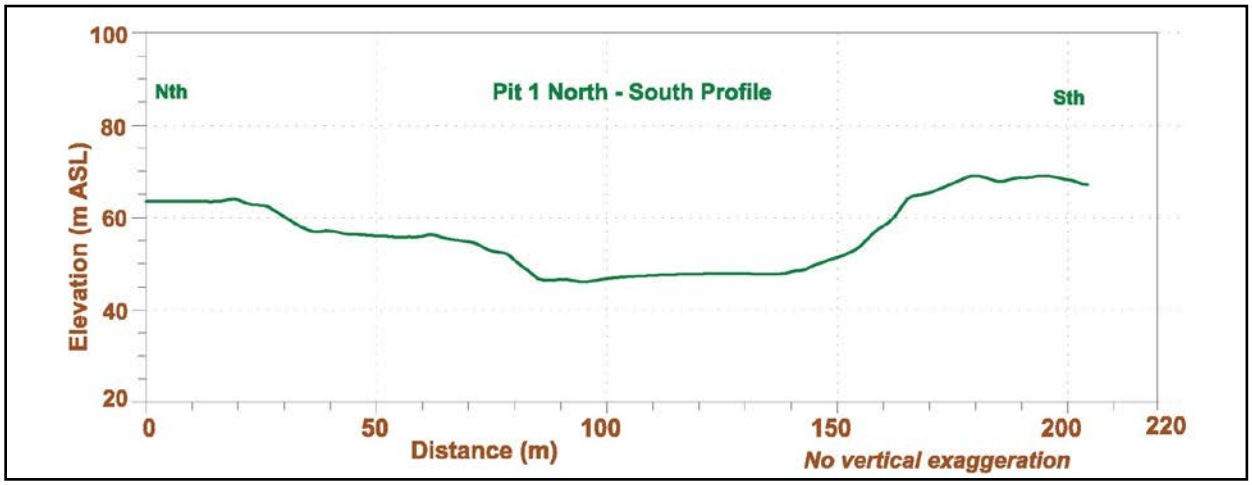


FIGURE 5 : PIT 1 PLAN



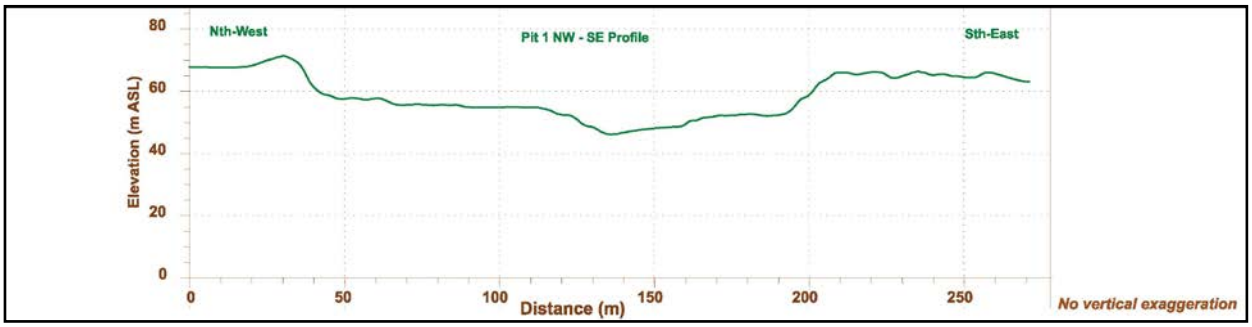


FIGURE 6 : PIT 1 CROSS SECTIONS



FIGURE 7 : SOUTHEAST SECTION OF PIT 1 (224 780 E, 7 450 648 N)



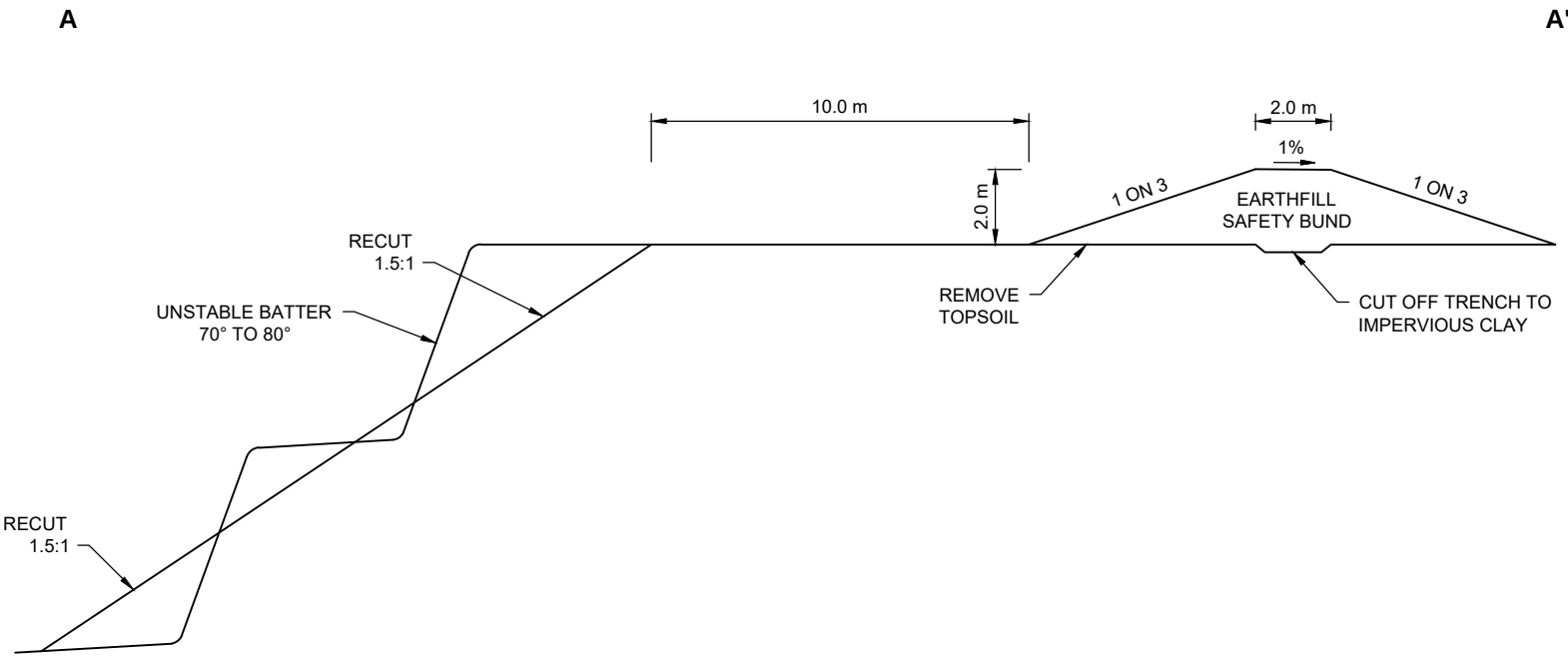
FIGURE 8 : SOUTHEAST BATTERS OF PIT 1 (224 785 E, 7 450 564 N)



FIGURE 9 : EAST WALL OF PIT 1 (224 791 E, 7 450 514 N)



FIGURE 10 : SOUTH WALL OF PIT 1 (224 779 E, 7 450 505 N)



SCALE 1:200

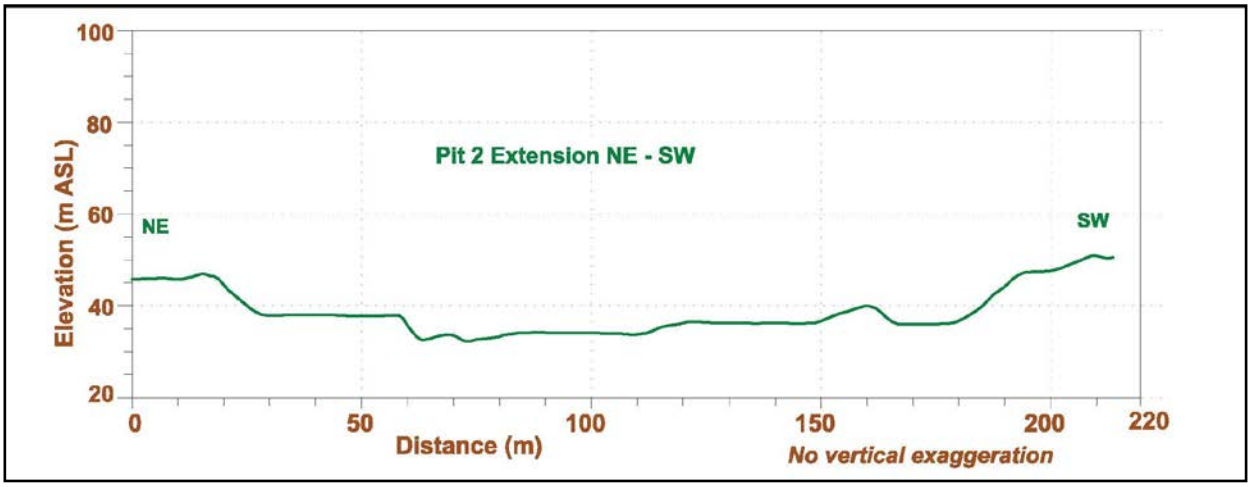
0 2 4 6 8 10 m

FIGURE 11

PROPOSED PIT 1 RECUT



FIGURE 12: PIT 2 EXTENSION



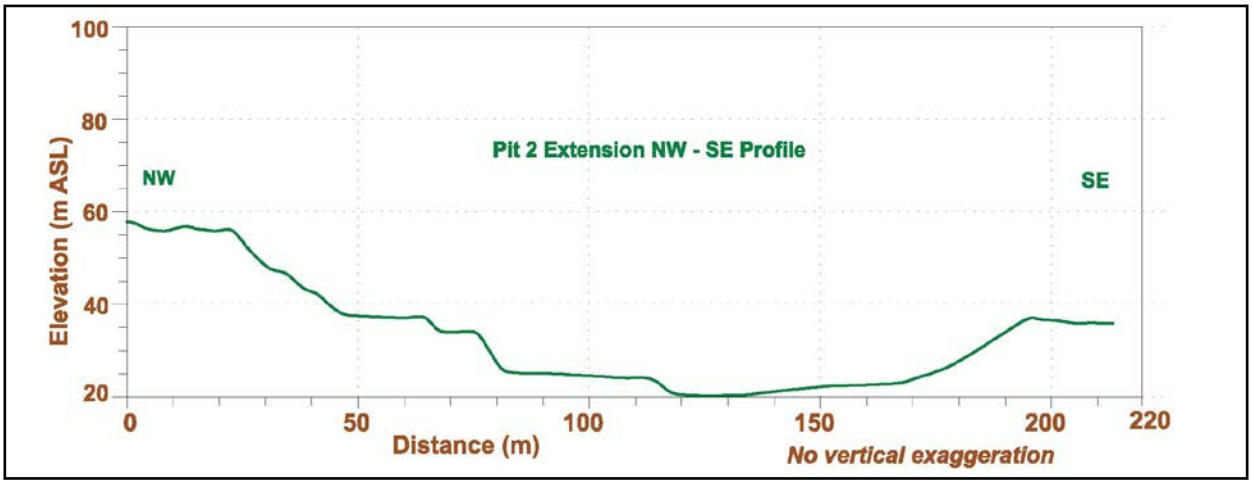


FIGURE 13 : PIT 2 EXTENSION CROSS SECTIONS



FIGURE 14 : STRONG SAPROLITE IN PIT 2 EXTENSION WALL (224 842 E, 7 450 314 N)



FIGURE 15 : PIT 2 EXTENSION NORTHWEST WALL (224 896 E, 7 450 246 N)



FIGURE 16 : COMPETENT NORTHWEST WALL OF PIT 2 EXTENSION (224 868 E, 7 450 287 N)



FIGURE 17 : STABLE NORTHWEST WALL BOTTOM TERRACE IN PIT 2 EXTENSION (224 845 E, 7 450 299 N)



FIGURE 18 : STABLE, SECOND LOWEST BATTER AND BERM, PIT 2 EXTENSION (224 847 E, 7 450 303 N)



FIGURE 19 : OVERSIZED DUMP BATTER (225 123 E, 7 450 480 N)



FIGURE 20 : STRONG ROCK IN OVERSIZED DUMP (225 124 E, 7 450 481 N)

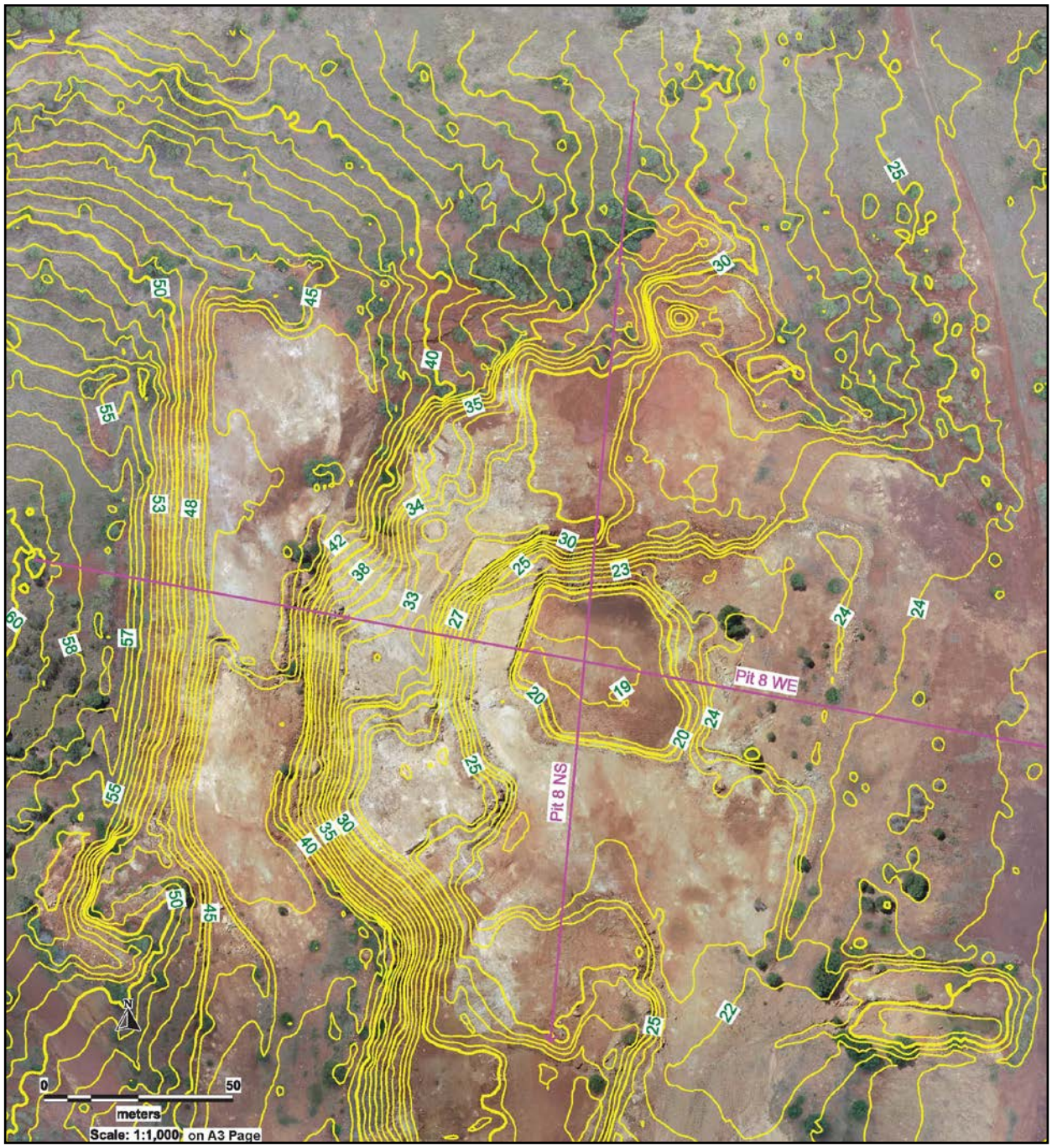
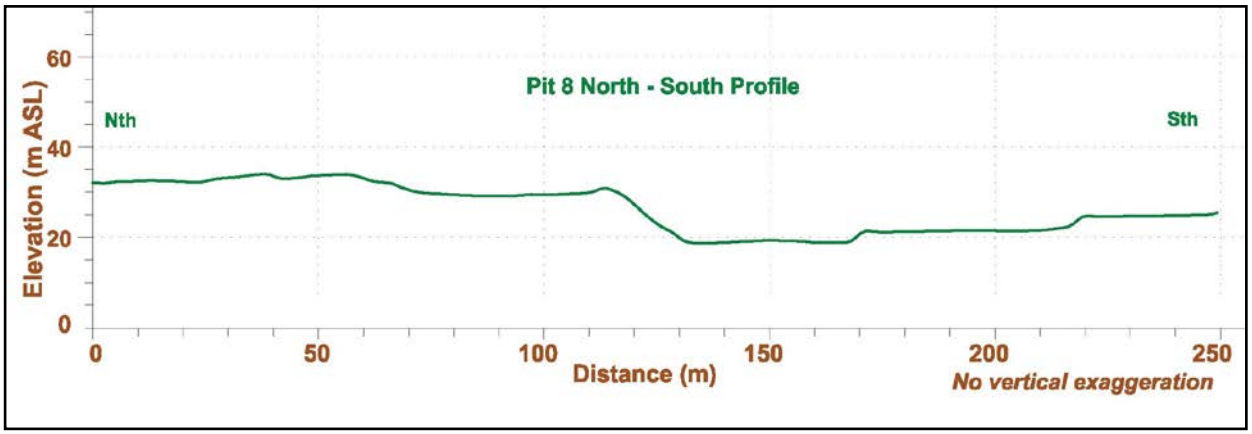


FIGURE 21 : PIT 8 PLAN



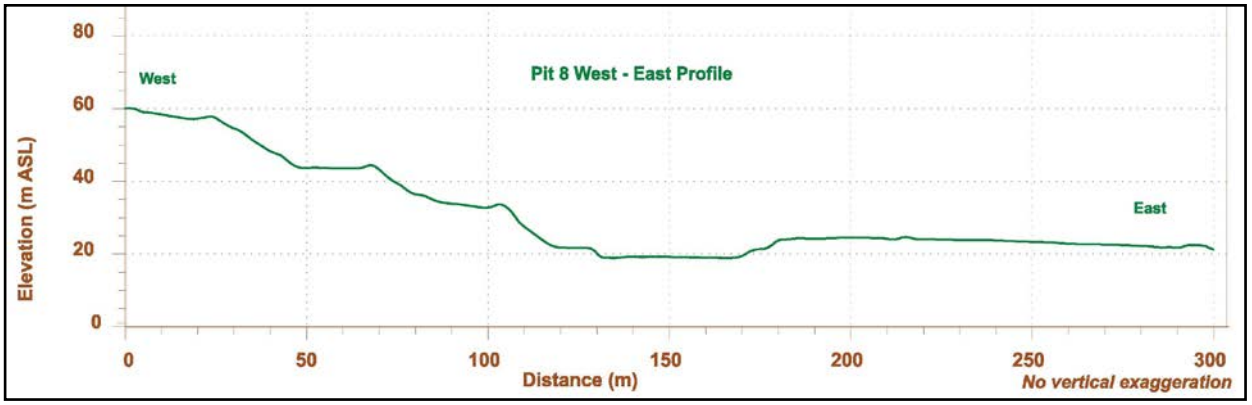


FIGURE 22 : PIT 8 CROSS SECTIONS



FIGURE 23 : PIT 8 LOOKING WEST (225 359 E, 7 450 752 N)



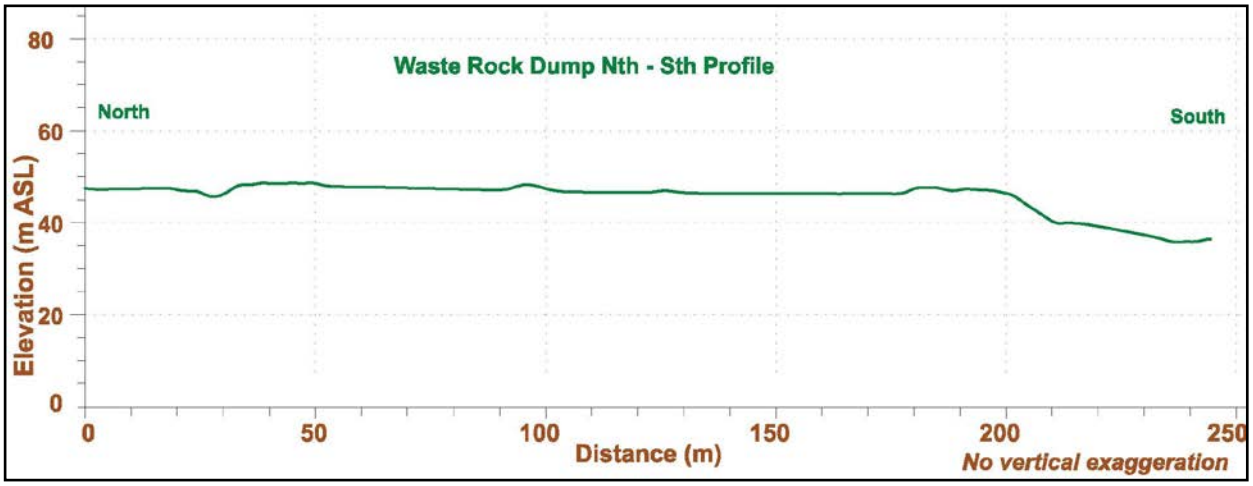
FIGURE 24 : WEST WALL BATTER, PIT 8 (225 316 E, 7 450 777 N)



FIGURE 25 : PIT 8 WEST BATTER LOOKING SOUTH (225 294 E, 7 450 747 N)



FIGURE 26 : WASTE ROCK DUMP PLAN



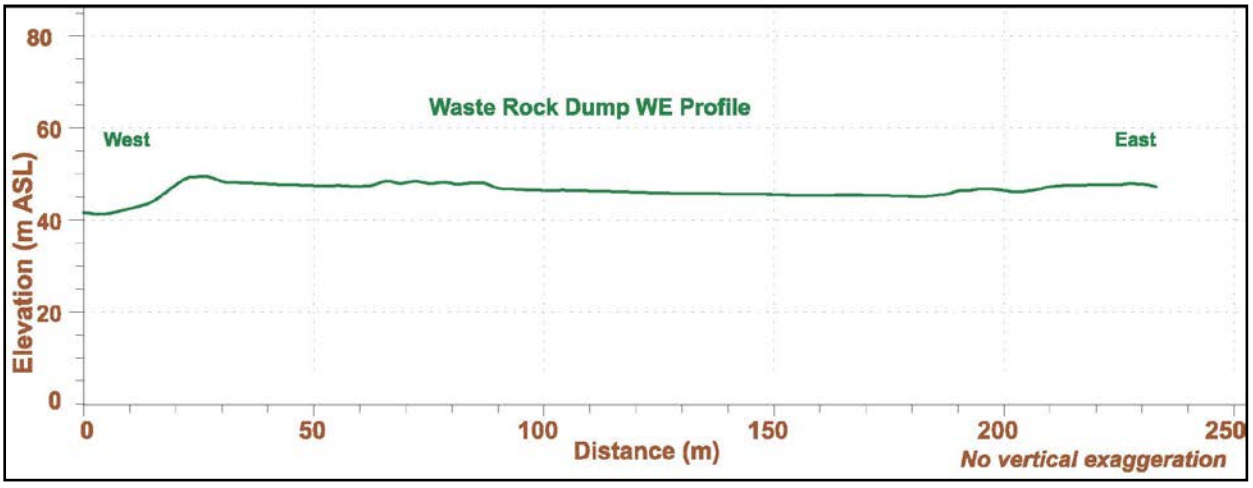


FIGURE 27 : WASTE ROCK DUMP CROSS SECTIONS



FIGURE 28 : WASTE ROCK DUMP BATTER (224 602 E, 7 450 249 N)



FIGURE 29 : WASTE ROCK DUMP MATERIAL (224 604 E, 7 450 255 N)

APPENDIX 1

DESCRIPTIONS AND PHOTOGRAPHS OF SAMPLES

APPENDIX 1 – BROLGA PROJECT SAMPLES

Figure 1 shows the locations of the samples. Descriptions are included in Table 1. Photographs are attached.

