2021

2021 Annual Review

TOMINGLEY GOLD OPERATIONS

ENVIRONMENTAL PERFORMANCE

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Definitions / Acronyms

Term	Definition
CCC	Community Consultative Committee
EEC	Endangered ecological community
EC	Electrical Conductivity
EPA	Environment Protection Authority
EP&A	*Environment Planning and Assessment Act 1979*
EPL	Environment Protection Licence
DPE	Department of Planning and Environment (formerly DPIE)
ha	Hectares
HVAS	High volume air sampler
LFA	Landscape function analysis
MEG	Mining, Exploration and Geoscience (MEG) – A Division of the Department of Regional NSW
Mining Act	*Mining Act 1992*
MOP	Mining Operations Plan
ML	Mining Lease
NSC	Narromine Shire Council
NOW	NSW Office of Water
OEH	Former NSW Office of Environment and Heritage
PM10	Particulate matter
TEOM	Tapered Element Oscillating Microbalance
TGO	Tomingley Gold Operations
TSP	Total suspended particulates
WAD	Weak acid dissociable cyanide
WAL	Water access licence
WHS	*Work Health & Safety Act 2011*
WRE	Waste rock emplacement

Title Block

Table 1: Annual Review Title Block

Name of operation	Tomingley Gold Operations
Name of operator	Tomingley Gold Operations Pty Ltd
Development consent I project approval #	PA 09_0155 (MOD 5)
Name of holder of development consent I project approval	Alkane Resources Ltd
Mining lease #	ML 1684, ML 1821
Name of holder of mining lease	Tomingley Gold Operations Pty Ltd
Water licence #	WAL20270; WAL28643; WAL29266
Name of holder of water licence	Alkane Resources Ltd
MOP/RMP start date	1 October 2017
MOP/RMP end date	2 July 2022
Annual Review start date	1 January 2021
Annual Review end date	31 December 2021

I, David Pritchard, certify that this audit report is a true and accurate record of the compliance status of Tomingley Gold Operations for the period 1 January to 31 December 2021 and that I am authorised to make this statement on behalf of Alkane Resources Pty Ltd.

Note.

a) The Annual Review is an 'environmental audit' for the purposes of section 122B(2) of the *Environmental Planning and Assessment Act 1979.* Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.

b) The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (Intention to defraud by false or misleading statement-maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents- maximum penalty 2 years imprisonment or $22,000, or both).

Name of authorised reporting officer	David Pritchard
Title of authorised reporting officer	Environment and Community Manager
Signature of authorised reporting officer	
Date	28-03-2022

1 Statement of Compliance

Table 2 provides a statement of compliance status for Tomingley Gold Operations Pty Ltd (TGO) with its project approval (PA) and mining lease (ML), as at the end of the reporting period.

Table 2: Statement of Compliance

Were all conditions of the following approvals complied with?	
PA 09_0155	No
ML 1684	Yes
ML 1821	Yes

Table 3 provides a summary of approval conditions not complied with as at the end of the reporting period.

Table 3: Non-compliances

Relevant approval	Condition #	Condition description (summary)	Compliance status	Comment	Relevent Section
PA 09_0155	Schedule 3. 23(b)	Surface water discharges from site comply with EPL limits.	Low	Concentration limits exceeded during offsite water discharge from Sediment Basin 1	11.1.1

Compliance status key for Table 3		
Risk level	**Colour Code**	**Description**
High	Non-compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-compliant	Non-compliance with: • potential for serious environmental consequences, but is unlikely to occur; or • potential for moderate environmental consequences, but is likely to occur
Low	Non-compliant	Non-compliance with: • potential for moderate environmental consequences, but is unlikely to occur; or • potential for low environmental consequences, but is likely to occur
Administrative non-compliance	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions)

2 Introduction

2.1 Tomingley Gold Mine

This Annual Review reports on the environmental management activities undertaken at Tomingley Gold Operations Pty Ltd (TGO) during the calendar year 2021, and provides details on activities proposed for 2022. The report has been produced in accordance with the *Post-approval requirements for State significant mining developments. Annual Review Guideline* (DP&E, October 2015) to meet the annual reporting requirements conditioned in the TGO Mining Lease (ML 1684) and Project Approval (PA09_0155).

TGO is a wholly owned subsidiary of Alkane Resources Ltd. TGO is a medium-sized gold project which aims to produce 60,000 ounces of poured gold over the next 12 months, based on an annual ore throughput of approximately 1,335,800 milled tonnes.

The Tomingley area has a long history of gold mining and exploration, with gold first discovered and mined from the Tomingley Goldfield in the 1880s. Numerous underground mining operations were subsequently located in the McPhail area, immediately south of the TGO minesite. The last economic 'mining' activities were completed in the late 1990s and involved the re-treatment of tailings from the McPhail Mine.

TGO's process plant, with associated residue facilities were commissioned between December 2013 and February 2014.

In January 2019 the Tomingley Mine commenced development for underground mining with the establishment of 2 portals from the base of Wyoming 1 open cut pit. Development and processing of stope material continued throughout 2021.

In April 2021, the Department of Planning, Industry and Environment approved Modification 5 to PA 09_0155 which was to allow construction of a second Residue Storage Facility, comprising an additional 2.36 Million tonne (Mt) of capacity. Works did not take place during the current reporting and are scheduled to occur during the next reporting period.

Open cut operations continued throughout 2021 in the Caloma 1 pit on the Eastern Cut Back which is recovering ore from the eastern perimeter of the Caloma 1 pit.

Waste rock from the operations was hauled in pit with some waste being placed in temporary surface dumps and also used for various activities such as the Stage 8 lift of the Residue Storage Facility (RSF), while ore was transported to the existing ROM pad for processing at the processing plant.

Other operations on site during the reporting period included the ongoing completion of regular site monitoring and maintenance activities in accordance with the Project Approval and site management plans.

TGO hosted three Community Consultative Committee (CCC) meetings and did so in accordance with the relevant State and Local Government COVID 19 safe operating protocols.

2.2 Mine Contacts

The primary contacts for the TGO during the review period are detailed in Table 4.

Table 4: Tomingley Gold Operations Key Contacts

Key Contact	Position	Contact Details
Jason Hughes	General Manager Operations	PO Box 59 Peak Hill, NSW, 2869 Phone: (02) 6867 9780
Chris Taylor	Underground Manager	
Daniel Short	Open Cut Manager	
David Pritchard	Environment and Community Manager	
James Didovich	Processing Manager	
Community Information		(02) 6865 6116

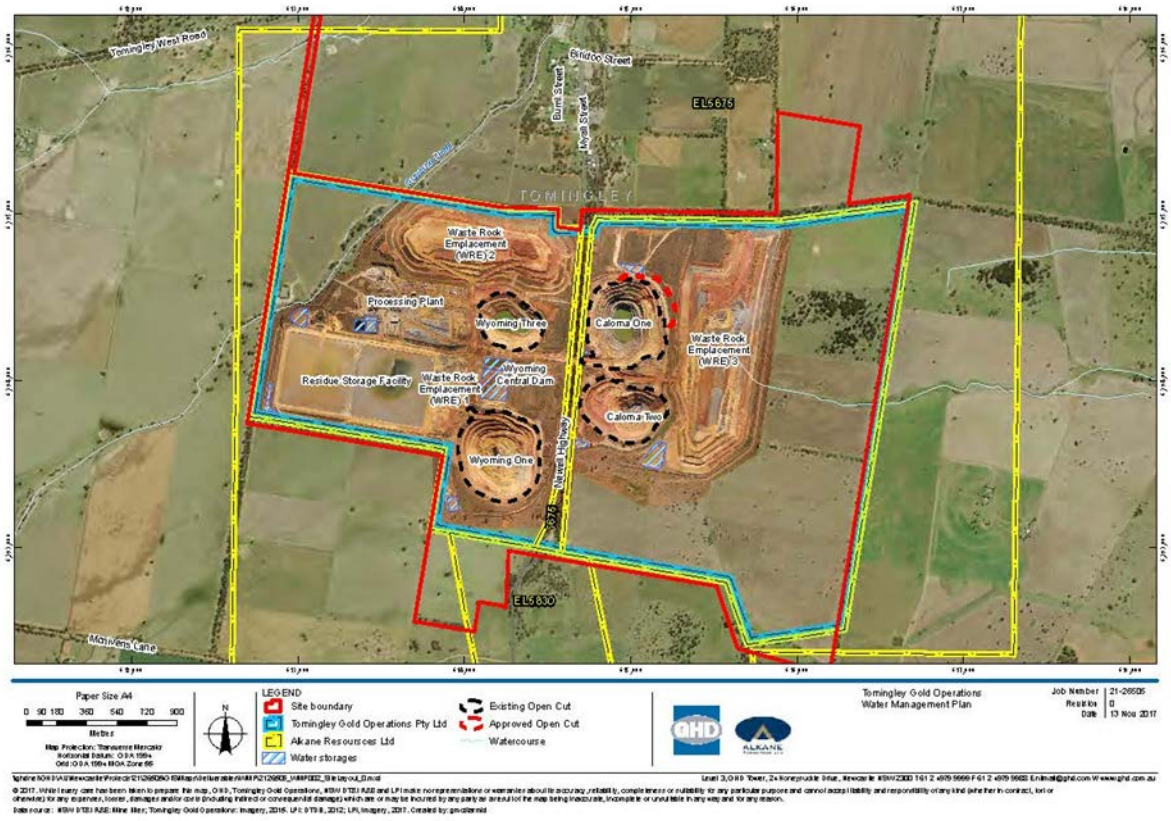

Figure 1 – Tomingley Gold Operations Site Layout

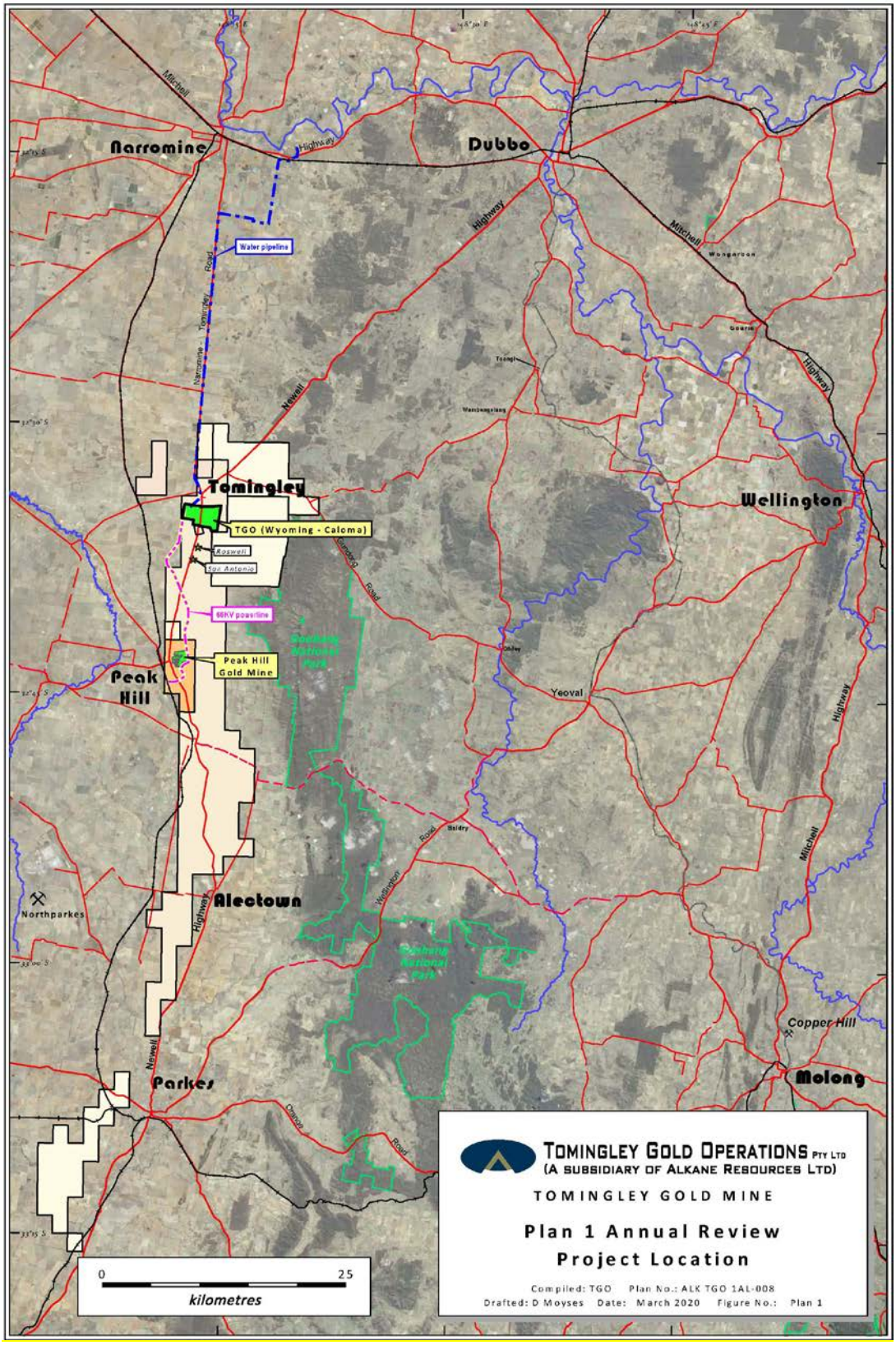

Figure 2 – Tomingley Gold Operations Regional Setting

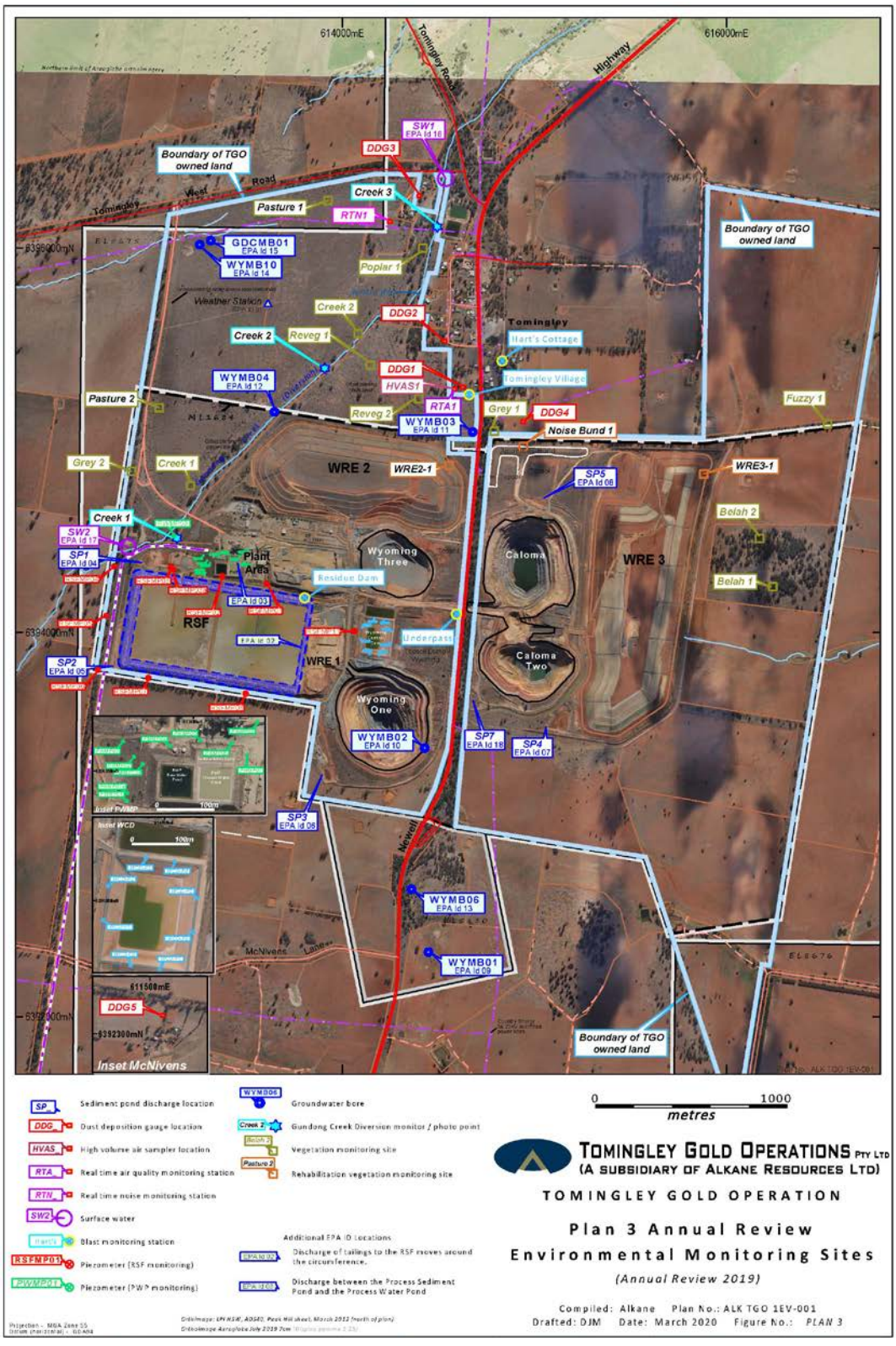

Figure 1 – Tomingley Gold Operations Environmental Monitoring Locations

3 Approvals

TGO operates under the environmental consents, leases and licences specified in Table 5.

Table 5: Consents, Leases and Licences

Title	Legislation	Regulatory Authority	Approval Duration/ Expiry
Project approval 09_0155 (MOD 1 – 24 July 2012) (MOD 2 – 13 May 2015) (MOD 3 – 5 July 2016) (MOD 4 - 25 May 2020) (MOD 5 – April 2021)	Environmental Planning & Assessment (EP&A) Act 1979	DPIE	31 December 2025
Mining Lease 1684	Mining Act 1992	Regional NSW – Mining, Exploration and Geoscience (MEG)	11 February 2034
Mining Lease 1821	Mining Act 1992	Regional NSW – Mining, Exploration and Geoscience (MEG)	11 February 2034
Environment Protection Licence (EPL) 20169	Protection of the Environment Operations (POEO) Act 1997	NSW Environment Protection Authority (EPA)	Ongoing until surrendered
Flood Works Approval 80FW723901 (Gundong Creek levy)	Water Management Act 2000	NSW Office of Water (NOW)	2 January 2028
Groundwater licences WAL20270, WAL28643 and WAL29266	Water Management Act 2000	NSW Office of Water (NOW)	N/A
Notification of Dangerous Goods NDG200150	Work Health & Safety Act (WHS) 2011	WorkCover NSW	N/A

4 Operations Summary

4.1 Mining

Underground mining continued with the extraction of the Wyoming 1 and Caloma ore bodies through open stoping. The development of additional levels at Caloma and Wyoming has continued. TGO have commenced the development of the San Antonio / Roswell exploration drive to access new high grade ore zones in the coming years.

Waste was hauled in-pit and some to temporary surface dumps. Waste was also used to backfill stope voids and this material was taken from surface and in-pit dumps. Ore was transported to the existing ROM pad for processing at the processing plant.

Allowing for replacement plant and temporary introduction of additional plant for short projects, the TGO open cut mobile plant fleet remained generally consistent with the indicative mining fleet presented in *'MOD 3 Environmental Assessment'* (RW Corkery, 2015) (EA) during the reporting period.

Opencut mining re-commenced on dayshift only mining in October 2020 in the Caloma 1 cutback. Waste was stockpiled for future Residue Storage Facility (RSF) raises or backfilled in pit. The cut back of the approved Caloma 1 Open Cut was approved in MOD 2 (April 2015). Opencut mining is currently planned to continue through to late 2022.

A summary of production during the reporting period is provided in Table 6.

Table 6: Production Summary

Material		Approved Limit (specify limit)	Previous Reporting period (actual) (CY 2020)	This reporting period (actual) (CY 2021)	Next reporting period (forecast) (CY 2022)
Waste Rock	Underground	-	325,904 t	322,962	424,800
	Open Cut	-	904,315 t	3,200,000	1,900,000
Ore (kt)	Underground	1.5 million tonnes*	606,368 t	778,417	945,800
	Open Cut		17,734 t	252,900	390,000
Process Residue (tailings) (t)		-	807,342	944,158	1,029,600
Saleable Product (Oz)		-	46,498	58,618	60,000
Note: No coarse process waste produced at TGO * PA 09_0155 Schedule 2 Condition 6 (not process more than 1.5 million tonnes of ore at the site in a calendar year)					

4.2 Other Operations

TGO employed 227 (205 permanent and 22 casuals) people onsite as at 31 December 2021, meeting Condition 9 of ML 1684 which requires that:

"The lease holder must:

(a) ensure that at least 30 competent people are efficiently employed in relation to the mining process or mining operations on the lease area OR

(b) expend on operations carried out in the course of prospecting or mining the lease area, an amount of not less than $525,000.00 per annum whilst the lease is in force."

4.3 Next Reporting Period

During the next reporting period, underground mining will continue with further development and mining of stopes in Wyoming 1 and Caloma on a 24/7 basis.

Open cut mining will continue in Caloma 1 pit.

Processing of ore will continue on a 24-hour roster.

Rehabilitation will be minimal as remaining disturbed areas are still required for ongoing operations.

The development of the San Antonio / Roswell exploration drive will continue.

5 Actions Required from Previous Annual Review

The NSW Department of Planning, Industry and Environment (DPIE) approved the 2020 Annual Review in its correspondence dated 8 April 2021. No additional actions were required from the above correspondence.

6 Environmental Performance

6.1 Noise Management

6.1.1 Statutory Attended Monitoring

Statutory attended noise monitoring to meet the requirements of EPL 20169 Condition M4.1 and PA 09_0155 Schedule 3 Condition 3A was completed over three consecutive day, evening and night periods between 09-11 November 2021 (see Appendix 1). The monitoring indicated noise generated by TGO complies with PA noise limits at all six monitored locations as shown in Table 7.

To address Condition 6 of Schedule 3 of PA 09_0155 a program to calibrate and validate the real-time noise monitoring results with the attended monitoring results has been completed. The validation compares monthly attended monitoring results against the closest assessed unattended monitoring location.

TGO has one unattended real-time monitoring terminal installed at the Brooklands property (nearest to R23). Figure 3 identifies the location of the monitor which is situated 600m west of the attended noise monitoring location R23, therefore, background (LA90) noise levels are significantly lower due to offset distance to highway traffic.

Muller Acoustic Consulting Pty Ltd (MAC) states that a comparison of mine noise contributions between attended and unattended noise monitoring demonstrates a general consistency between attended and unattended results (see Table 8 in Appendix 1).

Table 7: Attended Noise Monitoring Summary

Noise Receiver Locations	DAY Approval criteria[1] LAeq 15 min (dBA)	DAY Results (dBA)	EVENING Approval criteria[1] LAeq 15 min (dBA)	EVENING Results (dBA)	NIGHT Approval criteria[1] LAeq 15 min (dBA)	NIGHT Results (dBA)	Key management implications
R2	36	[2] - 31	35	[2] - 29	35	29 - 31	Compliance with PA 09_0155/ EPL 1684 noise limits
R3/29	45	[2]	35	[2]	35	[2]	
R4	35	[2]	35	[2]	35	[2]	
R5	35	[2]	35	[2]	35	[2]	
R6	35	[2]	35	[2] - 34	35	[2] - 34	
R23	43	[2]	38	[2]	36	[2]	

Notes:

1. Approval Criteria from Schedule 3 Condition 3A of PA 09_0155 which applies from 30 June 2019.
2. Mine inaudible. See full report for further details in Appendix 1.

6.1.2 Supplementary Attended Monitoring

As required by PA 09_0155 supplementary attended monitoring is undertaken for the 11 months each year that statutory EPL attended monitoring does not occur (see TGO web page for all reports) https://www.alkane.com.au/projects/tomingley-gold-project/tomingley-gold-operations/tgo-reports/environmental-reports/.

All months showed no exceedances of PA noise criteria during this supplementary monitoring.

TGO's noise consultant also reviews real time monitoring data on a weekly basis to monitor compliance. Whilst this is only an indicator due to not being able to validate data in the field, nil exceedances were recorded during the reporting period.

Whilst TGO does not consider the number of complaints to be a measure of compliance, TGO received nil noise related complaints for the reporting period (see Appendix 2).

6.1.3 Proposed Improvements

TGO will continue to monitor noise levels however it is not envisaged that any additional improvements will be required to maintain compliance.

6.1.4 EA Predictions

TGO's night time noise levels were consistent with and/or below those predicted in Table 14 of Section 4.2.6 of the MOD3 EA (2016) inlcuding: NAG A 37 dBA, NAG B 36 dBA, NAG C 38 dBA and NAG D 38 dBA. Note: EA critieria are higher than EPL and PA 09_0155 Schedule 3 Condtion 3A noise criteria which are defined as follows: NAG A 35 dBA, NAG B 35 dBA, NAG C 35 dBA and NAG D 36 dBA.

6.2 Blasting

Blasting at TGO is managed in accordance with the TGO Blast Management Plan (BMP), which was prepared to meet relevant conditions of EPL 20169 and PA 09_0155.

During the reporting period TGO fired 66 blasts in the Open Cut, and 255 underground. All blasts were below the prescribed levels for over pressure and vibration (PA 09_0155, Schedule 3, Condition 7) as presented in Table 8.

Table 8: Blasting Criteria

Location	*Airblast Overpressure (dB(Lin Peak))*	*Ground Vibration (mm/s)*	*Allowable Exceedance*	Exceedances during reporting period
Residence on privately-owned land	*120*	*10*	*0%*	0
	115	*5*	*5% of total blasts over any 12 month period*	0
All Public Infrastructure	-	*50, or alternatively, a specific limit determined to the satisfaction of the Secretary by the structural design methodology in AS 2187.2-2006, or its latest version*	*0%*	0
RSF 1 and RSF 2 embankments		*49*	*0%*	0

*Approval Criteria from PA 09_0155, Schedule 3, Condition 7.

With regards to blast timing, TGO complied with Condition L5.6 of EPL 20169 for all underground blasting which states that underground blasting is permitted at anytime. In accordance with Schedule 3 Condition 8 of PA 09_0155, surface blasting was undertaken between the hours of 9:00am and 5:00pm with no blasts being carried out on Sundays or public holidays.

Consistent with Schedule 3, Condition 9 of PA 09_0155 and Condition L5.9 of EPL 20169, less than three surface blasts per day occurred.

6.2.1 Management Measures

Blasts are designed and scheduled to ensure air blast overpressure and ground vibration levels remain within PA blast criteria. Weather conditions are also monitored to avoid blasting in conditions that will enhance offsite impacts, such as south westerly winds and low cloud cover. These management measures have been successful in the prevention of any exceedances during 2021.

6.2.2 Proposed Improvements

TGO will continue to monitor and record blast results. Open cut blasts during 2021 were conducted in accordance with PA 09_0155 Blasting Conditions. No exceedance of blast limits was recorded and accordingly TGO is not considering any further improvements.

Whilst TGO does not consider the number of complaints to be a measure of compliance, TGO received nil blast related complaints for the reporting period (see Appendix 2).

6.2.3 EA Predictions

TGO's over pressure and vibration levels are consistent with and/or below those predicted in the EA for PA MOD 3 (2016).

6.3 Air Quality

The TGO Air Quality and Greenhouse Gas Management Plan (AQGGMP) was prepared to describe dust control and monitoring measures at TGO and meet Schedule 3, Condition 19 of PA 09_0155.

Air quality monitoring results for the reporting year are presented in Appendix 3. Monitoring sites are shown on Figure 3.

During the reporting period, TGO did not receive any complaints relating to dust (see Appendix 2).

6.3.1 Depositional Dust

The AQGGMP includes five depositional dust gauges used for compliance monitoring: DDG1, DDG2, DDG3, DDG4, and DDG5.

All depositional dust gauges were below the annual average criteria of 4g/m^2/month with annual averages as follows. The maximum increase in deposited dust levels was below the criteria of 2g/m^2/month for all five (5) depositional gauges.

6.3.2 PM10

As at 31 December 2021, the rolling annual average PM_{10} measured at the RTA1 TEOM was 14.4 ug/m^3 which was under the annual average criteria for PM_{10} of 30 ug/m^3.

During the reporting period, nil results measured at the RTA1 TEOM exceeded the PM_{10} 24 hour average criteria of 50 ug/m^3. Above average rainfall and and an abundance of groundcover in the region attributed to the nil exceedances. The previous reporting period, in comparison recorded a number of exceedances, largely in January and the first week of Feburary 2020. These exceedances could be attributed to extraordinary events including dust storms and severe bushfires.

PM_{10} results for January to December 2021 are shown in **Figure 4**.

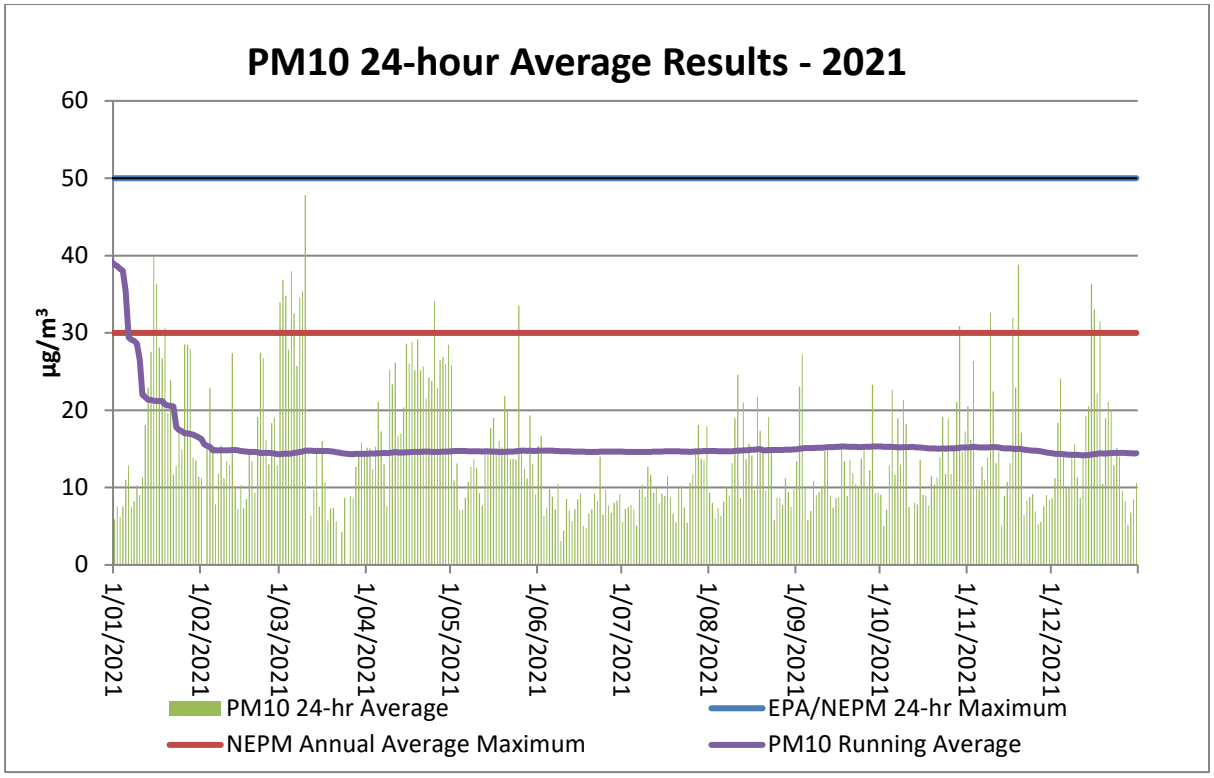

Figure 2 – PM10 RTA1 TEOM 24hr Results Jan-Dec 2021

6.3.3 TSP

Total Suspended Patrticulates (TSP) are measured at one high volume air sampler (HVAS) HVAS1, and are compared with the annual average criteria of 90 µg/m^3.

The annual average for TSP for 2021 was 42.94 µg/m^3 which is below the annual average criteria and lower than the previous four reporting periods.

The annual average for TSP in 2020 was 69.84 µg/m^3, 2019 was 89.96 µg/m^3, 57 µg/m^3 in 2018, 58 µg/m^3 in 2017, 38 µg/m^3 in 2016 and 59 µg/m^3 in 2014.

6.3.4 Management Measures

As is described in the Dust Site Specific Procedure (SSP), Shift supervisors, and the mining production team are provided with forecasts of high dust risk weather (such as hot, dry south westerly winds) in pre-shift meetings, sourced from the TGO Weatherzone portal.

During these conditions, PM_{10} levels measured at RTA1 are monitored online and, where required, modifications are made to mining operations until conditions improve. Such modifications include the:

- Reduction, cessation or relocation of dust generating activities;
- Increased watering of the operational footprint.

6.3.5 Proposed Improvements

TGO will continue with its current dust management systems so as to maintain its ongoing level of compliance. It is not proposed that there will be any changes to the Dust SSP unless there is a new issue identified.

6.3.6 EA Predictions

TGO's performance in relation to dust emissions is consistent with and/or below those predicted in the EA for PA MOD 3 (2016).

6.4 Biodiversity

Biodiversity at TGO is managed under the Biodiversity Management Plan (BMP), completed in accordance with Schedule 3, Condition 37 of PA 09_0155. The BMP details the actions implemented at TGO to mitigate impacts on native fauna and vegetation from mining related activities such as storage of potentially hazardous process residue and the clearing of native vegetation.

Along with mitigation of mining impacts, the major biodiversity enhancement measure at TGO is the establishment, management and long-term protection of biodiversity offset areas in accordance with Schedule 3, Conditions 33 and 34 of PA 09_0155.

To facilitate long-term security for the offset areas, a Property Vegetation Plan (PVP) was agreed to by TGO and approved by Local Land Services NSW in April 2015. The BMP incorporates measures and activities to manage and enhance TGO biodiversity offset areas, as required by the PVP.

6.4.1 Management Measures

6.4.1.1 Clearing Management

No pre-clearing surveys were completed in accordance with PA 09_0155 Schedule 3, Condition 35 and the BMP as no clearing was undertaken.

6.4.1.2 Offset Management

In accordance with the authorised activities and management actions required by the PVP, the offset areas continued to be managed to enhance and maintain their bidoversity values during the reporting period.

Specific management measures within the biodiversity offset areas included:

- Spraying of African boxthorn (Lycium ferocissimum) and other common pasture weeds such as Bathurst Burr (Xanthium spinosum);
- Maintenance and repair of fencing to separate offset areas from cropping/grazing;
- Exclusion of grazing livestock and native herbivores where possible to reduce potential impacts on replanted native tubestock.
- Exclusion of grazing livestock to increase natural regeneration, and
- Regular inspections to monitor overall condition of all offset areas.

6.4.2 Biodiversity and Rehabilitation Monitoring

TGO biodiversity and rehabiltation monitoring was completed by DNA Environmental to assess the condition and development of remnant and re-established native vegetation communities (DNA Report).

The DNA Report presents tables for the performance of the woodland biodiversity monitoring sites and pasture monitoring sites against "Primary Performance Indicators".

The DNA Report is presented in full in Appendix 4.

Monitoring methodology is based on Landscape Function Analyses (LFA) and ecosystem diversity / habitat value measurements adapted from the Biometric Assessment Methodology (BAM).

Monitoring sites have been established (year established), consisting of:

- Six remnant woodlands sites (2014): Poplar1, Belah1, Belah2, Grey1, Grey2 and Fuzzy1;
- Two EEC woodland revegetation sites (2014): Reveg 1 and Reveg 2;
- Two riparian woodland sites along Gundong Creek (2014): Creek1 and Creek2;
- Two pasture reference sites (2014): Pasture1 and Pasture2;
- Two pasture rehabilitation sites (2017): WRE2-1; and WRE3-1;
- One rehabilitation monitoring site (2016): Noise Bund1;
- One pasture rehabiltation site (2020): WRE3-2; and
- One woodland rehabiltation site (2020): WRE2-2.

Biodiversity and rehabilitation monitoring has been undertaken during August in all monitoring years and was completed from 9 – 12 August 2021.

Key observations from the DNA Report are summarised below.

6.4.2.1 General Observation

- Data indicates that the various biodiversity monitoring sites are different in structure and function and have recovered to varying degrees from a long disturbance history largely associated with clearing, grazing and cultivation. Sites with intact woodland typically occur along the roadsides and within farm laneways as well as sections along Gundong Creek and most of these sites were recovering relatively well after the removal of livestock. During 2017 – 2019 prolonged drought conditions combined with the simultaneous increase in grazing and disturbance by wildlife, typically caused a decline in ecological function in all monitoring sites. Since 2020 however, improved seasonal conditions resulted in an abundance of annual and perennial ground covers and overall ecological function has typically improved.
- Both pasture reference sites continued to be comprised of scattered native perennial grasses and sub-shrubs and contained an abundance of exotic annual grasses and herbs. The ongoing drought caused a decline in live plant growth and a deterioration of the litter layer with minor bare patches having developed in Pasture 1 in 2019. Over the past two years, improved conditions resulted in a significant increase in plant growth and both pastures sites continued to have 100% functional patch areas.

6.4.2.2 Remnant Woodlands Sites (Poplar1, Belah1, Belah2, Grey1, Grey2 and Fuzzy1)

- The reference sites (Fuzzy 1 and Grey 2) were structurally and functionally different to each, but both had relatively high perennial plant components due to the mature eucalypts and perennial grasslands. They had a well-developed leaf litter layer and/or patches of hard crusted soil surfaces which typically were stabilised by cryptogams. During 2018 and 2019 there was a reduction in perennial ground covers and increased disturbances by animals as a result of the ongoing drought conditions. Since 2020, the improved rainfall conditions resulted in a significant increase in plant growth and 100% LO being recorded in both reference sites. Poplar 1, a small area of remnant *Eucalyptus populneus* (Bimble Box), was structurally similar to the woodland reference sites, however some minor disturbance by animals has caused a reduction to 96% LO this year.
- The most ecologically functional sites continued to be Fuzzy 1 with a total sum of scores of 211, closely followed by Poplar 1 with a score of 195, with the ecological function in these two sites remaining significantly higher than the remaining monitoring sites. The Grey 2 reference site was the next most functional of the remnant woodlands scoring a total

function of 166, and this was closely followed by WRE2-2, Creek 1, Reveg 1 and Creek 2 which were very similar to each other with scores of 150 - 157. The two sites, Reveg 2 and Belah 1, were very similar to each other with scores of 146 and 143 respectively. Belah 2 was the least functional woodland community with a score of 136.

- The reference sites were chosen to represent open grassy woodlands which are characteristic of the area, with mature tree densities ranging from 8 – 10 individuals or of 80 - 100 stems per hectare. The average tree diameters ranged from 54 – 55 cm with some old growth individuals having a dbh up to 129 cm. Most trees were in moderate to good health, however one individual had died in Grey 2 over the past year, while there continued to be one dead stag in Fuzzy 1. Reproductive structures such as fruit, flowers or bud were recorded in fewer individuals and neither site had mistletoe this year, however a small number of individuals had tree hollows. While the composition of species in the woodland reference sites varied between sites, dominant tree species included a combination of Eucalyptus conica (Fuzzy Box), E. microcarpa (Grey Box). In Grey 1, which was last monitored in 2019 , E. populnea (Bimble Box), Allocasuarina luehmannii (Bulloak) and Acacia oswaldii (Miljee) were also present.

6.4.2.3 Belah Revegetation Sites (Belah 1 and Belah 2)

- Initially the *Casuarina cristata* (Belah) remnant woodland had also suffered from a long grazing history with the ridges of the gilgais being predominantly bare and eroding and perennial plant cover was particularly low. Since the removal of domestic livestock in 2013, there was an increase in vegetative covers in both Belah 1 and Belah 2 monitoring sites, however in 2018 and 2019 the prolonged drought and heavy macropod grazing caused a loss of integrity of the litter layers and other protective ground covers. Improved seasonal conditions over the last two years has resulted in improved levels of ground covers, and this year both Belah sites had 100% functional patch area.

6.4.2.4 Two EEC Woodland Revegetation Sites (Reveg 1 and 2)

- Reveg 1 and Reveg 2 were old cropping paddocks which were essentially recovering native grasslands that had been direct seeded with local woodland species in 2013. In the early development stages, there were rows of bare soil as a result of the ground preparation techniques such as scalping, cultivation and direct seeding. Within the second year of monitoring, the ground cover vegetation and cryptogams had colonised the exposed soils and significantly increased the functional patch areas to 100%. This year, high functional area was maintained in Reveg 1, however Reveg 2 which has a higher density of trees and shrubs, continues to have some disturbance by kangaroos with LO further declining to 76% this year.

6.4.2.5 Riparian Woodland Sites along Gundong Creek (Creek1 and Creek2)

- Creek 1 and Creek 2 were also positioned within an old cropping paddock which was similar in composition to Reveg 1 and Reveg 2, and these were also seeded with a woodland mix in 2013. Creek 2 also incorporated a flat upper floodplain and extended down the sloping creek banks. During 2018 and 2019 these sites had a reduction in perennial ground covers and increased disturbances by animals has caused deterioration of the litter layers. The improved seasonal conditions over the last two years and resulted in a slight improvement in functional patch areas with 88 – 92% LO.

- Creek 1 and Creek 2 were also positioned within an old cropping paddock which was similar in composition to Reveg 1 and Reveg 2, and these were also seeded with a woodland mix in 2013. Creek 2 also incorporated a flat upper floodplain and extended down the sloping creek

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6.4.2.6 Pasture Reference Sites (Pasture1 and Pasture2)

- The most ecologically functional site continued to be Pasture 2 which scored a sum of indices of 172. This was followed by Pasture 1 with a score of 166, with rehabilitation sites Noise Bund, WRE2-1 and WRE3-1 being marginally lower with a sum of scores of 152 - 156. The newest area of rehabilitation WRE3-2 continued to be the lowest functional grassland community and a sum of scores of 141.
- In the pasture reference sites there were minor changes in plant diversity with 45 species recorded in both sites, and the number of native species had slightly increased to 25 – 26 species, while there were 19 - 20 exotic species. On the rehabilitation areas, there were 22 – 36 different species and of these the majority were exotic with 15 (WRE2-1) to 21 species (WRE3-1) being recorded. There was a small number of native species recorded in WRE3-2 with 7 species, while an increased diversity of native species was recorded in the other sites with up to 16 native species being recorded in the Noise Bund this year. This year total and native species diversity remained too low compared to the reference sites, however there was an acceptable diversity of exotic species in all sites except WRE3-1 which had only one more.

6.4.2.7 Rehabilitation Monitoring Site (Noise Bund1)

- On Noise Bund 1 and WRE3-1, small bare patches had developed during the drought as a result of macropod grazing, however, there has been a significant increase in annual plant cover over the last two years.
- There was a small number of native species recorded in WRE3-2 with 7 species, while an increased diversity of native species was recorded in the other sites with up to 16 native species being recorded in the Noise Bund this year. This year total and native species diversity remained too low compared to the reference sites, however there was an acceptable diversity of exotic species in all sites except WRE3-1 which had only one more.

6.4.2.8 Two Pasture Rehabilitation Sites (WRE2-1 and WRE3-1)

- The new area of woodland which was rehabilitated in 2019 on top of WRE2 was heavily dominated by annual and perennial plants and had good litter cover and soil profile development and continued to score 100% LO. Revegetation sites WRE2-2, Reveg 1 and Belah 1 and Belah 2 had an LO comparable to the reference sites this year.
- On WRE2-1, there has been adequate establishment of exotic grasses and medics and good ground cover has been maintained despite the limited active plant growth during the drought, largely due to less disturbance by macropods compared to the other rehabilitation sites. On Noise Bund 1 and WRE3-1, small bare patches had developed during the drought as a result of macropod grazing, however, there has been a significant increase in annual plant cover over the last two years. The newest area of rehabilitation on the western side of WRE3 (WRE3-2), was also dominated by annual plants, however there was a slight decline in cover with 91% LO this year.

6.4.3 Fauna Monitoring

TGO engaged Advanced Regional Environmental Assessments (AREA) to complete its biannual field survey for the fauna monitoring program. The field assessment for 2021 occurred on 14 to 17 December. The AREA Report is included in full in Appendix 5.

The fauna survey in 2011 recorded 134 vertebrate species, a substantially higher number than recorded in the following survey years. The 2011 survey however was conducted under a much higher degree of survey over a broader study area to meet project approvals. The 2016 proceeded to record 41 species showing a declining trend of fauna from 2011. The 2019 survey recorded 38 and followed three years of below average rainfall. Opposed to the 2021 survey which was conducted during a high volume of rain fall throughout NSW in 2011, and December 2016. A bat survey was undertaken in 2014.

The 2021 monitoring event aimed to address the following criteria as outlined in TGO's Biodiversity Management Plan (Revision 8):

- Grey-crowned Babbler population census;
- Bat monitoring;
- Fat-tailed Dunnart monitoring;
- Cyanide impacts on native fauna; and
- Amphibian survey.

Key observations from the 2021 AREA Report are summarised below.

- TGO has 127 ha of biodiversity offset areas (BOA) in place secured under a PVP. Amelioration planting has been carried out to improve biodiversity across these areas where the previous use was cropping and grazing.
- 39 species were recorded. Of these 39 species, 18 were birds, 14 were bats, four were amphibians, two were mammals, and one was a reptile. No fauna was detected on camera traps or in the Elliot traps.
- Two threatened species were recorded, Grey-crowned Babbler and Southern Myotis. The Southern Myotis was possibly recorded for the second time in 2021 - the first being in 2019 however identification of this species has not been confirmed through other survey methods.
- The 2021 survey of bat species positively identified nine species with a further five species possibly recorded.
- The Fat-tailed Dunnart was not recorded in the area
- Many Eastern Grey Kangaroos were sighted along Gundong creek. A European Hare was sighted near the dam adjacent to Gundong creek. A European Red Fox scat was recorded within the biodiversity offset area.
- Cyanide does not appear to be significantly affecting fauna. Fauna observations on and around the RSF are recorded twice daily.
- Four amphibian species were detected in healthy population levels, water levels for Gundong creek were healthy and the creek was flowing at the time of the survey. One of these species, Broad Palmed Rocket Frog, has been recorded for a second time.

- There has been an increase in fauna activity within TGO since the last monitoring event in 2019 which is likely to be linked to improved weather conditions and regular rainfall throughout 2020 and 2021.
- Survey indicated there is still moderate diversity in the fauna within the mine site which is on par with previous assessments. The trend is likely linked to rainfall rather than disturbance. The result reflects the environments capacity to provide resources depending on rainfall. Fauna numbers should increase as the quality of habitat improves and rainfall becomes more abundant and regular.

The next survey for the fauna monitoring program is due to be completed in 2023.

6.4.4 Proposed Improvements

During the next reporting period, TGO will continue to implement the biodiversity conservation and enhancement measures outlined in the BMP.

Management actions, such as livestock exclusion in the areas to the east and feral animal/weed controls will be continued.

6.5 Heritage

The Cultural Heritage Management Plan (CHMP) outlines measures to manage Aboriginal and Non-Aboriginal heritage sites at TGO.

The CHMP was developed from a previous assessment, which identified 60 Aboriginal sites and eight Non-Aboriginal heritage features.

With all existing or relocated sites adequately maintained, no active cultural heritage management occurred during the reporting period.

6.5.1 Management Measures

As recorded heritage sites are located away from site operational areas, and no new sites or items were identified during the reporting year, the management of existing sites consisted of weed control and ensuring approriate signage remains in place.

6.5.2 Proposed Improvements

No improvements to the management of cultural heritage sites and items is proposed in the next reporting period.

6.6 Contaminated Land

As TGO is a relatively new site with compliant bunding structures in place, the risk of site contamination remains relatively low. The contamination assessment completed as part of the EA, also determined risk of land contamination onsite to be very low.

During 2021 a single diesel spill occurred adjacent to the TGO bulk diesel storage tanks (as described in section 11.1.2).The remediation of hydocarbon contamninated soil was carried by a remediation specialist engaged by the fuel contractor with 657 tonnes of contaminated soil material removed and transported to a licenced waste facility in Dubbo. Approximately 300t of saprolite and 300t of road base were used to backfill the excavated area.

This compares to three minor hydrocarbon spills in 2018, seven minor hydrocarbon spills in 2017, six hydrocarbon spills in 2016, and four minor hydrocarbon spills in 2015.

6.6.1 Management Measures

An internal site investigation was conducted and from this several improvement measures were identified and implemented. These included, restricting bulk diesel deliveries to day light hours,

deliveries only during normal operating hours, improved lighting at the fuel farm and installation of CCTV at the fuel farm.

The safe and responsible storage and handling of hazardous materials remains the key strategy to preventing, and therefore managing, land contamination.

All chemical and hydrocarbon storage at TGO has been designed and constructed in accordance with the relevant Australian Standard, including:

- AS/NZS 4452: The Storage and Handling of Toxic Substances; and
- AS 1940-2004: The storage and handling of flammable and combustible liquids

Vehicle washdown and re-fuelling facilities were upgraded in 2017, which have assisted in the prevention of land contamination.

6.6.2 Proposed Improvements

No improvements to the management of contaminated sites is proposed in the next reporting period.

7 Water Management

The WMP details how TGO will manage site water to comply with the *Water Performance Measures* contained in Schedule 3, Condition 27 of PA 09_0155. Table 9 presents these measures and where each measure is addressed in the WMP.

Table 9: Water Performance Measures (PA 09_0155, Schedule 3, Condition 27)

Feature	Performance measure	Where addressed
Water management – General	Minimise the use of clean water on site	Section 4.5.14.5.4
	Minimise the need for make-up water from external potable water supplies	Section 4.5.4
Construction and operation of infrastructure	Design, install and maintain erosion and sediment controls generally in accordance with the series Managing Urban Stormwater: Soils and Construction including Volume 1, Volume 2A – Installation of Services and Volume 2C – Unsealed Roads	Section 4.6
	Design, install and maintain the infrastructure within 40 m of watercourses generally in accordance with the: • Guidelines for Controlled Activities on Waterfront Land (DPI 2007), or its latest version • Guidelines for fish habitat conservation and management – Chapter 4 (DPI 2013), or its latest version.	Section 4.1.1.3
Clean water diversion & storage infrastructure	Design, install and maintain the clean water system to capture and convey the 100 year average recurrence interval (ARI) flood	Section 4.1.1.1 and Section 4.1.1.2
	Maximise as far as reasonable and feasible the diversion of clean water around disturbed areas on site	Section 4.1.1.1 and Section 4.1.1.2
Sediment dams	Design, install and maintain the dams generally in accordance with the series Managing Urban Stormwater: Soils and Construction – Volume 1 and Volume 2E Mines and Quarries	Section 4.1.3.1
	Ensure the capacity of all sediment dams is sufficient to contain rainfall up to a 10 day 90 percentile rain event	Section 4.1.3.1
Mine water management system, including residue storage facility and associated collection pond	No unlicensed or uncontrolled discharge of mine water off-site (except in accordance with condition 23)	Section 4.5.3
	Ensure that the capacity of the residue storage facilities (RSF1 and RSF2) and associated collection pond are designed to meet the requirements of the Australian National Committee on Large Dams' Guidelines on Tailings Dams – Planning, Design and Construction, Operation and Closure (July 2019) or its latest version, and that the floor and walls are lined to achieve a permeability standard of at least 1 x 10^{-9} m/s and 1 metre depth (or equivalent permeability performance), unless otherwise agreed by the EPA and the Secretary;	Section 4.1.5.3
	Maintain adequate freeboard (i.e. minimum 500 mm)	Section 4.1.5.3

Feature	Performance measure	Where addressed
	in the residue storage facilities (RSF1 and RSF2) at all times	
	All water storages on site that receive chemical or salt laden water, including the dewatering ponds, raw water dams and process water dams are lined to achieve a permeability standard of at least 1 x 10^{-9} m/s, unless otherwise agreed by the EPA and the Secretary	Section 4.1.5.1
	Maintain adequate freeboard (i.e. minimum 500 mm) in the process water dam and minimum of 200 mm in the raw water dam at all times	Section 4.1.5.1 Section 4.1.2.2
Chemical and hydrocarbon storage	Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standards	Section 4.3
Gundong Creek	Maintain or improve baseline channel stability	Section 7.2.2
	Develop site-specific water quality trigger levels in accordance with ANZECC 2000 and Using the ANZECC Guidelines and Water Quality Objectives in NSW procedures (DECC 2006), or its latest version	Section 7.2.2

7.1 Water Supply

The principal source of water for TGO is a licensed production bore located approximately 7km east of Narromine, with water transported to the TGO site Raw Water Dam via the Narromine water pipeline. During extensive dry periods, emergency water haulage from Peak Hill Mine may also be used; however, this option was not utilised during the reporting period.

Maximum Harvestable Rights Dams Capacity (MHRDC) is the volume of water landholders are entitled to capture and use without need for licencing. Landholders are permitted to intercept and store a proportion of runoff from their property without a licence under the *Water Management Act 2000*. In addition, no licence is required for water stored within dams that:

- Control or prevention of soil erosion.
- Capture, contain and recirculate drainage.
- Have no catchment (i.e. “turkey’s nests”).

The existing surface water storages that are part of TGO all fall into one of the above categories and therefore do not require licensing. In addition there were no new water storages constructed during the reporting period.

Processing water (including RSF decant) is recovered and pumped to the Process Water Dam for re-use in processing. During the year, it is estimated that 600.5 ML was recycled process/decant water, significantly reducing the volume of water needing to be imported.

An onsite water treatment plant is used to produce potable water onsite, eliminating the requirement to import potable water.

Table 10: Water Supply

Water Licence	Water sharing plan, source and management zone (as applicable)	Entitlement (ML)	Passive take / inflows	Active pumping (ML)	TOTAL (ML)
WAL20270 (Narromine Pipeline)	Lower Macquarie Zone 6 Groundwater Source	1,000	nil	592	592
WAL28643 & WAL29266 (open cut)	NSW Murray Darling Basin Fractured Rock Aquifer	220	Negligible (not measurable)	nil	Negligible
N/A	Direct rainfall and catchment runoff captured under harvestable rights	N/A	0	nil	0
WAL 34968 (Peak Hill Gold Mine)	Upper Bogan River Water Source/ Macquarie Bogan Unregulated and Alluvial Water Sources 2012	300	nil	nil	nil

* Direct rainfall and catchment runoff volume based on modelled in WB.

7.2 Water Balance

During the current reporting period GHD was engaged to review the WMP with the site water balance included as part of this review. The water balance indicates that TGO is dependent on raw water supplied from the licensed "Woodlands" bore and conveyed to site via the Narromine pipeline.

The water balance indicates that approximately 50% of TGO's water supply is sourced from the borefield with the remaining 50% sourced from recycled water from processing and water captured and retained on site from sediment ponds.

7.3 Clean Water Management (Surface)

For reporting purposes, clean water management is divided into:

- Site Water; and
- Gundong Creek

7.3.1 Site Water

Clean water consists of through-flow from offsite and water from onsite non-mine disturbed catchments. This water is diverted away from contamination sources (mine disturbance and infrastructure) and directed offsite.

Management includes the construction of drains and bunds to collect and divert surface water flow past, or away from, mining disturbed catchments. Mangement of site drains and sediment basins is discussed in **Section 4**.

7.3.2 Gundong Creek

Gundong Creek is an ephemeral watercourse which flows along the northern and western boundaries of the TGO site. TGO sample the creek weekly during any flow, which is over and above the requirements prescribed in condition M2 of EPL 20169, which requires sampling on discharge.

Gundong Creek flowed for several months during 2021. In accordance with the TGO Water Management Plan, weekly samples were taken and analysed by ALS Laboratories. No exceedances of specified water quality parameters were recorded.

7.4 Dirty Water Management

Dirty water runoff is intercepted and managed by a series of dirty water drains and sediment basins to allow for treatment and reuse on site for various activities such as dust suppression.

7.4.1 Sediment Basins

Water collected in the sediment basins may be pumped into the partially backfilled Wyoming Three void and subsequently to the north cell of the Wyoming Central Dam for reuse in dust suppression and as process water make up.

7.4.2 Offsite Discharge

During rainfall events that exceed the design criteria, discharges off site may occur via the licensed discharge points (which includes all six Sediment Basins) Discharges from the sediment basin will only occur after all reasonable measures to prevent the discharges have been exhausted.

During a heavy rainfall event on the 26th November 2021 (approx. 180mm over 48hrs) water was discharged from Sediment Basin 1 (Licensed discharge point 4 - EPL 20169) via the spillway into Gundong Creek (as described in Section 11.1.1). Sediment Basin 1 is compliant with the original 90th percentile 5 day criteria. This was the single discharge event for the year with the last offsite discharge occuring in December 2018.

7.4.3 EA Predictions

More frequent discharges were predicted in the original EA, with the suggested processes for managing discharges in the original proven to be not practical in the operational environment.

7.5 Mine Water Management

Water which has been impacted by mining operations, is considered to be not suitable for offsite discharge and requires onsite managmeent or treatment (mine water). This includes:

- ***Open cut pit water*** – water collected in the Wyoming 1, Caloma 1 and Caloma 2 voids is pumped to the Wyoming 3 void and re-used for site operations;
- ***Process water*** – recycled for re-use via decant from the RSF, the raw water dam and process water dam;
- ***Oily water*** – treated at onsite oily water separator, with clean discharge to Sediment Basin 1; and
- ***Onsite sewerage*** - treated at an onsite treatment plant and used to irrigate site revegetation adjacent to the mine acces road.

Decant water from the RSF was sampled twice daily during the reporting period for Weak Acid Dissociable (WAD) Cyanide, with no WAD Cyanide concentrations above the 90th percentile limit of 20 mg/L.

Stored water is summarised in Table 11.

Table 11: Stored Water

Description and structure name	Storage Capacity (m^3)	Start of Reporting Period m^3	At end of Reporting Period m^3	Comments
Raw Water Dam[1]	10,700	10,700	10,700	
WyCD – small cell	17,900	17,000	17,000	
WyCD – large cell	162,000	60,660	94,000	
Residue Storage Facility	434,000	20,000	50,000	Design capacity for 217 ML PMF per dam = 434 ML total. No water on dams at end of reporting period.
Process Water Dam[1]	9,200	7,500 (82%)	8,000 (87%)	
Caloma 1 Pit	3,308,249	280,000	160,000	*Storage capacity to the 140mRL portal is 340,000m^3
Caloma 2 Pit	1,501,479	5,000	0	
Wyoming 3 Pit	1,300,000	66,000	353,000	

[1] Operational water storage - volumes fluctuate frequently based on operational demand.

7.6 Erosion and Sediment Control

Inspections of drains and sediment basins were conducted throughout the reporting period, with all sediment basins being inspected every quarter. Following heavy rain and/or dewatering, sediment basins were inspected and, when water levels allowed, sampled for reference purposes.

There were no desilting works undertaken during the reporting period and no works were required on any of the sediment ponds or associated water control structures.

7.7 Groundwater

Sampling and inspection of local district groundwater bores and RSF monitoring piezometers continued during the reporting period.

Any groundwater inflows into the open cut pits could be best described as seepage and intermitent. Ground water inflows are not measurable. This is due to the nature of the factured rock zone that the ground water is captured in. There is no water table present at TGO.

7.7.1 Depth

As shown in Table 12, four of the seven bores recorded relatively steady groundwater levels during the reporting period (i.e. less than 1 m range). WYMB 01 had a range of 4.48 m, WYMB02 had a range of 31m, and WYBM06 had a range of 5.95m. Quarterly groundwater levels since 2019 are shown in **Figure 5**.

The onsite meteorological station recorded 1122.8 mm of rainfall in 2021 (558.6 mm more than the annual average).

WYMB02 is a deep bore located adjacent to the Wyoming 1 Open Cut. During the reporting period TGO received almost double its annual average rainfall. As a response to the high rainfall by the end of the reporting period water levels in the bore had increased by 31 metres.

WYMB01 and WYMB06 are to the south of site and are influenced from rainfall and surface water inflows into the historic McPhails underground workings. Levels and water quality are not influenced by site activities.

WYMB03, WYMB04 and WYMB10 are deep bores around the perimeter of the mine and show very little movement in depth consistent with each being located in a fractured rock aquifer.

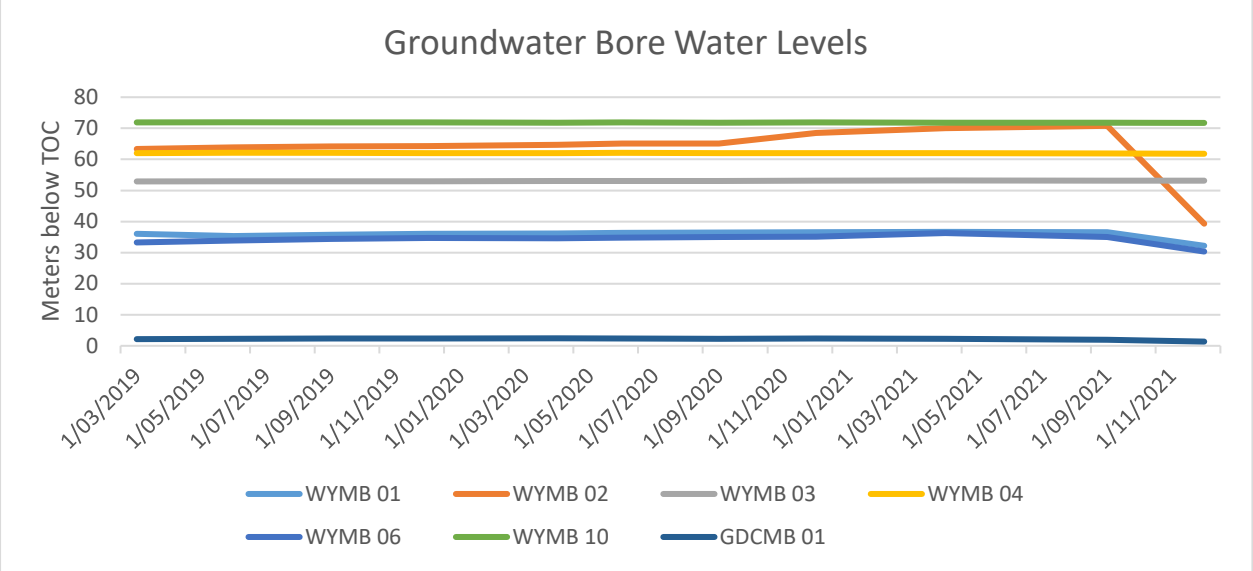
GDCMB01 is located in the shallow Gundong creek aquifer and any variations in levels are dependant on rainfall.

A summary of water chemistry results is provided in Appendix 6.

Table 12: Groundwater Bore Water Levels

Period	Groundwater level (- metres below Top of Casing)						
	WYMB 01 (EPA09)	WYMB 02 (EPA10)	WYMB 03 (EPA11)	WYMB 04 (EPA12)	WYMB 06 (EPA13)	WYMB 10 (EPA14)	GDCMB 01 (EPA15)
13/04/2021	36.67	70	53.21	62.03	36.29	71.84	2.25
13/09/2021	36.57	70.79	53.1	61.95	35.02	71.81	2
22/12/2021	32.19	39.3	53.1	61.8	30.34	71.73	1.36
Range (2021)	*4.48*	*31.49*	*0.11*	*0.23*	*5.95*	*0.11*	*0.89*
Range (2020)	*0.40*	*3.80*	*0.10*	*0.10*	*0.50*	*0.10*	*0.10*
Range (2019)	*0.73*	*0.97*	*0.06*	*0.10*	*1.42*	*0.06*	*0.17*

Figure 3 – Groundwater Levels (2019-2021)



7.7.2 RSF Piezometers

During the reporting period the RSF monitoring piezometeres were monitored on a monthly basis. The depth from TOC to water is recorded and water samples are taken where possible. During the reporting period, water samples were taken from piezometers RSFMP03A, RSFMP05, RSFMP07, RSFMP08, and RSFMP11 each month excluding September.

Piezometer RSFMB01 and RSFMB02 were decommissioned and buried in September 2021 as part of further operational development. RSFMP03, RSFMP09 and RSFMP10 were decomissioned and buried in previous years as part of operational development. To allow monitoring to continue in the vicinity of RSFMP03, a new bore RSFMP03A was established in 2019.

RSFMP02, RSFMP04, RSFMP06, RSFMP09, and RSFMP10 were dry throughout the reporting period with no samples being able to be collected.

Results continue to show that water chemistry is consistant with the water coming from existing shallow aquifers that were intercepted during the RSF construction.

7.8 EA Predictions

7.8.1 Ground Water

The initial ground water modelling and assessment that accompanied the EA predicted some groundwater drawdown and ground water production in the pits. This has not occurred.

8 Rehabilitation

The 2021 Annual Review reporting period was the 8th year of mining operations at TGO and largely overlaps with the 2020/21 FY. To ensure the MOP tables align with the TGO FY based works schedule, the rehabilitation completion figures are based on a FY rather than a Calendar Year.

Whilst this conflicts with the timing of this report, it presents a more accurate record of the rehabiliation completed, commenced and planned.

During the reporting period the NSW Government introduced new standard rehabilitation and reporting conditions on mining leases.

The conditions will be implemented through the Mining Amendment (Standard Conditions of Mining Leases – Rehabilitation) Regulation 2021 (the Regulation), which commenced on 2 July 2021. There is a transitional period in place for existing mining leases. Being an existing large mine, TGO will comply to the new requirements by 2 July 2022.

Upon commencement of the Regulation, the requirement for a MOP will be replaced by the requirement for a rehabilitation management plan (large mines only).

8.1 Rehabilitation During Reporting Period

During the reporting period, rehabilitation and land management activities comprised of ongoing monitoring and maintenance of the extensive rehabilitation work that was completed on WRE2 and 3.

The majority of the site is still operational and as such opportunities for rehabilitation activities were limited to maintenance and of the existing rehabilitation that has taken place on WRE 2 and 3.

Progress against key rehabilitation performance indicators is shown in Table 13.

Mine disturbance and rehabilitation activities are shown on Figure 6.

Table 13: Rehabilitation Status

Mine Area Type	Previous Reporting Period (Actual) FY 2020 (ha)	This Reporting Period (Actual) FY 2021 (ha)	Next Reporting Period (Forecast) FY 2022 (ha)
A. Total mine footprint	434.9	434.9	517.9
B. Total active disturbance	405.0	405.0	484.6
C. Land being prepared for rehabilitation	0.0	0.0	0.0
D. Land under active rehabilitation	113	113	113
E. Completed rehabilitation	0.0	0.0	0.0

Plate 3: Vegetation establishment on WRE 2

Plate 4: Vegetation establishment on WRE 3

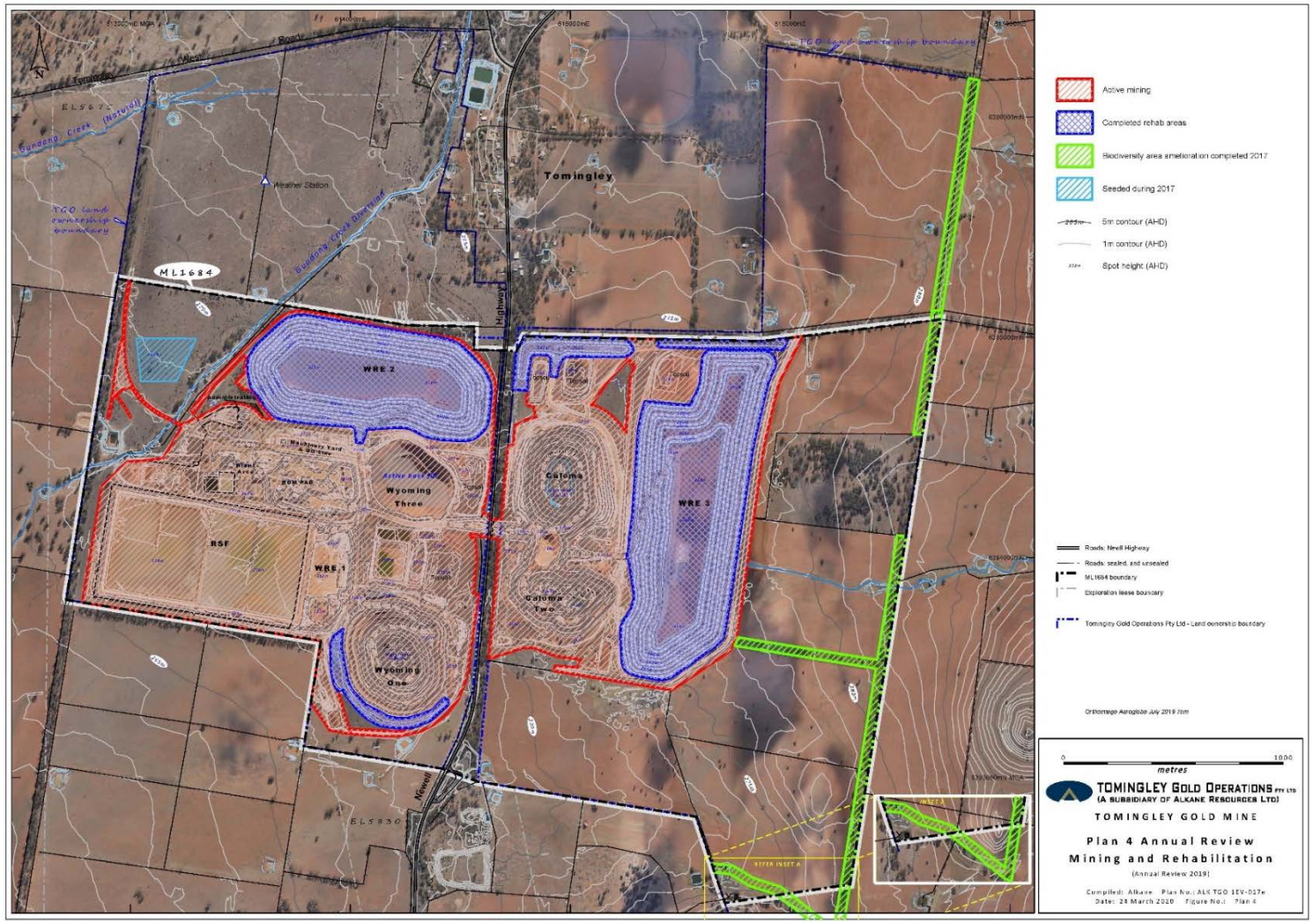


Figure 4 – Rehabilitation and Land Management Activities completed during the reporting period

8.2 Post Rehabilitation Land use

As approved in the MOP, the TGO post rehabilitation area is proposed to consist of the following land uses:

- Infrastructure - entrance roads and void safety berms;
- Water Management Areas - water bodies on floor of final voids;
- Grasslands – rehabilitated WRE outside batters;
- Woodlands - rehabilitated WRE outside batters;
- Rural Land – existing open buffer land;
- Final Void – residual open cut voids; and
- Conservation and Biodiversity Offset – registered offset areas under PVP.

These post-rehabilitation land uses are shown on MOP Plan 4 are included as Figure 7.

8.3 Buildings, Infrastructure, and other Rehabilitation

All buildings and infrastructure were still operational during the reporting period and no decommissioning, removal or demolition was undertaken.

8.4 Completed Rehabilitation

No areas of final rehabilitation have received formal relinquishment sign-off from Regional NSW - MEG. Nor are any areas anticipated to do so in the next reporting period.

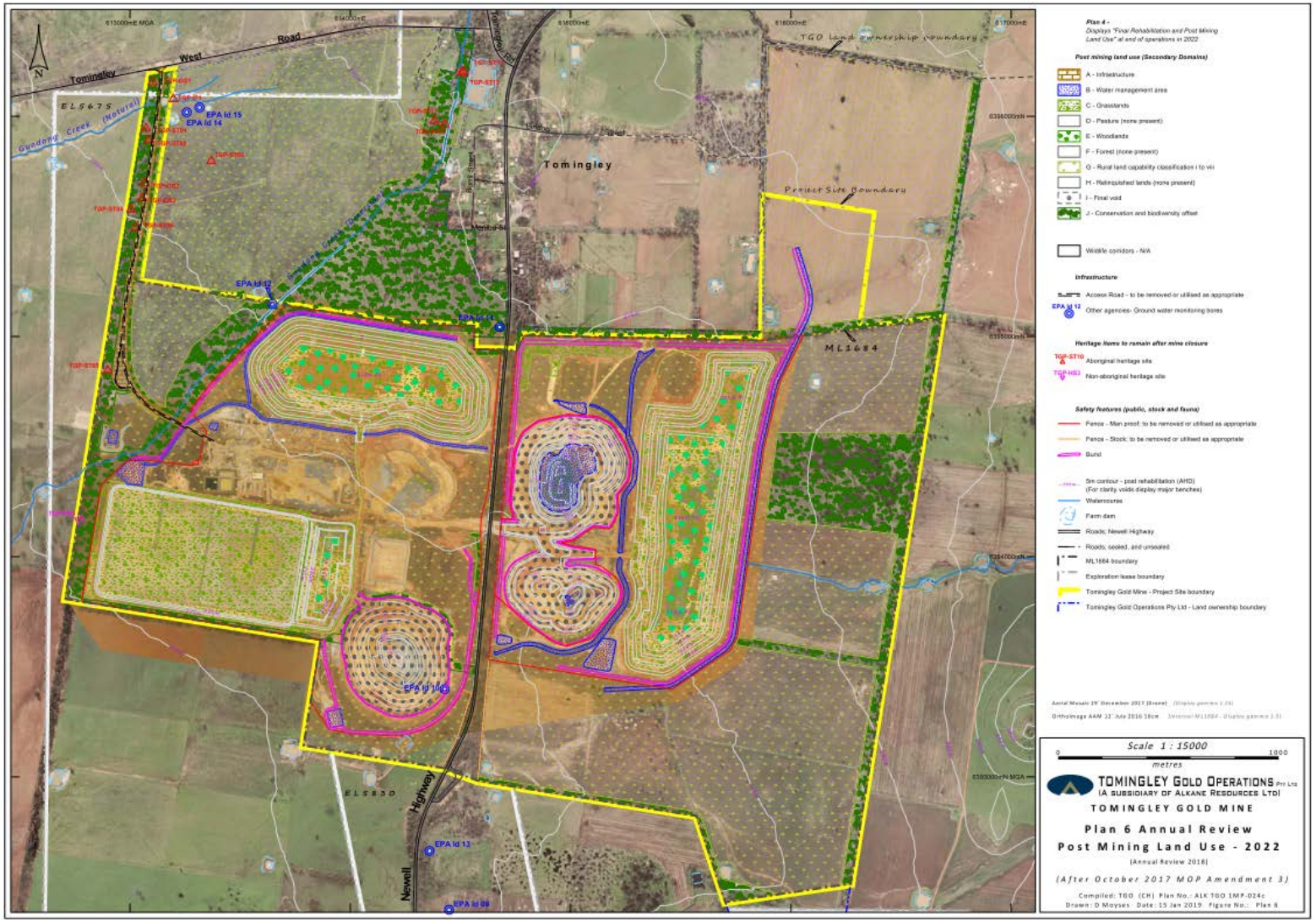


Figure 5 – MOP Plan 4 showing proposed final land uses at TGO

8.5 Trials, Monitoring and Research

TGO invested significant time and resources in 2015 and 2016 to ensure the final landform design is constructed to protect the dispersive waste material and ameliorate the sodic topsoil used for vegetation establishment. TGO has continued to engage with soil and waste dump specialists from SLR Consulting with site visits during the 2020 reporting period to review civil works, remediation of a void in the northern end of WRE2 and vegetation establishment.

As WRE landform areas are rehabilitated, monitoring plots are established and incorporated into the biodiversity monitoring program (see Section 6.4.2 for details).

During 2016 biodiversity monitoring, the first rehabilitation monitoring plots were established and monitored, along with two pasture reference sites. Two additional pasture montoring sites were established in 2017. In 2020 an additional pasture and woodland rehabilitation monitoring site was established on new areas of rehabilitation completed in February 2019 on WRE3 and WRE2 respectively.

Monitoring has been carried out annually by DNA Environmental with a comprehensive report tracking progress over time summarised in Section 6.4.2 and included in Appendix 4.

8.6 Actions for Next Reporting Period

During the next reporting period there are no major rehabiliation projects planned to be carried out.

It is planned to undertake some revegetation work to reestablish and improve groundcover on areas of WRE 2 and 3 that have reduced groundcover. Routine maintenance will continue to control noxious weeds such as African Boxthorn.

An additional topsoil stockpile will be made from material collected and stored as a result of the construction of RSF2 and a new Sediment Pond (No.8) will be constructed in association with RSF 2.

9 Community

9.1 Consultation

The key strategy to ensure an effective passage of information between TGO and the surrounding community is the Community Consultative Committee (CCC). The CCC is an independently chaired eight member committee representing TGO, the local community, and the Aboriginal community. During the reporting period, the CCC met in:

- February
- May and
- November

At CCC meetings, members are updated by TGO personnel on the progress of current and proposed mining operations and projects. Community representatives are given the opportunity to raise concerns regarding the project and to offer advice regarding TGO's consultation with the community. CCC meeting minutes are available via the Alkane Resources website (www.alkane.com.au). TGO will resume quarterly CCC meetings in the next reporting period provided Local Government Covid 19 restrictions can be met.

In addition to the CCC, TGO utilised a number of methods of communication/consultation with the community during the reporting period, including:

- Making relevant information regarding mine approvals, operations and environmental monitoring available to the public on the Alkane Resources website;
- Distributing a community newsletter, to provide the Tomingley community with information on TGO operations;
- Providing a 24 hour community information line; and
- Write a column for the Narromine Star (newsletter)

These methods of community consultation will continue during the next reporting period.

9.2 Support

As per TGO's planning agreement in Appendix 3 of PA 09_0155 the following contributions to NSC are made annually.

- $53,750/annum to the Community Fund;
- $45,000/annum for road maintenance (except for Tomingley West Road) and
- $20,000/annum for NSC Environmental Management Expertise.

The Tomingley Gold Project Community Fund has been established to support projects within the Narromine Shire that promote the long term economic growth, community connectivity, education and training, or community infrastructure.

Allocation of funds is decided by a fund panel, consisting of two TGO representatives and two from NSC. TGO contribution for 2021 are publicly listed on its webpage. https://www.alkane.com.au/projects/tomingley-gold-project/tomingley-gold-operations/community-resources/tgo-community-fund/

9.2.1 Tomingley Village Water Supply

During the reporting period,TGO continued to provide raw water to the Narromine Shire Council (NSC) water supply dams for the Tomingley Village via the previously installed valves and pipe line. Upon mine closure the entire system will be handed over to the NSC.

9.3 Complaints and Enquiries

TGO manage complaints in accordance with the protocols and procedures contained in the EMS.

During the reporting period, zero (0) complaints were received via the community information line, other Alkane/TGO phone lines, or other method. TGO complaint history for the previous 4 years is presented in Table 14.

A register of complaints and enquiries received from the community is maintained by TGO. A modified version of this register (excluding personal details of complainants) is published on the Alkane Resources website and reproduced in Appendix 2.

Table 14: TGO Complaint History

Year	Number of complaints	Complaint Type				
		Dust	Noise	Blasting	Traffic/ Road Safety	Other
2021	0	0	0	0	0	0
2020	0	0	0	0	0	0
2019	0	0	0	0	0	0
2018	3	1	0	1	0	1 (radio signal affected)

10 Independent Audit

An Independent Environmental Audit (IEA) of the TGO was conducted during May 2021. The IEA period is from 9th March 2018 (day after previous audit visit) to 11th May 2021 (first day of 2021 audit). This is the third IEA since operation began. The final IEA report along with TGO's responses to the recommendations was submitted to DPIE on 17 September 2021.

The IEA identified several minor non-compliances against conditions of Project Approval PA 09_0155 MOD5 and other licences and approvals. The audit identified a total of 29 non-compliances (8 low risk and 21 administrative).

The IEA identified strong compliance in the field. Issues identified during the IEA related to low risk or administrative non – compliances:

• There were 5 low risk non – compliances and 15 administrative non – compliances for the Project Approval;

• There were 2 low risk non – compliances and 5 administrative non – compliances for the Statement of Commitments;

• There were 1 low risk non – compliances and1 administrative non – compliances for the Environment Protection Licence;

• There were 0 non - compliances for the Mining Lease; and

• There were 0 non - compliances for the PVP.

The IEA report also provided a series of recommendations arising from a review of site documentation and identified non-compliances. These recommendations along with an update of TGO's progress in responding to the recommendations are included in Appendix 7.

The full audit report and responses to the recommendations are available on the TGO's website at http://www.alkane.com.au/operations/tomingley-gold-operations/ .

The next Independent Environmental Audit of the TGO is scheduled to be undertaken in the second quarter of 2024.

11 Incidents and non-compliances during reporting period

This section provides further detail on the incidents and non-compliances reported in Section 1 as well as any other official regulatory interaction that occurred during the reporting period.

11.1 Concentration limits exceeded during offsite water discharge from Sediment Basin 1

During a heavy rainfall event on the 26th November 2021 water was discharged from Sediment Pond 1 (Licensed discharge point 4 - EPL 20169) via the spillway into Gundong Creek.

Heavy rainfall commenced on Thursday 25th November (80.4 mm) with pumping of sediment basin 1 starting during the day. Pumping continued during the night of the 25th and into Friday 26th (90.8 mm). The intensity of the rainfall had seen the level of sediment basin 1 continue to rise during the night of the 25th and with the prediction of continued rainfall for Friday 26th, two pumps were operated to reduce rising water levels. At approximately 18.30 hrs on Friday evening during regular checks of the sediment basin level and the pumps, it was observed that water level had reached and overtopped the spillway. Water continued to discharge from sediment basin 1 for approximately 22hrs.

The water is classified as being “dirty water” in the Tomingley Gold Operations (TGO) Water Management Plan (WMP). The volume of the discharge is unknown, however the discharge flow rate was insignificant in comparison to the flow of Gundong Creek at the time.

