DONALDSONCOAL

Part of the Yancoal Australia Group

ABN: 87 073 088 945

Annual Review

Donaldson Coal Mine

1 November 2022 – 31 October 2023

This page has intentionally been left blank

DONALDSON COAL

PTY LTD

ABN: 87 073 088 945

Annual Review

for the

Donaldson Coal Mine

1 November 2022 – 31 October 2023

Compiled for:

Donaldson Coal Pty Ltd
ABN 87 073 088 945
1132 John Renshaw Drive
BLACK HILL NSW 2322

Telephone: (02) 4015 1140
Facsimile: (02) 4934 2736
Email: donaldson@doncoal.com.au

Compiled by:

R.W. Corkery & Co. Pty. Limited
Geological & Environmental Consultants
ABN: 31 002 033 712

Telephone: (02) 9985 8511
Email: admin@rwcorkery.com
Postal: PO Box 1796
CHATSWOOD NSW 2057

Sydney | Orange | Townsville

Sydney
Suite 12.01, 1-5 Railway Street
CHATSWOOD NSW 2067

Orange
62 Hill Street
ORANGE NSW 2800

Ref No. 737/29a

January 2023

DONALDSONCOAL
Part of the Yancoal Australia Group

Title Block

Name of Operation	Donaldson Coal Mine
Name of Operator	Donaldson Coal Pty Ltd
Development consent / project approval #	DA 98/01173 and 118/698/22
Name of holder of development consent / project approval	Donaldson Coal Pty Ltd
Mining Lease #	ML 1461
Name of holder of mining lease	Donaldson Coal Pty Ltd
Water licence #	20WA218980, 20WA211590 and WAL41522
Name of holder of water licence	Donaldson Coal Pty Ltd
RMP start date	02/07/2022
RMP end date	Not Applicable
Annual Review start date	01/11/2022
Annual Review end date	31/10/2023

I, Phillip Brown, certify that, to the best of my knowledge this report is a true and accurate record of the compliance status of the Donaldson Coal Mine for the period 01 November 2022 to 31 October 2023 and that I am authorised to make this statement of behalf of DONALDSON COAL 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); Section 307A, 307B and 307C (false or misleading application/information/documents – maximum penalty 2 years imprisonment or $22,000, or both).

Name of authorised reporting officer	Phillip Brown
Title of authorised reporting officer	Environment and Community Relations Superintendent
Signature of authorised reporting officer	
Date	22 January 2024

CONTENTS

Page

CONTENTS

APPENDICES

FIGURES

TABLES

1. STATEMENT OF COMPLIANCE

The compliance status of relevant approvals was reviewed for the reporting period (see **Appendix 3**) and is summarised in **Table 1.1**. There were no non-compliances during the reporting period.

Table 1.1
Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	Yes / No
Development Consent (combined DA 98/01173 and DA 118/698/22)	Yes
Mining Lease 1461	Yes

2. INTRODUCTION

2.1 OVERVIEW OF OPERATIONS

The Donaldson Coal Mine ("the mine") was an open cut coal mining operation located ~23km from the Port of Newcastle, north of John Renshaw Drive and west of Weakleys Drive (**Figure 2.1**). The mining lease is contained within the Cessnock and Maitland Local Government Areas. A locality plan and aerial photograph showing the location of the mine in a regional context is attached as **Appendix 1** of this report.

The mine commenced operation on 25 January 2001, following approval by the (then) Minister of Urban Affairs and Planning in 1999.

The first load of coal was railed from the mine on 26 March 2001. Up to 31 October 2013, approximately 13Mt of coal had been produced and exported from the site for either domestic (i.e. Hunter Valley power stations) or international use (via the Port of Newcastle).

Mining operations at the mine were completed in April 2013. Progressive rehabilitation activities were undertaken throughout the operation of the mine and a final rehabilitation project commenced in May 2013. This involved removal of roads, excavation of contaminated material, decommissioning of the fuel storage area, buildings and other surface infrastructure, reshaping surfaces to the final landform, topsoil spreading, drainage line construction and seeding with local tree and shrub species. The rehabilitation works at the mine were completed in March 2014 and, to date, remain in care and maintenance with ongoing monitoring.

2.2 SCOPE AND FORMAT

This Annual Review for the Donaldson Coal Mine has been compiled by R.W. Corkery & Co. Pty Limited on behalf of Donaldson Coal Pty Ltd ("Donaldson"). Donaldson Coal Pty Ltd is a fully owned subsidiary of Yancoal Australia Limited.

This is the eighth Annual Review submitted for the mine, following 13 Annual Environmental Management Reports, and is applicable for the period 1 November 2022 to 31 October 2023 ("the reporting period").

This Annual Review generally follows the format and content requirements identified in the NSW Government's *Annual Review Guideline* dated October 2015.

2.3 KEY PERSONNEL CONTACT DETAILS

Donaldson owns the mining operation and is the holder of Mining Lease (ML) 1461. Donaldson is also the mining operator. **Table 2.1** outlines the site personnel responsible for the various aspects of the operation during the reporting period.

Table 2.1
Site Personnel

Position	Site Personnel
Operations Manager, Donaldson Coal Mine	Mr William Farnworth
Environment and Community Relations Superintendent, Donaldson Coal Mine	Mr Phillip Brown

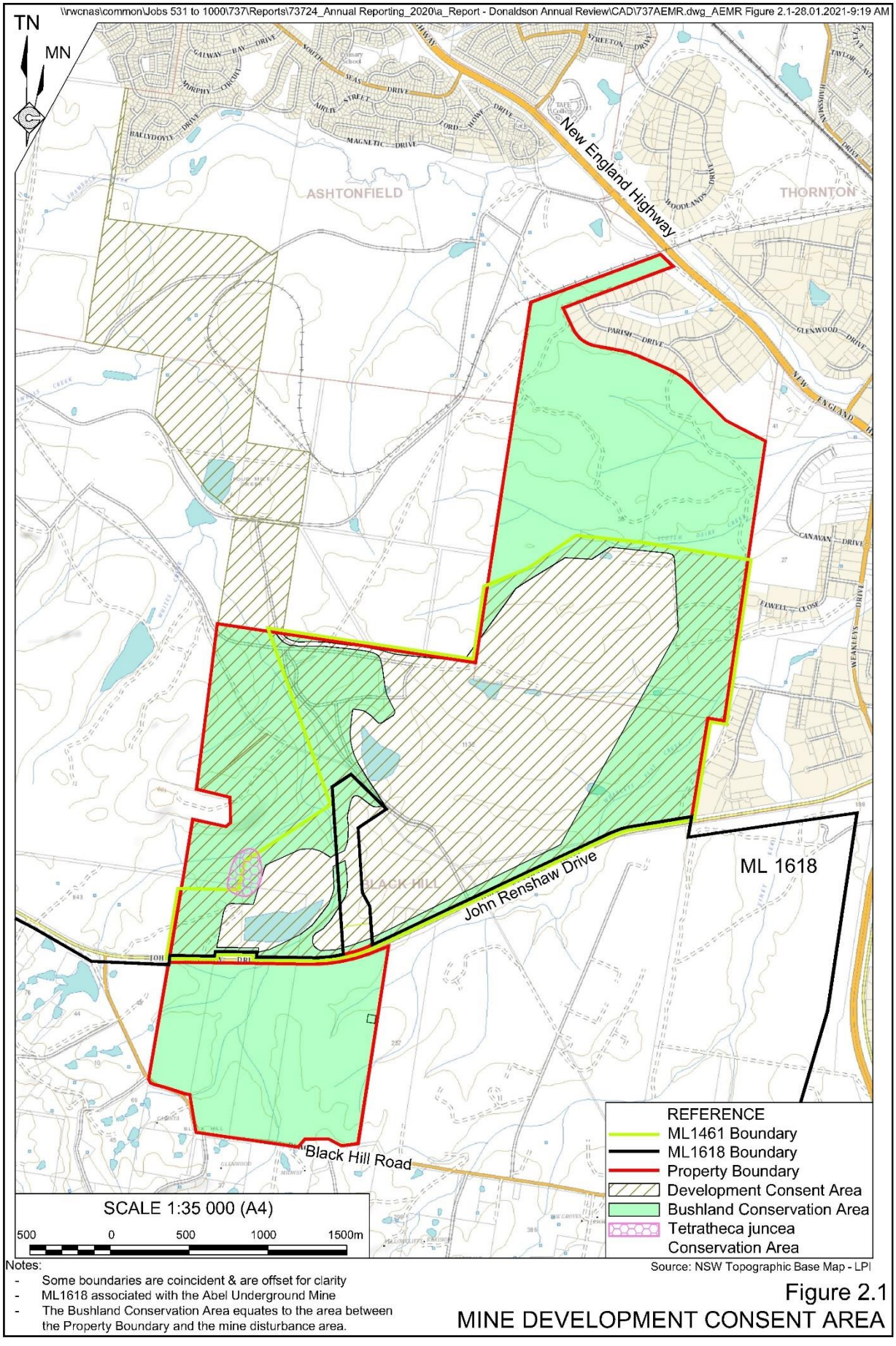


Figure 2.1
MINE DEVELOPMENT CONSENT AREA

Table 2.2 outlines the contacts for the Donaldson Coal Operations Manager, Mr William Farnworth, and the Environment and Community Relations Superintendent, Mr Phillip Brown.

Table 2.2
Contact Details

Physical Address:	Donaldson Coal Mine 1132 John Renshaw Drive BLACK HILL NSW 2322
Postal Address:	PO Box 2216 GREEHILLS NSW 2323
Community Hotline (24hrs):	1800 111 271
Phone:	(02) 4993 7356 (William Farnworth) (02) 6570 9219 (Phillip Brown)
Fax:	(02) 4015 1159
e-mail:	donaldson@doncoal.com.au
Website:	www.doncoal.com.au

A 24-hour Environmental Hotline (Tel: 1800 111 271) is maintained by Donaldson. Details of calls are recorded by the Environment & Community Relations Superintendent for further actioning, if required.

3. APPROVALS

Table 3.1 provides a current list of statutory instruments in effect, including the date of grant of all leases, subleases, consents, approvals and licenses. It also includes information relating to the current Rehabilitation Management Plan (RMP).

Table 3.1
Donaldson Coal Mine – Approvals, Leases and Licences

Approval/Lease/ Licence	Issue / Approval Date	Expiry Date	Details / Comments
Mining Lease (No. 1461)	21/12/1999	20/12/2040	Granted by the (then) Minister for Mineral Resources. Incorporates a surface area of 515.6ha (following excision of the Abel Surface Infrastructure Area from the lease in 2008). Standard conditions were implemented for the mining lease on 17 October 2022 in accordance with the *Mining Regulation 2016* amendments. A renewal application for ML 1461 which was lodged 27 November 2019 was subsequently approved 12 May 2023.
Rehabilitation Management Plan	01/08/2022	Not Applicable	In accordance with the Operational Rehabilitation Reform a Rehabilitation Management Plan was prepared and finalised on 1 August 2022. The Rehabilitation Objectives and Final Landform and Rehabilitation Plan were approved by the Resources Regulator on 25 August 2023.
Development Consent (combined DA 98/01173 and 118/698/22)	14/10/1999	-	• Modified on 26 September 2005 and 24 June 2011. • Consent for mining operations lapsed on 31 December 2013. • Certain conditions of the consent will continue to operate after the consent for mining operations has lapsed.
Environment Protection Licence (No. 12856)	09/07/2008	Not Applicable	• Anniversary date 09 July. • Current licence version dated 20 April 2023. • Combined licence for the Donaldson Coal Mine and Abel Underground Coal Mine.
Water Supply Works Approval 20WA218980	01/07/2016	30/06/2029	Bore Licence 20BL168123 was issued to cover groundwater extraction as a result of the active mining area. Following commencement of the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* in July 2016 20BL168123 was converted to a water supply works approval and water access licence with an allocation of 300ML/year.
Water Access Licence (WAL) 41522	01/07/2016	Continuing	
Water Supply Works Approval 20WA211590	01/08/09	31/07/32	Issued for the works associated with the open cut mining pits as located within the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009.*

4. OPERATIONS SUMMARY

4.1 MINING OPERATIONS

Coal mining activities ceased in April 2013 and all mining equipment was removed from site. No coal mining was undertaken during the reporting period or is planned during the next reporting period (see **Table 4.1**).

Table 4.1
Production Summary

Material	Approved limit (specify source)	Previous reporting period (actual)	This reporting period (actual)	Next reporting period (forecast)
Waste Rock / Overburden	No longer applicable	0	0	0
ROM Coal / Ore		0	0	0
Coarse Reject		0	0	0
Fine Reject (Tailings)		0	0	0
Saleable Product		0	0	0

4.2 OTHER OPERATIONS DURING THE REPORTING PERIOD

During the reporting period no exploration, land preparation or construction activities were undertaken. Additionally, no coal processing or transportation activities were undertaken within ML 1461 during the reporting period.

Environmental monitoring activities continued throughout the reporting period including surface water, groundwater, flora and fauna and rehabilitation monitoring. Results of this monitoring are summarised in Sections 6 and 7.

Rehabilitation activities were completed in March 2014 with no further rehabilitation work occurring during the reporting period.

The Rehabilitation Objectives submitted during the previous reporting period were approved on 25 August 2023. Following this a review and update of the Rehabilitation Management Plan was undertaken to include the approved Rehabilitation Objectives, as required by Clause 11(a), Division 3, Part 2 of Schedule 8a of the *Mining Regulation 2016*.

4.3 NEXT REPORTING PERIOD

The activities proposed for 2023/2024 will principally involve continued monitoring and, if required, maintenance activities in accordance with the approved management plans and RMP. The following provides a summary of the planned activities.

Exploration

Donaldson currently does not intend to undertake any drilling within ML 1461 during the 2023/2024 reporting period.

Mining

No further mining will be undertaken.

Rehabilitation

All rehabilitation works have previously been completed. Any rehabilitation works during the 2023/2024 reporting period will relate to ongoing maintenance, principally erosion and sediment control, weed management and vegetation establishment, as required. Planning activities will also be undertaken including preparation of an implementation program for the recommendations arising from the *Sediment Dam Investigation* report and commencement of a rehabilitation materials balance report as discussed in the RMP.

Monitoring

The following monitoring will be undertaken during the next reporting period.

- Surface water – ongoing surface water quality monitoring in accordance with the site Water Management Plan. Monitoring will be undertaken by CBased Environmental.
- Groundwater – ongoing groundwater level and quality monitoring will be undertaken by CBased Environmental.
- Flora and Fauna – Wedgetail Project Consulting (Wedgetail) will continue to undertake annual flora and fauna surveys and reporting.
- Rehabilitation – Wedgetail will continue to undertake rehabilitation monitoring and reporting.

Community Consultation and Liaison

The 24-hour environmental hotline will be maintained and a register retained of any complaints received.

5. ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

The 2021/2022 Annual Review was submitted to the Department of Planning and Environment (DPE) compliance unit and the Resources Regulator on 31 January 2023. Feedback from the DPE compliance unit was received on 17 April 2023 confirming the Annual Review was considered to generally satisfy the requirements of the Development Consent and the Department's *Annual Review Guideline* (October 2015). No specific actions were raised.

No feedback was received from the Resources Regulator in relation to the Annual Review.

6. ENVIRONMENTAL PERFORMANCE

6.1 SUMMARY OF ENVIRONMENTAL PERFORMANCE

A summary of environmental performance for the principal environmental aspects is provided in **Table 6.1**. Further detail regarding specific environmental aspects is also provided in the following subsections.

Table 6.1
Environmental Performance

Aspect	Approval criteria / EIS prediction	Performance during the reporting period	Trend/key management implications	Implemented/ proposed management actions
Noise and Vibration	DA Condition 15 – approved noise limits range from 35dB(A) to 50dB(A).	No mining or earthmoving activities occurred and rehabilitation has been completed.	No community noise complaints were received for the mine during the reporting period. Implies management measures are currently adequate.	No noise monitoring undertaken. No additional management action required.
Blasting	DA Condition 24 – Overpressure 115dB(A) and max 120dB(A) -Vibration 5mm/s and max 10mm/s	No blasts undertaken.	No specific management implications given no blasts undertaken.	No specific management actions required.
Air Quality	DA Condition 37 – Annual Average TSP 90ug/m^3 and deposited dust 4g/m^2/month.	No mining or earthmoving activities occurred and rehabilitation has been completed. No exceedances recorded.	No community air quality complaints were received for the mine during the reporting period. Implies management measures are currently adequate.	No additional management action required.
Biodiversity	DA Condition 70 – Provision of compensatory habitat.	There have been no significant negative impacts on biodiversity within the Donaldson Bushland Conservation Area over the last 20 years. Whilst a slight recovery was recorded in 2020 following drought breaking rain, *Tetratheca juncea* numbers continued to show an overall decline since commencement of monitoring.	Trend has been an increase in biomass which has now plateaued. Overall fauna diversity consistent, however, decrease in birds with an interior habitat speciality since 2012 (possibly due to large-scale clearing associated with adjacent industrial estate in 2012). Continued maturation of mine rehabilitation areas may reverse this trend. Continued increase in ground species density appears to be the probable cause for the decline in the *Tetratheca juncea* population. A hazard reduction burn within the Tetratheca Juncea Conservation Area (TJCA) is recommended by ecologist. Renewal of clump flagging (for identification) is also recommended.	Continued monitoring of flora and fauna trends and further hazard reduction burns, particularly within the TJCA.
Heritage	DA Condition 81-86 – Aboriginal Heritage Conservation Area and Management Plan	No heritage items identified or disturbed during the reporting period. No complaints or other management issues.	No heritage complaints were received and no heritage-related issues were identified during the reporting period. Implies no specific management actions were necessary.	No additional management action required.

6.2 METEOROLOGICAL MONITORING

An on-site automated weather station continued to be operated during the reporting period, recording rain, wind speed and direction. **Figure 6.1** presents the monthly wind roses for the reporting period whilst **Table 6.2** provides the monthly rainfall data.

Table 6.2
Monthly Rainfall

Average Monthly Rainfall (mm)													
Period	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
2000	61.0	32.0	279.0	146.0	45.0	24.0	27.0	31.0	33.0	47.0	106.0	32.0	863.0
2001	46.0	169.0	193.0	114.0	244.0	3.4	63.0	22.0	12.0	31.0	91.0	38.0	1026.4
2002	48.0	281.0	184.0	66.4	62.1	30.0	30.0	21.0	17.4	18.8	56.2	149.2	964.1
2003	6.0	90.0	22.2	77.0	135.0	13.2	43.0	27.4	0.0	63.2	137.6	39.0	653.6
2004	86.0	176.6	80.0	33.6	17.4	9.4	15.4	43.1	61.2	136.0	77.4	69.8	805.9
2005	64.4	95.8	127.8	57.4	61.8*	56.8	7.2	0.8	37.0	84.0	22.8	9.6	625.4
2006	29.8	47.4	63.6	4.6	7.8	43.8	42.6	49.2	162.4	25.4	37.8	35.6	550.0
2007	13.4	88.0	102.0	86.0	60.0	301.0	17.0	79.6	19.8	17.2	163.8	49.5	997.3
2008	153.4	154.3	46.0	237.6	2.2	122.9	30.0	28.5	195.3	62.2	73.3	62.6	1168.3
2009	11.3	97.7	136.5	157.2	125.7	75.7	32.1	1.8	29.2	59.8	51.4	62.0	840.4
2010	0.0	52.1	83.9	37.1	89.4	112.8	65.3	38.5	26.4	80.6	171.1	39.9*	797.1
2011	26.0	34.5	65.6	137.9	98.8	152.0	129.0	49.0	103.0	100.0	171.9	75.9	1143.6
2012	96.1	207.0	137.6	114.7	11.8	172.3	53.8	26.6	18.7	5.7	21.8	1.2	867.3
2013	1.0	100.0	64.2	65.8	59.8	63.8	71.8	9.6	21.8	27.0	261.8	2.6	1094.0
2014	15.6	108.3	112.8	99.3	44.3	31.4	24.6	104.0	42.4	55.0	38.4	133.4	809.5
2015	167.0	48.0	73.3	412.0	89.4	44.6	17.9	30.6	56.8	59.0	69.8	103.8	1172.2
2016	430.8	26.0	78.0	31.8	13.4	113.0	44.2	74.2	60.0	43.8	44.5	41.8	1001.5
2017	66.9	71.7	150.4	94.5	12.7	128.5	3.2	6.0	12.6	77.7	66.8	41.6	624.2
2018	6.6	120.0	191.4	52.8	7.0	107.4	4.2	21.4	55.4	109.0	92.2	65.0	832.4
2019	17.2	32.8	158.0	27.0	19.4	97.4	26.0	66.6	69.4	22.0	28.2	0.0	564.0
2020	55.2	214.8	106.3	52	45.4	80.2	166.6	41	35.6	146.6	53.0	118.4	1115.1
2021	89.4	101.8	234.8	48.6	31.4	72.0	20.6	20.6	31.0	67.4	198.6	55.4	971.6
2022	78.8	102.2	271.4	107.4	86.2	12.6	304.8	43	111.2	97.2	**47.0**	**18.4**	1280.2
2023	**71.0**	**98.0**	**111.0**	**76.0**	**21.6**	**8.2**	**18.2**	**35.4**	**15.0**	**49.4**	**-**	**-**	-
Minimum	0.0	26.0	22.2	4.6	2.2	3.4	3.2	0.8	0.0	5.7	21.8	0.0	550.0
Average	68.4	106.2	128.0	97.4	57.8	78.2	52.4	36.3	51.1	61.9	90.5	54.8	902.9
Maximum	430.8	281.0	279.0	412.0	244.0	301.0	304.8	104.0	195.3	146.6	261.8	149.2	1280.2
Note: Results relevant to this reporting period are in **bold**.													

During the reporting period, winds dominated from the south-eastern quadrant during summer and early autumn (between December 2022 and March 2023) and from the north-western quadrant during autumn, winter and early spring (between April 2023 and September 2023). Winds dominated from both the south-eastern and north-western quadrants during periods of transition between cooler and warmer periods (i.e. November 2022, March 2023 and October 2023).

Total rainfall during the reporting period was 569.2mm, which is 333.7mm less than the average rainfall recorded to date. Rainfall recorded for all months was generally consistent with or below the long-term average since commencement of monitoring in 2000.

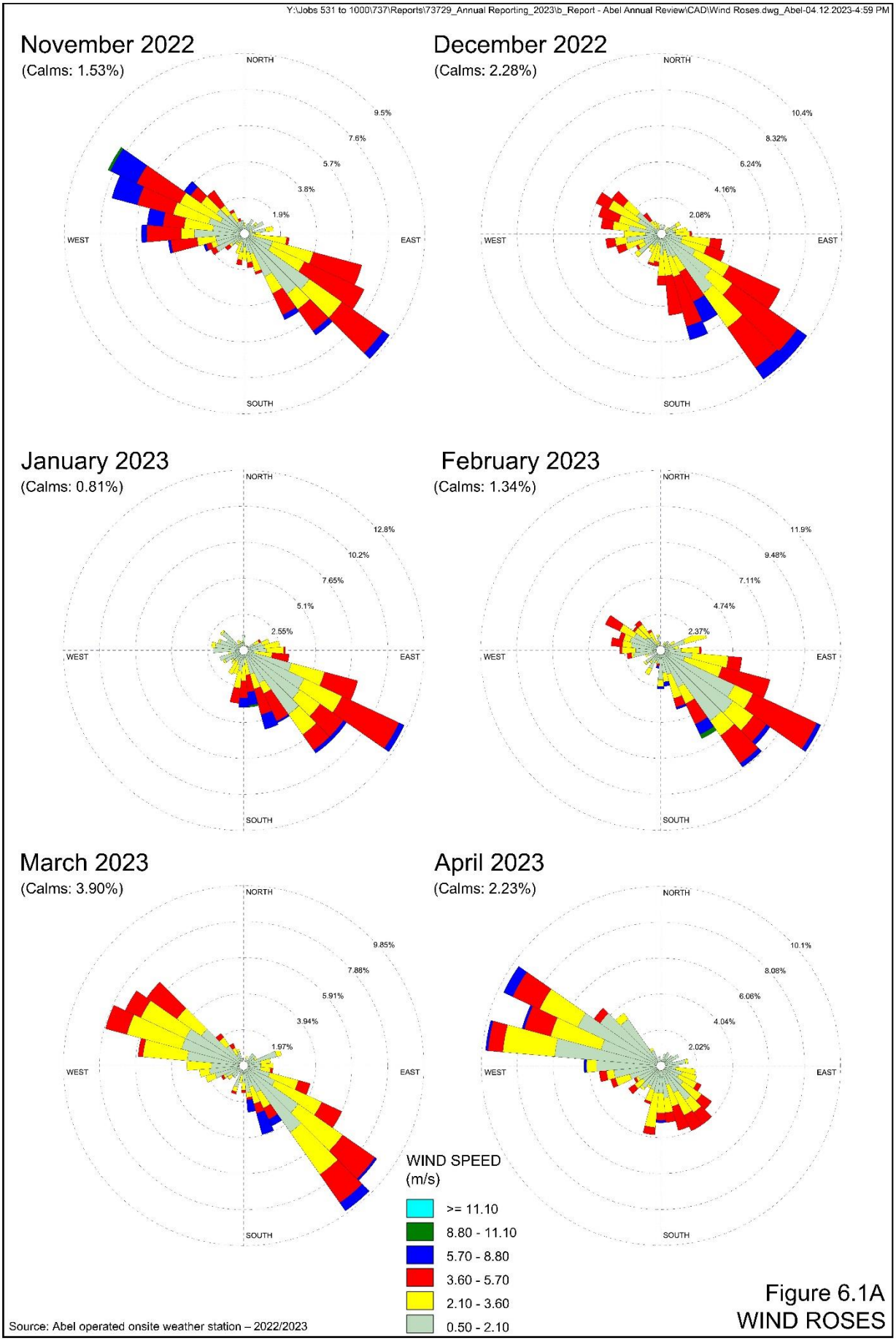


Figure 6.1A
WIND ROSES

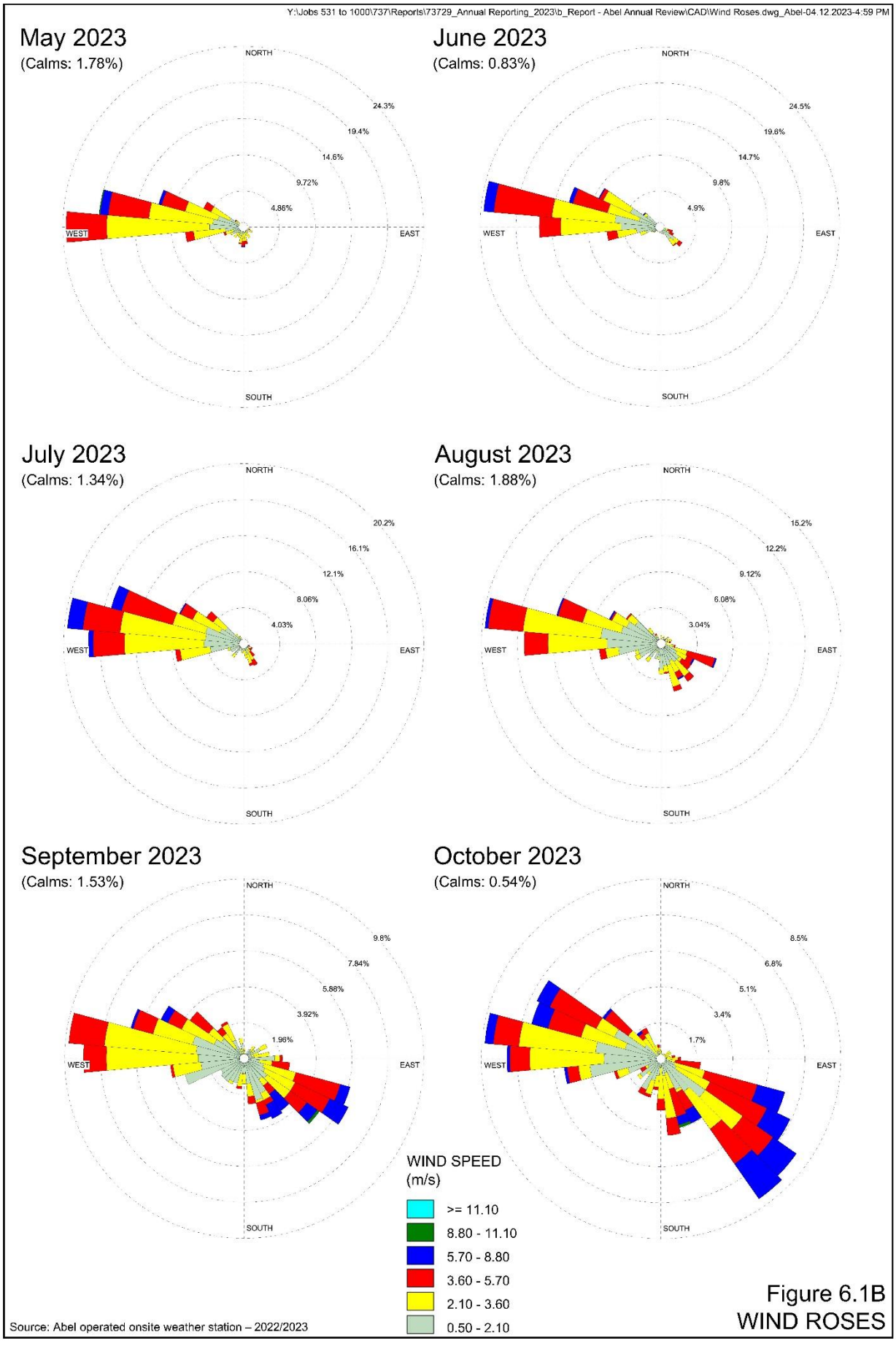


Figure 6.1B
WIND ROSES

6.3 NOISE

As mining ceased in April 2013, no noise monitoring was undertaken for the Donaldson Open Cut Coal Mine during the reporting period. Based on the absence of activities and community complaints, no specific noise management measures were required and no further improvements are currently considered necessary. No further monitoring is currently proposed.

6.4 BLASTING

No blasting was undertaken during the reporting period.

6.5 AIR QUALITY

Environmental Management

The Donaldson Air Quality and Greenhouse Gas Management Plan (Donaldson Coal Pty Ltd, 2019) reflects the reduced air quality monitoring requirements during the care and maintenance period of the mine in accordance with recommendations made in the 2019 Independent Environmental Audit for the Abel Underground Mine[1].

It is noted that, as part of the consolidation of EPL 11080 with EPL 12856, the requirement to monitor deposited dust and total suspended particulates (TSP) was removed. The date of consolidation (and corresponding reduction in monitoring requirements) occurred on 01 October 2021. The following dust monitoring equipment has been decommissioned.

- Nine Depositional Dust Gauges measuring insoluble solids.
- Two HVAS measuring PM_{10}.
- One High Volume Air Sampler (HVAS) measuring TSP.

In accordance with EPL 12856, air quality monitoring data will now only be collected and reported for the continuous E-Sampler monitor measuring PM_{10} located at Black Hill. The locations of dust monitoring equipment, including both active equipment and equipment that has now been decommissioned, are outlined in **Appendix 1**.

As there were no operational activities during the reporting period and the majority of the site has been rehabilitated, no specific air quality management measures were required throughout the reporting period.

Environmental Performance

Donaldson operated one continuous E-Sampler monitor measuring PM_{10} during the reporting period with the results of monitoring presented as follows. It is noted that measurements taken include all background air pollution as well as any contribution occurring from the mine.

Previous data for the Depositional Dust Gauges measuring insoluble solids, High Volume Air Sampler (HVAS) measuring PM_{10}, and HVAS measuring TSP is available in the previous Annual Reporting for the Mine.

[1] Note: The Air Quality Management Plan is a joint management plan covering both the mine and the Abel Underground Coal Mine.

Continuous Monitor

Donaldson operated one continuous E-Sampler air quality monitor at Black Hill Public School during the reporting period. **Table 6.7** and **Figure 6.5** summarise the continuous monitoring data since installation of the current E-Sampler unit. The measurement of PM_{10} by optical methods (such as by DustTrak and E-Sampler monitors) is known to be particularly sensitive to rainfall or high humidity events. Monthly inspections of the E-Sampler monitor and regular servicing of the instrument assist with reducing occasions when the measurements become unstable or drift from sensible values.

Table 6.3
E-Sampler Results – PM_{10} (November 2022 to October 2023)

Site	Data Collection	Days Sampled	Highest 24-hour average PM_{10} ($\mu g/m^3$)	Annual average PM_{10} ($\mu g/m^3$)	Lowest 24-hour average PM_{10} ($\mu g/m^3$)
Black Hill Public School	Continuous	365	46.0	9.0	0.9
Note: Data in this table is for the annual reporting period 1 November 2022 to 31 October 2023.					

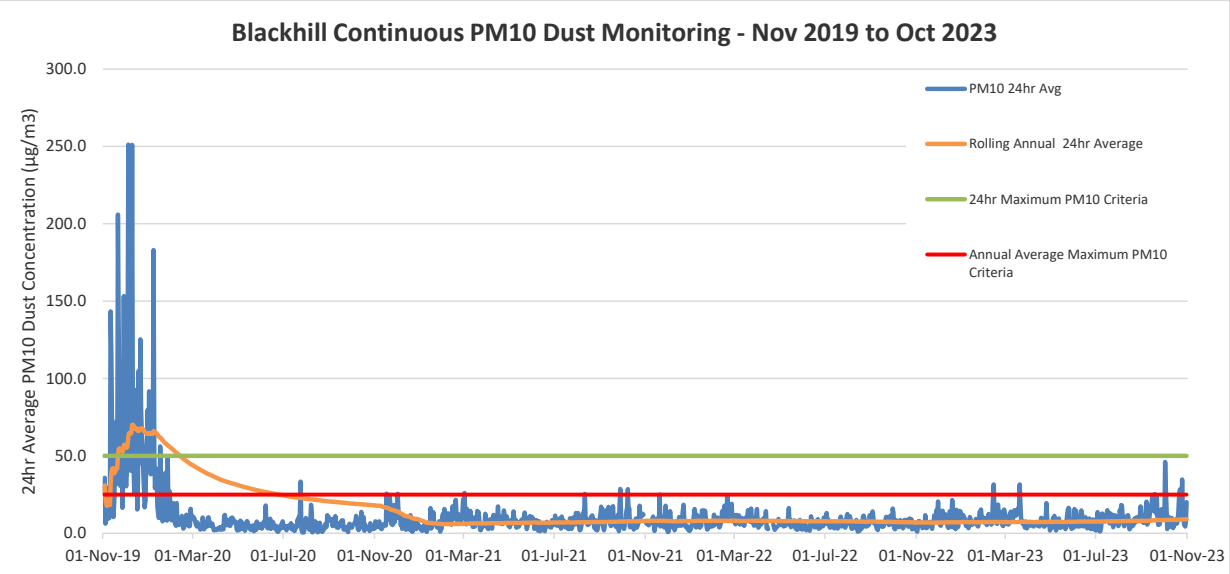


Figure 6.2 Results of Continuous PM_{10} Monitoring

Samples were successfully collected on 365 days of the sampling period of which there were 3 days in which there was partial data capture. In total 8,757hrs of data was captured out of 8,760hrs of possible data capture, equating to a 99.97% capture rate, in line with EPA's minimum capture requirements for continuous monitoring. Data loss during the period principally resulted from power outages with some data loss also occurring during daylight savings change over. Notwithstanding this, the level of data capture is high and suitably characterises the air quality during the reporting period.

The average annual PM_{10} result was 9.0$\mu g/m^3$ from the continuous monitoring. Maximum measured PM_{10} at the continuous monitor was 46.0 $\mu g/m^3$.

The rolling annual 24-hour average did not exceed the annual average criteria of 25$\mu g/m^3$ during the reporting period.

Greenhouse Gases

As the Donaldson Coal Mine has ceased operations, the principal activities undertaken include monitoring and inspections. Beyond maintenance of vehicles, no specific management measures were implemented during the reporting period.

It is noted that the Environmental Impact Statement for the mine was prepared in 1998 prior to current greenhouse gas assessment and reporting requirements.

Reportable Incidents

No reportable air quality incidents were recorded during the 2022/2023 Annual Review reporting period.

Further Improvements

No improvements relating to air pollution are planned or considered necessary.

6.6 BIODIVERSITY

During the reporting period, biodiversity values have principally been managed through the ongoing implementation of the flora and fauna monitoring program. These management measures are outlined in detail within the 'Flora and Fauna Management Plan' (dated June 2019) prepared for the mine. Full copies of the monitoring reports are provided as **Appendices 4** and **5**.

Management of biodiversity over the life of the mine has also been achieved through the implementation of the Bushland Conservation Area (BCA) in accordance with Conditions 70 to 74A of DA98/01173 and 118/698/22.

In accordance with the approved *Bushland Conservation Area Management Plan* and Condition 72, the BCA will continue to be actively managed until 2036.

6.6.1 Flora

Environmental Management

Flora monitoring has been conducted through several flora surveys throughout the reporting period. Surveys have been conducted in the Bushland Conservation Area (BCA), rehabilitation areas, and on *Tetratheca juncea*. Management and monitoring of flora within rehabilitation areas is discussed in Section 8.2.

Bushland Conservation Area

Annual flora quadrat monitoring has been conducted in the BCA since 2001. In 2022, nine 20m x 20m quadrats were monitored for species richness, density, floristic composition and biomass parameters. Quadrat monitoring occurs in late spring to early summer each year and aims to monitor the influence of mining activities on flora around the mine site.

Weed control measures were undertaken during the reporting period, including targeted Pampas grass (Cortaderia sp.) treatment and opportunistic treatment of Lantana camara (West Indian Lantana). The primary means of controlling weeds was through herbicide use and manual

removal. Wedgetail (2023a) noted during the 2022 annual survey that weed control has been effective in controlling Lantana camara (West Indian Lantana) and allowing the subsequent requirement of native species (particularly in Quadrats 5 and 7).

Tetratheca Juncea

There was one species of threatened flora identified during the preparation of the 1998 Environmental Impact Statement (EIS), namely *Tetratheca juncea* (Black-eyed Susan). As a result, a Tetratheca Juncea Management Plan was developed (Gunninah, 2000a) and a survey and identification report (Gunninah, 2000b) was completed, which located the boundaries of the population and defined the limit of the conservation precinct. Subsequent works during 2001 and 2002 extended the boundary and up to an additional two hundred (200) plants were found during routine monitoring and vegetation characterisation.

In addition, approximately four hundred (400) plants were discovered during routine pre-clearing surveys and monitoring episodes. A large proportion of these plants fell outside of the active mine area, adding further conservation significance to the area(s) identified and managed by Donaldson as the Tetratheca Juncea Conservation Area (TJCA) (see **Figure 2.1**).

In addition to the creation of the TJCA, the following additional control measures have previously been employed.

- The protection of 650ha of bushland around the mine to conserve habitat.
- Ongoing mapping and management protocols.
- Pre-clearing surveys by a qualified biologist prior to any clearing activities.

In 2005, a design was also developed for the experimental translocation of *Tetratheca Juncea* from the planned mine disturbance area. The experimental design for the translocation was based on a study being conducted in the Gwandalan area (Ecobiological, 2005). The ongoing monitoring of the translocated plants focused upon collecting data and information about the circumstances under which the plants are growing. Each plant and each recipient site was photographed following translocation and every twelve months for 5 years. The plants were monitored and watered on a weekly basis for 6 weeks post planting to help ensure maximum initial survival and inspected twice per year for the 5 year period.

Environmental Performance

Bushland Conservation Area

The following summary of environmental performance has been extracted and compiled from Wedgetail (2023a and 2023b). A full copy of these reports, including survey methodology, data and statistical analysis, is presented in **Appendix 4**.

The 2022 flora survey results show an overall increase in plant species richness and structural components since the baseline survey in 2001. An overall increase in plant species richness and cover of groundcover species compared to 2019 continued to be observed, likely indicative of the early stages of recovery from drought conditions experienced during 2018 and 2019. To date, a total of 306 flora species have been recorded across all survey events with 160 flora species identified during the 2022 survey. This represents a decrease of 28 species compared to 2021, and an increase of 26 species since the 2001 baseline survey. Since commencement of monitoring

the cumulative number of species steadily increased until 2009 and has since levelled and stabilised. This is consistent with expected ecological processes, weather patterns, and other variables.

Despite minor year-to-year fluctuations, all biomass variables examined (i.e. basal area, height, foliage projective cover (FPC), and stand volume) have shown substantial increases since the baseline survey in 2001. All quadrats continued to record an increase in FPC compared to the 2001 baseline survey. FPC increased from 2001 with peak levels recorded in 2012/2013 followed by a general decline between 2015 and 2017. Survey results for 2022 recorded mixed results with some quadrats recording a small increase (Q1 to Q3) and some a small decrease (Q4 to Q9). The 2022 survey also recorded an increase in both basal area and stand volume at all quadrats with both parameters generally increasing since the 2001 baseline survey. Wedgetail (2023a) conclude that the protection of the Bushland Conservation Area from a history of logging, clearing, frequent fire, firewood collection and rubbish dumping has likely contributed to the significant increase in biomass at all monitored sites since 2001.

Overall, the recorded trends are indicative of a dynamic plant community with high recruitment from the seed pool, an indicator of a healthy native plant community, and Wedgetail (2023a) conclude that the Donaldson Coal operations are causing minimal impacts on biodiversity within the Donaldson Bushland Conservation Area.

Tetratheca Juncea

A baseline report was completed in January 2003 by Barker Harle. This report describes the implementation of the Tetratheca Juncea Management Plan and includes baseline information for use in subsequent reports. Subsequent monitoring and reporting is undertaken on an annual basis.

The 2023 annual monitoring was completed by Wedgetail (2023c) (see **Appendix 5**). Wedgetail reported that the monitoring data has shown a declining population between 2005 and 2014, with a small recovery, followed by a continued decline. The probable cause for the continuing reduction was a measured increase in the density of ground species outcompeting *Tetratheca juncea*. The monitoring indicates that the *Tetratheca juncea* population would benefit from a fire which would both reduce the current level of competition and provide more nesting areas for tunnelling native bee pollinators.

Notwithstanding the overall decline, Wedgetail note that there is a core of clumps that have survived over all, or for the majority of, the 19 years of monitoring potentially representing a permanent population. In addition, drought breaking rainfall in 2020 may have resulted in the recovery of 14 clumps since the 2019 survey, however, even after exceptional rainfall, the 2021 survey showed a declining population with low flowering. The 2022 results show flowering has increased, again likely due to increased rainfall associated with a persistent La Nina.

The monitoring also indicates that clump flagging had deteriorated to the point where it is difficult to identify clumps. Wedgetail recommend that a certified surveyor is engaged to locate the original clump coordinates for further monitoring to continue.

Reportable Incidents

During the 2022/2023 Annual Review period no reportable incidents occurred.

Further Improvements

Excluding ongoing weed monitoring and control, including targeting of *L. camara* and *T. fluminensis*, there are no proposed improvements to the management of flora in the BCA or TJCA in the next reporting period.

In response to previous recommendations from Kleinfelder, applications were submitted to the NSW Rural Fire Service (RFS) for 'hazard reduction burns' in several areas including the TJCA in order to improve the *Tetratheca juncea* habitat. Hazard reduction burns were undertaken in the northern part of the BCA, but not within the TJCA, by the RFS in October 2020 and September 2021. Wedgetail (2023c) continue to recommend burning of the TJCA at an appropriate time. Renewal of flagging for clumps of *Tetratheca juncea* will be reviewed during the next reporting period as recommended by Wedgetail.

6.6.2 Fauna

Environmental Management

Several species of threatened fauna were identified during the 1998 EIS and supplementary reports, including both the areas proposed for mining and the immediate environs. They include the following.

- Powerful Owl
- Masked Owl
- Barking Owl
- Sooty Owl
- Varied Sittella
- Yellow-bellied Sheathtail Bat
- Eastern Bent-wing Bat
- Eastern Freetail Bat
- Eastern Cave Bat
- Greater Broad-nose Bat
- Little Bent-winged Bat
- Southern Myotis
- Little Lorikeet
- Squirrel Glide
- Eastern False Pipistrelle

To ensure a high level of conservation for the threatened fauna species found on the site, the following measures have been taken.

- The protection of 650ha of bushland around the mine to conserve habitat.
- Ongoing survey and management protocols.
- Routine annual quadrant monitoring.
- Wild dog and fox baiting programs, including a program undertaken by Enright Land Management between October and November in 2022 and 2023 (with required public notification undertaken).
- Placement of nest boxes in the Bushland Conversation Area to replace nesting sites destroyed by clearing.
- Ongoing and progressive rehabilitation of disturbed areas.

The following fauna monitoring activities were undertaken during the 2022/2023 reporting period.

- Terrestrial and arboreal mammal trapping
- Microbat call detection
- Owl call playback
- Spotlighting
- Bird surveys
- Nest box monitoring

These monitoring activities were carried out during summer and winter surveys, as well as during recolonisation surveys of rehabilitated areas at the mine. Wedgetail (2023b) reported that a total of 41 out of the 45 nest boxes were available for fauna use during the reporting period, greater than the previous winter period.

Environmental Performance

The following summary of environmental performance has been extracted and compiled from Wedgetail (2023a) and Wedgetail (2023b). A full copy of these reports, including survey methodology, data and statistical analysis, are presented in **Appendix 4**.

A total of 180 fauna species have been recorded since monitoring began in 2001. The spring/summer 2022 survey detected a total of 75 fauna species consisting of 45 bird, 15 bats, four arboreal mammals, four frog, and two reptile species (Wedgetail 2023a). Of these species six bat and one bird species are listed as Vulnerable under the NSW *Biodiversity Conservation Act 2016*. The 2023 survey detected a total of 57 fauna species consisting of 41 bird, 15 mammal, and one amphibian species (Wedgetail 2023b). Of these species four bat and one bird species are listed as Vulnerable under the NSW *Biodiversity Conservation Act 2016*. The total number of fauna species recorded (57) in winter 2023 has decreased from the 64 species recorded in winter 2022, however, it remains two above the long-term yearly average of 55.

Similarity analysis of faunal assemblages for all years indicates a similarity of 68% with two clusters of years (2007, 2010-2012) showing 80% similarity. Further analysis of assemblage similarity for various faunal groups revealed the following.

- Arboreal Mammals
  - The four arboreal mammals recorded in the 2022 survey is approximately equal to the long-term average of 4.35 species.
  - Species assemblages for all years show a minimum similarity of 65% with four years (2003, 2008, 2016, and 2020) and three groupings (2013/2015, 2010/2017-2019, and 2006/2007/2009/2012/2014) showing 100% similarity.
  - Variation can likely be attributed to sporadic detections of less common or highly mobile species such as the Greater Glider and Squirrel Glider.
- Terrestrial Mammals
  - The five terrestrial mammals recorded in the 2022 survey is slightly above the long-term average of 4.6 species.

  - Species assemblages for all years show a minimum similarity of 60%, with several clusters of years showing similarities ≥80%. The 2022 data was closely related to the 2020 data (90% similarity).
  - One introduced pest species was detected during the 2022 survey; the Black Rat (*Rattus rattus*).

- Bats
  - The 15 bat species recorded in the 2022 survey is comparable to the long-term average of 15.1 species.
  - Species assemblages for all years show a minimum similarity of at least 68%, with three clusters of years showing similarities ≥80%. The 2022 results were 88% similar with 2014, 2016, and 2020. There is no clear pattern in the variation in the species assemblages over time.

- Birds
  - The 45 bird species recorded in the 2022 survey is below the long-term average of 54.9 species. Overall the number of bird species recorded each year has remained relatively constant.
  - The cumulative number of species has increased steadily since the 2001 baseline survey but has flattened suggesting that most species likely to occur at the site have now been recorded, although a few new species are still being recorded.
  - Bird assemblages from the years 2016 and 2019 remained the most dissimilar compared to other years with all other years being at least 74% similar.
  - Further breakdown based on general habitat preferences was undertaken. The analysis indicates that birds with generalist habitat preference remained consistent between 2005 and 2016 and a slow increase occurring over the past 4 years. For specialist species the previous 4 years of data record an increase in interior specialist species and a decrease in edge/open area specialist species. . This analysis will be repeated in 2024 to determine whether the identified trends have continued.
  - It is possible that changes in disturbance from mining have resulted in specialist bird species to move in or out of the area. However, it is also possible that the change is a result of the large-scale clearing that commenced in the neighbouring industrial precinct in 2012 and remains ongoing. The creation of more edge habitat along the eastern edge of the Bushland Conservation Area as a result of the industrial precinct may have made the habitat less suitable for some specialist species or detectability of these species may have been lower. Wedgetail (20203a) notes that observed changes are likely related to a combination of these factors.

Nest box monitoring undertaken by Wedgetail within the BCA shows that fauna utilisation increased over the 12 month period from 66.7% (2022) to 68.3% (2023) with four nest boxes (out of 45) being unavailable due to deterioration. The increase in utilisation is consistent with expected increases in utilisation since the replacement of damaged boxes in winter 2018 and 2021. Previous survey results show that the highest utilisation rate occurs after 5 years from installation.

Reportable Incidents

No reportable fauna related incidents were recorded during the 2022/2023 reporting period.

Further Improvements

Improvements during the next reporting period will include ongoing assessment of the effectiveness of the installed nest boxes and completion of repairs or replacement as necessary. Consideration will also be given to the use of hollow creation to permanently replace nest boxes. General fauna survey within the Bushland Conservation Area will also continue together with statistical analysis of trends. There are no other proposed improvements to the management of fauna in the next reporting period.

6.7 HERITAGE

The following section outlines the commitment made by Donaldson for the protection of cultural and natural heritage of the area. A summary table showing the known Aboriginal cultural heritage sites is attached as **Appendix 2** of this report.

Thirty-one (31) sites of Aboriginal Cultural Heritage were previously identified on property owned by Donaldson. However, none of these sites were impacted by general management activities undertaken during the 2022/2023 Annual Review period.

There are no European heritage sites within the development consent or mining lease areas for the mine.

Archaeological Studies

The mine has been the subject of four archaeological studies since 1998. During each study the principal aims were to:

- consult and involve the Aboriginal Community at every stage of the investigation and to provide continuous opportunities for the Aboriginal Community through the Mindaribba Local Aboriginal Land Council (MLALC) to participate in the interpretation and decision making process;
- identify and record by field survey the material evidence of Aboriginal cultural heritage or locations of potential evidence with the land owned by Donaldson;
- assess the archaeological significance and understand the Aboriginal significance of material evidence of Aboriginal cultural heritage of the study area; and
- assess the impacts of the mine on Aboriginal Cultural Heritage.

No further archaeological studies have been required since the cessation of mining operations.

Management

In accordance with Conditions 84, 85 and 86 of the Development Consent, Donaldson has prepared an Aboriginal Sites Management Plan for the mine. Separate plans were produced for each year of operation at the mine. This provided a better opportunity to address specific issues for each year as well as an opportunity to review and address the management of Aboriginal Sites both inside the mine impact area and within associated bushland areas surrounding the mine.

The following control measures have been employed at the mine in order to ensure that reasonable duty of care is taken to ensure sites of Aboriginal cultural significance are not knowingly disturbed or destroyed.

- An Aboriginal Sites Management Plan was developed and implemented for the mine in consultation with the MLALC and other registered Aboriginal parties, where relevant.
- The MLALC is actively involved in the management of Aboriginal Sites at Donaldson.
- Representatives of the Lands Council were invited on site to monitor clearing and topsoil stripping activities during development and operation of the mine.

Performance

Donaldson and MLALC enjoy a good working relationship and to date there have been no complaints or incidents recorded in relation to the management of sites of Aboriginal cultural heritage.

Reportable Incidents and Further Improvements

No reportable heritage related incidents were recorded during the 2022/2023 reporting period and no further improvements are currently considered necessary.

7. WATER MANAGEMENT

7.1 WATER BUDGET

The mine area is primarily free draining with runoff from rehabilitated areas now returning to local catchments. With the exception of the localised Big Kahuna Dam catchment, all rehabilitated areas to the east of the site access road are now clean water catchments and drain off site. The Big Kahuna Dam continues to be used as an operational water storage for the Abel Underground Mine. Water from the Abel underground, Square Pit and West Pit are pumped to the Big Kahuna for storage.

During the reporting period the Abel underground mine transferred a total of 271.5ML into the Donaldson's Big Kahuna Dam. Runoff from the Abel surface facilities and water stored within the Square Pit and West Pit were also transferred to the Big Kahuna Dam as required. A total of 535ML of water was transferred from the Big Kahuna Dam to the Bloomfield mine site to be stored and used for operational purposes. There was no water discharged from the mine's licenced discharge point into Four Mile Creek.

A total of 0.22ML of potable water was imported to the Donaldson mine for the Abel Underground Mine operations during the reporting period. **Table 7.1** summarises the status of water storage at the beginning and end of the reporting period.

Table 7.1
Water Stored at Donaldson

	Volumes Held (ML)		
	Start of Period	**End of Period**	**Storage Capacity**
Big Kahuna	361.25	368	400
Discharge to Creek	0	0	0
Contaminated Water	N/A	N/A	N/A

This data assumes that water in the West and Square Pits are managed and used by the Abel Underground Coal Mine. Water take is reported as part of the Annual Review for the Abel Underground Coal Mine

7.2 SURFACE WATER

Environmental Management

The Water Management Plan (Donaldson Coal Pty Ltd, 2019) details the measures employed by Donaldson to ensure protection of surface water on and around the mine site. Surface water monitoring has been ongoing since June 2000. A plan showing the location of the water monitoring sites is provided in **Appendix 1**. Routine sampling and analysis is undertaken at six (6) permanent surface water stream monitoring locations, when in flow. Opportunistic samples are also taken from various other locations around the mine area as required (sediment dams and mine water storage dams).

The surface stream water monitoring sites include:

- Four Mile Creek Upstream (FMCU) (EM1);
- Four Mile Creek Downstream (FMCD) (EM2);
- Scotch Dairy Creek Upstream (SDCU) (EM3);
- Scotch Dairy Creek Downstream (SDCD) (EM4);
- Weakleys Flat Creek Downstream (WFCD) (EM5); and
- Weakleys Flat Creek Upstream (WFCU) (EM6).

Samples collected from the six existing stream sites are analysed for Electrical Conductivity (EC), pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and Sulfates (SO_4), on a monthly basis. A full suite analysis is also carried out on a quarterly basis and includes analysis for EC, pH, TDS, TSS, SO_4, Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Chloride (Cl), Fluoride (Fl), Arsenic (As), Aluminium (Al), Barium (Ba), Cadmium (Cd), Cobalt (Co), Copper (Cu), Chromium (Cr), Iron (Fe), Manganese (Mn), Lead (Pb), Zinc (Zn), Total Alkalinity as $CaCO_3$, Turbidity, Nitrates and Phosphates (total).

In addition to the physical and chemical water quality work, biological monitoring (macroinvertebrates) was undertaken between 2000 and 2019 as previously required under the Water Management Plan. The program consisted of:

- a pre-mining baseline survey;
- a construction survey; and
- twice yearly operational surveys.

In accordance with the revised Water Management Plan, biological monitoring ceased following the September 2019 monitoring survey as rehabilitation and rehabilitation establishment is now considered to have been completed at the mine. Results of previous monitoring is presented in the respective Annual Reviews and AEMRs.

In addition to ongoing water quality monitoring, the following control measures are employed at the mine to ensure an appropriate level of protection to surface water on and around the mine site.

- Minimal disturbance and progressive rehabilitation (noting operational activities have now ceased).
- Source separation in order to separate water of differing quality.
- Collection and containment of mine water for dust suppression at the Abel Underground Mine surface facilities and/or transfer to the Bloomfield Colliery for operational use, as required.

In addition to these measures, inspections of drainage channels and structures were undertaken throughout the reporting period. The outcomes of the site investigation by SLR to assess the sediment generating potential of the site and the conveyance channels was also completed with the *Sediment Dam Investigation* report finalised in June 2022. The recommendations of this report are summarised under ‘Further Improvements’.

Environmental Performance

A summary of three key parameters, required by EPL 12856, for the reporting period as well as the pre-mining baseline is included in **Table 7.2**. Monitoring results for pH and EC since the year 2000 are also presented graphically in **Figure 7.1** to assist in identifying trends.

pH

During the reporting period monthly pH values have been variable with a number of pH values recorded below the ANZECC Guideline criteria for freshwater 95% level protection (pH 6.5). The lowest pH of 5.53 was recorded at the SDCU site in February 2023 where water flow was recorded as 'still'. The yearly average pH for SDCU (pH 6.56) was above the ANZECC Guideline but similar to the upper pre-mining level of pH 6.81. Samples collected at SDCD during the reporting period closely mirror the pH trends at the SDCU site (see **Figure 7.1**). The yearly average pH for SDCD (pH 6.47) whilst below the ANZECC Guideline but is greater than the long-term average and remains within the pre-mining range.

As noted during previous reporting periods, lower pH values appear to be correlated to periods of low flow within the creeks and could be the result of acidification from the surrounding soils which naturally have a pH in the order of 4.5 to 4.8 (GSS, 2015). In addition to SDCU and SDCD, WFCU recorded one exceedance (pH 6.30 in April 2023) of the lower limit for pH in the ANZECC Guideline.

The results for all sites during the reporting period were generally consistent with or higher than pre-mining levels and consistently higher than the long-term mean. Notwithstanding, it is noted that there remained little divergence of the pH between the upstream and downstream monitoring locations during the reporting period, continuing the trend identified during the previous reporting period. Previous divergence of pH values at FMCU and FMCD is thought to be the result of leakage from the Stoney Pinch Reservoir (now Black Hill Reservoir) above the FMCD sample point. As repair works have been completed on the reservoir these effects have become less prominent and more readily reflect rainfall conditions that result in overflows from the reservoir.

Electrical Conductivity

During the reporting period, the average electrical conductivity (EC) values at all monitoring locations remained below the long-term averages and remained within relevant ANZECC criteria.

Yearly average EC values were also generally consistent with pre-mining levels except for SDCU which recorded average values slightly higher than those recorded pre-mining. At SDCU, whilst the average EC during the period was slightly greater than pre-mining levels it remained well below the long-term trend.

Monthly values at the remaining sites were generally consistent with pre-mining levels with only minor variations above pre-mining levels.

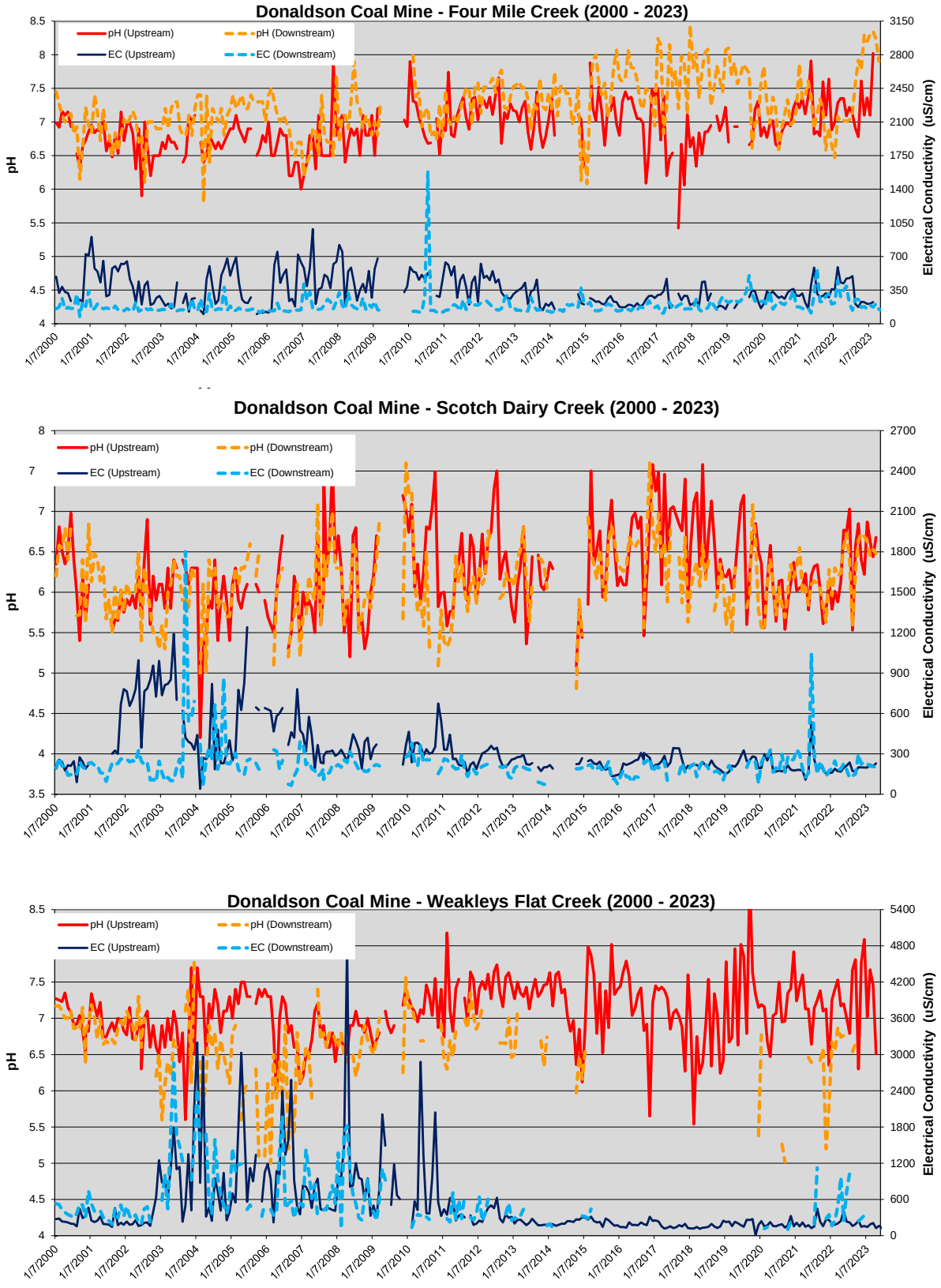


Figure 7.1 Surface Water Monitoring – 2000 to 2023

Table 7.2
Summary of Surface Water Quality Monitoring Results – 2022/2023

Sample Site	Pre-mining	2022		2023										Mean 2022 / 2023	Long-term Mean
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
Rainfall (mm)															
-	-	47.00	18.40	71.00	98.00	111.0	76.00	21.60	8.20	18.20	35.40	15.00	49.40	-	-
pH															
FMCU	6.70 - 7.44	7.09	7.22	7.12	6.91	6.78	**7.61**	7.10	7.36	7.10	**8.02**	Dry	Dry	7.23	6.90
FMCD	6.40 - 7.73	7.03	7.14	7.57	**7.92**	**7.78**	**8.29**	**8.20**	**8.30**	**8.35**	**8.23**	**7.90**	**7.83**	**7.88**	7.25
SDCU	5.90 - 6.81	6.77	6.75	**7.03**	**5.53**	6.57	**6.85**	6.40	6.22	**6.87**	6.62	6.44	6.68	6.56	6.24
SDCD	5.80 - 6.80	6.56	6.73	6.39	**5.58**	6.25	6.64	6.73	6.69	6.63	6.45	6.53	6.48	6.47	6.12
WFCU	6.60 - 7.49	7.20	7.00	6.79	**7.67**	**7.81**	**6.30**	**7.77**	**8.09**	7.02	**7.67**	7.46	**6.51**	7.27	7.09
WFCD	6.40 - 7.28	6.76	Dry	Dry	6.54	6.65	6.61	Dry	Dry	Dry	Dry	Dry	Dry	6.64	6.56
Electrical Conductivity (mS/cm)															
FMCU	*265 – 522*	471.3	474.9	495.5	206.2	172.8	228.7	224.8	207.3	206.6	225.2	Dry	Dry	291.3	354.0
FMCD	*120 - 265*	209.7	139.9	256.2	253.0	170.0	178.9	156.7	193.8	172.5	207.1	148.3	144.0	185.8	192.4
SDCU	*71 - 200*	198.5	**211.7**	**236.2**	172.7	165.0	199.9	199.5	198.1	198.3	**218.4**	**209.6**	**228.6**	**203.0**	**329.6**
SDCD	*145 - 270*	226.6	182.9	121.4	137.0	150.2	**298.1**	223.6	238.5	227.0	208.5	206.6	198.7	201.6	219.9
WFCU	*200 - 310*	218.3	160.3	190.9	251.0	148.2	161.5	143.5	186.8	209.7	125.0	162.8	126.4	173.7	**488.4**
WFCD	*230 - 546*	**1037.0**	Dry	Dry	242.0	287.2	334.1	Dry	Dry	Dry	Dry	Dry	Dry	475.1	**583.8**
Total Suspended Solids (mg/L)															
FMCU	*32 - 180*	8	<5	**209**	16	21	24	17	7	<5	<5	Dry	Dry	43	24
FMCD	*2 - 32*	<5	<5	<5	16	32	<5	<5	<5	<5	<5	<5	15	21	30
SDCU	*9 – 47*	<5	45	47	5	35	14	10	6	9	21	<5	24	22	**129**
SDCD	*12 - 1283*	58	44	186	10	91	173	39	NS	23	86	31	99	76	90
WFCU	*1 – 3*	<5	**10**	<5	<5	<5	**15**	<5	<5	<5	<5	<5	<5	**13**	**24**
WFCD	*3 - 17*	**41**	Dry	Dry	10	**32**	**23**	Dry	Dry	Dry	Dry	Dry	Dry	**27**	**116**

Bold values exceed pre-mining levels. Red values exceed ANZECC Guideline criteria for lowland rivers (pH 6.5 to 8.0, and EC 125µS/cm to 2,200µS/cm). NS = No Sample

FMCU = Four Mile Creek Upstream, FMCD = Four Mile Creek Downstream, SDCU = Scotch Dairy Creek Upstream, SDCD = Scotch Dairy Creek Downstream,
WFCU = Weakly's Flat Creek Upstream, WFCD = Weakly's Flat Creek Downstream.

Since monitoring commenced in July 2000, at the Four Mile Creek and Scotch Dairy Creek sites, with a few exceptions, the EC at the downstream sites has been consistently lower or similar to the upstream sites with no obvious trends evident (see **Figure 7.1**). However, since 2020 the EC at SDCD was regularly slightly higher than that of SDCU (five occasions during 2022/2023). This appears to be a function of reduced EC upstream at SDCU rather than an increase in EC at SDCD which remains within pre-mining levels and below the long-term average.

Previous monitoring results also show that, between 2003 and 2010, both the upstream and downstream EC levels within Weakleys Flat Creek varied to a substantially greater extent than the Four Mile and Scotch Dairy Creek sites. However, since 2011, EC levels in Weakleys Flat Creek Upstream have remained relatively consistent. Samples for the reporting period maintain this trend.

Overall, the available results suggest that the mine has had a negligible impact on the EC of surface waters in the surrounding area.

Total Suspended Solids

During the reporting period, TSS values at monitoring locations were generally low and similar to the respective pre-mining levels and the 2022/2023 mean for the reporting period remained below the long-term mean for all monitoring sites. One exceedance of the TSS objective of 50mg/L was recorded at FMCU and six exceedances of the objective were recorded at SDCD during the reporting period. The highest value recorded was for FMCU during January 2023 (209mg/L) which exceeds the maximum pre-mining value level for this upstream location (180mg/L). High TSS levels are not considered to reflect mine-related impacts as no mining operations or mine-related disturbance or discharge occurred during the reporting period.

Reportable Incidents and Further Improvements

No reportable incidents relating to surface water were recorded during the 2022/2023 reporting period.

In relation to further improvements, the *Sediment Dam Investigation* report finalised by SLR in June 2022 included a range of recommendations relating to: updated water quality criteria for the sediment dams; remediation works for erosion; liaising with TransGrid in relation to erosion in the easement; and confirmation of harvestable rights for retained structures. A program for implementation of these recommendations will be prepared during the next reporting period and status of implementation updated during future Annual Reviews.

7.3 GROUNDWATER

Environmental Management

The Water Management Plan (Donaldson Coal Pty Ltd, 2019) details the measures employed by Donaldson to ensure protection of groundwater on and around the mine site.

Groundwater monitoring has been ongoing since June 2000. There are six (6) current monitoring sites, the locations of which are provided in **Appendix 1**.

The groundwater piezometers are monitored to determine impacts on both Standing Water Levels (SWL) and groundwater quality. A regional site, REG DPZ1, is also included in the monitoring program and is located in Avalon Estate approximately 1.2km north of the mine.

Samples collected from the six bores are analysed for EC, pH, TDS, TSS and Sulfates (SO_4), on a monthly basis. A full suite analysis is also carried out on a quarterly basis and includes analysis for EC, pH, TDS, TSS, Sulfates (SO_4), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Chloride (Cl), Fluoride (Fl), Arsenic (As), Aluminium (Al), Barium (Ba), Cadmium (Cd), Cobalt (Co), Copper (Cu), Chromium (Cr), Iron (Fe), Manganese (Mn), Lead (Pb), Zinc (Zn), Total Alkalinity as $CaCO_3$ and Turbidity.

The standing water level of each of the monitoring bores is measured each month, as metres below ground level.

Environmental Performance

Monthly water monitoring results were routinely reviewed to determine whether there were any changes as a result of activities at the mine.

A summary of the three key parameters required by the EPL (Standing Water Level, pH and EC) for the 2022/2023 reporting period, along with the pre-mining baseline, is included in **Table 7.3**. Monitoring results since commencement of monitoring are also presented graphically in **Figure 7.2**.

Standing Water Levels

REGDPZ-1: Regional control bore located in strata well below the Donaldson Seams. Shows groundwater level trends that generally reflect long-term rainfall patterns, declining gradually from 2000 to 2005 (a period of below average rainfall); rising gradually from 2007 to 2013 (a period of slightly above average rainfall) before plateauing between 2013 and 2016; and declining gradually since 2016, reflecting regional drought conditions. Since 2020 groundwater levels have been gradually rising reflecting high levels of rainfall received throughout 2020 to 2023. It is noted that a tap was installed on the bore resulting in a depth measurement being unable to be taken in April 2023. A sharp increase in groundwater level was recorded in May 2023 and a subsequent drop in June 2023 back to expected levels. This is considered likely due to the installation of the tap with no ongoing impacts upon recorded levels.

DPZ3: Located in the open cut area and screened in coal measures below Donaldson Seam. An unexplained rise in water level was recorded from 2004 to 2010 followed by a decline which was a response to mining from the Donaldson Open Cut. Between 2015 and 2018 the SWL remained relatively stable and slightly higher than pre-mining levels. A slight decrease occurred in 2019 followed by a consistent increase during 2020 to 2023 likely in response to increased rainfall during this period.

DPZ6: Showed drawdown during latter stages of the Donaldson Open Cut and then more pronounced drawdown once development of the Abel Underground South Mains started in April 2008. A partial recovery was subsequently evident during 2013 to 2016, most likely due to recovery within in the completed Donaldson Open Cut. Levels during the reporting period remained generally consistent with the ranges recorded since 2016. Notably a sharp increase in groundwater levels was observed from July 2022 following the substantial rainfall received in that month whilst the April 2023 measurement recorded a sharp, unexplained decrease in water level before returning to levels observed in prior months.

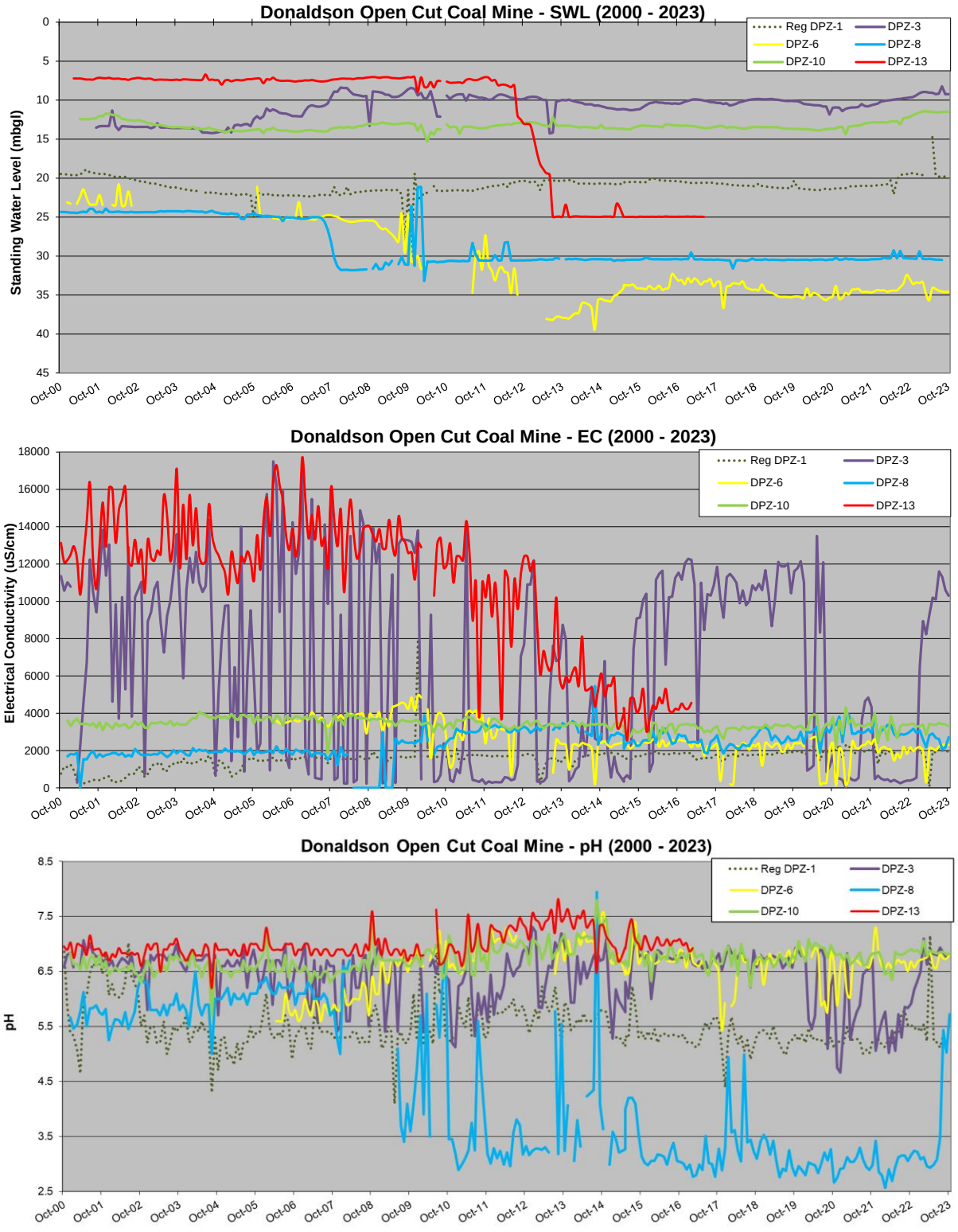


Figure 7.2 Groundwater Monitoring – 2000 to 2023

Table 7.3
Summary of Groundwater Monitoring Results – 2022/2023

Sample Site	Pre-mining	Site Average[1]	2022		2023									
			Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Rainfall (mm)														
-	-	-	*47.00*	*18.40*	*71.00*	*98.00*	*111.0*	*76.00*	*21.60*	*8.20*	*18.20*	*35.40*	*15.00*	*49.40*
Standing Water Level (m below natural ground surface)														
REG DPZ-1	*N/A*	*21.02*	*19.41*	*19.48*	*19.51*	*19.62*	*19.64*	*N/A*	*14.74*	*19.63*	*19.81*	*19.79*	*19.81*	*19.85*
DPZ3	*12.05 - 11.51*	*10.81*	*8.94*	*9.04*	*9.05*	*9.22*	*9.18*	*8.23*	*9.22*	*9.22*	*9.26*	*9.10*	*9.11*	*9.20*
DPZ6	*N/A*	*31.30*	*33.59*	*33.38*	*33.47*	*33.33*	*34.82*	*35.70*	*34.11*	*34.22*	*34.45*	*34.55*	*34.61*	*34.57*
DPZ8	*24.35*	*28.58*	*30.26*	*30.30*	*30.31*	*30.36*	*29.38*	*30.36*	*30.38*	*30.35*	*30.41*	*30.45*	*30.46*	*30.50*
DPZ10	*12.4*	*13.25*	*11.43*	*11.46*	*11.52*	*11.56*	*11.55*	*11.51*	*11.50*	*11.47*	*11.63*	*11.65*	*11.22*	*11.80*
DPZ13	*7.01 - 7.25*	*12.05*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
pH														
REG DPZ-1	*N/A*	*5.48*	*5.45*	*5.49*	*5.40*	*5.54*	*5.23*	*7.16*	*5.22*	*5.21*	*5.12*	*5.34*	*5.23*	*5.18*
DPZ3	*5.99 - 6.96*	*6.46*	*6.17*	*6.33*	*6.50*	*7.10*	*6.63*	*6.85*	*6.82*	*6.80*	*6.93*	*6.84*	*6.76*	*6.82*
DPZ6	*N/A*	*6.57*	*6.57*	*6.67*	*6.71*	*6.73*	*6.76*	*6.84*	*6.59*	*6.57*	*6.81*	*6.74*	*6.73*	*6.80*
DPZ8	*5.46 - 5.66*	*4.33*	*3.24*	*3.22*	*3.09*	*3.12*	*2.96*	*2.93*	*2.99*	*3.09*	*3.48*	*5.43*	*5.03*	*5.72*
DPZ10	*6.48 - 6.97*	*6.74*	*6.87*	*6.89*	*6.83*	*7.06*	*6.79*	*6.88*	*6.85*	*6.83*	*6.85*	*6.86*	*6.81*	*6.83*
DPZ13	*6.67 - 7.22*	*7.00*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Electrical Conductivity (µS/cm)														
REG DPZ-1	*N/A*	*1567*	*1989*	*1899*	*1948*	*1839*	*1578*	*66*	*1949*	*1898*	*2134*	*2000*	*1991*	*1938*
DPZ3	*10200 - 11350*	*6749*	*452*	*551*	*6500*	*8940*	*8230*	*9290*	*10200*	*10100*	*11600*	*11300*	*10600*	*10300*
DPZ6	*N/A*	*2625*	*1960*	*2126*	*2180*	*1969*	*282*	*2110*	*2101*	*2012*	*2217*	*2303*	*2320*	*2302*
DPZ8	*1690 - 1820*	*2487*	*3170*	*2950*	*3080*	*2599*	*2177*	*2830*	*2910*	*2679*	*2610*	*2048*	*2174*	*2717*
DPZ10	*3670*	*3423*	*3440*	*3280*	*3310*	*3400*	*2840*	*3440*	*3390*	*3370*	*3480*	*3430*	*3400*	*3310*
DPZ13	*12200 - 13750*	*10939*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*

1. Since monitoring commenced at that site. N/A = Not Accessible

DPZ8: Screened in Donaldson and Big Ben Seams. Responded to mining in the Donaldson Open Cut in 2007 and then slight post-mining recovery. The water level has remained steady since 2014.

DPZ10: Screened in the Beresfield Seam and shows modest open cut mining effect from 2001 to 2006, then modest recovery, and more recent response to Abel Underground mining from 2011. The SWL has remained relatively stable since 2011, with a steadying of groundwater level shown over the reporting period following a slight increase during the 2021/2022 period, likely in response to more stable rainfall compared to the previous reporting period.

DPZ13: Screened in Donaldson Seam overburden, and showed no response to open cut mining, but clear response to Abel Underground mining from early 2012. Groundwater level has remained consistent since 2013. Access has not been available to DPZ13 since April 2017 due to ongoing restricted access to the landholding. As a result, DPZ13 will no longer form part of the monitoring network.

Groundwater Quality

Salinity (EC and TDS) varies over a wide range from bore to bore, but within bores Reg DPZ1, DPZ6, DPZ8, and DPZ10, salinity generally is quite stable over time. However, some of the monitored bores have reported occasional outliers of significantly lower salinity and corresponding reduction in pH which are likely due to ingress of rainwater temporarily lowering the salinity in the bore. This occurred during the reporting period at DPZ6 and, to a lesser extent, at DPZ8 and DPZ10, during March 2023 following significant rainfall in February and March 2023.

Salinity levels within DPZ3 remained variable with large fluctuations as previously recorded. During the reporting period EC levels rapidly increased from January 2023 following 14 months of generally low salinity. Upper EC levels at DPZ3 remained within previously recorded levels.

A downward trend in EC is observed at bores DPZ6 and DPZ13, starting in 2010 or 2011, which could be due to enhanced recharge following drawdowns in the coal measures as a result of open cut mining. The downward trend has levelled out from the start of 2015.

Conversely, a rise in EC was observed at DPZ8, starting in 2008 or 2009, which is almost certainly related to open cut mining. However, the EC in DPZ8 has not continued rising, having stabilised at about 500µS/cm to 1 000µS/cm higher than pre-2008.

Apart from the EC rise in DPZ8 in 2008, the monitoring has not indicated any rising trend in salinity in any bore, apart from the regional control bore REGDPZ1, which experienced a rise between 2000 and 2007, unrelated to any mining activity, and is thought to be a result of increased urbanisation.

Likewise, although there are some pH variations from bore to bore, the monitoring has generally reported relatively consistent pH values at individual bores since 2016. In the past, both DPZ3 and DPZ8 show changes in pH that are likely related to mining or associated activities.

The pH values reported from DPZ3 were generally in the range 6.5 to 7.0 until around 2006, when the pH started to be more erratic, and more frequent lower pH values than previously, possibly indicating slightly more acidic conditions. Since around May 2006, pH values at DPZ3

have been generally in the range 5.2 to 7.2. During the 2022/2023 reporting period, pH levels within DPZ3 ranged between 6.17 and 7.10.

The pH values reported from DPZ8 were generally in the range 5.0 to 6.5 until late 2007, when the pH started to be more erratic, and generally much lower than previously, indicating more acidic conditions. Water levels in DPZ8 dropped sharply in September 2007, at the same time that EC noticeably increased and pH started to be erratic and eventually fell to a much lower level. Since February 2009, pH values at DPZ8 have been generally in the range 3.0 to 4.0 albeit with a number of higher outlier values, but significantly lower than the pre-mining levels. This is most likely due to the open cut exposing sulphides or other acid-forming minerals present in the coal seams or interburden strata to oxidation, leading to the reduction in pH at the time that mining reached the vicinity of this bore. This is an expected outcome given the nature of the geology, of which some strata are known to be net acid producing, and the predicted drawdown resulting from mining operations. During the reporting period DPZ8 recorded a significant increase in pH from ~pH 3 to above pH 5 during the August, September, and October 2023 monitoring rounds. This is consistent with previous rapid increases. The duration of the increase will continue to be monitored during the next reporting period.

Reportable Incidents and Further Improvements

No reportable groundwater incidents were recorded during the 2022/2023 reporting period and no future improvements to groundwater management are currently planned.

8. REHABILITATION

8.1 REHABILITATION PERFORMANCE DURING THE REPORTING PERIOD

Assorted infrastructure was removed from site as part of the final rehabilitation activities during the 2013/14 reporting period. This included the removal of fuel storage tanks, traffic control boom gates and a number of bitumen and dirt roads. No additional infrastructure was removed during the current reporting period. As at the end of the reporting, the mine-related infrastructure remaining within ML 1461 included the following.

- Administration office.
- Workshop.
- Core shed.
- Selected access roads.

These infrastructures are not proposed to be removed during the near term until their potential utilisation for future land uses is determined (discussed below).

Rehabilitation works previously completed, as outlined in the *Mine Closure Plan for Donaldson Open Cut*, include the following.

- Excavation of waste rock and contaminated material to the West Pit.
- Reshaping of the land surface to as near as possible to natural topography.
- Spreading of topsoil on reshaped surfaces.
- Spreading of a seed mix of local tree and shrub species, as well as fast growing, sterile groundcovers which grow rapidly to provide erosion control, of the remaining 27.7ha of rehabilitated area.

The post rehabilitation land uses for Donaldson include conservation area, open spaces and light industrial area. The rehabilitated open cut area is completely vegetated with native shrubs and trees. These areas will be conserved and managed similar to the adjacent Bushland Conservation Area. Subject to future approval, the areas around the former open cut maintenance workshop and administration building may be used as a light industrial area.

The West Pit and Square Pit have been made safe and left for use by the Abel Underground Mine which will be responsible for ongoing management. No specific management was required during the reporting period.

In October 2023 a section of Donaldson rehabilitation area was transferred to Snowy Hydro Limited for the Kurri Kurri Lateral Gas Pipeline. The Rehabilitation Management Plan including the Final Landform and Rehabilitation Plan and corresponding spatial domain and area calculations were updated to reflect the removal of this area from the Donaldson rehabilitation area.