TABLE 1 - DESCRIPTION OF SAMPLES

SAMPLE	PHOTOGRAPH	DESCRIPTION	COMMENTS
Pit 1 Sample 1	1	Brown laterite, compact	Minor silt
Pit 1 Sample 2	2	Grey saprolite	Compact
Pit 2 Extension Sample 1	3	Whitish grey saprolite	Strong
Pit 2 Extension Sample 2	4	Brown oxidised saprolite	Heavy, strong
Pit 8 Sample 1	5	Whitish brown saprolite	Strong
Pit 8 Sample 2	6	Whitish saprolite	Strong
WRD Sample 1	7	Brown clayey, gravelly silt	Angle of repose 30°
Oversize Dump Sample 1	8	Greenish brown saprolite	Strong

224,500 225,000 225,500

7,451,000 7,450,500 7,450,000 7,449,500

Go Line Pad
Pit 8
Pit8 - Sample1
E 225,305 N 7,450,781
Pit8 - Sample2
E 225,277 N 7,450,749
Nontronite Stockpile
Top Pad
HR01
TS5
Top Pad
Pit 1
Pit1-Sample1
E 224,797 N 7,450,563
Pit1-Sample2
E 224,693 N 7,450,521
TS7
Pit 4
Pit 5
TS3
Pit 3
Oversized Dump OSD - Sample1
E 225,117 N 7,450,477
ROM
Pit2Ext - Sample1 (first terrace on base)
Pit2Ext - Sample2 (last terrace on top)
E 224,842 N 7,450,314
TS2
USLG Stockpile
WRD-Sample1
E 224,604 N 7,450,255
Pit 2 Extension
Pit 2
Low Grade Screened Stockpile
TS1
WRD1
HR01
S_Pit_05_OB
Sample_Pit_05
TS6
Dam_4
Dam_3

LEGEND

Disturbed areas

Brolga MLs - Geotechnical Report - Samples

Coordinate System: GDA 1994 MGA Zone 56
Datum: GDA 1994
Drawn By: John Bernal
Date: 24/10/2021

N

0 100 200 300 400
metres

1:4,426 at A3

FIGURE 1

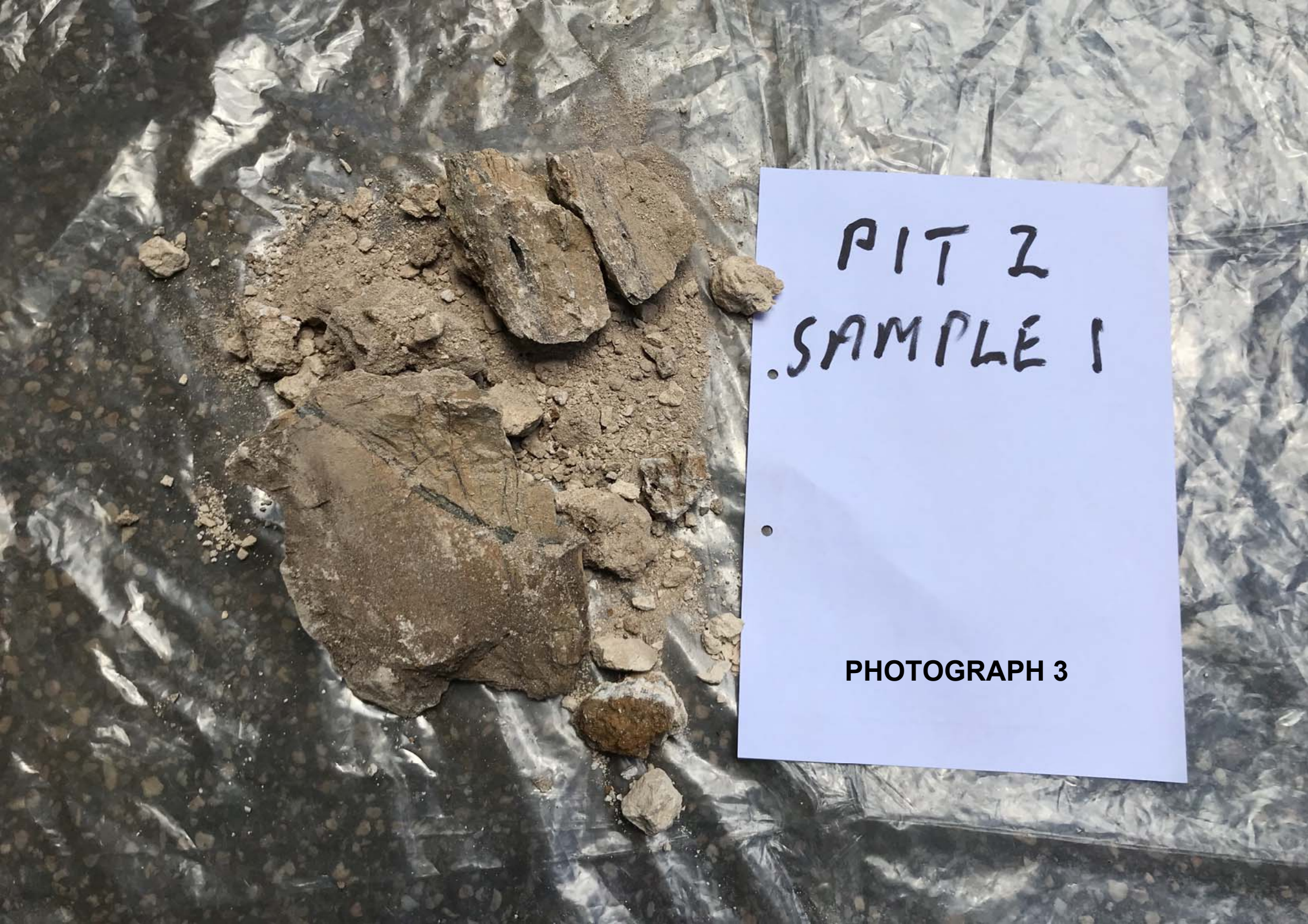
Path: C:\Users\jaber\OneDrive\Documents\ArcGIS\GIS\Maps\Malrborough Nickel\Brolga\Brolga Map _ Samples.mxd



PHOTOGRAPH 1



PHOTOGRAPH 2



PHOTOGRAPH 3



PHOTOGRAPH 4



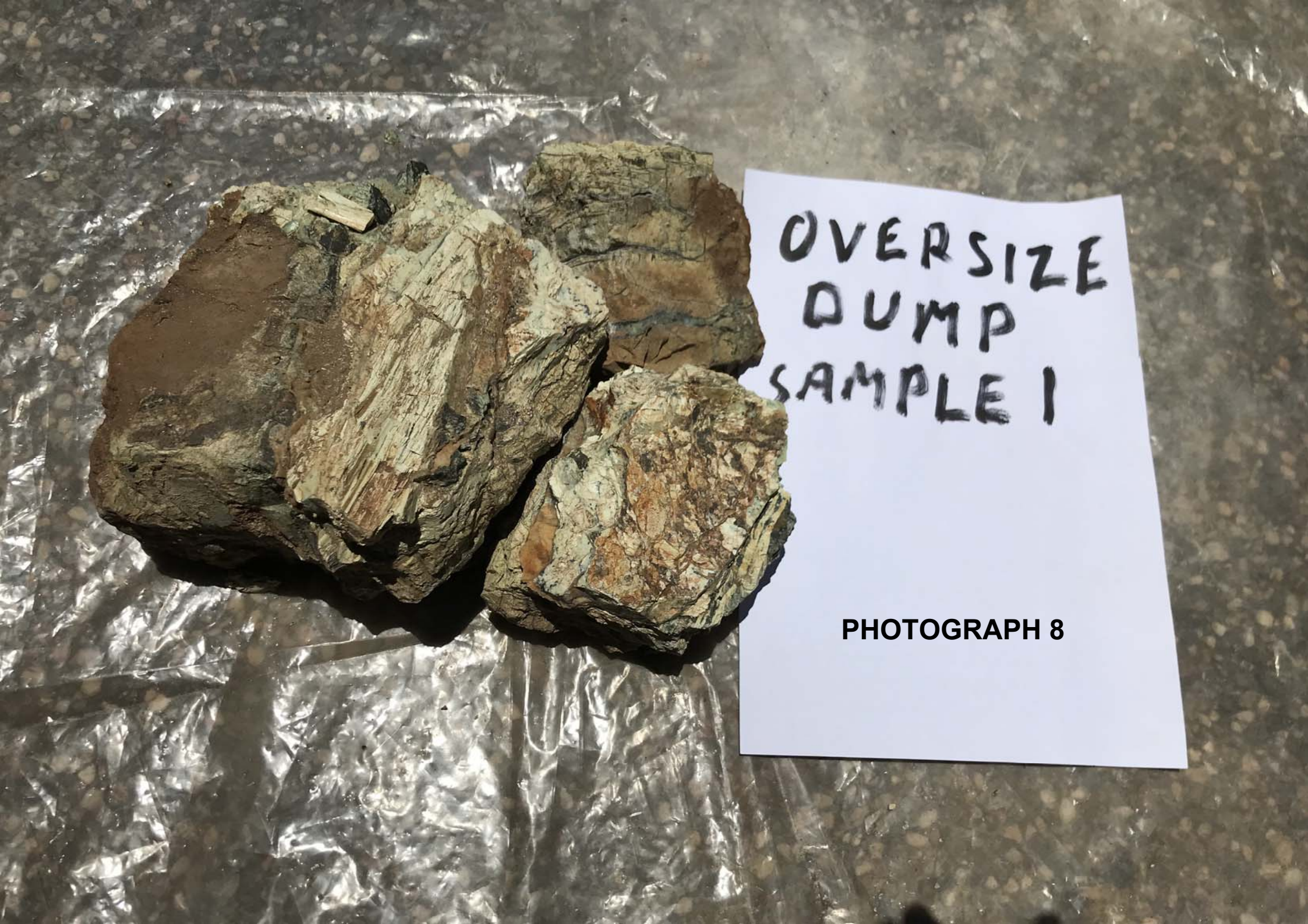
PHOTOGRAPH 5



PHOTOGRAPH 6



PHOTOGRAPH 7



PHOTOGRAPH 8

APPENDIX 2

DESIGN OF SAFETY BUNDS

Designs for highwall safety bunds in open cut coal mines

Correctly designed and cost-effective highwall bunds are essential for safety in large open cut coal mines

George Klenowski MAusIMM(CP), Manager, Australian Mining Engineering Consultants and Steven Winter MAusIMM, Technical Services Manager, Oaky Creek Coal Pty Ltd

Highwall and low wall stability are essential during open cut mining. Geotechnical investigations are required to quantify the mass and substance properties of soils and rocks within the mining horizons. The required minimum safety factor for open cut batters is 1.2. The effect of highwall mining and augering needs to be considered for long-term highwall performance.

Temporary highwall bunds are required for safety during open cut mining prior to the infilling of pits, and permanent highwall safety bunds are necessary to prevent public access to abandoned open cut final voids. Safety bunds should be located at adequate distances from highwall crest edges to ensure long-term integrity. There are a number of geotechnical features that affect highwall stability, including:

- depth of surface clay and weathered rock
- shear strength of soil and rock units
- batter angles for material types and the presence or absence of presplit blasting
- attitudes of structural defects such as faults and dykes
- the location of the water table and the influence of pore pressure
- subsidence caused by longwall undermining, highwall mining and highwall augering
- the presence of highwall spoil.

Material properties of overburden

Shear strength values have been determined for tertiary clay; completely, highly and moderately weathered mudstone; highly weathered claystone; completely weathered siltstone; highly weathered sandstone; fresh siltstone and fresh sandstone for use in slope stability analyses. The results listed in Table 1 are indicative of stable batter angles and can be used to calculate highwall safety factors.

Geological structures such as faults, intense jointing, bedding, folds, rolls and weathered dykes can affect slope integrity and require investigation.

For improved stability, highwalls are generally excavated at one (horizontal) to one (vertical) in clay and completely to highly weathered rock and 0.5 (horizontal) to one (vertical) in fresh rock. Presplit blasting facilitates highwall integrity. Safety benches are sometimes constructed at the base of weathering. Where there is a substantial surface thickness of tertiary clay and/or highly to completely weathered rock, advance benches are commonly excavated to maintain practical highwall geometries. Efficient drainage prevents highwall scour and degradation.

Highwall monitoring is recommended where highwall mining and augering have been completed to ensure ongoing stability.

Figure 1 shows a typical highwall after open cut and highwall mining. In Figure 2, spoil that has been dumped on the highwall is to be rehabilitated. Spoil is dumped on the highwall during dragline mining of the final strip if low wall placement becomes spoil bound.

Locating highwall safety bunds

Geotechnical assessments of the highwalls and underground mining subsidence effects are required prior to locating sites for bund construction. The bunds need to be constructed outside of the potentially unstable zones adjacent to the highwall crests. A guideline for safety bund walls around abandoned open pit mines was prepared by the Western Australian Department of Industry and Resources in 1997. No recommendations are available for highwall safety bunds adjacent to open cut coal mines in

Table 1. Shear strength of materials in open cut mines (after Klenowski, Ward and Xaykhamphoune, 1992).

Material	Friction (degrees)	Cohesion (kPa)	Dry density (t/m3)
Tertiary clay	20-40	15-40	1.9
Mudstone, completely weathered	20	60-100	1.9
Mudstone, highly weathered	24	60	1.9
Mudstone, moderately weathered	25	200	1.9
Claystone, highly weathered	40	50	2.0
Siltstone, completely weathered	43	60	2.0
Sandstone, highly weathered	38	60	2.1
Siltstone, fresh	33	3500	2.3
Sandstone, fresh	41-53	3500-6000	2.4



Figure 1. Exposed highwall after open cut and auger mining.


Figure 2. Spoil on highwall to be rehabilitated.

Queensland or New South Wales.

The extent of the potentially unstable highwall edge is generally related to the depth of surface clay and weathering. The following angles from the horizontal plus 10 m should be used as a guide for locating highwall safety bunds away from potentially unstable edges. Offset details (Figure 3) are as follows:

- an angle of 30° for clay and completely weathered rock
- an angle of 45° for highly weathered to slightly weathered rock
- an angle of 60° or greater for fresh rock.

Where highwall mining or augering has occurred, geotechnical monitoring is required to assess highwall stability and estimate the extent of long-term highwall edge deterioration. According to Geotechnical Consulting Services Pty Ltd (2016), a standoff distance of 10 m is recommended for highwall augering. Mining-induced subsidence is not considered deleterious to the integrity of offset highwall safety bunds. Where such bunds are also used as levees to divert water flows, any subsidence cracks require remediation to prevent leakage.

Specifications for highwall safety bunds

Safety bunds should be 2 m high with 2 m wide crests. The crests need to slope away from the highwall at one per cent. They are constructed as homogeneous embankments comprising either dozed or compacted earthfill or dumped rockfill. Bunds constructed from dumped rockfill are cheaper and easier to build. Fresh Permian spoil comprising sandstone and siltstone is a suitable rockfill. Bunds are primarily built for safety, but compacted earthfill bunds divert run-off water away from the highwall, particularly where the topographic surface downdip of the highwall slopes towards the highwall or there is a creek adjacent to the highwall.

Highwall monitoring is recommended where highwall mining and augering have been completed to ensure ongoing stability.

Temporary highwall safety bunds need to be cost-effective, easy to construct and stable until final voids are infilled. Permanent highwall safety bunds should be durable, erosion resistant and properly constructed.

Specification for rockfill safety bunds

Foundations for rockfill safety bunds need to be stripped of topsoil, which is stockpiled. Fresh Permian spoil or other suitable rockfill is to be used. Fill is dumped and trimmed using an excavator. Batter angles are one (vertical) on 1.5 (horizontal; Figure 4).

Spoil safety bunds can be constructed on the crests of rehabilitated,

Figure 3. Determination of offset distance for highwall safety bund.

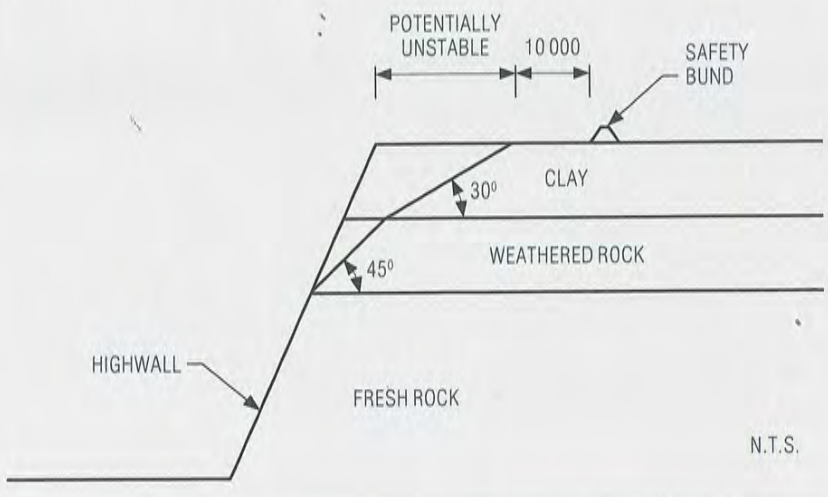
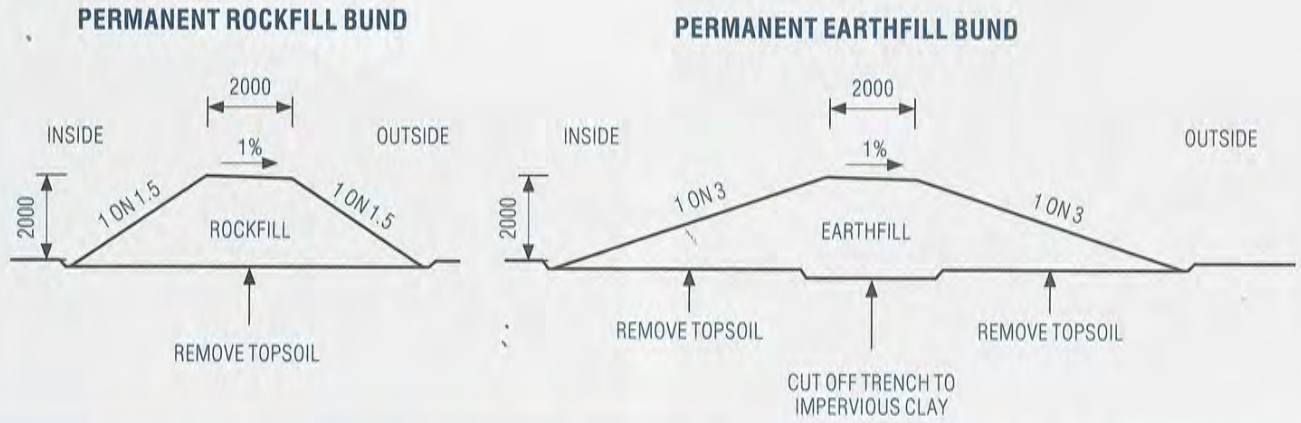


Figure 4. Highwall safety bund designs.



Open cut coal mines cover extensive areas, and cost-effective highwall bunds are required for safety.

geotechnically stable highwall spoil piles. These bunds are constructed using local spoil and have the same dimensions as permanent rockfill bunds.

Specifications for earthfill safety bunds

Temporary and permanent earthfill bunds can be constructed. Temporary earthfill bunds are only required during mining until final voids are infilled. Permanent earthfill bunds are constructed for safety and management of surface water flows.

Temporary earthfill bunds are constructed by a dozer pushing local earthfill after topsoil has been removed and stockpiled. Batters are generally one (vertical) on 1.5 (horizontal). Although earthfill quality control is not essential, erosion resistance can be improved by using non-dispersive soils. After final void infilling, temporary earthfill bunds need to be rehabilitated.

Permanent earthfill bunds require one (vertical) on three (horizontal) batters (Figure 4). Topsoil needs to be removed and a cut-off trench is required with excavation down to impervious clay. Good-quality, non-dispersive, impervious material is required for the permanent bund. The material should be a well-graded, sandy, silty clay with the following properties:

Liquid Limit WL 30-60 per cent
Plasticity Index Ip 15-45 per cent.

The first 1000 mm placed in contact with natural foundations should have a minimum of 20 per cent passing the 75 μm sieve. The Emerson dispersion class, as defined in Table 2, should be Class 4 or higher.

The minimum required density ratio is 100 per cent standard compaction at optimum moisture content ±2 per cent. The maximum dry density should be determined in accordance with Test No 5.1.1 (Standard Compaction) of AS 1289 for cohesive materials and in accordance with Test No 5.5.1 and 5.6.1 of AS 1289 for cohesionless materials.

The batters and crests need to be topsoiled and seeded for long-term erosion resistance.

Table 2. Emerson dispersion classification.

Class	Description
Class 1	Slaking and complete dispersion before remoulding.
Class 2	Slaking and some dispersion before remoulding.
Class 3	Slaking and no dispersion before remoulding, dispersion after remoulding.
Class 4	Slaking and no dispersion before remoulding, no dispersion after remoulding, calcite or gypsum present.
Class 5	Slaking and no dispersion before remoulding, no dispersion after remoulding, no calcite or gypsum present, dispersion after shaking in a 1:5 soil/water suspension.
Class 6	Slaking and no dispersion before remoulding, no dispersion after remoulding, no calcite or gypsum present, flocculation after shaking in a 1:5 soil/water suspension.
Class 7	No slaking, swelling occurs.
Class 8	No slaking, swelling does not occur.

Conclusions

Open cut coal mines cover extensive areas, and cost-effective highwall bunds are required for safety. Durable rockfill bunds are constructed using fresh Permian spoil consisting of sandstone and siltstone. Temporary earthfill bunds can be constructed using local clayey material. Permanent earthfill bunds are needed where surface water management from run-off and creeks is required adjacent to highwalls. Suitable clayey material is required for construction.

References

Department of Industry and Resources, 1997. Safety bund walls around abandoned open pit mines: guideline [online], Government of Western Australia. Available from: www.dmp.wa.gov.au/Documents/Safety/MSH_G_SafetyBundWallsAroundAbandonedMines.pdf

Geotechnical Consulting Services Pty Ltd, 2016. Stability of undermined highwalls (unpublished).

Klenowski G, Ward B and Xaykhamphoune P, 1992. An economically viable method of dragline mining in weak unstable ground at German Creek Mine, Central Queensland, in *Proceedings Third Large Open Pit Mining Conference* (The Australasian Institute of Mining and Metallurgy: Melbourne).



Consulting

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Queensland Nickel Pty Ltd

Ecosystem Function Analysis (EFA) for ML5866 (Brolga), Nickel Road, Kunwarara, Qld

FINAL REPORT – January 2012

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Executive Summary

Queensland Nickel Pty Ltd's (QNPL's) ML5866 – Brolga is a historic nickel ore mine approximately 53 kilometres north of Rockhampton, Queensland. The total area of the lease encompasses 203 hectares of undulating land positioned across Lots 174,177 and 167 on LN473. The mine site was decommissioned approximately 15 years ago. Following closure of the mine, the Study Site has been under the process of landform and vegetative rehabilitation to return it to its former land use as a grazing property.

Although rehabilitation has not been formally described as complete for this site (for which ownership and management responsibility remains with QNPL), the site is presently leased to a private landholder for grazing use. Land management practices in keeping with maintaining a grazing property are currently undertaken by the lessee with overarching responsibility for management remaining with QNPL.

CQG Consulting (CQG) was engaged by QNPL to undertake an assessment of the current rehabilitation status of ML5866.

Over two days in January 2012, a CQG Ecologist and Environmental Scientist performed an Ecosystem Function Analysis (EFA) across the Study Site. Information collected through the process of an EFA provides description of the functionality of the biogeochemical processes of the landscape through use of rapid assessable field indicators. The process assists in characterising soil quality, vegetation suites and structure composition across a site as functional indicators of rehabilitation performance and monitoring.

An EFA was performed across a total of six transects throughout the Study Site. In addition to soil quality and vegetation structure investigations, erosion, weeds and other environmentally relevant issues were also recorded. Transects were positioned with focus on areas of historic mine workings with accompanying reference transects placed outside of these areas (but within the mining lease) as a controls. The EFA has been performed in accordance with the CSIRO published manual by D. Tongway and N. Hindley (2004).

Ground cover across the Study Site was above 50 percent indicating that revegetation has had a visible positive impact. Some small areas, particularly those disturbed by historic mine workings and tracks, do contain bare dispersive soil with potential for erosion.

Vegetation and grass patches contribute greatly to the stability, infiltration and nutrient cycling of ML5866. Low indices for transects 001, 002 (historic mine workings) indicate that follow-up revegetation may be required in these specific areas.

The ecosystems on ML5866 are functioning successfully, although work is required to address the monoculture effect caused by the prevalence of Lantana and *Acacia* spp.

Weed control strategies are recommended to control both Lantana and GRT within the mining lease. The removal of lantana, which is currently contributing to soil stability and nutrient cycling, should be conducted in concert with revegetation activities such as planting of native seedlings and grasses to prevent the backtracking of the land condition. Weed control practices that do not involve the removal of the plant matter (i.e. herbicide spraying) will allow the remaining dead plant material to provide some soil erosion protection.

The current condition of ML5866 - Brolga is largely suitable for its target end use as grazing land.

1. Site Description

Queensland Nickel Pty Ltd's (QNPL's) ML5866 – Brolga, the Study Site, is a historic nickel ore mine approximately 53 kilometres north of Rockhampton, Queensland. The total area of the lease encompasses 203 hectares of undulating land across Lots 174,177 and 167 on LN473. The mine site was decommissioned approximately 15 years ago. Following closure of the mine, the Study Site has been under the process of landform and vegetative rehabilitation to return it to its former land use as a grazing property.

A desktop survey (search results are included in Appendix A) of the Study Site and immediate surround suggests the following ecological values may apply:

- Small areas of high value regrowth of least concern regional ecosystem are suggested along sections of the northern boundary of the Study Site;
- Potential presence of the threatened plant *Pimelea leptospermoides* (*Nature Conservation Act 1992* - near threatened, *Environmental Protection and Biodiversity Conservation Act 1999* – vulnerable) across the Study Site; and
- Within the area listed on the Register of National Estate (RNE) - Capricornia Serpentinite Landscape.

1.1 Site Characteristics

The Study Site is acknowledged for historic mining activity with subsequent rehabilitation and grazing land management practices. A small area of mapped regrowth in the form of eucalypt woodlands was identified on a section of the northern boundary of the mining lease. Artificial and naturally occurring ephemeral drainage lines exist across the Study Site in addition to contour banks approaching agricultural dams. Erosion is evident along tracks and at exposed soil areas. Several weed species were identified including extensive establishment of the class two noxious weed *lantana camara* (lantana).



Photograph 1.1: Active erosion along access track

1.2 General Ecological Condition

Earthworks and extensive clearing across the site as have resulted in a largely altered landscape. Subsequent erosion and weed establishment may impede the ecological recovery process.

Table 1.1 shows approximate areas of "bare soil" (determined as less than 50 percent cover) across the Study Site as being less than five hectares.

Table 1.1: Approximate areas of "bare soil" within ML5866 - Brolga

Disturbance	Approximate area of bare soil (Ha)
Main Access Track	2.9
Mine Workings #1	0.8
Mine Workings #2	0.4
TOTAL	4.1

Revegetation of the site has had a visible positive impact, with grass cover percentages generally well above 50 percent. The presence of lantana and other weeds has prevented most tree species (other than *Acacia spp*.) from taking hold creating a monoculture effect where dominant species thrive, reducing biological diversity. The land in its current condition is largely suitable for use as grazing land. The presence of non-native grasses and other weeds may also contribute to increased risk and severity of wildfire which would further impede natural rejuvenation of native species.

Vegetation across the site is dominated by grasses. Several individual *Eucalypt spp.* trees are scattered across the site, few appear to have been there prior to historic mining activities. Regrowth vegetation in the northern section of the mining lease consists of Eucalypt woodland. *Xanthorrhoea spp*. was also present in this area. Revegetated sites were dominated by pasture grasses, two species of Acacia and lantana.