EPL 20169 has an upper limit of 50mg/L for Total Suspended Solids (TSS) for discharges from licensed discharge points including Sediment Pond 1. The results from ALS indicate that the water sample SP1 Spill had a TSS level of 64 mg/L. The background levels for TSS in Gundong Creek during this rain event were higher than the EPL upper limit at both upstream SW1 (60mg/L) and downstream SW 2 (62mg/L). The TSS level had fallen to 26 mg/L at GCML, Gundong Creek at McNivens Lane (approx. 3km downstream of the ML boundary).

The incident was reported to the EPA and DPIE in accordance with PA reporting requirements.

TGO have not been subject to any enforcement action by the EPA.

Figure 8 Incident Water Sample Locations

11.2 Diesel Spill from Bulk Fuel Tanker

At approximately 5.45 am on May 19th 2021, a bulk fuel tanker was transferring its load of diesel into the TGO self-bunded diesel tanks. During the unloading the truck driver noticed diesel running from underneath his truck and immediately shut the tanker pump down and notified a shift supervisor from TGO that a spill had occurred. On inspection by the TGO staff member and truck driver it was evident a coupling between two hoses that were being used to transfer the diesel had become disconnected and allowed diesel to be pumped onto the ground. The truck driver reconnected the hose to prevent any additional leakage. Approximately 4730 litres of diesel was lost as a result of the spill.

Diesel had run across the hardstand in front of the diesel tank and found its way in to a shallow grassed spoon drain and had flowed approximately 60 metres from the fuel farm before soaking into the soil. Saprolite (clay material) was placed in the drain to provide a small bund wall at the furthest extent of the spill to contain any further movement of diesel along the drain. Work commenced on Tuesday 25th May and continued until May 27th with 657 tonnes of material removed and transported to Dubbo Regional Council Waste Depot. Approximately 300t of saprolite and 300t of road base were used to backfill the excavated area.

TGO conducted an internal review of procedures relating to fuel delivery. The following improvements have been made;

- deliverys only occur in daylight hours
- fixed lighting upgrade in Fuel Bay area
- installation of CCTV

The incident was reported to the EPA and DPIE in accordance with PA reporting requirements. A cleanup notice was issued to the Fuel Contract Company.

TGO have not been subject to any enforcement action by the EPA.

12 Activities to be Completed in Next Reporting Period

Environmental activities and initiatives to be implemented in the next reporting period will focus on continuity of the TGO monitoring program for noise, dust, vibration and water quality, continued management of all biodiversity offset areas, and monitoring of revegetation on WRE 2 and WRE3.

Details on these activities are shown in Table 15.

Table 15: Environmental Management Activities proposed for 2022

Proposed Activities	Location	Proposed Completion Date
Pest control program	TGO site & biodiversity offset areas	Ongoing
Weed management	TGO site & biodiversity offset areas	Ongoing
Regular monitoring of site water management structures for erosion and stability	TGO site	Ongoing
Continue monitoring and maintenance program for WRE 2 and WRE3 including progress of revegetation	Waste rock emplacements	Ongoing
Noise, air quality, blasting and water quality monitoring in accordance with EPL and PA.	TGO site and district	Ongoing
Review of biodiversity monitoring sites and methodology (LFA versus BAM)	TGO Biodiversity Monitoring Sites	3rd Quarter 2022
Determine location of new noise, dust, and groundwater monitoring stations for the Tomingley Gold Extension Project (TGEP if approved)	To be confirmed	3rd Quarter 2022
Install environmental monitoring stations for the TGEP	To be confirmed	4th Quarter 2022

Appendix 1

Annual Noise Assessment

Noise Compliance Assessment

Tomingley Gold Mine
Tomingley, NSW
November, 2021

Prepared for: Tomingley Gold Operations Pty Limited
November 2021
MAC160243RP7

Muller Acoustic Consulting

Document Information

Noise Compliance Assessment

Tomingley Gold Mine, November 2021

Prepared for: Tomingley Gold Operations Pty Limited

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Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
MAC160243RP7	Final	29 November 2021	Nicholas Shipman		Oliver Muller	

CONTENTS

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Tomingley Gold Operations Pty Ltd (TGO) to complete a Noise Compliance Assessment (NCA) for Tomingley Gold Mine ('the mine'), Tomingley, NSW.

The NCA involved quantifying the noise contribution of the mine by direct attended measurements to determine mining noise emissions to address Condition M4.1 their Environment Protection License 20169 ('the EPL') from NSW Environment Protection Authority (EPA) and Condition 6 of Schedule 3 of the Project Approval (PA) number 09_0155 issued by the Department of Planning and Environment (DPE) at six representative receivers.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Environment Protection Licence EPL 20169 (EPL);
- Project Approval 09_0155 (PA); and
- Australian Standard AS 1055:2018 - Acoustics - Description and measurement of environmental noise - General Procedures.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A.**

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2 Environmental Protection License and Project Approval Noise Limits

2.1 Environmental Protection License (EPL)

Historic assessments for the mine categorise receivers into Noise Assessment Groups (NAGs). The NAGs were derived based on ambient noise data that controlled receiver RBLs.

Table 1 reproduces the noise limits for assessed receivers referenced from the EPL, adopted for this NMA and are consistent with historic EPL monitoring locations.

Table 1 Noise Limits, dBA

Noise Assessment Group	Receivers	Day	Evening	Night	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
NAG A	R4, R5, R6	35	35	35	45
NAG B	R2	36	35	35	45
NAG C	R3, R29	45	35	35	45
NAG D	R23	43	38	36	45

Note: Refer to figure in Appendix 4 of Project Approval 09-0155 for noise locations. However, these criteria do not apply if the Proponent has an agreement with the relevant owner(s) of these residences / land to generate higher noise levels, and the Proponent has advised the Department of Planning and Infrastructure and EPA in writing of the terms of this agreement.

Conditions L4.3 to L4.8 of the EPL set out the conditions under which the noise limits apply and are reproduced below.

L4.3 For the purpose of condition L3.1:

- *Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sunday and Public Holidays.*
- *Evening is defined as the period 6pm to 10pm.*
- *Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sunday and Public Holidays.*

L4.4 The noise limits set out in condition L3.1 apply under all meteorological conditions except for the following:

- *Wind speeds greater than 3m/second at 10 metres above ground level;*
- *Stability category F temperature inversion conditions and wind speeds greater than 2m/second at 10 metres above ground level; or*

- *Stability category G temperature inversion conditions.*

L4.5 For the purposes of condition L3.3:

- *Data recorded by a meteorological station installed on site must be used to determine meteorological conditions; and*
- *Temperature inversion conditions (stability category) are to be determined by the sigma-theta method referred to in Part D1.4 of Appendix D of the NSW Industrial Noise Policy (INP).*

L4.6 To determine compliance:

a) with the $LA_{eq(15min)}$ noise limits in condition L3.1, the noise measurement equipment must be located:

- *approximately on the property boundary, where any dwelling is situated 30 metres or less from the property boundary closest to the premises; or*
- *within 30 metres of a dwelling façade, but not closer than 3 metres, where any dwelling on the property is situated more than 30 metres from the property boundary closest to the premises; or, where applicable within approximately 50 metres of the boundary of a National Park or a Nature Reserve.*

b) with the $LA_{1(1\ minute)}$ noise limits in condition L3.1:

- *the noise measurement equipment must be located within 1 metre of a dwelling façade.*

c) with the noise limits in condition L3.1 the noise measurement equipment must be located:

- *at the most affected point at a location where there is no dwelling at the location; or*
- *at the most affected point within an area at a location prescribed by conditions L3.5(a) or L3.5(b).*

L4.7 A non-compliance of condition L3.1 will still occur where noise generated from the premises in excess of the appropriate limit is measured:

- *at a location other than an area prescribed by conditions L3.5(a) and L3.5(b); and/or*
- *at a point other than the most affected point at a location.*

L4.8 For the purposes of determining the noise generated at the premises the modification factors in Appendix C of the NSW Industrial Noise Policy (INP) must be applied, as appropriate, to the noise levels measured by the noise monitoring equipment.

Condition M4.1 of the EPL identifies that to assess compliance with Condition L3.1, attended noise monitoring must be undertaken in accordance with Conditions L3.5 and:

a) At each one of the locations listed in Condition L3.1;

b) Occur annually in a reporting period;

c) Occur during each day, evening and night period as defined in the NSW Industrial Noise Policy for a minimum of:

- *1.5 hours during the day;*
- *30 minutes during the evening; and*
- *1 hour during the night.*

d) Occur for three consecutive days.

2.2 Project Approval 09_0155

Condition 6 of Schedule 3 of the Project Approval states:

(c) include a monitoring program that:

i. uses a combination of real-time and supplementary attended monitoring measures to evaluate the performance of the project;

ii. adequately supports the proactive and reactive noise management system on site;

iii. defines what constitutes a noise incident, and includes a protocol for identifying noise incidents and notifying the Department and relevant stakeholders of any such incident;

iv. evaluates and reports on the effectiveness of the noise management system on site;

v. includes a program to calibrate and validate the real-time noise monitoring results with the attended monitoring results over time (so the real time monitoring program can be used as a better indicator of compliance with the noise criteria in this approval and a trigger for further attended monitoring); and

(d) *include a noise reduction strategy for progressively reducing mine noise during open cut mining operations, consistent with the noise scenarios described in the document 'Tomingley Gold Mine Environmental Assessment – Project Approval No. 09_0155 Modification 3' dated November 2015.*

A comparison of attended versus unattended data has been completed as part of this assessment with results presented in Section 6.

3 Methodology

3.1 Locality

The mine is located to the south of the village of Tomingley, NSW. Receivers in the locality surrounding the mine are primarily rural/residential and for consistency the naming convention for each receiver has been retained from historic noise assessments. The monitoring locations with respect to the mine are presented in the locality plan shown in **Figure 1.**

3.2 Assessment Methodology

The attended noise surveys were conducted in general accordance with the procedures described in Australian Standard AS 1055:2018, "Acoustics - Description and Measurement of Environmental Noise" and the EPL. The measurements were carried out simultaneously by two MAC staff members at separate locations using Svantek Type 1, 971 noise analysers from Tuesday 9 November 2021 to Friday 12 November 2021. The acoustic instrumentation used carries current NATA calibration and complies with AS IEC 61672.1-2019-Electroacoustics - Sound level meters - Specifications. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Day measurements consisted of six 15 minutes (ie 1 hour 30 minutes), evening measurements of two 15 minutes (ie 30 minutes) in duration and night measurements were of four 15 minute (ie 1 hour) durations at each location over three consecutive dates. Where possible, throughout each survey the operator quantified the contribution of each significant noise source. Where possible, extraneous noise sources were excluded from the analysis as to calculate the $LA_{eq(15min)}$ mine noise contribution for comparison against the relevant EPL limit.

Prevailing meteorological conditions for the monitoring period were sourced from TGO's meteorological station and handheld weather meters and therefore analysed in accordance with Appendix D of the NPI to determine the stability category present at the time of each measured sample. This was undertaken to determine applicability of results in accordance with Condition L4.4 of the EPL. Results obtained during non-prevailing meteorological conditions (ie F Class in conjunction with a 2m/s drainage wind or a G class inversion) are considered not applicable against the EPL criteria.

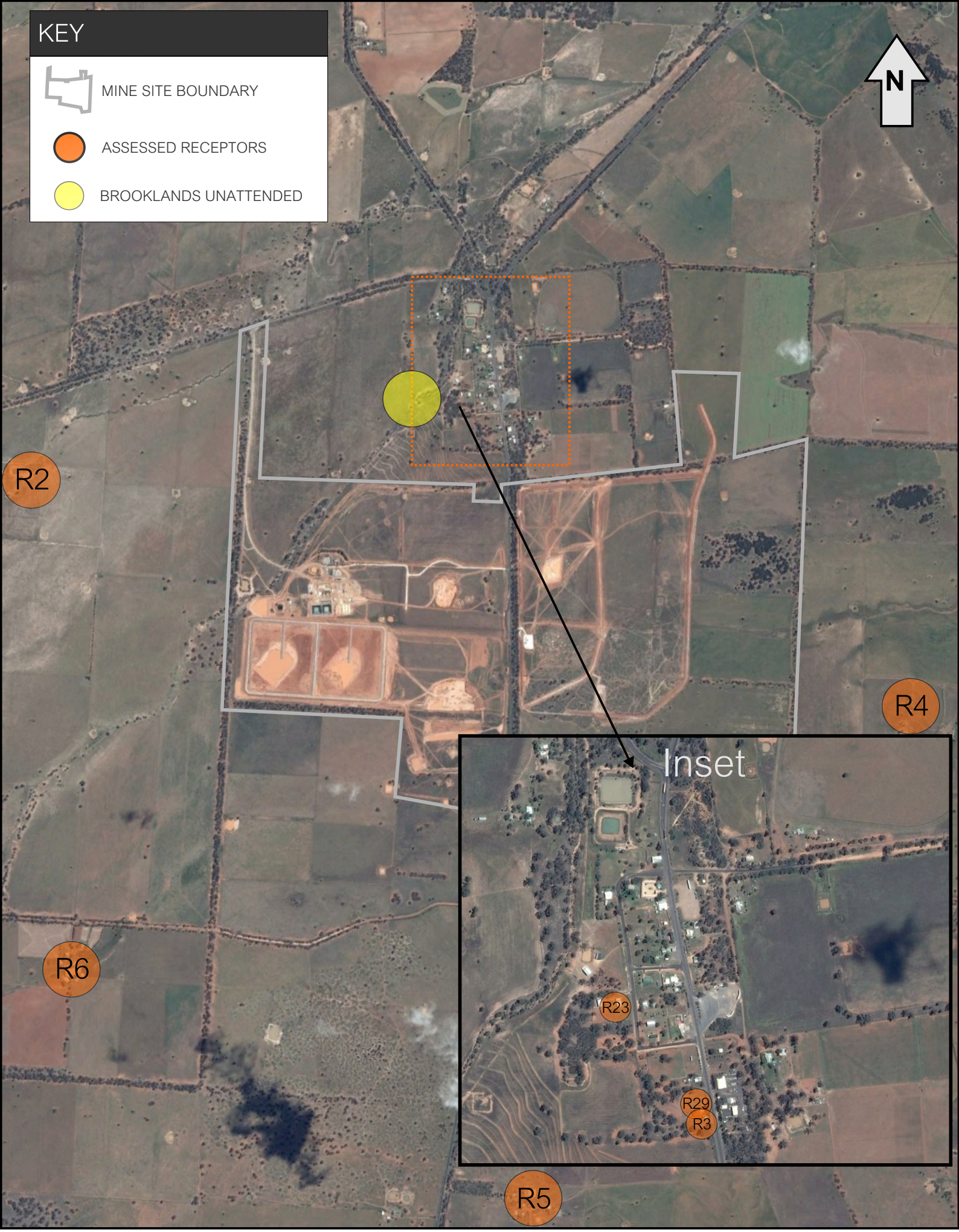

FIGURE 1 - LOCALITY PLAN AND ASSESSMENT LOCATIONS

TOMINGLEY GOLD MINE EPL NOISE MONITORING

REF: MAC160243

0 1000m

MAC
Muller Acoustic Consulting

4 Results

The monitoring and assessment results are presented in individual tables for each assessment location.

4.1 Assessment Results - Location R2

The results of the attended noise measurements at location R2 for the 2021 survey are summarised in **Table 2** with the relevant EPL limits, the calculated mining noise contribution and prevailing meteorological conditions at the time of each measurement.

Table 2 Operator-Attended Noise Survey Results – Location R2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
Day							
9/11/2021	14:15	73	43	28	36	WD: N WS: 1m/s Stab Class: A	Birds 25-63 Traffic 25-73 Wind in trees 26-38 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<25
10/11/2021	08:54	77	47	34	36	WD: N WS: 2m/s Stab Class: D	Wind in trees 31-53 Birds 30-66 Traffic 30-77 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
11/11/2021	12:25	77	46	30	36	WD: SE WS: 0.5m/s Stab Class: A	Local residential noise 25-38 Birds 25-62 Traffic 28-77 TGO Haul Truck 28-36 TGO Processing 25-30
TGO Site $L_{Aeq(15min)}$ Contribution							31
Evening							
9/11/2021	20:07	67	41	27	35	WD: NW WS: 0.5m/s Stab Class: E	Insects 26-33 Dog bark 25-35 Traffic 25-67 Birds 26-45 TGO Processing 26-30
TGO Site $L_{Aeq(15min)}$ Contribution							28
10/11/2021	21:16	66	41	32	35	WD: E WS: 0.5m/s Stab Class: D	Insects 30-33 Traffic 27-66 TGO Processing 27-32
TGO Site $L_{Aeq(15min)}$ Contribution							29
11/11/2021	20:32	70	43	34	35	WD: N	Insects 30-38

Table 2 Operator-Attended Noise Survey Results – Location R2							
Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
						WS: 1.5m/s Stab Class: D	Traffic 27-70 Wind in trees 30-60 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
Night							
9/11/2021	22:00	68	39	30	35	WD: NE WS: 1m/s Stab Class: E	Insects 30-38 Wind in trees 27-36 Birds 26-46 Traffic 25-68 Dog bark 25-39 Operator 44-48 TGO Processing 26-32
TGO Site $L_{Aeq(15min)}$ Contribution							29
11/11/2021	00:13	48	30	27	35	WD: E WS: 0.5m/s Stab Class: E	Insects 25-30 Traffic 25-40 Birds 25-40 Operator 47-48 Dog bark 30-46 TGO Processing 25-34
TGO Site $L_{Aeq(15min)}$ Contribution							29
11/11/2021	23:24	66	36	27	35	WD: N WS: 0.5m/s Stab Class: D	Insects 25-30 Operator 49-51 Traffic 25-66 Birds 35-66 TGO Loading 28-38 TGO Processing 25-37
TGO Site $L_{Aeq(15min)}$ Contribution							31

Note 1: Meteorological data obtained from TGO's on-site weather station or by direct measurement by the operator.

4.2 Assessment Results - Location R3/R29

The results of the attended noise measurements at location R3/R29 for the 2021 survey are summarised in **Table 3** with the relevant EPL limits, the calculated mining noise contribution and prevailing meteorological conditions at the time of each measurement.

Table 3 Operator-Attended Noise Survey Results – Location R3/R29

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
Day							
9/11/2021	15:53	73	50	47	45	WD: NW WS: 1m/s Stab Class: A	Construction 44-64 Traffic 41-73 Dog bark 43-50 Birds 41-56 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<45
10/11/2021	10:34	92	54	47	45	WD: N WS: 2m/s Stab Class: D	Wind in trees 38-54 Traffic 38-72 Construction 41-59 Local residential noise 41-72 Thunder 86-92 Birds 39-45 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<45
11/11/2021	08:57	73	45	39	45	WD: E WS: 0.1m/s Stab Class: C	Traffic 35-60 Construction 38-51 Birds 35-73 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<35
Evening							
9/11/2021	20:46	60	44	38	35	WD: N WS: 0.5m/s Stab Class: E	Traffic 26-60 Dog bark 33-40 Insects <33 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<35
10/11/2021	20:02	57	47	41	35	WD: N WS: 1m/s Stab Class: D	Traffic 35-57 Birds 32-43 Wind in trees 32-40 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
11/11/2021	21:09	55	40	33	35	WD: N	Insects 30-35

Table 3 Operator-Attended Noise Survey Results – Location R3/R29							
Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
						WS: 1m/s Stab Class: E	Traffic 27-55 Wind in trees 28-38 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
Night							
9/11/2021	23:08	61	44	34	35	WD: NE WS: 1m/s Stab Class: E	Insects 29-35 Traffic 26-61 Wind in trees 28-38 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
10/11/2021	22:00	55	41	33	35	WD: NE WS: 0.5m/s Stab Class: D	Traffic 26-55 Birds 30-43 Insects <31 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
12/11/2021	00:32	59	44	41	35	WD: NE WS: 1m/s Stab Class: D	Traffic 36-59 Insects <36 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<35

Note 1: Meteorological data obtained from TGO's on-site weather station or by direct measurement by the operator.

4.3 Assessment Results - Location R4

The results of the attended noise measurements at location R4 for the 2021 survey are summarised in **Table 4** with the relevant EPL limits, the calculated mining noise contribution and prevailing meteorological conditions at the time of each measurement.

Table 4 Operator-Attended Noise Survey Results – Location R4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}	Limit		
Day							
9/11/2021	15:16	65	42	29	35	WD: W WS: 0.6m/s Stab Class: A	Birds 26-65 Offsite Drilling 28-32 Insects 26-31 Wind in trees 26-36 Traffic 26-36 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<25
10/11/2021	10:41	71	49	34	35	WD: N WS: 2m/s Stab Class: D	Wind in trees 35-69 Birds 28-66 Thunder 41-71 Insects 28-37 Traffic 28-34 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
11/11/2021	10:07	71	44	25	35	WD: NE WS: 0.3m/s Stab Class: B	Birds 22-71 Traffic 22-64 Insects 22-24 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<25
Evening							
9/11/2021	20:44	50	31	29	35	WD: SE WS: 0.1m/s Stab Class: F	Insects 26-28 Traffic 26-50 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
10/11/2021	20:45	59	29	26	35	WD: N WS: 0.4m/s Stab Class: D	Traffic 23-47 Insects 23-25 Wildlife 52-59 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<25
11/11/2021	20:20	67	40	38	35	WD: NW	Traffic 35-58

Table 4 Operator-Attended Noise Survey Results – Location R4							
Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
						WS: 0.7m/s Stab Class: D	Insects <35 Thunder 36-48 Birds 36-67 TGO Inaudible
		TGO Site $L_{Aeq(15min)}$ Contribution					<35
Night							
9/11/2021	23:16	62	34	31	35	WD: E WS: 0.6m/s Stab Class: E	Insects 29-32 Traffic 29-44 Wildlife 32-62 TGO Inaudible
		TGO Site $L_{Aeq(15min)}$ Contribution					<30
10/11/2021	23:12	57	29	24	35	WD: N WS: 0.1m/s Stab Class: F	Insects 21-22 Traffic 21-45 Wildlife 34-57 TGO Inaudible
		TGO Site $L_{Aeq(15min)}$ Contribution					<25
11/11/2021	23:20	59	34	30	35	WD: N WS: 0.1m/s Stab Class: F	Traffic 27-59 Insects <27 TGO Inaudible
		TGO Site $L_{Aeq(15min)}$ Contribution					<30

Note 1: Meteorological data obtained from TGO's on-site weather station.

4.4 Assessment Results - Location R5

The results of the attended noise measurements at location R5 for the 2021 survey are summarised in **Table 5** with the relevant EPL limits, the calculated mining noise contribution and prevailing meteorological conditions at the time of each measurement.

Table 5 Operator-Attended Noise Survey Results – Location R5

Date	Time (hrs)	Descriptor (dBA re 20 µPa) LAmax	LAeq	LA90	EPL Limit	Meteorology[1]	Description and SPL, dBA
Day							
10/11/2021	12:19	83	64	46	35	WD: N WS: 2m/s Stab Class: D	Traffic 39-83 Insects <39 Birds 29-62 Local residential noise 39-44 Wind in trees 39-46 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<35
11/11/2021	11:44	81	65	38	35	WD: N WS: 0.1m/s Stab Class: A	Insects 30-33 Birds 30-57 Traffic 24-81 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<35
12/11/2021	09:04	82	65	46	35	WD: NW WS: 2m/s Stab Class: D	Wind in trees 39-62 Birds 39-58 Traffic 39-82 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<35
Evening							
9/11/2021	20:07	80	63	38	35	WD: SE WS: 0.1m/s Stab Class: E	Traffic 37-80 Insects <37 Birds 37-44 Offsite Drilling 36-37 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<35
10/11/2021	20:08	82	64	38	35	WD: N WS: 0.1m/s Stab Class: D	Insects <36 Birds 36-44 Traffic 36-82 Offsite Drilling <36 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<35

Table 5 Operator-Attended Noise Survey Results – Location R5							
Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
11/11/2021	19:43	81	61	38	35	WD: N WS: 0.2m/s Stab Class: D	Insects <36 Birds 35-45 Traffic 36-81 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<35
Night							
10/11/2021	00:25	82	61	36	35	WD: E WS: 0.6m/s Stab Class: E	Traffic 33-82 Insects <34 Offsite drilling 33-39 Wind in trees 33-38 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<35
11/11/2021	00:21	83	61	31	35	WD: N WS: 0.1m/s Stab Class: F	Insects 29-30 Traffic 29-83 Offsite drilling 31-34 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
12/11/2021	00:28	82	59	35	35	WD: N WS: 0.1m/s Stab Class: D	Birds 34-55 Insects <34 Traffic 34-82 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30

Note 1: Meteorological data obtained from TGO's on-site weather station.

4.5 Assessment Results - Location R6

The results of the attended noise measurements at location R6 for the 2021 survey are summarised in **Table 6** with the relevant EPL limits, the calculated mining noise contribution and prevailing meteorological conditions at the time of each measurement.

Table 6 Operator-Attended Noise Survey Results – Location R6

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
Day							
9/11/2021	13:37	74	42	32	35	WD: W WS: 0.1m/s Stab Class: A	Insects 26-34 Birds 29-69 Livestock 29-45 Traffic 26-74 Local residential noise 32-38 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
10/11/2021	08:57	73	47	38	35	WD: N WS: 2m/s Stab Class: D	Wind in trees 34-52 Birds 37-70 Insects <40 Aircraft 40-45 Livestock 35-39 Traffic 37-73 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<35
11/11/2021	08:28	77	46	30	35	WD: NE WS: 0.1m/s Stab Class: D	Traffic 25-68 Birds 30-77 Livestock 25-34 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<30
Evening							
9/11/2021	21:22	51	40	36	35	WD: SE WS: 0.1m/s Stab Class: E	Insects <34 Traffic 34-51 TGO Processing <31
TGO Site $L_{Aeq(15min)}$ Contribution							<31
10/11/2021	21:25	58	38	35	35	WD: N WS: 0.1m/s Stab Class: D	Traffic 31-47 Insects <33 Livestock 33-42 Operator 31-58 TGO Processing 33-36
TGO Site $L_{Aeq(15min)}$ Contribution							34
11/11/2021	21:03	49	38	35	35	WD: NE	Insects <34

Table 6 Operator-Attended Noise Survey Results – Location R6							
Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
						WS: 0.1m/s	Traffic 30-49
						Stab Class: E	Thunder 30-36
							TGO Inaudible
		TGO Site $L_{Aeq(15min)}$ Contribution					<30
Night							
							Insects 31-32
						WD: SE	Traffic 31-46
9/11/2021	22:04	49	38	34	35	WS: 0.1m/s	Livestock 31-49
						Stab Class: E	Birds 31-45
							TGO Processing 30-34
		TGO Site $L_{Aeq(15min)}$ Contribution					32
						WD: N	Traffic 33-65
10/11/2021	22:00	65	40	36	35	WS: 0.1m/s	Insects <34
						Stab Class: D	TGO Processing 33-37
		TGO Site $L_{Aeq(15min)}$ Contribution					34
						WD: NE	Traffic 27-54
11/11/2021	22:10	54	34	30	35	WS: 0.1m/s	Insects <29
						Stab Class: D	TGO Inaudible
		TGO Site $L_{Aeq(15min)}$ Contribution					<30

Note 1: Meteorological data obtained from TGO's on-site weather station.

4.6 Assessment Results - Location R23

The results of the attended noise measurements at location R23 for the 2021 survey are summarised in **Table 7** with the relevant EPL limits, the calculated mining noise contribution and prevailing meteorological conditions at the time of each measurement.

Table 7 Operator-Attended Noise Survey Results – Location R23

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
Day							
10/11/2021	12:08	87	68	49	43	WD: NE WS: 2m/s Stab Class: D	Traffic 40-87 Birds 40-61 Construction 42-50 Wind in trees 40-56 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<40
11/11/2021	10:31	85	68	45	43	WD: SW WS: 0.5m/s Stab Class: B	Traffic 35-85 Birds 35-60 Industrial 38-72 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<35
12/11/2021	07:28	85	65	46	43	WD: N WS: 2m/s Stab Class: D	Traffic 40-85 Birds 38-51 Wind in trees 39-50 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<40
Evening							
9/11/2021	21:20	89	64	38	38	WD: N WS: 0.5m/s Stab Class: E	Traffic 28-89 Insects 31-35 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<30
10/11/2021	20:39	85	62	30	38	WD: NE WS: 0.5m/s Stab Class: D	Traffic 25-85 Insects 26-28 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<25
11/11/2021	19:55	84	64	39	38	WD: N WS: 0.5m/s Stab Class: E	Traffic 31-84 Insects 34-38 TGO Inaudible
TGO Site $LA_{eq(15min)}$ Contribution							<30

Table 7 Operator-Attended Noise Survey Results – Location R23							
Date	Time (hrs)	Descriptor (dBA re 20 µPa)			EPL Limit	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}			
Night							
10/11/2021	00:12	88	62	30	36	WD: E WS: 0.5m/s Stab Class: E	Insects 28-36 Traffic 25-88 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<25
10/11/2021	23:06	87	64	31	36	WD: NE WS: 0.5m/s Stab Class: F	Traffic 25-87 Local residential noise 25-35 Dog bark 25-39 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<25
11/11/2021	22:17	83	62	33	36	WD: N WS: 1m/s Stab Class: D	Traffic 25-83 Insects 27-41 Dog bark 30-45 TGO Inaudible
TGO Site $L_{Aeq(15min)}$ Contribution							<25

Note 1: Meteorological data obtained from TGO's on-site weather station.

5 Discussion

5.1 Discussion of Results - Location R2

Monitoring between Tuesday 9 November 2021 and Thursday 11 November 2021 identified that TGO was audible during six measurements at location R2, although the estimated mining contribution remained below 31dBA, therefore the relevant noise limits were satisfied. Extraneous sources such as birds, traffic, wind in trees, local residential noise, dog bark, insects and operator noise were audible during the survey periods.

In summary, the noise contribution from TGO satisfied the relevant noise criteria ($L_{Aeq(15min)}$ and L_{Amax}) for all monitored assessment periods at Location R2.

5.2 Discussion of Results - Location R3/R29

Monitoring between Tuesday 9 November 2021 and Friday 12 November 2021 identified that TGO remained inaudible at location R3. The estimated mining contribution remained below 35dBA, therefore, the relevant noise limits were satisfied. Extraneous sources such as traffic, insects, birds, wind in trees, dog bark, construction noise, local residential noise and thunder were audible during the measurements.

In summary, the noise contribution from TGO satisfied the relevant noise criteria ($L_{Aeq(15min)}$ and L_{Amax}) for all monitored assessment periods at Location R3/29.

5.3 Discussion of Results - Location R4

Monitoring between Tuesday 9 November 2021 and Thursday 11 November 2021 identified that TGO was inaudible during all measurements at location R4. The estimated mining contribution remained below 35dBA, therefore, the relevant noise limits were satisfied. Extraneous sources such as traffic, insects, wildlife, thunder, birds, wind in trees and offsite drilling were audible during the measurements.

In summary, the noise contribution from TGO satisfied the relevant noise criteria ($L_{Aeq(15min)}$ and L_{Amax}) for all monitored assessment periods at Location R4.

5.4 Discussion of Results - Location R5

Monitoring between Tuesday 9 November 2021 and Friday 12 November 2021 identified that TGO was inaudible during all measurements at location R5. The estimated mining contribution remained below 35dBA, therefore the relevant noise limits were satisfied. Extraneous sources such as traffic, insects, birds, local residential noise, wind in trees and offsite drilling were audible during the measurements.

In summary, the noise contribution from TGO satisfied the relevant noise criteria ($L_{Aeq(15min)}$ and L_{Amax}) for all monitored assessment periods at Location R5.

5.5 Discussion of Results - Location R6

Monitoring between Tuesday 9 November 2021 and Thursday 11 November 2021 identified that TGO was audible during four measurements at location R6. Notwithstanding, the estimated mining contribution remained below 35dBA, therefore the relevant noise limits were satisfied. Extraneous sources such as insects, birds, livestock, traffic, local residential noise, aircraft, wind in trees, thunder and operator noise were audible during the measurements.

In summary, the noise contribution from TGO satisfied the relevant noise criteria ($L_{Aeq(15min)}$ and L_{Amax}) for all monitored assessment periods at Location R6.

5.6 Discussion of Results - Location R23

Monitoring between Tuesday 9 November 2021 and Friday 12 November 2021 identified that TGO remained inaudible during the measurement period at location R23. Notwithstanding, the estimated mining contribution remained below relevant criteria, therefore the noise limits were satisfied. Extraneous sources such as traffic, birds, construction noise, wind in trees, industrial noise, local residential noise and dogs barking were audible during the survey periods.

In summary, the noise contribution from TGO satisfied the relevant noise criteria ($L_{Aeq(15min)}$ and L_{Amax}) for all monitored assessment periods at Location R23.

6 Comparison of Attended and Unattended Monitoring Results

To address Condition 6 of Schedule 3 of the Project Approval, a program to calibrate and validate the real-time noise monitoring results with the attended monitoring results has been completed.

The validation compares monthly attended monitoring results against the closest assessed unattended monitoring location. Currently, TGO has one unattended real-time monitoring terminal installed at the Brooklands property (nearest to R23). Figure 1 identifies the location of the monitor with respect to the attended monitoring locations. It is noted that the Brooklands unattended monitor is situated 600m west of the attended noise monitoring location R23, therefore, background (LA90) noise levels are significantly lower due to offset distance to highway traffic.

A comparison of mine noise contributions between attended and unattended noise monitoring demonstrates a general consistency between attended and unattended results. It was noted that highway traffic noise, birds, and insect noise influenced measured noise levels for this assessment. Furthermore, for November 2021, results remained below the relevant criteria for both attended and unattended locations.

Table 8 provides a summary of comparisons or results between the attended and unattended noise surveys for R23.

Table 8 Comparison of Attended and Unattended Results – R23								
Assessment Type	Time (hrs)	Descriptor (dBA re 20 µPa)			Criteria	Mine Noise Contribution	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}				
Tuesday 9 November 2021								
Attended	21:20	89	64	38	38	<30	WD: N WS: 0.5m/s Stab Class: E	Traffic 28-89 Insects 31-35 TGO Inaudible
Unattended	21:30	59	48	39	38	<32		Traffic Insects TGO Inaudible
Wednesday 10 November 2021								
Attended	12:08	87	68	49	43	<40	WD: NE WS: 2m/s Stab Class: D	Traffic 40-87 Birds 40-61 Construction 42-50 Wind in trees 40-56 TGO Inaudible
Unattended	12:15	61	46	40	43	<38		
Attended	20:39	85	62	30	38	<25	WD: NE WS: 0.5m/s Stab Class: D	Traffic 25-85 Insects 26-28 TGO Inaudible
Unattended	20:45	55	40	30	38	<25		Traffic TGO Inaudible
Attended	00:12	88	62	30	36	<25	WD: E WS: 0.5m/s Stab Class: E	Insects 28-36 Traffic 25-88 TGO Inaudible
Unattended	00:15	60	41	31	36	<26		Insects Traffic TGO Inaudible
Attended	23:06	87	64	31	36	<25	WD: NE WS: 0.5m/s Stab Class: F	Traffic 25-87 Local residential noise 25-35 Dog bark 25-39 TGO Inaudible
Unattended	23:15	47	37	31	36	<28		Traffic TGO Inaudible
Thursday 11 November 2021								
Attended	10:31	85	68	45	43	<35	WD: SW WS: 0.5m/s Stab Class: B	Traffic 35-85 Birds 35-60 Industrial 38-72 TGO Inaudible
Unattended	10:30	93	66	31	43	<28		

Table 8 Comparison of Attended and Unattended Results – R23								
Assessment Type	Time (hrs)	Descriptor (dBA re 20 µPa)			Criteria	Mine Noise Contribution	Meteorology[1]	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}				
Attended	19:55	84	64	39	38	<30	WD: N WS: 0.5m/s Stab Class: E	Traffic 31-84 Insects 34-38 TGO Inaudible
Unattended	20:00	54	40	33	38	<31		Insects Traffic TGO Inaudible
Attended	22:17	83	62	33	36	<25	WD: N WS: 1m/s Stab Class: D	Traffic 25-83 Insects 27-41 Dog bark 30-45 TGO Inaudible
Unattended	22:15	53	40	30	36	<28		Insects Traffic TGO Inaudible
Friday 12 November 2021								
Attended	07:28	85	65	46	43	<40	WD: N WS: 2m/s Stab Class: D	Traffic 40-85 Birds 38-51 Wind in trees 39-50 TGO Inaudible
Unattended	07:30	59	42	36	43	<33		

Note 1: Meteorological data obtained from TGO's on-site weather station.

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7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Compliance Assessment on behalf of Tomingley Gold Operations (TGO). The assessment was completed to quantify site noise emissions in accordance with relevant Environment Protection License EPL20169 (EPL) conditions pertaining to mine noise emissions.

Attended monitoring for three consecutive days between Tuesday 9 November 2021 to Friday 12 November 2021, identifies that noise emissions generated by TGO comply with relevant noise limits specified in EPL conditions at all assessed locations.

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Appendix A - Glossary of Terms

Several technical terms have been used in this report and are explained in **Table A1**.

Table A1 Glossary of Terms

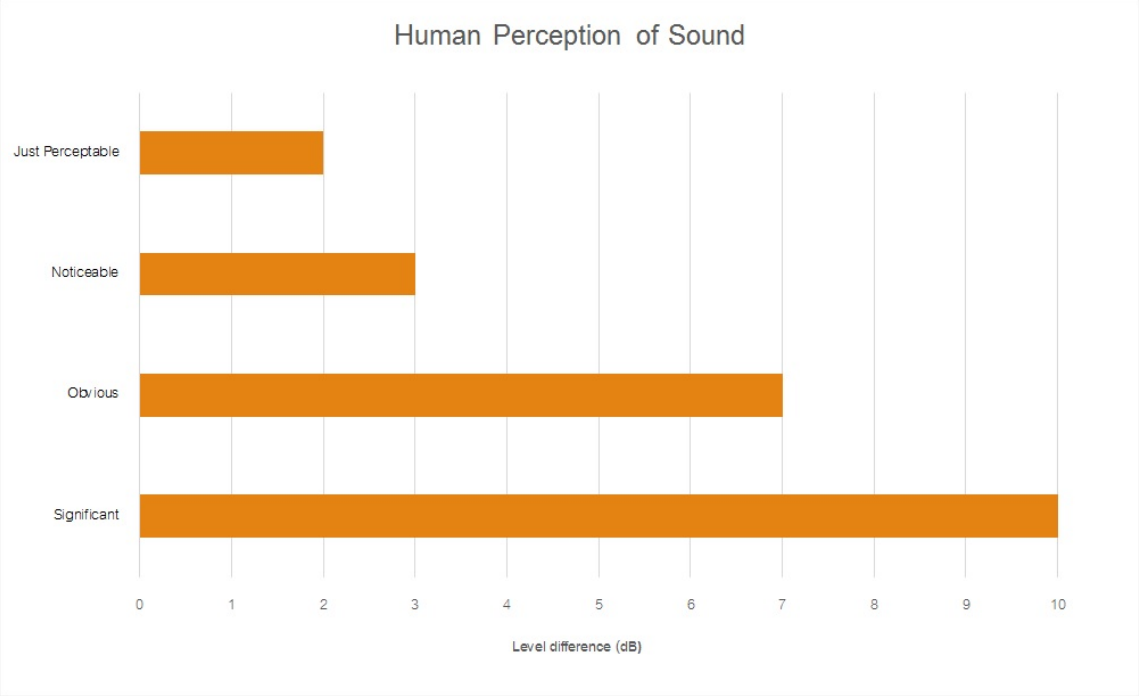
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (SWL)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by : = 10.log10 (W/Wo) Where : W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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Appendix 2

TGO Community Complaints Database

TGO Complaint History

Year	Number of complaints	Complaint Type				
		Dust	Noise	Blasting	Traffic/ Road Safety	Other
2021	0	0	0	0	0	0
2020	0	0	0	0	0	0
2019	0	0	0	0	0	0
2018	3	1	0	1	0	1 (radio signal affected)
2017	4	0	3	0	0	1 (use of TGO land)
2016	18	1	10	0	3	4 (lighting, TV reception)
2015	16	2	11	3	0	0
2014	53	11	35	2	4	1 (UHF radio misuse)
2013	9	4	0	0	3	2 (property damage)
2012	2	0	0	0	0	2 (property damage)

Appendix 3

Air Quality Monitoring Summary

Date	24-hour Average	Annual Rolling Average	Comment/s
1/01/2021	5.9	38.8	
2/01/2021	7.5	38.6	
3/01/2021	6.2	38.3	
4/01/2021	7.6	38.0	2 hours of missing data due to a power failure - Recalc using 22 hours of 1hr data
5/01/2021	11.0	35.3	
6/01/2021	12.9	29.4	
7/01/2021	7.5	29.2	
8/01/2021	8.2	29.0	
9/01/2021	10.3	28.6	
10/01/2021	9.0	26.4	1 hour of high negatives removed - Recalc using 23 hours of 1hr data
11/01/2021	11.3	22.0	
12/01/2021	18.1	21.7	
13/01/2021	22.9	21.4	
14/01/2021	27.6	21.3	
15/01/2021	39.8	21.2	3 hours of missing data due to a power failure - Recalc using 21 hours of 1hr data
16/01/2021	36.4	21.2	
17/01/2021	28.1	21.2	
18/01/2021	26.7	21.2	
19/01/2021	30.7	20.7	3 hours of missing data due to a power failure - Recalc using 21 hours of 1hr data
20/01/2021	19.6	20.6	
21/01/2021	23.9	20.6	
22/01/2021	11.7	20.5	
23/01/2021	12.8	17.8	
24/01/2021	17.7	17.4	
25/01/2021	14.9	17.3	
26/01/2021	28.5	17.0	
27/01/2021	28.5	17.0	
28/01/2021	28.0	16.9	
29/01/2021	13.9	16.8	
30/01/2021	13.5	16.7	
31/01/2021	11.4	16.5	
Average	**17.8**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/02/2021	11.2	16.3	
2/02/2021	NA	15.6	Insufficient data
3/02/2021	15.1	15.4	
4/02/2021	22.9	15.3	
5/02/2021	15.4	14.8	
6/02/2021	7.8	14.8	24hr recalc - 1 hours excluded due to high negatives
7/02/2021	11.8	14.8	
8/02/2021	15.4	14.8	
9/02/2021	11.2	14.8	
10/02/2021	13.5	14.8	24hr recalc - 3 hours excluded due to power outages
11/02/2021	12.9	14.8	
12/02/2021	27.4	14.9	
13/02/2021	10.1	14.8	24hr recalc - 1 hours excluded due to high negatives
14/02/2021	7.2	14.8	
15/02/2021	10.3	14.7	
16/02/2021	7.3	14.7	
17/02/2021	8.5	14.7	
18/02/2021	14.4	14.6	
19/02/2021	13.5	14.6	
20/02/2021	9.3	14.6	24hr recalc - 1 hours excluded due to high negatives
21/02/2021	19.1	14.6	24hr recalc - 1 hours excluded due to high negatives
22/02/2021	27.5	14.4	
23/02/2021	26.7	14.5	
24/02/2021	16.2	14.5	
25/02/2021	13.0	14.5	24hr recalc - 3 hours excluded due to maintenance/calibration
26/02/2021	18.4	14.4	
27/02/2021	19.1	14.4	
28/02/2021	12.9	14.3	
Average	**14.7**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/03/2021	34.0	14.3	
2/03/2021	36.9	14.4	
3/03/2021	34.8	14.4	
4/03/2021	27.9	14.4	
5/03/2021	38.0	14.4	
6/03/2021	32.5	14.5	
7/03/2021	25.8	14.5	
8/03/2021	34.6	14.6	
9/03/2021	35.4	14.7	
10/03/2021	47.8	14.8	
11/03/2021		14.8	Insufficient data
12/03/2021	6.4	14.8	
13/03/2021	9.8	14.8	
14/03/2021	15.2	14.8	
15/03/2021	7.6	14.7	
16/03/2021	16.0	14.7	
17/03/2021	10.7	14.7	
18/03/2021	5.7	14.7	
19/03/2021	7.3	14.7	
20/03/2021	7.4	14.6	
21/03/2021	5.6	14.6	
22/03/2021		14.5	Insufficient data
23/03/2021	4.3	14.4	24hr recalc - 2 hours excluded due to power outages
24/03/2021	8.7	14.4	
25/03/2021		14.4	Insufficient data
26/03/2021	8.9	14.3	
27/03/2021	8.6	14.3	
28/03/2021	12.7	14.3	
29/03/2021	14.1	14.3	
30/03/2021	15.8	14.4	
31/03/2021	14.4	14.4	24hr recalc - 1 hour excluded due to power outages
Average	**18.8**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/04/2021	15.1	14.4	24hr recalc - 2 hours excluded due to power outages
2/04/2021	15.1	14.4	
3/04/2021	12.4	14.4	
4/04/2021	15.3	14.4	
5/04/2021	21.1	14.5	
6/04/2021	17.3	14.5	
7/04/2021	13.0	14.5	
8/04/2021	7.6	14.5	
9/04/2021	25.3	14.5	
10/04/2021	23.3	14.5	
11/04/2021	26.1	14.6	
12/04/2021	16.6	14.5	
13/04/2021	17.0	14.5	24hr recalc - 1 hour excluded due to power outages
14/04/2021	20.4	14.5	
15/04/2021	28.6	14.6	
16/04/2021	26.0	14.6	
17/04/2021	28.8	14.6	
18/04/2021	25.2	14.6	24hr recalc - 3 hours excluded due to power outages
19/04/2021	29.2	14.6	24hr recalc - 2 hours excluded due to power outages
20/04/2021	25.2	14.6	24hr recalc - 1 hours excluded due to power outages
21/04/2021	25.7	14.6	
22/04/2021	21.5	14.7	24hr recalc - 3 hours excluded due to power outages
23/04/2021	24.2	14.6	
24/04/2021	23.8	14.6	
25/04/2021	34.1	14.6	
26/04/2021	22.9	14.6	
27/04/2021	26.5	14.6	
28/04/2021	26.9	14.6	
29/04/2021	26.0	14.7	
30/04/2021	28.5	14.6	
Average	**22.3**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/05/2021	25.8	14.7	24hr recalc - 1 hours excluded due to power outages
2/05/2021	10.9	14.7	24hr recalc - 2 hours excluded due to power outages
3/05/2021	13.1	14.7	
4/05/2021	7.1	14.7	
5/05/2021	7.1	14.7	
6/05/2021	8.7	14.7	
7/05/2021	10.7	14.7	
8/05/2021	12.7	14.7	
9/05/2021	13.7	14.7	
10/05/2021	12.5	14.7	
11/05/2021	9.3	14.7	
12/05/2021	7.6	14.7	
13/05/2021	14.9	14.7	
14/05/2021	14.4	14.7	
15/05/2021	17.7	14.7	
16/05/2021	19.0	14.7	
17/05/2021	15.0	14.7	
18/05/2021	16.0	14.6	
19/05/2021	15.2	14.6	
20/05/2021	21.8	14.6	
21/05/2021	19.9	14.6	24hr recalc - 3 hours excluded due to Maintenance/Calibrations
22/05/2021	13.7	14.7	
23/05/2021	13.7	14.7	
24/05/2021	13.6	14.7	
25/05/2021	33.5	14.7	
26/05/2021	14.7	14.8	
27/05/2021	12.4	14.8	
28/05/2021	11.2	14.7	
29/05/2021	19.4	14.8	
30/05/2021	13.0	14.8	
31/05/2021	9.1	14.7	
Average	**14.4**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/06/2021	15.4	14.8	
2/06/2021	16.6	14.8	
3/06/2021	6.3	14.8	
4/06/2021	7.4	14.8	
5/06/2021	9.8	14.8	
6/06/2021	8.8	14.8	
7/06/2021	7.2	14.8	
8/06/2021	10.5	14.7	
9/06/2021	3.1	14.7	
10/06/2021	4.4	14.7	
11/06/2021	8.5	14.7	
12/06/2021	7.0	14.7	
13/06/2021	5.7	14.7	
14/06/2021	7.2	14.7	
15/06/2021	8.5	14.7	
16/06/2021	9.2	14.6	
17/06/2021	5.0	14.6	
18/06/2021	4.7	14.6	
19/06/2021	6.6	14.6	
20/06/2021	7.2	14.6	
21/06/2021	9.2	14.6	
22/06/2021	8.3	14.6	
23/06/2021	14.0	14.6	
24/06/2021	6.5	14.7	
25/06/2021	9.8	14.7	
26/06/2021	7.6	14.7	
27/06/2021	6.8	14.7	
28/06/2021	8.0	14.7	
29/06/2021	8.3	14.7	
30/06/2021	9.1	14.7	
Average	**8.2**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/07/2021	5.5	14.6	
2/07/2021	7.3	14.6	
3/07/2021	7.4	14.6	
4/07/2021	7.7	14.6	
5/07/2021	7.2	14.6	
6/07/2021	5.1	14.6	
7/07/2021	9.8	14.6	
8/07/2021	10.4	14.6	
9/07/2021	8.8	14.6	24hr recalc - 3 hours excluded due to power outage
10/07/2021	12.7	14.6	
11/07/2021	11.6	14.6	
12/07/2021	9.3	14.6	
13/07/2021	10.0	14.7	
14/07/2021	7.9	14.7	
15/07/2021	9.2	14.7	
16/07/2021	8.9	14.7	
17/07/2021	11.6	14.7	
18/07/2021	8.7	14.7	
19/07/2021	6.6	14.7	
20/07/2021	5.5	14.7	
21/07/2021	10.0	14.7	
22/07/2021	10.3	14.7	
23/07/2021	7.4	14.7	
24/07/2021	5.5	14.6	
25/07/2021	10.6	14.6	
26/07/2021	11.8	14.6	
27/07/2021	15.2	14.7	
28/07/2021	18.1	14.7	
29/07/2021	13.7	14.7	
30/07/2021	13.5	14.7	
31/07/2021	17.9	14.8	
Average	**9.6**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/08/2021	9.3	14.7	
2/08/2021	8.0	14.7	24hr recalc - 2 hours excluded due to power outages
3/08/2021	6.0	14.7	24hr recalc - 1 hours excluded due to power outages
4/08/2021	7.4	14.7	
5/08/2021	6.3	14.7	
6/08/2021	8.2	14.7	
7/08/2021	10.1	14.7	
8/08/2021	8.9	14.7	
9/08/2021	13.2	14.7	
10/08/2021	19.0	14.7	
11/08/2021	24.6	14.8	
12/08/2021	8.6	14.8	
13/08/2021	21.0	14.8	
14/08/2021	13.7	14.8	
15/08/2021	15.7	14.9	
16/08/2021	14.2	14.9	
17/08/2021	9.7	14.9	
18/08/2021	21.7	14.9	24hr recalc - 1 hours excluded due to power outages
19/08/2021	17.4	15.0	24hr recalc - 2 hours excluded due to power outages
20/08/2021	14.5	14.8	
21/08/2021	9.6	14.8	
22/08/2021	19.1	14.8	
23/08/2021	14.6	14.9	24hr recalc - 2 hours excluded due to power outages
24/08/2021	5.8	14.9	
25/08/2021	8.7	14.9	
26/08/2021	8.7	14.9	
27/08/2021	7.7	14.9	
28/08/2021	11.2	14.9	
29/08/2021	9.4	14.9	
30/08/2021	7.5	14.9	
31/08/2021	9.8	14.9	
Average	**12.0**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/09/2021	13.4	15.0	
2/09/2021	23.1	15.0	
3/09/2021	27.2	15.1	
4/09/2021	9.9	15.1	
5/09/2021	5.9	15.1	
6/09/2021	7.0	15.1	
7/09/2021	10.9	15.1	
8/09/2021	9.0	15.1	
9/09/2021	9.4	15.1	
10/09/2021	10.2	15.2	
11/09/2021	14.7	15.2	
12/09/2021	15.6	15.2	
13/09/2021	9.0	15.2	
14/09/2021	7.4	15.2	
15/09/2021	8.6	15.3	
16/09/2021	8.7	15.3	
17/09/2021	15.4	15.3	24hr recalc - 2 hours excluded due to power outages
18/09/2021	13.4	15.3	
19/09/2021	8.9	15.3	
20/09/2021	13.6	15.3	
21/09/2021	11.9	15.3	
22/09/2021	10.4	15.3	
23/09/2021	10.2	15.2	
24/09/2021	13.8	15.2	
25/09/2021	15.3	15.3	
26/09/2021	10.1	15.3	
27/09/2021	12.2	15.3	
28/09/2021	23.3	15.3	
29/09/2021	9.3	15.3	
30/09/2021	9.3	15.3	
Average	**12.2**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/10/2021	9.1	15.3	
2/10/2021	5.0	15.3	
3/10/2021	7.1	15.3	
4/10/2021	12.8	15.3	
5/10/2021	22.6	15.3	24hr recalc - 3 hours excluded due to power outages
6/10/2021	11.7	15.2	
7/10/2021	19.0	15.2	
8/10/2021	13.0	15.2	
9/10/2021	21.3	15.2	
10/10/2021	18.2	15.2	
11/10/2021	7.5	15.2	
12/10/2021	No data	15.3	Insufficient data
13/10/2021	8.0	15.2	
14/10/2021	7.8	15.2	24hr recalc - 2 hours excluded due to power outages
15/10/2021	13.6	15.2	
16/10/2021	9.1	15.1	
17/10/2021	8.9	15.1	24hr recalc - 3 hours excluded due to power outages
18/10/2021	7.7	15.1	24hr recalc - 2 hours excluded due to power outages
19/10/2021	11.5	15.1	
20/10/2021	10.4	15.0	
21/10/2021	11.3	15.0	
22/10/2021	13.9	15.0	
23/10/2021	19.1	15.1	
24/10/2021	11.8	15.0	24hr recalc - 3 hours excluded due to power outages
25/10/2021	18.9	15.1	
26/10/2021	11.8	15.1	
27/10/2021	14.8	15.1	
28/10/2021	21.1	15.1	
29/10/2021	30.9	15.2	
30/10/2021	14.6	15.2	
31/10/2021	17.3	15.2	
Average	**13.5**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/11/2021	20.5	15.2	
2/11/2021	16.2	15.2	
3/11/2021	26.4	15.3	
4/11/2021	9.9	15.2	
5/11/2021	9.8	15.2	
6/11/2021	12.7	15.2	
7/11/2021	11.0	15.2	
8/11/2021	13.9	15.2	
9/11/2021	32.6	15.2	
10/11/2021	22.5	15.2	
11/11/2021	13.2	15.2	24hr recalc - 1 hour excluded due to high negatives
12/11/2021	14.6	15.2	24hr recalc - 1 hour excluded due to high negatives
13/11/2021	5.1	15.1	
14/11/2021	9.0	15.1	24hr recalc - 1 hour excluded due to high negatives
15/11/2021	10.7	15.1	
16/11/2021	13.2	15.1	24hr recalc - 3 hours excluded due to Maintenance/Calibration
17/11/2021	32.0	15.0	
18/11/2021	23.0	15.0	
19/11/2021	38.8	15.0	
20/11/2021	17.1	15.0	
21/11/2021	6.4	14.9	
22/11/2021	8.3	14.8	
23/11/2021	8.8	14.8	
24/11/2021	9.1	14.8	
25/11/2021	6.9	14.8	
26/11/2021	5.3	14.7	24hr recalc - 3 hours excluded due to power outages
27/11/2021	5.6	14.7	
28/11/2021	7.6	14.6	
29/11/2021	9.0	14.5	
30/11/2021	8.4	14.5	
Average	**14.2**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Date	24-hour Average	Annual Rolling Average	Comment/s
1/12/2021	8.6	14.5	
2/12/2021	11.2	14.4	
3/12/2021	18.4	14.3	
4/12/2021	24.2	14.3	
5/12/2021	14.2	14.3	
6/12/2021	9.9	14.3	
7/12/2021	10.1	14.3	
8/12/2021	14.0	14.2	
9/12/2021	15.6	14.2	
10/12/2021	11.3	14.2	
11/12/2021	8.7	14.2	
12/12/2021	14.3	14.2	
13/12/2021	19.3	14.2	24hr recalc - 2 hours excluded due to power outages
14/12/2021	20.5	14.2	
15/12/2021	36.3	14.3	
16/12/2021	33.1	14.3	
17/12/2021	22.2	14.4	
18/12/2021	31.5	14.4	
19/12/2021	10.5	14.4	
20/12/2021	19.0	14.4	
21/12/2021	21.1	14.4	
22/12/2021	20.1	14.5	
23/12/2021	12.9	14.5	
24/12/2021	15.1	14.5	
25/12/2021	14.0	14.5	
26/12/2021	9.6	14.5	24hr recalc - 6 hours excluded due to power outages
27/12/2021	8.3	14.5	
28/12/2021	5.2	14.5	
29/12/2021	6.8	14.4	
30/12/2021	8.5	14.4	
31/12/2021	10.6	14.4	
Average	**15.8**		
	Yellow shading indicates 24-hr criteria (50µg/m3) exceedance		*Units = µg/m3*

Location	Sample Date	Results	Performance Criteria	Complies

		(TSP µg/m³)	(Annual Average)	
HVAS1	02/01/2021	48.4	90 µg/m3.	Y
HVAS1	08/01/2021	54		Y
HVAS1	14/01/2021	20.1		Y
HVAS1	20/01/2021	20.8		Y
HVAS1	26/01/2021	36		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	01/02/2021	29.3	90 µg/m3.	Y
HVAS1	07/02/2021	32.1		Y
HVAS1	13/02/2021	25		Y
HVAS1	19/02/2021	36.5		Y
HVAS1	25/02/2021	47.5		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	03/03/2021	61.4	90 µg/m^3	Y
HVAS1	09/03/2021	82.6		Y
HVAS1	15/03/2021	32.7		Y
HVAS1	21/03/2021	8.3		Y
HVAS1	27/03/2021	13.8		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	02/04/2021	28.1	90 µg/m^3	Y
HVAS1	08/04/2021	36.4		Y
HVAS1	14/04/2021	37.1		Y
HVAS1	20/04/2021	54.1		Y
HVAS1	26/04/2021	47.6		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	02/05/2021	21.4		Y

HVAS1	08/05/2021	22.4	90 µg/m^3	Y
HVAS1	14/05/2021	26.0		Y
HVAS1	20/05/2021	42.4		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	07/07/2021	16.6	90 µg/m^3	Y
HVAS1	13/07/2021	23.9		Y
HVAS1	19/07/2021	10.0		Y
HVAS1	25/07/2021	17.6		Y
HVAS1	31/07/2021	35.8		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	06/08/2021	21.6	90 µg/m^3	Y
HVAS1	12/08/2021	27.4		Y
HVAS1	24/08/2021	8.0		Y
HVAS1	30/08/2021	14.6		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	05/09/2021	15.8	90 µg/m^3	Y
HVAS1	11/09/2021	58.1		Y
HVAS1	17/09/2021	44.8		Y
HVAS1	23/09/2021	21.1		Y
HVAS1	29/09/2021	24.9		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	05/10/2021	58.8	90 µg/m^3	Y
HVAS1	11/10/2021	16.3		Y
HVAS1	17/10/2021	16		Y
HVAS1	23/10/2021	48.7		Y
HVAS1	29/10/2021	76.5		Y

Location	Sample Date	Results (TSP µg/m³)	Performance Criteria (Annual Average)	Complies
HVAS1	04/11/2021	20.9	90 µg/m³	Y
HVAS1	10/11/2021	44.4		Y
HVAS1	16/11/2021	30.6		Y
HVAS1	22/11/2021	18.0		Y
HVAS1	28/11/2021	12.1		Y
Location	**Sample Date**	**Results (TSP µg/m³)**	**Performance Criteria (Annual Average)**	**Complies**
HVAS1	04/12/2021	41.4	90 µg/m³	Y
HVAS1	10/12/2021	22.0		Y
HVAS1	16/12/2021	50.8		Y
HVAS1	22/12/2021	37.2		Y
HVAS1	28/12/2021	11.9		Y

DDG Sampling Dates	DDG1 Total Insoluble Matter (g/m²/month)	DDG2 Total Insoluble Matter (g/m²/month)	DDG3 Total Insoluble Matter (g/m²/month)	DDG4 Total Insoluble Matter (g/m²/month)	DDG5 Total Insoluble Matter (g/m²/month)
04/01/2021 – 03/02/2021	2.3	1.5	1.1	0.9	0.9
03/02/2021 – 02/03/2021	1.2	1.05	1.25	1.1	0.9
02/03/2021 – 08/04/2021	1.6	0.6	0.8	1.1	0.8
08/04/2021 – 03/05/2021	1.6	1	1.4	1.6	0.7
03/05/2021 – 01/06/2021	0.8	0.7	0.5	1.8	0.6
01/06/2021 – 06/07/2021	1.2	0.4	0.4	3.5	0.6
06/07/2021 – 07/08/2021	1.7	0.5	1.4	0.9	1.5
07/08/2021 – 06/09/2021	1.9	0.9	0.9	4	1
06/09/2021 - 05/10/2021	0.7	0.4	0.5	0.5	0.5
05/10/2021 - 10/11/2021	1.3	0.9	0.9	1.3	0.6

Appendix 4

Biodiversity and Rehabiltation Monitoring Report

2021

Biodiversity & Rehabilitation Monitoring Report

Tomingley Gold Operations

September 2021

DnA Environmental

Disclaimer

This is a report of work carried out by DnA Environmental on behalf of Tomingley Gold Operations Pty Ltd and has been prepared according to the brief provided by the client. The information contained herein is complete and correct to the best of my knowledge. The representations, statements, opinions and advice, expressed or implied in this report are produced in good faith but on the basis that DnA Environmental are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any or all of the content.

Signed: 

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Draft submitted: 13th September 2021.
Reviewed: 6th December, Jenna Lehmann, TGO Environmental Coordinator
Final Report submitted: 6th December

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Executive summary

The 2021 Tomingley Gold Operations (TGO) Biodiversity and Rehabilitation Monitoring Report is a result of work carried out by DnA Environmental to satisfy monitoring and reporting requirements of the Mining Operations Plan (MOP), Biodiversity Management Plan (BMP) and associated Biodiversity Offset Strategy. The primary aim of the TGO BMP is the protection, enhancement and long-term conservation of the remnant native vegetation on the mine site and surrounding lands with particular focus on the Endangered Ecological Communities (EECs) dominated by *E. microcarpa* (Inland Grey Box) and *E. conica* (Fuzzy Box).

As part of the Biodiversity Offset Strategy, remnant woodland in moderate to good condition will be allowed to naturally regenerate, while those in poorer condition may be enhanced via strategic planting and seeding of endemic trees, shrubs, herbs and grasses. Ongoing management activities include weed control, grazing management and feral animal control. Large areas of revegetation have been undertaken in previously cultivated paddocks to the north of the ML and along Gundong Creek as well as areas adjacent to the existing linear woodland corridors to increase their size, condition and connectivity. Native woodlands and grasslands are also the primary vegetation communities to be rehabilitated on the mine disturbed landforms including the large Waste Rock Emplacements (WRE's) and the Noise Bund.

The NSW Government requires regular monitoring of Biodiversity Offset Areas and mine disturbed rehabilitation areas to ensure progressive ecological targets are being met. A revised ESG3 MOP guideline was released in 2013 that details the process for monitoring and managing progression towards successful rehabilitation outcomes which are quantified by completion criteria. Successful rehabilitation of a mine site can be conceptually described in terms of logical steps or phases, and these are made applicable to each of the similar land management units or domains within the mine site. These guidelines will soon be superseded by the Rehabilitation Management Plan and Associated Annual Rehabilitation Report and Forward Program for large mines Codes of Practice. The rehabilitation monitoring and reporting procedure continues to be broken down into five rehabilitation phases including:

1. Decommissioning;
2. Landform Establishment and Stability;
3. Growth medium development;
4. Ecosystem and Land Use Establishment; and
5. Ecosystem and Land Use Development.

Reference sites are considered to be effective completion criteria against which rehabilitation progress can be measured, assuming that the reference sites are themselves sustainable. They provide the ability to monitor both success against true values of an existing ecosystem and the effects of climatic variations and disturbance events (such as fire, flooding, drought, insect plagues etc.). The reference sites can be used as the target outcome of the final rehabilitated landscape and a time series record of ecosystem change or development can be obtained.

Thus, the primary objective of the TGO biodiversity and rehabilitation monitoring program is to compare the ecological recovery of conservation enhancement and revegetation areas and mine rehabilitation areas by comparing a selection of ecological targets or completion criteria, against less disturbed areas of remnant woodland and native grasslands, referred to as reference sites.

The biodiversity and rehabilitation monitoring methodology includes a combination of Landscape Function Analyses (LFA) and various measurements of ecosystem diversity and habitat values based on and adapted from the Biometric Assessment Methodology (BAM). Soil samples and accredited soil analyses are also taken from mine disturbed rehabilitation sites and their comparative reference sites to satisfy requirements of the MOP. A range of ecological data obtained from replicated reference sites are used to provide upper and lower ecological performance indicator ranges which are obtained and adapted in each monitoring year. As not all key performance

indicators are considered to be fundamental to completion, or in some cases achievable (e.g. average trunk diameter, tree hollows etc), key performance indicators have been further separated into "*Primary*" performance indicators and "*Secondary*" performance indicators. Primary performance indicators are those chosen as completion criteria targets and revegetation sites should equal, exceed or show positive trends towards those attributes of the reference sites. When these primary performance indicators have been met, or trending in the right direction, the sites should therefore theoretically be eligible for closure sign off.

OEH guidelines propose a minimum number of rehabilitation monitoring sites according to the size of the rehabilitation area. In 2016, ten sites were established which included six remnant woodlands, two areas of EEC woodland revegetation (Reveg sites) and two areas of riparian woodland revegetation along Gundong Creek (Creek sites). One woodland site was situated within remnant *E. populnea* (Poplar Box) woodland to the north, while two sites were established within the large *Casuarina cristata* (Belah) remnant to the east of the mine. Three remnant woodland sites including two Inland Grey Box - Poplar Box - White Cypress Pine EEC (Grey 1, Grey 2) and one Fuzzy Box Woodland EEC (Fuzzy 1) are used as woodland reference sites in both the biodiversity and woodland rehabilitation monitoring programs. In the past two years only two woodland reference sites Fuzzy 1 and Grey 2 have been monitored.

In 2016 the monitoring program also involved establishing two pasture reference sites in order to provide ecological completion targets for the pasture rehabilitation areas on the slopes of the Noise Bund. Two additional pasture rehabilitation sites were established in 2017 on the sides of WRE2 and WRE3. In 2020 an additional pasture and woodland rehabilitation monitoring site were established on new areas of rehabilitation completed in February 2019 on WRE3 and WRE2 respectively.

Biodiversity and rehabilitation monitoring have been undertaken by Dr Donna Johnston and Andrew Johnston from DnA Environmental. In 2021, field surveys were undertaken by Andrew Johnston (DnA Environmental) and Ray Mjadwesch (Mjadwesch Environmental Service Support) during 9th – 12th August.

Rainfall

The average annual rainfall at Peak Hill is 562mm, however there was below average rainfall during 2014 and 2015, with low rainfall conditions extending into 2016. April 2016 marked the beginning of above average monthly rainfall, with record breaking rains falling from April through to September causing widespread flooding. These floods were however again followed by drought conditions throughout most of 2017 and these continued for another two years and extended into January 2020. Above average rainfall was recorded for the remainder of 2020, with a total of 705mm recorded the year. In 2021, January through to March were also particularly wet, however these were followed by limited rain in April and May. Months of June and July were also wet with 120mm followed by an additional 73mm in July. To the end of July, a total of 607mm had already been recorded, which was well above the long-term average of 334mm for the same period. The dynamic seasonal conditions have a significant impact on the composition and diversity of the vegetation communities at TGO and these trends have been reflected in the ecological monitoring data.

Summary of results: Woodland enhancement and revegetation sites

The reference sites (Fuzzy 1 and Grey 2) were structurally and functionally different to each, but both had relatively high perennial plant components due to the mature eucalypts and perennial grasslands. They had a well-developed leaf litter layer and/or patches of hard crusted soil surfaces which typically were stabilised by cryptogams. During 2018 and 2019 there was a reduction in perennial ground covers and increased disturbances by animals as a result of the ongoing drought conditions. Since 2020, the improved rainfall conditions resulted in a significant increase in plant growth and 100% LO being recorded in both reference sites. Poplar 1, a small area

of remnant *Eucalyptus populneus* (Bimble Box), was structurally similar to the woodland reference sites, however some minor disturbance by animals has caused a reduction to 96% LO this year.

Reveg 1 and Reveg 2 were old cropping paddocks which were essentially recovering native grasslands that had been direct seeded with local woodland species in 2013. In the early development stages, there were rows of bare soil as a result of the ground preparation techniques such as scalping, cultivation and direct seeding. Within the second year of monitoring, the ground cover vegetation and cryptogams had colonised the exposed soils and significantly increased the functional patch areas to 100%. This year, high functional area was maintained in Reveg 1, however Reveg 2 which has a higher density of trees and shrubs, continues to have some disturbance by kangaroos with LO further declining to 76% this year.

Creek 1 and Creek 2 were also positioned within an old cropping paddock which was similar in composition to Reveg 1 and Reveg 2, and these were also seeded with a woodland mix in 2013. Creek 2 also incorporated a flat upper floodplain and extended down the sloping creek banks. During 2018 and 2019 these sites had a reduction in perennial ground covers and increased disturbances by animals has caused deterioration of the litter layers. The improved seasonal conditions over the last two years and resulted in a slight improvement in functional patch areas with 88 – 92% LO.

Initially the *Casuarina cristata* (Belah) remnant woodland had also suffered from a long grazing history with the ridges of the gilgais being predominantly bare and eroding and perennial plant cover was particularly low. Since the removal of domestic livestock in 2013, there was an increase in vegetative covers in both Belah 1 and Belah 2 monitoring sites, however in 2018 and 2019 the prolonged drought and heavy macropod grazing caused a loss of integrity of the litter layers and other protective ground covers. Improved seasonal conditions over the last two years has resulted in improved levels of ground covers, and this year both Belah sites had 100% functional patch area. The new area of woodland which was rehabilitated in 2019 on top of WRE2 was heavily dominated by annual and perennial plants and had good litter cover and soil profile development and continued to score 100% LO. Revegetation sites WRE2-2, Reveg 1 and Belah 1 and Belah 2 had an LO comparable to the reference sites this year.

The most ecologically functional sites continued to be Fuzzy 1 with a total sum of scores of 211, closely followed by Poplar 1 with a score of 195, with the ecological function in these two sites remaining significantly higher than the remaining monitoring sites. The Grey 2 reference site was the next most functional of the remnant woodlands scoring a total function of 166, and this was closely followed by WRE2-2, Creek 1, Reveg 1 and Creek 2 which were very similar to each other with scores of 150 - 157. The two sites, Reveg 2 and Belah 1, were very similar to each other with scores of 146 and 143 respectively. Belah 2 was the least functional woodland community with a score of 136.

The reference sites were chosen to represent open grassy woodlands which are characteristic of the area, with mature tree densities ranging from 8 – 10 individuals or of 80 - 100 stems per hectare. The average tree diameters ranged from 54 – 55 cm with some old growth individuals having a dbh up to 129 cm. Most trees were in moderate to good health, however one individual had died in Grey 2 over the past year, while there continued to be one dead stag in Fuzzy 1. Reproductive structures such as fruit, flowers or bud were recorded in fewer individuals and neither site had mistletoe this year, however a small number of individuals had tree hollows. While the composition of species in the woodland reference sites varied between sites, dominant tree species included a combination of *Eucalyptus conica* (Fuzzy Box), *E. microcarpa* (Grey Box). In Grey 1, which was last monitored in 2019, *E. populnea* (Bimble Box), *Allocasuarina luehmannii* (Bulloak) and *Acacia oswaldii* (Miljee) were also present.

In the enhancement and revegetation sites trees and/or mature shrubs were recorded in all sites except the newest area of rehabilitation WRE2-2, with some Reveg and Creek sites had increasing densities indicating good

growth and development. Most sites except WRE2-2, Reveg 1 and Belah 2 continued to have tree population density comparable to the woodland reference sites.

In all Reveg and Creek sites, most individuals were in moderate to good health, however there was one acacia in Reveg 2 that was in poor health. Most sites, except Creek 1, had some individuals with reproductive structures such as fruit, flowers or bud, but no mistletoe was recorded. This year there appears to have been an improvement in the overall health of the Belah woodlands, but 11 – 14% of the trees in the Belah woodlands were [dead] stags. Mistletoes continued to be recorded in 25 – 56% of trees in the Belah woodland sites. In the Poplar Box woodland most individuals were healthy or in moderate health however there continued to be 31% of the population that were dead, probably as a result of under spraying of the Boxthorn in 2018. No revegetation or enhancement site had tree hollows suitable for nesting by wildlife. Trees and mature shrubs in the enhancement and revegetation sites were considered to be local endemic species.

The number of native shrubs and juvenile trees in the reference sites ranged from 21 – 32, with additional individuals being recorded in Fuzzy 1 this year as a result of natural regeneration. There was also an increasing number of seedlings in numerous enhancement sites, including the new rehabilitation site WRE2-2. Reveg 2 and Creek 2 continued to be the only sites which continued to have an adequate density of native shrubs and juvenile trees compared to the reference sites. There were also increased densities of the priority weed *Lycium ferocissimum* (African Boxthorn) in the reference sites and continued to be recorded in low abundance in most other monitoring sites except WRE2-2 and Reveg 1.

In the two woodland reference sites there were six species of shrubs and juvenile trees. Compared to the woodland reference sites the diversity of shrub species was low in all sites except Reveg 2 this year. In the woodland revegetation and enhancement sites the species of shrubs and juvenile trees were also variable between sites, but they were all essentially different compositions of the endemic natives, and most also had some *Lycium ferocissimum* seedlings.

In the woodland reference sites, there has been an increase in perennial plant cover this year which provided 33 – 36% of the total ground cover. In Fuzzy 1, annual plant cover had declined 11%, while litter cover has increased to 47%. In Grey 2 annual plant cover had increased to 34% cover, while there was 22% dead litter cover. Branches and logs provided 6 - 7% cover in both sites, with additional branches having fallen in 2019 in Fuzzy 1 and Grey 2. While rocks were not a feature of these woodland communities, cryptogams continue to provide a small amount of cover in Grey 2. There was also an increase in perennial plants and litter cover in most revegetation and enhancement areas, especially in Belah 2, with there being a simultaneous decrease in annual plants. This year only Belah 2 had a cover of perennial plants comparable to the reference sites, however the 33% target was close to being met in Poplar 1.

The Box woodland reference sites were characterised by having at least some mature canopy cover which exceeded 6.0 m and there were some scattered or occasional understorey shrubs. In Belah 2 and Poplar 1, there was also a mature overstorey, and in Creek 1 and Belah 1 there was some limited vertical foliage cover in all height categories due to the occurrence of the occasional trees, but overall canopy cover was low. Sites WRE2-2, Reveg 1, Reveg 2 and Creek 2 do not yet contain mature canopy covers however the scattered saplings were starting to provide some lower vertical structures in Reveg 2 and Creek 2.

In the woodland reference sites, total floristic diversity has slightly declined with a total of 53 - 67 species being recorded this year. Species diversity in the enhancement and revegetation sites ranged from a low of 35 species in the new WRE2-2 revegetation site to a high of 67 species in Belah 1. This year sites Reveg 2, Creek 2 and both Belah woodland sites had a diversity of plants comparable to the woodland reference sites. Native species tended to be more diverse than exotic species across the range of sites, except the new rehabilitation area WRE2-2. In the reference sites, 12 – 17 species were exotic and this year only Belah 2 and Poplar 1 were the only

revegetation and enhancement sites that had an acceptable diversity of exotic species with 16 exotic species, with the remaining sites being weedier than desired.

There was also an increase in live endemic cover which was recorded in most sites as annual plant cover tended also to decline, except in WRE2-2 and Creek 2. There was 80 - 83% native plant cover in the reference sites, with native plants providing more cover than exotics in most sites, however in sites WRE2-2, Reveg 1 and Creek 2, exotic plants were more abundant than natives, with only 2% native cover being recorded in WRE2-2 this year. All sites fell short of meeting native abundance targets this year compared to the reference sites.

Compared to the reference sites, the woodland enhancement and revegetation areas had a low diversity of tree species in all sites except Reveg 2, Belah 1 and Poplar 1 and there was a low diversity of shrub species in Reveg 1 and Belah 1. There was also a low diversity of herbs and grasses in WRE2-2. Reveg 2 was the only site that had a composition of growth forms comparable to the reference sites.

This year, *Trifolium subterraneum* (Subterraneum Clover) and *T. angustifolium* (Narrow-leaf Clover) were the most abundant species in the old cropping revegetation sites, while in WRE2-2 *Chloris gayana* (Rhodes Grass) and *Medicago truncatula* (Barrell Medic) were most dominant. The native species *Vittadinia cuneata* (Fuzzweed) was the most abundant in Creek 2, *Einadia trigonos* (Fishweed) was abundant in Poplar 1 while in Fuzzy 1, *Carex inversa* (Knob Sedge) provided the most ground cover. While species diversity was relatively high in the Creek 1, the Belah woodland sites and Grey 2, no species was sufficiently abundant to meet the criteria in these sites this year.

Soil analyses are not included for sites associated with the biodiversity monitoring program, however they are required for completion criteria for woodland rehabilitation monitoring sites on the mine disturbed areas such as WRE2 and WRE3. In 2020, a new woodland rehabilitation area was established on top of WRE2, with the results of the soil tests compared to the two woodland reference sites and/or desirable agricultural levels in clay loam soils for growing introduced pastures and crops. The results of the soil tests indicate that soils in the new woodland rehabilitation area WRE2-2 tended to be similar to the local woodlands, except that they were and slightly saline in 2020. This year they remained low in organic matter and while EC continued to exceed that recorded in the local woodlands, it had declined to acceptable and non saline levels this year.

The table below presents the performance of the woodland biodiversity and rehabilitation monitoring sites against “Primary performance indicators” in 2021. Primary performance targets are considered to be met when they fall within the specified target ranges, and these have been represented by a coloured box. A striped coloured box indicates that the soil characteristics may not necessarily be similar to the local soils but fall within agricultural industry guidelines.

Performance of the woodland biodiversity and rehabilitation monitoring sites against a primary performance indicators in 2021.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement (desirable)	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
Performance indicators are quantified by the range of values obtained from replicated reference sites assessed in 2021					Lower KPI	Upper KPI	2021							
Phase 2: Landform establishment and stability	Landform slope, gradient	Landform is designed accordingly and suitable for final land use	Slope	< Degrees (18°)	0	0	0	0	0	0	4	6	4	0
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	No.	0	0	0	0	0	0	0	0	0	0
Phase 3: Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH (5.6-7.3)	5.8	6.1	7.3	NA	NA	NA	NA	NA	NA	NA
			Organic Matter	% (4.5)	3.4	5.9	1.2	NA	NA	NA	NA	NA	NA	NA
			Phosphorous (Colwell)	mg/kg (50)	24.9	29.2	34.1	NA	NA	NA	NA	NA	NA	NA
Phase 4: Ecosystem & Land Use Establishment	Landscape Function Analysis (LFA): Landform stability and organisation	Landform is stable and performing as it was designed to do	LFA Stability	%	70	78.8	73.0	67.8	66.2	70	67.7	67.6	68.1	78
			LFA Landscape organisation	%	100	100	100	100	76	92	88	100	100	96
	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	% population	39	76	100	100	97	100	94	12	17	53
			Exotic species richness	<No./area	12	17	18	20	21	18	27	21	16	16
	Vegetation density	Vegetation contains a density of species comparable to the local remnant vegetation	Density of shrubs and juvenile trees	No./area	21	32	15	1	30	17	33	14	17	10
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to the local remnant vegetation	Trees	No./area	3	5	0	1	3	2	1	3	1	3
			Shrubs	No./area	3	4	4	1	6	4	4	2	4	4
			Herbs	No./area	25	44	21	26	27	26	39	43	35	19

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement (desirable)	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
			Grasses	No./area	10	14	5	13	15	10	8	10	11	10
Phase 5: Ecosystem & Land Use Development	Landscape Function Analysis (LFA): Landform function and ecological performance	Landform is ecologically functional and performing as it was designed to do	LFA Infiltration	%	48.3	67	38.9	42.8	40.8	41.3	40.3	36.4	32.5	60.8
			LFA Nutrient recycling	%	47.3	65.6	44.6	42.6	38.8	42.3	41.5	39.1	35.5	55.7
	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Perennial plant cover (< 0.5m)	%	33	36.1	6	4	6.5	6.7	11.4	27	40	32
			Total Ground Cover	%	96	100	96.5	97.5	91	86	96.5	71.5	78	97
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance	> species/m^2	5	8.6	0.2	4.2	5.4	4.8	4.2	7.8	5.6	5
	Native ground cover abundance	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	%	80	83.1	2	35.2	66.7	58.0	40.7	70.8	73.3	72.1
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	No./area	12	16	3	0	0	3	1	35	24	13
			shrubs and juvenile trees 1.5 - 2m in height	No./area	3	5	5	0	6	3	0	9	6	0
	Ecosystem structure	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	% cover	0	6	0	0	5	3.5	3	2.5	1.6	0
			Foliage cover 2 - 4m	% cover	0	4	0	0	12	6	0	2	2	0
			Foliage cover >6m	% cover	16	20	0	0	0	4	0	4	19.5	0
	Tree diversity	Vegetation contains a diversity of tree and mature shrub species comparable to that of the local remnant vegetation	Tree diversity	%	100	100	0	100	100	100	100	100	100	100

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement (desirable)	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
	Tree density	Vegetation contains a density of tree and mature shrub species comparable to that of the local remnant vegetation	Tree density	No./area	**9**	**11**	**0**	**1**	**20**	**12**	**37**	**9**	**8**	**13**
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Healthy trees	% population	**0**	**64**	**0**	**0**	**60**	**83**	**81**	**11**	**13**	**15**
			Flowers/fruit: Trees	% population	**11**	**36**	**0**	**100**	**15**	**0**	**43**	**33**	**25**	**54**

Summary of results: Pasture rehabilitation sites

Both pasture reference sites continued to be comprised of scattered native perennial grasses and sub-shrubs and contained an abundance of exotic annual grasses and herbs. The ongoing drought caused a decline in live plant growth and a deterioration of the litter layer with minor bare patches having developed in Pasture 1 in 2019. Over the past two years, improved conditions resulted in a significant increase in plant growth and both pastures sites continued to have 100% functional patch areas.