No further areas remain to be rehabilitated as part of the Donaldson Coal Mine operation and no additional rehabilitation works were undertaken during the 2022/2023 reporting period. **Figure 8.1** shows the final landform and current revegetation status. A summary of the total area of rehabilitation is provided in **Table 8.1.**

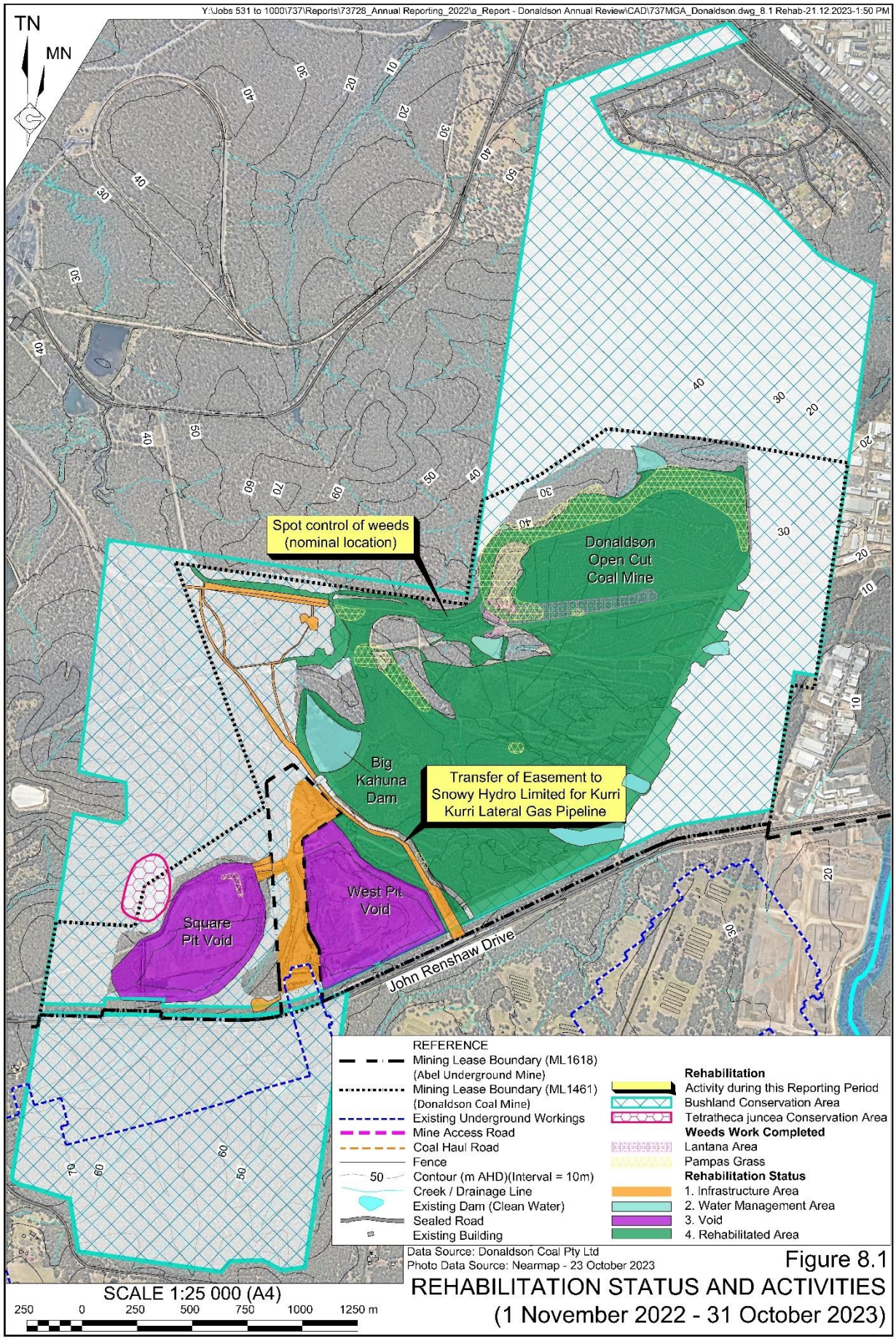

Y:\Jobs 531 to 1000\737\Reports\73728_Annual Reporting_2022\a_Report - Donaldson Annual Review\CAD\737MGA_Donaldson.dwg_8.1 Rehab-21.12.2023-1:50 PM
TN
MN
Spot control of weeds (nominal location)
Donaldson Open Cut Coal Mine
Big Kahuna Dam
Transfer of Easement to Snowy Hydro Limited for Kurri Kurri Lateral Gas Pipeline
West Pit Void
Square Pit Void
John Renshaw Drive
REFERENCE
Mining Lease Boundary (ML1618) (Abel Underground Mine)
Mining Lease Boundary (ML1461) (Donaldson Coal Mine)
Existing Underground Workings
Mine Access Road
Coal Haul Road
Fence
50 Contour (m AHD)(Interval = 10m)
Creek / Drainage Line
Existing Dam (Clean Water)
Sealed Road
Existing Building
Rehabilitation
Activity during this Reporting Period
Bushland Conservation Area
Tetratheca juncea Conservation Area
Weeds Work Completed
Lantana Area
Pampas Grass
Rehabilitation Status
1. Infrastructure Area
2. Water Management Area
3. Void
4. Rehabilitated Area
Data Source: Donaldson Coal Pty Ltd
Photo Data Source: Nearmap - 23 October 2023
SCALE 1:25 000 (A4)
250 0 250 500 750 1000 1250 m
Figure 8.1
REHABILITATION STATUS AND ACTIVITIES
(1 November 2022 - 31 October 2023)

Table 8.1
Rehabilitation Summary (Cumulative)

Mine Area Type	Previous Reporting Period (Actual) Year 19 (ha)	This Reporting Period (Actual) Year 20 (ha)	Next Reporting Period (Forecast) Year 21 (ha)
Total mine footprint	308	305.4[2]	305.4[2]
Total active disturbance	78[1]	78[1]	78[1]
Land being prepared for rehabilitation	0	0	0
Land under active rehabilitation	230	227.4[2]	227.4[2]
Completed rehabilitation	0	0	0

Notes: 1. Includes 60ha for the Square Pit and West Pit and 18ha for other retained infrastructure. These areas are used to support the operation of the Abel Underground Mine.
2. Represents a reduction of 2.6ha associated with the transfer of responsibility for the Kurri Kurri Gas Pipeline easement to Snowy Hydro Limited.

As noted in **Table 8.1**, the 'active disturbance' area for the Donaldson Coal Mine includes the Square Pit (27ha) and West Pit (33ha). The areas encompassing these pits will be subject to closure and rehabilitation in accordance with the respective Rehabilitation Management Plans and *Abel Underground Mine and Donaldson Open Cut Mine – Closure Strategy for the West and Square Pits* with final closure scenarios to be confirmed depending on the closure or resumption of mining operations at the Abel Underground Mine (currently under care and maintenance). The rehabilitation security for these areas will continue to be held against Mining Lease 1461.

8.2 REHABILITATION MONITORING

Assessment of rehabilitation performance (fauna and habitat) was conducted by Wedgetail (2023d and 2023e) in December 2022 (see **Appendix 6**). Rehabilitation performance (flora) monitoring is scheduled on a 2-yearly basis and was undertaken in October and November 2022 by Wedgetail after being delayed in 2021 due to restrictions from the Covid-19 pandemic.

The fauna and habitat monitoring undertaken annually aims to determine the effectiveness of the rehabilitation program in re-establishing pre-mining / natural biodiversity levels and to determine the habitat requirements of recolonising fauna. Surveys are undertaken within a total of four monitoring plots, including one control plot, and four nesting box plots. Monitoring commenced in 2008. The flora monitoring undertaken by Wedgetail is undertaken 2-yearly and includes one control plot in the remnant bushland (Plot 1) and nine monitoring plots in the rehabilitated areas of the mine (Plots 2 to 10). The plots have been established for between 8 and 19 years.

The results of these assessments are compared with the completion criteria adopted by Donaldson. These criteria cover soil quality, vegetation, growth rates, species diversity and stem densities. A summary of the results of the December 2022 fauna and habitat monitoring and October/November 2022 flora and soil monitoring compared to the previous completion criteria is provided in **Table 8.2**.

It is noted that new Rehabilitation Objectives and Completion Criteria were proposed during the reporting period as part of the preparation of the Rehabilitation Management Plan. The Rehabilitation Objectives for the Mine were approved in August 2023 and updated Completion Criteria for the Rehabilitation Objectives were prepared. In the next reporting period it is proposed that all monitoring is undertaken with consideration to the proposed completion criteria prepared as part of the Rehabilitation Management Plan to ensure rehabilitation is progressing as soon as reasonably practicable.

Table 8.2
Status of Monitoring Against Completion Criteria

Feature	Completion Criteria	Current Status
General	Stable landform	All monitoring plots were observed to be 'stable' with no signs of active erosion recorded during the 2022 monitoring.
	Effective drainage	The rehabilitated areas are effectively draining with no evidence of pooling water.
	Resilience to drought episodes in rehabilitated area.	No signs of drought stress was documented by Wedgetail (2023e) during the 2022 monitoring.
Flora	Re-establishment of a dense and diverse mixture of local native understory and overstorey vegetation species, specifically four (4) overstorey and four (4) understorey species in each monitoring plot.	Plot 1 (control) = 23 understorey and 8 overstorey species. Plots 2 to 10 = 12 to 20 understorey and 6 to 15 overstorey species.
	Limited presence of weeds	Increasing evidence of weeds (*Lantana camara, Cortaderia selloana, Senecio madagascariensis* and annual weeds) noted in Plots 2, 5, 7, 8, 9 and 10. Plot 2 was overrun by Lantana and could not be surveyed in the 2022 monitoring.
	Tree/shrub densities of 3 000 stems/ha after 5 years and 1 000 stems/ha after 15 years.	Plot 1 (control) = 3,100. Plots 2 to 10 range from 2,650 to 14,650. Therefore stem density meets the completion criteria.
	Evidence of natural regeneration in at least four species.	Natural recruitment was observed in all plots with seedlings and saplings apparent and indicating more than one round of germination. Flowers and fruit were also observed and an increase in species indicates colonisation by natural seed vectors (e.g. wind and fauna).
Fauna	Reinvasion of rehabilitated area by native fauna.	In 2022 a total of 47 fauna species were recorded, above the yearly average of 39.2. Statistical analysis of the similarity of fauna diversity between the analogue site (Q1) and rehabilitation monitoring sites (Q2 to Q4) show that in 2011 the rehabilitation quadrats were 20% similar to the analogue site, increasing to >40% in 2015. In 2022 Quadrats Q1 and Q2 have a similarity of 60% whilst quadrats Q3 and Q4 have a 40% similarity with quadrats Q1 and Q2. These results show that the rehabilitation areas are trending towards the remnant forest analogue site conditions, with some year-to-year variation.
Soil Loss	Minimal erosion and soil movement, specifically soil loss from less than 40t/ha/year	Soil loss per annum for Plots 2 to 10 was 13, 43, 50, and 150 tonnes/ha. However, Plots 1, 6, 7, and 10 all recorded net soil gain (between 23 and 50 tonnes/ha) rather than loss in 2022. The average soil loss/gain over the eight plots is a gain of 31 tonnes of soil per hectare since 2019. Therefore Wedgetail conclude that this parameter can be considered to have been met.
Soil Quality	Soil pH to be no lower than 10% of analogue plot pH after 5 years.	Plot 1 (analogue) – pH 4.54 Plots 2 to 10 – pH 4.33 to 5.03 Therefore the pH for all plots meet the completion criteria.
	Conductivity of replaced soil to be below 900uS/cm after 5 years	EC for all plots ranged from 27.1 to 77.1µS/cm and therefore meets the completion criteria.
	Surface layer to be free of any hazardous material to a depth of at least 1m.	There has been no evidence of hazardous material following deep ripping (recorded in 2019).
	Runoff water conductivity to be less than 1 000µS/cm after 5 years.	Internal monitoring of the retained on-site sediment dams confirms ECs generally ranging between 211µS/cm and 893µS/cm.
	Soil nitrogen and phosphorous levels to be within 20% of levels in analogue site after 5 years.	All plots had nitrogen levels similar to or above the analogue plot value and met the completion criteria. The phosphorous levels within all rehabilitation plots remained lower than 20% of the analogue site, except for Plot 2. Phosphorous levels at both the analogue and rehabilitation plots decreased to levels previously recorded in 2015 (following a spike in 2017 – potentially due to sampling technique).

Table 8.2 (Cont'd
Status of Monitoring Against Completion Criteria

Feature	Completion Criteria	Current Status
Pollution	Soil should not be a source of pollutants. Quality of water leaving the site to be in accordance with EPL requirements.	No non-compliance with EPL surface water quality requirements have been recorded with no discharges required. Internal due diligence monitoring within the on-site sediment dams confirms that all measured ECs and the majority of total suspended solid results during the reporting period would be compliant with discharge criteria. The pH of the dams are slightly acidic but generally consistent with surrounding watercourses.
Source: Wedgetail (2023d and 2023e), Donaldson Coal.		

To date, the monitoring has found that several of the rehabilitated areas have already met the completion criteria and that all rehabilitated areas assessed are on track to meet the previously required completion criteria.

In addition to the standard monitoring, a walkover survey was undertaken over the northern-most rehabilitation area to determine if this area is suitable for seeking relinquishment. The key issue preventing this area from relinquishment is the presence of a large area of Lantana and scattered areas of Lantana and Pampass Grass. Areas without high weed density were considered to be 'successful revegetation' with good diversity of canopy species, the presence of species from multiple strata, evidence of natural recruitment, and excellent litter and vegetation coverage of the soil surface preventing erosion. This indicates that the revegetation is demonstrably on trajectory for successful rehabilitation.

8.3 ACTIONS FOR THE NEXT REPORTING PERIOD

8.3.1 Rehabilitation

The primary activity planned to occur in the next reporting period is monitoring as outlined in the Flora and Fauna Management Plan and Rehabilitation Management Plan for the mine together with ongoing weed control, in particular for Lantana and Pampas Grass. Additional mine closure planning, including commencement of a rehabilitation materials balance report, will be undertaken.

8.3.2 Monitoring

Rehabilitation monitoring required to be undertaken at the mine under the development consent and other regulatory documents will continue to be carried out in the 2023/2024 reporting period.

In the next reporting period it is proposed that all monitoring is undertaken with consideration to the proposed completion criteria prepared as part of the Rehabilitation Management Plan to ensure rehabilitation is progressing as soon as reasonably practicable.

9. COMMUNITY

No complaints, matters of concern, or environmental queries were raised with Donaldson during the 2022/2023 reporting period.

In accordance with the conditions of the mine's development consent, Donaldson established a community consultative committee for the mine. The last committee meeting was held on 7 August 2013. No meetings were held during the reporting period and further meetings are currently deemed unnecessary.

No other specific community engagement activities relating to the mine were undertaken during the reporting period.

Given that coal mining activities ceased in April 2013 and rehabilitation was completed by March 2014, there has been negligible social impact to the community throughout the reporting period. As a result, during the reporting period Donaldson did not:

- provide community donations;
- need to conduct mitigation works to address any community impacts; or
- undertake any mine-related property acquisitions.

However, continued community benefits have occurred as a result of the utilisation of locally based employees for completion of maintenance activities within the rehabilitated areas. Additionally, contractors who are engaged to conduct routine and non-routine land management works are also sourced locally.

10. INDEPENDENT AUDIT

The last and final independent environmental audit of the mine was undertaken in March 2015 following the completion of mining in 2013 and rehabilitation in 2014. The audit found a high degree of compliance and identified the conditions of the development consent which were considered to remain active following the completion of mining. These remaining conditions have been treated as 'recommendations' and the status of these conditions is outlined within the 2014/2015 AEMR and further updated in **Table 10.1**.

Table 10.1
2015 Independent Audit Recommendations and Status Update

Page 1 of 2

Cond No.	Development Consent Condition	Comment	Update
63(xiv)	**Biological Monitoring** The Applicant shall prepare and implement a detailed monitoring program for groundwater and surface water (xiv) monitoring of macro-invertebrates and vegetation in accordance with protocols developed for the Hunter SIGNAL biological assessment criteria, with an assessment of inflows to the wetlands.	The biological monitoring will continue in accordance with Development Consent condition 63(xiv) "for a period of at least five years after the completion of mining, or other such period as determined by the Director- General."	Monitoring has been undertaken for period of at least 5 years from completion of mining (i.e. until April 2018). Annual monitoring ceased at the end of the 2019 reporting period in accordance with the approved updated Water Management Plan. **Status: Complete**
69	**Tetratheca juncea Management Plan** The Plan shall be consistent with the Flora and Fauna Management Plan and include measures for fire management.	The ongoing control measures employed at the Donaldson Coal Mine site ensure a high level of conservation for the *Tetratheca juncea*.	The *Tetratheca juncea* area is contained within the Bushland Conservation Area (BCA). Refer to comment below.
72(ii) & (iii)	**Bushland Conservation Area Management** (ii) retain management and ownership of the land for a minimum of 36 years from the commencement of construction, unless other arrangements are agreed in accordance with Condition 73; and (iii) prepare and implement a Management Plan for that area in consultation with OEH and to the satisfaction of the Director-General, during the period in which the Applicant is responsible for management.	Donaldson Coal Pty Ltd will retain management and ownership of the land for a minimum of 36 years from the commencement of construction, unless other arrangements are agreed in accordance with Development Consent condition 73.	The BCA is currently being managed in accordance with the BCA Management Plan and will be maintained for the period as per Condition 73 (i.e. until January 2037 or as agreed).

Table 10.1 (Cont'd)
2015 Independent Audit Recommendations and Status Update

Cond No.	Development Consent Condition	Comment	Update
78	**Rehabilitation** The Flora and Fauna Management Plan shall also include a Rehabilitation Plan that details the measures to be undertaken to progressively rehabilitate disturbed areas of the mine to replicate the original vegetation cover that existed before mining occurred. The Applicant shall be responsible for the management and monitoring of the rehabilitated mine site until such time as the Director-General agrees that restoration has been successful.	The Rehabilitation Plan is included in the Mining Operations Plans (MOP) and amendments for the Donaldson Coal Mine. The current MOP is for May 2014 to May 2021. Recommendation: As the reporting on the Mining Operations Plan is required under the Mining Lease, the rehabilitation progress and monitoring will be reported to the DRE and it is recommended that approval be sought from DPE to submit this MOP report to DPE to satisfy this condition.	Currently the Annual Reviews are provided to both Resources Regulator and the DPE compliance team and will continue to be provided.
114	**ANNUAL ENVIRONMENTAL MANAGEMENT REPORT** The Applicant shall prepare and submit an Annual Environmental Management Report (AEMR) throughout the life of the mine to the satisfaction of the Director-General. The AEMR shall review the performance of the mine against the Environmental Management Strategy and the Conditions of this Consent, and other licences and approvals relating to the mine.	The preparation of the Annual Environmental Management Report for the Donaldson Coal Mine will be required unless an exemption is obtained from the Director-General/Secretary of DPE. *Recommendation:* It should be considered that reporting on the rehabilitation progress, the biological monitoring and bushland conservation area could be achieved by submitting the expert consultant reports and placing the reports on the Donaldson Coal website.	Donaldson is continuing to prepare the full Annual Review, however, this recommendation will be further considered in future reporting periods.

Email correspondence from the (then) Department of Planning dated 31 October 2018 confirms that, given the completion of mining in 2013 and the previous independent audit in 2015, no further independent audits are required unless otherwise directed by the Secretary (see **Appendix 7**).

11. INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

During the reporting period there were no:

- non-compliances;
- reportable incidents or exceedances; or
- official cautions, warning letters, penalty notices or prosecution proceedings.

12. ACTIVITIES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

Activities planned to be completed during the next reporting period are outlined in Sections 4.3 and 8.3 and planned improvements in environmental management practices are outlined in Sections 6 and 7. In summary, the key activities planned for the next reporting period are as follows.

- Continued environmental monitoring.
- Continued weed control within the BCA and rehabilitation areas.
- Preparation of a program to implement measures recommended in the *Sediment Dam Investigations* report by SLR and potential commencement of works.
- Commencement of the rehabilitation materials balance report.

Appendices

Appendix 1	Site Locality Plan and Monitoring Locations
Appendix 2	Description and Location of Known Aboriginal Sites
Appendix 3	Compliance Review
Appendix 4	2022 Annual Flora and Fauna Monitoring and 2023 Annual Winter Monitoring prepared by Wedgetail Project Consulting
Appendix 5	Annual Survey of the *Tetratheca Juncea* Conservation Area 2022 prepared by Wedgetail Project Consulting
Appendix 6	2022 Rehabilitation Monitoring and 2022 Rehabilitation Monitoring Report prepared by Wedgetail Project Consulting
Appendix 7	Approval to Cease Independent Environmental Audits

Appendix 1

Site Locality Plan and Monitoring Locations

(Total No. of pages including blank pages = 6)

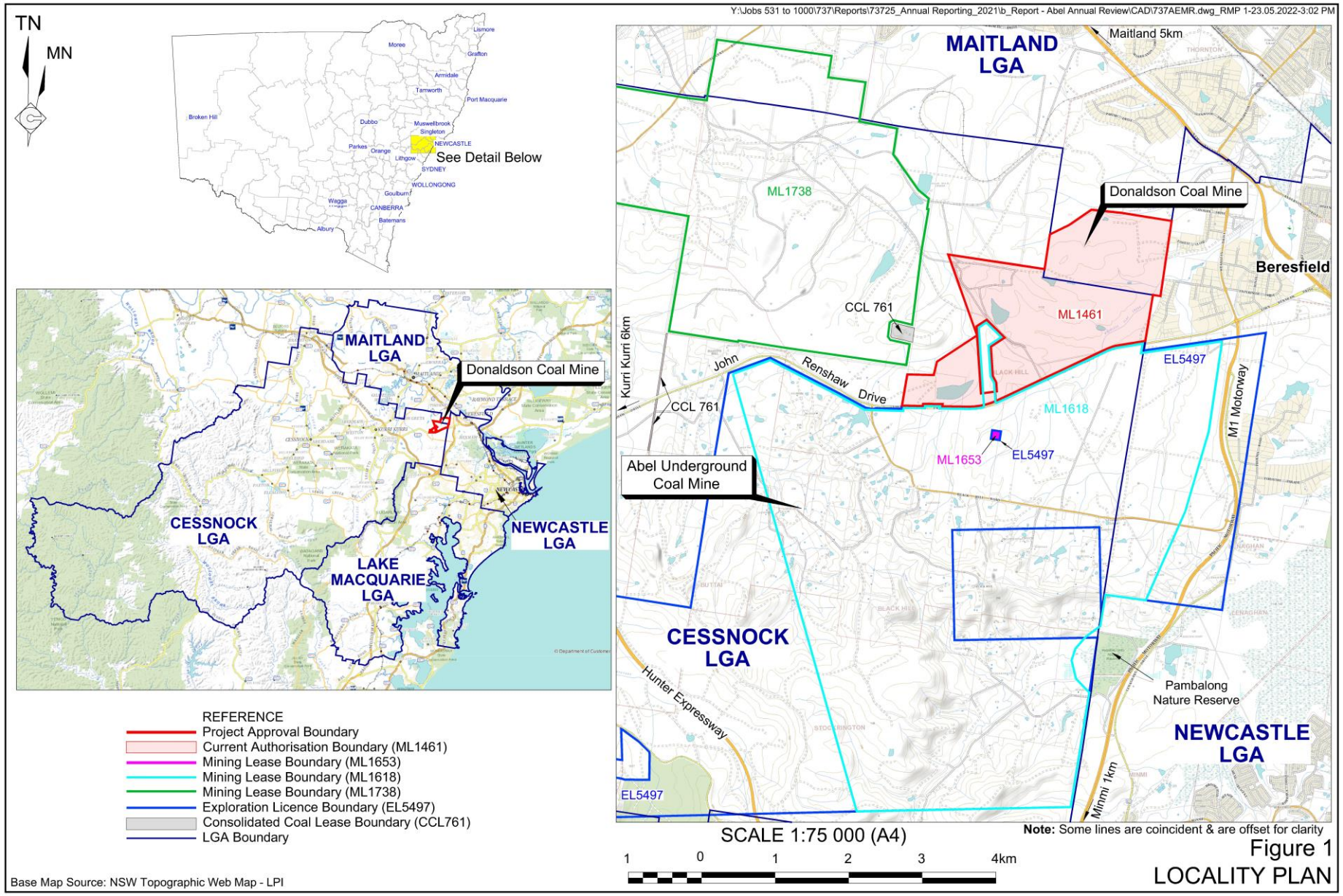
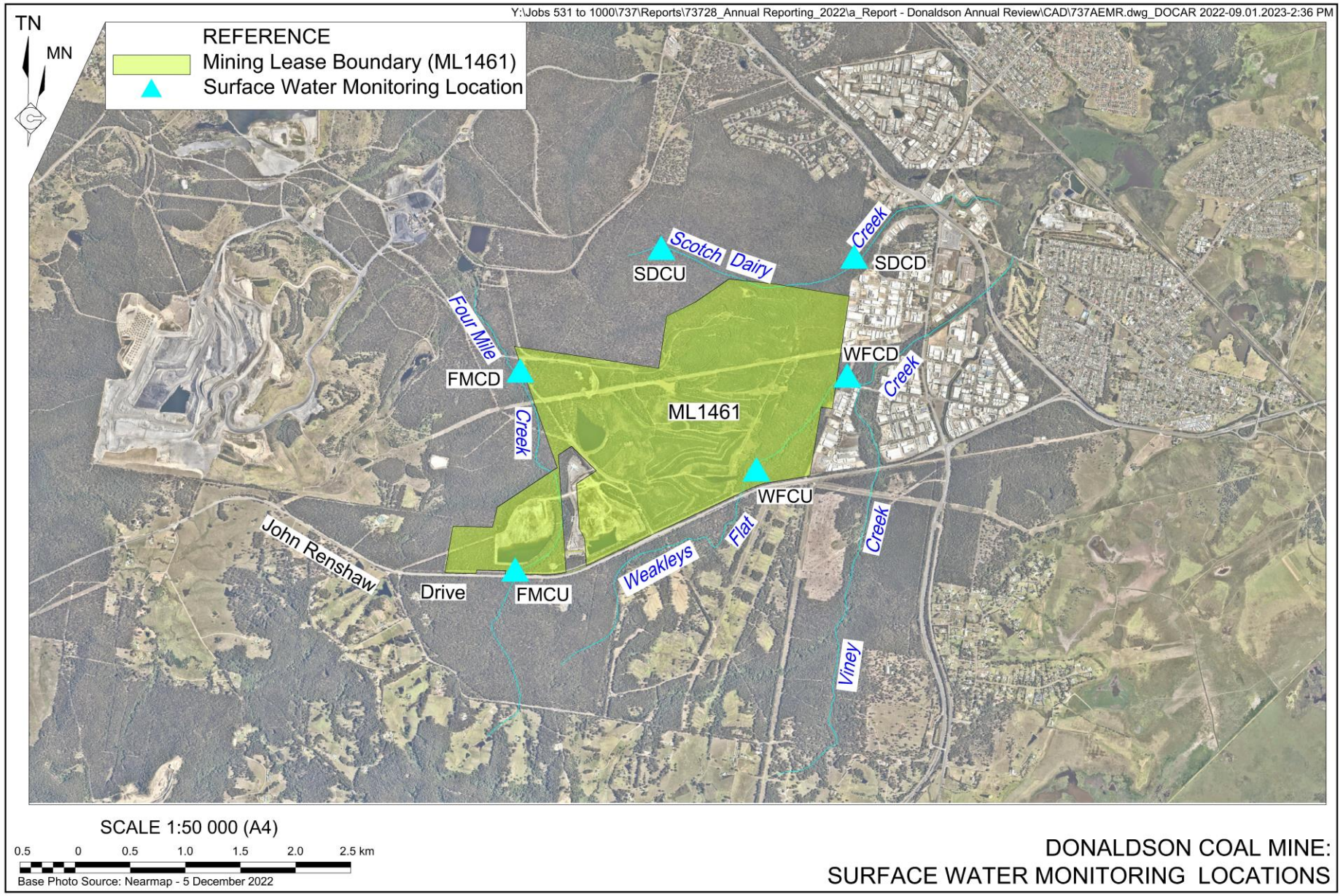


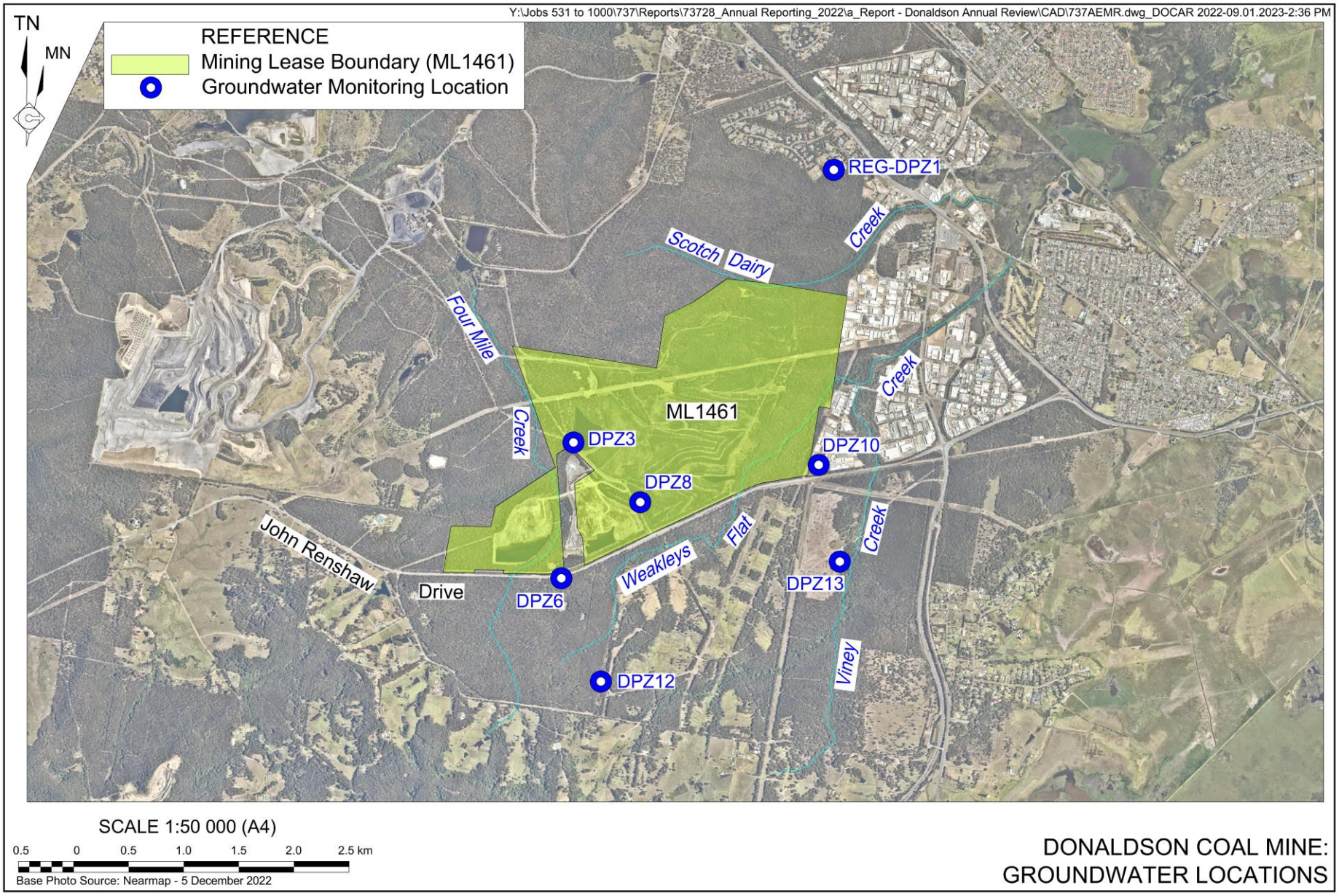
Figure 1
LOCALITY PLAN

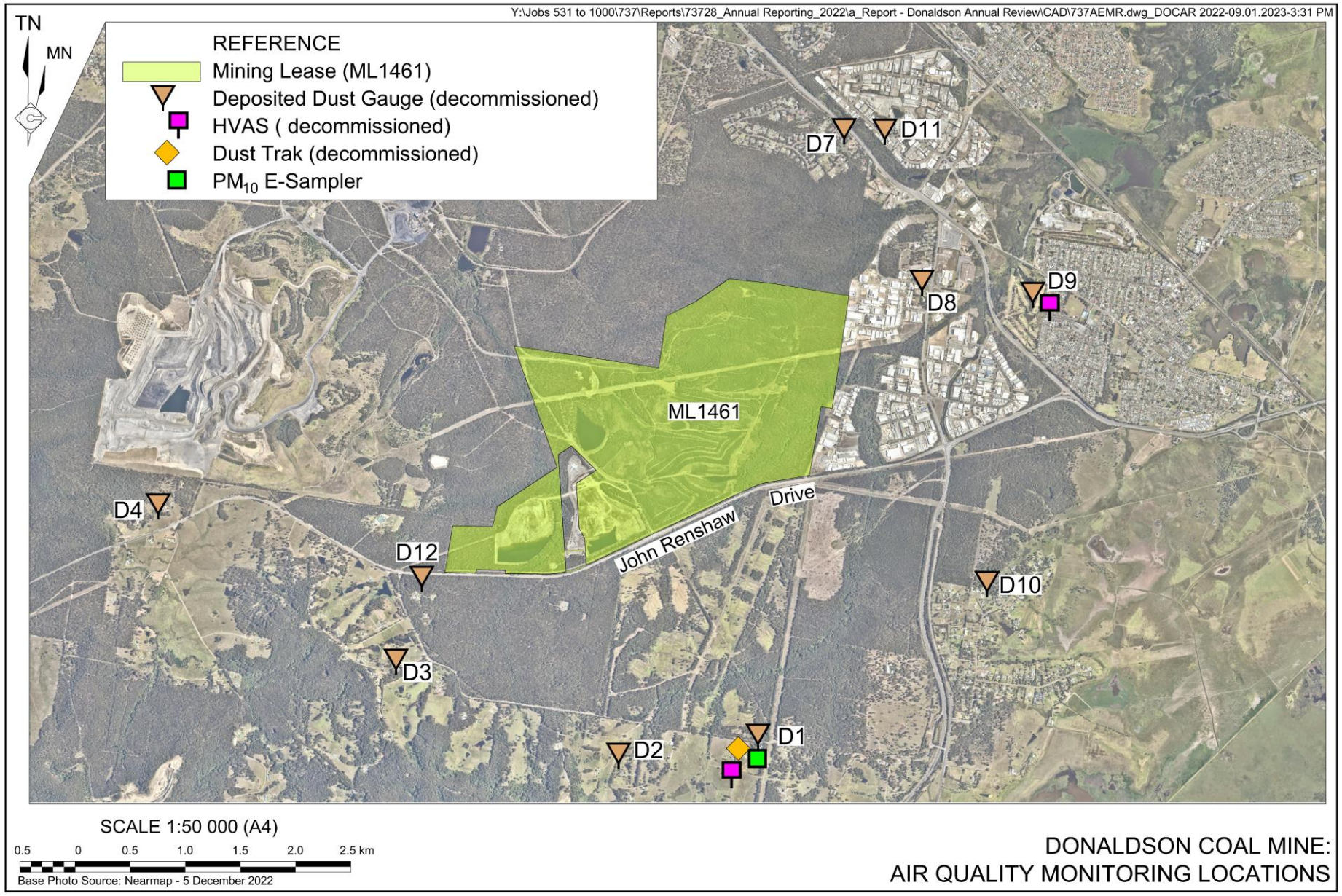
DONALDSONCOAL
Part of the Yancoal Australia Group


Y:\Jobs 531 to 1000\737\Reports\73725_Annual Reporting_2021\a_Report - Donaldson Annual Review\CAD\737AEMR.dwg_DOCAR 2021-11.01.2022-2:42 PM
TN
MN
ML1461
John Renshaw
Drive
SCALE 1:35 000 (A4)
500 0 500 1000 1500m
Base Photo Source: Nearmap - 15 December 2021
DONALDSON COAL MINE:
REGIONAL CONTEXT



DONALDSONCOAL
Part of the Yancoal Australia Group


Y:\Jobs 531 to 1000\737\Reports\73728_Annual Reporting_2022\a_Report - Donaldson Annual Review\CAD\737AEMR.dwg_DOCAR 2022-09.01.2023-2:36 PM
TN
MN
REFERENCE
Mining Lease Boundary (ML1461)
Groundwater Monitoring Location
REG-DPZ1
Scotch Dairy Creek
Four Mile Creek
ML1461
DPZ3
DPZ10
DPZ8
John Renshaw Drive
DPZ6
Weakleys Flat Creek
DPZ13
Viney Creek
DPZ12
SCALE 1:50 000 (A4)
0.5 0 0.5 1.0 1.5 2.0 2.5 km
Base Photo Source: Nearmap - 5 December 2022
DONALDSON COAL MINE:
GROUNDWATER LOCATIONS



DONALDSONCOAL
Part of the Yancoal Australia Group

Appendix 2

Description and Location of Known Aboriginal Sites

(Total No. of pages including blank pages = 3)

Site Name	Recorder	Location	Description	Comments
Bushland Conversation Area				
FMC3	Effenberger (1997)	368300E 6368900N Bank of Four Mile Creek	Artefact scatter (5 artefacts), one axe grinding groove	
FMC4	Effenberger (1997)	368250E 6368650N Lower slope above Four Mile Creek	Artefact scatter (2 artefacts)	
FMC5	Effenberger (1997)	368500E 6368700N Lower slope above Four Mile Creek	Artefact scatter (2 artefacts)	
FMC6	Effenberger (1997)	368400E 6366100N Upper slope above Four Mile Creek	Artefact scatter (4 artefacts)	
FMC7	Effenberger (1997)	367600E 6366500N Crest between Four Mile Creek and a major tributary	Artefact scatter (3 artefacts)	
FMC8	Effenberger (1997)	367600E 6366850N Upper slope above tributary of Four Mile Creek	Scarred tree	
WFC1	Effenberger (1997)	371200E 6369200N Lower slope above Weakleys Flat Creek	Artefact scatter (3 artefacts)	
ISF3	Umwelt (1998)	368750E 6367650N Lower slope above Four Mile Creek	Isolated find	
ISF4	Umwelt (2001)	370550E 6368625N Mid slope above Weakleys Flat Creek	Isolated find	
Four Mile Creek 1 (38-4-139)	Brayshaw (1985)	368130E 6367020N Bank of Four Mile Creek	Artefact scatter (19 artefacts)	
Four Mile Creek 2 (38-4-140)	Brayshaw (1985)	367820E 6366880N Terrace of Four Mile Creek	Artefact scatter (10 artefacts)	
CA1	Umwelt (2001)	370658E 6368051N Mid slope, south of Weakleys Flat Creek	Isolated find	
CA2	Umwelt (2001)	371132E 6369039N Lower slope, north west of Weakleys Flat Creek	Artefact scatter (2 artefacts)	
CA3	Umwelt (2001)	370985E 6370511N Lower slope above a tributary of Scotch Dairy Creek	Isolated find	
CA4	Umwelt (2001)	369568E 6370040N Mid slope above Scotch Dairy Creek	Isolated find	
CA5	Umwelt (2001)	368391E 6366747N Mid slope, east of Four Mile Creek	Isolated find	
CA6	Umwelt (2001)	368229E 6366592N Lower slope above a tributary of Four Mile Creek	Isolated find	

Site Name	Recorder	Location	Description	Comments
CA7	Umwelt (2001)	367617E 6366456N Mid slope above Four Mile Creek	Isolated find	
CA8	Umwelt (2001)	370746E 6369747N Lower slope, south of Scotch Dairy Creek	Isolated find	
DMS2	Umwelt (2002)	370966E 6368184N Mid slope, south of Weakleys Flat Creek	Artefact scatter (2 artefacts)	
DMS4	Umwelt (2002)	368649E 6368181N Mid slope, east of Four Mile Creek	Isolated find	
DMS5	Umwelt (2002)	370665E 6368177N Mid slope, south of Weakleys Flat Creek	Isolated find	
DMS6	Umwelt (2002)	370809E 6369721N Mid slope, south of Scotch Dairy Creek	Scarred tree	
Mine Impact Area				
ISF1	(Effenberger 1997)	370500E 6369100N Lower slope above small tributary of Weakleys Flat Creek	Isolated find	Consent to Destroy granted (2002)
ISF2	(Effenberger 1997)	369800E 6368950N Lower slope above tributary of Weakleys Flat Creek	Isolated find	Consent to Destroy granted (2002)
ISF5	Umwelt (2001)	370275E 6368626N Mid slope above Weakleys Flat Creek	Isolated find	Application being prepared for consent to remove
ISF6	Umwelt (2001)	370305E 6368600N Mid slope above Weakleys Flat Creek	Isolated find	Application being prepared for consent to remove
Ironbark 2 (38-4-339)	Ruig (1993)	369190E 6367890N Upper slope above tributary of Weakleys Flat Creek	Isolated find	
DMS1	Umwelt (2002)	369734E 6369122N	Isolated find	Consent to Destroy granted (2002)
DMS3	Umwelt (2002)	369090E 6367962N Mid slope above Four Mile Creek	Isolated find	

Appendix 3

Compliance Review

(Total No. of pages including blank pages = 41)

Table A3.1
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
OPERATION OF DEVELOPMENT			
1	(1) Applicant shall carry out the development generally in accordance with the: • Development application DA 8/01173, dated 13 February 1998, lodged with Maitland City Council and DA 118/698/22 dated 19 February 1998, lodged with Cessnock City Council and the accompanying *Environmental Impact Statement* (EIS) dated 10 February 1998, and prepared by PPK Environment and Infrastructure, as modified by reports in Schedule 4; • Submissions to the Commission of Inquiry by the applicant; • Statement of Environmental Effects titled Modification to the approved mining area at the Donaldson Open Cut Cola Mine, Beresfield, dated 10 November 2004, and prepared by GSS Environmental; • modification application DA 98/01173 & DA 118/698/22 MOD 2 and supporting information, prepared by Donaldson Coal Pty Limited and dated 16 December 2010 and 25 March 2011; and Conditions of this consent. (2) If there is any inconsistency between the above, the most recent document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of any inconsistency. (3) Unless otherwise specifically stated, the conditions of consent do not apply to lot 131 DP 234203 (owned by Steggles Limited at the date of this consent), provided the Deed of Agreement between Steggles Limited and the Applicant is in effect.	YES	The Donaldson Coal project has been developed generally in accordance with the specified documents, with the mine pits and rehabilitation conducted in accordance with the *Mining Operations Plan (Amendment)* approved by the Resources Regulator.
2	Except as expressly provided by the *Statement of Environmental Effects*, dated 10 November 2004, the development shall be restricted as follows: (i) the mine plan in the EIS shall be reduced such that no mining shall be undertaken in any area identified in accordance with these Conditions as a Conservation Area. This includes the Tetratheca Juncea Conservation Area (Condition 68); and (ii) the Applicant shall not clear any land or erect any structures within any Conservation Area without obtaining any further development approval from the Director-General.	YES	The mining area is delineated on the mine plans with the Conservation Area that surrounds the disturbed area of the mine managed for the protection of the vegetation and habitat value. The relocation of the 11kV power line required clearing a small area of the Bushland Conservation Area on the western end of the site and rehabilitation of the existing power line easement. The clearing and rehabilitation of these areas and the adjustment to the boundaries of the Bushland Conservation Area were approved by DoP in Nov 2006. It is noted that the illegal clearing within the BCA reported as an incident in 2022 was not undertaken by or authorised by the Company. Therefore compliance is considered to have been maintained.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

<table>
<tr><th>Cond. No.</th><th>Minister's Conditions of Consent (MCoA)</th><th>Compliance</th><th>Comments/Notes</th></tr>
<tr><td colspan="4">OPERATION OF DEVELOPMENT (Cont'd)</td></tr>
<tr><td>3</td><td>(1) Subject to (2) the approved hours of operation are as follows:
<table><tr><th>Works</th><th>Period</th><th>Hours</th></tr><tr><td>Construction, including construction of any bunds</td><td>Monday to Friday</td><td>7am to 6pm</td></tr><tr><td></td><td>Saturday</td><td>8 am to 1pm</td></tr><tr><td>Mining operations, including mining, haulage of waste to dumps and coal processing</td><td>Monday to Friday</td><td>24 hours per day</td></tr><tr><td></td><td>Saturday, Sunday</td><td>7am to 6pm</td></tr><tr><td>Road transportation and stockpiling of coal</td><td>7 days per week</td><td>24 hours per day</td></tr><tr><td>Rail loading of coal</td><td>7 days per week</td><td>7am to 10pm</td></tr><tr><td>Maintenance of mobile and fixed plant</td><td>7 days per week</td><td>24 hours per day</td></tr><tr><td>Blasting, not involving closure of John Renshaw Drive</td><td>Monday to Saturday</td><td>7am to 5pm</td></tr><tr><td>Blasting, involving closure of John Renshaw Drive</td><td>Monday to Saturday</td><td>10am to 2pm</td></tr></table>Table 1: Approved Hours of Operation
Notes: Restrictions on Public Holidays are the same as Sundays.</td><td>YES</td><td>No construction or mining activities occurred during the reporting period.</td></tr>
<tr><td></td><td>(2) The Applicant shall submit a report to the Director-General's satisfaction demonstrating that the noise limits in Condition 15 can be met while rail loading of coal is occurring during the period from 6pm to 10pm. If that report does not demonstrate that the noise limits can be met to the Director-General's satisfaction, then the hours of operation for rail loading of coal shall be restricted to 7am to 6pm.</td><td>YES</td><td>Report previously submitted.</td></tr>
<tr><td>4</td><td>The Applicant shall comply with any order of the Director-General to cease activities causing serious or irreversible environmental concerns, until those concerns have been addressed to the satisfaction of the Director-General.</td><td>Not Activated</td><td>No order issued to date.</td></tr>
<tr><td colspan="4">COMMENCEMENT AND DURATION</td></tr>
<tr><td>5</td><td>(1) To ensure the employment benefits of this development are realised without delay, the Applicant shall commence mining within two years of the date of this Consent. This does not remove the obligation of the Applicant to comply with any other requirement listed in the Conditions of this Consent.
(2) To minimise potential delays to development on adjoining lands, consent for mining operations shall lapse on 31 December 2013.
Note: Under this consent, the Applicant is required to rehabilitate the site and perform additional undertakings to the satisfaction of the Director-General and DRE. Consequently this approval will continue to apply in all other respects other than the right to conduct mining operations until the site has been properly rehabilitated.</td><td>YES</td><td>Mining commenced on 25 January 2001 (i.e. within 2 years of granting of the Consent) therefore this condition was complied with.
Extension of time approved by Department of Planning.

The Donaldson Open Cut Coal Mine operations ceased in April 2013.</td></tr>
<tr><td>6</td><td>The Applicant shall notify the Director-General and the Councils in writing of the dates of commencement of:
(i) construction works,
(ii) mining, and
(iii) coal processing operations,
14 days prior to the commencement of such works.</td><td>YES</td><td>Donaldson Coal provided written Notification to the Director-General and Councils prior to commencement of construction works, mining and coal processing operations.</td></tr>
<tr><td>7</td><td>No construction or mining shall commence until:
(i) the relevant compliance reports in Condition 121 have been completed to the satisfaction of the Director-General; and
(ii) the Applicant provides evidence to the Director-General of an agreement with the adjoining Bloomfield mine for the use of rail loading infrastructure.</td><td>YES</td><td>Compliance Reports for construction and mining were prepared and submitted to DUAP prior to commencement of the activities on the site in 2001.</td></tr>
</table>

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
ENVIRONMENTAL OFFICER			
8	The Applicant shall employ an Environmental Officer, whose qualifications are suitable to the Director-General, throughout the life of the mine. The Environmental Officer shall: (i) be responsible for the preparation of the *Environmental Management Strategy* (Conditions 10-13) and environmental management plans; (ii) be responsible for considering and advising on matters specified in the Conditions of this Consent and compliance with such matters; (iii) be responsible for receiving and responding to complaints in accordance with Condition 113; (iv) facilitate an induction and training program for all persons involved with construction activities, mining and environmental management activities; and (v) have the authority and independence to require reasonable steps to be taken to avoid or minimise unintended or adverse environmental impacts and failing the effectiveness of such steps, to stop work immediately if an adverse impact on the environment is likely to occur.	YES	Phillip Brown was employed as Environmental Manager in May 2003 and Planning NSW was notified on 7 April 2003 as required by MCoA 8.
9	The Applicant shall notify the Director-General, OEH, NOW, DRE, Councils and the Community Consultative Committee (Conditions 107-110) of the name and contact details of the Environmental Officer upon appointment and upon any changes to that appointment.	YES	The Director-General, EPA, DLWC, DMR, NPWS, Councils and the Community Consultative Committee were notified 30 May 2003 by letter of the appointment of Phillip Brown.
ENVIRONMENTAL MANAGEMENT STRATEGY			
10	The Applicant shall prepare an *Environmental Management Strategy* (the Strategy) for the development, providing a strategic context for environmental management. All environmental management plans required by the Conditions of this Consent shall be consistent with the Strategy. The Strategy shall be prepared in consultation with the relevant authorities and the Community Consultative Committee and to the satisfaction of the Director-General, prior to commencement of construction.	YES	The *Environmental Management Strategy* was prepared in May 2000 for the Donaldson Mine for construction of the mine and mining operations. Revision of the EMS occurred to integrate the requirements of the Donaldson Mine and the mining contractor to provide a single EMS for the project occurred in 2002. Review and revision of the EMS has occurred as management plans for the Donaldson Coal operations are revised and an integrated *Environmental Management Strategy* to include the Tasman and Abel Coal projects was approved by DoP on 26 February 2008. The current version of the EMS was updated August 2018 and approved by DPE on 31 August 2018.
11	The Strategy shall cover the area of mining, the haul road and rail loading facility, and the Conservation Areas. The Strategy shall include: (i) statutory and other obligations which the Applicant is required to fulfil during construction and mining, including all approvals and consultations and agreements required from authorities and other stakeholders, and key legislation and policies;	YES	The *Environmental Management Strategy* prepared for the Abel and Donaldson Mine includes sections addressing each of the requirements of MCoA 11.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
ENVIRONMENTAL MANAGEMENT STRATEGY (Cont'd)			
11 Cont'd	(ii) definition of the role, responsibility, authority, accountability and reporting of personnel relevant to environmental management including the Environmental Officer; (iii) overall environmental management objectives and performance outcomes, during construction, mining and decommissioning of the mine for each of the key environmental elements for which management plans are required under this Consent; (iv) overall ecological and community objectives and a strategy for restoration and management including habitat areas, creeklines and drainage channels, within the context of those objectives; (v) identification of cumulative environmental impacts and procedures for dealing with these at each stage of the development; (vi) overall objectives and strategies for minimising the impacts of the development on economic productivity; (vii) steps to be taken to ensure that all approvals, plans, and procedures are being complied with; (viii) processes for conflict resolution in relation to the environmental management of the project; and (ix) documentation of the results of consultations undertaken in the development of the Strategy.		
12	The Applicant shall make copies of the *Environmental Management Strategy* available to Councils, OEH, NOW, DRE and the Community Consultative Committee within 14 days of approval by the Director-General.	YES	Copies of the *Environmental Management Strategy* and revisions prepared for Donaldson Coal projects have been made available.
ENVIRONMENTAL MONITORING AND REVIEWING			
13	(1) Except as provided in (2), the Applicant shall provide six-monthly monitoring reports on all environmental monitoring required under this Consent for the first three years of the project and for any further period as may be determined necessary by the Director-General. The reports shall contain interpretations of the monitoring data, and summarise exceedances and action taken. The Applicant shall make copies of the monitoring reports available to the Director-General, NOW, OEH, DRE, Councils and the Community Consultative Committee. (2) Noise monitoring reports shall be provided six-monthly for the life of the mine, unless the Director-General, on the advice of the independent noise expert (Condition 48) requires more frequent reports.	YES	Monitoring Reports including all noise, blasting, air quality, surface and groundwater, indigenous heritage, flora and fauna, employment statistics, community consultation and complaints, were prepared six monthly and provided to the relevant authorities listed in MCoA 13 (1) between 2001 and 2004. DIPNR approved the reporting of monitoring an annual basis on 1 April 2004. All monitoring data and reporting has occurred in the AEMR's / Annual Reviews since 2004.
14	All sampling strategies and protocols undertaken as part of any monitoring program shall include a quality assurance/quality control plan and shall require approval from the relevant regulatory agencies to ensure the effectiveness and quality of the monitoring program. Only accredited laboratories shall be used for laboratory analysis.	YES	Quality assurance/Quality Control information and data is included in the laboratory reports from the NATA registered laboratory, with the monitoring data. All sampling and analysis has been conducted by NATA or AS/NZS ISO 17025 registered laboratories, as from 23 May 2002.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

<table>
<tr><th>Cond. No.</th><th>Minister's Conditions of Consent (MCoA)</th><th>Compliance</th><th>Comments/Notes</th></tr>
<tr><td colspan="4">NOISE AND VIBRATION</td></tr>
<tr><td colspan="4">Noise Limits</td></tr>
<tr><td>15</td><td>Except as may be expressly provided by a OEH licence under the Protection of the Environment Operations Act 1997, or unless subject to a negotiated agreement in accordance with Condition 23, the Applicant shall ensure that the noise emission from construction or mining operations, when measured or computed at the boundary of any dwelling not owned by the Applicant (or within 30 metres of the dwelling, if the boundary is more than 30 metres from the dwelling), shall not exceed the following limits:
<table><tr><td colspan="3">Location LA10(15 minute) noise limits (dB(A))</td></tr><tr><td></td><td>Daytime</td><td>Night-time</td></tr><tr><td>Beresfield (residential)</td><td>45</td><td>35</td></tr><tr><td>Steggles Poultry Farm</td><td>50</td><td>40</td></tr><tr><td>Ebenezer Park</td><td>46</td><td>41</td></tr><tr><td>Black Hill Area</td><td>40</td><td>38</td></tr><tr><td>Buchanan/Louth Pk</td><td>38</td><td>36</td></tr><tr><td>Ashtonfield Area</td><td>41</td><td>35</td></tr><tr><td>Thornton Area</td><td>48</td><td>40</td></tr></table>Table 2: Noise Limits

Note: Daytime is 7am to 10pm Monday – Saturday, and 8am to 10pm Sundays and Public Holidays. Night-time is 10pm to 7am Monday – Saturday, and 10pm to 8am Sundays and Public Holidays.

The noise limits apply for prevailing meteorological conditions (winds up to 3 m/s), except under conditions of temperature inversions.</td><td>YES</td><td>Given that mining operations have ceased, no noise monitoring was undertaken during the reporting period. Previous Quarterly Noise Surveys generally identified that noise levels contributed by Donaldson Mine operations do not exceed noise emission goals for any of the periods. In the absence of operations, complaints and previous monitoring results, compliance is considered likely.</td></tr>
<tr><td colspan="4">Noise Management</td></tr>
<tr><td>16</td><td>Prior to 31 October 2005, the Applicant shall prepare a Noise Monitoring Program for the development in consultation with OEH, and to the satisfaction of the Director-General, which includes a noise monitoring protocol for evaluating compliance with the criteria in condition 15.</td><td>YES</td><td>The Mine Noise Monitoring Plan was forwarded to DoP and DEC in Oct 2005 and a final revised copy submitted on 27 Dec 2005 for approval. The Plan was approved by DoP on 22 Jan 2007. An updated Noise Management Plan was approved by the (then) DPE in June 2019 and covers both the Abel and Donaldson mines.</td></tr>
<tr><td>17</td><td colspan="3">Deleted in Notice of Modification 26 August 2005</td></tr>
<tr><td>18</td><td colspan="3">Deleted in Notice of Modification 26 August 2005</td></tr>
<tr><td>19</td><td colspan="3">Deleted in Notice of Modification 26 August 2005</td></tr>
<tr><td>20</td><td>In the event that a landowner or occupier considers that noise or vibration from the project at their property is in excess of the relevant criteria set out in this Consent, the Applicant shall, upon receipt of a written request and at its own expense immediately undertake direct discussion with the landowners or occupiers affected to determine their concerns. Independent investigations of the noise complaints shall be carried out if the matter is not resolved within six weeks, in accordance with Conditions 48-53</td><td>Not activated</td><td>No request for acquisition by any landowners due to noise or vibration impact had been initiated.</td></tr>
</table>

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Noise Acquisition			
21	If noise monitoring or independent noise investigations indicate that noise from construction or operation of the mine at the boundary of a dwelling, or within 30 metres of the dwelling where the boundary is more than 30 metres from the dwelling, is in excess of the noise limits set out in this Consent under adverse weather conditions and if appropriate noise control measures cannot be achieved on the mine site, the landowner may request the Applicant in writing to acquire the whole of the property or such part of the property requested by the landowner where subdivision is approved. Note: Adverse weather conditions means the presence of winds up to 3 metres per second, and/or temperature inversions of up to 4 degrees Celsius per 100 metres.	Not activated	As above.
22	Any such request shall be referred to the Director-General for determination in consultation with the independent expert. If the Director-General determines acquisition is necessary, the Applicant shall acquire the property in accordance with Conditions 54-55.	Not activated	As above.
Negotiated Agreements			
23	If monitoring or independent investigations indicate that noise or dust from the mine is in excess of the criteria set out in this Consent and the affected landowner does not wish to be acquired, the Applicant shall, if requested by the affected landowner, enter into a negotiated agreement. Where a negotiated agreement is required, the Applicant shall, within the time period specified by the Director-General: (i) appoint an independent facilitator, approved by the Director-General; (ii) negotiate a package of benefits for the landowner, which may include undertaking noise reduction measures on the property or at the dwelling(s) or compensation; (iii) pay all reasonable costs of the process; and (iv) report to the Director-General and the OEH on the agreement reached.	Not activated	No requirement has arisen for a negotiated agreement with any land owners.
BLASTING			
Blasting Criteria			
24	The Applicant shall ensure that the airblast over pressure level from blasting at the development does not exceed the criteria in Table 3, and the ground vibration level does not exceed the criteria in Table 4, at any residence on privately-owned land or noise sensitive location as defined in the EPA's Industrial Noise Policy. Airblast overpressure (db(Lin Peak) — Allowable exceedance 115 — 5% of total number of blasts in a 12 month period 120 — 0% *Table 3: Airblast Overpressure Impact Assessment Criteria*	YES	No blasting occurred during the reporting period.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

<table>
<tr><th>Cond. No.</th><th>Minister's Conditions of Consent (MCoA)</th><th>Compliance</th><th>Comments/Notes</th></tr>
<tr><td colspan="4">BLASTING (Cont'd)</td></tr>
<tr><td colspan="4">Blasting Criteria (Cont'd)</td></tr>
<tr><td>24 Cont'd</td><td><table><tr><td>Peak Particle Velocity mm/s</td><td>Allowable exceedance</td></tr><tr><td>5</td><td>5% of total number of blasts in a 12 month period</td></tr><tr><td>10</td><td>0%</td></tr></table>Table 4: Ground Vibration Impact Assessment Criteria</td><td></td><td></td></tr>
<tr><td colspan="4">Blasting Design and Management</td></tr>
<tr><td rowspan="5">25e</td><td>(1) The Applicant shall not blast within 500 metres of an occupied residence.</td><td>YES</td><td>No blasting occurred during the reporting period.</td></tr>
<tr><td>(2) The Applicant shall not blast within 500 metres of private lands unless there is a written agreement between the Applicant and the landowner/occupier(s) to the satisfaction of the Director-General that guarantees the safety of persons who might use those lands.</td><td>YES</td><td>No blasting occurred during the reporting period.</td></tr>
<tr><td>(3) The Applicant shall not blast within 500 metres of public lands unless public access to those areas is prevented at times of blasting.</td><td>YES</td><td>No blasting occurred during the reporting period.</td></tr>
<tr><td>(4) The Applicant shall not blast within 500 metres of a public road unless the road is closed with the prior written agreement of the Regional Traffic Committee (or in the absence of the Regional Traffic Committee, the Director-General). A copy of any such agreement shall be supplied to the Director-General within 14 days of the agreement.
If determined necessary by the Regional Traffic Committee, the Applicant shall prepare a Traffic Study to identify upgrading of the surrounding road system commensurate with the additional traffic volumes. The Study shall be prepared in consultation with Councils and the RTA, and to the satisfaction of the Regional Traffic Committee. All recommended traffic management measures and road infrastructure upgrading are to be undertaken at the Applicant's expense prior to any closure of John Renshaw Drive. If the study identifies the need for acquisition to enable the works to be undertaken, acquisition shall occur in accordance with the acquisition procedures established under this Consent.</td><td>YES</td><td>No blasting occurred during the reporting period.</td></tr>
<tr><td>(5) The 500 metre distance may be reduced by the Director-General if a risk analysis undertaken by the Applicant to the Director-General's requirements indicates a lesser distance provides an appropriate level of safety.</td><td>Not activated</td><td>The 500m setback distance was not requested to be reduced.</td></tr>
</table>

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
BLASTING (Cont'd)			
Blasting Design and Management (Cont'd)			
26	The Applicant shall prepare and implement a *Blast Management Plan* in consultation with DRE and Councils, prior to the commencement of blasting (including trial blasting). The Applicant shall make copies of the *Blast Management Plan* available to the independent noise expert (Condition 48), OEH, /DRE, Councils and the Community Consultative Committee within 14 days of approval by the Director-General.	YES	*Blast Management Plan* was developed for the Donaldson Mine in consultation with the DMR and Maitland City Council, Cessnock City Council, and Newcastle City Council, prior to the commencement of blasting at the Donaldson Mine and copies of the Plan were distributed to the relevant authorities and the CCC. The *Blast Management Plan* was revised in 2007 and approved by the (then) DoP.
27	The *Blast Management Plan* shall: (i) provide details of any proposed trial blasting;	YES	The *Blast Management Plan 2001* addresses Trial Blasting in Section 6.2.
	(ii) identify a monitoring program, including locations and justification for selection of locations such as the Steggles Black Hill poultry operations and areas of old underground mine workings;	YES	The *Blast Management Plan 2007* Section 6 addressed the Monitoring Program for the specified areas.
	(iii) detail measures to ensure that air blast overpressure and vibration monitoring and control is generally carried out in accordance with the recommendations of Australian Standard AS-2187-1993 (or its latest version) and in terms of ANZECC Guidelines;	YES	The *Blast Management Plan 2007* addresses Monitoring Procedures, in Section 4 and 6. The monthly *Blast Monitoring and Assessment Reports* by Hunter Acoustics addressed the quality control and monitored the data collection and recording.
	(iv) detail methods to measure weather data as soon as practicable prior to blasting and from that data predict whether noise levels are likely to be increased above the levels expected under prevailing meteorological conditions;	YES	The *Blast Management Plan 2007* addresses Meteorological Data Collection in Section 5.1. The meteorological station located at the Donaldson Mine provides continuous records of the prevailing weather conditions and this data was available immediately prior to blasting.
	(v) detail measures to be taken to minimise disruptions from blasting, including any road closures agreed in accordance with Condition 25, and management of impacts on local traffic and pedestrian movements;	YES	The *Blast Management Plan 2007* addresses minimisation of disruptions caused by blasting in Section 5.2.
	(vi) specify procedures for ensuring that the occurrence of concurrent blasts with the adjoining coal mine operators is avoided; and	YES	The *Blast Management Plan 2007* addresses timing of blasts in Section 5.1.
	(vii) identify procedures for notifying landowners/occupiers within 2 km of the site of the general blasting program and for notifying landowners or occupiers within 500m of blasting events (or any reduced area approved by the Director-General under Condition 25(5)) prior to blasting occurring.	YES	The *Blast Management Plan 2007* addresses notification of blasting events to land owners in Section 5.3.
28	The Applicant shall not blast if weather conditions indicate that air blast overpressure levels are likely to be exceeded at residences not owned by the Applicant.	Not Applicable	No blasting occurred during the reporting period.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
29	The Applicant shall report on blasting practices (including any trial blasting), weather data and the results of blast emissions monitoring in the six-monthly environmental monitoring reports and in the AEMR.	Not Applicable	No blasting occurred during the reporting period.
30	The Applicant shall revise the *Blast Management Plan* as necessary and provide an updated Plan five years after commencement of mining to the Director-General, the independent noise expert, OEH, DRE, Councils and the Community Consultative Committee.	YES	The *Blast Management Plan* was revised and submitted to the DoP on 16 July 2007. Approval from DoP was received on 17 July 2007.
Blasting Impacts			
31	Prior to the commencement of blasting, the Applicant shall undertake baseline structural surveys of all buildings and structures within 1.5 kilometres of blasting locations, unless it can be demonstrated to the satisfaction of the Director-General in consultation with DRE that surveys of certain properties are unnecessary because blasting damage is unlikely to occur to those properties. In conducting these structural surveys, the Applicant shall ensure that: (i) the surveys are carried out by a technically qualified person, as agreed in consultation with the Director-General and relevant landowners; and (ii) a copy of any inspection report (including video or photographs, if requested), certified by the person who undertook the inspection, is supplied to the relevant property owner within 14 days of receipt of same.	YES	Two consultants - Burke Engineering Services and Geoff Craig & Associates, were offered to building owners for the structural survey reports in 2000. All the required surveys of residences had been conducted when blasting commenced at the mine site, except for buildings on the Steggles property (as per a commercial agreement with Steggles). The survey of ABAKK House at the western end of the property was carried out later when the Donaldson Mine operations progressed to the west. Donaldson Coal corresponded with ABAKK Pty Ltd in 2007 in relation to three dwellings and infrastructure that would be within 1 500m of the area of blasting at the Donaldson Mine and arranged for structural inspections. A copy of the structural survey reports were provided to the property owners for each residence/structure.
32	In the event that a landowner or occupier considers that blast emissions from the development may have affected the material condition of their property, the landowner may make a written request to the Director-General for an independent dilapidation assessment. If the Director-General, in consultation with the DRE, is satisfied that an independent investigation is required, the Applicant shall ensure: (i) the survey is carried out by a technically qualified person, as agreed in consultation with the Director-General and the relevant landowners or occupiers; and (ii) a copy of any inspection report (including video or photographs, if requested), certified by the person who undertook the inspection, is supplied to the relevant property owner within 14 days of receipt of same.	Not activated	No requests for structural surveys have been received during this reporting period.
33	Where a dilapidation assessment concludes that structural damage has occurred as a result of blast emissions, the Applicant shall undertake immediate preventative and/or remedial measures at its expense.	YES	No dilapidation assessments have been requested during this reporting period.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Newcastle Herald's Printing Facilities at Holmwood Business Park			
34	Prior to commencement of mining, the Applicant shall: (i) conduct ambient vibration monitoring adjacent to (on the floor) and if required, on the most vibration-sensitive component of the printing facilities in order to establish both the levels of ambient vibration generated by the operation of the Printing Facility itself and that of any other nearby vibration sources; (ii) provide a detailed report on the monitoring procedures and the monitoring results and findings to the Newcastle Herald upon completion of the survey; (iii) meet with Herald representatives to discuss the results of the survey and determine whether the initially agreed limit of 0.3 mm/s is appropriate; and (iv) design initial blasting for compliance with a peak particle velocity vibration criterion of 0.3 mm/s adjacent to or on the Printing Facility, unless a more appropriate limit is mutually agreed.	YES	Blast Vibration Assessment was conducted for the Newcastle Fairfax Printing facility in 2001. The report results established the ambient vibration levels at the site. Discussions with Fairfax in 2001 resulted in an agreement that the vibration criteria be 3 mm/s ppv. Correspondence in relation to the 3mm/s ppv was received by Donaldson and DUAP advised of the change on 18 December 2001.
35	The Applicant shall monitor the impacts of blasting on the Printing Facility throughout the life of the mine, at a mutually agreed location in or adjacent to the Printing Facility during every blast. The Applicant shall provide results of the monitoring to the Newcastle Herald and provide a summary in the AEMR.	Not Applicable	No blasting occurred during the reporting period.
Hunter Water Corporation Pipelines			
36	The Applicant shall ensure that blasting is undertaken in a manner that protects the Hunter Water Corporation's pipeline to the satisfaction of the Hunter Water Corporation.	YES	Consultation with HWC resulted in agreement of a peak particle velocity of 100mm/sec at the pipeline. Vibration monitoring has previously been conducted for each blast at monitors located along the pipeline corridor. No blasting occurred during the reporting period.
AIR QUALITY			
Air Quality Criteria			
37	The Applicant shall take all practical steps to manage the mine's operations so that the ambient air quality goals for total suspended particles (TSP) of 90ug/m^3 (annual average) and the dust deposition goal of 4gm/m^2 (annual average) are not exceeded as a result of the development when monitored at any monitoring location specified in the *Air Quality Management Plan*.	YES	The air quality results reported for the Donaldson Mine are compliant with the criteria in MCoA 37. The dust deposition criteria of 4gm/m^2 and the TSP goal of 90ug/m^3 have not been exceeded during this reporting period. The *Air Quality Management Plan* approved in 2019 no longer requires ongoing deposited dust or TSP monitoring.
Air Quality Management			
38	The Applicant shall prepare and implement an *Air Quality Management Plan*, containing strategies to manage the mine's contribution to dust deposition, TSP, PM10 and PM2.5 to the satisfaction of the Director-General, prior to the commencement of construction. The Applicant shall make copies of the *Air Quality Management Plan* available to the independent expert (Condition 48), OEH, Councils and the Community Consultative Committee within 14 days of approval by the Director-General.	YES	The *Air Quality Management Plan* for the Donaldson Mine was finalised in November 2000 and presented to the CCC on 13 November 2000.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Air Quality Management (Cont'd)			
38 Cont'd			The *Air Quality Management Plan* was reviewed in 2007 by Holmes Air Services and no revision was required. A revised plan was prepared 3 June 2019 for care and maintenance and approved by the (then) DPE 4 June 2019. A copy is provided on the Company website and the CCC was notified of the revised plan.
39	The *Air Quality Management Plan* shall: (i) identify potential sources of dust deposition, TSP and fine particulates (PM10 and PM2.5) and specify appropriate monitoring intervals and locations. The purpose of the monitoring is to evaluate, assess and report on these emissions and the ambient impacts with the objective of understanding the mine's contribution to levels of dust deposition, TSP and fine particulates in ambient air around the mine site;	YES	The 2019 *Air Quality Management Plan* addresses potential sources of dust emissions and presents an appropriate monitoring program in Section 8. The monitoring program was implemented and the results are presented in Section 6 of the Annual Review.
	(ii) provide the mine's monitoring plan having regard to local meteorology and the relevant Australian Standards, identifying the methodologies to be used, including justification for monitoring intervals, weather conditions, seasonal variations, selecting locations, periods and times of measurements;	YES	The 2019 *Air Quality Management Plan* addresses the monitoring plan in Section 8.
	(iii) provide the design of any modelling or other studies, including the means for determining the contribution to dust deposition, TSP and fine particulates from the development;	YES	The 2019 *Air Quality Management Plan* addresses modelling and other studies in Section 10.
	(iv) provide details of dust suppression measures for all sources of dust from the development (including the haul road and the rail loading site);	YES	The 2019 *Air Quality Management Plan* addresses dust suppression measures in Section 7.2.
	(v) provide details of actions to ameliorate impacts if they exceed the relevant criteria; and	YES	The 2019 *Air Quality Management Plan* addresses amelioration and mitigation measures for dust control in Section 10.3.
	(vi) provide the design of the reactive management system intended to reduce the day-to-day impacts of dust and fine particulates due to the mine's operation.	YES	The 2019 *Air Quality Management Plan* addresses dust management procedures in Sections 7.2 and 10.3.
40	The Applicant shall ensure the prompt and effective rehabilitation of all disturbed areas as soon as practicable to minimise the generation of dust.	YES	Rehabilitation progressively occurred on disturbed land at the Donaldson Mine overburden and backfill areas to minimise generation of wind blown dust, with revegetation established using local indigenous species.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Air Quality Management (Cont'd)			
41	The Applicant shall cease offending work at such times when the hourly average wind speed exceeds 5 metres per second and the operations are resulting in visible dust emissions blowing in a direction so as to cross onto public roads or lands not owned by the Applicant.	YES	The meteorological station installed at the Donaldson Mine site (and relocated to the Abel mine area in 2017) provides continuous reading of wind speed. Results are available instantly on computer. Wind speed above 5 m/s triggers a response to stop work at the mine site until wind conditions return to below 5 metres/sec. No earthmoving activities occurred during the reporting period.
42	The Applicant shall revise the *Air Quality Management Plan* as necessary and provide an updated Plan five years after commencement of mining and to the Director-General, independent air quality expert (Condition 48), OEH, Councils and the Community Consultative Committee.	YES	The *Air Quality Management Plan* and monitoring program was reviewed by Holmes Air Services in 2007 and it was concluded that the plan was adequate and did not require to be updated. A further review was undertaken in 2019 and the plan updated to reflect care and maintenance.
Air Quality Monitoring			
43	The Applicant shall install, maintain and continuously operate a meteorological station in accordance with the relevant Australian Standards and to the satisfaction of the OEH. The meteorological station shall be installed within six weeks of the date of this consent and remain for the life of the mine. The Applicant shall analyse and report the meteorological data on a monthly basis to adequately characterise the site, and shall use the data collected by the wind monitoring and recording station to determine when and how the mine operation is to be modified in accordance with the *Air Quality Management Plan* and the Conditions of this Consent.	YES	A meteorological station installed at the Donaldson Mine site since December 2000 and was relocated to the Abel mine area in 2017. Meteorological data is collected continuously and analysed monthly.
44	The Applicant shall install, maintain and operate dust deposition gauges in accordance with the relevant Australian Standards and to the satisfaction of the OEH. The dust deposition gauges shall be installed and operational within six weeks of the date of this consent and the Applicant shall determine the dust deposition rate in grams/m2/month in each calendar month so that any increases in dust deposition rates can be presented in the AEMR.	YES	Nine (9) dust deposition gauges were previously installed on the Donaldson Mine site, in accordance with Australian Standards. Approval from the (then) DPE was granted on 4 June 2019 for the decommissioning of deposited dust monitoring in accordance with the revised *Air Quality Management Plan* (2019). EPL 11080 has now also been surrendered and monitoring requirements of the combined EPL 12856 reflect updated air quality monitoring requirements.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Air Quality Monitoring (Cont'd)			
45	(1) The Applicant shall install, maintain and operate an air quality monitoring network in accordance with the relevant Australian Standards and to the satisfaction of the OEH. The network shall be installed and operational within six weeks of the date of this consent and in each calendar year the Applicant shall determine the concentrations of TSP in g/m3 (annual average) and fine particulates (PM10 and PM2.5) in g/m3 (24 hour average and annual average) so that the contribution of the mine to regional ambient air quality can be presented in the AEMR. (2) The Applicant shall also participate in (and if appropriate contribute reasonable funds to) regional air quality studies conducted by or on behalf of the OEH or the Director-General.	YES	See MCoA 44 above. All air quality meteorological data is stored on the air quality database at the Donaldson Mine site. High Volume Air Samplers (HVAS) were previously installed at Bartter Enterprise site and Beresford Golf Course for collection of TSP and PM_{10}. The revised *Air Quality Management Plan*, approved by the (then) DPE on 4 June 2019, replaces the previously installed HVAS and Dustrak monitors with a PM_{10} E-Sampler. Only continuous data from the E-Sampler will be collected and reported in future Annual Reviews. No approach has been made to Donaldson Mine in relation to regional air quality studies during this reporting period.
Air Quality Acquisition			
46	If dust monitoring or independent dust investigations indicate that dust from operation of the mine at a dwelling is in excess of the criteria set out in this Consent and if appropriate dust control measures cannot be achieved on the mine site, the landowner may request the Applicant in writing to acquire the whole of the property or such part of the property requested by the landowner where subdivision is approved.	Not activated.	No such requests received.
47	Any such request shall be referred to the Director-General for determination. If the Director-General determines acquisition is necessary, the Applicant shall acquire the property in accordance with Conditions 54-55.	Not activated.	No such requests received.
INDEPENDENT MONITORING OF NOISE, VIBRATION OR DUST			
48	The Applicant shall bear the reasonable costs of the appointment by the Director-General of an independent noise and air quality expert(s) and/or mediator to assist in the implementation of the Conditions of this Consent. The independent expert(s) shall: (i) receive and advise the Director-General on the Noise, Blast and Air Quality Management Plans; (ii) receive and advise the Director-General on noise and dust monitoring results; (iii) be responsible for, or supervise, the independent investigation of complaints; and (iv) advise the Director-General on the need for acquisition due to noise, vibration or dust. The independent expert(s) shall report directly to the Director-General and provide such advice as agreed by the Director-General to the Applicant and the landowner or occupier.	Not activated	No independent experts have been required to be appointed.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
INDEPENDENT MONITORING OF NOISE, VIBRATION OR DUST (Cont'd)			
49	In the event that a landowner or occupier considers that noise, vibration and/or dust from the project at their property is in excess of the relevant criteria set out in this Consent the landowner may make a written request to the Applicant for an investigation. If the Director-General, on the advice of the independent expert, is satisfied that an investigation is required, the independent expert shall ensure that: (i) direct discussions are undertaken with the landowners or occupiers affected to determine their concerns and to plan and implement an investigation to quantify the impact and determine the sources of the effect; (ii) independent investigations are conducted to quantify the impact and determine the source of the effect; and (iii) a report is submitted to the Director-General, the Applicant and the landowner or occupier.	Not activated	No such requests received.
50	If exceedances are identified, within six weeks or as otherwise directed by the Director-General, the Applicant shall modify the mining activity which may be causing the impacts and/or enter into a negotiated agreement (Condition 23) with the affected landowner.	Not activated	As above.
51	The Applicant shall bear the cost of the independent investigations and make available plans, programs and other information necessary for the independent expert(s) to form an appreciation of the past, present and future works and their effects on noise, vibration and/or dust emissions.	Not activated	As above.
52	Investigations shall be carried out in accordance with a documented Plan. The Plan shall be designed and implemented to measure and/or compute (with appropriate calibration by measurement) the relevant noise, vibration and/or dust levels at the complainant's residence/property boundary emitted by the development.	Not activated	As above.
53	Further independent investigations shall cease if the Director-General, in consultation with the independent expert, is satisfied that the relevant approval levels are not being exceeded and are unlikely to be exceeded in the future.	Not activated	As above.
ACQUISITION PROCEDURE			
54	Upon determination of the Director-General in relation to the purchase of a property in accordance with any Conditions of this Consent, the Applicant shall negotiate and purchase the whole of the property (unless the request specifically requests acquisition of only part of the property and subdivision has already been approved) within six months of receipt of notification from the Director-General. The Applicant shall pay the landowners an acquisition price resulting from proper consideration of: (i) a sum not less than the current market value of the owner's interest in the land, whosoever is the occupier, having regard to:	Not activated	As above.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
ACQUISITION PROCEDURE (Cont'd)			
54 Cont'd	(a) the existing use and permissible use of the land in accordance with the applicable planning instruments at the date of the written request; (b) the presence of improvements on the land and/or any Council approved building or structure which although substantially commenced at the date of the request is completed subsequent to that date; and (c) as if the land was unaffected by the development proposal. (ii) the owner's reasonable compensation for disturbance allowance and relocation within the Lower Hunter Region; (iii) the owner's reasonable costs for obtaining legal advice and expert witnesses for the purposes of determining the acquisition price for the land and the terms upon which it is to be acquired; and (iv) the purchase price determined by reference to points (i), (ii) and (iii) shall be reduced by the amount of any compensation awarded to a landowner pursuant to the *Mining Act, 1992* or other legislation providing for compensation in relation to coal mining but limited to compensation for dwellings, structures and other fixed improvements on the land, unless otherwise determined by the Director-General in consultation with the DRE.		
55	Notwithstanding any other Condition of this Consent, the Applicant may, upon request of the landowner, acquire any property affected by the project during the course of this Consent on terms agreed to between the Applicant and the landowner.	Not activated	As above.
INDEPENDENT VALUATION			
56	In the event that the Applicant and the landowner cannot agree within three months upon the acquisition price of the land and/or the terms upon which it is to be acquired under the terms of this Consent, then either party may refer the matter to the Director-General who shall request an independent valuation to determine the acquisition price. The independent valuer shall consider any submissions from the landowner and the Applicant in determining the acquisition price.	Not activated	As above.
57	If the independent valuer requires guidance on any contentious legal, planning or other issues, the independent valuer shall refer the matter to the Director-General, who, if satisfied that there is a need for a qualified panel, shall arrange for the constitution of the panel. The panel shall consist of: (i) the appointed independent valuer; (ii) the Director-General; and/or (iii) the President of the Law Society of NSW or nominee. The qualified panel shall, on the advice of the valuer, determine the issue referred to it and advise the valuer.	Not activated	As above.
58	The Applicant shall bear the costs of any independent valuation or survey assessment requested by the Director-General.	Not activated	As above.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
INDEPENDENT VALUATION (Cont'd)			
59	The Applicant shall, within 14 days of receipt of a valuation by the independent valuer, offer in writing to acquire the relevant land at a price not less than the said valuation.	Not activated	As above.
WATER			
Water Management			
60	The Applicant shall prepare and implement a *Water Management Plan* in consultation with NOW, Councils, OEH and the Hunter Catchment Management Trust, and to the satisfaction of the Director-General, prior to the commencement of construction. The Applicant shall make copies of the *Water Management Plan* available to the OEH, NOW, DRE, Councils, the Hunter Catchment Management Trust and the Community Consultative Committee within 14 days of approval by the Director-General.	YES	The *Water Management Plan 2000* was developed in consultation with the EPA, DLWC, Councils, Hunter Catchment Management Trust and to the satisfaction of the Director-General, prior to the commencement of construction. The *Water Management Plan* was reviewed in 2005 and a revision of the Plan occurred in 2008. The Water Management plan was again revised in 2019.
61	The *Water Management Plan* shall include but not be limited to: (i) management of the impacts of the development on the quality and quantity of surface and groundwater, including water in dirty water dams and clean water diversion dams;	YES	(i) The *Water Management Plan* addresses the management of impacts of the development on the quality and quantity of surface and ground water in Sections 3 and 5.
	(ii) stormwater and general surface runoff diversion to ensure separate effective management of clean and dirty water;		(ii) The *Water Management Plan* addresses the management of impacts of the development on the quality and quantity of surface and ground water in Sections 3, 4 and 5.
	(iii) stormwater management facilities designed to at least a 1:10 year storm design criteria;		(iii) The *Water Management Plan* addresses the stormwater management issues, in Sections 3 and 5.
	(iv) identification of any possible adverse effects on water supply sources (both surface and groundwater) of landowners or occupiers from the development, and implementation of mitigation measures as necessary;		(iv) The *Water Management Plan* addresses possible adverse effects of the development on water supply sources, in Sections 3 and 5.
	(v) identification of the fresh quality groundwater zones within the DA area and appropriate protection strategies;		(v) The *Water Management Plan* addresses the quality of groundwater zones within the DA area, in Sections 4 and 5.
	(vi) management of the impacts of the development on the quality and quantity of groundwater within 2 kilometres of the boundary of the DA area, with particular attention to mobilisation of salts and contingency plans for managing any adverse impacts;		(vi) The *Water Management Plan* addresses the management of impacts on the quality and quantity of groundwater within 2km of the DA area, in Sections 4 and 5.
	(vii) management of the impacts of the development on the quality and quantity of surface water discharged, including scheduling of mining operations to minimise the area excised from the catchment draining to Woodberry Swamp at any one time;		(vii) The *Water Management Plan* addresses the management of impacts on the quality and quantity of surface water discharged from the Donaldson Mine site, in Sections 3 and 5.
	(viii) identification of a defined buffer zone between the mine pit and Four Mile Creek and measures to minimise the risk of blast-induced fractures in the buffer zone to prevent saline seepage from the rehabilitated landform toward Four Mile Creek in the post-mining period;		(viii) The *Water Management Plan* addresses the buffer zone and protection Four Mile Creek in Sections 3 and 5.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Water Management (Cont'd)			
61 Cont'd	(ix) procedures for the maintenance of drainage systems and water management structures; and	YES	(ix) The *Water Management Plan* addresses the procedures for maintenance of drainage systems and water management structures in Sections 3 and 5.
	(x) development of a strategy for the decommissioning of water management structures, including dirty water dams and clean water diversion dams, and long term management of the final void.		(x) The *Water Management Plan* addresses the strategy for decommissioning of the water management structures in Sections 3, 4 and 5.
62	The Applicant shall revise the *Water Management Plan* as necessary and provide an updated Plan five years after commencement of mining to the Director-General, OEH, NOW, DRE, Councils, the Hunter Catchment Management Trust and the Community Consultative Committee.	YES	The *Water Management Plan* was reviewed in 2005 and Tasman Mine requirements included. The Plan was further revised in 2008 to include the Abel Mine water management and again revised in 2019 to cover the care and maintenance period for the Abel Underground Mine.
Water Monitoring			
63	The Applicant shall prepare and implement a detailed monitoring program for groundwater and surface water in consultation with DP&I, OEH, DRE, and the Hunter-Central Rivers Catchment Management Authority, throughout the life of the mine and for a period of at least 5 years after the completion of mining, or other such period as determined by the D_G. The results of the monitoring shall be included in the AEMR (Conditions 114-116). The monitoring program shall contain: (i) details of proposed monitoring sites, frequency and parameters to be tested; (ii) pre-mining baseline data;	YES	(i) *Water Management Plan* section 3.6 and 4.2. (ii) *Water Management Plan* section 3.6 and 4.1. (iii) *Water Management Plan* section 3.6. (iv) Biological monitoring in the three creeks using SIGNAL and AUSRIVAS assessment criteria was undertaken between 2000 and 2019. Biological monitoring ceased in 2019 in accordance with the revised *Water Management Plan* (2019). (v) Macro-invertebrate surveys included bank and bed stability. (vi) Continuous metering of water transfer volumes between the Donaldson and Bloomfield operations occurs. (vii) Whilst four (4) monitoring bores were previously destroyed as part of the mining operations, a review of the groundwater monitoring network by Dundon Consulting Pty Ltd concluded that the existing network is adequate with no changes considered necessary. It is noted that the mine has ceased operations for ~10years – as such, the requirements of this condition have been met and are no longer applicable.
	(iii) monitoring of surface water quality to detect any changes in ambient water quality between the mine site and the wetlands; (iv) monitoring of macroinvertebrates and vegetation in accordance with the protocols developed by the Hunter SIGNAL biological assessment criteria, with an assessment of inflows to the wetlands; (v) monitoring of stream bank and bed stability; (vi) monitoring of the volume and quality of water transfer between the Donaldson and Bloomfield operations; and (vii) a program for replacement of any monitoring bores destroyed by the development.		
64	Prior to 31 October 2005, the Applicant shall revise, and then implement any necessary changes in the monitoring program for groundwater and surface water to the satisfaction of the Director-General.	YES	The *Water Management Plan* was revised in 2005 under the Notification of Modification condition with comments received from DLWC and DoP and response from Peter Dundon & Associates.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Water Supply			
65	On request of a landowner whose water supply from licensed bore holes or springs has been determined by NOW at any time to have been affected by the project, the Applicant shall replace lost water supply with water of an equivalent quality and quantity to meet the landowner's requirements, to the satisfaction of NOW.	Not activated	No such request received.
EROSION AND SEDIMENT CONTROL			
66	The Applicant shall prepare and implement an *Erosion & Sediment Control Plan* for the development (including the haul road and the relocation of utilities and services) to the satisfaction of NOW and submit the Plan to the OEH as part of applications for a licence under the Protection of the *Environment Operations Act*. The Plan shall be prepared prior to the commencement of work in the relevant areas. The Applicant shall make copies of all Erosion & Sediment Control Plan(s) available to Director-General, Councils and the Community Consultative Committee within 14 days of approval.	YES	*Erosion and Sediment Control Plan* was submitted to the EPA on 4 May 2000 as part of the application for Environment Protection Licence No. 11080. A review of the *Erosion and Sediment Control Management Plan* was conducted in 2005 following the DPI-MR inspection in May 2005, and the Plan revised.
67	The Erosion and Sediment Control Plan(s) shall include consideration and management of erosion and sedimentation of watercourses and water bodies, including Woodberry Swamp.	YES	The *Erosion and Sediment Control Plan* addresses the management of erosion and sedimentation of watercourses and water-bodies on the Donaldson Mine site, in Sections 4. Control of erosion and monitoring of water quality of watercourses and water bodies on the mine site and to the boundaries of the Donaldson property, results in management of impact from the mine on downstream habitats (e.g. Woodberry Swamp). Monitoring also previously included assessment of bank and bed stability as part of the macroinvertebrate survey reports.
FLORA AND FAUNA			
Tetratheca Juncea Conservation Area			
68	Prior to the commencement of construction, the Applicant shall: (i) undertake a survey of potential Tetratheca Juncea habitat in the southwest portion of the site. The survey shall: (a) be undertaken by a suitably qualified botanist, with the assistance of a suitably qualified surveyor, both approved by the Director-General; (b) re-examine the outcomes of previous surveys; (c) be undertaken between the months of August and December (inclusive); (d) record the location of Tetratheca Juncea clumps on the ground using suitable tags and by using either theodolite and electronic measuring equipment or differential GPS;	YES	(i) Figures 1 and 4 of the *Tetratheca Juncea Management Plan* show the Southwest Conservation Area. (a) a T. Juncea survey of the Conservation Area was undertaken by Gunninah Environmental Consultants and the aerial survey of the area was conducted by a qualified surveyor. (b) The results of previous T. Juncea surveys were assessed and collated with the current data for the preparation of the maps and T. Juncea Management Plan. (d) T. Juncea clumps have been located using GPS and surveyed onto the site maps in the T.Juncea Management Plan.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
FLORA AND FAUNA (Cont'd)			
Tetratheca Juncea Conservation Area (Cont'd)			
68 Cont'd	(e) investigate the occurrence of any native sonicating bee habitat within 500 metres of the Tetratheca Juncea population; and (ii) establish a Conservation Area for the Tetratheca Juncea based on the findings of the survey. The Conservation Area shall include a 50 metre buffer. The boundaries of the Conservation Area shall be surveyed and marked by a suitably qualified surveyor, with the assistance of a botanist, using either a theodolite and electronic measuring equipment or differential GPS. No clearing, construction or mining shall commence until the boundary of the Conservation Area has been approved by the Director-General.	YES	e) Bee habitat is discussed in Section 5.2.2 of the T. Juncea Management Plan. (ii) The southwest Conservation Area has been established with a 50 metre buffer to the closest area that may become part of the mine operations (see Figure 1 from the *Flora and Fauna Management Plan*). The area is pegged but not fenced.
69	The Applicant shall prepare a Management Plan for the Tetratheca Juncea Conservation Area in consultation with OEH and to the satisfaction of the Director-General, prior to commencement of construction. The Plan shall be consistent with the *Flora and Fauna Management Plan* (Conditions 76-79); and include measures for fire management. The Applicant shall clearly mark the boundary of the Conservation Area and make provision for signage which specify that no dumping, clearing or other works are permitted in the Conservation Area. Such signage shall be replaced as required. The Applicant shall make copies of the *Tetratheca Juncea Management Plan* available to OEH, Councils and the Community Consultative Committee within 14 days of approval by the Director-General.	YES	NPWS provided correspondence advising they were satisfied with the T Juncea Management Plan in November 2000. The property boundary of the Conservation Area is fenced along John Renshaw Drive and the T.Juncea areas are pegged but not fenced or signed. (The presence of a fence or signage around the specific areas of T.Juncea would highlight their location and result in unwanted attention and possibly vandalism to the area). The current status of the Conservation Area indicates that there is no intrusion of work areas or other disturbance to the T.Juncea locations. A biologist monitors the T.Juncea areas to keep records of the status of growth and flowering.
70	Within six months of this Consent, or as otherwise agreed by the Director-General, the Applicant shall identify a bushland area(s) in the region that will adequately compensate for the impact of the mine on biodiversity, provide compensatory habitat and be managed for the primary purposes of conservation. The area shall be identified in consultation with OEH and Councils and be to the satisfaction of the Director-General. Identification of the bushland area(s) shall include: (i) a detailed assessment of the current characteristics and ecological values of existing ecosystems affected by the mine, including the habitat of threatened species identified in the EIS as possibly occurring in the area and the Spotted Gum Ironbark community; (ii) identification of conservation objectives to be achieved by the establishment of the bushland area(s), with reference to the *Regional Biodiversity Strategy* and the principles of Ecologically Sustainable Development;	YES	(i) A detailed assessment of the current flora and fauna and habitat values of the mine site was conducted by Barker Harle in 2001. (ii) The *Bushland Area Management Plan* was prepared and submitted to the Director-General in 2005 for approval. The Plan included identification of conservation objectives. (iii) NPWS provided Donaldson Mine with a number of compensatory bushland areas to consider in 2001. Donaldson assessed inclusion of land around the mining lease, and have established the Conservation Area for bushland protection, within the mine lease area.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Tetratheca Juncea Conservation Area (Cont'd)			
70 Cont'd	(iii) consideration of alternative locations within the region, including, but not limited to, the land proposed as compensatory area in the EIS (i.e. land adjoining the mine site); (iv) a detailed assessment of appropriate boundaries, size and shape of the bushland area(s), in relation to the characteristics, values and objectives; (v) consideration of appropriate management options necessary to protect the conservation values; and (vi) consideration of opportunities to incorporate cultural heritage conservation into the bushland area(s).		
BUSHLAND AREA			
71	In identifying the bushland area(s), the following broad criteria shall be applied: (i) a ratio of 2:1 in terms of compensatory area to the area to be directly impacted by mining and associated infrastructure; (ii) the vegetation communities and habitat values of the bushland area(s) are to be broadly representative of the area which will be subject to mining and contain a similar suite of fauna species; (iii) the location of the bushland area(s) will aim to consolidate existing reserves in the lower Hunter Area; and (iv) reserve design criteria, including edge-to-area ratio, size and connectivity shall be taken into account.	YES	(i) The Donaldson owned property around the mine area has been retained as a buffer and compensatory conservation area. (ii) The compensatory area of bushland is adjacent to and surrounds the mining area and is representative of the vegetation communities and habitat present on the disturbed areas. (iii) The compensatory area around the Donaldson Mine is contiguous with the Ironbark-Spotted Gum vegetative corridors in the Maitland area.
72	Upon approval of the identified bushland area(s) by the Director-General, the Applicant shall: (i) secure care, control and management of the bushland area(s) prior to the commencement of mining; (ii) retain management and ownership of the land for a minimum of 36 years from the commencement of construction, unless other arrangements are agreed in accordance with Condition 73; and (iii) prepare and implement a Management Plan for that area in consultation with OEH and to the satisfaction of the Director-General, during the period in which the Applicant is responsible for management. The Management Plan shall be consistent with the *Flora and Fauna Management Plan* (Conditions 76-79) and consider the integration of cultural conservation objectives and management. The Applicant shall make copies of the Management Plan available to OEH and the Community Consultative Committee within 14 days of approval by the Director-General. For the purposes of the Conditions of this Consent, the bushland area(s) approved by the Director-General shall be known as the Bushland Conservation Area until the completion of the period referred to in Condition 72(ii) and any Conditions relating to Conservation Areas shall apply to that area during that period. The Management Plan referred to in Condition 72(iii) shall be referred to as the Bushland Conservation Area Management Plan.	YES	(i) The bushland area around the mine operations is owned by Donaldson Mine and managed as part of the overall land management strategies. (ii) See above. Management will continue until 2036. (iii) The *Bushland Conservation Area Management Plan* was developed in consultation with the NWPS and the Plan submitted to the Director-General on 31 October 2005. (Refer to MCoA 74).