1.3 Regional Ecosystems Vegetation

There are no regional ecosystems mapped for the Study Site. There are small areas of mapped regrowth vegetation that is a least concern regional ecosystem. While these areas were evident along the northern boundary of the site, the areas mapped by DERM in the southern extent of the site do not appear to exist on the ground.

1.4 Essential Habitat Mapping

There are no essential habitats mapped over this site (see Appendix A), although there is essential habitat allocated for the threatened plant *Pimelea leptospermoides* approximately one kilometre to the east. Its presence has not been recorded within the Study Site in desktop studies or during the EFA activities however the habitat and conditions required by *Pimelea leptospermoides* are present onsite.

1.5 Weeds

The declared weed species lantana (*Lantana camara*) exists over most of the disturbed areas, in impenetrable thickets in some places. Giant Ratstail grass (*Sporobolus pyramidalis*) was also present along access tracks, particularly in the eastern section of the Study Site.

The environmental weeds Snakeweed (*Stachytarpheta jamaicensis*), Guinea grass *(Megathyrsus maximus* var *maximus*) and Buffel grass (*Cenchrus ciliaris*) were also recorded. Due to the dry weather prior to the EFA being

undertaken, it is possible that other weeds are also present and laying dormant.

Table 1.2.2 outlines the weeds present, and their current declaration status under Queensland's *Land Protection (Pest and Stock Route Management) Regulation 2003* (LPA), as well as any other listing.

There are three categories of declared plants defined under the LPA:

- Class 1 - plants not commonly present in the State and, if introduced, would cause an adverse economic, environmental or social impact. Class 1 plants established in the State are subject to eradication;
- Class 2 - plants are established in the State and have, or could have, an adverse economic, environmental or social impact. Landowners must take reasonable steps to keep land free of Class 1 and Class 2 plants; and
- Class 3 - primarily environmental weeds where the plants are established in the State and have, or could have, and adverse economic, environmental or social impact. A pest control notice can only be issued for land that is, or is adjacent to, an environmentally significant area.

The Weeds of National Significance (WoNS) program coordinates the national effort against 20 of Australia's worst invasive plant species. Each WoNS specifies actions to better manage the weed.

Table 1.2: List of Weeds Present in ML5866 - Brolga

Name	Scientific Name	QLD Declaration Class	Other listings/comments
Lantana	*Lantana camara*	3	WoNS
Giant ratstail grass (GRT)	*Sporobolus pyramidalis*	2	Environmental weed
Snakeweed	*Stachytarpheta jamaicensis*	Not declared	Environmental and Agricultural weed
Guinea grass	*Megathyrsus maximus* var *maximus*	Not declared	Environmental weed (common pasture grass)
Buffel grass	*Cenchrus ciliaris*	Not declared	Environmental weed (common pasture grass)

Under both the LPA and local government legislation, landowners (and lessees) must take reasonable steps to keep their land free of Class 2 declared plants.



Photograph 1.2: Lantana within ML5866 (large shrubs with pink and orange flowers)

1.6 Referable Wetlands

This site does not lie within or adjacent to any wetlands management areas or associated trigger area (see Appendix C).

1.7 Other Ecological Values

1.7.1 Register of the National Estate

According to search results from the EPBC Act Protected Matters Report (Appendix A) the study site falls within an area listed as Capricornia Serpentinite Landscape on the Register of the National Estate (RNE). This encompasses an area of approximately 1,000 square kilometres of serpentinite landscape in Central Queensland.

This area is distinctive for low fertility soils with high concentrations of heavy metals, making it of great interest to researchers and miners. Several unique plant species exist in this area with the ability to hyperaccumulate nickel, magnesium and manganese from the soil. Due to this harsh environment, this area also has the highest level of endemism of any serpentinite area in Australia and also contains a number of species of conservation significance.

2. Ecosystem Function Analysis

2.1 Introduction

Rehabilitation monitoring using the EFA methodology focuses on qualifying the critical functional processes occurring within an ecosystem such as nutrient cycling, water flow, retention and availability, topsoil quality and organic matter content. The EFA process is comprised predominantly of a Landscape Function Analysis (LFA), with additional measures of vegetation and habitat complexity.

The LFA methodology was developed by the CSIRO and provides a field monitoring method successfully constructed to assess mine site rehabilitation progress. The method employs indicators such as soil stability, soil infiltration and nutrient cycling indices to assess and determine the functional status of the landscape.

Long term monitoring over the rehabilitation of a site using EFA methodology has the potential to provide information that quantifies and qualifies the rehabilitation efforts and potentially estimates final rehabilitation timelines and other supporting information for management decisions.

A total of six transects (Figure 2.1) were selected to encompass the historic mine workings as well as reference sites outside of this areas (but still within ML5866). Transects 001 – 002 were located on historic mine workings, transect 003 was located within the mapped significant regrowth in the northern section on ML5866 ("woodland" analogue site). The area of Transect 004 also appears to have been heavily disturbed previously and transects 005 - 006 were located within areas identified by CQG as "grazing" analogue sites (i.e. sites representative of the target final land use).

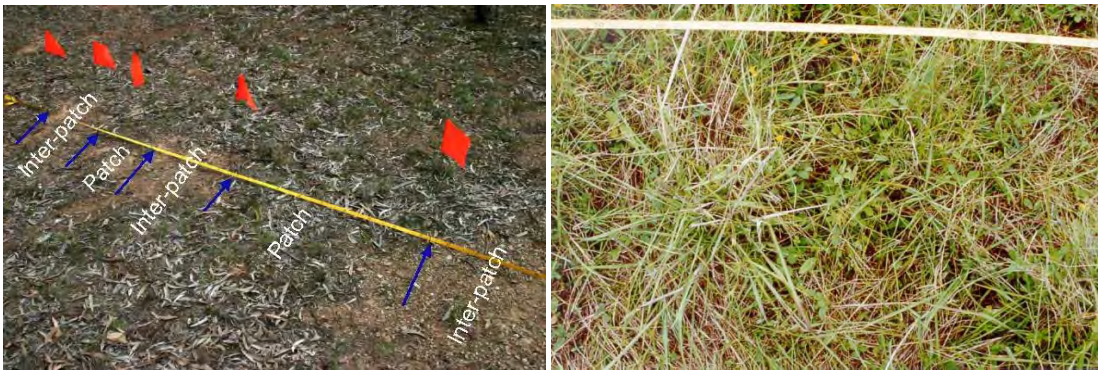
2.2 Landscape Characterisation/Organisation

2.2.1 Methodology

Each of the six transects were identified by their GPS position, gradient of slope, directional heading and a visual description including photographs. A continuous record of patch/inter-patch classification was collected along the 50 metre transect. The transect was permanently located (white wooden pickets were placed in the ground) to facilitate repeated measurements in the future if required.

Patches are long lived features (e.g. perennial grass plants, large rocks, etc.) which obstruct or divert water flow and/or collect/filter out sediment materials carried by stormwater runoff. They display clear evidence of resource accumulation. Inter-patches are the "bare" sections between patches, where no obstruction of material occurs.

Not all landscapes have a patch/inter-patch organisation. As grasslands become denser, there comes a point when litter and soil are no longer mobile and transported by flowing water. The patch is then a large area comprised of a sward made up from a large number of functionally linked plants acting as a single unit rather than a series of isolated individuals. This was the case for several of the transects investigated as a part of this EFA. These have been recorded as "swards" and given a value of 10,000 centimetres (10 metres) in data analysis.



Photograph 2.1: Example of a patch/inter-patch organisation (left) and a grass sward (right)

224000

003
001
002
006
004
005

7450000

224000

Legend

ML5866

Historic Mine Workings

Transect

N

Scale 1:7,500 (A3)

0 100 200 400 600

Metres

Map Projection: Map Grid of Australia 1994 Zone 56

Figure: 2.1 - QNPL ML5866- Brolga
Project: QNI Brolga
Date: 13/01/2012 **Author:** R. Hearn
Document Path: EFA Transects

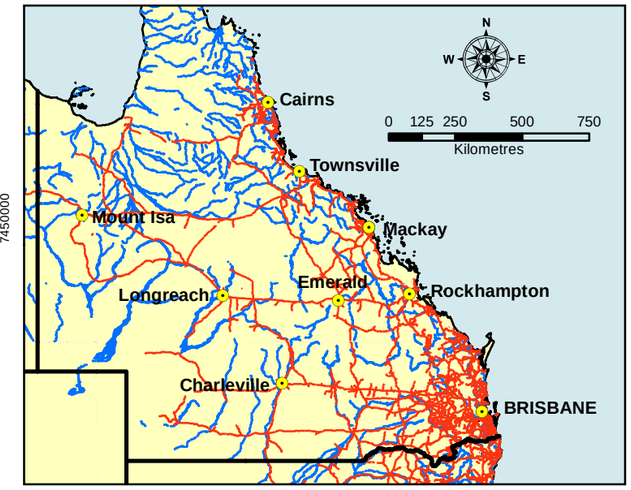


Figure 2.1:
Queensland Nickel Pty. Ltd.
ML5866- Brolga
EFA Transects

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2.2.2 Findings

Each of the six transects generally consisted of a mixture of four zones, as follows:

- Bare soil (BS);
- Bare with rocks (BR) – bare soil with small rocks/gravel;
- Grass only patch (GP) – patches made up only of grass and small herbage; and
- Vegetation patch (VP) – patches made up of perennial grass, shrubs and trees.

From the landscape organisation data, the boundaries of the functional zones enable the calculation of the proportion of each (Table **2**.1 and Table 2.2).

Table 2.1: The percentage (%) of each functional zone for ML5866 – Brolga transects

Transect	BS	BR	GP	VP
001	13.0%	28.4%	52.1%	6.5%
002	-	43.3%	2.8%	53.9%
003	17.6%	26.3%	20.7%	35.4%
004	1.4%	-	-	98.6%
005	-	-	-	100%
006	1.2%	-	98.8%	-

Table 2.2: Percentage of bare ground and ground cover summarised for each transect

Transect	Bare Ground	Ground Cover
001	41.4%	58.6%
002	43.3%	56.7%
003	43.9%	56.1%
004	1.4%	98.6%
005	0%	100%
006	1.2%	98.8%

As the information in Table 2.2 indicates, although the ground cover percentage (in the form of grass, shrubs and trees) is above 50 percent at each transect, it is only marginally above for Transects 001 to 003. The shade of canopy trees restricting the growth of ground species accounts for this at Transect 003, even though the trees themselves are distantly spaced. The percentages in Transects 004 to 006 are very good, although Lantana does contribute to the results for Transect 004.

2.3 Soil Surface Assessment

2.3.1 Methodology

Each patch/inter-patch type identified in the landscape organisation has soil surface properties classified utilising the Soil Surface Assessment (SSA) methodology as described by D. Tongway and N. Hindley (2004). This included an assessment of the following:

- Rainsplash protection – the degree to which physical surface cover and projected plant cover ameliorate the effect of raindrops impacting on the soil surface;
- Perennial vegetation cover – estimation of the basal cover of perennial grass and/or the density of canopy cover of trees and shrubs;
- Litter – assessment of the amount, origin and degree of decomposition of plant litter;
- Cryptogram cover – assessment of the cover of cryptograms visible on the soil surface;
- Crust brokenness – extent that the soil surface is broken;
- Soil erosion type and severity – assessment of the type and severity of recent/current soil erosion;
- Deposited Materials – the nature and amount of alluvium recently transported to and deposited within the query zone;
- Soil surface roughness – assessment of the surface roughness for its capacity to capture and retain mobile resources;
- Surface Nature (resistance to disturbance) – the ease with which the soil can be physically disturbed to release material suitable for removal by wind or water;
- Slake test – assessment of the stability of natural soil fragments when rapidly wetted; and
- Soil surface texture – assessment of the texture class of the surface soil.

2.3.2 Findings

The SSA data is utilised to calculate indices for stability, infiltration and nutrient cycling (Table 2.3).

Table 2.3: The SSA indices of stability, infiltration and nutrient cycling for each ML5866 – Brolga transect

	Stability Index				Infiltration Index				Nutrient Cycling Index			
Transect	BS	BR	GP	VP	BS	BR	GP	VP	BS	BR	GP	VP
001	41.3	45.0	60.0	57.5	20.1	14.0	21.1	29.8	17.0	11.6	16.3	37.9
002	-	43.3	46.9	89.3	-	13.2	15.1	78.2	-	10.3	12.8	82.1
003	55.6	55.6	55.6	55.6	31.6	31.6	31.6	31.6	27.9	27.9	27.9	27.9
004	55.6	-	-	85.4	33.9	-	-	74.3	25.6	-	-	83.1
005	-	-	-	80.6	-	-	-	69.1	-	-	-	74.4
006	68.8	-	81.3	-	42.9	-	64.5	-	44.7	-	76.3	-

Using the data in Table 2.1 and Table 2.3 the contribution of each zone type to the overall mining lease index were calculated (Table 2.4).

Table 2.4: The contribution of each zone to the whole of ML5866 – Brolga

	Stability Index				Infiltration Index				Nutrient Cycling Index			
Transect	BS	BR	GP	VP	BS	BR	GP	VP	BS	BR	GP	VP
001	5.4	12.8	31.3	3.7	2.6	4.0	11.0	1.9	2.2	3.3	8.5	1.8
002	-	18.8	1.3	48.1	-	5.7	0.4	42.2	-	1.1	0.4	44.2
003	9.8	14.6	11.5	19.7	5.6	8.3	6.5	11.2	4.9	7.3	5.8	9.9
004	0.8	-	-	84.2	0.5	-	-	73.2	0.4	-	-	82.0
005	-	-	-	80.6	-	-	-	69.1	-	-	-	74.4
006	0.8	-	80.3	-	0.5	-	63.7	-	0.5	-	75.4	-

Figures 2.2 to 2.4 illustrate the proportion each zone contributes to the overall mining lease index.

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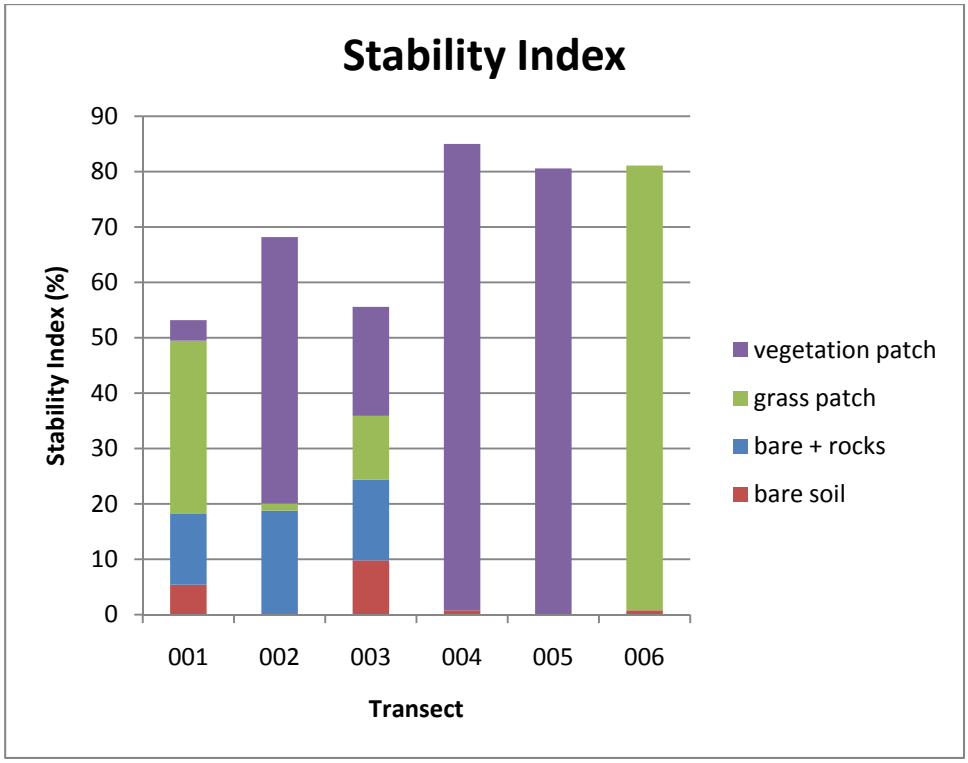


Figure 2.2: The contribution of each zone to the stability index

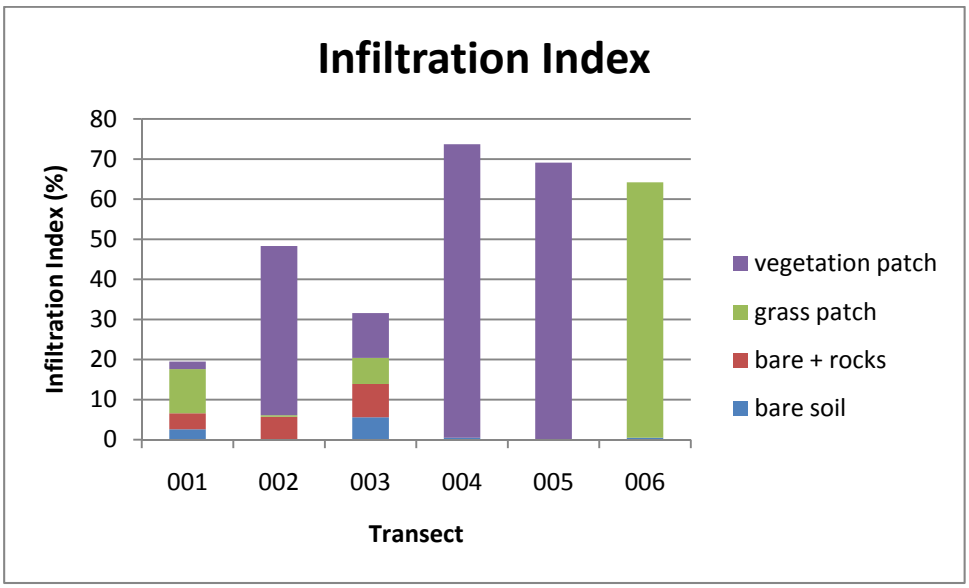


Figure 2.3: The contribution of each zone to the infiltration index

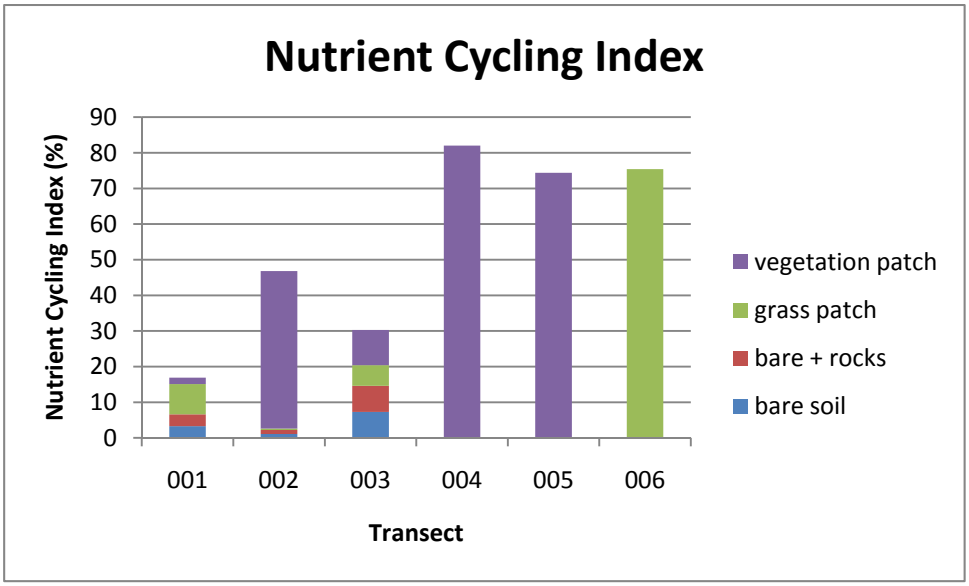


Figure 2.4: The contribution of each zone to the nutrient cycling index

Figures 2.2 to 2.4 show that Transect 004 displays the highest indices (percentages) for stability, infiltration and nutrient cycling. This is in part due to the presence of Lantana at that location. The high indices for Transects 005 and 006 also indicate that these areas are functioning well as a landscape.

2.4 Interpretational Framework

Long-term monitoring using the EFA process enables elucidation as to the functional status of an ecosystem and quantification and qualification of rehabilitation progress across a site. An EFA may also assess the current functional condition of a site when performed as a snapshot technique.

For this Study Site continued monitoring using the EFA methodology will support quantification and qualification of rehabilitation progress into the future.

2.5 Vegetation Dynamics

Vegetation has a functional role in not only providing suitable habitat, food and shelter, but also soil stability, infiltration and nutrient cycling. Typically, vegetation monitoring looks at species composition and structure.

As ML5866 has been historically cleared there are few adult trees present and limited canopy. There were no trees present greater than approximately 15 metres tall with the exception of regrowth in the northern section of the site. Vascular plants that were present on ML5866 were predominantly shrubby *Acacia* spp. and Lantana. Diversity of vascular plants was limited to between three and five species.

Grasslands themselves have an important role in an ecosystem, providing soil stability, nutrient cycling, habitat and food source. In general terms the ecosystems on ML5866 are functioning successfully, although work is required to address the monoculture effect caused by the prevalence of Lantana and *Acacia* spp.

2.6 Habitat Complexity

As vegetation develops in size and diversity the faunal habitat structure becomes more complex and more conducive to faunal colonisation. As vegetation diversity increases, shade, shelter and food resources for fauna

are created.

The “habitat complexity” index assesses the extent to which habitat and shelter for vertebrate fauna are developing. Habitat complexity is assessed on the basis of five features:

- Canopy cover;
- Shrub cover;
- Ground vegetation cover;
- The amount of litter, fallen logs and rocks; and
- Free water availability.

A general assessment for the overall habitat present within ML5866 was undertaken during the EFA field assessment (Table 2.5). The higher a score, the more that feature contributes to habitat complexity.

Table 2.5: The features and scores for the habitat complexity scores

Structure	Score/Index
Tree Canopy	1
Shrub Canopy	2
Ground Herbage	3
Logs, Rocks, Debris, etc.	2
Soil Moisture	1

As Table 2.5 indicates, ground herbage contributes the most to habitat complexity within ML5866. This is due to the general “grassland” nature of site. Shrub canopy also contributes due to the presence of Acacia spp. and Lantana.

3. Conclusions and Recommendations

As is evidenced by the Landscape Characterisation (Section 2.2) ground cover across the site is above 50 percent. Some small areas (estimated at less than five hectares) across site are bare, particularly the access tracks and patches within the historic mine workings.

Vegetation and grass patches contribute to the stability, infiltration and nutrient cycling of ML5866, although the low indices for transects 001, 002 (historic mine workings) indicate that secondary revegetation should be considered in these specific areas.

The ecosystems on ML5866 are functioning successfully, although additional effort is required to address the monoculture effect developing as a result of the dominance of Lantana and *Acacia* spp.

Weed control strategies should be implemented to control both Lantana and GRT within the mining lease. The removal of lantana, which is currently contributing to soil stability and nutrient cycling, will need to be conducted in concert with revegetation activities such as planting of native seedlings and grasses to prevent the backtracking of the land condition. Weed control practices that do not involve the removal of the plant matter (i.e. herbicide spraying) will allow the remaining dead plant material to provide soil erosion protection.

The current condition of ML5866 - Brolga is largely suitable for its target end use as grazing land.

APPENDIX A:

Desktop Search Results



Map of Referable Wetlands
Wetland Protection Areas

Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.18.40

Centered on Lot on Plan:
177 LN473

Legend

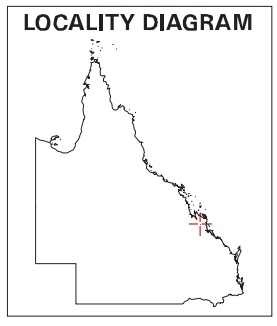
- Selected Land Parcel
- Property Boundary

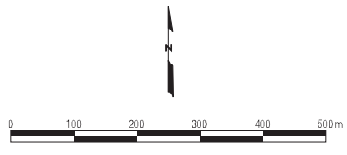
Wetland Protection Areas

- HES Wetland
- Trigger Area

Queensland Government

LOCALITY DIAGRAM





This scale bar is approximate only
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
This product is unprojected and is not suitable for measuring distances

Note:
This map shows the location of wetland protection areas which are defined under the Environmental Protection Regulation 2008.

Within wetland protection areas, certain types of development involving high impact earthworks are made assessable under Schedule 3 of the Sustainable Planning Regulation 2009.

The Department of Environment and Resource Management has been made a concurrence agency under Schedule 7 of the Sustainable Planning Regulation 2009 for assessable development involving high impact earthworks within wetland protection areas.

The policy outcome and assessment criteria for assessing these applications are described in the State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments.

This map is produced at a scale relevant to the size of the lot on plan identified and should be printed at A4 size in portrait orientation. Consideration of the effects of mapped scale is necessary when interpreting data at a large scale.

For further information or assistance with interpretation of this product, please contact the Department of Environment and Resource Management at <www.derm.qld.gov.au> or email <planning.support@derm.qld.gov.au>.