On WRE2-1, there has been adequate establishment of exotic grasses and medics and good ground cover has been maintained despite the limited active plant growth during the drought, largely due to less disturbance by macropods compared to the other rehabilitation sites. On Noise Bund 1 and WRE3-1, small bare patches had developed during the drought as a result of macropod grazing, however, there has been a significant increase in annual plant cover over the last two years. The newest area of rehabilitation on the western side of WRE3 (WRE3-2), was also dominated by annual plants, however there was a slight decline in cover with 91% LO this year.

The most ecologically functional site continued to be Pasture 2 which scored a sum of indices of 172. This was followed by Pasture 1 with a score of 166, with rehabilitation sites Noise Bund, WRE2-1 and WRE3-1 being marginally lower with a sum of scores of 152 - 156. The newest area of rehabilitation WRE3-2 continued to be the lowest functional grassland community and a sum of scores of 141.

The pasture reference sites were structurally very simple, and these have been greatly influenced in the past by the seasonal conditions. This year there was a reduction in the abundance of annual plants which provided 29 - 36% of the total cover, with most of the remaining cover provided by dead leaf litter (46 – 52%) and scattered perennial plants (19 – 20%). Annual plants and dead leaf litter were also the dominant form of ground cover in the rehabilitation sites, with annual plants providing 45% cover in Noise Bund and up to 81% in WRE3-2 this year. There was 14 – 40% dead litter cover and scattered perennial plants provided up to 14% in Noise Bund, but none were recorded along the transect in WRE3-1. This year vertical structure greater than 0.5 m was limited.

In the pasture reference sites there were minor changes in plant diversity with 45 species recorded in both sites, and the number of native species had slightly increased to 25 – 26 species, while there were 19 - 20 exotic species. On the rehabilitation areas, there were 22 – 36 different species and of these the majority were exotic with 15 (WRE2-1) to 21 species (WRE3-1) being recorded. There was a small number of native species recorded in WRE3-2 with 7 species, while an increased diversity of native species was recorded in the other sites with up to 16 native species being recorded in the Noise Bund this year. This year total and native species diversity remained too low compared to the reference sites, however there was an acceptable diversity of exotic species in all sites except WRE3-1 which had only one more.

In the pasture reference sites native plant cover has increased to provide 36 – 52% of the live plant cover. In Noise Bund, native plant cover has increased to 21%, while native plants were also slightly more abundant than last year in both sites on the WRE3 with 10 - 26% endemic cover being recorded this year. In WRE2-1 however, there was only 2% native plant cover.

Compared to the reference sites, most pasture rehabilitation sites had a low diversity of herbs and grasses, except Noise Bund 1 and WRE3-1 which had an acceptable diversity of herbs. There was also scattered *Acacia deanei* seedlings recorded in WRE2-1, one *Lycium ferocissimum* seedling on the Noise Bund and a dozen *Lycium ferocissimum* seedlings and one *Acacia deanei* seedling was recorded in WRE3-2. There were no trees, reeds, vines or ferns in the rehabilitation areas.

As a result of the favourable seasonal conditions numerous species of *Medicago* (Medics) and *Trifolium* (Clovers) continued to be abundant in many pasture sites. In particular, *Medicago truncatula* (Barrel Medic) provided the

most ground cover in WRE2-1 and both WRE3 sites, while *Medicago arabica* (and probably mixed with *M. truncatula*) were dominant on the Noise Bund. *Chloris gayana* (Rhodes Grass) was also abundant in WRE2-1. Pasture 1 was dominated by *Chondrilla juncea* (Skeleton Weed) and *Trifolium subterraneum* (Subterraneum Clover) this year, while *Trifolium arvense* (Haresfoot Clover) and the native *Vittadinia cuneata* (Fuzzweed) were quite abundant in Pasture 2.

The extent of rilling is recorded along the 50 m vegetation transect and there continued to be one significant rill at Noise Bund 1. Last year no change was recorded with the total cross-sectional area remaining at 0.125m^2 while it had slightly decreased to 0.100 m^2 this year as the vegetation has begun to slowly establish. It was noted that it has widened above and below the transect and some of the walls of the gully have collapsed.

The soils in the native pastures were typically moderately acidic, non-saline and non-sodic and had low CEC. They were also low in organic matter, phosphorus and nitrates. On the pasture rehabilitation areas, many soil characteristics were similar to the local pastures or were within desirable agricultural ranges, but most had very low levels of organic matter and nitrates. While ESP was previously recorded to be high indicating the soils were sodic, ESP has continued to decline with all rehabilitation areas now having an ESP within acceptable thresholds and considered to be non-sodic. At WRE3-1 the soil pH had slightly decreased to 7.8, however they continue to be borderline slightly to moderately alkaline.

The table below presents the performance of the pasture rehabilitation monitoring sites against a selection of proposed “Primary Performance Indicators” in 2021. Primary Performance Targets are considered to be met when they fall within the specified target ranges, and these have been represented by a coloured box. A striped coloured box indicates that the soil characteristics may not necessarily be similar to the local soils but fall within agricultural industry guidelines.

Performance of the pasture rehabilitation monitoring sites against primary performance indicators in 2021.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement (desirable)	Pasture 1	Pasture 2	2021 Pasture ecosystem range		Noise Bund 1	WRE2-1	WRE3-1	WRE3-2
Performance indicators are quantified by the range of values obtained from replicated reference sites assessed in 2021					2021	2021	Lower KPI	Upper KPI	2021			
Phase 2: Landform establishment and stability	Landform slope, gradient	Landform is designed accordingly and suitable for final land use	Slope	< Degrees (18°)	1	1	1	1	17	14	14	16
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	No.	0	0	0	0	1	0	0	0
Phase 3: Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH (5.6-7.3)	5.9	5.9	5.9	5.9	7.1	7.0	7.8	7.0
			Organic Matter	% (4.5)	2.1	2.5	2.1	2.5	1.7	1.2	1.3	1.1
			Phosphorous (Colwell)	mg/kg (50)	43.6	38.0	38.0	43.6	81.0	24.9	53.5	27.2
Phase 4: Ecosystem & Land Use Establishment	Landscape Function Analysis (LFA): Landform stability and organisation	Landform is stable and performing as it was designed to do	LFA Stability	%	69.0	72.0	69.0	72.0	71	69.5	69.5	68.6
			LFA Landscape organisation	%	100	100	100	100	100	100	100	91
	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Exotic species richness	<No./area	20	19	19	20	20	15	21	19
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to the local remnant vegetation	Herbs	No./area	27	22	22	27	24	14	22	16
			Grasses	No./area	14	13	13	14	3	3	5	8
Phase 5: Ecosystem & Land Use Development	Landscape Function Analysis (LFA): Landform function and ecological performance	Landform is ecologically functional and performing as it was designed to do	LFA Infiltration	%	48	49.8	48.0	49.8	41.3	41	39.9	34.4
			LFA Nutrient recycling	%	48.9	50.3	48.9	50.3	43.2	43.2	42.3	37.5

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement (desirable)	Pasture 1	Pasture 2	2021 Pasture ecosystem range		Noise Bund 1	WRE2-1	WRE3-1	WRE3-2
	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Perennial plant cover (< 0.5m)	%	**18.5**	**19.5**	**18.5**	**19.5**	**13.5**	**6**	**0**	**3**
			Total Ground Cover	%	**100**	**100**	**100**	**100**	**98**	**100**	**100**	**98**
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Exotic understorey abundance	< species/m^2	**7.2**	**4.4**	**4.4**	**7.2**	**5.4**	**2.4**	**6.8**	**2.4**

Weeds

This year *Lycium ferocissimum* (African Boxthorn) a "Weed of National Significance" (WoNS) was recorded in increasing numbers across many of the monitoring sites. *Nassella trichotoma* (Serrated Tussock) also a WoNS was recorded in isolated numbers in four sites. Other target weeds include *Eragrostis curvula* (African Lovegrass), and *Galenia pubescens* (Galenia). While *Bidens pilosa* (Cobblers' Peg) is not listed as a priority weed at TGO, it is capable of rapidly infesting disturbed areas and was found along the Creek at Poplar 1 this year and its spread should also be limited. There were also a range of other common agricultural weeds listed under the general biosecurity measures in NSW.

Threatened species

No threatened species were positively identified within the range of monitoring sites however an individual *Pterostylis* spp. (Greenhood Orchid) was recorded in Grey 1 in 2016. Threatened fauna including Grey-crowned Babblers and Superb Parrot were frequently heard within the woodland remnants, especially on the eastern side of the Newell Highway near Fuzzy 1, Belah 1 and Belah 2. Reveg 2 also had a high abundance of a range of woodland birds. Poplar 1 had previously supported a diverse range of small woodland birds however there appeared to be fewer since 2020, potentially due to the loss of the Boxthorn understorey.

Elevated soils tests results

The results indicate there were elevated levels of sulfur and silicon in the rehabilitation areas, with these also being slightly elevated in most of the woodland and pasture reference sites suggesting that these elements may naturally occur at elevated concentrations in the local area and/or may have some implications with the long agricultural and mining history of the area. The concentrations of sulfur in WRE2-2 and both WRE3 rehabilitation areas, however, were quite a lot higher than were recorded in the reference sites and recommended guidelines, but these had demonstrated a significant decline over the past year.

Conclusion and management recommendations

These data indicate that the various biodiversity monitoring sites are different in structure and function and have recovered to varying degrees from a long disturbance history largely associated with clearing, grazing and cultivation. Sites with intact woodland typically occur along the roadsides and within farm laneways as well as sections along Gundong Creek and most of these sites were recovering relatively well after the removal of livestock. During 2017 – 2019 prolonged drought conditions combined with the simultaneous increase in grazing and disturbance by wildlife, typically caused a decline in ecological function in all monitoring sites. Since 2020 however, improved seasonal conditions resulted in an abundance of annual and perennial ground covers and overall ecological function has typically improved.

The flooding in Gundong Creek resulted in some stream bank erosion in 2016, however, a series of small leaky weirs had begun to form as a result of sediment and litter accumulating behind tree roots or larger branches which had become lodged in the bed. The development of these weirs indicates the creek was starting to repair itself. Since the 2017 monitoring, heavy flows along the creek have damaged many of the small weirs, however it is likely they will continue to rebuild themselves over time, however some management intervention in severe washouts would be beneficial. In 2018 and 2019, Gundong Creek has only been subjected to a few flows and was dry at the time of monitoring. In 2020 and 2021 heavy flows were experienced, which caused additional instream erosion and undercutting and/or slumping of the steep sided banks.

Along the Gundong Creek there are areas of bare, crusted and eroding soils and would benefit from the application of organic mulches such as weed free native pasture hay combined with seeding of nitrogen fixing and endemic colonising species such as acacias and sennas. Large trunks and tree branches spread out along the steep sided creek banks may assist in stabilising the areas and will also provide critical habitat. In worst affected areas the stream banks may require intensive earthworks and rock armouring to prevent further stream bank erosion, floodplain stripping and slumping. The Local Land Services (LLS) would need to approve any in-stream restoration works.

Sites which have been subjected to a cultivation history including Reveg 1, Reveg 2 and Creek 1 and Creek 2 were essentially recovering native grasslands that had been seeded with local woodland species. While the ground preparation such as scalping, cultivation, deep ripping and direct seeding initially resulted in the exposure of bare soil, these sites have shown positive signs of recovery largely as a result of minimising disturbances including the removal of livestock. Annual plants and dead leaf litter have been accumulating, and decomposing to form a rich humus layer, and in most sites, there has been a significant reduction in soil surface crusting. Over the last few years heavy grazing by macropods has caused a deterioration of the litter layer in most sites and in some sites bare patches have developed, particularly beneath the shady tree canopies. Despite the improved seasons, there continued to be persistent bare patches in some of these areas largely due to ongoing disturbances by animals, except in Reveg 1 where there were much fewer shady trees to attract macropods.

The large Belah remnant was significantly affected by the drought which resulted in increased grazing pressure and disturbance from resident macropod populations particularly during 2017 - 2019. Since 2020, there has been a noticeable reduction in grazing as a result of the improved seasonal conditions and there has been a significant increase in functional patch area and perennial plant cover. The overall ecological function of these areas however continued to be low compared to the other woodland monitoring sites and macropods numbers should continue to be monitored.

The new area of woodland rehabilitation on the top of WRE2 was highly stable and has numerous ecological attributes which are similar to the other biodiversity monitoring sites. Major differences, however, include the low density of tree and shrub seedlings, as well as low cover and diversity of native perennial ground covers and high abundance of exotic annual species presently establishing across the area.

This year, there was an increase in cover provided by live native plants, however all sites fell short of meeting native abundance targets this year and were weedier than desired. Nonetheless, many sites were dominated by the exotic annual clovers and medics which are usually considered to be valuable pasture species. Due to the long disturbance history of the area, it is expected that these monitoring sites and subsequently the local pastures and woodlands, will always contain a certain level of weeds, especially species that have become widely naturalised in the area.

In the roadside corridors along the main access road (Grey 2), tree trunks and associated piles of soil as a result of tree clearing have been dumped and presently contain hotspots of weeds. The piles of weed bearing topsoil should be removed from the offset areas and monitored for weeds when conditions are suitable.

In the large revegetation areas to the north of the ML and along Gundong Creek, the results of the direct seeding revegetation program were patchy. While most of the area was establishing very well, large areas to the west had less establishment success and tree and shrub diversity and densities were presently low compared to the reference sites, as recorded in Reveg 1. In the large woodland revegetation area with low tree and shrub densities, and sites such as the Poplar woodland, additional habitat planting would be beneficial. On the top of WRE2, the density of tree and shrub seedlings was also too low and may be unable to reach completion criteria targets without further intervention.

There were also increased seedling densities of the priority weed *Lycium ferocissimum* (African Boxthorn) in many monitoring sites, including the reference sites. Follow up surveillance and control will continue to be required as part of the TGO land management plans and care should be undertaken to avoid spraying of non-target species. While *L. ferocissimum* requires control, supplementary habitat plantings should be considered prior to its control and removal as it provides critical habitat for a diverse range of small woodlands birds. Dense plantings of native shrub thickets would improve habitat resources for small and declining woodland bird populations. Physical removal of the *L. ferocissimum* thickets should also be limited as the dead shrubs will continue to provide some habitat value, and destructive removal techniques are likely to promote further weed invasion. Other weeds that were recorded in the monitoring sites and should be part of the weed control program include *Nassella trichotoma* (Serrated Tussock), *Eragrostis curvula* (African Lovegrass), *Galenia pubescens* (Galenia) and if possible, *Bidens pilosa* (Cobblers Peg).

The soils in most of the rehabilitation areas were similar to the reference sites or within acceptable agricultural guidelines. While soils in some WRE rehabilitation sites may have previously had elevated EC and ESP, they had typically declined to acceptable levels over the past few years. At WRE3-1 however, the soils remained borderline slightly to moderately alkaline, despite having declined in pH over the past year. There were however elevated concentrations of sulfur in WRE2-2 and both WRE3 rehabilitation areas which remained significantly higher than were recorded in the reference sites and recommended guidelines, despite having demonstrated a significant decline over the past year. Therefore, rehabilitation strategies should include the regular testing and classification of all topsoil stockpiles and/or topsoil prior to use on rehabilitation areas to ensure only weed-free and good quality topsoil is used. Regular monitoring of soil of the WREs will ensure anomalies are detected and can be ameliorated if required.

Minor rilling has previously been recorded on the Noise Bund during its early establishment stages and was likely to have been exacerbated by downward indentation of machinery tracks. Extensive establishment of ground cover plants and litter have presently stabilised some of the rills at this site. There continues to be some larger rills that would require more permanent amelioration measures, as heavy rainfall activity has resulted in further erosion and slumping of the gully walls.

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Tables

1 Introduction: 2021 Rehabilitation and Biodiversity Monitoring Report

The Tomingley Gold Operations (TGO) Biodiversity and Rehabilitation monitoring report is a result of work carried out by DnA Environmental to satisfy monitoring and reporting requirements of the Mining Operations Plan (MOP) and the Biodiversity Management Plan and associated Offset Strategy.

The primary objective of the Biodiversity and Rehabilitation monitoring program is to compare the ecological recovery of a range of biodiversity offset and rehabilitation areas by comparing a selection of ecological targets or completion criteria against less disturbed areas of remnant vegetation (reference sites) that are representative of the desired vegetation assemblage. The Biodiversity and Rehabilitation monitoring program has defined a set of completion criteria that are consistent with the TGO Environmental Strategy (TGO 2012), Second Mining Operations Plan - Amendment 4 (TGO & Corkery July 2020) and Biodiversity Management Plan (TGO 2013, 2018) and is compliant with the ESG3 MOP guidelines (NSW T&I 2013).

The monitoring program was established in 2014 with ten permanent monitoring quadrats being established within the remnant biodiversity and biodiversity revegetation areas which were completed in 2013. Three of the remnant woodland sites will be used as woodland reference sites which will provide ecological completion targets for the biodiversity revegetation areas as well as mine rehabilitation areas with a final woodland land use. One area of grassland rehabilitation was completed on the Noise Bund within the active Mining Lease (ML) in 2016 and two grassland reference sites were also established in that year. In 2017 two additional pasture rehabilitation sites were established on the lower batter of the waste rock emplacements of WRE2 and WRE3.

Biodiversity and rehabilitation monitoring have been undertaken by Dr Donna Johnston and Andrew Johnston from DnA Environmental. In 2021, field surveys were undertaken by Andrew Johnston (DnA Environmental) and Ray Mjadwesch (Mjadwesch Environmental Service Support) during 9th – 12th August.

1.1 Tomingley Gold Operations

The gold operations at Tomingley are based on a 579,000 ounce gold resource approximately 50 kilometres south-west of Dubbo in Central West NSW. The TGO is 821 ha in area and straddles the Newell Highway south of Tomingley. Operated by Tomingley Gold Operations Pty Ltd (TGO), a wholly owned subsidiary of Alkane, Tomingley Gold Mine (TGO) was commissioned in January 2014 and officially opened in March of that same year (http://www.alkane.com.au/projects/current-projects/tomingley-gold-operations).

The operations are based on four gold deposits – Wyoming One, Wyoming Three, Caloma and Caloma Two. Construction of the mine was expected to take one year, mining and processing operations a further nine years and site rehabilitation an additional year. Open cut mining activity has been underway since commissioning, with the Wyoming Three pit completed in late 2015 and the Caloma Two pit commencing in late 2016. Operations at the mine will include the extraction of ore and the onsite processing of this ore. Therefore the site comprised a processing plant, three waste rock emplacements, a residue storage facility and associated civil infrastructure (Figure 1-1).

Open cut mining occurred on the deposits until late 2018 producing 60,000 to 80,000 ounces of gold per year. Underground mining commenced in early 2019 from the bottom of the Wyoming One pit. Open cut mining at Tomingley Gold Operations finished in Quarter 1 of FY2019. (http://www.alkane.com.au/projects/tomingley-gold-operations/).

The current underground project approval extends to 2022, however TGO are seeking government approval to extend (MOD5). MOD5 incorporates the first two stages of a second residue storage facility to provide sufficient tailings capacity to support processing until the end of 2025. TGO are also seeking State Significant Development (SSD) approval for the Tomingley Gold Extension Project, based on the San Antonio and Roswell deposits immediately to the south. The Tomingley Gold Extension Project, if approved, is expected to extend the life of TGO for at least seven to ten years. Total resources at TGO and the exploration tenements to the immediate south are now in excess of one million ounces of contained gold.

TGO is undertaking progressive rehabilitation of the site to stable and productive ecosystems as viable. Project biodiversity offset areas are protected by binding Conservation Property Vegetation Plans, signed in agreement with regional Local Land Services organisations (https://www.alkane.com.au/projects/tomingley-gold-project/tomingley-gold-operations/, accessed 8/9/2021).

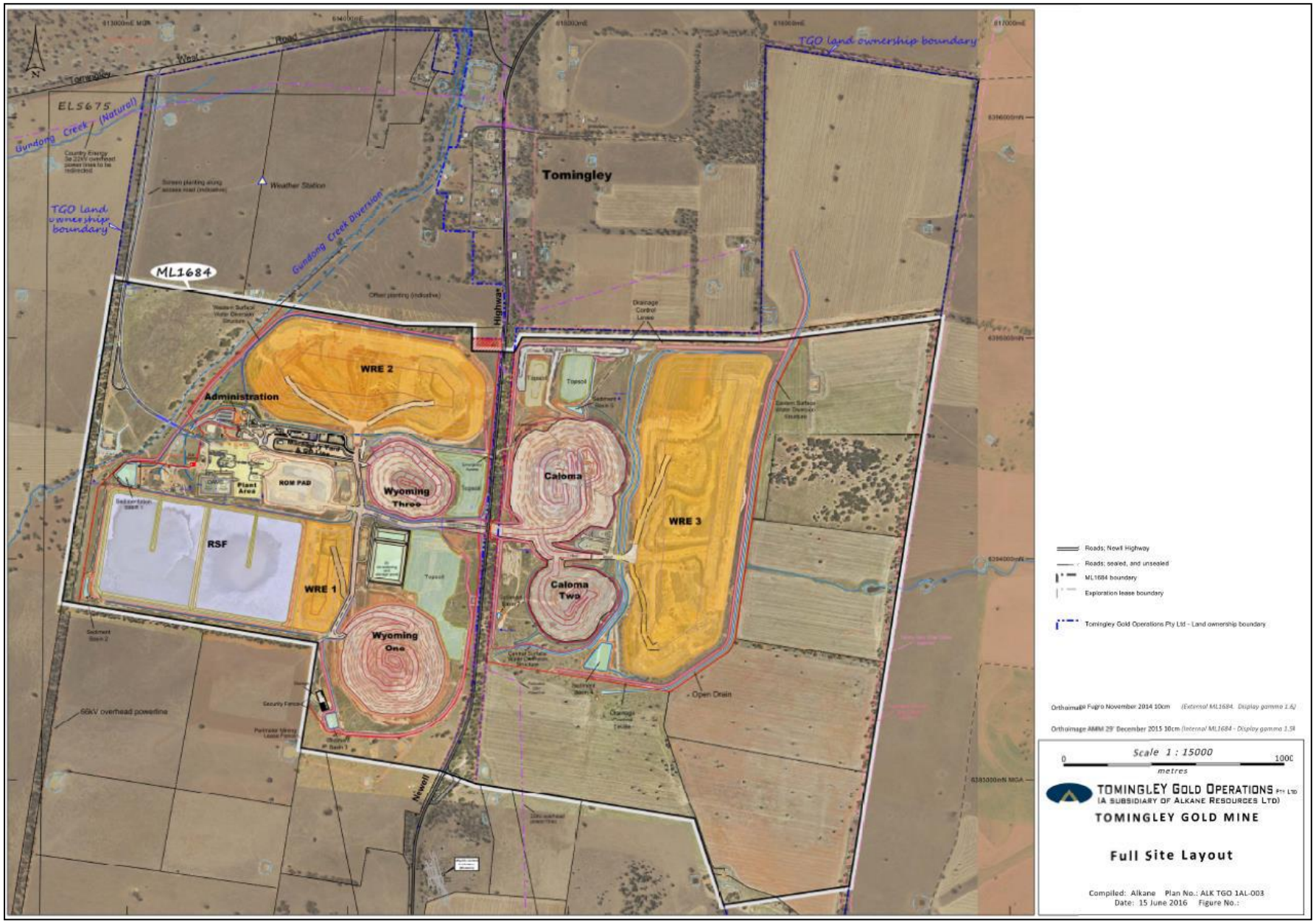


Figure 1-1. Layout of the TGO (TGO & Corkery 2016)

1.2 Vegetation communities

The Tomingley area has been subjected to a long agricultural and mining history and subsequently extensive clearing and fragmentation of the native vegetation has occurred with approximately 19.0% (or 155.6ha) native woodland cover retained within the mining lease (OzArk 2011). Of these five main vegetation communities have been identified by OzArk (2011) and include:

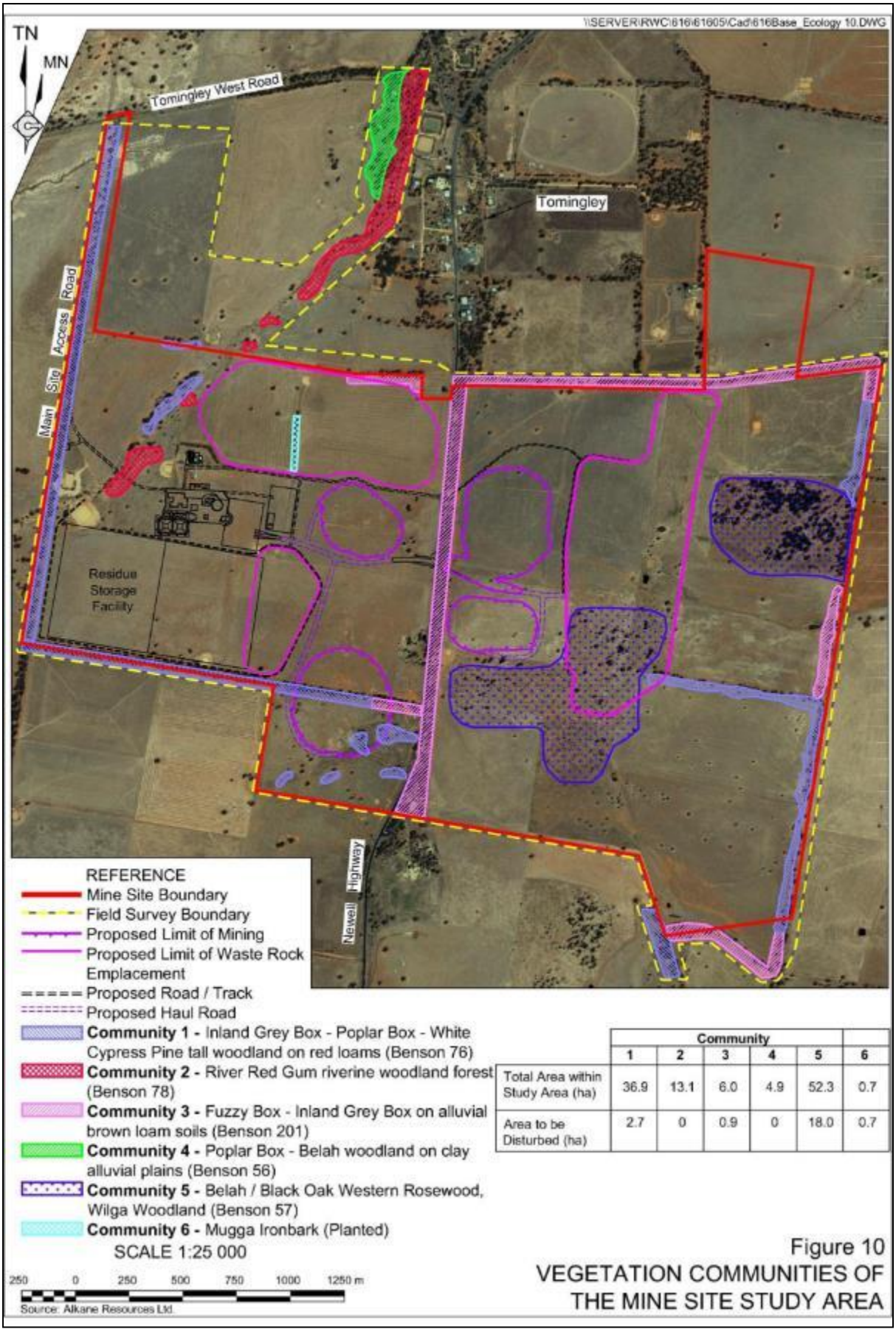
1. *Eucalyptus microcarpa* (Inland Grey Box) – *E. populnea* (Poplar Box) – *Callitris glaucophylla* (White Cypress Pine) tall woodland on red loams. This community is a component of the NSW Inland Grey Box Woodland EEC;
2. *Eucalyptus camaldulensis* (River Red Gum) riverine woodland forest;
3. *Eucalyptus conica* (Fuzzy Box) – *Eucalyptus microcarpa* (Inland Grey Box) on alluvial brown soils. This community is a component of a Fuzzy Box on Alluvials EEC;
4. *Eucalyptus populnea* (Poplar Box) – *Casuarina cristata* (Belah) woodland on clay alluvial plains; and
5. *Casuarina cristata (*Belah) / *C. Pauper* (Black Oak) – *Alectryon oleifolius* (Western Rosewood) - *Geijera parviflora* (Wilga) Woodland.

The remainder of the Mine Site Study Area comprised either a small (0.7ha) area of planted Mugga Ironbarks or cleared and farmed land dominated by exotic pasture and crops. The distribution of the vegetation communities across the TGO is provided in Figure 1-2.

1.3 Disturbance history

The TGO Mining Lease has undergone considerable disturbance as a result of agricultural activities and historic mining exploration (OzArk 2011). Such disturbances have included clearing, logging, cultivation and grazing and waterways and surface flows have been modified through the construction of 16 farm dams and channel excavation. It has also been subject to mining related activities as well as road and building construction. An existing homestead, ancillary buildings and access roads (farm tracks) existed in the vicinity of the Wyoming Three Open Cut.

The dominant agricultural use of the area was and remains grazing and cropping. Most of the remnant woodlands on the mining lease are long and linear (~50m wide)) and typically occur along roadsides and drainage systems such as Gundong Creek or occur on land unsuitable for cultivation such as those associated with gilgais to the east of the ML. Remnant woodlands have also been subjected to heavy and continuous grazing regimes especially by sheep with most areas of woodland lacking a diverse grass and shrub understorey and natural recruitment has been limited.



	Community					
	1	2	3	4	5	6
Total Area within Study Area (ha)	36.9	13.1	6.0	4.9	52.3	0.7
Area to be Disturbed (ha)	2.7	0	0.9	0	18.0	0.7

Figure 1-2. Vegetation communities of the TGO (OzArk 2011).

1.4 Flora

124 species of flora were recorded by OzArk (2011) of which 66 (53.2%) were native and 58 (46.8%) were exotic (excluding commercially grown agricultural species).

Native species generally dominated the ground cover of native woodland and forested areas (albeit very sparsely) where thickets of *Lycium ferocissimum* (African Boxthorn) are absent. Highly modified areas were characterised by higher diversity of introduced species, both intentional (agricultural and planted) and exotic weeds.

The best quality and most diverse vegetation is outside the Mine Site Study Area within the Newell Highway transport corridor where grazing has been excluded for an extended period. Weeds declared as noxious included *Lycium ferocissimum* which is a Class 4 noxious weed. No plants listed as threatened were recorded (OzArk 2011).

1.5 Fauna

Despite a long disturbance history, the remnant woodlands within the project area continue to support a moderate diversity of fauna (OzArk 2011) including:

- 17 reptile species (no threatened species, one with local conservation concern);
- 6 frog species (no threatened species, two with local conservation concern);
- 86 bird species (including five listed as threatened under the NSW TSC Act, one listed as a threatened and migratory species under the Commonwealth EPBC Act, and seven species of local conservation concern); and
- 25 mammals (including three threatened and three species with local conservation concern under the NSW TSC Act).

Previous fauna surveys have identified 11 threatened species and one EPBC migratory species within the boundaries of the Mine Site these are:

- Grey-crowned Babbler (Pomatostomus temporalis (eastern subspecies)) - listed as Vulnerable (V) under the Threatened Species Conservation Act 1995 (TSC Act);
- Little Pied Bat (*Chalinolobus pictatus* (V TSC Act);
- Superb Parrot (*Polytelis swainsonii*) (V TSC Act, V Environmental Protection, Biodiversity Conservation Act 1999 (EPBC Act));
- Koala (*Phascolarctos cinereus*) (V TSC Act);
- Eastern Bentwing Bat (*Miniopterus (schreibersii) orianae oceanensis*) (V SC Act);
- Brown Treecreeper (*Climacteris picumnus*) (V TSC Act);
- Rainbow Bee-eater (*Merops ornatus*) (listed as a Migratory Species in the EPBC Act);
- Little Eagle (*Hieraaetus morphnoides*) (V TSC Act);
- Spotted Harrier (*Circus assimilis*) (V TSC Act);
- White-breasted Woodswallow (*Artamus leucorynchus*) (V TSC Act); and
- Flame Robin (*Petroica phoenicea*) (V TSC Act).

2 TGO Biodiversity Management Plan

TGO was required to prepare a Biodiversity Management Plan (BMP) Under Schedule 3, Condition 37 as part of the approval conditions specified by the NSW Department of Planning and Infrastructure (OzArk 2013). Key objectives of the BMP include:

- Protection of Grey-Crowned Babbler and their nests;
- Maximise preservation of remnant Inland Grey Box woodland and Fuzzy Box woodland EEC;
- Preserve maximum remnant vegetation;
- Minimise impact to tree dependent microbats;
- Minimise impact to nesting fauna during tree clearing; and
- Prevent cyanide poisoning of fauna.

2.1 Biodiversity Offset Strategy

On the basis that the TGP would result in unavoidable impacts on local biodiversity, TGO has committed to developing and implementing a Biodiversity Offset Strategy (BOS). The TGP BOS has considered the scale of the impacts proposed, the NSW and Commonwealth requirements for biodiversity offsets, as well as local factors such as land use both current and future. The following key outcomes were central to the development of the TGP BOS.

1. The Biodiversity Offset Strategy should aim to "maintain or improve" biodiversity value;
2. The Biodiversity Offset Strategy should be enforceable, monitored and audited; and
3. TGO will investigate conservation agreements as a means of securing "long-term security" for the proposed offsets.

In order to achieve the nominated key outcomes, the focus of the TGP BOS is the protection, enhancement and long-term conservation of the existing remnant native vegetation on the Mine Site and surrounding lands. Particular focus has been given to enhancing and conserving those remnants of Inland Grey Box and Fuzzy Box woodlands which are listed Endangered Ecological Communities (EECs) occurring on and immediately surrounding the Mine Site.

Section 2.15.5 of the Environmental Assessment indicates that the Biodiversity Offset Strategy would be secured in perpetuity through preparation of a Conservation Property Vegetation Plan (Conservation PVP) under Part 4 of the Native Vegetation Act 2003 (NV Act). That plan would be placed on a register under the Real Property Act 1900 in accordance with Section 31(2)(b) of the NV Act. The Conservation PVP signed with Central West CMA (now part of Local Land Services) will protect in perpetuity the requisite vegetation types and hectares generated in the BioBanking Credit Report to offset impacts associated with the Mine Site (TGO 2014).

2.2 Enhancement and revegetation

As a result of the approved mining activities some 23.2 ha of remnant woodland will be required to be cleared and will result in the loss of 476 habitat trees (OzArk 2013). As part of the BMP the native habitat which will be cleared will be offset by the conservation and enhancement of 67 ha of remaining woodland areas combined with the revegetation of an additional 61.0ha of woodland (Table 2-1).

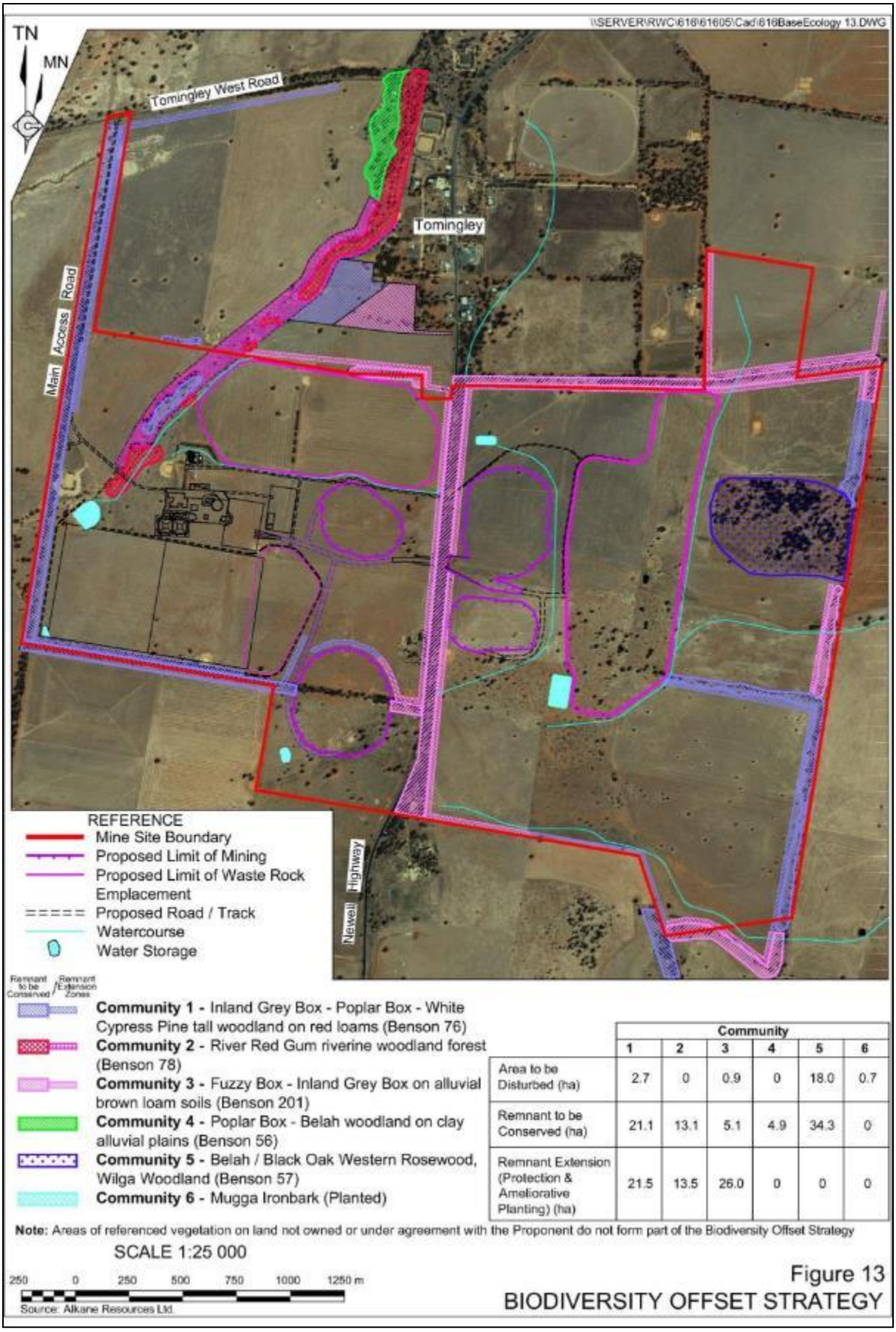
Remnant woodland in moderate to good condition will be allowed to naturally regenerate, while those in poorer condition may be enhanced via strategic planting and seeding of endemic natives including trees, shrubs, herbs

and grasses. In the longer term all protected sites will require active management including weed control, grazing management and feral animal control.

Revegetation will primarily be undertaken adjacent to existing woodland areas with the aim to increase the size, condition and connectivity. The sediment basins and drainage lines established for the Project would be retained and revegetated incorporating native vegetation such as rushes, sedges, grasses and trees common to watercourses and storage areas. The distribution of existing woodlands and proposed revegetation areas is provided in Figure 2-1.

Table 2-1. Area of each woodland community which will be cleared and/or revegetated (OzArk 2013).

Community type	Area to be cleared (ha)	Area to be conserved (ha)	Remnant extension/ revegetation (ha)
Inland Grey Box – Poplar Box – White Cypress Pine tall woodland on red loams (Benson 76)	3.6	21.1	21.5
River Red Gum riverine woodland forest (Benson 78)	0	13.1	13.5
Fuzzy Box – Inland Grey Box on alluvial brown loam soils (Benson 201)	0.9	5.0	26.0
Poplar Box – Belah woodland on clay alluvial plains (Benson 56)	0	1.9	0
Belah/ Black Oak Western Rosewood, Wilga Community (Benson 57)	18.0	25.5	0
Planted Mugga Ironbark	0.7	0	0
Total	**23.2**	**66.6**	**61.0**



	Community					
	1	2	3	4	5	6
Area to be Disturbed (ha)	2.7	0	0.9	0	18.0	0.7
Remnant to be Conserved (ha)	21.1	13.1	5.1	4.9	34.3	0
Remnant Extension (Protection & Ameliorative Planting) (ha)	21.5	13.5	26.0	0	0	0

Figure 2-1. Distribution of existing woodlands and proposed revegetation areas (OzArk 2011).

3 Monitoring and reporting requirements

3.1 Biodiversity Management Plan

Key objectives at TGO according to the BMP (OzArk 2013) include establishing a long-term monitoring program which will:

- Provide the scientific basis for defining rehabilitation objectives, help develop closure criteria and a rehabilitation program that will facilitate lease relinquishment following mine closure;
- Assess the long-term stability and functioning of re-established ecosystems within post-mining rehabilitation areas, as well as revegetated areas within the Biodiversity Offset;
- Facilitate continuous improvement in rehabilitation and revegetation practices;
- Record and document changes in retained vegetation within the Mine Site Area and Biodiversity Offset Area, through comparison with baseline data from permanent monitoring sites and comparison with predictions in the EA;
- Record and document changes in the structure, composition and condition of revegetation within the Biodiversity Offset Area over time;
- Assess the functioning of the landscape in post-mining rehabilitation areas (and suitable analogue sites), using Model for Practical Partnerships in Resource Condition 2011 to determine if the impacts on key threatened species are consistent with predictions in the EA;
- Assess progressive changes to flora and fauna species assemblages within the Approved Project Disturbance Areas and Biodiversity Offset Area as the Project progresses;
- Ensure the ecological integrity/function of the Biodiversity Offset Area is maintained or improved as a result of ongoing management practices;
- Control of feral and overabundant native herbivores; and
- Report natural flow regimes.

3.2 Mining Operations Plan

Key objectives at TGO according to the MOP (TGO & Corkery 2020) include establishing a long-term monitoring program which will:

- Provide for a combination of sustainable agriculture, light industrial / commercial and biodiversity conservation;
- Minimise adverse socio-economic outcomes following mine closure;
- Provide a low maintenance, geotechnically stable and safe, non-polluting landform which blends with surrounding landforms and provides land suitable for the proposed final land use;
- Construct the final landform such that it is self-sustaining, i.e. has maintenance requirements consistent with the agreed post mining land use(s);
- Provide rehabilitated woodland communities which adjoin conserved and improved native vegetation remnants to create a continuous corridor of grassy woodland vegetation across the Mine Site;
- Maintain or improve the species diversity and habitat value of the Mining Lease;
- Decommission and remove all surface infrastructure (unless required for a lawful post mining land use);
- Ensure all final voids are safe, stable and secure; and
- Rehabilitation management allows for the relinquishment of the Mining Lease and the return of the security lodged over the Mining Lease within a reasonable time after the end of the mine life.

3.3 ESG3 MOP guidelines

The Mining Operations Plan (MOP) is a tool used by the Department to monitor the progress of mining and rehabilitation activities across the life of a mine (NSW T&I 2013). In NSW mining operations must be carried out in accordance with a Mining Operations Plan (MOP) that has been approved by the NSW Trade and Investment - Division of Resources and Energy (the Department). The MOP is intended to fulfil the function of both a rehabilitation plan and a mine closure plan. It should document the long-term mine closure principles and outcomes whilst outlining the proposed rehabilitation activities during the MOP term (NSW T&I 2013).

NSW Trade & Investment released revised ESG3 MOP guidelines in September 2013 which detailed a process for monitoring and managing progression towards successful rehabilitation outcomes quantified by completion criteria (NSW T&I 2013). The Guideline requires industry to identify and provide measurable data and demonstrate that proposed rehabilitation outcomes are achievable and realistic within a given timeframe. Completion criteria are objective target levels or values that can be measured to quantitatively demonstrate the progress and ultimate success of a biophysical process. The requirement for more targeted information strengthens the capacity of the Department to regulate rehabilitation and environmental performance and more accurately determine rehabilitation security liabilities.

These guidelines will soon be superseded by the Rehabilitation Management Plan and Associated Annual rehabilitation Report and Forward Program for large mines Codes of Practice (NSW Department of Planning 2018). Successful rehabilitation of a mine site can be conceptually described in terms of logical steps or phases, and these should be made applicable to each of the similar land management units or domains within the mine site. The rehabilitation monitoring and reporting procedure continues to be broken down into five rehabilitation phases including:

1. Decommissioning;
2. Landform Establishment and Stability;
3. Growth medium development;
4. Ecosystem and Land Use Establishment; and
5. Ecosystem and Land Use Development.

Reference sites are effective completion criteria against which rehabilitation progress can be measured, assuming that the reference sites are themselves sustainable. Data from reference sites provide suitable target values of key biophysical parameters, vegetation structures and diversity, and habitat complexity. It provides the ability to monitor both success against true values of an existing ecosystem and the effects of climatic variations and disturbance events (such as fire, flooding etc.). The reference site can be used as the target outcome of the final rehabilitated landscape and a time series record of ecosystem change or development can be obtained. By comparing data with reference sites, it is possible to see if the rehabilitation or disturbed site is developing adequately. All completion criteria at a given site should be within critical threshold values if ecosystem rehabilitation is to be judged successful (NSW T&I 2013, NSW Department of Planning 2018).

4 Biodiversity monitoring approach

To assess the rate of recovery and determine the performance of the disturbed remnant woodlands and revegetation areas a long-term monitoring program is required as part of the Biodiversity Management Plan. The same approach is applied to assess the performance of rehabilitation of mine disturbed areas and will partially fulfil requirements of the Rehabilitation Management Plans and MOP reporting requirements.

The monitoring programs aim to establish clearly defined, repeatable and consistent methodologies for monitoring changes in various aspects of ecosystem function, succession and long-term sustainability. Part of this process includes:

- Establishing a range of relevant reference sites to compare and track the progress and inherent ecosystem function of rehabilitation areas;
- Selecting a range of suitable reference sites that reflect the desired final land use, biodiversity targets, historical disturbances and local community expectations; and
- Undertaking a monitoring program that provides simple but informative and reliable information that indicates positive recovery trends or rapid detection of rehabilitation failure.

Some primary performance indicators relevant to the rehabilitation of native ecosystems Nichols (2005) have been identified in Table 4-1. These performance indicators have been grouped to align with natural ecosystem succession and primary rehabilitation phases as described in ESG3 MOP guidelines (NSW T&I 2013). The application of the ecological performance data during the Decommissioning phase (Phase 1) are not considered applicable within the presentation of this ecological data.

Subsequently the ecological performance criteria which are assessed and consolidated into Key Performance Indicator (KPI) tables are only represented within Rehabilitation Phases 2 (Landform establishment) to Phase 5 (Ecosystem and Land Use Development).

Table 4-1. Performance indicators relevant to the rehabilitation of native ecosystems

Rehabilitation Phase	Performance Indicator
Phase 1: Decommissioning	No applicable ecological data obtained
Phase 2: Landform Establishment and Stability	Landform slope/gradient
	Active erosion
Phase 3: Growth medium development	Soil chemical/physical properties
Phase 4: Ecosystem and Landuse Establishment	Landform stability and organisation
	Vegetation diversity
	Vegetation density
	Ecosystem composition
Phase 5: Ecosystem and Land Use Development	Landform function and ecological performance
	Protective ground cover
	Ground cover diversity
	Native ground cover abundance
	Ecosystem growth and natural recruitment
	Tree diversity
	Floristic diversity
	Ecosystem health

4.1 Completion criteria and key performance indicators

At TGO, a range of Key Performance Indicators (KPI's) were determined and are quantified by data obtained from reference sites which are representative of the agreed final land use which includes grassy Box woodlands and exotic pastures. All ecological performance indicators are quantified by range values measured annually from these reference sites which form both an *upper* and *lower* KPI targets. The same ecological performance indicators are also measured in the revegetation/rehabilitation sites, and these should be comparable to, exceed or at least demonstrate an increasing trend towards meeting the values of the reference sites.

These Key Performance Indicators have been further separated into "*Primary performance indicators*" and "*Secondary performance indicators"*. Primary performance indicators are those chosen as essential completion criteria targets and have been identified as those that will satisfy requirements specifically identified within the EIS, BMP, MOP or other relevant Management Plans, and in particular the final land use and any relevant conditions of consent relating to vegetation type, specific use of species and condition for example.

Secondary performance indicators are those that would be desirable to achieve but will not necessarily have an influence on relinquishment requirements. *Please note that not all ecological performance indicators are set as primary completion criteria targets.*

5 Monitoring methodology

5.1 The monitoring quadrats

The monitoring methodology adopted is a standard and simple procedure that can be easily replicated over any vegetation community or revegetation area. The 20 x 50m plot is positioned such that the base line forms the basis for the LFA transect which must face down slope. The vegetation monitoring usually occurs along the 50m transect situated at the 10m interval that runs perpendicular to the 20m LFA transect, however in some situations the same transect may be used. Four marker pegs are used to establish a permanent transect position. GPS readings are taken to ensure quadrats can be located over time. Permanent photo-points are also established at various marker pegs of the quadrat to record changes in these attributes over time.

The layout of the monitoring quadrats and information recorded for structural complexity and diversity is detailed in DnA Environmental (2014).

To obtain the range of ecological data which quantifies the completion criteria targets the monitoring program incorporates a combination of Landscape Function Analyses (CSIRO Tongway & Hindley 1996), accredited soil analyses and various measurements of ecosystem diversity and habitat values based on and adapted from the Biobanking/Biometric methodologies (e.g. Gibbons 2002, Gibbons *et al* 2008a, 2008b) and Biometric Manual 3.1 (DECCW 2011). These have been described in more detail below.

5.2 Landscape Function Analyses

Landscape Function Analyses (LFA) is a methodology used to assess key indicators of ecosystem function including landscape organisation and soil surface condition as a measure of how well the landscape retains and uses vital resources. It was developed by CSIRO scientists Tongway and Hindley (Tongway 1994, Tongway and Hindley 1995, 1996, 2003, 2004). The indicators used quantify the utilisation of the vital landscape resources of water, topsoil, organic matter and perennial vegetation in space and time. Detailed information on LFA can be readily obtained on the internet using the following link: https://www.researchgate.net/profile/David_Tongway/publication/238748160_Landscape_Function_Analysis_Procedures_for_Monitoring_and_Assessing_Landscapes_-_with_Special_Reference_to_Minesites_and_Rangelands/links/0deec52c915ae0139e000000/Landscape-Function-Analysis-Procedures-for-Monitoring-and-Assessing-Landscapes-with-Special-Reference-to-Minesites-and-Rangelands.pdf A brief description is provided below.

The LFA methodology collects data at two "nested" spatial scales.

1. At coarse scale, **landscape organisation** is characterised. Patches and interpatches, indicators of resource regulation, are mapped at the 0.5 to 100 m scale from a gradient-oriented transect (making sense of landscape heterogeneity); and
2. At fine scale, **soil surface assessment** (soil "quality") examines the status of surface processes at about the 1-m scale, with rapidly assessed indicators on the patches and interpatches identified at coarse scale.

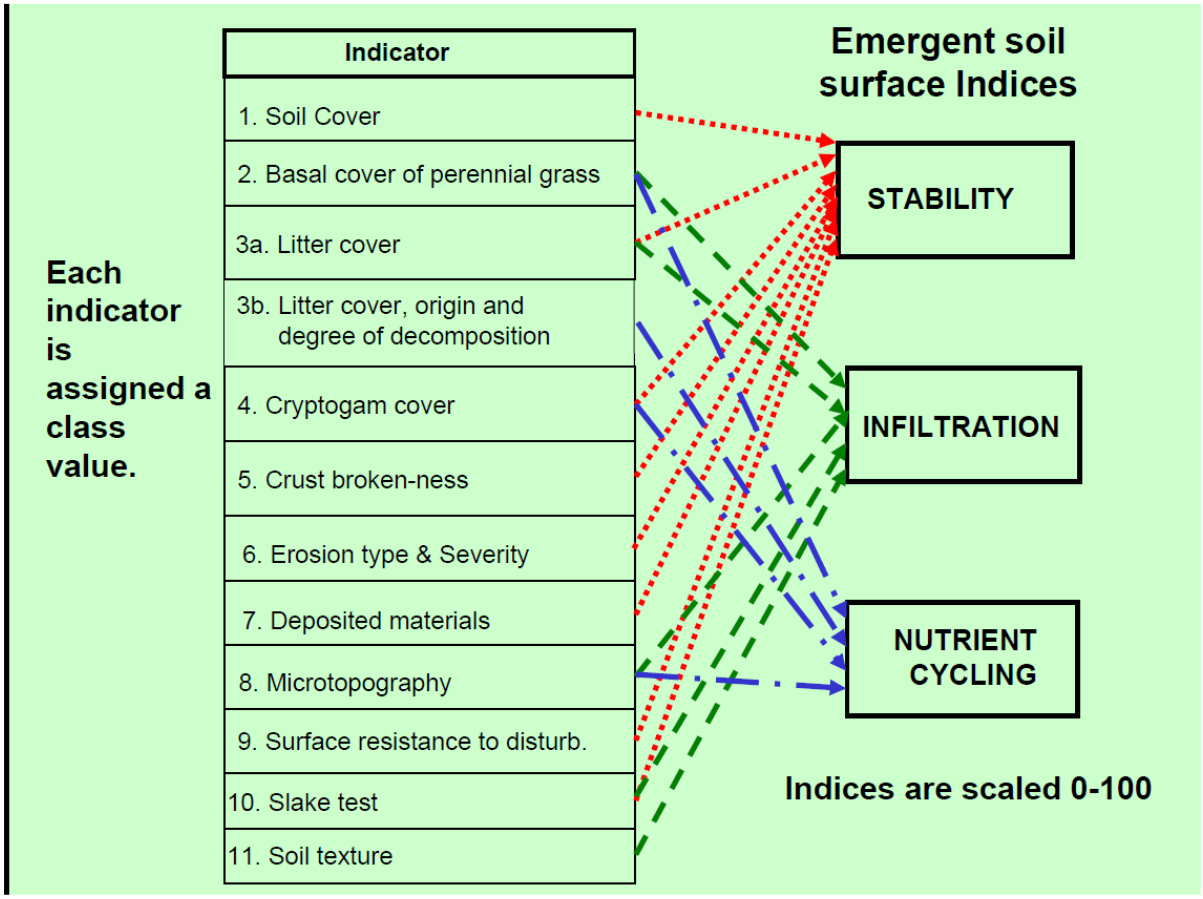
At each scale, parameters are calculated that reflect several aspects of landscape function. In the first stage, we identify and record the patches and interpatches along a line oriented directly down slope. Sometimes there are several different types of each patch/interpatch which provides a measure of heterogeneity or "**landscape organisation**".

In the second stage, called "**soil surface condition" (SSC)** assessment, it is possible to assess and monitor soil quality using simple indicators including:

- Rain splash protection;
- Perennial vegetation cover;
- Litter;
    - Percent litter cover;
    - Origin of the litter;
    - Extent of decomposition;
- Cryptogam cover;
- Crust Brokenness;
- Soil Erosion Type and Severity;
- Deposited Materials;
- Soil Surface Roughness;
- Surface Nature (resistance to disturbance);
- Slake Test; and
- Soil Surface Texture.

These 11 features are compiled and calculated into three indices of soil quality:

1. **Stability** (that is, resistance to accelerated erosion),
2. **Infiltration** (the rate soil absorbs water) and
3. **Nutrient Cycling** (the way plant litter and roots decompose and become available for use by other plants).



5.3 Soil analyses

Soil samples are obtained using standard soil sampling techniques within the monitoring quadrat. At least 12 random samples are taken at each site and bulked together. Soil samples are sent to Southern Cross University at their National Association of Testing Authorities (NATA) accredited laboratory for analysis. Soil analyses consist of assessing the parameters, pH, Electrical Conductivity (EC), Available calcium (Ca), magnesium (Mg), potassium (K), nitrate nitrogen (N), sulphur (S), organic matter (OM), exchangeable sodium (Na), Ca, Mg, K, hydrogen (H), cation exchange capacity, available and extractable phosphorus (P), micronutrients zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), boron (B), silicon (Si), aluminium (Al), molybdenum (Mo), cobalt (Co) and selenium (Se) and Total carbon. The heavy metals including cadmium (Cd), lead (Pb), arsenic (As), chromium (Cr), nickel (Ni), mercury (Hg) and silver (Ag) are also tested.

A report with analysis and desirable levels recommended in the agricultural industry is provided by the laboratory. Exchangeable Sodium Percentages were calculated as a measure of sodicity or dispersion.

Please note that soil analyses are not part of the monitoring requirements in the BMP and soil samples were only taken from sites to be used as reference sites or rehabilitation sites within mine disturbed areas.

5.4 Monitoring structural diversity, floristic and other biodiversity attributes

In addition to LFA, assessments of various biodiversity components must also be made to monitor changes in particular plants and groups of plants through the various successional phases and to document and/or identify critical changes or management actions required.

Some simple and rapid procedures for making these assessments were developed by CSIRO scientists (Gibbons 2002, Gibbons *et al* 2008). They were developed for assessing habitat quality across a range of vegetation types in the southern NSW Murray-Darling Basin and formed the basis of the Biometric Model used in the Property Vegetation Planning Process (DECCW 2011, OEH 2012). Some adaptations have been made to reduce monitoring effort where possible, and to incorporate aspects of newly formed revegetation sites or sites in the early stages of recovery.

The rapid ecological assessment provides quantitative data that measures changes in:

- Ground cover diversity and abundance in five repeated 1 x 1m sub-plots every 10m (50m transect) using Braun Blanquet method;
- Ground cover composition and habitat characteristics including % cover in 10 repeated 1 m lengths every 5m (50m transect) provided by:
  - dead leaf litter;
  - annual plants
  - perennial plants
  - cryptogams;
  - logs; and
  - rocks.
- Vegetation structure and projected foliage cover at 0 – 0.5 and increasing 2m height increments to >6.0m height in 10 repeated 1 m lengths every 5m (50m transect);
- Floristic diversity and growth forms in 20 x 50m quadrats;
- Shrub and juvenile tree density and diversity in 20 x 50m quadrat;
- Tree and mature shrub density, diversity and health condition in 20 x 50m quadrat; and

- Other habitat attributes such as the presence of hollows, fire scars, mistletoe and the production of buds, flowers and fruit in 20 x 50m quadrat.

Since 2020, the standardised OEH monitoring form was also completed. Measurements in 20 x 20m quadrats were also made of percent of:

- Native overstorey cover;
- Midstory cover;
- Ground cover grass;
- Ground cover shrub;
- Ground cover other;
- Exotic foliage cover (overstorey/midstory/ground cover)
- native species richness;

In a 20 x 50m quadrat, measurements also included:

- Proportion of canopy species regenerating;
- Total length of fallen logs.

6 TGO monitoring sites

The long-term monitoring program has been developed from requirements specified in the Mining Operation Plan (MOP) and Biodiversity Management Plan (BMP) combined with discussions with TGO Environmental staff. The monitoring program will need to be reviewed annually to ensure developments in the progressive rehabilitation strategy are also encompassed within the monitoring program. The objectives of the Rehabilitation and Biodiversity Monitoring Programs and how they relate to each other is illustrated in Figure 6-1.

6.1 Rehabilitation monitoring program

6.1.1 Final land uses and community types

The proposed location of each domain and rehabilitation area is given in Figure 6-2. Grasslands and woodlands are the primary communities to be rehabilitated on the mine disturbed landforms including the large Waste Rock Emplacements (WREs).

6.1.1.1 Grasslands

The monitoring program involved the establishment of two pasture reference sites in 2016 which provide ecological completion targets for areas requiring grassland/pasture rehabilitation on the slopes of the WREs and satisfy monitoring requirements within rehabilitation domain C as specified in the MOP.

6.1.1.1.1 Domain C – Rehabilitation Area – Grassland

This domain includes those areas of the Mine Site that would be rehabilitated to grassland, without shrubs or trees. This would include areas where a mid- or over-storey of vegetation may adversely impact on the stability of the final landform such as more steeply sloped areas, or where more deeply rooted vegetation would be undesirable, such as on the upper surface of the Residue Storage Facility. This domain includes:

- the higher-gradient side slopes of the Waste Rock Emplacements; and
- the upper surface and embankment of the Residue Storage Facility.

6.1.1.2 Woodlands

The monitoring program in the short-term will include the establishment of three woodland reference sites, which will aim to incorporate two representatives of the Inland Grey Box-Poplar Box-White Cypress Pine Community (Benson 76) and one representative Fuzzy Box Woodland EEC (Benson 202).

As numerous areas of the mapped woodlands consisted of a combination of co-dominants, the collective use of these communities as reference sites is likely to provide a more robust and suitable range of ecological indicators. These sites will be satisfactory for assessing the performance of the rehabilitation domains C/E and J over the longer-term according to the MOP, as well as satisfy monitoring requirements of the Biodiversity Management Plan as provided below.

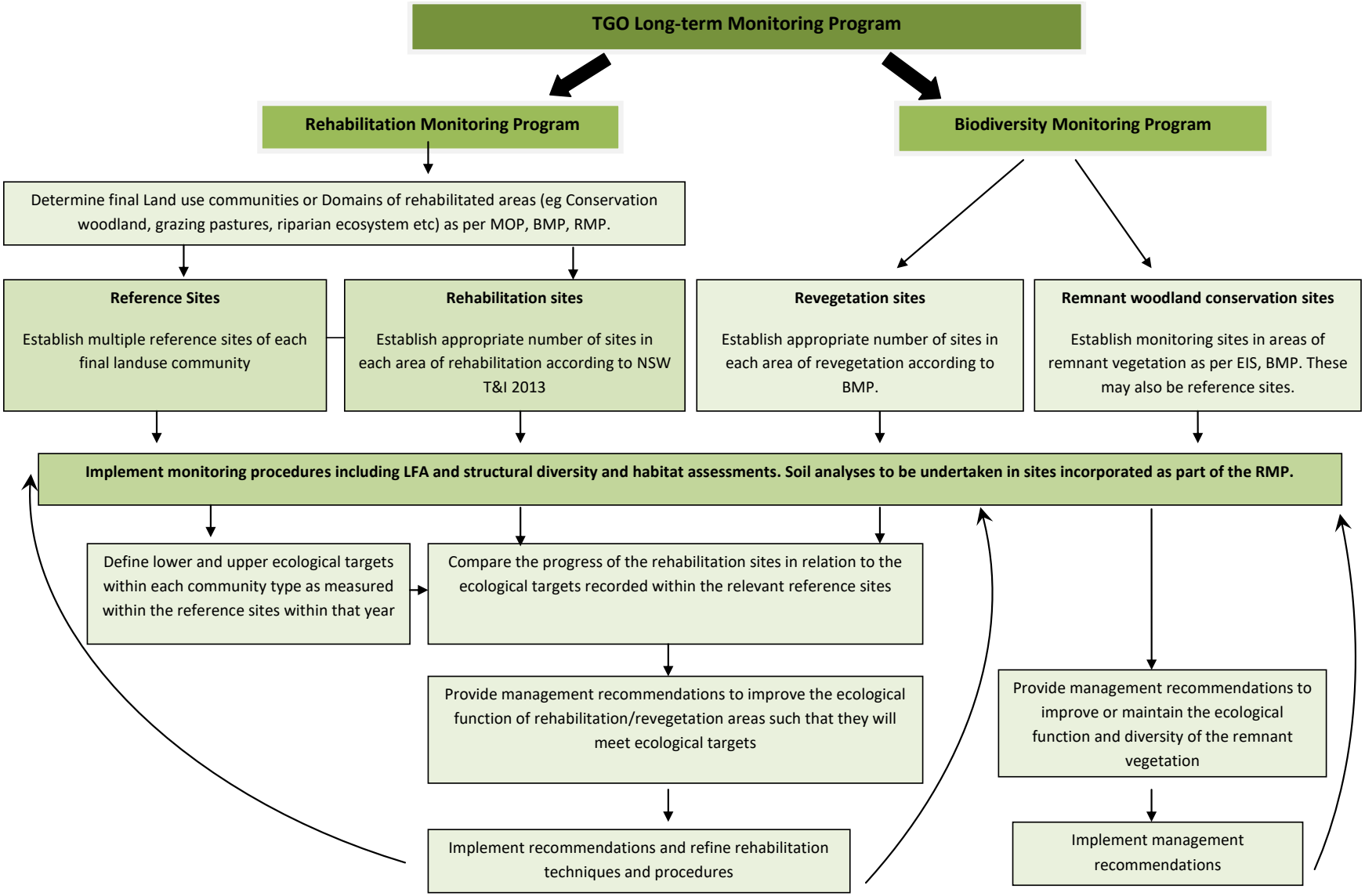


Figure 6-1. The TGO long-term monitoring program.

6.1.1.2.1 Domain C/E – Rehabilitation Area – Grassy Woodland

This domain includes those areas of the Mine Site that would be rehabilitated to grassy woodland consistent with the Inland Grey Box-Poplar Box-White Cypress Pine Community (Benson 76). This domain includes the upper surface of the waste rock emplacements.

6.1.1.2.2 Domain J – Conservation and Biodiversity Offset Areas

This domain includes areas identified in the *Biodiversity Management Plan.* Preserve a minimum area of 21.2 ha of remnant Inland Grey Box Woodland and 5 ha of Fuzzy Box Woodland Endangered Ecological Community. Preserve maximum amount of remnant vegetation.

6.2 Biodiversity Monitoring program

Biodiversity monitoring sites were established in several woodland types across TGO they include suitable reference sites for both the biodiversity and rehabilitation monitoring programs.

6.3 Number of monitoring sites required

OEH guidelines (2012) propose minimum number of rehabilitation monitoring sites according to the size of the rehabilitation area. Rehabilitation areas 0 – 4 ha require1 plot per 2 ha, areas 4 – 20 ha in size typically require 2 - 3 transects, while areas 20 – 50ha require 3 – 4 sites depending on the condition of the vegetation. In all cases the condition of vegetation was considered to be low and delineation between communities was not always apparent as they often formed ecotones. The number of monitoring sites required for TGO in the longer-term as defined by BMP, community type and size have been provided in Table 6-1.

It is estimated that a minimum of 18 permanent monitoring sites including five reference sites will be established in the longer-term and will be assessed annually as part of the annual Biodiversity and Rehabilitation monitoring program. Analyses of the topsoils are not monitoring requirements associated with the BMP; therefore, soil analyses are applied only to sites associated with the Rehabilitation Management Plan.

Subsequently 10 sites were monitored in 2014 and 2015 which included six remnant woodlands, two areas of EEC woodland revegetation and two areas of riparian woodland revegetation. Three remnant woodland sites including two Inland Grey Box-Poplar Box-White Cypress Pine EEC and one Fuzzy Box Woodland EEC will be used as reference sites in both the Biodiversity and Rehabilitation monitoring programs. In 2016, one site was established on the newly rehabilitated noise bund with a final grassland/pasture landuse while two sites were established in areas of (recovering) native grassland to be used as pasture reference sites. In 2017 two pasture rehabilitation sites were established on new rehabilitation areas on WRE2 and WRE3, with the total number of monitoring sites equating to 15. In 2018 and 2019, there were no changes to the monitoring program (Table 6-1).

A new pasture monitoring site was established in an area of new rehabilitation on the side of WRE3 and a new woodland monitoring site was established in an area of new rehabilitation on the top of WRE2 in 2020. The Grey Box-Poplar Box-White Cypress Pine woodland situated on the TSR adjacent to the Newell Highway has not been monitored since 2020, largely due to restricted access.

Table 6-1. The number of monitoring sites required in the long-term and those monitored since 2014.

Community type	MOP/ RMP	BMP	Purpose	Size (Ha)	Min No. sites	Soil analyses	No. Sites 2014	No. Sites 2015	No. Sites 2016	No. Sites 2017	No. Sites 2018	No. Sites 2019	No. Sites 2020	No. Sites 2021
Inland Grey Box-Poplar Box-White Cypress Pine Endangered Ecological Community (low condition)	☑	☑	Conservation & Enhancement Remnant reference site	21.1	2	2	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
Fuzzy Box Woodland Endangered Ecological Community (low condition)	☑	☑	Conservation & Enhancement Remnant reference site	5.1	1	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Inland Grey Box-Poplar Box-White Cypress Pine Endangered Ecological Community		☑	Revegetation	21.5	2	N/A	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Fuzzy Box Woodland Endangered Ecological Community		☑	Revegetation	26.0	2	N/A	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
River Red Gum Riverine woodland forest: Gundong Creek		☑	Conservation, enhancement & revegetation	13.1 + 13.5	2	N/A	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Belah / Black Oak Western Rosewood Wilga woodland (low condition)		☑	Conservation & Enhancement	25.5	2	N/A	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Poplar Box – Belah woodland on clay alluvial plains (low condition)		☑	Conservation & Enhancement	4.9	1	N/A	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Native grassland	☑		Remnant reference site/Rural landuse	?	2	2	**0**	**0**	**2**	**2**	**2**	**2**	**2**	**2**
Native grassland	☑		Rehabilitation WRES slopes/Rural landuse	10	2	2	**0**	**0**	**1**	**3**	**3**	**3**	**4**	**4**
Inland Grey Box-Poplar Box-White Cypress Pine Community	☑		Rehabilitation WRES to surfaces	24	2	2	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Total sites				**164.7**	**18**	**9**	**10**	**10**	**13**	**15**	**15**	**15**	**16**	**16**

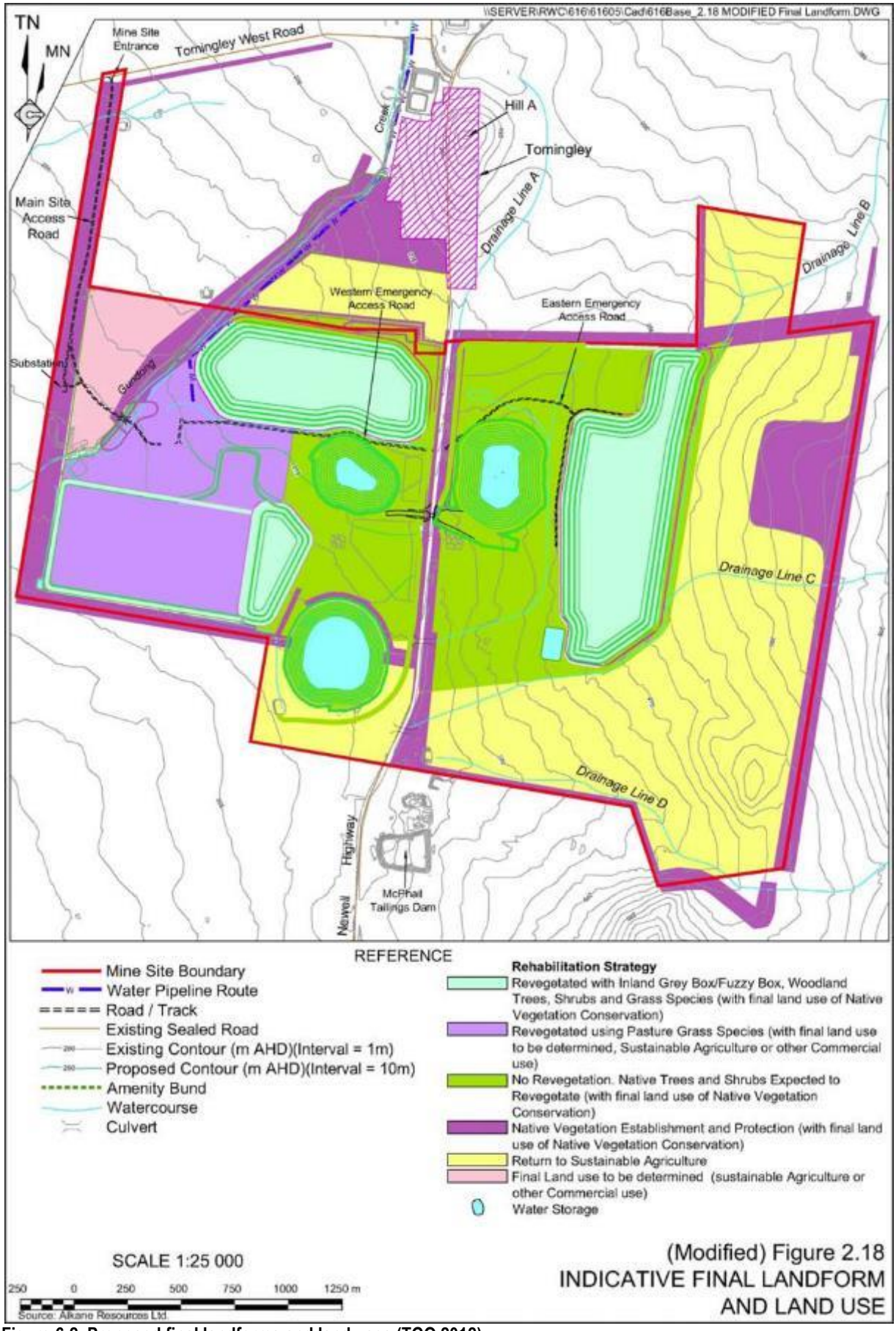


Figure 6-2. Proposed final landforms and land uses (TGO 2012).

6.4 Limitations

6.4.1 Suitable reference sites

All remnant vegetation within the ML and subsequent reference sites have been subjected to some form of disturbance, in particular clearing, over grazing, erosion and "woody weed invasion". The long-term historical disturbance associated with agriculture (and mining) is evident across significant areas of Central Western NSW. Therefore, the woodland reference sites were considered to be in a degraded and modified state but were considered to be the best representative examples of the remnant woodland communities within the ML and the local areas. The Grey Box-Poplar Box-White Cypress Pine woodland situated on the TSR adjacent to the Newell Highway has not been monitored since 2020, largely due to restricted access. As this site is particularly shrubby, minimum ecological targets are not likely to have been affected.

6.4.2 Plant identification

Due to the seasonal conditions, recent germination and/or heavy grazing there may have been a lack of reproductive structures of low ground cover species that are required for the positive identification of numerous plant genera in some years. Therefore, some species were only able to be identified to the genera level.

6.4.3 Transect orientation

The majority of remnant woodland on and around the ML are long linear corridors which made it difficult to orientate the LFA down slope and the vegetation transect perpendicular to this. To resolve this issue, a number of monitoring sites utilised the same transect for the LFA and vegetation monitoring. This is unlikely to affect LFA results as there are limited to no slope in these sites.

6.5 Amendments

6.5.1 Monitoring methodology

The Rehabilitation and Biodiversity monitoring at TGO has always followed early versions of the BioBanking/Biometric Assessment Methodologies (DECCW 2011, OEH 2012) however BAM has undergone various changes over time. Subsequently, some changes of methodology have not been adopted to ensure continuity of the monitoring data. Since 2020 however the most recent revision of the OEH monitoring form has been completed to ensure monitoring requirements of the BMP are satisfied and are included in the Appendices.

7 Location of the monitoring sites

The location of the biodiversity and rehabilitation monitoring sites are provided in Figure 7-1. GPS coordinates and other site specific information is provided in Table 7-1.

Table 7-1. GPS co-ordinates, aspects and slopes of the biodiversity and rehabilitation monitoring sites.

Site Reference	LFA Start	LFA Finish	LFA slope°	LFA bearing°	Veg transect start	Veg transect finish	Veg transect bearing °
Reveg 1	55614146 6395391	55614165 6395405	0	41	55614146 6395391	55614188 6395424	41
Reveg 2	55614397 6395216	55614385 6395209	0	223	55614397 6395216	55614362 6395193	223
Creek 1	55613200 6394761	55613218 6394751	0	105	55613210 6394764	55613231 6394799	14
Creek 2	55614082 6395556	55614095 6395545	4	120	55614082 6395556	55614111 6395596	23
Belah 1	55616240 6394239	LFA = 20m Veg transect	6	209	55616240 6394239	55616185 6394194	209
Belah 2	55616171 6394490	LFA = 20m Veg transect	4	45	55616171 6394490	55616207 6394522	45
Poplar 1	55614419 6396000	55614411 6396008	0	286	55614419 6396000	55614985 6396021	286
Fuzzy 1	55616525 6395086	55616506 6395083	0	253	55616525 6395086	55616481 6395078	253
Grey 1	55614791 6395048	LFA = 20m Veg transect	2	186	55614791 6395048	55614782 6394997	186
Grey 2	55612904 6394839	55612902 6394822	0	180	55612904 6394839	55612900 6394794	180
Pasture 1	55613926 6396247	55613937 6396233	1	130	55613932 6396240	55613891 6396212	220
Pasture 2	55613059 6395167	LFA = 20m Veg transect	1	177	55613059 6395167	55613055 6395120	177
Noise Bund 1	55614942 6394968	55614944 6394985	17	350	55614942 6394977	55614992 6394976	78
WRE2-1	55614557 6394870	55614573 6394883	14	37	55614567 6394877	55614600 6394839	128
WRE2-2	55614269 6394820	55614279 6394807	0	123	55614274 6394814	55614237 6394779	213
WRE3-1	55615881 6394825	55615901 6394819	14	94	55615892 6394823	55615876 6394773	183
WRE3-2	55615347 6393909	55615329 6393911	16	256	55615338 6393910	55615337 6393958	346

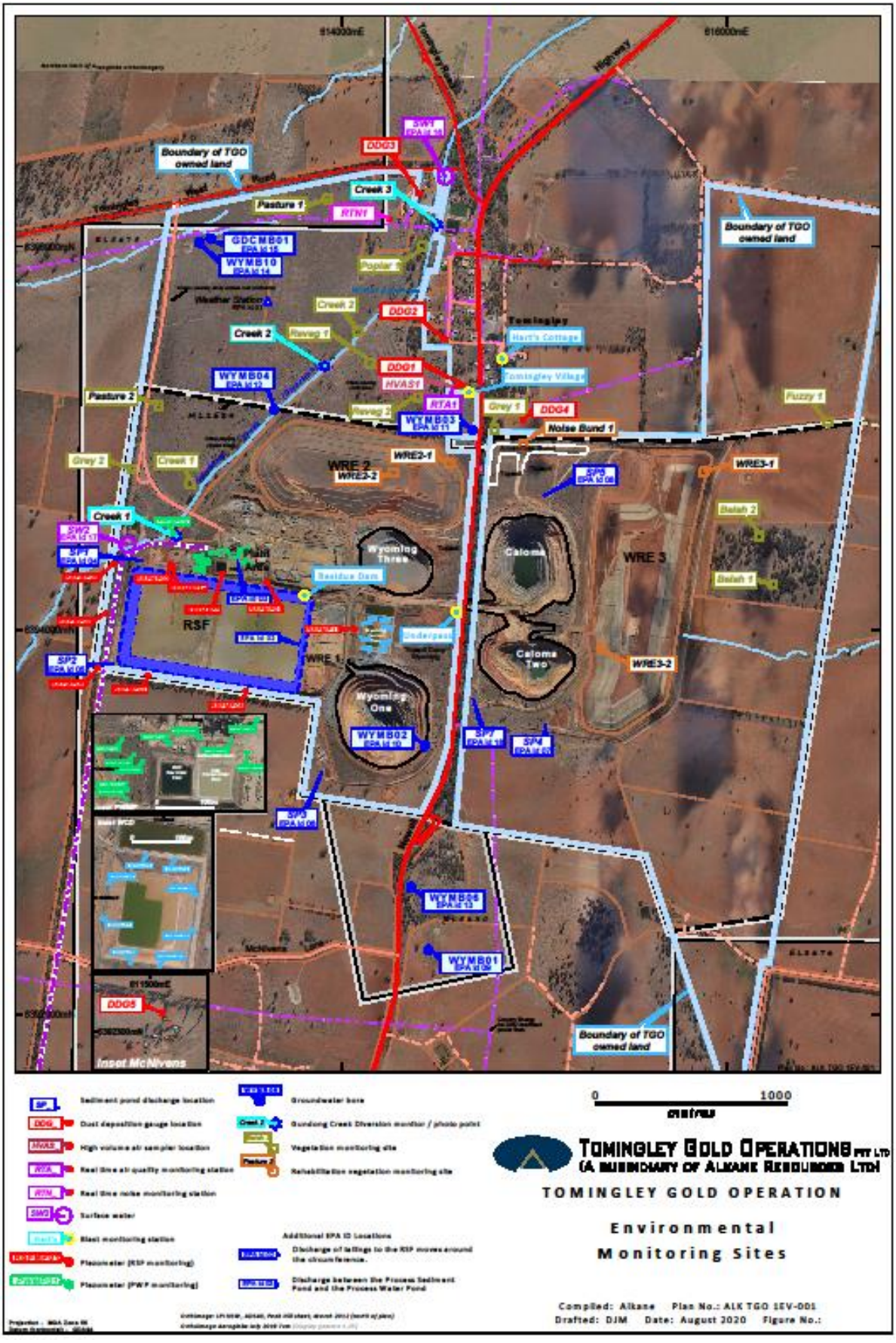


Figure 7-1. Map showing the location of the TGO biodiversity and rehabilitation monitoring sites.

8 Rainfall

The average annual rainfall at Peak Hill is 562mm (BoM 2021), however annual rainfall since 2014 has been highly variable and included periods of drought and flood (Figure 8-1). While annual rainfall was slightly above average during 2014 and 2015, there was a lot of variation in monthly rainfall activity during the year, with below average rainfall during the spring growing period in 2014. In 2015, February and March were also dry, however above average rainfall was experienced during April through to July which stimulated a flush of annual plant growth during the 2015 monitoring period. Except in October and November, there was limited rainfall from August 2015 through to March 2016, resulting in severe conditions for plant growth and increased grazing pressure.