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
BUSHLAND AREA (Cont'd)			
73	The Applicant shall undertake negotiations with the OEH and Councils to reach agreement on the long term tenure and management status of the Bushland Conservation Area. These negotiations must commence within six months of commencement of construction.	YES	Donaldson Coal provided information on the management of the proposed bushland conservation area to NPWS in May 2001 and undertook consultation and negotiations with the authorities. A Draft Plan of Management for the Bushland Conservation Area was presented to the D-G in February 2005 and the Plan revised and submitted to the D-G in October 2005. Studies by DEC during 2006 in preparation for the *Draft Lower Hunter Conservation Plan* (LHCP), which was to be released together with the final LHRS, identified parts of the Donaldson land for conservation reserve and bio-banking investment (NAPS Map). The identified conservation land does not align exactly with the Donaldson Bushland Conservation Area. Donaldson, along with other Lower Hunter major landowners, was formally requested by DEC to consider dedication of lands for conservation in the reserve system prior to announcement of the final LHRS and Draft LHCP. Donaldson presented a formal proposal to DEC in late 2006, and discussions with B&CD are continuing for a major portion of the Donaldson land to be dedicated as conservation reserve or nominated as Bio-banking investment area. The likely outcome of the intensive investigations described above is that some 400-500 hectares of the Donaldson land may be placed in permanent conservation (via either the reserve system or bio-banking) and the remainder of the land will be zoned consistent with the final LHRS.
74	Prior to 31 October 2005, the Applicant shall revise the *Bushland Conservation Area Management Plan* to compensate for the extension of the disturbance area in the vicinity of Weakleys Flat Creek, to the satisfaction of the Director-General, and provide an updated Plan to the OEH, Councils and the Community Consultative Committee.	YES	The *Bushland Conservation Area Management Plan* was prepared and revised following consultation with the NPWS/OEH.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
BUSHLAND AREA (Cont'd)			
74A	By 30 September 2011, the Applicant shall revise the *Bushland Conservation Area Management Plan* to the satisfaction of the Director-General. The revised plan must: (i) be prepared in consultation with OEH; and (ii) include the 3 hectares of land removed from the approved mining area, as detailed in the letter from Donaldson Coal Pty Limited to the Minister for Planning dated 25 March 2011.	Yes	The *Bushland Conservation Area Management Plan* was prepared, submitted to OEH 22 September 2011 and revised following consultation with the NPWS/OEH. The map of the bushland conservation area was updated to compensate for the extension of the disturbance area in the vicinity of Weakleys Flat Creek.
Flora and Fauna Management			
75	The Applicant shall bear the reasonable costs of the appointment by the Director-General of an independent flora and fauna expert(s) to assist in the implementation of the Conditions of this Consent. The independent expert(s) shall: (i) be selected in consultation with the applicant; (ii) assess and advise the Director-General on the Applicant's proposed Conservation Areas and Management Plans for those areas; (iii) assess and advise the Director-General on the Applicant's proposed bushland area(s); (iv) assess and advise the Director-General on the Applicant's proposed Flora and Fauna Management and the Rehabilitation Plan; and (v) assess and advise the Director-General on the Applicant's monitoring of flora and fauna management and rehabilitation.	Planning NSW - condition of approval	Robert Payne was commissioned as an independent flora and fauna expert by Director-General to assess and advise on the flora and fauna management for the Donaldson Mine proposed conservation areas and flora and fauna management plans.
76	The Applicant shall prepare and implement a *Flora and Fauna Management Plan* for the mine site (in addition to the management plans for specific Conservation Areas), in consultation with NOW, OEH and Councils, and to the satisfaction of the Director-General, prior to the commencement of construction. The Applicant shall make copies of the *Flora and Fauna Management Plan* available to NOW, OEH, Councils and the Community Consultative Committee within 14 days of approval by the Director-General.	YES	The *Flora and Fauna Management Plan* was prepared and approved by DUAP in December 2000. The *Flora and Fauna Management Plan* was implemented for the Donaldson Mine site and the Plan reviewed in 2007 and 2019. The flora and fauna monitoring programs have been conducted and results summarised in the AEMR's / Annual Reviews.
77	The *Flora and Fauna Management Plan* shall include but not be limited to: (i) additional surveys to more precisely identify the distribution of known and potential nest and roost trees for owl species. The surveys shall: (a) be undertaken by a person experienced in the identification of owl nest and roost trees, approved by the Director-General; and (b) record the location of known and potential nest and roost trees on the ground by marking the tree and by using either theodolite and electronic measuring equipment or differential GPS; (c) a vegetation map delineating major vegetation communities, topographic features and the location of threatened species habitats, including potential and known owl nest and roost trees;	YES	(i)(a) Additional surveys of owl habitat were conducted by Rod Kavanagh on the Donaldson Mine site during Sept - Oct 2000. (ii) Figure 4-1 and 4-3 in the *Flora and Fauna Management Plan* present vegetation communities and locations of threatened species habitats on the Donaldson Mine site.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Flora and Fauna Management (Cont'd)			
77 Cont'd	(ii) details of measures to manage the impacts of the development, including: (a) restoration of degraded areas; (b) management of invasive weeds and feral animals; (c) establish an appropriate hazard reduction regime in keeping with the ecological values of the area; (d) revegetation and provision of compensatory areas of equivalent ecological and habitat value where necessary; and (e) strategies to provide increased security for existing habitats and communities; iii) details of measures to manage the impacts of environmental management on flora and fauna, including the impact of erosion and sediment control measures and hazard reduction burning; (v) priorities for action and a timetable for all works outlined in the Plan; and (vi) a program to monitor flora and fauna impacts on undisturbed portions of the mining lease area and downstream environments (such as the Woodberry Swamp). The program shall extend for the life of the mine and for a period thereafter as approved by the Director-General, and include: (a) justification for monitoring intervals and locations; (b) monitoring of the presence and persistence of native flora and fauna species over time, particularly threatened species; and (c) monitoring the effectiveness of management measures.	YES	(iii)(a) Degraded area restoration procedures are presented in the *Rehabilitation Plan* Dec 2000 section 4.3.7. (iii)(b) Weed management and feral animal control are presented in the *Rehabilitation Plan* sections 5.2 and 5.3. (iii)(c) Hazard reduction addressed in the *Rehabilitation Plan* Section 5.4, and the *Bushfire Management Plan*. (iii)(d) See comments on MCoA 71 to 74. (iii)(e) Protection strategies for existing habitats and communities include pre-clearing surveys of all areas to be disturbed, fenced perimeter of the mine lease area, and the *Flora and Fauna Management Plan* Section 4. (v) The priorities for action in relation to protection of flora and fauna are outlined in Section 7 of the 2019 *Flora and Fauna Management Plan.* (vi) Section 5 of the 2019 *Flora and Fauna Management Plan* describes the proposed monitoring programs.
78	The Flora and Fauna Management Plan shall also include a Rehabilitation Plan that details the measures to be undertaken to progressively rehabilitate disturbed areas of the mine to replicate the original vegetation cover that existed before mining occurred. The Applicant shall be responsible for the management and monitoring of the rehabilitated mine site until such time as the Director-General agrees that restoration has been successful.	YES	The *Rehabilitation Management Plan* was updated in 2019 and is presented as Appendix 1 in the 2019 Flora and Fauna Management Plan and as a separate document on the Company website.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Flora and Fauna Management (Cont'd)			
78A	By 31 October 2011, the Applicant shall revise the *Rehabilitation Plan* to the satisfaction of the Director-General. The revised plan must: (i) be prepared in consultation with DRE; (ii) include: • the rehabilitation objectives for the site; • a strategic description of how the rehabilitation of the site would be integrated with surrounding land uses; • a general description of the short and long term measures that would be implemented to rehabilitate the site, including; – managing remnant vegetation and habitat on site; – minimising impacts on fauna; – minimising visual impacts; – conserving and reusing topsoil; – controlling weeds, feral pests, and access; and – managing bushfires; • detailed performance and completion criteria for the rehabilitation of the site; • a detailed description of how the performance of the rehabilitation works would be monitored over time to achieve the stated objectives and against the relevant performance and completion criteria; and • details of who is responsible for monitoring, reviewing and implementing the plan.	Yes	The *Rehabilitation Plan* was also addressed as part of the current MOP (period ending 1 May 2021) for the Donaldson Mine and was prepared in consultation with the (then) DRE and includes: • Section 5.2 Domain Rehabilitation Objectives; • Section 5 *Rehabilitation Planning and Management* provides a strategic description of integration of the rehabilitation of the site with surrounding land uses; • Section 7 *Rehabilitation Implementation* describes the short and long term measures to be implemented to rehabilitate the site; • performance and completion criteria for rehabilitation; • Section 8 *Rehabilitation Monitoring* addresses monitoring performance of the rehabilitation works over time to achieve stated objectives and against performance and completion criteria; and • responsibilities for monitoring, reviewing and implementing the plan. The new *Rehabilitation Management Plan* prepared in accordance with the Resources Regulator's Operational Rehabilitation Reform also addresses these matters and replaces the previous MOP.
79	The Applicant shall revise the *Flora and Fauna Management Plan* as necessary and provide an updated Plan five years after commencement of mining to the Director-General, OEH, Councils and the Community Consultative Committee.	YES	The *Flora and Fauna Management Plan* was reviewed by Ecobiological in March 2007 and a *Revised Flora and Fauna Management Plan* submitted to DoP on 17 July 2007. DoP approved the revised Plan on 25 July 2007. A further revision to reflect care and maintenance was prepared on 3 June 2019 and approved by the (then) DPE 4 June 2019.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Flora and Fauna Management (Cont'd)			
80	The Applicant shall participate in (and if appropriate, contribute such reasonable funds as determined by the Director-General in consultation with OEH) research into the Powerful Owl and Masked Owl habitat requirements in the region, and the habitat requirements and lifecycle of *Tetratheca Juncea.*	YES	Donaldson Mine supported projects by the University of Newcastle with financial and technical help for: Deborah Landenberger - 2 year Honours project 'Defining the Niche of T. Juncea'; and Adam Blundell with Rod Kavanagh during 2002-2003 for 'Comparing Ecology of Powerful Owl in Disturbed and Undisturbed Environments'. Both these projects have been completed.
HERITAGE			
Heritage Statutory Requirements			
81	Prior to commencement of construction, the Applicant shall: (i) comply with the statutory requirements of OEH in relation to works affecting Aboriginal sites; and (ii) undertake a targeted archaeological survey of the slopes component within the mining impact area in cooperation with the Aboriginal community. Any Aboriginal sites located will be recorded, the significance of the sites assessed, and management strategies for the sites identified.	YES	Management of the Aboriginal heritage sites occurs in accordance with the *Aboriginal Sites Management Plan* and the status of management is reported in the respective AEMR / Annual Review.
82	If, during the course of construction, the Applicant becomes aware of any heritage or archaeological material, all work likely to affect the material shall cease immediately and the relevant authorities consulted about an appropriate course of action prior to recommencement of work. The relevant authorities may include OEH, the Heritage Office, and the Local Aboriginal Land Councils. Any necessary permits or consents shall be obtained and complied with prior to recommencement of work.	YES	Section 90 Consents to Destroy under the *National Parks and Wildlife Act 1979*, were obtained for Aboriginal artefact areas DMS1 on 22 April 2000 and ISF1 and ISF2 on 3 May 2000. No further Section 90 Consents have been required since that time.
Aboriginal Heritage Management			
83	Prior to commencement of construction, the Applicant shall establish an Aboriginal Conservation Area along Four Mile Creek and tributaries in accordance with a plan approved by the Director-General. The plan shall include: (i) identification of an appropriate boundary and the basis on which the boundary has been selected; (ii) a map at a scale of 1:1 000 or larger which clearly delineates the Conservation Area boundary and specific features; and (iii) documentation of consultations with OEH and Aboriginal community groups in relation to the definition of the Conservation Area.	YES	(i) A 50 metre buffer along Four Mile Creek as an Aboriginal Conservation Area (ACA) has been established by Donaldson Coal. The ACA boundary is shown in Figure 2.3 of the *Aboriginal Sites Management Plan*. ii) Maps of the Four Mile Creek Conservation Area and other Conservation Areas (1:1 000 scale) have been prepared by Donaldson Coal for the Donaldson Mine area. (iii) Consultation with the Mindaribba Aboriginal Local Land Council was held during the preparation of the *Aboriginal Sites Management Plan*. NPWS consultation and correspondence was available on file.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
Aboriginal Heritage Management (Cont'd)			
84	The Applicant shall prepare and implement an *Aboriginal Sites Management Plan* in consultation with the Aboriginal community, Councils and OEH, and to the satisfaction of the Director-General, prior to the commencement of construction. The Applicant shall make copies of the *Aboriginal Sites Management Plan* available to the Director-General, Aboriginal community, Councils and the Community Consultative Committee within 14 days of approval by OEH.	YES	An *Aboriginal Sites Management Plan* was prepared prior to commencement of mining operations in 2000, with Supplementary Plans prepared for Years 2 to 5 of the operations. The *Aboriginal Sites Management Plan* has been submitted to the relevant authorities within 14 days of approval by the NPWS. The *Aboriginal Sites Management Plan* has not required revision since 2005.
85	The Management Plan shall include, but not be limited to: (i) documentation of consultation with the relevant Aboriginal community groups to identify any outstanding concerns they may have with the project and a clear statement about how these concerns will be addressed, including any action to be taken; (ii) identification of conservation objectives for the site as a whole and for the Conservation Area specifically; (iii) a program to monitor the impacts of the development on the Conservation Area, including justification for monitoring locations and intervals; (iv) strategies to achieve conservation objectives, including an access policy; (v) the provision of fencing to permit faunal movement and the removal of fencing within six months of completion of mining; (vi) further investigations; and (vii) long term management requirements upon completion of mining.	YES	(i) Consultation with the Mindaribba Aboriginal Local Land Council is addressed in the Plan with relevant correspondence attached in Appendix 1 of the Plan. (ii) Conservation objectives are addressed in Section 1.3 of the *Aboriginal Sites Management Plan*. (iii) Monitoring of the Conservation Area is outlined in Section 2.1 and 3 of the *Aboriginal Sites Management Plan*. The location of the monitoring datum points are illustrated in Figure 2.4 of the Plan. (iv) Strategies to achieve the conservation objectives are outlined in Section 2 of the *Aboriginal Sites Management Plan*. (v) The boundary of the Mining lease area and the Donaldson owned land is fenced. (vi) The mining lease area was re-surveyed for Year 2 to 5 of the mining operations. Ongoing monitoring and surveys will occur prior to disturbance of any new areas required for mining.
86	The Applicant shall revise the *Aboriginal Sites Management Plan* as necessary and provide an updated Plan five years after commencement of mining to the Director-General, OEH, Councils and the Community Consultative Committee.	YES	The *Aboriginal Sites Management Plan* was subjected to annual review until 2005 and amendments to the Plan made by Umwelt as required. The Plan has not required revision since 2005.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
WASTE			
87	The Applicant shall prepare and implement a *Waste Management Plan* in consultation with OEH, DRE and the Hunter Waste Planning and Management Board, and to the satisfaction of the Director-General, prior to commencement of construction. The Applicant shall make copies of the *Waste Management Plan* available to Councils and the Community Consultative Committee within 14 days of approval by the Director-General.	YES	The *Waste Management Plan* was prepared prior to commencement of construction of the mine. The Plan was submitted to DUAP and approved on 10 October 2000. Copies of the *Waste Management Plan* were distributed to the Councils and the CCC, within 14 days of approval by the Director-General.
88	The *Waste Management Plan* shall include, but not be limited to the management of the mine site to prevent dumping of waste; and the management and treatment of Potentially Acid Forming waste.	YES	Management of waste streams including overburden, coarse rejects material and fine reject material is included in Section 7 of the *Waste Management Plan*. The management and treatment of potential acid forming (PAF) material is addressed in the geotechnical report and there is ongoing assessment of PAF material to ensure application of best practice management options.
89	The Applicant shall meet the requirements of Councils, OEH and Hunter Water Corporation with respect to water and sewer.	YES	Potable water for use on the mine site is supplied from the Hunter Water Corporation. There is no discharge to sewer from the site operations. All ablutions are connected to onsite biocycle systems.
VISUAL AMENITY			
Landscaping			
90	The Applicant shall provide a minimum of 50 metres of landscaping between the outer edge of the bund wall and the edge of John Renshaw Drive. The 50 metres may include landscaping within the road verge if agreed by Cessnock Council.	YES	The *Landscape Management Plan* has been implemented with revegetation of the 50m strip along the power-line easement between John Renshaw Drive and the earthen bund on the edge of the high-wall of the open cut. The *Landscape Management Plan* was reviewed and revised in March 2008 by GSS Environmental. The 2008 *Landscape Management Plan* is an integrated plan for all the Donaldson Coal projects (i.e. the Donaldson Mine, Tasman Mine and Abel Mine).
91	The Applicant shall, within three months of the date of this Consent, or within such further period as Councils may require, submit for the Councils' approval a detailed Landscaping Plan covering all land within the proposed mining area (including the haul road and transmission line easements) and road reserve along the frontage to John Renshaw Drive. The Applicant shall engage a suitably qualified person to assist in the landscaping plan.	YES	

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
VISUAL AMENITY (Cont'd)			
Landscaping (Cont'd)			
92	The Landscaping Plan shall be consistent with the *Environmental Management Strategy* and include: (i) provision for the establishment of trees and shrubs and the construction of mounding or bunding along the planned highwall and any other areas identified as necessary by the Councils for the maintenance of satisfactory visual amenity and the re-establishment of flora and fauna habitats and corridors; (ii) appropriate erosion control and sediment control practices for earthworks associated with the landscaping; (iii) details of the visual appearance of all buildings, structures, facilities or works (including paint colours and specifications). Buildings and structures shall be designed and constructed so as to present a neat and orderly appearance and to blend as far as possible with the surrounding landscape; and (iv) details, specifications and staged work programs to be undertaken, including a maintenance program of all landscape works, building materials and cladding.	YES	The *Landscape Management Plan 2000* addresses the establishment of trees and shrubs for visual amenity and re-establishment of flora and fauna corridors in Section 4.3. The *Landscape Management Plan 2000* addresses erosion and sediment control in Section 4.3 and refers to the Erosion and Sediment Management Plan. The *Landscape Management Plan 2000* addresses the visual appearance of buildings, structures, facilities and works in Section 4.0. The *Landscape Management Plan 2000* addresses the staged work programs for maintenance program of all landscape works, building materials and cladding in Section 4.2
93	The Applicant shall implement the approved Plan in accordance with Councils' requirements and make copies available to the Community Consultative Committee within 14 days of approval by Councils.	YES	Copies of the *Landscape Management Plan 2000* were provided to the CCC following approval by the Councils 9 March 2000. The revised *Landscape Management Plan* was submitted to the CCC in 2008.
94	The Applicant shall plant screening vegetation on properties at higher elevation and with views across the mine site in the Black Hill area if requested in writing by the landowner, within three months of that request. The species, density and location of the plantings shall be determined in consultation with the landowner.	Not activated	No such requests received.
95	The Applicant shall lodge a landscaping bond with Cessnock Council, to a maximum of $10,000 at any one time, for landscaping during the life of mine. This bond does not affect rehabilitation works covered by the *Mining Act*.	No Longer Applicable	Landscaping bond of $10,000 was lodged with the Cessnock City Council on 19 April 2007.This bond was previously refunded due to the satisfactory completion of the works.
Lighting			
96	The Applicant shall screen or direct all onsite lighting and vehicle lights away from residences and roadways to the satisfaction of Councils. All screening to be completed prior to commissioning of the coal preparation plant and associated facilities.	YES	Lighting from site activities has not given rise to complaints. No lighting is used on high points at night and no light scatter occurs to roadways or residential areas from the Donaldson Mine operations.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
HAZARDS, RISKS AND SAFETY			
97	The Applicant shall: (i) provide adequate fire protection works on site. This shall include one fully equipped fire fighting unit on standby and hazard reduction works at a time determined by the relevant Council, with particular attention to boundaries of adjoining land holdings;	YES	(i) Meetings have been held between Donaldson Mine and the Cessnock City Council / Thornton Fire Rural Fire Brigade/ Benwerrin Rural Fire Brigade in relation to access to the mine site in case of fire.
	(ii) submit an annual report on fire management activities to the local Bush Fire Management Committee; and	YES	(ii) A *Bushfire Management Plan* for the areas owned by Donaldson Coal was prepared in 2004 and submitted to the Rural Fire Service for review. Following a site inspection the RFS provided comments and the Plan was updated and finalised. A report on controlled burn-off at the Donaldson site was forwarded to the RFS for inclusion in the Bush Fire Management Committee folder in Oct 2005. Hazard burning is conducted on the Donaldson Mine site and reported to the Bushfire Management Committee by the RFS. Mechanical works along the southern and eastern sections of the Avalon Estate at Thornton is also carried out annually by Donaldson and reported to RFS. An inspection of the Donaldson Mine site with the RFS is conducted at least annually.
	(iii) ensure that all dangerous goods and materials stored on site are stored in accordance with the relevant Australian standards.	YES	Fuels and lubricants are no longer stored within the Donaldson Open Cut Coal Mine area.
UTILITIES AND SERVICES			
98	The Applicant shall consult with affected service authorities and make arrangements satisfactory to those authorities for the protection or relocation of utilities and services (such as transmission lines and pipelines) at the Applicant's expense, prior to any existing utilities or services being affected by mining activity. Relocation of utilities and services shall be conducted in accordance with the relevant Management Plans and the Erosion and Sediment Control Plan(s).	YES	The Energy Australia 11kV power-line was relocated along an easement adjacent to the John Renshaw Drive boundary of the mine lease, in 2002. Part of the Hunter Water Corporation water pipeline was relocated for the progression of the Donaldson Mine, in accordance with the (then)MOP. Telstra lines off the new intersection on John Renshaw Drive were relocated in 2006.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
99	Prior to commencement of construction, or as otherwise agreed by the Councils, the Applicant shall design, construct and seal the private haul road and access road to the satisfaction of the Councils, and with consideration of the impact on the fragmentation of fauna habitat and fauna movement.	YES	The internal haul road was constructed from Donaldson Mine to Bloomfield CPP and Coal Loader in 2001. Cessnock City Council advised it did not require to approve the road construction as it was an internal haul road. The *Flora and Fauna Management Plan* included pre-clearing protocol, road design and general measures covering erosion and sediment control, removal of weeds and rubbish, and incident reporting that were applied to the construction of the road.
100	No coal shall be hauled on public roads.	YES	No coal is transported on public roads.
TRANSPORT AND ACCESS			
101	The Applicant shall carry out intersection improvements as determined necessary by the Regional Traffic Committee as a result of the development and by such times as directed by the Regional Traffic Committee.	YES	A Development Application was submitted to the Cessnock City Council for the John Renshaw Drive intersection in November 2001. The Hunter Regional Traffic Committee considered the DA and recommended a number of changes, and the plan was amended and re-submitted to the Council. The Council re-exhibited the DA and granted consent in July 2003. The intersection from John Renshaw Drive to the Donaldson Mine access road was completed in accordance with the consent.
102	If closure of John Renshaw Drive is agreed by the Regional Traffic Committee under Condition 25(4), the Applicant shall: (i) pay $20,000 to Cessnock City Council to upgrade the alignment and surface of the unsealed western end of Black Hill Road; (ii) provide a water cart and apply water to the unsealed western end of Black Hill Road to the requirements of Cessnock City Council prior to each closure of John Renshaw Drive for blasting; and (iii) prepare a *Traffic Management Plan* for the approval of the RTA in relating to the closure of John Renshaw Drive during blasting.	YES	The $20,000 contribution was provided to the Cessnock City Council in November 2004 for the upgrade of the western end of Black Hill Road. The improvements to Black Hill Road were completed by Cessnock City Council. The improvement of the Black Hill Road intersection with a John Renshaw Drive turning lane, was constructed during 2010 as part of the Abel Underground approval. Donaldson received a Road Occupancy Licence for the closure of John Renshaw Drive during blasting.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
INITIAL COAL WASHING (Cont'd)			
103	The Applicant shall provide for signalling of the Bloomfield rail loop to the satisfaction of Freight Corp prior to the commencement of mining.	YES	Freightcorp correspondence provided options for implementation of safe working procedures for the rail loop to satisfy MCoA 103. Bloomfield upgraded the rail system alarm signals on the Entry road to the mines, from the old key system. The management of trains on the loop has been upgraded with implementation of safe work practices.
INITIAL COAL WASHING			
104	Upon commencement of coal extraction, the Applicant shall initially make use of the coal preparation plant (CPP) at the adjoining Bloomfield coal mine for up to two years from commencement of mining or such other period as approved by the Director-General. This will allow the Applicant to: (i) trial the washing of Donaldson coal to assist in the determination of its washing characteristics; and (ii) commence the earliest possible coal extraction at Donaldson, and hence hasten project completion.	YES	Approval for the ongoing use of the Bloomfield CPP is now in place under the Abel Mine consent with an extended agreement between Bloomfield Coal and Donaldson Coal.
105	The haulage route for raw coal from the Donaldson pit to the Bloomfield CPP shall be the same as that proposed for haulage of product coal from the proposed Donaldson CPP to the existing Bloomfield rail loading facility up to the point of intersection with the Bloomfield Mine access road, and thence westward along the Bloomfield Mine access road to the CPP, unless otherwise agreed to with the owners of Bloomfield. However, any variation to the route shall be considered to determine whether a modification to this Consent is required to enable the variation.	YES	Donaldson Coal constructed an internal sealed haul road to transport ROM coal to the Bloomfield CPP, the road alignment crossing Four Mile Creek.
106	The Applicant shall notify the Director-General within eighteen months of the commencement of mining as to the results of the Bloomfield washery trials.	YES	See comment on MCoA 104.
COMMUNITY INVOLVEMENT			
Community Consultative Committee			
107	The Applicant shall establish a Community Consultative Committee which shall be chaired by an independent chairperson approved by the Director-General. Selection of representatives shall be agreed by the Director-General and include (unless otherwise agreed by the Director-General) two representatives from the Applicant (including the Environmental Officer), four community representatives (including a representative of the local Aboriginal Community) and representatives of the local Councils. Representatives from relevant government agencies (including DUAP) may be invited to attend meetings of the Committee as required.	YES	The CCC was established on 30 May 2000 and meetings have been held regularly during operations. As the mine has ceased operations and been rehabilitated, no further meetings are currently planned.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
COMMUNITY INVOLVEMENT (Cont'd)			
Community Consultative Committee (Cont'd)			
108	The Committee may make comments and recommendations about the implementation of the development. The Applicant shall ensure that the Committee has access to the necessary plans and/or studies for such purposes. The Applicant shall consider the recommendations and comments of the Committee and provide a response to the Committee and the Director-General.	YES	Management Plans have previously been provided to the CCC for comment and information. Discussion of management plans occurred at the CCC meetings.
109	The Applicant shall, at its own expense: (i) provide appropriate facilities for meetings of the Committee;	YES	CCC Meetings were previously held at Donaldson Mine offices. Donaldson arranged and provided the required material and administrative backup for the meetings.
	(ii) nominate a representative to attend all meetings of the Committee;	YES	Donaldson Coal nominated representative to attend all meetings is the Environmental Manager-Phillip Brown.
	(iii) ensure that the first meeting is held prior to commencement of construction, that meetings are held at least every six months for the first 24 months from the date of the mining lease and at least annually thereafter;	YES	The first meeting of the CCC was held on 30 May 2000 prior to commencement of construction and subsequent meetings were held on a regular basis. The meetings were arranged by the Independent Chairperson as required.
	(iv) provide to the Committee regular information on the progress of the work and monitoring results;	YES	Reports on project status, monitoring results and AEMR's/Annual Reviews and complaints are provided to the CCC and published on the Company website.
	(v) promptly provide to the Committee such other information as the Chairperson of the Committee may reasonably request concerning the environmental performance of the development; and	YES	Material is provided to the CCC as and when requested as detailed in the CCC Minutes.
	(vi) provide reasonable access for site inspections by the Committee.	YES	Site inspections by members of the CCC to view the mine and rehabilitation areas, following CCC Meetings.
110	The Applicant shall establish a trust fund to be managed by the Chairperson of the Committee to facilitate functioning of the Committee, and pay $2,000 per annum to the fund for the duration of mining operations. The payment shall be indexed according to the Consumer Price Index (CPI) at the time of payment. The first payment shall be made by the date of the first Committee meeting.	YES	A trust fund for the functioning of the CCC was established in May 2000 and has been managed by the Independent Chairperson. Donaldson Coal provides all the requirements for the CCC Meetings with any additional funding reported to be provided upon request by the Chairperson.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
COMMUNITY INVOLVEMENT (Cont'd)			
Community Information			
111	The Applicant shall, in consultation with Councils, ensure that the local community is kept informed of the progress of the project, including prior notice of: (i) the nature of works proposed for the forthcoming period; (ii) hours of construction; (iii) a 24 hour contact telephone number; (iv) any traffic disruptions and controls; (v) proposed blasting program, and any changes to the program; (vi) work required outside the normal working hours; (vii) individuals' rights under the Conditions of this Consent (such as the rights for acquisition or independent monitoring) and mechanisms proposed to be used to safeguard the community and individual properties against adverse impacts from the development.	YES	Since June 2003, community information has been made available on the Donaldson website.
112	By 30 September 2011, the Applicant shall: (i) make copies of the following publicly available on its website: • all relevant statutory approvals for the development; • all approved strategies, plans and programs required under the conditions of this consent; • monitoring results, reported in accordance with the specifications in any approved plans or programs required under the conditions of this consent or any other approval; • a complaints register, which is to be updated on a monthly basis; • minutes of CCC meetings; • the Annual Environmental Management Reports required under condition 114; • any independent environmental audit of the development, and the Applicant's response to the recommendations in any audit; • any other matter required by the Director-General; and (ii) keep this information up-to-date, to the satisfaction of the Director-General.	YES	Donaldson website has been established and information on the CCC, monitoring and company status and activities is available on the site, including Minutes of the CCC Meetings, AEMR's / Annual Reviews and any project Newsletters.
Complaints			
113	(1) The Applicant shall record details of all complaints received and ensure that a response is provided to the complainant within 24 hours. (2) If the Applicant's response does not address the complaint to the satisfaction of the complainant within six weeks, the Applicant shall refer the matter to an independent mediator (approved by the Director-General) and bear the costs of such mediation. The Applicant shall immediately carry out such works as agreed through the mediation process. (3) The Applicant shall make available a 3 monthly report on complaints to the Community Consultative Committee and to relevant government agencies and the Councils upon request; and include a summary in the AEMR. The report shall include the complaints that have been resolved with or without mediation.	YES	(1) The Complaints Register is on a database held at the Donaldson Mine office and maintained by the Environment Manager. (2) This requirement of the condition had not been activated at the time of the audit. (3) A Complaints Report was prepared and presented to the CCC at each meeting. A summary of complaints/actions/status is presented in the AEMR's / Annual Reviews.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
ANNUAL ENVIRONMENTAL MANAGEMENT REPORT			
114	The Applicant shall prepare and submit an Annual Environmental Management Report (AEMR) throughout the life of the mine to the satisfaction of the Director-General. The AEMR shall review the performance of the mine against the *Environmental Management Strategy* and the Conditions of this Consent, and other licences and approvals relating to the mine. To enable ready comparison with the EIS's predictions, diagrams and tables, the report shall include, but not be limited to, the following matters:	YES	The AEMR's / Annual Review have been prepared in accordance with the relevant guidelines and submitted to the DPE and Resources Regulator.
	(i) an annual compliance audit of the performance of the project against Conditions of this Consent and statutory approvals; (ii) a review of the effectiveness of the environmental management of the mine in terms of OEH, NOW, DRE, and the Councils' requirements and provide an explanation of any variance; (iii) results of all environmental monitoring required under this Consent or other approvals, including interpretations and discussion by a suitably qualified person; (iv) identification of trends in monitoring results over the life of the mine; (v) a comparison of the actual impacts with predictions made in the EIS and supporting documents; (vi) a review of the social impact of the mine, including mitigation works and acquisition; (vii) a listing of any variations obtained to approvals applicable to the subject area during the previous year; (viii) the outcome of the water budget for the year, the quantity of water used from water storages and details of discharge of any water from the site; (ix) rehabilitation report; and (x) environmental management targets and strategies for the next year, taking into account identified trends in monitoring results.	YES	(i) Compliance Audit conducted by Donaldson Mine in August 2001. Compliance with the conditions of consent is commented on in each AEMR / Annual Review. (ii) Commented on throughout the Annual Review. (iii) Environmental monitoring data included in the Annual Review in the relevant sections. (iv) Trends in monitoring data are presented under each specific heading in Sections 6 & 7 of the Annual Review. (v) Comparison with the EIS predictions for the development are provided in each AEMR / Annual Review. (vi) No acquisition requests have been made to the time of this audit. Mitigation measures are part of the normal mine operation. (vii) Approval status is summarised in Section 3 of the Annual Review viii) Water management is reported in Section 7 of the Annual Review. (ix) Rehabilitation progress is reported in Section 8 of the Annual Review. (x) Targets and strategies for the next 12 months are reported in Section 12 of the Annual Review.
115	In preparing the AEMR, the Applicant shall: (i) consult with the Director-General during preparation of each report for any additional requirements; (ii) comply with any requirements of the Director-General or other relevant government agency and with any guidelines current at the time of reporting; and (iii) ensure that the first report is completed and submitted within 12 months of this Consent, or at a date determined by the Director-General in consultation with the DRE and the OEH.	YES	Actions / requirements raised by DPE and Resources Regulator from previous Annual Review have been summarised and addressed within this Annual Review (Section 5).

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
ANNUAL ENVIRONMENTAL MANAGEMENT REPORT (Cont'd)			
116	The Applicant shall ensure that copies of each AEMR are submitted at the same time to DP&I, OEH, NOW, Councils and the Community Consultative Committee, and made available for public information at Councils within 14 days of submission to these authorities.	YES	Copies of the previous AEMR's / Annual Reviews prepared for the Donaldson Mine have been submitted to the authorities following receipt of acceptance of the document by the (then) DII (or DPI-MR) and the Director-General. The AEMR's / Annual Reviews are made publicly available on the Company website.
INDEPENDENT ENVIRONMENTAL AUDIT			
117	At 3 yearly intervals after the commencement of mining and at the completion of mining, unless the Director-General directs otherwise, the Applicant shall commission and pay the full cost of an Independent Environmental Audit of the development.	YES	An Independent Environmental Audit was conducted in March 2015 by Trevor Brown & Associates to fulfil the requirements of MCoA 117. The (then) DPE confirmed via email on 31 October 2018 that no further audits are required unless otherwise directed by the Secretary.
	This audit must: (i) be conducted by a suitably qualified, experienced and independent person whose appointment has been endorsed by the Director-General; (ii) be consistent *with ISO 19011:2002 – Guideline for Quality and/or Environmental Systems Auditing*, or equivalent updated versions of these guidelines; (iii) assess the environmental performance of the development, and its effects on the surrounding environment; (iv) assess whether the development is complying with the relevant standards, performance measures and statutory requirements; (v) review the adequacy of the Applicant's *Environmental Management Strategy* and *Environmental Monitoring Program*; (vi) and if necessary, recommend measures or actions to improve the environmental performance of the development, and/or the environmental management and monitoring systems.	YES	The March 2015 audit was conducted by Trevor Brown of Trevor Brown & Associates Applied Environmental Management Consultants. The conduct of the 2015 audit was consistent with the requirements of ISO 19011. The environmental performance of the development was reviewed and comments are provided in Section 4 of the audit report. The development demonstrated a high degree of compliance with the standards, performance measures and statutory requirements relevant to the development (v) Comment on the *Environmental Management Strategy* and *Environmental Monitoring Program* are provided in Sections 4.1 and 4.2 of the audit report
118	The audit shall: (i) assess compliance with the requirements of this Consent, licences and approvals; (ii) review the effectiveness of the environmental management of the mine, and any mitigation works; (iii) be carried out at the Applicant's expense; and (iv) be conducted by a duly qualified independent person or team approved by the Director-General in consultation with the Councils.	YES	An Independent Environmental Audit was conducted in March 2015 by Trevor Brown & Associates to fulfil the requirements of MCoA 117 and 118.
119	The Director-General may, after assessing compliance in accordance with this Consent and after considering any submission made by the OEH,NOW, DRE, the Councils or the Community Consultative Committee on the report, notify the Applicant of any reasonable requirements for compliance with this Consent. The Applicant shall comply with those requirements within such time as the Director-General may require.	Noted	

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
COMPLIANCE			
120	The Applicant shall comply with all requirements of the Director-General in respect of the implementation of any measures arising from the Conditions of this Consent. The Applicant shall bring to the attention of the Director-General any matter that may require further investigation and the issuing of instructions from the Director-General. The Applicant shall ensure that these instructions are implemented to the satisfaction of the Director-General within such time that the Director-General may specify. If necessary, the Director-General may order the Applicant to cease work until non-compliance has been addressed to her satisfaction.	Noted	
121	The Applicant shall submit for the approval of the Director-General compliance reports concerning the implementation of Conditions of this Consent as applicable: (i) before the commencement of construction works; and (ii) before the commencement of mining.	YES	Compliance Reports were prepared and submitted to DUAP for construction of the Donaldson Mine on 20 October 2000, and a Compliance Report was submitted to DUAP prior to commencement of mining works on 17 January 2001.
Y2K COMPLIANCE			
122	One month prior to the commencement of operation of any automated system, included embedded systems used for operation, pollution control, monitoring and safety (including fire safety), the Applicant shall provide the Director-General with a report confirming that the system(s) has been tested in accordance with the most recent edition of BSI/DISC PD2000-1 to confirm continuous time and date functionality of that system.	YES	The Donaldson Mine commenced after 1 January 2000. Systems installed and operated for the Donaldson Mine are Y2K compliant.
DISPUTE RESOLUTION			
123	In the event that the Applicant and an individual, the Councils or a Government agency, other than DP&I, cannot agree on the specification or requirements applicable under this Consent, the matter shall be referred by either party to the Director-General or if not resolved within six months, to the Minister for Planning and Infrastructure, whose determination of the disagreement shall be final and binding on the parties.	Noted	The development consent was accepted by the parties and construction and commencement of mining occurred after 1 January 2000.

Table A3.1 (Cont'd)
Donaldson Development Approval – Compliance Review

Cond. No.	Minister's Conditions of Consent (MCoA)	Compliance	Comments/Notes
OTHER ISSUES			
124	The Applicant shall participate in (including a financial contribution if appropriate, to a maximum of $10,000) the preparation of a revised Planning Strategy for the Thornton-Beresfield area. Any such financial contribution shall be paid as directed by the Director-General and any amounts not expended in the review upon completion of mining shall be refunded to the Applicant.	Not activated	The Thornton-Beresford Area has been incorporated into the Lower Hunter Area and a Planning Strategy as an employment generating area with a transport internodal hub proposed for the area. Donaldson has participated in meetings associated with the Thornton-Killingworth study, *Lower Hunter Regional Strategy* and *Lower Hunter Conservation Plan*. Donaldson also made some financial contributions including analysis and participation in the planning of a Newcastle rail by-pass line through the Stony Pinch site. The *Lower Hunter Regional Strategy and Conservation Plan* is not yet finalised, but Donaldson Coal continues to be involved in discussions with the authorities on the Strategy and Plan.
125	The Applicant shall provide reasonable funding to Councils for independent counselling services for any landowner within 1.5 kilometres of the mining lease area who may request support on stress-related matters resulting from the development.	Not Activated	No requests have been made for the activation of this condition.
126	Within six months of the date of this Consent and in each AEMR thereafter, the Applicant shall report to the Director-General on the number of personnel employed by the mine in construction, mining and environmental management during that reporting period. The report shall compare the employment figures with those predicted in the EIS.	YES	As the mine is now on care and maintenance there are a total of eight full-time equivalent positions on site.

Table A3.2
Mining Lease 1461 – Compliance Review

Cond. No.	Requirement	Compliance	Comments/Notes
GENERAL CONDITIONS			
1	Notice to Landholders (a) Within 90 days from the date of grant or renewal of this mining lease, the lease holder must give each landholder notice in writing: (i) that this mining lease has been granted or renewed; and (ii) whether the lease includes the surface. The notice must include a plan identifying the lease area and each landholder and individual land parcel within the lease area. (b) If there are ten or more landholders to which notice must be given, the lease holder will be taken to have complied with condition 1(a) if a notice complying with condition 1(a) is published in a newspaper circulating in the region where the lease area is situated	Yes	The 2019 renewal application was approved 12 May 2023. The Company notified Hunter Water Corporation and Donaldson Coal of the renewal on 26 May 2023.
2	Security The lease holder is required to provide and maintain a security deposit to secure funding for the fulfilment of obligations under the mining lease, including obligations under the mining lease that may arise in the future. The amount of the security deposit to be provided has been assessed at $3,576,000.	Yes	The required security deposit has been established. A revised RCE was submitted as part of Rehabilitation Management Plan in July 2022. Awaiting DRNSW response.
3	Cooperation Agreement The lease holder must make every reasonable attempt, and be able to demonstrate its attempts to the satisfaction of the Secretary, to enter into a cooperation agreement with the holder(s) of any overlapping authorisations issued under the Mining Act 1992 and petroleum titles issued under the Petroleum (Onshore) Act 1991. The cooperation agreement should address but not be limited to: • access arrangements • operational interaction procedures • dispute resolution • information exchange • well location • timing of drilling • potential resource extraction conflicts; and • rehabilitation issues.	Not Applicable	There are currently no overlapping authorisations with other Companies.
4	Assessable Prospecting Operations (a) The lease holder must not carry out any assessable prospecting operation on land over which this lease has been granted unless: (i) it is carried out in accordance with any necessary development consent; or (ii) if development consent is not required, the prior written approval of the Minister has been obtained. (b) The Minister may require the lease holder to provide such information as required to assist the Minister to consider an application for approval. (c) An approval granted by the Minister under this condition may be granted subject to terms. (d) The lease holder must comply with the approval granted to the holder under this condition.	Yes	No assessable prospecting operations occurred during the reporting period.

Table A3.2 (Cont'd)
Mining Lease 1461 – Compliance Review

Cond. No.	Requirement	Compliance	Comments/Notes
SPECIAL CONDITIONS			
5	Aboriginal Place or Relic The lease holder shall not knowingly destroy, deface or damage any aboriginal place or relic within the subject area except in accordance with an authority issued under the National Parks and Wildlife Act, 1974, and shall take every precaution in drilling, excavating or disturbing the land against any such destruction, defacement or damage.	Yes	No Aboriginal places or relics were disturbed during the reporting period.
6	Dams Safety – Mining Leases (a) The lease holder must not mine within any part of the lease area which is within the notification area of the Stoney Pinch Reservoir Dam without the prior written approval of the Minister and subject to any conditions the Minister may stipulate. (b) Where the lease holder desires to mine within the notification area, the lease holder must: (i) at least twelve (12) months before mining is to commence or such lesser time as the Minister may permit, notify the Minister of the desire to do so. A plan of the mining system to be implemented must accompany the notice; and (ii) provide such information as the Minister may direct. (c) The Minister must not, except in the circumstances set out in sub-paragraph (ii), grant approval unless sub-paragraph (i) of this paragraph has been complied with. (i) This sub-paragraph is complied with if: (a) Dams Safety NSW as constituted by section 6 of the Dams Safety Act 2015 and the owner of the dam have been notified in writing of the desire to mine referred to in paragraph (b). (b) the notifications referred to in clause (a) are accompanied by a description or plan of the area to be mined. (c) the Secretary has complied with any reasonable request made by Dams Safety NSW or the owner of the dam for further information in connection with the mining proposal. (d) Dams Safety NSW has made its recommendations concerning the mining proposal or has informed the Minister in writing that it does not propose to make any such recommendations; and (e) where Dams Safety NSW has made recommendations the approval is in terms that are: - in accordance with those recommendations; or - where the Minister does not accept those recommendations or any of them - in accordance with a determination under sub-paragraph (ii) of this paragraph.	Yes	No mining activities occurred during the reporting period.

Table A3.2 (Cont'd)
Mining Lease 1461 – Compliance Review

Cond. No.	Requirement	Compliance	Comments/Notes
SPECIAL CONDITIONS			
6 cont'd	(ii) Where the Minister does not accept the recommendations of Dams Safety NSW or where Dams Safety NSW has failed to make any recommendations and has not informed the Minister in writing that it does not propose to make any recommendations, the approval shall be in terms that are, in relation to matters dealing with the safety of the dam: - as determined by agreement between the Minister and the Minister administering the Dams Safety Act 2015; or - in the event of failure to reach such agreement - as determined by the Premier. (d) The Minister, on notice from Dams Safety NSW, may at any time or times: (i) cancel any approval given where a notice pursuant to section 19 of the Dams Safety Act 2015 is given. (ii) suspend for a period of time, alter, omit from or add to any approval given or conditions imposed.		
EXPLORATION REPORTING			
Note:	Exploration Reports (Geological and Geophysical) The lease holder must lodge reports in accordance with the requirements in section 163C of the Mining Act 1992 and clauses 59, 60 and 61 of the Mining Regulation 2016 as well as any further requirements issued by the Secretary under clause 62 of the Mining Regulation. Guidelines for the structure, content and data format requirements for reports are set out in the Exploration Reporting: A guide for reporting on exploration and prospecting in New South Wales.	Yes	The 2022 exploration report was lodged 14/06/23 (as part of an approved group report) .

Appendix 4

2022 Annual Flora and Fauna Monitoring

prepared by

Wedgetail Project Consulting Pty Ltd

(Total No. of pages including blank pages = 122)

2022 Annual Flora and Fauna Monitoring

Donaldson Open-Cut Coal Mine, Beresfield, NSW

Rev 1
13 March 2023

2022 Annual Flora and Fauna Monitoring
Donaldson Open-Cut Coal Mine, Beresfield, NSW

REPORT PREPARED FOR:

Yancoal Australia Ltd
1132 John Renshaw Drive
Black Hill, NSW, 2322

REPORT PREPARED BY:

WEDGETAIL PROJECT CONSULTING PTY LTD
27 Groves Road
Bennett's Green, NSW 2290

ABN: 93 640 388 683

File Ref: WPCDonaldsonF&FQuads_2022-2023_v1.0

Version Control

Rev. No.	Revision Date	Author / Position	Reviewer	Details
Rev 1	13 March 2023	Jake Mauger Ecologist	Nigel Fisher Senior Ecologist	Draft For Client review

EXECUTIVE SUMMARY

Findings of the 2022 annual quadrat monitoring survey are presented in this document in accordance with Section 5.1 Monitoring Program of the Donaldson Coal Flora and Fauna Management Plan (F&FMP). Data collected biannually since 2001 have been analysed in order to investigate trends in the flora and fauna species composition over time.

The 2022 flora survey results show that floristic diversity and cover of ground cover species has increased since 2019 across most quadrats. This is likely indicative of early stages of recovery following the end of drought conditions including below average rainfall and higher mean maximum temperature recorded in 2019.

An overall increase in plant species richness and structural components has been recorded since the baseline survey in 2001. This trend is indicative of a dynamic plant community with high recruitment from the seed pool, normally an indicator of a healthy, regenerating native plant community. While the species composition recorded in each quadrat has changed slightly over the entire survey period, the number of species identified within each quadrat has remained relatively consistent over time.

All biomass variables examined (i.e., basal area, height, foliage projective cover (FPC) and stand volume), have shown consistent increases since the baseline survey. The regression analyses confirmed that the relationship between time and increases to stand volume were highly significant indicating that the community biomass has increased substantially across time with no significant year-to-year variation. The regression analyses of FPC shows a slight downward trend although the cover has significantly increased since the baseline surveys except for Q6 which was impacted by Myrtle rust in previous years.

The 2022 survey detected a total of 75 fauna species consisting of 45 bird, four arboreal and five terrestrial mammals, 15 bat, four amphibian and two reptile species. Six bat species and one bird species detected are listed as vulnerable under the NSW Biodiversity Conservation Act 2016 (BC Act). The 2022 fauna survey results indicated further improvement with a significant decrease in species richness compared to the previous 3 years.

Nest box surveys in 2022 (summer average) saw 56% (Summer) of all available boxes showing signs of use (both actual animals present and evidence of usage). Nest box utilisation has remained constant from previous years (winter and summer average of 38.5% in 2019). This is potentially due to 15 nest boxes being replaced (which often experience low utilisation immediately after installation) and three nest boxes requiring maintenance. It is expected that the usage rate will increase in coming years as fauna become acclimatised to the boxes.

Overall results conclude that there has been minimal impact to floristic and fauna diversity within the Donaldson Bushland Conservation Area (BCA) over the last 20 years. Fluctuations in ecological diversity across all quadrats have been observed which are consistent with natural ecosystem functioning, weather patterns and the changing nature of the adjoining habitat, resulting from past mining activities and neighbouring development.

Contents

Figures

Tables

Plates

1. INTRODUCTION

Yancoal Australia Ltd operated Donaldson Coal Open Cut Mine from 2001 until 2013, when operations ceased due to the exhaustion of resources. Donaldson Coal is located on a mining lease near Beresfield in the Lower Hunter Valley, NSW (**Figure 1**). As part of the Conditions of Consent, a Flora and Fauna Management Plan (F&FMP) was prepared prior to the commencement of operations (Gunninah 2000) with subsequent revisions made by Ecobiological in 2007 and Donaldson Coal in 2019 (Donaldson Coal 2019).

The F&FMP prescribes the approach and the frequency of monitoring of the remnant bushland surrounding the mine disturbance area, referred to hereafter as the Bushland Conservation Area (BCA). Regular monitoring activities are conducted at nine permanently established 20 x 20 m quadrats positioned across the mining lease (**Figure 1**). A Baseline Report (Barker Harle 2001) was prepared at the commencement of mining activities and each year since, to monitor the impact of mining activities on flora and fauna at the mine.

This report provides a comparison of flora and fauna species richness and composition, as well as several specific vegetation parameters over time to determine potential impacts of mining activities at Donaldson Coal on flora and fauna in the BCA. Statistical analyses were conducted to detect significant patterns in any data set that was deemed comprehensive enough to pick up significant trends or changes overtime. Due to the adaptive nature of the monitoring program, including changes to methodologies and to the intensity of survey effort over time, not all data sets were considered to be comprehensive, only relevant data was analysed and discussed.

1.1 COMPLIANCE WITH THE F&FMP

The nine permanent quadrats were established in accordance with Section 5.1 Monitoring Program in the F&FMP. One of the permanent quadrats was to be established downstream of the mine in Woodbury Swamp, however this location was not situated within Donaldson Coal's mining lease. In consultation with the Donaldson Environmental Officer (EO) it was decided not to establish this quadrat. In 2003 Quadrat 9 was established in an area of bushland of similar type to that originally found over the pit area.

The monitoring program was to include a quarterly assessment of:

- Condition and type of vegetation and fauna habitat.
- Flora and fauna species list and the Braun-Blanquet cover scale of each plant species within a quadrat; and
- Proximity of the quadrat to the mine site and other areas having the potential to affect the quality of the vegetation.

The Baseline Report (Barker Harle 2001) prepared to fulfil part of the requirements of Section 5.0 of the F&FMP provides a detailed discussion of the program requirements. During initial discussions with the Donaldson EO, it was decided that the program requirements could be met by a very detailed annual assessment and a quarterly general inspection of each quadrat for any significant change. In 2004, winter fauna monitoring methods were changed from trapping to artificial nest box inspection.

The change was implemented as a result of poor trapping results and the high risk of mortality to captured animals from cold exposure.

Reporting requirements outlined in Section 6.1 of the F&FMP include the following:

Pre-clearing Verification Reports and Clearing Verification Reports prepared for bushland to be cleared as mining and associated activities require.

Both the Pre-clearing Verification Reports and the Clearing Verification reports were prepared.

Monitoring reports which are provided biannually and summarise all monitoring activities carried out in the preceding six months and brief monitoring reports to be provided following each monitoring event.

In order to meet Condition 13(1) of the Conditions of Consent a six-monthly environmental monitoring report should be provided to the stakeholders. A six-monthly fauna report was provided.

1.2 AIMS AND OBJECTIVES

The aim of the monitoring program is to assess the diversity and abundance of flora and fauna species at a temporal and spatial scale across the BCA.

The long-term objectives of the program include:

- Monitor flora and fauna present on the BCA on an annual basis through targeted surveys.
- Document and report annually on the flora and fauna present on the BCA.
- Document and report changes in species diversity and floristic composition of flora on the site.
- Document and report changes in stand volume and biomass parameters.
- Provide recommendations that will assist in the management of flora and fauna species.
- Make recommendations that will contribute to minimising mine disturbance on the remnant vegetation around the mine site; and
- Determine the temporal impacts of mining operations on the ecological attributes of the BCA.

Created by: KBlundell
Date: 09.03.2023

WEDGETAIL PROJECT CONSULTING

https://wedgetail.com.au

Legend

- Donaldson Coal Mine Disturbance (Pit) Area
- Subject Site
- Quadrat Locations

Extent of Donaldson Open Cut Mine & the Location of Nine Permanent Monitoring Quadrats

Figure: 1

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N

2. METHODOLOGY

Field surveys are conducted annually from late spring to early summer (October – December). Field survey methods are summarised below. More detailed information regarding survey methodologies are available in the Baseline Report (Barker Harle 2001). Nest boxes are inspected twice a year, once in winter and again in late spring/summer.

2.1 FLORA SURVEY

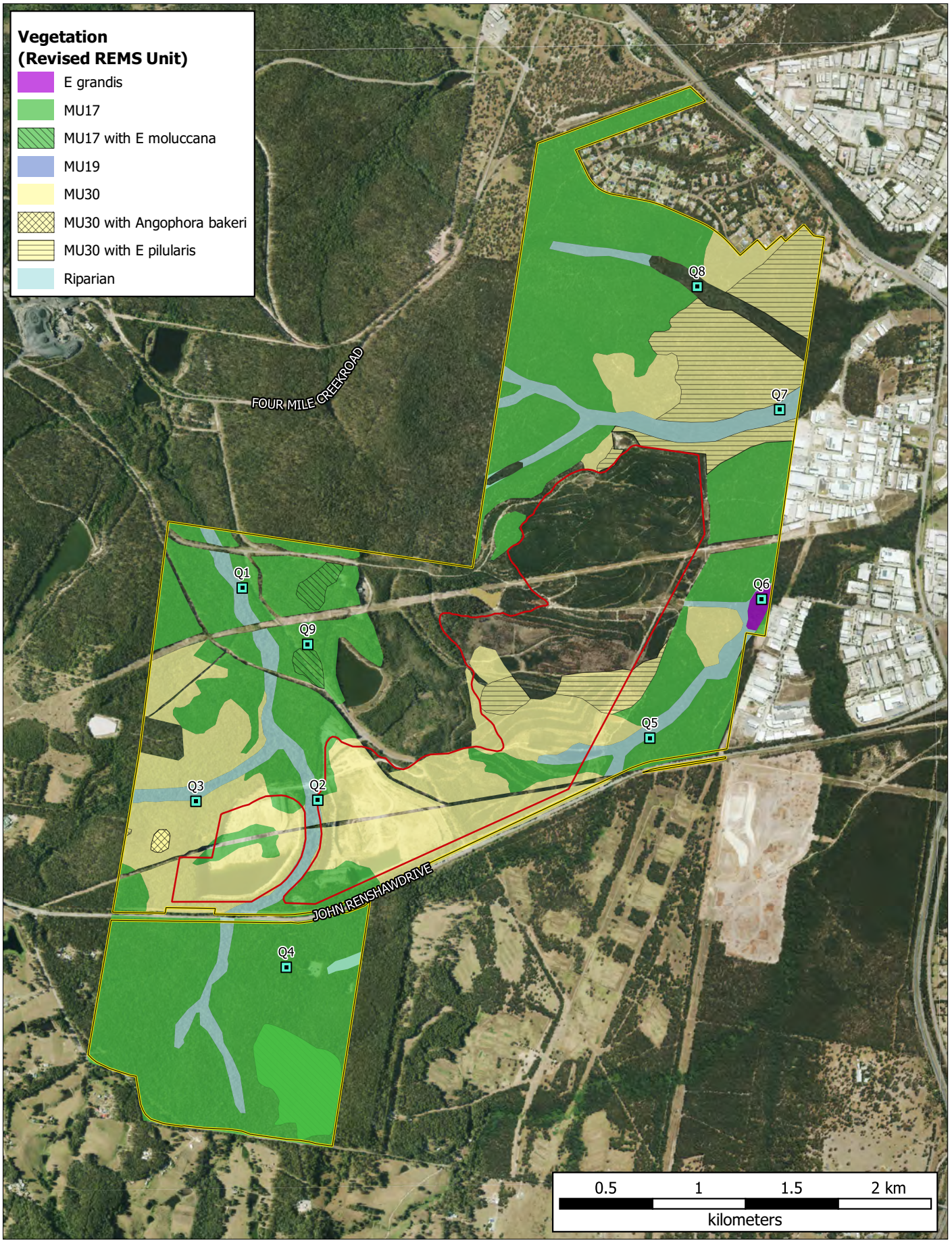
Eight permanent 20 m x 20 m (0.04 ha) monitoring quadrats (Quadrats 1-8) were established in 2001 across the Donaldson coal mine property **(Figure 1)** An additional quadrat (Quadrat 9) was established in 2003. These quadrats are permanently marked with star pickets to allow precise replication of the measurement of floristic structure, content, and biomass on an annual basis.

2.1.1 Vegetation Communities

The vegetation communities present within the BCA, as confirmed by ecobiological (2004), are presented in **(Figure 2).** Each quadrat was classified according to its vegetation type (i.e., dominant association). Brief descriptions on the condition and structure of each vegetation community are provided in Section 3.2.

2.1.2 Floristic Identification and Nomenclature

Floristic identification and nomenclature were based on Harden (1992, 1993, 2000 and 2002) with subsequent revisions as published on PlantNET (http://plantnet.rbgsyd.nsw.gov.au). If a plant was unable to be identified using these references, a sample was sent to the National Herbarium, Royal Botanic Gardens, Sydney, NSW.



Created by: KBlundell
Date: 09.03.2023

WEDGETAIL PROJECT CONSULTING

https://wedgetail.com.au

Legend

- Donaldson Coal Mine Disturbance (Pit) Area
- Subject Site
- Quadrat Locations

Vegetation Communities Surrounding Donaldson Coal Open Cut Mine

Figure: 2

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N

2.1.3 Biomass

2.1.3.1 Foliage Projective Cover

Foliage Projective Cover (FPC) is described as the horizontal spread of the foliage of all the vegetation covering any area and is a measure of the total photosynthetic respiratory surface over that area (Specht 1983; Specht & Specht 1999). A system for classifying structure of vegetation communities is detailed in Specht & Specht (1999). This method allows for precise and repeatable comparison of plant communities. An example of this classification technique can be found in Le Brocque & Buckney (1997).

Foliage Projective Coverage (FPC) was measured in each quadrat. Methods used were adapted from Specht (1981) and Specht (1983). FPC was recorded for canopy species and for groups of species making up the shrub and ground cover. The spread of foliage was measured on a 1 m by 1 m grid, set out with measuring tapes and recorded on grid paper. Vegetation layers included ground cover, shrubs (≤ 2 m), overstorey and emergent trees. **Plate 1** shows an example (Quadrat 5) of the grid layout with measuring tapes for each quadrat.

All vegetation covering the quadrat was recorded, including plants with overlapping foliage inside the quadrat and bases located outside. A vertical sighting device adapted from the crosswire sighting device described by Winkworth and Goodall (1962) was used to determine the position of overhead foliage. The outline of each predominant species or group of species foliage was established by walking the foliage perimeter and at specific points recording the locations from the tape measures onto grid paper. These points were then joined to give polygons representing FPC.

2.1.3.2 Basal Area

The location of individual shrub and tree stems was recorded on grid paper to allow temporal comparisons. Trees taller than two metres had their girth measured at 1.4 m above the ground. The girth was used to assess the Diameter at Breast Height (DBH). Trees over two metres also had their height measured with a Haglöf digital hypsometer.

Basal area was determined for all trees over two metres tall. The total basal area and total basal area of each species in the quadrats was determined. The basal area was calculated using the below equation:

Basal area $m^2 = a^2 \div 4\pi$, where girth (a) in metres is measured at 1.4 m high.

2.1.3.3 Total Stand Volume

Total stand volume was calculated from basal areas and tree heights. The below equation was used:

•Total stand volume $m^3/ha = (b \div 0.04ha) \times (c \div 3)$, where (b) is basal area in m^2 and (c) is tree height in m.

Research has shown that there is a relationship between the growth of one part of an organism and another part that is known as allometric growth or allometry (where a part is a constant exponential function of the whole). The relationship between the basal area of a tree and the height can be used to monitor the development of the trees within the quadrats over time.

Plate 1: Example of grid layout for collection of biomass measurements (Quadrat 5)

2.2 FAUNA SURVEY

Field surveys were conducted in accordance with the revised F&FMP (Ecobiological 2007). Early surveys followed a methodology designed around the observation of fauna species within the 20 x 20 m quadrats. This method proved inadequate to accurately assess fauna species richness. The revised field survey methodologies are summarised below.

2.2.1 Terrestrial and Arboreal Mammal Trapping

Terrestrial and arboreal trapping was undertaken at Quadrats 1, 2, 3 and 9 on 19-23rd December 2022 and at Quadrats 4, 5, 6, 7 and 8 on 12-16th December 2022. Trapping was conducted within a 300-metre radius of each quadrat. Trapping effort spanned four nights and employed 20 Elliott A, three Elliott B and three cage traps set on the ground and five Elliott B traps set about two metres above the ground, mounted on the trunks of trees. Traps were checked each morning.

2.2.2 Microbat Trapping

Since 2004, one harp trap per quadrat has been used for four nights total trapping effort. These are used in addition to microbat call detection, as not all species can be identified by echolocation calls alone.

2.2.3 Microbat Call Detection

One Anabat™ Express bat detector (Titley Scientific, Lawnton, Qld) per quadrat was used to undertake passive monitoring of bats flying or foraging within each quadrat. Detectors were set up at dusk when bat activity is highest, and recording occurred for one hour on one night.

2.2.4 Owl Call Playback

Calls of four threatened owl species (Powerful Owl, Sooty Owl, Masked Owl, and Barking Owl) were broadcast by loudspeaker in the area of each quadrat after dusk. Each species' call was played for a 2-3-minute period followed by quiet listening for approximately 10 minutes.

2.2.5 Spotlighting

Spotlighting was undertaken from dusk for at least one-person hour (i.e., one observer for an hour or two observers for 30 minutes) in the area of each quadrat to detect the presence of nocturnal fauna species.

2.2.6 Bird Surveys

A two-hectare area centered on each quadrat was searched by one observer for 30 minutes and all birds detected were identified either visually with the aid of binoculars, or by call interpretation. Surveys were conducted in the early morning when bird activity is highest.

2.2.7 Nest Box Monitoring

Forty-five nest boxes were originally installed in 2005. Nest boxes are inspected twice a year, once in winter and again in late spring/summer. Evidence of usage is determined through either direct detection of animals at the time of the visit or indirect evidence such as recent chew marks, hair, or leaf nests.

2.3 STATISTICAL ANALYSIS

2.3.1 Flora

Data for FPC and stand volume (a derivative of basal area and tree height) for flora survey quadrats from 2001 to 2023 were analysed to determine whether the plant communities were increasing in biomass over time and undergoing succession towards a mature plant community structure (Specht & Specht 2002, pp 28-41). An increase in these parameters over time is taken as an indicator of plant community health and viability, in addition to other measures such as species diversity and richness. The analysis was undertaken using a linear regression model, with time as the explanatory variable. R^2 values were also calculated to determine how well the fitted lines explained the data. The closer the R^2 value is to 1, the higher confidence that the trend line fits the data.

Similarity indices were calculated for all pairs of quadrats in the baseline survey to determine the level of floristic similarity between the different plant communities surveyed across the quadrats. Similarity indices were also calculated for each quadrat between two different monitoring events (i.e., 2001 vs 2002), to determine changes in floristic composition at each quadrat over time. The index used was Sorensen's Similarity Index (Krebs, 1999, p. 377) computed as SI = 2a/ (2a + b + c) where a = the number of species present in both quadrats, b = the no. of species presents in only one quadrat of a pair, and c = no. of species presents in only the second quadrat of a pair. Quadrat pairs

with a low index (minimum possible = 0; no species in common) share fewer species in common, and pairs with a higher index share more species in common (maximum possible = 1.00 where all species recorded in the pair of quadrats are present in both).

2.3.2 Fauna

Data on fauna species detected between 2001 and 2023 were analysed to determine changes in species richness and diversity over time. Non-metric Multidimensional Scaling (nMDS) and cluster analysis were undertaken to explore the relationship between fauna species assemblages detected in different sample years. The Primer-E software program was used with the Kulczynski Similarity Index for presence only data (Clarke and Gorley, 2006). This analysis produced scatterplots which depict, in 2-dimensional space, the similarity between species assemblages of different survey years. Associated dendrograms were also produced that graphically depict the relationship between sample years.

The strength of any clusters apparent in the scatterplot were tested by running a similarity profile routine (SIMPROF) over branches in the dendrogram. Solid black lines in the dendrogram indicate statistically significant differences between clusters at the 95% confidence level. Broken red lines link clusters that are not significantly different. The results of the SIMPROF analysis are shown in **AppendiX 8.**

Single factor Analysis of Variance (ANOVA) was used to determine if there was a significant difference between nest box usage in summer and winter with all years combined. Percentages were arcsine transformed before analysis.

3. RESULTS

3.1 WEATHER

Monthly temperature and rainfall data from 2001-2022 are presented in **Table 1** and **Table 2**. Data was accessed from the Bureau of Meteorology weather station at Maitland Visitors Centre (BOM station ID 061388, 2016) up until July 2016, when this station closed. For the remainder of the year, data was collected from the Maitland Airport (BOM station ID 061428). Average monthly and annual figures are used to derive overall climatic trends.

Monthly average maximum temperatures for 2022 are lower than the average maximum temperatures for each month over the 20 years, excluding August. The annual rainfall recorded in 2022 was above the average of all the previous years combined (2001 – 2022). March recorded the highest monthly rainfall in 2022 (277 mm) and June recorded the lowest (9.8 mm).

Table 1: Monthly and annual average maximum temperatures for Maitland Visitors Centre (2001-July 2016) and Maitland Airport (August 2016 onwards)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
2001	31.4	29.8	25.9	24.8	19.8	19.5	18.2	19.7	23.2	25.4	25.4	29.3	24.4
2002	30	27.1	27.2	24.8	20.6	18.6	18.8	20.6	24	28.3	29.6	28.9	24.9
2003	29.9	29.1	26.2	23.3	20.7	20	18.2	19.7	23.9	23.3	26.2	28.7	24.1
2004	31.5	31.5	26.8	25.5	21.9	19.7	18.5	20.4	23.3	24.8	27.4	28.2	25
2005	30.2	30	25.8	26	21.1	19	19	20.6	22	26.1	27.1	32.8	25
2006	31.6	31.4	28.2	25.7	21.3	18.1	18.2	20.3	23.7	26.2	28.5	28.2	25.1
2007	31.6	30.1	28.7	24.3	23.1	16.9	17.3	20.8	22.8	28.5	26.7	27.6	24.9
2008	28.5	26.1	27.1	22.7	21.4	19.1	17.8	18.3	23.2	25.4	25.4	29	23.7
2009	31.2	29.5	27.9	23.5	21.1	18.9	18.3	22.4	24.6	24.2	30	28.7	25
2010	31.4	30	28.1	25.8	21.4	18.3	17.7	18.5	22.6	23.8	26.2	28.5	24.4
2011	30.8	31.4	28.5	23.6	20.2	18.5	17.5	20.5	23.3	23.9	27.6	24.6	24.2
2012	28.2	27.1	26.4	23.9	21.3	18.1	17.6	20.3	24.4	25.8	27.7	29.2	24.2
2013	30.9	27.8	27.6	25.2	21.4	18.1	19.3	21.7	26.6	28.4	26.6	29.1	25.2
2014	30	28.1	27.9	25.1	22.8	19.1	18.5	19.1	22.8	27.8	29.8	-	24.6
2015	30	29	30	24	21	19	18	20	22	28	28	30	24.9
2016	29.3	30.7	30.3	26.9	24.1	18.8	17.2	19.4	21.8	24.7	29.6	31.6	25.4

2017	32.8	33.2	27.2	23.9	21.4	18	19.1	20.2	25.5	26.8	25.8	31.8	25.5
2018	33.3	31.4	28.5	26.5	21.7	17.4	19.6	20.0	22.3	24.1	27.3	31.3	25.3
2019	35.2	31.9	29.6	25.8	22.3	18.8	19.5	20.7	23.7	27.2	31.2	33.0	26.5
2020	32.7	29.3	26.0	25.0	20.0	18.6	17.8	18.8	23.0	25.6	29.4	27.4	24.4
2021	29.0	27.3	25.9	23.8	21.1	17.7	17.7	20.9	23.6	25.5	24.3	28.4	23.8
2022	29.7	28.2	26.1	24.6	20.9	17.5	17.2	19.8	21.2	24.0	25.8	27.6	23.55
Mean	29.4	29.5	27.5	24.7	21.3	19.3	18.2	20.1	23.3	24.7	27.5	30.3	24.73

Source: Bureau of Meteorology. (-) indicates no temperature data available.

Table 2: Monthly and yearly rainfall (mm) totals and totals for Maitland Visitors Centre (2001 – July 2016) and Maitland Airport (August 2016 onwards)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average monthly	Annual total
2001	20	128	170	74	145	5	51	21	15	28	76	59	**66**	**792**
2002	26	247	103	61	44	29	25	13	25	10	51	106	**62**	**740**
2003	11	75	59	77	107	16	30	43	0	53	125	61	**55**	**657**
2004	90	166	74	38	20	10	28	31	49	172	71	89	**70**	**838**
2005	-	141	141	22	120	65	12	1	43	68	61	21	**63**	**695**
2006	28	55	106	31	12	58	65	50	157	6	-	45	**56**	**613**
2007	21	57	86	55	44	392	23	-	-	24	-	-	**88**	**702**
2008	-	170	35	213	4	121	38	19	178	83	97	70	**93**	**1028**
2009	8	234	50	164	70	62	23	2	26	66	33	58	**66**	**796**
2010	66	48	75	22	73	111	62	32	20	60	192	63	**69**	**824**
2011	37	38	48	140	92	160	87	57	76	105	142	157	**95**	**1139**
2012	84	174	102	79	12	125	45	14	22	7	46	45	**63**	**755**
2013	141	134	79	67	51	80	30	12	17	51	365	16	**87**	**1043**
2014	21	86	115	81	30	45	22	111	31	50	22	164	**65**	**778**
2015	155	41	35	358	80	42	15	38	57	44	102	135	**92**	**1102**
2016	405	35	26	26	7	114	7	-	71	48	44	95	**80**	**878**
2017	74	59	181	57	22	95	1	7	11	93	28	55	**57**	**683**
2018	10	103	182	35	6	78	1	15	49	108	78	43	**59**	**708**
2019	30	28	156	13	18	62	20	47	49	16	12	1	**38**	**452**
2020	38	204	118	28	44	55	107	24	34	87	32	156	**77**	**927**
2021	98	117	269	29	28	43	13	52	29	68	205	36	**82**	**986**
2022	95.2	112.2	277	79.8	68.2	9.8	162.4	38.0	91.6	109.6	48.6	31.4	**94**	**1124**
Mean	**72**	**111**	**105**	**80**	**49**	**84**	**34**	**31**	**48**	**59**	**94**	**74**	**71**	**816**

Source: Bureau of Meteorology. (–) Indicates no rainfall data available.

3.2 VEGETATION COMMUNITIES

Four vegetation communities (ecobiological 2004) have been mapped across the Donaldson Coal BCA. Also present are some variants within each of these communities. Of note is the "riparian zone" as indicated in **Figure 2**. These areas should be regarded as being of a similar vegetation type to the surrounding vegetation, albeit with some floristic differences associated with minor gullies.

These vegetation communities are listed below:

- Tall Moist Forest with *E. grandis*.
- Riparian Moist Forest.
- Spotted Gum Communities.
- Spotted Gum with *E. moluccana*;
- Hunter Lowland Redgum Forest.
- Smooth-barked Apple Forest.
- Smooth-barked Apple Forest with *A. bakeri;*
- Smooth-barked Apple Forest with *E. pilularis.*

The Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS) (NPWS 2000) mapping for the BCA maps large areas as the endangered MU 17 – Lower Hunter Spotted Gum Ironbark Forest. Ground-truthing of the BCA by ecobiological (2004) confirmed the identity of this ecological community as most consistent with MU 16 Seaham Spotted Gum – Ironbark Forest. The following account was given in the analysis by ecobiological (2004):

"The Spotted Gum data from Donaldson was compared with 126 other sites from the Central Coast and Hunter region using both cluster analysis (PATN) and non-metric Multi-Dimensional Scaling (nMDS). The analysis indicates that there are five probable Spotted Gum community types across the region, and that the Spotted Gum vegetation at Donaldson is more closely related to the Seaham Spotted Gum – Ironbark Forest than the Lower Hunter Spotted Gum – Ironbark Forest. From this analysis, it would appear that the Lower Hunter Spotted Gum – Ironbark Forest is restricted to the area immediately around Cessnock and that the Quorrobolong Valley vicinity marks the transition from Seaham Spotted Gum – Ironbark Forest to Coastal Foothills Spotted Gum – Ironbark Forest."

Some sites show distinct riparian characteristics which makes them very different from the surrounding vegetation (Quadrat 1 and Quadrat 2), referred to as "Riparian Moist Forest". The characteristics of this vegetation are summarised below (Ecobiological 2004).

"A range of sites extending from Clarence Town to the Holgate Ranges near Gosford support a moist forest type which has been tentatively termed here Hunter Valley Moist Forest. However, NPWS (2000) do not map this community south of Quorrobolong Valley, but sites from Gosford and Wyong fall within this group. There may be some overlap with some of the other moist forest communities defined by NPWS (2000), but further clarification is beyond the scope of this report. Two riparian sites from within Donaldson Coal occur within this group."

Brief descriptions of the vegetation communities occurring at each quadrat and a summary of key vegetation parameters are provided in **Table 3**. Note that some vegetation layers have changed their cover considerably over the 20 years of monitoring and only 2022 data is provided in this table.

Table 3: Summary of vegetation communities occurring at Quadrats 1-9

Quadrat	Vegetation Community	Revised REMS Unit	Dominant Overstorey Species	Midstory/ Shrub Cover (%)	Ground cover (%)	Overall Condition
1	Riparian Moist Forest	-	*Backhousia myrtifolia* *Corymbia maculata* *Syncarpia glomulifera* *Angophora costata* *Eucalyptus umbra*	0%	10%	The vegetation at Q1 was identified as being in moderately good condition as a result of groundcover remaining low at 10%. A total of 33 plant species were identified in 2022 which is nine species less than that recorded in 2020. No weed species were identified or any other forms of land degradation (i.e. erosion). Some dieback was noted in select *Eucalyptus umbra* individuals.
2	Riparian Moist Forest	-	*Backhousia myrtifolia* *Corymbia maculata* *Eucalyptus acmenoides* *Glochidion ferdinandi* *Syncarpia glomulifera*	5%	75%	The vegetation at Q2 was identified as being in good condition this year due to the continued high percentage of ground cover carried on from 2021, likely due to an increase in rainfall. A total of 42 plant species were identified in 2022 which is a decrease from the previous year (52 species). Species richness in 2022 still remains below that recorded between 2006 and 2018. The ground cover slightly increased from 70% in 2021 to 75% in 2022. The shrub layer cover has remained the same as the 2020 survey. *Lantana camara* has occurred in low densities within the quadrat since the baseline surveys were conducted in 2001. The occurrence of this species has increased between the 2021 and 2022 monitoring events, likely due to favourable conditions e.g., high rainfall. Despite this, most the individuals are juvenile and occupy little space within the quadrat.
3	Smooth-barked Apple Forest	MU 30	*Angophora costata* *Eucalyptus fibrosa* *Eucalyptus umbra* *Melaleuca styphelioides* *Syncarpia glomulifera*	22%	25%	The vegetation at Q3 was identified as being in good condition. A total of 49 plant species were identified in 2022, an significant decrease from the number recorded in 2021 (59 species). The ground layer cover has remained 25%. The shrub layer canopy cover has declined substantially over the previous two years. *L. camara* continues to be present.
4	Spotted Gum –	MU 17	*Corymbia maculata*	7%	80%	The vegetation at Q4 was identified as being in good condition. A total of 48 plant species were identified in 2022

Quadrat	Vegetation Community	Revised REMS Unit	Dominant Overstorey Species	Midstory/ Shrub Cover (%)	Ground cover (%)	Overall Condition
	Ironbark Forest		*Eucalyptus acmenoides* *Eucalyptus fibrosa*			remaining the same with 48 species recorded in 2021. The ground layer cover increased to 80% in 2022 from a low of 35% in 2019. The shrub layer cover remained relatively stable at 7%. One weed species was identified in 2022, *Hypochaeris radicata* (Catsear).
5	Spotted Gum – Ironbark Forest	MU 17	*Corymbia maculata* *Eucalyptus acmenoides* *Eucalyptus siderophloia* *Syncarpia glomulifera*	1%	85%	The vegetation at Q5 was identified as being in good condition. A total of 45 plant species were identified in 2022, which is a significant decrease of fifteen species compared to that recorded in 2021. The ground cover has slightly increased from 80% to 85% between the 2021 and 2022 monitoring events, suggesting the vegetation is recovering from the dry conditions in 2019. The groundcover in 2021 is now comparable to that recorded in 2018 (75%). The shrub cover remains low in 2022 similar to 2021. A greater abundance of the exotic species, *Lantana camara* and *Senecio Madagascariensis* was present within the quadrat during the 2022 survey, likely in response to favourable conditions.
6	Tall Moist Forest with *Eucalyptus grandis*	-	*Cryptocarya microneura* *Eucalyptus acmenoides* *Eucalyptus grandis* *Syncarpia glomulifera* *Melaleuca styphelioides* *Melicope micrococca*	5%	95%	The vegetation at Q6 was identified as being in moderately good condition. A total of 47 plant species were identified in 2022 which is a slight decrease of one specie compared from the 2021 monitoring event. The ground cover has remained the same at 85% The shrub cover result in 2022 (5%) is slightly increased to that recorded in 2021. Three weed species were identified in the 2022 survey: *Tradescantia fluminensis, Solanum mauritianum* and *L. camara*. *T. fluminensis* remains the dominant ground cover species *L. camara* occurs along the edge of the quadrat along the creek line. Whilst targeted spraying of large stands of *L. camara* adjacent to Q6 was undertaken in the past, regrowth is now occurring in these areas and requires follow-up control for effective long-term management.