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Map of Referable Wetlands
Wetland Management Areas

Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.18.41

Centered on Lot on Plan:
177 LN473

Legend

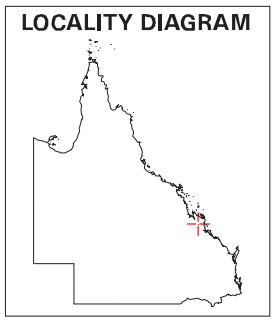
Selected Land Parcel
Property Boundary

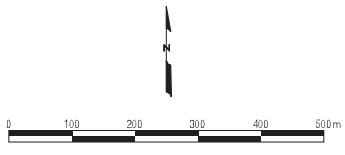
Wetland Management Areas

Wetland
Trigger Area

Queensland Government

LOCALITY DIAGRAM





This scale bar is approximate only
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
This product is unprojected and is not suitable for measuring distances

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Map of Referable Wetlands
Wetland Protection Areas

Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.18.38

Centered on Lot on Plan:
176 LN473

Legend

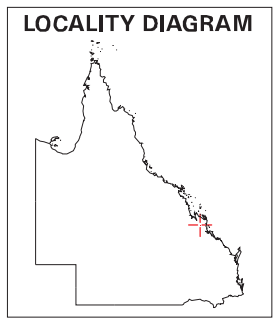
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Property Boundary

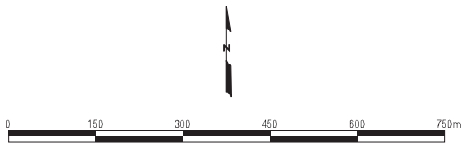
Wetland Protection Areas

HES Wetland
Trigger Area

Queensland Government

LOCALITY DIAGRAM





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Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
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Map of Referable Wetlands
Wetland Management Areas

Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.18.39

Centered on Lot on Plan:
176 LN473

Legend

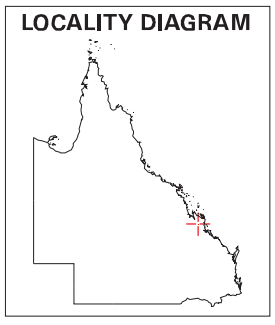
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Property Boundary

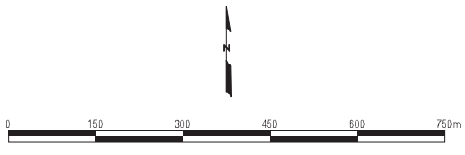
Wetland Management Areas

Wetland
Trigger Area

Queensland Government

LOCALITY DIAGRAM





This scale bar is approximate only
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
This product is unprojected and is not suitable for measuring distances

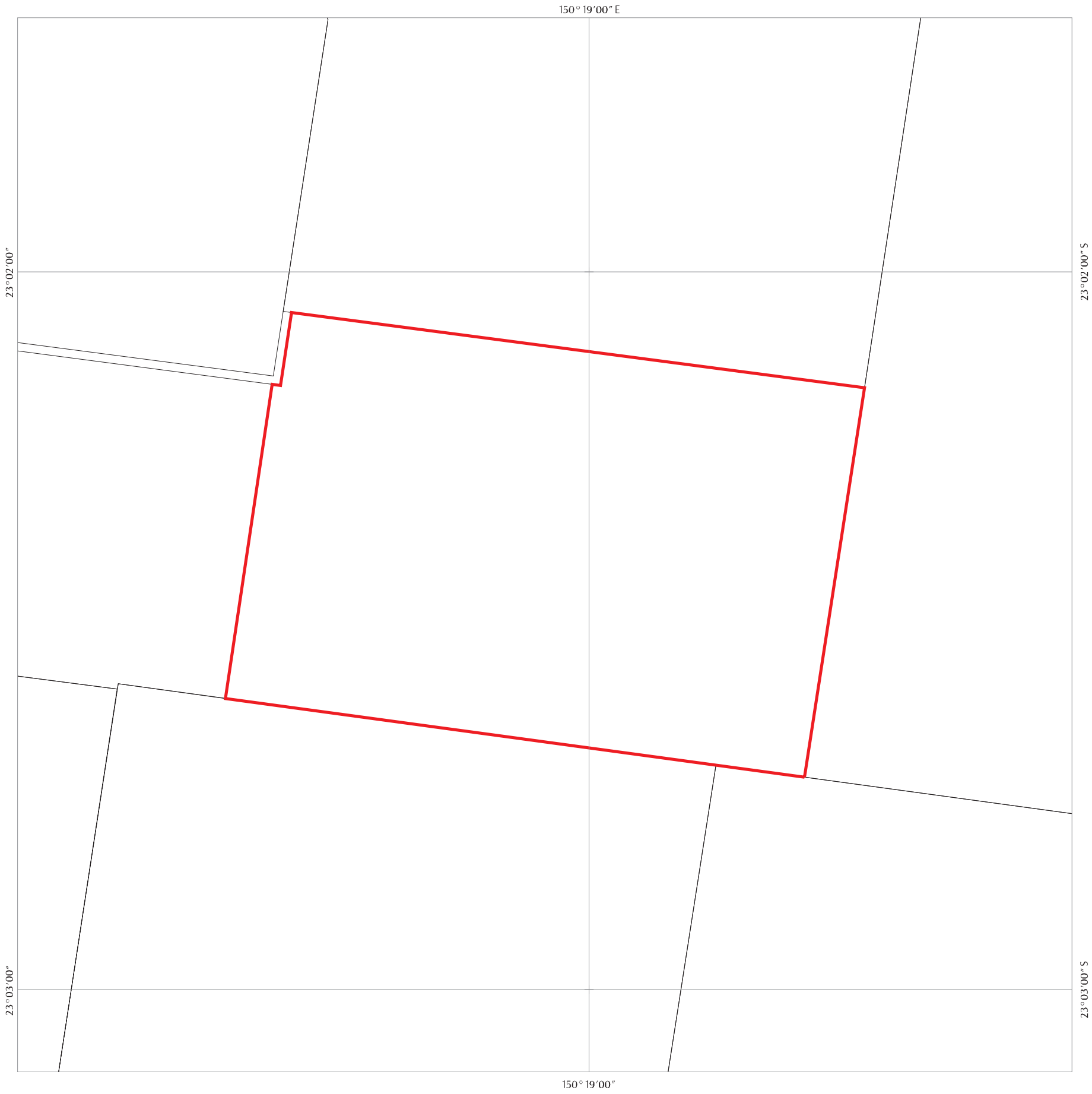
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Map of Referable Wetlands
Wetland Protection Areas

Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.18.45

Centered on Lot on Plan:
174 LN473

Legend

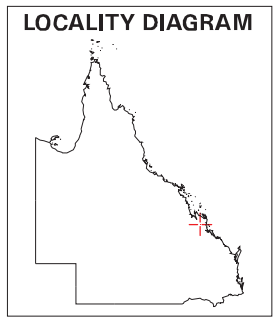
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- Property Boundary

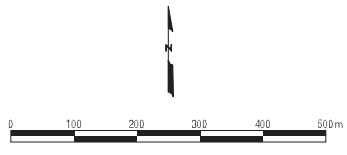
Wetland Protection Areas

- HES Wetland
- Trigger Area

Queensland Government

LOCALITY DIAGRAM





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Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
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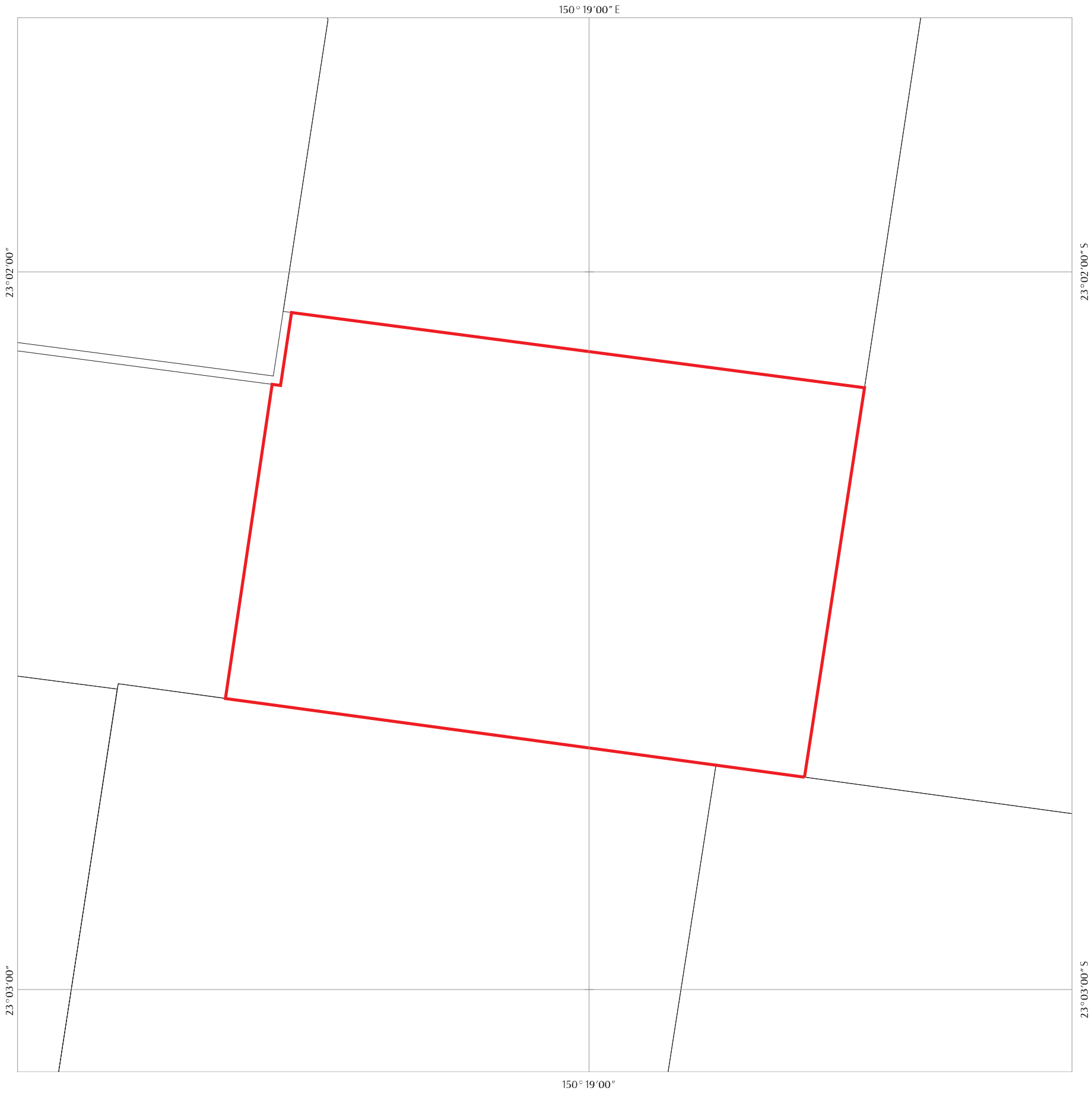
The Department of Environment and Resource Management has been made a concurrence agency under Schedule 7 of the Sustainable Planning Regulation 2009 for assessable development involving high impact earthworks within wetland protection areas.

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Map of Referable Wetlands
Wetland Management Areas

Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.18.46

Centered on Lot on Plan:
174 LN473

Legend

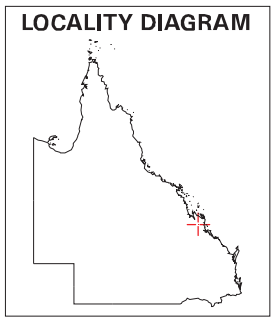
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- Property Boundary

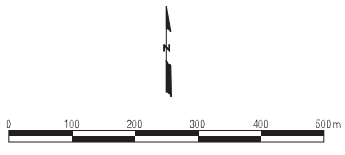
Wetland Management Areas

- Wetland
- Trigger Area

Queensland Government

LOCALITY DIAGRAM





This scale bar is approximate only
Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)
This product is unprojected and is not suitable for measuring distances

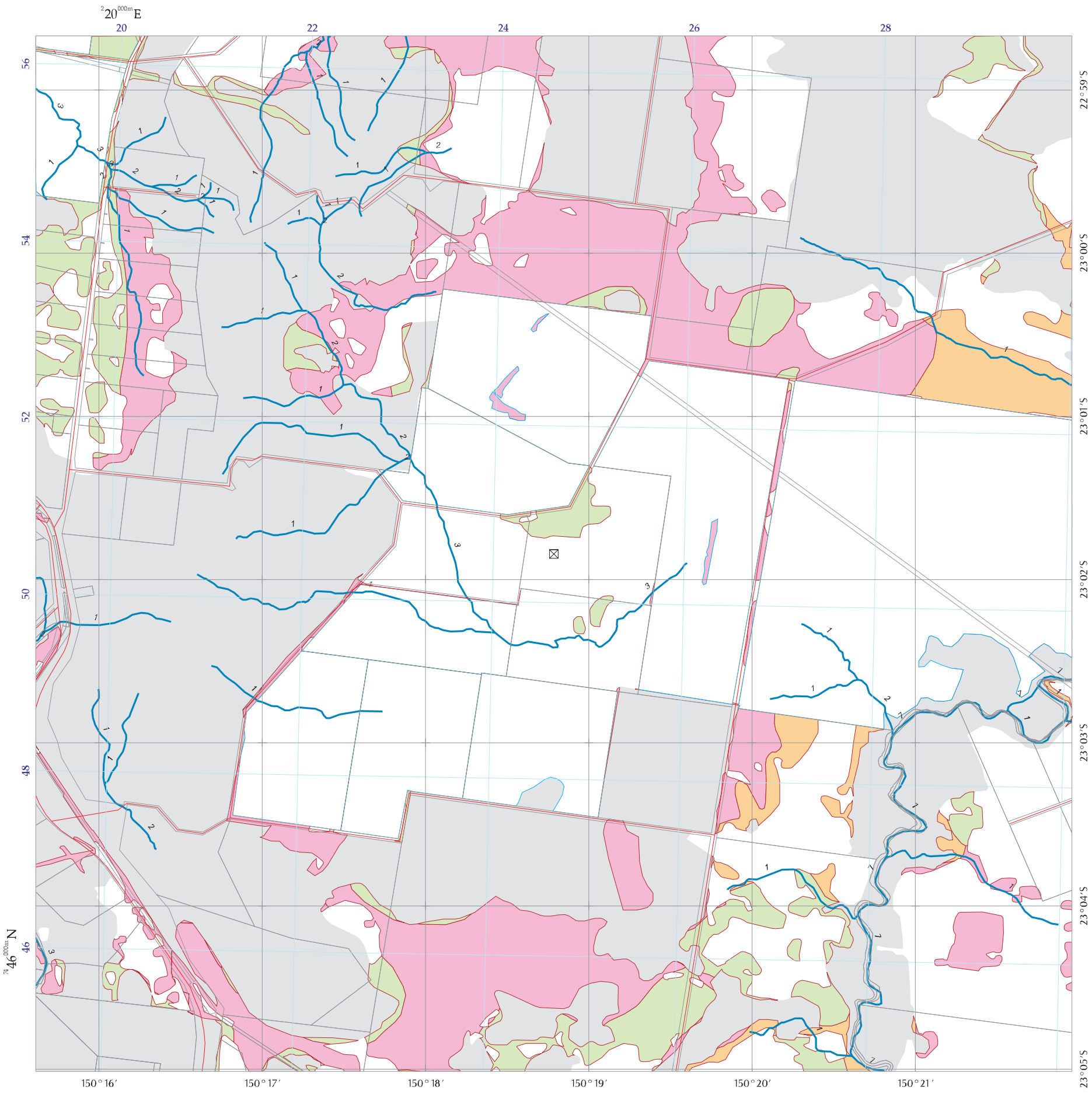
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REGROWTH VEGETATION MAP - Version 2.1

1087 Vegetation Management Act Essential Regrowth Habitat with example label number

Great Barrier Reef Wetland Protection Area

High value regrowth vegetation containing Endangered regional ecosystems

High value regrowth vegetation containing Of Concern regional ecosystems

High value regrowth vegetation that is a Least Concern regional ecosystem

Remnant Vegetation
(Refer to the Vegetation Management Act Regional Ecosystem and Remnant Map also available from the Department of Environment and Resource Management website for further information on these areas)

Non-remnant

PMAV Category X area

Regrowth watercourse (Stream order shown as black number against stream)

Other watercourse(Stream order shown as black number against stream where available)

Subject Lot

Roads
© Pitney Bowes Business Insight 2011

Cadastral line
Property boundaries shown are provided as a locational aid only.

Towns

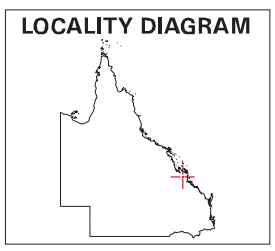
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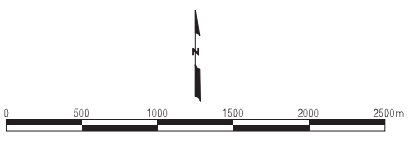
Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.18.18

Centered on Coordinate:
Latitude: -23.0307 Longitude: 150.3131 (decimal degrees)

Queensland Government

LOCALITY DIAGRAM





Labels for Vegetation Management Act Essential Regrowth Habitat are centred on the subject lot.
Labels correlate to the label field in the attached essential regrowth habitat database.

The high value regrowth, regrowth watercourse, other watercourse, Great Barrier Reef wetland protection area and essential regrowth habitat data shown on this map are representations of the preliminary data.

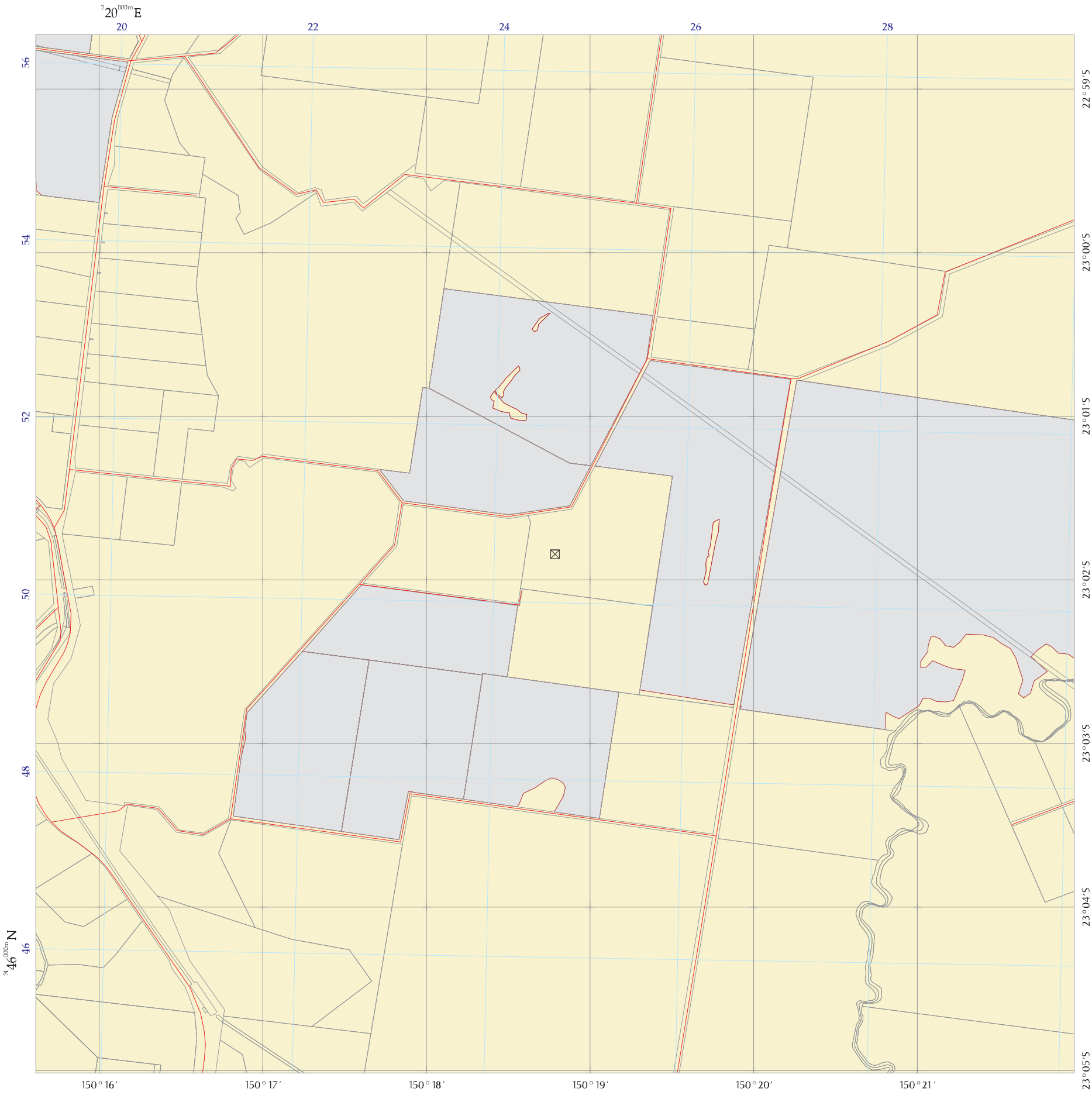
Some watercourse lines are derived from GeoScience Australia 1:250 000 mapping.

For further information go to the website:
http://www.derm.qld.gov.au or contact Vegetation Management, Department of Environment and Resource Management.

Areas covered by a Property Map of Assessable Vegetation (PMAV) are represented on the map attached as Page 2 to this Regrowth Vegetation Map and provided with it.

Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

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Property Maps of Assessable Vegetation (PMAVs)

Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.18.20

Centered on Coordinate:
Latitude: -23.0307 Longitude: 150.3131 (decimal degrees)

The PMAV data shown on this map are a representation of the data used to create certified PMAVs. Variations may occur between PMAV boundaries and cadastral boundaries. PMAV data incorporates cadastral boundary data as at the time of certification of the PMAV. The cadastral boundaries shown on this map may have shifted relative to the PMAV boundaries as more accurate cadastral boundary data have become available.

All datasets are updated as they become available to provide the most current information as of the date shown on this map.

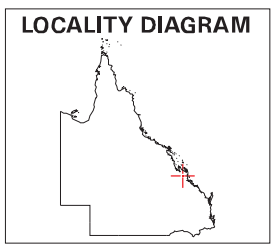
For further information go to the website:
http://www.derm.qld.gov.au/vegetation/index.html
or contact Vegetation Management, Department of Environment and Resource Management.

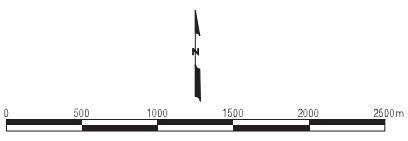
Property Map of Assessable Vegetation Vegetation Category Area

- Category A area
- Category B area
- Category C area
- Category X area
- Area that is subject to other PMAVs or, if no PMAV exists, a regional ecosystem map, remnant map or regrowth vegetation map
- Subject Lot
- Roads
  © Pitney Bowes Business Insight 2011
- Cadastral line
  Property boundaries shown are provided as a locational aid only.
- Towns
- ⊠ Coordinate entered

Queensland Government

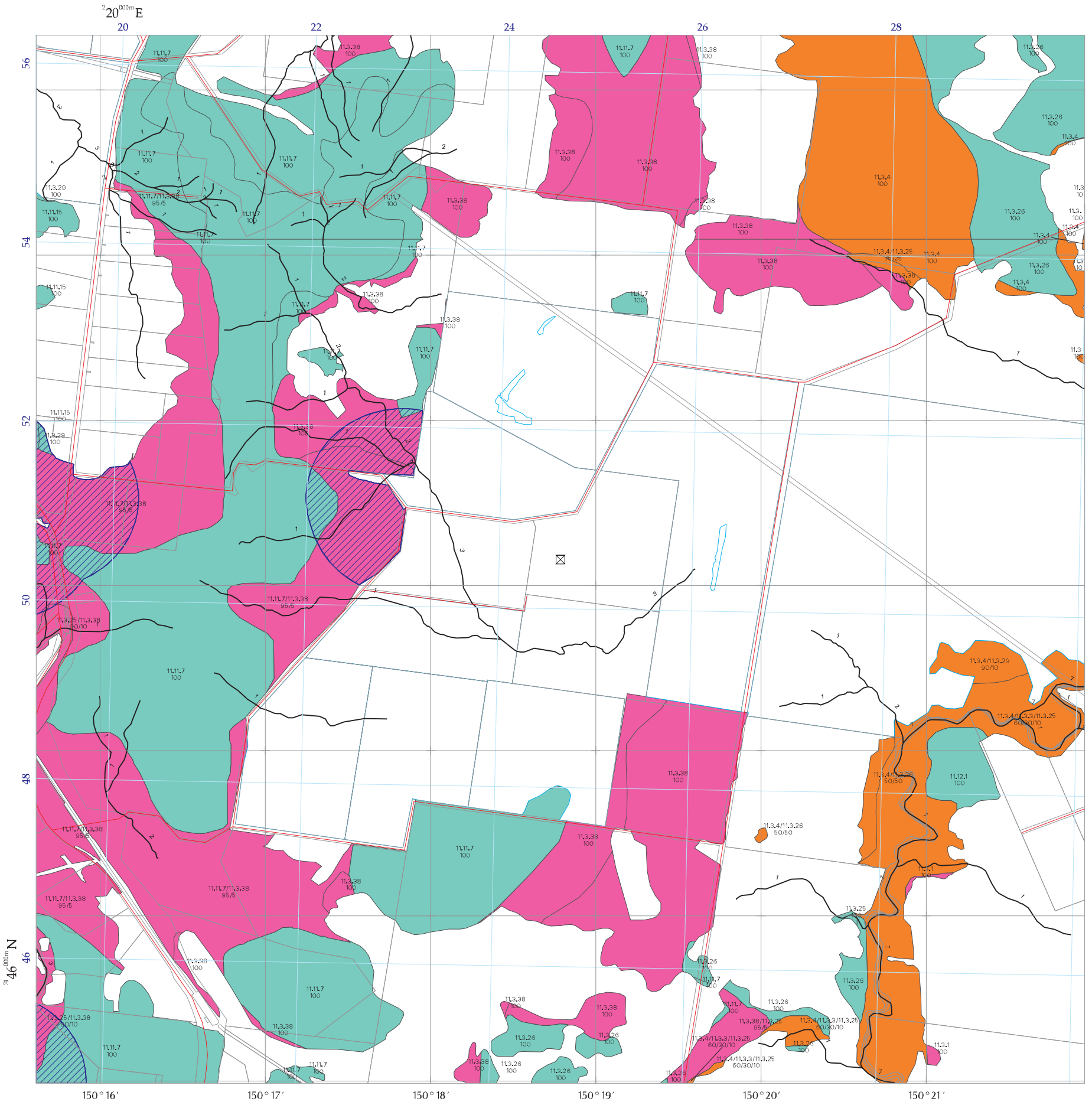
LOCALITY DIAGRAM





Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

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Vegetation Management Act Regional Ecosystem and Remnant Map-Version 6.1

Based on 2006 Landsat TM imagery

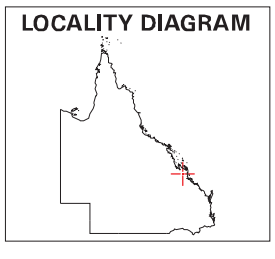
Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.17.56

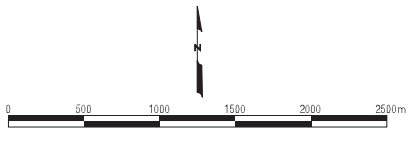
Centered on Coordinate:
Latitude: -23.0307 Longitude: 150.3131 (decimal degrees)
Bioregion: Brigalow Belt

- Remnant vegetation containing endangered regional ecosystems
- Remnant vegetation containing of concern regional ecosystems
- Remnant vegetation that is a least concern regional ecosystem
- Remnant vegetation under Section 20AH of the VMA
- Non-remnant
- Plantation Forest
- Dam or Reservoir
- Remnant Vegetation
- PMAV Category X area
- Great Barrier Reef Wetlands
- Vegetation Management Act Essential Habitat
  For further information on VMA Essential Habitat, please see the attached VMA Essential Habitat map.
- Subject Lot
- Watercourse (Stream order shown as black number against stream where available)
- Bioregion boundary
- Roads
  © Pitney Bowes Business Insight 2011
- National Park, Conservation Area State Forest and other reserves
- Cadastral line
  Property boundaries shown are provided as a locational aid only.
- Towns
- Coordinate entered

Queensland Government

LOCALITY DIAGRAM





A remnant map covers areas not covered by a regional ecosystem map.