April 2016 marked the beginning of above average monthly rainfall, with record breaking rains falling from April through to September causing widespread flooding. Average to high rainfall conditions extended into December and during these nine months alone, a total of 901mm was recorded, with this being significantly higher than the long-term annual average. These flood conditions were however followed by very dry conditions, with the exception of March, October and December 2017 where above average rainfall was recorded. Rainfall continued to be limited throughout 2018 with only 355mm of rainfall recorded for the year.

Above average rainfall of 105mm was received in January 2019, however rainfall activity was limited for the remainder of the year, for the second consecutive year with a total of only 274mm being recorded. These drought conditions extended into January 2020 where only 8mm rainfall was recorded, however since February above average rainfall was recorded for the remainder of the year, with a total of 705mm (Figure 8-2). In 2021, January through to March were particularly wet, however these were followed by limited rain in April and May. Months of June and July were also wet with 120mm followed by an additional 73mm in July. To the end of July, a total of 607mm had already been recorded, and was well above the long-term average of 334mm for the same period.

The dynamic seasonal conditions have a significant impact on the composition and diversity of the vegetation communities at TGO and these trends have been reflected in the ecological monitoring data.

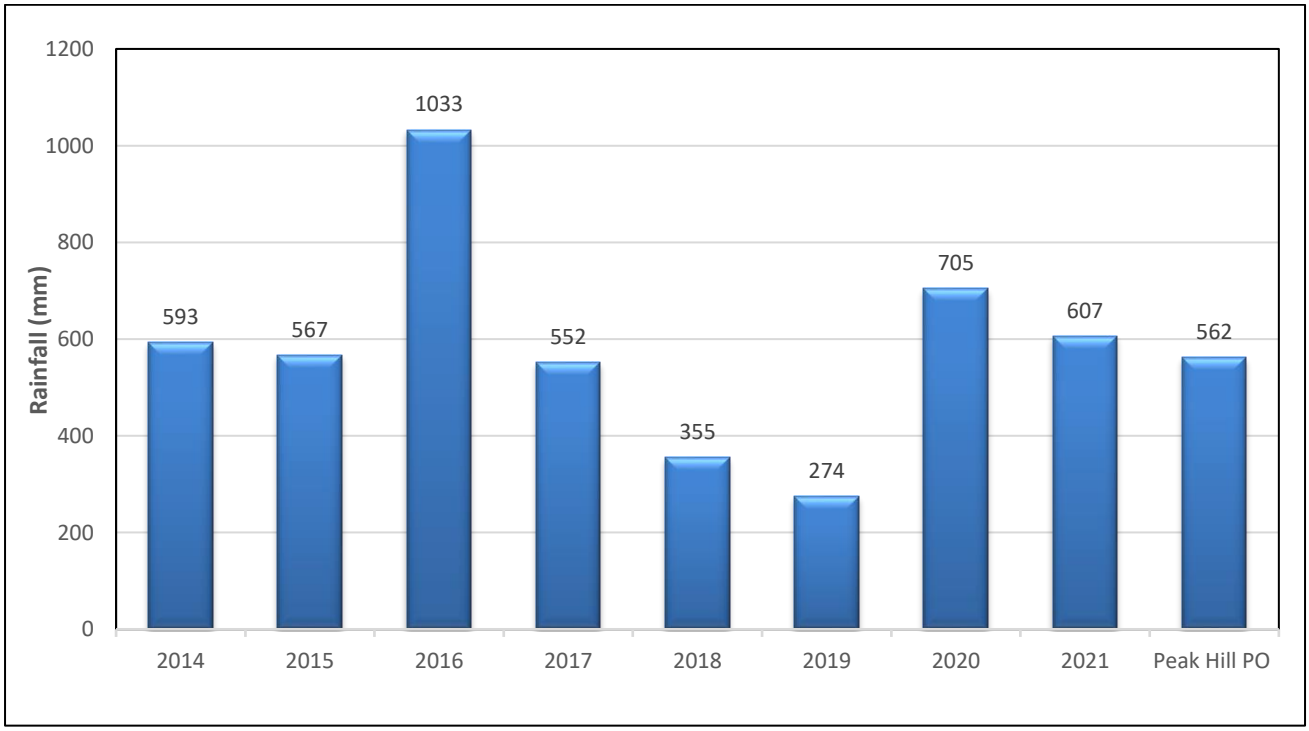


Figure 8-1. Total annual rainfall recorded at TGO 2014 – July 2021 compared to the long-term mean annual rainfall at Peak Hill PO (BoM 2021).

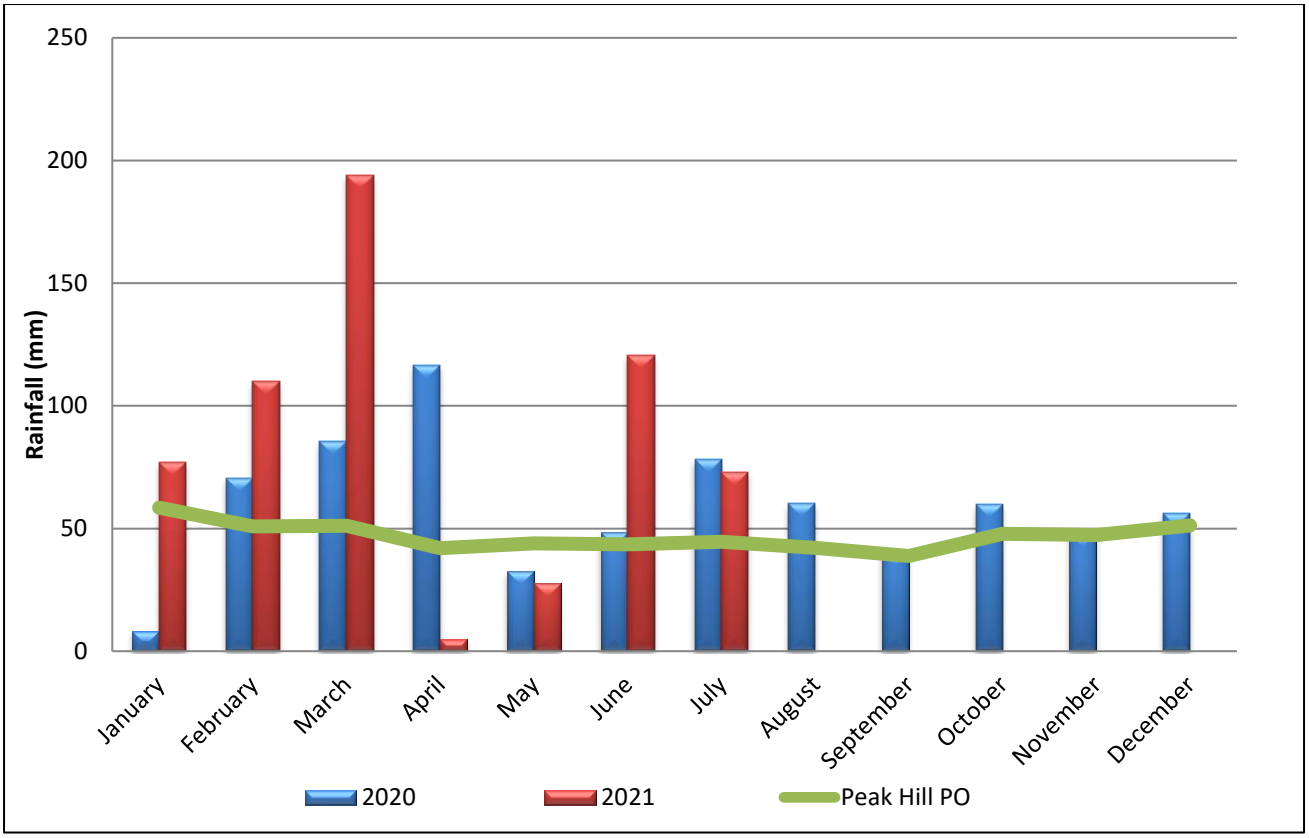


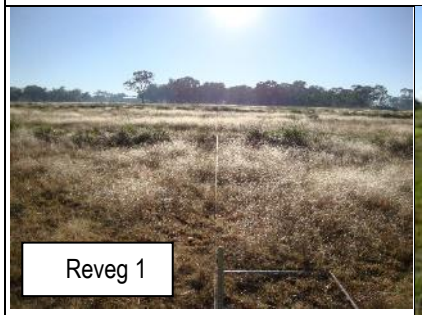
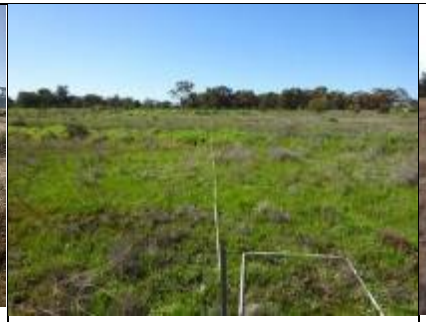
Figure 8-2. Monthly rainfall recorded at TGO 2020 to July 2021 compared to the long-term monthly averages recorded at Peak Hill Post Office (BoM 2021).

9 Results: Woodland monitoring sites

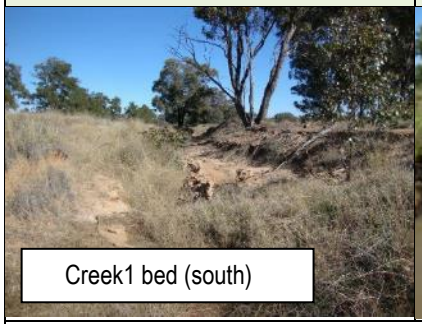
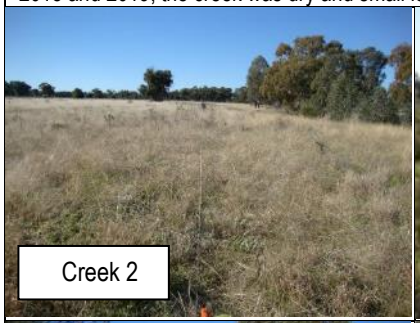
9.1 Permanent photo-points

Photographs taken of the woodland rehabilitation and biodiversity monitoring sites, including the woodland reference sites along the permanent vegetation monitoring transect have been provided in Table 9-1. Note that photos in some years have been omitted due to the increasing quantities of data. Please refer to previous reports.

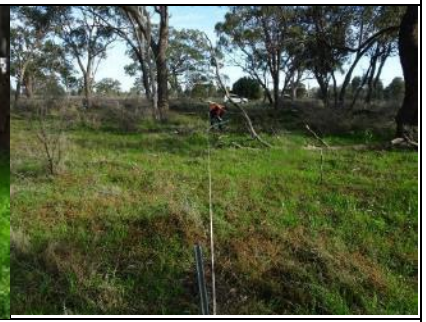
Table 9-1. Permanent photo-points of the woodland rehabilitation and biodiversity monitoring sites.

2014 Photo	2016 Photo	2018 Photo	2020 Photo	2021 Photo
Reveg 1: *LFA transect = Vegetation transect.* This site was situated in an old cropping paddock north of the ML. It had been contour scalped and seeded in 2013 with the intention to re-establish Inland Grey Box woodland EEC.				
				
Reveg 2: *LFA transect = Vegetation transect.* This site was situated in an old cropping paddock north of the ML. It had been contour scalped and seeded in 2013 with the intention to re-establish Fuzzy Box woodland EEC.				
				

2014 Photo	2016 Photo	2018 Photo	2020 Photo	2021 Photo
WRE2-2 (Rehabilitation site): This site was rehabilitated in February 2019. It was rehabilitated using 200mm of topsoil, 10t/ha gypsum and hydro-mulched and seeded with a pasture and native tree and shrub mix (see MOP).				
WRE2-2	NA	NA		
Creek 1 (Floodplain): This site was situated along Gundong Creek adjacent to the TGO administration building. The site had also been subjected to a long cropping history and was dominated by a combination of native and exotic species. The area had been deep ripped and seeded in 2013 with scattered eucalypts and acacias becoming established. Scattered shrubs were establishing across the wider revegetation area and within the monitoring plot. In 2020 and 2021 the creek was fast flowing.				
 Creek 1				
 Creek1 bed (north)				

2014 Photo	2016 Photo	2018 Photo	2020 Photo	2021 Photo
 Creek1 bed (south)				
Creek 2: This monitoring site aimed to capture the recovery of the Gundong Creek including the creek banks and adjacent old cropping paddock. Along the creek there were scattered mature *E. camaldulensis* (River Red Gum) and scattered shrubs which were naturally regenerating along the creek line. The banks were typically well vegetated except in the steeper sections which continue to actively slump. In 2014 the creek was dry at the time of monitoring, while it rapidly flowing in 2015, and in 2016 the creek had recently flooded onto the floodplain leaving piles of debris and sandy depositions. Some floodplain stripping and slumping had occurred within the stream channel. In 2017, 2018 and 2019, the creek was dry and small leaky weirs were establishing within the creek channel. In 2020 and 2021 the creek was fast flowing.				
 Creek 2				
 Creek 2 (LFA transect)				

2014 Photo	2016 Photo	2018 Photo	2020 Photo	2021 Photo
 Creek bed 2 (north)				
 Creek bed 2 (south)				
Belah 1: *LFA transect = Vegetation transect.* This site was situated within the larger remnant east of WRE 3 in the eastern half of the ML on an area of gilgais and has subsequently not been cultivated. It was degraded regrowth woodland with some old growth trees and was dominated by *Casuarina cristata* (Belah) with scattered individuals of *Alectryon oleifolius* (Rosewood).				
 Belah 1				

2014 Photo	2016 Photo	2018 Photo	2020 Photo	2021 Photo
Belah 2: *LFA transect = Vegetation transect.* This site was situated within the larger remnant east of WRE 3 in the eastern half of the ML on an area of gilgais and has subsequently not been cultivated. It was degraded regrowth woodland with some old growth trees and was dominated by *Casuarina cristata* (Belah).				
				
Poplar 1: *LFA transect = Vegetation transect.* This site was situated at the northern end of Gundong Creek. It was open grassy woodland dominated by *E. populnea* with scattered occurrences of *E. conica* and *Myoporum montanum.* The understorey was dominated by native grasses and had a well-developed litter layer.				
				
Fuzzy 1 (Reference site): This site was situated east of the ML within a remnant woodland on the northern laneway. It was open woodland dominated by *E. microcarpa* with scattered *E. conica* (Fuzzy Box), *Geijera parviflora*, *Allocasuarina luehmannii* and *A. deanei*.				
				

2014 Photo	2016 Photo	2018 Photo	2020 Photo	2021 Photo
Grey 1 (Reference site): Situated on the eastern side of the Newell highway roadside corridor. Shrubby woodland dominated by *E. microcarpa* (Grey Box) and *E. populnea* (Poplar Box) scattered individuals of *Casuarina glaucophylla* (White Cypress Pine), *Allocasuarina luehmannii* (Bulloak), *Brachychiton populneus* (Kurrajong) and *Geijera parviflora* (Wilga) sub dominants. The site contained some large old regrowth trees but was predominantly comprised of scattered regrowth and patches of shrubs.				
			NA	NA
Grey 2 (Reference site): Situated along the mine access road along the western boundary. Open grassy woodland dominated *by E. microcarpa* with several mature *Allocasuarina luehmannii* and scattered *A. deanei* (Deane's Wattle), regenerating *Allocasuarina luehmannii* and an individual *A. oswaldii* (Miljee).				
				

9.2 Ecological trends and performance against a selection of ecological performance indicators

The following section provides a summary of ecological data obtained from the ten woodland monitoring sites. The performance of the more disturbed woodland and offset woodland revegetation areas have been compared to two remnant eucalypt woodland communities (reference sites) which were named Fuzzy 1 and Grey 2. The reference sites were chosen to represent open grassy woodlands which are characteristic of the local area. Grey 1 which contained a higher diversity and density of trees and shrubs was not assessed again this year.

9.2.1 Landscape Function Analyses

9.2.1.1 Landscape Organisation

A patch is an area within an ecosystem where resources such as soil and litter tend to accumulate, while areas where resources are mobilised and transported away are referred to as interpatches. Landscape Organisation Indices (LOI) are calculated by the length of the patches divided by the length of the transect to provide an index or percent Landscape Organisation (LO) of the transect which is occupied by functional patch areas (Tongway and Hindley 2004). In 2016 and 2020, flooding and persistent water logging in some sites made it difficult to undertake some aspects of the LFA as the soils remained very wet.

The reference sites (Fuzzy 1, Grey 1 and Grey 2) were structurally and functionally different to each, but all had relatively high perennial plant components due to the mature eucalypts and perennial grasslands and had a well-developed leaf litter layer and/or patches which had hard crusted soil surfaces which have been stabilised by cryptogams. During 2018 and 2019 there was a reduction in perennial ground covers and increased disturbances by animals as a result of the ongoing drought conditions, however there continued to be high functional patch area. Since 2020, the improved rainfall conditions resulted in a significant increase in plant growth, with 100% LO recorded in both reference sites (Figure 9-1). Poplar 1 was structurally similar to the woodland reference sites, however some minor disturbance by animals has caused a reduction to 96% LO this year.

Reveg 1 and Reveg 2 were old cropping paddocks which were essentially recovering native grasslands that had been direct seeded with local woodland species in 2013. In the early development stages, there were rows of bare soil as a result of the ground preparation techniques such as scalping, cultivation and direct seeding. Within the second year of monitoring, the ground cover vegetation and cryptogams had colonised the exposed soils and significantly increased the functional patch areas to 100%. This year, high functional area was maintained in Reveg 1, however Reveg 2 continues to be affected by disturbance and by kangaroos, with LO further declining to 76% this year.

Creek 1 was also positioned within an old cropping paddock which was similar in composition to Reveg 1 and Reveg 2, with most of the rip lines having a good grassy ground cover. Creek 2 incorporated a flat upper floodplain and extended down the sloping creek banks. During 2018 and 2019 these sites had a reduction in perennial ground covers and increased disturbances by animals has caused deterioration of the litter layers. The improved seasonal conditions over the last two years and resulted in a slight improvement in functional patch areas with 88 – 92% LO (Figure 9-1).

Initially Belah 1 and Belah 2 had also suffered from a long grazing history with the ridges of the gilgais being predominantly bare and eroding and perennial plant cover was particularly low. Since the removal of domestic livestock in 2013, there has been an increase in vegetative covers in both Belah sites, however in 2018 and 2019 the prolonged drought and heavy macropod grazing caused a loss of integrity of the litter layers and other

protective ground covers. Improved seasonal conditions over the last two years has resulted in improved levels of ground covers, and this year both Belah sites had 100% functional patch area and 100% LO.

The new area of woodland which was rehabilitated in 2019 on top of WRE2 was heavily dominated by annual and perennial grasses and had good litter cover and soil profile development and continued to score 100% LO this year. Revegetation sites WRE2-2, Reveg 1 and Belah 1 and Belah 2 had an LO comparable to the reference sites this year.

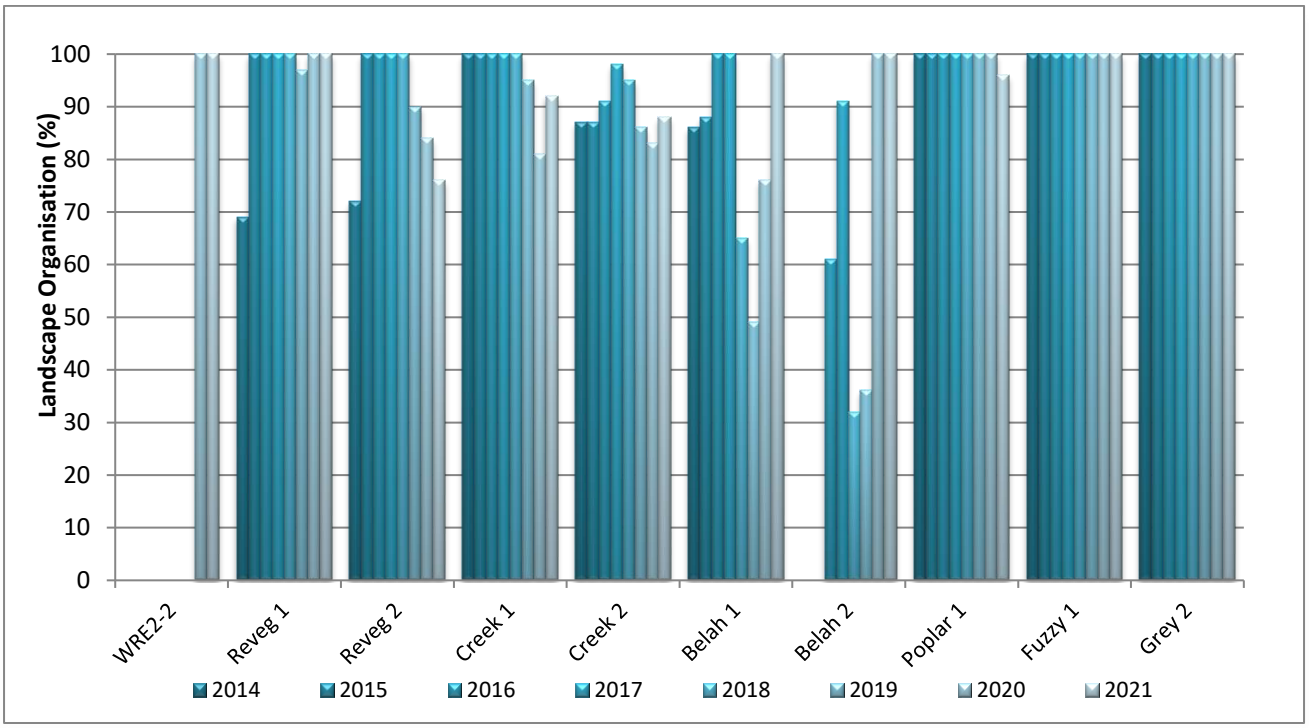


Figure 9-1. Landscape Organisation recorded in the woodland monitoring sites.

9.2.1.2 Soil surface assessments

9.2.1.2.1 Stability

The stability within the reference sites were largely dependent on the degree of cover provided by the perennial ground covers, leaf litter (which includes annual plants) and cryptogam abundance which collectively increase soil coherency and the development of a more stable soil surface which provides protective cover against erosion. The soils within the reference sites were typically sandy clay loam and these were usually highly stable beneath the organic surface covers but may be slightly unstable when exposed.

The reference sites had a mature canopy and grassy understorey. Despite the variability in the density of the native ground covers and leaf litter layers, the hard compacted and less vegetated areas were usually well colonised by cryptogams, providing additional site stability. The stability indices recorded in the reference sites have previously shown an increasing trend after the removal of livestock grazing which promoted increased perennial and annual ground cover and improved litter development. During the drought in 2018 - 2020 however, there was a decline in the stability in the reference sites and heavy grazing pressure by macropods has tended to reduce the integrity of the decomposing litter layer and perennial grass covers but there continued to be a lot of variation in stability within the sites. This year, stability had increased to provide a range of 70.0 – 78.8 (Figure 9-2). Poplar 1 also contained a mature canopy, a grassy understorey which had become dominated by annual

grasses and forbs and continued to have a well-developed litter layer, with the changes in stability continuing to be comparable to the reference sites this year with a score of 78.8.

A slight increase in stability was also recorded in WRE2-2 and both creek and Belah woodland monitoring sites, but a marginal decline was recorded in the revegetation sites due to ongoing macropod disturbances beneath the maturing trees and shrubs. Sites which had stability completion targets comparable to the local woodlands included WRE2-2, Creek 1 and Poplar 1. The remaining sites had stability scores ranging from 66.2 – 68.1 which were only marginally lower.

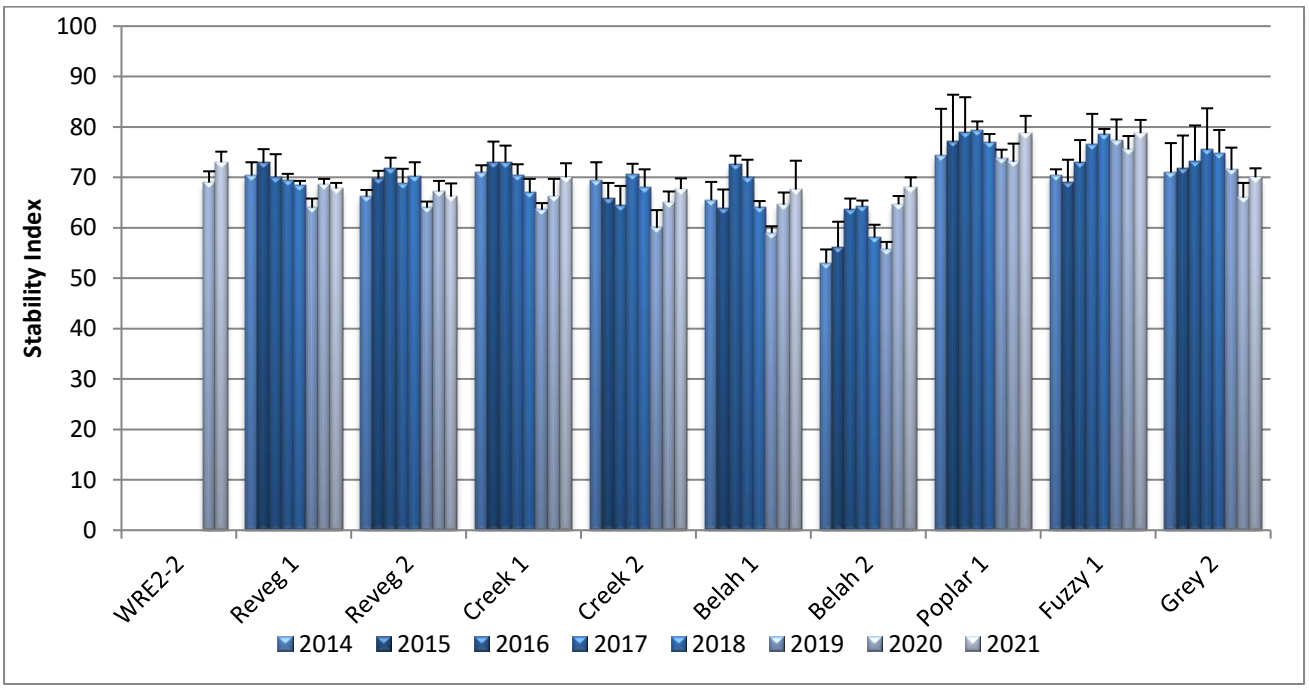


Figure 9-2. LFA stability indices recorded in the woodland monitoring sites.

9.2.1.2.2 Infiltration

Infiltration capacity is largely influenced by the extent of perennial vegetation (canopy and ground), litter cover and degree of surface crusting, which are also influenced by other variables such as rate of litter decomposition, soil type and stability. This year increased infiltration was recorded in Grey 2 and Fuzzy 1 to provide a target range of 48.3 – 67.0 (Figure 9-3).

This year, all monitoring sites except WRE2-2 and Belah 2 demonstrated an increase in infiltration capacity. Infiltration indices ranged from 40.8 – 42.8 in the revegetation sites, 40.3 – 41.3 in the Creek sites and 32.5 – 36.4 in the Belah woodlands. In WRE2-2 the infiltration index was presently 38.9. Poplar 1 continued to have a high infiltration capacity which was comparable to the Fuzzy Box and Grey Box reference sites with an infiltration index of 60.8 this year.

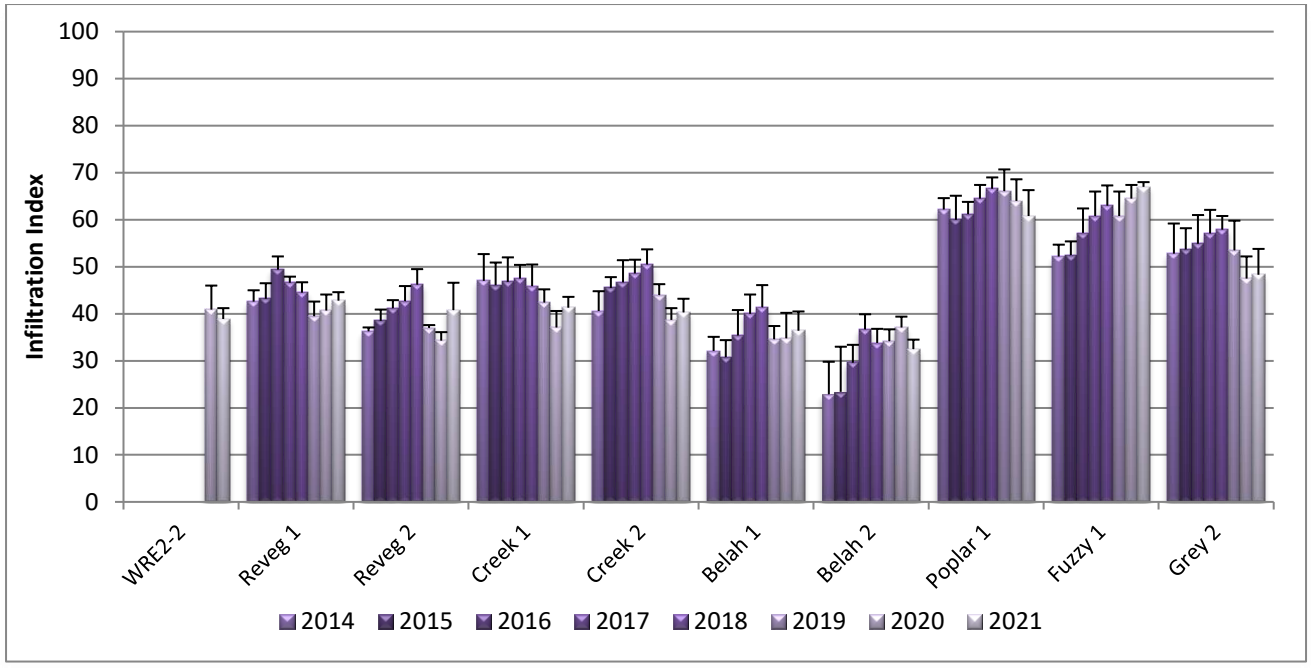


Figure 9-3. LFA infiltration indices recorded in the woodland monitoring sites.

9.2.1.2.3 Nutrient recycling

There were similar trends occurring in the nutrient recycling capacity of the sites and this year the woodland reference sites provided a nutrient recycling target of 47.3 – 65.6. The remnant woodland site Poplar 1 continued to have a high nutrient recycling capacity of 55.7 which remained comparable to the reference sites. This year all other monitoring sites demonstrated an increase in nutrient recycling capacity, however all sites continued to have a low infiltration capacity compared to the reference sites. Infiltration indices ranged from 38.8 – 42.6 in the revegetation sites, 41.5 – 42.3 in the Creek sites and 35.5 – 39.1 in the Belah woodlands. In WRE2-2, the infiltration index was 44.6 this year.

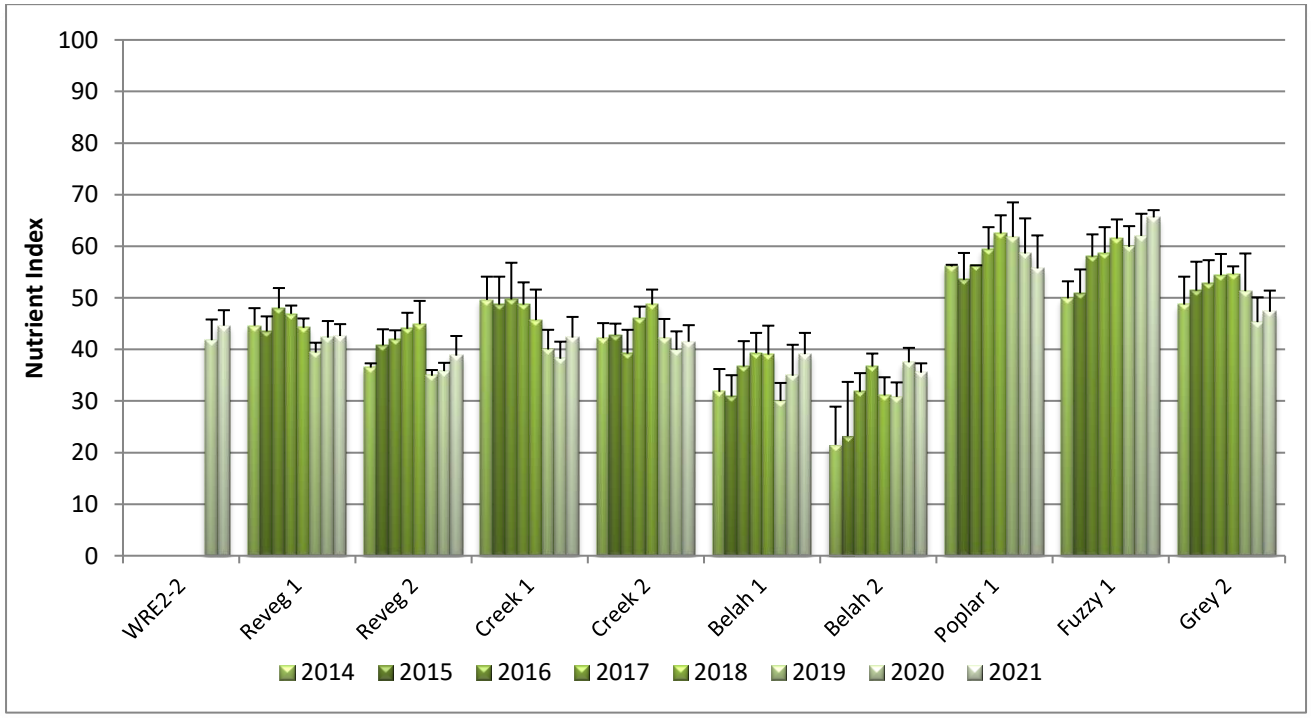


Figure 9-4. LFA nutrient recycling indices recorded in the woodland monitoring sites.

9.2.2 LFA Summary

The sum of the LFA stability, infiltration and nutrient recycling components provide an indication of the most functional to least functional monitoring site recorded in 2021 and is provided in Figure 9-5. The most ecologically functional sites this year continued to be Fuzzy 1 with a total sum of scores of 211, closely followed by Poplar 1 with a score of 195, with the ecological function in these two sites being significantly higher than the remaining monitoring sites.

The Grey 2 reference sites was the next most functional of the remnant woodlands scoring a total function of 166, and this was closely followed by WRE2-2, Creek 1, Reveg 1 and Creek 2 which were very similar to each other with scores of 150 - 157. The two sites Reveg 2 and Belah 1 were very similar to each other with scores of 146 and 143 respectively. Belah 2 was the least functional woodland community with a score of 136. Examples of the various combinations of ground covers which are critical to overall ecosystem function have been provided in Table 9-2.

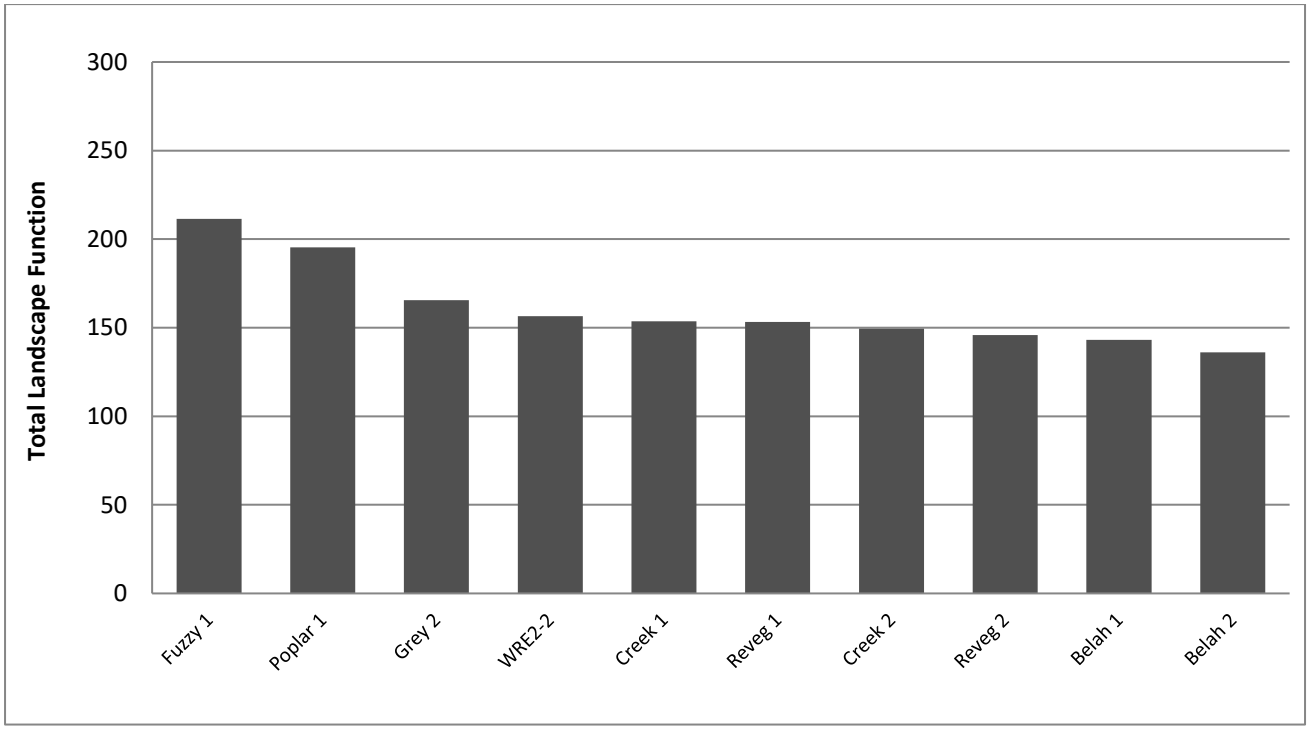
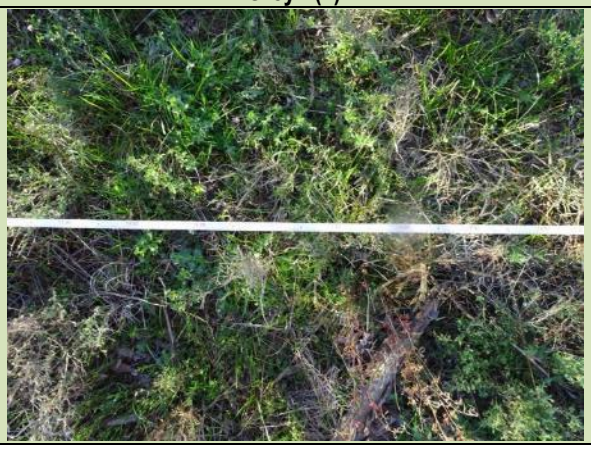


Figure 9-5. Sum of the LFA stability, infiltration and nutrient recycling components indicating the most functional to least functional monitoring site recorded in 2021.

Table 9-2. Examples of the different ground covers in the biodiversity monitoring sites in 2021.

WRE2-2 (1)	WRE2-2 (2)
	

Reveg1	Reveg2
	
Creek1	**Creek2**
	
Belah1	**Belah2**
	
Poplar1	**Fuzzy1**
	

Grey2 (1)	Grey2 (2)
	

9.2.3 Tree and mature shrub populations

9.2.3.1 Population density

The tree population includes trees and mature shrubs with a diameter at breast height greater than 5cm. In the woodland reference sites Grey 2 and Fuzzy 1, tree densities ranged from 8 – 10 individuals in each 0.1 ha monitoring plot, translating into a density of 80 - 100 stems per hectare.

In the enhancement and revegetation sites trees and/or mature shrubs were recorded in all sites except the newest area of rehabilitation WRE2-2. One tree was now recorded in Reveg 1, while there were 20 trees in Reveg 2. There were 12 and 37 individuals in Creek 1 and Creek 2 respectively, with these densities continuing to increase indicating good growth and development (Figure 9-6). There was no change in Belah 1 with 8 individuals, while slightly higher densities were recorded in Belah 2 with 7 individuals. There was no further change in Poplar 1 with a density of 9. Most sites except WRE2-2, Reveg 1 and Belah 2 continued to have tree population density comparable to the woodland reference sites.

9.2.3.2 Size

The average tree diameters in the two reference sites were slightly lower this year due to the addition of a young sapling with the average dbh ranging from 54 – 55 cm (Table 9-3). Large old growth trees were recorded in Grey 2 with an old growth *E. microcarpa* (Grey Box) having a dbh of 129 cm, and in Fuzzy 1 the largest had a dbh of 120 cm. In Reveg 1 and Reveg 2 the average dbh was now 5 – 9 cm, with individuals in Reveg 2 having a dbh up to 17cm. In the Creek sites, the average dbh was 11 – 12 cm, with naturally occurring individuals in Creek 2 being up to 34 cm dbh. In the Belah woodlands, the average dbh was 33 – 39cm, with one old growth *Casuarina cristata* (Belah) tree having a dbh of 114 cm in Belah 2. In Poplar 1, the average dbh was 34 cm, with the largest being an old growth *E. conica* with a dbh of 81 cm.

9.2.3.3 Condition

In the reference sites, most trees were in good to moderate to health, however one individual had died in Grey 2 over the past year, while there continued to be one dead stag in Fuzzy 1. Reproductive structures such as fruit, flowers or bud were recorded in fewer 11 – 36% of individuals and neither site had mistletoe this year (Table 9-3). There were tree hollows recorded in 22 - 36% of the populations and are therefore valuable habitat trees.

In all Reveg and Creek sites, most individuals were in moderate to good health, however there were five individuals in Reveg 2 that were in poor health. Most sites except Creek 1, had some individuals with reproductive structures such as fruit, flowers or bud, but no mistletoe was recorded.

This year there appears to have been an improvement in the overall health of the Belah woodlands, but 11 – 14% of the trees in the Belah woodlands were [dead] stags. Mistletoes continued to be recorded in 25 – 56% of trees in the Belah woodland sites (Table 9-3). In the Poplar Box woodland most individuals were healthy or in moderate health however there continued to be 31% of the population that had died, probably as a result of under spraying of the Boxthorn. No revegetation or enhancement site had tree hollows suitable for nesting by wildlife.

9.2.3.4 Species Composition

While the composition of species in the woodland reference sites varied between sites, dominant tree species included a combination of *Eucalyptus conica* (Fuzzy Box), *E. microcarpa* (Grey Box). In Grey 1, *E. populnea* (Bimble Box), *Allocasuarina luehmannii* (Bulloak) and *Acacia oswaldii* (Miljee) were also present.

Trees and mature shrubs in the enhancement and revegetation sites were considered local endemic species. The Gundong Creek sites and floodplains were dominated by *Eucalyptus camaldulensis* (River Red Gum) with scattered individuals of *E. microcarpa, A. deanei, A. salicina,* while Belah 1 and Belah 2 were dominated by *Casuarina cristata* (Belah) and scattered *Alectryon oleifolius* (Rosewood). Poplar 1 was dominated by *E. populnea* and contained one large individual *E. conica.* In Reveg 2, the tree population consisted of *E. microcarpa, E. conica* and mature individuals of *Acacia implexa* and *A. deanei* and this year there was one *E. camaldulensis* in Reveg 1.

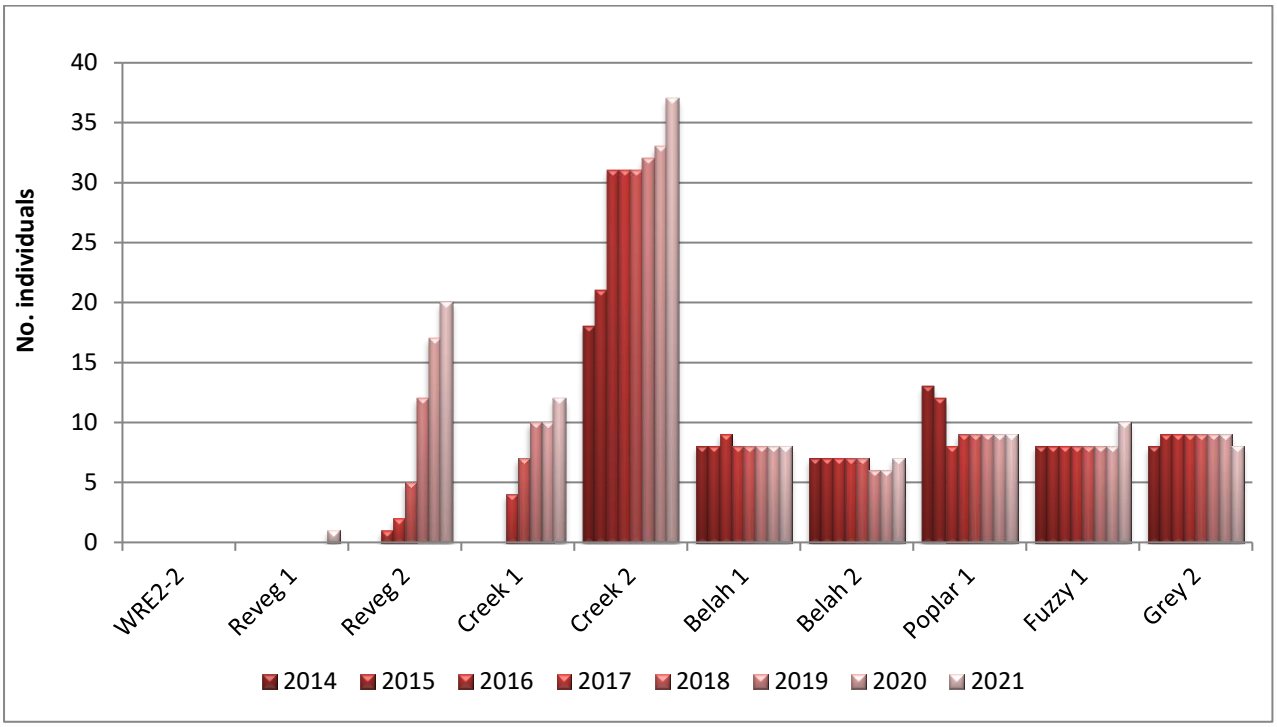


Figure 9-6. Tree and mature shrub densities (>5cm dbh) recorded in the woodland monitoring sites.

Table 9-3. Summary of the tree and mature shrub populations (>5cm dbh) recorded in 2021.

Site Name	No species	Average dbh (cm)	Max dbh (cm)	Min dbh (cm)	Total trees	No. with multiple limbs	% Live trees	% Healthy	% Medium Health	% Advanced Dieback	% Dead	% Mistletoe	% Flowers / fruit	%. Trees with hollows
WRE2-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reveg 1	1	5	5	5	1	0	100	0	100	0	0	0	100	0
Reveg 2	4	9	17	6	20	4	0	60	35	5	0	0	15	0
Creek 1	5	12	19	6	12	8	100	83	17	0	0	0	0	0
Creek 2	1	11	34	5	37	4	100	81	19	0	0	0	43	0
Belah 1	2	33	56	8	9	4	89	11	67	11	11	56	33	0
Belah 2	1	39	114	5	8	3	88	13	75	0	13	25	25	0
Poplar 1	2	34	81	11	13	3	69	15	46	8	31	0	54	0
Fuzzy 1	**3**	**55**	**120**	**5**	**11**	**2**	**91**	**64**	**9**	**18**	**9**	**0**	**36**	**36**
Grey 2	**3**	**54**	**129**	**8**	**9**	**1**	**89**	**0**	**56**	**33**	**11**	**0**	**11**	**22**

9.2.4 Shrubs and juvenile trees

9.2.4.1 Native shrub densities

The number of native shrubs and juvenile trees (<5cm dbh) in the reference sites ranged from 21 – 32, with additional individuals being recorded in Fuzzy 1 this year as a result of natural regeneration (Figure 9-7). There were also 10 additional seedlings in the Poplar Box woodlands. There were minor changes in native shrubs densities in the Belah woodland with 14 – 17 seedlings.

Native shrub densities in the other enhancement and revegetation areas ranged from a low of 1 in Reveg 1 to a high of 33 in Creek 2. There were also slightly more native shrubs recorded in the new rehabilitation site WRE2-2 with 15 individuals this year. Reveg 2 and Creek 2 continued to be the only sites which continued to have an adequate density of native shrubs and juvenile trees compared to the reference sites, with 30 and 33 individuals respectively.

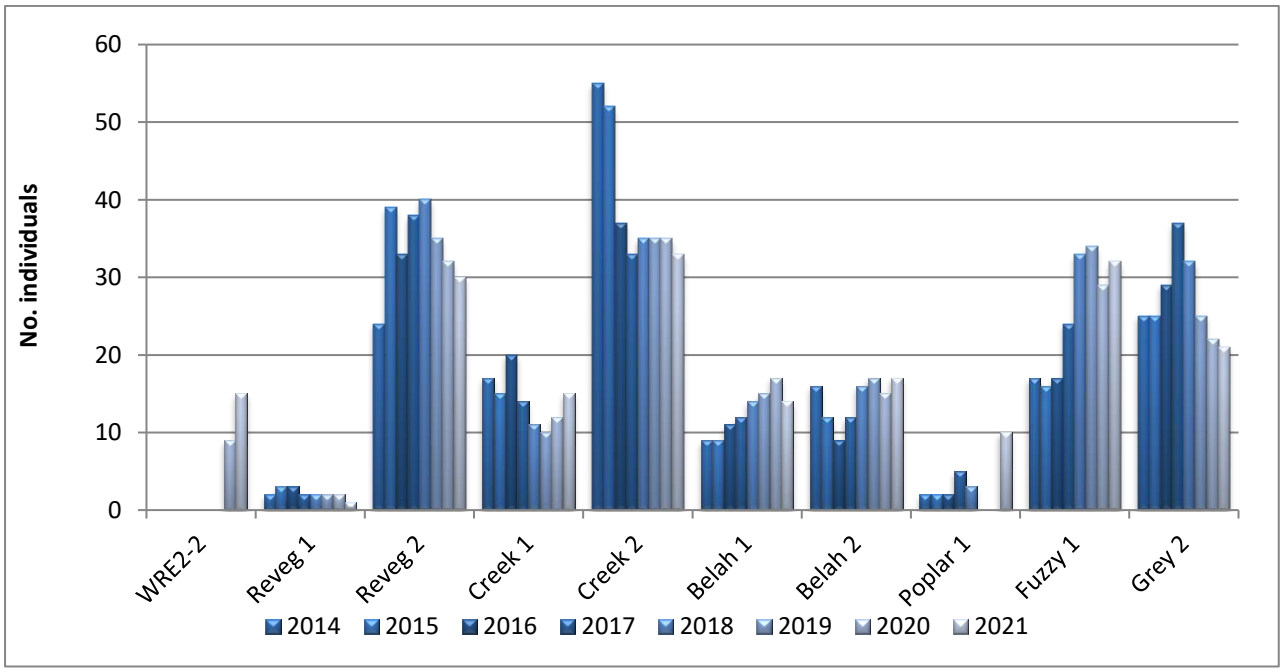


Figure 9-7. Native shrubs and juvenile trees recorded in the woodland monitoring sites.

9.2.4.2 Exotic shrub densities

The densities of *Lycium ferocissimum* (African Boxthorn) a priority weed, had increased in the reference sites this year where there were 10 – 33 individuals (Figure 9-8). *Lycium ferocissimum* was also recorded in low abundance in most sites except WRE2-2 and Reveg 1. This year there has also been a significant increase in *L. ferocissimum* seedlings in the Belah woodlands with 106 and 82 individuals being recorded in the respective sites. In Poplar 1 there was a significant reduction in *L. ferocissimum* densities in 2018 as a result of Boxthorn control program, however, there has been a small increase in the number of seedlings/suckers over the past year.

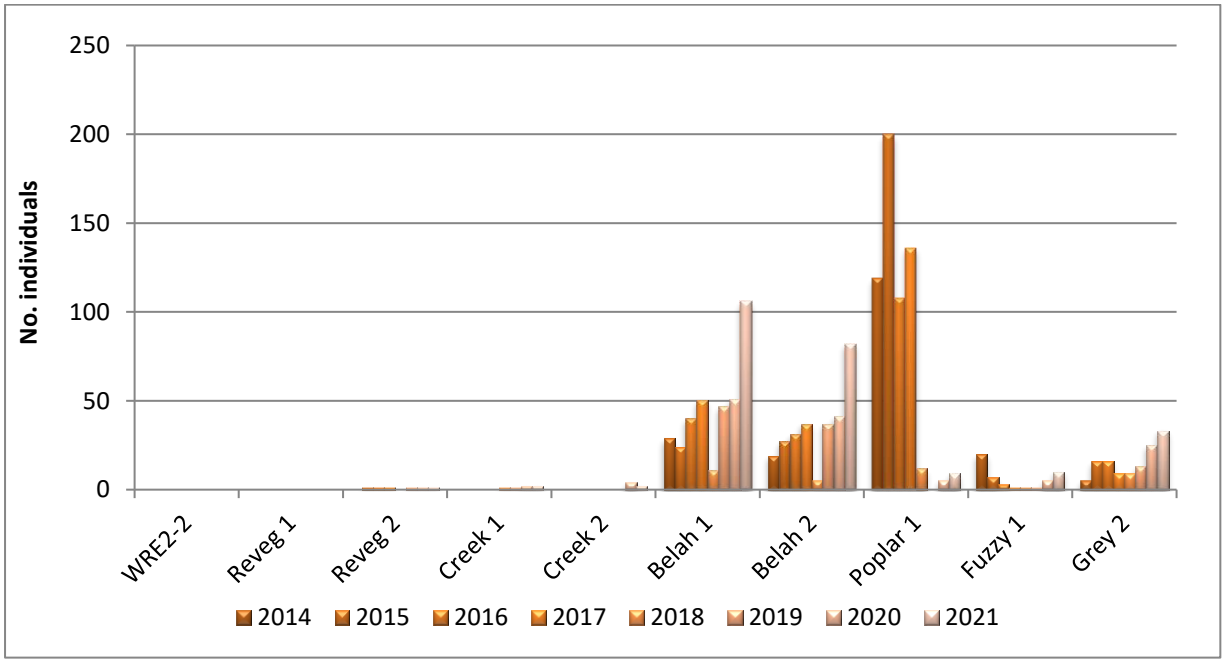


Figure 9-8. Exotic shrubs and juvenile trees recorded in the woodland monitoring sites.

9.2.4.3 Height class

In the reference sites, there were shrubs and juvenile trees occurring in all height classes, with most individuals being <1.0m in height. Smaller individuals have regenerated after the change in land use and a reduction in grazing pressure, with some of these also being *L. ferocissimum* seedlings (Table 9-4, Figure 9-9).

In the older revegetation and enhancement areas, most individuals had exceeded 2.0m in height, and this year there were tall individuals in the newest area WRE2-2. While all height classes were recorded in WRE2-2, and the Creek sites, no small seedlings were recorded in the older Reveg 1 and Reveg 2 areas. In Belah 1 and Belah 2 the majority of individuals were less than 1.5 m in height, but there were some in the taller height classes. In Poplar 1, some individuals were up to 1.5 m tall and numerous small seedlings were recorded this year.

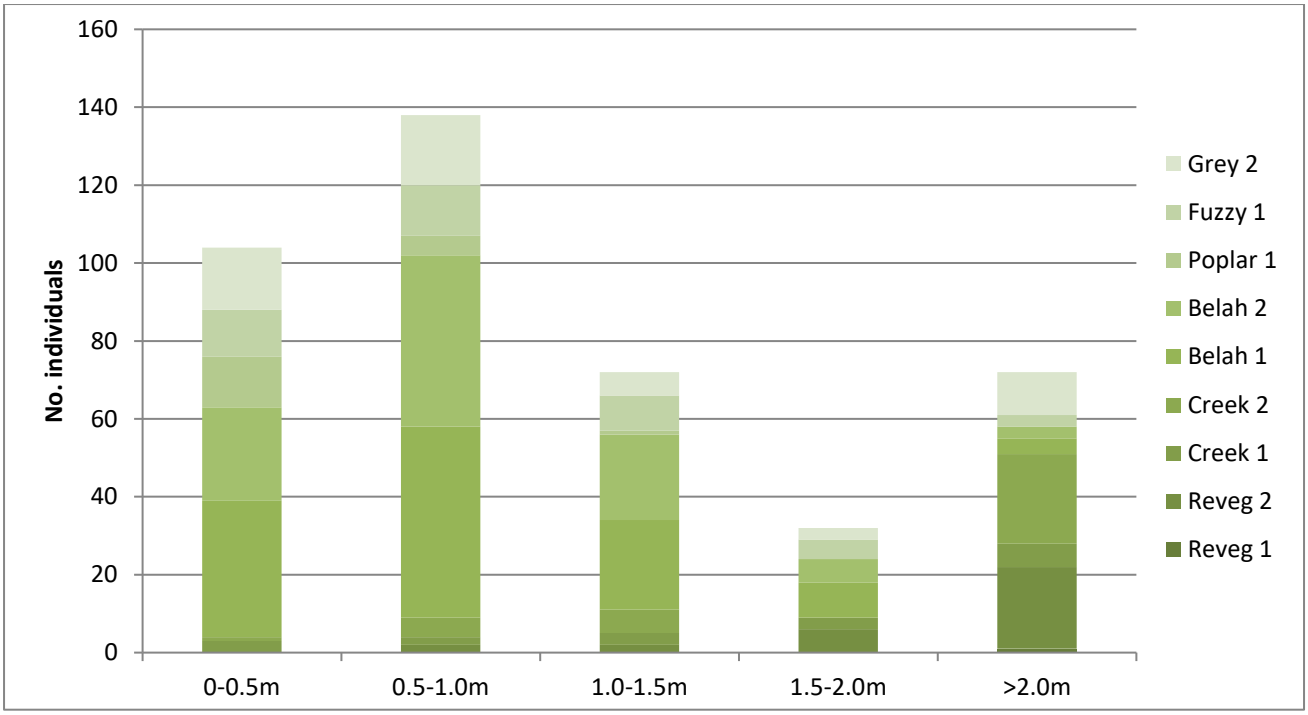


Figure 9-9. Number of individuals represented in each height class across the range of monitoring sites in 2021.

9.2.4.4 Species diversity

In the two woodland reference sites there were six species of shrubs and juvenile trees. In the older revegetation sites there was only one shrub species in Reveg 1, while there were nine different species in Reveg 2. There were 4 – 5 species in both Creek sites and both Belah woodlands. In the new area WRE2-2 there were four species and in Poplar 1, there were five shrub species found this year. Compared to the woodland reference sites species diversity was low in all sites except Reveg 2 this year.

The populations across the range of woodland reference sites differed in composition and common species may have included *Allocasuarina luehmannii*, *Geijera parviflora* and *Myoporum montanum* (Water Bush). There may also have been other isolated occurrences of species such as *Acacia deanei* (Green Wattle), *Alectryon oleifolius* (Rosewood), *Dodonaea viscosa* subsp. *cuneata* (Wedge-leaf Hopbush) and/or juvenile *Eucalyptus microcarpa*. *Acacia hakeoides* (Hakea Wattle), *Brachychiton populneus* (Kurrajong), *A. oswaldii* (Miljee), *Senna artemisioides* subsp. *zygophylla* (Punty Bush) have previously been recorded in Grey1.

In the woodland revegetation and enhancement sites the species of shrubs were also variable between sites, but they were all essentially different compositions of the endemic natives including *E. microcarpa*, *E. camaldulensis, E. conica*, *Acacia deanei, A decora, A. hakeoides, A. implexa* (Hickory), *A. oswaldii, A. salicina* (Willow Wattle) and *A. pendula* (Weeping Myall). In Reveg 2 the native vine/climber *Hardenbergia violacea* (Happy Wanderer) was also recorded. In the Belah woodlands *Casuarina cristata* (Belah) was common and *Myoporum montanum* and/or *Geijera parviflora* were present in low densities and in Belah 2, there were also one or two *A. oswaldii* and *Apophyllum anomalum* (Warrior Bush). This year, a volunteer seedlings of *A. salicina, Brachychiton populneus Myoporum montanum* and *Acacia baileyana* (Cootamundra Wattle) were recorded in Poplar 1.

Lycium ferocissimum, the priority weed was also recorded in most sites, including the reference sites.

Table 9-4. Number of individuals represented in each height class across the range of monitoring sites in 2021.

Site Name	0-0.5m	0.5-1.0m	1.0-1.5m	1.5-2.0m	>2.0m	Total	No. species	% endemic
WRE2-2	3	4	1	5	2	15	4	100
Reveg 1	0	0	0	0	1	1	1	100
Reveg 2	0	2	2	6	21	31	9	97
Creek 1	3	2	3	3	6	17	4	88
Creek 2	1	5	6	0	23	35	5	94
Belah 1	35	49	23	9	4	120	4	12
Belah 2	24	44	22	6	3	99	5	17
Poplar 1	13	5	1	0	0	19	5	53
Fuzzy 1	12	13	9	5	3	42	6	76
Grey 2	16	18	6	3	11	54	6	39
Total	76	107	57	24	58	322		

9.2.5 Total ground Cover

Total ground cover is a combination of leaf litter, annual plants, cryptogams, rocks, logs and live perennial plants (<0.5m in height) and is expressed as an average of 10 repeated measures along the 50m vegetation transect. Total ground cover in the two woodland reference sites remained high but had slightly increased in Grey 2 and ranged from 96 – 100% this year (Figure 9-10). In all of the revegetation and offset sites there has been an increase in total ground cover in all sites except Reveg 1, as bare areas caused by macropod disturbance have persisted.

There was 97% ground cover in WRE2-2 and 91 – 98% in the farmland revegetation sites. There was 86 - 97% cover in the Creek sites, 72 – 78% cover in the Belah woodlands and 97% cover in the Poplar Box woodland. Sites WRE2-2, Reveg 1, Creek 2 and Poplar 1 had total ground cover levels that were comparable to the reference sites this year.

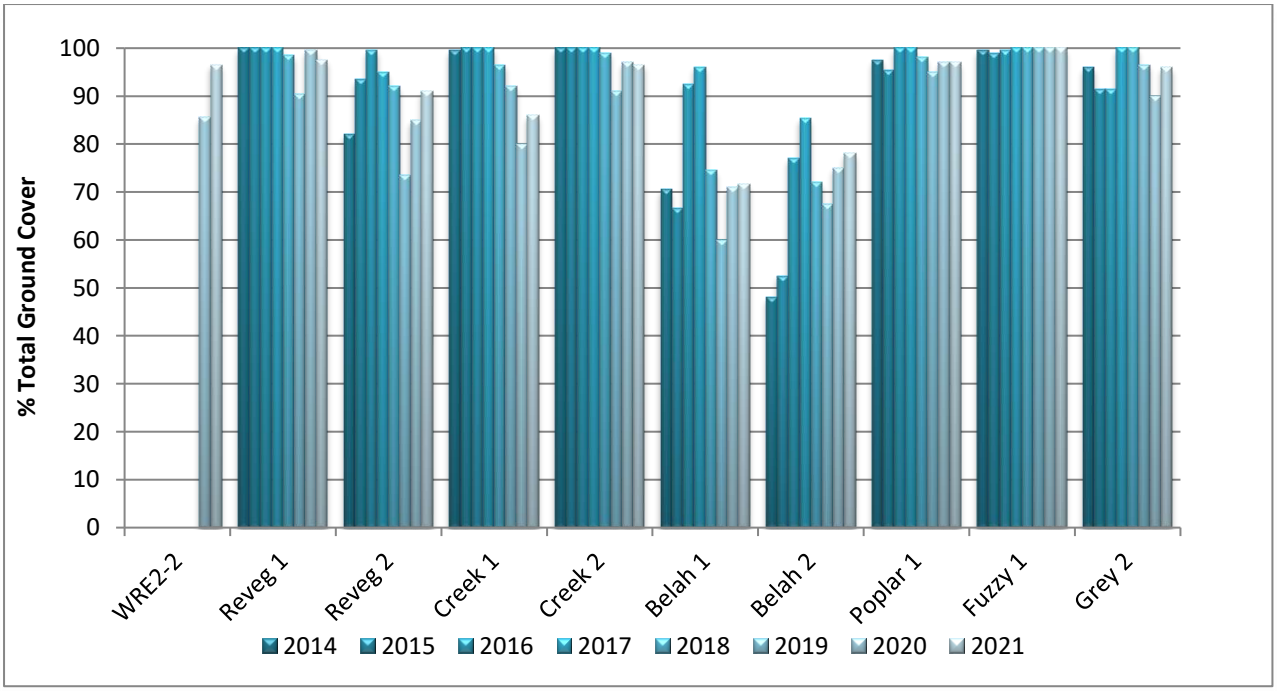


Figure 9-10. Total ground cover recorded in the woodland monitoring sites.

9.2.6 Structural composition

The various combinations of the ground covers and structural compositions of the biodiversity monitoring sites are provided in Figure 9-11. In the woodland reference sites, there has been an increase in perennial plant cover this year which provided 33 – 36% of the total ground cover in the two sites. There was also a decline in annual plant cover in Fuzzy 1 with only 11% cover, while there was an increase in litter which provided 47% cover. In Grey 2 there tended to be a higher abundance of annuals this year with 34% cover and 22% litter. Branches and logs provided 6 - 7% cover in both sites, with additional branches having fallen in 2019 in Fuzzy1 and Grey 2. While rocks were not a feature of these woodland communities, cryptogams continue to provide a small amount of cover in Grey 2.

There was also an increase in perennial plants and litter cover in most revegetation and enhancement areas this year, with there being a simultaneous decrease in annual plants. In Poplar 1 there was a significant increase in perennial plant cover which provided 32% of the total ground cover. There was slightly more litter cover with 36% cover this year and 27% annual plant cover and a small branch, making it characteristically similar to the reference sites.

The three revegetation and both Creek sites continued to have an abundance of annual plants with scattered perennial plants, dead leaf litter and a minor cover of cryptogams. There was however a decline in annual plants and increased litter cover in these sites this year, except in WRE2-2 where annual plant cover has continued to increase. In the Belah woodlands, total ground cover was provided by pockets of annual plants and scattered perennial plant and cryptogams, with a significant increase in perennial plant cover being recorded in Belah 2. This year only Belah 2 had more than the minimum 33% perennial plant cover with 40% cover, however targets were close to being met in Poplar 1 with 32% perennial plant cover.

The Box woodland reference sites were characterised by having at least some mature canopy cover which exceeded 6.0 m in height and typically there was limited projected foliage 0.5 - 6.0 m in height, which was provided by the scattered or occasional understorey shrubs. In terms of mature canopy cover, Belah 2 and Poplar 1 were structurally similar to the reference sites in having a mature overstorey which provided 24 - 29% projected foliage covers on average across the sites. Creek 1 and Belah 1 contained some limited vertical foliage cover in all height categories due to the occurrence of the occasional trees, but overall canopy cover was low. Sites WRE2-2, Reveg 1, Reveg 2 and Creek 2 do not yet contain mature canopy covers however the scattered saplings were starting to provide some lower vertical structures in Reveg 2 and Creek 2. In WRE2-2 and Reveg 1 there were limited trees and/or shrubs and a mature tree canopy is unlikely to develop without intervention.

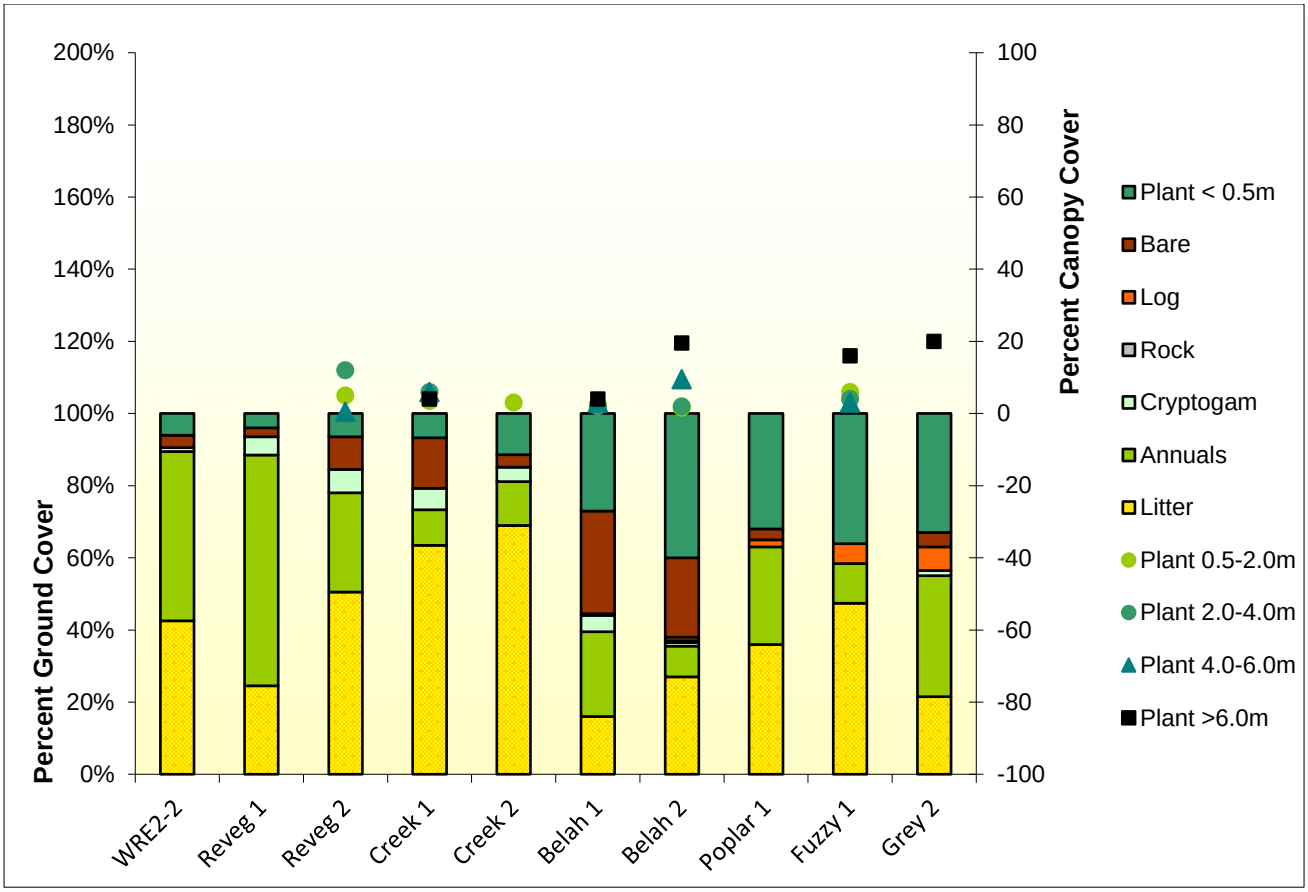


Figure 9-11. Average percent ground cover and projected foliage cover recorded in the woodland monitoring sites in 2021.

9.2.7 Floristic Diversity

In the woodland reference sites total floristic diversity has slightly declined with a total of 53 - 67 species being recorded this year (Figure 9-12). In the enhancement and revegetation sites, there was an increase in total species diversity in Reveg 1 and Reveg 2, however a decline was also recorded in the remaining sites, while no change was recorded in Poplar 1. Species diversity ranged from a low of 35 species in the new WRE2-2 revegetation site to a high of 67 species in Belah 1. This year sites Reveg 2, Creek 2 and both Belah woodland sites had a diversity of plants comparable to the woodland reference sites.

There was also a slight decrease in native (Figure 9-13) and exotic species (Figure 9-14) in most sites, except in Reveg 1 and Reveg 2 where more were recorded this year. In the woodland reference sites, there were 41 – 50 native species, with both Belah woodland sites having a diversity of native species comparable to the woodland reference sites (Figure 9-13). While native species tended to be more diverse than exotic species across the range of sites, the new rehabilitation area WRE2-2 had more exotics than natives and had the lowest native species diversity with 17 species being recorded this year.

In the reference sites, 12 – 17 species were exotic and this year Belah 2 and Poplar 1 were the only revegetation and enhancement sites that had a comparable diversity of exotic species with 16 exotic species. A comprehensive list of flora recorded across the range of biodiversity monitoring sites in 2021 is provided in Appendix 1.

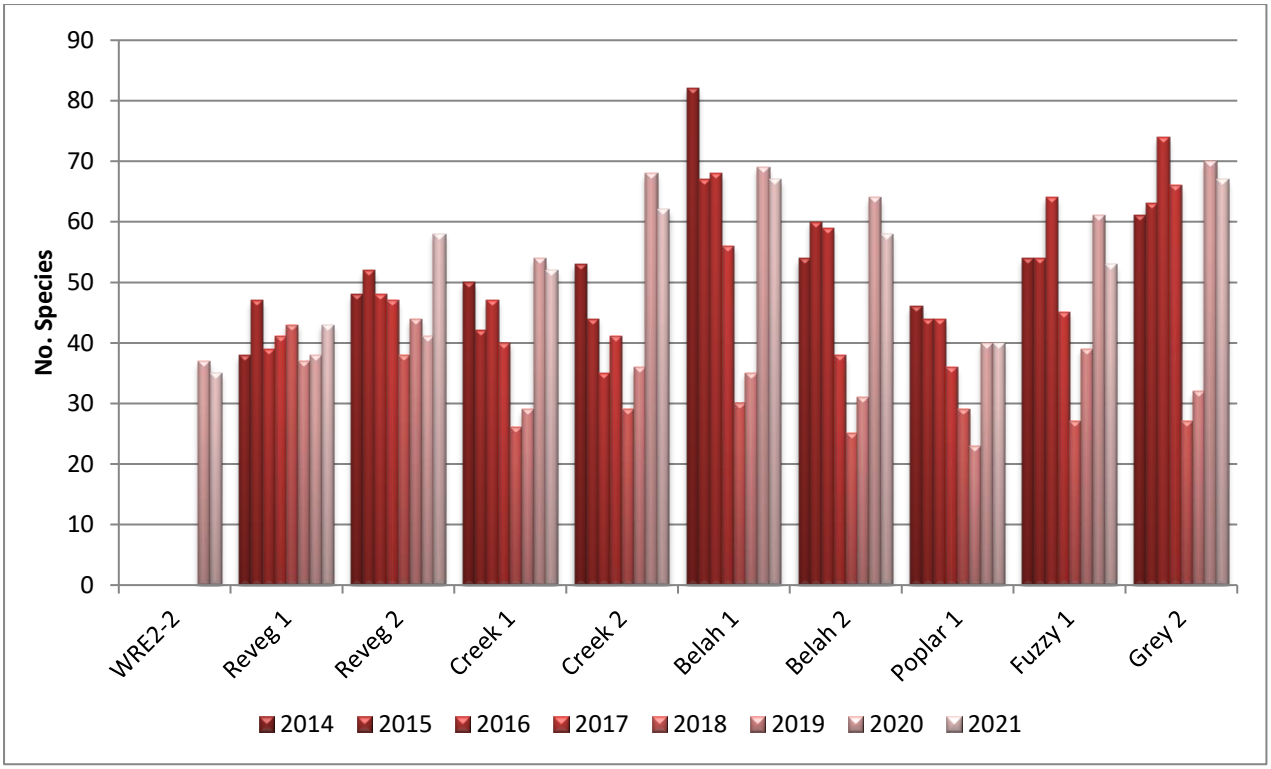


Figure 9-12. Total floristic diversity recorded in the woodland monitoring sites.

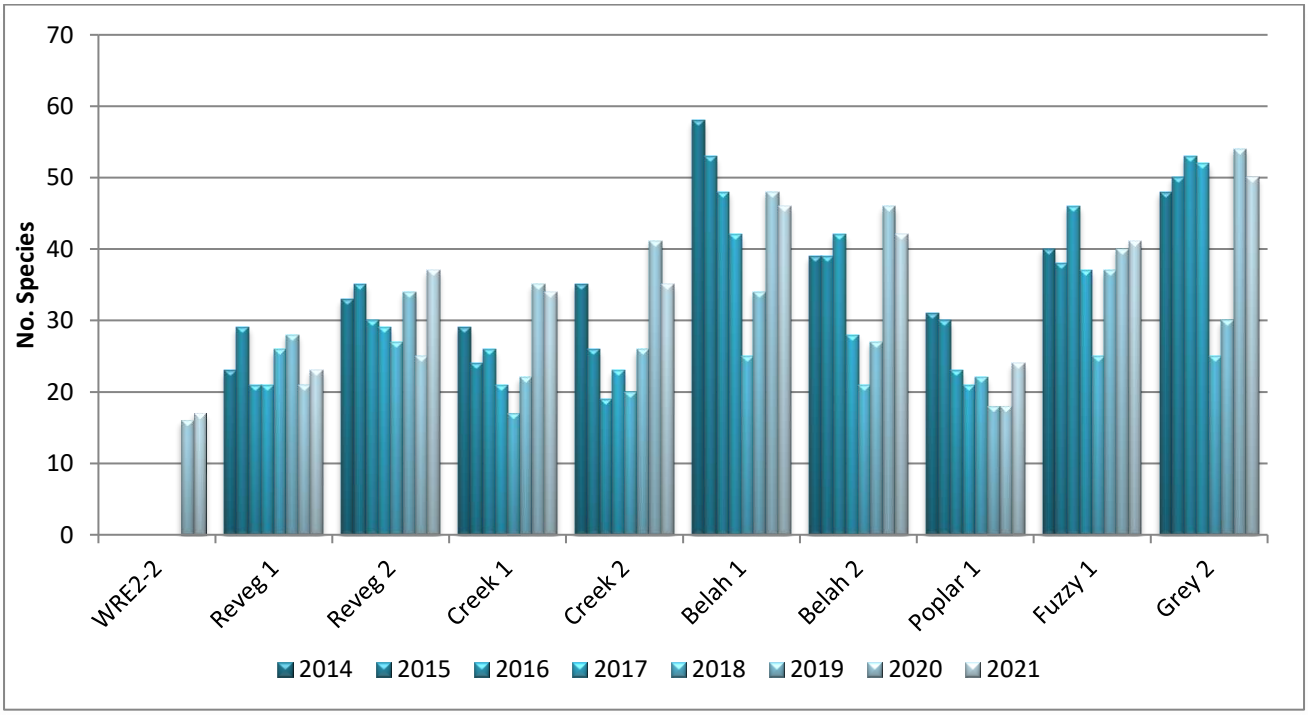


Figure 9-13. Native species diversity recorded in the woodland monitoring sites.

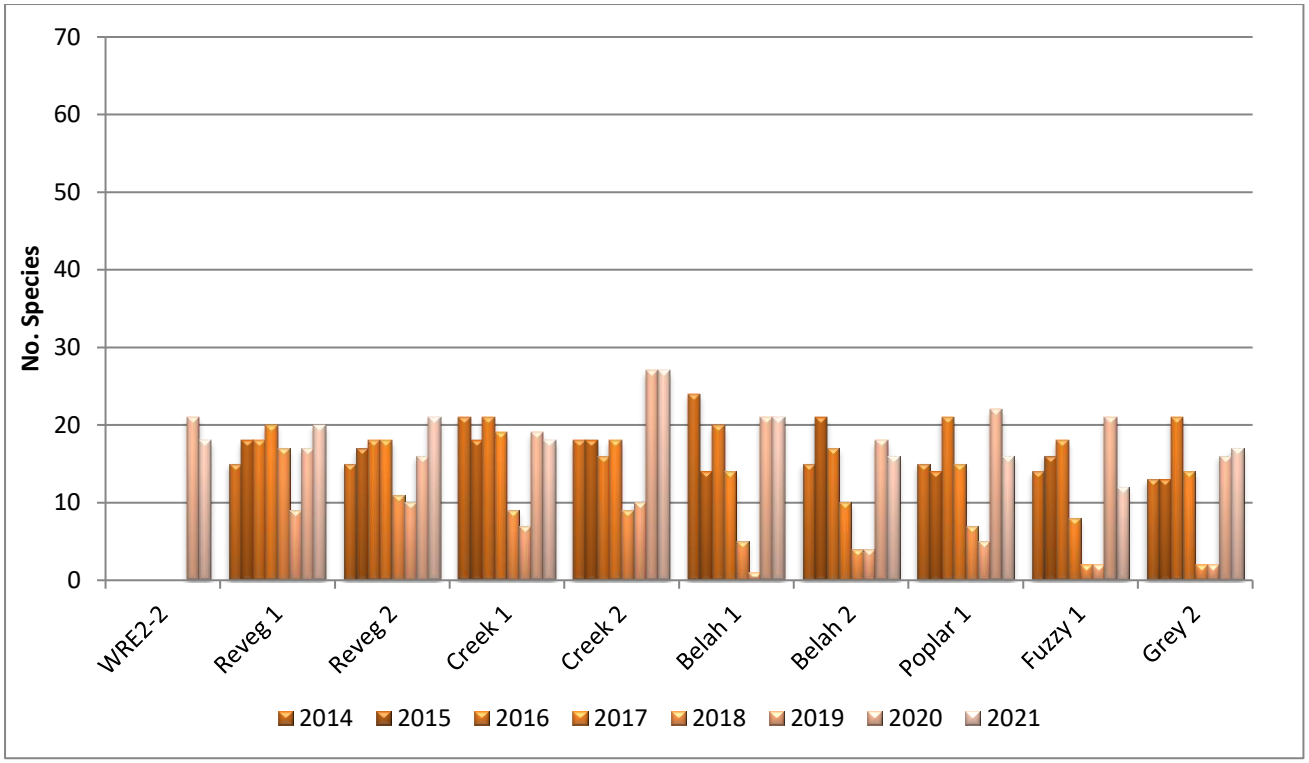


Figure 9-14. Exotic species diversity recorded in the woodland monitoring sites.

9.2.8 Percent endemic ground cover

The percentage of endemic (native) ground cover is an ecological indicator used to provide some measure of the cover abundance of the live native vegetation along the vegetation transect and provides an indication of the level of weediness at the monitoring sites. While it is only an estimation, the percent cover of endemic ground cover species has been derived by the following equation.