Quadrat	Vegetation Community	Revised REMS Unit	Dominant Overstorey Species	Midstory/ Shrub Cover (%)	Ground cover (%)	Overall Condition
7	Smooth-barked Apple Forest with *Eucalyptus pilularis*	MU 30	*Angophora costata* *Eucalyptus pilularis,* *Glochidion ferdinandi* *Melaleuca linariifolia* *Eucalyptus acmenoides* *Allocasuarina torulosa*	29%	60%	The vegetation at Q7 was identified as being in good condition. A total of 49 plant species were identified in 2022, a slight increase of one specie as the previous monitoring event (2021). The ground cover significantly decreased from 80% (2020) to 60% (2021). The weed species *L. camara* has occurred within the site since 2001. Midstorey vegetation has remained stable at 29% as observed in 2021.Targeted spraying of large stands of *L. camara* adjacent to Q7 was undertaken previously. The spraying has been effective within the quadrat although other large patches remain along the creek line.
8	Hunter Lowland Redgum Forest	MU 19	*Corymbia maculata* *Eucalyptus punctata* *Eucalyptus siderophloia* *Eucalyptus tereticornis* *Melaleuca linariifolia* *Melaleuca styphelioides*	19%	85%	The vegetation at Q8 was identified as being in good condition. A total of 69 plant species were recorded in 2022 compared to 67 plant species identified in 2021, an increase of two species. The recorded ground cover has remained stable at 85% in 2022, maintaining the pre-drought returning to levels recorded in 2018. The shrub layer coverage slightly reduced this year compared to the 2019 surveys, from 21% to 19%. Three weed species, *L. camara, Ochna serrulata, Paspalum dilatatum* was recorded in 2022 compared one weed specie of L. camara in 2021 survey. Targeted spraying of *L. camara* adjacent to Q8 was undertaken in previous years which appears to have been effective in controlling most of the large stands.
9	Spotted Gum – Ironbark Forest with *Eucalyptus moluccana*	MU 30	*Corymbia maculata* *Eucalyptus fibrosa* *Eucalyptus umbra* *Eucalyptus punctata* *Eucalyptus moluccana*	5%	95%	The vegetation at Q9 was identified as being in moderately good condition. A total of 38 plant species were identified in 2022 compared to 71 in 2021 which is a sharp decline of 33 species. The ground cover has remained stable at 95% during 2022 returning to levels recorded in 2018. The shrub layer cover has remained stable at 5% during 2022 survey Three weed species, *L. camara, Conyza sp., Hypochaeris radicata* was recorded in 2022, compared to one weed specie *L. Camara* recorded in 2021.

3.3 BIOMASS

3.3.1 Foliage Projective Cover

Each quadrat has shown an increase in FPC when compared to the baseline survey results. However, there has been a general decline in FPC since the highest levels were recorded in 2012/2013, with most quadrats recording a decrease in FPC between the years of 2015 to 2017 **(Figure 3**; **AppendiX 1).** The 2022 FPC results are mixed, with three quadrats recording a small increase (Q1, Q2, Q3,) and others recording a small increase (Q4-Q9).

Fluctuations in FPC are likely to be a result of one or a combination of factors:

- Observer variation, where no noticeable canopy dieback or fallen limbs were observed.
- Dieback of canopy and shrub species.
- Wilting of midstorey species, decrease of ground cover and species diversity due to the impact of the drought, with recent increases indicating the early stages of recovery.
- The lack of fire or an inappropriate fire regime for the ecological community over time will decrease the density and diversity of species.

In 2014, *Rhodomyrtus psidioides* seedlings were recorded in Quadrat 6. Most of these seedlings were observed to be infected with a rust fungus (most likely Myrtle Rust). By 2016, the mature trees of this species had completely died, and only one small seedling was observed within the quadrat. No *R. psidioides* were recorded during the current survey (2022) in Quadrat 6 or in any of the additional quadrats. No evidence of Myrtle Rust was observed.

3.3.2 Basal Area

Basal area in 2021 has generally increased since baseline surveys (2001 for Quadrats 1-8; 2009 for Quadrat 9), with basal area increasing across all 9 quadrats again in 2022 **(Figure 4, AppendiX 2).**

Minor decreases in basal area recorded in quadrat Q9 of *C. maculata* are likely the result of bark shed (hence reduction in tree girth).

A noticeable reduction in tree height between 2003 and 2004 may be attributable to the change in methodology associated with the use of the Hypsometer.

3.3.3 Total Stand Volume

Total stand volume (derived from height and basal area measurements) has increased by an average of 156.94 m^3/ha across the quadrats since the initial monitoring event in 2001 (2003 for Quadrat 9) (**Figure 6**). All quadrats recorded an increase in total stand volume in 2022 compared to 2021. The minor changes in total stand volume recorded in 2020 do not represent a significant change in forest condition, instead it is likely the result of changes in basal areas (as discussed in Section 3.3.2), along with the influence adding additional small trees to quadrats has on average height data.

The total stand volume has been presented in this report instead of the average stand volume which was used prior to 2012. The use of total stand volume allows for the recruitment and addition of new trees in the quadrats without lowering the values.

3.3.4 Biomass Trends

Despite minor year-to-year fluctuations in these vegetation parameters, overall positive trends in growth have been observed for all quadrats from the baseline survey to the current survey. The protection of remnant bushland surrounding the pit area from a history of logging, clearing, frequent fire, firewood collection and rubbish dumping has likely contributed to the overall increase in biomass at all quadrats between the baseline survey and current survey year.

Vegetation parameters are presented graphically in **Figure 3** through to **Figure 6.** The raw data for tree height, foliage cover, basal area and stand volume recorded at each quadrat from the baseline (2001/2003) through to 2022 (see **AppendiX 1**, **AppendiX 2**, and **AppendiX 3**).

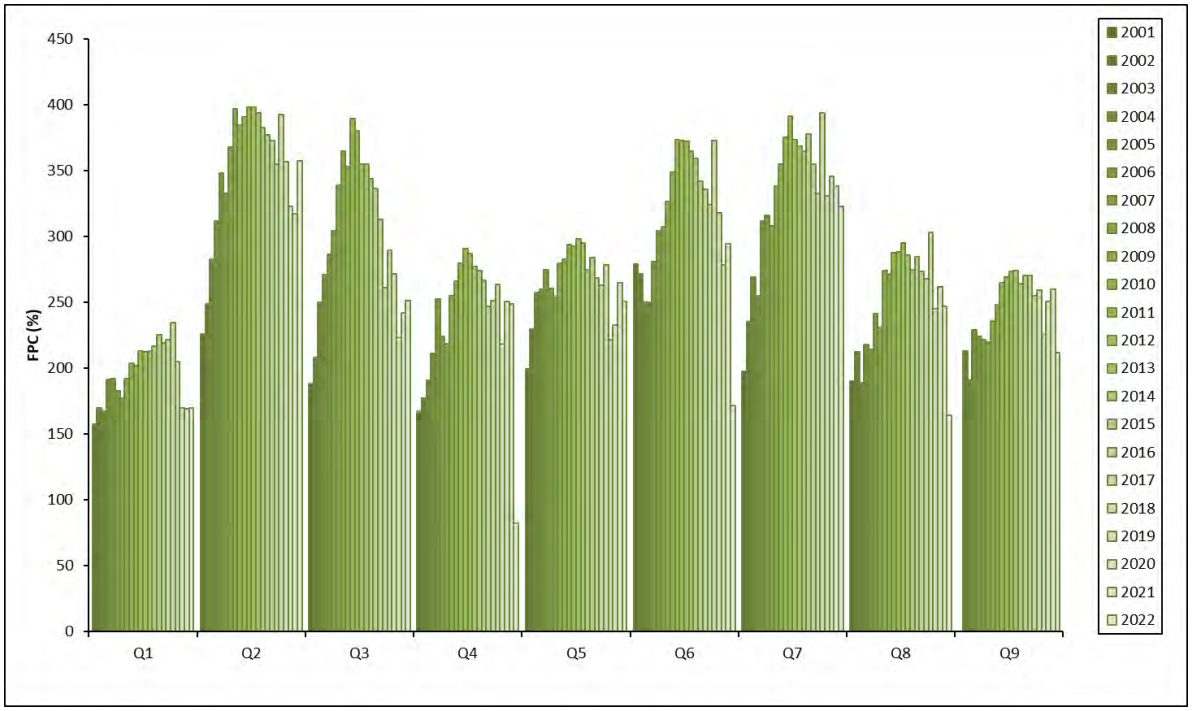


Figure 3: Total foliage projective cover for each quadrat between 2001 and 2022

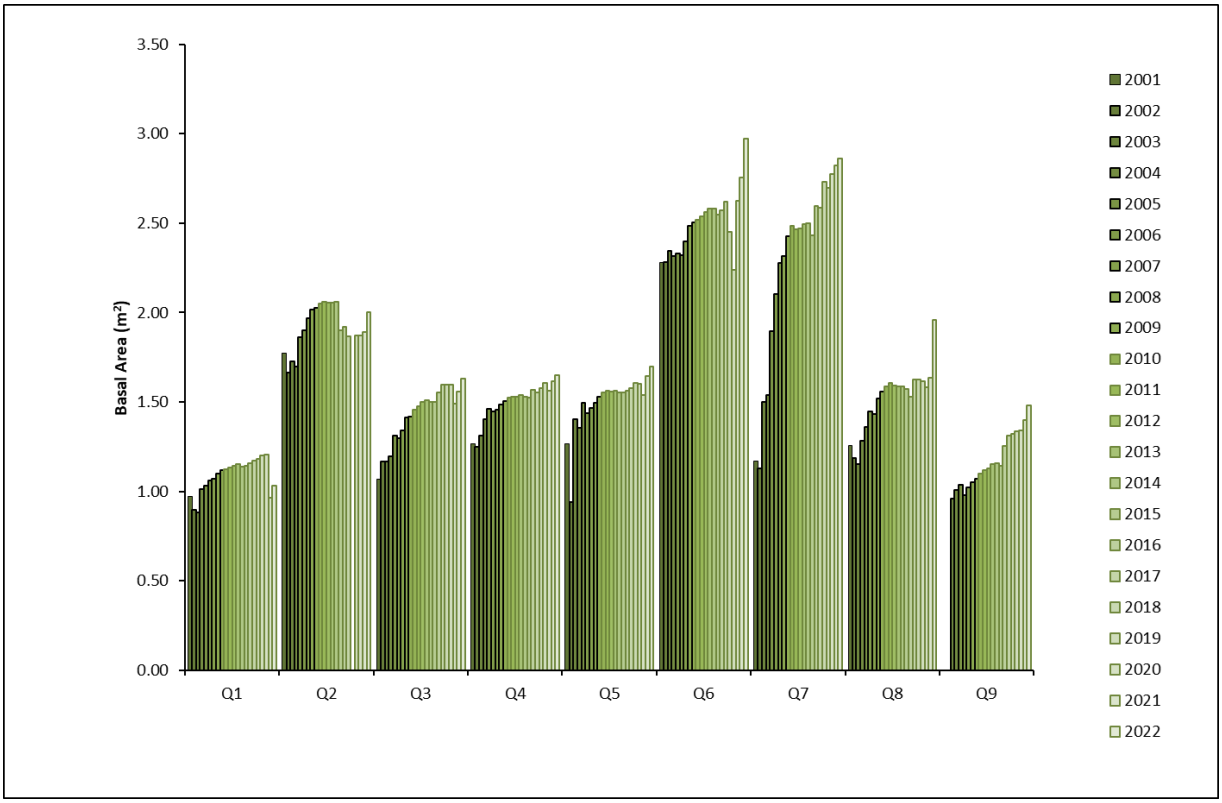


Figure 4: Basal area for each quadrat between 2001 and 2022.

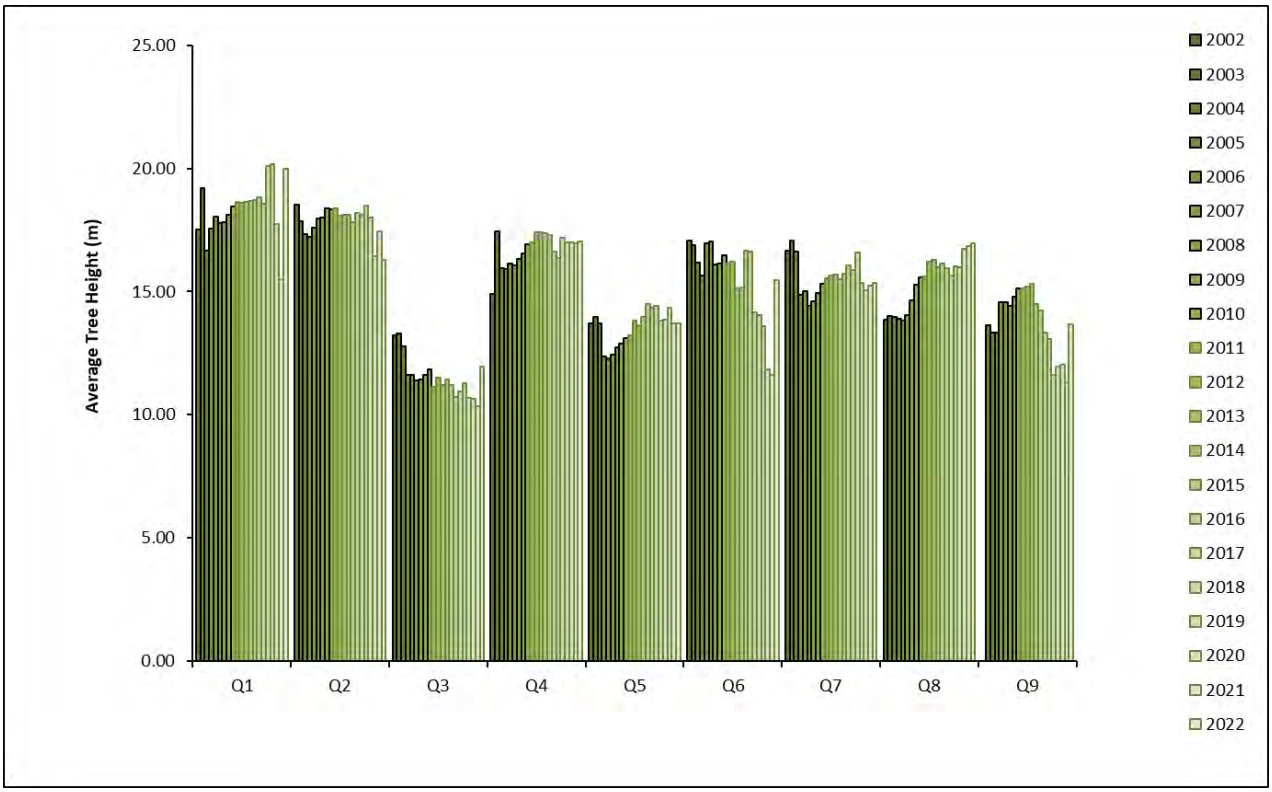


Figure 5: Average tree height for each quadrat between 2001 and 2022

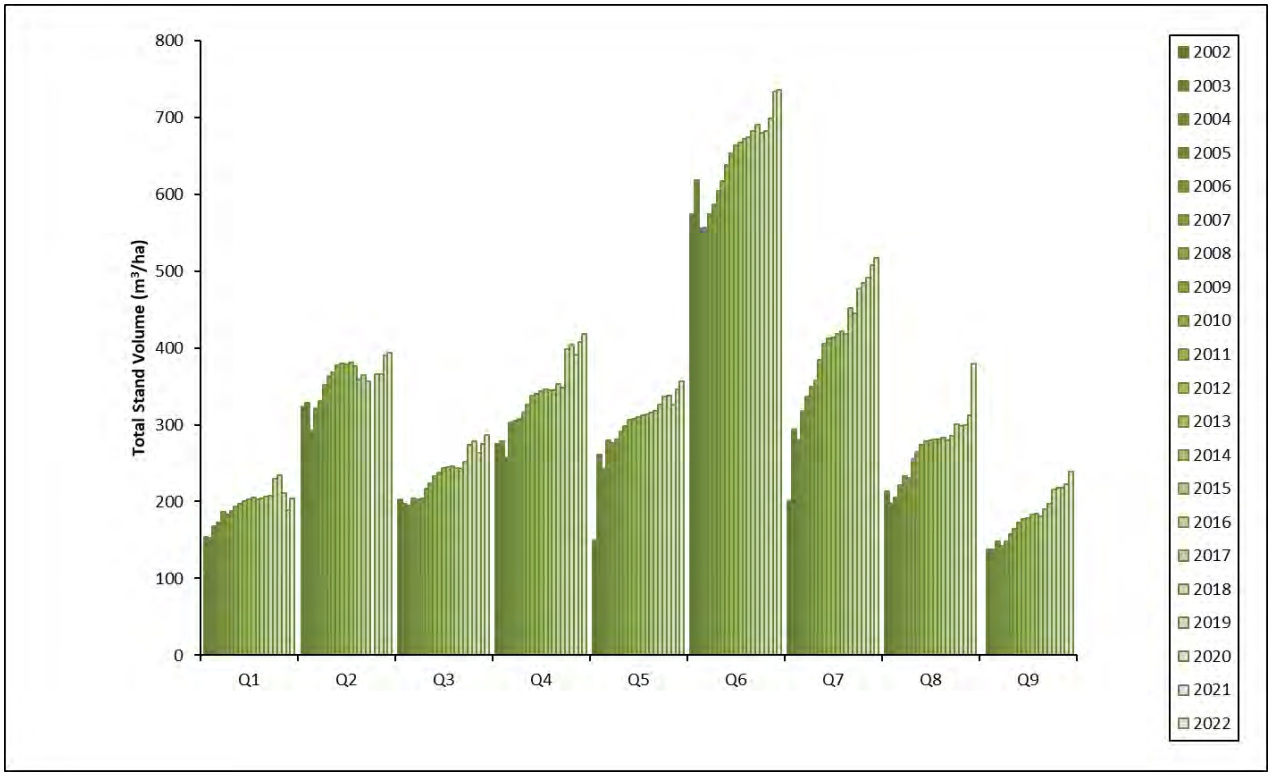


Figure 6: Total stand volume for each quadrat between 2001 and 2022

Linear regression analysis was performed for all quadrat data to assess the relationship between biomass measurements (FPC and stand volume) and time. The analysis highlights variations in vegetation growth and development over time, which may be attributed to previous edge effects from mining activities (i.e., dust, weed invasion, changes in hydrology). The analysis indicates that FPC has increased since baseline across all quadrats, except Quadrat 8 which has displayed significant variations in FPC ($F_{1, 20} = 2.40$; $p = 0.14$), although there has been an overall gradual decrease since 2011. The R^2 value has decreased from 0.26 (2021) to 0.107 (2022) which indicates that there has been a slight increase in the variation from previously modelled results **(Figure 7).**

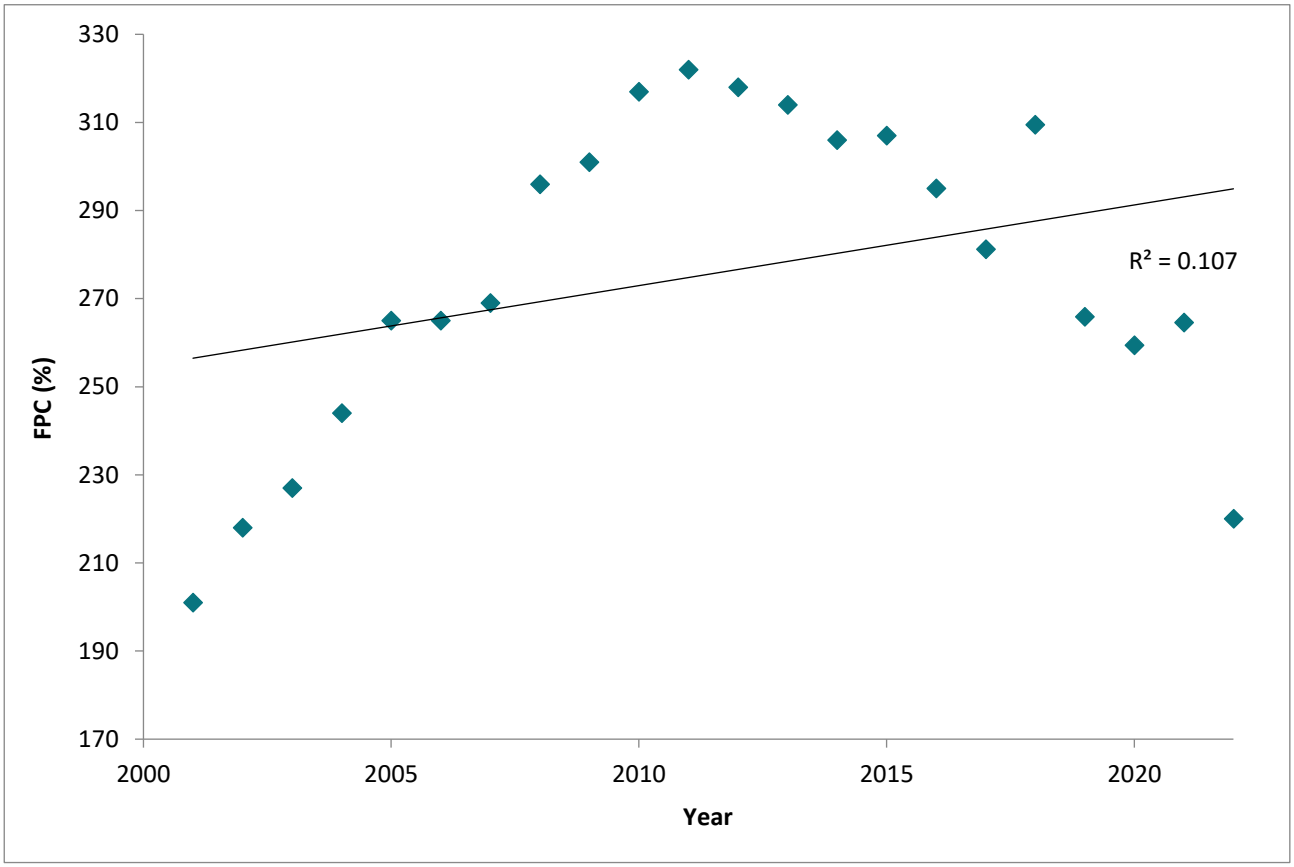


Figure 7: **Total FPC (%) for combined quadrats across time (2001-2022). R-squared values from linear regression analysis displayed.**

The linear regression analysis for stand volume indicates that this parameter has increased significantly over time across all quadrats ($F1, 20 = 263.5$; $p = <0.05$). The R^2 value is high (>0.93), which indicates that there is little variation in stand volume from year-to-year among the quadrats **(Figure 8).** An overall progressive increase in stand volume since the baseline survey is evident. Some variation may be attributed to the maturation of trees to over 2 m and /or trees dying.

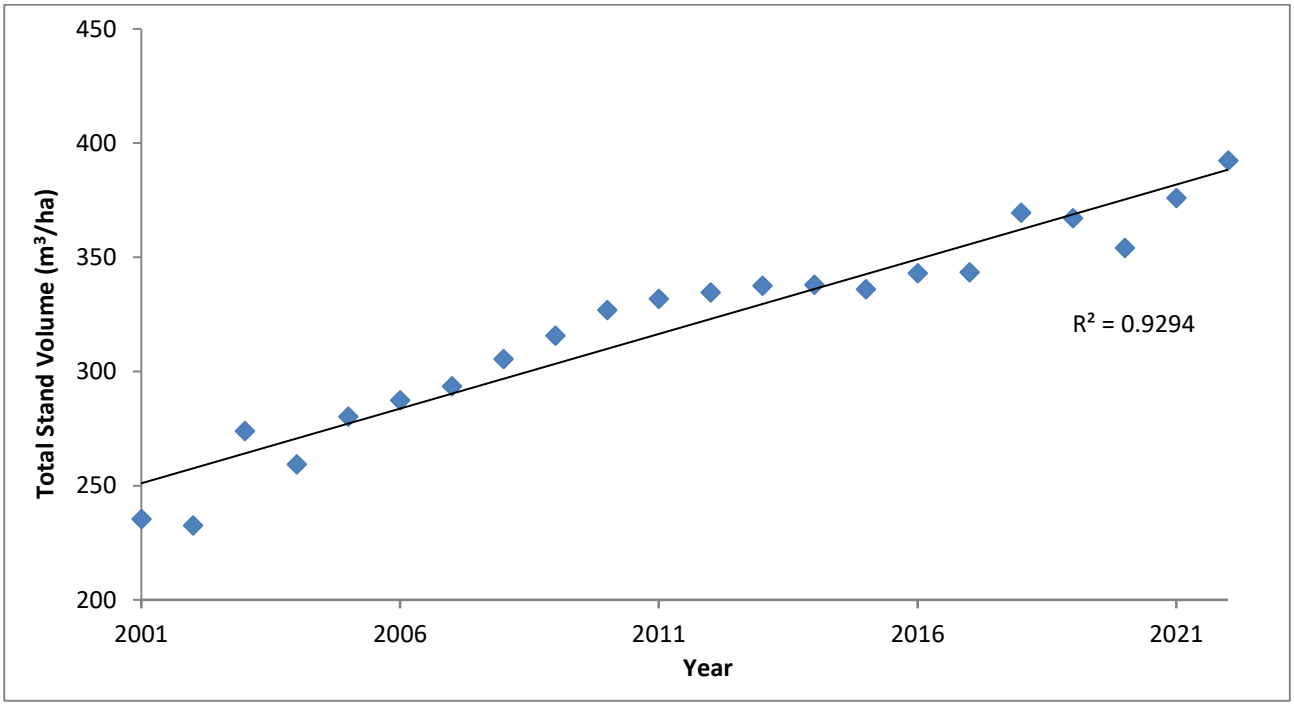


Figure 8: Total stand volume (m3/ha) for combined quadrats across time (2001-2022). R-squared values from linear regression analysis displayed.

3.4 FLORISTICS

A total of 160 flora species were recorded in 2022, including seven exotic and 153 native species. This represents an decrease on 28 species since 2021 (188 species), and an increase of 26 species since the 2001 baseline survey (134 species) (see **AppendIX 4**).

A total of 306 species have been recorded across all survey events since baseline surveys in 2001. **Figure 9** presents the cumulative number of species recorded since the baseline, illustrating a steady increase in species number until 2009 where numbers levelled off and stabilised through to 2019. The 2022 assessment revealed a stable number of species for the site.

The stabilisation of species numbers recorded over time can be explained by the species-time relationship (STR), which is similar to the pattern observed for species-area relationship (SAR), whereby the species richness of a given plant community being observed typically fits a power or exponential model. The potential number of plant species within a defined area (i.e., a quadrat) is expected to increase substantially over the short-term, and then plateau to an asymptotic maximum value as the time period increases (White et al. 2006; Specht and Specht 2002).

Ecological processes and variables which generally explain the observation of most plant species within the short-term include disturbance events, detectability (i.e., sporadic flowering time, dormancy), and variable climatic conditions such as rainfall. The expected decrease in the cumulative number of observed species richness over a longer time scale is less influenced by short-term variables and affected more by processes such as metapopulation dynamics and successional changes (White et al. 2006). For example, a reasonable proportion of many plant community assemblages consist of dormant/ephemeral species which are only detectable when conditions are suitable for germination, such as post-fire or high rainfall events. The majority of these species are likely to be detected within the short-term (i.e., within 5 years). The floristic results of the quadrat surveys within the BCA are consistent with this fundamental ecological pattern.

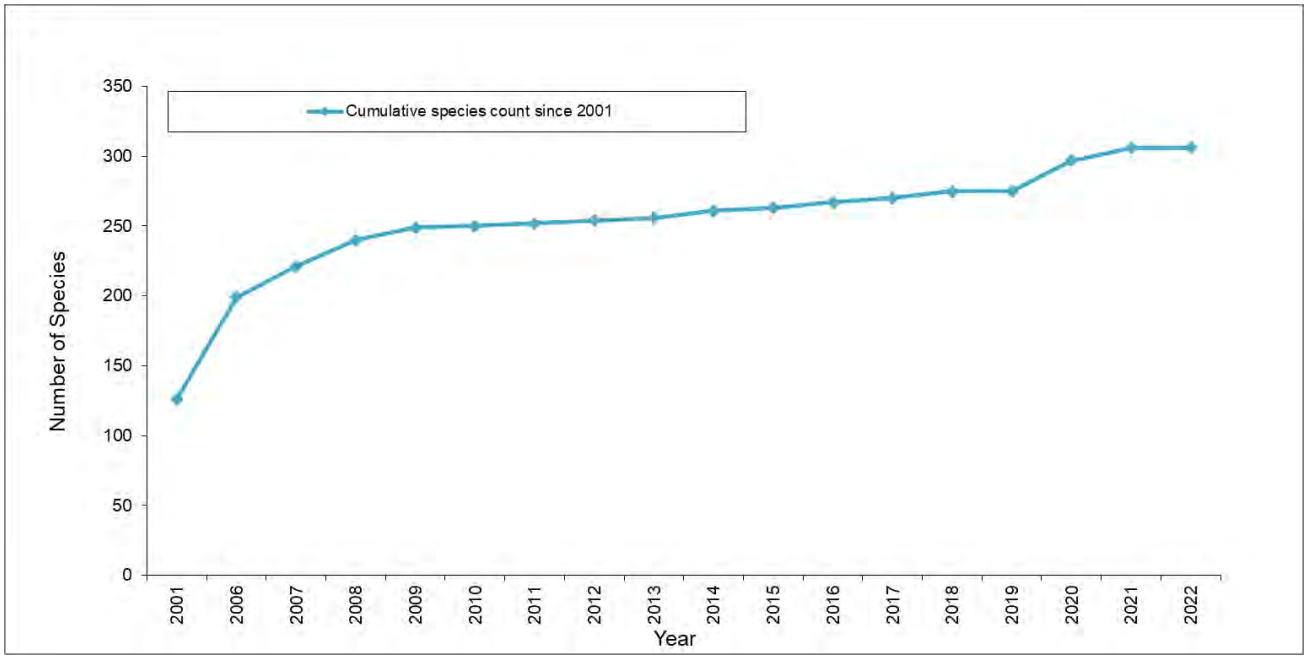


Figure 9: Cumulative species count since the baseline (2001) survey event.

Similarity indices were calculated for all pairs of quadrats in the baseline survey to determine how similar in species composition to each other the plant communities were in the quadrats surveyed. The similarity indices are shown in **Table 4**. Values from the baseline survey varied between 0.000 and 0.517 indicating a wide range in the degree of similarity between pairs of quadrats, from pairs with no shared species (Quadrat 6 and Quadrat 9), to pairs with many shared species (i.e., Quadrat 6 and Quadrat 2). This indicates that the nine quadrats sampled capture a wide degree of community and species diversity across the mining lease.

Table 4: Sorensen's Similarity Index for all pair-wise comparisons between quadrats 1-9 determined from the presence/absence data for all plant species recorded during the baseline flora survey.

Similarity Index Matrix: Baseline Flora									
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**
Q1		0.290	0.427	0.281	0.222	0.207	0.328	0.273	0.310
Q2	0.290		0.160	0.063	0.222	0.517	0.149	0.182	0.103
Q3	0.427	0.160		0.234	0.241	0.113	0.425	0.278	0.423
Q4	0.281	0.063	0.234		0.255	0.033	0.261	0.324	0.367
Q5	0.222	0.222	0.241	0.255		0.146	0.160	0.163	0.195
Q6	0.207	0.517	0.113	0.033	0.146		0.063	0.032	0.000
Q7	0.328	0.149	0.425	0.261	0.160	0.063		0.254	0.222
Q8	0.273	0.182	0.278	0.324	0.163	0.032	0.254		0.419
Q9	0.310	0.103	0.423	0.367	0.195	0.000	0.222	0.419	
Mean	0.292	0.211	0.288	0.227	0.201	0.139	0.233	0.241	0.255
SD	0.068	0.142	0.124	0.119	0.041	0.167	0.112	0.116	0.153
Overall Mean	0.232								
SD	0.125								

Values from 0.3-0.4 highlighted green (moderate similarity); > 0.4 highlighted orange (high similarity).

A comparison of the similarity indices for Quadrats 1-9 between 2001 (2003 baseline for Q9), 2007 and 2015 (i.e., 7- and 15-year intervals), as well as the previous (2021) and current (2022) survey periods are presented in **Table 5**. This analysis was performed on interval data to examine the across-time trends in floristic changes for each quadrat. The analysis shows that generally the similarity of the quadrats has stabilised over time. The comparison between consecutive years shows moderate to high similarity between survey periods, with similarity indices of 0.624 to 0.887 recorded between 2021 and 2022. This represents that a greater change in floristics occurred between 2021-2022 when compared to the previous period of between 2020-2021 (i.e., >0.85 similarity for all quadrats between 2020 and 2021 surveys). This is likely the result of the reappearance of a species as a result of more favourable climatic conditions (i.e., no longer drought conditions).

A review of similarity indices from baseline surveys through to 2022 reveal changes in floristics throughout the last 19 years indicative of a dynamic plant community responding to climatic conditions and ecological variables over time. Floristic similarities between baseline and the current assessment indicate that most quadrats have a species composition moderately similar to that in 2001 (2003 for Q9). The lowest similarity was recorded at Q7 which identified a significant reduction in species similarity with only one species present in both baseline and 2022 surveys, whilst a reduction of species similarity in Q1 of six species was observed from baseline to 2022 survey period.

Table 5: Sorensen's Similarity Index for Quadrats 1-9, comparing species composition from baseline (2001 for Q1-Q8; 2003 for Q9), 2007, and 2015, as well as the previous and current surveys. Values for quadrats may range between 0 (no species present at both survey periods) to 1.0 (all species present in both surveys).

		Baseline vs '07	2007 vs '15	Baseline vs '15	Baseline vs 2022	2021 vs '22
Q1	No. of sp. present only 1 year	32	22	34	32	23
	No. of sp. present in both years	22	33	20	16	26
	Similarity Index	0.579	0.75	0.541	0.500	0.693
Q2	No. of sp. present only 1 year	45	37	40	31	16
	No. of sp. present in both years	22	40	25	21	39
	Similarity Index	0.494	0.684	0.556	0.575	0.830
Q3	No. of sp. present only 1 year	47	32	51	40	20
	No. of sp. present in both years	27	44	29	27	46
	Similarity Index	0.535	0.733	0.532	0.574	0.821
Q4	No. of sp. present only 1 year	44	28	52	43	12
	No. of sp. present in both years	19	37	17	19	47
	Similarity Index	0.463	0.725	0.395	0.469	0.887
Q5	No. of sp. present only 1 year	39	39	42	37	17
	No. of sp. present in both years	10	28	11	11	44
	Similarity Index	0.339	0.589	0.344	0.373	0.838
Q6	No. of sp. present only 1 year	36	30	40	41	14
	No. of sp. present in both years	17	33	20	16	40
	Similarity Index	0.486	0.688	0.500	0.438	0.851
Q7	No. of sp. present only 1 year	43	30	47	49	15
	No. of sp. present in both years	22	38	22	1	42
	Similarity Index	0.506	0.717	0.484	0.039	0.848
Q8	No. of sp. present only 1 year	40	42	46	64	24
	No. of sp. present in both years	23	33	23	20	56

		Baseline vs '07	2007 vs '15	Baseline vs '15	Baseline vs 2022	2021 vs '22
	Similarity Index	0.535	0.611	0.500	0.385	0.824
Q9	No. of sp. present only 1 year	52	34	50	35	41
	No. of sp. present in both years	16	40	17	15	34
	Similarity Index	0.381	0.702	0.405	0.462	0.624

3.5 FAUNA

A total of 180 fauna species have been recorded since monitoring began in 2001, including 12 frog, 18 non-flying mammal, 26 bat, 111 bird and 13 reptile species. Fauna species recorded in 2022 totalled 75, consisting of 45 birds, 15 bat, five terrestrial mammal, four arboreal mammal, four frog and two reptile species (**Figure 10**). Six bat and one bird species are listed as Vulnerable under the NSW Biodiversity Conservation Act 2016 (BC Act). The low numbers observed in 2002, 2003 and 2004 are due to the lack of bird surveys completed in those years.

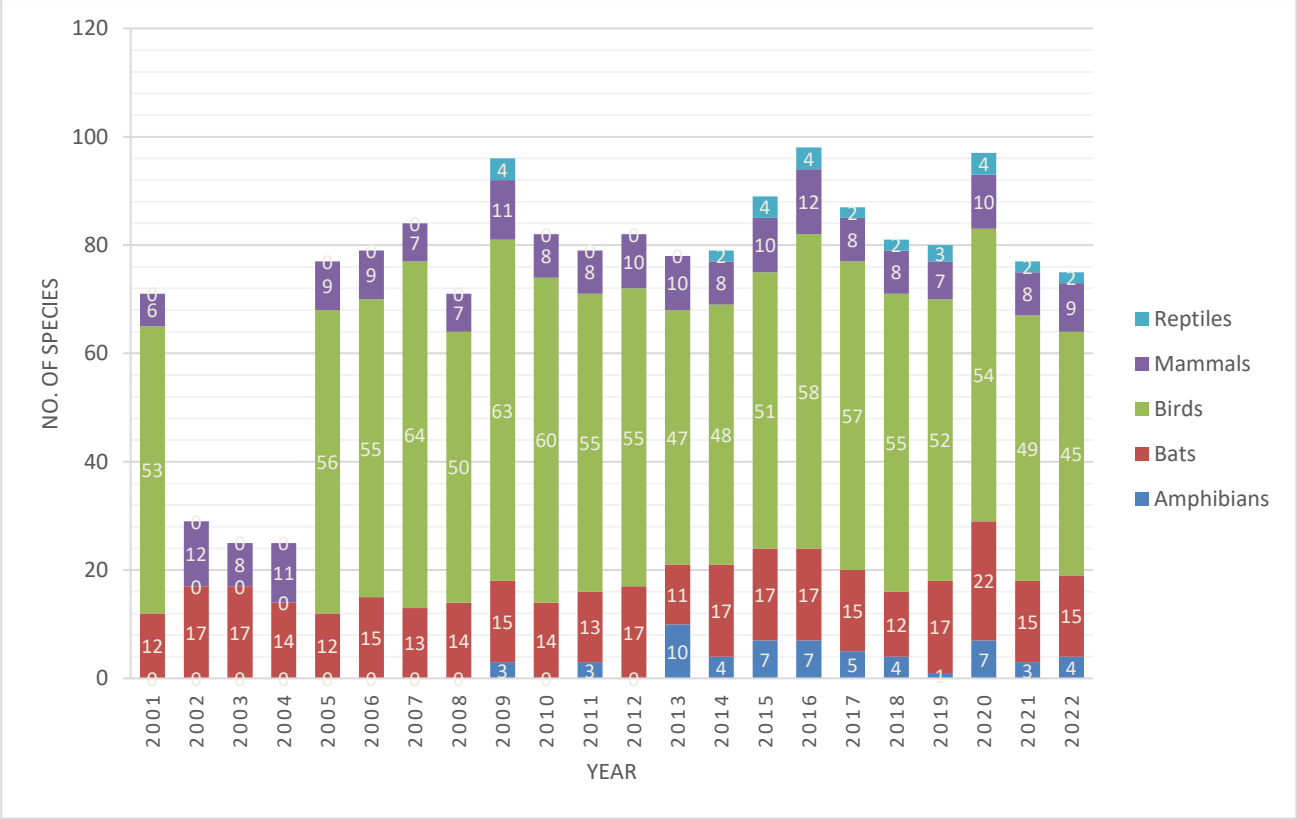


Figure 10: Total fauna species recorded across all years (2001 – 2022).

The nMDS analysis (**Figure 11**) illustrates the degree of similarity, across years, for the number of fauna species detected within each survey period. Two clusters of years containing 2007 and 2010-2012 show 80% similarity (**AppendiX 8**) (indicated by the red dotted line) with all other years having between 60-80% similar fauna assemblages.

Fauna assemblages for all year's show at least 68% similarity. The SIMPROF test (**AppendiX 8**) showed that the greatest similarity of fauna assemblages exists between years 2010 and 2011 (83%). This year's results (2022) show a statistically significant difference from the previous year (2021) of monitoring although no statistical difference from six other years with the greatest similarity to 2016 (78%). This difference with 2021 is likely to be due to differences in the composition of bird species detected. This is discussed in greater detail in Section **3.5.1.4.**

It should also be noted that a hazard reduction burn was undertaken within the very northern portion of the BCA (within the vicinity of Quadrat 8). Specially, all ground vegetation was burnt ensuring that all large trees and the flora quadrat was avoided. The burn was undertaken following fauna surveys in 2020. The reduction burn has the potential to influence fauna occurrence in the coming years.

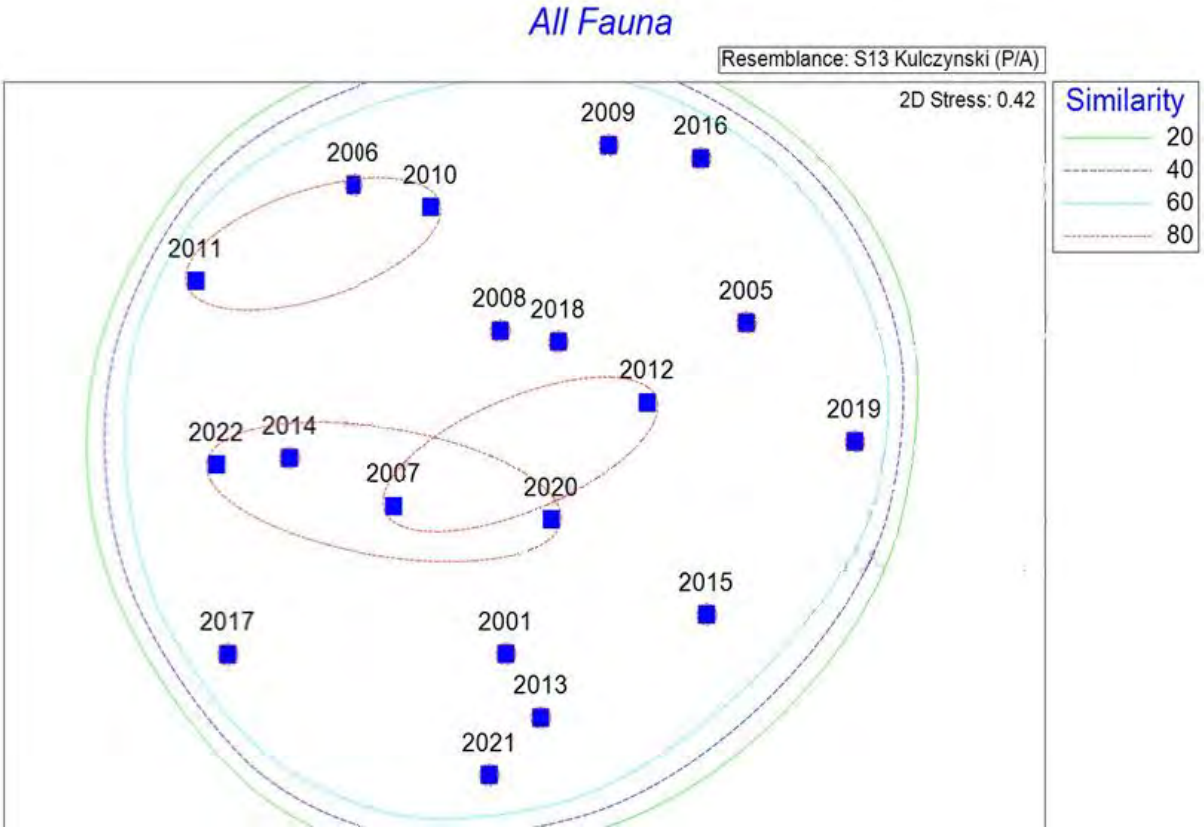


Figure 11: nMDS analysis of all fauna species detected in all quadrats 2001 – 2022 (excluding 2002 – 2004)

3.5.1 Mammals

A total of 24 mammal species were detected during the 2022 surveys, comprising 15 microbats, one megabat, five terrestrial species and four arboreal species. Six of the bat species detected were listed under the BC Act, The number of mammals detected during the current survey (24) which is equal to the yearly average of 24 species across all survey years and is the highest since surveys began in 2001 (**Figure 12**). During the 2022 surveys one introduced pest species were detected the Black Rat (*Rattus rattus*).

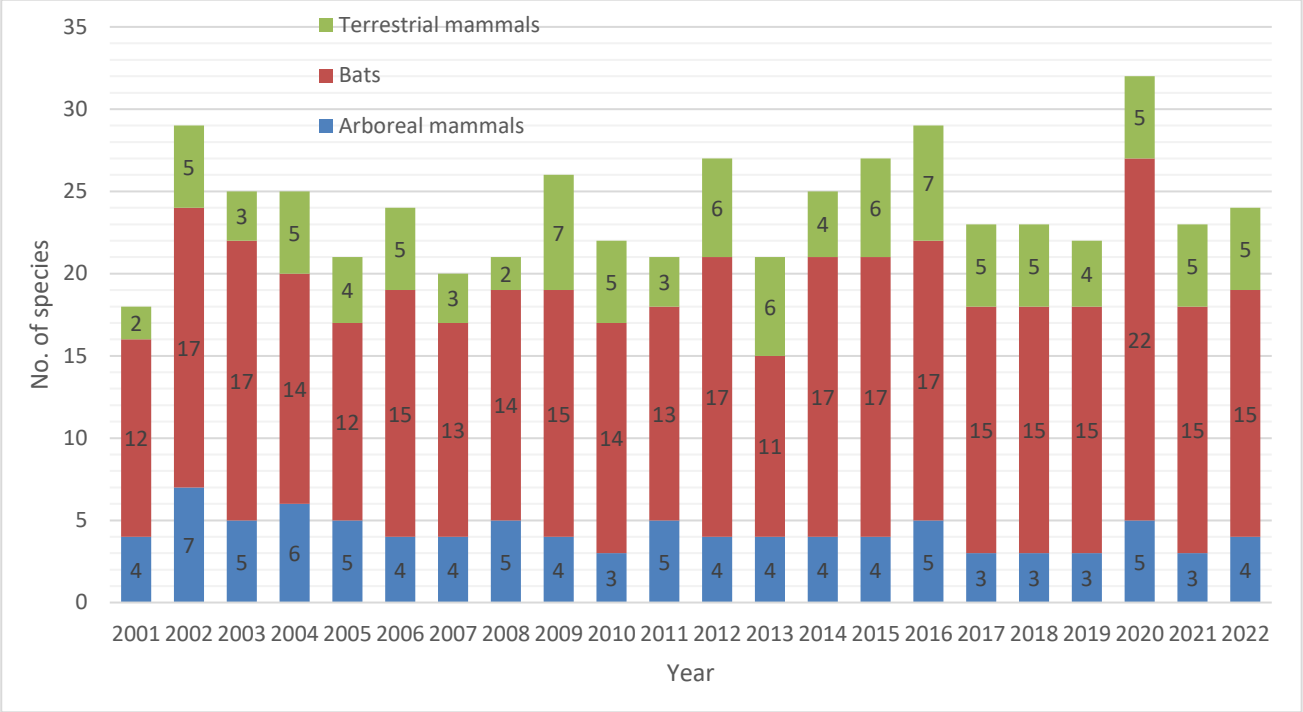


Figure 12: Total mammal species recorded at each survey event 2001 – 2022.

A list of all mammal species detected from 2001-2022 is provided in **AppendiX 5**. To investigate trends in species assemblages across the years, mammals were categorised for analysis into arboreal species, highly mobile flying species (Chiroptera or bats) and terrestrial species.

3.5.1.1 Arboreal Mammals

During the 2022 fauna surveys, four species of arboreal mammal were detected (**Figure 12**), which is approximately equal to the yearly average (4.35 species). The arboreal mammals detected included Sugar Glider (*Petaurus breviceps*) recorded during all survey periods except for 2001, as well as the Brown Antechinus (*Antechinus stuartii*) and the Common Brushtail Possum (*Trichosurus vulpecula*), which have been detected every year. Additionally, the Feathertail Glider (*Acrobates pygmaeus*) was observed, which has not been detected since 2020.

The nMDS analysis demonstrates that overall, the assemblages of arboreal mammal species have remained similar since 2001 **(Figure 13)**. All years' show at least 65% similarity, with the most similar years being 2003, 2016, 2008 and 2020 (100% similarity) also year groupings of (2013 and 2015) (2010, 2017-2019) and (2006, 2007, 2009, 2012, 2014) all have 100% similarity within each grouping. Variation of arboreal mammal assemblages, year to year, can be attributed to the sporadic

detections of less common or highly mobile species such as the Greater Glider (*Petauroides volans*) and Squirrel Glider (*Petaurus norfolcensis*).

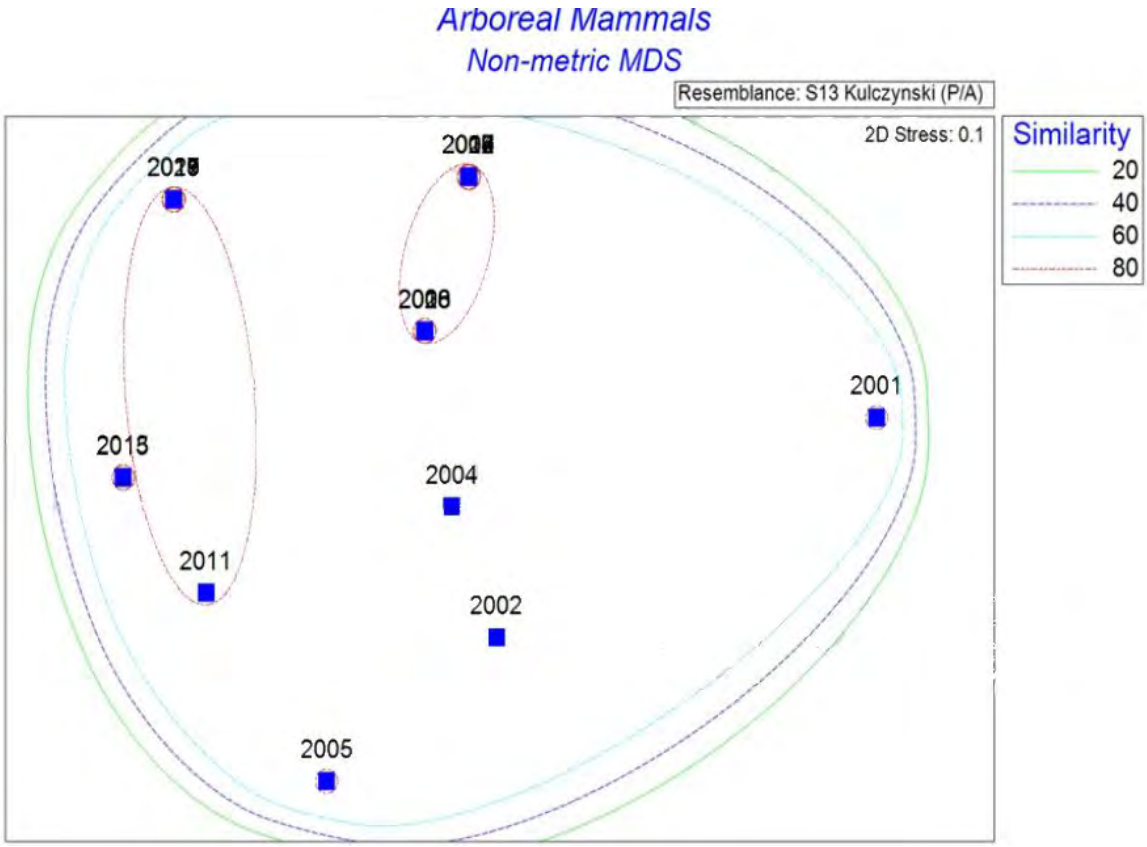


Figure 13: nMDS analysis of arboreal mammal species detected in all quadrats 2001 – 2022.

3.5.1.2 Terrestrial Mammals

The 2022 surveys recorded a total of five terrestrial mammal species (**Figure 12**) which is slightly above the average for all years (4.6 species). The terrestrial species comprised four native species; Bush Rat (*Rattus fuscipes*), Eastern Grey Kangaroo (*Macropus giganteus*), Swamp Wallaby (*Wallabia bicolor*) and the Long-nosed Bandicoot (*Perameles nasuta*) with one feral species detected in this year's surveys - the Black Rat (*Rattus rattus*). The nMDS analysis of terrestrial mammals (**Figure 14**) shows variation in species assemblages throughout the monitoring period with all years being at least 60% similar with several clusters of years being highly similar to each other (≥80%) with the 2022 data being closely related to 2020 (90%).

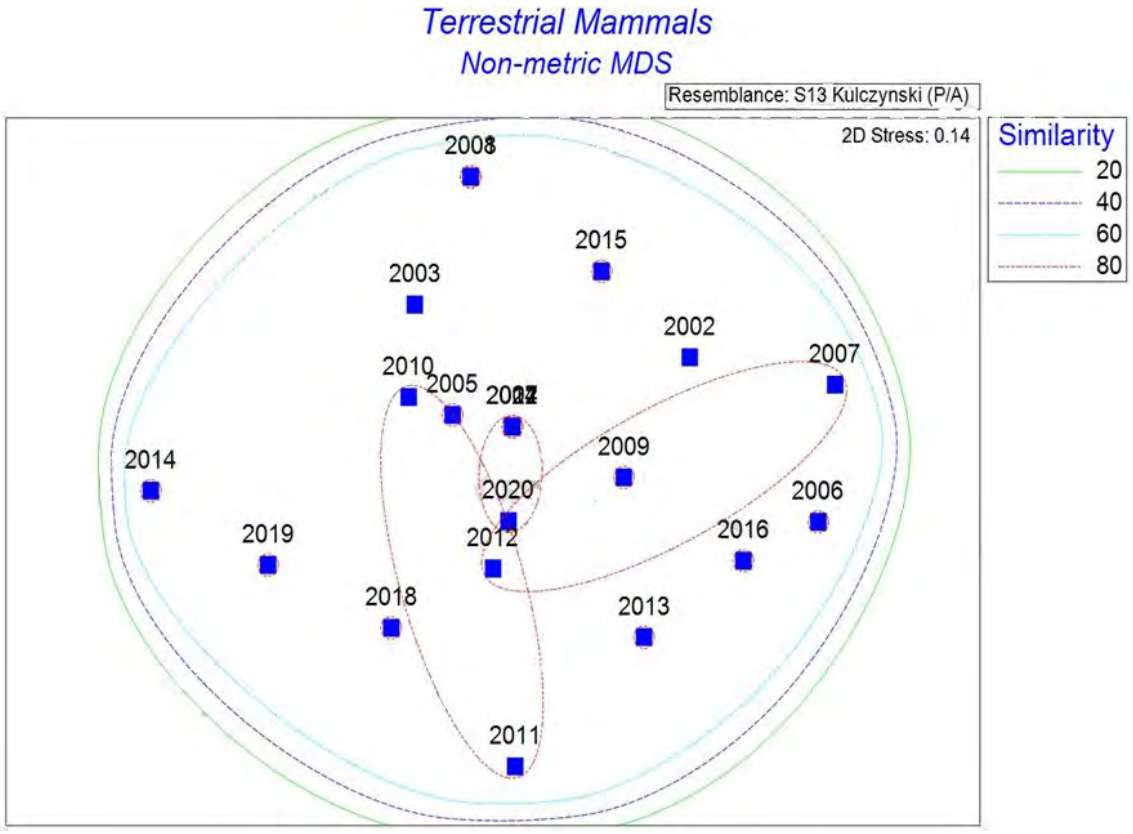


Figure 14: nMDS analysis of terrestrial mammal species detected in all quadrats 2001 – 2022.

3.5.1.3 Bats

A total of 15 species of bat were recorded across all nine quadrats during 2022 (**Figure 12**). This is equal to the yearly average of 15 species. Six of the 15 bat species recorded during the 2022 survey are listed as threatened under the BC Act. The six threatened bat species included: Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Little Bentwing-bat (*Miniopterus australis*), Eastern Bentwing-bat (*Miniopterus oceansis*) Large-footed Myotis (*Myotis macropus*), East Coast Freetail-bat (*Mormopterus norfolkensis*) and Grey-headed Flying-fox (*Pteropus poliocephalus*). Bats account for 20% of all fauna species detected in the 2022 surveys.

The nMDS showed the bat assemblages of all years were at least 68% similar, with three clusters of years that were at least 80% similar (**Figure 15**). The 2022 results are 88% similar with 2014, 2016 and 2020 with all results being at least 80% similar with each other. There was no clear pattern in the variation in species assemblages over time.

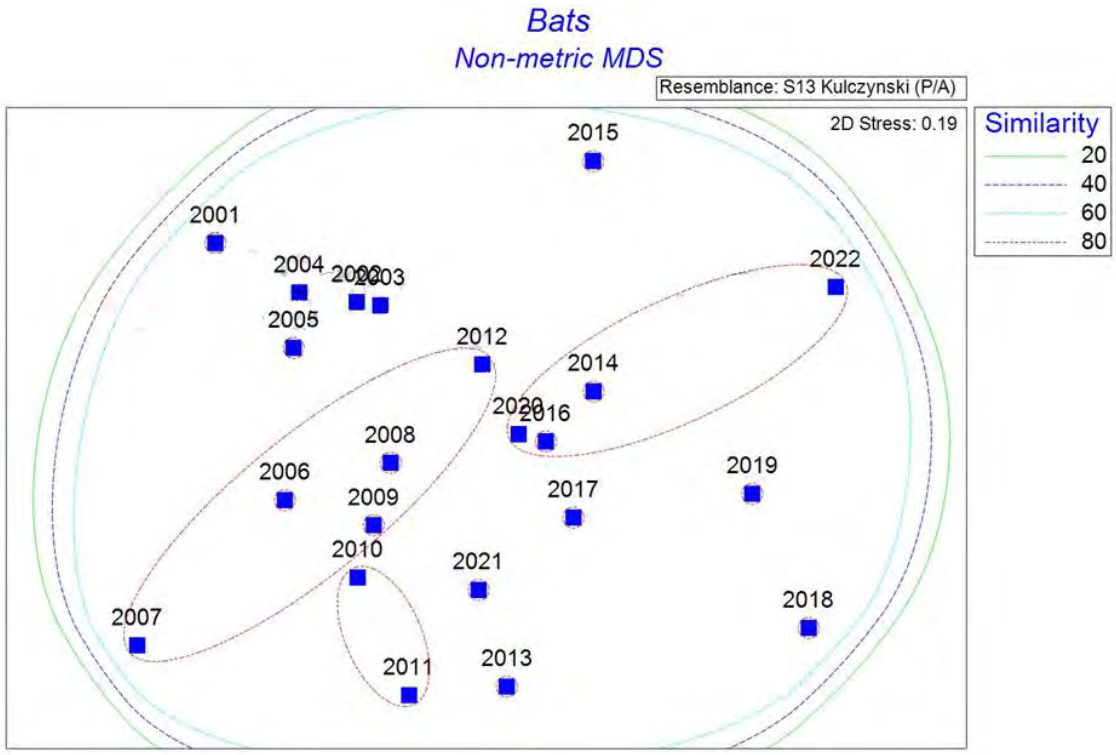


Figure 15: nMDS analysis of bat species detected in all quadrats 2001 – 2022.

3.5.1.4 Birds

A total of 45 bird species were recorded across the nine quadrats during the 2022 surveys, which is below the average of 54.9 species across all years (**Figure 10**). Overall, the number of bird species recorded each year has remained relatively constant with no marked increase or decrease. No previously undetected species (from quadrat surveys) was recorded in 2022. One species listed as vulnerable under the BC Act were detected in 2022, the Little Lorikeet (*Glossopsitta pusilla*) at Q3, Q4, Q8.

A total of 111 species have been recorded since monitoring began which belong to 41 families, of which the most common are Meliphagidae (Honeyeaters), Psittacidae (Parrots), Acanthizidae (Thornbills, Scrub wrens and Gerygones), Columbidae (Pigeons and Doves), Cuculidae (Cuckoos) and Artamidae (Woodswallows, Butcherbirds, Australian Magpies and Currawongs). A total of 20 families were only represented on site by one species, however, several of these families such as the Podargidae (Frogmouths), Coraciidae (Rollers), Oriolidae (Orioles and Figbird), Dicaeidae (Flowerpeckers) and Megapode (Mound Builders) have only 1 – 3 species present in Australia.

A total of seven threatened bird species have been recorded across the nine quadrats to date. Three of these species are large forest owls (Sooty Owl, Powerful Owl, and Masked Owl) and four are woodland bird species (Glossy Black-Cockatoo, Little Lorikeet, Dusky Wood Swallow and Varied Sittella).

The Sooty Owl has only been recorded within the BCA twice (2001 and 2016). The Masked Owl has been recorded between 2014 and 2018, as well as 2009 and 2010, but was not recorded in this survey period. The Powerful Owl has been recorded in all years except 2009, 2012, 2013, 2016, 2021 and was not recorded this year (2022). The Little Lorikeet and Varied Sittella have been recorded infrequently throughout the monitoring period. The Glossy Black-Cockatoo was recorded for the first time in 2016. No feral bird species have been recorded on or in the immediate vicinity of the quadrats to date.

The total number of bird species recorded each year is displayed in **Figure 16**.

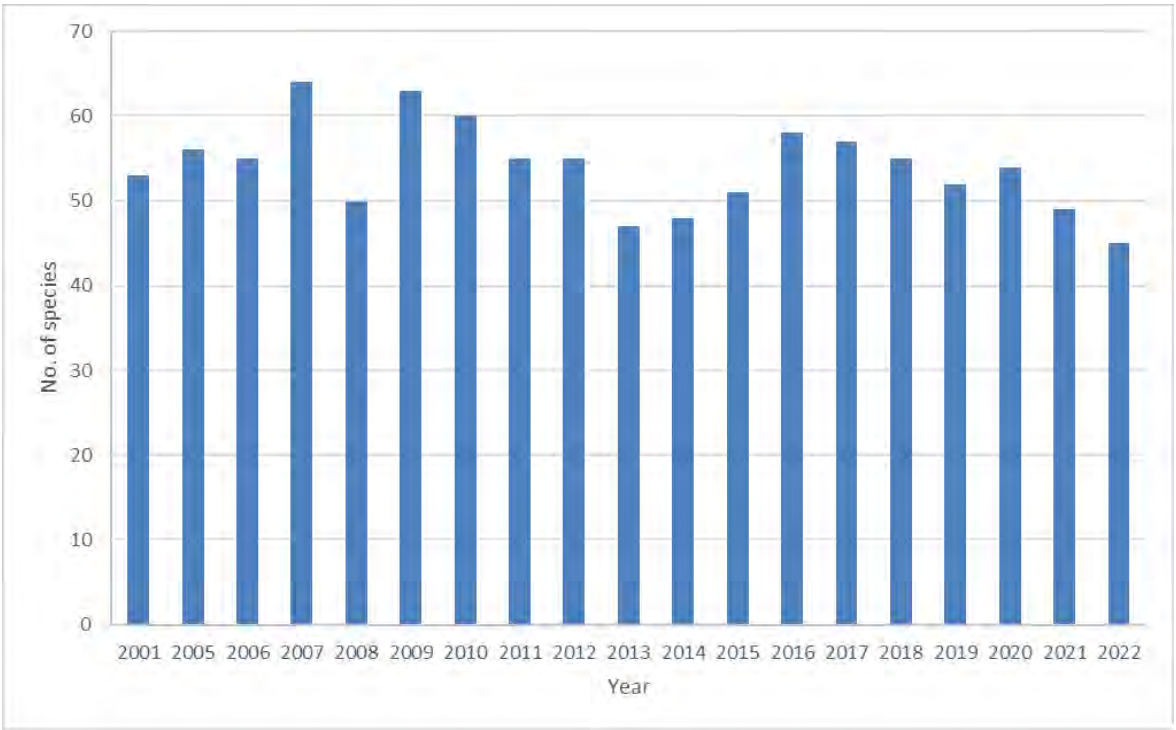


Figure 16: Total number of bird species recorded in all quadrats 2001 – 2022 (excluding 2002 - 2004).

Figure 17 shows the cumulative number of bird species recorded since the baseline survey event. The cumulative number of species has been increasing steadily every year since the baseline. The flattening of the species curves suggests that most species likely to occur at the site have now been recorded; however, a few new species are still being recorded in recent years.

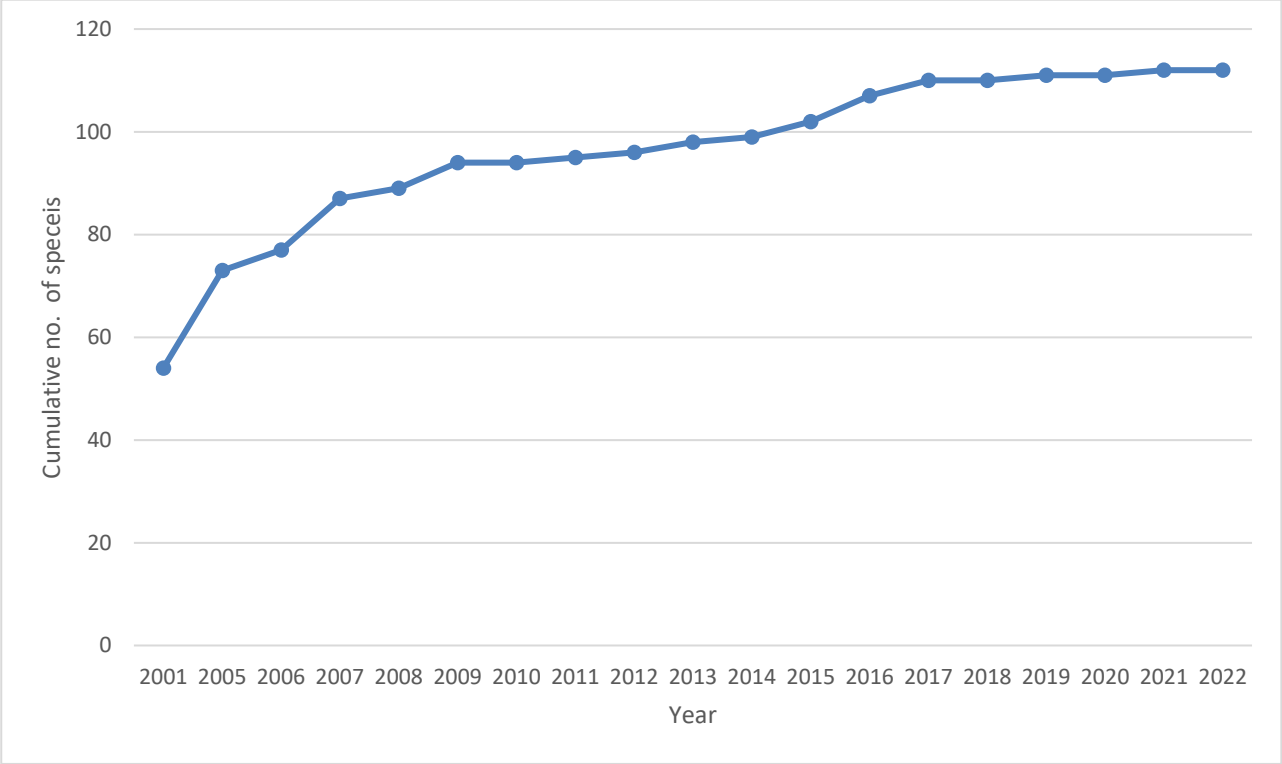


Figure 17: The cumulative bird species count since the baseline (2001) survey event.

Despite the total number of bird species recorded each year remaining relatively constant over time, the nMDS similarity analysis (**Figure 17**) showed a pattern of clustering of survey years similar to that observed for all fauna groups, suggesting that changes in bird assemblages may be responsible for the similarity results observed for all fauna (when vertebrate classes are grouped together due to the number of species within the bird group).

The SIMPROF cluster analysis (**AppendiX 8**) revealed that bird assemblages from the years 2016 and 2019 are the most dissimilar statistically (70% confidence) compared to other years. With all other years being at least 74% similar with each other. To investigate this recent trend further, bird species were pooled (refer to 2016 annual report) based on general habitat preference (generalist, forest interior specialist, forest edge/open grassland preferred). Survey years were then pooled together to form the groups 2005 – 2008, 2008 – 2012 and 2013 – 2016 (the period since mining operations has ceased).

The analysis found that the average of the 2005-2008, 2009-2012 and 2013-2016 periods shows birds with generalist habitat preference have continued to be around 26-27 species per 4-year period with an increase to 30 species within the latest period of 2019-2022. In the period of 2013-2016 there was an average of 35 species (decrease of 12.5% from previous period) in the number of forest-interior specialists recorded increasing in the 2019-2022 period to 38 species (increase of 8%). Forest edge/open grassland species did increase by 20% (2009-2012 12 species to 15 species 2013-2016) since the cessation of mining operations in 2012 although decreasing by 26.6% to 11 species in the 2017-2020 period. This analysis will be undertaken again in 2024 (24 years of monitoring) to see whether this identified trend continues.

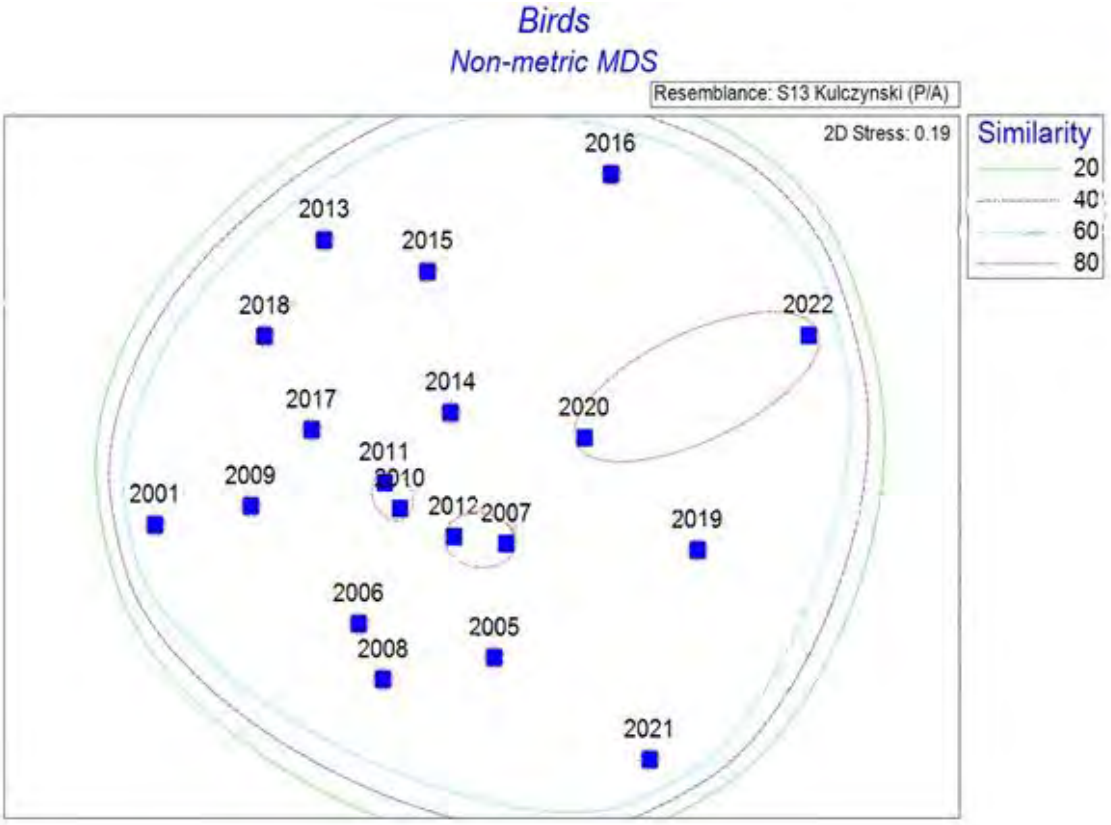


Figure 18: nMDS analysis of bird species detected in all quadrats 2001 – 2022 (excluding 2002 – 2004)

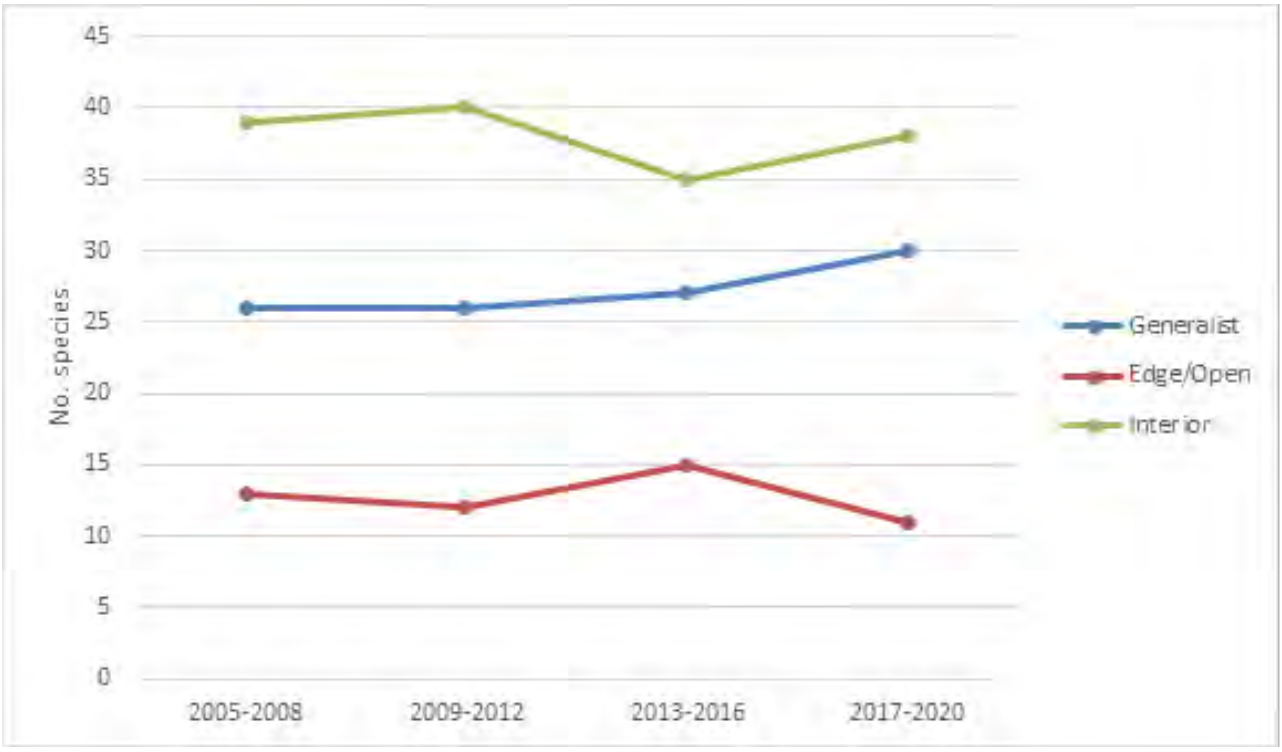


Figure 19: Number of birds per guild from 2005-2022

3.5.2 Herpetofauna

Although herpetofauna monitoring is not officially part of the monitoring program, reptile and amphibian species were recorded opportunistically during survey events. No reptile or amphibian species were recorded prior to 2009, as such, herpetofauna was excluded from the statistical analyses comparing species assemblage similarity for those years.

Current survey identified four amphibian species, two reptile species the Eastern Bearded Dragon (*Pogona barbarta*) was identified in Q7 and the Lace Monitor (*Varanus varius*) within Q5.

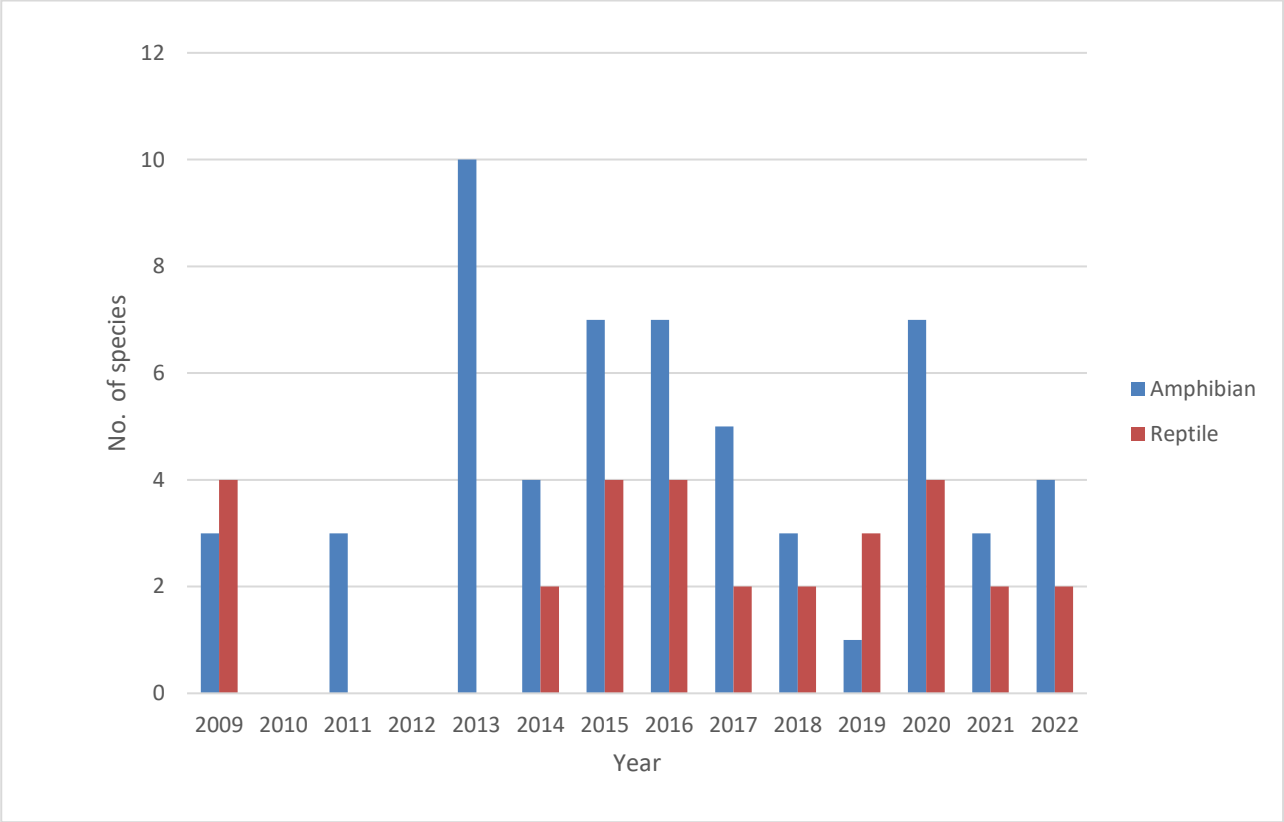


Figure 20: Number of amphibian and reptile species recorded within all quadrats over time.

3.5.3 Nest Box Monitoring

Initially, 45 nest boxes were installed across the nine quadrats in 2005, however, three (3) were removed in 2010 due to the construction of the western Square Pit. The three (3) nest boxes removed were replaced in May 2016 with new nest boxes at different locations within Quadrat 2. In total 15 nest boxes were replaced in 2016. After the 2018 winter surveys, 15 nest boxes were replaced and three (3) repaired bringing the total available boxes back to 45. Total nest box utilisation is 56% in the summer period (**Figure 21**). A single factor ANOVA was not conducted for Summer 2022 due to the difference in the number of available boxes between seasons. All 45 nest boxes were checked once during summer in 2022 to determine occupancy rates.

Nest box utilisation appears to be plateauing with similar usage rates to last year **Figure 22**. Four mammal species were confirmed to have used the nest boxes, Sugar Glider (*Petaurus breviceps*),

Brown Antechinus (*Antechinus stuartii*), Feather Tail Glider (*Acrobates pygmaeus*) and Common Brushtail Possum (*Trichosurus vulpecula*).

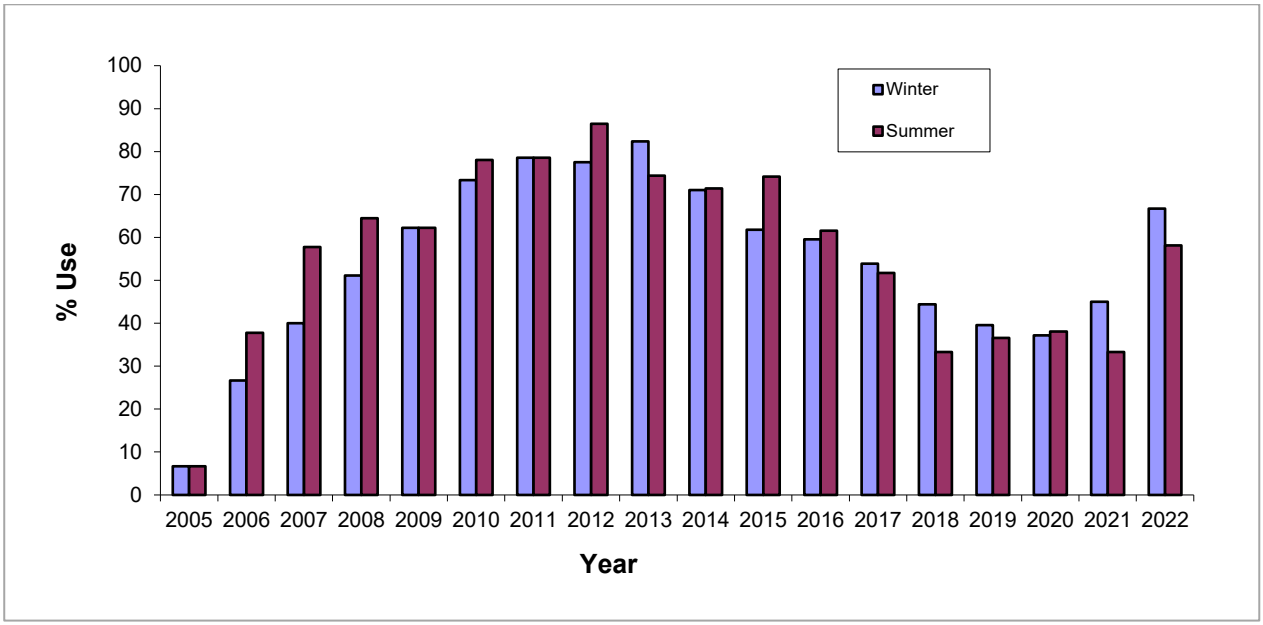


Figure 21: The proportion of nest boxes utilised in winter and summer between 2005 and 2022.

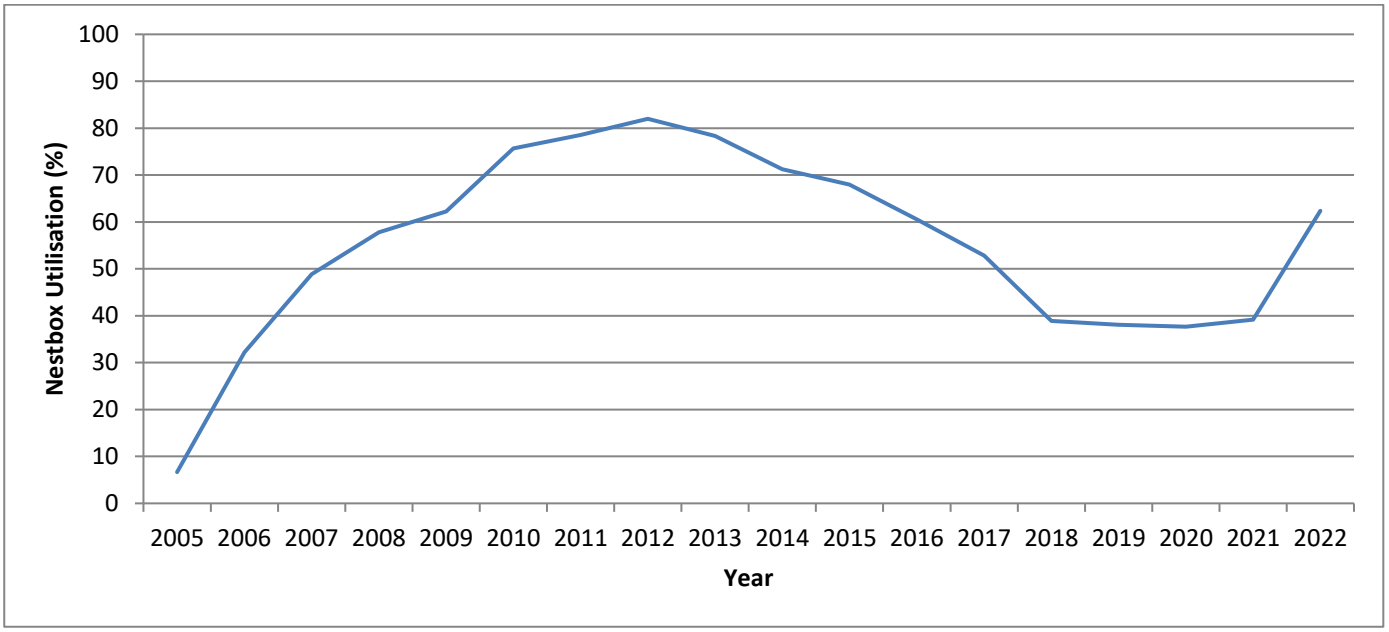


Figure 22: **Nest box usage, summer and winter combined (2005 – 2022). Usage rates are calculated based on available boxes.**

Figure 23 shows the number of nest boxes available for use since installation in 2005. There was no decline in nest box availability from 2005 until 2010. Since then, nest box availability has fluctuated due to weather and termite damaged and the repair/instalment of new nest boxes.