Defined map areas are labelled with the regional ecosystem (RE) code along with the percentage breakdown if more than one RE occurs within the area. Detailed definitions of regional ecosystems are available from www.derm.qld.gov.au/REDD. Defined map areas smaller than 5ha may not be labelled.

Regional ecosystem linework has been compiled at a scale of 1:100 000, except in designated areas where a compilation scale of 1:50 000 is available. Linework should be used as a guide only. The positional accuracy of RE data mapped at a scale of 1:100 000 is +/-100 metres. The extent of remnant regional ecosystems as of 2006, depicted on this map is based on rectified 2006 Landsat TM imagery (supplied by the Statewide Landcover and Trees Study (SLATS), Department of Environment and Resource Management (DERM)).

Some watercourse lines are derived from GeoScience Australia 1:250 000 mapping.

Disclaimer:
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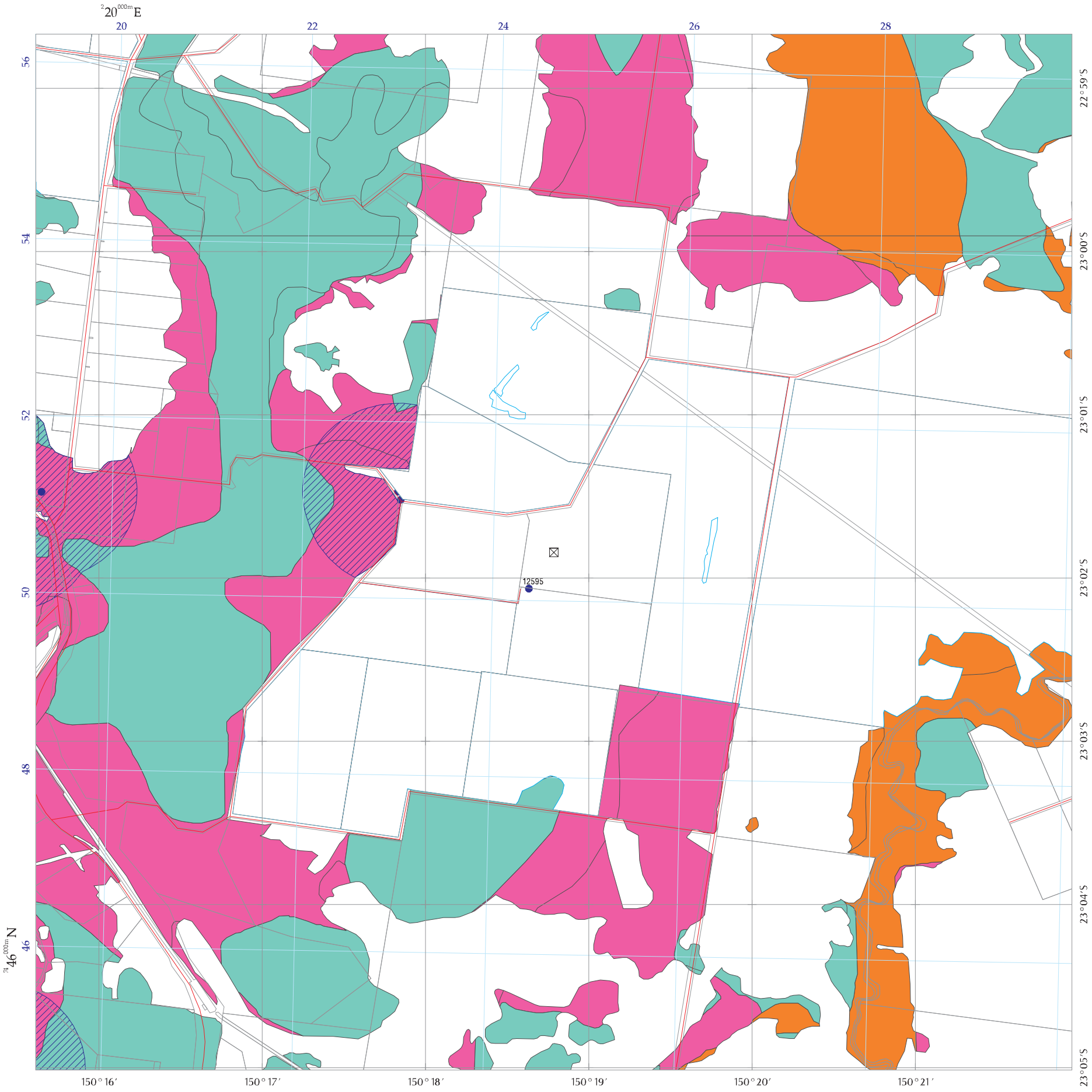
All datasets are updated as they become available to provide the most current information as of the date shown on this map.

Additional information is required for the purposes of land clearing or assessment of a regional ecosystem map or PMAV applications. For further information go to the web site: www.derm.qld.gov.au/vegetation or contact the Department of Environment and Resource Management.

Digital regional ecosystem data is available in shapefile format, for Lot on Plans from www.derm.qld.gov.au/REDATA or from DERM for larger areas.

Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

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Vegetation Management Act Essential Habitat Map Version 3.1

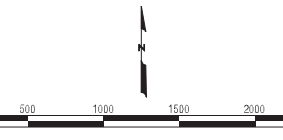
- Remnant vegetation containing endangered regional ecosystems
- Remnant vegetation containing of concern regional ecosystems
- Remnant vegetation that is a least concern regional ecosystem
- Remnant vegetation under Section 20AH of the VMA
- Non-remnant
- Plantation Forest
- Dam or Reservoir
- Remnant Vegetation
- PMAV Category X area
- Vegetation Management Act Essential Habitat
- Vegetation Management Act Essential Habitat Species Records
- Subject Lot
- Roads
  © Pitney Bowes Business Insight 2011
- National Park, Conservation Area State Forest and other reserves
- Cadastral line
  Property boundaries shown are provided as a locational aid only.
- Towns
- ⊠ Coordinate entered

Requested By: REBBEKAH.HEARN@CQGROUP.COM.AU
Date: 04 Jan 12 Time: 08.17.58

Centered on Coordinate:
Latitude: -23.0307 Longitude: 150.3131 (decimal degrees)

Queensland Government

LOCALITY DIAGRAM



Labels for the Vegetation Management Act Essential Habitat are centred on the subject lot (1.1km surrounding and including a Lot on Plan). Labels correlate to the label field in the attached essential habitat database.

Regional ecosystem linework has been compiled at a scale of 1:100 000, except in designated areas where a compilation scale of 1:50 000 is available. Linework should be used as a guide only. The positional accuracy of RE data mapped at a scale of 1:100 000 is +/-100 metres. The extent of remnant regional ecosystems as of 2006, depicted on this map is based on rectified 2006 Landsat TM imagery (supplied by SLATS, Department of Environment and Resource Management).

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Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

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Wildlife Online Extract

Search Criteria: Species List for a Specified Point
Species: All
Type: All
Status: All
Records: All
Date: All
Latitude: 23.0308
Longitude: 150.3135
Distance: 1
Email: rebbekah.hearn@cqgroup.com.au
Date submitted: Wednesday 04 Jan 2012 08:29:06
Date extracted: Wednesday 04 Jan 2012 08:31:03

The number of records retrieved = 50

Disclaimer

As the DERM is still in a process of collating and vetting data, it is possible the information given is not complete. The information provided should only be used for the project for which it was requested and it should be appropriately acknowledged as being derived from Wildlife Online when it is used.

The State of Queensland does not invite reliance upon, nor accept responsibility for this information. Persons should satisfy themselves through independent means as to the accuracy and completeness of this information.

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Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	higher dicots	Acanthaceae	*Harnieria hygrophiloides*	white karambal		C		1/1
plants	higher dicots	Anacardiaceae	*Pleiogynium timorense*	Burdekin plum		C		1/1
plants	higher dicots	Apocynaceae	*Carissa ovata*	currantbush		C		1/1
plants	higher dicots	Apocynaceae	*Marsdenia viridiflora subsp. viridiflora*			C		1/1
plants	higher dicots	Araliaceae	*Polyscias elegans*	celery wood		C		1/1
plants	higher dicots	Chenopodiaceae	*Chenopodium carinatum*	green crumbweed		C		1/1
plants	higher dicots	Combretaceae	*Terminalia porphyrocarpa*			C		1/1
plants	higher dicots	Ebenaceae	*Diospyros humilis*	small-leaved ebony		C		1/1
plants	higher dicots	Euphorbiaceae	*Croton insularis*	Queensland cascarilla		C		1/1
plants	higher dicots	Euphorbiaceae	*Acalypha eremorum*	soft acalypha		C		1/1
plants	higher dicots	Euphorbiaceae	*Claoxylon tenerifolium subsp. tenerifolium*			C		1/1
plants	higher dicots	Euphorbiaceae	*Excoecaria dallachyana*	scrub poison tree		C		2/2
plants	higher dicots	Fabaceae	*Austrosteenisia blackii var. blackii*			C		1/1
plants	higher dicots	Lamiaceae	*Vitex melicopea*			C		1/1
plants	higher dicots	Loganiaceae	*Strychnos psilosperma*	strychnine tree		C		1/1
plants	higher dicots	Loranthaceae	*Amyema congener subsp. rotundifolia*			C		1/1
plants	higher dicots	Meliaceae	*Owenia venosa*	crow's apple		C		1/1
plants	higher dicots	Meliaceae	*Melia azedarach*	white cedar		C		1/1
plants	higher dicots	Meliaceae	*Turraea pubescens*	native honeysuckle		C		1/1
plants	higher dicots	Mimosaceae	*Acacia complanata*	flatstem wattle		C		1/1
plants	higher dicots	Mimosaceae	*Acacia aulacocarpa*			C		1/1
plants	higher dicots	Moraceae	*Trophis scandens subsp. scandens*			C		1/1
plants	higher dicots	Moraceae	*Ficus rubiginosa forma glabrescens*			C		1/1
plants	higher dicots	Myrtaceae	*Gossia bidwillii*			C		1/1
plants	higher dicots	Oleaceae	*Jasminum simplicifolium subsp. australiense*			C		1/1
plants	higher dicots	Petiveriaceae	*Rivina humilis*		Y			1/1
plants	higher dicots	Phyllanthaceae	*Bridelia leichhardtii*			C		1/1
plants	higher dicots	Phytolaccaceae	*Phytolacca octandra*	inkweed	Y			1/1
plants	higher dicots	Pittosporaceae	*Pittosporum spinescens*			C		1/1
plants	higher dicots	Proteaceae	*Grevillea helmsiae*			C		1/1
plants	higher dicots	Rubiaceae	*Psydrax lamprophylla forma lamprophylla*			C		1/1
plants	higher dicots	Rubiaceae	*Pavetta australiensis var. australiensis*			C		1/1
plants	higher dicots	Rutaceae	*Acronychia laevis*	glossy acronychia		C		1/1
plants	higher dicots	Rutaceae	*Flindersia collina*	broad-leaved leopard tree		C		1/1
plants	higher dicots	Rutaceae	*Flindersia australis*	crow's ash		C		1/1
plants	higher dicots	Sapindaceae	*Cupaniopsis wadsworthii*			C		1/1
plants	higher dicots	Sapindaceae	*Elattostachys xylocarpa*	white tamarind		C		1/1
plants	higher dicots	Solanaceae	*Solanum ellipticum*	potato bush		C		1/1
plants	higher dicots	Solanaceae	*Solanum nodiflorum*		Y			1/1
plants	higher dicots	Solanaceae	*Physalis ixocarpa var. ixocarpa*		Y			1/1
plants	higher dicots	Sterculiaceae	*Sterculia quadrifida*	peanut tree		C		1/1
plants	higher dicots	Thymelaeaceae	*Pimelea leptospermoides*			NT	V	3/3
plants	higher dicots	Verbenaceae	*Lantana camara*		Y			1/1
plants	higher dicots	Vitaceae	*Cissus oblonga*			C		1/1
plants	lower dicots	Annonaceae	*Melodorum leichhardtii*			C		1/1
plants	lower dicots	Lauraceae	*Neolitsea brassii*			C		1/1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	monocots	Cyperaceae	*Scleria brownii*			C		1/1
plants	monocots	Dioscoreaceae	*Dioscorea transversa*	native yam		C		1/1
plants	monocots	Poaceae	*Entolasia stricta*	wiry panic		C		1/1
plants	monocots	Poaceae	*Aristida gracilipes*			C		1/1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

EPBC Act Protected Matters Report

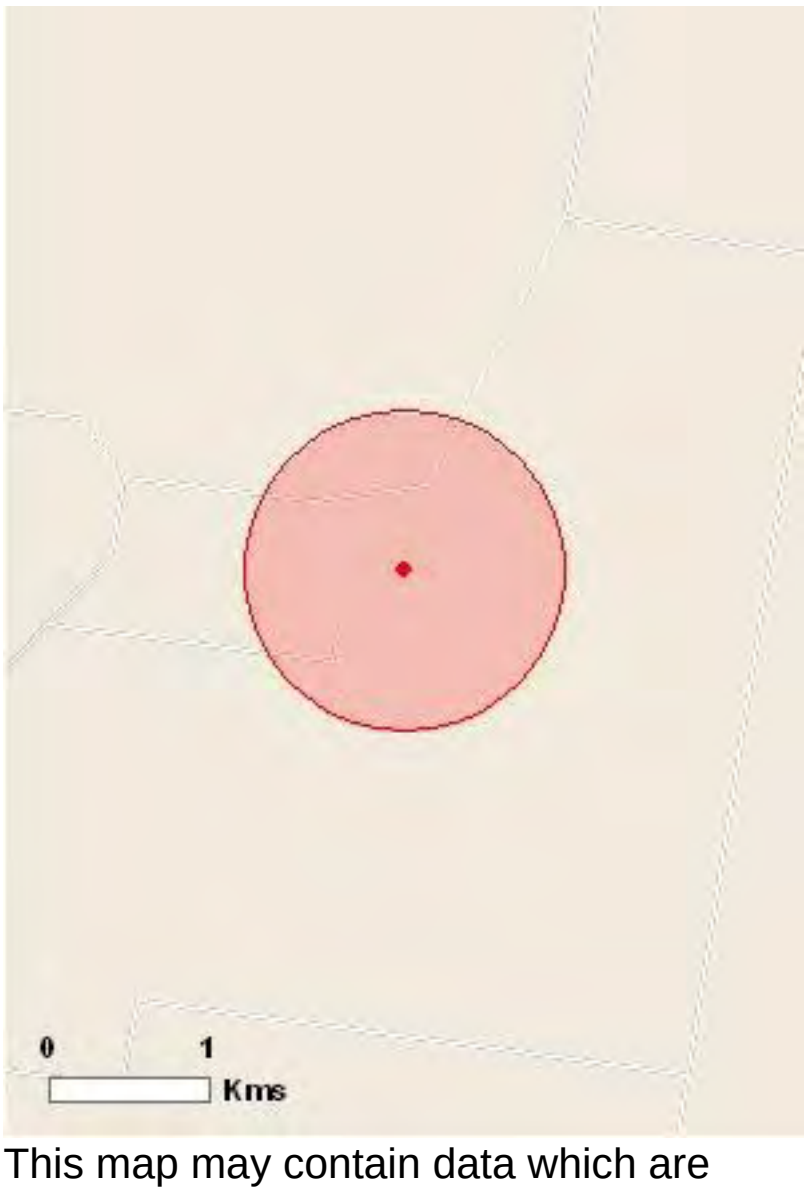
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Report created: 04/01/12 09:22:41

Summary
Details
Matters of NES
Other Matters Protected by the EPBC Act
Extra Information
Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 1.0Km



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	19
Migratory Species:	17

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

Place on the RNE:	1
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None

Details

Matters of National Environmental Significance

Threatened Species		[Resource Information]
Name	Status	Type of Presence
BIRDS		
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Erythrotriorchis radiatus		
Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta		
Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat likely to occur within area
Neochmia ruficauda ruficauda		
Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta		
Black-throated Finch (southern) [64447]	Endangered	Species or species habitat likely to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Vulnerable	Species or species habitat may occur within area
MAMMALS		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus		
Northern Quoll [331]	Endangered	Species or species habitat may occur within area
Nyctophilus timoriensis (South-eastern form)		
Greater Long-eared Bat, South-eastern Long-eared Bat [66888]	Vulnerable	Species or species habitat may occur within area
OTHER		
Cycas megacarpa		
[55794]	Endangered	Species or species habitat may occur within area
Cycas ophiolitica		
[55797]	Endangered	Species or species habitat known to occur within area
PLANTS		
Corymbia xanthope		
[64021]	Vulnerable	Species or species habitat likely to occur within area
Leucopogon cuspidatus		
[9739]	Vulnerable	Species or species habitat likely to occur within area
REPTILES		
Delma torquata		
Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Denisonia maculata		
Ornamental Snake [1193]	Vulnerable	Species or species habitat likely to occur within area
Egernia rugosa		
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Paradelma orientalis		
Brigalow Scaly-foot [59134]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
[Rheodytes leukops](#) Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle [1761]	Vulnerable	Species or species habitat may occur within area

Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat may occur within area
[Ardea alba](#) Great Egret, White Egret [59541]		Species or species habitat may occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Marine Species		
[Crocodylus porosus](#) Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Hirundapus caudacutus](#) White-throated Needletail [682]		Species or species habitat may occur within area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat may occur within area
[Monarcha trivirgatus](#) Spectacled Monarch [610]		Breeding likely to occur within area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Species or species habitat likely to occur within area
[Rhipidura rufifrons](#) Rufous Fantail [592]		Breeding may occur within area
Migratory Wetlands Species		
[Ardea alba](#) Great Egret, White Egret [59541]		Species or species habitat may occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
[Nettapus coromandelianus albipennis](#) Australian Cotton Pygmy-goose [25979]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Rostratula benghalensis s. lat.]		
Painted Snipe [889]	Vulnerable*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
[Anseranas semipalmata]		
Magpie Goose [978]		Species or species habitat may occur within area
[Apus pacificus]		
Fork-tailed Swift [678]		Species or species habitat may occur within area
[Ardea alba]		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
[Ardea ibis]		
Cattle Egret [59542]		Species or species habitat may occur within area
[Gallinago hardwickii]		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
[Haliaeetus leucogaster]		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Hirundapus caudacutus]		
White-throated Needletail [682]		Species or species habitat may occur within area
[Hirundo rustica]		
Barn Swallow [662]		Species or species habitat may occur within area
[Merops ornatus]		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Monarcha melanopsis]		
Black-faced Monarch [609]		Species or species habitat may occur within area
[Monarcha trivirgatus]		
Spectacled Monarch [610]		Breeding likely to occur within area
[Myiagra cyanoleuca]		
Satin Flycatcher [612]		Species or species habitat likely to occur within area
[Nettapus coromandelianus albipennis]		
Australian Cotton Pygmy-goose [25979]		Species or species habitat may occur within area
[Rhipidura rufifrons]		
Rufous Fantail [592]		Breeding may occur within area

Name	Threatened	Type of Presence
[Rostratula benghalensis s. lat.]		
Painted Snipe [889]	Vulnerable*	Species or species habitat may occur within area
Reptiles		
[Crocodylus porosus]		
Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
[Capricornia Serpentinite Landscape]	QLD	Indicative Place

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit,

Name	Status	Type of Presence
Frogs		
[Bufo marinus]		
Cane Toad [1772]		Species or species habitat likely to occur within area
Mammals		
[Felis catus]		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
[Oryctolagus cuniculus]		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
[Sus scrofa]		
Pig [6]		Species or species habitat likely to occur within area
[Vulpes vulpes]		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
[Acacia nilotica subsp. indica]		
Prickly Acacia [6196]		Species or species habitat may occur within area
[Cryptostegia grandiflora]		
Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
[Hymenachne amplexicaulis]		
Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area

Coordinates

-23.03079 150.31345

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales

-Department of Sustainability and Environment, Victoria

-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX B:

Field Notes

LFA Site Description

Site No: 001 **Date:** 5/1/2012

Site Name: Brolga ML5866 **Observer** R.H, M.E

Position (GPS): 225044.47 E, 7450796.40N

Transect Compass Bearing: -

Position in Landscape: from top of slope in historic mine

Lithology: Serpentinite

Soils: deep red silt loam

Slope: <30% **Aspect:**

Vegetation Type: Grassland

Landuse: historic - mining, current - grazing

State of Soil Surface: bare & crusted with gravel/rocks

Comments: Within an area identified as historic mine workings. Earthworks are evident. Large bare soil areas require revegetation works. Pasture grasses dominate, some Snakeweed present.

LFA Landscape Organisation Data Sheet

Date: 5/01/2012 Observer: R.H., ME

Site Name: Brolga Transect : 001

Distance (m)	Patch Width (cm)	Patch/Interpatch Identity	Notes
0			
1.1	-	bare w rocks (br)	
1.85	50	grass (gp)	
4.55	-	br	
5.2	1450	vegetation (vp)	
5.7	-	bare (bs)	
6	270	gp	
6.2	-	bs	
7.4	50	gp	
8.4	-	bs	
8.8	1600	gp	
9.1	-	bs	
10.6	1400	gp	
11.6	-	bs	
14.	1550	vp	
14.3	-	bs	
14.8	250	gp	
15.2	-	br	
15.4	900	vp	
16.2	-	bs	
16.5	500	gp	
26.5	-	br	
29.8	10000	gp	
30	-	bs	
39.2	10 000	gp	
39.6	-	bs	
39.9	500	gp	
41.7	-	bs	
50	10 000	gp	

LFA Soil Surface Assessment (SSA) Data Sheet

Date: 5/01/2012 Observer: RH, ME Transect 001

Site Name Brolga

Each mini-transect needs to have it's **location on the L/O transect** (in metres from 0) and its **patch or interpatch type** identified in this row of cells.

	Class Values of Surface Features														
SSA.Indicators.	1.8-4.5	16.5-26.5	26.5-29.8	30-39.2	41.7-50										
Rainsplash Protection (1-5)	1	2	1	1	3										
Perennial vegetation cover (1-4)	1	1	1	1	1										
Litter cover, origin & incorporation (1-10)	1tn	2ln	1tn	2ts	3is										
Cryptogam cover (1-4)	1	2	1	1	2										
Crust broken-ness (1-4)	3	4	4	4	2										
Erosion type & Severity (1-4)	3	3	2	2	4										
Deposited materials (1-4)	4	3	3	2	1										
Soil Surface Roughness (1-5)	2	1	3	4	3										
Surface resistance to disturbance (5-1)	4	4	4	3	4										
Slake test (1-4)	1	4	1	1	4										
Surface Texture (1-4)	2	2	2	2	2										

CSIRO Rill Assessment Data Sheet

Site: Brolga Transect: 001

Date: 5/01/2012 Observer: RH, ME

Transect	EFA Transect Distance (m)	Start of Rill Edge (m)	Finish of Rill Edge (m)	Rill Depth (m)	Rill Bed Nature	Comment
001	50	24.2	26.6	0.38	loose soil	active

LFA Site Description

Site No: 002 **Date:** 5/01/2012

Site Name: Brolga ML5866 **Observer** RH, ME

Position (GPS): 224517.63 E, 7450616.79N

Transect Compass Bearing: -

Position in Landscape: top of hill

Lithology: serpentinite

Soils: deep red silt loam

Slope: < 20% **Aspect:**

Vegetation Type: grass & shrubs (Lantana, wattles)

Landuse: historic - mine, current - grazing

State of Soil Surface: bare with gravel

Comments: within an area identified as historic mine workings. Recent (<min 10yrs) earthworks are evident. Large bare area require revegetation works. Lantana thickets present.

LFA Landscape Organisation Data Sheet

Date: 5/01/2012 Observer: RH, ME

Site name: Brolga Transect : 002

Distance (m)	Patch Width (cm)	Patch/Interpatch Identity	Notes
0			
4·4	–	br	
4·75	25	gp	
20·3	–	br	
21·35	2000	gp	
23·05	–	br	
50	10000	up	sward

LFA Soil Surface Assessment (SSA) Data Sheet

Date: 5/01/2012 Observer: RH, ME Transect 002

Site Name Brolga

Each mini-transect needs to have it's **location on the L/O transect** (in metres from 0) and its **patch or interpatch type** identified in this row of cells.