Percent cover endemic species = sum of the five Braun- Blanquet scores for native species / (sum of the five Braun- Blanquet scores of exotic species + native species) x 100

Percentage endemic plant cover is strongly correlated with seasonal conditions and levels of disturbance. During improved rainfall conditions there is often an increased abundance of exotic annual species especially in agricultural areas, which subsequently causes a decline in the percentage cover of native plants. During dry periods, often the reverse situation occurs, as the live plant cover is usually left to the hardiest native plants. In addition, the longer an area has had to recover from disturbance such as being newly rehabilitation or cultivated, an increase in endemic plant cover could also be expected.

These trends have occurred in the range of monitoring sites since 2014, and this year an increase in endemic cover was recorded in most sites as annual plant cover tended also to decline, except in WRE2-2 and Creek 2. There was 80 - 83% native plant cover in the reference sites, and while native plants provided more cover than exotics in most sites, all sites fell short of meeting native abundance targets this year. In sites WRE2-2, Reveg 1 and Creek 2 exotic plants were more abundant than natives, with only 2% native cover being recorded in WRE2-2 this year and were therefore weedier than desired (Figure 9-15).

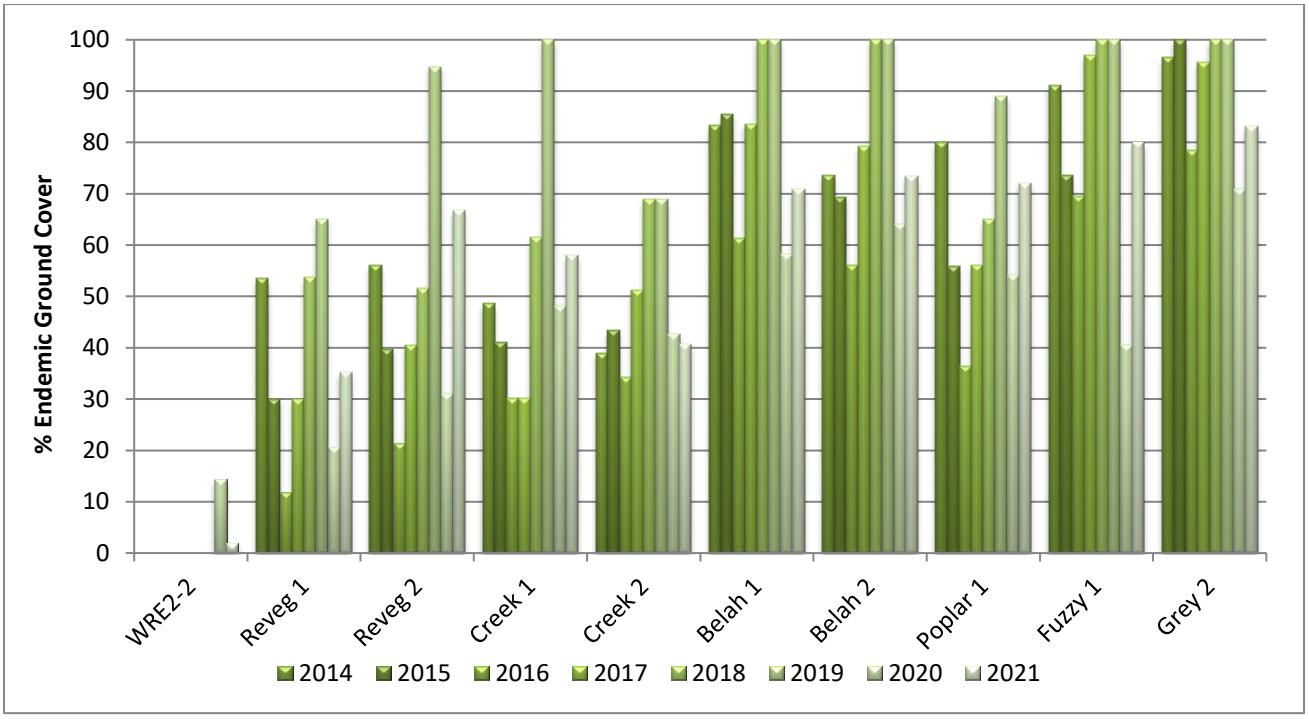


Figure 9-15. Percent endemic ground cover recorded in the woodland monitoring sites.

9.2.9 Vegetation composition

The composition of the vegetation as categorised by nine different growth forms is given in Figure 9-16. In the reference sites herbs and grasses continued to be the most diverse growth forms this year with 25 – 44 different herbs and 10 - 14 grasses. There were 3 - 5 tree species, 3 - 4 shrubs and 2 - 5 different sub-shrubs. There were also up to three reed species and one fern species was recorded in Fuzzy 1.

Compared to the reference sites, the woodland enhancement and revegetation areas had a low diversity of tree species in all sites except Reveg 2, Belah 1 and Poplar 1 and there was a low diversity of shrub species in Reveg 1 and Belah 1. There was also a low diversity of herbs and grasses in WRE2-2. This year Reveg 2 was the only site that had a composition of growth forms comparable to the reference sites.

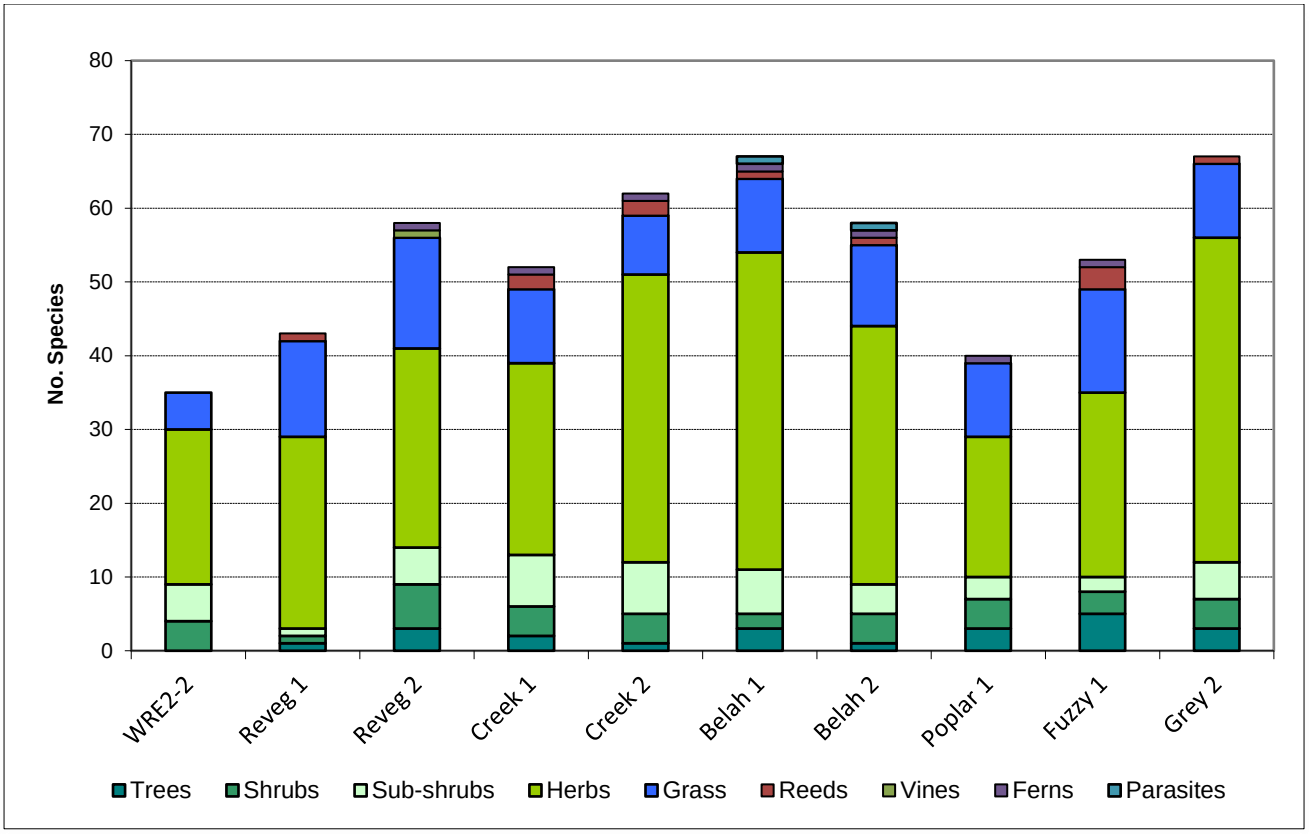


Figure 9-16. Composition of the vegetation recorded in the woodland monitoring sites in 2021.

9.2.10 Most common species

The most common species, those that were recorded in at least seven of the eight biodiversity revegetation and enhancement monitoring sites in 2021, is given in Table 9-5. Plant families with common representatives included Poaceae (Grasses), Chenopodiaceae (saltbushes) and Asteraceae (Daisies).

The native perennials *Vittadinia cuneata* (Fuzzweed), *Crassula colorata* (Dense Stonecrop), *Sclerolaena muricata* Black Roly Poly), *Austrostipa scabra* (Speargrass), *Calotis lappulacea* (Yellow Burr Daisy), *Dichondra repens* (Kidney Weed) and *Oxalis perennans* (Yellow Wood-sorrel) were recorded in at least seven sites. There was also a range of exotic species that were common in most sites and included species such as *Conyza bonariensis* (Fleabane), *Lolium rigidum* (Wimmera Ryegrass), *Sonchus oleraceus* (Milk Thistle), *Arctotheca calendula* (Capeweed) and *Lepidium africanum* (Peppercress).

Most of the other common exotic species were annual ground covers, with the exception of *Lycium ferocissimum* (African Boxthorn) which was also recorded in six revegetation and enhancement areas as well as both reference sites. There were also a variety of different native perennial sub-shrubs and ground covers. Most of these species were also recorded in at least one of the reference sites. A comprehensive list of species recorded in all woodland monitoring sites in 2021 has been included in Appendix 1.

Table 9-5. Species that were recorded in at least seven of the eight biodiversity revegetation and enhancement monitoring sites in 2021.

exotic	Scientific Name	Common Name	Habit	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	WRE2-2	Total	Fuzzy 1	Grey 2
*	*Conyza bonariensis*	Fleabane	h	1	1	1	1	1	1	1	1	**8**	1	
*	*Lolium rigidum*	Wimmera Ryegrass	g	1	1	1	1	1	1	1	1	**8**	1	1
*	*Sonchus oleraceus*	Milk Thistle	h	1	1	1	1	1	1	1	1	**8**	1	1
	Vittadinia cuneata	Fuzzweed	h	1	1	1	1	1	1	1	1	**8**	1	1
*	*Arctotheca calendula*	Capeweed	h		1	1	1	1	1	1	1	**7**		1
	Crassula colorata	Dense Stonecrop	h		1	1	1	1	1	1	1	**7**		1
	Sclerolaena muricata	Black Roly Poly	ss	1	1	1		1	1	1	1	**7**		1
	Austrostipa scabra	Speargrass	g	1	1	1	1	1	1	1		**7**	1	1
	Calotis lappulacea	Yellow Burr Daisy	h	1	1	1	1	1	1	1		**7**	1	1
	Dichondra repens	Kidney Weed	h	1	1	1	1	1	1	1		**7**	1	1
*	*Lepidium africanum*	Peppercress	h	1	1		1	1	1	1	1	**7**	1	1
	Oxalis perennans	Yellow Wood-sorrel	h	1	1	1	1	1	1	1		**7**	1	1

9.2.11 Most abundant species

The most abundant species recorded in each of the woodland monitoring sites this year are provided in Table 9-6. The most abundant species were those nominated to have collectively summed to a Braun-Blanquet total of 10 or more from the five replicated sub-plots along the vegetation transect. The maximum score that can be obtained by an individual species is 30.

This year, two *Trifolium* species were the most abundant in the old cropping revegetation sites, while in WRE2-2 *Chloris gayana* (Rhodes Grass) and *Medicago truncatula* (Barrell Medic) were most dominant. The native species *Vittadinia cuneata* (Fuzzweed) was the most abundant in Creek 2, *Einadia trigonos* (Fishweed) was abundant in Poplar 1 while in Fuzzy 1, *Carex inversa* (Knob Sedge) provided the most ground cover. While species diversity was relatively high in the Creek 1, the Belah woodland sites and Grey 2, no species was sufficiently abundant to meet the criteria in these sites this year.

Table 9-6. The most abundant species recorded in the biodiversity monitoring sites in 2021.

Scientific Name	Common Name	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1	WRE2-1	Fuzzy 1	Grey 2
**Trifolium subterraneum*	Subterraneum Clover	16									
* *Trifolium angustifolium*	Narrow-leaf Clover		10								
Vittadinia cuneata	Fuzzweed				12						
Einadia trigonos	Fishweed							17			
**Chloris gayana*	Rhodes Grass								21		
* *Medicago truncatula*	Barrel Medic								17		
Carex inversa	Knob Sedge									12	

9.2.12 Rill assessment

No rills have been recorded in any woodland monitoring site.

9.2.13 Soil analyses

Soil analyses have been taken from the woodland reference sites as they will provide the completion targets for woodland rehabilitation monitoring sites. Soil analyses are not included in the Biodiversity Monitoring program (TGO 2014). In 2020, a new woodland rehabilitation area was established on top of WRE2. The soil results from the rehabilitation areas are compared to the two woodland reference sites and/or desirable agricultural levels in clay loam soils for growing introduced pastures and crops. The results of the full soil analyses are provided in Appendix 2.

9.2.13.1 pH

Figure 9-17 shows the pH recorded in the woodland reference sites compared to the "desirable" range in medium or clay loam soils as prescribed by the agricultural industry for growing introduced pastures and crops. There continues to be minimal change in the reference sites with Fuzzy 1 and Grey 2 having a pH range of 5.8 – 6.1 this year and continue to be classed as moderately acidic (Bruce & Rayment 1982) and within desirable levels. Soil pH in WRE2-2 had increased to 7.3 and while it was higher than the local soils, it can be considered neutral and within acceptable agricultural ranges.

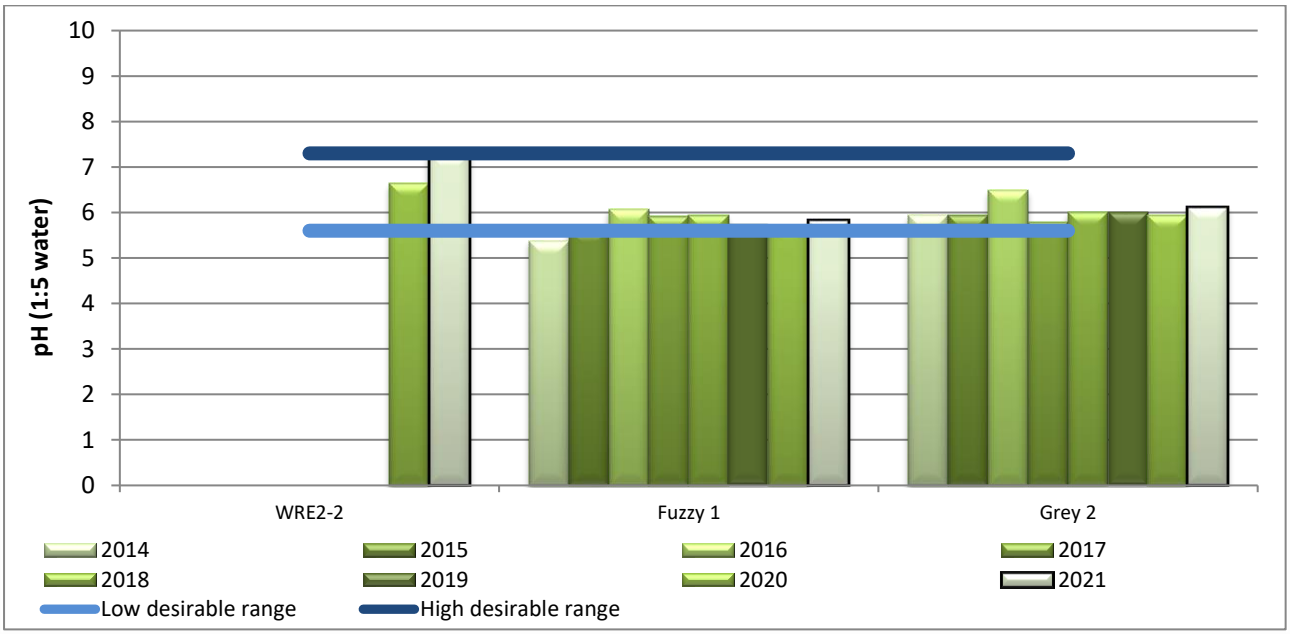


Figure 9-17. Soil pH recorded in the woodland monitoring sites compared to desirable agricultural ranges.

9.2.13.2 Conductivity

Figure 9-18 shows the Electrical Conductivity (EC) recorded in the woodland reference sites compared to the "desirable" range in medium or clay loam soils as prescribed by the agricultural industry for growing introduced pastures and crops. EC concentrations in the woodland reference sites continue to be low and ranged from 0.025 – 0.045 dS/cm indicating there were low levels of soluble salts and the soils are non-saline. In WRE2-2, EC was significantly high last year and were slightly saline. This year, a dramatic reduction in EC was recorded and with an EC of 0.065 dS/cm, was within acceptable levels and non saline.

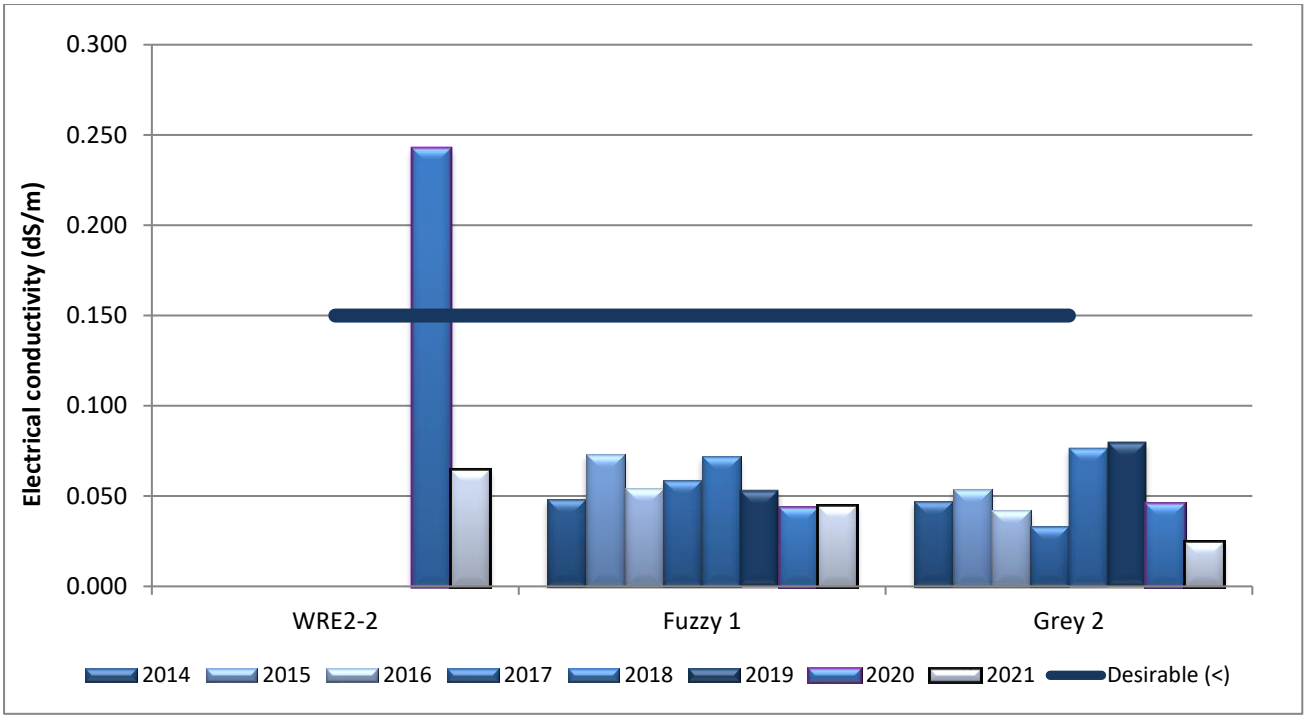


Figure 9-18. Electrical Conductivity recorded in the woodland monitoring sites compared to the desirable agricultural threshold.

9.2.13.3 Organic Matter

There has been some variation in Organic matter (OM) within and between the woodland reference sites with this likely to be associated with inherent variability within the sites, and or old stockcamps and/or disturbance history. High levels of OM continue to be recorded in Fuzzy 1, while they were comparatively low in Grey 2 and ranged from 3.4 – 5.9% (Figure 9-19). In WRE2-2, OM levels have marginally improved with 1.2% OM being recorded this year.

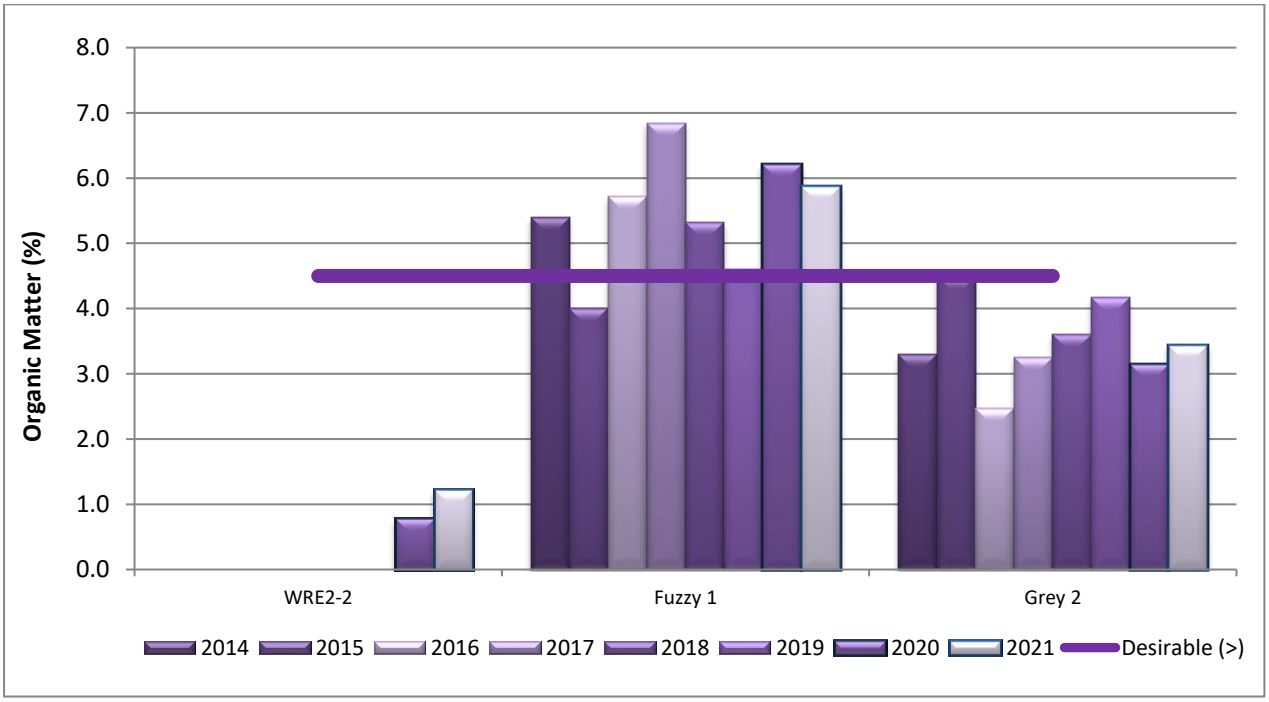


Figure 9-19. Organic Matter concentrations recorded in the woodland monitoring sites compared to desirable agricultural levels.

9.2.13.4 Phosphorous

Phosphorous levels in the woodland reference sites had slightly increased but remained considerably lower than the desirable level with concentrations of 25 – 29 mg/kg (Figure 9-20). In WRE2-2, P levels were higher than the local levels with 34 mg/kg.

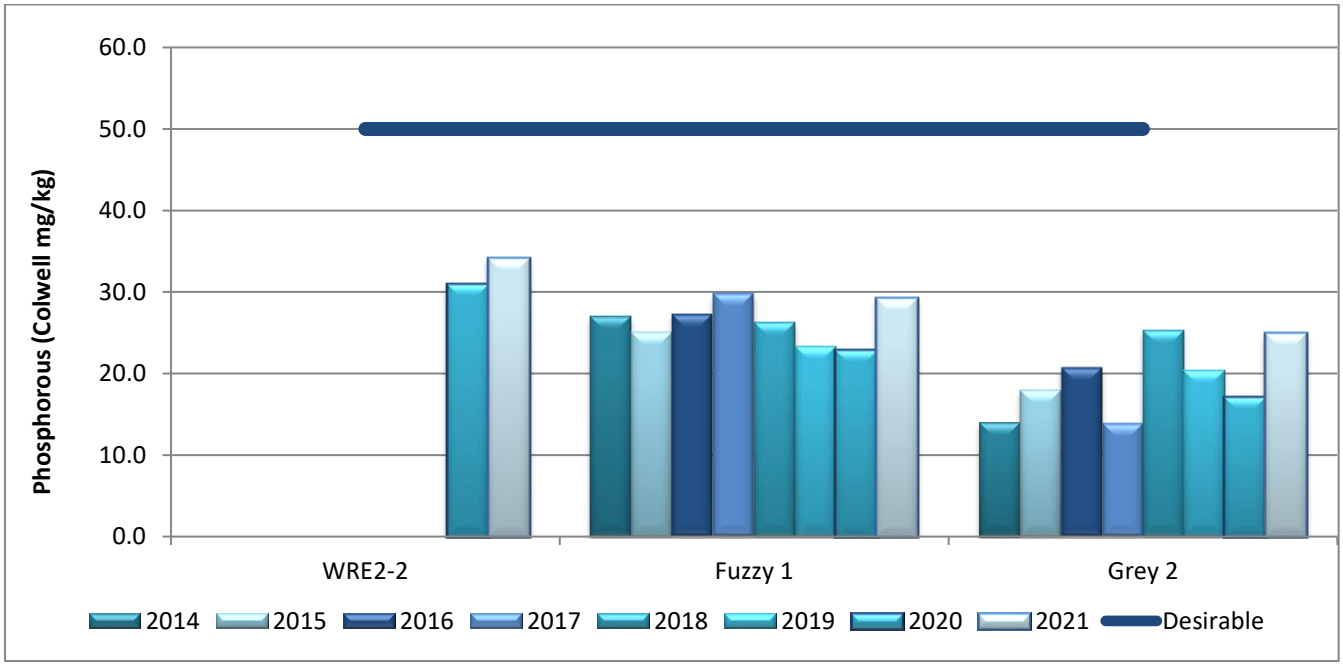


Figure 9-20. Phosphorous (Colwell) concentrations recorded in the woodland monitoring sites compared to the desirable agricultural level.

9.2.13.5 Nitrate

There is often high variability in nitrate concentration in response to changes in seasonal conditions. Nitrate concentrations in Fuzzy 1 and Grey 2 have been declining since 2019 and were significantly lower than the agricultural levels with N concentrations of 1.6 – 1.9 mg/kg (Figure 9-21). This year N levels in WRE2-2 had slightly increased and were comparable to those recorded in the local woodlands 1.6 mg/kg being recorded this year.

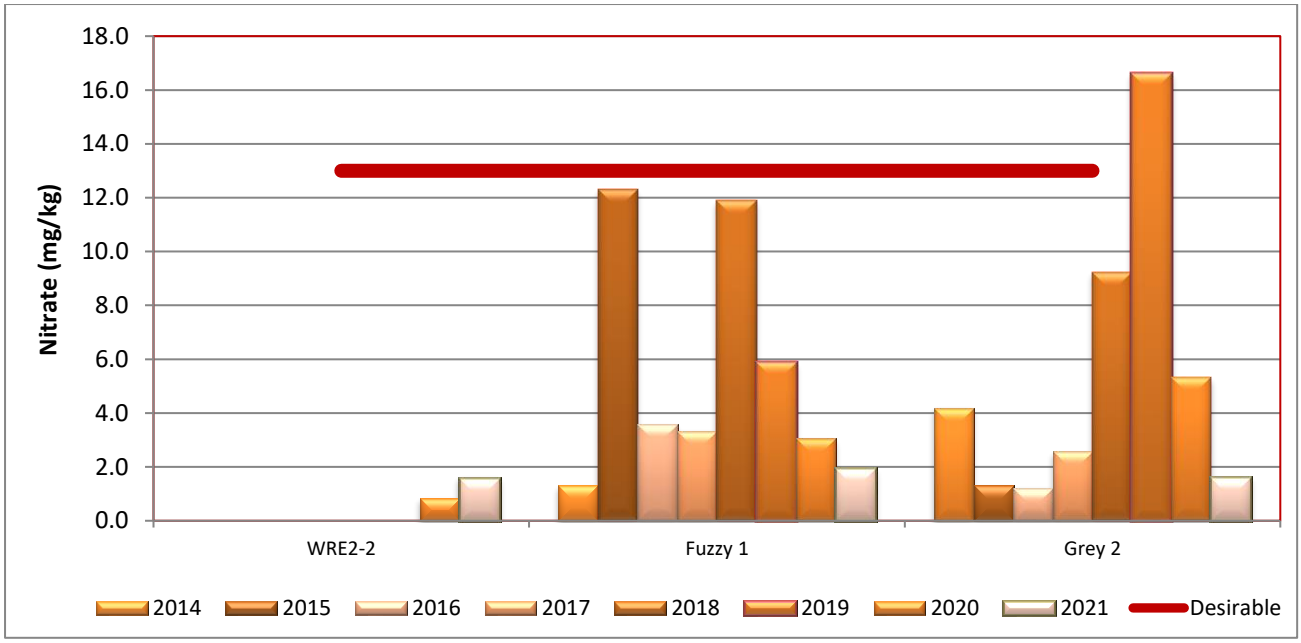


Figure 9-21. Nitrate concentrations recorded in the woodland monitoring sites compared to the desirable agricultural levels.

9.2.13.6 Cation Exchange Capacity

Cation Exchange Capacity (CEC) is the capacity of the soil to hold the major cations (Calcium, Magnesium, Sodium and Potassium) and is also a measure of the potential fertility of the soil. Soils with a higher clay fraction tend to have a higher CEC. Organic matter has a very high CEC, while sandy soils rely heavily on the high CEC of organic matter for the retention of nutrients in the topsoil. Because a higher CEC usually indicates more clay and organic matter is present in the soil, high CEC soils generally have greater water holding capacity than low CEC soils. This year there was a slight increase in CEC in the woodland reference sites and ranged from 8.3 – 10.8 cmol+/kg (Figure 9-22) indicating they are likely to have a slightly low fertility and retention capacity. In WRE2-2, CEC was slightly lower this year with 9.8 cmol+/kg but was comparable to the local woodlands.

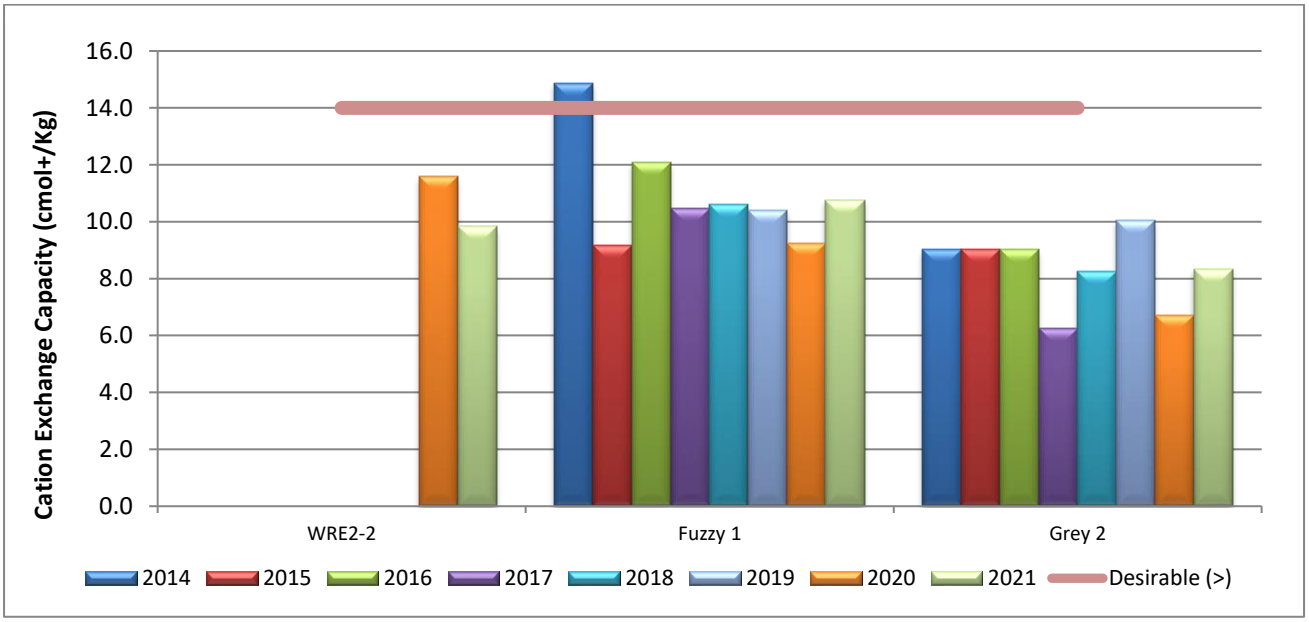


Figure 9-22. Cation Exchange Capacity recorded in the woodland monitoring sites compared to the desirable agricultural levels.

9.2.13.7 Exchangeable Sodium Percentage

Sodicity refers to a significant proportion of Sodium in the soil compared to other cations with soil considered to be sodic when there is sufficient sodium to interfere with its structural stability which often interferes with plant growth. Sodic soils tend to suffer from poor soil structure including hard soil, hardpans, surface crusting and rain pooling on the surface, which can affect water infiltration, drainage, plant growth, cultivation and site accessibility.

The soils in the woodland reference sites continued to show low ESP this year, ranging between 0.8 – 1.1% and this range continued to be well below the threshold of 5% indicating the soils were non sodic (Figure 9-23, Isbell 1996). In WRE2-2, ESP had slightly increased to 2.4% however these remained within acceptable levels and were non sodic.

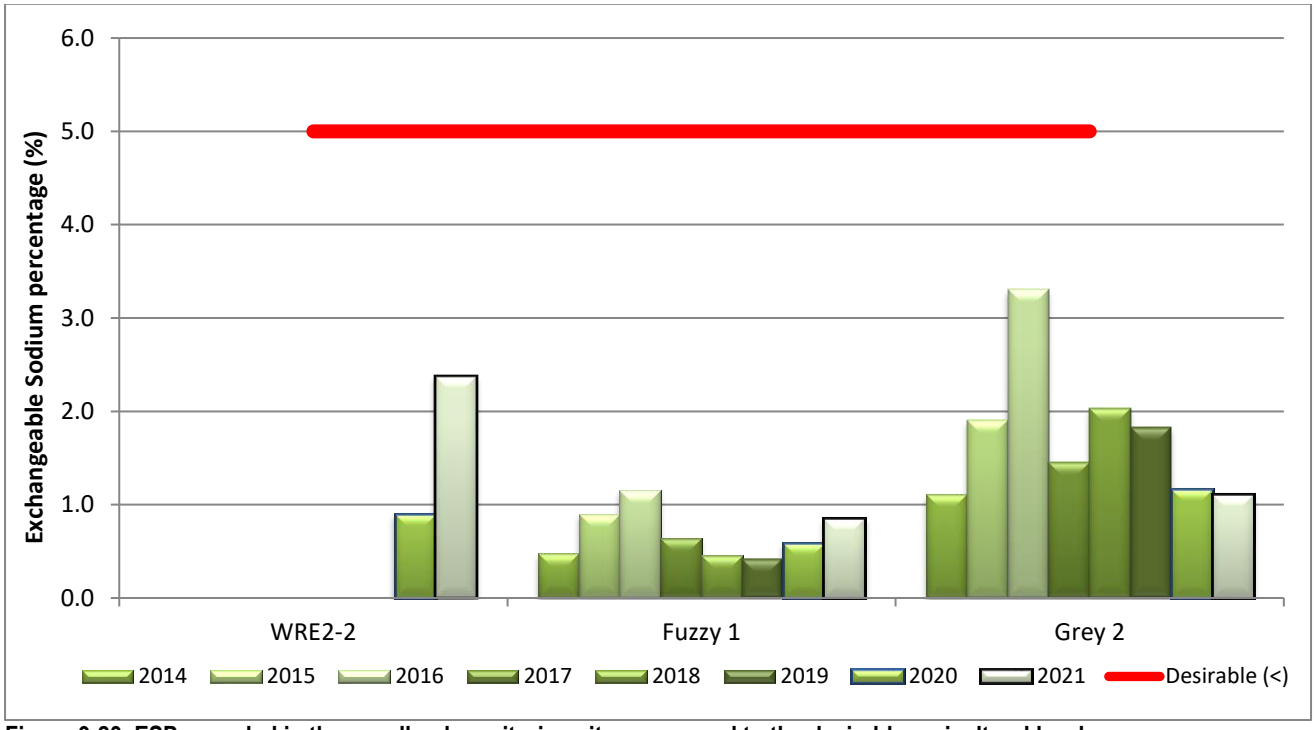


Figure 9-23. ESP recorded in the woodland monitoring sites compared to the desirable agricultural levels.

9.3 Woodland monitoring site performance towards meeting ecological performance indicators

Table 9-7 indicates the performance of the TGO woodland rehabilitation monitoring sites against a range of primary and secondary ecological performance indicators obtained from the woodland reference sites in 2021. The selection of criteria has been presented in order of ecosystem successional processes, beginning with landform establishment and stability (orange) and ending with indicators of ecosystem and land use development (blue) to remain consistent with the latest revision of the ESG3 MOP guidelines (NSW T&I 2013). Rehabilitation sites meeting or exceeding the range values of the reference sites have been identified with a shaded colour box and have therefore been deemed to meet the ecological targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites. In some cases, the site may not fall within ranges based on these data but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a striped shaded box to indicate that it falls within "desirable agricultural" ranges.

Table 9-7. Performance of the TGO woodland biodiversity monitoring sites against primary and secondary ecological performance indicators in 2021.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
Performance indicators are quantified by the range of values obtained from replicated reference sites assessed in 2021							2021	2021	Lower KPI	Upper KPI	2021							
Phase 2: Landform establishment and stability	**Landform slope, gradient**	Landform is designed accordingly and suitable for final land use	Slope	Landform is generally compatible within the context of the local topography and final landform design.		< Degrees (18°)	0	0	0	0	0	0	0	0	4	6	4	0
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Number of gullies or rills >0.3m in width or depth in a 50m transect are limited and stabilising		No.	0	0	0	0	0	0	0	0	0	0	0	0
			Cross-sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	0	0	0	0	0	0	0	0	0	0	0	0
Phase 3: Growth medium development	**Soil chemical, physical properties and amelioration**	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6-7.3)	5.8	6.1	5.8	6.1	7.3	NA	NA	NA	NA	NA	NA	NA

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
			EC		Electrical Conductivity is typical of the surrounding landscape or is less than the desirable threshold as provided by the agricultural industry	< dS/m (<0.150)	0.045	0.025	0.025	0.045	0.065	NA	NA	NA	NA	NA	NA	NA
			Organic Matter	Organic Matter levels are typical of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (4.5)	5.9	3.4	3.4	5.9	1.2	NA	NA	NA	NA	NA	NA	NA
			Phosphorous (Colwell)	Available Phosphorus is typical of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		mg/kg (50)	29.2	24.9	24.9	29.2	34.1	NA	NA	NA	NA	NA	NA	NA
			Nitrate		Nitrate levels are typical of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	mg/kg (12.5)	1.9	1.6	1.6	1.9	1.6	NA	NA	NA	NA	NA	NA	NA
			CEC		Cation Exchange Capacity is typical of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	10.8	8.3	8.3	10.8	9.8	NA	NA	NA	NA	NA	NA	NA
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of the surrounding landscape or is less than the 5% threshold for sodicity	% (<5)	0.8	1.1	0.8	1.1	2.4	NA	NA	NA	NA	NA	NA	NA

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
Phase 4: Ecosystem & Land Use Establishment	**Landscape Function Analysis (LFA): Landform stability and organisation**	Landform is stable and performing as it was designed to do	LFA Stability	The LFA stability index is comparable to the local remnant vegetation		%	78.8	70	70	78.8	73.0	67.8	66.2	70	67.7	67.6	68.1	78
			LFA Landscape organisation	The Landscape Organisation Index is comparable to the local remnant vegetation		%	100	100	100	100	100	100	76	92	88	100	100	96
	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees		The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to the local remnant vegetation.	species/area	6	6	6	6	4	1	9	4	5	4	5	5
				The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species are comparable to the local remnant vegetation		% population	76	39	39	76	100	100	97	100	94	12	17	53
			Total species richness		The total number of live plant species is comparable to the local remnant vegetation	No./area	53	67	53	67	35	43	58	52	62	67	58	40
			Native species richness		The total number of live native plant species is greater than or comparable to the local remnant vegetation	>No./area	41	50	41	50	17	23	37	34	35	46	42	24

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
			Exotic species richness	The total number of live exotic plant species is less than or comparable to the local remnant vegetation		<No./area	12	17	12	17	18	20	21	18	27	21	16	16
			Ratio of native to exotic species		The ratio of live native species compared to live exotic plant species is more than or comparable to the local remnant vegetation	>	3.4	2.9	2.9	3.4	0.9	1.2	1.8	1.9	1.3	2.2	2.6	1.5
	Vegetation density	Vegetation contains a density of species comparable to the local remnant vegetation	Density of shrubs and juvenile trees		The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to the local remnant vegetation	No./area	42	54	42	54	15	1	31	17	35	120	99	19
				The density of native shrubs or juvenile trees with a stem diameter < 5cm is comparable to the local remnant vegetation		No./area	32	21	21	32	15	1	30	17	33	14	17	10
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to the local remnant vegetation		No./area	5	3	3	5	0	1	3	2	1	3	1	3
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to the local remnant vegetation		No./area	3	4	3	4	4	1	6	4	4	2	4	4
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to the	No./area	2	5	2	5	5	1	5	7	7	6	4	3

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
					local remnant vegetation													
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to the local remnant vegetation		No./area	25	44	25	44	21	26	27	26	39	43	35	19
			Grasses	The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	14	10	10	14	5	13	15	10	8	10	11	10
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to the local remnant vegetation	No./area	3	1	1	3	0	1	0	2	2	1	1	0
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to the local remnant vegetation	No./area	0	0	0	0	0	0	1	0	0	0	0	0
			Ferns		The number of ferns comprising the vegetation community is comparable to the local remnant vegetation	No./area	1	0	0	1	0	0	1	1	1	1	1	1
			Parasites		The number of parasitic plants comprising the vegetation community is comparable to the local remnant vegetation	No./area	0	0	0	0	0	0	0	0	0	1	1	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
Phase 5: Ecosystem & Land Use Development	**Landscape Function Analysis (LFA): Landform function and ecological performance**	Landform is ecologically functional and performing as it was designed to do	LFA Infiltration	LFA infiltration index is comparable to the local remnant vegetation		%	67	48.3	48.3	67	38.9	42.8	40.8	41.3	40.3	36.4	32.5	60.8
			LFA Nutrient recycling	LFA nutrient recycling index is comparable to the local remnant vegetation		%	65.6	47.3	47.3	65.6	44.6	42.6	38.8	42.3	41.5	39.1	35.5	55.7
	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Litter cover		Percent ground cover provided by dead plant material is comparable to the local remnant vegetation	%	47.4	21.5	21.5	47.4	42.5	24.5	50.5	63.5	69	16	27	36
			Annual plants		Percent ground cover provided by live annual plants is comparable to the local remnant vegetation	<%	11	33.5	11	33.5	47	64	27.5	9.8	12.1	23.5	8.5	27
			Cryptogam cover		Percent ground cover provided by cryptogams (e.g. mosses, lichens) is comparable to the local remnant vegetation	%	0	1.5	0	1.5	1	5	6.5	6	4	4.5	1	0
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to the local remnant vegetation	%	0	0	0	0	0	0	0	0	0	0.5	0.5	0
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to the local remnant vegetation	%	5.5	6.5	5.5	6.5	0	0	0	0	0	0	1	2

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
			Bare ground		Percentage of bare ground is less than or comparable to the local remnant vegetation	< %	0	4	0	4	3.5	2.5	9	14	3.5	28.5	22	3
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (<0.5m in height) is comparable to the local remnant vegetation		%	36.1	33	33	36.1	6	4	6.5	6.7	11.4	27	40	32
			Total Ground Cover	Total groundcover (the sum of protective ground cover components) is comparable to the local remnant vegetation		%	100	96	96	100	96.5	97.5	91	86	96.5	71.5	78	97
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance	The abundance of native species per square metre averaged across the site is comparable to the local remnant vegetation		> species/m^2	5	8.6	5	8.6	0.2	4.2	5.4	4.8	4.2	7.8	5.6	5
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site is comparable to the local remnant vegetation	< species/m^2	1.2	2	1.2	2	3.6	6.2	3.4	4	6.4	3.2	2.6	2.8
	Native ground cover abundance	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m) compared to exotic species is comparable to the local remnant vegetation		%	80	83.1	80	83.1	2	35.2	66.7	58.0	40.7	70.8	73.3	72.1

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees <0.5m in height is comparable to the local remnant vegetation		No./area	12	16	12	16	3	0	0	3	1	35	24	13
			shrubs and juvenile trees 0.5 - 1m in height		The number of shrubs or juvenile trees 0.5-1m in height is comparable to the local remnant vegetation	No./area	13	18	13	18	4	0	2	2	5	49	44	5
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height is comparable to the local remnant vegetation	No./area	9	6	6	9	1	0	2	3	6	23	22	1
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to the local remnant vegetation		No./area	5	3	3	5	5	0	6	3	0	9	6	0
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees >2m in height is comparable to the local remnant vegetation	No./area	3	11	3	11	2	1	21	6	23	4	3	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
	Ecosystem structure	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to the local remnant vegetation		% cover	6	0	0	6	0	0	5	3.5	3	2.5	1.6	0
			Foliage cover 2 - 4m	Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to the local remnant vegetation		% cover	4	0	0	4	0	0	12	6	0	2	2	0
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to the local remnant vegetation	% cover	3	0	0	3	0	0	0.5	6	0	3	9.5	0
			Foliage cover >6m	Projected foliage cover provided by perennial plants >6m vertical height stratum indicates the community structure is comparable to the local remnant vegetation		% cover	16	20	16	20	0	0	0	4	0	4	19.5	0
	Tree diversity	Vegetation contains a diversity of tree and mature shrub species comparable to that	Tree diversity		The diversity of trees or shrubs with a stem diameter >5cm is comparable to the local remnant vegetation	species/area	3	3	3	3	0	1	4	5	1	2	1	2

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
		of the local remnant vegetation		The percentage of trees and shrubs with a stem diameter >5cm dbh which are local endemic species, and these percentages are comparable to the local remnant vegetation		%	100	100	100	100	0	100	100	100	100	100	100	100
	Tree density	Vegetation contains a density of tree and mature shrub species comparable to that of the local remnant vegetation	Tree density	The density of shrubs or trees with a stem diameter > 5cm is comparable to the local remnant vegetation		No./area	11	9	9	11	0	1	20	12	37	9	8	13
			Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards the local remnant vegetation.	cm	55	54	54	55	0	5	9	12	11	33	39	34
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees		The percentage of the tree population which are live individuals is comparable to the local remnant vegetation	% population	91	89	89	91	0	100	100	100	100	89	88	69
			Healthy trees	The percentage of the tree population which are in healthy condition is comparable to the local remnant vegetation		% population	64	0	0	64	0	0	60	83	81	11	13	15
			Medium health		The percentage of the tree population which are in a medium health condition is comparable to the local remnant vegetation	% population	9	56	9	56	0	100	35	17	19	67	75	46

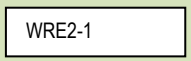
Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Fuzzy 1	Grey 2	2021 Woodland ecosystem range		WRE2-2	Reveg 1	Reveg 2	Creek 1	Creek 2	Belah 1	Belah 2	Poplar 1
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback is comparable to the local remnant vegetation	<% population	18	33	18	33	0	0	5	0	0	11	0	8
			Dead Trees		The percentage of the tree population which are dead (stags) is comparable to the local remnant vegetation	<% population	9	11	9	11	0	0	0	0	0	11	13	31
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	0	0	0	0	0	0	0	0	0	56	25	0
			Flowers/fruit: Trees	The presence of reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to the local remnant vegetation		% population	36	11	11	36	0	100	15	0	43	33	25	54
			Hollows		The percentage of the tree population which have hollows provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	36	22	22	36	0	0	0	0	0	0	0	0

10 Results: Pasture monitoring sites

10.1 Permanent photo-points

Photographs taken along the permanent vegetation monitoring transect of the pasture rehabilitation and reference monitoring sites have been provided in Table 10-1. Note that photos in some years have been omitted due to the increasing quantities of data. Please refer to previous reports.

Table 10-1. Permanent photo-points of the pasture monitoring sites.

2016 Photo	2017 Photo	2018 Photo	2020 Photo	2021 Photo
Noise Bund 1 (Rehabilitation site): This site was rehabilitated in October 2015. It was rehabilitated using 200mm of topsoil, 10t/ha gypsum and seeded with a pasture mix (see MOP). Straw mulch was hydro-mulched over the entire area.				
				
WRE2-1 (Rehabilitation site): This site was rehabilitated in February 2017. It was rehabilitated using 200mm of topsoil, 10t/ha gypsum and seeded with a pasture mix (see MOP). Straw mulch was hydro-mulched over the entire area.				
N/A 				

2016 Photo	2017 Photo	2018 Photo	2020 Photo	2021 Photo
WRE3-1 (Rehabilitation site): This site was rehabilitated in February 2017. It was rehabilitated using 200mm of topsoil over rock, 10t/ha gypsum and seeded with a pasture mix (see MOP). Straw mulch was hydro-mulched over the entire area.				
N/A WRE3-1				
WRE3-2 (Rehabilitation site): This site was rehabilitated in February 2019. It was rehabilitated using 200mm of topsoil over rock, 10t/ha gypsum and seeded with a pasture mix (see MOP). Straw mulch was hydro-mulched over the entire area.				
WRE3-2	NA	NA		
Pasture 1 (Reference site): This was an area of pasture recovering after a long cropping history.				
Pasture 1				

Pasture 2 (Reference site): This was an area of pasture recovering after a long cropping history.

10.2 Ecological trends and performance against a selection of ecological performance indicators

The following section provides a summary of a range of ecological data obtained from the pasture rehabilitation areas on the Noise Bund, WRE2 and WRE3 compared to two native pasture reference sites, Pasture 1 and Pasture 2, which have been recovering after a long agricultural history.

10.2.1 Landscape Function Analyses

10.2.1.1 Landscape Organisation

Both pasture reference sites continued to be comprised of scattered native perennial grasses and sub-shrubs and exotic annual grasses and herbs. The ongoing drought caused a decline in live plant growth and a deterioration of the litter layer with minor bare patches developing in Pasture 1 in 2019, but both sites continued to have a high functional patch area. Over the past two years improved conditions resulted in a significant increase in annual and perennial plant growth and both pastures sites continued to have 100% functional patch areas (Figure 10-1).

On WRE2-1, there has been adequate establishment of exotic pasture grasses and good ground cover has been maintained despite the limited active plant growth during the drought, largely due to less disturbance by macropods compared to the other rehabilitation sites. On Noise Bund 1 and WRE3-1, small bare patches had developed during the drought as a result of macropod grazing, resulting in a slight reduction in functional patch area in 2018 and 2019. There has also been a significant increase in annual plant cover on Noise Bund 1, with 100% functional patch area continuing to be recorded, and in WRE3-1, 100% LO was also recorded this year. The newest area of rehabilitation on the western side of WRE3 (WRE3-2), was also dominated by annual plants, however there was a slight decline in cover and with 91% LO was slightly low this year compared to the pasture reference sites.

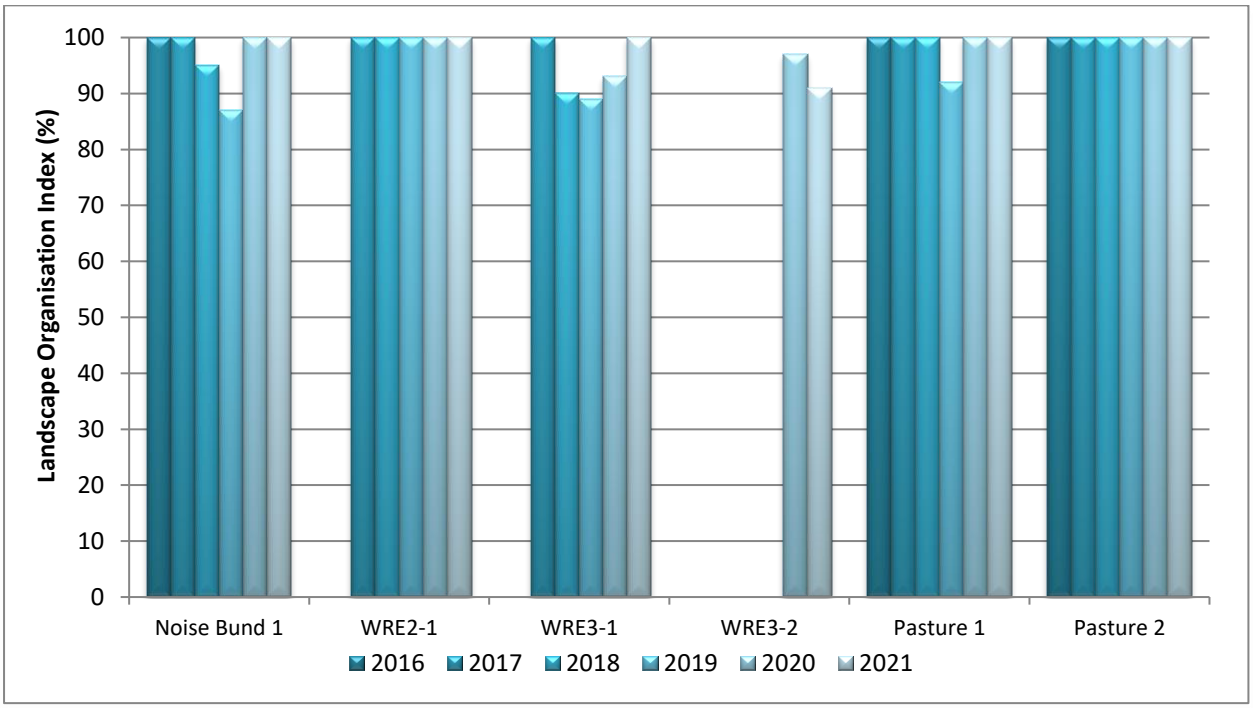


Figure 10-1. Landscape Organisation recorded in the pasture monitoring sites.

10.2.1.2 Soil surface assessments

10.2.1.2.1 Stability

The stability within the pasture reference sites were largely dependent on the degree of cover provided by the perennial ground covers, leaf litter and annual plants and cryptogam abundance which collectively increase soil coherency and the development of a more stable soil surface which provided protective cover against erosion. The soils within the reference sites were typically sandy clay and these may become slightly unstable when exposed. Due to the improved seasonal conditions, there has been a slight increase in stability in the reference sites over the past two years which provided a range of 69.0 – 72.0 this year (Figure 10-2).

Increased stability was also recorded at the Noise Bund 1, WRE2-1 and both sites on the WRE3 this year largely due to the significant increase in annual plants and decomposing litter cover. Stability indices ranged from a low of 68.6 in WRE3-2 to a high of 71.0 on the Noise Bund. All rehabilitation sites except the newest area of rehabilitation WRE3-2, had a stability comparable to the reference sites, however it was only negligibly lower this year.

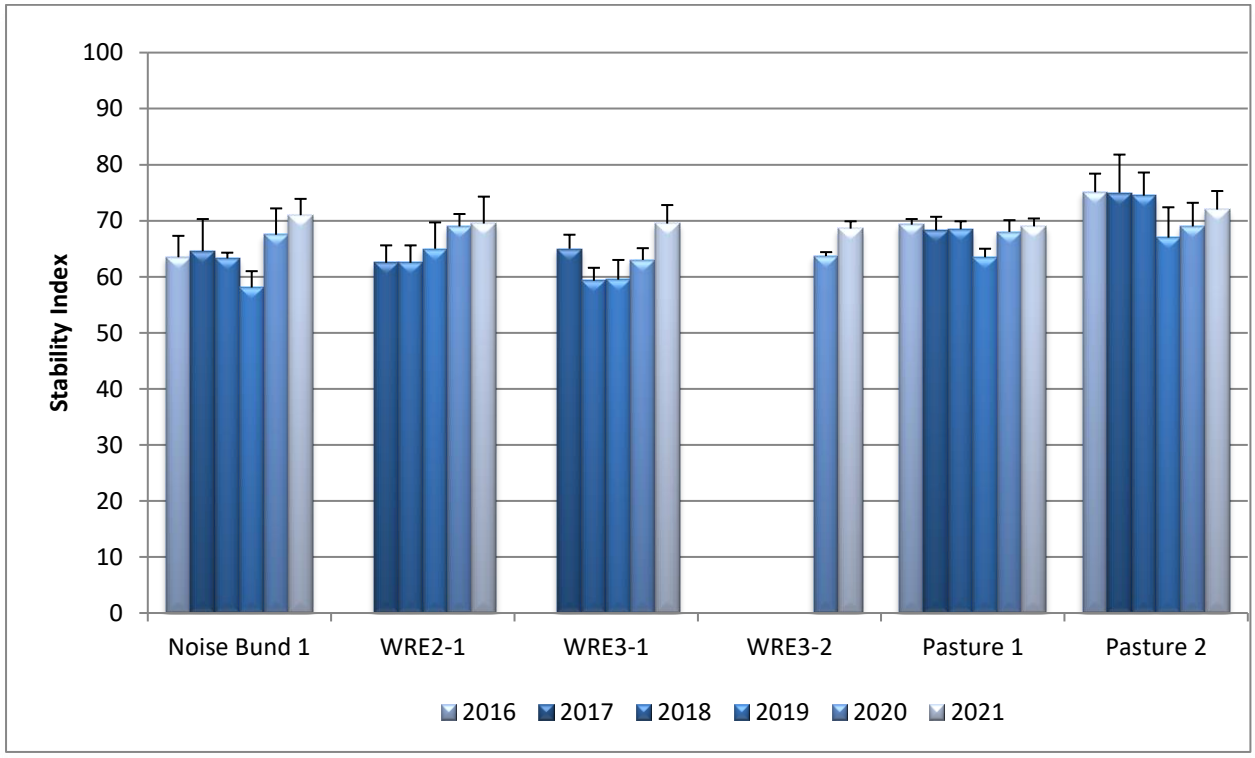


Figure 10-2. LFA stability indices recorded in the pasture monitoring sites.

10.2.1.2.2 Infiltration

Infiltration capacity is largely influenced by the extent of perennial vegetation, litter cover and degree of surface crusting, which are also influence by other variables such as rate of litter decomposition, soil type and stability and soil surface relief. This year the infiltration capacities recorded in the pasture reference sites have also increased and ranged from 48.0 – 49.8 (Figure 10-3). Infiltration capacity at the pasture rehabilitation areas have however tended to decline or have had marginal change and ranged from a low of 34.4 in the new rehabilitation site WRE3-2 to a high of 41.3 at the Noise Bund. No rehabilitation site had an infiltration capacity comparable to the reference sites this year.

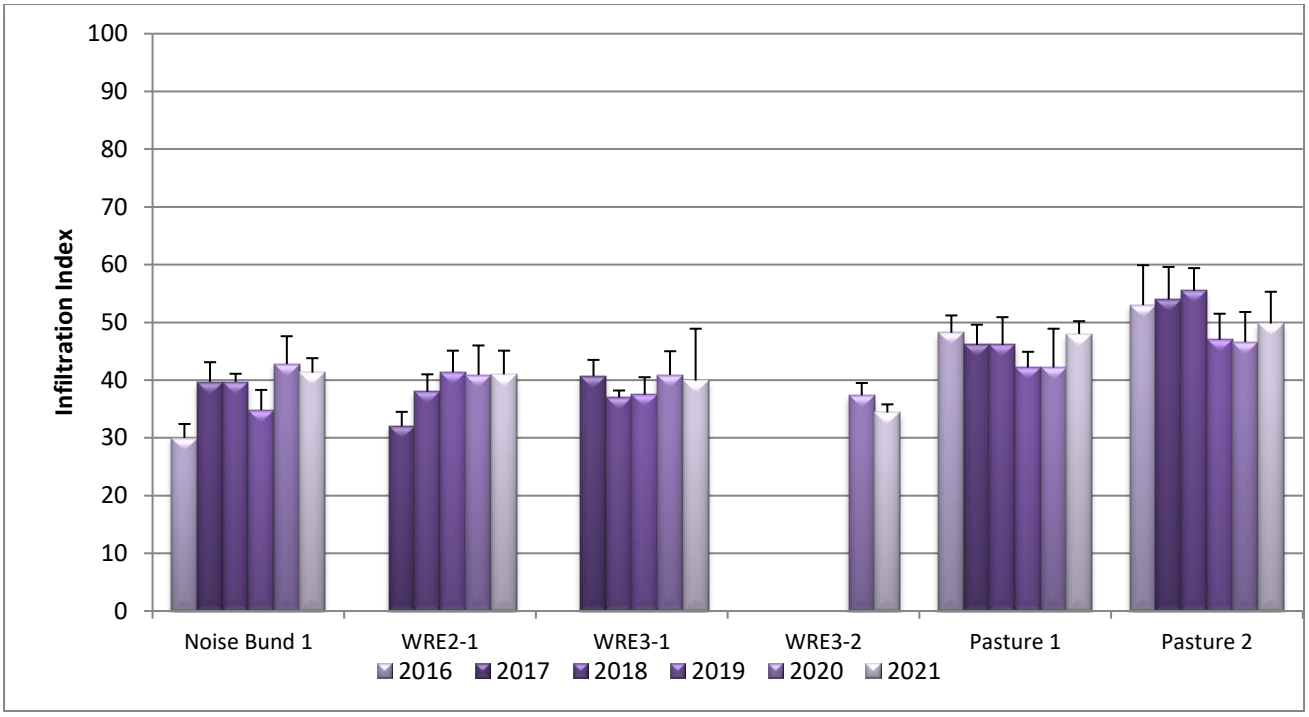


Figure 10-3. LFA infiltration indices recorded in the pasture monitoring sites.

10.2.1.2.3 Nutrient recycling

The nutrient recycling capacities in the pasture reference sites have also increased this year to provide a range of 48.9 – 50.3 (Figure 10-4). Nutrient recycling indices on the Noise Bund, WRE2-1 and both sites of WRE3 have also demonstrated an increase, with indices ranging from a low of 37.5 at WRE3-2 to a high of 43.2 at Noise Bund and WRE2-1. Despite having improved, all rehabilitation sites continued to have a nutrient recycling capacity which remained lower than the pasture reference sites this year.

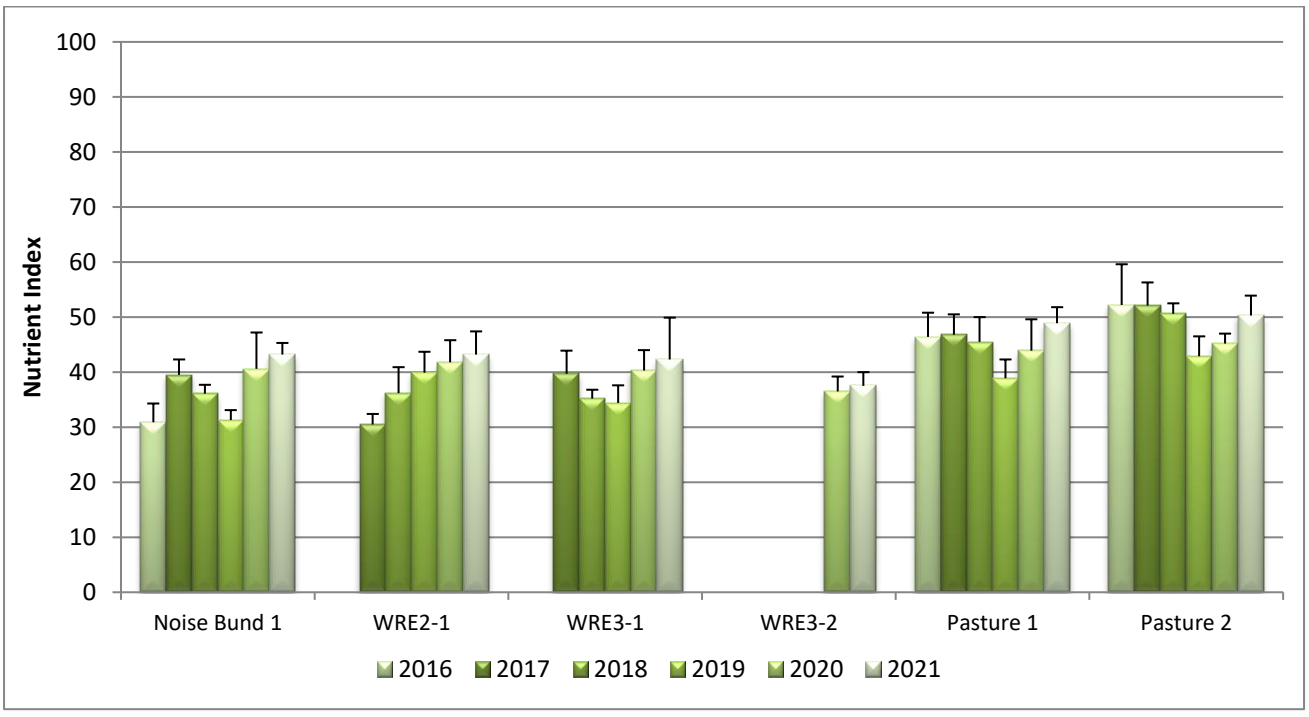


Figure 10-4. LFA nutrient recycling indices recorded in the pasture monitoring sites.

10.2.2 LFA Summary

The sum of the LFA stability, infiltration and nutrient recycling components provide an indication of the most functional to least functional pasture monitoring site in 2021 and is provided in Figure 10-5. The most ecologically functional site continued to be Pasture 2 which scored a sum of indices of 172. This was followed by Pasture 1 with a score of 166, with rehabilitation sites Noise Bund, WRE2-1 and WRE3-1 being marginal lower with a sum of scores of 152 - 156. The newest area of rehabilitation WRE3-2 continued to be the lowest functional grassland community and scored 141. Examples of the various combinations of ground covers which are critical to overall ecosystem function have been provided in Table 10-2.

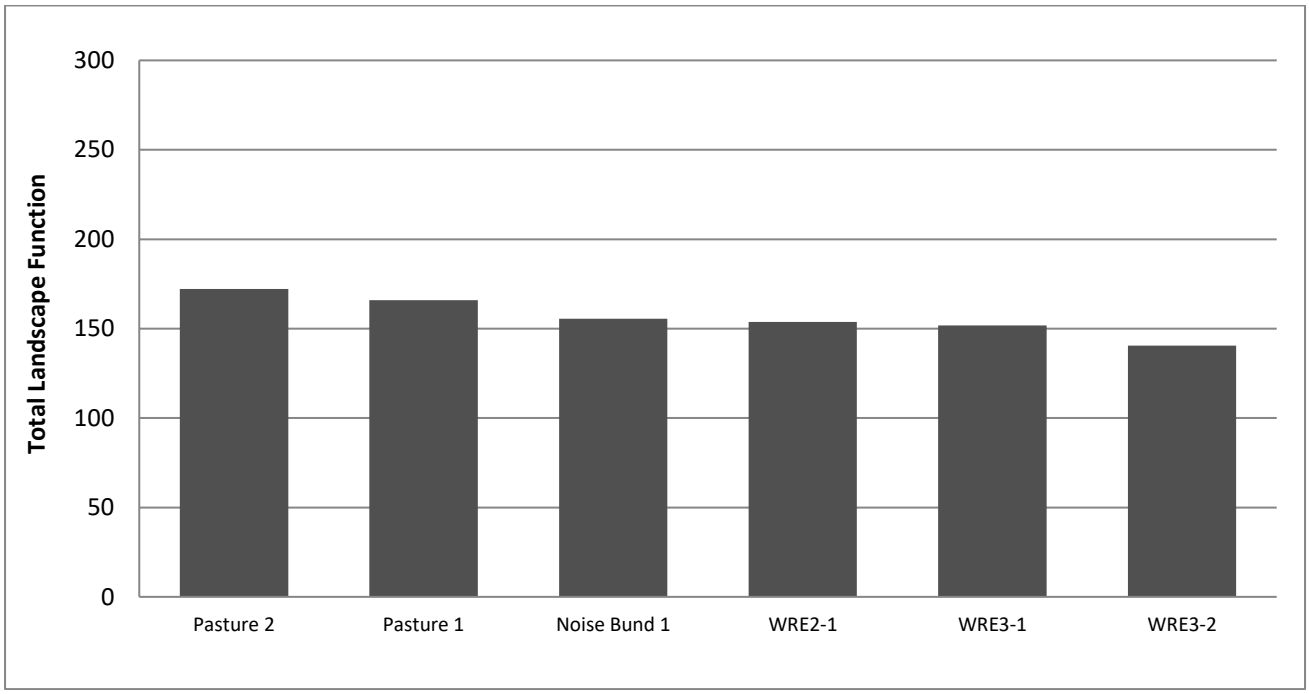
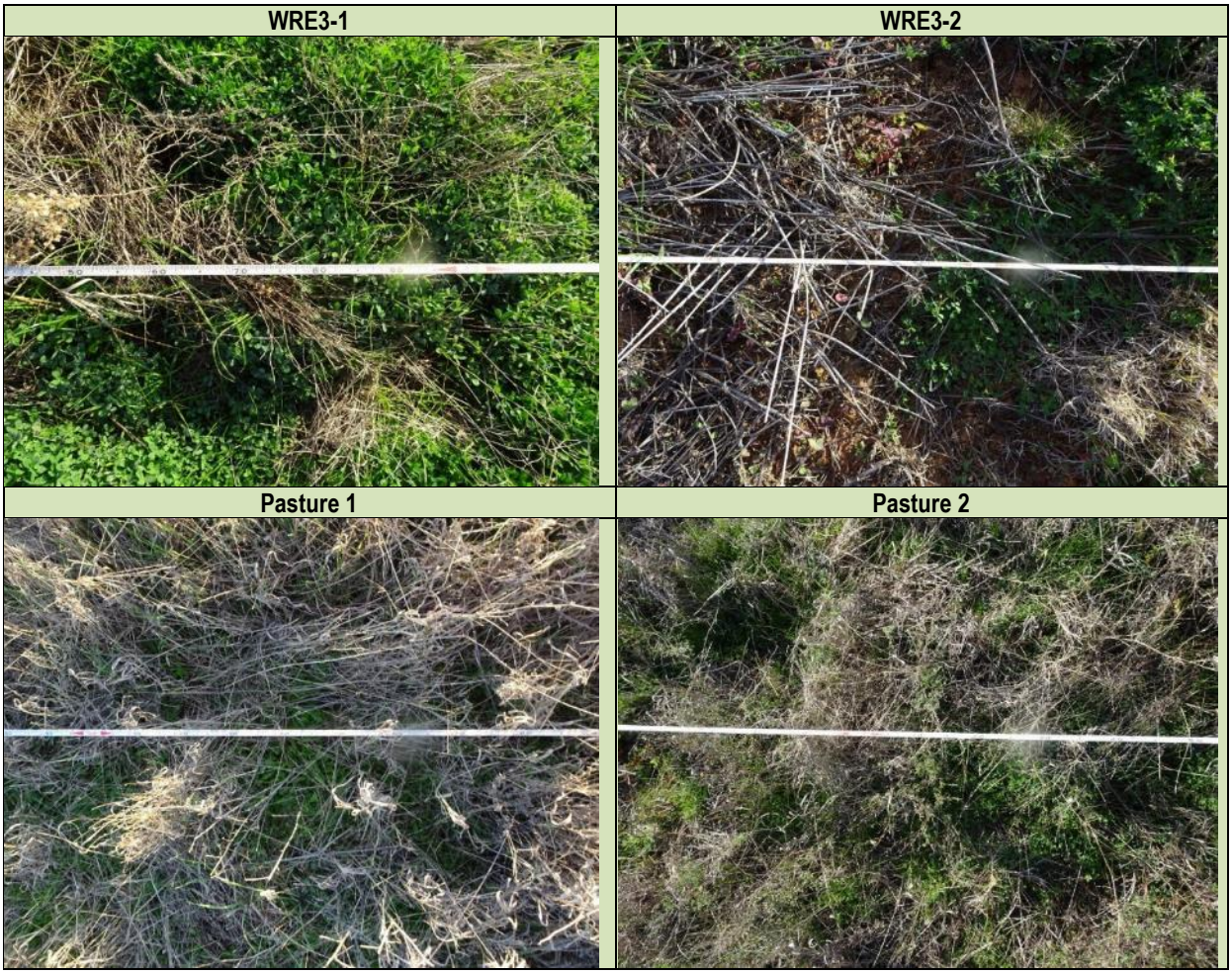


Figure 10-5. Sum of the LFA stability, infiltration and nutrient recycling components indicating the most functional to least functional monitoring site recorded in 2021.

Table 10-2. Examples of the different ground covers in the pasture monitoring sites in 2021.

Noise Bund 1	WRE2-1
	



10.2.3 Tree and mature shrub populations

No trees or mature shrubs (>5cm dbh) were recorded in the pasture monitoring sites.

10.2.4 Shrubs and juvenile trees

There continued to be one *Lycium ferocissimum* recorded in Pasture 1, while in Pasture 2 four individuals were recorded this year. In WRE2-1, the number of *Acacia deanei* seedlings has increased from 14 to 24, while none were yet recorded in WRE3-1. In the newest area of rehabilitation at WRE3-2, the number of *L. ferocissimum* has increased from 4 to 12, while one *Acacia deanei* was also recorded in this site this year.

10.2.5 Total ground Cover

Total ground cover is a combination of leaf litter, annual plants, cryptogams, rocks, logs and live perennial plants (<0.5m in height) and is expressed as an average of 10 repeated measures along the 50m vegetation transect. This year the favourable seasonal conditions have maintained high levels of ground cover at all pasture monitoring sites with 100% total ground cover recorded in the reference sites this year (Figure 10-6). Total ground cover in the pasture rehabilitation was 98% at the Noise Bund and WRE3-2, while 100% cover was recorded in WRE2-1 and WRE3-1.

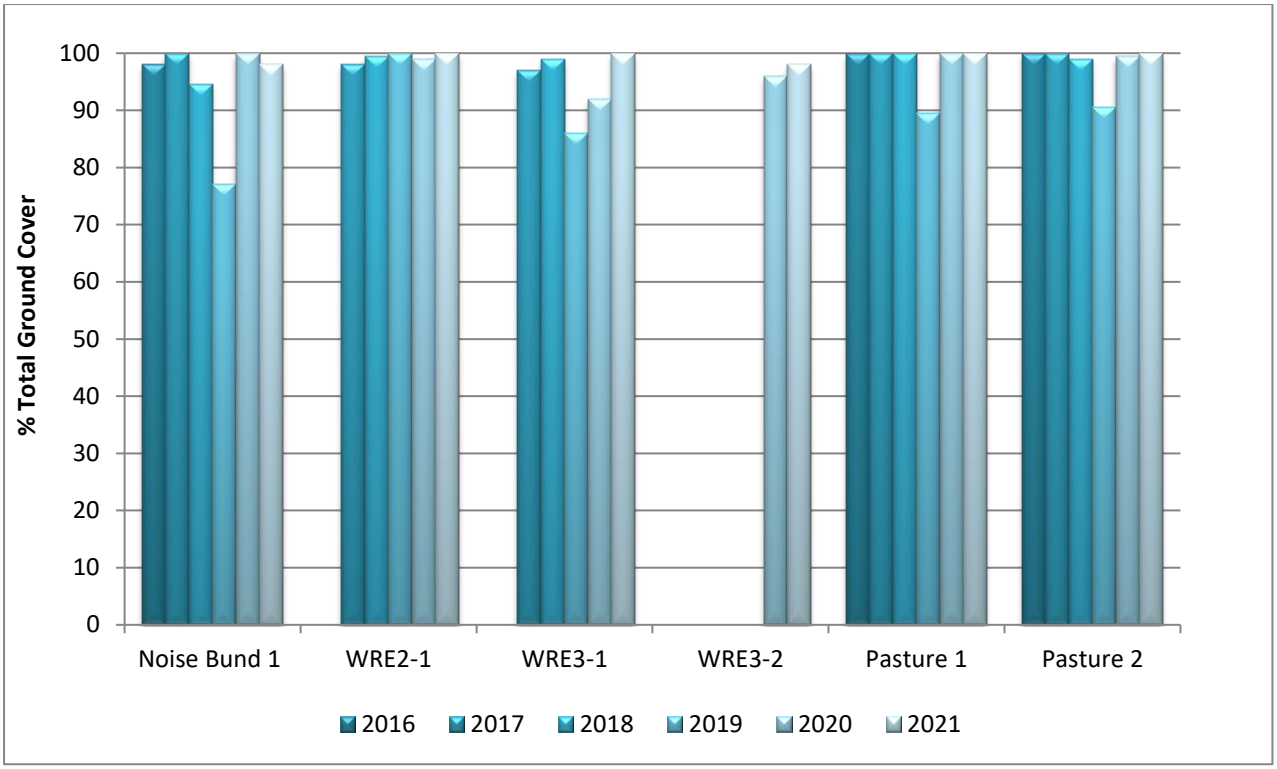


Figure 10-6. Total ground cover recorded in the pasture monitoring sites.

10.2.6 Structural composition

The various combinations of the ground covers and structural compositions of the pasture monitoring sites along the vegetation transects are provided in Figure 10-7. The pasture reference sites were structurally very simple, and these have been greatly influenced in the past by the seasonal conditions. This year there was a reduction in the abundance of annual plants which provided 29 - 36% of the total cover, with most of the remaining cover provided by dead leaf litter (46 – 52%) and an increased abundance of perennial plants (19 – 20%).

Annual plants and dead leaf litter were also the dominant form of ground cover in the rehabilitation sites, with annual plants providing 45% cover in Noise Bund up to 81% in WRE3-2 this year. There was 14 – 40% dead litter cover and some cover was provided by scattered perennial plants that provided up to 14% in Noise Bund, but none were recorded in WRE3-1. This year vertical structure greater than 0.5 m was limited to a minor occurrence in WRE2-1.

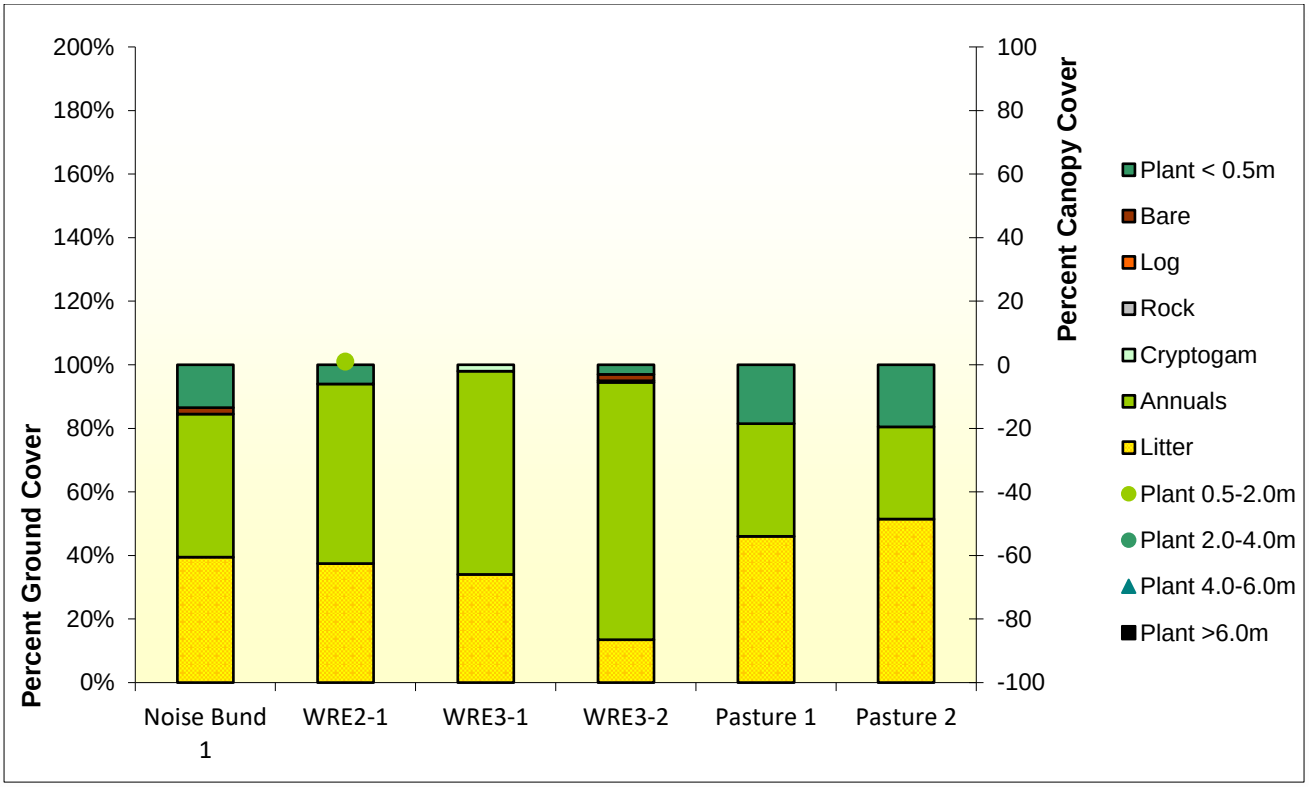


Figure 10-7. Average percent ground cover and projected foliage cover recorded in the pasture monitoring sites.