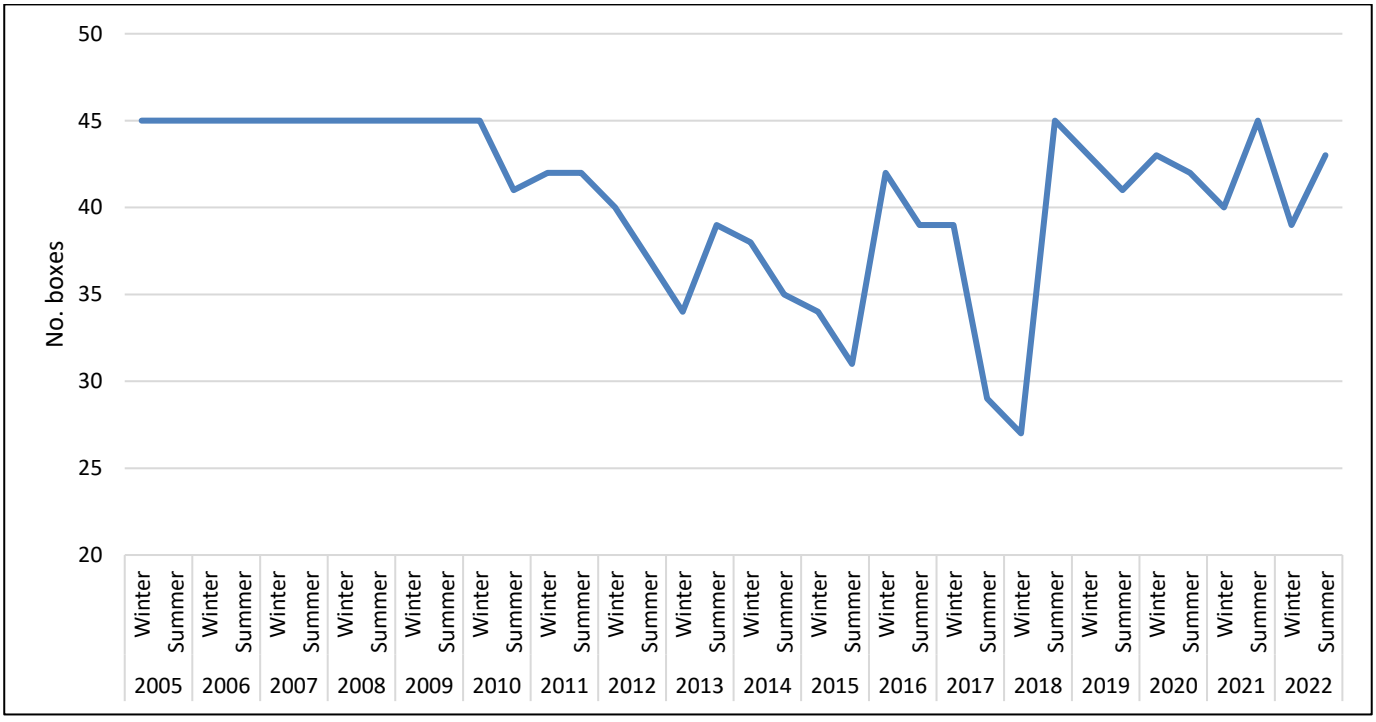


Figure 23: **Number of available nest boxes over time (2005 - 2022)**

4. DISCUSSION

4.1 VEGETATION

Plant species numbers have increased since 2001, as have all floristic structural components. This is indicative of a dynamic plant community with high recruitment from the seed pool, indicating a healthy plant community status. While the species composition recorded in each quadrat has changed over the survey period, the number of species identified within each quadrat has remained relatively consistent over time. The current survey results have revealed a moderate increase in species richness and cover since the 2019 survey, likely indicative of recovery from drought conditions experienced on site between 2018 and 2019.

Previous weed control has been effective in controlling *L. camara* and allowing the subsequent recruitment of native species, particularly in Quadrats 5 and Quadrat 7 where *L. camara* has noticeably declined. Follow-up weed control is critical to ensure the effective long-term management of these infestations and to limit regrowth. *L. camara* was identified as having a low cover (<5%) but common at Quadrats 6, 7 and 8. Quadrat 6 has a persistently high exotic plant coverage, with an estimated cover of >75% in the ground layer (primarily *Tradescantia fluminensis*). Immediate control in Quadrat 6 for *T. fluminensis* is recommended to prevent further decline, while surrounding areas around Quadrats 2, 3, 5,6 and 7 should be considered for future weed control for *L. camara.*

Given that total weed abundance has been relatively low within the BCA since 2001, it is difficult to identify changes in community condition based on weed abundance. Community condition has more likely been affected by the steady increases in biomass, resulting from the removal of weed species, fire management and tree removal, and a healthy native seedbank.

Regression analyses examining the change in stand volume for all quadrats over time demonstrate a steady increase in these parameters. In contrast, FPC parameters demonstrated an increase in Q1-3, whilst Q4-9 displayed decreases in FPC. Biomass results indicate minimal discernible adverse impact on vegetation growth and development from the surrounding mining operations. While an overall progressive increase in biomass parameters (stand volume) in the quadrats is supported by the data, the rate of increase has slowed with both parameters remaining relatively constant and displaying variability in FPC since the 2010 survey.

The FPC analysis in 2022 indicate mixed results, albeit lower than the highest values recorded in 2012/2013 survey periods. Quadrats have recorded an increase in FPC since 2019, indicating early stages of recovery post-drought conditions, however a decline in Q4-9 during 2022 survey period. Stand volume continues to broadly trend positively with some quadrats recording a slightly lower stand volume likely the result of the inclusion of a number of small trees which had reached the 2m threshold. Minimal regeneration of the canopy layer, a declining shrub layer and reduced ground cover is evident to various degrees at each quadrat – however results indicate early stages of recovery following the return of more favourable climatic conditions.

4.1.1 Myrtle Rust

In 2013 Quadrat 6 recorded a decrease in FPC resulting from the decline of *R. psidioides* species from rust fungus. In 2015, several of the seedlings were still present despite being infected, however the mature trees within and adjacent to Quadrat 6 were declining in health. By 2016, the mature trees had completely died off, and only one seedling was present. The species has been recorded absent from Quadrat 6 during the 2018, 2019 and 2020 surveys.

Myrtle rust is a plant disease caused by the exotic fungus *Uredo rangelii.* It is a serious pathogen which affects plants belonging to the family Myrtaceae including Australian natives such as *Callistemon spp., Melaleuca spp.* and *Eucalyptus spp.* It was first detected in Australia in 2010 on the NSW Central Coast. Over 100 native plant species in NSW are known to be susceptible host species to the fungus, including several species present within the BCA: *Backhousia myrtifolia*, *Callistemon salignus*, *Eucalyptus pilularis, Melaleuca linariifolia* and *Syncarpia glomulifera.* While no other evidence of Myrtle Rust was observed within Quadrat 6, or other areas of the BCA, monitoring for evidence of the fungus will continue as part of future surveys.

4.2 FAUNA

Fauna species richness has declined steadily during 2022. The current survey recorded 60 species, which is 22.5 above the yearly average of 81.5 (excluding 2002-2004 where no bird surveys were conducted). Species recorded include 45 birds, which is slightly below to the long-term average. Nine non-flying mammals were recorded, matching the yearly average of nine. The species assemblages of arboreal mammals have been relatively constant throughout the monitoring period as Brown Antechinus, Sugar Glider and Common Brushtail Possum have been recorded every year.

The nMDS analysis of terrestrial mammals (**Figure 14**) indicates variation in species assemblages with no clear pattern. This may be attributed to the detectability of species, for example the Short-beaked Echidna (*Tachyglossus aculeatus*) was recorded in 2014 and 2019 only. This species is somewhat secretive and could easily go undetected despite its presence within the BCA.

Bat species assemblages have remained stable over the years, any variations do not fit a clear pattern. The ecology of most Australian bat species is poorly understood making interpretation difficult. The number of species detected each year has remained high which is a positive sign that bats are not in a decline. In 2018 and 2019 a difference is evident in the nMDS analysis from the rest of the other years, this is likely a result of the variation of species detected compared to earlier years. In 2022 the nMDS analysis shows that the species assemblages have return to more similar levels before the 2018 and 2019 periods.

The cluster analysis identified a trend in the bird species assemblages. The assemblages recorded in the most recent years being most different from those recorded prior to 2013. To investigate the cause of the changing species assemblage, species were grouped according to general habitat preference (generalist, forest-interior specialist, and forest edge specialist). With the addition of the 2019 - 2022 time period, trends indicate that the species with generalist habitat requirements have remained relatively stable since from 2005 to 2016 with an increase of three species. Species that prefer forest edges or open areas have decreased since the 2013-2016 period where previously they had increased. While interior specialist species appeared to be significantly decreasing at the end of the 2013-2016 period (Kleinfelder 2016), in the latest period there has been an increase in numbers. This latest four-year period shows that there are fluctuations within the edge/open and interior species throughout the years with generalist species slowly increasing each period.

Given that mining ceased in 2012 it is possible that changes in disturbance have led specialist species to move in or out of the area. Observed changes in species assemblages over the last four-years show that interior species have moved back into the area with edge/open area species moving out. The change in the bird species assemblage may fluctuate slowly occurring over time as a result of mining activities or due to large-scale vegetation clearing and development in the neighbouring industrial estate immediately to the east, which commenced in 2012 and is still ongoing.

The creation of more edge habitat along the eastern edge of the BCA may have made the habitat less suitable for some specialist species or detectability of these species may have been lower. It is most likely a combination of these two factors that has caused the changes observed in the 2022 analysis. The specialist species either the interior or edge that were recorded pre-2012 but not post-2012 may still be present within the BCA but might have experienced population decline, reducing their detectability. These increases and declines in species assemblages cannot be explained by any single factor but could be linked to many factors such as the closing of the mine in 2012, clearing of habitat in 2012 on the eastern boundary, natural fluctuations of species numbers, climatic conditions over each time period or detectability of some species within the BCA may all be factors.

With the cessation of the open-cut mine and the continued maturation of the adjacent rehabilitation area, these species may return or recover to previous population levels. This observed change in species composition may also be due to natural fluctuations either locally or regionally and not be related to mining activities.

The threatened Powerful Owl was not detected during the 2022 surveys which was previously recorded for the 2021 survey period within multiple locations (Quadrat 3, 6 and 8). The Sooty Owl has rarely been observed over the survey period with the last detection in 2001 (Quadrat 2) and in 2016 (Quadrat 3). The Masked Owl, however, has been more regularly detected with sightings in 2014, 2015, 2016, 2017 and 2018 but has not been sighted in the last four years. Given that the species has been recorded for five consecutive years, this would suggest that there is a roosting location nearby. This was supported in 2015 when regurgitated pellets were found around the base of a tree where a Masked Owl was observed.

Given that a hazard reduction burn occurred in the northern portion of the BCA in late 2020, future fauna surveys should consider the potential influence of the burn on species occurrence and diversity.

4.3 NEST BOXES

The usage rate of nest boxes (percentage of available nest boxes showing signs of usage) by fauna increased in a linear fashion for the first five years following installation, after which, usage plateaued, followed by a decline. This pattern of nest box usage after five years of deployment has been observed in several other nest box monitoring programs in native forest (Kleinfelder 2015; Lindenmayer et al. 2009). For the first few years after installation, reasonable levels of nest box use were recorded. This was followed by high levels of nest box attrition after 8-10 years. These findings led to the suggestion of an ‘effective occupancy time’ of approximately five years for arboreal mammals. That is, the materials used in current nest box designs have a lifespan of only 8 – 10 years before they reach a point of decay where arboreal fauna no longer use them.

Another explanation for the rapid rise in nest box use, followed by a plateau and subsequent decrease could be due to the installation of new nest boxes as those installed in 2005 began to deteriorate as materials aged. Several nest box repair and replacement events have occurred since 2005. Although nest box utilisation is calculated based on the number of available nest boxes, this does not discount the fact that new nest boxes are not inhabited immediately and take time for fauna to take residence. Similar to the trends experienced for those nest boxes installed in 2005, it may take up to 3-4 years for new nest boxes to reach ~50% utilisation and about eight years for nest boxes to reach peak occupancy.

The current survey demonstrates a change after the decline of unusable nest boxes with levels similar to 2019. However, given that previous trends indicate that nest box utilisation is often low for boxes less than 5 years old, it could be expected that future monitoring may show a considerable increase in utilisation (as a large number of boxes will now have been installed for 4-5 years). Ongoing maintenance (fixing broken lids and hinges and removal of undesirable species such as termites and wasps) and replacement of broken boxes is required to ensure the ongoing success of the nest box program within the Donaldson BCA.

5. CONCLUSION

The monitoring program indicates that the Donaldson Coal operations are causing minimal impact to biodiversity within the BCA. This conclusion is based on the summary of information provided below:

All biomass variables examined (i.e., basal area, height, foliage projective cover (FPC) and stand volume), have shown relatively consistent increases over the last 19 years since the baseline survey in 2001. The regression analyses also confirmed that the relationship between time and increases in stand volume were highly significant indicating that the community biomass has increased substantially across time with no significant year-to-year variation from 2001 to 2022. The rate of increase in both biomass parameters has slowed since 2010, with slight decreases in FPC at most quadrats since 2011. Analysis indicates that FPC may be stabilising at levels lower than the highest levels recorded during the 2012 and 2013 survey periods. Most quadrats have recorded an increase in FPC since 2019,except Q8 suffering from previous fire event, however future surveys and analysis should reveal whether FPC is stabilising.

Overall plant species numbers have increased since 2001 as have all floristic structural components which is indicative of a dynamic plant community with high recruitment from the seed pool, normally an indicator of healthy, regenerating plant community status. Results from the current survey indicate early stages of recovery in floristics and structural components following the return of more favourable climatic conditions and end of the drought.

The total number of fauna species recorded during the monitoring surveys has remained relatively constant over the 20 years since monitoring began. There has been a general increase in the total number of species recorded since the cessation of mining in 2012.

The number of mammal species recorded has remained constant. There has been some variation in the species assemblages over time, which is likely due to species detectability and their ecology.

The number of bird species recorded each year for those with generalist habitat preferences remained relatively constant over the monitoring period. Between 2019 – 2022, the number of species that prefer the forest-interior have increased; the number of forest edge specialists have decreased. In recent years, there has been a shift in species assemblages with respect to birds with habitat specialisation. This trend will be investigated further in 2024 (year 24 of monitoring).

Nest box monitoring shows that fauna utilisation increased from the year of installation (2005) to 2012 and then decreased. A decrease in fauna utilisation following the 2012 monitoring event is likely to be due to weather damage, which makes the nest boxes less habitable. The replacement of damaged boxes occurred in winter 2018 which has reduced the downward trend of utilisation due uninhabitable boxes. It is expected that nest boxes installed in 2018 will become more suitable over the coming years as arboreal fauna become more habituated.

6. RECOMENDATIONS

The following recommendations are considered necessary to maintain biodiversity values within the BCA:

Monitoring should continue so that trends evident in the first 20 years may be better understood.

Nest boxes should continue to be monitored biannually. Repairs and nest box replacements should be made as required.

Weed control, targeting *L. camara* and *T. fluminensis* is recommended in areas with dense infestations. This should be conducted by a suitably qualified bush regenerator using correct spraying applications in high density zones and manual removal techniques in native vegetation dominant areas to limit off target damage. Follow up weed control applications are highly recommended for *T. fluminensis* and *L. Camara* for successful eradication.

The monitoring program indicates that the Donaldson Coal operations are causing minimal impact to biodiversity within the BCA; however, further monitoring will be required to assess accumulative impacts on biodiversity caused by other direct impacts and indirect pressures. This will elucidate the effects of confounding factors such as the impacts of residential development at the eastern edge of the BCA from 2012 and determine the influence of climate change and seasonal variation. Future years of monitoring should continue to analyse the diversity of specialist and generalist species separately and should focus on abundance trends of sensitive flora and fauna species, including threatened species.

7. REFERENCES

Barker Harle 2001, Donaldson open-cut coal mine Beresfield, Quadrat monitoring program baseline report, September-October 2001, Barker Harle Pty Limited Report to Donaldson Coal.

Ecobiological 2002, Donaldson Open-cut Coal Mine Beresfield, Flora and Fauna Management Plan, Revision March 2007, EcoBiological Survey & Assessment, Gateshead, NSW.

Ecobiological 2004, Donaldson Open-cut Coal Mine Beresfield, Annual Flora and Fauna Monitoring, EcoBiological Survey & Assessment, Gateshead, NSW.

Ecobiological 2007, Donaldson Open-cut Coal Mine Beresfield, Flora and Fauna Management Plan, Revision March 2007, EcoBiological Survey & Assessment, Gateshead, NSW.

Department of Primary Industries 2015. Myrtle Rust. http://www.dpi.nsw.gov.au/biosecurity/plant/myrtle-rust#What-is-Myrtle-rust-em-?--em-

Donaldson Coal 2019, Donaldson Coal Mine and Abel Underground Coal Mine Flora and Fauna Management Plan – Care and Maintenance (Version 4), Donaldson Coal, Beresfield NSW.

Gunninah 2000, Donaldson Open-cut Mine Beresfield, Flora and Fauna Management Plan, Gunninah Environmental Consultants, Crow's Nest.

Harden, GJ (ed) 1992, Flora of New South Wales Volume 3, NSW University Press, Sydney.

Harden, GJ (ed) 1993, Flora of New South Wales Volume 4, NSW University Press, Sydney.

Harden, GJ (ed) 2000, Flora of New South Wales Volume 1, NSW University Press, Sydney.

Harden, GJ (ed) 2002 Flora of New South Wales Volume 2, NSW University Press, Sydney.

Krebs, CJ 1999, Ecological Methodology, Benjamin/Cummings, Menlo Park, CA.

Kleinfelder 2018, Annual Flora and Fauna Monitoring: Donaldson Open-cut Coal Mine, Beresfield NSW. Report prepared for Yancoal Australia Pty Ltd, January 2019.

Le Brocque, AF and Buckney, RT 1997, Multivariate Relationships between Floristic Composition and Stand Structure in Vegetation of Ku-ring-gai Chase National Park, New South Wales, Australian Journal of Botany 45, pp 1033-1044.

Lindenmayer DB, Welsh A, Donnelly C, Crane M, Michael D, Macgregor C, McBurney L, Montague-Drake R and Gibbons P, 2009. Are nest boxes a viable alternative source of cavities for hollow-dependent animals? Long-term monitoring of nest box occupancy, pest use and attrition, Biological Conservation, 142: 33-42.

NSW NPWS 2000. Vegetation Survey, Classification and Mapping Lower Hunter and Central Coast Region Version 1.2, A project undertaken for The Lower Hunter and Central Coast Regional Environment Management Strategy CRA Unit Sydney Zone, NSW National Parks and Wildlife Service.

Office of Environment and Heritage (2011). Management Plan for Myrtle Rust on the National Parks Estate. Office of Environment and Heritage NSW, Sydney.

Specht, RL 1981, Foliage Projective Cover and Standing Biomass, In 'Vegetation Classification in Australia' (Eds AN Gillison and DJ Anderson.) pp 10-21 (CSIRO-ANU Press, Canberra).

Specht, RL 1983, Foliage projective covers of overstorey and understorey strata of mature vegetation in Australia, Australian Journal of Ecology 8, pp 433-439.

Specht, RL & Specht, A 1999, Australian Plant Communities, Dynamics of Structure, Growth and Biodiversity, Oxford University Press.

Specht, RL & Specht, A 2002, Australian Plant Communities, Dynamics of Structure, Growth and Biodiversity 2nd Edition, Oxford University Press.

Winkworth, RE & Goodall, DW 1962 A Crosswire Sighting Tube for Point Quadrat Analyses, Ecology 43, pp 342-343.

Wintle, BA, Kavanagh, RP, McCarthy, MA & Burgman, MA 2005, Estimating and dealing with detectability in occupancy surveys for forest owls and arboreal marsupials, Journal of Wildlife Management 69(3), pp 905-917.

APPENDIX 1: TOTAL FOLIAGE PROJECTION COVER 2001 (BASELINE) (2003 FOR Q9), 2007- 2022

Q1	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Ground cover	8.40%	10.20%	20.00%	20.00%	20.00%	20.00%	5.00%	5.00%	5.00%	10.00%
Shrubs to 2m	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Overstorey	150.44%	166.72%	205.49%	198.86%	201.75%	214.21%	199.80%	164.45%	164.00%	159.56%
Total FPC	158.83%	176.92%	225.49%	218.86%	221.75%	234.21%	204.80%	169.45%	169.00%	169.56%
Q2	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Ground cover	36.21%	70.00%	65.00%	60.00%	65.00%	55.00%	30.00%	70.00%	70.00%	75.00%
Shrubs to 2m	7.96%	9.37%	10.31%	11.87%	8.08%	8.74%	9.45%	5.18%	4.95%	4.84%
Overstorey	181.59%	288.10%	301.56%	300.65%	281.86%	328.71%	317.12%	247.70%	242.45%	277.55%
Total FPC	225.76%	367.48%	376.86%	372.52%	354.94%	392.45%	356.57%	322.88%	317.40%	357.39%
Q3	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Ground cover	28.95%	60.00%	65.00%	65.00%	30.00%	30.00%	15.00%	15.00%	25.00%	25.00%
Shrubs to 2m	33.65%	62.96%	61.81%	48.16%	42.92%	45.29%	35.43%	25.45%	21.53%	22.57%
Overstorey	125.30%	215.67%	209.53%	199.57%	188.35%	213.86%	221.28%	182.85%	195.58%	203.83%
Total FPC	187.90%	338.62%	336.34%	312.73%	261.28%	289.15%	271.71%	223.30%	242.10%	251.40%
Q4	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Ground cover	53.41%	40.00%	70.00%	70.00%	75.00%	75.00%	35.00%	75.00%	80.00%	0.00%
Shrubs to 2m	0.00%	23.56%	37.69%	22.90%	18.29%	14.22%	8.77%	7.83%	7.00%	6.81%
Overstorey	113.78%	155.08%	158.74%	154.09%	157.75%	173.97%	174.75%	167.55%	161.75%	75.47%
Total FPC	167.19%	218.63%	266.43%	246.99%	251.04%	263.20%	218.52%	250.38%	248.75%	82.27%
Q5	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Ground cover	81.73%	80.00%	80.00%	80.00%	75.00%	75.00%	35.00%	45.00%	80.00%	85.00%
Shrubs to 2m	10.00%	1.27%	1.64%	1.87%	1.14%	1.14%	1.12%	1.13%	1.03%	1.51 %

Overstorey	107.75%	172.51%	202.07%	186.35%	186.79%	202.22%	185.48%	186.78%	183.68%	164.11%
Total FPC	**199.48%**	**253.78%**	**283.71%**	**268.22%**	**262.93%**	**278.36%**	**221.60%**	**232.90%**	264.70%	250.62%
Q6	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Ground cover	24.31%	80.00%	90.00%	90.00%	90.00%	90.00%	55.00%	55.00%	95.00%	0.00%
Shrubs to 2m	49.54%	4.19%	3.64%	3.01%	4.26%	4.26%	4.79%	1.88%	1.85%	3.08%
Overstorey	152.61%	225.19%	247.91%	242.57%	229.52%	278.17%	258.17%	221.23%	197.43%	168.50%
Total FPC	**278.95%**	**309.38%**	**341.54%**	**335.58%**	**323.78%**	**372.43%**	**317.96%**	**278.10%**	294.28%	171.57%
Q7	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Ground cover	89.01%	80.00%	80.00%	80.00%	80.00%	85.00%	20.00%	80.00%	85.00%	60.00%
Shrubs to 2m	20.27%	31.62%	39.29%	36.75%	37.54%	38.54%	38.54%	38.54%	28.90%	31.89%
Overstorey	101.60%	196.31%	258.56%	238.00%	228.19%	270.12%	272.43%	226.80%	223.93%	230.65%
Total FPC	**210.88%**	**307.93%**	**377.85%**	**354.75%**	**345.73%**	**393.66%**	**330.97%**	**345.34%**	337.83%	322.54%
Q8	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Ground cover	85.38%	50.00%	80.00%	80.00%	80.00%	80.00%	35.00%	80.00%	85.00%	0.00%
Shrubs to 2m	11.00%	23.24%	25.90%	22.03%	20.13%	24.22%	21.40%	16.98%	19.13%	24.08%
Overstorey	93.53%	157.44%	178.55%	171.43%	167.50%	198.53%	188.40%	164.48%	142.98%	139.93%
Total FPC	**189.91%**	**230.67%**	**284.45%**	**273.46%**	**267.63%**	**302.74%**	**244.80%**	**261.45%**	247.10%	164.01%
Q9	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Ground cover	87.56%	75.00%	85.00%	85.00%	80.00%	80.00%	50.00%	80.00%	95.00%	0.00%
Shrubs to 2m	9.52%	14.43%	22.81%	24.19%	14.06%	12.85%	14.54%	3.60%	0.00%	0.00%
Overstorey	93.75%	130.05%	162.61%	161.27%	161.05%	166.02%	161.46%	167.13%	165.00%	211.89%
Total FPC	190.83%	219.48%	270.42%	270.46%	255.11%	258.87%	226.00%	250.73%	260.00%	211.89%

APPENDIX 2: TOTAL TREE BASAL AREAS FROM 2001 (BASELINE) (2003 FOR Q9), 2007- 2022

Q1	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Corymbia maculata	0.293	30.13%	0.313	29.29%	0.337	29.46%	0.337	29.14%	0.343	29.26%	0.345	29.24%	0.350	29.67%	0.353	29.92%	0.344	35.71%	0.855	37.42%
Eucalyptus resinifera	0.228	23.45%	0.240	22.41%	0.248	21.70%	0.252	21.76%	0.253	21.58%	0.253	21.43%	0.261	22.07%	0.262	22.17%	0.271	28.05%	0.272	26.37%
Eucalyptus umbra	0.044	4.56%	0.050	4.70%	0.060	5.20%	0.059	5.08%	0.063	5.37%	0.064	5.46%	0.066	5.58%	0.069	5.83%	0.072	7.44%	0.072	6.97%
Syncarpia glomulifera	0.166	17.07%	0.209	19.51%	0.246	21.49%	0.257	22.24%	0.261	22.29%	0.266	22.52%	0.269	22.81%	0.266	22.54%	0.278	28.80%	0.301	29.23%
TOTAL BA (m³/ha)	**0.971**		**1.070**		**1.14**		**1.158**		**1.173**		**1.181**		**1.199**		**1.204**		**0.965**		1.500	**100%**

Q2	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Backhousia myrtifolia	0.349	19.71%	0.362	18.37%	0.165	8.66%	0.166	8.64%	0.168	9.01%	0.172	9.17%	0.186	9.92%	0.186	9.97%	0.115	6.06%	0.110	6%
Corymbia maculata	0.287	16.18%	0.342	17.39%	0.380	20.00%	0.389	20.24%	0.387	20.76%	0.390	20.82%	0.387	20.69%	0.385	20.58%	0.415	21.94%	0.415	22%
Cryptocarya microneura	0.064	3.64%	0.077	3.90%	0.088	4.62%	0.095	4.92%	0.096	5.16%	0.096	5.14%	0.096	5.14%	0.096	5.15%	0.089	4.72%	0.093	5%
Eucalyptus acmenoides	0.467	26.37%	0.531	26.96%	0.597	31.40%	0.626	32.58%	0.624	33.43%	0.624	33.32%	0.609	32.52%	0.612	32.72%	0.681	35.97%	0.681	36%
Eucalyptus siderophloia	0.038	2.15%	0.044	2.24%	0.047	2.48%	0.050	2.59%	0.048	2.59%	0.048	2.59%	0.050	2.65%	0.047	2.52%	0.048	2.56%	0.054	3%
Glochidion ferdinandi	0.064	3.63%	0.076	3.85%	0.075	3.92%	0.077	4.01%	0.025	1.32%	0.025	1.31%	0.024	1.30%	0.025	1.32%	0.013	0.69%	0.026	1%
Hymenosporum flavum	0.022	1.21%	0.028	1.43%	0.030	1.56%	0.030	1.57%	0.030	1.59%	0.030	1.58%	0.030	1.58%	0.030	1.58%	0.029	1.54%	0.030	2%
Melaleuca styphelioides	0.387	21.85%	0.398	20.20%	0.410	21.57%	0.375	19.54%	0.374	20.06%	0.374	19.99%	0.374	19.98%	0.372	19.90%	0.376	19.86%	0.377	20%
Melicope micrococca	0.013	0.74%	0.014	0.70%	0.012	0.64%	0.013	0.66%	0.013	0.68%	0.013	0.68%	0.012	0.65%	0.013	0.72%	0.013	0.71%	0.014	1%
Syncarpia glomulifera	0.080	4.52%	0.097	4.95%	0.098	5.16%	0.101	5.25%	0.101	5.40%	0.101	5.39%	0.103	5.49%	0.104	5.54%	0.113	5.95%	0.113	6%

Q1	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
TOTAL BA (m³/ha)	**1.772**		**1.968**		**1.90**		**1.920**		**1.866**		**1.872**		**1.871**		**1.870**		**1.893**		1.913	**100%**
Q3	**2001**		**2007**		**2015**		**2016**		**2017**		**2018**		**2019**		**2020**		**2021**		**2022**	
Acacia fimbriata	0.0069	0.65%	0.012	0.93%	0.00	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.002	0.05%	0.002	0.13%	0.002	0.11%	0.002	0%
Acacia linifolia	0.0122	1.14%	0.000	0.00%	0.00	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%			0.000	0.00%	0.000	0.00%		0%
Allocasuarina torulosa	0.0113	1.06%	0.031	2.27%	0.05	3.26%	0.044	2.81%	0.086	5.37%	0.038	1.35%	0.038	1.34%	0.037	3.17%	0.037	2.40%	0.041	3%
Angophora costata	0.0690	6.45%	0.073	5.43%	0.08	5.22%	0.080	5.16%	0.081	5.08%	0.083	2.89%	0.082	2.86%	0.082	5.15%	0.087	5.55%	0.093	6%
Callistemon salignus	0.0315	2.95%	0.054	3.98%	0.06	4.23%	0.067	4.33%	0.069	4.33%	0.069	2.42%	0.069	2.43%	0.068	5.77%	0.071	4.54%	0.080	5%
Corymbia maculata													0.000	0.00%	0.000	0.00%	0.000	0.02%	0.000	0%
Corymbia gummifera	0.0709	6.63%	0.084	6.24%	0.09	5.95%	0.095	6.16%	0.096	6.04%	0.100	3.50%	0.101	3.52%	0.101	8.56%	0.108	6.94%	0.113	7%
Eucalyptus fibrosa	0.2443	22.86%	0.264	19.62%	0.30	19.97%	0.3026	19.51%	0.3073	19.26%	0.3088	10.81%	0.3120	10.91%	0.0032	0.27%	0.322	20.62%	0.3440	21%
Eucalyptus umbra	0.1288	12.05%	0.148	11.04%	0.17	11.62%	0.181	11.67%	0.185	11.59%	0.195	6.82%	0.199	6.98%	0.198	16.77%	0.208	13.33%	0.216	13%
Melaleuca styphelioides	0.0237	2.22%	0.057	4.28%	0.05	3.19%	0.053	3.41%	0.051	3.20%	0.054	1.90%	0.053	1.85%	0.052	4.40%	0.057	3.66%	0.060	4%
Syncarpia glomulifera	0.4702	44.00%	0.618	46.01%	0.68	45.65%	0.707	45.58%	0.699	43.79%	1.986	69.50%	0.720	25.20%	0.620	52.57%	0.651	41.73%	0.667	41%
Glochidion ferdinandi			0.003	0.19%	0.01	0.92%	0.021	1.38%	0.021	1.34%	0.024	0.83%	0.020	0.71%	0.016	1.38%	0.017	1.11%	0.019	1%
TOTAL BA (m³/ha)	**1.069**		**1.343**		**1.50**		**1.551**		**1.595**		**2.858**		**1.597**		**1.179**		**1.559**		1.635	100%
Q4	**2001**		**2007**		**2015**		**2016**		**2017**		**2018**		**2018**		**2020**		**2021**		**2022**	
Corymbia maculata	0.110	8.72%	0.118	8.07%	0.12	8.11%	0.126	8.05%	0.125	8.04%	0.128	8.08%	0.128	8.11%	0.133	8.49%	0.140	8.63%	0.143	9%

Q1	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Eucalyptus acmenoides	0.341	26.94%	0.454	31.14%	0.47	30.89%	0.487	31.11%	0.468	30.13%	0.477	30.22%	0.485	30.75%	0.481	30.78%	0.483	29.92%	0.500	30%
Eucalyptus fibrosa	0.813	64.34%	0.886	60.78%	0.93	61.00%	0.952	60.84%	0.961	61.84%	0.973	61.69%	0.992	62.90%	0.948	60.73%	0.993	61.45%	1.017	61%
TOTAL BA (m³/ha)	**1.264**		**1.458**		**1.52**		**1.565**		**1.554**		**1.578**		**1.605**		**1.562**		**1.616**		1.660	100%

Q5	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Corymbia maculata	0.167	13.22%	0.212989	14.54%	0.23	14.62%	0.238	15.18%	0.226	14.30%	0.230	14.32%	0.233	14.51%	0.239	15.49%	0.248	15.11%	0.260	15%
Eucalyptus acmenoides	0.496	39.25%	0.565672	38.63%	0.61	39.02%	0.611	39.08%	0.620	39.26%	0.621	38.67%	0.614	38.24%	0.601	39.06%	0.644	39.21%	0.669	39%
Eucalyptus siderophloia	0.423	33.44%	0.478676	32.69%	0.49	31.45%	0.496	31.72%	0.505	32.00%	0.520	32.35%	0.503	31.34%	0.485	31.51%	0.509	31.01%	0.518	30%
Syncarpia glomulifera	0.178	14.08%	0.207098	14.14%	0.23	14.92%	0.219	14.02%	0.228	14.44%	0.236	14.66%	0.253	15.72%	0.215	13.94%	0.241	14.67%	0.252	15%
TOTAL BA (m³/ha)	**1.264**		**1.464**		**1.55**		**1.564**		**1.578**		**1.606**		**1.603**		**1.540**		**1.643**		1.699	100%

Q6	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Allocasuarina torulosa	0.042	1.86%	0.045	1.89%	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%			0.000	0.00%	0.000	0.000%		
Backhousia myrtifolia	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.001	0.03%	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.000%		
Claoxylon australe	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.003	0.12%	0.004	0.14%	0.004	0.19%	0.001	0.02%	0.001	0.021%	0.001	0%
Cryptocarya microneura	0.090	3.95%	0.116	4.83%	0.150	5.90%	0.158	6.14%	0.163	6.24%	0.168	6.83%	0.168	7.50%	0.230	8.76%	0.241	8.740%	0.252	9%
Eucalyptus acmenoides	0.539	23.66%	0.545	22.72%	0.567	22.26%	0.566	22.04%	0.575	21.98%	0.576	23.49%	0.576	25.74%	0.558	21.29%	0.578	21.001%	0.580	21%
Eucalyptus grandis	0.933	40.98%	1.061	44.25%	1.140	44.79%	1.158	45.05%	1.179	45.02%	1.187	48.41%	1.012	45.20%	1.200	45.77%	1.268	46.045%	1.268	46%
Ficus fraseri	0.007	0.29%	0.010	0.40%	0.011	0.44%	0.012	0.47%	0.011	0.42%	0.011	0.46%	0.003	0.13%	0.000	0.00%	0.000	0.000%		0%

Q1	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Melaleuca styphelioides	0.018	0.79%	0.019	0.81%	0.020	0.78%	0.020	0.79%	0.022	0.85%	0.023	0.92%	0.022	0.98%	0.021	0.79%	0.024	0.888%	0.025	1%
Melicope micrococca	0.038	1.66%	0.042	1.75%	0.050	1.96%	0.051	1.99%	0.055	2.10%	0.056	2.28%	0.056	2.50%	0.055	2.11%	0.060	2.182%	0.062	2%
Rhodomyrtus psidioides	0.005	0.22%	0.006	0.25%	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%			0.000	0.00%	0.000	0.000%	0.000	0%
Syncarpia glomulifera	0.606	26.59%	0.554	23.10%	0.606	23.81%	0.603	23.45%	0.607	23.17%	0.426	17.37%	0.381	17.03%	0.556	21.19%	0.573	20.812%	0.575	21%
Syzygium oleosum																	0.005	0.181%		0%
Streblus brunonianus					0.002	0.06%	0.002	0.07%	0.002	0.07%	0.002	0.08%	0.016	0.72%	0.002	0.08%	0.004	0.130%	0.004	0%
TOTAL BA (m³/ha)	**2.278**		**2.398**		**2.55**		**2.569**		**2.618**		**2.453**		**2.239**		**2.623**		**2.754**		**2.767**	100%

Q7	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Allocasuarina torulosa	0.046	3.95%	0.053	2.33%	0.058	2.37%	0.058	2.22%	0.058	2.23%	0.061	2.25%	0.061	2.27%	0.060	2.18%	0.076	2.69%	0.078	3%
Angophora costata	0.265	22.62%	0.224	9.85%	0.233	9.57%	0.241	9.29%	0.286	11.06%	0.289	10.59%	0.289	10.69%	0.239	8.61%	0.2516	8.92%	0.260	9%
Corymbia gummifera	0.295	25.21%	0.712	31.29%	0.707	29.05%	0.707	27.21%	0.638	24.67%	0.704	25.80%	0.704	26.08%	0.703	25.31%	0.734	26.03%	0.708	24%
Eucalyptus acmenoides	0.057	4.83%	0.036	1.58%	0.044	1.80%	0.044	1.68%	0.042	1.61%	0.043	1.56%	0.043	1.58%	0.043	1.53%	0.047	1.67%	0.048	2%
Eucalyptus pilularis	0.196	16.75%	0.210	9.23%	0.233	9.56%	0.255	9.81%	0.246	9.54%	0.252	9.24%	0.255	9.45%	0.258	9.29%	0.255	9.04%	0.261	9%
Eucalyptus paniculata	0.033	2.80%	0.037	1.64%	0.033	1.34%	0.033	1.25%	0.000	0.00%	0.000	0.00%	0.000	0.01%	0.000	0.01%	0.000	0.01%	0.001	0%
Glochidion ferdinandi	0.028	2.42%	0.679	29.81%	0.871	35.79%	1.007	38.74%	1.078	41.69%	1.127	41.32%	1.096	40.60%	1.246	44.89%	1.230	43.60%	1.308	45%

Q1	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Melaleuca linariifolia	0.200	17.10%	0.242	10.64%	0.160	6.56%	0.155	5.97%	0.136	5.25%	0.146	5.36%	0.146	5.39%	0.144	5.18%	0.140	4.96%	0.144	5%
Notelaea longifolia	0.002	0.14%	0.022	0.95%	0.024	0.97%	0.025	0.94%	0.025	0.98%	0.028	1.03%	0.027	1.02%	0.000	0.01%	0.000	0.01%	0.000	0%
Syncarpia glomulifera	0.049	4.17%	0.057	2.53%	0.066	2.71%	0.067	2.59%	0.070	2.69%	0.070	2.58%	0.071	2.63%	0.075	2.70%	0.078	2.77%	0.078	3%
Clerodendrum tomentosum			0.004	0.15%	0.007	0.28%	0.007	0.28%	0.007	0.28%	0.008	0.29%	0.008	0.29%	0.008	0.29%	0.009	0.31%	0.010	0%
TOTAL BA (m³/ha)	**1.171**		**2.277**		**2.43**		**2.598**		**2.585**		**2.729**		**2.699**		**2.775**		**2.820**		**2.894**	100%

Q8	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Corymbia maculata	0.312	24.91%	0.309	21.57%	0.337	21.40%	0.354	23.21%	0.3450	21.24%	0.3459	21.30%	0.3437	21.27%	0.3531	22.33%	0.360	22.04%	0.3470	21%
Eucalyptus siderophloia	0.243	19.34%	0.263	18.34%	0.282	17.90%	0.290	19.01%	0.285	17.52%	0.286	17.64%	0.286	17.71%	0.294	18.61%	0.290	17.76%	0.293	18%
Eucalyptus fibrosa	0.035	2.80%	0.042	2.96%	0.059	3.74%	0.061	3.99%	0.061	3.75%	0.062	3.80%	0.062	3.81%	0.070	4.45%	0.072	4.40%	0.072	4%
Eucalyptus punctata	0.297	23.66%	0.296	20.68%	0.306	19.48%	0.306	20.05%	0.317	19.53%	0.317	19.54%	0.314	19.42%	0.254	16.07%	0.260	15.94%	0.267	16%
Eucalyptus tereticornis	0.155	12.33%	0.173	12.11%	0.202	12.85%	0.205	13.41%	0.212	13.08%	0.210	12.93%	0.210	13.00%	0.211	13.31%	0.239	14.61%	0.239	15%
Melaleuca linariifolia	0.152	12.09%	0.242	16.89%	0.275	17.47%	0.195	12.79%	0.286	17.62%	0.285	17.52%	0.282	17.48%	0.266	16.82%	0.275	16.86%	0.284	17%
Melaleuca styphelioides	0.061	4.88%	0.107	7.45%	0.113	7.15%	0.115	7.54%	0.118	7.26%	0.118	7.27%	0.118	7.30%	0.133	8.42%	0.137	8.41%	0.142	9%
TOTAL BA (m³/ha)	**1.254**		**1.432**		**1.57**		**1.527**		**1.624**		**1.624**		**1.616**		**1.581**		**1.634**		**1.644**	100%

Q9	2003		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Alphitonia excelsa													0.000	0.02%	0.000	0.02%	0.000	0.00%		
Angophora costata	0.014	1.49%	0.018	1.72%	0.022	1.92%	0.023	1.82%	0.023	1.77%	0.000	0.00%							0.025	2%

Q1	2001		2007		2015		2016		2017		2018		2019		2020		2021		2022	
Corymbia maculata	0.288	30.06%	0.286	28.04%	0.296	25.87%	0.376	30.02%	0.421	32.05%	0.447	33.81%	0.453	33.90%	0.460	34.34%	0.472	33.79%	0.505	34%
Eucalyptus fibrosa	0.279	29.18%	0.283	27.71%	0.333	29.17%	0.346	27.65%	0.353	26.86%	0.356	26.92%	0.360	26.93%	0.356	26.56%	0.378	27.05%	0.403	27%
Eucalyptus moluccana	0.043	4.52%	0.046	4.54%	0.052	4.56%	0.055	4.41%	0.056	4.24%	0.056	4.26%	0.057	4.29%	0.058	4.35%	0.061	4.33%	0.065	4%
Eucalyptus punctata	0.060	6.27%	0.072	7.01%	0.084	7.33%	0.088	7.04%	0.091	6.96%	0.091	6.92%	0.092	6.87%	0.091	6.80%	0.097	6.92%	0.101	7%
Eucalyptus umbra	0.273	28.48%	0.316	30.97%	0.356	31.14%	0.364	29.06%	0.369	28.12%	0.371	28.09%	0.374	27.99%	0.374	27.92%	0.390	27.91%	0.405	27%
TOTAL BA (m³/ha)	**0.958**		**1.020**		**1.14**		**1.25**		**1.31**		**1.32**		**1.34**		**1.34**		**1.40**		**1.50**	100%

APPENDIX 3: MEAN TREE HEIGHTS FROM 2001 (BASELINE) (2003 FOR Q9), 2007-2022

Q1	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Angophora costata	19.32	20	20.50	21.30	21.80	21.80	21.80	12.00	0.00	0.00
Corymbia maculata	20.04	21.18	21.93	21.58	21.35	22.60	22.60	22.60	22.57	22.70
Eucalyptus resinifera	18.55	19.27	19.97	20.00	19.53	22.63	22.73	20.97	21.07	22.23
Eucalyptus umbra	17.99	17.3	18.70	18.60	18.00	20.70	20.70	20.70	20.70	22.00
Syncarpia glomulifera	11.029	11.17	12.46	12.63	12.12	12.81	11.41	12.38	13.19	13.10
Average height (m)	**17.386**	**17.785**	**18.712**	**18.822**	**18.560**	**20.108**	**19.848**	**17.728**	**15.505**	16.006
Q2	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Backhousia myrtifolia	10.82	8.67	7.55	8.13	7.89	7.62	6.93	6.93	6.94	6.96
Corymbia maculata	29.68	29.00	30.25	30.50	31.20	33.25	33.45	33.45	33.45	33.45
Cryptocarya microneura	26.06	23.60	23.60	23.90	24.10	24.10	24.00	7.95	19.26	7.16
Eucalyptus acmenoides	30.25	30.15	30.70	30.80	30.70	31.30	31.35	31.35	31.45	31.65
Eucalyptus siderophloia	22.94	25.20	26.00	26.60	27.10	27.10	27.10	27.10	26.00	26.00
Glochidion ferdinandi	8.71	10.12	8.50	10.00	9.17	9.83	8.67	8.67	8.73	8.83
Hymenosporum flavum	17.27	18.00	18.70	19.00	18.40	19.00	19.00	19.00	19.00	19.00
Melaleuca styphelioides	9.83	12.35	9.70	9.73	9.83	10.57	7.53	7.53	7.40	7.40
Melicope micrococca	9.82	9.30	11.00	11.20	10.90	10.90	10.90	10.90	11.00	11.00
Syncarpia glomulifera	12.90	13.46	12.22	12.08	11.95	11.23	11.21	11.39	11.14	11.50
Average height (m)	**17.827**	**17.985**	**17.822**	**18.194**	**18.124**	**18.490**	**18.015**	**16.427**	**17.437**	16.295
Q3	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Acacia fimbriata	6.03	7.80	0.00	0.00	0.00	0.00	4.50	4.50	4.50	4.50
Acacia linifolia	7.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Allocasuarina torulosa	6.88	7.25	7.53	7.491	7.200	8.260	7.950	7.620	7.92	7.930
Angophora costata	18.42	17.60	19.40	19.05	19.25	20.45	14.90	15.10	15.30	15.30

Q1	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Callistemon salignus	8.63	10.30	8.45	8.05	7.75	6.97	7.22	7.22	7.25	7.28
Corymbia maculata							5.00	5.00	5.00	5.00
Corymbia gummifera	11.88	12.30	16.53	15.17	15.30	18.63	18.63	18.67	14.80	14.80
Eucalyptus fibrosa	35.93	26.50	28.80	26.20	29.20	29.20	30.40	30.40	30.40	30.40
Eucalyptus umbra	11.00	15.15	15.53	15.63	15.68	17.60	17.60	17.60	17.60	17.60
Melaleuca styphelioides	6.48	7.92	7.71	7.59	7.43	7.60	6.76	6.76	6.47	6.47
Syncarpia glomulifera	12.37	12.52	11.97	11.96	11.81	10.23	10.27	10.08	10.23	10.23
Glochidion ferdinandi		8.00	7.25	7.00	6.92	5.26	5.03	4.79	4.72	4.72
Average height (m)	**12.496**	**11.395**	**11.197**	**10.739**	**10.958**	**11.291**	**10.689**	**10.645**	**10.349**	10.353
Q4	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Corymbia maculata	12.27	14.50	15.39	15.54	15.17	15.20	15.40	15.26	15.46	15.46
Eucalyptus acmenoides	14.54	14.38	15.69	15.82	15.52	15.76	14.89	15.11	14.90	14.94
Eucalyptus fibrosa	16.21	19.34	20.81	18.53	18.39	20.60	20.75	20.68	20.58	20.74
Average height (m)	**14.339**	**16.075**	**17.298**	**16.630**	**16.358**	**17.188**	**17.014**	**17.015**	**16.978**	17.047
Corymbia maculata	14.94	16.26	17.79	17.93	18.72	16.93	16.93	19.33	17.07	17.07
Eucalyptus acmenoides	14.14	13.61	18.08	16.89	16.94	16.49	16.48	16.48	16.36	16.36
Eucalyptus siderophloia	16.37	12.96	14.18	14.20	13.59	13.34	13.48	13.48	13.40	13.41
Syncarpia glomulifera	9.95	6.90	7.99	8.40	8.46	8.50	8.61	8.08	7.96	7.96
Average height (m)	**13.847**	**12.432**	**14.508**	**14.356**	**14.426**	**13.816**	**13.875**	**14.344**	**13.697**	13.700
Q6	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Allocasuarina torulosa	16.18	18.00								0
Backhousia myrtifolia					5.500	5.500	5.500			0.000

Q1	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Claoxylon australe					6.500	6.500	6.000	5.500	5.50	5.500
Cryptocarya microneura	11.70	12.15	13.43	13.13	11.69	12.26	11.28	10.22	10.25	10.25
Eucalyptus acmenoides	21.88	23.45	24.65	24.80	24.20	24.40	24.40	24.40	24.40	24.40
Eucalyptus grandis	36.16	37.37	41.63	41.47	41.67	42.33	42.33	42.33	42.33	42.33
Ficus fraseri	10.71	9.20	7.30	7.30	6.30	5.40	1.90			0.00
Melaleuca styphelioides	10.22	10.35	9.60	9.60	9.35	9.75	9.75	9.75	9.75	9.75
Melicope micrococca	13.70	16.75	10.97	11.10	11.37	11.77	11.77	11.77	12.13	12.17
Rhodomyrtus psidioides	7.81	7.35								
Syncarpia glomulifera	16.35	18.67	19.13	19.30	18.93	16.52	16.18	19.40	19.40	19.40
Streblus brunonianus			6.50	6.40	6.10	6.10	7.00	7.00	7.00	7.00
Syzygium oleosum									8.50	
Average height (m)	**16.077**	**17.031**	**16.651**	**16.636**	**14.161**	**14.052**	**13.611**	**11.851**	**11.605**	**11.891**
Q7	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Allocasuarina torulosa	12.53	13.15	14.45	14.25	14.00	14.95	14.95	15.00	15.25	15.25
Angophora costata	18.73	19.94	21.26	21.80	22.90	23.98	24.58	22.32	22.32	22.32
Corymbia gummifera	20.36	22.85	25.05	25.10	25.65	25.95	26.15	26.15	26.15	26.15
Eucalyptus acmenoides	11.55	9.33	11.57	12.77	12.33	13.07	12.67	12.67	12.70	12.70
Eucalyptus pilularis	29.23	28.10	30.50	30.70	30.70	30.70	31.70	31.80	31.80	32.20
Eucalyptus paniculata	17.16	17.10	18.00	18.00			4.90	4.80	4.80	4.80
Glochidion ferdinandi	8.63	9.48	10.81	11.13	10.65	10.44	10.06	11.71	10.97	11.04
Melaleuca linariifolia	7.64	8.18	8.94	9.15	9.36	9.88	9.84	9.86	9.91	9.91
Notelaea longifolia		6.40	7.10	7.30	6.90	8.30	5.35	2.40	4.60	4.60
Syncarpia glomulifera	18.70	16.00	18.00	18.60	18.10	20.00	20.00	20.20	20.20	21.00

Q1	2001	2007	2015	2016	2017	2018	2019	2020	2021	2022
Clerodendrum tomentosum		8.00	7.35	7.75	8.00	8.75	8.75	8.80	8.90	8.90
Average height (m)	**16.057**	**14.411**	**15.730**	**16.050**	**15.859**	**16.601**	**15.358**	**15.065**	**15.236**	**15.352**
Q8	**2001**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Corymbia maculata	13.33	14.29	15.55	15.73	15.56	17.09	17.16	17.15	17.11	17.29
Eucalyptus siderophloia	11.33	12.43	11.69	11.36	11.18	11.02	11.18	11.17	11.68	11.79
Eucalyptus fibrosa	16.65	19.70	22.40	22.30	22.20	24.50	24.50	24.50	24.50	24.50
Eucalyptus punctata	19.44	19.85	23.40	22.30	22.17	19.97	20.50	25.60	25.60	25.70
Eucalyptus tereticornis	15.13	11.98	17.30	17.40	16.57	18.60	18.60	18.60	18.73	18.80
Melaleuca linariifolia	6.65	7.32	8.96	9.32	8.72	7.29	6.46	6.55	6.51	6.69
Melaleuca styphelioides	9.38	12.75	13.65	13.30	13.05	13.60	13.65	13.65	13.75	13.85
Average height (m)	**13.129**	**14.045**	**16.135**	**15.959**	**15.634**	**16.009**	**16.007**	**16.746**	**16.840**	**16.946**
Q9	**2003**	**2007**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Alphitonia excelsa							2.50	2.50		
Angophora costata	11.50	14.4	12.50	11.10	11.40	0.00				14.20
Corymbia maculata	12.79	14.8	14.67	12.83	11.79	12.83	12.86	12.46	12.26	12.30
Eucalyptus fibrosa	16.09	15.65	14.66	12.30	12.26	12.23	12.39	12.40	11.74	11.77
Eucalyptus moluccana	12.53	10.83	10.20	10.33	10.33	9.45	9.45	9.48	8.55	8.43
Eucalyptus punctata	17.53	19.6	20.25	20.50	20.55	23.00	23.00	23.00	23.1	23.10
Eucalyptus umbra	11.47	12.24	13.14	13.00	12.14	12.25	11.64	12.26	12.30	12.35
Average height (m)	**13.651**	**14.587**	**14.236**	**13.344**	**13.079**	**11.625**	**11.972**	**12.017**	**11.326**	**13.691**

APPENDIX 4: PLANT SPECIES RECORDED IN THE BASELINE (2001), 2020, 2021 AND 2022 SURVEY EVENTS

A represents the baseline (2001) survey.

B represents the 2021 survey

C represents the 2022 survey

Family Name	Scientific Name	Common Name	Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8			Q9		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Acanthaceae	*Brunoniella australis*	Blue Trumpet		1	1					2	2		2	2		1	1								1	1		2	2
Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower		1	1		2	2		2	2	+	1	2		2	2				+	2	2		2	2			
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair Fern	+	2	2	+	2	3	+	2	2					1	1		1	1	+	2	3	+	2	2			
Adiantaceae	*Adiantum formosum*	Giant Maidenhair Fern				+	3	3																					
Adiantaceae	*Adiantum hispidulum*	Rough Maidenhair Fern					2	2											1	1									
Adiantaceae	*Cheilanthes sieberi subsp. sieberi*	Poison Rock Fern											1	1	+	2	2							+	1	1		2	2
Adiantaceae	*Pellaea falcata*	Sickle Fern					2	2																					
Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily											1				1											1	1
Anthericaceae	*Caesia parviflora* subsp. *parviflora*																												
Anthericaceae	*Thysanotus tuberosus* subsp. *tuberosus*	Common Fringe-lily																											
Anthericaceae	*Tricoryne simplex*																												
Aphanopetalaceae	*Aphanopetalum resinosum*	Gum Vine					1																						
Apiaceae	*Hydrocotyle peduncularis*																												
Apiaceae	*Hydrocotyle laxiflora*															2	2					2	2						
Apiaceae	*Centella asiatica*	Indian Pennywort																							2	2			
Apocynaceae	*Marsdenia flavescens*	Hairy Milk Vine																											
Apocynaceae	*Marsdenia rostrata*	Common Milk Vine																	2	1									
Apocynaceae	*Marsdenia suaveolens*	Scented Marsdenia																											
Apocynaceae	*Parsonsia straminea*	Common Silkpod		1	2	+	1	1		1			1	1				+	1	1									
Apocynaceae	*Tylophora barbata*	Bearded Tylophora								1																			
Araceae	*Gymnostachys anceps*	Settlers Flax				+	2	2										+	1	1									
Araliaceae	*Polyscias sambucifolia* subsp. *sambucifolia*									1	1											1			1	1		2	2
Arecaceae	*Livistona australis*	Cabbage-tree Palm		1	1																								
Asteraceae	**Sonchus asper*	Prickly Sowthistle																										1	1
Asteraceae	**Facelis retusa*	Annual Trampweed																										1	
Asteraceae	**Ageratina adenophora*	Crofton Weed																		1									
Asteraceae	**Cirsium vulgare*	Spear Thistle																											
Asteraceae	**Conyza* sp.	Fleabane						1								1										1			2
Asteraceae	**Conyza canadensis*						1																						
Asteraceae	**Galinsoga parviflora*	Potato Weed																											
Asteraceae	**Gamochaeta calviceps*	Cudweed																							1				
Asteraceae	**Hypochaeris radicata*	Catsear										1	1		1	1									1	2		1	1
Asteraceae	**Senecio madagascariensis*	Fireweed											1												1				
Asteraceae	*Brachyscome multifida*																												
Asteraceae	*Cassinia* sp.																												1
Asteraceae	*Epaltes australis*	Spreading Nut-heads																											
Asteraceae	*Euchiton sphaericus*																											1	1
Asteraceae	*Lagenophora stipitata*	Blue Bottle-daisy								1	2		2	2		1	1						1		2	2		1	1
Asteraceae	*Olearia nernstii*	Daisy							+		2																		
Asteraceae	*Ozothamnus diosmifolius*	White Dogwood																											
Asteraceae	*Senecio linearifolius*	Fireweed Groundsel																											
Asteraceae	*Sigesbeckia orientalis*	Indian Weed					1									1													
Asteraceae	*Vernonia cinerea* var. *cinerea*												1	1		1	1								2	1		1	
Asteraceae	*Vittadinia cuneata*	Fuzzweed																											
Bignoniaceae	*Pandorea pandorana* subsp. *pandorana*	Wonga Wonga Vine		2	2		2	2		1	1	+	2	2					2	2				+	2	2	+	2	2
Blechnaceae	*Blechnum minus*	Soft Water Fern				+																							
Blechnaceae	*Doodia aspera*	Prickly Rasp Fern	+	1		+	3	3										+	2	3		1	1						

Family Name	Scientific Name	Common Name	Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8			Q9		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Blechnaceae	*Doodia australis*	Common Rasp Fern																+	2										
Campanulaceae	*Wahlenbergia gracilis*	Australian Bluebell										+																1	
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak							+	3	3							+				1	2						
Celastraceae	*Maytenus silvestris*	Narrow-leaved Orangebark	+	1	1		1		+	1	1	+	2	2		1	1		1		+	1	1					1	1
Clusiaceae	*Hypericum gramineum*	Small St. John's Wort																											
Commelinaceae	**Tradescantia fluminensis*	Wandering Jew																	5	5									
Commelinaceae	*Aneilema acuminatum*						1	1																					
Commelinaceae	*Aneilema biflorum*					+																		+					
Commelinaceae	*Commelina cyanea*	Native Wandering Jew																+	2	1						2			
Convolvulaceae	*Dichondra repens*	Kidney Weed					2	1								2	2					2	1			2			
Convolvulaceae	*Polymeria calycina*											+				1	1				+	2	1	+	1	1	+		
Cyperaceae	**Cyperus eragrostis*																												
Cyperaceae	*Baumea articulata*	Jointed Twig-rush																											
Cyperaceae	*Baumea juncea*																								2	2			
Cyperaceae	*Carex appressa*	Tall Sedge										+	2	2											1	2			
Cyperaceae	*Carex longebrachiata*			1	2	+								1					1	1			1	+					
Cyperaceae	*Cyperus fulvus*	Sticky Sedge																											
Cyperaceae	*Cyperus polystachyos*																												
Cyperaceae	*Cyperus tetraphyllus*							1												1									
Cyperaceae	*Eleocharis cylindrostachys*																												
Cyperaceae	*Fimbristylis dichotoma*	Common Fringe-sedge																											
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge					1	1		2	2											3	3						
Cyperaceae	*Gahnia sieberiana*	Red-fruit Saw-sedge							+												+								
Cyperaceae	*Isolepis inundata*																												
Cyperaceae	*Lepidosperma concavum*				1				+															+					
Cyperaceae	*Lepidosperma laterale*			1						2	2		2	2		1	2					1	1		1	1		2	2
Cyperaceae	*Machaerina rubiginosa*									1																			
Cyperaceae	*Ptilothrix deusta*									2	1																		
Cyperaceae	*Schoenus apogon*																												
Cyperaceae	*Schoenus lepidosperma* subsp. *pachylepis*																												
Cyperaceae	*Schoenus paludosus*																							+					
Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken							+	1	1										+	2	2	+	1	1			
Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower											3	3								1				2			
Dilleniaceae	*Hibbertia empetrifolia* subsp. *empetrifolia*		+																										
Dilleniaceae	*Hibbertia obtusifolia*	Hoary guinea flower										+																	
Dilleniaceae	*Hibbertia pedunculata*																											1	
Dilleniaceae	*Hibbertia riparia*	Erect Guinea-flower																											
Dilleniaceae	*Hibbertia scandens*	Climbing Guinea Flower							+	2	2										+		1						
Dioscoreaceae	*Dioscorea transversa*	Native Yam	+	2	2	+	2	2							2	2		+	1	1			1						
Ebenaceae	*Diospyros australis*	Black Plum																											
Elaeocarpaceae	*Elaeocarpus* sp.																												
Elaeocarpaceae	*Tetratheca juncea*	Black-eyed Susan							+																				
Ericaceae - Styphelioideae	*Leucopogon juniperinus*	Prickly Beard-heath								1	1		1	2			1					1	1	+	2	2	+	2	2
Ericaceae - Styphelioideae	*Leucopogon lanceolatus*												1	1															
Ericaceae - Styphelioideae	*Lissanthe strigosa* subsp. *strigosa*	Peach Heath																											1
Ericaceae - Styphelioideae	*Styphelia triflora*	Pink Five-Corners																							1	1		2	2
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart		1																									
Euphorbiaceae	*Alchornea ilicifolia*	Dovewood																											
Euphorbiaceae	*Claoxylon australe*	Brittlewood																+	2	3									
Euphorbiaceae	*Croton verreauxii*	Green Native Cascarilla				+	3	3																					
Eupomatiaceae	*Eupomatia laurina*	Bolwarra																											
Fabaceae - Faboideae	*Daviesia squarrosa*																												
Fabaceae - Faboideae	*Daviesia ulicifolia*	Gorse Bitter Pea																										1	1

Family Name	Scientific Name	Common Name	Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8			Q9		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Fabaceae - Faboideae	*Desmodium gunnii*	Slender Tick-trefoil								1			1	1															
Fabaceae - Faboideae	*Desmodium rhytidophyllum*											+									+				1	1			
Fabaceae - Faboideae	*Desmodium varians*	Slender Tick-trefoil																											
Fabaceae - Faboideae	*Dillwynia retorta*																											2	2
Fabaceae - Faboideae	*Glycine clandestina*									2	2		2	2														2	2
Fabaceae - Faboideae	*Glycine microphylla*	Small-leaf Glycine			1											1	1												
Fabaceae - Faboideae	*Glycine tabacina*			2	1											2	2					1	1		2	2		2	2
Fabaceae - Faboideae	*Gompholobium latifolium*	Golden Glory Pea							+																				
Fabaceae - Faboideae	*Hardenbergia violacea*	Purple Coral Pea									1	+	2	2										+		1		1	1
Fabaceae - Faboideae	*Indigofera australis*	Australian Indigo												1															
Fabaceae - Faboideae	*Kennedia rubicunda*	Dusky Coral Pea										+									+								
Fabaceae - Faboideae	*Pultenaea euchila*	Orange Pultenaea																										1	1
Fabaceae - Faboideae	*Pultenaea retusa*	Notched Bush-pea																											
Fabaceae - Faboideae	*Pultenaea spinosa*	Spiny Bush-pea										+	2	2															
Fabaceae - Faboideae	*Pultenaea villosa*	Hairy Bush-pea							+				1														+		
Fabaceae - Mimosoideae	*Acacia decurrens*	Black Wattle													+														
Fabaceae - Mimosoideae	*Acacia elongata*	Swamp Wattle																										2	2
Fabaceae - Mimosoideae	*Acacia falcata*																											1	1
Fabaceae - Mimosoideae	*Acacia fimbriata*	Fringed Wattle							+	1	1	+	3	3															
Fabaceae - Mimosoideae	*Acacia irrorata* subsp. *irrorata*	Green Wattle																											
Fabaceae - Mimosoideae	*Acacia linifolia*	White Wattle							+																		+		
Fabaceae - Mimosoideae	*Acacia myrtifolia*	Red-stemmed Wattle							+																			1	1
Fabaceae - Mimosoideae	*Acacia parvipinnula*	Silver-stemmed Wattle							+							1	1							+	2	2	+	1	1
Fabaceae - Mimosoideae	*Acacia sp.*						1																						
Gentianaceae	**Centaurium erythraea*	Common Centaury																											
Goodeniaceae	*Goodenia hederacea* subsp. *hederacea*	Forest Goodenia										+																	
Goodeniaceae	*Goodenia heterophylla* subsp. *heterophylla*									1																			
Goodeniaceae	*Goodenia rotundifolia*												2	2															
Haloragaceae	*Gonocarpus humilis*																							+					
Haloragaceae	*Gonocarpus teucrioides*	Raspwort											1	2											1	2		2	2
Hydrocharitaceae	*Ottelia ovalifolia* subsp. *ovalifolia*	Swamp Lily																											
Hypoxidaceae	*Hypoxis pratensis*	Golden-weather Grass															1												
Iridaceae	*Patersonia sericea*	Silky Purple-flag									1														1				
Juncaceae	**Juncus cognatus*																												
Juncaceae	*Juncus continuus*																												
Juncaceae	*Juncus planifolius*																												
Juncaceae	*Juncus subsecundus*																												
Juncaceae	*Juncus usitatus*																								1				
Juncaginaceae	*#Maundia triglochinoides*																												
Juncaginaceae	*Triglochin procera*																							+	1	1			
Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum															1				+	2	2						
Lamiaceae	*Plectranthus parviflorus*																			1									
Lauraceae	**Cinnamomum camphora*	Camphor Laurel																						+					
Lauraceae	*Cassytha glabella*											+	2	2	+	1	2												
Lauraceae	*Cassytha pubescens*																											1	1
Lauraceae	*Cryptocarya microneura*	Murrogun	+	1	2	+	3	3										+	3	3									
Lindsaeaceae	*Lindsaea linearis*	Screw Fern																											
Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge Fern								2	2																		
Lobeliaceae	*Isotoma fluviatilis* subsp. *fluviatilis*	Swamp Isotome										+																	
Lobeliaceae	*Lobelia alata*											+																	
Lobeliaceae	*Pratia purpurascens*	Whiteroot		1	1				+	2	2	+	2	2	+	2	2			1		2	2	+	2	2	+	2	2
Loganiaceae	*Logania albiflora*																				+								
Loganiaceae	*Logania pusilla*																												
Lomandraceae	*Lomandra confertifolia* subsp. *rubinigosa*	Mat-rush		1						2			2	2															
Lomandraceae	*Lomandra cylindrica*	Needle Mat-Rush																											
Lomandraceae	*Lomandra filiformis* subsp. *coriacea*	Wattle Mat-rush										+	2	2		1	1							+	1	1	+	1	1

Family Name	Scientific Name	Common Name	Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8			Q9		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*	Wattle Mat-rush								2	2					1												2	2
Lomandraceae	*Lomandra glauca*	Pale Mat-rush						1																					
Lomandraceae	*Lomandra longifolia*	Spiny Mattrush	+	2	2	+		1	+	1	1				+	2	2				+	3	3			1	+	2	
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	Many-flowered Mat-rush								2	2		2	2											2	2		1	2
Loranthaceae	*Dendrophthoe vitellina*				1								1	1		1	1											1	1
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry					1	1		1	1		2	2		1	1					1	1		2	2			
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily	+	1	2		2	2		1	1	+	2	2		2	2		1	1	+	1	2	+	1	1		1	2
Malvaceae	*Hibiscus heterophyllus* subsp. *heterophyllus*	Native Rosella	+	1	2														2	1									
Menispermaceae	*Sarcopetalum harveyanum*	Pearl Vine					2													1	+	1	2						
Menispermaceae	*Stephania japonica* var. *discolor*	Snake Vine			1		1	2			2					1	1			1	+	2	2					1	1
Monimiaceae	*Hedycarya angustifolia*	Native Mulberry				+												+											
Monimiaceae	*Palmeria scandens*	Anchor Vine																+											
Monimiaceae	*Wilkiea huegeliana*	Veiny Wilkiea					2	2											2	2									
Moraceae	*Ficus coronata*	Sandpaper Fig		1	1	+	2	2										+											
Moraceae	*Ficus fraseri*	Sandpaper Fig																	1	1									
Moraceae	*Streblus brunonianus*	Whalebone Tree																+	1	1									
Myrsinaceae	*Embelia australiana*																												
Myrsinaceae	*Myrsine variabilis*	Muttonwood	+	2	2			1	+	3	3					1	1		1	1	+	1	1						
Myrtaceae	*Acmena smithii*	Lilly Pilly																+											
Myrtaceae	*Angophora costata*	Smooth-barked Apple		3	3				+	3	3										+	4	3				+		
Myrtaceae	*Angophora leiocarpa*	Smooth-barked Apple	+																										
Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle	+	6	6	+	4	4										+	1	1									
Myrtaceae	*Callistemon salignus*	Willow Bottlebrush	+						+	3	3																		
Myrtaceae	*Corymbia gummifera*	Red Bloodwood							+	3	3										+		3						
Myrtaceae	*Corymbia maculata*	Spotted Gum	+	4	4	+	3	3			1	+	4	4	+	4	4							+	3	3	+	3	3
Myrtaceae	*Eucalyptus acmenoides*	White Mahogany				+	4	4				+	3	3	+	5	5	+	3	3		1	1						
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark																											
Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark							+	3	3	+	4	4											2	2	+	3	3
Myrtaceae	*Eucalyptus grandis*	Flooded Gum																+	4	4									
Myrtaceae	*Eucalyptus moluccana*	Grey Box																										2	2
Myrtaceae	*Eucalyptus paniculata* subsp. *paniculata*	Grey Ironbark																				1		+					
Myrtaceae	*Eucalyptus pilularis*	Blackbutt																			+	4	3						
Myrtaceae	*Eucalyptus punctata*	Grey Gum																	1	1				+	3	3	+	2	2
Myrtaceae	*Eucalyptus resinifera* subsp. *resinifera*	Red Mahogany	+	3	3																								
Myrtaceae	*Eucalyptus saligna*	Sydney Blue Gum																+											
Myrtaceae	*Eucalyptus siderophloia*	Grey Ironbark				+	3	3							+	4	4								3	3	+		
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum																						+	3	2			
Myrtaceae	*Eucalyptus umbra*	Broad-leaved White Mahogany	+	2	2				+	3	3											1	1				+	4	4
Myrtaceae	*Leptospermum polygalifolium* subsp. *polygalifolium*	Tantoon	+						+	2	2										+	1	1	+	3	3			
Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark																			+	3	3	+	3	3			
Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea tree				+	2	2	+	3	3							+	3	2	+			+	3	3			
Myrtaceae	*Rhodomyrtus psidioides*	Native Guava																+											
Myrtaceae	*Sannantha pluriflora*																												
Myrtaceae	*Sannantha similis*			2	2																								
Myrtaceae	*Syncarpia glomulifera*	Turpentine	+	4	4	+	3	3	+	5	5				+	4	4	+	4	4		2							
Myrtaceae	*Syzygium oleosum*	Blue Lilly Pilly																	1	1									
Ochnaceae	**Ochna serrulata*	Mickey Mouse Plant																				1	1						
Oleaceae	*Notelaea longifolia* forma. *intermedia*	Large Mock-olive		1	2		2	2		1	1	+				1	1		2	2	+				1	2		2	2
Oleaceae	*Notelaea venosa*	Mock Olive											3	3				+				3	2						
Orchidaceae	*Acianthus fornicatus*	Pixie Caps							+																				
Orchidaceae	*Acianthus sp.*																									2			
Orchidaceae	*Caladenia catenata*	White Caladenia							+						+														
Orchidaceae	*Calochilus robertsonii*	Purplish Beard Orchid																										1	
Orchidaceae	*Chiloglottis trapeziformis*	Broad-lip Bird Orchid													1	1							1						
Orchidaceae	*Chiloglottis sp.*													1															
Orchidaceae	*Cymbidium suave*	Snake Orchid																											

Family Name	Scientific Name	Common Name	Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8			Q9		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Orchidaceae	*Epipogium roseum*	Drooping Orchid																											
Orchidaceae	*Plectorrhiza tridentata*	Tangle Orchid				+																							
Orchidaceae	*Pterostylis curta*	Blunt Greenhood													+														
Orchidaceae	*Pterostylis nutans*	Nodding Greenhood	+						+			+												+					
Orchidaceae	*Pterostylis sp.*										1																		
Oxalidaceae	*Oxalis exilis*												2												2				
Oxalidaceae	*Oxalis perrenans*			1						1						1						2					2	2
Passifloraceae	*Passiflora aurantia*	Blunt-leaved Passionfruit					1																						
Phormiaceae	*Dianella caerulea* var. *caerulea*	Blue Flax-Lily	+	1			2	1	+		2	+	2	2	+	2	2				+	2	2		2	2		2	2
Phormiaceae	*Dianella longifolia* var. *longifolia*	Blueberry Lily										+																	
Phormiaceae	*Dianella revoluta* var. *revoluta*	Blue Flax-Lily											1																
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	+	1	2		1	1	+	1	1		1	2		1	2		1	1	+	2	2	+	3	3	+	3	3
Phyllanthaceae	*Glochidion ferdinandi* var. *ferdinandi*	Cheese Tree		1	1	+	3	2	+	3	3					2	2				+	4	4		1	1			1
Phyllanthaceae	*Phyllanthus gunnii*																												
Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge							+	1	1																		
Phyllanthaceae	*Poranthera microphylla*															2	1								1	1		1	
Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry	+						+	1	2	+		1		2	2					1					+	2	2
Pittosporaceae	*Bursaria spinosa* subsp. *spinosa*	Native Blackthorn	+									+	3	3										+	2	2	+	3	2
Pittosporaceae	*Hymenosporum flavum*	Native Frangipani				+	2	2																					
Pittosporaceae	*Pittosporum multiflorum*	Orange Thorn				+	1	1										+	2	2									
Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum	+	1			1	2	+	1	1					1	1												
Plantaginaceae	*Veronica plebeia*	Trailing Speedwell																											1
Poaceae	**Axonopus fissifolius*	Narrow-leafed Carpet Grass																											
Poaceae	*Anisopogon avenaceus*	Oat Speargrass																											
Poaceae	*Aristida vagans*	Threeawn Speargrass											1			1	1								2	2		3	3
Poaceae	*Austrostipa* sp.																												
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass											1	2														2	3
Poaceae	*Cynodon dactylon*	Couch																						+					
Poaceae	*Dichelachne micrantha*	Shorthair Plumegrass											2	2														1	1
Poaceae	*Digitaria parviflora*	Small-flowered Finger Grass																							1				
Poaceae	*Digitaria ramularis*																												
Poaceae	*Echinopogon caespitosus* var. *caespitosus*	Bushy Hedgehog-grass											2	2		2	2					1			2	2		2	2
Poaceae	*Echinopogon ovatus*	Forest Hedgehog Grass										+												+					
Poaceae	**Ehrharta erecta*																												
Poaceae	*Entolasia marginata*	Bordered Panic				+													3	3		4	4	+	2	2			
Poaceae	*Entolasia stricta*	Wiry Panic		2	2		2	2		3	3		3	3		3	3					3	3		2	2		3	3
Poaceae	*Eragrostis brownii*	Brown's Lovegrass																											
Poaceae	*Imperata cylindrica*	Bladey Grass	+		1				+	2	2	+	3	3	+	2	3				+	1	1	+	3	3	+	3	3
Poaceae	*Lachnagrostis filiformis*																												
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Grass		1	2		2	2		2	2			1		2	2			1		1	1		3	2		1	2
Poaceae	*Oplismenus aemulus*			2												2	2		3	3	+				2	2			
Poaceae	*Oplismenus imbecillis*				3		3	3		2	2		2	2		3	3		4	4	+	4	4						
Poaceae	*Ottochloa gracillima*		+																		+								
Poaceae	*Panicum simile*	Two-colour Panic												1											2	2		1	3
Poaceae	*Paspalidium distans*										1					1													
Poaceae	**Paspalum dilatatum*	Paspalum																								1			
Poaceae	*Poa affinis*																												
Poaceae	*Poa labillardierei var. labillardierei*	Tussock Grass									2		3	3											2	2		2	2
Poaceae	*Rytidosperma fulvum*											+	1	1													+	1	1
Poaceae	*Rytidosperma pallidum*	Silvertop Wallaby Grass											3	3														3	3
Poaceae	*Rytidosperma tenuius*																												
Poaceae	*Themeda australis*	Kangaroo Grass	+						+	1	2		3	3		1	1							+			+	4	4
Poaceae	*Urochloa piligera*	Hairy Armgrass																			+								
Polygonaceae	*Persicaria hydropiper*	Water Pepper		1	1																								
Polypodiaceae	*Platycerium bifurcatum*	Elkhorn Fern					1	1																					
Proteaceae	*Grevillea montana*																											2	2

Family Name	Scientific Name	Common Name	Q1			Q2			Q3			Q4			Q5			Q6			Q7			Q8			Q9		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Proteaceae	*Lomatia silaifolia*	Crinkle Bush								1	1																		
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung							+	2	2					1	1								1	1			
Proteaceae	*Stenocarpus salignus*	Scrub Beefwood		1																									
Ranunculaceae	*Clematis glycinoides*	Headache Vine						1		1	2						1			2				+	1	1	+	1	1
Rhamnaceae	*Alphitonia excelsa*	Red Ash		1	1											1	1		1	1		1	1					1	1
Rhamnaceae	*Pomaderris sp.*																												1
Ripogonaceae	*Ripogonum album*	White Supplejack				+	3	3																					
Rosaceae	*Rubus parvifolius*	Native Rasberry																											
Rubiaceae	*Galium propinquum*	Maori Bedstraw											2	2											1	1		1	1
Rubiaceae	*Galium binifolium*															1													
Rubiaceae	*Morinda jasminoides*	Sweet Morinda	+		2	+	1	2			1							+	2	2									
Rubiaceae	*Opercularia aspera*	Coarse Stinkweed																			+						+		
Rubiaceae	*Opercularia diphylla*									1	2		2	1											1	1			1
Rubiaceae	*Pomax umbellata*	Pomax									1																	2	2
Rutaceae	*Acronychia oblongifolia*	White Aspen					1																		1				
Rutaceae	*Boronia polygalifolia*	Dwarf Boronia							+																	1	+	1	
Rutaceae	*Melicope micrococca*	Hairy-leaved Doughwood				+	2	2								1	1	+	3	2									
Rutaceae	*Zieria smithii*	Sandfly Zieria		2	2		1	2	+	3	3										+	1	1						
Sapindaceae	*Alectryon subcinereus*	Native Quince																											
Sapindaceae	*Dodonea triquetra*	Hop Bush																			+						+		
Smilacaceae	*Smilax australis*	Lawyer Vine	+	1	2		2	2		1									1										
Smilacaceae	*Smilax glyciphylla*	Sweet Sarsaparilla																		1									
Solanaceae	*Duboisia myoporoides*	Corkwood	+																		+	1	1						
Solanaceae	**Solanum nigrum*	Black-berry Nightshade					1																						
Solanaceae	*Solanum prinophyllum*	Forest Nightshade										+		1		1													
Solanaceae	*Solanum mauritianum*	Wild Tobacco Bush														1	1						1			1			
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia																											1
Stylidiaceae	*Stylidium graminifolium*	Grass Trigger-plant																											
Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*	Slender Rice Flower							+	1	1																		
Verbenaceae	**Lantana camara*	Lantana				+	1	2	+	1	1			1	+	1	1	+	2	2	+	2	2		2	2		1	1
Violaceae	*Hybanthus stellarioides*															1	1								1	1			
Violaceae	*Viola betonicifolia*	Native Violet															1												
Violaceae	*Viola hederacea*	Ivy-leaved Violet						2																+					
Vitaceae	*Cayratia clematidea*	Native Grape					1	1	+									+	1	1									
Vitaceae	*Cissus antarctica*	Water Vine				+	1	2									1		1	1									
Vitaceae	*Cissus hypoglauca*	Giant Water Vine			2	+													1	2									
Xanthorrhoeaceae	*Xanthorrhoea latifolia* subsp. *latifolia*	Grass Tree																											
Xanthorrhoeaceae	*Xanthorrhoea macronema*	Grass Tree							+		1																+	2	2
Zamiaceae	*Macrozamia communis*	Burrawang	+	1	1				+	2	2	+															+		
Zamiaceae	*Macrozamia reducta*												1	2														2	2

* denotes an introduced species

# denotes a species listed on NSW Biodiversity Conservation Act 2016

APPENDIX 5: MAMMAL SPECIES RECORDED 2001-2022

+ equals presence.