	Class Values of Surface Features														
SSA.Indicators.	0-4	4.75-20.3	21.35-23.05	23.05-50	23.05-50										
Rainsplash Protection (1-5)	1	1	1	5	5										
Perennial vegetation cover (1-4)	1	1	1	1	1										
Litter cover, origin & incorporation (1-10)	1tn	1tn	2tn	10le	10le										
Cryptogam cover (1-4)	0	0	0	0	0										
Crust broken-ness (1-4)	0	2	2	0	0										
Erosion type & Severity (1-4)	3	3	3	n/a	n/a										
Deposited materials (1-4)	3	3	3	4	4										
Soil Surface Roughness (1-5)	2	2	2	1	1										
Surface resistance to disturbance (5-1)	4	4	4	2	2										
Slake test (1-4)	0	0	0	4	4										
Surface Texture (1-4)	2	2	2	2	2										

LFA Site Description

Site No: 003 **Date:** 5/01/2012

Site Name: Brolga ML5866 **Observer** RH, ME

Position (GPS): 224439.49 E, 7450745.43 N

Transect Compass Bearing:

Position in Landscape: on downslope of hill

Lithology: serpentinite

Soils: dark grey red silt loam

Slope: <20% **Aspect:**

Vegetation Type: Eucalypt woodlands (regrowth)

Landuse: grazing

State of Soil Surface: crusted where bare

Comments: Analogue "woodland" site

LFA Landscape Organisation Data Sheet

Date: 5/01/2012 Observer: RH, ME

Site name: Brolga Transect : 003

Distance (m)	Patch Width (cm)	Patch/Interpatch Identity	Notes
0			
10.7	-	br	
19.25	1000	sp	
19.5	-	br	
23.1	30	vp	
25.3	-	br	
27.3	1200	vp	
30.7	-	bs	
31.5	2700	vp	
32.3	-	bs	
34	2000	vp	
34.5	-	bs	
35	70	sp	
36.1	-	bs	
38	35	vp	
40.8	-	bs	
48.5	1970	vp	
48.7	-	bs	
50	70	sp	

LFA Soil Surface Assessment (SSA) Data Sheet

Date: 5/01/2012 Observer: RH, ME Transect 003

Site Name Braga

Each mini-transect needs to have it's **location on the L/O transect** (in metres from 0) and its **patch or interpatch type** identified in this row of cells.

	Class Values of Surface Features														
SSA.Indicators.	0 - 8.1	10.7 - 19.25	23.1 - 25.3	38 - 40.8	40.8 - 48.5										
Rainsplash Protection (1-5)	2	2	2	2	2										
Perennial vegetation cover (1-4)	3	3	3	3	3										
Litter cover, origin & incorporation (1-10)	3Ls	3Ls	3Ls	3Ls	3Ls										
Cryptogam cover (1-4)	1	1	1	1	1										
Crust broken-ness (1-4)	0	0	0	0	0										
Erosion type & Severity (1-4)	3	3	3	3	3										
Deposited materials (1-4)	3	3	3	3	3										
Soil Surface Roughness (1-5)	2	2	2	2	2										
Surface resistance to disturbance (5-1)	4	4	4	4	4										
Slake test (1-4)	4	4	4	4	4										
Surface Texture (1-4)	2	2	2	2	2										

LFA Site Description

Site No: 004 **Date**: 6/1/2012

Site Name: Brolga ML5866 **Observer** RH, SC

Position (GPS): 224314.83 E, 7450268.70N

Transect Compass Bearing: -

Position in Landscape: top of slope

Lithology: Serpentinite

Soils: grey red silt loam

Slope: <15% **Aspect**:

Vegetation Type: ~~gee~~ lantana thickets & wattle

Landuse: grazing

State of Soil Surface: loose, no crust

Comments: Area appears to have been disturbed historically, top of hill does not appear to be a natural shape - may be wider area of mining works. Heavy lantana infestation

LFA Landscape Organisation Data Sheet

Date: 6/9/2012 Observer: RH, SC

Site name: Braga Transect : 004

Distance (m)	Patch Width (cm)	Patch/Interpatch Identity	Notes
0			
3.1	10 000	up	sward
3.25	-	bs	
11.6	10 000	up	sward
11.9	-	bs	
13.9	10 000	up	sward
14.15	-	bs	
50	10.000	up	sward

LFA Soil Surface Assessment (SSA) Data Sheet

Date: 6/01/2012 Observer: RH, SC Transect 004

Site Name Bridge

Each mini-transect needs to have it's **location on the L/O transect** (in metres from 0) and its **patch or interpatch type** identified in this row of cells.

	Class Values of Surface Features														
SSA.Indicators.	0 - 3.1	3.25 - 11.6	3.25 - 11.6	13.9 - 14.15	14.15 - 50										
Rainsplash Protection (1-5)	3	5	5	2	5										
Perennial vegetation cover (1-4)	1	4	4	1	4										
Litter cover, origin & incorporation (1-10)	10e	8e	10e	2e	10e										
Cryptogam cover (1-4)	1	1	1	1	1										
Crust broken-ness (1-4)	0	0	0	0	0										
Erosion type & Severity (1-4)	4	4	4	4	4										
Deposited materials (1-4)	4	4	4	4	4										
Soil Surface Roughness (1-5)	3	3	3	3	3										
Surface resistance to disturbance (5-1)	4	4	4	3	3										
Slake test (1-4)	4	4	4	4	4										
Surface Texture (1-4)	2	2	2	2	2										

LFA Site Description

Site No: 005 **Date**: 6/1/2012

Site Name: Brolga ML5688 **Observer** ...RH., SC.....

Position (GPS): 22 4941.03 E, 7449907.93 N

Transect Compass Bearing: -

Position in Landscape: top of slope

Lithology: Serpentinite

Soils: grey red silt loam

Slope: < 10% **Aspect**:

Vegetation Type: grasslands, lantana

Landuse: grazing

State of Soil Surface: loose, no crust

Comments: Analogue "grazing" site.

LFA Landscape Organisation Data Sheet

Date: 6/01/2010 Observer: RH, SC

Site name: BROLGA Transect : 005

Distance (m)	Patch Width (cm)	Patch/Interpatch Identity	Notes
0			
50	10 000	Up	sward

LFA Soil Surface Assessment (SSA) Data Sheet

Date: 6/01/2012 Observer: RH, SC Transect 005

Site Name Bridge

Each mini-transect needs to have it's **location on the L/O transect** (in metres from 0) and its **patch or interpatch type** identified in this row of cells.

	Class Values of Surface Features														
SSA.Indicators.	0-50	0-50	0-50	0-50	0-50										
Rainsplash Protection (1-5)	4	4	4	4	4										
Perennial vegetation cover (1-4)	1	1	1	1	1										
Litter cover, origin & incorporation (1-10)	10Le	10Le	5Le	5Le	10Le										
Cryptogam cover (1-4)	0	0	0	0	0										
Crust broken-ness (1-4)	0	0	0	0	0										
Erosion type & Severity (1-4)	4	4	4	4	4										
Deposited materials (1-4)	3	3	3	3	3										
Soil Surface Roughness (1-5)	4	4	4	4	4										
Surface resistance to disturbance (5-1)	4	4	2	2	2										
Slake test (1-4)	4	4	4	4	4										
Surface Texture (1-4)	2	2	2	2	2										

LFA Site Description

Site No: 006 **Date:** 6/1/2012

Site Name: Brolga ML5866 **Observer** RH, SC

Position (GPS): 225403.04 E, 7450435.49 N

Transect Compass Bearing: -

Position in Landscape: slope (mid)

Lithology: Serpentinite

Soils: grey red silt loam

Slope: <15% **Aspect:**

Vegetation Type: grassland (cranthe & lantana)

Landuse: grazing

State of Soil Surface: loose, no crust

Comments: Analogue "grazing" site.

LFA Landscape Organisation Data Sheet

Date: 6/1/2012 Observer: RH, SC

Site name: Brolga Transect : 006

Distance (m)	Patch Width (cm)	Patch/Interpatch Identity	Notes
0			
17.25	10 000	gp	sward
17.5	–	bs	
20.6	10 000	gp	sward
20.95	–	bs	
50	1000	gp	

LFA Soil Surface Assessment (SSA) Data Sheet

Date: 6/01/2012 Observer: RH, SC Transect 006

Site Name Bvalsa

Each mini-transect needs to have it's **location on the L/O transect** (in metres from 0) and its **patch or interpatch type** identified in this row of cells.

	Class Values of Surface Features														
SSA.Indicators.	0 - 17.25	0 - 17.25	17.25 - 17.35	20.45 - 50	20.95 - 50										
Rainsplash Protection (1-5)	4	4	4	4	4										
Perennial vegetation cover (1-4)	1	1	1	1	1										
Litter cover, origin & incorporation (1-10)	5LS	10Le	5Lm	10Le	10Le										
Cryptogam cover (1-4)	0	0	0	0	0										
Crust broken-ness (1-4)	0	0	0	0	0										
Erosion type & Severity (1-4)	3	2	2	2	2										
Deposited materials (1-4)	3	3	3	3	3										
Soil Surface Roughness (1-5)	3	4	4	4	4										
Surface resistance to disturbance (5-1)	4	4	4	4	4										
Slake test (1-4)	4	4	4	4	4										
Surface Texture (1-4)	2	2	2	2	2										

CSIRO Rill Assessment Data Sheet

Site: Brolga   Transect: 006

Date: 6/9/2012   Observer: RH, SC

Transect	EFA Transect Distance (m)	Start of Rill Edge (m)	Finish of Rill Edge (m)	Rill Depth (m)	Rill Bed Nature	Comment
006	50	17.25	17.5	0.20	loose	active

APPENDIX C:

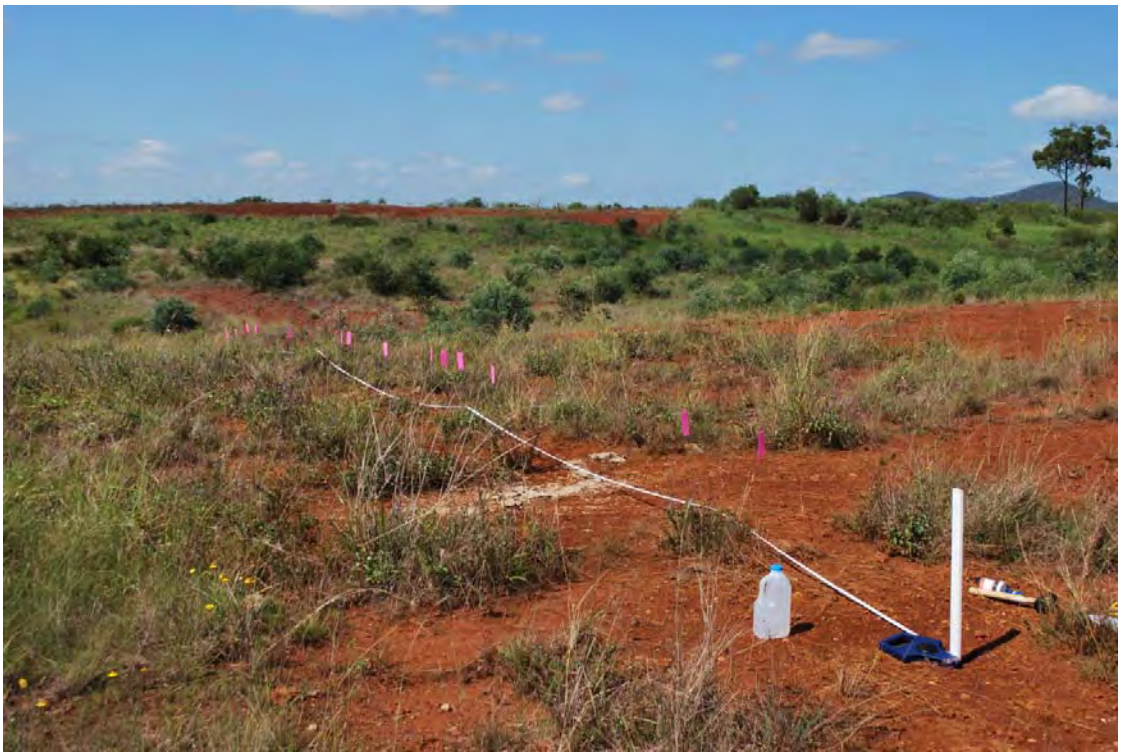
Fieldwork Photographs



Photograph 1: Entrance to ML4866 - Brolga



Photograph 2: Transect 001



Photograph 3: Transect 001 set up for Landscape Organisation assessment



Photograph 4: Example of a lantana thicket on ML5866



Photograph 5: Transect 002



Photograph 6: Transect 003



Photograph 7: Transect 004



Photograph 8: Transect 005



Photograph 9: Native paper daisies are common on ML5866



Photograph 10: Transect 006

APPENDIX D:

Data Input and Calculations

Landscape Function data entry V3-0 7th November 2003

This spreadsheet (workbook) has been developed by CSIRO Sustainable Ecosystems to assist you in entering and interpreting data collect whilst accessing your Landscape using the LFA and SSA method as per Manual for assessing Soil in Tropical Grasslands. The spreadsheet is divided up into 14 sheets.

A separate workbook is used for each transect. The sheets are used in the following way for entering data

Sheet 1	Start	Enter the site, location, transect, observers names and the date. Enter **ALL** the identified patches and inter-patches Enter the indentified patches
	Note:	**Patches must be entered in both 'transect zone' and 'patch zone' tables**
Sheet 2	Summary	This page is the collected data summarised.
Sheet 3	LFA	Enter the transect log data on this page.
Sheet 4	LFA_work	Calculations *(no data entered here)*
Sheet 5-14	SSA	The assessed soil surface condition for each zone recorded. (a separate sheet is used for each zone)
	Note:	***Litter - has a minimum value of 1.*** **When litter cover is greater then 1 its Origin and Incorporation must be entered ie 3LS.**
	Note:	**For No data or n/a leave as zero this removes it from the calculation.**

Data is entered into bold outlined boxes

Site Name	Brolga Historic Mine Rehabilitation Assessment
Location	Brolga Historic Mine Rehabilitated area
Transect Name	4
Observers	R. Hearn, S, Clarke
Date	6/01/2012

Transect Zones
(patch & inter-patch)

Zone	Code
bare soil	bs
vegetation patch	vp

Transect Patch Zones

Patch Zone	Code
vegetation patch	vp

Site Name Brolga Historic Mine Rehabilitation Assessment

Location Brolga Historic Mine Rehabilitated area

Transect Name 4

Date 6/01/2012

Landscape

Zone	Mean Zone Length (m)	%
bare soil	0.23	1.4
vegetation pa	12.33	98.6
Total		100.0

Patches

Patch zone	Code	Width (cm)	No	Mean
vegetation pa	vp	40000	4	10000.0
Total		40000	4	10000.0

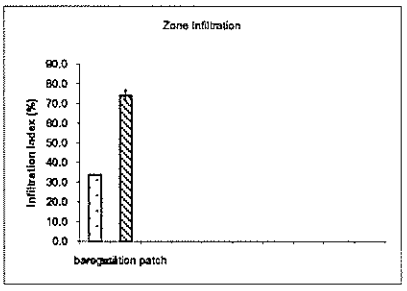
Number of Patches/10m		0.8		
Total Patch Area		4930.0	sq. m.	
Patch Area Index		9.86		total patch area/max. area of patches (transect length * 10)
Landscape Organisation Index		0.99		length of patches/length of transect
Average Interpatch Length (m)		0.23	m	
Range Interpatch length	0.2	to	0.3	m.

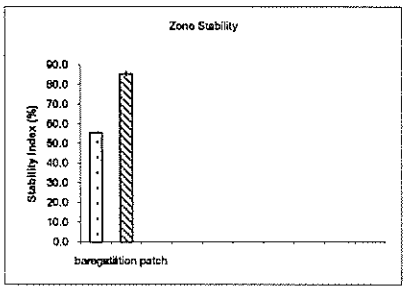
Soil Surface Assessment Of individual Zones

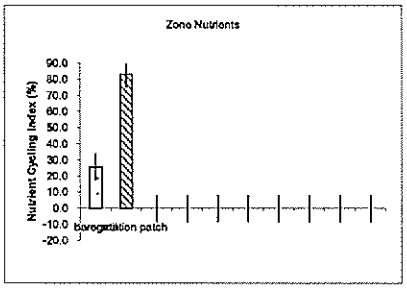
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
bare soil	55.6		33.9		25.6	
vegetation pa	85.4	1.3	74.3	3.2	83.1	3.3

Soil Surface Assessment Individual zones contribution to the whole Landscape

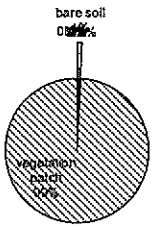
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
bare soil	0.8		0.5		0.4	
vegetation pa	84.2	1.3	73.2	3.1	82.0	3.3
Total	85.0	2.6	73.7	6.2	82.3	6.6



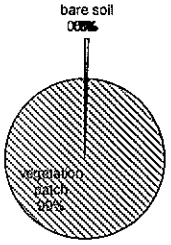




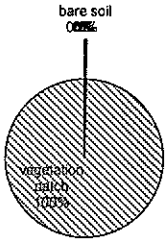
Stability (individual Contributions)



Infiltration (individual Contributions)



Nutrients (individual Contributions)



Transect:-	4		
Distance (m)	**Patch width (cm)**	**Patch/ Interpatch Identity**	**Comments**
0			
3.1	10000	vp	
3.25		bs	
11.6	10000	vp	
11.9		bs	
13.9	10000	vp	
14.15		bs	
50	10000	vp	

Location:-			Brolga Historic Mine Rehabilit		**Transect:-**	4			
Fetch	Patch Area		Zone	code	Fetch	No	Mean	Proportion	%
3.1	310		bare soil	bs	0.7	3	0.23	0.01	1.40
0.15	0		vegetation patch	vp	49.3	4	12.33	0.99	98.60
8.35	835								
0.3	0								
2	200								
0.25	0								
35.85	3585								
-50	0								
0	0								
0	0								
0	0		Total		50	7	12.56	1	100
0	0								

Patch	Code	Width	No	Mean Width (cm)
vegetation patch	vp	40000	4	10000
Total		40000	4	

Total Patch Length	49.3	**m**
Total Patch Width	40000	**cm**
Total Patch Area	4930	**sq m**

Standard Error calculation for proportional index

Zone	Stability	Infiltration	Nutrients
bare soil			
vegetation patch	2.622286	6.242366	6.586208
Total	2.622286	6.242366	6.586208
Number	1	1	1
Standard Error	2.622286	6.242366	6.586208

Soil Surface Assessment							
Location:-	Brolga Historic Mine Rehabilitated are	Transect:-	4				
Zone:-	bare soil						
Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	10	2le	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	4	0	0	0	0	0
Deposited materials	4	4	0	0	0	0	0
Soil surface roughness	5	3	0	0	0	0	0
Surface resist. to disturb.	5	3	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Litter Cover (simple)	10	2	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	4	0	0	0	0	0
Deposited materials	4	4	0	0	0	0	0
Surface resist. to disturb.	5	3	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Total		20	0	0	0	0	0
Divide by		36	0	0	0	0	0
%		55.56					
Proportion	0.014	0.78					

Grand Total	55.6	0.8
Number of Reps	1.0	1.0
Mean	55.6	0.8
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	6	0	0	0	0	0
Soil surface roughness	5	3	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	3.3	0	0	0	0	0
Total		19.3	0	0	0	0	0
Divide by		57	0	0	0	0	0
%		33.86					
Proportion	0.014	0.47					

Grand Total	33.9	0.5
Number of Reps	1.0	1.0
Mean	33.9	0.5
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	6	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Soil surface roughness	5	3	0	0	0	0	0
Total		11	0	0	0	0	0
Divide by		43	0	0	0	0	0
%		25.6					
Proportion	0.014	0.4					

Grand Total	25.6	0.4
Number of Reps	1.0	1.0
Mean	25.6	0.4
Std Dev	n/a	n/a
Std Err	n/a	n/a

Soil Surface Assessment

Location:- Brolga Historic Mine Rehabilitated area Transect:- 4

Zone:- vegetation patch

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	3	5	5	5	0	0
Per. basal / canopy cover	4	1	4	4	4	0	0
Litter cover, orig & incorp.	10	10le	8le	10le	10le	0	0
Cryptogam cover	4	1	1	1	1	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	4	4	4	4	0	0
Deposited materials	4	4	4	4	4	0	0
Soil surface roughness	5	3	3	3	3	0	0
Surface resist. to disturb.	5	4	4	4	3	0	0
Slake test	4	4	4	4	4	0	0
Texture	4	2	2	2	2	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	3	5	5	5	0	0
Litter cover (simple)	10	10	8	10	10	0	0
Cryptogam cover	4	1	1	1	1	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	4	4	4	4	0	0
Deposited materials	4	4	4	4	4	0	0
Surface resist. to disturb.	5	4	4	4	3	0	0
Slake test	4	4	4	4	4	0	0
Total		30	30	32	31	0	0
Divide by		36	36	36	36	0	0
%		83.33	83.33	88.89	86.11		
Proportion	0.986	82.17	82.17	87.64	84.91		

Grand Total	341.7	336.9
Number of Reps	4.0	4.0
Mean	85.4	84.2
Std Dev	2.7	2.6
Std Err	1.3	1.3

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	4	4	4	0	0
Litter cover, orig & incorp.	30	30	24	30	30	0	0
Soil surface roughness	5	3	3	3	3	0	0
Slake test	4	4	4	4	4	0	0
Texture	4	2	2	2	2	0	0
Surface resist. to disturb.	10	1	1	1	3.3	0	0
Total		41	38	44	46.3	0	0
Divide by		57	57	57	57	0	0
%		71.93	66.67	77.19	81.23		
Proportion	0.986	70.92	65.73	76.11	80.09		

Grand Total	297.0	292.9
Number of Reps	4.0	4.0
Mean	74.3	73.2
Std Dev	6.3	6.2
Std Err	3.2	3.1

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	4	4	4	0	0
Litter cover, orig & incorp.	30	30	24	30	30	0	0
Cryptogam cover	4	1	1	1	1	0	0
Soil surface roughness	5	3	3	3	3	0	0
Total		35	32	38	38	0	0
Divide by		43	43	43	43	0	0
%		81.4	74.4	88.4	88.4		
Proportion	0.986	80.3	73.4	87.1	87.1		

Grand Total	332.6	327.9
Number of Reps	4.0	4.0
Mean	83.1	82.0
Std Dev	6.7	6.6
Std Err	3.3	3.3

Landscape Function data entry V2-1 7th November 2003

This spreadsheet (workbook) has been developed by CSIRO Sustainable Ecosystems to assist you in entering and interpreting data collect while assessing your Landscape using the LFA and SQA method as per Manual for assessing Soil in Tropical Grasslands. The spreadsheet is divided up into 14 sheets.

A separate workbook is used for each transect. The sheets are used in the following way for entering data:

Sheet 1	Start	Enter the site, location, transect, observers names and the date. Enter ALL the identified patches and inter-patches. Enter the indentified patches.
	Note:	Patches must be entered in both 'transect zone' and 'patch zone' tables.
Sheet 2	Summary	This page is the collected data summarised.
Sheet 3	LFA	Enter the transect log data on this page.
Sheet 4	LFA_work	Calculations (no data entered here)
Sheet 5-14	SQA	The assessed soil surface condition for each zone recorded. (a separate sheet is used for each zone)
	Notes:	Litter - has a minimum value of 1. When litter cover is greater than 1 the Origin and Incorporation must be entered as S,S.
	Note:	For bio data or rate leave as zero this removes it from the calculations.

Data is entered into bold outlined boxes.

Site Name	Bridge Historic Mine Rehabilitation Assessment
Location	Bridge Historic Mine Rehabilitation Area
Transect Name	5
Observers	R. Steen, S. Clarke
Date	24/11/2012

Transect Zones
(patch & inter-patch):

Zone	Code
vegetation patch	veg

Transect Patch Zones

Patch Zone	Code
vegetation patch	veg

Site Name Brolga Historic Mine Rehabilitation Assessment

Location Brolga Historic Mine Rehabilitation Area

Transect Name 5

Date 6/01/2012

Landscape

Zone	Mean Zone Length (m)	%
vegetation pa	50.00	100.0
Total		100.0

Patches

Patch zone	Code	Width (cm)	No	Mean
vegetation pa	vp	10000	1	10000.0
Total		10000	1	10000.0

Number of Patches/10m		0.2	
Total Patch Area		5000.0	sq. m.
Patch Area Index		10.00	
Landscape Organisation Index		1.00	
Average Interpatch Length (m)		#DIV/0!	m
Range Interpatch length	0.0	to	0.0 m.