10.2.7 Floristic Diversity

In the pasture reference sites there were minor changes in plant diversity with 45 species recorded in both sites this year (Figure 10-8) and the number of native species had slightly increased to 25 – 26 native species (Figure 10-9). There was 19 - 20 exotic species (Figure 10-10). On the rehabilitation areas, there were 22 – 36 different species and of these the majority were exotic with 15 (WRE2-1) – 21 (WRE3-1) being recorded. There was a small number of native species recorded in WRE3-2 with 7 species, while an increased diversity of native species was recorded in the other sites with up to 16 native species being recorded in the Noise Bund this year.

This year total and native species diversity remained too low compared to the reference sites, however there was an acceptable diversity of exotic species in all sites except WRE3-1 which had only one more. A comprehensive list of flora recorded across the range of pasture monitoring sites in 2021 is provided in Appendix 1.

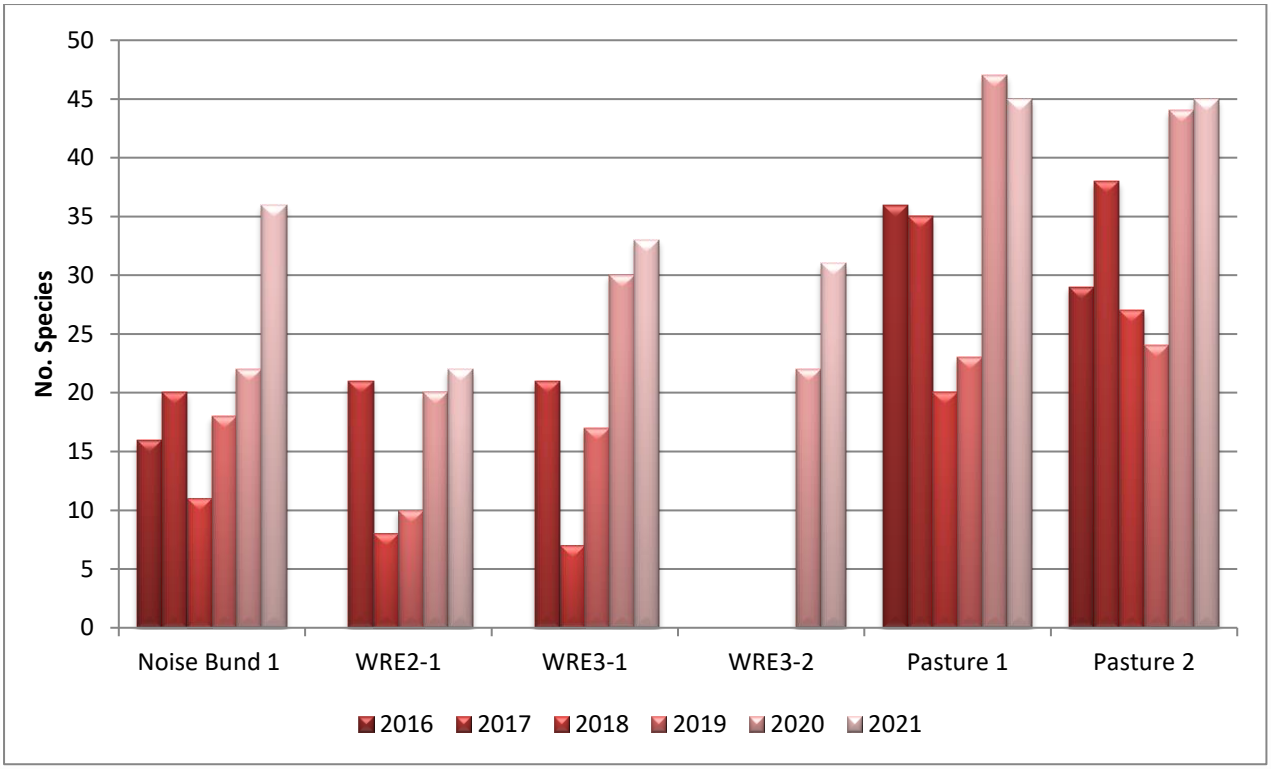


Figure 10-8. Total floristic diversity recorded in the pasture monitoring sites.

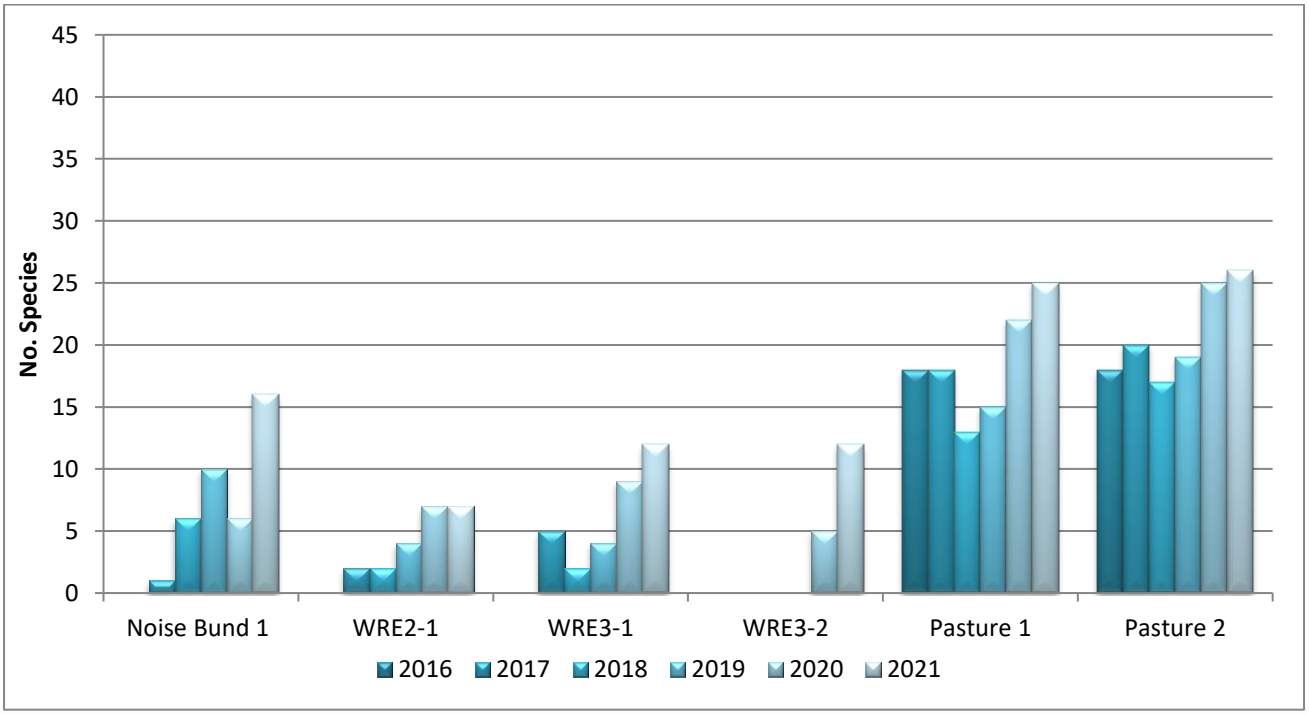


Figure 10-9. Native species diversity recorded in the pasture monitoring sites.

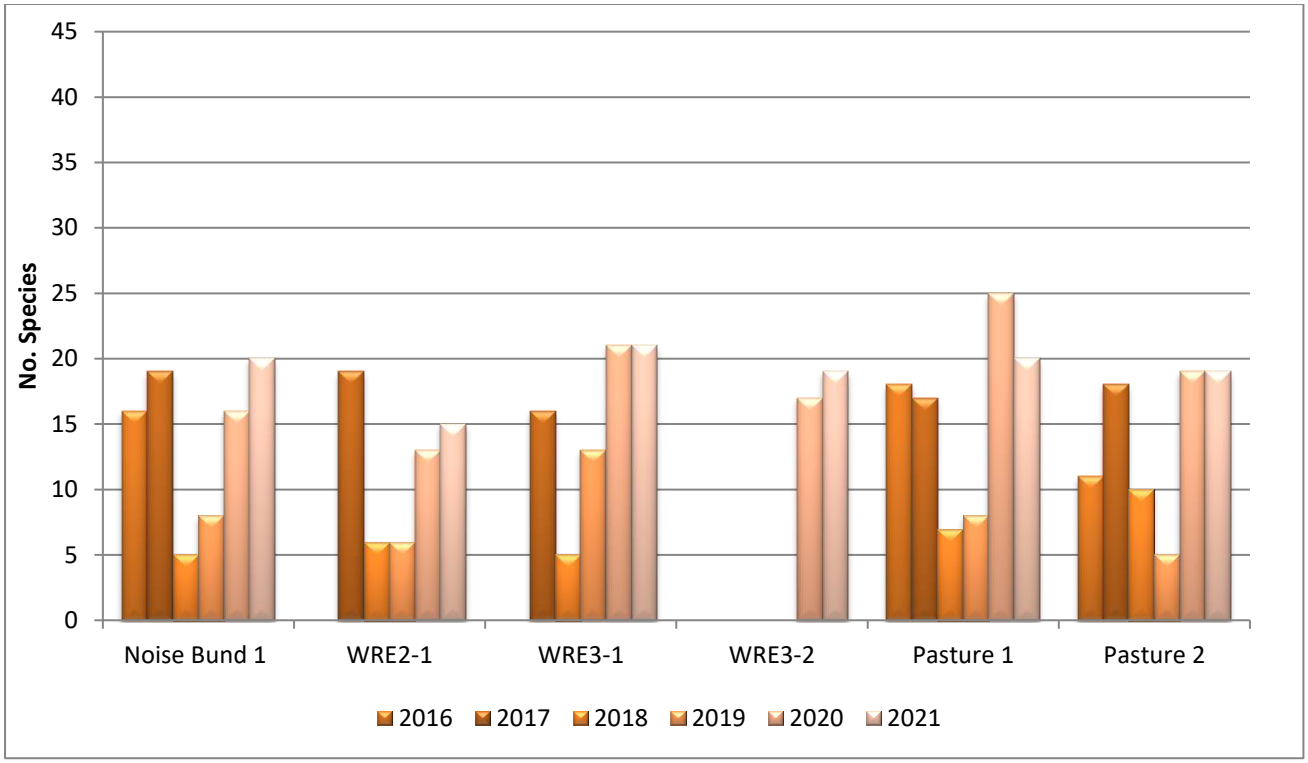


Figure 10-10. Exotic species diversity recorded in the pasture monitoring sites.

10.2.8 Percent endemic ground cover

The percent endemic ground cover is an ecological indicator used to provide some measure of the cover abundance of live native vegetation along the vegetation transect and provides an indication of the level of weediness at the monitoring sites. While it is only an estimation, the percent cover of endemic ground cover species has been derived by the following equation.

Percent cover endemic species = sum of the five Braun- Blanquet scores for native species / (sum of the five Braun- Blanquet scores of exotic species + native species) x 100

This year, exotic annual plant cover has tended to decline in most sites resulting in an increase in the percent cover provided by perennial native plants. In the pasture reference sites native plants provided 36 – 52% of the live plant cover. In Noise Bund, native plant cover has increased to 21%, while native plants were also slightly more abundant in both sites on the WRE3 with 10 - 26% endemic cover being recorded this year. In WRE2-1, there was only 2% native plant cover.

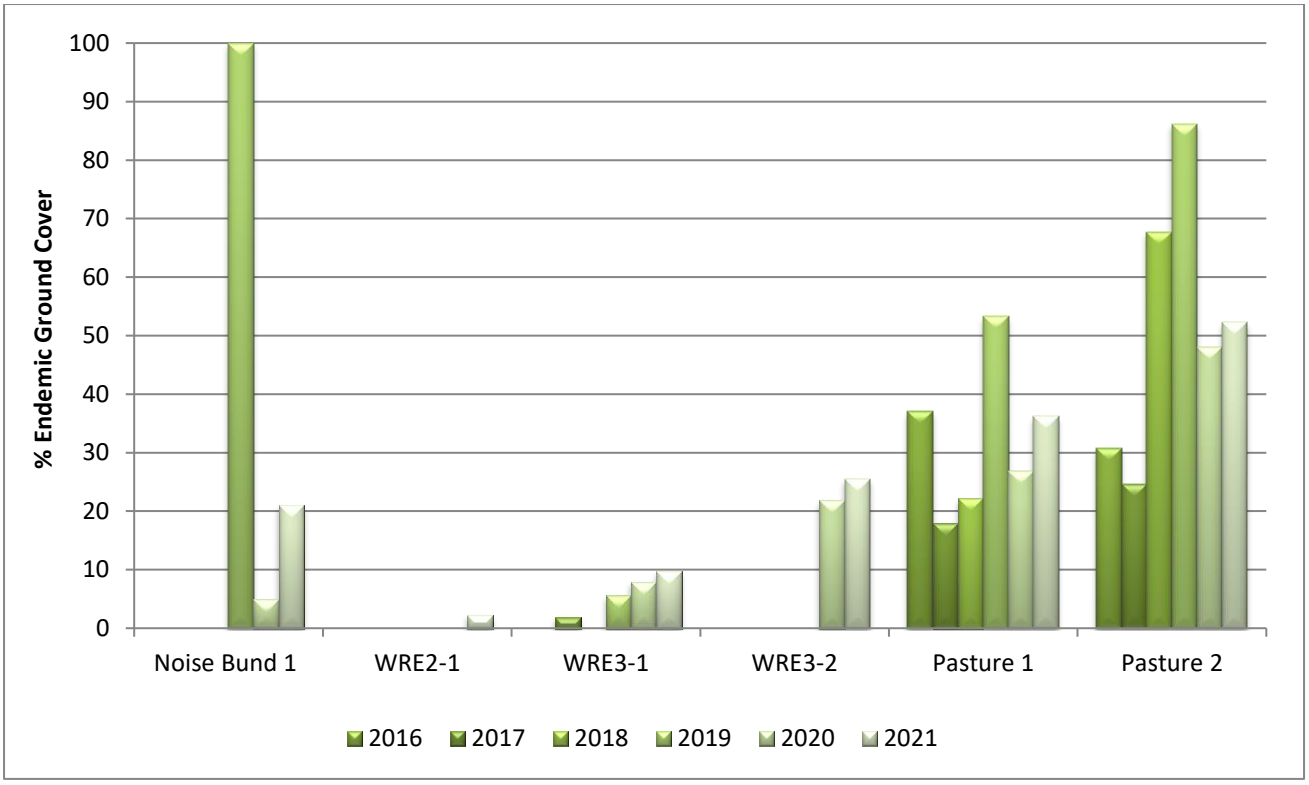


Figure 10-11. Percent endemic ground cover recorded in the pasture monitoring sites.

10.2.9 Vegetation composition

The composition of the vegetation as categorised by eight different growth forms is given in Figure 10-12. In the reference sites herbs continued to be the most dominant growth form with 22 - 27 different species followed by grasses where there were 13 - 14 species. There was one Callitris seedling (tree) in Pasture 2, one shrub species (*Lycium ferocissimum*) in both sites, 2 - 5 sub-shrubs. Two reeds were recorded in Pasture 2 and both sites had a fern. No vines were recorded again this year.

Compared to the reference sites, most pasture rehabilitation sites had a low diversity of herbs and grasses, except Noise Bund 1 and WRE3-1 had an acceptable diversity of herbs. There was also scattered *Acacia deanei* seedlings recorded in WRE2-1, one *Lycium ferocissimum* seedling on the Noise Bund and a dozen *Lycium ferocissimum* seedlings and one *Acacia deanei* seedling was recorded in WRE3-2. There were no trees, reeds, vines or ferns in the rehabilitation areas.

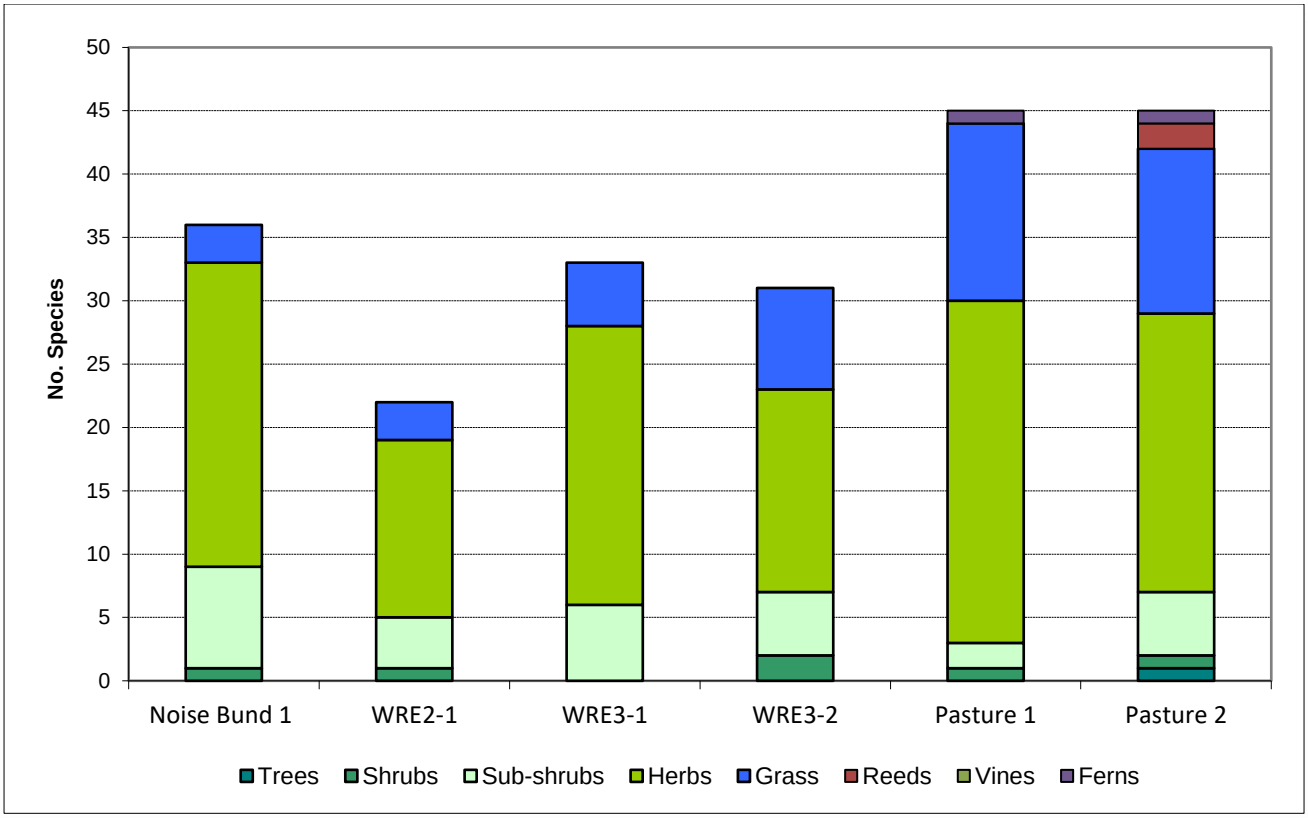


Figure 10-12. Composition of the vegetation recorded in the pasture monitoring sites for 2021.

10.2.10 Most common species

The most common species, those that were recorded in at least three of the four pasture rehabilitation sites in 2021 is given in Table 10-3. This year the natives *Roepera* [*Zygophyllum*] *aurantiacum* (Shrubby Twinleaf), *Salsola australis* (Buckbush), *Vittadinia cuneata* (Fuzzweed), *Atriplex semibaccata* (Creeping Saltbush), *Sclerolaena muricata* (Black Roly Poly) and *Convolvulus erubescens* (Australian Bindweed) were the most common native species. The remaining species were typically exotic annuals commonly associated with agricultural areas. The exotic perennial grass *Chloris gayana* (Rhodes Grass) was also recorded in sites of the WRE2 and WRE3 and was sown as part of the site rehabilitation. Some but not all were also recorded in the pasture reference sites.

Roepera aurantiacum, previously named *Zygophyllum aurantiacum*, is a low spreading native sub-shrub recorded in a more eastern distribution than indicated on PlantNet and may be out of range of its natural distribution of the far western plains of NSW (http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Zygophyllum~aurantiacum). A comprehensive list of species recorded in all pasture monitoring sites in 2021 has been included in Appendix 1.

Table 10-3. Species that were recorded in at least three of the four pasture rehabilitation monitoring sites.

exotic	Scientific Name	Common Name	Habit	Noise Bund 1	WRE2-1	WRE3-1	WRE3-2	Total	Pasture 1	Pasture 2
*	*Medicago truncatula*	Barrel Medic	h	1	1	1	1	**4**		
	Roepera aurantiaca	Shrubby Twinleaf	ss	1	1	1	1	**4**		
	Salsola australis	Buckbush	ss	1	1	1	1	**4**		
*	*Sisymbrium irio*	London Rocket	h	1	1	1	1	**4**		
*	*Arctotheca calendula*	Capeweed	h	1	1	1	1	**4**		1
*	*Lactuca serriola*	Prickly Lettuce	h	1	1	1	1	**4**		1
*	*Lolium rigidum*	Wimmera Ryegrass	g	1	1	1	1	**4**		1
*	*Avena fatua*	Wild Oats	g	1	1	1	1	**4**	1	1
*	*Echium plantagineum*	Paterson's Curse	h	1	1	1	1	**4**	1	1
*	*Sonchus oleraceus*	Milk Thistle	h	1	1	1	1	**4**	1	1
	Vittadinia cuneata	Fuzzweed	h	1	1	1	1	**4**	1	1
*	*Chloris gayana*	Rhodes Grass	g		1	1	1	**3**		
*	*Medicago laciniata*	Cut-leaf Medic	h	1		1	1	**3**		
*	*Trifolium hirtum*	Rose Clover	h	1	1	1		**3**		
*	*Trifolium repens*	White Clover	h		1	1	1	**3**		
	Atriplex semibaccata	Creeping Saltbush	ss	1	1		1	**3**		1
	Sclerolaena muricata	Black Roly Poly	ss	1		1	1	**3**		1
*	*Carthamus lanatus*	Saffron Thistle	h	1		1	1	**3**	1	1
	Convolvulus erubescens	Australian Bindweed	h	1	1	1		**3**	1	1
*	*Trifolium subterraneum*	Subterraneum Clover	h		1	1	1	**3**	1	1

10.2.11 Most abundant species

The most abundant species recorded in each of the pasture monitoring sites this year are provided in Table 10-4. The most abundant species were those nominated to have collectively summed to a Braun-Blanquet total of ten or more from the five replicated sub-plots along the vegetation transect. The maximum score that can be obtained by an individual species is 30.

As a result of the favourable seasonal conditions numerous species of *Medicago* (Medics) and *Trifolium* (Clovers) continued to be abundant in many pasture sites. In particular, *Medicago truncatula* (Barrel Medic) provided the most ground cover in WRE2-1 and both WRE3 sites, while *Medicago arabica* (probably mixed with *M. truncatula*) were dominant on the Noise Bund. *Chloris gayana* (Rhodes Grass) was also abundant in WRE2-1.Pasture 1 was dominated by *Chondrilla juncea* (Skeleton Weed) and *Trifolium subterraneum* (Subterraneum Clover) this year, while *Trifolium arvense* (Haresfoot Clover) and the native *Vittadinia cuneata* (Fuzzweed) were quite abundant in Pasture 2.

Table 10-4. The most abundant species recorded in the pasture monitoring sites in 2021.

Scientific Name	Common Name	Noise Bund 1	WRE2-1	WRE3-1	WRE3-2	Pasture 1	Pasture 2
* *Medicago arabica*	Spotted Medic	13					
**Chloris gayana*	Rhodes Grass		19				
**Medicago truncatula*	Barrel Medic		22	16	28		
Cynodon dactylon	Couch				11		
* *Chondrilla juncea*	Skeleton Weed					12	
**Trifolium subterraneum*	Subterraneum Clover					10	
**Trifolium arvense*	Haresfoot Clover						12
Vittadinia cuneata	Fuzzweed						13

10.2.12 Rill Assessment

The extent of rilling is recorded along the 50 m vegetation transect and there continued to be one significant rill at Noise Bund 1 (Figure 10-13). The rill had increased in size in 2018 and 2019 and continued to exceed the minimum value of concern (Nichols 2005). Last year no change was recorded with the total cross-sectional area remaining at 0.125m^2 while it had slightly decreased to 0.100 m^2 this year as the vegetation has begun to slowly establish, however it has widened above and below the transect and some of the walls of the gully have collapsed (Figure 10-14).

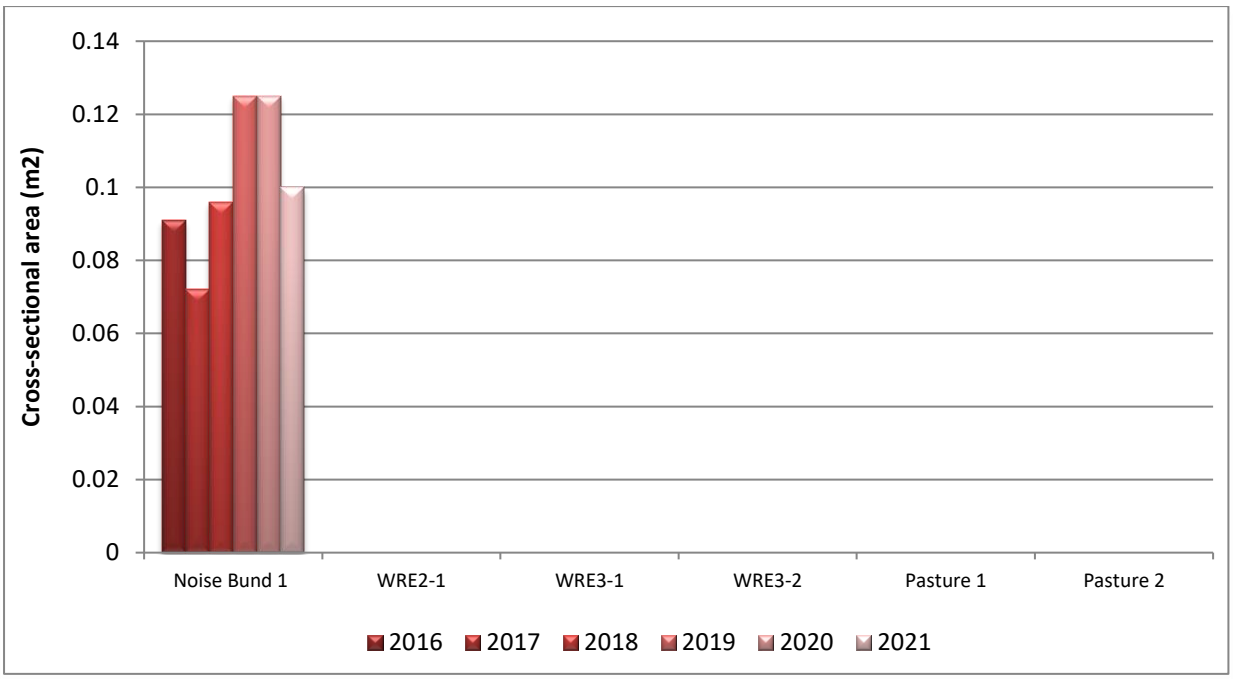


Figure 10-13. Total cross-sectional area of rills.

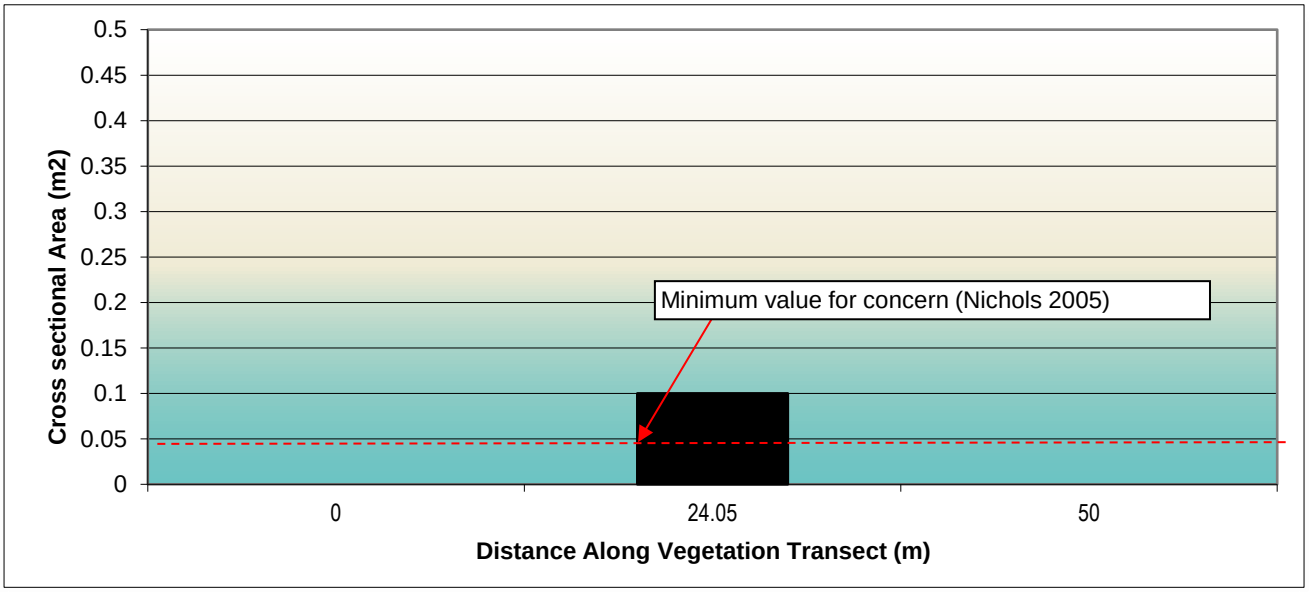


Figure 10-14. Sum of the cross-sectional area of the rill recorded in the Noise Bund site in 2021.

10.2.13 Soil analyses

10.2.13.1 pH

Figure 10-15 shows the pH recorded in the pasture rehabilitation sites compared to the pasture reference sites and "desirable" range in medium or clay loam soils as prescribed by the agricultural industry for growing introduced pastures and crops. This year there were minimal changes in soil pH in the pasture reference sites and both sites had a pH of 5.9, with these soils being moderately acidic (Bruce & Rayment 1982). At Noise Bund 1, WRE2-1 and WRE3-2, the soil pH was 7.0 – 7.1 and neutral. At WRE3-1 the soil pH had slightly decreased to 7.8, however these continue to be borderline slightly to moderately alkaline.

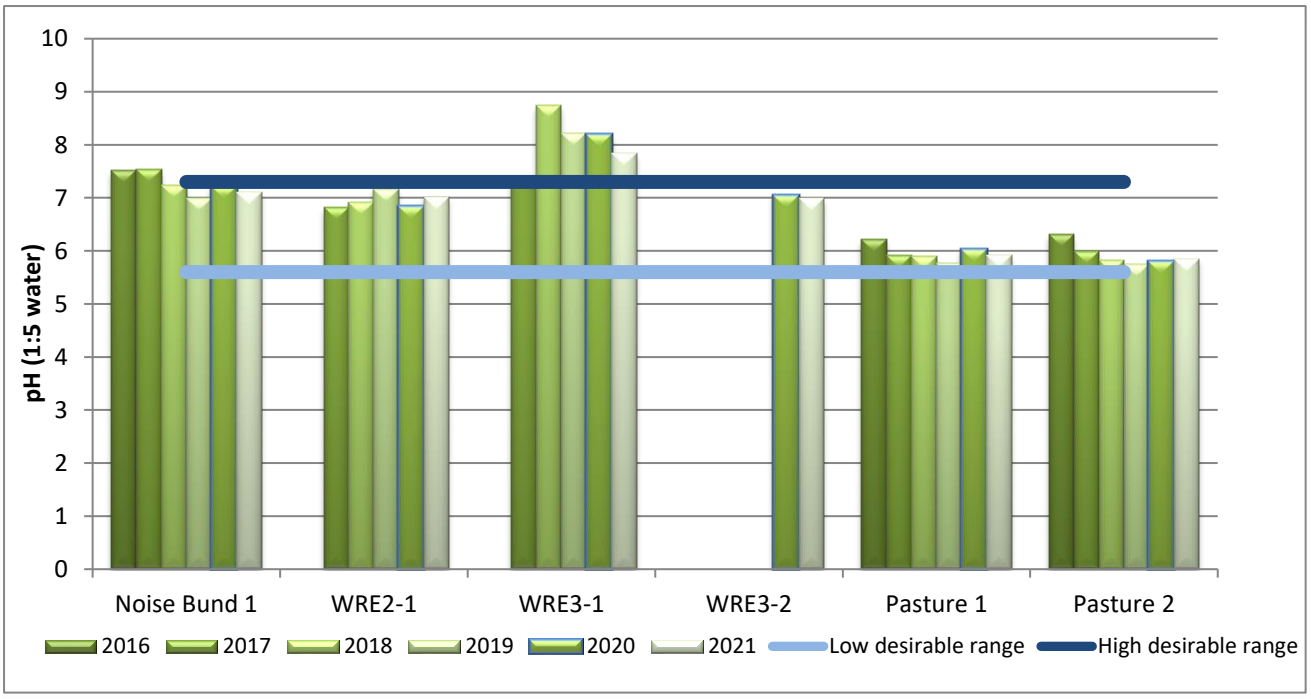


Figure 10-15. Soil pH recorded in the pasture rehabilitation site compared to the pasture reference sites and desirable agricultural ranges.

10.2.13.2 Conductivity

Figure 10-16 shows the Electrical Conductivity (EC) recorded in the pasture rehabilitation sites compared to the pasture reference sites and the "desirable" range in medium or clay loam soils as prescribed by the agricultural industry for growing introduced pastures and crops. EC concentrations in the local pasture reference sites continued to be very low and both sites had an EC 0.030 dS/cm this year, indicating there were low levels of soluble salts and that they are non-saline.

Initially, EC was significantly high at WRE3-1, however EC levels in Noise Bund 1, WRE2-1 and WRE3-1 have shown a declining trend since 2016, with EC ranging from 0.041 – 0.101 dS/cm and continued to be within acceptable levels (Slavich and Petterson 1993). In the newest rehabilitation area on WRE3-2, EC has also declined over the past year however with an EC of 0.194 dS/cm, continued to be higher than acceptable EC levels, but were within non-saline levels this year.

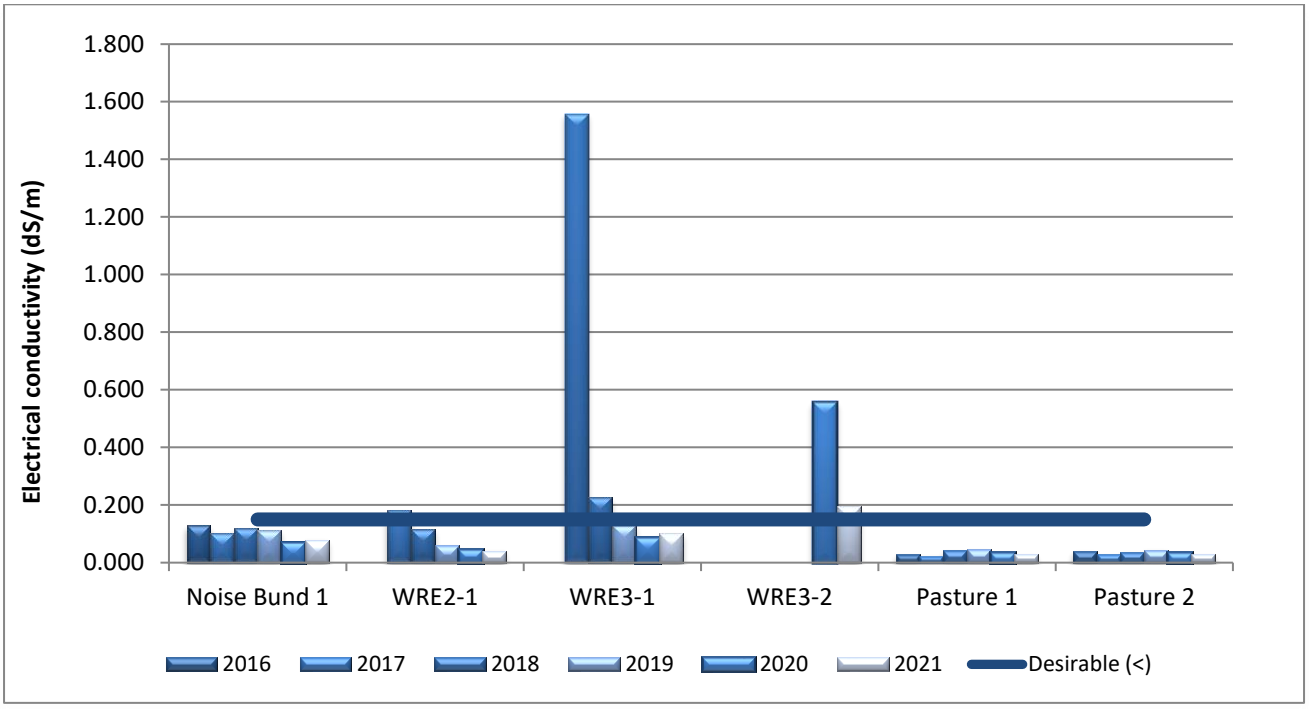


Figure 10-16. Electrical Conductivity recorded in the pasture rehabilitation site compared to the pasture reference sites and desirable agricultural ranges.

10.2.13.3 Organic Matter

Organic Matter (OM) concentrations in the pasture reference sites were considerably lower than the desirable agricultural levels and provided a target of 2.1 – 2.5%. The soils at all three of the pasture rehabilitation sites were also low in OM with these ranging from 1.1% at WRE3-2 to 1.7% at Noise Bund, with these having marginally increased this year (Figure 10-17).

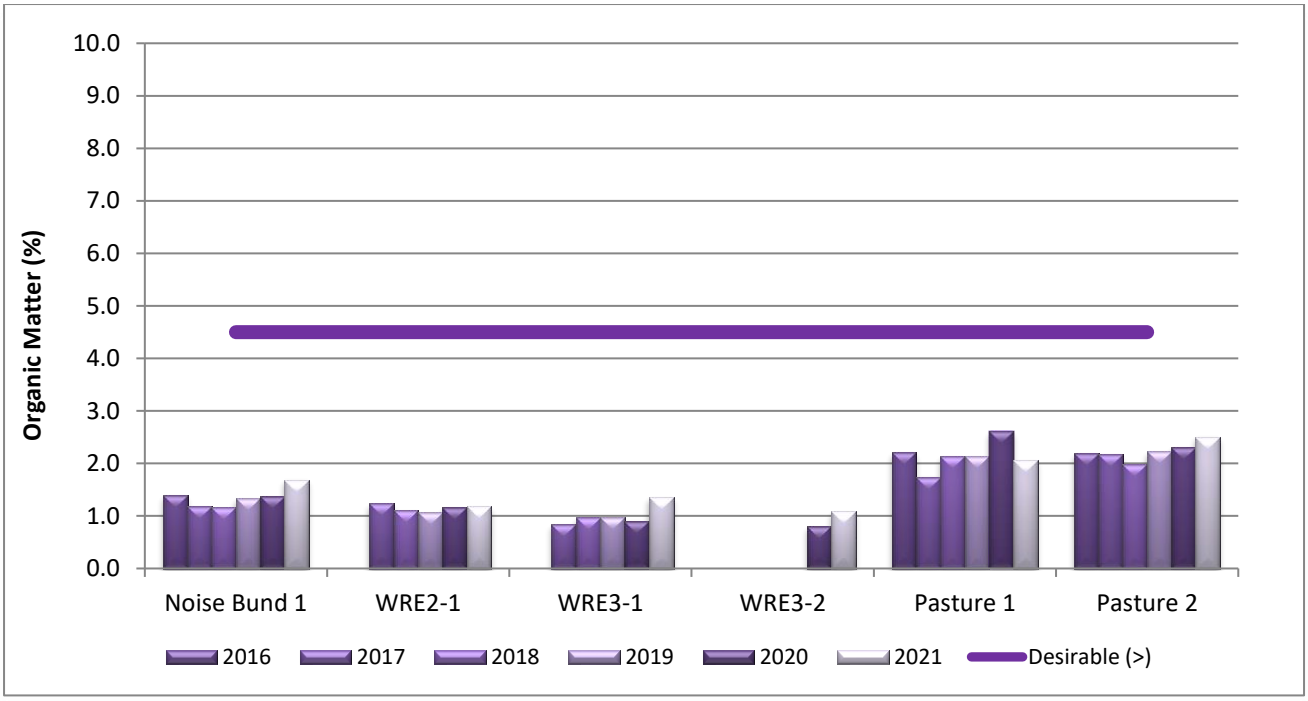


Figure 10-17. Organic Matter recorded in the pasture rehabilitation sites compared to the pasture reference sites and desirable agricultural ranges.

10.2.13.4 Phosphorous

There has been some variation in Phosphorous (P) levels in the pasture reference sites and this year P ranged from 38 – 44 mg/kg and remained slightly lower than the desirable threshold of 50 mg/kg. P has increased in all the rehabilitation areas and ranged from 27 mg/kg in WRE3-2 to 81 mg/kg at the Noise Bund. In Noise Bund and WRE3-1, P concentrations were similar to or higher than agricultural levels but were too low in WRE2-1 and WRE3-2 even when compared to the pasture reference sites (Figure 10-18).

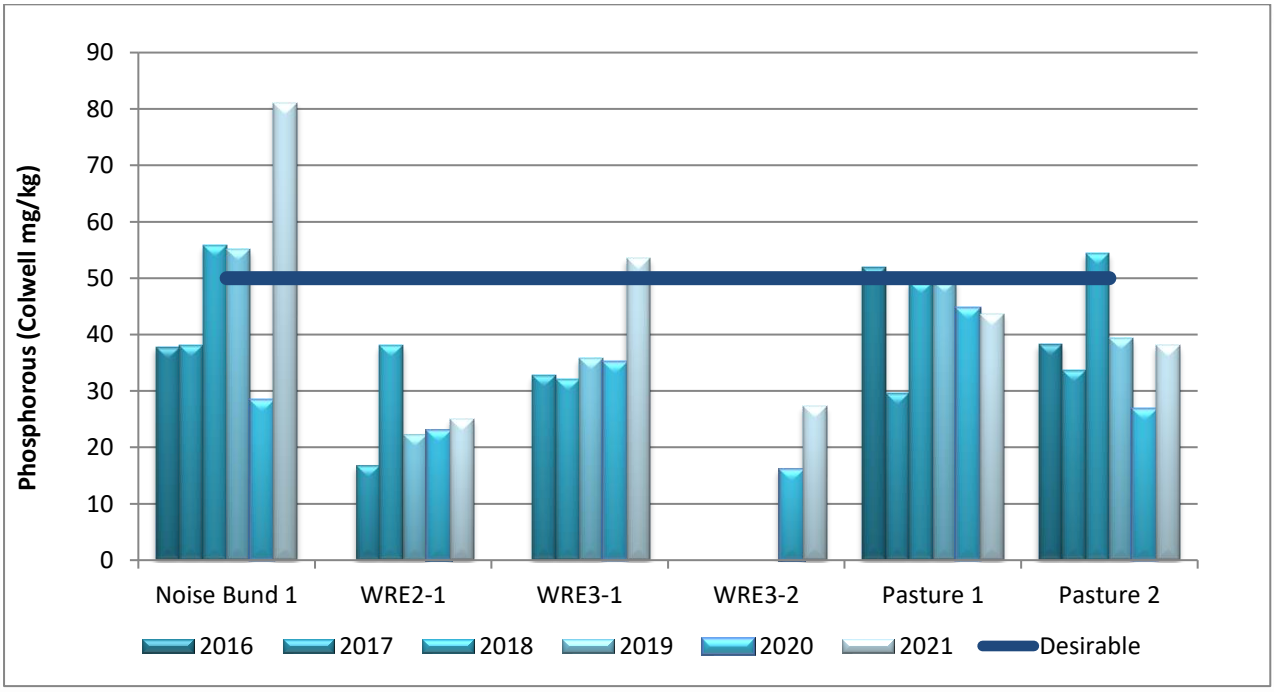


Figure 10-18. Phosphorous (Colwell) recorded in the pasture rehabilitation sites compared to the pasture reference sites and desirable agricultural ranges.

10.2.13.5 Nitrate

There is often high variability in nitrate concentration in response to changes in seasonal conditions. This year N levels in the pasture reference have slightly increased to range from 3.3 – 3.7 mg/kg however they continued to be lower than the desired agricultural threshold of 13 mg/kg (Figure 10-19). On the rehabilitation areas N also increased this year, with N on the Noise Bund 1 higher than the local pasture levels with 4.7 mg/kg. On the other rehabilitation sites N was low and ranged from 1.8 – 2.3 mg/kg.

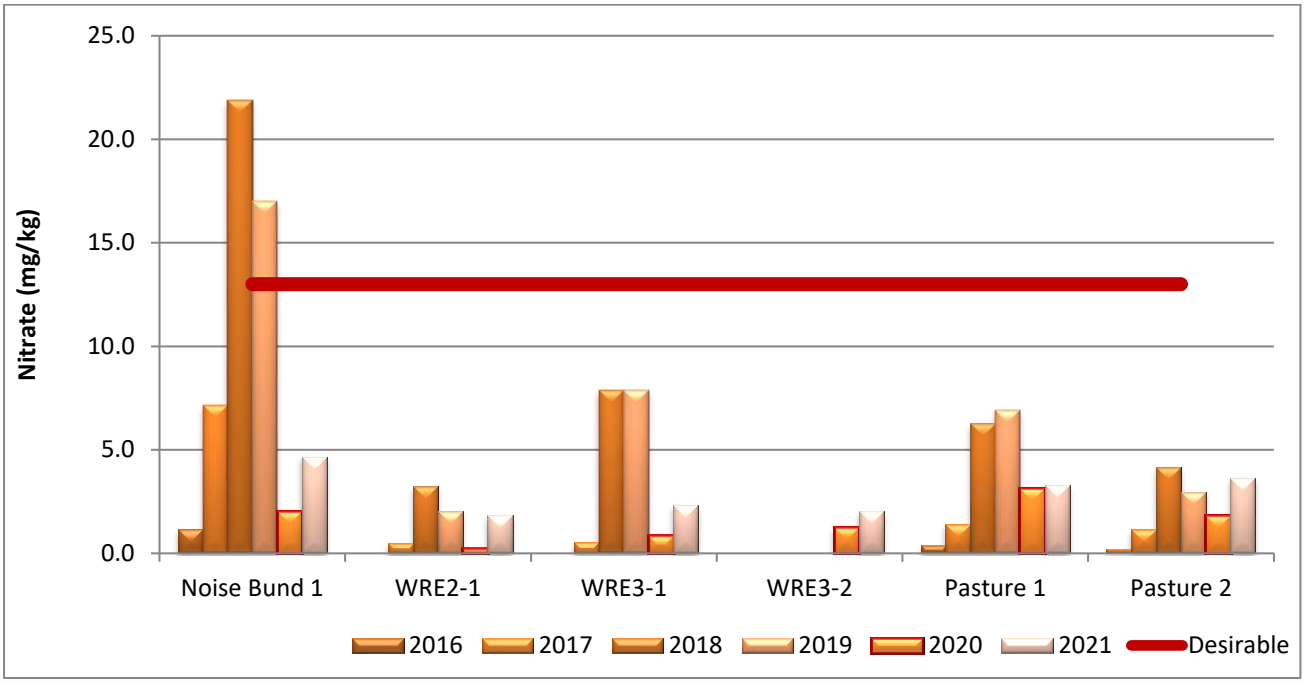


Figure 10-19. Nitrate concentrations recorded in the pasture rehabilitation sites compared to the pasture reference sites and desirable agricultural ranges.

10.2.13.6 Cation Exchange Capacity

CEC in the pasture reference sites continued to have low CEC's compared to desirable agricultural levels and both sites had a CEC of 5.7 cmol/kg this year (Figure 10-20) indicating they are likely to have a slightly low fertility and retention capacity. In the rehabilitation areas, CEC has also slightly increased and remained higher than the local pastures in all sites, ranging from 9.0 cmol/kg in WRE2-1 to a high of 16.7 cmol/kg in WRE3-1.

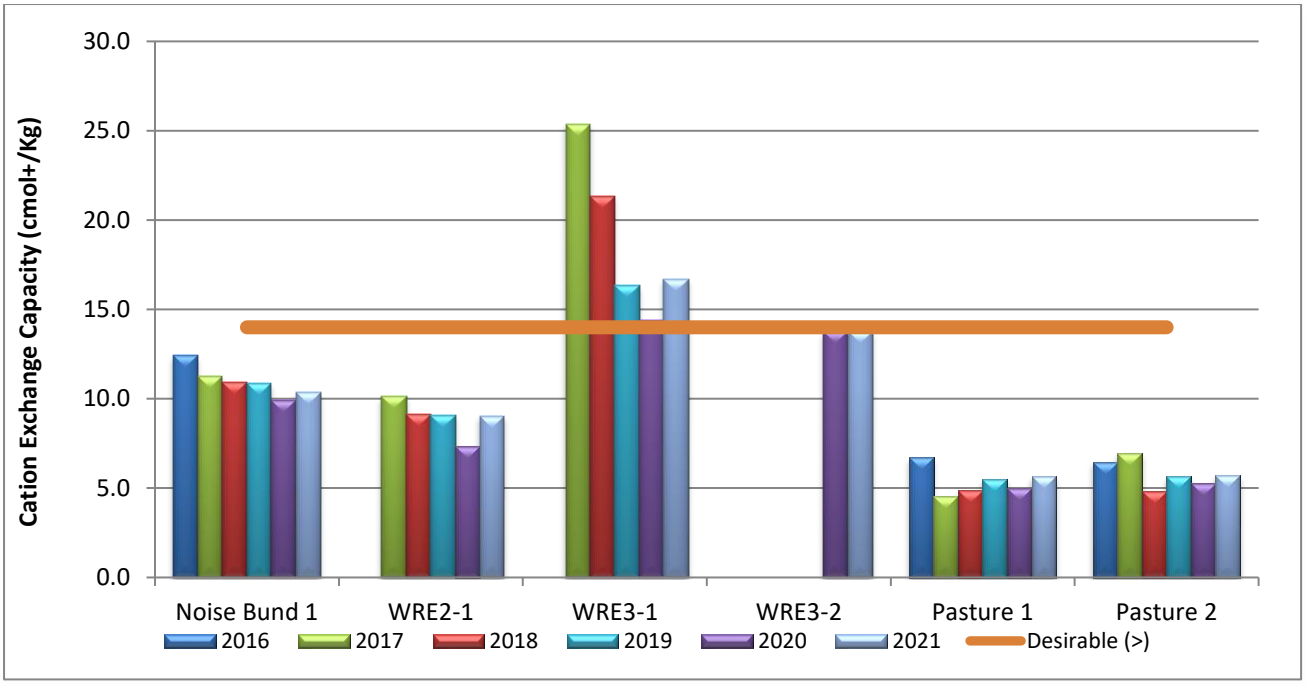


Figure 10-20. Cation Exchange Capacity recorded in the pasture rehabilitation sites compared to the pasture reference sites and desirable agricultural ranges.

10.2.13.7 Exchangeable Sodium Percentage

ESP in soils in the pasture reference sites was 1.1% in both sites and continued to be well below the threshold of 5% indicating the soils were non sodic (Figure 10-21, Isbell 1996). Initially, soils on most of the rehabilitation areas tended to be sodic however they have shown a declining trend since 2016. This year soils in all rehabilitation areas ranged from 1.8 – 4.3% and were within non saline thresholds.

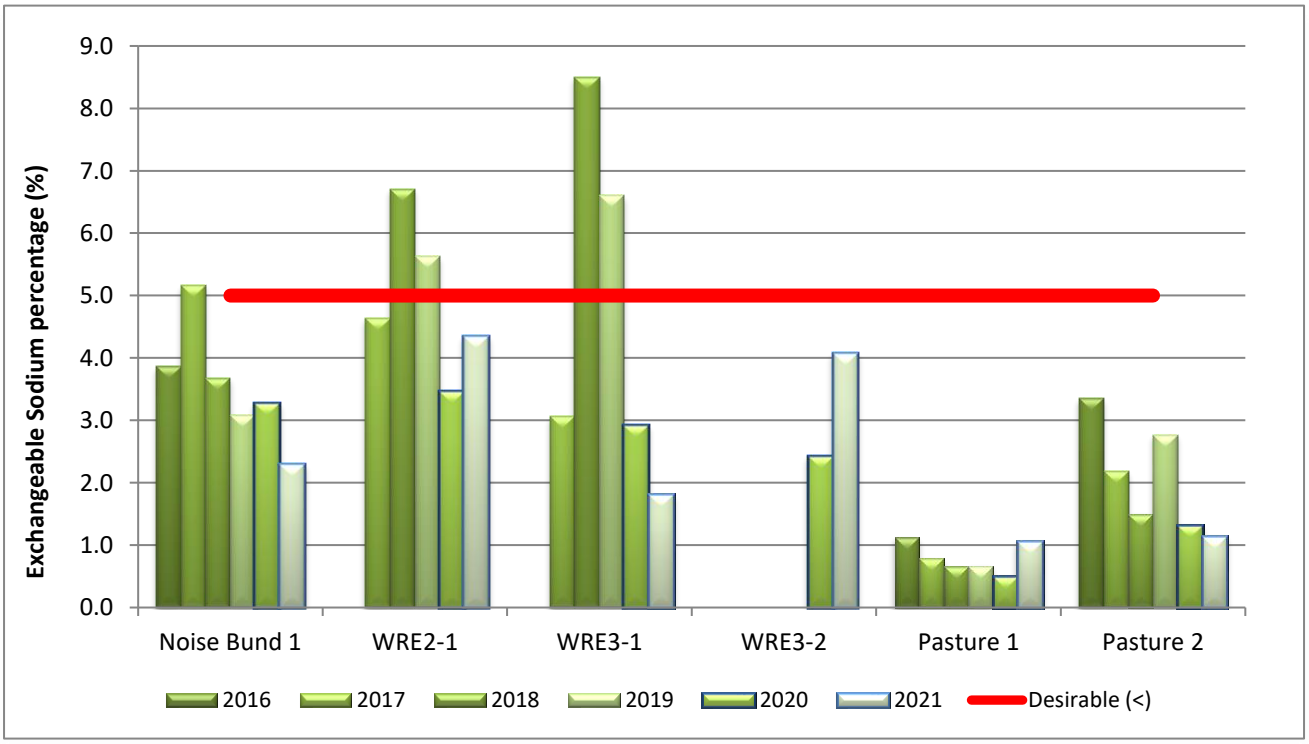


Figure 10-21. ESP recorded in the pasture rehabilitation site compared to the pasture reference sites and desirable agricultural ranges.

10.3 Pasture rehabilitation site performance towards meeting ecological performance indicators

Table 10-5 indicates the performance of the TGO pasture rehabilitation monitoring sites against a range of primary and secondary ecological performance indicators obtained from the pasture reference sites in 2021. The selection of criteria has been presented in order of ecosystem successional processes, beginning with landform establishment and stability (orange) and ending with indicators of ecosystem and land use development (blue) to remain consistent with the latest revision of the ESG3 MOP guidelines (NSW T&I 2013). Rehabilitation sites meeting or exceeding the range values of the reference sites have been identified with a shaded colour box and have therefore been deemed to meet the ecological targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites. In some cases, the site may not fall within ranges based on these data but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a *striped* shaded box to indicate that it falls within "desirable agricultural" ranges.

Table 10-5. Performance of the TGO pasture rehabilitation monitoring sites against primary and secondary ecological performance indicators in 2021.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Pasture 1	Pasture 2	2021 Pasture ecosystem range		Noise Bund 1	WRE2-1	WRE3-1	WRE3-2
Performance indicators are quantified by the range of values obtained from replicated reference sites assessed in 2021							2021	2021	Lower KPI	Upper KPI	2021			
Phase 2: Landform establishment and stability	**Landform slope, gradient**	Landform is designed accordingly and suitable for final land use	Slope	Landform is generally compatible within the context of the local topography and final landform design.		< Degrees (18°)	**1**	**1**	**1**	**1**	**17**	**14**	**14**	**16**
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Number of gullies or rills >0.3m in width or depth in a 50m transect are limited and stabilising		No.	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**
			Cross-sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	**0**	**0**	**0**	**0**	**0.100**	**0**	**0**	**0**
Phase 3: Growth medium development	**Soil chemical, physical properties and amelioration**	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6-7.3)	**5.9**	**5.9**	**5.9**	**5.9**	**7.1**	**7.0**	**7.8**	**7.0**

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Pasture 1	Pasture 2	2021 Pasture ecosystem range		Noise Bund 1	WRE2-1	WRE3-1	WRE3-2
			EC		Electrical Conductivity is typical of the surrounding landscape or is less than the desirable threshold as provided by the agricultural industry	< dS/m (<0.150)	0.030	0.030	0.030	0.030	0.078	0.041	0.101	0.194
			Organic Matter	Organic Matter levels are typical of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (4.5)	2.1	2.5	2.1	2.5	1.7	1.2	1.3	1.1
			Phosphorous (Colwell)	Available Phosphorus is typical of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		mg/kg (50)	43.6	38.0	38.0	43.6	81.0	24.9	53.5	27.2
			Nitrate		Nitrate levels are typical of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	mg/kg (12.5)	3.3	3.7	3.3	3.7	4.7	1.8	2.3	2.0
			CEC		Cation Exchange Capacity is typical of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	5.7	5.7	5.7	5.7	10.4	9.0	16.7	13.8
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of the surrounding landscape or is less than the 5% threshold for sodicity	% (<5)	1.1	1.1	1.1	1.1	2.3	4.3	1.8	4.1
Phase 4: Ecosystem & Land Use Establishment	**Landscape Function Analysis (LFA): Landform stability and organisation**	Landform is stable and performing as it was designed to do	LFA Stability	The LFA stability index is comparable to the local remnant vegetation		%	69.0	72.0	69.0	72.0	71	69.5	69.5	68.6

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Pasture 1	Pasture 2	2021 Pasture ecosystem range		Noise Bund 1	WRE2-1	WRE3-1	WRE3-2
			LFA Landscape organisation	The Landscape Organisation Index is comparable to the local remnant vegetation		%	100	100	100	100	100	100	100	91
	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees		The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to the local remnant vegetation.	species/area	1	2	1	2	1	1	0	2
					The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species are comparable to the local remnant vegetation	% population	0	25	0	25	0	100	0	8
			Total species richness		The total number of live plant species is comparable to the local remnant vegetation	No./area	45	45	45	45	36	22	33	31
			Native species richness		The total number of live native plant species is greater than or comparable to the local remnant vegetation	>No./area	25	26	25	26	16	7	12	12
			Exotic species richness	The total number of live exotic plant species is less than or comparable to the local remnant vegetation		<No./area	20	19	19	20	20	15	21	19
			Ratio of native to exotic species		The ratio of live native species compared to live exotic plant species is more than or comparable to the local remnant vegetation	>	1.3	1.4	1.3	1.4	0.8	0.5	0.6	0.6

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Pasture 1	Pasture 2	2021 Pasture ecosystem range		Noise Bund 1	WRE2-1	WRE3-1	WRE3-2
	Vegetation density	Vegetation contains a density of species comparable to the local remnant vegetation	Density of shrubs and juvenile trees		The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to the local remnant vegetation	No./area	**1**	**4**	**1**	**4**	**1**	**24**	**0**	**13**
					The density of native shrubs or juvenile trees with a stem diameter < 5cm is comparable to the local remnant vegetation	No./area	**0**	**1**	**0**	**1**	**0**	**24**	**0**	**1**
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to the local remnant vegetation	Trees		The number of tree species regardless of age comprising the vegetation community is comparable to the local remnant vegetation	No./area	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**
			Shrubs		The number of shrub species regardless of age comprising the vegetation community is comparable to the local remnant vegetation	No./area	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**2**
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to the local remnant vegetation	No./area	**2**	**5**	**2**	**5**	**8**	**4**	**6**	**5**
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to the local remnant vegetation		No./area	**27**	**22**	**22**	**27**	**24**	**14**	**22**	**16**
			Grasses	The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	**14**	**13**	**13**	**14**	**3**	**3**	**5**	**8**
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to the local remnant vegetation	No./area	**0**	**2**	**0**	**2**	**0**	**0**	**0**	**0**

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Pasture 1	Pasture 2	2021 Pasture ecosystem range		Noise Bund 1	WRE2-1	WRE3-1	WRE3-2
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to the local remnant vegetation	No./area	0	0	0	0	0	0	0	0
			Ferns		The number of ferns comprising the vegetation community is comparable to the local remnant vegetation	No./area	1	1	1	1	0	0	0	0
			Parasites		The number of parasitic plants comprising the vegetation community is comparable to the local remnant vegetation	No./area	0	0	0	0	0	0	0	0
Phase 5: Ecosystem & Land Use Development	**Landscape Function Analysis (LFA): Landform function and ecological performance**	Landform is ecologically functional and performing as it was designed to do	LFA Infiltration	LFA infiltration index is comparable to the local remnant vegetation		%	48	49.8	48.0	49.8	41.3	41	39.9	34.4
			LFA Nutrient recycling	LFA nutrient recycling index is comparable to the local remnant vegetation		%	48.9	50.3	48.9	50.3	43.2	43.2	42.3	37.5
	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Litter cover		Percent ground cover provided by dead plant material is comparable to the local remnant vegetation	%	46	51.5	46	51.5	39.5	37.5	34	13.5
			Annual plants		Percent ground cover provided by live annual plants is comparable to the local remnant vegetation	<%	35.5	29	29	35.5	45	56.5	64	81
			Cryptogam cover		Percent ground cover provided by cryptogams (e.g. mosses, lichens) is comparable to the local remnant vegetation	%	0	0	0	0	0	0	2	0.5

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement (desirable)	Pasture 1	Pasture 2	2021 Pasture ecosystem range		Noise Bund 1	WRE2-1	WRE3-1	WRE3-2
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to the local remnant vegetation	%	0	0	0	0	0	0	0	0
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to the local remnant vegetation	%	0	0	0	0	0	0	0	0
			Bare ground		Percentage of bare ground is less than or comparable to the local remnant vegetation	< %	0	0	0	0	2	0	0	2
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (<0.5m in height) is comparable to the local remnant vegetation		%	18.5	19.5	18.5	19.5	13.5	6	0	3
			Total Ground Cover	Total groundcover (the sum of protective ground cover components) is comparable to the local remnant vegetation		%	100	100	100	100	98	100	100	98
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance		The abundance of native species per square metre averaged across the site is comparable to the local remnant vegetation	> species/m^2	3.8	4.4	3.8	4.4	1.6	0.2	1.2	1
			Exotic understorey abundance	The abundance of exotic species per square metre averaged across the site is comparable to the local remnant vegetation		< species/m^2	7.2	4.4	4.4	7.2	5.4	2.4	6.8	2.4
	Native ground cover abundance	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall		The percent ground cover abundance of native species (<0.5m) compared to exotic species is comparable to the local remnant vegetation	%	36.2	52.2	36.2	52.2	21	2.3	9.7	26

11 Priority weeds

Weed of National Significance (WONS), priority weeds listed for the Central West and/or weeds with a general biosecurity duty of NSW that were recorded in the TGO monitoring sites are provided in Table 11-1. This year *Lycium ferocissimum* (African Boxthorn) a WONS was recorded in a total of 12 monitoring sites and is common in the TGO area. Despite its noxious weed status *L. ferocissimum* also provides critical habitat for small native birds which are protected by its dense foliage and prickly spines with these shrubs often forming impenetrable thickets. *Nassella trichotoma* (Serrated Tussock) also a WONS was recorded in isolated numbers in several sites.

Galenia pubescens (Galenia) was recorded on the Noise Bund 1 and has been observed in increasing abundance on the old topsoil stockpile areas near the Noise Bund and this year was recorded in WRE2-1. While *Bidens pilosa* (Cobblers' Peg) is not listed as a priority weed at TGO, it is capable of rapidly infesting disturbed areas and was found along the Creek near Creek 2 this year and should also be a target weed.

Eragrostis curvula (African Lovegrass) is an invasive introduced grass species which is a listed priority weed under the general biosecurity measures in NSW. As it can readily displace native plants and can contribute to changed fire regimes that affect native vegetation structure and biodiversity it and other similar exotic perennial grasses have been listed as a key threatening process under the NSW *Threatened Species Conservation Act 1995*. *Eragrostis curvula* was abundant along Gundong Creek and was recorded in several pasture sites. It has been sprayed with herbicide over the past few years however as most plants were very stressed as a result of the drought and frosty conditions, the overall effectiveness of the control program cannot be confirmed. There were noticeably fewer live individuals along Gundong Creek but follow up inspection and control is likely to be required.

Table 11-1. Priority weeds recorded at TGO.

Scientific Name	Common Name	Fuzzy 1	Grey 2	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	Pasture 1	Pasture 2	Noise Bund 1	WRE2-1	WRE2-2	WRE3-1	WRE3-2	Total
Bidens pilosa	Cobbler's Peg			1														**1**
Carthamus lanatus	Saffron Thistle	1			1		1		1	1	1	1	1			1	1	**10**
Echium plantagineum	Paterson's Curse	1					1	1	1	1	1	1	1	1	1	1	1	**12**
Eragrostis curvula	African Lovegrass						1		1	1		1						**4**
Galenia pubescens	Galenia												1	1				**2**
Lycium ferocissimum	African Boxthorn	1	1	1	1	1		1	1	1	1	1	1				1	**12**
Marrubium vulgare	Horehound	1								1								**2**
Nassella trichotoma	Serrated Tussock	1			1	1					1							**4**
Onopordum acanthium	Scotch Thistle										1							**1**
Raphanus raphanistrum	Wild Radish										1			1				**2**

12 Threatened flora and fauna

12.1 Threatened flora

No threatened species were positively identified within the range of monitoring sites however an individual *Pterostylis* spp. (Greenhood Orchid) has previously been recorded in Grey 1 (2014, 2015 and 2016). According to Dr Colin Bower (FloraSearch) it is not likely to be *P. cobarensis*, the threatened Cobar Greenhood but may be *P. biseta* but flowering specimens are required for positive identification. This monitoring site was not assessed this year.

12.2 Threatened fauna

Survey of fauna was not the focus of this study, however threatened fauna including Grey-crowned Babblers and Superb Parrot were frequently heard within the woodland remnants, especially on the eastern side of the Newell Highway near Fuzzy 1, Belah 1 and Belah 2. Reveg 2 also had a high abundance of a range of woodland birds. Poplar 1 had previously supported a diverse range of small woodland birds however there appeared to be fewer since 2020, potentially due to the loss of the Boxthorn understorey.

13 Elevated soil test results

The full results of the soil analysis are provided in Appendix 2, however a summarised version highlighting elevated results is provided in Table 13-1. The soil results have been compared to EPA guidelines. The EPA indicative fertility guidelines are based on Albrecht and Reams concepts for achieving ideal soil fertility in clay loam soils. The EPA Contaminant guidelines are based on limits for 'Residential A - Residential with gardens and accessible soil including children's daycare centres, preschools, primary schools, town houses or villas' soils (NSW EPA 1998). Further detail can be found in the "End notes" of the Soil Analyses results (Appendix 2). Sites which contained elevated levels compared to these guidelines have been shaded to provide a general indication of how much an element or heavy metal may exceed acceptable concentrations. The colour coding used when comparing against these recommended guidelines is approximately as follows: Purple = excessively high; Brown = significantly high; Red = very high; Yellow = moderately high; Green = slightly high.

The results indicate there were elevated levels of sulfur and silicon in the rehabilitation areas, with these also being slightly elevated in most of the woodland and pasture reference sites suggesting that these elements may naturally occur at elevated concentrations in the local area. They may also have some implications with the long agricultural and/or mining history of the area. The concentrations of sulfur in WRE2-2 and both WRE3 rehabilitation areas, however, were quite a lot higher than were recorded in the reference sites and recommended guidelines, but these had demonstrated a significant decline over the past year. There were also elevated concentrations of iron and manganese in the woodland and pasture refence sites areas.

Table 13-1. Summarised soil analyses highlighting elevated soil test results.

	Site	Fuzzy1	Grey2	Pasture 1	Pasture 2	Noise Bund	WRE2-01	WRE2-02	WRE3-01	WRE3-02	*Medium Soil Clay Loam*
Parameter	**Method reference**	**M0337/2**	**M0337/1**	**M0337/3**	**M0337/4**	**M0337/5**	**M0337/6**	**M0337/7**	**M0337/8**	**M0337/9**	**Indicative guidelines - refer to Notes 6 and 8**
Sulfur (mg/kg S)	**Inhouse S37 (KCl)	9.4	7.0	8.7	8.5	11	10	23	17	75	*8.0*
Manganese (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	72	50	42	28	10	11	9.7	5.8	14	*22*
Iron (mg/kg)		117	56	60	73	23	15	14	12	21	*22*
Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	51	47	46	47	64	69	52	73	82	*45*

14 Conclusion and management recommendations

These data indicate that the various biodiversity monitoring sites are different in structure and function and have recovered to varying degrees from a long disturbance history largely associated with clearing, grazing and cultivation. Sites with intact woodland typically occur along the roadsides and within farm laneways as well as sections along Gundong Creek and most of these sites were recovering relatively well after the removal of livestock. During 2017 – 2019 prolonged drought conditions combined with the simultaneous increase in grazing and disturbance by wildlife, typically caused a decline in ecological function in all monitoring sites. Since 2020 however, improved seasonal conditions resulted in an abundance of annual and perennial ground covers and overall ecological function has typically improved.

The flooding in Gundong Creek resulted in some stream bank erosion in 2016, however, a series of small leaky weirs had begun to form as a result of sediment and litter accumulating behind tree roots or larger branches which had become lodged in the bed. The development of these weirs indicates the creek was starting to repair itself. Since the 2017 monitoring, heavy flows along the creek have damaged many of the small weirs, it is likely they will continue to rebuild themselves over time, however some management intervention in severe washouts would be beneficial. In 2018 and 2019, Gundong Creek has only been subjected to a few flows and was dry at the time of monitoring. In 2020 and 2021 heavy flows were experienced, which caused additional instream erosion and undercutting and/or slumping of the steep sided banks.

Along the Gundong Creek there are areas of bare, crusted and eroding soils and would benefit from the application of organic mulches such as weed free native pasture hay combined with seeding of nitrogen fixing and endemic colonising species such as acacias and sennas. Large trunks and tree branches spread out along the steep sided creek banks may assist in stabilising the areas and will also provide critical habitat. In worst affected areas the stream banks may require intensive earthworks and rock armouring to prevent further stream bank erosion, floodplain stripping and slumping. The Local Land Services (LLS) would need to approve any in-stream restoration works.

Sites which have been subjected to a cultivation history including Reveg 1, Reveg 2 and Creek 1 and Creek 2 were essentially recovering native grasslands that had been seeded with local woodland species. While the ground preparation such as scalping, cultivation, deep ripping and direct seeding initially resulted in the exposure of bare soil, these sites have shown positive signs of recovery largely as a result of minimising disturbances including the removal of livestock. Annual plants and dead leaf litter have been accumulating, and decomposing to form a rich humus layer, and in most sites, there has been a significant reduction in soil surface crusting. Over the last few years heavy grazing by macropods has caused a deterioration of the litter layer in most sites and in some sites bare patches have developed, particularly beneath the shady tree canopies. Despite the improved seasons, there continued to be persistent bare patches in some of these areas largely due to ongoing disturbances by animals, except in Reveg 1 where there were much fewer shady trees to attract macropods.

The large Belah remnant was significantly affected by the drought which resulted in increased grazing pressure and disturbance from resident macropod populations particularly during 2017 - 2019. Since 2020, there has been a noticeable reduction in grazing as a result of the improved seasonal conditions and there has been a significant increase in functional patch area and perennial plant cover. The overall ecological function of these areas however continued to be low compared to the other woodland monitoring sites and macropods numbers should continue to be monitored.

The new area of woodland rehabilitation on the top of WRE2 was highly stable and has numerous ecological attributes which are similar to the other biodiversity monitoring sites. Major differences, however, include the low density of tree and shrub seedlings, as well as low cover and diversity of native perennial ground covers and high abundance of exotic annual species presently establishing across the area.

This year, there was an increase in cover provided by live native plants, however all sites fell short of meeting native abundance targets this year and were weedier than desired. Nonetheless, many sites were dominated by the exotic annual clovers and medics which are usually considered to be valuable pasture species. Due to the long disturbance history of the area, it is expected that these monitoring sites and subsequently the local pastures and woodlands, will always contain a certain level of weeds, especially species that have become widely naturalised in the area.

In the roadside corridors along the main access road (Grey 2), tree trunks and associated piles of soil as a result of tree clearing have been dumped and presently contain hotspots of weeds. The piles of weed bearing topsoil should be removed from the offset areas and monitored for weeds when conditions are suitable.

In the large revegetation areas to the north of the ML and along Gundong Creek, the results of the direct seeding revegetation program were patchy. While most of the area was establishing very well, large areas to the west had less establishment success and tree and shrub diversity and densities were presently low compared to the reference sites, as recorded in Reveg 1. In the large woodland revegetation area with low tree and shrub densities, and sites such as the Poplar woodland, additional habitat planting would be beneficial. On the top of WRE2, the density of tree and shrub seedlings was also too low and may be unable to reach completion criteria targets without further intervention.

There were also increased seedling densities of the priority weed *Lycium ferocissimum* (African Boxthorn) in many monitoring sites, including the reference sites. Follow up surveillance and control will continue to be required as part of the TGO land management plans and care should be undertaken to avoid spraying of non-target species. While *L. ferocissimum* requires control, supplementary habitat plantings should be considered prior to its control and removal as it provides critical habitat for a diverse range of small woodlands birds. Dense plantings of native shrub thickets would improve habitat resources for small and declining woodland bird populations. Physical removal of the *L. ferocissimum* thickets should also be limited as the dead shrubs will continue to provide some habitat value, and destructive removal techniques are likely to promote further weed invasion. Other weeds that were recorded in the monitoring sites and should be part of the weed control program include *Nassella trichotoma* (Serrated Tussock), *Eragrostis curvula* (African Lovegrass), *Galenia pubescens* (Galenia) and if possible, *Bidens pilosa* (Cobblers Peg).

The soils in most of the rehabilitation areas were similar to the reference sites or within acceptable agricultural guidelines. While soils in some WRE rehabilitation sites may have previously had elevated EC and ESP, they had typically declined to acceptable levels over the past few years. At WRE3-1 however, the soils remained borderline slightly to moderately alkaline, despite having declined in pH over the past year. There were however elevated concentrations of sulfur in WRE2-2 and both WRE3 rehabilitation areas which remained significantly higher than levels recorded in the reference sites and recommended guidelines, despite having demonstrated a significant decline over the past year. Therefore, rehabilitation strategies should include the regular testing and classification of all topsoil stockpiles and/or topsoil prior to use on rehabilitation areas to ensure only weed-free and good quality topsoil is used. Regular monitoring of soil of the WREs will ensure anomalies are detected and can be ameliorated if required.

Minor rilling has previously been recorded on the Noise Bund during its early establishment stages and was likely to have been exacerbated by downward indentation of machinery tracks. Extensive establishment of ground cover plants and litter have presently stabilised some of the rills at this site. There continues to be some larger rills that would require more permanent amelioration measures, as heavy rainfall activity has resulted in further erosion and slumping of the gully walls.