Species Name	Common Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Arboreal mammals																							
Acrobates pygmaeus	Feathertail Glider	+	+	+	+		+	+	+	+			+		+		+				+		+
Antechinus stuartii	Brown Antechinus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
Petauroides volans ^	Greater Glider	+	+			+																	
Petaurus breviceps	Sugar Glider		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		+
Petaurus norfolcensis #	Squirrel Glider		+		+	+						+											
Pseudocheirus peregrinus	Common Ringtail Possum		+	+	+				+			+		+		+	+				+		
Trichosurus vulpecula	Common Brushtail Possum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
Bats																							
Chalinolobus dwyeri #^	Large-eared Pied Bat							+								+							
Chalinolobus gouldii	Gould's Wattled Bat	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
Chalinolobus morio	Chocolate Wattled Bat	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
Falsistrellus tasmaniensis #	Eastern False Pipistrelle											+	+	+	+	+	+	+	+	+	+		+
Miniopterus australis #	Little Bentwing-bat	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+

Species Name	Common Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Miniopterus oceanensis #	Eastern Bentwing-bat		+	+	+	+	+		+	+	+	+	+		+	+	+	+			+		+
Mormopterus norfolkensis #	East-coast Freetail-bat	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		+
Mormopterus ridei	Eastern Freetail-bat	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+		+
Mormopterus spp. 4	Undescribed Freetail-bat																			+			
Myotis macropus #	Southern Myotis	+	+	+	+	+			+	+	+	+	+	+	+	+	+	+		+	+		+
Nyctophilus geoffroyi	Lesser Long-eared Bat														+	+	+	+			+		
Nyctophilus gouldii	Gould's Long-eared Bat												+		+	+	+	+	+		+		
Nyctophilus sp.	Unidentified Long-eared Bat	+	+	+	+		+		+	+	+		+	+	+		+	+	+	+	+		+
Pteropus poliocephalus #	Grey-headed Flying-fox						+		+	+	+	+			+		+		+	+	+		+
Rhinolophus megaphyllus	Eastern Horseshoe Bat				+		+	+		+		+				+		+	+		+		+
Saccolaimus flaviventris #	Yellow-bellied Sheathtail Bat	+	+	+	+		+									+					+		
Scoteanax rueppellii #	Greater Broad-nosed Bat		+	+		+	+	+		+	+	+	+	+	+	+	+			+	+		
Scotorepens balstoni	Inland Broad-nosed Bat			+									+										
Scotorepens orion	Eastern Broad-nosed Bat	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+	+	+	+		+
Scotorepens sp.	Undescribed Broad-nosed Bat	+	+																				

Species Name	Common Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Tadarida australis	White-striped Mastiff Bat	+	+	+	+	+	+	+	+	+			+		+	+	+	+		+	+		
Vespadelus darlingtoni	Large Forest Bat		+	+					+							+				+	+		+
Vespadelus pumilus	Eastern Forest Bat		+	+			+	+	+	+	+	+	+	+	+		+	+		+	+		+
Vespadelus regulus	Southern Forest Bat							+			+										+		
Vespadelus troughtoni #	Eastern Cave Bat		+	+	+	+							+		+		+				+		
Vespadelus vulturnus	Little Forest Bat	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+		+
Terrestrial Mammals																							
Lepus europaeus *	Brown Hare		+				+	+		+						+	+						
Macropus giganteus	Eastern Grey Kangaroo		+		+	+	+	+		+	+	+	+	+			+	+	+	+	+		+
Macropus rufogriseus	Red-necked Wallaby						+			+		+	+	+			+				+		
Oryctolagus cuniculus *	European Rabbit												+	+	+	+			+				
Perameles nasuta	Long-nosed Bandicoot		+		+		+			+				+		+	+	+	+				+
Rattus fuscipes	Bush Rat	+	+	+	+	+			+	+	+	+	+		+	+		+	+	+	+		+
Rattus rattus *	Black Rat	+	+	+	+	+	+	+	+	+	+		+	+		+	+	+			+		+
Tachyglossus aculeatus	Short-beaked Echidna														+								
Thylogale thetis	Red-necked Pademelon?										+												

Species Name	Common Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Vulpes vulpes *	Red Fox																+						
Wallabia bicolor	Swamp Wallaby			+	+	+				+	+		+	+	+	+	+	+	+		+		+
Arboreal mammals		4	7	5	6	5	4	4	5	4	3	5	4	4	4	4	5	3	3	2	5	3	4
Bats		12	17	17	14	12	15	13	14	15	14	13	16	12	17	17	17	15	12	15	22	15	15
Terrestrial mammals		2	5	3	5	4	5	3	2	7	5	3	6	6	4	6	7	5	5	2	5	5	5
Total mammals		18	29	25	25	21	24	20	21	26	22	21	26	22	24	27	29	23	20	19	32	23	24

APPENDIX 6: BIRD SPECIES RECORDED ACROSS ALL QUADRATS DURING 2001 & 2005-2022 SURVEYS

Scientific Name	Common Name	Status	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Alectura lathami	Australian Brush-turkey														+						
Alisterus scapularis	Australian King-Parrot		+	+		+			+	+	+	+	+	+	+			+			
Cracticus tibicen	Australian Magpie		+		+	+	+	+	+	+	+		+	+	+	+			+	+	+
Aegotheles cristatus	Australian Owlet-nightjar		+	+		+		+					+	+	+		+				+
Corvus coronoides	Australian Raven		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Chenonetta jubata	Australian Wood Duck				+							+	+								
Alcedo azurea	Azure Kingfisher														+						
Geopelia humeralis	Bar-shouldered Dove		+	+	+	+		+	+	+	+	+	+	+		+	+	+	+		+
Zoothera lunulata	Bassian Thrush		+																		
Manorina melanophrys	Bell Miner			+	+	+	+	+	+	+	+	+	+	+	+				+		
Coracina novaehollandiae	Black-faced Cuckoo-shrike		+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Monarcha melanopsis	Black-faced Monarch		+		+	+	+	+	+	+	+		+		+	+	+	+	+	+	
Macropygia amboinensis	Brown Cuckoo-Dove		+		+			+	+	+		+	+	+	+	+	+		+		
Gerygone mouki	Brown Gerygone		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Accipiter fasciatus	Brown Goshawk		+																		
Acanthiza pusilla	Brown Thornbill			+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	
Melithreptus brevirostris	Brown-headed Honeyeater		+		+			+	+	+		+			+	+			+	+	
Cacomantis variolosus	Brush Cuckoo		+	+		+			+	+		+							+		
Acanthiza reguloides	Buff-rumped Thornbill			+	+																

Scientific Name	Common Name	Status	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Scythrops novaehollandiae	Channel-billed Cuckoo			+	+	+	+		+	+	+	+	+	+	+	+	+	+	+		+
Anas castanea	Chestnut Teal					+															
Coracina tenuirostris	Cicadabird		+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+		+
Accipiter cirrocephalus	Collared Sparrowhawk															+					
Phaps chalcoptera	Common Bronzewing			+															+		+
Ocyphaps lophotes	Crested Pigeon				+																
Falcunculus frontatus	Crested Shrike-tit		+			+		+	+	+	+										
Platycercus elegans	Crimson Rosella							+		+	+										
Eurystomus orientalis	Dollarbird		+			+	+	+				+		+	+	+		+	+		+
Artamus cyanopterus	Dusky Woodswallow	V		+							+										
Eudynamys orientalis	Eastern Koel			+	+			+	+			+		+	+			+			+
Platycercus eximius	Eastern Rosella		+	+	+	+	+	+	+	+	+				+	+	+	+			
Acanthorhynchus tenuirostris	Eastern Spinebill		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Psophodes olivaceus	Eastern Whipbird		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Eopsaltria australis	Eastern Yellow Robin		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cacomantis flabelliformis	Fan-tailed Cuckoo		+	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+	+

Scientific Name	Common Name	Status	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Cacatua roseicapilla	Galah				+	+	+	+			+				+						
Calyptorhynchus lathami	Glossy Black-Cockatoo														+				+		
Pachycephala pectoralis	Golden Whistler		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cracticus torquatus	Grey Butcherbird		+	+	+	+	+	+	+	+	+				+	+		+	+	+	+
Rhipidura fuliginosa	Grey Fantail		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Accipiter novaehollandiae	Grey Goshawk			+	+			+							+						
Colluricincla harmonica	Grey Shrike-thrush		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo		+		+				+												
Microeca fascinans	Jacky Winter			+		+			+												
Dacelo novaeguineae	Laughing Kookaburra		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Myiagra rubecula	Leaden Flycatcher		+	+		+	+	+	+	+	+	+		+	+	+	+		+	+	
Meliphaga lewinii	Lewin's Honeyeater		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cacatua sanguinea	Little Corella													+					+	+	+
Glossopsitta pusilla	Little Lorikeet	V		+		+									+			+	+	+	+
Grallina cyanoleuca	Magpie-lark					+		+			+							+	+	+	
Vanellus miles	Masked Lapwing							+				+								+	

Scientific Name	Common Name	Status	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Tyto novaehollandiae	Masked Owl	V						+	+				+	+	+	+	+				
Dicaeum hirundinaceum	Mistletoebird			+				+	+	+	+	+	+	+		+		+		+	
Glossopsitta concinna	Musk Lorikeet										+								+		+
Falco cenchroides	Nankeen Kestrel													+							
Phylidonyris novaehollandiae	New Holland Honeyeater														+	+		+	+	+	
Philemon corniculatus	Noisy Friarbird		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Manorina melanocephala	Noisy Miner					+	+		+		+				+				+	+	+
Oriolus sagittatus	Olive-backed Oriole		+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	
Aviceda subcristata	Pacific Baza											+			+						
Anas superciliosa	Pacific Black Duck					+								+							
Turnix varius	Painted Button-quail							+													
Geopelia striata	Peaceful Dove						+		+	+							+				
Falco peregrinus	Peregrine Falcon											+			+					+	
Centropus phasianinus	Pheasant Coucal													+							
Cracticus nigrogularis	Pied Butcherbird			+	+	+	+		+	+	+	+		+		+	+	+		+	
Strepera graculina	Pied Currawong		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
Ninox strenua	Powerful Owl	V	+	+	+	+	+		+	+			+	+		+	+	+		+	

Scientific Name	Common Name	Status	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Trichoglossus haematodus	Rainbow Lorikeet			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Anthochaera carunculata	Red Wattlebird															+	+			+	
Neochmia temporalis	Red-browed Finch		+	+	+	+	+	+	+	+	+	+	+	+		+	+		+	+	+
Petroica rosea	Rose Robin			+	+	+		+	+		+					+	+			+	
Rhipidura rufifrons	Rufous Fantail		+	+		+	+	+	+	+	+	+	+	+		+	+		+		+
Pachycephala rufiventris	Rufous Whistler		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			+	
Todiramphus sanctus	Sacred Kingfisher		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ptilonorhynchus violaceus	Satin Bowerbird									+						+	+	+			
Myiagra cyanoleuca	Satin Flycatcher		+					+													
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet						+											+	+		+
Myzomela sanguinolenta	Scarlet Honeyeater		+	+	+	+		+	+	+	+	+	+	+	+	+	+		+	+	+
Chrysococcyx lucidus	Shining-Bronze Cuckoo			+			+		+	+						+	+				
Zosterops lateralis	Silvereye		+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+		+
Tyto tenebricosa	Sooty Owl	V	+												+						
Ninox novaeseelandiae	Southern Boobook		+					+								+	+				
Pardalotus punctatus	Spotted Pardalote		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cinclosoma punctatum	Spotted Quail-thrush		+		+	+	+	+	+		+										

Scientific Name	Common Name	Status	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Threskiornis spinicollis	Straw-necked Ibis					+															
Pardalotus striatus	Striated Pardalote			+	+	+	+											+		+	
Acanthiza lineata	Striated Thornbill		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cacatua galerita	Sulphur-crested Cockatoo					+									+			+	+		
Malurus cyaneus	Superb Fairy-wren		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Podargus strigoides	Tawny Frogmouth					+										+	+	+			+
Lopholaimus antarcticus	Topknot Pigeon		+																		
Daphoenositta chrysoptera	Varied Sittella	V		+			+		+				+								
Malurus lamberti	Variegated Fairy-wren		+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	
Aquila audax	Wedge-tailed Eagle														+						
Hirundo neoxena	Welcome Swallow			+								+		+							
Sericornis frontalis	White-browed Scrubwren		+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+
Phylidonyris niger	White-cheeked Honeyeater												+					+		+	+
Lichenostomus leucotis	White-eared Honeyeater																	+			
Melithreptus lunatus	White-naped Honeyeater		+	+	+	+	+	+	+	+	+		+				+	+	+	+	
Gerygone albogularis	White-throated Gerygone					+		+			+				+	+	+				

Scientific Name	Common Name	Status	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hirundapus caudacutus	White-throated Needletail													+			+				
Eurostopodus mystacalis	White-throated Nightjar		+		+		+	+				+					+				
Cormobates leucophaeus	White-throated Treecreeper		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Corcorax melanorhamphos	White-winged Chough				+			+								+					
Rhipidura leucophrys	Willie Wagtail							+							+						+
Leucosarcia picata	Wonga Pigeon					+		+	+	+	+		+	+	+	+	+	+	+		+
Acanthiza nana	Yellow Thornbill			+	+	+			+		+		+	+	+		+	+	+	+	+
Lichenostomus chrysops	Yellow-faced Honeyeater		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo					+		+									+				
Sericornis citreogularis	Yellow-throated Scrubwren															+	+				+
Total			**53**	**56**	**55**	**64**	**50**	**63**	**60**	**53**	**55**	**47**	**48**	**51**	**58**	**57**	**55**	**52**	**54**	**49**	**45**

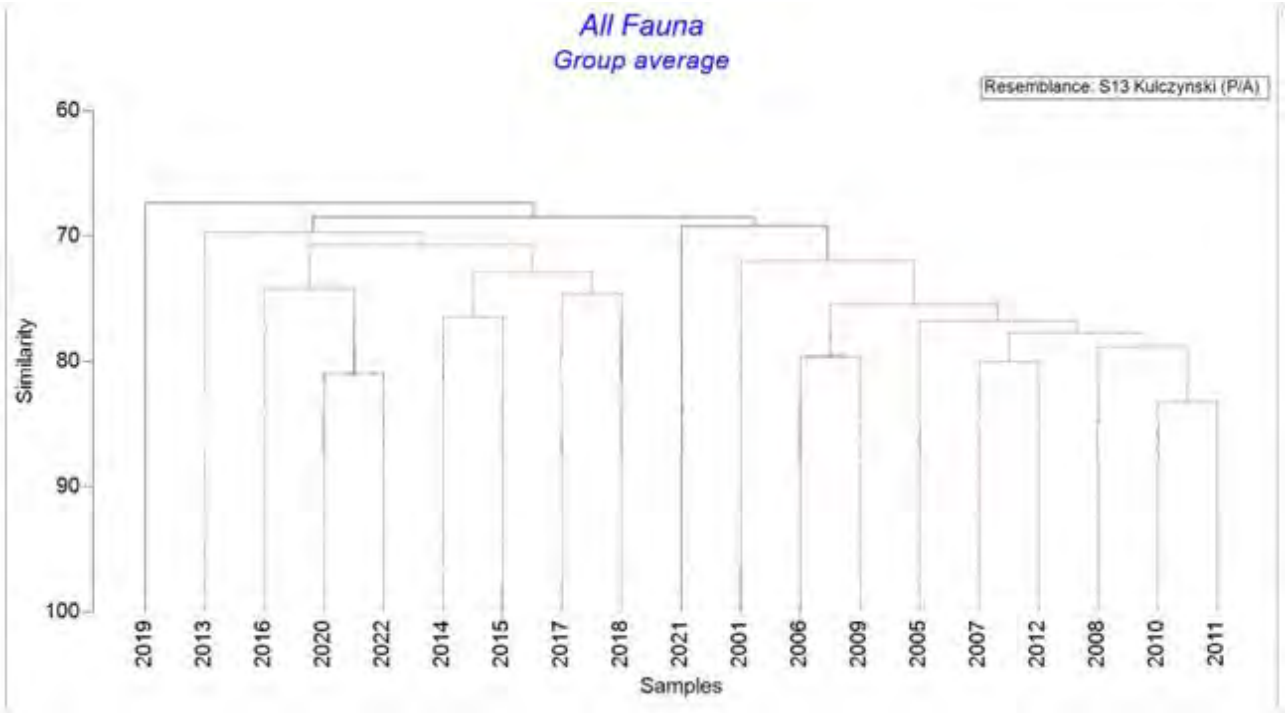
Status: V = Threatened (Vulnerable) under the *Biodiversity Conservation Act 2016* (NSW)

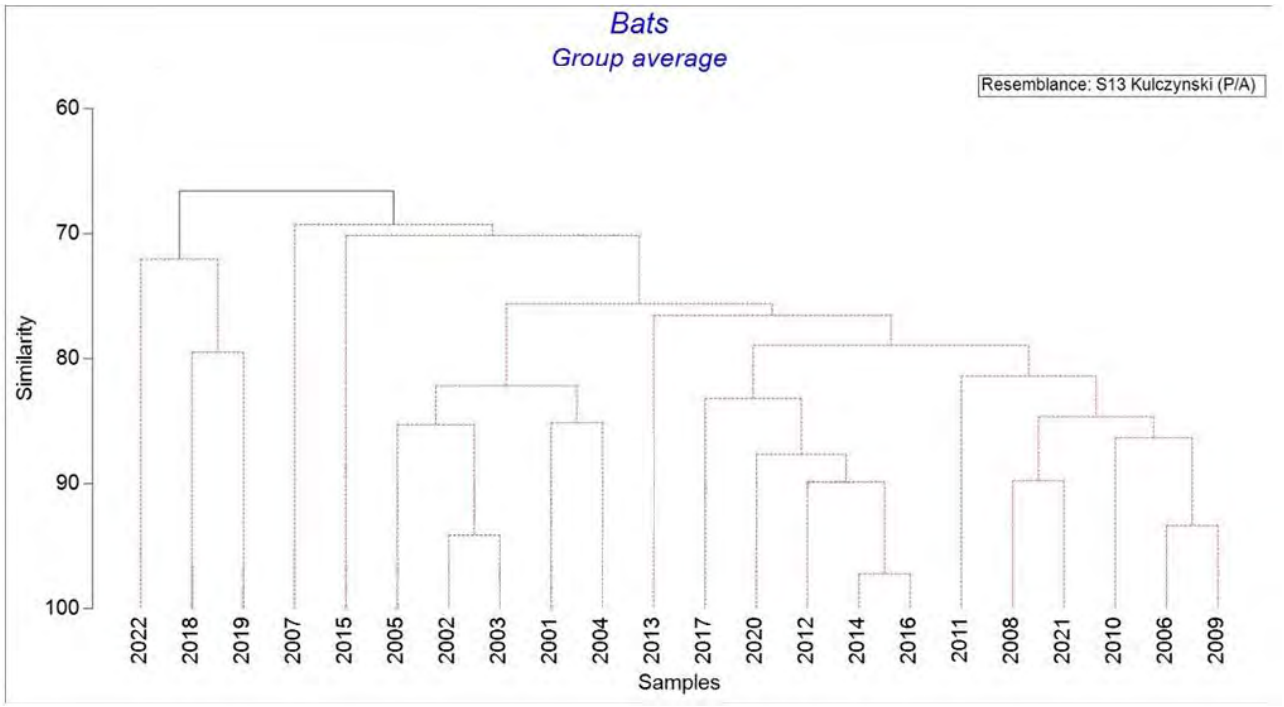
APPENDIX 7: AMPHIBIAN AND REPTILE SPECIES RECORDED ACROSS ALL QUADRATS 2009 - 2022

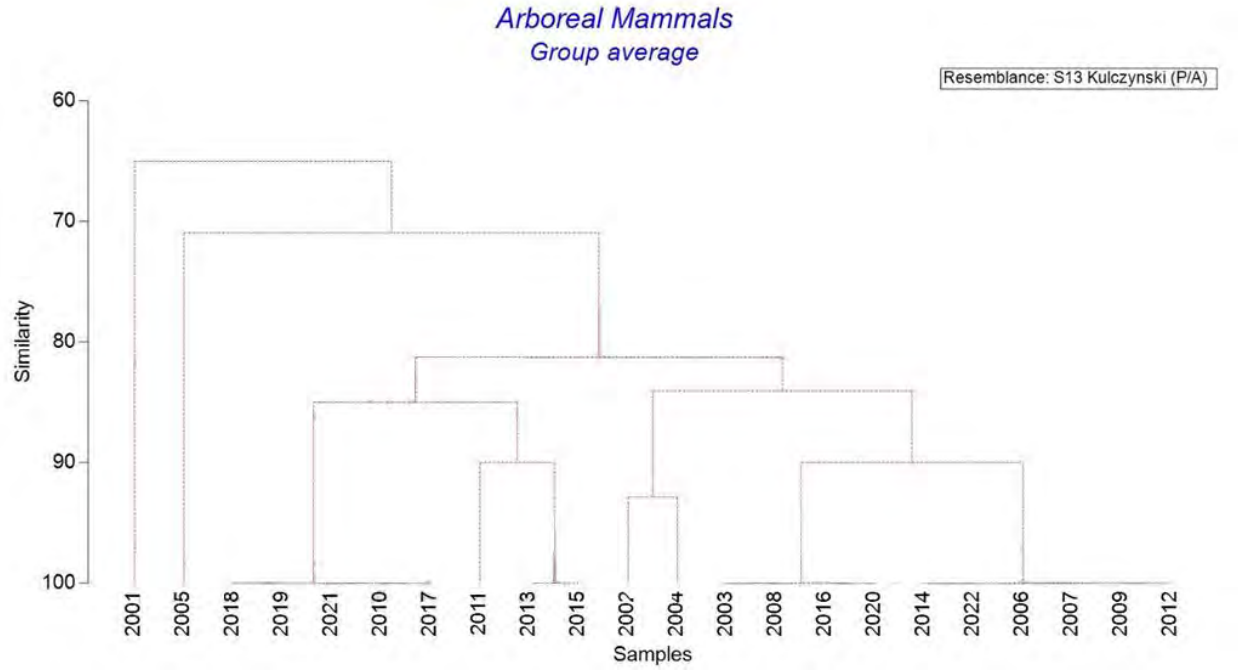
Scientific name	Common name	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Adelotus brevis	Tusked Frog					+	+	+	+	+			+		+
Crinia signifera	Common Toadlet			+		+	+	+	+	+			+	+	+
Limnodynastes peronii	Striped Marsh Frog			+		+		+	+				+		
Limnodynastes tasmaniensis	Spotted Grass Frog					+					+		+	+	
Litoria fallax	Sedge Frog	+				+	+	+				+	+		+
Litoria latopalmata	Broad-palmed Frog	+				+			+	+	+		+		
Litoria peronii	Emerald-spotted Tree Frog	+						+	+	+					
Litoria revelata	Revealed Frog					+									
Litoria tyleri	Tyler's Tree Frog					+		+	+						
Pseudophryne bibronii	Bibron's Toadlet					+									
Pseudophryne coriacea	Red-backed Toadlet			+		+	+	+	+		+		+	+	+
Uperoleia laevigata	Eastern Toadlet									+					
Total		**3**	**0**	**3**	**0**	**10**	**4**	**7**	**7**	**5**	**3**	**1**	**7**	**3**	**4**
Amphibolurus muricatus	Jacky Lizard	+													
Anilios nigrescens	Blackish Blind Snake												+		
Dendrelaphis punctulata	Green Tree Snake	+													
Demansia psammophis	Yellow-faced Whipsnake											+			
Furina diadema	Red-naped Snake	+													

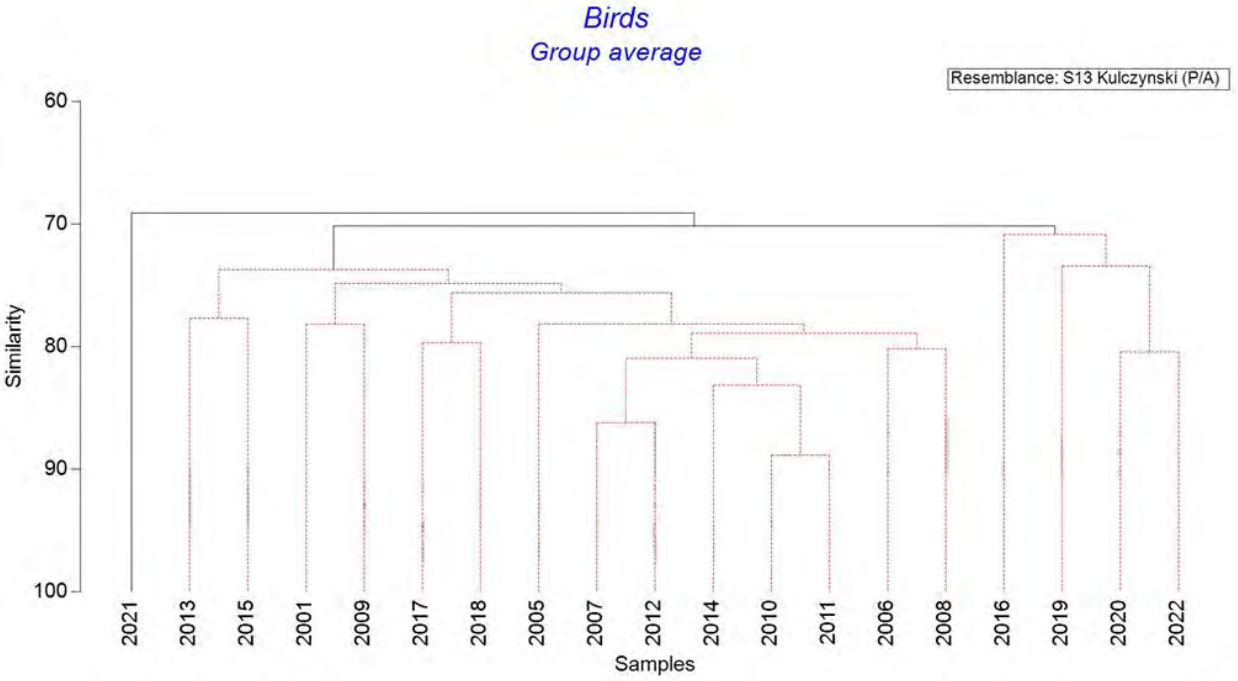
Scientific name	Common name	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hemisphaeriodon gerrardii	Pink-tongued Skink							+							
Intellagama lesueurii	Eastern Water Dragon							+	+	+			+	+	
Lampropholis delicata	Delicate Skink							+	+						
Morelia spilota spilota	Diamond Python						+								
Pogona barbarta	Eastern Bearded Dragon												+		
Pseudechis porphyriacus	Red-bellied Black Snake								+		+	+			+
Pseudonaja textilis	Eastern Brown Snake							+							
Varanus varius	Lace Monitor	+					+		+	+	+	+	+	+	+
Total		**4**	**0**	**0**	**0**	**0**	**2**	**4**	**4**	**2**	**2**	**3**	**4**	**2**	**2**

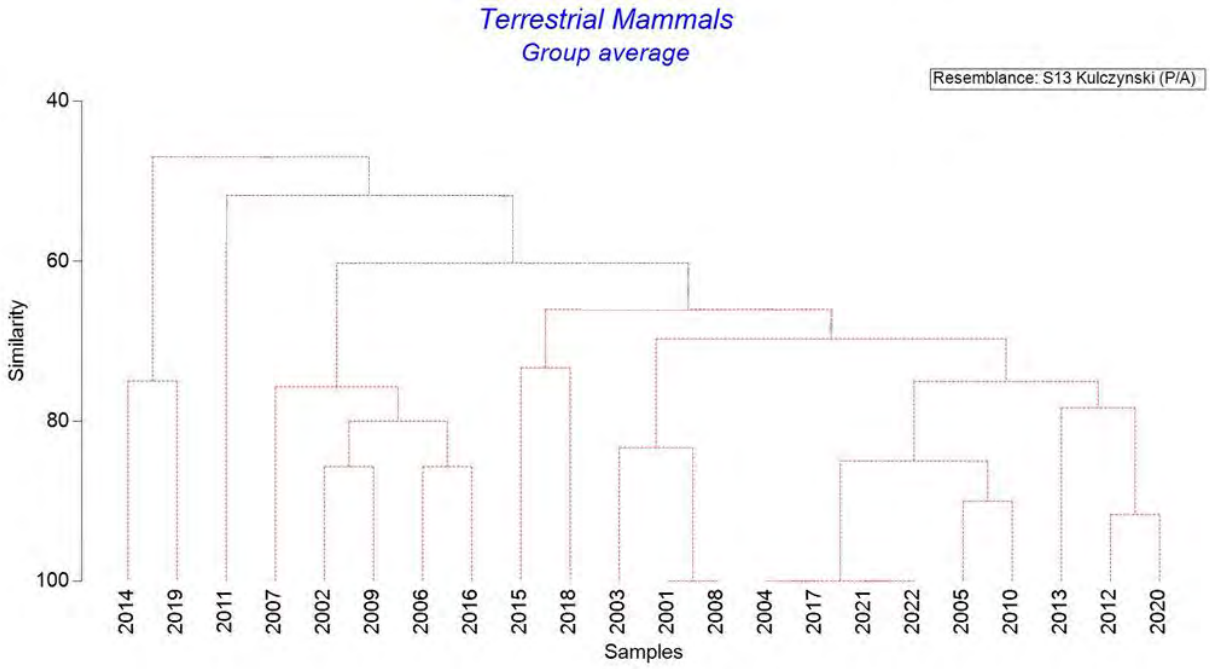
APPENDIX 8: CLUSTER ANALYSIS DENDOGRAMS AND SIMPROF RESULTS






Arboreal Mammals
Group average
Resemblance: S13 Kulczynski (P/A)
Similarity
60
70
80
90
100
2001
2005
2018
2019
2021
2010
2017
2011
2013
2015
2002
2004
2003
2008
2016
2020
2014
2022
2006
2007
2009
2012
Samples


Birds
Group average
Resemblance: S13 Kulczynski (P/A)
Similarity
60
70
80
90
100
2021
2013
2015
2001
2009
2017
2018
2005
2007
2012
2014
2010
2011
2006
2008
2016
2019
2020
2022
Samples


Terrestrial Mammals
Group average
Resemblance: S13 Kulczynski (P/A)
Similarity
40
60
80
100
2014
2019
2011
2007
2002
2009
2006
2016
2015
2018
2003
2001
2008
2004
2017
2021
2022
2005
2010
2013
2012
2020
Samples

APPENDIX 9: PHOTOS - FAUNA

Plate 2: **Glossy Black-Cockatoos (Calyptorhynchus lathami)**

Plate 3: **Sugar Glider nest in new nest box**

Plate 4: **Gould's Long-eared Bat (Nyctophilus gouldii)**

Plate 5: **Southern Myotis (Myotis macropus)**

Plate 6: **Red-backed Toadlet (Pseudophryne coriacea)**

APPENDIX 10: STAFF CONTRIBUTIONS AND QUALIFICATIONS

The following staff were involved in the compilation of this report.

Name	Qualification	Title/Experience	Contribution
Jake Mauger	BEnvSc & Mgt	Ecologist	Flora surveys, Report Writing
Nigel Fisher	BSc (Hons) PhD	Senior Ecologist	Flora Surveys, Report Review
David Martin	MSc	Senior Ecologist (Botanist)	Flora surveys
Isaac Blundell		Ecologist	Fauna Surveys
Mark Dean	BEnvSc & Mgt	Senior Ecologist (Zoology)	Fauna surveys, Report Writing

2023 Annual Winter Monitoring

Donaldson Open-Cut Coal Mine, Beresfield, NSW

Rev 2
04 August 2023

2023 Annual Winter Monitoring
Donaldson Open-Cut Coal Mine, Beresfield, NSW

REPORT PREPARED FOR:

Yancoal Australia Ltd
1132 John Renshaw Drive
Black Hill, NSW, 2322

REPORT PREPARED BY:

WEDGETAIL PROJECT CONSULTING PTY LTD
27 Groves Road
Bennett's Green, NSW 2290

ABN: 93 640 388 683

File Ref: 20230804_DonWinMon_V2

Version Control

Rev. No.	Revision Date	Author / Position	Reviewer	Details
Rev 1	26 July 2023	Rachel Neal Ecologist	Nigel Fisher Senior Ecologist	Draft for Internal review
Rev 2	04 August 2023	Rachel Neal Ecologist	Nigel Fisher Senior Ecologist	Draft for Client review

EXECUTIVE SUMMARY

Findings of the 2023 annual quadrat monitoring survey are presented in this document in accordance with Section 5.1 Monitoring Program of the Donaldson Coal Flora and Fauna Management Plan (F&FMP). Data collected biannually since 2001 have been analysed to investigate trends in fauna species composition over time.

The 2023 survey detected a total of 57 fauna species consisting of 41 bird, 15 mammals and one amphibian species. Of these, Little Bentwing-bat (Miniopterus australis) and Eastern Coastal Free-tailed Bat (Micronomus norfolkensis) are listed as Vulnerable under the Biodiversity Conservation Act 2016 (NSW).

Nest box surveys in 2023 (winter average) saw 60.9% of all available boxes showing signs of use (both actual animals present and evidence of usage). Nest box utilisation has increased since 2022 from 57.8% to 62.2% in 2023 due to increased nest box availability and only four boxes requiring maintenance compared to previous years.

Overall results conclude that there has been minimal impact to fauna diversity within the Donaldson Bushland Conservation Area (BCA) over the last 20 years. Fluctuations in ecological diversity across all quadrats have been observed which are consistent with natural ecosystem functioning, weather patterns and the changing nature of the adjoining habitat, resulting from past mining activities and neighbouring development.

Contents

Figures

Tables

Plates

Appendices

1. INTRODUCTION

Yancoal Australia Ltd operated Donaldson Coal Open Cut Mine from 2001 until 2013, when operations ceased due to the exhaustion of resources. Donaldson Coal is located on a mining lease near Beresfield in the Lower Hunter Valley, NSW (**Figure 1**). As part of the Conditions of Consent, a Flora and Fauna Management Plan (F&FMP) was prepared prior to the commencement of operations (Gunninah, 2000) with subsequent revisions made by EcoBiological in 2007.

The F&FMP prescribes the approach and the frequency of monitoring of the remnant bushland surrounding the mine disturbance area, referred to hereafter as the Bushland Conservation Area (BCA). Regular monitoring activities are conducted at nine permanently established 20 x 20 m quadrats positioned across the mining lease (**Figure 1**). A Baseline Report (Barker Harle 2001) was prepared at the commencement of mining activities and each year since, to monitor the impact of mining activities on flora and fauna at the mine.

This report presents the winter results for the 2023 Donaldson Coal Open Cut Coal Mine Annual Fauna Monitoring Program. A thorough analysis of all data collected during winter and summer surveys will be given in the 2023 Annual Report.

1.1 COMPLIANCE WITH THE F&FMP

The nine permanent quadrats were established in accordance with Section 5.1 Monitoring Program in the F&FMP. One of the permanent quadrats was to be established downstream of the mine in Woodbury Swamp, however this location was not situated within Donaldson Coal's mining lease. In consultation with the Donaldson Environmental Officer (EO) it was decided not to establish this quadrat. In 2003 Quadrat 9 was established in an area of bushland of similar type to that originally found over the pit area.

The Baseline Report (Barker Harle 2001) prepared to fulfil part of the requirements of Section 5.0 of the F&FMP provides a detailed discussion of the program requirements. During initial discussions with the Donaldson EO, it was decided that the program requirements could be met by a very detailed annual assessment and a quarterly general inspection of each quadrat for any significant change. In 2004, winter fauna monitoring methods were changed from trapping to artificial nest box inspection. The change was implemented as a result of poor trapping results and the high risk of mortality to captured animals from exposure to cold.

This report meets the requirement of section 6.1 of the F&FMP, specifically 'Monitoring reports which are provided biannually and summarise all monitoring activities carried out in the preceding six months and brief monitoring reports to be provided following each monitoring event'.

Created by: KBlundell
Date: 28.07.2023

WEDGETAIL PROJECT CONSULTING

https://wedgetail.com.au

Legend

- Donaldson Coal Mine Disturbance (Pit) Area
- Subject Site
- Quadrat Locations

Extent of Donaldson Open Cut Mine & the Location of Nine Permanent Monitoring Quadrats

Figure: 1

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N

2. METHODOLOGY

Field surveys (**Table 1**) were undertaken at nine permanent quadrats located in the vegetation buffer (known as the Bushland Conservation Area) surrounding the mine (**Figure 1**). All surveys were undertaken between 10th to the 12th of July 2023 (refer to **Table 3** for details of sample effort and weather conditions). Survey techniques followed those used previously, enabling a valid comparison of results.

Table 1: Methodology

Survey	Methodology
Microchiropteran Bat Detection	Passive Anabat™ detectors were placed in bat flyways for a one-hour period at each of the nine quadrats. Detectors were programmed to record the echolocation calls of passing micro bats and the identification of recorded calls was completed using Anabat Insight software and Pennay et al. 2004 as the primary reference.
Call Playback	Recorded calls of threatened owl and mammal species were broadcast by loudspeaker at each quadrat after dusk. Species calls played included; Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*) and Squirrel Glider (*Petaurus norfolcensis*).
Nocturnal Surveys	Spotlighting was carried out by two observers in the vicinity of each quadrat for 30 minutes (between 17:45 and 21:00 hours). Birds, mammals, reptiles and amphibians observed or heard during the sample period were recorded.
Bird Surveys	A 2 hectare area centered on each quadrat was surveyed by one observer for 30 minutes on the mornings of 11th and 12th of July 2023. Birds detected were identified either visually, with the aid of binoculars or by call.
Nest Box Inspection	Forty-five (45) nest boxes were inspected on 10th of July 2023. Chew marks, hair, nests, scats or the presence of an animal in the nest box were used as evidence of nest box usage. Nest boxes that were infested with termites, wasps or bees, had missing lids or were heavily damaged, were considered unavailable for use.
Opportunistic Sightings	Fauna species observed opportunistically within the boundaries of the Donaldson Coal Open Cut Coal Mine area during the survey period were also recorded, however these species are not considered in quadrat-to-quadrat statistical comparisons.

3. RESULTS

Surveys were completed by two ecologists from the 10th to the 12th July 2023. Weather conditions and the survey effort are shown in **Appendix B**.

3.1 QUADRAT MONITORING

A total of 57 fauna species were detected during the 2023 winter monitoring period, including 41 birds, 15 mammals and one amphibian species (**Figure 2**). An average of 17 species per quadrat was observed during the 2023 winter survey (**Figure 3**). Of these, Little Lorikeet (*Glossopsitta pusilla*), Little Bentwing-bat (*Miniopterus australis*), Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*), Northern bentwing-bat (*Miniopterus orianae*) and Eastern Cave bat (*Vespadelus troughtonii*) are listed as Vulnerable under the Biodiversity Conservation Act 2016 (NSW).

A complete list of all fauna detected during the 2023 winter surveys is provided in **Table 3.**

Table 2: Results of the 2023 winter monitoring surveys

Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Aves										
Ninox boobook	Australian Boobook									
Cracticus tibicen	Australian Magpie			+						
Aegotheles cristatus	Australian Owlet-Nightjar	+			+					
Corvus coronoides	Australian Raven	+	+	+	+		+	+	+	+
Geopelia humeralis	Bar-shouldered Dove									
Manorina melanophrys	Bell Miner									
Coracina novaehollandiae	Black-faced cuckooshrike					+		+		+
Macropygia amboinensis	Brown Cuckoo-Dove									
Gerygone mouki	Brown Gerygone	+		+		+	+			+
Acanthiza pusilla	Brown Thornbill									
Platycercus eximius	Eastern Rosella		+							
Acanthorhynchus tenuirostris	Eastern Spinebill		+						+	+
Psophodes olivaceus	Eastern Whipbird									
Eopsaltria australis	Eastern Yellow Robin	+	+	+	+	+			+	+
Cacomantis flabelliformis	Fan-tailed Cuckoo						+	+	+	+
Pachycephala pectoralis	Golden Whistler					+				
Cracticus torquatus	Grey Butcherbird				+			+		
Rhipidura fuliginosa	Grey Fantail		+	+						
Colluricincla harmonica	Grey Shrike-thrush		+					+		
Microeca fascinans	Jacky Winter		+							
Dacelo novaeguineae	Laughing Kookaburra						+			
Meliphaga lewinii	Lewin's Honeyeater	+	+	+		+	+	+	+	+
Glossopsitta pusilla	Little Lorikeet				+					
Philemon corniculatus	Noisy Friarbird									
Manorina melanocephala	Noisy Miner				+		+		+	
Oriolus sagittatus	Olive-backed Oriole									

Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Strepera graculina	Pied Currawong					+			+	
Ninox strenua	Powerful Owl									
Trichoglossus haematodus	Rainbow Lorikeet	+			+		+	+		
Myiagra inquieta	Restless Flycatcher					+				+
Petroica rosea	Rose Robin									
Myiagra cyanoleuca	Satin Flycatcher						+			
Myzomela sanguinolenta	Scarlet Honeyeater									
Chrysococcyx lucidus	Shining Bronze-Cuckoo				+					
Zosterops lateralis	Silvereye									+
Pardalotus punctatus	Spotted Pardalote		+	+	+	+	+		+	+
Acanthiza lineata	Striated Thornbill									
Malurus cyaneus	Superb Fairy-wren	+	+	+	+	+	+	+	+	+
Podargus strigoides	Tawny Frogmouth						+			
Smicrornis brevirostris	Weebill									
Sericornis frontalis	White-browed Scrubwren							+	+	
Phylidonyris niger	White-cheeked Honeyeater									
Melithreptus lunatus	White-naped Honeyeater									
Cormobates leucophaeus	White-throated Treecreeper	+	+	+		+	+	+	+	+
Corcorax melanorhamphos	White-winged Chough									+
Rhipidura leucophrys	Willie Wagtail	+								
Leucosarcia picata	Wonga Pigeon	+	+							+
Acanthiza nana	Yellow Thornbill	+								
Lichenostomus chrysops	Yellow-faced Honeyeater					+	+	+	+	
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo		+							
Sericornis citreogularis	Yellow-throated Scrubwren									
	Sub-total	**11**	**13**	**9**	**10**	**11**	**13**	**11**	**12**	**14**
Mammalia										
Austronomus australis	White-striped Freetail-bat									
Chalinolobus gouldii	Gould's Wattled Bat		+		+					
Chalinolobus morio	Chocolate Wattled Bat									
Isoodon macrourus	Northern Brown Bandicoot									
Micronomus norfolkensis #	Eastern Coastal Freetail-bat		+		+					
Miniopterus australis #	Little Bentwing-bat	+	+	+	+	+	+	+	+	+
Miniopterus orianae #	Northern Bentwing-bat		+							
Myotis macropus #	Southern Myotis									
Notamacropus rufogriseus	Red-necked Wallaby			+		+				
Nyctophilus geoffroyi	Lesser Long-eared Bat									
Nyctophilus sp.	Long-eared Bat		+	+	+		+		+	+
Oryctolagus cuniculus	European Rabbit									
Ozimops ridei	Eastern Free-tailed Bat				+		+			
Perameles nasuta	Long-nosed Bandicoot	+								
Petaurus breviceps	Sugar Glider	+		+			+			+
Rhinolophus megaphyllus	Eastern Horseshoe Bat	+	+	+	+			+		+

Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Saccolaimus flaviventris #	Yellow-bellied Sheathtail-bat									
Scotorepens orion / Scoteanax rueppellii	Broad-nosed Bat sp.									
Trichosurus vulpecula	Common Brushtail Possum	+		+	+		+		+	+
Unidentified	Microbat sp.									
Vespadelus pumilis	Eastern Forest Bat		+	+	+					
Vespadelus regulus	Southern Forest Bat	+				+				
Vespadelus troughtonii	Eastern Cave bat							+	+	
Vespadelus vulturnus	Little Forest Bat	+			+	+	+	+	+	
Wallabia bicolor	Swamp Wallaby									
	Sub-total	**7**	**7**	**7**	**9**	**4**	**6**	**4**	**5**	**5**
Amphibia										
Crinia signifera	Common Eastern Froglet									
Pseudophryne coriacea	Red-Backed Toadlet								+	
Litoria latopalmata	Broad-palmed Frog									
Litoria peronii	Peron's Tree Frog									
	Sub-total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
	Total birds	**11**	**13**	**9**	**10**	**11**	**13**	**11**	**12**	**14**
	Total mammals	**7**	**7**	**7**	**9**	**4**	**6**	**4**	**5**	**5**
	Total amphibians	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
	Total species	**18**	**20**	**16**	**19**	**15**	**19**	**15**	**18**	**19**

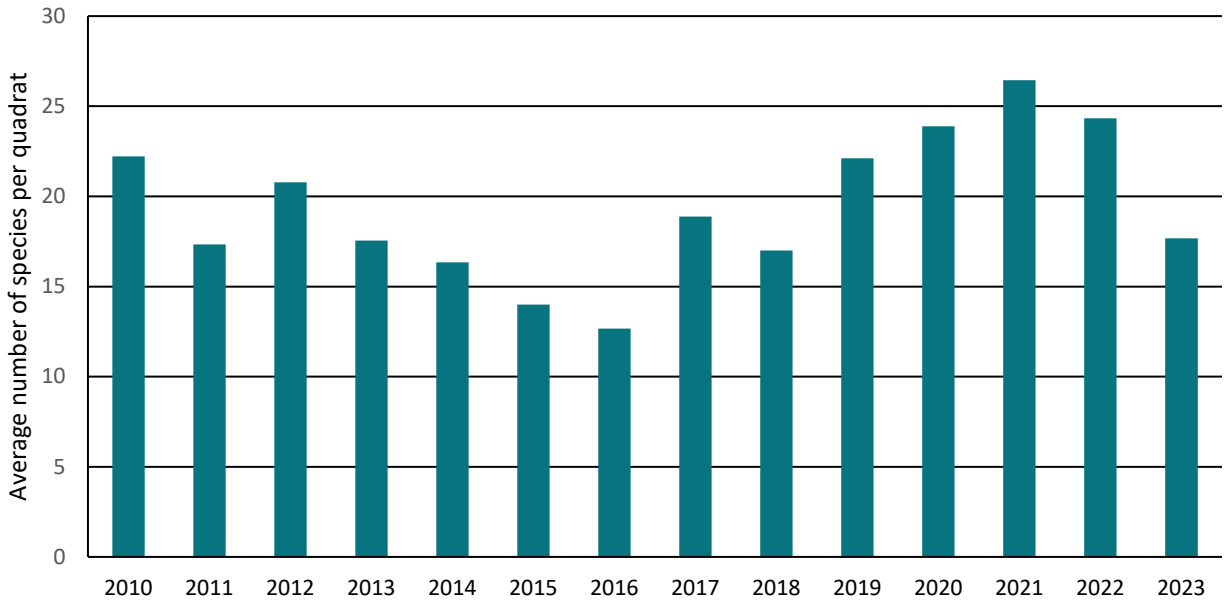


Figure 2: **Average species diversity across all quadrats during winter surveys from 2010 to 2023 at Donaldson Coal**

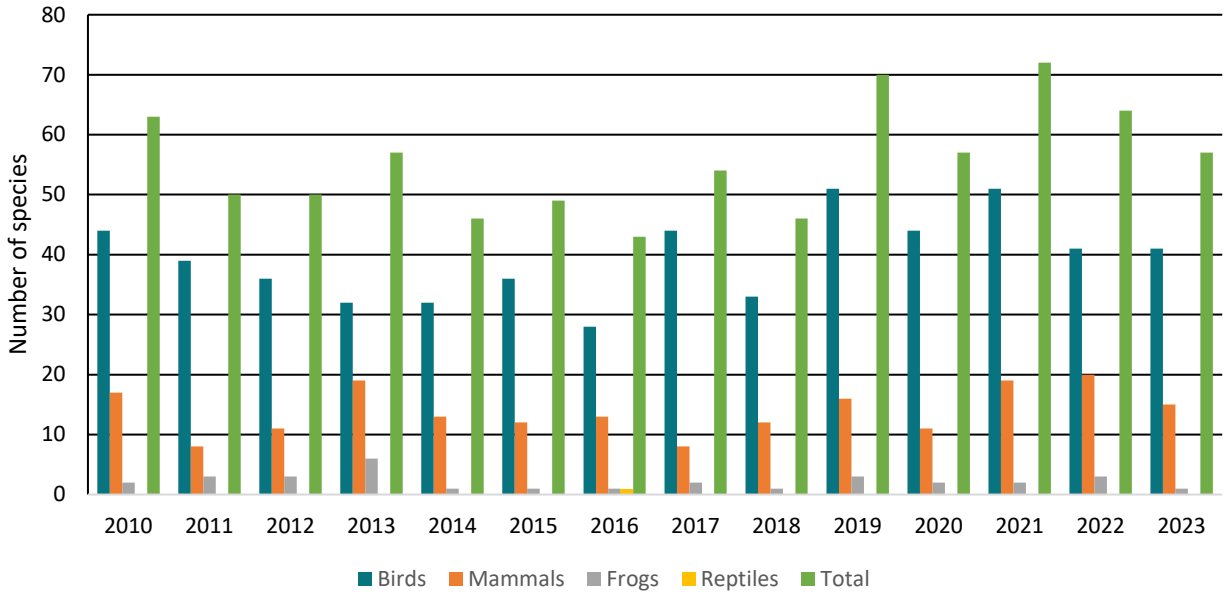


Figure 3: **Species diversity detected across all quadrats during winter surveys from 2010 to 2023 at Donaldson Coal mine.**

3.2 NEST BOXES

Figure 4 shows the number of available nest boxes over time since installation in 2005, with variations due to some boxes falling into disrepair over time and replacement with new boxes. More recently installed nest boxes are constructed of plastic and are expected to last longer than those constructed of plywood.

Nest box utilization increased over the last 12 months, from the Winter 2022 surveys (66.7%) to the current survey in Winter 2023 (68.3%) (**Figure 5**). Nest box availability has increased since the previous year as damaged and weathered boxes have been replaced/repaired. The utilisation of nest boxes has increased in the previous two years when compared to data collected prior. With large numbers of boxes being reinstalled in 2015 and 2018 it was expected that these boxes would increase in utilization in 2023. Previous survey results show that the highest utilisation rates occurred after five years from installation. Three nest boxes were discovered to contain Sugar Gliders (*Petaurus breviceps*) (**Appendix A**).

Physical evidence of fauna use was detected in 62.2% of all nest boxes in the winter 2023 surveys in which four boxes were not useable due to deterioration of materials. (**Figure 5**). Evidence of fauna use primarily consists of nests constructed from Eucalypt leaves (indicative of gliders). Overall, the utilisation of nest boxes has previously, and continues to, show high evidence of use within the study area.

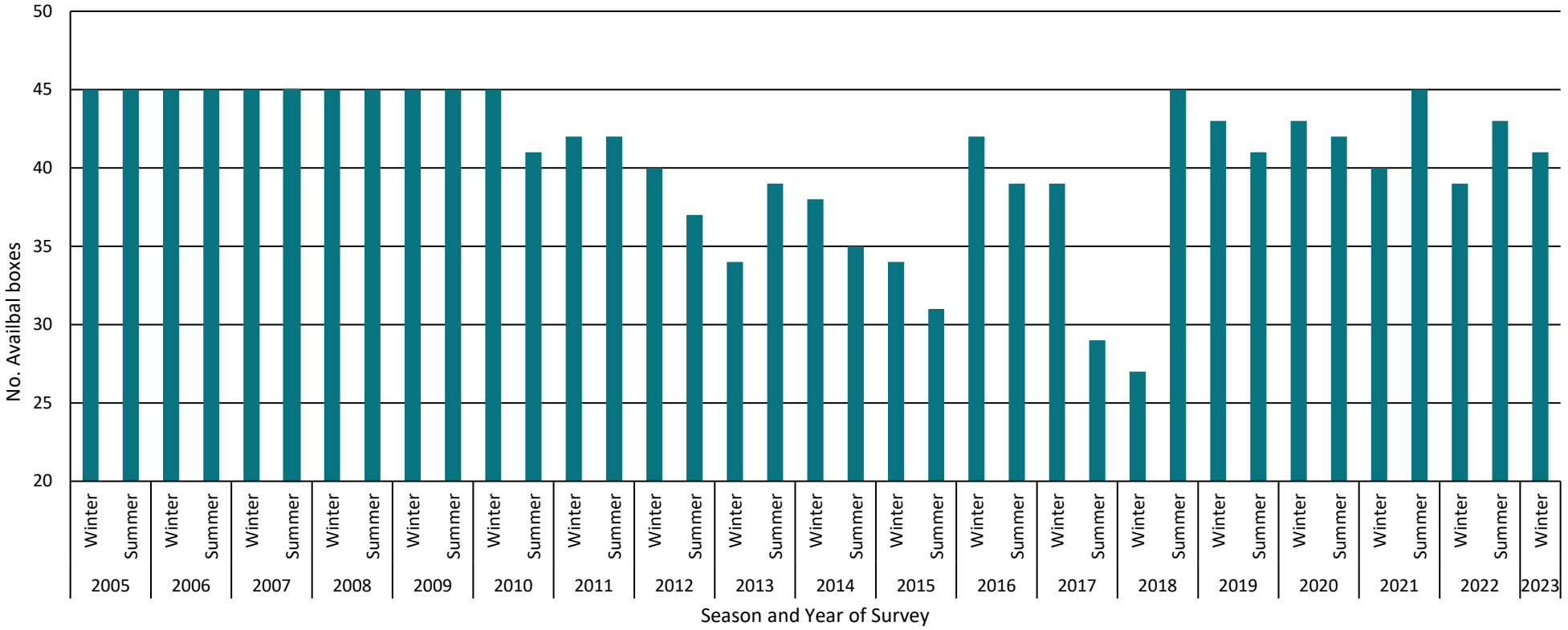


Figure 4: Available nest boxes 2005 – 2023

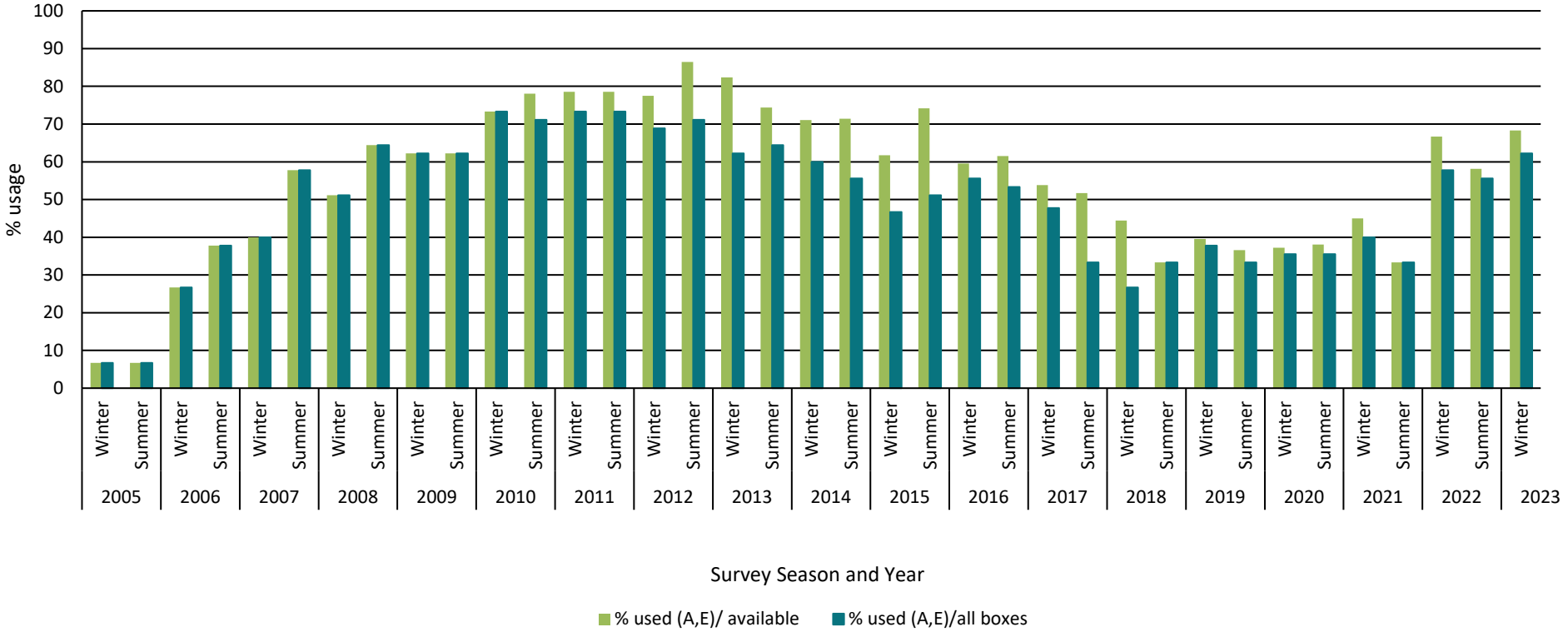


Figure 5: Nest Box utilisation 2005-2023 (Winter)

4. DISCUSSION

4.1 FAUNA

Species diversity has decreased compared to previous years. The total number of detected species has decreased from 64 species in winter 2022, to 57 species detected in winter 2023; although this trend has not impacted the long-term species average of the site. The long-term species average across all quadrats (2010 to 2022) is 55 (**Figure 3**).

In previous years there has been a progressive decline in the average species diversity detected across all quadrats from 2010 to 2016, dropping to 13 species per quadrat. In recent years (2017-2021) the average species diversity has improved, peaking to 26 species per quadrat in 2021, although these improvements have not been sustained. An average of 17 species per quadrat was recorded for the 2023 winter survey, which has decreased from 26 species in 2021, and 24 species in 2022 (**Figure 2**).

Despite the increased availability of nest boxes and the increased utilisation of nest boxes compared to previous years, it was assumed that species diversity would increase in the area. There has however, been a decline in species diversity. It is possible that normal ecosystem fluctuations and changing weather patterns are cause for this impact as mining operations have ceased.

One threatened bird species was detected in the 2023 winter surveys, Little Lorikeet (*Glossopsitta pusilla*). Three threatened microbat species were also detected, including Little Bentwing-bat (*Miniopterus australis*), Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*) and Northern Bentwing-bat (*Miniopterus orianae*). Lastly, one bat species was also detected, Eastern cave bat (*Vespadelus troughtonii*). All of which are listed as Vulnerable under the Biodiversity Conservation Act 2016 (NSW). The Little Bentwing-bat has been regularly detected during surveys in recent years and was detected across all quadrats (**Figure 3**). Of note, the Little Bentwing-bat typically roosts in caves, tunnels, old mine workings and buildings.

4.2 NEST BOXES

The usage rate of nest boxes (percentage of available nest boxes showing signs of usage) by fauna increased in a linear fashion for the first five years following installation, after which, usage plateaued, followed by a decline. This was generally repeated for nest boxes replaced in 2018 and 2021.This pattern of nest box usage after five years of deployment has been observed in several other nest box monitoring programs in native forest (Lindenmayer et al. 2009). For the first few years after installation, reasonable levels of nest box use were recorded. These findings led to the suggestion of an ‘effective occupancy time’ of approximately five years for arboreal mammals. That is, the materials used in wooden nest box designs have a lifespan of only 8 – 10 years before they reach a point of decay where arboreal fauna no longer use them. It is expected that the new design nest boxes installed will have a much longer effective occupancy time with improved materials of construction.

Four nest boxes were unavailable due to ongoing deterioration that will either need replacement or reparation by the end of the year. Ongoing maintenance (fixing broken lids and hinges and removal of undesirable species such as termites and wasps) and replacement of broken boxes is required to ensure the ongoing success of the nest box program within the Donaldson BCA.

5. RECOMENDATIONS

The following recommendations are considered necessary to maintain biodiversity values within the BCA. Monitoring should continue so that trends evident in the first 20 years may be better understood and to demonstrate the fauna are still utilising the natural bushland surrounding the Donaldson Coal bushland. Nest boxes should continue to be monitored biannually to demonstrate usage. While nest boxes are being utilised, they provide a convenient means identifying fauna occupying the area. Repairs and nest box replacements should be made as required to facilitate fauna utilisation of the area. Four nest boxes were observed to require replacement. Ongoing maintenance of nest boxes is always an issue – Donaldson Coal may want to investigate the use of hollow creation to permanently replace nest boxes.

The monitoring program indicates that the Donaldson Coal operations are causing minimal impact to biodiversity within the BCA. However, further monitoring will be required to assess accumulative impacts on biodiversity caused by other direct impacts and indirect pressures. This will elucidate the effects of confounding factors such as the impacts of development at the eastern edge of the BCA from 2012 and determine the influence of climate change and seasonal variation. Future years of monitoring should continue to analyse the diversity of specialist and generalist species separately and should focus on abundance trends of sensitive flora and fauna species, including threatened species.

6. REFERENCES

Barker Harle 2001, Donaldson open-cut coal mine Beresfield, Quadrat monitoring program baseline report,September-October 2001, Barker Harle Pty Limited Report to Donaldson Coal.

Churchill S, 2008. Australian Bats, second edition, Allen & Unwin, Sydney.

EcoBiological 2002, Donaldson Open-cut Coal Mine Beresfield, Flora and Fauna Management Plan, Revision March 2007, EcoBiological Survey & Assessment, Gateshead, NSW.

EcoBiological 2004, Donaldson Open-cut Coal Mine Beresfield, Annual Flora and Fauna Monitoring, EcoBiological Survey & Assessment, Gateshead, NSW.

EcoBiological 2007, Donaldson Open-cut Coal Mine Beresfield, Flora and Fauna Management Plan, Revision March 2007, EcoBiological Survey & Assessment, Gateshead, NSW.

Lindenmayer DB, Welsh A, Donnelly C, Crane M, Michael D, Macgregor C, McBurney L, Montague-Drake R and Gibbons P, 2009. Are nest boxes a viable alternative source of cavities for hollow-dependent animals? Long-term monitoring of nest box occupancy, pest use and attrition, *Biological Conservation*, 142: 33-42.

Kleinfelder 2022, Annual Winter Fauna Monitoring: Donaldson Open-cut Coal Mine, Beresfield NSW. Report prepared for Yancoal Australia Pty Ltd, November 2022.

Pennay, M., Law, B., and Reinhold, L., 2004. Bat calls of New South Wales, Dept of Environment and Conservation (NSW)

APPENDIX A: PHOTOS - FAUNA

Plate 1: Sugar Glider x 3

Plate 2: Evidence of use, likely Antechinus

Plate 3: **Sugar glider in glider bowl**

Plate 4: **Woodchip disturbance, likely Brushtail possum**

APPENDIX B: WEATHER CONDITIONS AND SURVEY EFFORT

Table 3: Sample effort and weather conditions during the survey period

Date	Time	No. Observers	Temp ° C	RH %	Rain (mm)	Cloud (x/8)	Wind Speed (Km/h)	Wind Direction	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
July 10	15:00	2	18.9	43	0	-	20	WNW	+	+							
July 11	9:00	2	9.7	77	0	-	17	WNW	+	+		+					+
July 11	15:00	2	17.8	42	0	-	9	WNW			+	+	+	+	+	+	+
July 12	9:00	2	7.1	89	0	-	11	WNW			+		+	+	+	+	

Weather observations were sourced from the Maitland weather station ID 061

APPENDIX C: STAFF CONTRIBUTIONS AND QUALIFICATIONS

The following staff were involved in the compilation of this report.

Name	Qualification	Title/Experience	Contribution
Rachel Neal	BBSc (hons)	Ecologist	Report Writing
Nigel Fisher	BSc (Hons) PhD	Senior Ecologist	Flora Surveys, Report Review, Project Management
David Martin	MSc	Senior Ecologist (Botanist)	Flora surveys
Isaac Blundell		Ecologist	Fauna Surveys
Mark Dean	BEnvSc & Mgt	Senior Ecologist (Zoology)	Fauna surveys, Report Writing

Appendix 5

Annual Survey of the *Tetratheca Juncea* Conservation Area 2022

prepared by

Wedgetail Project Consulting Pty Ltd

(Total No. of pages including blank pages = 23)

Annual Survey of the *Tetratheca juncea* Conservation Area 2022

Yancoal Donaldson Open-Cut

Rev 3
Monday, 6 March 2023

Annual Survey of the Tetratheca juncea Conservation *Area 2022*

Yancoal Donaldson Open-Cut

REPORT PREPARED FOR:

Yancoal Australia Pty Ltd

REPORT PREPARED BY:

WEDGETAIL PROJECT CONSULTING PTY LTD
PO Box 234
Cardiff, NSW 2285

ABN: 93 640 388 683

File Ref: DonaldsonTjReport2022_Final

Version Control

Rev. No.	Revision Date	Author / Position	Reviewer	Details
Rev 1	28 Feb 2023	Colin Driscoll Ecologist	David Martin Senior Ecologist	Draft
Rev 2	3 Mar 2023	Colin Driscoll Ecologist	Nigel Fisher Senior Ecologist	Draft for client comment
Rev 3	6 Mar 2023	Colin Driscoll Ecologist	Nigel Fisher Senior Ecologist	Final

Contents

Figures

Tables

Appendices

1. INTRODUCTION

1.1 BACKGROUND INFORMATION

The Yancoal Donaldson Open-Cut coal mine is located near Beresfield in the Lower Hunter region, just west of Newcastle New South Wales (NSW) and operated from 2001 to 2013 when the resource was exhausted. During the initial flora and fauna investigations for the project, a substantial population of the threatened plant *Tetratheca juncea* was found to be present in about 6 hectares (ha) of land at the western edge of the lease. As part of meeting the Conditions of Consent for mining, a conservation area was established to preserve these plants in a reserve. This area is known as the *Tetratheca juncea* Conservation Area (TjCA) and the management guidelines are documented in the *Tetratheca juncea* Management Plan (TjMP) (Donaldson Coal, 2019). **Figure 1** shows the TjCA in the context of the overall mine and **Figure 2** shows the TjCA in detail.

The TjMP details management and monitoring of the TjCA in relation to mining/post-mining operations, conservation area preservation and protection as well as biological and ecological data collection.

The TjCA has been monitored annually since the baseline report by Barker Harle (2003).

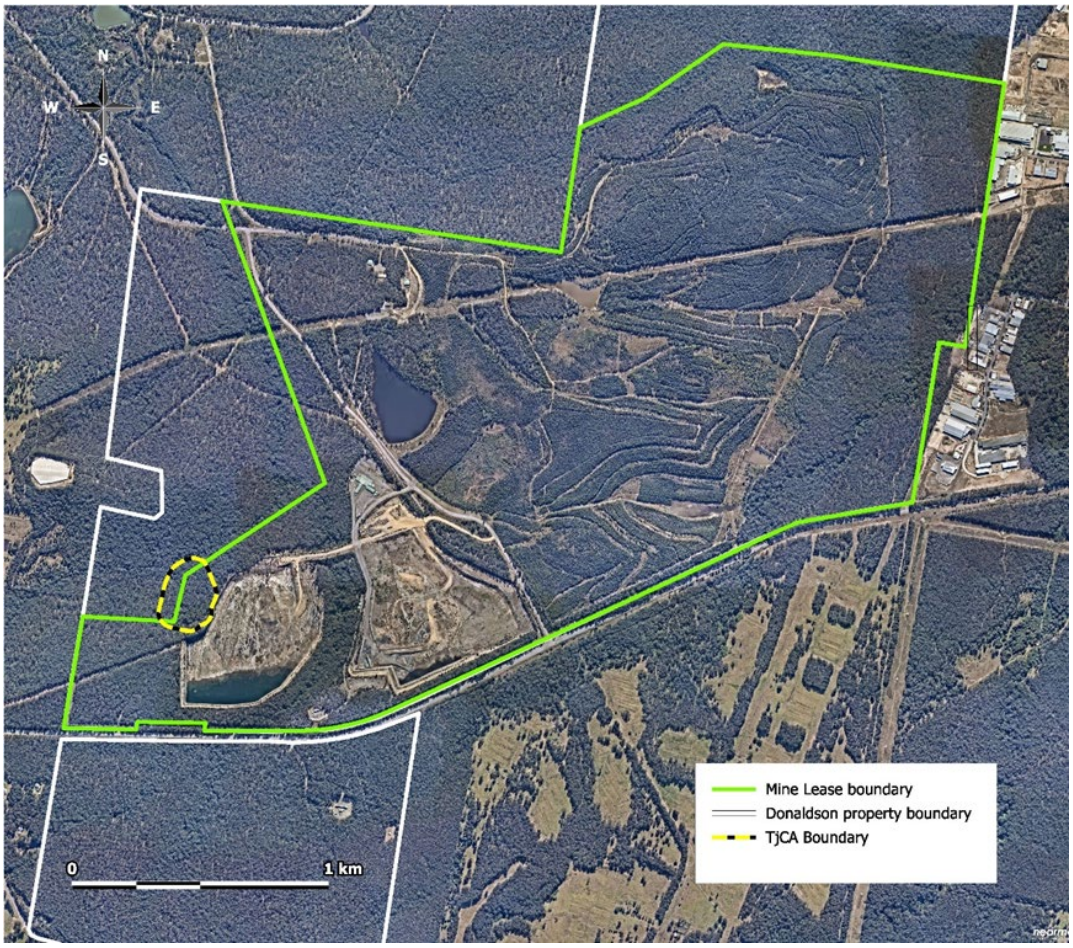


Figure 1: The *Tetratheca juncea* Conservation Area (TjCA) in the context of the overall mine (Image Near map December 2022).

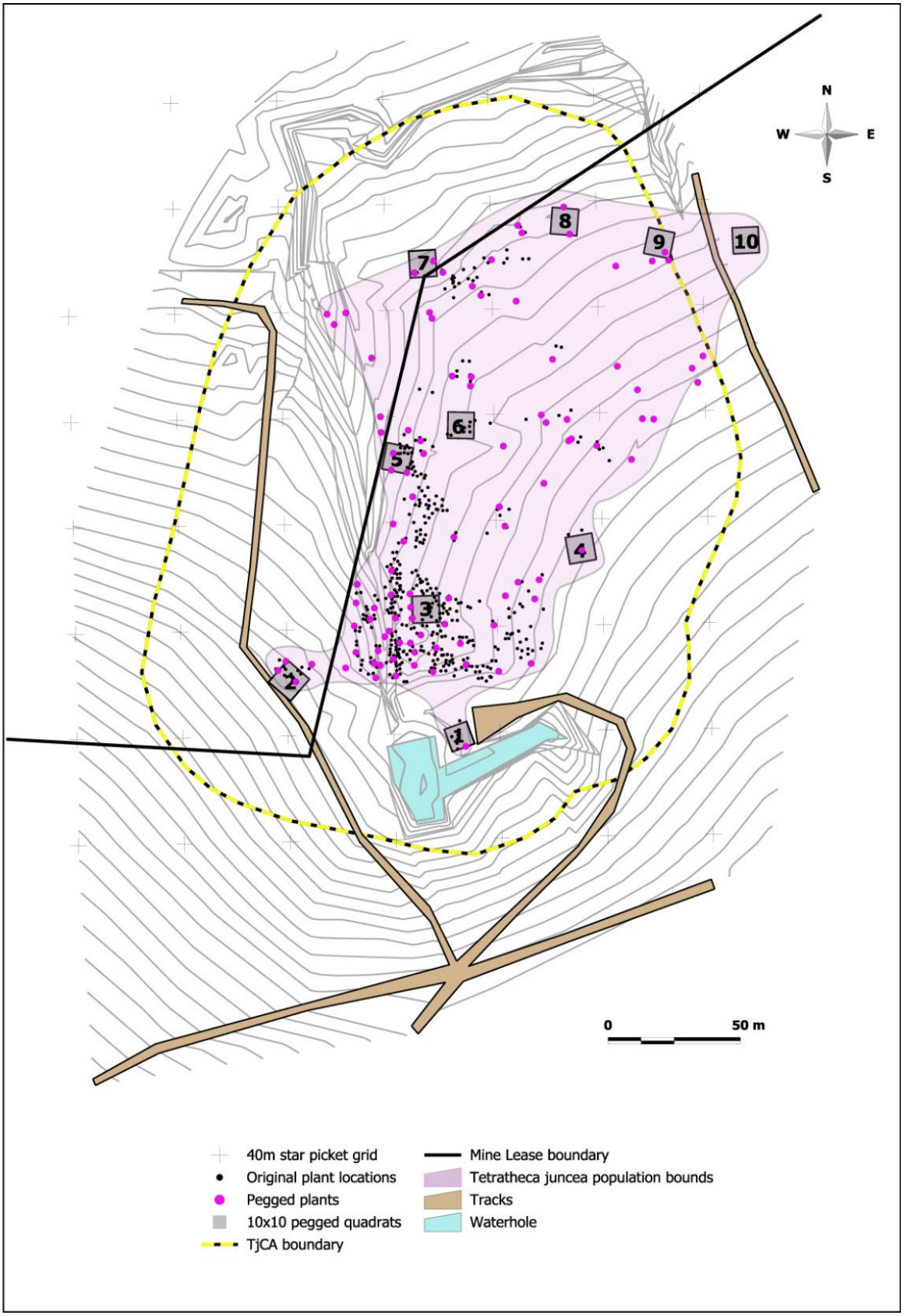


Figure 2: The *Tetratheca juncea* Conservation Area (TjCA) detail.

1.2 SCOPE

Tetratheca juncea Smith (Elaeocarpaceae, formerly Tremandraceae, Crayn et al. 2006) is a terrestrial herbaceous plant listed under both the NSW Biodiversity Conservation Act 2016 and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 as Vulnerable and has a ROTAP coding of 3Vca (Briggs and Leigh 1995). It is endemic to NSW with a coastal distribution from the Gosford/Wyong area in the south to Bulahdelah in the north (Gardner & Murray 1992, Payne 2000). The plant grows in disjunct populations throughout its range and there is no consensus about its growing requirements or preferred habitat. It can be found growing on Narrabeen sandstone-derived soil in open woodland amongst a low shrub understorey with grassy ground cover on Nerong Volcanics derived soil or in coastal sand woodland and heath. Putting aside the limited geographical range of the plant and limited representation in reserves, the species rarity is probably, in part, due to the fact that the plant is virtually leafless and, outside of the flowering season, is very difficult to locate amongst the grasses with which it grows. The flowering period for *Tetratheca juncea* is generally reported as being from mid to late winter through to late summer (Gardner & Murray 1992). Driscoll (2013) confirmed that budding commenced shortly after the winter equinox with flowering peaking in September/October.

The flowers of *Tetratheca juncea* grow from nodes on the leafless stem and are generally solitary but occasionally in pairs with each flower facing downward, suspended on a peduncle approximately 10 millimetres (mm) in length (**Figure 3**).

Commonly there are four petals (can be 5 – 8) ranging in colour from mauve through pink to (rarely) white. There are eight dark mauve poricidal anthers attached by short stout filaments in four pairs surrounding the carpel with the stigma protruding beyond their length. The flowers of *Tetratheca juncea*, in common with other members of the *Tetratheca* genus produce no nectar that could serve as a pollinator attractor, and it would appear that pollen is the sole reward available to an insect such as a bee.

Figure 3: ***Tetratheca juncea*** **flowers showing the grass-like stems**

The reproduction and propagation strategies of *Tetratheca juncea* are seed production and vegetative spread with stems sprouting from underground rhizomes. The species grows in a variety of forms, from single stems through multi-stemmed discrete clumps, to spreading patches covering several square metres. It has been assumed that clonal spread is a significant form of propagation for the species. However, recent genetic research (Jones 2011) has revealed that, even in a closely spaced population, the level of clonality was very low.

The growth form of the species makes counting individual 'plants' difficult and a standard method has been adopted that defines a clump as being a group of stems separated by >30 cm from the next group (Payne et al. 2002). Jones (2011) showed that genetically different individuals were growing <30 cm apart.

1.3 TJCA POPULATION SIZE

The TjCA occupies an area of 6.0 ha and the population of *Tetratheca juncea* lies in about 2.2 ha of that area. In 2003, a population density estimate was carried out (Barker Harle 2003) and **Table 1** shows the results. The population was divided into individually identifiable plant clumps and clonal patches where individual clumps could not be distinguished.

Table 1: TjCA Population Size Estimate

Category	Estimate
Clumps	476
Patches	112
Average patch size	4.3 m2
Combined patch area	453 m2

m2 = square metres

This method deviated from the method of Payne et al. (2002) by the inclusion of patch size. Driscoll & Bell (2008) developed a regression relationship between patch size and the number of clumps in a patch and while the authors note that the results are not necessarily transferable to other areas, this can be used as an indicator of the total clumps in the Donaldson TjCA. Using the regression, a patch of 4.3 m^2 would contain 6 clumps which would extrapolate to the equivalent of 672 clumps in patches with the total population being 1,171 clumps.

1.4 MONITORING

Monitoring has been conducted on 100 permanently pegged clumps which represent approximately 10% of the total population. On each annual monitoring occasion **(Table 2),** the 100 pegged clumps in the TjCA were inspected with the number of flowers and seed capsules being recorded for each plant clump along with the number of surviving clumps. The sum of flowers and seed capsules gives total flowers produced by the plant and total seed capsules divided by total flowers gives a rate of conversion that indicates pollinator activity. This index is commonly referred to as the fruit-flower ratio (FFR). As used here, FFR is primarily an index of pollinator activity up to the point at which data are collected. A true FFR would be determined by counting total flowers and total fruit produced across the entire flowering season.

Table 2: Dates of Annual Monitoring

Year	Survey	Year	Survey
2005	22/12/2005	*2014*	5/12/2014
2006	4/12/2006	*2015*	9/12/2015
2007	19/12/2007	*2016*	12/12/2016
2008	24/12/2018	*2017*	18/12/2017
2009	9/12/2009	*2018*	7/12/2018
2010	21/12/2010	*2019*	10/12/2019
2011	15/12/2011	*2020*	22/10/2020
2012	15/12/2012	*2021*	3/12/2021
2013	9/12/2013	*2022*	9/12/2022

2. RESULTS AND DISCUSSION

2.1 POLLINATOR ACTIVITY

The *Tetratheca juncea* flower has no nectar and is a pollen source only for native bees to use as food for their developing young. The consequence of this is that flower fertilisation and subsequent seed capsule development is likely to be pollinator limited. This means that the quantity of seed produced is entirely dependent on the number of available pollinators. The species has in fact been shown to be pollinator limited (Gross et al. 2003). Combined with the fact that the flowers do not self-pollinate (even though the pollination system is self-compatible) the number of seed capsules produced on plants can be used as a direct indicator of pollinator activity (Driscoll 2003; Driscoll 2013).

These data have been collected since 2005 so there are now 18 years over which trends can be observed.

Figure 4 shows a plot of mean fruit per clump versus monitoring year which is characterised by high variance and wide error bars. While the trendline shows a slight increase in fruit per clump over time this is not significant ($r^2 = 0.0023$, $F_{1,17} = 0.04$, $p = 0.850$).

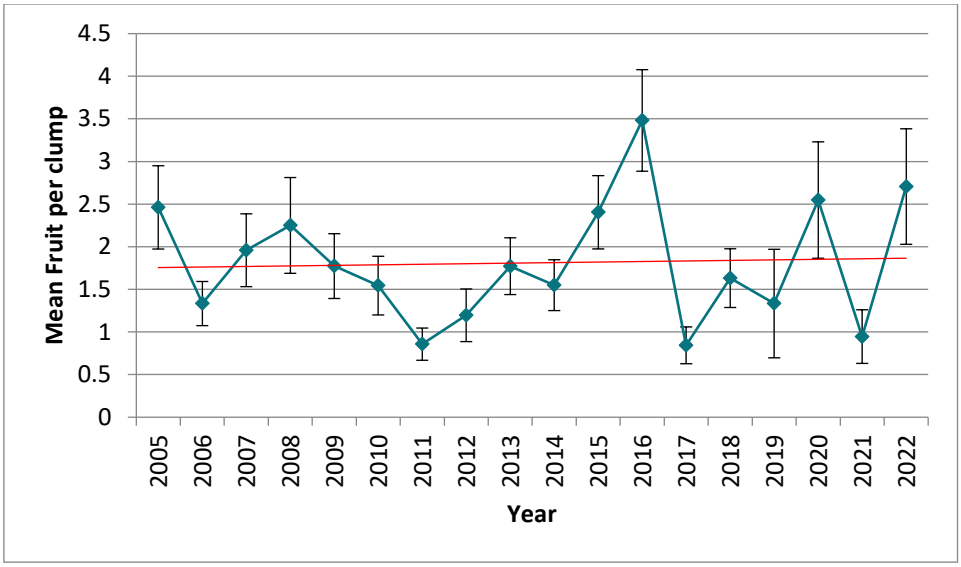


Figure 4: **Mean fruit per clump from 2005 to 2022 (bars are ± 1 s.e.).**

Figure 5 shows a plot of mean total flowers per clump over time indicating an overall increase to 2013 followed by a steady decline. A linear regression was significant ($r^2 = 0.17$, $F_{1,17} = 3.37$, $p = 0.085$).

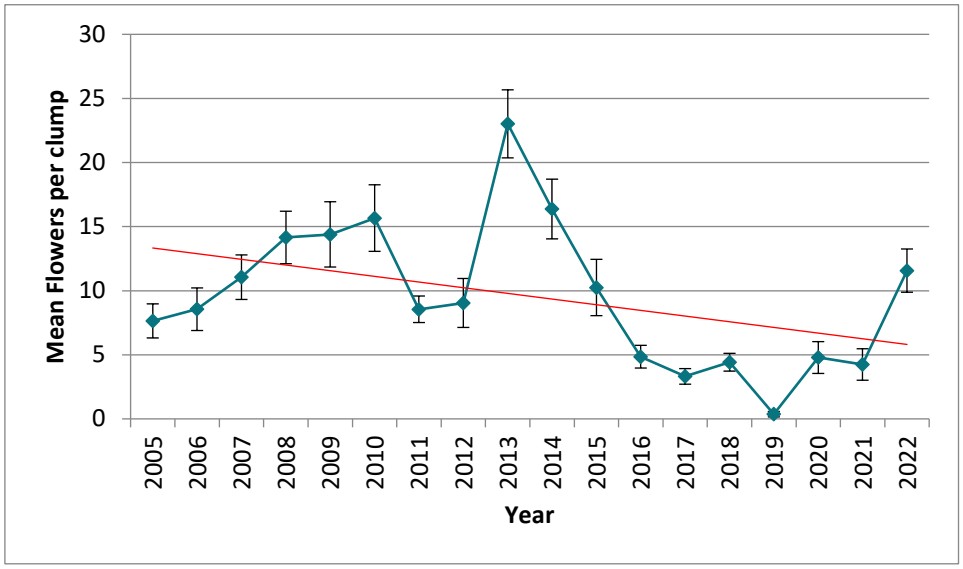


Figure 5: **Mean total flowers per clump from 2005 to 2022 (bars are ± 1 s.e.).**

Figure 6 shows the pattern of FFR values over the 18 years. While the trendline suggests an increase in FFR over time this is not significant ($r^2 = 0.057$ $F_{1,17} = 0.96$, $p = 0.342$). The shape of this plot is difficult to explain other than to say that there are a number of potential factors influencing pollinator activity, particularly total available pollinators, and pollen availability from all floral sources across the *Tetratheca juncea* population. Furthermore, as demonstrated in Driscoll (2013) FFR calculated in this manner is an indicative value rather than a true value.

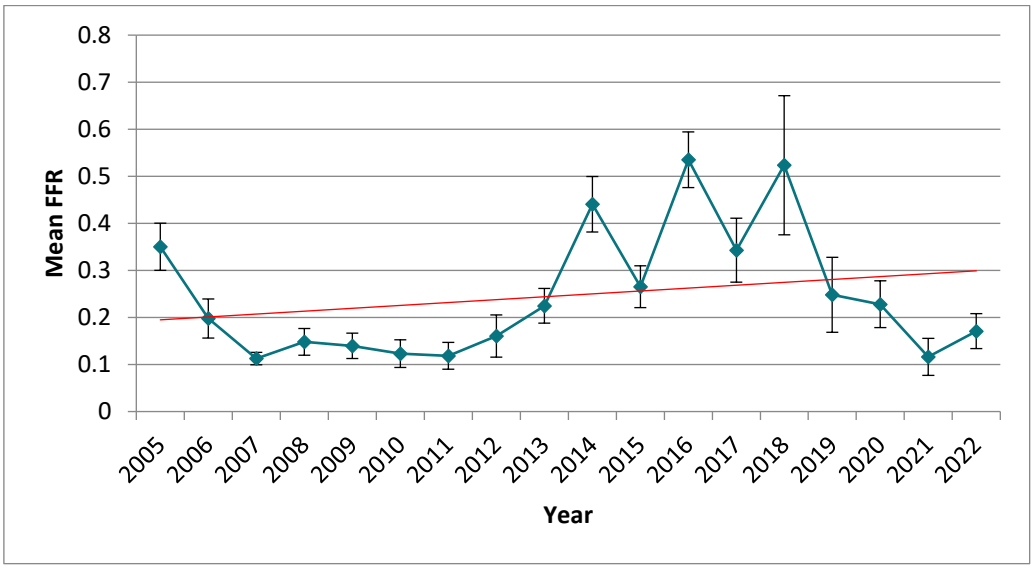


Figure 6: **Mean fruit-flower ratio (FFR) 2005 – 2022 (bars are ± 1 s.e.).**

Figure 7 shows a plot of mean flowers per clump against mean fruit per clump where it would be expected that if there were no shortage of pollinators, this would show an increased number of fruits with increased flower numbers. However, this was not the case (r^2 = 0.006, $F_{1,17}$ = 0.10, p = 0.757). This suggests that there are limited pollinator numbers and that numbers vary from year to year, for unexplained reasons.

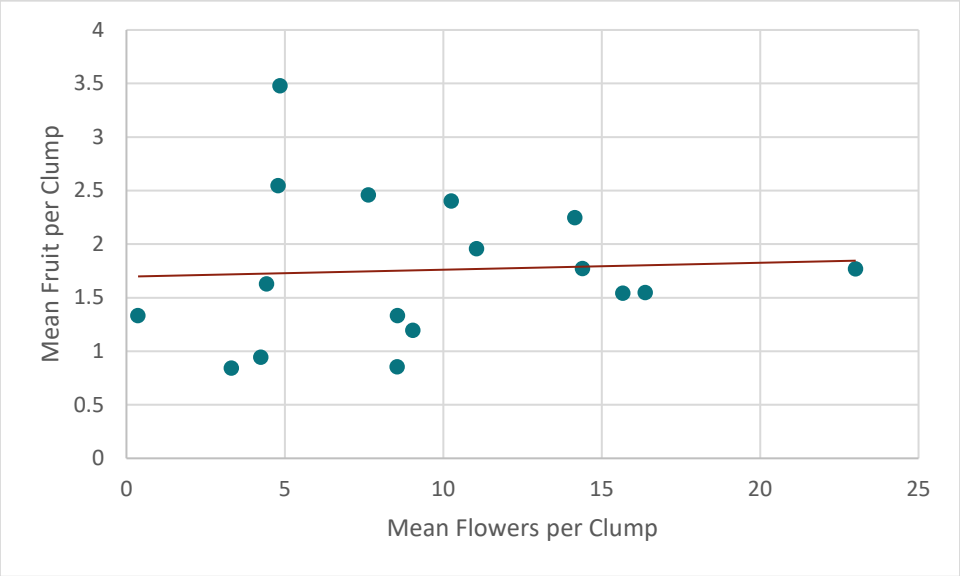


Figure 7: **Mean fruit per clump versus mean flowers per clump**

2.2 POPULATION DYNAMICS

Each year the number of the 100 pegged clumps missing has been recorded and the summary results from 2004 to 2022 are shown in **Figure 8**. The trendline is significant (r^2 = 0.87, $F_{1,18}$ = 117, p < 0.001).

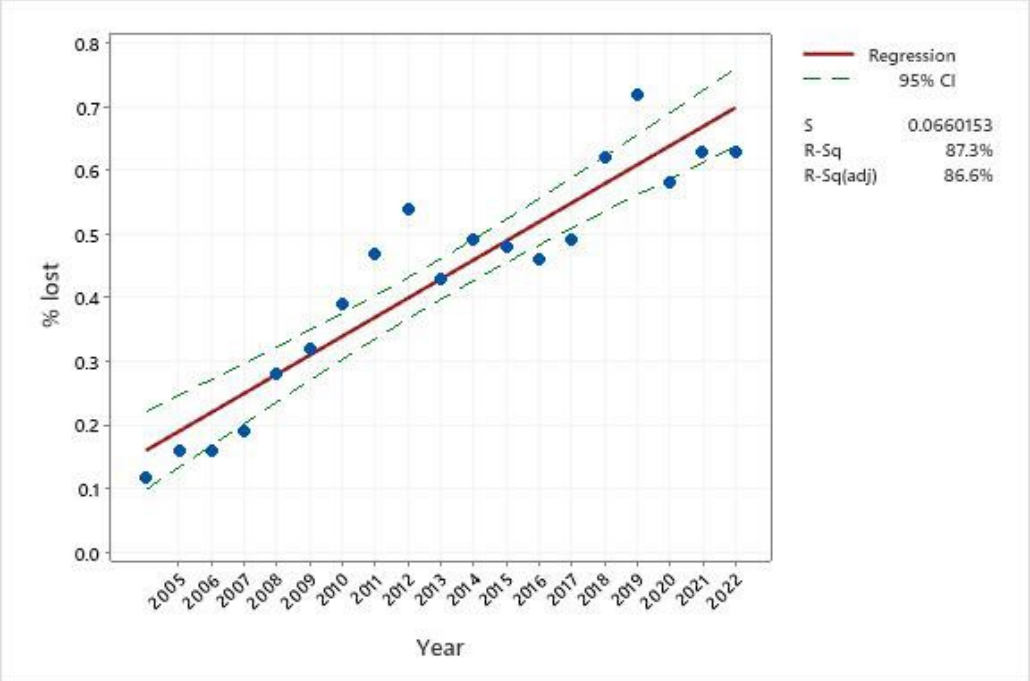


Figure 8: **Percentage of the 100 clumps missing in each year.**

Appendix A provides a graphical summary of the presence/absence of clumps over time.

Figure 9 shows a summary plot of the number of years that individual clumps have been recorded with 32% of clumps surviving 15 years or more. Only two clumps have been present for all 19 years.