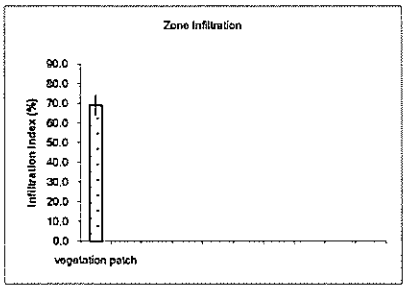
total patch area/max. area of patches (transect length * 10)
length of patches/length of transect

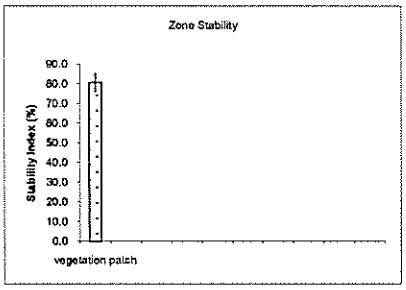
Soil Surface Assessment Of individual Zones

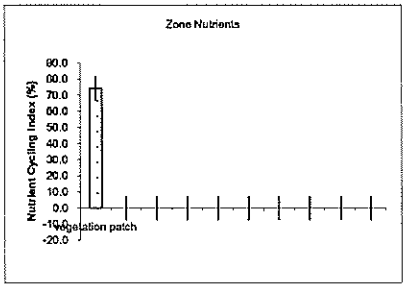
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
vegetation pa	80.6	5.0	69.1	5.2	74.4	9.4

Soil Surface Assessment Individual zones contribution to the whole Landscape

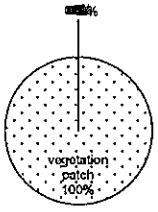
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
vegetation pa	80.6	5.0	69.1	5.2	74.4	9.4
Total	80.6	11.1	69.1	11.5	74.4	21.1



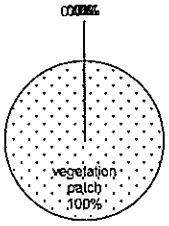




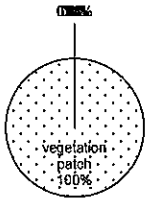
Stability (individual Contributions)



Infiltration (individual Contributions)



Nutrients (individual Contributions)



Transect:-	5		
Distance (m)	**Patch width (cm)**	**Patch/ Interpatch Identity**	**Comments**
0			
50	10000	vp	one complete sward. No identifiable inter-patche

Location:-			Brolga Historic Mine Rehabilit	**Transect:-**	5			

Fetch	Patch Area
50	5000
-50	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0

Zone	code	Fetch	No	Mean	Proportion	%
vegetation patch	vp	50	1	50.00	1.00	100.00
Total		50	1	50.00	1	100

Patch	Code	Width	No	Mean Width (cm)
vegetation patch	vp	10000	1	10000
Total		10000	1	

Total Patch Length	50	**m**
Total Patch Width	10000	**cm**
Total Patch Area	5000	**sq m**

Standard Error calculation for proportional index

Zone	Stability	Infiltration	Nutrients
vegetation patch	11.13658	11.54541	21.06625
Total	11.13658	11.54541	21.06625
Number	1	1	1
Standard Error	11.13658	11.54541	21.06625

Soil Surface Assessment							
Location:-	Brolga Historic Mine Rehabilitation Are	Transect:-	5				
Zone:-	vegetation patch						
Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	4	4	4	4	4	0
Per. basal / canopy cover	4	1	1	1	1	1	0
Litter cover, orig & incorp.	10	10le	10le	5le	5le	10le	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	4	4	4	4	4	0
Deposited materials	4	3	3	3	3	3	0
Soil surface roughness	5	4	4	4	4	4	0
Surface resist. to disturb.	5	4	4	2	2	2	0
Slake test	4	4	4	4	4	4	0
Texture	4	2	2	2	2	2	0

Stability

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	4	4	4	4	4	0
Litter Cover (simple)	10	10	10	5	5	10	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	4	4	4	4	4	0
Deposited materials	4	3	3	3	3	3	0
Surface resist. to disturb.	5	4	4	2	2	2	0
Slake test	4	4	4	4	4	4	0
Total		29	29	22	22	27	0
Divide by		32	32	32	32	32	0
%		90.63	90.63	68.75	68.75	84.38	
Proportion	1	90.63	90.63	68.75	68.75	84.38	

Grand Total	403.1	403.1
Number of Reps	5.0	5.0
Mean	80.6	80.6
Std Dev	11.1	11.1
Std Err	5.0	5.0

Infiltration/runoff

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	1	1	1	0
Litter cover, orig & incorp.	30	30	30	15	15	30	0
Soil surface roughness	5	4	4	4	4	4	0
Slake test	4	4	4	4	4	4	0
Texture	4	2	2	2	2	2	0
Surface resist. to disturb.	10	1	1	6.6	6.6	6.6	0
Total		42	42	32.6	32.6	47.6	0
Divide by		57	57	57	57	57	0
%		73.68	73.68	57.19	57.19	83.51	
Proportion	1	73.68	73.68	57.19	57.19	83.51	

Grand Total	345.3	345.3
Number of Reps	5.0	5.0
Mean	69.1	69.1
Std Dev	11.5	11.5
Std Err	5.2	5.2

Nutrient cycling status

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	1	1	1	0
Litter cover, orig & incorp.	30	30	30	15	15	30	0
Cryptogam cover	4	0	0	0	0	0	0
Soil surface roughness	5	4	4	4	4	4	0
Total		35	35	20	20	35	0
Divide by		39	39	39	39	39	0
%		89.7	89.7	51.3	51.3	89.7	
Proportion	1	89.7	89.7	51.3	51.3	89.7	

Grand Total	371.8	371.8
Number of Reps	5.0	5.0
Mean	74.4	74.4
Std Dev	21.1	21.1
Std Err	9.4	9.4

Landscape Function data entry V3-0 7th November 2003

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Sheet 1	Start	Enter the site, location, transect, observers names and the date. Enter **ALL** the identified patches and inter-patches Enter the indentified patches
	Note:	**Patches must be entered in both 'transect zone' and 'patch zone' tables**
Sheet 2	Summary	This page is the collected data summarised.
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Sheet 4	LFA_work	Calculations *(no data entered here)*
Sheet 5-14	SSA	The assessed soil surface condition for each zone recorded. (a separate sheet is used for each zone)
	Note:	***Litter - has a minimum value of 1.*** **When litter cover is greater then 1 its Origin and Incorporation must be entered ie 3LS.**
	Note:	**For No data or n/a leave as zero this removes it from the calculation.**

Data is entered into bold outlined boxes

Site Name	Brolga Historic Mine Rehabilitation Assessment
Location	Brolga Historic Mine Rehabilitation Area
Transect Name	6
Observers	R. Hearn, S. Clarke
Date	6/01/2012

Transect Zones
(patch & inter-patch)

Zone	Code
grass only patch	gp
bare soil	bs

Transect Patch Zones

Patch Zone	Code
grass only patch	gp

Site Name Brolga Historic Mine Rehabilitation Assessment

Location Brolga Historic Mine Rehabilitation Area

Transect Name 6

Date 6/01/2012

Landscape

Zone	Mean Zone Length (m)	%
grass only pat	16.47	98.8
bare soil	0.30	1.2
Total		100.0

Patches

Patch zone	Code	Width (cm)	No	Mean
grass only pat	gp	21000	3	7000.0
Total		21000	3	7000.0

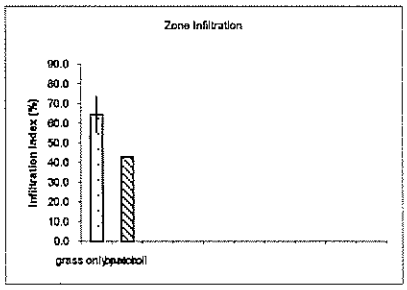
Number of Patches/10m		0.6		
Total Patch Area		2325.5	sq. m.	
Patch Area Index		4.65		total patch area/max. area of patches (transect length * 10)
Landscape Organisation Index		0.99		length of patches/length of transect
Average Interpatch Length (m)		0.30	m	
Range Interpatch length	0.3	to	0.3	m.

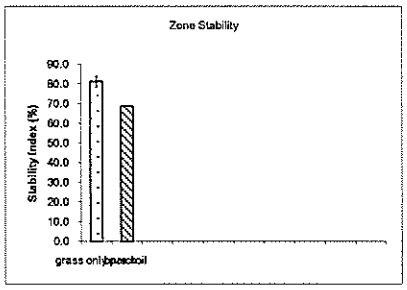
Soil Surface Assessment Of individual Zones

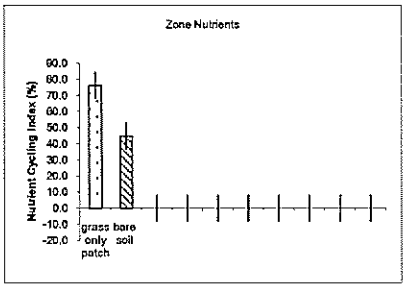
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
grass only pat	81.3	3.1	64.5	9.2	76.3	13.5
bare soil	68.8		42.9		44.7	

Soil Surface Assessment Individual zones contribution to the whole Landscape

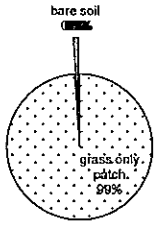
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
grass only pat	80.3	3.1	63.7	9.1	75.4	13.3
bare soil	0.8		0.5		0.5	
Total	81.1	6.2	64.2	18.2	75.9	26.6



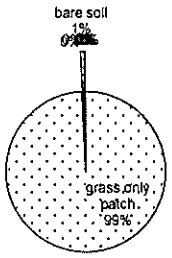




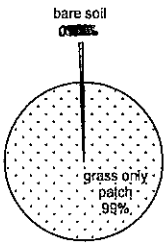
Stability (individual Contributions)



Infiltration (individual Contributions)



Nutrients (individual Contributions)



Transect:-	6		
Distance (m)	**Patch width (cm)**	**Patch/ Interpatch Identity**	**Comments**
0			
17.25	10000	gp	
17.5		bs	
20.6	10000	gp	
20.95		bs	
50	1000	gp	

Location:- Brolga Historic Mine Rehabilit **Transect:-** 6

Fetch	Patch Area
17.25	1725
0.25	0
3.1	310
0.35	0
29.05	290.5
-50	0
0	0
0	0
0	0
0	0
0	0
0	0

Zone	code	Fetch	No	Mean	Proportion	%
grass only patch	gp	49.4	3	16.47	0.99	98.80
bare soil	bs	0.6	2	0.30	0.01	1.20
Total		50	5	16.77	1	100

Patch	Code	Width	No	Mean Width (cm)
grass only patch	gp	21000	3	7000
Total		21000	3	

Total Patch Length	49.4	**m**
Total Patch Width	21000	**cm**
Total Patch Area	2325.5	**sq m**

Standard Error calculation for proportional index

Zone	Stability	Infiltration	Nutrients
grass only patch	6.175	18.22167	26.63167
bare soil			
Total	6.175	18.22167	26.63167
Number	1	1	1
Standard Error	6.175	18.22167	26.63167

Soil Surface Assessment

Location:- Broiga Historic Mine Rehabilitation Are Transect:- 6

Zone:- grass only patch

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	4	4	4	4	0	0
Per. basal / canopy cover	4	1	1	1	1	0	0
Litter cover, orig & incorp.	10	5ls	10le	10le	10le	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	2	2	2	0	0
Deposited materials	4	3	3	3	3	0	0
Soil surface roughness	5	3	4	4	4	0	0
Surface resist. to disturb.	5	4	4	4	4	0	0
Slake test	4	4	4	4	4	0	0
Texture	4	2	2	2	2	0	0

Stability

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	4	4	4	4	0	0
Litter Cover (simple)	10	5	10	10	10	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	2	2	2	0	0
Deposited materials	4	3	3	3	3	0	0
Surface resist. to disturb.	5	4	4	4	4	0	0
Slake test	4	4	4	4	4	0	0
Total		23	27	27	27	0	0
Divide by		32	32	32	32	0	0
%		71.88	84.38	84.38	84.38		
Proportion	0.988	71.01	83.36	83.36	83.36		

Grand Total	325.0	321.1
Number of Reps	4.0	4.0
Mean	81.3	80.3
Std Dev	6.3	6.2
Std Err	3.1	3.1

Infiltration/runoff

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	1	1	0	0
Litter cover, orig & incorp.	30	9.975	30	30	30	0	0
Soil surface roughness	5	3	4	4	4	0	0
Slake test	4	4	4	4	4	0	0
Texture	4	2	2	2	2	0	0
Surface resist. to disturb.	10	1	1	1	1	0	0
Total		20.975	42	42	42	0	0
Divide by		57	57	57	57	0	0
%		36.80	73.68	73.68	73.68		
Proportion	0.988	36.36	72.80	72.80	72.80		

Grand Total	257.9	254.8
Number of Reps	4.0	4.0
Mean	64.5	63.7
Std Dev	18.4	18.2
Std Err	9.2	9.1

Nutrient cycling status

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	1	1	0	0
Litter cover, orig & incorp.	30	9.975	30	30	30	0	0
Cryptogam cover	4	0	0	0	0	0	0
Soil surface roughness	5	3	4	4	4	0	0
Total		13.975	35	35	35	0	0
Divide by		39	39	39	39	0	0
%		35.8	89.7	89.7	89.7		
Proportion	0.988	35.4	88.7	88.7	88.7		

Grand Total	305.1	301.4
Number of Reps	4.0	4.0
Mean	76.3	75.4
Std Dev	27.0	26.6
Std Err	13.5	13.3

Soil Surface Assessment							
Location:-	Brolga Historic Mine Rehabilitation Are	Transect:-	6				
Zone:-	bare soil						
Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	4	0	0	0	0	0
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	10	5lm	0	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	2	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Soil surface roughness	5	4	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	4	0	0	0	0	0
Litter cover (simple)	10	5	0	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	2	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Total		22	0	0	0	0	0
Divide by		32	0	0	0	0	0
%		68.75					
Proportion	0.012	0.82					

Grand Total	68.8	0.8
Number of Reps	1.0	1.0
Mean	68.8	0.8
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	12.45	0	0	0	0	0
Soil surface roughness	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	1	0	0	0	0	0
Total		24.45	0	0	0	0	0
Divide by		57	0	0	0	0	0
%		42.89					
Proportion	0.012	0.51					

Grand Total	42.9	0.5
Number of Reps	1.0	1.0
Mean	42.9	0.5
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	12.45	0	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Soil surface roughness	5	4	0	0	0	0	0
Total		17.45	0	0	0	0	0
Divide by		39	0	0	0	0	0
%		44.7					
Proportion	0.012	0.5					

Grand Total	44.7	0.5
Number of Reps	1.0	1.0
Mean	44.7	0.5
Std Dev	n/a	n/a
Std Err	n/a	n/a

Landscape Function data entry V3-0 7th November 2007

This spreadsheet (workbook) has been developed by CSIRO Sustainable Ecosystems to assist you in entering and interpreting data collect whilst undertaking your Landscape Using the LFA and SAA method as per Manual for assessing Soil in Tropical Grasslands. The spreadsheet is divided up into 14 sheets.

A separate workbook is used for each transect. The sheets are used in the following way for entering data

Sheet 1	Start	Enter the site location, transect observers names and the date Enter ALL the identified patches and inter-patches Enter the transect zones
	Note:	Patches must be entered in both 'transect zones' and 'patch zones' tables
Sheet 2	Summary	This page is the calculated data summarised
Sheet 3	LFA	Enter the transect leg data on this page
Sheet 4	LFA_calc	Calculations for data entered here
Sheet 5 to	SAA	The assessment and surface condition for each zone recorded. (a separate sheet is used for each zone)
	Note:	Litter - Use a consistent value of 1 Where litter cover is greater than 1 the Origin and Incorporation must be entered as S,S.
	Note:	For bio data or rep leave as zero this removes it from the calculation.

Data is entered into bold outlined boxes

Site Name	Bridge Hatch Mine Rehabilitation Assessment
Location	Bridge Hatch Mine Workings #1
Transect Name	1
Observers	R. Hasen, M. Dyke
Date	5/01/2012

Transect Zones
(patch & inter-patch)

Zone	Code
bare with rocks	br
grass only patch	gp
vegetation patch	vp
bare soil	bs

Transect Patch Zones

Patch Zone	Code
grass only patch	gp
vegetation patch	vp

Site Name Brolga Historic Mine Rehabilitation Assessment

Location Brolga Historic Mine Workings #1

Transect Name 1

Date 5/01/2012

Landscape

Zone	Mean Zone Length (m)	%
bare with rock	3.55	28.4
grass only pat	2.37	52.1
vegetation pat	1.08	6.5
bare soil	0.65	13.0
Total		100.0

Patches

Patch zone	Code	Width (cm)	No	Mean
grass only pat	gp	34920	11	3174.5
vegetation pat	vp	3900	3	1300.0
Total		38820	14	2772.9

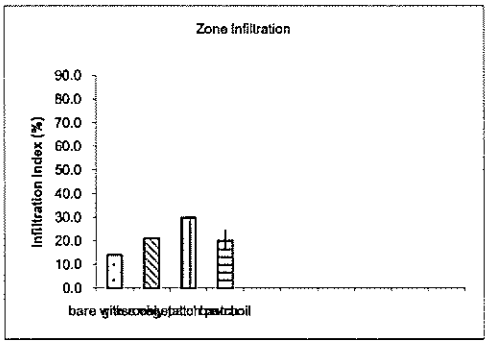
Number of Patches/10m		2.8		
Total Patch Area		2162.8	sq. m.	
Patch Area Index		4.33		total patch area/max. area of patches (transect length * 10)
Landscape Organisation Index		0.59		length of patches/length of transect
Average Interpatch Length (m)		1.48	m	
Range Interpatch length	0.2	to	10.0	m.

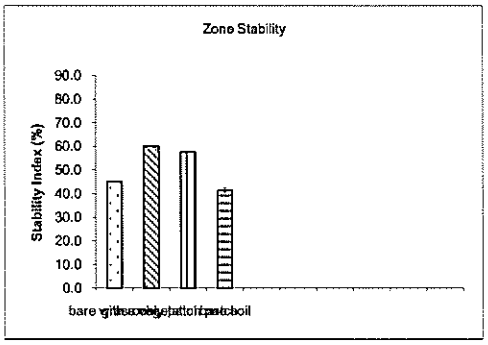
Soil Surface Assessment Of individual Zones

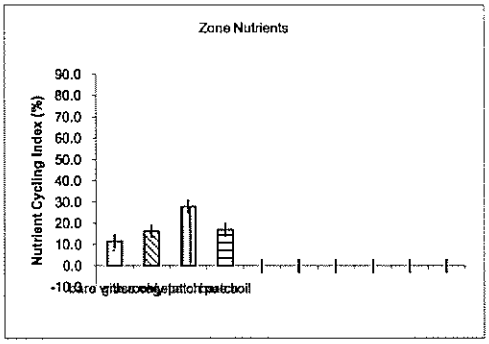
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
bare with rock	45.0		14.0		11.6	
grass only pat	60.0		21.1		16.3	
vegetation pat	57.5		29.8		27.9	
bare soil	41.3	1.3	20.1	4.4	17.0	3.1

Soil Surface Assessment Individual zones contribution to the whole Landscape

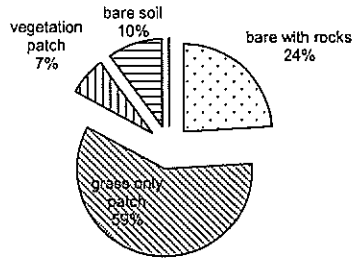
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
bare with rock	12.8		4.0		3.3	
grass only pat	31.3		11.0		8.5	
vegetation pat	3.7		1.9		1.8	
bare soil	5.4	0.2	2.6	0.6	2.2	0.4
Total	53.1	0.2	19.5	0.8	15.8	0.6



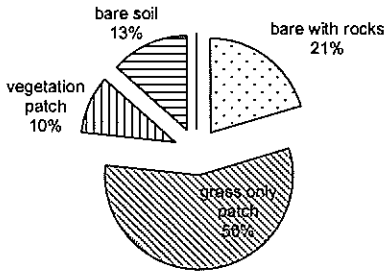




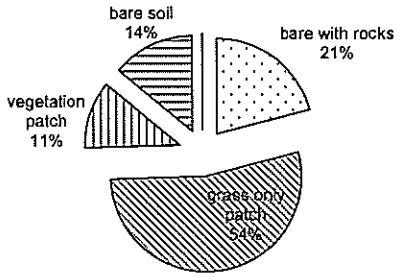
Stability (individual Contributions)



Infiltration (individual Contributions)



Nutrients (individual Contributions)



Transect:-	1		
Distance (m)	Patch width (cm)	Patch/ Interpatch Identity	Comments
0			
1.1		br	
1.85	50	gp	
4.55		br	
5.2	1450	vp	
5.7		bs	
6	270	gp	
6.2		bs	
7.4	50	gp	
8.4		bs	
8.8	1600	gp	
9.1		bs	
10.6	1400	gp	
11.6		bs	
14	1550	vp	
14.3		bs	
14.8	250	gp	
15.2		br	
15.4	900	vp	
16.2		bs	
16.5	500	gp	
26.5		br	
29.8	10000	gp	
30		bs	
39.2	10000	gp	
39.6		bs	
39.9	800	gp	
41.7		bs	
50	10000	gp	

Location:- Brolga Historic Mine Workings **Transect:-** 1

Fetch	Patch Area
1.1	0
0.75	0.375
2.7	0
0.65	9.425
0.5	0
0.3	0.81
0.2	0
1.2	0.6
1	0
0.4	6.4
0.3	0
1.5	21
1	
2.4	37.2
0.3	
0.5	1.25
0.4	
0.2	1.8
0.8	
0.3	1.5
10	
3.3	330
0.2	
9.2	920
0.4	
0.3	2.4
1.8	
8.3	830

Zone	code	Fetch	No	Mean	Proportion	%
bare with rocks	br	14.2	4	3.55	0.28	28.40
grass only patch	gp	26.05	11	2.37	0.52	52.10
vegetation patch	vp	3.25	3	1.08	0.07	6.50
bare soil	bs	6.5	10	0.65	0.13	13.00
Total		50	28	7.65	1	100

Patch	Code	Width	No	Mean Width (cm)
grass only patch	gp	34920	11	3174.545
vegetation patch	vp	3900	3	1300
Total		38820	14	

Total Patch Length	29.3	**m**
Total Patch Width	38820	**cm**
Total Patch Area	2162.76	**sq m**

Standard Error calculation for proportional index

Zone	Stability	Infiltration	Nutrients
bare with rocks			
grass only patch			
vegetation patch			
bare soil	0.22981	0.799899	0.568645
Total	0.22981	0.799899	0.568645
Number	1	1	1
Standard Error	0.22981	0.799899	0.568645

Soil Surface Assessment							
Location:-	Brolga Historic Mine Workings #1		Transect:-	1			
Zone:-	bare with rocks						
Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	1	0	0	0	0	0
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	10	1tn	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	3	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	4	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	1	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	1	0	0	0	0	0
Litter Cover (simple)	10	1	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	3	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	4	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	1	0	0	0	0	0
Total		18	0	0	0	0	0
Divide by		40	0	0	0	0	0
%		45.00					
Proportion	0.284	12.78					

Grand Total	45.0	12.8
Number of Reps	1.0	1.0
Mean	45.0	12.8
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	1	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Slake test	4	1	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	1	0	0	0	0	0
Total		8	0	0	0	0	0
Divide by		57	0	0	0	0	0
%		14.04					
Proportion	0.284	3.99					

Grand Total	14.0	4.0
Number of Reps	1.0	1.0
Mean	14.0	4.0
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	1	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Total		5	0	0	0	0	0
Divide by		43	0	0	0	0	0
%		11.6					
Proportion	0.284	3.3					

Grand Total	11.6	3.3
Number of Reps	1.0	1.0
Mean	11.6	3.3
Std Dev	n/a	n/a
Std Err	n/a	n/a

Soil Surface Assessment

Location:- Brolga Historic Mine Workings #1 Transect:- 1

Zone:- grass only patch

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	10	2ln	0	0	0	0	0
Cryptogam cover	4	2	0	0	0	0	0
Crust broken-ness	4	4	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Soil surface roughness	5	1	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Litter cover (simple)	10	2	0	0	0	0	0
Cryptogam cover	4	2	0	0	0	0	0
Crust broken-ness	4	4	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Total		24	0	0	0	0	0
Divide by		40	0	0	0	0	0
%		60.00					
Proportion	0.521	31.26					

Grand Total	60.0	31.3
Number of Reps	1.0	1.0
Mean	60.0	31.3
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	3	0	0	0	0	0
Soil surface roughness	5	1	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	1	0	0	0	0	0
Total		12	0	0	0	0	0
Divide by		57	0	0	0	0	0
%		21.05					
Proportion	0.521	10.97					

Grand Total	21.1	11.0
Number of Reps	1.0	1.0
Mean	21.1	11.0
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	3	0	0	0	0	0
Cryptogam cover	4	2	0	0	0	0	0
Soil surface roughness	5	1	0	0	0	0	0
Total		7	0	0	0	0	0
Divide by		43	0	0	0	0	0
%		16.3					
Proportion	0.521	8.5					

Grand Total	16.3	8.5
Number of Reps	1.0	1.0
Mean	16.3	8.5
Std Dev	n/a	n/a
Std Err	n/a	n/a

Soil Surface Assessment

Location:- Brolga Historic Mine Workings #1 Transect:- 1

Zone:- vegetation patch

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	3	0	0	0	0	0
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	10	3ls	0	0	0	0	0
Cryptogam cover	4	2	0	0	0	0	0
Crust broken-ness	4	2	0	0	0	0	0
Erosion type & severity	4	4	0	0	0	0	0
Deposited materials	4	1	0	0	0	0	0
Soil surface roughness	5	3	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	3	0	0	0	0	0
Litter Cover (simple)	10	3	0	0	0	0	0
Cryptogam cover	4	2	0	0	0	0	0
Crust broken-ness	4	2	0	0	0	0	0
Erosion type & severity	4	4	0	0	0	0	0
Deposited materials	4	1	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Total		23	0	0	0	0	0
Divide by		40	0	0	0	0	0
%		57.50					
Proportion	0.065	3.74					

Grand Total	57.5	3.7
Number of Reps	1.0	1.0
Mean	57.5	3.7
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	5.985	0	0	0	0	0
Soil surface roughness	5	3	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	1	0	0	0	0	0
Total		16.985	0	0	0	0	0
Divide by		57	0	0	0	0	0
%		29.80					
Proportion	0.065	1.94					

Grand Total	29.8	1.9
Number of Reps	1.0	1.0
Mean	29.8	1.9
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	5.985	0	0	0	0	0
Cryptogam cover	4	2	0	0	0	0	0
Soil surface roughness	5	3	0	0	0	0	0
Total		11.985	0	0	0	0	0
Divide by		43	0	0	0	0	0
%		27.9					
Proportion	0.065	1.8					

Grand Total	27.9	1.8
Number of Reps	1.0	1.0
Mean	27.9	1.8
Std Dev	n/a	n/a
Std Err	n/a	n/a

Soil Surface Assessment

Location:- Brolga Historic Mine Workings #1 Transect:- 1

Zone:- bare soil

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	1	1	0	0	0	0
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	10	1tn	2ts	0	0	0	0
Cryptogam cover	4	1	1	0	0	0	0
Crust broken-ness	4	4	4	0	0	0	0
Erosion type & severity	4	2	2	0	0	0	0
Deposited materials	4	3	2	0	0	0	0
Soil surface roughness	5	3	4	0	0	0	0
Surface resist. to disturb.	5	4	3	0	0	0	0
Slake test	4	1	1	0	0	0	0
Texture	4	2	2	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	1	1	0	0	0	0
Litter Cover (simple)	10	1	2	0	0	0	0
Cryptogam cover	4	1	1	0	0	0	0
Crust broken-ness	4	4	4	0	0	0	0
Erosion type & severity	4	2	2	0	0	0	0
Deposited materials	4	3	2	0	0	0	0
Surface resist. to disturb.	5	4	3	0	0	0	0
Slake test	4	1	1	0	0	0	0
Total		17	16	0	0	0	0
Divide by		40	40	0	0	0	0
%		42.50	40.00				
Proportion	0.13	5.53	5.20				

Grand Total	82.5	10.7
Number of Reps	2.0	2.0
Mean	41.3	5.4
Std Dev	1.8	0.2
Std Err	1.3	0.2

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	30	1	2.66	0	0	0	0
Soil surface roughness	5	3	4	0	0	0	0
Slake test	4	1	1	0	0	0	0
Texture	4	2	2	0	0	0	0
Surface resist. to disturb.	10	1	3.3	0	0	0	0
Total		9	13.96	0	0	0	0
Divide by		57	57	0	0	0	0
%		15.79	24.49				
Proportion	0.13	2.05	3.18				

Grand Total	40.3	5.2
Number of Reps	2.0	2.0
Mean	20.1	2.6
Std Dev	6.2	0.8
Std Err	4.4	0.6

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	30	1	2.66	0	0	0	0
Cryptogam cover	4	1	1	0	0	0	0
Soil surface roughness	5	3	4	0	0	0	0
Total		6	8.66	0	0	0	0
Divide by		43	43	0	0	0	0
%		14.0	20.1				
Proportion	0.13	1.8	2.6				

Grand Total	34.1	4.4
Number of Reps	2.0	2.0
Mean	17.0	2.2
Std Dev	4.4	0.6
Std Err	3.1	0.4

Landscape Function data entry V3.0 7th November 2011

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you in entering and interpreting data collected whilst assessing your Landscape using the LFA and ESA
method as per Manual for assessing Soil in Tropical Grasslands. The spreadsheet is divided up into 14 sheets.