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Appendix 1. List of flora species recorded in the monitoring sites in 2021

Note "1" denotes the presence of that species and is not a measure of cover abundance
Key to habit legend: t = tree; s = shrub; ss =sub-shrub; h = herb; g = grass, r = reed; v = vine; f = fern; p = parasite

Group	Family	exotic	Scientific Name	Common Name	Habit	Fuzzy 1	Grey 2	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	Pasture 1	Pasture 2	Noise Bund 1	WRE2-1	WRE2-2	WRE3-1	WRE3-2	Total
Coniferopsida	Cupressaceae		*Callitris glaucophylla*	White Cypress Pine	t											1						**1**
Dicotyledon	Acanthaceae		*Rostellularia adscendens subsp. adscendens*		h		1															**1**
Dicotyledon	Aizoaceae	*	*Galenia pubescens*	Galenia	ss												1	1				**2**
Dicotyledon	Amaranthaceae		*Alternanthera denticulata*	Lesser Joyweed	h	1					1			1								**3**
Dicotyledon	Amaranthaceae		*Ptilotus exaltatus*	Lambs Tails	h				1	1												**2**
Dicotyledon	Amaranthaceae		*Ptilotus spathulatus*	Pussy Tails	h					1												**1**
Dicotyledon	Apiaceae		*Daucus glochidiatus*	Australian Carrot	h	1	1															**2**
Dicotyledon	Apiaceae		*Eryngium rostratum*	Blue Devil	h		1															**1**
Dicotyledon	Asteraceae	*	*Arctotheca calendula*	Capeweed	h		1		1	1	1	1	1	1		1	1	1	1	1	1	**13**
Dicotyledon	Asteraceae	*	*Bidens pilosa*	Cobbler's Peg	h			1														**1**
Dicotyledon	Asteraceae		*Brachyscome ciliaris var. subintegrifolia*	Variable Daisy	h				1													**1**
Dicotyledon	Asteraceae		*Brachyscome lineariloba*	Hard-headed Daisy	h				1													**1**
Dicotyledon	Asteraceae		*Calotis anthemoides*	Cut-leaved Burr-daisy	h		1							1								**2**
Dicotyledon	Asteraceae		*Calotis cuneifolia*	Purple Burr Daisy	h	1	1			1		1	1			1						**6**
Dicotyledon	Asteraceae		*Calotis lappulacea*	Yellow Burr Daisy	h	1	1	1	1	1	1	1	1	1	1		1					**11**
Dicotyledon	Asteraceae	*	*Carthamus lanatus*	Saffron Thistle	h	1			1		1		1	1	1	1	1			1	1	**10**
Dicotyledon	Asteraceae	*	*Centaurea melitensis*	Maltese Cockspur	h							1								1		**2**
Dicotyledon	Asteraceae	*	*Chondrilla juncea*	Skeleton Weed	h						1	1			1	1						**4**
Dicotyledon	Asteraceae		*Chrysocephalum apiculatum*	Common Everlasting	h				1	1	1				1							**4**
Dicotyledon	Asteraceae	*	*Cirsium vulgare*	Spear Thistle	h									1						1		**2**
Dicotyledon	Asteraceae	*	*Conyza bonariensis*	Fleabane	h	1		1	1	1	1	1	1	1		1			1	1	1	**12**
Dicotyledon	Asteraceae		*Glossocardia bidens*	Cobbler's Tack	h				1													**1**
Dicotyledon	Asteraceae	*	*Hypochaeris glabra*	Smooth Catsear	h			1	1	1		1	1	1		1				1		**8**
Dicotyledon	Asteraceae	*	*Hypochaeris radicata*	Flatweed	h		1		1		1	1	1	1	1	1			1	1		**10**
Dicotyledon	Asteraceae	*	*Lactuca serriola*	Prickly Lettuce	h		1	1		1		1	1	1		1	1	1	1	1	1	**12**

Group	Family	exotic	Scientific Name	Common Name	Habit	Fuzzy 1	Grey 2	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	Pasture 1	Pasture 2	Noise Bund 1	WRE2-1	WRE2-2	WRE3-1	WRE3-2	Total
Dicotyledon	Asteraceae		*Minuria leptophylla*	Minnie Daisy	h		1															**1**
Dicotyledon	Asteraceae	*	*Onopordum acanthium*	Scotch Thistle	h										1							**1**
Dicotyledon	Asteraceae		*Rhodanthe pygmaea*	Pigmy Sunray	h					1												**1**
Dicotyledon	Asteraceae		*Senecio prenanthoides*		h						1	1			1							**3**
Dicotyledon	Asteraceae		*Senecio quadridentatus*	Cotton Fireweed	h								1						1			**2**
Dicotyledon	Asteraceae		*Solenogyne bellioides*		h		1															**1**
Dicotyledon	Asteraceae	*	*Sonchus oleraceus*	Milk Thistle	h	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**16**
Dicotyledon	Asteraceae		*Triptilodiscus pygmaeus*	Austral Sunray	h				1													**1**
Dicotyledon	Asteraceae		*Vittadinia cuneata*	Fuzzweed	h	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**16**
Dicotyledon	Asteraceae		*Vittadinia gracilis*	A Fuzzweed	h										1							**1**
Dicotyledon	Asteraceae		*Vittadinia sp.*	Fuzzweed	h		1							1								**2**
Dicotyledon	Boraginaceae	*	*Echium plantagineum*	Paterson's Curse	h	1					1	1	1	1	1	1	1	1	1	1	1	**12**
Dicotyledon	Brassicaceae	*	*Capsella bursa-pastoris*	Shepherd's Purse	h				1						1							**2**
Dicotyledon	Brassicaceae	*	*Hirschfeldia incana*	Buchan Weed	h						1	1					1		1		1	**5**
Dicotyledon	Brassicaceae	*	*Lepidium africanum*	Peppercress	h	1	1	1	1		1	1	1	1	1	1	1	1	1			**13**
Dicotyledon	Brassicaceae	*	*Lepidium bonariense*	Peppercress	h		1		1		1		1	1		1	1		1			**8**
Dicotyledon	Brassicaceae		*Lepidium pseudohyssopifolium*	Peppercress	h					1												**1**
Dicotyledon	Brassicaceae	*	*Raphanus raphanistrum*	Wild Radish	h										1			1				**2**
Dicotyledon	Brassicaceae	*	*Sisymbrium erysimoides*	Smooth Mustard	h		1	1	1	1							1					**5**
Dicotyledon	Brassicaceae	*	*Sisymbrium irio*	London Rocket	h				1	1							1	1		1	1	**6**
Dicotyledon	Brassicaceae	*	*Sisymbrium spp.*		h		1															**1**
Dicotyledon	Campanulacea		*Lobelia purpurascens*	Whiteroot	h				1													**1**
Dicotyledon	Campanulaceae		*Wahlenbergia fluminalis*	River Bluebell	h		1															**1**
Dicotyledon	Capparidaceae		*Apophyllum anomalum*	Warrior Bush	s					1												**1**
Dicotyledon	Caryophyllaceae	*	*Spergularia rubra*	Sandspurry	h				1	1												**2**
Dicotyledon	Casuarinaceae		*Allocasuarina luehmannii*	Bulloak	t	1	1					1										**3**
Dicotyledon	Casuarinaceae		*Casuarina cristata*	Belah	t				1	1												**2**
Dicotyledon	Chenopodiaceae		*Atriplex leptocarpa*	Slender Fruit Saltbush	ss															1		**1**
Dicotyledon	Chenopodiaceae		*Atriplex semibaccata*	Creeping Saltbush	ss				1	1		1	1	1		1	1	1			1	**9**

Group	Family	exotic	Scientific Name	Common Name	Habit	Fuzzy 1	Grey 2	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	Pasture 1	Pasture 2	Noise Bund 1	WRE2-1	WRE2-2	WRE3-1	WRE3-2	Total
Dicotyledon	Chenopodiaceae		*Atriplex sp.*	A Saltbush	ss								1									**1**
Dicotyledon	Chenopodiaceae		*Atriplex spinibractea*	Spiny-fruit Saltbush	ss									1			1		1		1	**4**
Dicotyledon	Chenopodiaceae		*Chenopodium desertorum subsp. microphyllum*	Desert Goosefoot	ss		1						1							1		**3**
Dicotyledon	Chenopodiaceae		*Einadia nutans*	Climbing Saltbush	h			1	1	1	1	1	1		1		1					**8**
Dicotyledon	Chenopodiaceae		*Einadia nutans subsp. nutans*	Climbing Saltbush	h	1																**1**
Dicotyledon	Chenopodiaceae		*Einadia polygonoides*		h		1						1	1	1		1	1	1			**7**
Dicotyledon	Chenopodiaceae		*Einadia trigonos*	Fishweed	h	1		1	1	1	1	1					1					**7**
Dicotyledon	Chenopodiaceae		*Maireana brevifolia*	Yanga Bush	ss															1		**1**
Dicotyledon	Chenopodiaceae		*Maireana enchylaenoides*	Wingless Fissure Weed	h	1	1			1			1									**4**
Dicotyledon	Chenopodiaceae		*Maireana microphylla*	Eastern Cottonbush	ss	1	1		1	1		1	1	1	1	1	1		1			**11**
Dicotyledon	Chenopodiaceae		*Maireana sp.*		ss				1													**1**
Dicotyledon	Chenopodiaceae		*Salsola australis*	Buckbush	ss			1	1	1		1		1			1	1	1	1	1	**10**
Dicotyledon	Chenopodiaceae		*Sclerolaena birchii*	Galvanised Burr	ss		1	1	1		1	1	1	1	1	1	1					**10**
Dicotyledon	Chenopodiaceae		*Sclerolaena muricata*	Black Roly Poly	ss		1	1	1	1		1	1	1		1	1		1	1	1	**12**
Dicotyledon	Convolvulaceae		*Convolvulus erubescens*	Australian Bindweed	h	1			1			1	1	1	1	1	1	1	1	1		**11**
Dicotyledon	Convolvulaceae		*Dichondra repens*	Kidney Weed	h	1	1	1	1	1	1	1	1	1	1	1				1		**12**
Dicotyledon	Crassulaceae		*Crassula colorata*	Dense Stonecrop	h		1		1	1	1	1	1	1	1	1			1	1		**11**
Dicotyledon	Euphorbiaceae		*Euphorbia dallachyana*	Caustic Weed	h																1	**1**
Dicotyledon	Euphorbiaceae		*Euphorbia drummondii*	Caustic Weed	h		1		1	1												**3**
Dicotyledon	Fabaceae (Faboideae)		*Glycine tabacina*	Variable Glycine	h	1	1		1													**3**
Dicotyledon	Fabaceae (Faboideae)		*Hardenbergia violacea*	Happy Wanderer	v							1										**1**
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago arabica*	Spotted Medic	h		1	1									1					**3**
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago laciniata*	Cut-leaf Medic	h			1	1	1							1		1	1	1	**7**
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago minima*	Small Woolly Burr Medic	h				1	1												**2**
Dicotyledon	Fabaceae (Faboideae)	*	*Medicago truncatula*	Barrel Medic	h	1		1	1								1	1	1	1	1	**8**
Dicotyledon	Fabaceae (Faboideae)		*Swainsona sp.*		h									1								**1**
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium angustifolium*	Narrow-leaf Clover	h						1	1		1	1	1				1		**6**
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium arvense*	Haresfoot Clover	h								1			1						**2**

Group	Family	exotic	Scientific Name	Common Name	Habit	Fuzzy 1	Grey 2	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	Pasture 1	Pasture 2	Noise Bund 1	WRE2-1	WRE2-2	WRE3-1	WRE3-2	Total
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium hirtum*	Rose Clover	h												1	1		1		3
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium repens*	White Clover	h							1						1	1	1	1	5
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium resupinatum*	Shaftal Clover	h														1	1	1	3
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium sp.*	A Clover	h									1								1
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium subterraneum*	Subterraneum Clover	h		1		1		1	1	1	1	1	1		1	1	1	1	12
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia baileyana*	Cootamundra Wattle	s			1														1
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia deanei*	Green Wattle	s		1					1	1	1				1	1		1	7
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia decora*	Western Golden Wattle	s							1							1			2
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia hakeoides*	Hakea Wattle	s							1										1
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia implexa*	Hickory	s							1	1						1			3
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia oswaldii*	Miljee	s	1	1			1	1											4
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia pendula*	Myall	s							1										1
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia salicina*	Willow Wattle	s			1					1	1								3
Dicotyledon	Fumariaceae	*	*Fumaria muralis subsp. muralis*	Wall Fumitory	h						1	1			1							3
Dicotyledon	Geraniaceae	*	*Erodium cicutarium*	Common Crowsfoot	h					1												1
Dicotyledon	Geraniaceae		*Erodium crinitum*	Blue Storksbill	h	1	1	1	1	1				1		1	1					8
Dicotyledon	Goodeniaceae		*Goodenia pinnatifida*	Scrambled Eggs	h	1	1		1	1				1								5
Dicotyledon	Lamiaceae	*	*Lamium amplexicaule*	Dead Nettle	h		1															1
Dicotyledon	Lamiaceae	*	*Marrubium vulgare*	Horehound	h	1								1								2
Dicotyledon	Lamiaceae	*	*Salvia verbenaca*	Wild Sage	h				1				1								1	3
Dicotyledon	Loranthaceae		*Amyema linophylla subsp orientalis*	Slender-leaf Mistletoe	p				1	1												2
Dicotyledon	Lythraceae		*Lythrum hyssopifolia*	Hyssop Loosestrife	h									1					1			2
Dicotyledon	Malvaceae	*	*Malva parviflora*	Small-flowered Mallow	h		1										1					2
Dicotyledon	Malvaceae	*	*Modiola caroliniana*	Red-flowered Mallow	h						1			1								2
Dicotyledon	Malvaceae		*Sida corrugata*	Corrugated Sida	h	1	1	1	1	1		1	1	1	1							9
Dicotyledon	Malvaceae	*	*Sida rhombifolia*	Paddy's Lucerne	ss									1								1
Dicotyledon	Myoporaceae		*Eremophila debilis*	Amulla	ss	1	1						1			1						4

Group	Family	exotic	Scientific Name	Common Name	Habit	Fuzzy 1	Grey 2	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	Pasture 1	Pasture 2	Noise Bund 1	WRE2-1	WRE2-2	WRE3-1	WRE3-2	Total
Dicotyledon	Myoporaceae		*Myoporum montanum*	Western Boobialla	s	1		1	1	1				1								**5**
Dicotyledon	Myrtaceae		*Eucalyptus camaldulensis*	River Red Gum	t						1		1	1								**3**
Dicotyledon	Myrtaceae		*Eucalyptus conica*	Fuzzy Box	t	1		1				1										**3**
Dicotyledon	Myrtaceae		*Eucalyptus microcarpa*	Grey Box	t	1	1					1	1									**4**
Dicotyledon	Myrtaceae		*Eucalyptus populnea*	Bimble Box	t			1														**1**
Dicotyledon	Oxalidaceae		*Oxalis perennans*	Yellow Wood-sorrel	h	1	1	1	1	1	1	1	1	1	1	1						**11**
Dicotyledon	Oxalidaceae	*	*Oxalis pes-caprae*	Soursob	h		1							1								**2**
Dicotyledon	Plantaginaceae	*	*Plantago lanceolata*	Ribwort	h						1											**1**
Dicotyledon	Plantaginaceae		*Plantago varia*	Variable Plantain	h		1		1	1				1								**4**
Dicotyledon	Polygonaceae	*	*Polygonum aviculare*	Wireweed	h		1										1					**2**
Dicotyledon	Polygonaceae		*Rumex brownii*	Swamp Dock	h	1	1		1				1	1								**5**
Dicotyledon	Polygonaceae		*Rumex tenax*	Shiny Dock	h											1	1					**2**
Dicotyledon	Portulacaceae		*Calandrinia eremaea*	Purslane	h					1												**1**
Dicotyledon	Primulaceae	*	*Lysimachia arvensis*	Scarlet Pimpernel	h							1		1	1				1			**4**
Dicotyledon	Proteaceae		*Hakea tephrosperma*	Hooked-leaved Needlewood	s														1			**1**
Dicotyledon	Resedaceae	*	*Reseda luteola*	Weld	h						1											**1**
Dicotyledon	Rubiaceae		*Asperula subulifolia*		h		1															**1**
Dicotyledon	Rutaceae		*Geijera parviflora*	Wilga	t	1			1													**2**
Dicotyledon	Sapindaceae		*Alectryon oleifolius*	Rosewood	t		1		1													**2**
Dicotyledon	Sapindaceae		*Dodonaea viscosa subsp. cuneata*	Wedge-leaf Hopbush	s		1															**1**
Dicotyledon	Solanaceae	*	*Lycium ferocissimum*	African Boxthorn	s	1	1	1	1	1		1	1	1	1	1	1				1	**12**
Dicotyledon	Solanaceae		*Solanum cinereum*	Narrawa Burr	h		1	1														**2**
Dicotyledon	Solanaceae		*Solanum esuriale*	Quena	h		1		1	1				1								**4**
Dicotyledon	Solanaceae	*	*Solanum nigrum*	Blackberry Nightshade	h	1																**1**
Dicotyledon	Sterculiaceae		*Brachychiton populneus*	Kurrajong	t	1		1														**2**
Dicotyledon	Unidentified	*	*Unidentified broadleaf seedling*		h										1							**1**
Dicotyledon	Urticaceae		*Parietaria debilis*	Native Pellitory	h				1	1												**2**
Dicotyledon	Urticaceae	*	*Urtica urens*	Small Nettle	h				1	1												**2**
Dicotyledon	Verbenaceae	*	*Verbena bonariensis*	Purpletop	h									1								**1**

Group	Family	exotic	Scientific Name	Common Name	Habit	Fuzzy 1	Grey 2	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	Pasture 1	Pasture 2	Noise Bund 1	WRE2-1	WRE2-2	WRE3-1	WRE3-2	Total
Dicotyledon	Verbenaceae	*	*Verbena litoralis*	Coastal Verbena	h									1								**1**
Dicotyledon	Verbenaceae	*	*Verbena officinalis*	Common Verbena	h										1							**1**
Dicotyledon	Zygophyllaceae		*Roepera aurantiaca*	Shrubby Twinleaf	ss												1	1	1	1	1	**5**
Monocotyledon	Alliaceae	*	*Nothoscordum gracile*	Onion Weed	h									1								**1**
Monocotyledon	Asphodelaceae		*Bulbine semibarbata*	Leek Lily	h		1		1	1												**3**
Monocotyledon	Cyperaceae		*Carex appressa*	Sword Sedge	r									1								**1**
Monocotyledon	Cyperaceae		*Carex inversa*	Knob Sedge	r	1	1		1	1			1									**5**
Monocotyledon	Cyperaceae		*Cyperus gracilis*	Slender Flat-sedge	r	1																**1**
Monocotyledon	Juncaceae		*Juncus flavidus*	Tussock Rush	r								1	1		1						**3**
Monocotyledon	Juncaceae		*Juncus subsecundus*	A Rush	r	1					1											**2**
Monocotyledon	Juncaceae		*Juncus usitatus*	A Rush	r											1						**1**
Monocotyledon	Lomandraceae		*Lomandra filiformis*	Wattle Mat-rush	h		1															**1**
Monocotyledon	Lomandraceae		*Lomandra multiflora*	Many-flowered Mat-rush	h	1	1															**2**
Monocotyledon	Phormiaceae		*Dianella longifolia*	Blueberry Lily	h		1															**1**
Monocotyledon	Poaceae		*Aristida behriana*	Bunch Wiregrass	g	1	1			1						1						**4**
Monocotyledon	Poaceae		*Aristida jerichoensis var. jerichoensis*	Jericho Wiregrass	g						1	1			1	1						**4**
Monocotyledon	Poaceae		*Austrostipa scabra*	Speargrass	g	1	1	1	1	1	1	1	1	1	1	1						**11**
Monocotyledon	Poaceae		*Austrostipa verticillata*	Slender Bamboo Grass	g					1					1							**2**
Monocotyledon	Poaceae	*	*Avena fatua*	Wild Oats	g	1	1	1			1	1	1	1	1	1	1	1		1	1	**13**
Monocotyledon	Poaceae		*Bothriochloa decipiens*	Redgrass	g							1	1	1		1						**4**
Monocotyledon	Poaceae		*Bothriochloa sp.*	Redgrass	g						1											**1**
Monocotyledon	Poaceae	*	*Bromus cartharticus*	Prairie Grass	g	1		1				1			1							**4**
Monocotyledon	Poaceae	*	*Chloris gayana*	Rhodes Grass	g													1	1	1	1	**4**
Monocotyledon	Poaceae		*Chloris truncata*	Windmill Grass	g						1	1			1	1				1	1	**6**
Monocotyledon	Poaceae		*Chloris ventricosa*	Tall Windmill Grass	g							1										**1**
Monocotyledon	Poaceae		*Cymbopogon refractus*	Barbed-wire Grass	g			1														**1**
Monocotyledon	Poaceae		*Cynodon dactylon*	Couch	g										1				1	1	1	**4**
Monocotyledon	Poaceae	*	*Dactylis glomerata*	Cocksfoot	g														1		1	**2**
Monocotyledon	Poaceae		*Digitaria sp.*		g		1					1	1		1							**4**

Group	Family	exotic	Scientific Name	Common Name	Habit	Fuzzy 1	Grey 2	Poplar 1	Belah 1	Belah 2	Reveg 1	Reveg 2	Creek 1	Creek 2	Pasture 1	Pasture 2	Noise Bund 1	WRE2-1	WRE2-2	WRE3-1	WRE3-2	Total
Monocotyledon	Poaceae		*Elymus scaber*	Common Wheatgrass	g	1		1					1			1						**4**
Monocotyledon	Poaceae		*Enteropogon acicularis*	Curly Windmill Grass	g		1			1	1		1		1	1	1					**7**
Monocotyledon	Poaceae	*	*Eragrostis curvula*	African Lovegrass	g						1		1	1		1						**4**
Monocotyledon	Poaceae		*Eragrostis parviflora*	Weeping Lovegrass	g	1	1			1	1	1		1	1	1			1		1	**10**
Monocotyledon	Poaceae		*Eragrostis setifolia*	Neverfail	g	1	1		1			1										**4**
Monocotyledon	Poaceae	*	*Hordeum leporinum*	Barley Grass	g			1														**1**
Monocotyledon	Poaceae	*	*Lolium rigidum*	Wimmera Ryegrass	g	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	**15**
Monocotyledon	Poaceae	*	*Lolium spp.*	A Ryegrass	g	1																**1**
Monocotyledon	Poaceae	*	*Nassella trichotoma*	Serrated Tussock	g	1			1	1					1							**4**
Monocotyledon	Poaceae		*Panicum effusum*	Hairy Panic	g		1		1		1	1			1							**5**
Monocotyledon	Poaceae		*Paspalidium gracile*	Slender Panic	g	1		1	1													**3**
Monocotyledon	Poaceae	*	*Paspalum dilatatum*	Paspalum	g									1								**1**
Monocotyledon	Poaceae		*Rytidosperma erianthum*	Hill Wallaby Grass	g	1			1	1												**3**
Monocotyledon	Poaceae		*Rytidosperma racemosum*	Wallaby Grass	g				1													**1**
Monocotyledon	Poaceae		*Rytidosperma setaceum*	Small-flowered Wallaby Grass	g	1				1												**2**
Monocotyledon	Poaceae		*Rytidosperma sp.*	Wallaby Grass	g		1				1	1			1							**4**
Monocotyledon	Poaceae		*Sporobolus caroli*	Fairy Grass	g				1	1												**2**
Monocotyledon	Poaceae		*Themeda triandra*	Kangaroo Grass	g						1	1										**2**
Monocotyledon	Poaceae	*	*Vulpia sp.*	Rat's-tail Fescue	g			1		1	1	1	1		1	1						**7**
Monocotyledon	Poaceae		*Walwhalleya subxerophila*	Cane Panic	g	1		1	1				1	1		1					1	**7**
Pteridophyta	Adiantaceae		*Cheilanthes sieberi subsp. sieberi*	Rock Fern	f	1		1	1	1		1	1	1	1	1						**9**
Total						**53**	**67**	**40**	**67**	**58**	**43**	**58**	**52**	**62**	**45**	**45**	**36**	**22**	**35**	**33**	**31**	

Appendix 2. Routine agricultural soil analyses report

9 samples supplied by DnA Environmental on 17/08/2021. Lab Job No.M0337

			Site	Fuzzy1	Grey2	Pasture 1	Pasture 2	Noise Bund	WRE2-01	WRE2-02	WRE3-01	WRE3-02	*Heavy Soil Clay*	*Medium Soil Clay*	*Light Soil Loam*	*Sandy Soil Loamy*
	Parameter		**Method reference**	**M0337/2**	**M0337/1**	**M0337/3**	**M0337/4**	**M0337/5**	**M0337/6**	**M0337/7**	**M0337/8**	**M0337/9**	**Indicative guidelines - refer to Notes 6 and 8**			
	Soluble Calcium (mg/kg)		**Inhouse S10 - Morgan 1	639	565	395	421	645	717	933	1,200	1,150	*1150*	*750*	*375*	*175*
	Soluble Magnesium (mg/kg)			230	198	99	121	265	216	206	417	264	*160*	*105*	*60*	*25*
	Soluble Potassium (mg/kg)			317	199	231	233	397	178	153	223	116	*113*	*75*	*60*	*50*
	Soluble Phosphorus (mg/kg)			1.9	1.3	1.7	1.4	5.5	1.7	1.3	3.5	1.6	*15*	*12*	*10*	*5.0*
	Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9E2 (Bray 1)	5.8	4.4	13	7.5	33	8.5	8.9	21	7.7	*45note 8*	*30note 8*	*24note 8*	*20note 8*
			**Rayment & Lyons 2011 - 9B2 (Colwell)	29	25	44	38	81	25	34	53	27	*80*	*50*	*45*	*35*
			**Inhouse S3A (Bray 2)	10	9.7	25	16	50	13	18	36	15	*90note 8*	*60note 8*	*48note 8*	*40note 8*
	Nitrate Nitrogen (mg/kg N)		**Inhouse S37 (KCl)	1.9	1.6	3.3	3.7	4.7	1.8	1.6	2.3	2.0	*15*	*13*	*10*	*10*
	Ammonium Nitrogen (mg/kg N)			5.8	4.6	5.3	4.1	3.4	3.5	2.6	4.3	3.8	*20*	*18*	*15*	*12*
	Sulfur (mg/kg S)			9.4	7.0	8.7	8.5	11	10	23	17	75	*10.0*	*8.0*	*8.0*	*7.0*
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.81	6.10	5.92	5.85	7.11	7.02	7.28	7.84	6.99	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.045	0.025	0.030	0.030	0.078	0.041	0.065	0.101	0.194	*0.200*	*0.150*	*0.120*	*0.100*
	Estimated Organic Matter (% OM)		**Calculation: Total Carbon x 1.75	5.9	3.4	2.1	2.5	1.7	1.2	1.2	1.3	1.1	*> 5.5*	*>4 .5*	*> 3.5*	*> 2.5*
	Exchangeable Calcium	**(cmol$_+$/kg)**	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	5.9	4.8	3.1	3.0	5.2	5.4	6.7	10	9.5	*15.6*	*10.8*	*5.0*	*1.9*
		(kg/ha)		2,666	2,177	1,405	1,334	2,342	2,427	3,018	4,583	4,270	*7000*	*4816*	*2240*	*840*
		(mg/kg)		1,190	972	627	595	1,046	1,084	1,347	2,046	1,906	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium	**(cmol$_+$/kg)**		2.5	2.1	0.99	1.1	3.0	2.3	2.1	4.9	3.0	*2.4*	*1.7*	*1.2*	*0.60*

			Site	Fuzzy1	Grey2	Pasture 1	Pasture 2	Noise Bund	WRE2-01	WRE2-02	WRE3-01	WRE3-02	*Heavy Soil Clay*	*Medium Soil Clay*	*Light Soil Loam*	*Sandy Soil Loamy*
		(kg/ha)		686	570	270	298	830	638	563	1,322	809	*650*	*448*	*325*	*168*
		(mg/kg)		306	254	121	133	370	285	252	590	361	*290*	*200*	*145*	*75*
		(cmol$_+$/kg)		1.6	0.94	1.0	1.00	1.8	0.88	0.81	1.3	0.74	*0.60*	*0.50*	*0.40*	*0.30*
	Exchangeable Potassium	(kg/ha)		1,419	823	878	873	1,610	767	708	1,173	646	*526*	*426*	*336*	*224*
		(mg/kg)		634	367	392	390	719	342	316	524	288	*235*	*190*	*150*	*100*
		(cmol$_+$/kg)		0.09	0.09	<0.065	<0.065	0.24	0.39	0.23	0.30	0.56	*0.3*	*0.26*	*0.22*	*0.11*
	Exchangeable Sodium	(kg/ha)		47	48	<33	<33	122	202	120	155	288	*155*	*134*	*113*	*57*
		(mg/kg)		21	21	<15	<15	55	90	54	69	129	*69*	*60*	*51*	*25*
		(cmol$_+$/kg)	**Inhouse S37 (KCl)	0.05	0.03	0.03	0.05	<0.01	0.01	<0.01	<0.01	<0.01	*0.6*	*0.5*	*0.4*	*0.2*
	Exchangeable Aluminium	(kg/ha)		11	5.5	6.7	9.7	1.7	2.5	1.5	1.5	1.5	*121*	*101*	*73*	*30*
		(mg/kg)		4.8	2.5	3.0	4.3	<1	1.1	<1	<1	<1	*54*	*45*	*32*	*14*
		(cmol$_+$/kg)		0.55	0.34	0.44	0.52	<0.01	<0.01	<0.01	<0.01	<0.01	*0.6*	*0.5*	*0.4*	*0.2*
	Exchangeable Hydrogen	(kg/ha)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	12	7.6	10.0	12	<1	<1	<1	<1	<1	*13*	*11*	*8*	*3*
		(mg/kg)		5.5	3.4	4.4	5.2	<1	<1	<1	<1	<1	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	11	8.3	5.7	5.7	10	9.0	9.8	17	14	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)			55	58	55	52	50	60	68	61	69	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)			23	25	18	19	29	26	21	29	22	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	15	11	18	18	18	9.7	8.2	8.0	5.4	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)			0.85	1.1	1.1	1.1	2.3	4.3	2.4	1.8	4.1	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)			0.50	0.33	0.59	0.84	0.08	0.14	0.07	0.04	0.05	*6.0*	*7.1*	*10.5*	*12.1*

			Site	Fuzzy1	Grey2	Pasture 1	Pasture 2	Noise Bund	WRE2-01	WRE2-02	WRE3-01	WRE3-02	*Heavy Soil Clay*	*Medium Soil Clay*	*Light Soil Loam*	*Sandy Soil Loamy*
	Hydrogen (%)			5.1	4.1	7.9	9.1	0.00	0.00	0.00	0.00	0.00				
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium ($cmol_+/kg$)	2.4	2.3	3.2	2.7	1.7	2.3	3.2	2.1	3.2	*6.5*	*6.4*	*4.2*	*3.2*
	Zinc (mg/kg)		Rayment & Lyons 2011 - 12A1 (DTPA)	1.4	1.1	0.52	<0.5	0.64	<0.5	<0.5	<0.5	<0.5	*6.0*	*5.0*	*4.0*	*3.0*
	Manganese (mg/kg)			72	50	42	28	10	11	9.7	5.8	14	*25*	*22*	*18*	*15*
	Iron (mg/kg)			117	56	60	73	23	15	14	12	21	*25*	*22*	*18*	*15*
	Copper (mg/kg)			1.2	0.67	0.73	0.74	0.76	0.76	0.87	0.89	1.2	*2.4*	*2.0*	*1.6*	*1.2*
	Boron (mg/kg)		**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	1.1	0.78	0.42	0.64	1.1	0.97	1.1	0.96	1.5	*2.0*	*1.7*	*1.4*	*1.0*
	Silicon (mg/kg Si)		**Inhouse S11 (Hot CaCl2)	51	47	46	47	64	69	52	73	82	*50*	*45*	*40*	*35*
	Total Carbon (%)		Inhouse S4a (LECO Trumac Analyser)	3.4	2.0	1.2	1.4	0.96	0.67	0.70	0.77	0.62	*> 3.1*	*> 2.6*	*> 2.0*	*> 1.4*
	Total Nitrogen (%)			0.23	0.11	0.08	0.09	0.07	0.05	0.04	0.06	0.05	*> 0.30*	*> 0.25*	*> 0.20*	*> 0.15*
	Carbon/Nitrogen Ratio		**Calculation: Total Carbon/Total Nitrogen	15	18	14	16	14	15	16	14	13	*10–12*	*10–12*	*10–12*	*10–12*
	Basic Texture		**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Loam	Loam	..	..	..	..
	Basic Colour			Brownish	Brownish	Brownish	Brownish	Red	Red	Red	Brownish	Brownish	..	..	..	..
	Chloride Estimate (equiv. mg/kg)		**Calculation: Electrical Conductivity x 640	29	16	19	19	50	26	41	65	124	..	..	..	..
	Total Calcium (mg/kg)		Rayment & Lyons 2011 - 17C1 Aqua Regia	1,557	1,186	840	771	1,257	1,065	1,522	2,557	1,899	*1000–10 000 Ca*			
	Total Magnesium (mg/kg)			970	646	530	552	1,116	889	997	2,260	1,417	*500–5000 Mg*			
	Total Potassium (mg/kg)			1,954	1,173	1,368	1,247	1,813	1,399	1,491	2,299	1,607	*200–2000 K*			
	Total Sodium (mg/kg)			<50	<50	<50	<50	75	97	87	103	148	*100–500 Na*			
	Total Sulfur (mg/kg)			202	102	78	89	72	53	77	88	121	*100–1000 S*			
	Total Phosphorus (mg/kg)			367	197	240	219	233	157	156	223	152	*400–1500 P*			

			Site	Fuzzy1	Grey2	Pasture 1	Pasture 2	Noise Bund	WRE2-01	WRE2-02	WRE3-01	WRE3-02	*Heavy Soil Clay*	*Medium Soil Clay*	*Light Soil Loam*	*Sandy Soil Loamy*
	Total Zinc (mg/kg)			19	12	13	10	13	11	13	17	15	*20–50 Zn*			
	Total Manganese (mg/kg)			653	693	721	401	201	218	283	229	280	*200–2000 Mn*			
	Total Iron (mg/kg)			18,517	12,643	10,241	11,532	15,794	15,733	18,475	19,756	18,160	*1000–50 000 Fe*			
	Total Copper (mg/kg)			13	7.0	8.0	7.4	8.8	8.9	12	13	15	*20–50 Cu*			
	Total Boron (mg/kg)			3.1	2.5	2.6	2.7	4.0	3.0	3.0	6.8	5.3	*2–50 B*			
	Total Silicon (mg/kg)			774	789	1,239	920	820	697	823	519	747	*1000–3000 Si*			
	Total Aluminium (mg/kg)			14,080	9,577	7,967	9,396	11,131	11,642	13,898	15,800	13,415	*2000–50 000 Al*			
	Total Molybdenum (mg/kg)			0.64	0.55	0.69	0.45	0.58	0.52	0.52	0.54	0.56	*0.5–3.0 Mo*			
	Total Cobalt (mg/kg)			5.8	4.2	5.9	4.0	4.9	4.8	5.9	8.3	7.9	*5–50 Co*			
	Total Selenium (mg/kg)			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	*0.1–2.0 Se*			
	Total Cadmium (mg/kg)			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	*<1 Cd*			
	Total Lead (mg/kg)			9.6	8.7	11	8.7	8.7	8.6	9.6	9.0	9.0	*2–200 Pb*			
	Total Arsenic (mg/kg)			5.6	3.2	2.9	3.3	5.2	4.0	7.5	7.2	8.1	*1–50 As*			
	Total Chromium (mg/kg)			29	21	13	18	26	22	25	30	25	*5–1000 Cr*			
	Total Nickel (mg/kg)			10	7.2	6.0	6.6	7.9	7.3	8.6	13	11	*5–500 Ni*			
	Total Mercury (mg/kg)			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	*< 0.2 Hg*			
	Total Silver (mg/kg)			<1	<1	<1	<1	<1	<1	<1	<1	<1	*.. Ag*			

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*.CSIRO Publishing: Collingwood.

3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium,
    122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs).
17. This report was issued on 27/08/2021.

Quality Checked: Kris Saville
Agricultural Co-Ordinator

Appendix 3. OEH Monitoring Data Sheets 2021

Monitoring Data Sheet			
Monitoring Point Number	Belah 1	**Date**	11/8//2021
Vegetation Community	Belah/Black Oak - Western Rosewood - Wilga woodland of central NSW including Cobar Peneplain Bioregion (Benson 57)		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			19
Midstorey:			2
Groundcover(grass):			19.25
Groundcover (shrub):			0.125
Groundcover (other):			15
Native species richness:			36
Proportion of canopy species regenerating			1
Exotic cover			18.75
Length of fallen logs			33
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			*Casuarina cristata (*Belah) regeneration
Threatened species sightings			Nil. Most of mistletoe has died.
Fire event/fuel			low
Weeds			African Boxthorn seedings/suckers numerous
Pest animals			Nil
Visitor impact/vehicles			nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Belah 2	**Date**	11/8/2021
Vegetation Community	Belah/Black Oak - Western Rosewood - Wilga woodland of central NSW including Cobar Peneplain Bioregion (Benson 57)		
1. Site Photo(s)Taken	Yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			53
Midstorey:			0
Groundcover(grass):			22.5
Groundcover (shrub):			0.175
Groundcover (other):			13.75
Native species richness:			34
Proportion of canopy species regenerating			1
Exotic cover			4.25
Length of fallen logs			0.5
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Belah regeneration has been chewed. Isolated individuals of Acacia (oswaldii?), Myoporum montanum and Warrior Bush seedling.
Threatened species sightings			Most of mistletoe has died.
Fire event/fuel			Low
Weeds			African Boxthorn seedlings numerous
Pest animals			nil
Visitor impact/vehicles			nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Creek 1	**Date**	9/8/2020
Vegetation Community	River Red Gum riverine woodlands and forests in the Nandewar and Brigalow Belt South Bioregions (Benson 78) - Tubestock revegetation		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			6.25
Midstorey:			1.75
Groundcover(grass):			17.5
Groundcover (shrub):			1.75
Groundcover (other):			15
Native species richness:			26
Proportion of canopy species regenerating			0
Exotic cover			35
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Tubestock significantly grown, some >6m in height. Some natural acacia regeneration.
Threatened species sightings			nil
Fire event/fuel			Moderate in Summer
Weeds			Paterson's Curse, thistles, Peppercress, Vulpia seedlings
Pest animals			nil
Visitor impact/vehicles			nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Creek 2	**Date**	9/08/2021
Vegetation Community	River Red Gum riverine woodlands and forests in the Nandewar and Brigalow Belt South Bioregions (Benson 78) - remnant regrowth		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			21.5
Midstorey:			1.25
Groundcover(grass):			23.75
Groundcover (shrub):			0.25
Groundcover (other):			15
Native species richness:			28
Proportion of canopy species regenerating			1
Exotic cover			41.25
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Scattered regeneration of *E. camaldulensis* with a few new individuals and several acacia seedlings (*A. deanei*, *A salicina*). Two *Myoporum montanum* seedlings.
Threatened species sightings			Nil
Fire event/fuel			Nil, low in Summer
Weeds			Galenia was recorded for the first time. African Lovegrass, Patterson's Curse, African Boxthorn, Capeweed
Pest animals			Nil
Visitor impact/vehicles			.Nil
Rubbish dumping/ Erosion			Extensive slumping / bank erosion and stream incision

Monitoring Data Sheet

Monitoring Point Number	Fuzzy 1	**Date**	11/08/2021
Vegetation Community	Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion (Benson 201)		
1. Site Photo(s)Taken	yes		

2. Floristic BioMetric attributes	
Native cover	
Overstorey:	35
Midstorey:	0.75
Groundcover(grass):	36.25
Groundcover (shrub):	0.113
Groundcover (other):	27.5
Native species richness:	32
Proportion of canopy species regenerating	0.33
Exotic cover	17.5
Length of fallen logs	136

3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Older grey box regeneration. Young Bulloak, Wilga & Myoporum regeneration. A Kurrajong seedling was recorded this year. Sedges and native grasses abundant.
Threatened species sightings			nil
Fire event/fuel			Moderate – high in Summer
Weeds			African boxthorn, Wimmera Ryegrass
Pest animals			nil
Visitor impact/vehicles			Nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Grey 2	**Date**	9/08/2021
Vegetation Community	Inland Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions (Benson 76)		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			37
Midstorey:			2
Groundcover(grass):			9
Groundcover (shrub):			0.25
Groundcover (other):			36.25
Native species richness:			39
Proportion of canopy species regenerating			0.5
Exotic cover			13
Length of fallen logs			112.5
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Low numbers of Bulloak, Many A. deanei have died. Grey Box, Rosewood - limited individuals
Threatened species sightings			nil
Fire event/fuel			Low – moderate in Summer. Lots of woody debris.
Weeds			African Boxthorn, Wimmera Ryegrass, Sisymbrium sp.
Pest animals			nil
Visitor impact/vehicles			Weeds in topsoil mounds
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Noise Bund 1	**Date**	10/08/2021
Vegetation Community	Exotic Pasture		
1. Site Photo(s)Taken	Yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			0
Midstorey:			0
Groundcover(grass):			0.05
Groundcover (shrub):			0.4
Groundcover (other):			11.5
Native species richness:			13
Proportion of canopy species regenerating			0
Exotic cover			62.5
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Nil
Threatened species sightings			Heard Grey crowned Babblers in adjacent woodland vegetation
Fire event/fuel			Moderate – high in Summer
Weeds			Annual weeds and legumes abundant. Boxthorn seedling.
Pest animals			Low disturbance by macropods
Visitor impact/vehicles			Occasional gully /rill
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Pasture 1	**Date**	11/08/2020
Vegetation Community	*Eucalyptus microcarpa* (Inland Grey Box) – *E. populnea* (Poplar Box) – *Callitris glaucophylla* (White Cypress Pine) tall woodland on red loams - Derived grassland		
1. Site Photo(s)Taken	Yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			0
Midstorey:			0
Groundcover(grass):			21.25
Groundcover (shrub):			1.25
Groundcover (other):			6.25
Native species richness:			21
Proportion of canopy species regenerating			nil
Exotic cover			57.5
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			nil
Threatened species sightings			6 Superb Parrots flew over
Fire event/fuel			Low
Weeds			Skeleton weed, peppercress, Scotch Thistle seedlings; Isolated African Boxthorn. Dominated by Trifolium species.
Pest animals			nil
Visitor impact/vehicles			nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Pasture 2	**Date**	9/08/2020
Vegetation Community	*Eucalyptus microcarpa* (Inland Grey Box) – *E. populnea* (Poplar Box) – *Callitris glaucophylla* (White Cypress Pine) tall woodland on red loams - Derived grassland		
1. Site Photo(s)Taken	Yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			0
Midstorey:			0.1
Groundcover(grass):			16.25
Groundcover (shrub):			2.85
Groundcover (other):			16.25
Native species richness:			20
Proportion of canopy species regenerating			0.5
Exotic cover			46.25
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			1 Callitris glaucophylla seedling.
Threatened species sightings			nil
Fire event/fuel			Moderate in summer
Weeds			Scattered African Boxthorn seedlings
Pest animals			nil
Visitor impact/vehicles			nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Poplar 1	**Date**	11/08/2020
Vegetation Community	Poplar Box - Belah woodland on clay-loam soils of the alluvial plains of north-central NSW (Benson 56)		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			65
Midstorey:			0
Groundcover(grass):			1.9
Groundcover (shrub):			0.05
Groundcover (other):			48.75
Native species richness:			17
Proportion of canopy species regenerating			0
Exotic cover			31.25
Length of fallen logs			26
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Occasional Myoporum montanum, Acacia salicina and Kurrajong seedling
Threatened species sightings			nil
Fire event/fuel			Moderate – high in Summer
Weeds			African Boxthorn seedlings, Wimmera Ryegrass, annual grasses, Cootamundra wattle seedling
Pest animals			nil
Visitor impact/vehicles			nil
Rubbish dumping			nil

Monitoring Data Sheet

Monitoring Point Number	Reveg 1	**Date**	12/08/2020
Vegetation Community	Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion (Benson 201) - Revegetation Site		
1. Site Photo(s)Taken	Yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			0.5
Midstorey:			1.0
Groundcover(grass):			28.75
Groundcover (shrub):			0.025
Groundcover (other):			3.75
Native species richness:			20
Proportion of canopy species regenerating			0
Exotic cover			37.5
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Scattered saplings – revegetation. One Acacia (oswaldii?) seedling recorded this year
Threatened species sightings			nil
Fire event/fuel			Moderate in summer
Weeds			Paterson's Curse, Flatweed and annual weeds. Trifolium species abundant
Pest animals			Kangaroo grazing and camps under trees
Visitor impact/vehicles			nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	Reveg 2	**Date**	12/08/2021
Vegetation Community	Fuzzy Box - Inland Grey Box on alluvial brown loam soils of the NSW South Western Slopes Bioregion and southern BBS Bioregion (Benson 201) - Revegetation Site		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			5.5
Midstorey:			7.125
Groundcover(grass):			3.125
Groundcover (shrub):			1.625
Groundcover (other):			10.5
Native species richness:			27
Proportion of canopy species regenerating			0
Exotic cover			26.9
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Seeded trees and shrubs
Threatened species sightings			nil
Fire event/fuel			Moderate in summer
Weeds			Annual weeds, Trifolium species abundant, one Boxthorn seedling
Pest animals			Nil
Visitor impact/vehicles			nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	WRE2-1	**Date**	10/08/2021
Vegetation Community	Exotic Pasture		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			0
Midstorey:			1.125
Groundcover(grass):			0.5
Groundcover (shrub):			0.5
Groundcover (other):			3.1
Native species richness:			7
Proportion of canopy species regenerating			0
Exotic cover			75
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Acacia deanei x 24 (0 - >2m in height)
Threatened species sightings			nil
Fire event/fuel			Moderate - high in Summer
Weeds			Rhodes Grass, annual weeds. Medicago dominant
Pest animals			nil
Visitor impact/vehicles/ erosion			Some small sink holes developing in upper slope
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	WRE2-2	**Date**	10/08/2021
Vegetation Community	Woodland		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			0
Midstorey:			0.075
Groundcover(grass):			0.125
Groundcover (shrub):			0.15
Groundcover (other):			0.625
Native species richness:			12
Proportion of canopy species regenerating			0
Exotic cover			87.5
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Scattered acacias and saltbushes
Threatened species sightings			nil
Fire event/fuel			Moderate - high in summer
Weeds			Rhodes Grass and Medicago abundant, scattered annual weeds.
Pest animals			nil
Visitor impact/vehicles/ Erosion			nil
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	WRE3-1	**Date**	10/08/2021
Vegetation Community	Exotic Pasture		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:		0	
Midstorey:		0	
Groundcover(grass):		0.75	
Groundcover (shrub):		0.375	
Groundcover (other):		1.125	
Native species richness:		10	
Proportion of canopy species regenerating		0	
Exotic cover		87.5	
Length of fallen logs		0	
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			nil
Threatened species sightings			Hear Grey Crowned Babblers and Superb Parrots calling from adjacent woodland areas
Fire event/fuel			Moderate – high in summer
Weeds			Medicago and Trifolium dominant, scattered annual weeds, occasional Rhodes Grass
Pest animals			nil
Visitor impact/vehicles/ Erosion			Some minor tunnel erosion /rills developing.
Rubbish dumping			nil

Monitoring Data Sheet			
Monitoring Point Number	WRE3-2	**Date**	10/08/2021
Vegetation Community	Exotic Pasture		
1. Site Photo(s)Taken	yes		
2. Floristic BioMetric attributes			
Native cover			
Overstorey:			0
Midstorey:			0
Groundcover(grass):			4.75
Groundcover (shrub):			0.625
Groundcover (other):			1.0
Native species richness:			8
Proportion of canopy species regenerating			0
Exotic cover			65
Length of fallen logs			0
3. Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			One *Acacia deanei* seedling
Threatened species sightings			nil
Fire event/fuel			Low -moderate in summer
Weeds			Medicago and Trifolium dominant, scattered annual weeds, occasional Rhodes Grass, Scattered Boxthorn seedlings
Pest animals			nil
Visitor impact/vehicles/ Erosion			Some minor rilling and hot spots.
Rubbish dumping			nil

Appendix 5

Fauna Monitoring

Tomingley Gold Operations

Fauna Monitoring Report

Dubbo Regional LGA NSW

February 2022

IMAGE: Grey-crowned Babbler at TGO 2021

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AREA Landscape Design Consultants Pty Ltd ABN: 56 646 194 176

- ✓ Commercial external landscape designs for built or natural environments
- ✓ Vegetation Management Plans
- ✓ Stakeholder and community engagement
- ✓ Peer review / project briefs / budgeting assistance

AREA Environmental & Heritage Consultants ABN: 29 616 529 867

- ✓ Environmental impact assessments and approvals: REFs, MW REFs, PEAs
- ✓ Ecology, Aboriginal and historic heritage assessments
- ✓ Biodiversity assessment method (BAM) assessments (BDAR) and offsetting (BSAR)
- ✓ Plans of Management
- ✓ Aboriginal community engagement
- ✓ Stakeholder and community engagement
- ✓ Peer review / project briefs / budgeting assistance / expert witness

AREA Environmental & Heritage Consultants acknowledge Traditional Owners of the country on which we work

Executive Summary

Tomingley Gold Operations Pty Ltd (TGO) (the client) engaged AREA to undertake biannual fauna monitoring at the Tomingley Gold Mine and its associated biodiversity offset areas, as per the Tomingley Gold Operations Biodiversity Management Plan (BMP).

TGO was assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act), with Project Approval (PA 09_0155) being granted by the NSW Department of Planning and Infrastructure (now DPIE) in 2012. Approval has been modified five times subsequently.

TGO has 127 hectares of biodiversity offset areas (BOA) in place, with these areas secured under a Property Vegetation Management Plan (PVP). Amelioration planting has been carried out to improve biodiversity across these areas where the previous use was cropping and grazing. Field assessment for this year's monitoring occurred on 14 to 17 December 2021.

The 2021 monitoring event aimed to address the following areas as outlined in the Tomingley BMP:

1. Grey-crowned Babbler population census
2. Bat monitoring
3. Fat-tailed Dunnart monitoring
4. Cyanide impacts on native fauna
5. Amphibian survey

Grey-crowned Babblers were observed to be present in two of four of their previously known locations, with an addition of two new locations. The population appears to be recovering from the impacts of the severe drought which occurred in NSW from 2017 to 2019.

The fauna survey in 2011 recorded 134 vertebrate species, a substantially higher number than recorded in the following survey years. The 2011 survey however was conducted under a much higher degree of survey over a broader study area to meet project approvals. The 2016 proceeded to record 41 species showing a declining trend of fauna from 2011. The 2019 survey recorded 38 and followed three years of below average rainfall. Opposed to the 2021 survey which was conducted during a high volume of rain fall throughout NSW.

During 2021 monitoring, 39 species were recorded. Of these 39 species, 18 were birds, 14 were bats, two were mammals, one was a reptile and four were amphibians. No fauna was detected on camera traps or in the Elliot traps. Two threatened species were recorded, Grey-crowned Babbler *Pomatostomus temporalis* and Southern Myotis *Myotis Macropus.* The Southern Myotis was possibly recorded for the second time in 2021 - the first being in 2019 however identification of this species has not been confirmed through other survey methods.

The 2021 fauna monitoring event was completed to meet the objectives and monitoring targets outlined in Section 2.2, with targeted species searches undertaken and opportunistic sighting of other species recorded, rather than a complete fauna survey which was conducted to inform the project approval in 2011.

Fat-tailed Dunnart was not recorded in the area. Many Eastern Grey Kangaroos *Macropus giganteus* were sighted along Gundong creek. A European Hare *Lepus europaeus* was sighted near the dam adjacent to Gundong creek. A possible European Red Fox *Vulpes Vulpes* scat was recorded within the biodiversity offset area north east of the TGO administration buildings.

Cyanide does not appear to be significantly affecting fauna. A recommendation resulting from the 2019 fauna monitoring to update the fauna monitoring daily observation record sheet for the Residue Storage Facility has been implemented. Reporting occurs twice a day using the updated template in Appendix C.

Four amphibian species were detected in healthy population levels, water levels for Gundong creek were healthy and the creek was flowing at the time of the 2021 monitoring event. One of these species Broad Palmed Rocket Frog *Litoria latopalmata*, has been recorded for a second time since its first recording at TGO during the 2019 survey.

This was not a full biodiversity assessment. However, there has been an increase in fauna activity within TGO since the last monitoring event in 2021 which is likely to be linked to improved weather conditions and regular rainfall throughout 2020 and 2021. If favourable weather conditions continue a further increase in fauna activity would be expected during the 2023 monitoring event.

Recommendations have been made to maximise the effectiveness of future monitoring events.

Document Controls

Proponent	Tomingley Gold Operations (Alkane Resources)		
Client	Tomingley Gold Operations (Alkane Resources)		
Project No / Purchase Order No	PO322832		
Document Description	Fauna Monitoring Report 2021		
Clients Representative Managing this Document	**AREA Person(s) Managing this Document**		
David Pritchard	Gabrielle Green		
AREA Job Number	Q0237		
Document Status: FINAL	Version	Date	Action
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Prepared For	**Prepared By**		
David Pritchard Tomingley Gold Operations Alkane Resources Email: DPritchard@alkane.com.au Office: (02) 68 67 9780	Gabrielle Green Environment Consultant Cadet AREA Environmental & Heritage Consultants Pty Ltd 72 Brisbane Street Dubbo NSW 2830 Dubbo NSW 2830 M 0439 340 940 E gabbi@areaenv.com.au ABN:29 616 529 867		

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Terms and acronyms used in this document

Acronym	Definition
BC Act	Biodiversity Conservation Act 2016
BOA	Biodiversity Offset Area
BOM	Bureau of Meteorology
BOS	Biodiversity Offset Area
BMP	Biodiversity Management Plan
BOS	Biodiversity Offset Strategy
DPIE	NSW Government of Planning, Industry & Environment (Formally OEH)
EEC	Endangered Ecological Community
EPA	NSW Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
LGA	Local Government Area
NSW	New South Wales
OEH	Office of Environment and Heritage
PCT	Plant Community Types
VIS	Vegetation Information System

1 Introduction

1.1 Locality

Tomingley Gold Operations Pty Ltd (TGO), a wholly owned subsidiary gold mine and processing plant of Alkane Resources, is located approximately 50 kilometres south-west of Dubbo in Central West NSW in the Narromine Local Government Area (LGA) on the outskirts of the small town of Tomingley (Figure 1-1 and Figure 1-2).

Regional context of the study area is provided in Table 1-1.

Table 1-1: Regional context of the Biodiversity Offset Area

Criteria	Site context
Interim Biogeographic Regionalisation for Australia (IBRA Region)	Darling Riverine Plains Region, Bogan-Macquarie Sub-region
State	New South Wales
Topographical map sheet	Peak Hill 8532N
Local Government Area	Narromine
Nearest town / locality	Tomingley (1.5 kilometres) Peak Hill (18 kilometres)
Accessed from nearest town by	Tomingley via Tomingley West Road
Land use / disturbance	Agriculture (ploughed landscapes), continuous grazing, urban (Tomingley), road reserves, Biodiversity Offset Area and mining activities.
Nearest waterway	Gundong Creek traverses the north-western section of the Mine, while a number of unnamed drainage lines occur within and immediately north and east of the Mine. All ultimately drain into the Bogan River, approximately 10 kilometres south west of TGO.
Spot point Australian Height Datum (AHD)	Approximately 260m to 280m

Figure 1-1: Location of Tomingley Gold Operations

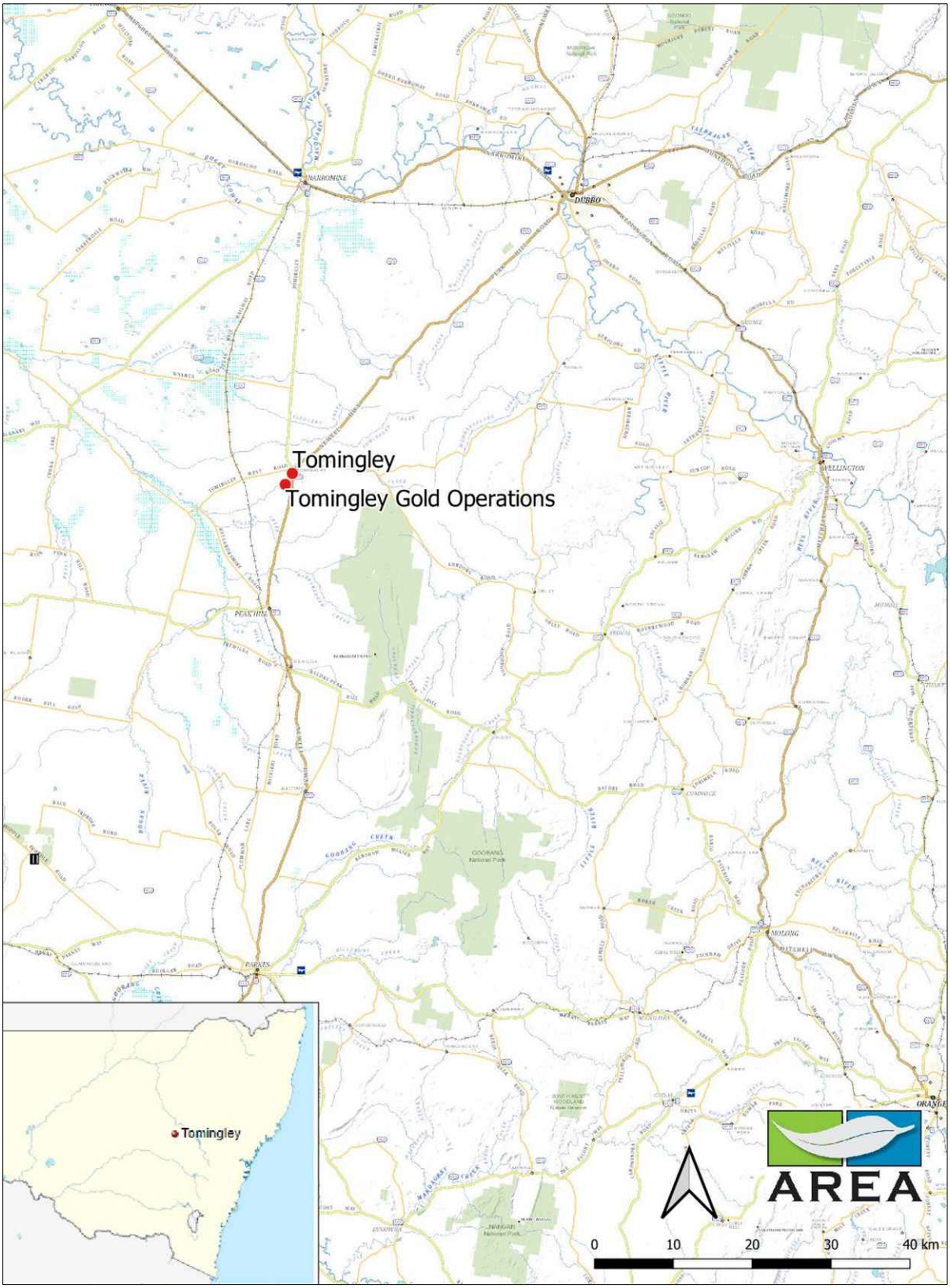
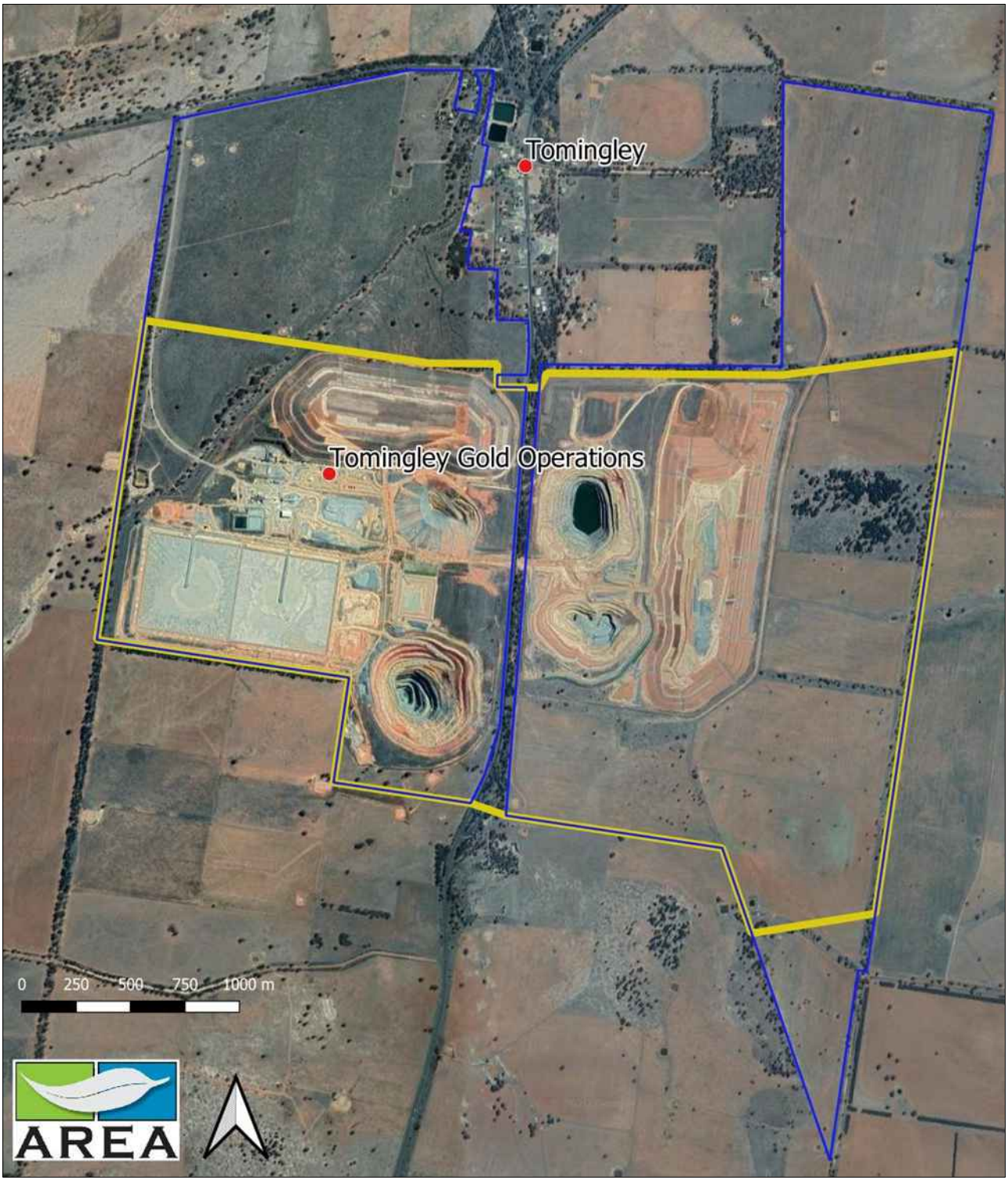


Figure 1-2: Tomingley Gold Operations Aerial view



1.2 Background

AREA Environmental & Heritage Consultants (AREA) was commissioned by Tomingley Gold Operations Pty Ltd to undertake fauna monitoring, as a requirement of the 'Tomingley Gold Operations Biodiversity Management Plan' (BMP) (Revision 8 November 2021).

TGO was assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act), with Project Approval (PA 09_0155) being granted by the NSW Department of Planning and Infrastructure (now DPIE) in 2012. Approval has been modified five times subsequently. Mining operations commenced at Tomingley in January 2014.

Biodiversity at TGO is managed under the Biodiversity Management Plan (BMP), completed in accordance with Schedule 3, Condition 37 of PA 09_0155. The BMP details the actions implemented at TGO to mitigate impacts on native fauna and vegetation from mining related activities such as storage of potentially hazardous process residue and the clearing of native vegetation.

Along with mitigation of mining impacts, the major biodiversity enhancement measure at TGO is the establishment, management and long-term protection of biodiversity offset areas in accordance with Schedule 3, Conditions 33 and 34 of PA 09_0155. To facilitate long-term security for the offset areas, a Property Vegetation Plan (PVP) was agreed to by TGO and approved by Local Land Services NSW in April 2015. The BMP incorporates measures and activities to manage and enhance TGO biodiversity offset areas (Figure 1-3), as required by the PVP.

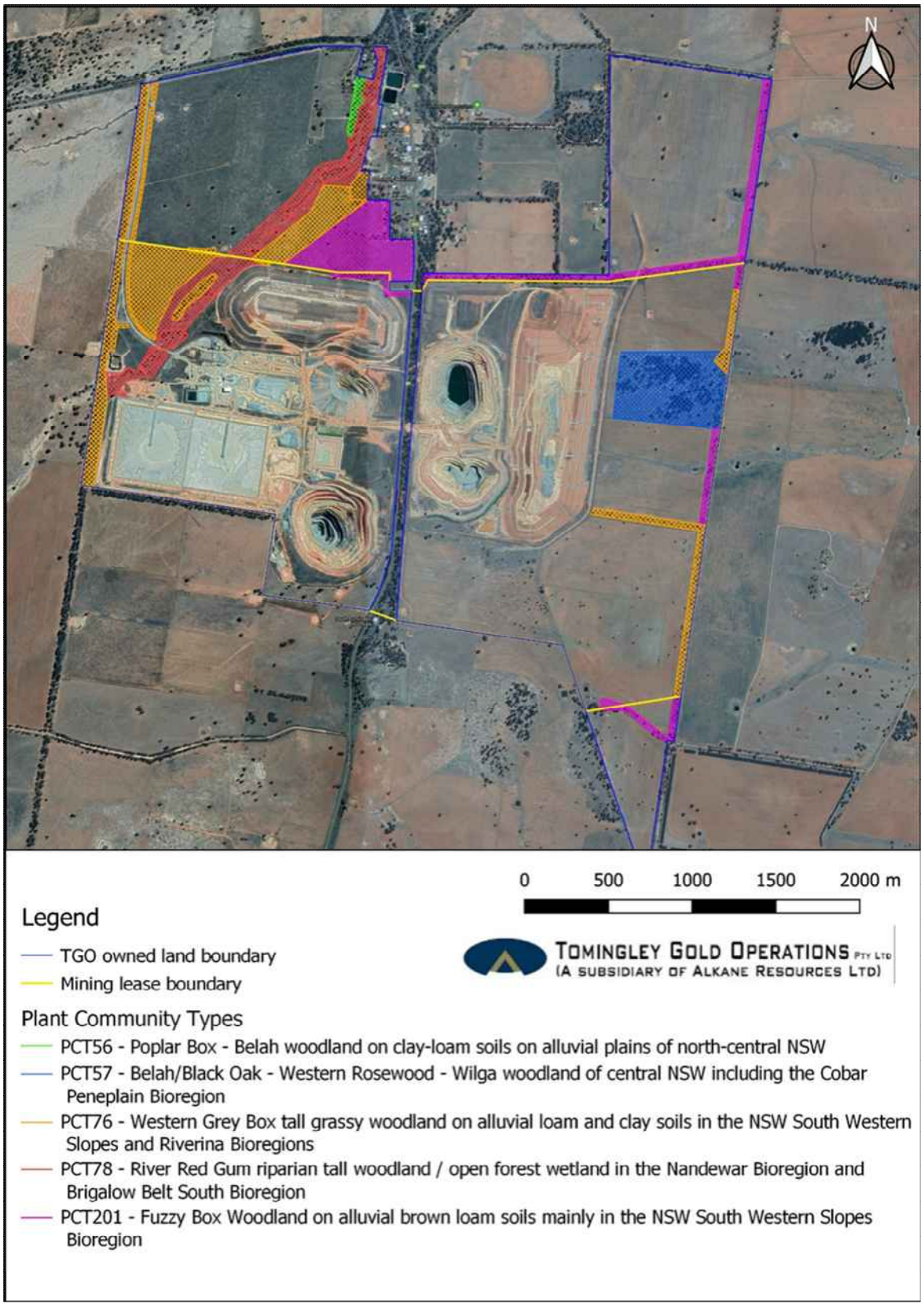
Biodiversity management at TGO consists of the following two main components:

- Management of vegetation communities within the designated Biodiversity Offset Area (BOA)
- Ongoing management and monitoring of flora and fauna within the mine site.

Ecology Assessment was first undertaken September 2011 prior to the mine operations commencing in 2014 and covered a much larger project site. Field survey for the biannual fauna monitoring program is completed every two years.

The 2011 fauna survey revealed the broader project site supported a moderate diversity of native fauna with a total of 134 vertebrate fauna species (123 native and 11 introduced) recorded.

Figure 1-3: TGO Biodiversity Offset Areas Plant Community Types



2 Methods

Field survey was undertaken on 14 to 17 December 2021 by two AREA ecologists Greg Bible and Gabrielle Green.

2.1 Project personnel

The monitoring and preparation of this monitoring report was carried out by appropriately qualified and experienced staff (Table 2-1).

Table 2-1: Summary of AREA project teams' qualifications

Name	Position	CV Details	Role in this project
Gabrielle Green	Cadet Environmental Consultant	• B. Env. Sc. New England University (in prep) • AHCPCM201- Recognising grasses • WHS White Card • WIRES training • First Aid Certificate (Cert No. 6995717)	• Fieldwork • Report writing • Data analysis • Cartography
Greg Bible	Environmental Consultant	• B. Env. Sc. with Honours in Ecology • WHS White Card • First Aid Certificate (Cert No. 93287)	• Field work • QMS
Addy Watson	Biodiversity Manager	• Grad. Dip. Captive Vertebrate Management, Charles Sturt University • Grad. Cert. Social Impact, University of NSW • B. Env. Sc. University of New England. • Diploma Project Management • NSW Biodiversity Assessment Method Accredited Assessor (Number BAAS19066) • Lean Six Sigma Certificate (Sydney Uni) • WHS White Card • Apply First Aid. Certificate number: 07328	• Project Management • Report Editing • QMS

2.2 Objectives and monitoring targets

Table 2-2 presents the objectives and targets as outlined in the Tomingley Gold Operations Biodiversity Management Plan. The objectives shaded in orange are the ones relevant to this report.

Table 2-2: Fauna management targets and completion criteria.

Objectives	Target	Completion criteria
Protection of Grey-crowned Babblers (eastern sub-species) and their habitat	• Nesting continues successfully.	Biodiversity monitoring indicates species still breeding in their known range.
Maintain Grey-crowned Babbler population.	• Resident population remains.	Biodiversity monitoring indicates species still present in their known range.
Maintain a healthy frog population.	• Maintain frog populations and aquatic habitat within the Biodiversity Offset Area.	Biodiversity monitoring indicates healthy frog populations and aquatic habitat in the Biodiversity Offset Area.
Confirm or deny presence of Fat-tailed Dunnart population.	• Resident population successfully detected • If detected risks to resident population are identified and managed	Presence or absence of a resident population is confirmed.

Maintain a healthy microbat population.	• Populations of microbats are not reduced.	Biodiversity monitoring indicates healthy microbat populations are still present in the Biodiversity Offset Area.
Vertebrate pest populations monitored and controlled	• Vertebrate pest populations are successfully reduced and/or controlled	Annual monitoring indicates reduction in extent of feral and overabundant native animals
Increase or maintain habitat value at the time of mine closure.	• Habitat enhancement and extension directives stated within PVP document are achieved	Vegetation monitoring indicates Vegetation enhancement criteria complete (see previous section).
Minimise or prevent cyanide related fauna deaths.	• Minimal fauna deaths from exposure to cyanide	If any cyanide related fauna deaths are recorded, appropriate action is taken to reduce the risk of it occurring again.

The BMP outlines Site Specific Procedures which have been developed for TGO fauna monitoring activities:

Relevant ecological information captured during vegetation monitoring indicates habitat usage and potential fauna population trends. Fauna monitoring surveys occur in spring or summer every two years and include the following activities:

1. *Grey-crowned Babbler monitoring as a means of population census and to identify breeding locations as a gauge breeding success.*
2. *Bat monitoring (over three consecutive nights per event) to establish population trends. Specialist recording equipment and expert data analysis is required to enable accurate species identification.*
3. *Fat-tailed Dunnart monitoring as a means of population census and to gather relevant species management information.*
4. *Cyanide impacts on native fauna as described in Section 8.1.*

These procedures have been the guideline of AREA's fauna monitoring. Additionally, a targeted amphibian survey has been included following recommendation from 2016 monitoring and to meet the BMP objective:

Objective	Target
Monitor frog population.	• Implement monitoring annually. • Maintain frog habitat within the Biodiversity Offset Area.

1.1 Fauna survey and habitat assessment

Methods used to monitor fauna populations within the mine site and the BOA are outlined in the following sections.

1.1.1 Birds

Bird monitoring for this survey aimed to address the BMP outlined Site Specific Procedure:

1. Grey-crowned Babbler monitoring as a means of population census and to identify breeding locations as a gauge breeding success.

Grey-crowned Babbler (GCB) populations were surveyed using a rolling bird survey, stopping and listening throughout the mine site, in vehicle and on foot in areas GCB's are known to

occur. During the stops, birds seen or heard are recorded. The survey also accounted for presence/absence, locating nests and breeding success, recording family size, composition and behaviour where possible. Opportunistic sightings of other bird species were also recorded.

1.1.2 Bats

Bat monitoring for this survey aimed to address the BMP outlined Site Specific Procedure:

2. Bat monitoring (over three consecutive nights per event) to establish population trends. Specialist recording equipment and expert data analysis is required to enable accurate species identification.

Two ultrasonic bat call recorders were used to monitor bat activity at TGO (See Figure 2-1):

- In the Biodiversity Offset Strategy Vegetation Community 1, *Inland Grey box, Poplar Box, White Cypress Pine all woodland on red loams* (Figure 1-3), near the TGO residue storage facility (RSF) (Plate 2-1)
- In the Biodiversity Offset Strategy Vegetation Community 5, *Belah / Black Oak, Western Rosewood, Wilga Woodland* (Commonly known as the 'Belah block').

Recorded calls were analysed by bat specialist, Heidi Kolkert, using Analook V4.1 bat call analysis software.

Figure 2-1: Location of bat monitoring equipment

Plate 2-1: Installing bat monitoring equipment at TGO

1.1.3 Small mammals and reptiles

Small mammal monitoring for this survey aimed to address the BMP outlined Site Specific Procedure:

3. Fat-tailed Dunnart monitoring as a means of population census and to gather relevant species management information.

Fifty (50) Type A Elliot traps were spaced at 10 metre intervals for three consecutive nights. The 50 Elliot traps were positioned at opposite ends of the TGO property, 25 along the western bank of Gundong Creek and 25 within the offset property at the eastern boundary of the TGO property (Figure 2-2). Fifty Elliot traps over three nights totally 150 trapping opportunities meeting the NSW DECC Draft Survey Guideline (2004) requirement.

A camera trap was also used over three nights to record nocturnal fauna activity and other incidental animals in the 'Belah block' observing an artificial hollow installed by TGO (Plate 2-2).

Figure 2-2: Location of mammal traps

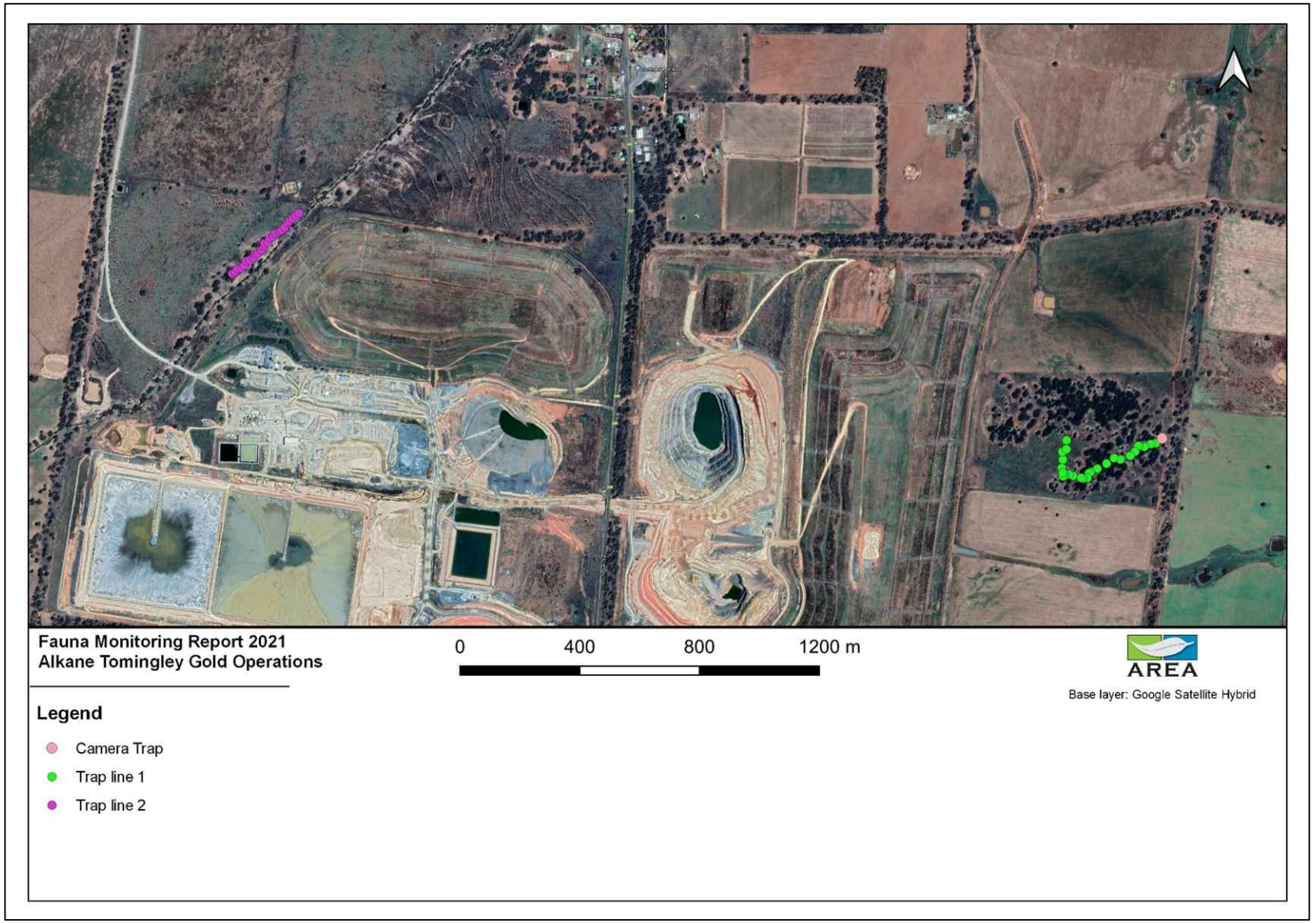
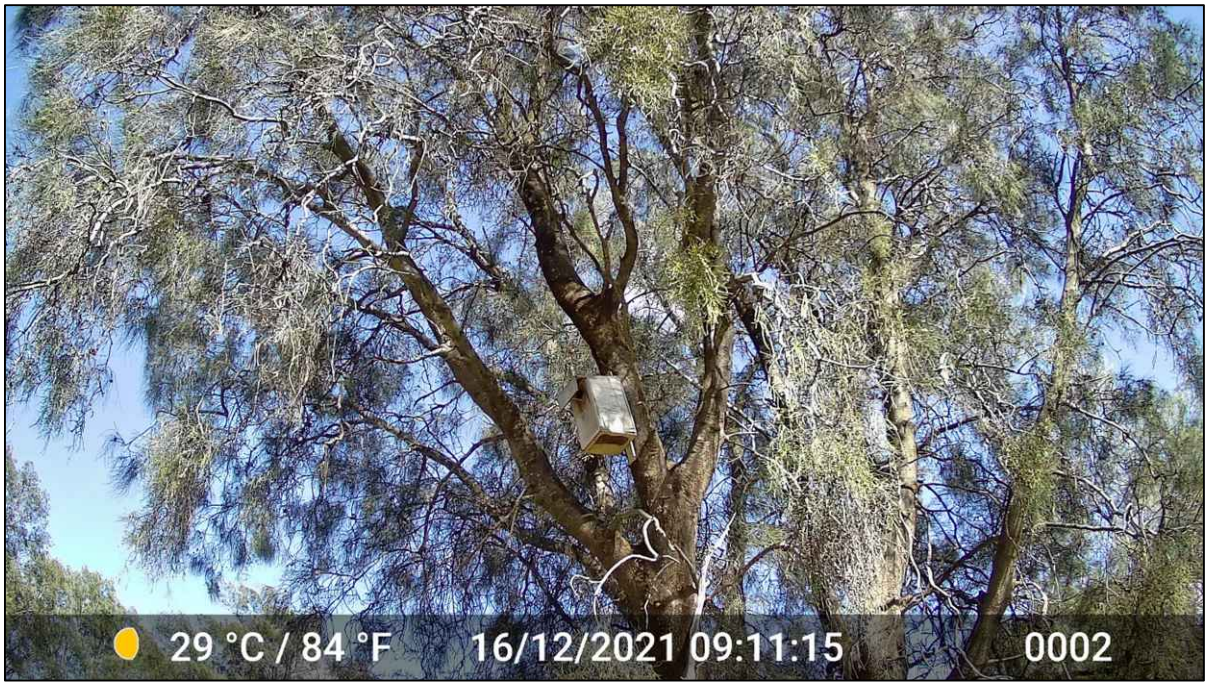


Plate 2-2: Artificial hollow observed via camera trap



1.1.4 Amphibians

A frog survey was conducted after dusk at three areas within the TGO property see Figure 2-3. The frog survey was conducted in areas where there was a high abundance of aquatic habitat both with an ephemeral water source at Gundong creek or a more constant water source at two dams in close proximity to TGO. The dam to the north and the dam to the west of the TGO mine site were both full of water, and reeds creating optimum frog habitat.

The recorded frog calls were submitted to The Australian Museum for identification of species.

Figure 2-3: Frog monitoring locations

1.1.5 Cyanide impact

Cyanide monitoring for this survey aimed to address the BMP outlined Site Specific Procedure:

4. Cyanide impact on native fauna as described in Section 9.3

This was undertaken via visual inspection of the residue storage facility and onsite review of TGO records regarding cyanide impacts on native fauna.

1.1.6 Pest fauna species

Vertebrate pest surveys were conducted by opportunistic sighting of animals or signs of the animals during all other surveys, with the results recorded as presence or absence of the pest species.

3 Results

3.1 Conditions of the assessment

The nearest weather monitoring station recorded on the Bureau of Meteorology (BoM) website is at Tomingley. Average annual rainfall for Tomingley is 596.4 millimetres (Bureau of Meteorology, 2021), see Table 3-2. The annual rainfall for Tomingley in 2020 was 775.4 millimetres. The 2021 total rainfall was more than double the 2019 total (Table 3-1). The 2021 monitoring event was undertaken during a period of high rainfall in NSW.

The weather temperature at the time of the 2021 monitoring was ranged from being cool and overcast to hot and sunny with relatively high humidity. There is no temperature monitoring data available from the Tomingley (Gundong) weather station therefore the closest weather station to provide temperature data is Peak Hill Post Office Weather Station (12 kilometres south of TGO). The daily maximum temperature during the monitoring event collected from Peak Hill Post Office Weather Station at ranged from 22.9 – 36.1°C (BoM, 2022).
Monitoring years highlighted in green demonstrate higher than average rainfall, orange highlighted rows demonstrate lower than average rainfall recorded.

Table 3-1: Tomingley (Gundong) weather station rainfall statistics

(Lat: 32.56° S; Lon: 148.34° E; Elevation: 355m)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2011	8.2	68.3	42.2	50.6	58	-	12.4	55	59.8	42.6	102.4	76.8	576.3*
2012	62.4	42.8	147.4	2.8	35.2	30.6	55.2	3.8	39.4	11.4	34	7.2	472.2
2013	21.8	29.4	97.8	8.8	19	119	41.2	7.2	49.2	9	15	37.6	455
2014	43.2	57.2	128.8	57.6	32.2	70.3	30.2	17.2	24.8	19.6	18.2	80.8	580.1
2015	105.4	12.8	8.4	113.4	49.6	40.4	94.4	29.4	4	72.8	101	51.6	683.2
2016	133.8	1.8	16.8	32.4	70.2	161.3	153.2	80.6	181	60	57.4	129.4	1077.9
2017	9.6	0.6	96.6	20.2	39.2	4	0.8	26.2	13	87.4	41	109.4	448
2018	47.8	1.6	6	-	12	27.6	3.8	30.8	24.6	52	108.4	32.2	346.8*
2019	95.2	34.4	61.2	0	18.2	23.4	12.4	10.8	20.4	8.2	39	6	329.2
2020	25.2	54.4	89.2	111.0	79.4	49.6	81.6	61.6	48.6	65.0	26.0	83.8	775.4
2021	103.6	78.6	167.2	5.8	19.6	116.2	59.0	51.6	52.2	41.0	159.6	-	854.4*

**incomplete data*

Table 3-2: Rainfall summary statistics for all years (Source: BoM)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	61.4	39.1	54.3	40.2	44.4	44.6	50.1	43.4	44.8	49.7	58.7	50.8	596.4
Lowest	7.4	0.0	0.0	0.0	0.4	1.8	0.0	0.0	0.8	1.0	0.0	0.0	285.1
5th %ile	9.0	1.6	0.0	0.0	2.1	4.0	5.6	4.0	3.9	7.0	3.2	3.1	318.9
95th %ile	165.4	89.8	147.6	127.3	111.6	116.0	121.8	113.7	116.3	111.6	128.4	120.4	958.9
Highest	201.6	139.2	178.5	352.0	167.1	161.3	153.2	133.5	181.0	140.3	159.6	178.8	1077.9

3.2 Limitations

Not all animals and plants can be fully accounted for within any given study area.

The presence of animals and plants changes over time and in response to changes in environmental conditions. This report presents data collected during the 2021 monitoring event to meet objectives outlined in Section 2-2. Data collected is indicative of the species present and site condition at the time of the assessment.

3.3 Fauna Species Richness

During 2021 monitoring, 39 fauna species were recorded (
Bird counts identified through opportunistic sightings have decreased from 22 in 2019 to 18 in 2021. This continues a slight decrease in the overall bird diversity from 25 species in 2016.

Table 3-3). Of these 39 species, 18 were birds, 14 were bats, two were mammals, one was a reptile and four were amphibians. No fauna was detected on camera traps or in the Elliot traps. The two threatened species, Grey-crowned Babbler *Pomatostomus temporalis* and the Southern Myotis *Myotis macropus* were recorded. Southern Myotis was possibly recorded however not confirmed through other survey methods.

The 2021 fauna monitoring event was to meet the objectives and monitoring targets outlined in Section 2.2, with targeted species searches undertaken and opportunistic sighting of other species recorded, rather than a complete fauna survey which was conducted in 2011.

Bird counts identified through opportunistic sightings have decreased from 22 in 2019 to 18 in 2021. This continues a slight decrease in the overall bird diversity from 25 species in 2016.