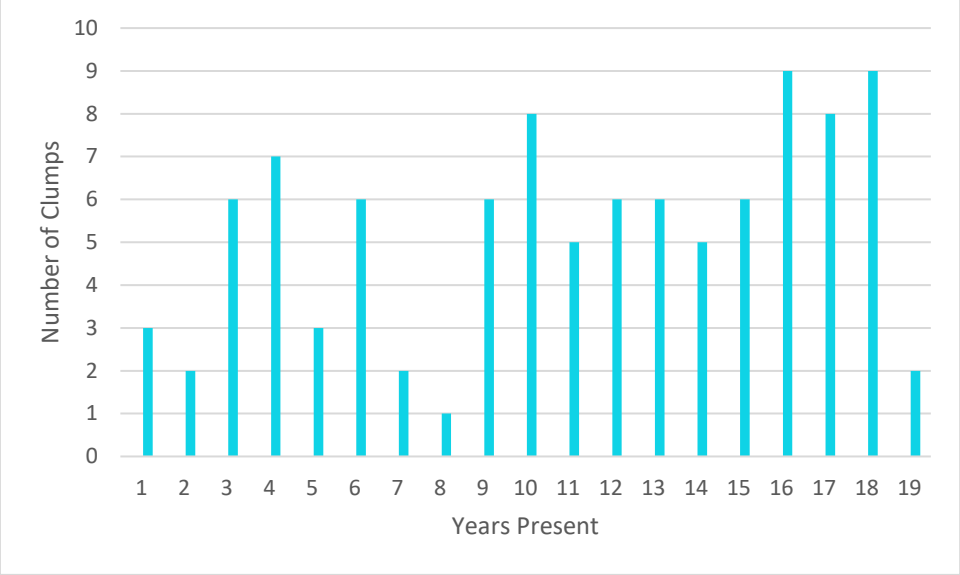


Figure 9: Clump survival times.

Kleinfelder (2012) suggested a probable cause for the continuing reduction in the population was a measured increase in the density of ground species out-competing *Tetratheca juncea* (**Figure 10**).

***Xanthorrhoea latifolia* and grasses**

***Banksia spinulosa* and grasses**

Rytidospermum pallidaum tussock grass | *Banksia spinulosa* and *Mirbelia rubifolia*

Figure 10: Examples of dense ground cover at location of lost clump (vertical arrows indicate the location of the original *Tetratheca juncea* clump).

3. DISCUSSION AND RECOMMENDATIONS

The monitoring data has shown a declining population since the start of monitoring up to 2014, with a small recovery followed by a continued decline. Evidence points to *Tetratheca juncea* being outcompeted by other ground species. Overall, this report builds on previous reports in demonstrating that the TjCA population would benefit from a fire. This would both reduce the current level of competition and provide more nesting areas for tunnelling native bee pollinators.

There has been one published study by Norton (1994) and one unpublished study (Driscoll) looking at the response of *Tetratheca juncea* to fire. Both studies showed that plant clumps resprout following fire. Norton (1994) noted that fire temperature and duration of heating experienced by plant clumps had an effect on their ability to resprout. High temperatures are likely to burn deep into the rootstock which results in the plants being killed. Driscoll (unpub.) observed that even if the main rootstock was killed, the plant could resprout from secondary roots away from the original location. Bartier et al. (2001) studied germination of *Tetratheca juncea* seed and found that application of smoke water resulted in a significant increase in germination rate.

As has been recommended since the 2007 annual report, it is again recommended that the TjCA be burned at an appropriate time. An appropriate time would be no later than April in order to take advantage of viable seed and to allow for re-sprouting during warm weather.

However, despite the lack of burning this long-term monitoring program is providing invaluable data about the dynamics of a *Tetratheca juncea* population. There is a core of clumps that have survived overall, for the majority of, the monitoring period and these give a sense of permanency to the population.

A broad scale analysis has previously found that neither temperature nor rainfall influence the number of flowers per clump. However, it is possible that these factors do have an effect that is lost due to the regional weather data used. Had these data been collected from the population site itself there might have been a different result.

Large areas of eastern Australia were experiencing severe drought through 2018/2019. It is expected that this would have negatively impacted the Donaldson *Tetratheca juncea* population through reduced flowering and loss of monitored clumps that were not in a strong condition prior to the onset of the drought. Drought-breaking rainfall in 2020 appeared to have resulted in recovery of 14 clumps since 2019. However, even after exceptional rainfall the 2021 records show a declining population with low flowering. The 2022 results show flowering has increased, again likely due to increased rainfall associated with a persistent La Nina.

Again, it has become apparent that clump flagging has deteriorated to the point where there is some ambiguity about clump identification. If this monitoring is to be continued it is recommended that a surveyor be engaged to locate the original clump coordinates and clump flagging renewed.

4. COMPLIANCE WITH THE MONITORING REQUIREMENTS OF THE TETRATHECA JUNCEA MANAGEMENT PLAN

The TjCMP provides an outline of the changes in the TjCA that should be monitored, and Table 3.1 summarises the compliance with the TjCMP since the commencement of monitoring.

Table 3: Compliance with the TjCMP

Item	Compliance	Comment About Non-compliance
Demographic monitoring	Yes	-
Fire response monitoring	No	Ecological burns were recommended in the TjCMP. At that time there was no research that supports the idea that *Tetratheca juncea* requires fire for the long-term viability of the population. In consultation with the Donaldson Project Environmental Officer (PEO) it was determined that until further information was available, burns would not be conducted. Further information is now available and burning is **recommended**.
Changes in native competitors	Yes	-
6-monthly reporting	No	In consultation with the Donaldson PEO, it was determined that annual reporting only would be required with periodic inspections and any significant incidents immediately reported.
Annual surveys conducted during flowering period	Yes	This report.

5. REFERENCES

Barker Harle (2003) Donaldson Open-cut Coalmine: *Tetratheca juncea* Conservation Area first annual report 2001-2003. A report prepared for Donaldson Coal.

Bartier, F.V., Gross, C.L., Mulligan, D.R., Bellairs, S.M. and Bowen, D. (2001) Understanding the Biology and Ecology of Vulnerable Plant Species – A Case Study With *Tetratheca juncea* Occurring Over Coal Leases, ACARP Project C8012. A report prepared for Australian Coal Research. June 2001.

Briggs, J.D. and J.H. Leigh (1996) Rare or Threatened Australian Plants - Revised Edition. Collingwood: CSIRO Publishing.

Crayn, D.M., Rossetto, M., and Maynard, D.J. (2006) Molecular phylogeny and dating reveals an oligomiocene radiation of dry-adapted shrubs (former Tremandraceae) from rainforest tree progenitors (Elaeocarpaceae) in Australia. American Journal of Botany 93(9): 1328–1342.

Donaldson Coal Ltd, (2019) *Tetratheca juncea* Management Plan. Report prepared by Donaldson Coal.

Driscoll, C. (2003) The pollination ecology of *Tetratheca juncea* Smith: finding the pollinators. Cunninghamia 8(1): 133-140.

Driscoll, C. (2013) The ecology of reproduction in a rare plant - *Tetratheca juncea*. PhD Thesis University of Newcastle. Faculty of Science & Information Technology, School of Environmental and Life Sciences. http://hdl.handle.net/1959.13/937469.

Driscoll, C. and Bell, S. (2008) Survey for *Tetratheca juncea* (Elaeocarpaceae) for the Morisset Structure Plan, Lake Macquarie LGA. A report prepared for Lake Macquarie City Council by Eastcoast Flora Survey.

Gardner, C. and Murray L. (1992) Tremandraceae. In: Flora of New South Wales Vol 3 (ed. G.J. Harden) pp. 74-78. UNSW Press.

Gross, C.L., Bartier, F.V. and Mulligan, D.R. (2003) Floral Structure, Breeding System and Fruit-set in the Threatened Sub-shrub *Tetratheca juncea* Smith (Tremandraceae) Annals of Botany 92: 771-777

Jones, A. (2011) A genetic investigation: multi-locus genotyping of *Tetratheca juncea* using microsatellite markers. University of Newcastle, unpublished honours thesis.

Norton, A.E. (1994) Field observations into *Tetratheca juncea*. Fire regeneration and its attribution within Lake Macquarie. Unpublished report, prepared for BHP Pty Ltd.

Kleinfelder (2012) Gloucester Coal Donaldson Opencut Annual Survey of the *Tetratheca juncea* Conservation Area 2013.

Payne, R.J. (2000). Lake Macquarie *Tetratheca juncea* Conservation Management Plan Final Report November 2000. A report prepared for Lake Macquarie City Council, NSW National Parks and Wildlife Service and BHP Pty Ltd.

Payne, R.J., Stevenson, D., and Wellington, R. (2002) A standardised method for counting Black-eyed Susan populations. Unpublished Report.

APPENDIX A: GRAPHICAL REPRESENTATION OF THE SURVIVAL OF INDIVIDUAL CLUMPS OVER TIME

Green = clump present, Pink = clump absent

Clump	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			

Clump	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			

Clump	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
41																			
42																			
43																			
44																			
45																			
46																			
47																			
48																			
49																			
50																			
51																			
52																			
53																			
54																			
55																			
56																			
57																			
58																			
59																			
60																			
61																			
62																			

Clump	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
63																			
64																			
65																			
66																			
67																			
68																			
69																			
70																			
71																			
72																			
73																			
74																			
75																			
76																			
77																			
78																			
79																			
80																			
81																			
82																			
83																			
84																			

Clump	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
85																			
86																			
87																			
88																			
89																			
90																			
91																			
92																			
93																			
94																			
95																			
96																			
97																			
98																			
99																			
100																			

Appendix 6

2022 Rehabilitation Monitoring and 202 Rehabilitation Monitoring Report

prepared by

Wedgetail Project Consulting Pty Ltd

(Total No. of pages including blank pages = 134)

WEDGETAIL
PROJECT CONSULTING

2022 Rehabilitation Monitoring

Donaldson Open Cut Mine

John Renshaw Drive

Beresfield NSW 2311

Rev 2
10 May 2023

2022 Rehabilitation Monitoring

Donaldson Open Cut Mine

John Renshaw Drive

Beresfield NSW 2311

REPORT PREPARED FOR:

Yancoal Australia Pty Ltd

REPORT PREPARED BY:

WEDGETAIL PROJECT CONSULTING PTY LTD
27 Groves Rd,
Bennets Green, NSW 2290

ABN: 93 640 388 683

File Ref: Donaldson Rehab Ann Mon Rep 2022 V2

Version Control

Rev. No.	Revision Date	Author / Position	Reviewer	Details
Rev 1	9 March 2023	Mark Dean Ecologist	Samara Schulz Principal Advisor	Draft for internal review
Rev 2	10 May 2023	Mark Dean Ecologist	Nigel Fisher Senior Ecologist	Draft for Client Review

Contents

Figures

Tables

Plates

Appendices

1. INTRODUCTION

1.1 BACKGROUND

The Donaldson Coal Open Cut Mine (Donaldson Mine), located in the vicinity of Beresfield in the Lower Hunter Valley of NSW, commenced operations in 2001. The current owner, Yancoal Australia Ltd ceased operation of the open cut mine in 2013 following exhaustion of the resource. The Donaldson Coal mining lease is shown in **Figure 1**.

1.2 SCOPE

Wedgetail has been engaged by Donaldson Coal to undertake annual fauna surveys of the revegetated areas of the Donaldson Coal mining lease. The aim of the survey is to provide information on the habitat requirements of recolonising fauna and to determine the effectiveness of the rehabilitation program in re-establishing pre-mining biodiversity levels. The surveys are carried out as part of the mining Conditions of Consent.

Stage One involved baseline fieldwork and the preparation of a baseline report (ecobiological 2008). A variation to the baseline study was approved by Donaldson Coal, adding an additional three quadrats, and incorporating an additional quadrat to target an area of rehabilitation where no woody debris had been deliberately placed. The locations of quadrats are shown in **Figure 1.**

Through the process of adaptive management, nest box monitoring was introduced in 2011 to target the monitoring of specific species: Brown Antechinus (*Antechinus stuartii*) and Sugar Glider (*Petaurus breviceps*) in relation to rehabilitation age and structure. The implementation of the nest boxes and their monitoring has provided insight into the effectiveness of the rehabilitation program and nest boxes as artificial hollows within rehabilitated sites.

Fauna surveys have been conducted annually from 2008 to 2022 and nest box monitoring annually from 2011 to 2022. This report provides results for the 15th fauna and 12th nest box monitoring surveys conducted for the 2022 report. The data for this report was collected in December 2022.

1.3 DESCRIPTION OF THE PROPOSAL

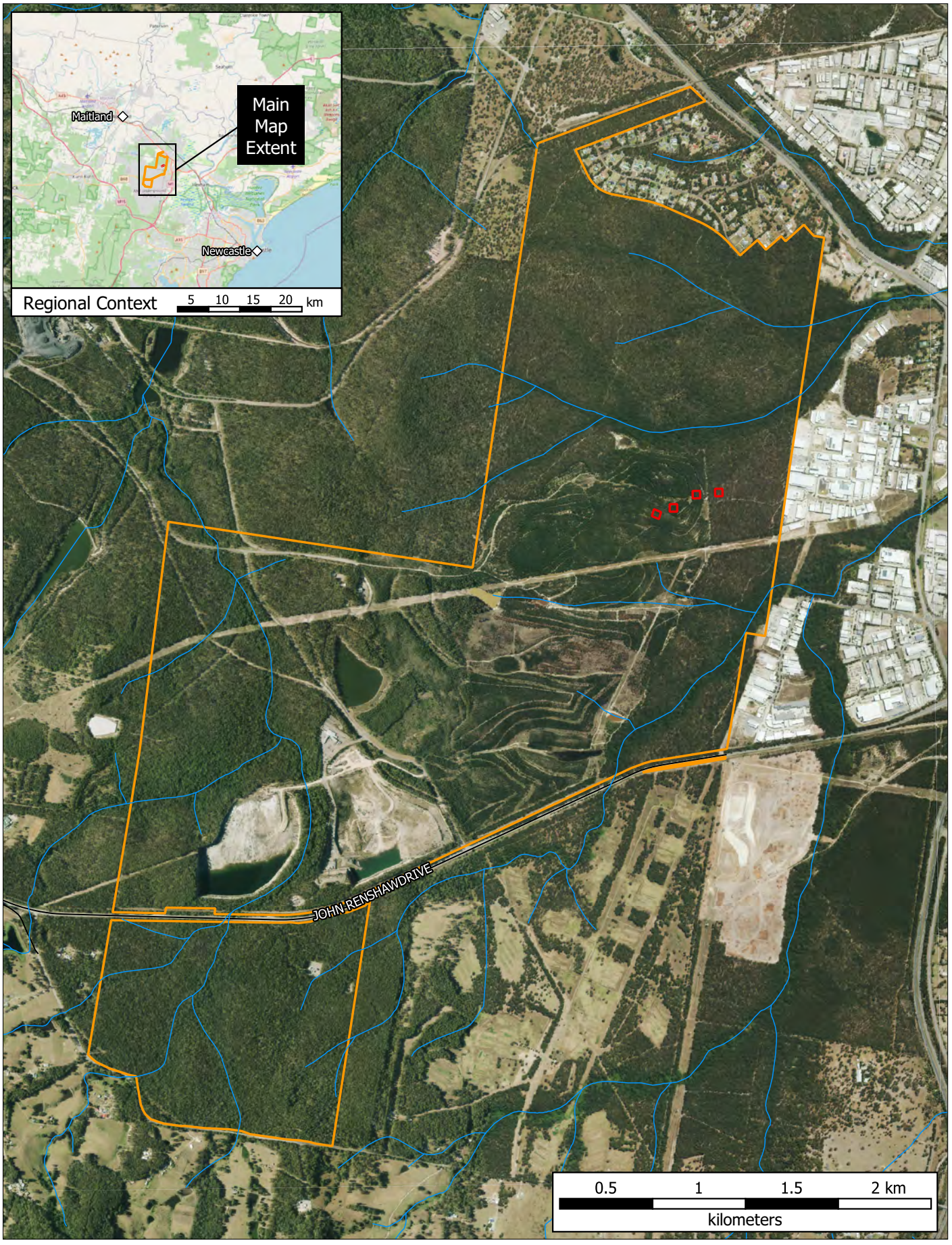
Monitoring of the Donaldson Mine rehabilitation area aims to assess the level of successful re-colonisation by native terrestrial and arboreal species into differing aged sites. A key question being 'Whether the introduction of woody debris and nest boxes has the ability to successfully facilitate fauna re-colonisation and therefore act as a management tool for current and future mine rehabilitation?'.

In an old growth forest, the development of a complex structure including ground cover and natural hollows is perpetual, consisting of tree growth, tree shed (branches and bark), hollow formation, tree death and ground material build up and decay. In areas that have been previously cleared and rehabilitated it takes long periods of time before the vegetation is old enough to start to produce the type of ground habitat and hollow structures required to support small terrestrial and arboreal mammals, reptiles, amphibians, and invertebrates. By designing rehabilitation to include structural elements such as woody debris, rocks and artificial hollows, the time over which a rehabilitated area can be successfully re-colonised by fauna has the potential to be greatly reduced (Ireland et al. 1994;

Carey and Johnson 1995; Loeb 1999; Butts and McComb 2000; MacNally et al. 2001; MacNally 2006; Lada et al. 2007).

Stage One of the program involved preliminary surveys and trapping within the existing rehabilitated areas containing varying quantities of woody debris and in nearby native open forest vegetation as a control. Three 40 x 40 metre (m) quadrats were used to monitor fauna species and their relocation into each of the differing aged sites. Additionally, the results from the two rehabilitated sites and the mature open forest area were compared to determine if there was a significant difference in species richness between areas containing varying quantities of woody debris.

The addition of a fourth quadrat in December 2008 was intended to enable comparison between the natural forested quadrat Q1, two rehabilitation quadrats Q2 and Q4 with varying manipulated woody debris levels and the fourth quadrat Q3 where no woody debris had been deliberately placed. Annual monitoring allows variations in fauna species richness in conjunction with the changing vegetation structure of the rehabilitation area to be assessed. The results from all four quadrats are compared to determine what effect vegetation structure and woody debris levels have on fauna re-colonisation. This information will assist with future rehabilitation design aimed at successful faunal re-colonisation.



Created by: KBlundell
Date: 09.03.2023

WEDGETAIL PROJECT CONSULTING

https://wedgetail.com.au

Legend

- Donaldson Coal Mine Lease Boundary
- Study Area Quadrats
- Watercourse
- Arterial Road

Locality Map & Quadrat Locations

Figure: 1

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N

2. METHODS

2.1 WOODY DEBRIS

Wood-load measurements from each original quadrat Q1, Q2, and Q4 were undertaken in March 2008 by measuring all pieces of fallen timber with ≥8cm end diameters within the three 40 m x 40 m quadrats. The volume of each piece was calculated by treating pieces as cylinders and multiplying the length and mean diameter of each piece. Volumes were then converted into mass by using the mean density of 0.6 tonne/m3 (Mg) (Robinson 1997; MacNally and Horrocks 2007).

The woody debris survey has not been replicated since the 2008 survey as the overall monitoring report results rely on original measurements of mean density to derive a future rehabilitation design. Quadrat Q2 and Q4 were managed for woody debris while Q3 was not. Quadrat Q1 remains as mature forest adjoining the rehabilitation area.

The 2008 procedure was adapted from studies undertaken in the Riverina region of NSW (Robinson 1997) which looked at the density and current loads of woody debris. Woody debris of similar ages was measured, and volumes calculated. The findings from this research identified that irrespective of decay status, the volume of woody debris remained at a relatively constant 0.6 tonne/m^3. This procedure was also undertaken for the additional quadrat Q3 added in December 2008.

Re-colonisation results, in conjunction with initial woody debris levels provides information on the potential threshold required to facilitate successful re-colonisation by fauna species in terms of suitable habitat structure. Any new debris would be a result of natural decay and ecological process.

2.2 FAUNA

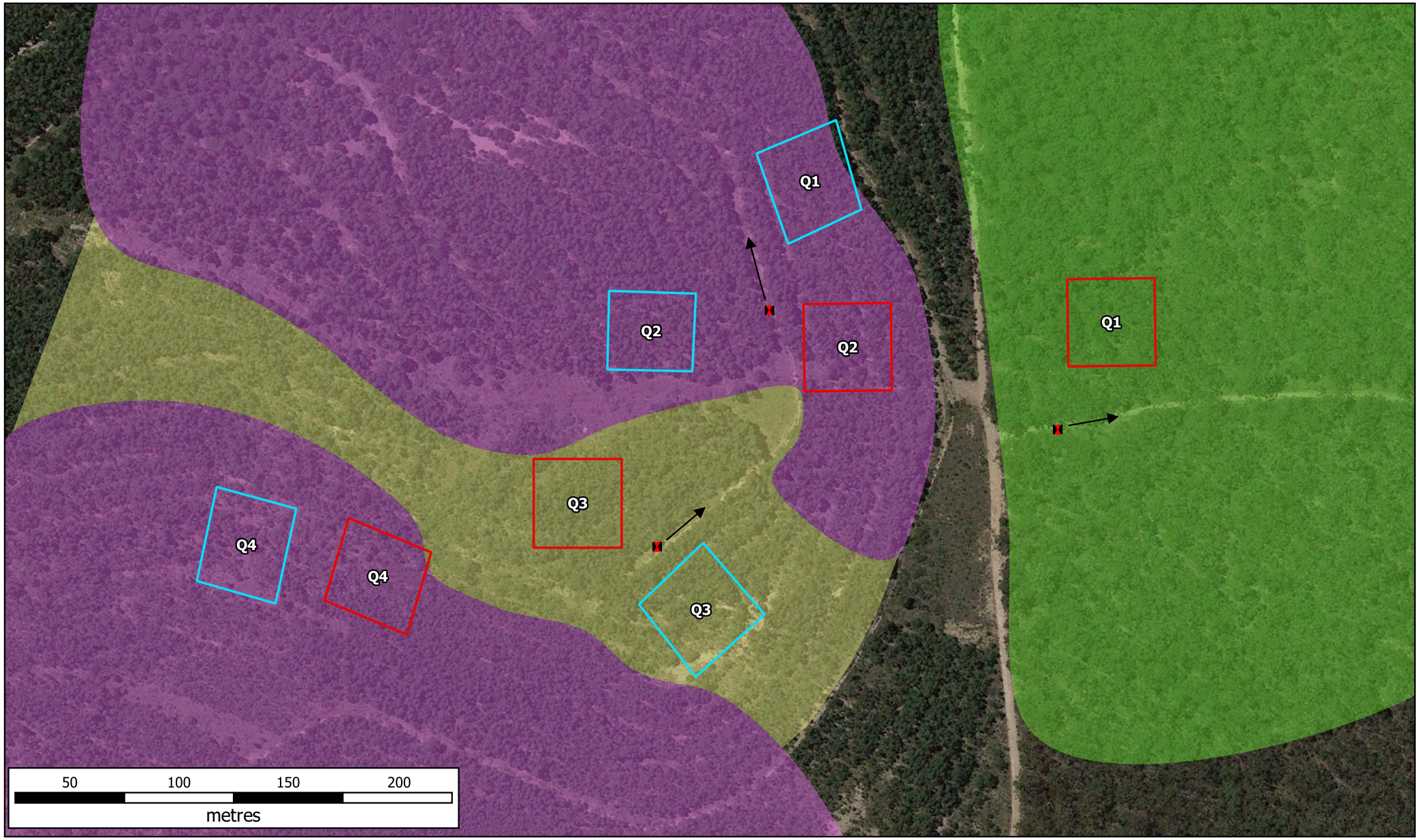
The assessment of fauna (including herpetofauna, microchiropteran bats and mammalia species) was undertaken across the four, 40 x 40 m (1600 m^2) quadrats Q1 – Q4 between 12 and 21 January 2022. The quadrats were positioned within vegetation communities at different stages of rehabilitation (**Figure 2**):

- Quadrat 1 Q1 is located in mature Spotted Gum – Ironbark open forest.
- Quadrat Q2 is situated approximately 80 m west of the first quadrat in a rehabilitated area containing 18-year-old vegetation.
- Quadrat Q3 is within 16-year-old rehabilitation and is located approximately 90 m to the southwest of quadrat Q2.
- Quadrat Q4 is located 45 m to the southwest of quadrat Q3 also in a rehabilitated area containing 18-year-old vegetation.

Table 1 depicts the total trap night count, and the location of trapping activities are shown in **Figure 3.**

Table 1: Trapping statistics for the four quadrats combined.

Trap type	Traps	Nights	Trap nights
Elliott A	80	8	640
Type IV Funnel	24	8	192
Cage	8	8	64
Camera	4	5	20



Created by: KBlundell
Date: 09.03.2023

WEDGETAIL
PROJECT CONSULTING PTY LTD
https://wedgetail.com.au

Legend

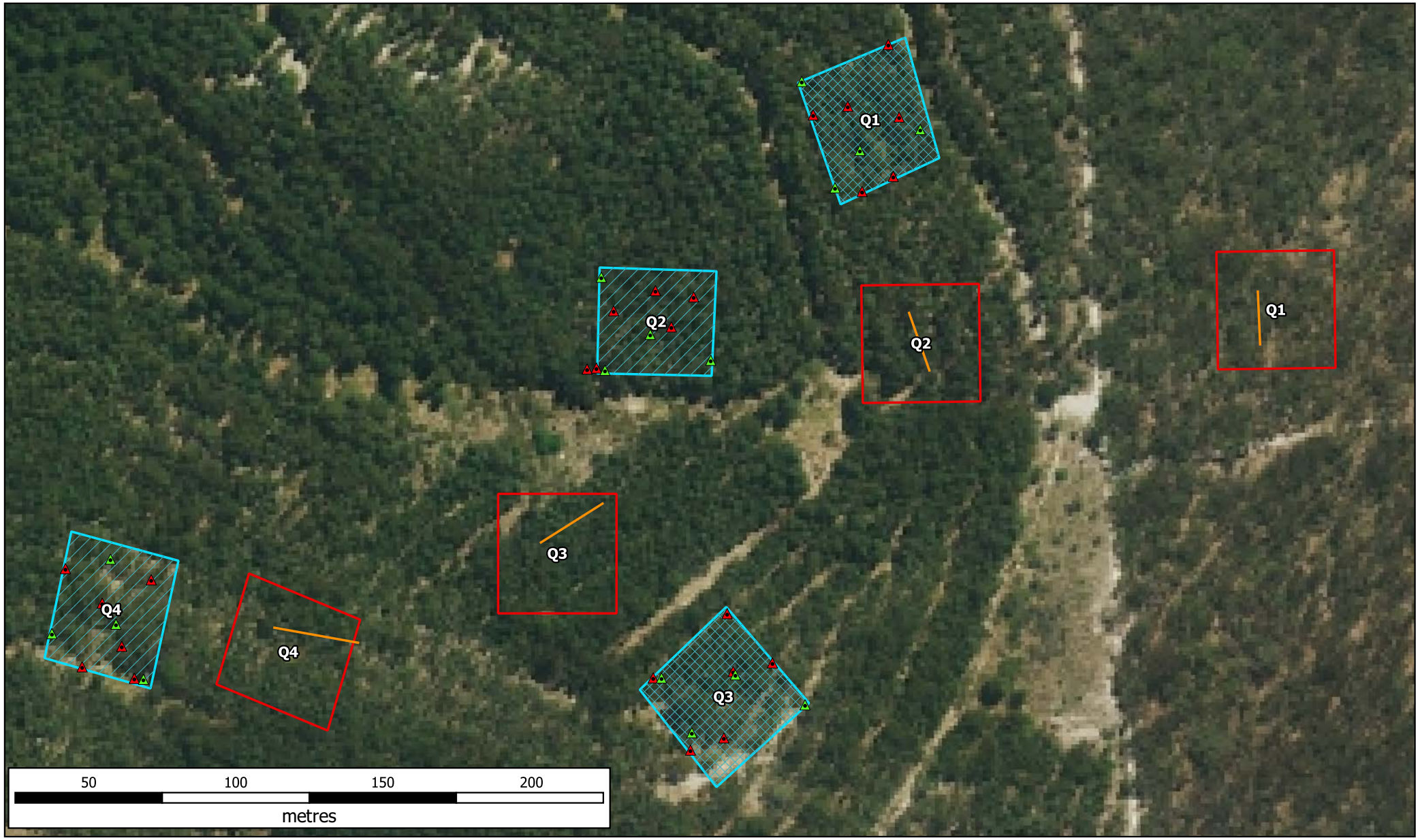
- Study Area Quadrats
- Nestbox Quadrats
- Anabat Locations (and Directions)
- 2003 Rehab
- 2005 Rehab
- Spotted Gum - Ironbark Open Forest

Survey Quadrats & Corresponding Age of Rehabilitation

Figure: 2

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N



Created by: KBlundell
Date: 09.03.2023

WEDGETAIL
PROJECT CONSULTING PTY LTD
https://wedgetail.com.au

Legend

- Study Area Quadrats
- ReptileRuns

Nestbox Quadrats

- high fallen timber
- low fallen timber

Nestbox Location

- Arboreal box
- terrestrial box

Nest Box and Fauna Quadrat Trapping Locations - Donaldson Coal Open Cut Mine

Figure: 3

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N

2.2.1 Terrestrial Mammals

Terrestrial mammals were surveyed between 12 – 21 December 2022. Eighty Elliott A traps (20 per quadrat) were placed in an irregular grid pattern (4 x 5 traps). The 'best lie' method was used to avoid placing traps in open or exposed positions. Small mammals tend to avoid open spaces, preferring to go around the edge of a clearing rather than across it. Traps are generally more successful when placed against logs, under thick vegetation or along natural pathways through vegetation. Traps were baited with a mix of rolled oats, honey, peanut butter, and treacle and set in position for eight consecutive nights and were checked each morning.

A Long-nosed Bandicoot (*Perameles nasuta*) was seen at quadrat Q3 during trap layout in December 2009. As a result, two cage traps were added to the trapping methodology for each quadrat to target larger terrestrial mammals. These traps were baited with the same mixture and set in position for eight consecutive nights and checked each morning. Additionally, remote camera sampling was utilised in 2022 for the first time in the monitoring program. This involved the installation of a single remote camera at a set location within each quadrat.

2.2.2 Bats

Insectivorous Microchiropteran bat species were surveyed using Anabat recording units (Titley Scientific, Lawnton QLD). This method was introduced in 2011 and is now replicated annually. An Anabat was placed in the remnant vegetation quadrat Q1, 18-year-old rehab quadrat Q2, 16-year-old rehab (near quadrat Q3) and within quadrat Q4 for the first time in 2021. The units were set out at 8 pm and recording continued through the night until 6 am for a total of 30 recording hours.

2.2.3 Birds

An area search within each quadrat was carried out on 30 November 2022 to survey for diurnal birds for a 20 minute period. Birds were identified either visually, with the aid of binoculars, or by call interpretation. Surveys were conducted in the morning when bird activity is at its peak (Bibby et al. 2000). Opportunistic sightings were also recorded and listed separately to actual survey results.

2.2.4 Herpetofauna

Six funnel traps were set along a 26 m run of drift fence in each quadrat between 12 – 21 December 2022. Trapping lines were left for eight consecutive nights and traps were checked daily.

Diurnal habitat searches for amphibians and reptiles were carried out within each quadrat during the January trapping period. Adult frogs encountered were identified by visual confirmation or their distinct advertisement calls. Suitable reptile habitat was inspected to detect any reptile species directly or indirectly through scats or other detectable traces. Suitable habitat included rock outcrops and crevices, fallen hollow logs and limbs, and burrows.

2.3 NEST BOXES

In 2011 an additional project was initiated within the rehabilitation areas involving the use of nest boxes as a method of promoting re-colonisation by arboreal and terrestrial species. Four quadrats located in similar rehabilitation age groups as the monitoring quadrats were selected and 10 nest boxes were erected (six terrestrial, four arboreal). The annual inspection was undertaken on 6 December 2022. The locations of the nest box plots and the existing fauna monitoring plots are provided in **Figure 3**. Photographs of the nest boxes design and current condition are provided in

Appendix B. All nest boxes were replaced on the 4 April 2022 with the older next boxes being of poor condition and not being utilised by fauna species.

2.4 STATISTICAL ANALYSIS

Data on fauna species detected between 2008 and 2022 were analysed to determine whether species richness or diversity differed between rehabilitation ages. Fourteen of the 15 sample periods were in summer and one in autumn (Baseline study in March 2008). The season in which surveys were conducted is known to have a significant influence on fauna diversity and abundance so data from March 2008 were excluded from analysis.

The relationship between two variables, species richness and sample year, was explored by linear regression. Regression statistics and charts were produced using Microsoft Excel. Non-metric Multidimensional Scaling (nMDS) and cluster analysis were also undertaken to explore the relationship between the fauna species assemblages detected in different rehabilitation age classes.

The Primer-E software program was used with the Kulczynski Similarity Index for presence only data (Clarke and Gorley 2006). This analysis produced scatterplots which graphically depicted, in 2-dimensional space, the similarity between species assemblages of different survey years. Associated dendrograms were also produced that graphically depict the relationship between sample years. The strength of any clusters apparent in the scatterplot was tested by running a similarity profile routine (SIMPROF) over branches in the dendrogram. Solid lines in the dendrogram indicate statistically significant clusters whereas dotted lines indicate clusters that are not statistically significant.

3. RESULTS

3.1 WEATHER CONDITIONS

The prevailing weather conditions throughout the trapping survey period (12 to 21 December 2022) were warm days to mild nights. The total rainfall for the survey period was 9.2 mm, which predominantly fell on the 13,19 and 20 of December. During the trapping survey period the mean minimum temperature was 13.5ºC and the maximum temperature was 27.6ºC for the month of Decmber.

3.2 VEGETATION STRUCTURE

Flora monitoring does not form part of the program, however due to its relevance to fauna richness and re-colonisation, observations (**Plate 1**) regarding changes in floral diversity and structure are provided. Descriptions of all four quadrats are as follows:

- Q1 – located in an area of remnant vegetation and consists of mature Ironbark and Spotted Gum. Woody debris levels are low (7.26 tonne/ha) (**Plate 1**and (**Plate 2**).
- Q2 – located in the rehabilitation areas planted in 2003 which are dominated by a canopy of Eucalypt and Acacia species. Little ground cover is present and woody debris is high (57.36 tonne/ha) (**Plate 3** and **Plate 4**).
- Q3 – located in the rehabilitation areas planted in 2005 which are dominated by a canopy of Eucalypt and Acacia species medium shrub growth. No wood was placed in Q3 hence the low woody debris score (3.33 tonne/ha) (**Plate 5**)and (**Plate 6**).
- Q4 – located in the rehabilitation areas planted in 2003. This area is dominated by a canopy of Eucalypt and Acacia species. This area has dense shrub growth and high woody debris levels (33.94 tonne/ha) (**Plate 7**and **Plate 8**)

As expected, the overstorey vegetation of the rehabilitation quadrats is noticeably taller (~10-15 m) than in March 2008 (average 3 m). The Eucalypt species have continued to grow, but many of the Acacia species that were present in previous surveys have reached the end of their life cycle and are dead or dying. All quadrats are dominated by a canopy of Eucalypts which have formed dense thickets in some areas mainly in Q3 and Q4 with Q2 understorey being more open with less Acacia and shrub layers.

Smaller shrubs and ground species have continued to emerge, and native grasses are plentiful in some areas. Additional ground layer structure (leaf litter and woody debris) is also continuing to develop due to natural processes. Although overall floristic diversity is still relatively low, as the vegetation continues to age, it is likely that thinning of the canopy will facilitate greater species diversity within the understorey. This may take many years to occur. Unfortunately, there has been an increase of weed density within Q2, Q3 and Q4 and surrounding areas with Lantana (*Lantana camara*) continuing the spread.

Plate 1: Q1 – Understorey

Plate 2: Q1 Mid storey and Canopy

Plate 3: Q2 – Understorey

Plate 4: Q2 – Mid storey and Canopy

Plate 5: Q3 – Understorey

Plate 6: Q3 – Mid storey and Canopy

Plate 7: Q4 – Understorey

Plate 8: Q4 – Mid storey and Canopy

3.3 FAUNA

Forty-seven (47) fauna species were recorded during the 2022 survey (above the yearly average 39.2) **(Figure 4).** Photographs of native fauna species trapped and observed during the current survey are provided in **Appendix C.** A large increase in the number of species detected across all quadrats between years prior to, and years post 2011 is attributed to the inclusion of Anabat detection of Microchiropteran bat species in Q1, Q2, Q3 (2011 onwards) and Q4 (2021) (**Figure 5)**.

The current survey results were comprised of two (2) arboreal and three (3) terrestrial mammals, 9 Microchiropteran bats, 29 bird species, three (3) reptiles and (1) amphibian species.

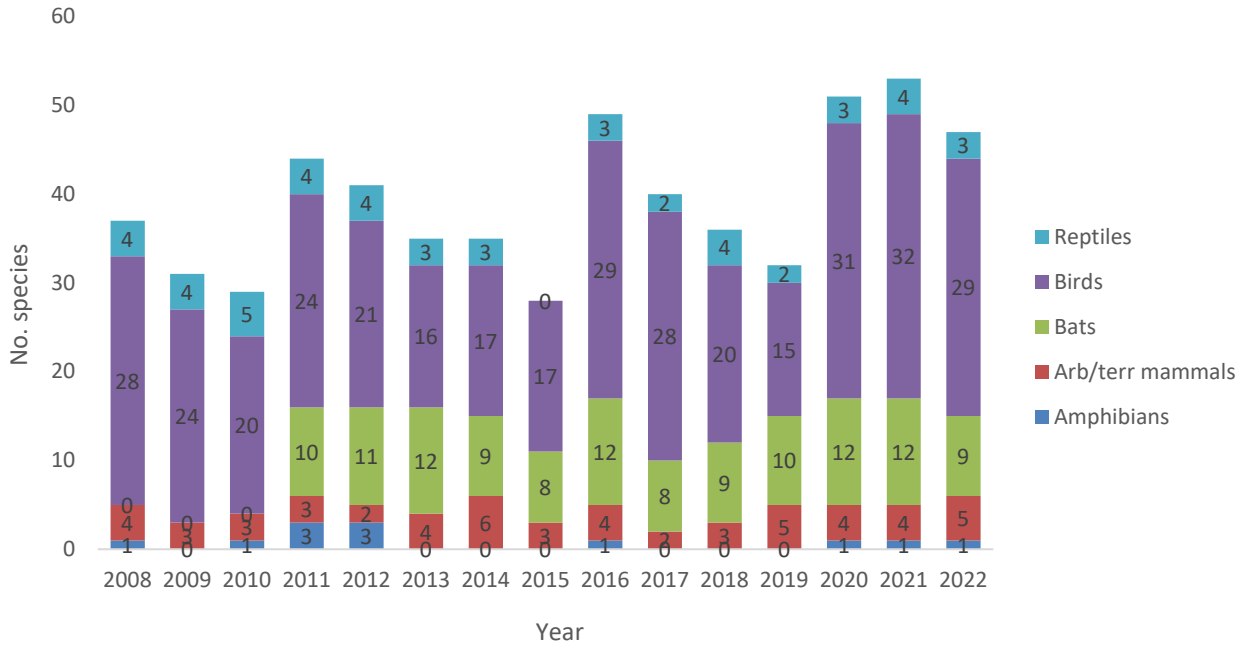


Figure 4: Number of fauna species per year from 2008 – 2022 (all quadrats combined)

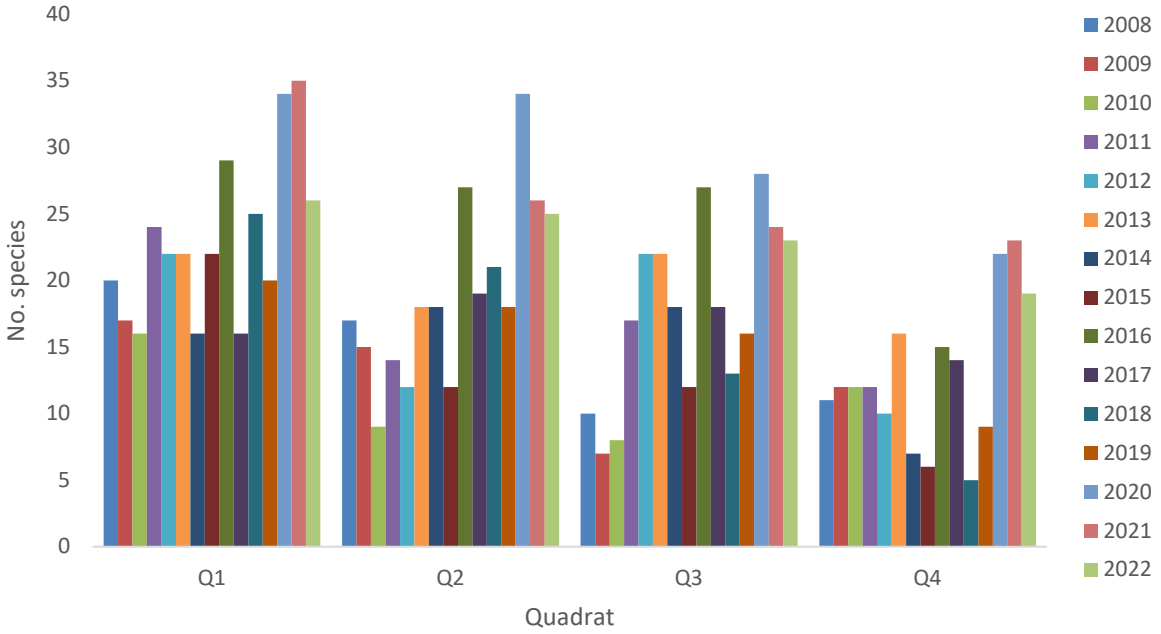


Figure 5: Number of fauna species per quadrat from 2008 – 2022

3.3.1 Arboreal and Terrestrial Mammals

Two arboreal and three terrestrial mammal species were recorded during survey **(Figure 6).** The Common Brushtail Possum (*Trichosurus vulpecula*) and the Brown Antechinus (*Antechinus stuartii*) were detected in all quadrats, whilst the Long-nosed Bandicoot (*Perameles nasuta*) was exclusively recorded in quadrat Q4.

The level of recorded mammalian species richness has been most variable in quadrat Q1, ranging between one to four species. Mammal species detected in quadrat Q2 have increased in recent years with four species detected in December 2022. Mammalian species richness has remained relatively consistent within quadrat Q3, ranging between two – three species. Q4 displayed a similar range of species richness to quadrat Q3, ranging between two-three species year to year, until 2020 where four species were recorded. The level of species richness recorded in this quadrat in 2022 is similar to previous years (three species).

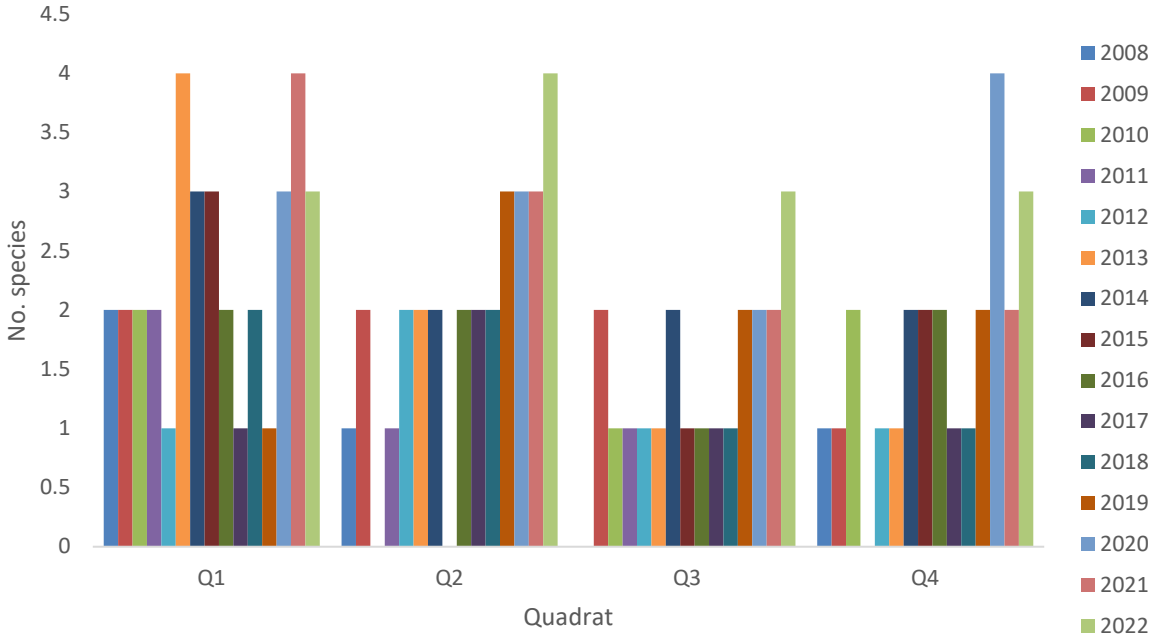


Figure 6: Number of arboreal and terrestrial mammal species per quadrat from 2008 – 2022.

The Brown Antechinus was not observed quadrat Q3 or quadrat Q4 during the early years of the monitoring program, however evidence of use by this species was recorded in 2013 in a nearby nest box quadrat. Usage of the rehabilitation area by the Brown Antechinus was confirmed in 2014 with the capture of a male animal in an Elliott A trap in quadrat Q4 over two consecutive mornings. The species has since been captured in quadrat Q4 from 2015 – 2022, excluding 2018. The first capture of a Brown Antechinus from quadrat Q3 was in 2017. Subsequent captures have now been recorded in 2020, 2021 and 2022, indicating that all ages of rehabilitation are now providing suitable habitat for this species.

3.3.2 Bats

A total of nine bat species were recorded across the mature forest and rehabilitation areas in the December 2022 survey, three of which, Little Bent-winged Bat (*Miniopterus australis*), Eastern Cave Bat (*Vespadelus troughtoni*), and the Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*) are listed as Vulnerable species under the NSW Biodiversity Conservation Act 2016 (BC Act). Previously, only quadrats Q1, Q2 and Q3 had been surveyed for bats according to survey methodologies introduced in 2011. The same methodology was introduced in quadrat Q4 during the 2021 monitoring period, allowing for five bat species to be recorded including the Vulnerable Little Bent-winged Bat in 2022. The number of bat species recorded per quadrat during current survey was above average for all quadrat locations **(Figure 7).**

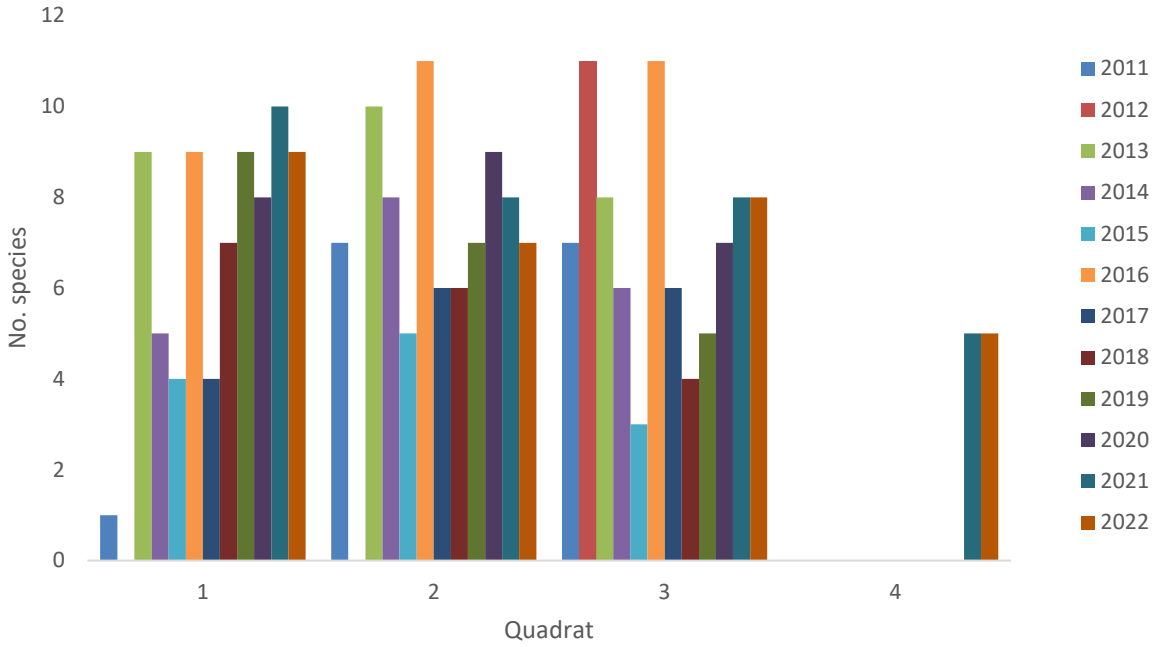


Figure 7: Number of bat species per quadrat from 2011-2022.

3.3.3 Birds

Twenty-nine bird species were recorded across all quadrats during the current survey **(Figure 8).** The result is well above the average of 23.4 species recorded across all quadrats between 2008 and 2022. In 2022, the number of bird species detected was above the yearly average for all quadrats however slight less than the previous year's monitoring event 32 species (2021). The number of bird species recorded per quadrat each year is highly variable, with some survey years (2011, 2012, 2015 and 2018) recording considerably higher diversity in the mature forest (quadrat Q1) in comparison with the rehabilitation quadrats. In 2022, there was a higher diversity of birds detected within the remnant vegetation (quadrat Q1) than in the rehabilitated vegetation (quadrats Q2, Q3, and Q4).

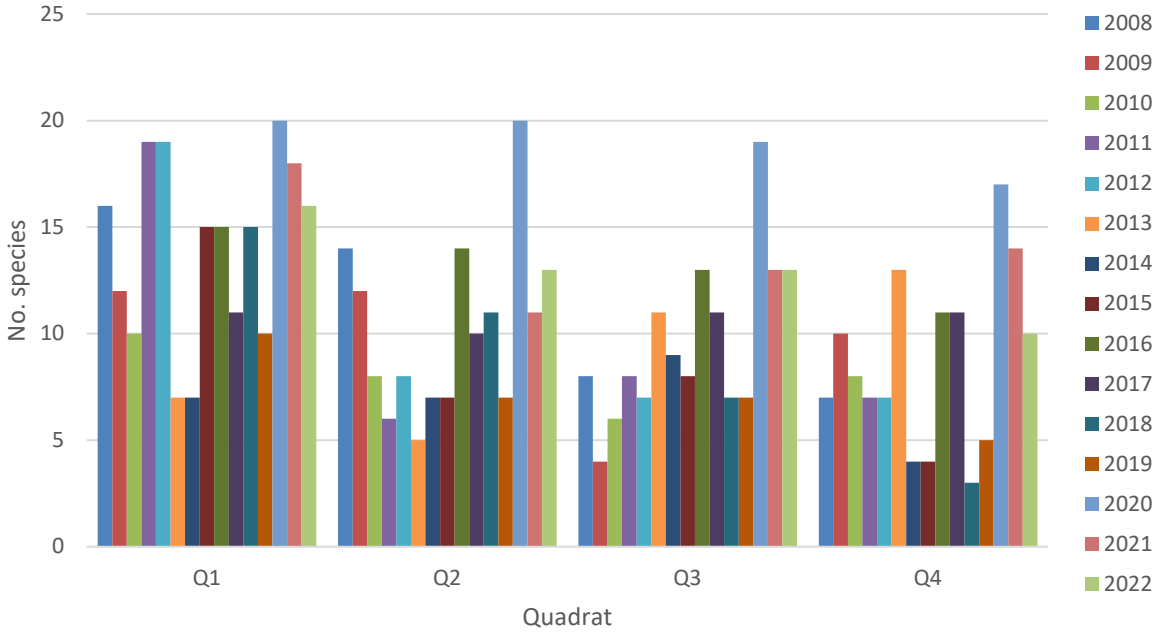


Figure 8: Number of bird species per quadrat from 2008-2022

3.3.4 Reptiles

Three reptile species were detected during current survey **(Figure 9).** Garden Skink (*Lampropholis delicata*) has been recorded sporadically throughout the monitoring program and was once again detected in all quadrats except quadrat Q3. The Southern Rainbow-skink (*Carlia tetradactyla*) was the only reptile species recorded within quadrat Q3 in 2022. The Jacky Lizard (*Amphibolurus muricatus*) was recorded in quadrat Q4.

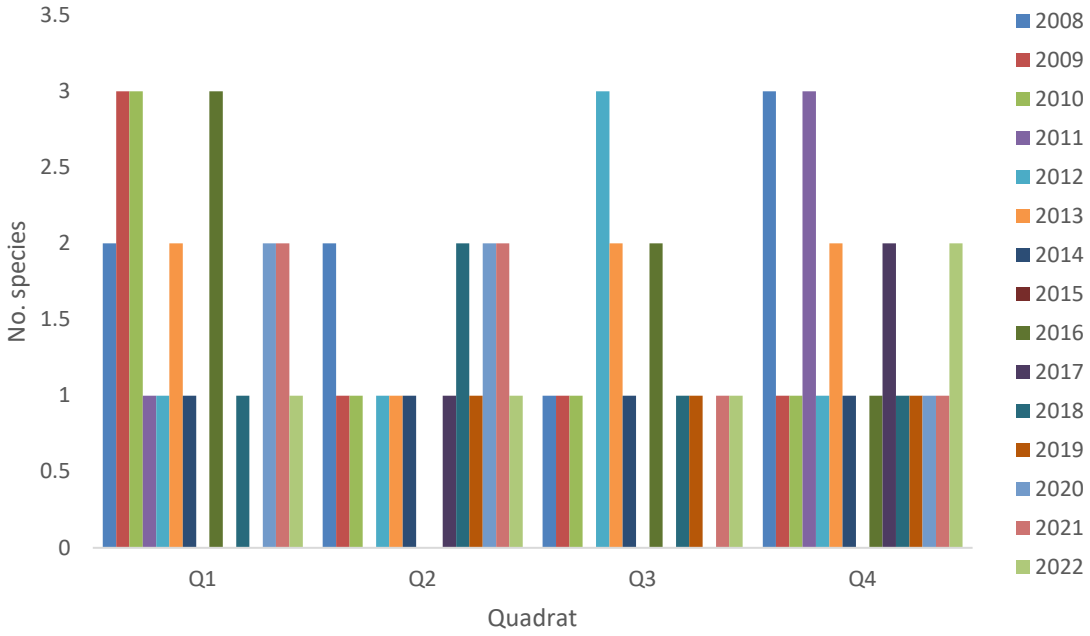


Figure 9: Number of reptile species per quadrat from 2008-2022.

3.4 FAUNA DIVERSITY PER QUADRAT

Three age classes of vegetation occur across the study area including remnant forest (**Plate 1-2**), rehabilitation planted in 2003 (**Plates 3-4 and 7-8**), and rehabilitation planted in 2005 (**Plate 5-6**). The location of all quadrats and corresponding rehabilitation age are shown in **Figure 2.** Non-metric Multidimensional Scaling (nMDS) analysis was used to investigate the relationship between the remnant vegetation and the rehabilitation vegetation based on the degree of similarity between fauna assemblages. The closer the data points are to each other, the more similar the fauna assemblages. Remnant refers to quadrat Q1, Rehab 1, 2 and 3 refer to quadrats Q2, Q3 and Q4, respectively.

The nMDS analysis showed that in 2011, after four years of monitoring, all three rehabilitated quadrats Q2, Q3, Q4 were at least 40% similar to each other with Rehab 1 and 2 being the most similar (greater than 60%) similar. The three rehabilitated areas, however, were marginally similar to the remnant forest in 2011, at only 20% similarity **(Figure 10).** After another four years, in 2015, all quadrats, including the remnant forest and rehabilitated areas, were greater than 40% similar. These findings show that over time the fauna assemblage in the rehabilitation areas is resembling the fauna species diversity of the remnant forest.

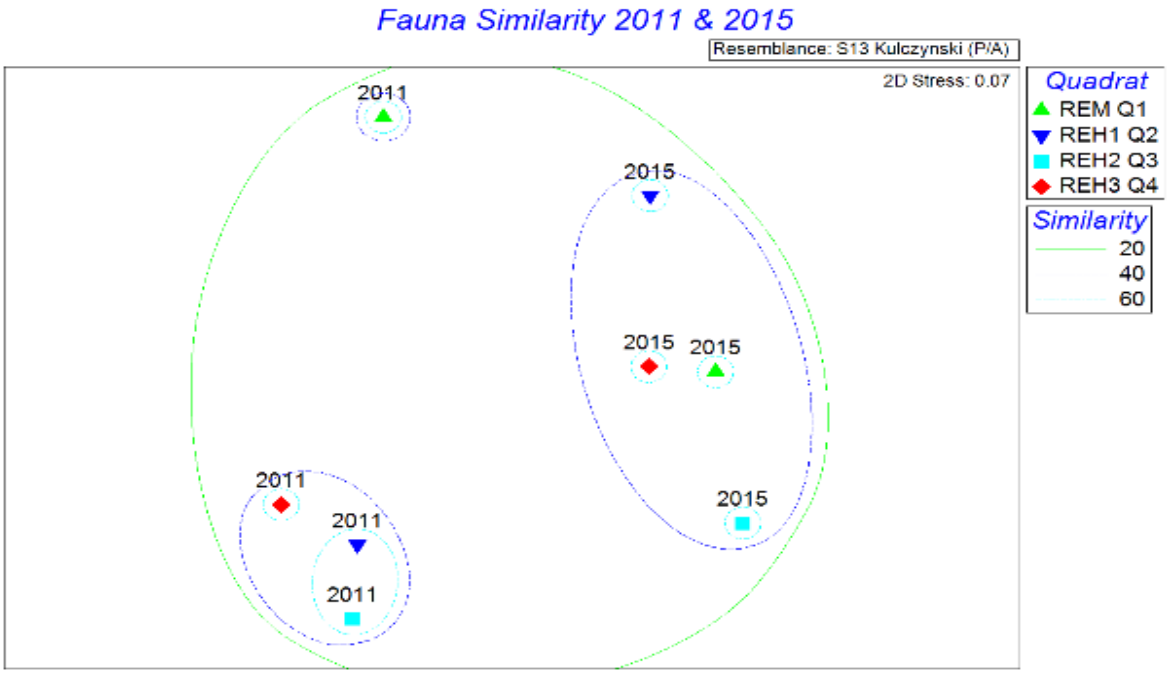


Figure 10: Non-metric Multidimensional Scaling analysis of all fauna per quad after 4 years (2011) and 8 years (2015). REM (Q1) = remnant vegetation; REH1 (Q2) = rehab planted in 2003; REH2 (Q3) = rehab planted in 2005; REH3 (Q4) = rehab planted 2003

Similarity measure analysis was also performed, comparing the fauna diversity of remnant and rehabilitated areas between 2016 – 2022 **(Figure 11).** In 2018, quadrats Q2 and Q3 were found to have a similarity index of 60%, with Q1 reducing in similarity to 40% in comparison to these other quadrats. In 2019, quadrats Q1 and Q2 had a similarity index of 60% increasing the index of quadrat Q1 from 40% in 2018. Both quadrats Q3 and Q4 having a 40% similarity in 2019 which is the first-time quadrat Q4 has had a 40% similarity to quadrat Q1 since 2015 being 20% in the previous years. In 2020, quadrats Q1, Q2 and Q3 all have a similarity of between 60-80% with quadrat Q4 being high in the range of between 40-60%. Within the 2021 monitoring period, quadrats Q1 and Q2 had a similarity 60% whilst quadrats Q3 and Q4 had a lower similarity, between 40-60%. In 2022 quadrats Q1 and Q2 have a similarity of 60% with each other and quadrats Q3 and Q4 having a 40% similarity with the other two quadrats.

In the earlier years quadrat Q4 was found to have a similarity index of only 20% when compared with all other quadrats until 2019-2020, where the similarity index increased to between 40% and 60%. It was expected that the fauna diversity at quadrat Q4 would continue to have less similarity to all other quadrats as the survey design did not incorporate Anabat (microbat detector) deployment. Microbat species often contribute to approximately 30-40% of species richness over the last six years at quadrats Q1, Q2 and Q3 where microbats are specifically surveyed (using Anabat detectors). The inclusion of bat surveying methodology may explain why the assemblage of quadrat Q4 experienced the highest similarity rate to the species assemblage of the other rehabilitation quadrats Q2 and Q3 since its introduction in 2021.

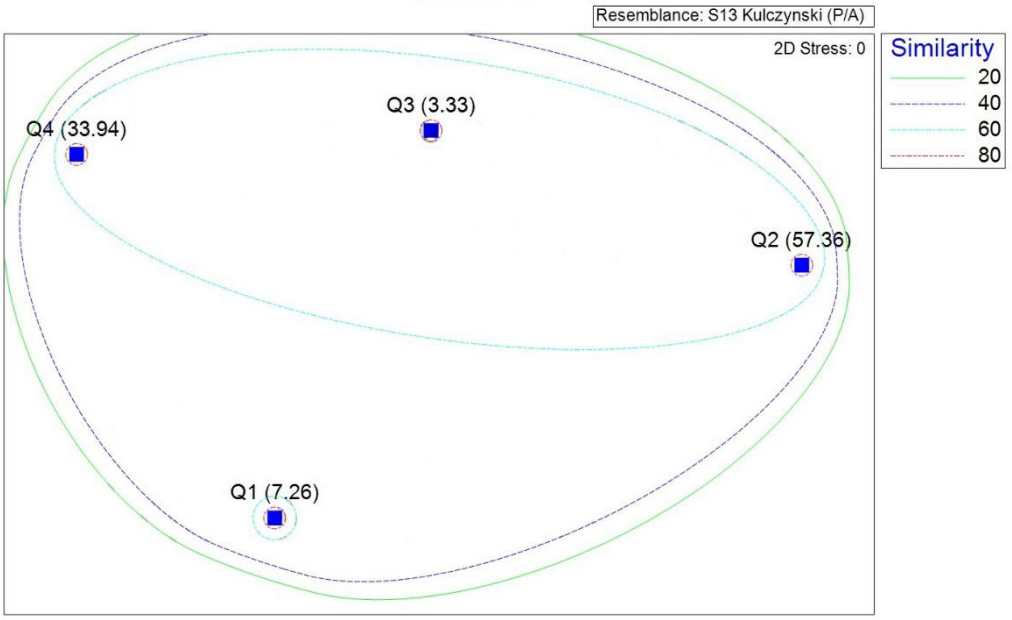


Figure 11: Non-metric Multidimensional Scaling analysis of all fauna per quad between years 2016-2022. REM (Q1) = remnant vegetation; REH1 (Q2) = rehab planted in 2003; REH2 (Q3) = rehab planted in 2005; REH3 (Q4) = rehab planted 2003.

3.5 FAUNA DIVERSITY VS WOODY DEBRIS

The results of the woody debris survey of each quadrat are presented in **Table 2** as background information. These data were collected in the preliminary survey quadrats Q1, Q2 and Q4 and the first quadrat Q3 monitoring event.

Table 2: Characteristics of woody debris between and within each quadrat

Quadrat No.	No. of pieces of woody debris per quadrat ≥8cm diameter	Average diameter of woody debris (cm)	Average length of woody debris (cm)	Total mass of woody debris in Tonne/Ha^{-1}
1 – mature forest stand	23	14.00	390.52	7.26
2 – now 18-year-old rehab	39	14.79	128.74	57.36
3 – now 16-year-old rehab	50	15.45	71.70	3.33
4 – now 18-year-old rehab	91	13.75	103.92	33.94

Figure 12 demonstrates the relationship between the average number of terrestrial species recorded in each quadrat since monitoring began and the total mass of woody debris in each quadrat. The low R^2 (0.00009) value shows no effect regarding the quantity of woody debris in each quadrat and the number of terrestrial species recorded.

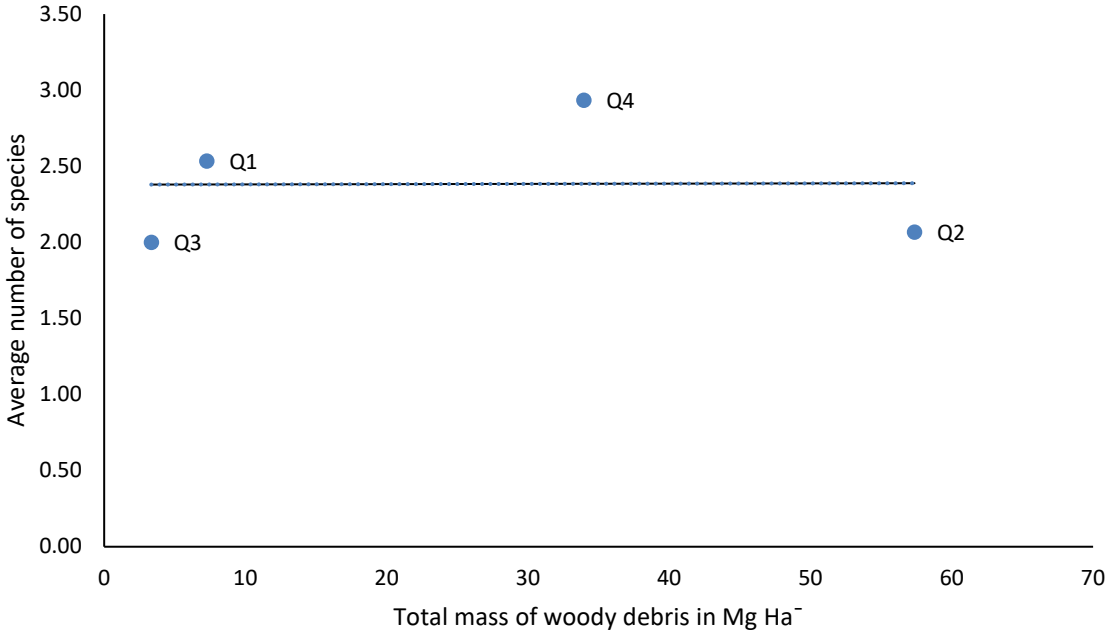


Figure 12: Average number of terrestrial species recorded each year, per quadrat and total mass of woody debris (T Ha⁻).

Non-metric Multidimensional Scaling (nMDS) was used to determine whether the quantity of woody debris influenced terrestrial fauna assemblage. **Figure 13** shows that all quadrats have a similarity index of at least 40-60%. A single cluster of quadrats Q2, Q3 and Q4 had a greater similarity (60-80%) than quadrat Q1 (remnant) However, these clusters are not related to the quantity of woody debris as the most similar quadrats, in terms of terrestrial fauna diversity, have significantly different quantities of woody debris.

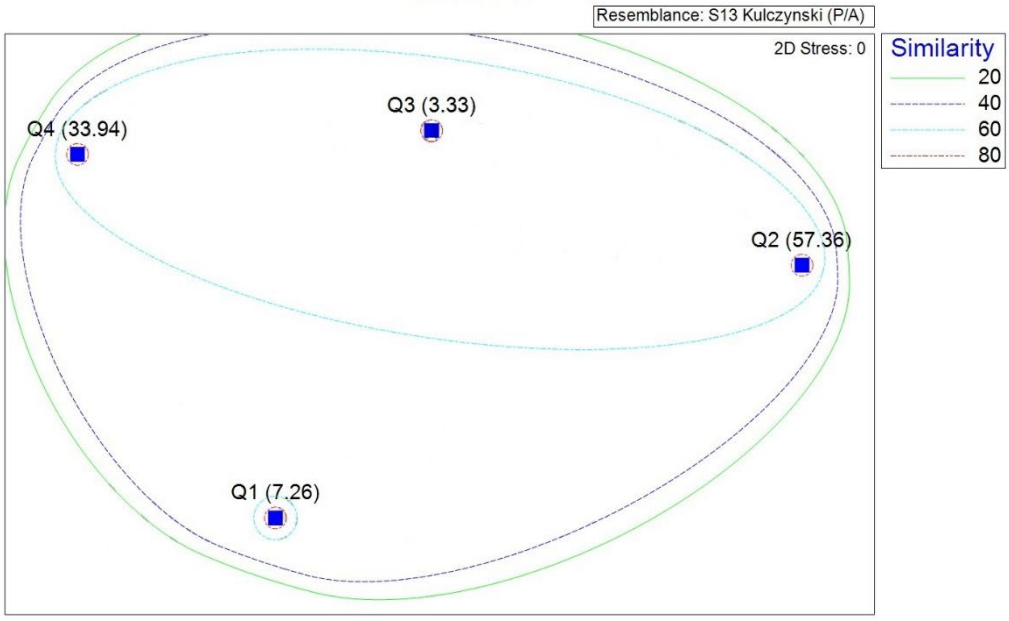


Figure 13: Non-metric Multidimensional Scaling analysis of number of terrestrial fauna species detected from 2008-2022 and its relationship to the quantity of woody debris at each quadrat.

3.6 NEST BOXES

Since monitoring began, all quadrats have shown evidence of activity in the form of individuals present, fresh leaf nests, scats, scratches, and hairs. The most prevalent species has been the Sugar Glider. **Appendix B** contains photographs of the nest boxes and contents.

Nest box usage is recorded in four ways:

- 1. Actual use, animals sighted in the nest box (A).
- 2. Evidence of use which includes nests, scats, and hair (E).
- 3. Unavailable (U) – the box is not habitable due to occupation by insects or from damage such as a missing lid or the box having fallen to the ground, and
- 4. No evidence (N).

In 2022, the total usage rate (A+E) for all usable nest boxes was 65% (26 out of 40 available boxes), equal to results from the previous 2 years **(**

Figure 14**).** The total actual usage rate (A), where fauna are present within nest boxes, in 2022 was 15% (6 of 40 boxes).

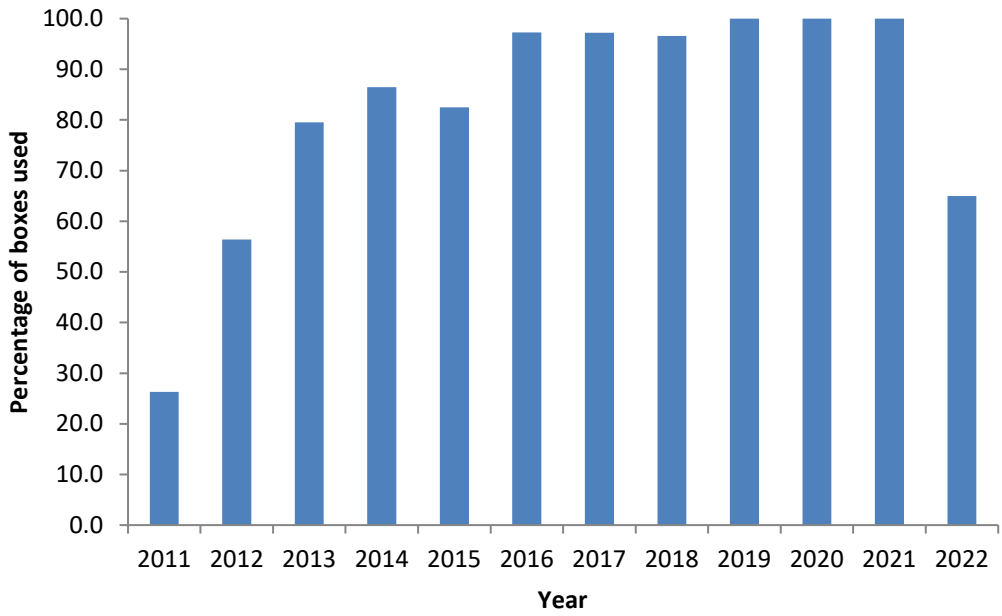


Figure 14: The percentage of total nest box (usable nest boxes only) usage (A+ E) for all quadrats 2011 – 2022.

The percentage of boxes containing resident fauna (A) has remained steady over much of the monitoring period until 2019 and 2020 where there was an approximate 50% decrease over two years **(**

Figure 15**).** In 2022, there has been a large increase in the percentage of boxes containing fauna, however there were more available nest boxes available during this time (40). Evidence of use (E) by fauna has increased every year until 2017 with a small decrease in 2018 with an increase in 2019 and 2020. In 2022, evidence of use increased substantially. The number of available boxes showing no signs of fauna use has now increased due to the more boxes becoming available with the new boxes being installed in April 2022.

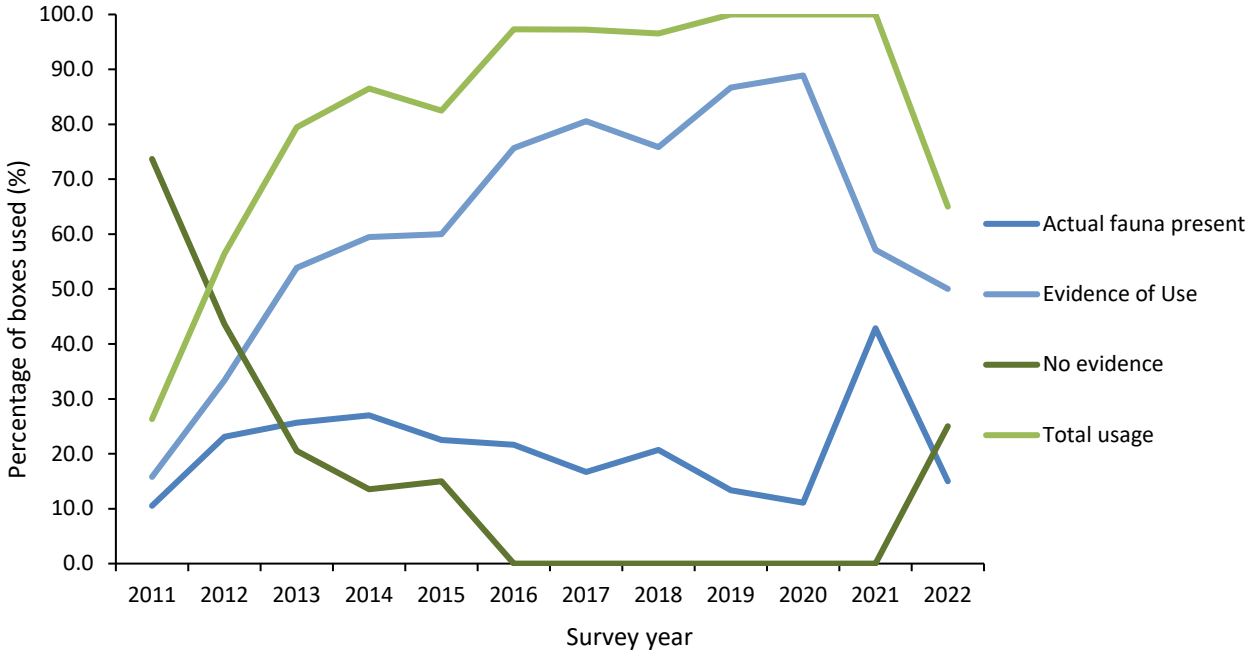


Figure 15: Percentage of available nest boxes used per usage category 2011 – 2022.

An analysis of Sugar Glider counts over time (2011 – 2022) **(Figure 16)** identified a steady increase from 2011 to 2015. The population has since declined; however, a sharp increase during 2022 monitoring, the rehabilitated quadrats still have a number of gliders present, suggesting breeding is occurring. The increased numbers of sugar gliders in boxes may be attributed to the replacement of available boxes. Instalment of new nest boxes which significantly increases the overall chance of detecting sugar gliders which are still likely to be using the rehabilitated areas.

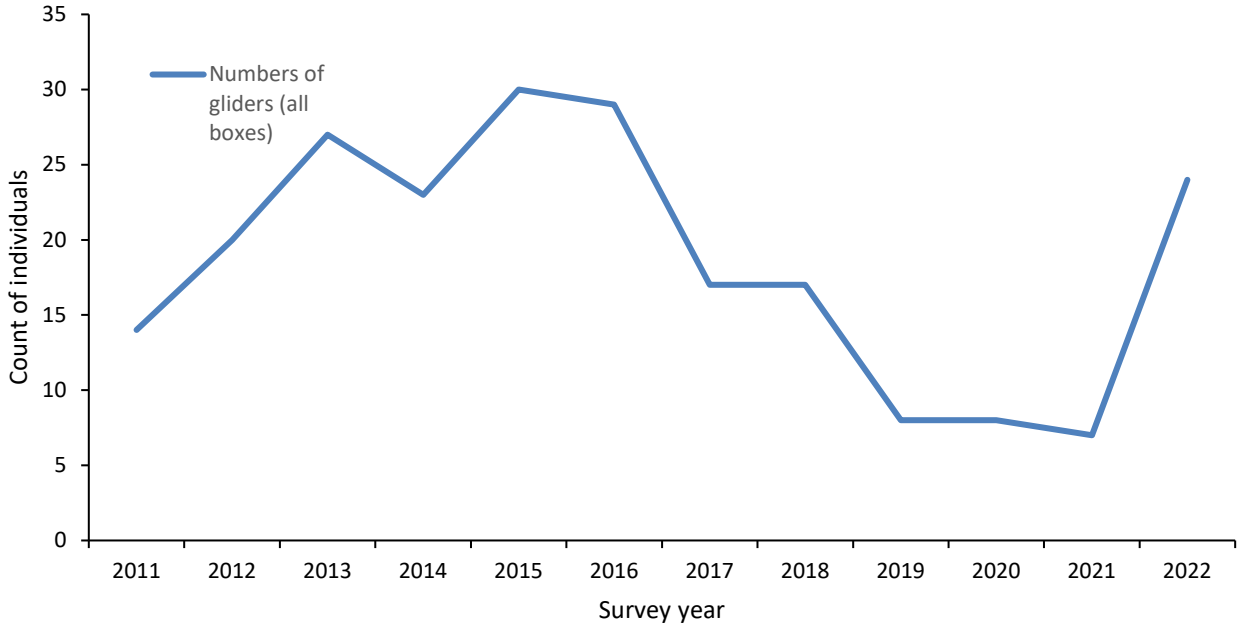


Figure 16: Number of Sugar Gliders (*Petaurus breviceps*) observed in boxes 2011 – 2022.

3.6.1 Arboreal nest boxes

Native fauna colonised the arboreal nest boxes soon after the installation, with fauna presence and evidence of use first being detected in 2011 (**Figure 17**). The overall utilisation of the boxes peaked in 2012 and remained stable until 2016. Since 2017, the overall number of utilised boxes has been declining. The rate of utilisation has significantly increased in 2022 as compared to 2021 nest box usage where twelve boxes either had fauna present or evidence thereof. The number of available boxes has been increased sharply and is likely responsible for the increasing rate of detected fauna due to replacement/reinstalment of new nest boxes.

All the arboreal nest boxes have been used at some point by *Petaurus sp*. (identified by an actual animal or by the distinctive nest shape constructed by the *Petaurus* genus). In 2022, 15% (6 of 40) of the available arboreal boxes were occupied by Sugar Gliders with a total of twenty-four individuals recorded.

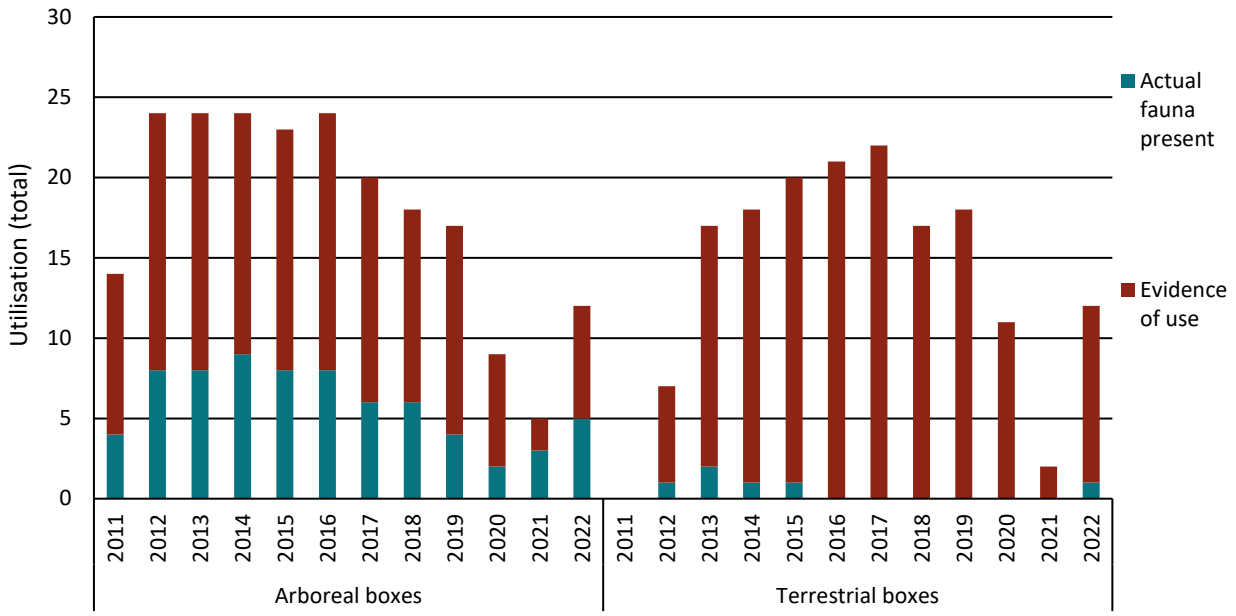


Figure 17: Evidence of use per nest box type 2011 – 2022 (usable nest boxes only).

3.6.2 Terrestrial nest boxes

The total usage of available terrestrial nest boxes has increased from zero usage (2011) **(Figure 17)** to 65% in 2022. In the 2022 monitoring period one box contained actual fauna (Brown Antechinus, *Antechinus stuartii*), however, thirteen boxes contained some evidence of fauna use. Utilisation of terrestrial boxes by Sugar Gliders, evident by spherical shaped leaf nests was first detected in 2013. With the replacement of all the terrestrial nest boxes in April 2022 there is a lower utilisation compared to previous years due to the nest boxes needing more time to be colonised by local fauna species. In the coming years we would expect to see an increase in usage of the new nest boxes.

3.6.3 Sugar Glider population

Sugar Gliders have been recorded within the rehabilitation area since the first nest box monitoring event in 2011. In 2022, twenty-four individual gliders were recorded using arboreal nest boxes only. Arboreal nest boxes have almost been at capacity for the years 2013 to 2016 through the number of actual Sugar Gliders observed in the available boxes. It is therefore expected that, given the lack of natural tree hollows in the rehabilitated areas, Sugar Gliders will begin to take up residence in the available terrestrial nest boxes. Consequently, lower numbers of antechinus use are being detected in nest boxes potentially due to colonisation by Sugar Gliders

The relationship between Brown Antechinus and Sugar Glider presence in terrestrial nest boxes is typically plotted and analysed each monitoring period. Given the large number of nest boxes that have become available in 2022 due to reinstalment, this relationship is considered irrelevant for the current monitoring period and analysis has therefore been omitted from this report.

4. DISCUSSION

The rehabilitation area is showing positive signs of re-colonisation by a variety of fauna species. Over the course of the monitoring program, the total number of fauna species detected by the fauna surveys has remained reasonably constant (including the remnant quadrat), albeit fluctuating year to year **(Figure 4).** However, surveys in 2022 detected the greatest species diversity (across all quadrats) since monitoring commenced. This is potentially attributed to increased rainfall over the past 12-24 months allowing eastern Australia to emerge from a prolonged period of drought.

Bird, mammal and herpetofauna species counts have been variable throughout the 13-year survey period. For example, nine new fauna species were recorded in 2012, two new species in 2014, and five new species in 2016. However, several species recorded in previous survey periods were not recorded in 2017, 2018 and 2019. These changes are considered normal and are likely to continue as the vegetation structure matures addressing different species-specific requirements. In addition, the species detected during an annual survey period will depend largely on the weather conditions prior to, and during the survey period. Of note, as of 2017, the Brown Antechinus has been detected in all rehabilitation quadrats but was only detected within quadrat Q1 in the 2018 surveys. Whilst in the 2019 surveys the Brown Antechinus was detected in quadrats Q2, Q3 and Q4 but not within the remnant quadrat Q1 showing variability from year to year. In 2021/2022 the Brown Antechinus was captured in all quadrats. The variability in 2019 could be attributed to the severe drought conditions that were observed over the East coast of Australia and now with wetter conditions in 2022, species have returned to the rehab areas due to improved conditions.

4.1 FAUNA DIVERSITY PER REHAB AGE

Non-metric Multidirectional Scaling (nMDS) analysis and cluster analysis were used to compare the faunal assemblages of each quadrat at two points in time; 2011 (four years post-rehabilitation), and 2015 (eight years post-rehabilitation) after monitoring began. The following abbreviations were used in the analysis and are discussed in the following section: REM = Remnant; REH1 = Q2, 2003-planted rehabilitation; REH2 = Q3, 2005-planted rehabilitation and REH3 = Q4, 2003 planted-rehabilitation.

The original hypothesis was that over time, as the age and structural complexity of the rehabilitation increases, species diversity will be equivalent to the diversity observed in the remnant forest quadrat Q1, REM. This was expected to take many decades, however as **Figure 10** and **Figure 11** shows, diversity in the two areas is already similar.

The 2011 faunal assemblages in the three quadrats in the rehabilitation area are clustered together and show 40-60% similarity but are only 20% similar to that of the remnant forest. However, after another four years, in 2015, all four quadrats are clustered together showing 40% similarity. In 2016, faunal assemblages of quadrats Q2 and Q3 were significantly more similar (60-80%) to the remnant quadrat than in 2015. When comparing 2018 with the previous two years **(Figure 11)** there is one large cluster showing a 40% similarity between all quadrats showing that these areas are becoming similar to each other.

In 2022, the species diversity of the rehabilitated vegetation plots (quadrats Q1 and Q2) were found to be highly similar (60-80%). This differs from last year's results in that quadrat Q4, is equally as similar to quadrats Q2 and Q3, whereas in 2022 it was 40-60% similar. This is likely attributed to the deployment of an Anabat within quadrat Q4 in 2021 since the beginning of the monitoring program. Five species of bat were detected in quadrat Q4 that were similar species to the other remnant plots.

Additionally, the assemblage of quadrat Q4 was less similar to quadrats Q2 and Q3 than the previous year, decreasing from 60-80% in 2021 to 40-60% in 2022. Despite this decrease, the overall similarity between the remnant and rehabilitated quadrats remains high. The overall decrease in fauna similarity may be attributed to general variation in fauna utilisation year to year or the somewhat later onset of the monitoring period, instead being in late December 2022.