A separate workbook is used for each transect. The sheets are used in the following way for entering data

Sheet 1	Start	Enter the site, location, transect, observers names and the date. Enter ALL the identified patches and inter-patches. Enter the transect data.
	Note:	Patches must be entered in both 'transect zone' and 'patch zone' tables
Sheet 2	Summary	This page is the calculated data summarised
Sheet 3	LFA	Enter the transect log data on this page.
Sheet 4	LFA_work	Calculations you data entered here.
Sheet 5-14	ESA	The woodwood soil surface condition for each zone recorded. (a separate sheet is used for each zone)
	Note:	Litter - has a minimum value of 1. When litter cover is greater than 1 its Origin and Incorporation must be entered or 'n/a'
	Note:	For No data or n/a leave as zero this removes it from the calculation.

Data is entered into (gold coloured) boxes

Site Name	Bridge Historic Mine Rehabilitation Assessment
Location	Bridge Historic Mine Workings #2
Transect Name	2
Observers	R. Howe, M. Dyer
Date	13/11/2012

Transect Zones
(patch & inter-patch)

Zone	Code
bare with rocks	br
grass only patch	gp
vegetation patch	vp

Transect Patch Zones

Patch Zone	Code
grass only patch	gp
vegetation patch	vp

Site Name Brolga Historic Mine Rehabilitation Assessment

Location Brolga Historic Mine Workings #2

Transect Name 2

Date 5/01/2012

Landscape

Zone	Mean Zone Length (m)	%
bare with rock	7.22	43.3
grass only pat	0.70	2.8
vegetation pat	26.95	53.9
Total		100.0

Patches

Patch zone	Code	Width (cm)	No	Mean
grass only pat	gp	2025	2	1012.5
vegetation pat	vp	10000	1	10000.0
Total		12025	3	4008.3

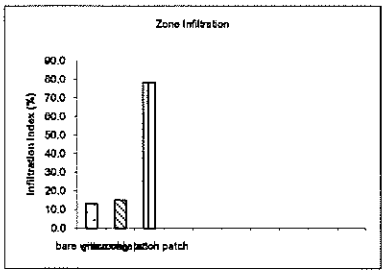
Number of Patches/10m		0.6		
Total Patch Area		2716.1	sq. m.	
Patch Area Index		5.43		total patch area/max. area of patches (transect length * 10)
Landscape Organisation Index		0.57		length of patches/length of transect
Average Interpatch Length (m)		7.22	m	
Range Interpatch length	1.7	to	15.6	m.

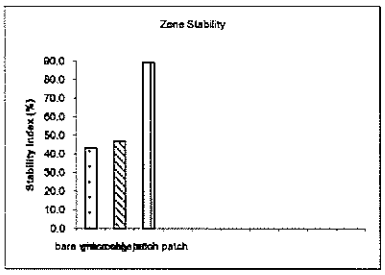
Soil Surface Assessment Of individual Zones

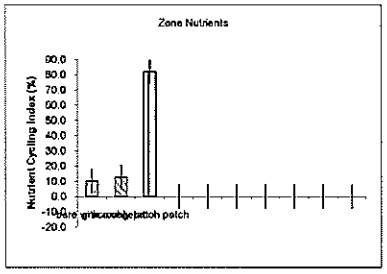
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
bare with rock	43.3	0.4	13.2	0.0	10.3	0.0
grass only pat	46.9		15.1		12.8	
vegetation pat	89.3	0.0	78.2	0.0	82.1	0.0

Soil Surface Assessment Individual zones contribution to the whole Landscape

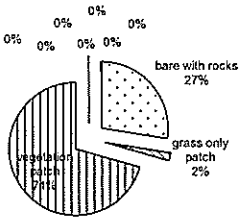
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
bare with rock	18.8	0.2	5.7	0.0	4.4	0.0
grass only pat	1.3		0.4		0.4	
vegetation pat	48.1	0.0	42.2	0.0	44.2	0.0
Total	68.2	0.2	48.3	0.0	49.0	0.0



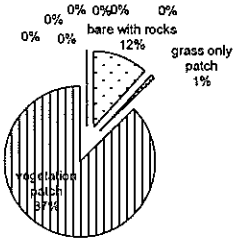




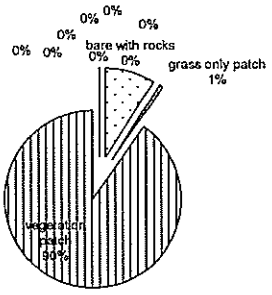
Stability (Individual Contributions)



Infiltration (individual Contributions)



Nutrients (individual Contributions)



Transect:-	2		
Distance (m)	**Patch width (cm)**	**Patch/ Interpatch Identity**	**Comments**
0			
4.4		br	
4.75	25	gp	
20.3		br	
21.35	2000	gp	
23.05		br	
50	10000	vp	

Location:-		Brolga Historic Mine Workings	**Transect:-**	2			

Fetch	Patch Area
4.4	0
0.35	0.0875
15.55	0
1.05	21
1.7	0
26.95	2695
-50	0
0	0
0	0
0	0
0	0
0	0

Zone	code	Fetch	No	Mean	Proportion	%
bare with rocks	br	21.65	3	7.22	0.43	43.30
grass only patch	gp	1.4	2	0.70	0.03	2.80
vegetation patch	vp	26.95	1	26.95	0.54	53.90
Total		50	6	34.87	1	100

Patch	Code	Width	No	Mean Width (cm)
grass only patch	gp	2025	2	1012.5
vegetation patch	vp	10000	1	10000
Total		12025	3	

Total Patch Length	28.35	**m**
Total Patch Width	12025	**cm**
Total Patch Area	2716.088	**sq m**

Standard Error calculation for proportional index

Zone	Stability	Infiltration	Nutrients
bare with rocks	0.273373	0	0
grass only patch			
vegetation patch	0	0	0
Total	0.273373	0	0
Number	2	2	2
Standard Error	0.193304	0	0

Soil Surface Assessment							
Location:-	Brolga Historic Mine Workings #2		Transect:-	2			
Zone:-	bare with rocks						
Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	1	1	0	0	0	0
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	10	1tn	1tn	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	2	0	0	0	0
Erosion type & severity	4	3	3	0	0	0	0
Deposited materials	4	3	3	0	0	0	0
Soil surface roughness	5	2	2	0	0	0	0
Surface resist. to disturb.	5	4	4	0	0	0	0
Slake test	4	0	0	0	0	0	0
Texture	4	2	2	0	0	0	0

Stability

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	1	1	0	0	0	0
Litter Cover (simple)	10	1	1	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	2	0	0	0	0
Erosion type & severity	4	3	3	0	0	0	0
Deposited materials	4	3	3	0	0	0	0
Surface resist. to disturb.	5	4	4	0	0	0	0
Slake test	4	0	0	0	0	0	0
Total		12	14	0	0	0	0
Divide by		28	32	0	0	0	0
%		42.86	43.75				
Proportion	0.433	18.56	18.94				

Grand Total	86.6	37.5
Number of Reps	2.0	2.0
Mean	43.3	18.8
Std Dev	0.6	0.3
Std Err	0.4	0.2

Infiltration/runoff

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	30	1	1	0	0	0	0
Soil surface roughness	5	2	2	0	0	0	0
Slake test	4	0	0	0	0	0	0
Texture	4	2	2	0	0	0	0
Surface resist. to disturb.	10	1	1	0	0	0	0
Total		7	7	0	0	0	0
Divide by		53	53	0	0	0	0
%		13.21	13.21				
Proportion	0.433	5.72	5.72				

Grand Total	26.4	11.4
Number of Reps	2.0	2.0
Mean	13.2	5.7
Std Dev	0.0	0.0
Std Err	0.0	0.0

Nutrient cycling status

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	30	1	1	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Soil surface roughness	5	2	2	0	0	0	0
Total		4	4	0	0	0	0
Divide by		39	39	0	0	0	0
%		10.3	10.3				
Proportion	0.433	4.4	4.4				

Grand Total	20.5	8.9
Number of Reps	2.0	2.0
Mean	10.3	4.4
Std Dev	0.0	0.0
Std Err	0.0	0.0

Soil Surface Assessment

Location:- Brolga Historic Mine Workings #2 Transect:- 2

Zone:- grass only patch

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	1	0	0	0	0	0
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	10	2tn	0	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	2	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	0	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	1	0	0	0	0	0
Litter cover (simple)	10	2	0	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	2	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	0	0	0	0	0	0
Total		15	0	0	0	0	0
Divide by		32	0	0	0	0	0
%		46.88					
Proportion	0.028	1.31					

Grand Total	46.9	1.3
Number of Reps	1.0	1.0
Mean	46.9	1.3
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	2	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Slake test	4	0	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	1	0	0	0	0	0
Total		8	0	0	0	0	0
Divide by		53	0	0	0	0	0
%		15.09					
Proportion	0.028	0.42					

Grand Total	15.1	0.4
Number of Reps	1.0	1.0
Mean	15.1	0.4
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	0	0	0	0	0
Litter cover, orig & incorp.	30	2	0	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Total		5	0	0	0	0	0
Divide by		39	0	0	0	0	0
%		12.8					
Proportion	0.028	0.4					

Grand Total	12.8	0.4
Number of Reps	1.0	1.0
Mean	12.8	0.4
Std Dev	n/a	n/a
Std Err	n/a	n/a

Soil Surface Assessment

Location:- Brolga Historic Mine Workings #2 Transect:- 2

Zone:- vegetation patch

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	5	5	0	0	0	0
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	10	10le	10le	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	0	0	0	0	0	0
Deposited materials	4	4	4	0	0	0	0
Soil surface roughness	5	1	1	0	0	0	0
Surface resist. to disturb.	5	2	2	0	0	0	0
Slake test	4	4	4	0	0	0	0
Texture	4	2	2	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	5	5	0	0	0	0
Litter Cover (simple)	10	10	10	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	0	0	0	0	0	0
Deposited materials	4	4	4	0	0	0	0
Surface resist. to disturb.	5	2	2	0	0	0	0
Slake test	4	4	4	0	0	0	0
Total		25	25	0	0	0	0
Divide by		28	28	0	0	0	0
%		89.29	89.29				
Proportion	0.539	48.13	48.13				

Grand Total	178.6	96.3
Number of Reps	2.0	2.0
Mean	89.3	48.1
Std Dev	0.0	0.0
Std Err	0.0	0.0

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	30	30	30	0	0	0	0
Soil surface roughness	5	1	1	0	0	0	0
Slake test	4	4	4	0	0	0	0
Texture	4	2	2	0	0	0	0
Surface resist. to disturb.	10	6.6	6.6	0	0	0	0
Total		44.6	44.6	0	0	0	0
Divide by		57	57	0	0	0	0
%		78.25	78.25				
Proportion	0.539	42.17	42.17				

Grand Total	156.5	84.3
Number of Reps	2.0	2.0
Mean	78.2	42.2
Std Dev	0.0	0.0
Std Err	0.0	0.0

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	1	1	0	0	0	0
Litter cover, orig & incorp.	30	30	30	0	0	0	0
Cryptogam cover	4	0	0	0	0	0	0
Soil surface roughness	5	1	1	0	0	0	0
Total		32	32	0	0	0	0
Divide by		39	39	0	0	0	0
%		82.1	82.1				
Proportion	0.539	44.2	44.2				

Grand Total	164.1	88.5
Number of Reps	2.0	2.0
Mean	82.1	44.2
Std Dev	0.0	0.0
Std Err	0.0	0.0

Landscape Function data entry V3.0 7th November 2008

This spreadsheet (workbook) has been developed by CSIRO Sustainable Ecosystems to assist you in entering and interpreting data collected whilst assessing your Landscape using the LFA and BSA method as per Manual for assessing Soil in Tropical Grasslands. The spreadsheet is divided up into 14 sheets.

A separate workbook is used for each transect. The sheets are used in the following way for entering data:

Sheet 1	Start	Enter the site, location, transect, observers names and the date Enter ALL the identified patches and inter-patches Enter the transition patches
	Note:	Patches must be entered in both 'transect zone' and 'patch zone' tables
Sheet 2	Summary	This page is the collected data summarised
Sheet 3	LFA	Enter the transect log data on this page
Sheet 4	LFA_calc	Calculations (no data entered here)
Sheet 5-13	BSA	The assessed soil surface condition for each zone recorded (a separate sheet is used for each zone)
	Note:	(Litter) has a minimum value of 1. Where litter cover is greater than 1 the Origin and Incorporation must be entered ie SLS.
	Note:	For No data or n/a leave as zero this removes it from the calculation

Data is entered into bold outlined boxes

Site Name	Dodge Historic Mine Rehabilitation Assessment
Location	Dodge Regrowth Woodlands (Analogue Site)
Transect Name	3
Observers	R. Hearn, M. Dyker
Date	13/1/2012

Transect Zones
(patch & inter-patch)

Zone	Code
bare with rocks	br
grass only patch	gp
vegetated patch	vp
bare soil	bs

Transect Patch Zones

Patch Zone	Code
grass only patch	gp
vegetated patch	vp

Site Name Brolga Historic Mine Rehabilitation Assessment

Location Brolga Regrowth Woodlands (Analogue Site)

Transect Name 3

Date 5/01/2012

Landscape

Zone	Mean Zone Length (m)	%
bare with rock	4.38	26.3
grass only pat	3.45	20.7
vegetation pat	2.95	35.4
bare soil	1.47	17.6
Total		100.0

Patches

Patch zone	Code	Width (cm)	No	Mean
grass only pat	gp	1040	3	346.7
vegetation pat	vp	7935	6	1322.5
Total		8975	9	997.2

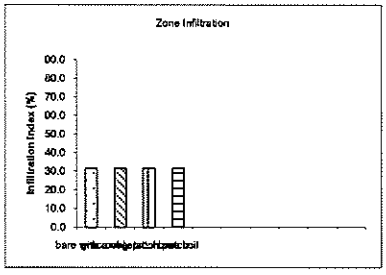
Number of Patches/10m		1.8		
Total Patch Area		318.9	sq. m.	
Patch Area Index		0.64		total patch area/max. area of patches (transect length * 10)
Landscape Organisation Index		0.56		length of patches/length of transect
Average Interpatch Length (m)		2.44	m	
Range Interpatch length	0.2	to	10.7	m.

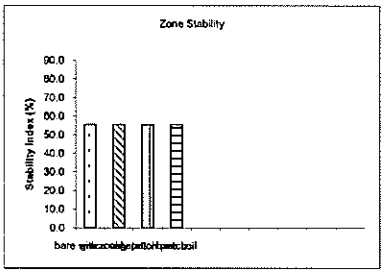
Soil Surface Assessment Of individual Zones

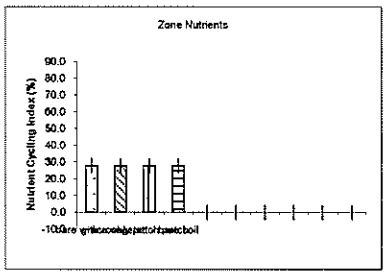
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
bare with rock	55.6		31.6		27.9	
grass only pat	55.6		31.6		27.9	
vegetation pat	55.6	0.0	31.6	0.0	27.9	0.0
bare soil	55.6		31.6		27.9	

Soil Surface Assessment Individual zones contribution to the whole Landscape

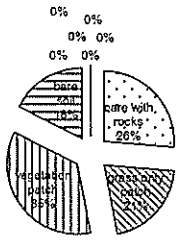
Zone	Stability	Std err	Infiltration	Std err	Nutrients	Std err
bare with rock	14.6		8.3		7.3	
grass only pat	11.5		6.5		5.8	
vegetation pat	19.7	0.0	11.2	0.0	9.9	0.0
bare soil	9.8		5.6		4.9	
Total	55.6	0.0	31.6	0.0	27.9	0.0



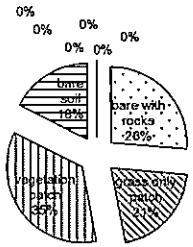




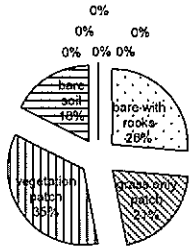
Stability (individual Contributions)



Infiltration (individual Contributions)



Nutrients (individual Contributions)



Transect:-	3		
Distance (m)	**Patch width (cm)**	**Patch/ Interpatch Identity**	**Comments**
0			
10.7		br	
19.25	1000	gp	
19.5		br	
23.1	30	vp	
25.3		br	
27.3	1200	vp	
30.7		bs	
31.5	2700	vp	
32.3		bs	
34	2000	vp	
34.5		bs	
35	20	gp	
36.1		bs	
38	35	vp	
40.8		bs	
48.5	1970	vp	
48.7		bs	
50	20	gp	

Location:-			Brolga Regrowth Woodlands (	Transect:-	3			

Fetch	Patch Area
10.7	0
8.55	85.5
0.25	0
3.6	1.08
2.2	0
2	24
3.4	0
0.8	21.6
0.8	0
1.7	34
0.5	0
0.5	0.1
1.1	
1.9	0.665
2.8	
7.7	151.69
0.2	
1.3	0.26

Zone	code	Fetch	No	Mean	Proportion	%
bare with rocks	br	13.15	3	4.38	0.26	26.30
grass only patch	gp	10.35	3	3.45	0.21	20.70
vegetation patch	vp	17.7	6	2.95	0.35	35.40
bare soil	bs	8.8	6	1.47	0.18	17.60
Total		50	18	12.25	1	100

Patch	Code	Width	No	Mean Width (cm)
grass only patch	gp	1040	3	346.6667
vegetation patch	vp	7935	6	1322.5
Total		8975	9	

Total Patch Length	28.05	**m**
Total Patch Width	8975	**cm**
Total Patch Area	318.895	**sq m**

Standard Error calculation for proportional index

Zone	Stability	Infiltration	Nutrients
bare with rocks			
grass only patch			
vegetation patch	0	0	0
bare soil			
Total	0	0	0
Number	1	1	1
Standard Error	0	0	0

Soil Surface Assessment							
Location:-	Brolga Regrowth Woodlands (Analogu	Transect:-	3				
Zone:-	bare with rocks						
Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	10	3ls	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Litter Cover (simple)	10	3	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Total		20	0	0	0	0	0
Divide by		36	0	0	0	0	0
%		55.56					
Proportion	0.263	14.61					

Grand Total	55.6	14.6
Number of Reps	1.0	1.0
Mean	55.6	14.6
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	30	5.985	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	1	0	0	0	0	0
Total		17.985	0	0	0	0	0
Divide by		57	0	0	0	0	0
%		31.55					
Proportion	0.263	8.30					

Grand Total	31.6	8.3
Number of Reps	1.0	1.0
Mean	31.6	8.3
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	30	5.985	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Total		11.985	0	0	0	0	0
Divide by		43	0	0	0	0	0
%		27.9					
Proportion	0.263	7.3					

Grand Total	27.9	7.3
Number of Reps	1.0	1.0
Mean	27.9	7.3
Std Dev	n/a	n/a
Std Err	n/a	n/a

Soil Surface Assessment

Location:- Brolga Regrowth Woodlands (Analogu Transect:- 3

Zone:- grass only patch

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	10	3ls	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Litter cover (simple)	10	3	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Total		20	0	0	0	0	0
Divide by		36	0	0	0	0	0
%		55.56					
Proportion	0.207	11.50					

Grand Total	55.6	11.5
Number of Reps	1.0	1.0
Mean	55.6	11.5
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	30	5.985	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	1	0	0	0	0	0
Total		17.985	0	0	0	0	0
Divide by		57	0	0	0	0	0
%		31.55					
Proportion	0.207	6.53					

Grand Total	31.6	6.5
Number of Reps	1.0	1.0
Mean	31.6	6.5
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	30	5.985	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Total		11.985	0	0	0	0	0
Divide by		43	0	0	0	0	0
%		27.9					
Proportion	0.207	5.8					

Grand Total	27.9	5.8
Number of Reps	1.0	1.0
Mean	27.9	5.8
Std Dev	n/a	n/a
Std Err	n/a	n/a

Soil Surface Assessment							
Location:-	Brolga Regrowth Woodlands (Analogu	Transect:-	3				
Zone:-	vegetation patch						
Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	2	0	0	0	0
Per. basal / canopy cover	4	3	3	0	0	0	0
Litter cover, orig & incorp.	10	3ls	3ls	0	0	0	0
Cryptogam cover	4	1	1	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	3	0	0	0	0
Deposited materials	4	3	3	0	0	0	0
Soil surface roughness	5	2	2	0	0	0	0
Surface resist. to disturb.	5	4	4	0	0	0	0
Slake test	4	4	4	0	0	0	0
Texture	4	2	2	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	2	0	0	0	0
Litter Cover (simple)	10	3	3	0	0	0	0
Cryptogam cover	4	1	1	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	3	0	0	0	0
Deposited materials	4	3	3	0	0	0	0
Surface resist. to disturb.	5	4	4	0	0	0	0
Slake test	4	4	4	0	0	0	0
Total		20	20	0	0	0	0
Divide by		36	36	0	0	0	0
%		55.56	55.56				
Proportion	0.354	19.67	19.67				

Grand Total	111.1	39.3
Number of Reps	2.0	2.0
Mean	55.6	19.7
Std Dev	0.0	0.0
Std Err	0.0	0.0

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	3	3	0	0	0	0
Litter cover, orig & incorp.	30	5.985	5.985	0	0	0	0
Soil surface roughness	5	2	2	0	0	0	0
Slake test	4	4	4	0	0	0	0
Texture	4	2	2	0	0	0	0
Surface resist. to disturb.	10	1	1	0	0	0	0
Total		17.985	17.985	0	0	0	0
Divide by		57	57	0	0	0	0
%		31.55	31.55				
Proportion	0.354	11.17	11.17				

Grand Total	63.1	22.3
Number of Reps	2.0	2.0
Mean	31.6	11.2
Std Dev	0.0	0.0
Std Err	0.0	0.0

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	3	3	0	0	0	0
Litter cover, orig & incorp.	30	5.985	5.985	0	0	0	0
Cryptogam cover	4	1	1	0	0	0	0
Soil surface roughness	5	2	2	0	0	0	0
Total		11.985	11.985	0	0	0	0
Divide by		43	43	0	0	0	0
%		27.9	27.9				
Proportion	0.354	9.9	9.9				

Grand Total	55.7	19.7
Number of Reps	2.0	2.0
Mean	27.9	9.9
Std Dev	0.0	0.0
Std Err	0.0	0.0

Soil Surface Assessment

Location:- Brolga Regrowth Woodlands (Analogue Transect:- 3

Zone:- bare soil

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	10	3ls	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0

Stability

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Soil Cover	5	2	0	0	0	0	0
Litter Cover (simple)	10	3	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Crust broken-ness	4	0	0	0	0	0	0
Erosion type & severity	4	3	0	0	0	0	0
Deposited materials	4	3	0	0	0	0	0
Surface resist. to disturb.	5	4	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Total		20	0	0	0	0	0
Divide by		36	0	0	0	0	0
%		55.56					
Proportion	0.176	9.78					

Grand Total	55.6	9.8
Number of Reps	1.0	1.0
Mean	55.6	9.8
Std Dev	n/a	n/a
Std Err	n/a	n/a

Infiltration/runoff

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	30	5.985	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Slake test	4	4	0	0	0	0	0
Texture	4	2	0	0	0	0	0
Surface resist. to disturb.	10	1	0	0	0	0	0
Total		17.985	0	0	0	0	0
Divide by		57	0	0	0	0	0
%		31.55					
Proportion	0.176	5.55					

Grand Total	31.6	5.6
Number of Reps	1.0	1.0
Mean	31.6	5.6
Std Dev	n/a	n/a
Std Err	n/a	n/a

Nutrient cycling status

Features	Max score	Rep1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Per. basal / canopy cover	4	3	0	0	0	0	0
Litter cover, orig & incorp.	30	5.985	0	0	0	0	0
Cryptogam cover	4	1	0	0	0	0	0
Soil surface roughness	5	2	0	0	0	0	0
Total		11.985	0	0	0	0	0
Divide by		43	0	0	0	0	0
%		27.9					
Proportion	0.176	4.9					

Grand Total	27.9	4.9
Number of Reps	1.0	1.0
Mean	27.9	4.9
Std Dev	n/a	n/a
Std Err	n/a	n/a



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