Table 3-3: Fauna survey results

Common Name	Scientific name	Listed?	Exotic?
BIRDS			
Zebra Finch	*Taeniopygia guttata*		
Will Wagtail	*Rhipidura leucophrys*		
Quail (Brown?)	*Coturnix ypsilophora*		
Galah	*Eolophus roseicapilla*		
Magpie	*Gymnorhina tibicen*		
Starling	*Sturnus vulgaris,*		Y
Apostle Bird	*Struthidea cinerea*		
White-winged Chough	*Corcorax melanorhamphos*		
Noisy Miner	*Manorina melanocephala*		
Peewee/Magpie Lark	*Grallina cyanoleuca*		
Eastern Rosella	*Platycercus eximius*		
Crested Pigeon	*Ocyphaps lophotes*		
Red-rumped Parrot	*Psephotus haematonotus*		
Australian raven	*Corvus coronoides*		
Australian wood duck	*Chenonetta jubata*		
Grey Crowned Babbler	*Pomatostomus temporalis*	BC - V	

Common Name	Scientific name	Listed?	Exotic?
Blue Faced Honey eater	*Entomyzon cyanotis*		
Indian Myna	*Acridotheres tristis*		Y
MAMMALS			
European Hare	*Lepus europaeus*		Y
Eastern Grey Kangaroos	*Macropus giganteus*		
REPTILES			
Bearded Dragon	*Pogona barbata*		
AMPHIBIANS			
Eastern sign-bearing froglet	*Crinia parinsignifera*		
Spotted marsh Frog	*Limnodynastes tasmaniensis*		
Red Tree Frog	*Littoria rubella*		
Broad Plamed Rocket Frog	*Litoria latopalmata*		
BATS			
Chocolate wattled bat	*Chalinolobus morio*		
Gould's wattled bat	*Chalinolobus gouldii*		
Long-eared bats	*Nyctophilus sp.*		
Little bentwing bat	*Miniopterus australis*		
Inland broad-nosed bat	*Scotorepens balstoni*		
Little broad-nosed bat	*Scotorpens greyii*		
Eastern broad-nosed bat	*Scotorepens orion*		
Little forest bat	*Vespadelus vulturnus*		
Southern myotis	*Myotis macropus#*	BC - V	
Inland free tailed bat	*Ozimops petersi*		
large forest bat	*Vespadlus darlingtoni*		
	S. balstoni or S. greyii		
	Vespdalus sp. or Miniopterus o. o.		
	V. vulurnus or V. regulus		

3.3.1 Grey-crowned Babbler

Background

The 2011 Ecology Assessment states TGO has adopted the Grey-crowned Babbler (GCB) as a flagship species and have produced a brochure to raise awareness of the species within the area and organisation (Appendix A).

The 2011 survey concluded:

"Within the Mine Site Study Area it was considered that two families of eight to ten individuals. Possibly one family east of the Newell Highway and the other west of the Newell Highway but this could not be determined by the end of the field assessment."

The 2016 survey recorded *"a breeding pair of Grey Crowned Babblers was recorded in the Grey Crowned Babbler habitat area of the TGO property"* but did not specify the exact location of the sighting.

Anecdotal reports from staff say GCB have been seen in three different locations on the TGO property, one east of the Newell highway and two on the west. Signs throughout the survey area indicates where there are known populations of GCBs and GCB habitat.

Result

During the 2021 survey GCB were identified at two of the four previous sites recorded in 2019. There were two new sites during the 2021 survey where GCB were also identified.

One site recorded in 2019 was not recorded to have GCB present in 2021.

GCB survey results for 2021 are shown in Figure 3-1. A comparison of GCB sightings recorded in 2019 and 2021 are shown in Figure 3-2.

Four individuals were observed in two separate locations close together along Gundong Creek which runs behind the administration buildings of TGO and are assumed to be from the same family.

Two single babbler individuals were sighted at two separate locations north east (one approx. 500 metres and the second approximately 1.4 kilometres from the initial sighting of GCB family of four.

Many GCB distinctive nests at variable stages of repair were also observed to be present (see example Plate 4-1).

Figure 3-1: Grey-crowned Babbler population census results

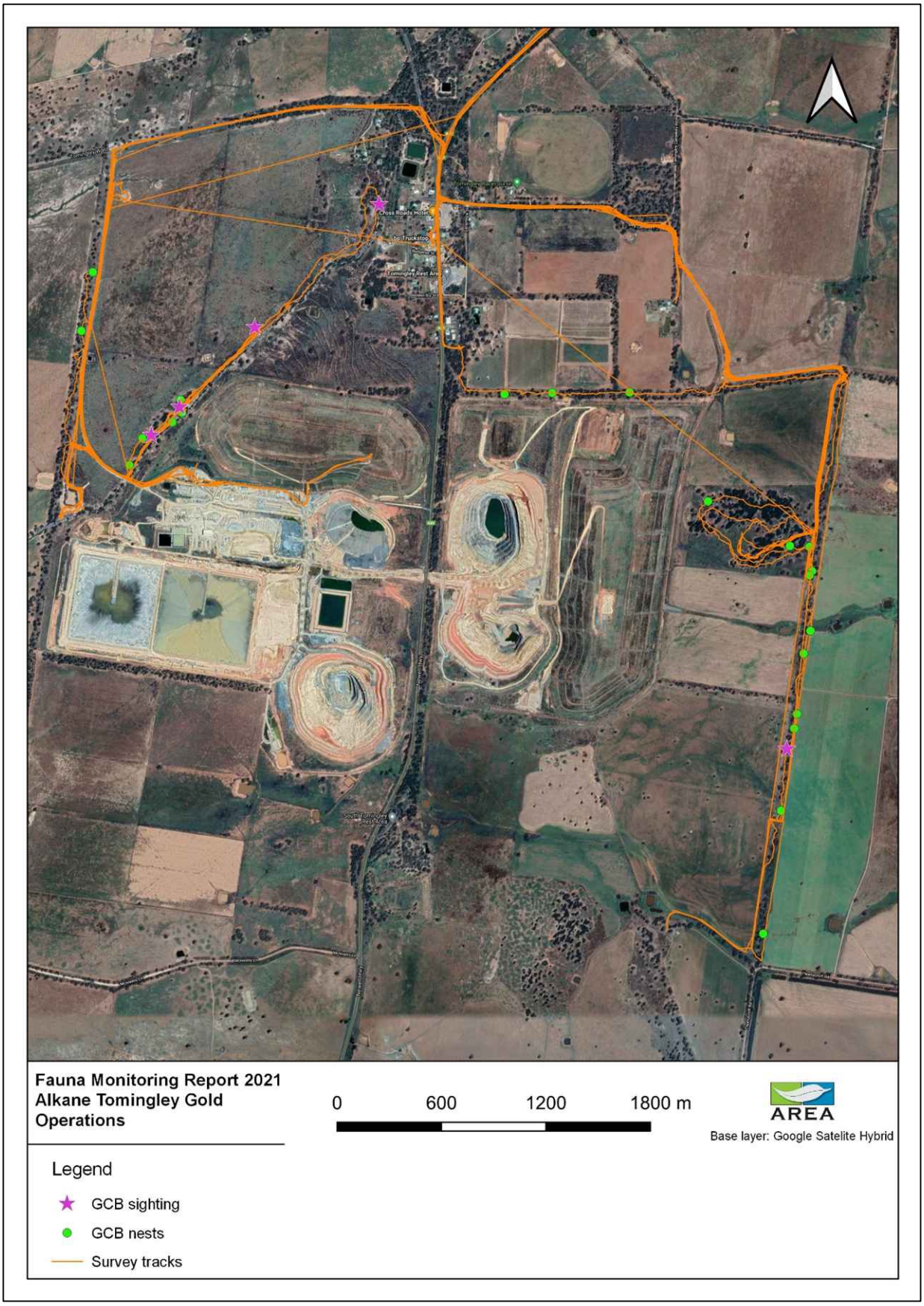


Figure 3-2: Comparison of GCB sightings in 2019 and 2021

GCB are present in the area and should increase as the quality of habitat in the biodiversity areas increases with the age of the trees.

Plate 3-1: Grey-crowned babbler nest in the study area

No survey effort for GCB was conducted within the Grey Box Community south of the residue storage facility as TGO have been approved to expand the residue storage facility. During the 2019 survey no active populations were observed in the Grey Box Community south of the residue storage facility where there were multiple nests in various states of repair.

3.3.2 Bats

The 2021 survey of bat species positively identified nine species with a further five species possibly recorded. The bat call analysis report is provided in Appendix B.

Table 3-4 shows the comparison of bat species recorded within the mine site over the previous fauna monitoring events. Southern Myotis *Myotis macropus* listed as vulnerable under the *Biodiversity Conservation Act 2016 (*indicated as BC – V in Table 4-2) was first recorded in 2019 and possibly recorded for a second time in 2021.

The 2021 monitoring event was conducted during a time of high rainfall in NSW creating abundant habitat for fauna and flora including insects. The increased number of bats recorded during the 2021 monitoring event has potentially occurred as a result of these abundant conditions. A fluctuation in numbers across the years is the current data trend. Future monitoring events occurring during the same abundant habitat conditions will be important to determine a stabilisation of numbers.

Table 3-4: Bat species recorded comparison table

Common Name	Scientific Name	Status	2011	2014	2016	2019	2021
Chocolate Wattled Bat	*Chalinolobus morio*		X	X	X	X	X
Little Pied Bat	*Chalinolobus picatus*	BC - V	X	X	X		possible
Eastern Bentwing Bat	*Miniopterus schrebersii oceanensis*	BC- V	X	X	X		
Little Forest Bat	*Vespadelus vulturnus*		X	X	X	X	X
Gould's Wattled Bat	*Chalinolobus gouldii*		X	X	X	X	X
Little Broad-nosed Bat	*Scotorpens greyii*		X		possible	X	X
Southern Freetail Bat	*Mormopterus planiceps*		X	X	X		
White-striped Freetail Bat	*Austronomus australis*		X	X	X		X
Inland Free-tailed Bat	*Mormopterus (Ozimops) petersi*			X	X		X
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	BC-V		X	X		
Beccari's Free-tailed Bat	Mormopterus (Ozimops) beccarii			X			
Eastern Cave Bat	*Vespadelus troughtoni*	BC - V		X			
Large Forest Bat	Vespadelus darlingtoni			X			X
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	BC - V		X			
Inland Broad-nosed Bat	*Scotorepens balstoni*			X	X	X	X
Long Eared Bats	*Nyctophilus sp.*			X		X	X
Little Bentwing Bat	*Miniopterus australis*					X	
Eastern Broadnosed Bat	*Scotorepens orion*					X	
Southern Myotis	*Myotis macropus*	BC - V				X	possible
S. balstoni or S. greyii							possible
Vespdalus sp. or Miniopterus o. o.							possible
V. vulurnus or V. regulus							possible
		Total	**8**	**15**	**11**	**9**	14

Due to the possible detection of the Southern Myotis *Myotis macropus* for the second time during a monitoring event, it would be worthwhile conducting targeted surveys in future monitoring events. Targeted surveys could include spotlighting near water sources in the study area or the deployment of additional BAT recorders for increased data collection to verify the presence of *Myotis Macropus* at TGO.

The DPIE threatened species profile for Southern Myotis states the species has:

"disproportionately large feet; more than 8 mm long, with widely-spaced toes which are distinctly hairy and with long, curved claws. It generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense

foliage and forages over streams and pools catching insects and small fish by raking their feet across the water surface".

The abundance of bat species present over the years indicates that the local area has diverse habitat resources suitable for a variety of microbat species. These species probably rely on local water resources for drinking and food resources. Additionally, TGO is often artificially lit at night, which attracts a high number of insects, which in turn can attract a high number insectivorous bat species.

3.3.3 Native Mammals

Only one species of native mammal, Eastern Grey Kangaroo *Macropus giganteus*, was recorded at Tomingley in 2021. This species is common.

Pedestrian surveys on 6 August 2009 recorded a dead female fat-tailed dunnart within the mine site on the eastern side of the Newell highway. At the time this species was a regionally significant species (no additional legislative consequence but a species of conservation concern). It is not currently listed as a threatened species and has not been recorded in the area again. The related threatened BC Act species, Stripe faced Dunnart *Sminthopsis macroura* also has the potential to occur. Neither species was recorded in 2021.

During the 2021 assessment, the Type-A Elliot traps did not trap any animals including any common house mice and the camera trap did not record any fauna using the artificial nest box. This may be due to no animals that would use the traps being present in the area at the time of the survey. Another possibility is the favourable conditions from high rainfall received in NSW throughout 2021 creating good habitat conditions. Good habitat conditions provide favourable food opportunities resulting in lower food competition.

3.3.4 Amphibians

Four frog species were identified during the extent of the night time frog call survey. All four were recorded within either the drainage line or the dam adjacent the drainage line that runs behind the TGO administration offices. No frog calls were identified in the dam furthest from the TGO gated mine site. Frog species positively identified by the Australian museum recording submissions captured during the survey are shown below in Table 3-5.

Table 3-5: Frog species identified

Common Name	Scientific Name
Broad-palmed Rocket frog	*Litoria latopalmata*
Eastern sign-bearing froglet	*Crinia parinsignifera*
Red Tree Frog	*Litoria rubella*
Spotted marsh frog	*Limnodynastes tasmaniensis*

All four species identified are common species and have a conservation status of least concern.

Broad Palmed Rocket Frog *Litoria latopalmata* was confidently identified by its appearance (Plate 4-2) during the 2019 survey. Broad Palmed Rocket Frog *Litoria latopalmata* was identified as a new record for the area during the 2019 survey and was identified again in 2021 refer to Plate 3-2.

A froglet (Plate 3-3) recorded in 2019 was similar to the BC Act and EPBC Act listed threatened species Sloane's Froglet *Crinia sloanei.* AREA consulted with a DPIE Senior Threatened Species Officer and confirmed the presence of Sloane's Froglet was possible but unlikely. Call recordings

collected during the 2021 fauna monitoring detected *Crinia parinsignifera* which is likely to have been the species of froglet identified in 2019 (Plate 3-3).

Plate 3-2: Broad Palmed Rocket Frog *Litoria latopalmata* frog calls identified at TGO (photo taken at TGO in 2019)

Plate 3-3: *Crinia sp.* (photo taken at TGO in 2019)

3.3.5 Management and monitoring program for cyanide impact on site

Management

The TGO BMP includes a section on 'Management and Monitoring Program for Cyanide Impact on Site'. Under the BMP, the residue storage facility (RSF) is to be operated in accordance with certain strategies to limit the potential for cyanide impact on fauna. The strategies, along with AREA's assessment of these strategies, are outlined below, Table 3-6.

Table 3-6: TGO cyanide management strategies assessment

Strategy	Achieved?	Reasoning
A cyanide destruction circuit has been included in the design of the processing plant to ensure that WAD cyanide concentration reporting to the RSF is less than 30mg/L and the 90th percentile discharge limit is less than 20mg/L as per the requirements of EPL 20169.	Yes	TGO must abide to the conditions of their Environmental Protection Licences, as monitored by EPA.
A fauna exclusion fence has been constructed surrounding the process water dam. The dam is the only location on site where cyanide concentrations could be injurious to fauna. The fence is constructed of 1.8m chain mesh fence (to exclude large mammals) and fine mesh skirt at the base (to exclude small mammals and reptiles).	Yes	The exclusion fence is established and has been maintained to ensure its integrity.
Aquatic vegetation is maintained around the perimeter of farm dams retained within the Biodiversity Offset Area and other non-operational TGO land to assist in preserving attractive bird habitat away from the RSF.	Yes	As far as possible alternative habitat is maintained.
Maintaining minimal decant water on the RSF so as not to attract fauna.	Yes	Site inspection on 16 December 2019 revealed minimal decant water on the RSF and no fauna present. Water levels are generally consistent with aerial images of TGO used in previous figures of this report.

Monitoring

The 2021 TGO BMP also outlines a cyanide monitoring program, which aims to assess cyanide impact on wildlife, focusing on routine wildlife inspections and mortality observations. The program is outlined below:

The monitoring program assesses cyanide impact on wildlife, focusing on routine wildlife inspections and mortality observations. The program includes:

- WAD cyanide concentrations are measured at discharge into the RSF daily as per the TGO Environmental Protection License.
- Processing personnel carryout wildlife observation surveys (see Appendix 8) twice a day at the beginning of each shift, and as soon after sunrise as possible for day shift.
- Wildlife observation information collected will provide an indication of wildlife visitations and mortality associated with RSF shown in Appendix D – Biodiversity Monitoring at TGO.
- The assessment will consider weather, number of animals present, type of species, and area of the RSF in use.
- Any incident of fauna death or injury (including bogging) associated with the RSF Impoundment is to be reported to the Environmental Department as soon as practical. As stipulated in EPL 20169 the incident is to be reported to the EPA's Pollution Line 131 555 as soon as the licensee becomes aware of the incident.
- The Production Superintendent or on call supervisor need to be informed of fauna deaths/injuries associated with the RSF Impoundment as soon as practical.

AREA reviewed TGO's daily RSF data inspection sheets by random selection from approximately the last month. These sheets, as well as meeting conditions of their Environmental Protection License, as monitored by EPA, should include detailed fauna observations as outlined above, to meet TGO's BMP monitoring conditions. This information is then used to quantify cyanide impacts on wildlife. A summary of the revised RSF record sheet is shown in Appendix C.

Environmental Monitoring Reports (www.alkane.com.au/projects/tomingley-gold-project/tomingley-gold-operations/tgo-reports/environmental-reports/) for TGO dating back to November 2019 were referenced. The 'Biodiversity Monitoring' section of these reports was summarized and is recorded in Appendix D.

Overall, these reports show that there were no recorded deaths of fauna between November 2019 and December 2021 at the RSF.

Over approximately six years of operation there have been three fauna deaths associated with the RSF recorded in the Environmental Monitoring Reports, one magpie, the other two species unknown. No fauna deaths were recorded at the RSF from 2018 to 2021.

3.3.6 Bio-indicator species

In OzArk's 2016 report, it refers to birds as bio-indicators and the following bird species were selected as the most relevant bio-indicator species for the project site and the monitoring objectives:

- Superb Parrot *Polytelis swainsonii*
- Brown Treecreeper *Climacteris picumnus*
- Eastern Yellow Robin *Eopsaltria australis*
- Grey-crowned Babbler (eastern subspecies) *Pomatostomus temporalis*
- Eastern Barn Owl *Tyto alba*

An indicator species can be described as "A species whose characteristics (e.g., presence or absence, abundance, density, mortality rate, breeding success) indicate the condition of ecosystems, the status of other taxa, the presence and impacts of stressors, or patterns of biological diversity" (Carrignan & Villard, 2002).

The 2021 bird monitoring was limited to a population survey of Grey-crowned Babblers, with opportunistic sightings of other species recorded. This was the only bio-indicator species recorded in this monitoring event.

Increased time allocated for monitoring would be required to undertake targeted bird transects to monitor bird bio-indicators.

3.3.7 Pests

One feral mammal, a European Hare (*Lepus europaeus*) species was recorded by opportunistic sighting at the project site in 2021. Evidence of a possible fox *(Vulpes vulpes)* scat was found during the monitoring transects shown below in Plate 3-4.

Plate 3-5: Fox scat found

Abundant native herbivores, Eastern Grey Kangaroos, are not currently considered a pest species. The population of Eastern Grey Kangaroos occupying the TGO land will be monitored, where population management is required it will be implemented under an DPIE licence and a management plan.

3.4 Habitat enhancement actions

Actions which can be implemented to improve habitat conditions of fauna surveyed during the Bi-annual monitoring report as per the BMP (Revision 8 November 2021) are shown below.

3.4.1 Grey-crowned Babblers

Actions which will increase the habitat for the Grey-crowned Babbler at TGO are:

- Increase trees in areas of open grassland; and
- Increase coarse woody debris

3.4.2 Microbats

Actions which will increase the habitat for microbats are:

- Control of feral cats;
- Exclusion or management of livestock grazing;
- Retaining/ revegetating foraging and roosting habitat; and
- Minimising the use of pesticides within or adjacent to areas where insectivorous bats occur.

3.4.3 Frogs

Habitat enhancement actions for frog habitat are better described as habitat protection actions. These actions include:

- Maintain aquatic vegetation in around waterbodies except were otherwise managed as part of mine operations (sediment dams).
- Maintain areas of native vegetation around waterbodies, and enhance habitat with increasing woody debris, rock and leaf litter – naturally or by adding habitat items.
- Prevent the chemicals or mine run off from entering waterbodies except where they are part of mine operations (dirty water drains).

Keep domestic stock away from the water edge (or a portion of it) to protect vegetation/ habitat.

3.4.4 Fat-tailed Dunnarts

Dunnarts are impacted by loss of habitat for shelter and food and competition and predation by pest animals. Actions to improve habitat for dunnarts include:

- Increase coarse woody debris – naturally or by adding logs; and
- Increase tussock grass cover – naturally or by planting and seeding native grasses.
- Management of pest animals will also aid the survival of this species.

4 Conclusions

This document addressed four specific monitoring actions recommended by the TGO Biodiversity Management Plan and made the following conclusions:

- Grey-crowned babbler were confirmed to still be present around the mine site at two of their three known locations, and two additional locations. The GCB population should improve as habitat values in the biodiversity offset areas improve
- Four Amphibian species were recorded in healthy aquatic environments
- No Fat Tailed Dunnarts, nor any other small native mammal were recorded during the monitoring event
- One reptile a Bearded dragon, *Pogona barbata* was identified sun baking on the main road on the outskirts of the TGO property, it was included in the survey results due to the proximity of it to the TGO offset property.
- Cyanide was not considered to be having a significant effect on fauna. To meet the monitoring conditions of the BMP, as recommended by the 2021 report the RSF data inspection sheet has been revised and updated see Appendix C.

This was not a full biodiversity assessment, however the 2021 survey indicated there is still moderate diversity of fauna within the mine site which is on par with previous assessments. A decline in general fauna observations in the TGO mine site has been observed. While it is not a requirement to make regular fauna observations, it can help determine ongoing impact of the mining operations and to give a better indication of fauna diversity on a day-to-day basis.

Since the 2019 survey the Tomingley area and widely across NSW have experience a high increase in rainfall. With the increased rainfall producing more favourable habitat conditions the next monitoring event may record higher diversity and abundance of fauna.

5 Recommendations

The following recommendations are made to ensure that the proponent is on target to meet the monitoring objectives:

- Continue feral animal control monitoring (foxes, cats and rabbits).
- Undertake more regular informal GCB population checks to establish if range and population has increased or continues to increase, remain stable or decline.
- Undertake nocturnal survey of potential feeding sites including dams around TGO or within the TGO BOA. A visual sighting could assist in confirming the presence of BC Act threatened bat species *Myotis macropus* in association with a future monitoring or assessment effort.
- Increase time allocated for monitoring to undertake targeted bird transects to monitor bird bio-indicators.

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Tomingley Gold Operations (Revision 8 November 2021) *Biodiversity Management Plan*

Appendix A – Grey-crowned Babbler information brochure

In the Tomingley area, the most valuable and important babbler habitat is the remnant tree corridors which connect our properties.

Tomingley Gold Operations is committed to protecting remnant habitat and monitoring the Grey-crowned Babbler.

TOMINGLEY
GOLD OPERATIONS PTY LTD

What can you do to support this threatened species?

Scientific name: Pomatostomus temporalis temporalis
Conservation status in NSW: Vulnerable

Grey-crowned Babblers

Tomingley Gold Mine: Tomingley West Road, Tomingley NSW 2869
Telephone: +61 2 6867 9780 mail@alkane.com.au www.alkane.com.au

ALKANE RESOURCES LTD

MULTI-COMMODITY MINER EXPLORER
www.alkane.com.au

Family is everything...

Grey-crowned Babblers live in family groups consisting of a breeding pair and their offspring forming groups of up to 15 birds. The group stays close together while looking for food and make soft 'chuck' calls to keep in touch.

The family group work together to build and maintain nests as well as to feed the young.

Their nest are conspicuous football shaped nests made from sticks which are usually in the small outermost branches of eucalypts. They will maintain up to ten nests, using most of them for roosting and only a few that are large enough for incubating eggs, like the one in the picture.

Breeding occurs from mid-winter through to the end of summer.

What you can do to help.

- Remember that vegetation corridors are very important. They provide habitat for the wildlife including Grey-crowned Babblers. If they are along fence lines, they won't take up too much productive land.
- In your garden and in your vegetation corridors and wherever else you can, leave the fallen branches on the ground and allow leaf litter and sticks to gather too.
- Encourage regeneration of habitat by fencing remnant stands of trees.
- Increase the size of existing remnants and plant trees to establish buffer zones of pasture around woodland remnants.
- If you are a cat owner, please keep your cat indoors as much as possible.

Who are these babblers?

The Grey-crowned Babblers are one of four babbler species in Australia. They have a scimitar-shaped bill, white eyebrows that blends into a patch of grey on the top of their head. A dark band across their eye gives them a masked look. They have a brownish orange patch on their wings that you can see when they spread their wings and fly.

When they are young, their iris is brown. It fades as they age, to yellow by three years old.

Where you will see them...

Grey-crowned Babblers live in patches of Box-Gum Woodland defending territories usually around 10 hectares, but up to 50 hectares.

They search amongst the leaf litter, amongst grassy tussocks or on the branches and bark of trees for insects and other invertebrates to eat.

These birds will often glide from tree to tree or from a tree to the ground, avoiding flight when they can. For this reason, they are unlikely to cross large open areas.

...Or hear them.

This species has a loud 'ya-hoo' call which is a duet between the male and female (the female says 'ya' and the male answers with 'hoo'). It is used to maintain the bond between the pair and as a territorial call.

Appendix B – Bat Analysis report

Impact Ecology

ABN: 92895504799

BAT CALL ANALYSIS **9 February 2022**

Client: Phil Cameron AREA

Location: Tomingley Gold Operations at Tomingley

Vegetation type: Woody vegetation surrounding mine area

Reporting standard

This report follows the nationally accepted standards for the interpretation and reporting of bat echolocation data (Reardon 2003). More recent versions these reporting standards are available from the Australasian Bat Society on-line at http://www.ausbats.org.au/. Calls were analysed by Heidi Kolkert using Analook V4.2 bat call analysis software.

Methods for species identification

Bats produce a wide range of different shaped pulses which can all be broken down into standard components for comparison (Pennay *et al.* 2004). In relation to the analysis of those microchiropteran (microbat) calls obtained, it is noted that some insectivorous bat species have distinctive echolocation calls that are unlikely to be confused with those of other species. Other bat species overlap in both call frequency and structure making identification difficult. Poor quality calls confound the issues of identifying species with similar call frequencies.

Species nomenclature

Species names used in this summary follow Churchill (2008), except for Mormopterus (Ozimops) species, which follow Reardon *et al.* (2014).

Call identification

Call identification was based on existing call descriptions and keys presented in Pennay *et al.* (2004) as well as reference calls collected in New South Wales. Species' identification was further refined by considering probability of occurrence based on distributional information presented in Churchill (2008) and Van Dyck & Strahan (2008) and spatial data stored on the NSW Bionet and Atlas of Living Australia (ALA 2022) and BatMap (Australasian Bat Society 2022).

Results

At least ten species of insectivorous bat were positively identified during the sampling period (Table 1). One threatened species, the Eastern bentwing bat listed under the *Biodiversity Conservation Act 2016* (BC Act) was confidently recorded in the study area. It is possible that an additional two species of bat including the Little Pied Bat (BC Act) and Southern Myotis (BC Act) were recorded. Several calls were possibly attributed to the Southern Myotis. This was based on a number of features, such as, an

Page | 1

initial slope of greater than 400 octaves per second (OPS), the shape of the pulse and mostly a pulse interval of <75ms. However, given the lack of records in the area, it would be worthwhile spotlighting near water sources in the study area, to confirm the presence of Myotis Macropus.

Notes on species identification

Chalinolobus morio calls were differentiated from *Vespadelus sp.* by the presence of a down-sweeping tail and pulse alternation on the majority of pulses.

Calls from *Ozimops sp.* were differentiated by the presence of mainly flat pulses.

Miniopterus schreibersii oceanensis, V. darlingtoni and *V. regulus* have overlapping calls around the 43-46 kHz frequency range. *M. s. oceanensis* usually have longer-duration diagonal shaped body, a flat or down-swept tail and uneven consecutive pulses. Several calls had somewhat erratic pulse shape (e.g. some down-swept tails and some up-swept) and variable Fc, suggesting *M. s. oceanenis*. Long, high quality call sequences with regularly-spaced consecutive pulses, few down-sweeping tails and higher or lower characteristic frequencies were assigned to *V. darlingtoni* or *Vespadelus regulus*. Those calls which had no discerning characteristics could not be readily separated to species level.

Chalinolobus gouldii was differentiated from other species by the presence of curved, alternating call pulses.

Three Nyctophilus species (*Nyctophilus gouldi* and *N. geoffroyi, N. corbeni*) have the potential to occur in the study area and overlap almost entirely in most frequency characteristics. All have steep near vertical call shapes. Calls belonging to the genus *Nyctophilus* could not be identified to genus level. *Myotis Macropus* and *Nyctophilus sp.* complex have similar steep fragmented calls. Poor quality, short or fragmented calls which had a call interval between 75 and 95 ms and slope between 300 and 400 OPS could not be separated from the *Nyctophilus sp.* complex.

Table 1: Insectivorous bat calls recorded during the survey.

	Recording machine	CAM #3			CAM #4		
Scientific name	Common name	14/12/2021	15/12/2021	16/12/2021	14/12/2021	15/12/2021	16/12/2021
Bat calls positively identified							
Austronomus australis	White-Striped Freetail Bat		x	x		x	
Chalinolobus gouldii	Gould's Wattled Bat	x			x	x	x
Chalinolobus morio	Chocolate Wattled Bat	x		x	x	x	x
Nyctophilus sp. complex	Long-Eared Bat Complex	x	x	x	x	x	
Ozimops petersi	Inland Free-Tailed Bat				x		
Scotorepens balstoni	Inland Broad-Nosed Bat				x		
Scotorepens greyii	Little Broad-Nosed Bat		P		x		
Vespadlus darlingtoni	Large Forest Bat	x	P		P		P
Vespadelus vulturnus	Little Forest Bat	x	x	x	x	x	x
Bat calls not positively identified							
Chalinolobus picatus #	Little Pied Bat		x		x		
Myotis macropus	Southern Myotis	x		x			
S. balstoni or S. greyii						x	
Vespdalus sp. or Miniopterus o. o.		x	x	x	x		
V. vulurnus or V. regulus		x		x			
	Bat calls	**144**	**101**	**238**	**44**	**16**	**7**
	Noise files	**6**	**6**	**7**	**12**	**10**	**3**
	Total files	**150**	**107**	**245**	**56**	**26**	**10**

\# Species listed under the *Biodiversity Conservation Act 2016*

* Species listed under the *Environmental Protection and Biodiversity Act 1999*

P Possible record

x Positive record

Impact Ecology

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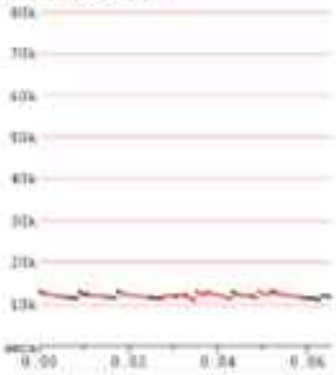
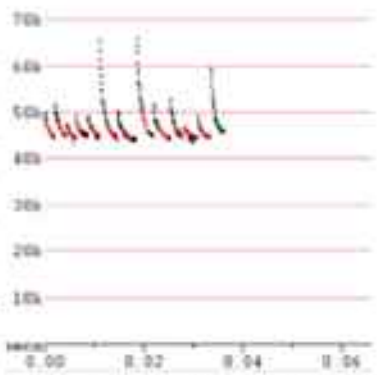
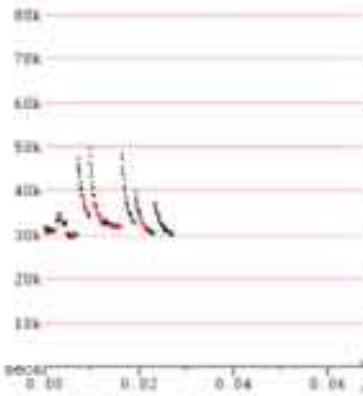
Example Calls



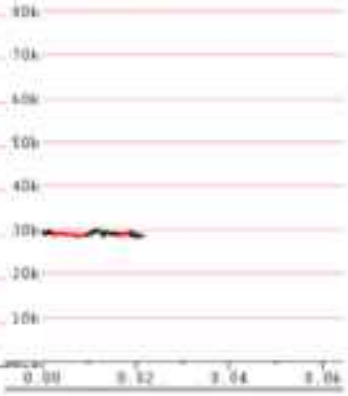
Austronomus australis



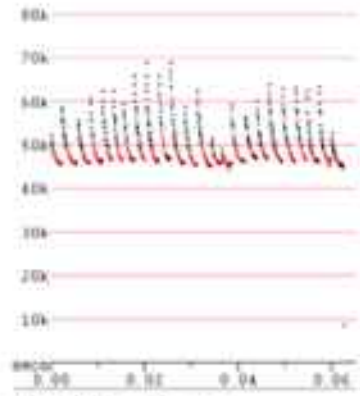
Miniopterus orianae oceanensis (possible)



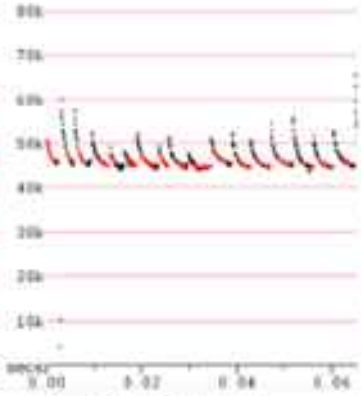
Chalinolobus gouldii



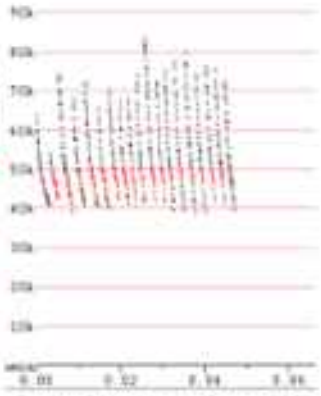
O. petersi



Vespadelus vulturnus



Vespadelus darlintoni



Myotis Macropus (possible)

Appendix C – Current RSF reporting at TGO

RESIDUE STORAGE FACILITY

Name: Date Shift: am / pm D/S or N/S

CONDITION INSPECTIONS	TIME	
Water Against Walls Inside RSF	Y / N	Y / N
Pipeline - Any leaks?	Y / N	Y / N
Dam Wall- Any cracks, erosion or slumping?	Y / N	Y / N
Water Freeboard < 1.0m	Y / N	Y / N
Slurry Freeboard < 0.5m	Y / N	Y / N
Seepage - Any signs of seepage from RSF?	Y / N	Y / N

South Wall Drainage		
Time		
Totaliser (m^2)		

WILDLIFE OBSERVATIONs: CIRCLE THE RELEVANT OBSERVATION

Weather	Hot	Cold	Windy	Rainy		
Number of Fauna on the Cells	0	1	2-5	6-10	11-25	25+
Type of Fauna	Bird	Kangaroo	Other mammal	Reptile	Other	
Fauna Location	Wall	Dry tailings	Wet tailings			

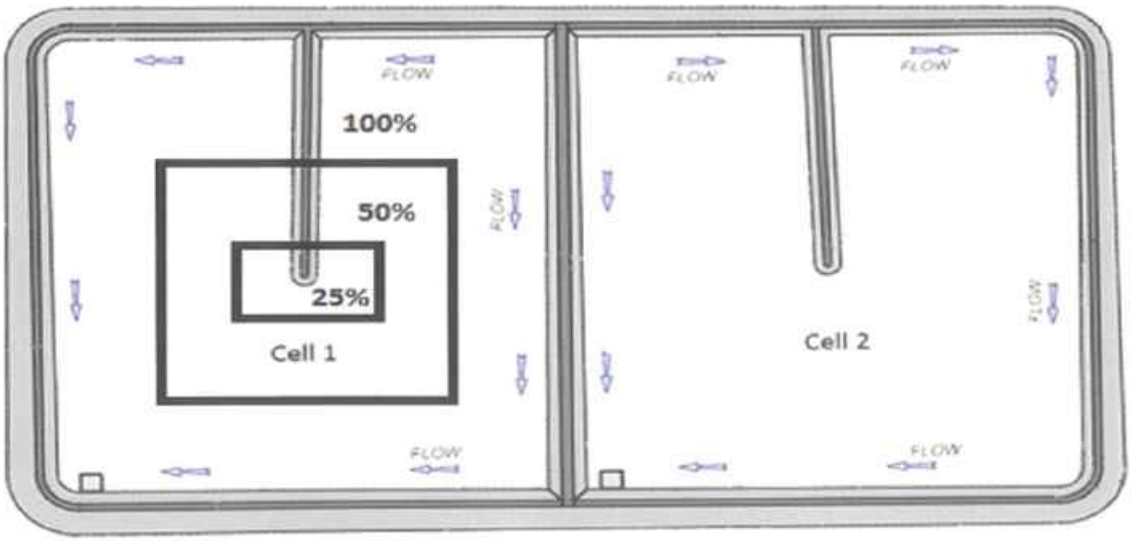
Any Observable Deaths Y / N

If YES, notify Production Superintendent (or on call person) and ensure the area is not disturbed. Do not retrieve or handle dead carcasses as they can contain disease.

Draw Decant Water Area on both cells

Cell 1 Decant Pond Area (%)

Cell 2 Decant Pond Area (%)



Comments

Safety/Environmental
If YES for any of the above make a comment below:

Appendix D – Biodiversity Monitoring at TGO

A summary of TGO Monthly Environmental Monitoring Reports Biodiversity Monitoring, November 2019- December 2021
(Results of interest have been highlighted)

Date	Fauna Deaths	Vertebrate Pests	Site Fauna
November-19	No fauna deaths were recorded during November	Zero reported	Zero reported
December-19	No fauna deaths were recorded during December	Zero reported	Zero reported
Jan-2020	No fauna deaths were recorded during January.	Zero reported	Zero reported
Feb-2020	No fauna deaths were recorded during February.	Zero reported	Zero reported
March-2020	No fauna deaths were recorded during March.	Zero reported	Zero reported
April-2020	No fauna deaths were recorded during April.	Zero reported	Zero reported
May-2020	No fauna deaths were recorded during May.	Zero reported	Zero reported
June-2020	No fauna deaths were recorded during June.	Zero reported	Zero reported
July-2020	No fauna deaths were recorded during July.	Zero reported	Zero reported
Aug-2020	No fauna deaths were recorded during August.	Zero reported	Zero reported
Sep-2020	No report available	Zero reported	Zero reported
Oct-2020	No fauna deaths were recorded during October.	Zero reported	Zero reported
Nov-2020	No fauna deaths were recorded during November	Zero reported	Zero reported
Dec-2020	No fauna deaths were recorded during December	Zero reported	Zero reported
Jan-2021	No fauna deaths were recorded during January	Zero reported	Zero reported
Feb-2021	No fauna deaths were recorded during February.	Zero reported	Zero reported
March-2021	No fauna deaths were recorded during March.	Zero reported	Zero reported
April-2021	No fauna deaths were recorded during April.	Zero reported	Zero reported
May-2021	No fauna deaths were recorded during May.	Zero reported	Zero reported
June-2021	No fauna deaths were recorded during June.	Zero reported	Zero reported
July-2021	No fauna deaths were recorded during July.	Zero reported	Zero reported
Aug-2021	No fauna deaths were recorded during August.	Zero reported	Zero reported
Sep-2021	No fauna deaths were recorded during September.	Zero reported	Zero reported
Oct-2021	No fauna deaths were recorded during October.	Zero reported	Zero reported
Nov-2021	No fauna deaths were recorded during November.	Zero reported	Zero reported
Dec-2021	No fauna deaths were recorded during December.	Zero reported	Zero reported

Appendix 6

Groundwater Monitoring Summary

Field_ID	Sampled_Date-Time	ChemName	Concentration	Output Unit
WYMB01 (EPA 9)	13/09/2021 16:30	Nitrate (as N)	0.35	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Nitrate (as N)	0.03	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Nitrate (as N)	0.01	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Nitrite (as N)	0.01	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Nitrite (as N)	0.01	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Sulfate as SO4 - Turbidimetric	1050	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Sulfate as SO4 - Turbidimetric	972	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Sulfate as SO4 - Turbidimetric	965	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Chloride	3580	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Chloride	3620	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Chloride	3600	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Fluoride	0.2	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Fluoride	0.2	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Fluoride	0.1	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Cyanide Total	0.015	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Cyanide Total	0.004	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Cyanide Total	0.014	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Cyanide (WAD)	0.004	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Cyanide (WAD)	0.004	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Cyanide (WAD)	0.004	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Iron	48	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Iron	0.51	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Iron	1.18	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Lead	0.022	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Lead	0.028	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Lead	0.036	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Magnesium	275	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Magnesium	237	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Magnesium	254	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Mercury	0.0001	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Mercury	0.0001	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Mercury	0.0001	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Nickel	0.003	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Nickel	0.001	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Nickel	0.037	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Potassium	6	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Potassium	6	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Potassium	12	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Sodium	2150	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Sodium	2190	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Sodium	2030	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Arsenic	0.004	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Arsenic	0.019	mg/L

WYMB01(EPA9)	22/12/2021 15:30	Arsenic	0.007	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Cadmium	0.0001	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Cadmium	0.0001	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Cadmium	0.0001	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Chromium (III+VI)	0.001	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Chromium (III+VI)	0.009	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Chromium (III+VI)	0.057	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Copper	0.009	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Copper	0.048	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Copper	0.004	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Zinc	0.048	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Zinc	0.091	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Zinc	0.018	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Calcium	266	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Calcium	262	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Calcium	222	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Ammonia as N	0.23	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Ammonia as N	0.03	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Ammonia as N	0.14	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Reactive Phosphorus as P	0.06	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Reactive Phosphorus as P	0.01	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Reactive Phosphorus as P	0.01	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Alkalinity (Bicarbonate as CaCO3)	287	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Alkalinity (Bicarbonate as CaCO3)	408	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Alkalinity (Bicarbonate as CaCO3)	340	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Alkalinity (total) as CaCO3	340	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Alkalinity (total) as CaCO3	408	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Alkalinity (total) as CaCO3	287	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Electrical conductivity *(lab)	12300	µS/cm
WYMB01(EPA9)	22/12/2021 15:30	Electrical conductivity *(lab)	12000	µS/cm
WYMB01 (EPA 9)	13/09/2021 16:30	Electrical conductivity *(lab)	12400	µS/cm
WYMB01(EPA9)	13/04/2021 13:00	Cyanide (Free)	0.004	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Cyanide (Free)	0.004	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Cyanide (Free)	0.004	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	Hardness as CaCO3	1630	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Hardness as CaCO3	1690	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Hardness as CaCO3	1710	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Ionic Balance	0.42	%

WYMB01 (EPA 9)	13/09/2021 16:30	Ionic Balance	3.24	%
WYMB01(EPA9)	22/12/2021 15:30	Ionic Balance	0.06	%
WYMB01(EPA9)	22/12/2021 15:30	Nitrite + Nitrate as N	0.03	mg/L
WYMB01(EPA9)	13/04/2021 13:00	Nitrite + Nitrate as N	0.01	mg/L
WYMB01(EPA9)	13/04/2021 13:00	pH (Lab)	7.17	pH_Units
WYMB01 (EPA 9)	13/09/2021 16:30	pH (Lab)	7.16	pH_Units
WYMB01(EPA9)	22/12/2021 15:30	pH (Lab)	7.11	pH_Units
WYMB01 (EPA 9)	13/09/2021 16:30	TDS	7790	mg/L
WYMB01(EPA9)	13/04/2021 13:00	TDS	7970	mg/L
WYMB01(EPA9)	22/12/2021 15:30	TDS	7890	mg/L
WYMB01(EPA9)	22/12/2021 15:30	Anions Total	128	meq/L
WYMB01 (EPA 9)	13/09/2021 16:30	Anions Total	129	meq/L
WYMB01(EPA9)	13/04/2021 13:00	Anions Total	130	meq/L
WYMB01(EPA9)	22/12/2021 15:30	Cations Total	128	meq/L
WYMB01(EPA9)	13/04/2021 13:00	Cations Total	129	meq/L
WYMB01 (EPA 9)	13/09/2021 16:30	Cations Total	121	meq/L
WYMB01(EPA9)	22/12/2021 15:30	TSS	12	mg/L
WYMB01 (EPA 9)	13/09/2021 16:30	TSS	46	mg/L
WYMB01(EPA9)	13/04/2021 13:00	TSS	16	mg/L
Field_ID	**Sampled_Date-Time**	**ChemName**	**Concentration**	**Output Unit**
WYMB02 (EPA 10)	14/09/2021 8:50	Nitrate (as N)	0.69	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Nitrate (as N)	0.69	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Nitrate (as N)	0.68	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Nitrite (as N)	0.01	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Nitrite (as N)	0.01	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Sulfate as SO4 - Turbidimetric	1950	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Sulfate as SO4 - Turbidimetric	1950	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Sulfate as SO4 - Turbidimetric	1310	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Chloride	6420	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Chloride	6620	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Chloride	6240	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Fluoride	0.6	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Fluoride	0.6	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Fluoride	0.5	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Cyanide Total	0.004	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Cyanide Total	0.004	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Cyanide Total	0.004	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Cyanide (WAD)	0.004	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Cyanide (WAD)	0.004	mg/L

WYMB02(EPA10)	22/12/2021 14:45	Cyanide (WAD)	0.004	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Iron	0.22	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Iron	0.09	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Iron	0.2	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Lead	0.004	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Lead	0.004	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Lead	0.003	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Magnesium	452	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Magnesium	428	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Magnesium	396	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Mercury	0.0001	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Mercury	0.0001	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Mercury	0.0001	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Nickel	0.002	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Nickel	0.002	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Nickel	0.002	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Potassium	9	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Potassium	9	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Potassium	9	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Sodium	4680	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Sodium	4580	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Sodium	4170	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Arsenic	0.003	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Arsenic	0.001	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Arsenic	0.001	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Cadmium	0.0001	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Cadmium	0.0001	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Cadmium	0.0004	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Chromium (III+VI)	0.001	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Chromium (III+VI)	0.001	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Chromium (III+VI)	0.001	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Copper	0.024	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Copper	0.017	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Copper	0.036	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Zinc	0.024	mg/L

WYMB02 (EPA 10)	14/09/2021 8:50	Zinc	0.021	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Zinc	0.058	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Calcium	142	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Calcium	144	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Calcium	141	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Ammonia as N	0.35	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Ammonia as N	0.01	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Ammonia as N	0.01	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Reactive Phosphorus as P	0.15	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Reactive Phosphorus as P	0.14	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Reactive Phosphorus as P	0.14	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Alkalinity (Bicarbonate as CaCO3)	1040	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Alkalinity (Bicarbonate as CaCO3)	896	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Alkalinity (Bicarbonate as CaCO3)	1020	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Alkalinity (total) as CaCO3	1040	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Alkalinity (total) as CaCO3	1020	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Alkalinity (total) as CaCO3	896	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Electrical conductivity *(lab)	21600	µS/cm
WYMB02(EPA10)	13/04/2021 9:45	Electrical conductivity *(lab)	22300	µS/cm
WYMB02 (EPA 10)	14/09/2021 8:50	Electrical conductivity *(lab)	21900	µS/cm
WYMB02(EPA10)	22/12/2021 14:45	Cyanide (Free)	0.004	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Cyanide (Free)	0.004	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Cyanide (Free)	0.004	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Hardness as CaCO3	1980	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Hardness as CaCO3	2220	mg/L
WYMB02(EPA10)	22/12/2021 14:45	Hardness as CaCO3	2120	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Ionic Balance	0.07	%
WYMB02 (EPA 10)	14/09/2021 8:50	Ionic Balance	0.01	%
WYMB02(EPA10)	22/12/2021 14:45	Ionic Balance	0.13	%

WYMB02(EPA10)	22/12/2021 14:45	Nitrite + Nitrate as N	0.68	mg/L
WYMB02(EPA10)	13/04/2021 9:45	Nitrite + Nitrate as N	0.69	mg/L
WYMB02(EPA10)	22/12/2021 14:45	pH (Lab)	7.16	pH_Units
WYMB02(EPA10)	13/04/2021 9:45	pH (Lab)	7.25	pH_Units
WYMB02 (EPA 10)	14/09/2021 8:50	pH (Lab)	7.22	pH_Units
WYMB02(EPA10)	22/12/2021 14:45	TDS	15100	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	TDS	14800	mg/L
WYMB02(EPA10)	13/04/2021 9:45	TDS	14800	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	Anions Total	221	meq/L
WYMB02(EPA10)	22/12/2021 14:45	Anions Total	242	meq/L
WYMB02(EPA10)	13/04/2021 9:45	Anions Total	248	meq/L
WYMB02(EPA10)	22/12/2021 14:45	Cations Total	242	meq/L
WYMB02 (EPA 10)	14/09/2021 8:50	Cations Total	221	meq/L
WYMB02(EPA10)	13/04/2021 9:45	Cations Total	248	meq/L
WYMB02(EPA10)	13/04/2021 9:45	TSS	17	mg/L
WYMB02(EPA10)	22/12/2021 14:45	TSS	18	mg/L
WYMB02 (EPA 10)	14/09/2021 8:50	TSS	8	mg/L
Field_ID	**Sampled_Date-Time**	**ChemName**	**Concentration**	**Output Unit**
WYMB03 (EPA 11)	14/09/2021 8:00	Nitrate (as N)	0.32	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Nitrate (as N)	0.36	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Nitrate (as N)	0.32	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Nitrite (as N)	0.01	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Nitrite (as N)	0.01	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Sulfate as SO4 - Turbidimetric	2150	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Sulfate as SO4 - Turbidimetric	2090	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Sulfate as SO4 - Turbidimetric	1460	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Chloride	6160	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Chloride	6250	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Chloride	5840	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Fluoride	0.8	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Fluoride	0.7	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Fluoride	0.6	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Cyanide Total	0.004	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Cyanide Total	0.004	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Cyanide Total	0.004	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Cyanide (WAD)	0.004	mg/L

WYMB03 (EPA 11)	14/09/2021 8:00	Cyanide (WAD)	0.004	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Cyanide (WAD)	0.004	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Iron	0.19	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Iron	0.12	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Iron	0.41	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Lead	0.026	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Lead	0.007	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Lead	0.01	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Magnesium	562	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Magnesium	527	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Magnesium	468	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Mercury	0.0001	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Mercury	0.0001	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Mercury	0.001	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Nickel	0.008	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Nickel	0.004	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Nickel	0.026	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Potassium	15	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Potassium	16	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Potassium	14	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Sodium	4380	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Sodium	4240	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Sodium	3770	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Arsenic	0.003	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Arsenic	0.002	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Arsenic	0.005	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Cadmium	0.0001	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Cadmium	0.0001	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Cadmium	0.0001	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Chromium (III+VI)	0.001	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Chromium (III+VI)	0.003	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Chromium (III+VI)	0.001	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Copper	0.014	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Copper	0.024	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Copper	0.022	mg/L

WYMB03(EPA11)	13/04/2021 14:00	Zinc	0.04	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Zinc	0.126	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Zinc	0.026	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Calcium	196	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Calcium	191	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Calcium	178	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Ammonia as N	0.11	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Ammonia as N	0.01	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Ammonia as N	0.02	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Reactive Phosphorus as P	0.1	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Reactive Phosphorus as P	0.09	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Reactive Phosphorus as P	0.27	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Alkalinity (Bicarbonate as CaCO3)	1060	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Alkalinity (Bicarbonate as CaCO3)	1100	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Alkalinity (Bicarbonate as CaCO3)	1220	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Alkalinity (total) as CaCO3	1060	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Alkalinity (total) as CaCO3	1220	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Alkalinity (total) as CaCO3	1100	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Electrical conductivity *(lab)	20600	µS/cm
WYMB03(EPA11)	13/04/2021 14:00	Electrical conductivity *(lab)	21600	µS/cm
WYMB03 (EPA 11)	14/09/2021 8:00	Electrical conductivity *(lab)	20800	µS/cm
WYMB03(EPA11)	23/12/2021 7:30	Cyanide (Free)	0.004	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Cyanide (Free)	0.004	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Cyanide (Free)	0.004	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Hardness as CaCO3	2370	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Hardness as CaCO3	2800	mg/L
WYMB03(EPA11)	23/12/2021 7:30	Hardness as CaCO3	2650	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Ionic Balance	0.3	%
WYMB03 (EPA 11)	14/09/2021 8:00	Ionic Balance	1.24	%

WYMB03(EPA11)	23/12/2021 7:30	Ionic Balance	0.16	%
WYMB03(EPA11)	23/12/2021 7:30	Nitrite + Nitrate as N	0.32	mg/L
WYMB03(EPA11)	13/04/2021 14:00	Nitrite + Nitrate as N	0.36	mg/L
WYMB03(EPA11)	23/12/2021 7:30	pH (Lab)	6.93	pH_Units
WYMB03(EPA11)	13/04/2021 14:00	pH (Lab)	7.08	pH_Units
WYMB03 (EPA 11)	14/09/2021 8:00	pH (Lab)	7.47	pH_Units
WYMB03(EPA11)	23/12/2021 7:30	TDS	14900	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	TDS	14500	mg/L
WYMB03(EPA11)	13/04/2021 14:00	TDS	14200	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	Anions Total	217	meq/L
WYMB03(EPA11)	23/12/2021 7:30	Anions Total	238	meq/L
WYMB03(EPA11)	13/04/2021 14:00	Anions Total	245	meq/L
WYMB03(EPA11)	23/12/2021 7:30	Cations Total	238	meq/L
WYMB03 (EPA 11)	14/09/2021 8:00	Cations Total	212	meq/L
WYMB03(EPA11)	13/04/2021 14:00	Cations Total	247	meq/L
WYMB03(EPA11)	13/04/2021 14:00	TSS	14	mg/L
WYMB03(EPA11)	23/12/2021 7:30	TSS	5	mg/L
WYMB03 (EPA 11)	14/09/2021 8:00	TSS	5	mg/L
Field_ID	**Sampled_Date-Time**	**ChemName**	**Concentration**	**Output Unit**
WYMB04 (EPA 12)	14/09/2021 9:30	Nitrate (as N)	0.17	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Nitrate (as N)	0.1	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Nitrate (as N)	0.09	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Nitrite (as N)	0.01	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Nitrite (as N)	0.01	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Sulfate as SO4 - Turbidimetric	2610	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Sulfate as SO4 - Turbidimetric	2600	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Sulfate as SO4 - Turbidimetric	2050	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Chloride	7990	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Chloride	8040	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Chloride	7700	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Fluoride	2.3	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Fluoride	1.8	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Fluoride	1.7	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Cyanide Total	0.004	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Cyanide Total	0.004	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Cyanide Total	0.004	mg/L

WYMB04(EPA12)	13/04/2021 10:40	Cyanide (WAD)	0.004	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Cyanide (WAD)	0.004	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Cyanide (WAD)	0.004	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Iron	21.1	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Iron	0.19	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Iron	0.82	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Lead	0.002	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Lead	0.011	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Lead	0.004	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Magnesium	702	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Magnesium	661	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Magnesium	592	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Mercury	0.0001	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Mercury	0.0001	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Mercury	0.0001	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Nickel	0.002	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Nickel	0.016	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Nickel	0.004	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Potassium	17	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Potassium	16	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Potassium	18	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Sodium	5650	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Sodium	5420	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Sodium	4750	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Arsenic	0.005	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Arsenic	0.001	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Arsenic	0.004	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Cadmium	0.0001	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Cadmium	0.0001	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Cadmium	0.0001	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Chromium (III+VI)	0.002	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Chromium (III+VI)	0.001	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Chromium (III+VI)	0.02	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Copper	0.02	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Copper	0.004	mg/L

WYMB04(EPA12)	23/12/2021 8:00	Copper	0.023	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Zinc	0.027	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Zinc	0.045	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Zinc	0.086	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Calcium	280	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Calcium	273	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Calcium	263	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Ammonia as N	0.03	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Ammonia as N	0.02	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Ammonia as N	0.01	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Reactive Phosphorus as P	0.03	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Reactive Phosphorus as P	0.01	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Reactive Phosphorus as P	0.03	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Alkalinity (Bicarbonate as CaCO3)	996	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Alkalinity (Bicarbonate as CaCO3)	800	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Alkalinity (Bicarbonate as CaCO3)	1150	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Alkalinity (total) as CaCO3	996	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Alkalinity (total) as CaCO3	1150	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Alkalinity (total) as CaCO3	800	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Electrical conductivity *(lab)	25500	µS/cm
WYMB04(EPA12)	13/04/2021 10:40	Electrical conductivity *(lab)	27000	µS/cm
WYMB04 (EPA 12)	14/09/2021 9:30	Electrical conductivity *(lab)	26300	µS/cm
WYMB04(EPA12)	23/12/2021 8:00	Cyanide (Free)	0.004	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Cyanide (Free)	0.004	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Cyanide (Free)	0.004	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Hardness as CaCO3	3090	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Hardness as CaCO3	3590	mg/L
WYMB04(EPA12)	23/12/2021 8:00	Hardness as CaCO3	3400	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Ionic Balance	2.23	%

WYMB04 (EPA 12)	14/09/2021 9:30	Ionic Balance	1.28	%
WYMB04(EPA12)	23/12/2021 8:00	Ionic Balance	0.79	%
WYMB04(EPA12)	23/12/2021 8:00	Nitrite + Nitrate as N	0.09	mg/L
WYMB04(EPA12)	13/04/2021 10:40	Nitrite + Nitrate as N	0.1	mg/L
WYMB04(EPA12)	23/12/2021 8:00	pH (Lab)	7.02	pH_Units
WYMB04(EPA12)	13/04/2021 10:40	pH (Lab)	7.22	pH_Units
WYMB04 (EPA 12)	14/09/2021 9:30	pH (Lab)	7.09	pH_Units
WYMB04(EPA12)	23/12/2021 8:00	TDS	19400	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	TDS	17600	mg/L
WYMB04(EPA12)	13/04/2021 10:40	TDS	18500	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	Anions Total	276	meq/L
WYMB04(EPA12)	23/12/2021 8:00	Anions Total	299	meq/L
WYMB04(EPA12)	13/04/2021 10:40	Anions Total	304	meq/L
WYMB04(EPA12)	23/12/2021 8:00	Cations Total	304	meq/L
WYMB04 (EPA 12)	14/09/2021 9:30	Cations Total	269	meq/L
WYMB04(EPA12)	13/04/2021 10:40	Cations Total	318	meq/L
WYMB04(EPA12)	13/04/2021 10:40	TSS	29	mg/L
WYMB04(EPA12)	23/12/2021 8:00	TSS	840	mg/L
WYMB04 (EPA 12)	14/09/2021 9:30	TSS	5	mg/L
Field_ID	**Sampled_Date-Time**	**ChemName**	**Concentration**	**Output Unit**
WYMB06 (EPA 13)	13/09/2021 17:00	Nitrate (as N)	0.54	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Nitrate (as N)	0.07	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Nitrate (as N)	0.56	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Nitrite (as N)	0.01	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Nitrite (as N)	0.01	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Sulfate as SO4 - Turbidimetric	2300	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Sulfate as SO4 - Turbidimetric	1840	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Sulfate as SO4 - Turbidimetric	1230	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Chloride	2320	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Chloride	2960	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Chloride	2410	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Fluoride	0.7	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Fluoride	0.7	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Fluoride	0.5	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Cyanide Total	0.144	mg/L

WYMB06(EPA13)	13/04/2021 12:30	Cyanide Total	0.169	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Cyanide Total	0.113	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Cyanide (WAD)	0.036	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Cyanide (WAD)	0.024	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Cyanide (WAD)	0.008	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Iron	0.26	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Iron	0.11	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Iron	0.48	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Lead	0.008	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Lead	0.008	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Lead	0.002	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Magnesium	339	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Magnesium	250	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Magnesium	228	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Mercury	0.0001	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Mercury	0.0001	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Mercury	0.0001	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Nickel	0.016	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Nickel	0.008	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Nickel	0.005	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Potassium	6	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Potassium	6	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Potassium	6	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Sodium	2730	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Sodium	2250	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Sodium	2030	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Arsenic	0.063	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Arsenic	0.027	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Arsenic	0.06	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Cadmium	0.0001	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Cadmium	0.0001	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Cadmium	0.0001	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Chromium (III+VI)	0.001	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Chromium (III+VI)	0.001	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Chromium (III+VI)	0.002	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Copper	0.007	mg/L

WYMB06 (EPA 13)	13/09/2021 17:00	Copper	0.008	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Copper	0.015	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Zinc	0.024	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Zinc	0.064	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Zinc	0.08	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Calcium	159	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Calcium	122	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Calcium	119	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Ammonia as N	0.19	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Ammonia as N	0.01	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Ammonia as N	0.01	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Reactive Phosphorus as P	0.19	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Reactive Phosphorus as P	0.09	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Reactive Phosphorus as P	0.14	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Alkalinity (Bicarbonate as CaCO3)	1020	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Alkalinity (Bicarbonate as CaCO3)	1040	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Alkalinity (Bicarbonate as CaCO3)	1360	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Alkalinity (total) as CaCO3	1020	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Alkalinity (total) as CaCO3	1360	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Alkalinity (total) as CaCO3	1040	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Electrical conductivity *(lab)	10900	µS/cm
WYMB06(EPA13)	13/04/2021 12:30	Electrical conductivity *(lab)	13400	µS/cm
WYMB06 (EPA 13)	13/09/2021 17:00	Electrical conductivity *(lab)	10900	µS/cm
WYMB06(EPA13)	22/12/2021 16:15	Cyanide (Free)	0.006	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Cyanide (Free)	0.028	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Cyanide (Free)	0.021	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Hardness as CaCO3	1240	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Hardness as CaCO3	1790	mg/L
WYMB06(EPA13)	22/12/2021 16:15	Hardness as CaCO3	1330	mg/L

WYMB06(EPA13)	13/04/2021 12:30	Ionic Balance	1.22	%
WYMB06 (EPA 13)	13/09/2021 17:00	Ionic Balance	0.53	%
WYMB06(EPA13)	22/12/2021 16:15	Ionic Balance	0.22	%
WYMB06(EPA13)	22/12/2021 16:15	Nitrite + Nitrate as N	0.56	mg/L
WYMB06(EPA13)	13/04/2021 12:30	Nitrite + Nitrate as N	0.07	mg/L
WYMB06(EPA13)	22/12/2021 16:15	pH (Lab)	7.48	pH_Units
WYMB06(EPA13)	13/04/2021 12:30	pH (Lab)	7.14	pH_Units
WYMB06 (EPA 13)	13/09/2021 17:00	pH (Lab)	7.56	pH_Units
WYMB06(EPA13)	22/12/2021 16:15	TDS	7490	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	TDS	6970	mg/L
WYMB06(EPA13)	13/04/2021 12:30	TDS	9490	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	Anions Total	114	meq/L
WYMB06(EPA13)	22/12/2021 16:15	Anions Total	124	meq/L
WYMB06(EPA13)	13/04/2021 12:30	Anions Total	158	meq/L
WYMB06(EPA13)	22/12/2021 16:15	Cations Total	125	meq/L
WYMB06 (EPA 13)	13/09/2021 17:00	Cations Total	113	meq/L
WYMB06(EPA13)	13/04/2021 12:30	Cations Total	155	meq/L
WYMB06(EPA13)	13/04/2021 12:30	TSS	17	mg/L
WYMB06(EPA13)	22/12/2021 16:15	TSS	12	mg/L
WYMB06 (EPA 13)	13/09/2021 17:00	TSS	5	mg/L
Field_ID	**Sampled_Date-Time**	**ChemName**	**Concentration**	**Output Unit**
WYMB10 (EPA 14)	14/09/2021 10:20	Nitrate (as N)	1.28	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Nitrate (as N)	4.19	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Nitrate (as N)	1.31	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Nitrite (as N)	0.01	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Nitrite (as N)	0.01	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Sulfate as SO4 - Turbidimetric	2040	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Sulfate as SO4 - Turbidimetric	2800	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Sulfate as SO4 - Turbidimetric	3380	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Chloride	8040	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Chloride	6080	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Chloride	7430	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Fluoride	1.2	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Fluoride	1.3	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Fluoride	1	mg/L

WYMB10 (EPA 14)	14/09/2021 10:20	Cyanide Total	0.004	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Cyanide Total	0.004	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Cyanide Total	0.004	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Cyanide (WAD)	0.004	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Cyanide (WAD)	0.004	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Cyanide (WAD)	0.004	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Iron	0.54	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Iron	0.06	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Iron	0.05	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Lead	0.001	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Lead	0.001	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Lead	0.001	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Magnesium	418	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Magnesium	571	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Magnesium	477	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Mercury	0.0001	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Mercury	0.0001	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Mercury	0.0001	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Nickel	0.002	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Nickel	0.007	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Nickel	0.004	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Potassium	20	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Potassium	18	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Potassium	14	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Sodium	4210	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Sodium	5590	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Sodium	4680	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Arsenic	0.003	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Arsenic	0.002	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Arsenic	0.005	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Cadmium	0.0001	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Cadmium	0.0001	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Cadmium	0.0001	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Chromium (III+VI)	0.001	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Chromium (III+VI)	0.001	mg/L

WYMB10(EPA14)	23/12/2021 8:45	Chromium (III+VI)	0.001	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Copper	0.015	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Copper	0.015	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Copper	0.018	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Zinc	0.024	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Zinc	0.019	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Zinc	0.018	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Calcium	178	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Calcium	223	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Calcium	205	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Ammonia as N	0.26	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Ammonia as N	0.01	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Ammonia as N	0.01	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Reactive Phosphorus as P	0.13	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Reactive Phosphorus as P	0.15	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Reactive Phosphorus as P	0.12	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Alkalinity (Bicarbonate as CaCO3)	953	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Alkalinity (Bicarbonate as CaCO3)	854	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Alkalinity (Bicarbonate as CaCO3)	1000	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Alkalinity (total) as CaCO3	953	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Alkalinity (total) as CaCO3	1000	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Alkalinity (total) as CaCO3	854	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Alkalinity (Carbonate as CaCO3)	1	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Alkalinity (Hydroxide) as CaCO3	1	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Electrical conductivity *(lab)	26200	µS/cm
WYMB10(EPA14)	13/04/2021 11:15	Electrical conductivity *(lab)	21000	µS/cm
WYMB10 (EPA 14)	14/09/2021 10:20	Electrical conductivity *(lab)	25000	µS/cm
WYMB10(EPA14)	23/12/2021 8:45	Cyanide (Free)	0.004	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Cyanide (Free)	0.004	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Cyanide (Free)	0.004	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Hardness as CaCO3	2480	mg/L

WYMB10(EPA14)	13/04/2021 11:15	Hardness as CaCO3	2160	mg/L
WYMB10(EPA14)	23/12/2021 8:45	Hardness as CaCO3	2910	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Ionic Balance	1.56	%
WYMB10 (EPA 14)	14/09/2021 10:20	Ionic Balance	7.9	%
WYMB10(EPA14)	23/12/2021 8:45	Ionic Balance	0.39	%
WYMB10(EPA14)	23/12/2021 8:45	Nitrite + Nitrate as N	1.31	mg/L
WYMB10(EPA14)	13/04/2021 11:15	Nitrite + Nitrate as N	4.19	mg/L
WYMB10(EPA14)	23/12/2021 8:45	pH (Lab)	6.95	pH_Units
WYMB10(EPA14)	13/04/2021 11:15	pH (Lab)	6.99	pH_Units
WYMB10 (EPA 14)	14/09/2021 10:20	pH (Lab)	7.04	pH_Units
WYMB10(EPA14)	23/12/2021 8:45	TDS	19600	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	TDS	16900	mg/L
WYMB10(EPA14)	13/04/2021 11:15	TDS	13900	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	Anions Total	297	meq/L
WYMB10(EPA14)	23/12/2021 8:45	Anions Total	304	meq/L
WYMB10(EPA14)	13/04/2021 11:15	Anions Total	234	meq/L
WYMB10(EPA14)	23/12/2021 8:45	Cations Total	302	meq/L
WYMB10 (EPA 14)	14/09/2021 10:20	Cations Total	254	meq/L
WYMB10(EPA14)	13/04/2021 11:15	Cations Total	227	meq/L
WYMB10(EPA14)	13/04/2021 11:15	TSS	5	mg/L
WYMB10(EPA14)	23/12/2021 8:45	TSS	5	mg/L
WYMB10 (EPA 14)	14/09/2021 10:20	TSS	5	mg/L

Appendix 7

2021 Audit Recommendations and TGO Responses

TOMINGLEY
GOLD OPERATIONS PTY LTD
(A wholly owned subsidiary of Alkane Resources Ltd)
ABN 53 149 040 371

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2021 Independent Environmental Audit Findings

Table 1: Action Plan to resolve non-compliances.

Audit Section	Audit Recommendations	Action	Due Date	Progress
Project Approval				
Schedule 3 - Condition 5(f) - *Operating Conditions*	Ensure there are improved record keeping for changes made at site relating to noise real time noise triggers and actions. Records should be kept indicating TGO has reviewed site activities when a trigger has been hit. Look into the implementation of operating a noise management system on site that uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day-to-day planning of mining operations. This is to cover Schedule 3 Condition 5b of the Project Approval.	If a trigger is recorded an appropriate record will be generated demonstrating internal review and actions. Noted and will be discussed with current noise monitoring consultants.	Ongoing August 2022	Have reviewed current system which is working well and will await outcome of SSD for TGEP before making any further decisions.
Schedule 3 - Condition 6(a) - *Noise Management Plan*	Update the Noise Management Plan to outline the monthly noise monitoring (currently says quarterly). This is consistent with what has been occurring at the site.	Noise Management Plan will be reviewed as part of annual Management Plan review and submitted to DPIE for approval.	30th January 2022	Ongoing

Schedule 3 - Condition 7 – *Blasting Criteria*	Ensure the Annual Review blasting criteria is outlined as per Schedule 3 Condition 7 of the Project Approval. This includes outlining that only 5% of blasts can be over 115 dBA for overpressure and 5% of blasts can be over 5 mm/s for vibration. Blasting results should be included as an appendix to the Annual Review. The monthly EPL monitoring reports only include maximum vibration levels for blasting, not overpressure. Results should be consistent to allow comparison against relevant blasting criteria. The Blast Management Plan should be updated to include information about underground blasting (e.g. timing, methods, criteria, monitoring and record keeping).	2021 Annual Review to include this. Noted. Noted, TGO blast reports record both vibration and overpressure. Noted, and will be reviewed as part of the current review of the Blast Management Plan.	31st March 2022 31st December 2021	Review of Blast Management Plan being finalised prior to submission to DPIE for review and approval.
Schedule 3 - Condition 14 – *Blast Management Plan*	Ensure the site keeps evidence of assessing weather conditions prior to blasting as well as recording this information in the Blast Summary Spreadsheet.	Currently done on the blast record sheets.	Ongoing	Ongoing

Schedule 3 - Condition 17 – *Air Quality Criteria*	Going forward it is recommended that a spreadsheet or spreadsheets are prepared to include ongoing environmental monitoring results (eg. Air, surface water and groundwater). This will enable an easier assessment of results and trends. Records should be kept in regards to planning for adverse weather requirements in an attempt to reduce dust emissions. Also if operations are changed due to adverse weather events (eg. wind direction, strength then this information should be recorded and kept at site. Liaise with an air quality specialist to utilise real time information and meteorological conditions to determine the incremental impact from site dust levels. This system should be easy enough that the site can determine it quickly. Utilising regional dust stations as well. A formal procedure for investigating any exceedances of ambient air quality criteria should be developed. Another alternative is to investigate the use of directional dust gauges to integrate with the current dust management system.	Monitoring results for air, surface water and groundwater are being imported into Esdat for improved data management. Noted, site currently uses weatherzone alerts which are tied to various site TARPS and operations are conducted according to weather alerts. There have not been any dust complaints since 2018. TGO will continue to monitor and manage dust emissions appropriately and investigate any potential practical and affordable improvements to current practices where necessary.	Ongoing	Ongoing

Schedule 3 - Condition 18 – *Air Quality & Greenhouse Gas Management Plan*	It is recommended that a procedure for review and validation of ambient air quality data be adopted. This would be of use when there are differing ratios between TSP and PM10. It is recommended that a formal procedure for investigating any exceedances of ambient air quality criteria, which includes quantitative estimation of the sites contribution to any exceedances be adopted.	Cbased Environmental Pty Ltd (Singleton) maintain and calibrate the TGO TEOM and HVAS. Consultation with Cbased Environmental Services will be undertaken in relation to this recommendation.	31st December 2021	Ongoing discussions with Cbased.
Schedule 3 - Condition 20 – *Meteorological Monitoring*	It is recommended that system calibration and diagnostic checks be performed at six-month intervals, or in accordance with manufacturer's recommendations, whichever is more frequent as required by AM-4.	Cbased conduct calibration in accordance with the manufacturers specified time intervals. Cbased will be consulted in relation to this recommendation.	Ongoing	
Schedule 3 - Condition 27- *Water Performance Measures*	Water Performance Measures in Schedule 3 Condition 27 should be included in the Water Management Plan.	Will be reviewed in the current review of the TGO Water Management Plan.	31st December 2021	Water Management Plan currently under review.

Schedule 3 - Condition 32- *Water Management Plan*	Complete all monitoring and inspections as per the requirement of approved Water Management Plan. This needs to occur until the revised Water Management Plan is approved. Ensure triggers relating to surface water and groundwater are implemented and actions recorded by TGO. Ensure groundwater quality is discussed in the Annual Reviews. Recommend streamlining and consolidating the Water Management Plan and appendices. The sub plans are quite repetitive of the Water Management Plan main document and could be streamlined to allow for easier implementation.	Will be reviewed in the current review of the TGO Water Management Plan.	31st December 2021	As above
Schedule 3 - Condition 32 (A)- *Water Management Plan*	Ensure there is information on the design and management for final void in the Surface Water Management Plan to cover Part iii of Schedule 3 Condition 32A. Implement recommendations from the 2020 TGO Biodiversity and Rehabilitation Monitoring Report in regards to erosion/biodiversity management along Gundong Creek. Include surface water monitoring results for SW1 and 2 (creek monitoring locations) in the Annual Review as there is currently little information in the Annual Review regarding surface water management.	Will be reviewed in the current review of the TGO Water Management Plan.	31st December 2021	As above
Schedule 3 - Condition 32 (B)- *Water Management Plan*	Information relating to geochemical testing should be included in the Water Management Plan. An acid rock and saline drainage strategy should be included in the Water Management Plan. This should be based on a trigger. Section 8.2 (Groundwater Trigger TARP) within the Water Management Plan could be updated. Ensure groundwater monitoring data is in the format of that is the same as the trigger levels within the Groundwater Management Plan	Will be reviewed in the current review of the TGO Water Management Plan.	31st December 2021	As above

Schedule 3 - Condition 37 - *Biodiversity Management Plan*	Ensure the Biodiversity Management Plan includes a cross referencing table. Section 3 mentions the conditions of consent, but not where they are covered. Figures to be updated and made clear (currently blurry). Further information should be included about the salvage of resources within the approved disturbance area. Ensure the Biodiversity and Rehabilitation Monitoring Report includes more defined recommendations. Currently recommendations are generally mixed in within general discussion points.	Will be reviewed / included in current review of Biodiversity Management Plan.	30th November 2021	Biodiversity Management Plan reviewed and approved by DPIE on 15th November 2021
Schedule 3 - Condition 33 - *Biodiversity Offset*	Liaison with DPIE to obtain approval for the PVP.	Letter will be provided to DPIE seeking approval of the PVP.	30th October 2021	
Schedule 3 - Condition 39 - *Heritage Management Plan*	Ensure the Heritage Management Plan is revised to include a strategy for the storage of any heritage items salvaged on site, both during the project and in the long term. Implementation of strategy and reporting in the Annual Review. The next review of the ACHMP should update the status of 'proposed controls' as many of these have been completed. E.g. Fencing, signage.	Will be reviewed/ addressed in current review of the Heritage Management Plan.	31st December 2021	Review to be completed following outcome of TGEP SSD application
Schedule 3 - Condition 43- *Operating Conditions* *&*	Ensure a log is kept for heavy vehicles to ensure compliance with Schedule 3 Condition 43. We recommend recording this information in a spreadsheet for easy tracking and assessment.	Will be reviewed and record keeping will be improved accordingly.	Ongoing	

Schedule 3 - Condition 44- *Traffic Management Plan*				
Schedule 3 - Condition 49 - *Waste*	Remove the older bulky bins at site that contain hydrocarbons. Where it is required that bulky bins are to remain onsite for a period of time they should be installed in an earthen bund. This bund will need to be constructed. It is noted the bund would be within the sites dirty water catchment. Details on waste management are to be included in the Annual Review.	Review of used IBC's completed. New procedure being implemented for management and disposal of IBC's. Will be included in Annual Review.	30th October 2021 31st March 2022	New procedure implemented for IBC management.
Schedule 3 Condition 51 - *Rehabilitation Objectives*	Liaise with the Resources Regulator about implementing the TAP for tailings and rehabilitation. Implement rehabilitation recommendations from the Biodiversity and Rehabilitation Monitoring Reports by DNA Environmental.	TGO has already initiated actions in relation to Regulator TAP Landform Establishment and Rehabilitation. Recommendations reviewed and implemented where practical at present.	30th January 2022 Ongoing	Ongoing
Schedule 3 Condition 53 - *Rehabilitation Management Plan*	It is recommended that the RMP includes reference to the consultation that took place in considering the option to backfill the Caloma Two void. There still is not much information in the current MOP regarding backfilling of Coloma Two void. This is to cover Schedule 2 Condition 53k. The DNA Environmental - TGO Biodiversity and Rehabilitation Monitoring Report need to have a more defined conclusion and recommendations section. Recommendations are mixed within this section and should be separated out and given specific recommendation ID numbers. The conclusion should also be	Will be addressed during preparation of new Rehabilitation Management Plan in accordance with NSW government reform agenda. Will be addressed in current review of 2021	2nd July 2022	Partial backfilling of Caloma 2 approved by DPIE as part of Mod 5. Completed in 2021 report.

	separated into biodiversity areas and rehabilitation areas as they are managed differently For future rehabilitation ensure better records are kept as to what activities were completed. This would details such as soil testing, landform shaping, ameliorants used, seed mix used and rates. This 'validation' process is a new requirement of the Resources Regulators Rehabilitation Reforms.	Rehabilitation and Biodiversity Monitoring Report. Noted.	31st December 2021	
Schedule 5 - Condition 2 -*Adaptive Management*	The site should keep improved internal records of short term PM10 exceedances. If any investigation determines a non - compliance with criteria then this should be reported to DPIE.	Noted, site currently completes internal investigations of such events. Records related to these events will continue to be kept on site and recording keeping will be improved where possible.	Ongoing	
Schedule 5 - Condition 3 - *Management Plan Requirements*	All Management Plans should include cross referencing tables outlining where the key statutory conditions have been covered. This relates to specific management plan conditions as well as the 'All Management Plan conditions'. All management plans should cover the requirements of Schedule 5 Condition 3. This includes baseline information and contingency measures. Contingency measures should generally be a consistent layout between plans and include a Trigger Action Response Plan in a traffic light system eg. green, amber and red triggers and subsequent responses.	Will be reviewed and amended where necessary in current round of Management Plan reviews.	28th February 2022	Ongoing as a number of Management Plans are waiting to be reviewed pending outcome of TGEP SSD application
Schedule 5 - Condition 4 – *Annual Review*	Additional detail needs to be provided in future Annual Reviews regarding longer term data trends. Section 8.1 of the Annual Review does not meet the requirements of the DPIE Annual Review Guidelines. It does not include details of the total amount of rehabilitation or the previous period. This should be completed in future Annual Reviews. See link to the guideline. https://www.planning.nsw.gov.au/-/media/Files/DPE/Guidelines/post-approval-requirements-for-state-	Noted, will be included in 2021 Annual Review.	31st March 2022	Ongoing

	significant-mining-developments-annual-review-guideline-2015-10.pdf?la=en (Mining Lease Condition 4)			
Schedule 5 - Condition 5 - *Revision Strategies, Plans and Programs*	Ensure management plans are updated as per the requirements of Schedule 5 Condition 5. Management Plans should be updated if they are identified by the auditor and actions are included in TGO's Audit Action Plan.	Noted, all TGO Environmental Management Plans are currently at various stages of review and will be submitted to DPIE for approval as they are completed.	31st March 2022	Ongoing as a number of Management Plans are waiting to be reviewed pending outcome of TGEP SSD application
Environment Protection Licence				
EPL *Operating Conditions* O1.1	As per Schedule 3 - Condition 49 - *Waste*	Review of used IBC's completed. New procedure being implemented for management and disposal of IBC's. .	30th October 2021	Completed
EPL *Reporting Conditions* R2.1	Ensure incident notification occurs immediately if there have been incidents that cause or threaten material harm.	Incidents that require reporting will be done so in the required form and timeframe.	Ongoing	Ongoing
Statement of Commitments				

4.4 Noise	As per recommendation from Schedule 3 Condition 6.	Noise Management Plan will be reviewed as part of annual Management Plan review and submitted to DPIE for approval.	30th January 2022	Ongoing
5.4 Surface Water/Hydrocarbons	Complete a full review of the refuelling infrastructure and procedure to ensure that refuelling is completed within bunded areas and there are appropriate controls to manage a spill.	Review to be completed in conjunction with site review of May 2021 Diesel spill from JLP Transport bulk diesel tanker.	31st December 2021	Ongoing
5.4 Surface Water/Hydrocarbons	Store used IBCs with residue contents in bunded area.	Review of used IBC's completed. New procedure being implemented for management and disposal of IBC's. IBC's will be rinsed and not stored with residue prior to removal from site.	30th October 2021	Completed
13.1 Traffic and Transportation	Including the Code of Conduct for all drivers of all heavy vehicles. Attaching as appendix to the Traffic Management Plan Complete training for drivers.	Noted. Will be reviewed when Traffic Management Plan is reviewed. All drivers on site must have current licence and are tested and permitted on each piece of	Ongoing	Ongoing

		equipment they drive / use on site.		
15.2 Waste	As per S3 C49 (Project Approval) recommendations.	Review of used IBC's completed. New procedure being implemented for management and disposal of IBC's. Details of waste management will be included in Annual Review.	30th October 2021 31st March 2022	Completed