Overall, these findings show that the rehabilitation area is on a positive trajectory and is becoming more like the remnant forest whilst also experiencing phases where species richness fluctuates as seen in the 2022 data. It is apparent that the original proposal - that species diversity in the rehabilitation sites will move closer to the species diversity of the remnant vegetation site - is supported by the monitoring data (with some year-to-year variation).

4.2 FAUNA DIVERSITY VS. WOODY DEBRIS

Several studies comparing mature forest and rehabilitated sites have found positive correlations between rock cover and woody debris with small mammal species richness and total reptile and amphibian captures. Most studies have found a positive correlation between habitat heterogeneity/diversity and species diversity (Tews et al. 2004). However, this may vary considerably depending on species specific requirements.

A comparison of the total number of terrestrial species recorded at each quadrat since monitoring began was made to determine if there is a positive correlation between this and the total mass of woody debris. As **Figure 12** shows there was no relationship between woody debris and number of species recorded (woody debris dependent species only). The nMDS analysis was then used to determine if the composition of all terrestrial species was affected by the quantity of woody debris. The analysis, shown in **Figure 13**, highlights one cluster based on similarity of terrestrial species assemblages: quadrats Q3 and Q4, with quadrats Q1 and Q2 having a lower similarity.

The mass of woody debris throughout quadrat Q2 and Q4 is heavily skewed due to two large fallen logs which is suspected to make up the majority of debris for that area. These two separate logs are not likely to provide significant amounts of refuge for fauna. The presence of large fallen branches is also absent from the rehab areas with the bulk of woody debris being categorised as immature trees which have fallen over due to poor ground stability. These, also, do not provide much refuge for fauna as they often do not fall flat on the ground, nor do they offer much cover underneath.

Originally it was expected that higher woody debris levels would result in greater species diversity. However, as the dataset has grown, it may be the case that woody debris levels may lead to greater abundance of a small number of species, not species diversity as a whole. As discussed previously, habitat structure and composition significantly affect the type and diversity of species present. For example, there is evidence that bird species diversity in forests is determined more by the physical structure of a plant community (i.e., how foliage is distributed vertically) than the diversity and quantity of vegetation (MacArthur and MacArthur 1961). This suggests that physical structure may be more important in promoting faunal re-colonisation than the actual composition of plant species and is an important consideration for land rehabilitation practices.

Future monitoring may benefit from surveys to determine species diversity within each quadrat in addition to a classification of each quadrat based on the complexity of its vegetation structure. These results, in conjunction with species diversity may provide insight into what specific factors (e.g., woody debris, vegetation structure) aid in fauna re-colonisation.

It may be that woody debris does affect fauna diversity and abundance but not in a linear pattern and that the differences in total mass of debris between quadrats are not great enough to cause marked differences in fauna species assemblage. Rather than the quantity of woody debris being the causal factor of terrestrial fauna species assemblage, it is possible that other factors, such as distance from the remnant forest or vegetation structure and complexity are also important in shaping terrestrial species assemblage.

Strong winds during a storm early in 2015 blew over many of the trees in the rehabilitation area, effectively increasing the total mass of woody debris in the area. Future monitoring could benefit through the recalculation of the mass of debris at each quadrat to determine if this change has had an impact on fauna diversity.

4.3 VEGETATION STRUCTURE

Overstorey vegetation within sections of quadrats Q3 and Q4 has increased in height, with height starting to plateau during the past three years of monitoring as the trees mature with no discernible increase in 2022 (~3 m in 2010, 4.5 m in 2011, 4.6 m in 2012, 5 m in 2013, 6 – 9 m in 2014, 7-10 m in 2015-2017, 8-12m in 2018 – 2021 and 10-14m in 2022). However, where trees are growing in proximity the canopy has become quite thick. This has resulted in some restricted growth and maturation of the trees in addition to preventing appropriate understorey growth and development. Other reasons for restricted growth could be too much competition or limited resources along with a drought period at the end of 2019. With wetter conditions over 2021 and 2022, the rehab has recovered its foliage cover. An assessment of the average tree height will be conducted in 2022.

Where the overstorey is not as dense or is absent (quadrats Q3 and Q4 compared to quadrat Q2), the understorey is more structurally and floristically diverse. These quadrats, Q3 and Q4 are comprised of tussock grasses, bare ground, rock, and pockets of leaf litter build-up below shrubs and juvenile trees. Improvements in understorey structure for quadrats Q3 and Q4 and shown with both quadrats containing Brown Antechinus and the Long-nosed Bandicoot *(Perameles nasuta*) found in quadrat Q4 during the 2022 monitoring event.

Poor regeneration of the shrub and ground layer could be due to the original high density of planting within quadrat Q2 of *Eucalyptus* and *Acacia* species which have formed a thick canopy preventing enough light to support understorey plants. During the 2022 assessment of vegetation structure, it was noted that the *Eucalyptus* species have continued to grow. All quadrats are dominated by a canopy of *Eucalyptus* which have formed dense thickets in some areas. Natural processes will allow the canopy to thin and clear over time in all quadrats (quadrat Q2 will be of interest and this process has started to occur between 2019 - 2022). This will in turn support greater understorey growth and diversity.

As noted above, the storm event in 2015 has caused some thinning of *Eucalyptus* trees across the rehabilitation sites. The impacts of this on ground and midstorey vegetation should be monitored in future survey events. During 2022 surveys, no healthy trees were observed to have fallen over, with observations of an increase in foliage cover of the canopy species following the drought period at the end of 2019.

The more complex ground cover and floristic diversity observed in quadrats Q3 and Q4 may be related to greater availability of light into those areas with less dense canopy. However, as observed throughout quadrat Q2, there are areas in quadrats Q3 and Q4 where the ground cover is poor due to *Eucalyptus* forming a closed canopy limiting light reaching the understorey. The ground layer structure of the three Rehab quadrats is still relatively poor but is improving with grass cover and an

increase in leaf litter observed in 2022. The paucity of ground cover has initially inhibited re-colonisation by small mammals due to a lack of shelter sites or habitat for their prey items. However, as the habitat matures, and the ground layer improves, native dasyurids such as the Brown Antechinus and native rodents such as the Bush Rat (*Rattus fuscipes*) are likely to increase in numbers which has occurred in 2022 with the Brown Antechinus seen in high numbers in all quadrats.

4.4 TERRESTRIAL AND ARBOREAL ANIMALS

The numbers of Brown Antechinus observed in quadrat Q1 had remained relatively consistent since surveys began in 2008 except for 2012 and 2019 when no Brown Antechinus were captured. The species was originally absent from the rehabilitated vegetation (quadrats Q2, Q3 and Q4) until 2014 where the first capture of an individual Brown Antechinus was recorded at Q4. Since then, the species has been recorded most years in every quadrat. The numbers have fluctuated over time. The numbers recorded in 2016 and 2018, were lower than usual (two and three captures in comparison to the yearly average of six), however recovered in 2020 with nine captures of Brown Antechinus within quadrat Q1 alone. In 2022, the Brown Antechinus were detected in all quadrats, the highest being nine individuals in quadrats Q2 and Q3. This may be attributed to favourable environmental conditions between 2021 and 2022 following the dry conditions in 2019. Additionally, surveys were conducted in late December (2022). Males of this species are short-lived, dying shortly after reaching sexual maturity and mating in late Winter. As such, the number of males may be lower in December than in late January where new immature males have become independent. Many males and female individuals were recorded in 2022.

Despite the increase in Brown Antechinus individuals potentially being attributed to seasonal variability, the species could act as an indicator species in determining the success of re-colonisation in the rehabilitated area. This is due to the sensitivity of this species to structural components such as understorey height and complexity, leaf litter and the abundance of logs. Previous observations of Brown Antechinus in quadrat Q2 are most likely due to its proximity to remnant vegetation. The nearby remnant vegetation has potentially aided in the re-colonisation of the rehabilitated area as species begin to forage in the new habitat. A similar trend was observed with the Common Brushtail Possum. This suggests that the rehabilitation area currently provides suitable foraging habitat for several species but may lack suitable nesting or breeding habitat for larger species.

The rate of nest box occupancy in the rehabilitation area supports these assumptions and highlights the importance of introducing habitat hollows into rehabilitation areas. In addition, the inconsistency in native terrestrial mammal observations in the rehabilitation area (quadrats Q2, Q3 and Q4) compared to the remnant habitat further suggests that the complexity of rehab vegetation does not match that of the remnant vegetation. Connectivity with remnant habitat is positive and will facilitate movement of native species into the rehabilitation area as suitable habitat becomes available.

Annual monitoring has shown slow improvements in the structure and complexity of the rehabilitation vegetation and further monitoring events will continue to provide insight into the relationship between the various vegetation/ground cover characteristics and fauna re-colonisation.

4.5 BATS

The recording of Microchiropteran bat species was added to the survey methodology in 2011 to determine whether bats are using the rehabilitation areas for foraging. In total, nine species were detected in December 2022 including three threatened species: the Little Bent-winged Bat

(*Miniopterus australis*), Eastern Cave Bat (*Vespadelus troughtoni*), and the Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*).

The highest number of bat species recorded within an individual quadrat (11 species) was recorded in 2016. In 2022, numbers of bat species recorded were found to be constant across all quadrats excluding quadrat Q4 where bat survey methodology way employed for the first time in 2021, and an average is yet to be established. Similar species were identified in each quadrat suggesting that the same bat species are utilising the remnant and rehabilitated vegetation. The survey methodology created in 2011 for bats did not previously include Anabat detectors in quadrat Q4, however this methodology was incorporated in 2021. A similar assemblage of bats was found in quadrat Q4 to the quadrats.

Microbats are primarily insectivores and are voracious feeders. Insects play important ecosystem roles by transporting pollen from one flower to another and thus achieving pollination. High pollination success is vital to the establishment of rehabilitated areas. It is encouraging to detect such a high number of microbat species not only from a fauna diversity perspective, but from an ecosystem perspective.

4.6 BIRDS

Species richness has varied slightly between each quadrat over the 11 years; however, quadrat Q1 has maintained the highest mean level of richness **(Figure 8).** This is not surprising as Q1 contains structurally diverse and complex habitat able to support different bird species and their habitat requirements. Several studies have confirmed this by showing that bird species richness was higher in complex revegetation compared to simple revegetation (Rossi 2003, Munro et al. 2007). Dynamic changes in species richness observed from year to year highlights the continual change in vegetation structure and complexity and can also be attributed to individual species' detectability and local climatic conditions.

Slight decline in overall species were observed in 2021 and 2022, 32 and 29 respectively, although with varying assemblages. The bird diversity for 2021 – 2022 are the highest recorded throughout the monitoring program with many of the same species being found in all four quadrats. Several nectar feeding birds that have been detected in previous years at both remnant and rehab quadrats were observed in 2022 most likely due to the flowering nectar trees and continuing favourable conditions between 2021-2022 compared within 2019 were we were in a drought. With the presence of nectar feeding birds the results have been above average. Other small to medium-sized insectivores were once again detected during the 2022 surveys within rehab quadrats including Superb Fairy-wren (*Malurus cyaneus*), Spotted Pardalote (*Pardalotus punctatus*), and Eastern Yellow Robin (*Eopsaltria australis*). The bird diversity for 2022 have remained constant for all quadrats with many of the same species being found across all four quadrats.

The species recorded in the rehabilitation areas compared to the remnant area are characteristic of the vegetation structure present. Many bird species found in the rehabilitation areas prefer scrub type vegetation and are more commonly found in open and fringe areas while some species that prefer forest with larger trees were only detected within the remnant quadrat.

Another sign indicating progress of the rehabilitation area is the presence of the hemiparasitic plant, Mistletoe, and the consistent recording of Mistletoe birds. Mistletoes are considered a keystone resource in forests and woodlands throughout the world and the Mistletoe bird, a specialist feeder on mistletoe fruit, is a key dispersal agent. Mistletoes provide food in the form of nectar, fruit and leaves to many bird and mammal species. They also provide a key foraging substrate for

insectivorous species, as well as nesting sites for many bird species. Several studies have found greater vertebrate species richness associated with higher mistletoe densities (Watson 2001).

4.7 HERPETOFAUNA

Herpetofauna results have remained reasonably constant across the monitoring program. However, as ground cover and understorey continue to develop it is expected that more amphibian and reptile species will recolonise the area. As stated previously, the lack of light penetrating the closed canopy of the rehabilitation sites may be inhibiting re-colonisation. A lack of suitable water bodies within the rehabilitation areas may also be a limiting factor restricting reptile and amphibian re-colonisation.

In 2022, the species richness of herpetofauna was relatively constant compared to the overall average.

4.8 NESTBOXES

Within the relatively new field of restoration ecology there is an assumption that successful rehabilitation of flora will facilitate fauna re-colonisation. However, natural tree hollows and remnant habitat required for successful re-colonisation can take hundreds of years to develop at a rehabilitation site.

To date, there have been very few studies which report successful fauna re-colonisation on mine sites and the effectiveness of artificial hollows/nest boxes within rehabilitation areas remains largely unknown. The information recorded from the 2022 nest box inspections is promising with 65% of all available arboreal and terrestrial nest boxes exhibiting actual use or evidence of use (equal to results from 2016, 2017, 2018 and 2019 2020;2021

Figure 14).

Usage rates were appearing to plateau from 2013 to 2015 but have had a positive trend in the past five years of surveys (

Figure 15). Arboreal nest boxes **(Figure 17)** reached a peak of 60% actual usage in 2014 but decreased to 28% in 2020. In 2022, this number has once again increased to 60%, however this is likely due to the large number of boxes that have been replaced particularly over the last year. As such, there are higher quantity of boxes available to arboreal fauna, making the overall occupation of nest boxes seem higher than the previous year's results.

Figure 16 plots Sugar Glider numbers over time (2011 – 2022) with the results showing a steady increase in individual glider numbers from 14 in 2011 to 29 in 2016, however there has been a steady decrease in glider numbers from 2017 onwards, with 24 individuals identified in 2022. The sharp increase in glider numbers is likely related to the large number of unavailable boxes that has been replaced during April 2022, resulting in increased opportunities to record the species. Other potential factors include seasonal variability or the presence of a predator species foraging in the area.

The limited number of artificial arboreal hollows (tall nest boxes) in the rehabilitated areas have led to Sugar Gliders taking up residence in terrestrial nest boxes in previous survey periods. Nest boxes near to the ground are not typical nesting locations for Sugar Gliders as predation risks are higher. The target species for terrestrial nest boxes, Brown Antechinus, appears to be competing for nest boxes as some individual boxes were found to have both a Sugar Glider nest as well as Antechinus scats.

The increase in nest box uses by Brown Antechinus each year since 2011 has been a positive sign for the re-colonisation of the rehabilitation area. However, with the 2015 and 2016 results showing increased competition from Sugar Gliders for available nest boxes, the data is beginning to show a decline in evidence of use by Brown Antechinus. Since the 2017 results there has been an increase in evidence of use by Brown Antechinus, with evidence of glider use decreasing. This trend could show fluctuations in the denning use between Sugar Gliders and the Brown Antechinus from year to year with 2020 swapping the trend again with Sugar Gliders being slightly more dominant than the Brown Antechinus.

Overall, the trends emerging after eight years of nest box monitoring continue to be positive. The continued uptake and high utilisation of all nest box types is an indicator of the potential of rehabilitated areas to support local fauna species. The observed encroachment of gliders using terrestrial boxes for the last five years further demonstrates how vital hollow availability is to forest ecosystem restoration.

5. RECOMMENDATIONS

Overall, the rehabilitation area is showing positive signs of re-colonisation by a variety of fauna species. The original proposition was that over time, as the age and structural complexity of the rehabilitation increases, species diversity will gradually match the diversity observed in the remnant forest (quadrat Q1, REM). This process was expected to take many decades, however as discussed above, the process is already being confirmed by the data analysis.

It is recommended that:

- Monitoring continue so that trends observed in the first 14 years may be better understood over a greater timeline.
- Nest boxes should continue to be monitored annually and any repairs/replacements made as required. To ensure that rehab areas continue to provide nesting habitat for fauna and to be able to quantify this, it is recommended that unavailable boxes be replaced or repaired prior to the next monitoring events in 2023.
- Control of weed species *Lantana camara* in the vicinity of the quadrats be undertaken to ensure this species does not become more widespread within the rehabilitation; and
- Monitoring woody debris every 3 to 5 years would provide insight into the natural decay process within the rehabilitation area. This in turn can be correlated to the success of the rehabilitation in terms of observed species richness. Furthermore, this information will allow informed recommendations regarding the initial rehabilitation design and management of ongoing natural processes as the rehabilitation is compared to the natural forest.

6. REFERENCES

Bibby, C.J., Burgess, N.D. and Hill, D.A. (2000). Bird Census Techniques. Academic Press Limited, London.

Butts, S.R. and McComb, W. (2000). Associations of Forest-Floor Vertebrates with Coarse Woody Debris in Managed Forests of Western Oregon, The Journal of Wildlife Management, 64:1, 95-104.

Carey, A.B. and Johnson, M.L. (1995). Small mammals in Managed, Naturally Young, and Old-Growth Forests, Ecological Applications, 5:2, 336-352.

Clarke, K.R. and Gorley, R.N. (2006). PRIMER v6: User Manual/Tutorial. PRIMER-E, Plymouth.

Ecobiological (2008) Donaldson Rehabilitation Baseline Monitoring Report. Report prepared for Yancoal Australia Ltd.

Ireland, T.T., Wolters, G.L. and Schemnitz, S.D. (1994). Recolonization of Wildlife on a Coal Strip-mine in North-western New Mexico, The Southwestern Naturalist 39(1): 53-57.

Lada, H., Thomson, J.R., MacNally, R., Horrocks, G. and Taylor, A.C. (2007). Evaluating simultaneous impacts of three anthropogenic effects on a floodplain-dwelling marsupial Antechinus flavipes, Biological Conservation 134: 527-536.

Loeb, S.C. (1999). Responses of Small Mammals to Coarse Woody Debris in a South-eastern Pine Forest, Journal of Mammalogy, 80:2, 460-471.

MacArthur, R.H. and MacArthur, J.W. (1961). On bird species diversity, Ecology, 42, 594- 598.

MacNally, R. (2006). Longer-term response to experimental manipulation of fallen timber on forest floors of floodplain forest in south-eastern Australia, Forest Ecology and Management, 229: 155-160.

MacNally, R. and Horrocks, G. (2007). Inducing whole-assemblage change by experimental manipulation of habitat structure, Journal of Animal Ecology 76: 643-650.

MacNally, R., Parkinson, A., Horrocks, G., Conole, L. and Tzaros, C. (2001). Relationships between terrestrial vertebrate diversity, abundance and availability of coarse woody debris on south-eastern Australian floodplains, Biological Conservation, 99: 191-205.

Munro, N.T., Lindenmayer, D.B. and Fischer, J. (2007). Faunal response to revegetation in agricultural areas of Australia: A review, Ecological Society of Australia 8: 199-207.

Robinson , R. (1997). Dynamics of coarse woody debris in flood-plain forests: impacts of forest management and flood frequency. BSc (Hons) Thesis, Charles Sturt University.

Rossi S. (2003). Birds, mammals and their habitat in a variegated landscape in the western Strzelecki Ranges. Masters Thesis, School of Applied Sciences, Faculty of Science, Monash University, Melbourne, Vic.

Tews, J., Brose, U., Grimm, V., Tielborger, K., Wichmann, M.C., Schwager, M. and Jeltsch, F. (2004). Animal species diversity driven by habitat heterogeneity/diversity: the importance of keystone structures. Journal of Biogeography, 31, 79–92.

Watson, D.M. (2001). Mistletoe – a keystone resource in forests and woodlands worldwide. Annual Review of Ecological Systematics, 32: 219-249

APPENDIX A: FAUNA SPECIES RECORDED AT EACH QUADRAT PER YEAR

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q1 (remnant)												Q2 (rehab)											
Scientific Name	**Common Name**	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Amphibians																									
Limnodynastes peroni	Striped Marsh Frog																								
Limnodynastes tasmaniensis	Spotted Marsh Frog																								
Litoria latopalmata	Broad-palmed Frog			+																					
Pseudophryne bibronii	Bibron's Toadlet				+																				
Pseudophryne coriacea	Red-backed Toadlet										+	+	+											+	+
Total		0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1
Birds																									
Sphecotheres vieilloti	Australasian Figbird																								
Cracticus tibicen	Australian King Parrot																								
Cracticus tibicen	Australian Magpie					+							+												
Corvus coronoides	Australian Raven		+		+	+		+	+		+	+	+							+			+		+
Geopelia humeralis	Bar-shouldered Dove				+		+						+	+	+						+				
Manorina melanophrys	Bell Miner											+													
Coracina novaehollandiae	Black-faced Cuckoo-shrike				+	+	+				+							+	+				+		
Elanus axillaris	Black-shouldered Kite																								
Gerygone mouki	Brown Gerygone																								
Acanthiza pusilla	Brown Thornbill		+		+										+	+	+			+	+				
Melithreptus brevirostris	Brown-headed Honeyeater						+						+										+		+
Cacomantis variolosus	Brush Cuckoo				+																				
Acanthiza reguloides	Buff-rumped Thornbill																								
Scythrops novaehollandiae	Channel-billed Cuckoo					+			+		+							+					+		+
Coracina tenuirostris	Cicadabird	+			+			+	+			+	+										+		+

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q1 (remnant)												Q2 (rehab)											
Scientific Name	**Common Name**	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Phaps chalcoptera	Common Bronzewing																								
Eurystomus orientalis	Dollarbird																								
Eudynamys orientalis	Eastern Koel	+	+			+								+					+	+			+		
Platycercus eximius	Eastern Rosella										+		+												+
Acanthorhynchus tenuirostris	Eastern Spinebill	+	+			+							+	+					+					+	+
Eopsaltria australis	Eastern Yellow Robin		+				+	+	+		+	+			+	+	+		+			+	+	+	
Cacomantis flabelliformis	Fan-tailed Cuckoo													+					+				+		
Calyptorhynchus lathami	Glossy Black Cockatoo									+			+												
Pachycephala pectoralis	Golden Whistler								+		+	+								+	+				
Cracticus torquatus	Grey Butcherbird	+					+	+		+	+	+		+					+			+			
Rhipidura fuliginosa	Grey Fantail	+	+	+			+		+	+		+							+	+		+		+	
Colluricincla harmonica	Grey Shrike-thrush											+			+	+			+					+	
Dacelo novaeguineae	Laughing Kookaburra	+		+	+	+	+	+	+	+	+				+				+	+			+		+
Myiagra rubecula	Leaden Flycatcher				+						+				+										
Meliphaga lewinii	Lewin's Honeyeater								+				+												
Hieraaetus morphnoides	Little Eagle																								
Glossopsitta concinna	Little Lorikeet										+														
Dicaeum hirundinaceum	Mistletoebird		+		+						+	+				+		+		+			+	+	
Glossopsitta concinna	Musk Lorikeet																								
Phylidonyris novaehollandiae	New Holland Honeyeater																								
Philemon corniculatus	Noisy Friarbird	+	+		+			+	+		+	+	+	+				+		+	+		+	+	
Oriolus sagittatus	Olive-backed Oriole	+		+	+			+	+		+	+									+				+
Turnix varia	Painted Button-quail														+										
Cracticus nigrogularis	Pied Butcherbird	+									+			+									+		
Strepera graculina	Pied Currawong	+		+			+	+				+				+								+	+
Ninox strenua	Powerful Owl																								

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q1 (remnant)												Q2 (rehab)											
Scientific Name	**Common Name**	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Trichoglossus haematodus	Rainbow Lorikeet	+		+		+				+	+	+	+								+	+	+	+	+
Neochmia temporalis	Red-browed Finch														+										
Anthochaera carunculata	Red Wattlebird																								
Rhipidura rufifrons	Rufous Fantail																								
Pachycephala rufiventris	Rufous Whistler	+		+	+	+								+	+	+	+				+	+			
Todiramphus sanctus	Sacred Kingfisher	+			+	+	+	+	+	+	+														
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet									+		+													
Myzomela sanguinolenta	Scarlet Honeyeater				+	+	+		+			+	+					+			+			+	
Zosterops lateralis	Silvereye													+		+	+						+		
Pardalotus punctatus	Spotted Pardalote							+	+	+		+	+						+	+			+		
Acanthiza lineata	Striated Thornbill				+		+			+	+								+			+	+	+	
Malurus cyaneus	Superb Fairy-wren				+	+	+		+	+	+							+	+		+	+	+		
Hirundo nigricans	Tree Martin																								
Malurus lamberti	Variegated Fairy-wren		+	+											+										
Hirundo neoxena	Welcome Swallow													+											
Sericornis frontalis	White-browed Scrubwren	+			+		+							+	+				+		+		+		+
Melithreptus lunatus	White-naped Honeyeater	+												+											
Hirundapus caudacutus	White-throated Needletail			+																					
Eurostopodus mystacalis	White-throated Nightjar				+																				
Cormobates leucophaeus	White-throated Treecreeper		+			+	+				+	+	+										+		+
Corcorax melanorhamphos	White-winged Chough			+										+			+								
Rhipidura leucophrys	Willie Wagtail												+												
Acanthiza nana	Yellow Thornbill		+																						
Lichenostomus chrysops	Yellow-faced Honeyeater	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+		+	+	+
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo																								
Total		16	12	10	19	14	15	11	15	10	20	18	16	14	12	8	6	7	14	10	11	7	19	11	13

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q1 (remnant)												Q2 (rehab)										
Scientific Name	**Common Name**	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
	Bats																								
Austronomus australis	White-striped Mastiff Bat					+	+	+	+	+	+		+				+	+	+	+		+	+		+
Chalinolobus gouldii	Gould's Wattled bat					+	+	+	+	+	+	+	+				+	+	+	+	+	+	+	+	+
Chalinolobus morio	Chocolate Wattled Bat						+		+	+		+							+	+	+				
Falsistrellus tasmaniensis	# Eastern False Pipistrelle						+		+										+		+				
Micronomus norfolkensis	# Eastern Coastal Free-tailed Bat											+	+					+	+						
Miniopterus australis	# Little Bent-wing Bat				+		+	+	+	+	+	+							+	+	+		+	+	
Miniopterus orianae oceanensis	# Large Bent-winged Bat												+				+								+
Mormopterus ridei	Eastern Free-tailed Bat						+			+	+	+	+					+	+		+	+	+	+	+
Myotis macropus	# Southern Myotis						+												+						
Nyctophilus sp.	Unidentified Long-eared Bat sp.					+				+		+	+				+				+	+	+	+	+
Rhinolophus megaphyllus	Eastern Horseshoe Bat						+																+	+	
Scoteanax rueppellii	# Greater Broad-nosed Bat										+	+						+				+	+		
Scotorepens orion	Eastern Broad- nosed bat							+	+	+	+	+					+		+			+	+	+	
Vespadelus darlingtoni	Large Forest Bat																								
Vespadelus pumilus	Eastern Forest Bat										+	+	+				+		+	+			+	+	+
Vespadelus troughtoni	Eastern Cave Bat									+			+									+		+	
Vespadelus vulturnus	Little Forest Bat					+	+		+	+	+	+	+				+		+	+				+	+
Total		0	0	0	1	4	9	4	7	9	8	10	9	0	0	0	7	5	11	6	6	7	9	9	7
	Mammals																								
Antechinus stuartii	Brown Antechinus	+	+	+	+	+	+	+	+		+	+	+		+				+	+		+	+	+	+
Macropus giganteus	Eastern Grey Kangaroo	+																							
Macropus rufogriseus	Red- necked Wallaby																								
Mus domesticus	*House Mouse																								
Perameles nasuta	Long-nosed Bandicoot											+													
Petaurus breviceps	Sugar Glider												+								+				+

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q1 (remnant)												Q2 (rehab)											
Scientific Name	**Common Name**	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Rattus fuscipes	Bush Rat													+			+								
Rattus rattus	*Black Rat					+									+										+
Sminthopsis murina	Common Dunnart																								
Trichosorus vulpecula	Common Brushtail Possum		+	+	+	+	+		+	+	+	+	+						+	+	+	+	+	+	+
Wallabia bicolor	Swamp Wallaby										+	+	+									+	+	+	+
Total		2	2	2	2	3	2	1	2	1	3	4	4	1	2	0	1	0	2	2	2	3	3	3	5
	Reptiles																								
Amphibolurus muricatus	Jacky Lizard	+	+	+			+							+	+	+									
Amphibolurus nobbi	Nobbi Dragon																								
Carlia tetradactyla	Southern Rainbow Skink										+														
Ctenotus robustus	Robust Striped Skink																								
Demansia psammophis	Yellow-faced Whip Snake						+					+									+		+		
Lampropholis delicata	Garden Skink		+	+	+		+				+	+	+							+	+	+	+	+	+
Lampropholis guichenoti	Grass Skink		+											+											
Pogona barbata	Eastern Bearded Dragon								+																
Pseudonaja textilis	Eastern Brown Snake																								
Varanus varius	Lace Monitor	+		+																				+	
Total		2	2	3	3	1	0	3	0	1	0	2	1	2	2	1	1	0	0	0	1	2	1	2	1
Yearly Totals		20	17	16	24	21	29	16	25	20	34	35	30	17	15	9	14	12	27	19	21	18	34	25	26

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q3 (rehab)												Q4 (rehab)											
Scientific Name	Common Name	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Amphibians																									
Limnodynastes peroni	Striped Marsh Frog																								
Limnodynastes tasmaniensis	Spotted Marsh Frog																								
Litoria latopalmata	Broad-palmed Frog	+			+											+	+								
Pseudophryne bibronii	Bibron's Toadlet																								
Pseudophryne coriacea	Red-backed Toadlet											+	+				+		+					+	+
Total		1	0	0	1	0	0	0	0	0	0	1	1	0	0	1	2	0	1	0	0	0	0	1	1
Birds																									
Sphecotheres vieilloti	Australasian Figbird																							+	
Cracticus tibicen	Australian King Parrot											+													
Cracticus tibicen	Australian Magpie									+	+		+		+							+			
Corvus coronoides	Australian Raven	+						+			+		+		+								+		
Geopelia humeralis	Bar-shouldered Dove								+							+			+	+			+		
Manorina melanophrys	Bell Miner																								
Coracina novaehollandiae	Black-faced Cuckoo-shrike						+				+									+					
Elanus axillaris	Black-shouldered Kite	+												+	+										
Gerygone mouki	Brown Gerygone																								
Acanthiza pusilla	Brown Thornbill		+	+	+				+			+		+			+								
Melithreptus brevirostris	Brown-headed Honeyeater																							+	
Cacomantis variolosus	Brush Cuckoo						+																		
Acanthiza reguloides	Buff-rumped Thornbill																		+						
Scythrops novaehollandiae	Channel-billed Cuckoo										+								+	+			+		
Coracina tenuirostris	Cicadabird								+	+	+												+		+
Phaps chalcoptera	Common Bronzewing					+																			
Eurystomus orientalis	Dollarbird																								
Eudynamys orientalis	Eastern Koel																								
Platycercus eximius	Eastern Rosella																								

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q3 (rehab)												Q4 (rehab)											
Scientific Name	Common Name	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Acanthorhynchus tenuirostris	Eastern Spinebill				+	+						+								+					
Eopsaltria australis	Eastern Yellow Robin						+		+	+	+	+										+	+	+	+
Cacomantis flabelliformis	Fan-tailed Cuckoo										+														
Calyptorhynchus lathami	Glossy Black Cockatoo																								
Pachycephala pectoralis	Golden Whistler						+	+			+									+			+		
Cracticus torquatus	Grey Butcherbird									+													+		
Rhipidura fuliginosa	Grey Fantail						+	+		+							+		+	+				+	
Colluricincla harmonica	Grey Shrike-thrush					+	+	+											+						
Dacelo novaeguineae	Laughing Kookaburra										+		+							+			+		
Myiagra rubecula	Leaden Flycatcher														+										
Meliphaga lewinii	Lewin's Honeyeater												+										+		
Hieraaetus morphnoides	Little Eagle		+																						
Glossopsitta concinna	Little Lorikeet																								
Dicaeum hirundinaceum	Mistletoebird		+				+			+	+	+			+			+	+				+	+	
Glossopsitta concinna	Musk Lorikeet																								
Phylidonyris novaehollandiae	New Holland Honeyeater						+																		
Philemon corniculatus	Noisy Friarbird						+				+		+						+					+	+
Oriolus sagittatus	Olive-backed Oriole			+																					
Turnix varia	Painted Button-quail	+	+	+	+										+										
Cracticus nigrogularis	Pied Butcherbird																						+		
Strepera graculina	Pied Currawong										+		+												
Ninox strenua	Powerful Owl											+													
Trichoglossus haematodus	Rainbow Lorikeet					+					+	+										+	+	+	+
Neochmia temporalis	Red-browed Finch				+			+				+				+									
Anthochaera carunculata	Red Wattlebird										+														
Rhipidura rufifrons	Rufous Fantail																								

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q3 (rehab)												Q4 (rehab)											
Scientific Name	Common Name	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Pachycephala rufiventris	Rufous Whistler	+		+	+	+			+			+	+		+	+	+	+	+	+	+	+			+
Todiramphus sanctus	Sacred Kingfisher																				+				
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet																								
Myzomela sanguinolenta	Scarlet Honeyeater				+	+		+	+			+	+				+							+	+
Zosterops lateralis	Silvereye	+		+	+		+	+			+			+	+	+	+		+	+			+		
Pardalotus punctatus	Spotted Pardalote						+			+													+		
Acanthiza lineata	Striated Thornbill							+			+	+	+						+				+		
Malurus cyaneus	Superb Fairy-wren	+				+		+			+	+	+	+		+	+	+		+		+	+	+	+
Hirundo nigricans	Tree Martin													+											
Malurus lamberti	Variegated Fairy-wren	+													+	+								+	
Hirundo neoxena	Welcome Swallow													+											
Sericornis frontalis	White-browed Scrubwren	+					+	+						+		+								+	
Melithreptus lunatus	White-naped Honeyeater																								
Hirundapus caudacutus	White-throated Needletail																								
Eurostopodus mystacalis	White-throated Nightjar																								
Cormobates leucophaeus	White-throated Treecreeper										+														+
Corcorax melanorhamphos	White-winged Chough																							+	
Rhipidura leucophrys	Willie Wagtail																								+
Acanthiza nana	Yellow Thornbill																							+	
Lichenostomus chrysops	Yellow-faced Honeyeater			+	+	+	+	+	+		+	+	+			+	+	+	+	+	+		+	+	+
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo																								
Total		8	4	6	8	8	13	11	7	7	19	13	11	7	9	8	7	4	11	11	3	5	17	14	10
Bats																									
Austronomus australis	White-striped Mastiff Bat						+	+		+	+		+												+
Chalinolobus gouldii	Gould's Wattled bat				+		+	+	+	+	+	+	+											+	+
Chalinolobus morio	Chocolate Wattled Bat					+	+	+	+																

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q3 (rehab)												Q4 (rehab)											
Scientific Name	Common Name	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Falsistrellus tasmaniensis	# Eastern False Pipistrelle						+		+																
Micronomus norfolkensis	# Eastern Coastal Free-tailed Bat				+	+	+	+			+		+												+
Miniopterus australis	# Little Bent-wing Bat						+					+												+	
Miniopterus orianae oceanensis	# Large Bent-winged Bat				+								+												
Mormopterus ridei	Eastern Free-tailed Bat						+		+	+		+	+												
Myotis macropus	# Southern Myotis				+		+																		
Nyctophilus sp.	Unidentified Long-eared Bat sp.					+					+	+												+	+
Rhinolophus megaphyllus	Eastern Horseshoe Bat						+																		
Scoteanax rueppellii	# Greater Broad-nosed Bat									+															
Scotorepens orion	Eastern Broad- nosed bat				+						+	+													
Vespadelus darlingtoni	Large Forest Bat										+														
Vespadelus pumilus	Eastern Forest Bat				+		+	+			+	+	+											+	
Vespadelus troughtoni	Eastern Cave Bat											+	+												
Vespadelus vulturnus	Little Forest Bat				+		+	+		+		+	+											+	+
Total		0	0	0	7	3	11	6	4	5	7	8	8	0	0	0	0	0	0	0	0	0	0	5	5
Mammals																									
Antechinus stuartii	Brown Antechinus							+		+	+	+	+					+	+	+		+	+	+	+
Macropus giganteus	Eastern Grey Kangaroo																								
Macropus rufogriseus	Red- necked Wallaby																								
Mus domesticus	*House Mouse																								
Perameles nasuta	Long-nosed Bandicoot		+	+												+			+						+
Petaurus breviceps	Sugar Glider												+												
Rattus fuscipes	Bush Rat				+																				
Rattus rattus	*Black Rat		+			+	+							+	+			+					+		
Sminthopsis murina	Common Dunnart																						+		
Trichosorus vulpecula	Common Brushtail Possum								+	+	+	+	+			+					+	+	+	+	+

+ indicates presence # Listed on NSW BC Act 2016 * Introduced species		Q3 (rehab)												Q4 (rehab)											
Scientific Name	Common Name	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22	'08	'09	'10	'11	'15	'16	'17	'18	'19	'20	'21	22
Wallabia bicolor	Swamp Wallaby																								
Total		0	2	1	1	1	1	1	1	2	2	2	3	1	1	2	0	2	2	1	1	2	4	2	3
Reptiles																									
Amphibolurus muricatus	Jacky Lizard	+					+							+			+								+
Amphibolurus nobbi	Nobbi Dragon																								
Carlia tetradactyla	Southern Rainbow Skink												+								+		+	+	
Ctenotus robustus	Robust Striped Skink		+											+	+	+									
Demansia psammophis	Yellow-faced Whip Snake			+						+							+			+		+			
Lampropholis delicata	Garden Skink						+		+										+	+					+
Lampropholis guichenoti	Grass Skink																								
Pogona barbata	Eastern Bearded Dragon																								
Pseudonaja textilis	Eastern Brown Snake													+			+								
Varanus varius	Lace Monitor											+													
Total		2	1	1	1	0	0	2	0	1	1	1	1	0	3	1	1	3	0	1	2	1	1	1	2
Yearly Totals		10	7	8	17	12	27	18	13	15	28	25	24	11	11	12	12	6	15	14	5	8	22	23	21

APPENDIX B: TERRESTRIAL AND ARBOREAL NEST BOXES

Plate 9: Arboreal Nest Box

Plate 10: Terrestrial nest box

APPENDIX C: NATIVE FAUNA PHOTOS

Plate 11: **Sugar Glider (*Petaurus breviceps*)**

Plate 12: **Brown Antechinus (*Antechinus stuartii*)**

Plate 13: **Sugar Glider (*Petaurus breviceps*)**

Plate 14: **Garden Skink (*Lampropholis guichenoti*)**

APPENDIX D: LICENSING

Wedgetail employees involved in the current study are licensed or approved under the National Parks and Wildlife Act 1974 (License Number: SL102506, Expiry: 28 February 2024) and the Animal Research Act 1985 to harm/trap/release protected native fauna and to pick for identification purposes native flora and to undertake fauna surveys.

APPENDIX 1 STAFF CONTRIBUTIONS

The following staff were involved in the compilation of this report.

Name	Qualification	Title/Experience	Contribution
Mark Dean	B EnvSc&Mgt	Ecologist	Fauna surveys, Report Writing
Jake Mauger	B EnvSc&Mgt	Ecologist	Report writing
Isaac Blundell		Junior Ecologist	Fauna Surveys
Kane Blundell	BT/BA & GCert Spatial Science (in progress)	GIS Specialist	GIS Preparation

2022 Rehabilitation Monitoring Report

Donaldson Coal Mine, Beresfield, New South Wales

Final
20 February 2023

2022 Rehabilitation Monitoring Report

Donaldson Coal Mine, Beresfield, New South Wales

REPORT PREPARED FOR:

Donaldson Coal PTY LTD

REPORT PREPARED BY:

WEDGETAIL PROJECT CONSULTING PTY LTD
PO Box 234
Cardiff, NSW 2285

ABN: 93 640 388 683

File Ref: 2022 Donaldson Rehabilitation Monitoring Report V3

Version Control

Rev. No.	Revision Date	Author / Position	Reviewer	Details
Rev 1	10 February 2023	Nigel Fisher Senior Ecologist	Jonathan Berry Principal Advisor	Draft for Client review
Rev 2	13 February 2023	Nigel Fisher Senior Ecologist		Response to Client Comments
Final	20 February 2023	Nigel Fisher Senior Ecologist		Final

Contents

Figures

Tables

Plates

Appendices

1. INTRODUCTION

1.1 BACKGROUND

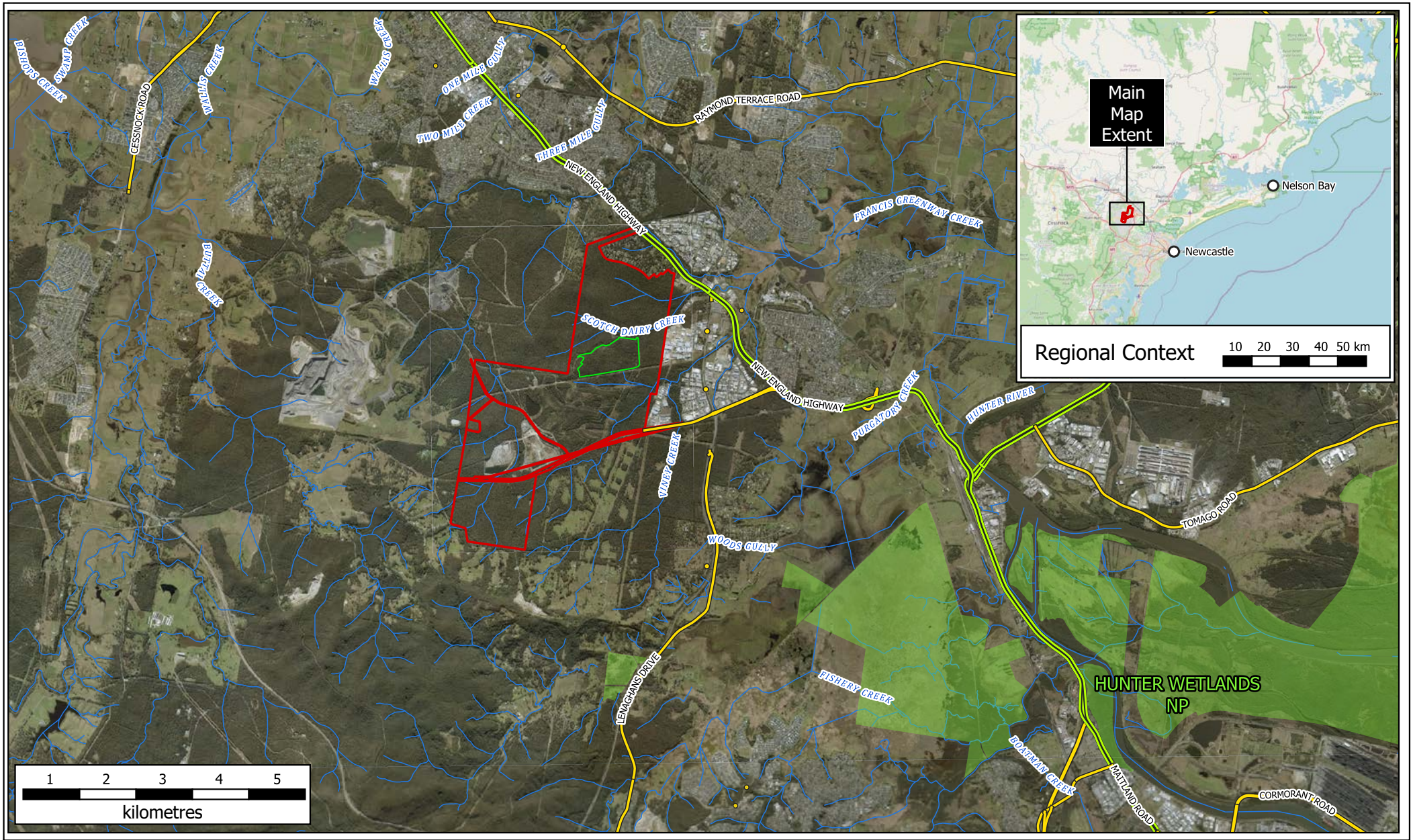
The Donaldson Open Cut coal mine is owned and operated by Donaldson Coal Pty Ltd, a wholly owned subsidiary of Yancoal Australia Limited. The development of the mine started in January 2001 with first coal production in March of that year. Production continued until April 2013 with consent lapsing in December 2013, with the open cut mine placed into care and maintenance at that time. However certain conditions, including rehabilitation and monitoring continue to be applicable (RMP, 2022).

Progressive backfilling of the open cut void commenced as soon practicable with the majority of the overburden having been placed since 2002. Revegetation commenced in 2004 with the latest revegetation completed in 2014 (RMP, 2022). Formal monitoring of the revegetation using the current methodology commenced in August 2009, undertaken by Global Soils Systems (GSS, 2019). The initial monitoring established six monitoring quadrats consisting of five rehabilitation quadrats on the revegetated overburden dump and one analogue quadrat in native woodland adjacent to the mine operations. With continuing progressive revegetation, further monitoring events occurred in successive years with additional monitoring quadrats added as required. GSS undertook the seventh monitoring event in 2019 when the final three monitoring quadrats were established. This marks the eighth monitoring event, the first undertaken by Wedgetail Project Consulting (WPC) Pty Ltd. A total of 10 quadrats have been monitored in 2022.

1.2 SCOPE

WPC was contracted to conduct the latest round of rehabilitation monitoring at the Donaldson coal mine utilising the the existing methodology. In addition, WPC was tasked with examining the oldest rehabilitation – 2004 and 2005 – to determine its suitablity for surrender and make recommendations to assist Donaldson Coal in achieving surrender. Thus a walkover of the 2004 and 2005 rehabilitation areas was conducted in additon to the quadrat monitoring.

The walkover monitoring was conducted on the 26th and 28th of October, 2022 with the quadrat monitoring conducted from the 2nd to the 5th of November, 2022.



Created by: KBlundell
Date: 03.02.2023

WEDGETAIL
PROJECT CONSULTING PTY LTD
https://wedgetail.com.au

Legend

- Subject Site
- Relinquishment Area
- National Park
- Primary Road
- Arterial Road
- Sub-Arterial Road
- Watercourse

Locality

Figure: **1**

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N

2. METHODOLOGY

The methodology and rationale for the monitoring as developed by GSS is based upon guidelines proposed in an Australian Coal Association Research Program (ACARP) study *Development of Rehabilitation Completion Criteria for Native Ecosystem Development on Coal Mines in the Hunter Valley – ACARP Hunter Valley Project C13048*, (Nicholls, 2005). With the revegetation effort aiming to reconstruct native woodland/forest the monitoring program focuses on the assessment of variable aged native tree plots, Quadrats 2 - 10, and compares them to the analogue quadrat located in unmined native forest, Quadrat 1.

The vegetation data is collected from 20m x 10m quadrats with five nested 2m x 2m plots located on the centre line. A 50m erosion transect is located down the centre line of the main quadrat and extends either side, parallel to the contour. Photo monitoring points are located at either end of the main quadrat. The data collected is summarised in **Table 1** below.

Table 1: Summary of data collection methodology

Plot Size	Data Collected
General Description	Describe the vegetation in general terms, e.g., mixed eucalypt woodland with grassy understorey, shrubby etc.
2m x 2m plots	Count of the total number of plants excluding grasses. Measure live vegetation cover for understorey and grasses separately using a line intercept method. Record details of ground cover including rocks, leaf litter, logs
20m x 10m Quadrat	Count by species of all trees and shrubs. Tag and measure DBH of trees >1.6m tall, to a maximum of 6 for any one species Record canopy cover over the whole 20m centreline when trees are tall enough. Subjectively describe tree health, by species if relevant, noting signs of drought stress, nutrient deficiencies, disease and severe insect attack. Where health problems are noted, record percentage of trees affected. Collect a soil sample for analysis – take five surface subsamples at approx. 5m intervals along the centreline and bulk together and subsample. See soils section for further details. Photographic Monitoring – a photo is be taken from each end of the quadrat looking in, along the centreline.
	For each 20m x 10m quadrat.
50m Transect	Record location, depth, and dimensions of all gullies >30cm wide and/or 30cm deep Measure the distance to the soil surface at installed erosion pins
Rehabilitation in general	When traversing between quadrats observe and note species not recorded elsewhere as well as any obvious problems such as bare patches and weeds.

A major change in the methodology this survey was the exclusion of species that are not classified as shrub, midstorey or canopy as defined by the Biodiversity Assessment Methodology from the stem counts. This removed species such as *Pteridium esculentum, Dianella caerulea, Kennedia rubicunda* and *Lomandra longifolia* from the stem counts and for some quadrats, resulted in large reductions in stem density from the 2019 survey.

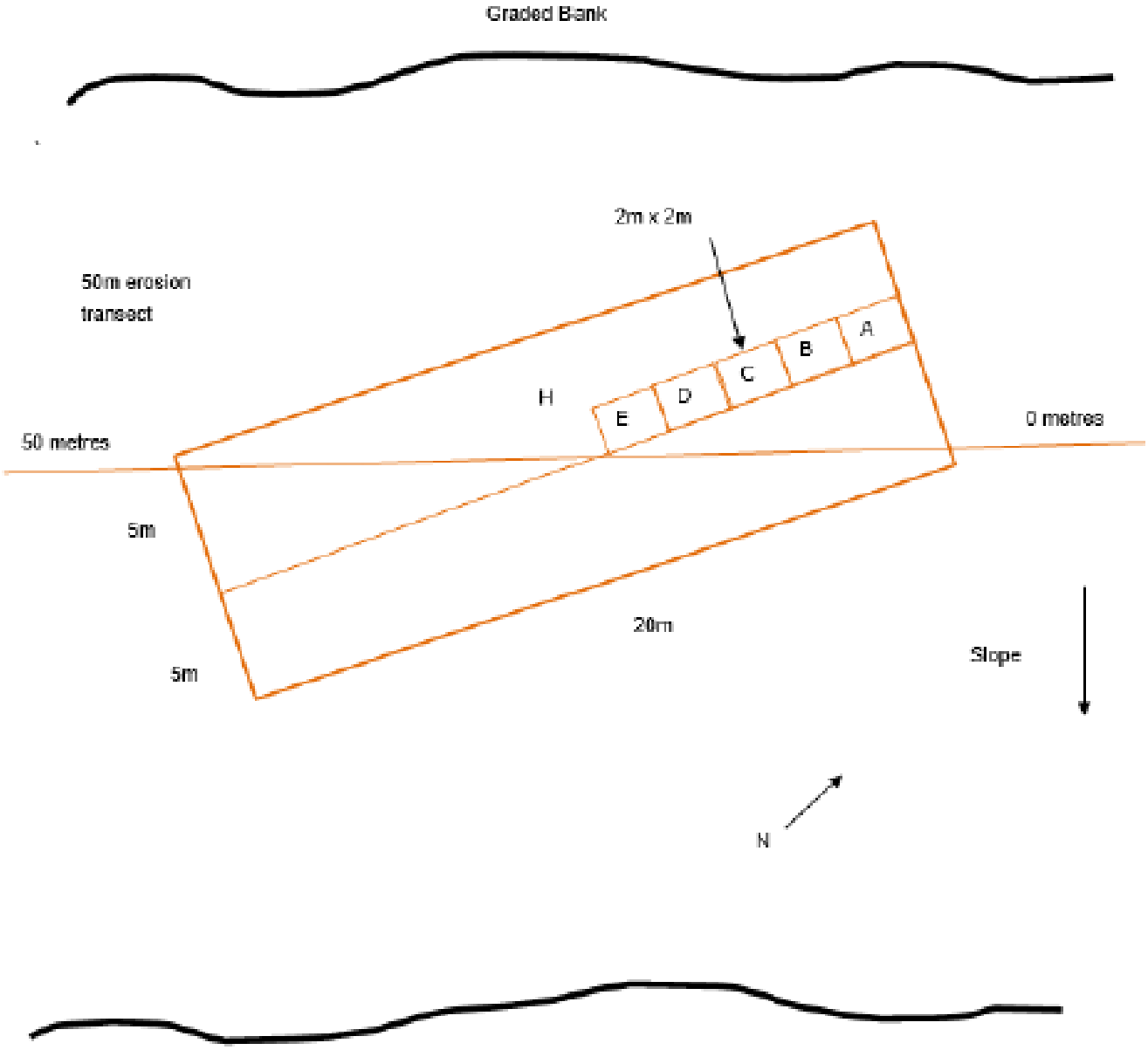
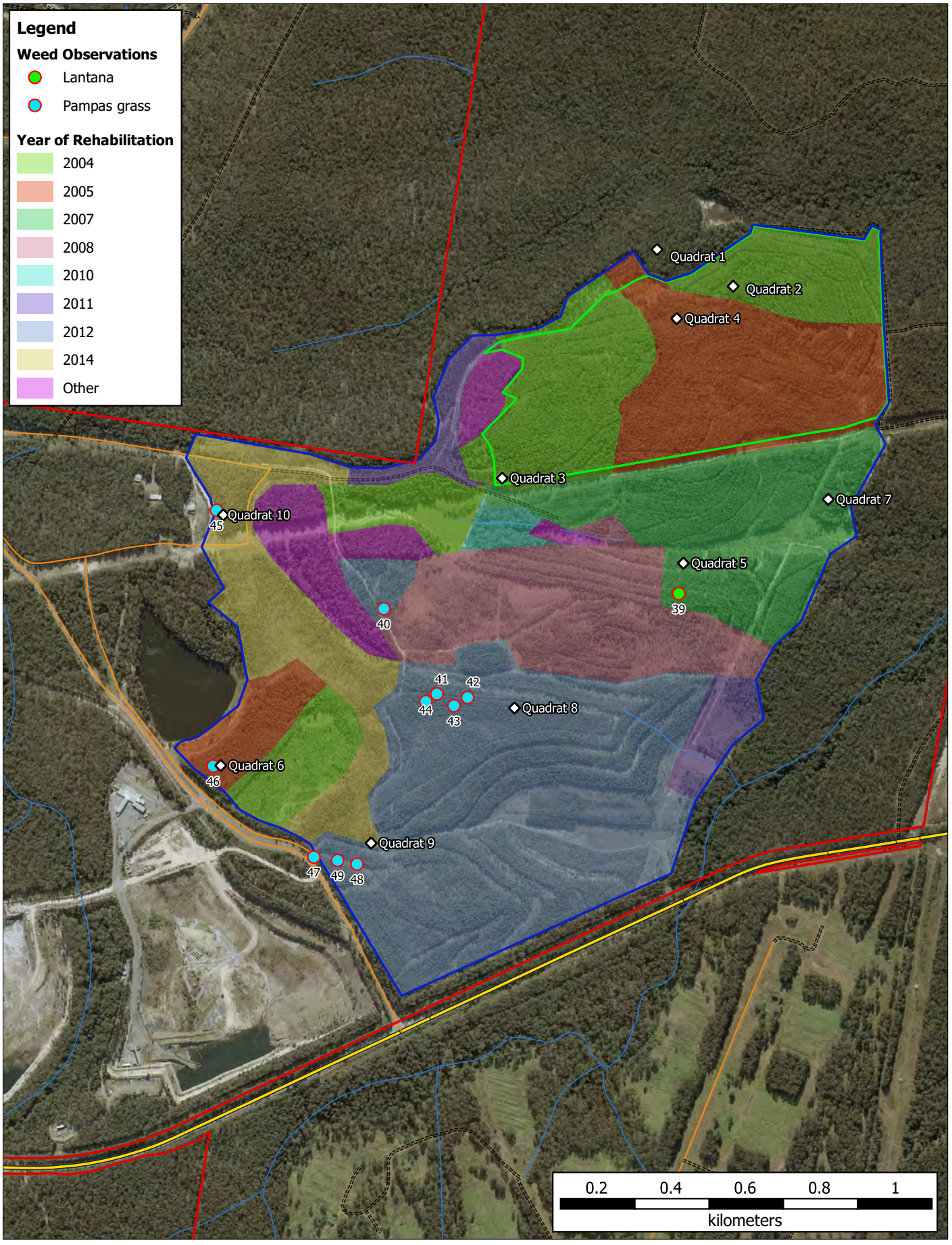


Figure 2: Representative design of the monitoring quadrats (GSS, 2019).

The location and ages of each monitoring quadrat are shown in **Figure 3** and **Table 2** below



Created by: KBlundell
Date: 07.02.2023

WEDGETAIL PROJECT CONSULTING

https://wedgetail.com.au

Legend

- Donaldson Coal Mine Lease
- Subject Site (Rehab Areas)
- Relinquishment Area
- Monitoring Quadrats
- Watercourse
- Arterial Road
- Local Road
- Track-Vehicular

Quadrat Locations

Figure: 3

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N

Table 2: Designation and age of the various monitoring quadrats.

Quadrat No.	Nature of Quadrat	Year Seeded	Age of Rehab (yrs)	Year First Monitored
1	Analogue – unmined native forest			2009
2	Tree Plot	September 2003	19	2009
3	Tree Plot	September 2003	19	2009
4	Tree Plot	April 2005	17	2009
5	Tree Plot	March 2007	15	2009
6	Tree Plot	February 2006	14	2009
7	Tree Plot	February 2006	14	2010
8	Tree Plot	2012	10	2019
9	Tree Plot	2014	8	2019
10	Tree Plot	2013	9	2019

3. RESULTS

3.1 FLORA MONITORING

3.1.1 Quadrat 1

Quadrat 1 is the analogue quadrat located in unmined native forest to the north of the spoil emplacement (**Figure 3**). This area consisted of mature native tree species, *Angophora costata* (Smooth-barked Apple), *Eucalyptus gummifera* (Red Bloodwood), *E. globoidea* (White Stringybark) and *E. punctata* (Grey Gum) (**Plate 1**). The midstorey consisted of *Allocasuarina torulosa* (Forest Oak) and *Glochidion ferdinandi* (Cheese Tree), with a relatively sparse but diverse shrub layer. The groundcover was entirely native grasses and forbs with no weed species observed. Groundcover was estimated to be 100%, evenly split between native vegetation and litter, 50% each. Some dieback of the canopy was observed with some death of older trees, but regeneration with seedlings was also observed.

Plate 1: Quadrat 1 monitoring photos. Top 1A, Bottom 1B

Canopy cover over the 20m centreline – 40%.

Average annual height increment (tagged trees): 2022 - 13.46m (2019 – 13.79m). A net decrease of 0.33m.

Annual average girth increment (tagged trees): 2022 – 499mm (2019 – 470mm). A net increase of 29mm or 9.67mm/year.

Stems/ha calculation: 2022 – 3,100 stems/ha. 2019 – 5, 950 stems/ha. **Please Note** - only species that are considered trees and shrubs were included in the stem count this survey. Species excluded in 2022 included *Pteridium esculentum* and *Dianella caerulea.*

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level = 418mm. This equates to a calculated soil gain of 670 tonnes/ha since the 2019 survey (2019 – 485mm).

Table 3: Quadrat 1 20m x 10m quad flora results

Species	No.	Ht (approx) (m)	Girth (mm)	Comments
Allocasuarina torulosa	4	Tag No. 9 = 13m	432	Seedlings
Angophora costata	6	Tag No. 1 = 12m	464	
		Tag No. 5 = 23m	832	
		Tag No. 10 = 10m	302	
Corymbia gummifera	8	Tag No. 3 = dead		
		Tag No. 6 = 12m	422	Broken crown
		Tag No 7 = dead		
		Tag No 13 = 18m	580	
Eucalyptus globoidea		Tag No. 2 = 19m	1070	Seedlings
		Tag No. 11 = 12m	360	
Eucalyptus punctata	1	Tag No. 4 = 13m	408	
Persoonia linearis	8	Tag No. 8 = 2.6m	118	Bent over, Fruit on other individuals
Acacia elongata	2			
Billardiera scandens				
Breynia oblongifolia	1			
Dianella caerulea	5			
Dillwynia retorta	2			
Entolasia stricta				
Glochidion ferdinandi	3			
Glycine clandestina				
Gonocarpus teucrioides				
Hibbertia aspera	2			Flower
Imperata cylindrica				
Leucopogon juniperinus	3			
Lomandra obliqua				

Species	No.	Ht (approx) (m)	Girth (mm)	Comments
Macrozamia spiralis	1			
Notelaea microcarpa	1			
Pandorea pandorana				
Platysace ericoides				Flower
Podolobium ilicifolium	1			
Pomax umbellata				
Pteridium esculentum				
Themeda triandra				
Xanthorrhoea latifolia	11			

Table 4: Quadrat 1 2m x 2m plot flora results

2m x 2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	*Xanthorrhoea latifolia*	1	*Entolasia stricta*	10
	Notelaea microcarpa	1	*Lomandra obliqua*	5
	Pteridium esculentum	1	*Imperata cylindrica*	5
	Billardiera scandens	1	Litter	80
B	*Xanthorrhoea latifolia*	2	*Entolasia stricta*	40
	Pteridium esculentum	1	*Imperata cylindrica*	5
	Persoonia linearis	1	Litter	55
C	*Xanthorrhoea latifolia*	2	*Entolasia stricta*	10
	Pteridium esculentum	2	*Imperata cylindrica*	5
	Billardiera scandens	2	Litter	85
	Gonocarpus teucrioides	1		
D	*Stylidium graminifolium*	1	*Entolasia stricta*	40
	Lepyrodia scariosa	1	*Imperata cylindrica*	2
	Pteridium esculentum	1	Litter	50
	Eucalyptus globoidea	1	Bare soil	8
	Platysace ericoides	1		
	Hibbertia aspera	1		
	Pandorea pandorana	1		
E	*Persoonia linearis*	1	*Entolasia stricta*	30
	Allocasuarina torulosa	1	*Themeda triandra*	5
	Gonocarpus teucrioides	1	*Rytidosperma fulvum*	20
	Platysace ericoides	1	Bare Soil	2
			Litter	43

Percentage groundcover - 100% consisting of approximately 50% litter and 50% grasses and forbs. Grasses were dominated by *Entolasia stricta.* No weeds were recorded.

3.1.2 Quadrat 2

Quadrat 2 was not monitored this year due to being completely overrun by *Lantana camara* making it inaccessible (**Plate 2**).

Plate 2: Quadrat 2 monitoring photos. Top 2A, Bottom 2B

3.1.3 Quadrat 3

Quadrat 3 is located in the 2004 rehabilitation area and is now 19 years old. This is an open forest/closed woodland dominated by *Corymbia maculata* (Spotted Gum) with several *A. costata and Eucalyptus tereticornis* (Forest Red Gums) with a single *E. globoidea* recorded (**Plate 3**). Several of the tags used for tree measurements were not able to be located resulting in some new trees being measured. The shrub layer is sparse with a good cover of native grasses. Total groundcover was estimated to be 96%, 60% litter and 36% native vegetation with 4% soil, logs and rocks. The older *Acacias* have all died back, but there were a few *Acacia* seedlings and many *Eucalyptus* seedlings and saplings. Lantana is starting to encroach into the quadrat from the surrounding area.

Plate 3: Quadrat 3 monitoring photos. Top 3A Bottom 3B

Canopy cover over the 20m centreline – 70%.

Average annual height increment (tagged trees): 2022 – 14.44m (2019 – 13.00m). A net increase of 1.44m.

Annual average girth increment (tagged trees): 2022 – 499mm (2019 – 470mm). A net increase of 29mm or 9.67mm/year.

Stems/ha calculation: 2022 – 2, 650 stems/ha. 2019 – 3, 450 stems/ha. A reduction of 800 stems/ha. Self-thinning of *C maculata* from 42 stems in the quadrat in 2019 to 26 in 2022 mainly responsible.

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level = 465mm. This equates to a calculated soil loss of 450 tonnes/ha since the 2019 survey (2019 – 420mm).

Table 5: Quadrat 3 20m x10m quad flora results

Species	No.	Ht (approx) (m)	Girth (mm)	Comments
Allocasuarina torulosa	1			
Angophora costata	8	Tag No 9 = 7	223	
Corymbia maculata	26	Tag No 1 = 17m	639	No tags on trees, so measured new ones
		Tag No 2 = 17m	527	
		Tag No 3 = 15	568	
		Tag No 4 = 15	648	
		Tag No 5 = 17	573	
Eucalyptus tereticornis	6	Tag No 6 = 15	504	
		Tag No 7 = 15	565	
		Tag No 8 = 12	328	
Acacia decurrens	2			
Acacia spp.				seedlings
Amyema pendula				
Austrostipa pubescens				
Billardiera scandens				
Breynia oblongifolia	3			
Cheilanthes sieberi				
Clematis glycinoides				
Entolasia stricta				
Eucalyptus globoidea	1			
Kennedia rubicunda				
**Lantana camara*				
Leptospermum polygalifolium	1			
Leptospermum spp.	1			
Leucopogon juniperinus	1			
Lobelia purpurascens				
Lomandra longifolia				
Microlaena stipoides				
Oplismenus imbecillis				
Ozothamnus diosmifolius	3			
Pandorea pandorana				
Parsonsia straminea				
Passiflora herbertiana				
Pomax umbellata				

Note – previous tags unable to be located – new trees tagged and measured.

Table 6: Quadrat 3 2m x 2m plot flora results

2m x 2m Plots				
Plots	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	*Lomandra longifolia*	1	*Austrostipa pubescens*	40
	Breynia oblongifolia	1	*Cheilanthes sieberi*	30
	Clematis glycinoides	1	*Entolasia stricta*	2
			Lobelia purpurascens	2
			Soil, Logs & Rocks	1
			Leaf Litter	25
B	*Corymbia maculata*	3	*Austrostipa pubescens*	5
	Lomandra longifolia	1	*Entolasia stricta*	48
	Leucopogon juniperinus	1	*Lobelia purpurascens*	5
	Ozothamnus diosmifolius	1	*Oplismenus aemulus*	2
	Passiflora herbertiana	1	Soil, Logs & Rocks	10
	Lantana camara	1	Leaf Litter	30
C	*Corymbia maculata*	1	*Austrostipa pubescens*	15
	Ozothamnus diosmifolius	1	*Entolasia stricta*	25
	Passiflora herbertiana	1	*Lobelia purpurascens*	10
	Lantana camara	5	Soil, Logs & Rocks	5
			Leaf Litter	45
D	*Acacia decurrens*	1	*Austrostipa pubescens*	10
	Angophora costata	1	*Entolasia stricta*	25
	Clematis glycinoides	1	*Lobelia purpurascens*	15
	**Lantana camara*	2	Soil, Logs & Rocks	5
			Leaf Litter	45
E	*Angophora costata*	1	*Austrostipa pubescens*	5
	Corymbia maculata	1	*Entolasia stricta*	5
	Passiflora herbertiana	1	*Lobelia purpurascens*	2
			Soil, Logs & Rocks	5
			Leaf Litter	83

3.1.4 Quadrat 4

Quadrat 4 is located in the 2005 rehabilitation area after being seeded in April 2005. This area appears as young rehabilitation with dense canopy of various ages resulting in reduced vegetative ground cover, but dense leaf and woody cover (**Plate 4**). The canopy species are dominated by *C. maculata* with over 70 stems counted. Other canopy species were recorded in much smaller numbers (single digits) include *A. costata, E. globoidea, Eucalyptus moluccana* (Grey Box), *E. punctata* and *E. tereticornis.* Midstorey species included *Leptospermum polygalifolium* (Tantoon) and *A. torulosa.* Shrub species were sparse but with good diversity – seven species. There was

considerable fallen timber as the canopy species self-thin. Estimated total groundcover was 85% consisting of 20% vegetation and 65% litter. The remaining 25% was soil, logs and rock.

Plate 4: Quadrat 4 monitoring photos. Top 4A, Bottom 4B.

Canopy cover over the 20m centreline – 60%.

Average annual height increment (tagged trees): 2022 - 10.46m (2019 – 9.75m). A net increase of 0.71m.

Annual average girth increment (tagged trees): 2022 – 422mm (2019 – 306mm). A net increase of 116mm or 39mm/year.

Stems/ha calculation: 2022 – 5250 stems/ha. 2019 – 10150 stems/ha. A net decrease of 4900 stems/ha. *C. maculata* numbers in the quadrat dropped substantially from 155 2019 to 70 in 2022.

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level = 390mm. This equates to a calculated soil loss of 130 tonnes/ha since the 2019 survey (2019 – 377mm).

Table 7: Quadrat 4 20m x10m quad flora results

Species	Number	Ht (approx) (m)	Girth (mm)	Comments
Angophora costata	3	Tag No 2 = 15	608	New
Allocasuarina torulosa	2			
Corymbia maculata	70	Tag No 3 = 7	298	New
		Tag No 5 = 7	260	New
		Tag No 9 = 8	286	New
		Tag No 11 = 10	340	New
		Tag No 13 = 9	298	New
Eucalyptus globoidea	9	Tag No 4 = 12	504	New
		Tag No 7 = 15	584	New
		Tag No 10 = 10	437	New
Eucalyptus moluccana	1			
Eucalyptus punctata	2	Tag No 6 = 7	184	New
		Tag 8 = 3.5	218	Dieback - New
Eucalyptus tereticornis	2	Tag No 1 = 15	608	New
		Tag No 12 = 17	860	New
Acacia elongata	1			
Acacia longifolia	1			
Acacia spp.	5			seedlings
Amyema pendula				
Billardiera scandens				
Clematis glycinoides				
Dillwynia retorta	1			
Dodonaea triquetra				
Entolasia stricta				
Glycine clandestina				
**Hypochaeris radicata*				
**Lantana camara*				
Leptospermum polygalifolium	2			
Lobelia purpurascens				
**Megathyrsus maximus*				
Pultenaea spinosa	1			
Pultenaea villosa	1			
Solanum prinophyllum	4			

Note – all tree measurements are new trees. Original tags were not located.

Table 8: Quadrat 4 2mx 2m plot flora results

2m x 2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	*Angophora costata*	1	*Entolasia stricta*	20
	Billardiera scandens	2	*Glycine clandestina*	1
	Corymbia maculata	2	Soil, Logs & Rocks	15
	Pultenaea villosa	1	Leaf Litter	64
B	*Billardiera scandens*	3	*Entolasia stricta*	5
	Corymbia maculata	4	Termite Mound	3
	Leptospermum polygalifolium	1	Soil, Logs & Rocks	7
	Eucalyptus globoidea	1	Leaf Litter	85
C	*Allocasuarina torulosa*	1	*Entolasia stricta*	5
	Acacia spp. seedlings	1	Termite Mound	5
	Angophora costata (seedling)	1	Soil, Logs & Rocks	5
	Corymbia maculata	2	Leaf Litter	85
	Glycine clandestina	2		
D	*Corymbia maculata*	2	*Entolasia stricta*	5
	Eucalyptus punctata	1	Soil, Logs & Rocks	90
	Persoonia linearis (seedling)	1	Leaf Litter	5
E	*Billardiera scandens*	1	*Entolasia stricta*	20
	Corymbia maculata	2	Soil, Logs & Rocks	10
			Leaf Litter	70

3.1.5 Quadrat 5

Quadrat 5 is located in the 2008 rehabilitation having been seeded in March 2007. This area is woodland/forest that is beginning to open up, with a sparse shrub layer, and more limited diversity than has been recorded in the previous quadrats (**Plate 5**). The main canopy species is *C. maculata* with 49 stems counted. Other canopy species included *A. costata, Eucalyptus crebra* (Narrow-leafed Ironbark), *E. moluccana* and *E. tereticornis.* No true midstorey species were recorded in the quadrat and only a single shrub species, *Leucopogon juniperinus* was recorded. The ground layer was dominated by native grasses, with vegetation estimated to cover 60% of the quadrat, with 26% litter cover and the remaining 14% soil, logs and rocks. The dominant ground cover species was *Oplismenus imbecillis* (Creeping Beard Grass) indicating that this quadrat was located in a wetter area of the rehabilitation. Lantana was quite dense in and around the quadrat with thickets observed whilst traversing to the quadrat. *Senecio madagascariensis* (Fireweed) was the only other weed of any significance observed.

Plate 5: Quadrat 5 monitoring photos. Top 5A, Bottom 5B

Canopy cover over the 20m centreline – 60%.

Average annual height increment (tagged trees): 2022 – 11.0m (2019 – 9.9m). A net increase of 1.1m.

Annual average girth increment (tagged trees): 2022 – 589mm (2019 – 308mm). A net increase of 281mm or 94mm/year.

Stems/ha calculation: 2022 – 3, 350 stems/ha. 2019 – 6, 050 stems/ha. This equates to a net loss of 2, 700 stems/ha. Self-thinning of *C. maculata* from 85 stems in 2019 to 49 stems in 2022, plus exclusion of non-woody species accounted for the reduction in stem density.

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level = 359mm. This equates to a calculated soil loss of 40 tonnes/ha since the 2019 survey (2019 – 355mm).

Table 9: Quadrat 5 20m x 10m quad flora results

Species	Number	Ht (approx) (m)	Girth (mm)	Comments
Acacia implexa	3	Tag No 1 = 5	150	
Angophora costata	7			
Eucalyptus tereticornis	4	Tag No 2 = 15	490	
Eucalyptus moluccana	3	Tag No 3 = 7	233	
		Tag No 8 = N/A		Fallen over but alive
		Tag No 9 =10	2053	
Corymbia maculata	49	Tag No 4 = 12.5	404	
		Tag No 5 = 15	631	
		Tag No 6 = 15	528	
Stag		Tag No 7 = Dead		
Eucalyptus crebra	1	Tag No 10 = 8.5	222	
Amyema pendula				
Cheilanthes sieberi				
Dichondra repens				
Entolasia stricta				
Glycine tabacina				
Hardenbergia violacea				
**Lantana camara*				
Lobelia purpurascens				
Lomandra longifolia				
Oplismenus imbecillis				
Plectranthus parviflorus				
Poa labillardierei				
**Senecio madagascariensis*				

Table 10: Quadrat 5 2m x 2m plot flora results

2m x 2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	*Corymbia maculata*	1	*Entolasia stricta*	20
	**Lantana camara*	2	*Oplismenus imbecillis*	70
			Soil, Logs & Rocks	9
			Leaf Litter	1
B	*Angophora costata*	1	*Entolasia stricta*	5
	Corymbia maculata	1	*Oplismenus imbecillis*	70
	**Lantana camara*	2	*Glycine tabacina*	2
			Lobelia purpurascens	2
			Soil, Logs & Rocks	11
			Leaf Litter	10
C	*Corymbia maculata*	2	*Entolasia stricta*	10
			Oplismenus imbecillis	65
			Poa labillardierei	2
			Soil, Logs & Rocks	3
			Leaf Litter	20
D	**Lantana camara*	1	*Cheilanthes sieberi*	2
			Entolasia stricta	35
			Oplismenus imbecillis	9
			Glycine tabacina	1
			Lobelia purpurascens	1
			Soil, Logs & Rocks	2
			Leaf Litter	50
E	*Eucalyptus crebra*	1	*Entolasia stricta*	40
			Cheilanthes sieberi	2
			Dianella caerulea	2
			Lobelia purpurascens	2
			Oxalis exilis	1
			Plectranthus parviflorus	3
			Soil, Logs & Rocks	45
			Leaf Litter	5

3.1.6 Quadrat 6

Quadrat 6 is located in the 2005 rehabilitation area and was seeded in February 2006. It is currently an open forest/closed woodland with a moderate midstorey and shrub layer over a grassy ground cover (**Plate 6**). The canopy is dominated by *C. maculata* (30) but has good diversity with lower numbers of *A. costata* and *E. globoidea* (4 each), *C. gummifera* (3) and a single individual of *E. moluccana*, *E. punctata* and *E. tereticornis.* Midstorey species (although noy yet necessarily at true

midstorey height) included *A. implexa, A. torulosa* and *Polyscias sambucifolia* (Elderberry panax). Dieback of older *A. decurrens* and two of the tagged *E. tereticornis* was also observed. The ground cover was dominated by *Entolasia stricta* (wiry Panic) and *Themeda triandra* (Kangaroo Grass) with an estimated vegetative cover of 47%. Litter made up 50% of the cover with soil, logs and rocks making up the reaming 3%. Lantana was recorded in the quadrat and is evident in the surrounding area.

Plate 6: Quadrat 6 monitoring photos Top 6A, Bottom 6B

Canopy cover over the 20m centreline – 30%.

Average annual height increment (tagged trees): 2022 – 10.13m (2019 – 10.43m). A net decrease of 0.30m.

Annual average girth increment (tagged trees): 2022 – 399mm (2019 - 387mm). A net increase of 12mm or 4mm/year.

Stems/ha calculation: 2022 – 4,200 stems/ha. 2019 – 8,500 stems/ha. This equates to net loss 4,300 stems/ha. Self-thinning of *C. maculata* from 82 stems in 2019 to 30 stems in 2022 plus exclusion of non-woody species accounts for the reduction is species.

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level = 372mm. This equates to a calculated soil gain of 130 tonnes/ha since the 2019 survey (2019 – 385mm).

Table 11: Quadrat 6 20m x 10m quad flora results

Species	Number	Ht (approx) (m)	Girth (mm)	Comments
Acacia decurrens	0	Tag No 3 = dead	-	Dead
		Tag No 4 = dead	-	Dead
Angophora costata	4	Tag No 8 = 9	251	
		Tag No 12 = 12	567	
Corymbia maculata	30	Tag No 5 = 9	352	
		Tag No 6 = 9	285	
		Tag 7 = 11	515	
		Tag No 11 = 12	584	
Eucalyptus moluccana	1	Tag No 10 = 10	434	
Eucalyptus punctata	1	Tag No 2 = 9	200	
Eucalyptus tereticornis	1	Tag No 1 = dead	-	Dead
		Tag No 9 = dead	-	Dead
Acacia implexa	2			
Acacia irrorata	2			
Acacia longifolia	1			
Allocasuarina torulosa	15			
Corymbia gummifera	3			
Daviesia ulicifolia	3			
Dodonaea triquetra	6			
Eucalyptus globoidea	4			
Leucopogon spp.	3			
Ozothamnus diosmifolius	1			
Persoonia linearis	2			
Polyscias sambucifolia	5			
Amyema pendula				
Billardiera scandens				

Species	Number	Ht (approx) (m)	Girth (mm)	Comments
Cheilanthes sieberi				
Dianella caerulea				
Entolasia stricta				
Glycine clandestina				
Gonocarpus teucrioides				
Goodenia heterophylla				
Hibbertia aspera				
Kennedia rubicunda				
Lepyrodia scariosa				
Lobelia purpurascens				
Lomandra multiflora				
Megathyrsus maximus				
Polymeria calycina				
Pomax umbellata				
Themeda triandra				

Table 12: Quadrat 6 2m x2m plot flora results

2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	*Acacia implexa*	1	*Entolasia stricta*	30
	Corymbia maculata	1	**Megathyrsus maximus*	5
			Glycine tabacina	1
			Cheilanthes sieberi	1
			Lobelia purpurascens	2
			Goodenia heterophylla	1
			Soil, Logs & Rocks	5
			Leaf Litter	55
B	*Acacia spp. seedling*	1	*Entolasia stricta*	30
	Allocasuarina torulosa	1	**Megathyrsus maximus*	1
	Corymbia maculata	1	*Lobelia purpurascens*	1
			Dianella caerulea	1
			Hibbertia aspera	2
			Soil, Logs & Rocks	2
			Leaf Litter	63
C	*Allocasuarina torulosa*	1	*Entolasia stricta*	40
	Corymbia maculata	1	*Lobelia purpurascens*	1
	Leucopogon spp.	1	Soil, Logs & Rocks	1
			Leaf Litter	58

2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
D	No shrubs		*Entolasia stricta*	40
			Billardiera scandens	1
			Gonocarpus teucrioides	1
			Lepyrodia scariosa	1
			Themeda triandra	10
			Lobelia purpurascens	1
			Soil, Logs & Rocks	5
			Leaf Litter	41
E	*Angophora costata*	1	*Lomandra multiflora*	1
			Entolasia stricta	40
			Themeda triandra	5
			Lobelia purpurascens	1
			Soil, Logs & Rocks	2
			Leaf Litter	51

3.1.7 Quadrat 7

Quadrat 7 is located in the 2007 rehabilitation area on the eastern edge of the spoil emplacement (**Figure 3**). This area was seeded in February 2006 at the same time as Quadrat 6 and is now 14 years old. The area is dense woodland/forest with a plethora of canopy species seedlings and saplings (**Plate 6**). The quadrat is dominated by *C. maculata* with 95 individuals counted. It was estimated that there have been three successful seeding events. Other canopy species recorded were *A. costata* (2) – which were resprouting from stems that had suffered die back, *E. tereticornis* (17), *E. punctata, E. moluccana* (3) and two *E. crebra.* Midstorey species included a single individual of *L. polygalifolium* and *Exocarpos cupressiformis* (Ballarat Cherry), and two *P. sambucifolia*. Mature *Acacias* had died back but multiple seedlings were observed, as were several seedlings of *A. costata.* The shrub layer was sparse in density, but quite diverse with five species recorded. The ground cover was sparse at 30%, dominated by *E. stricta.* Lantana was recorded in the quadrat and was sparsely scattered in the surrounding area.

Plate 7: Quadrat 7 monitoring photos. Top 7A, Bottom 7B

Canopy cover over the 20m centreline – 50%.

Average annual height increment (tagged trees): 2022 – 10.5m (2019 – 8.25m). A net increase of 2.25m.

Annual average girth increment (tagged trees): 2022 – 360mm (2019 – 325mm). A net increase of 35mm or 12mm/year.

Stems/ha calculation: 2022 – 7,150 stems/ha. 2019 –11,100 stems/ha. This equates to a decrease of 3, 950 stems/ha. The major reduction in stems resulted from self-thinning of *C. maculata* which reduced from 142 stems in 2019 to 95 in 2022. There was also a minor reduction from exclusion of non-woody species.

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level = 338mm. This equates to a calculated soil gain of 70 tonnes/ha since the 2019 survey (2019 – 345mm).

Table 13: Quadrat 7 20m x10m quad flora results

Species	Number	Ht (approx) (m)	Girth (mm)	Comments
Acacia decurrens	1	Tag No. 3 = dead		
		Tag No. 4 = dead		
Acacia falcata	0	Tag No. 2 = dead		
		Tag No. 5 = dead		
Acacia longifolia	8	Tag No. 1 = dead		
Angophora costata	2			
Corymbia maculata	95	Tag No. 8 = 2.6m		
		Tag No. 9 = 13m		
		Tag No. 12 = 13m	338	New tree
		Tag No. 14 = 14m	390	New tree
		Tag No. 15 = 12m	408	New tree
Eucalyptus crebra	2			
Eucalyptus moluccana	3			
Eucalyptus tereticornis	17	Tag No. 6 = 14m	441	
		Tag No 7 = 15m	490	
		Tag No. 10 = 15m	558	
Exocarpos cupressiformis	1	Tag No. 13 = 5	202	New Tree
Leptospermum polygalifolium	1	Tag No. 11 = 2.4m	50	reshoot - New tree
Amyema pendula				
Billardiera scandens				
Breynia oblongifolia	3			
Cheilanthes sieberi				
Dianella caerulea				
Dodonaea triquetra	5			
Entolasia stricta				
Gahnia sieberi				
Glycine tabacina				
Hibbertia aspera				
Lantana camara				
Lepyrodia scariosa				
Lobelia purpurascens				
Lomandra longifolia				
**Megathyrsus maximus*				
Oxalis exilis				
Persoonia linearis	1			sapling
Polyscias sambucifolia	2			
Pultenaea retusa	2			
Viola hederacea				

Table 14: Quadrat 7 2m x 2m plot flora results

2m x 2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	*Corymbia maculata*	2	*Entolasia stricta*	40
	Breynia oblongifolia	1	*Megathyrsus maximus*	20
	Lomandra longifolia	1	*Lobelia purpurascens*	5
			Soil, Logs & Rocks	5
			Leaf Litter	30
B	*Corymbia maculata*	3	*Entolasia stricta*	30
			**Megathyrsus maximus*	30
			Lobelia purpurascens	2
			Oxalis exilis	1
			Soil, Logs & Rocks	5
			Leaf Litter	32
C	*Corymbia maculata*	7	*Entolasia stricta*	10
	Dianella caerulea	2	*Lobelia purpurascens*	2
	Eucalyptus tereticornis	1	*Lepyrodia scariosa*	2
			Billardiera scandens	1
			Soil, Logs & Rocks	10
			Leaf Litter	75
D	*Corymbia maculata*	6	*Entolasia stricta*	20
			Oxalis exilis	1
			Glycine tabacina	1
			Soil, Logs & Rocks	10
			Leaf Litter	68
E	*Corymbia maculata*	7	*Entolasia stricta*	10
			Lobelia purpurascens	2
			Soil, Logs & Rocks	15
			Leaf Litter	73

3.1.8 Quadrat 8

Quadrat 8 is relatively young rehabilitation, located in the 2012 rehabilitation area that was seeded in 2012. While it is now 10 years old it appears much younger due to the large number of saplings, overwhelmingly *C. maculata* (50) (**Plate 8**). Other canopy species included a relatively high number of *E. moluccana* (13), with fewer numbers of *E. crebra* (4), *E. tereticornis* (3), *C. gummifera* (2), *E. punctata* and *A. costata* (1 each). The midstorey was still largely intact with a large number of *A. decurrens* (16) plus a few *A. torulosa* (three seedlings) and *A. implexa* (3). The shrub layer was not as diverse as older quadrats with only three shrub species recorded, while the ground layer recorded 10 native grass, forb and vine species. This quadrat also had several weed species in and nearby including *C. selloana* (Pampas Grass).

Plate 8: Quadrat 8 monitoring photos. Top 8A, Bottom 8B

Canopy cover over the 20m centreline – 60%.

Average annual height increment (tagged trees): 2022 – 7.0m (2019 – 6.44m). A net increase of 0.56m.

Annual average girth increment (tagged trees): 2022 – 275mm (2019 – 168mm). A net increase of 107mm or 35.0mm/year.

Stems/ha calculation: 2022 - 4, 900 stems/ha. 2019 – 7,100 stems/ha. This equates to a loss of 2200 stems/ha. Self-thinning of *C. maculata* which decreased from 61 stems to 50 stems from 2019 and 2022 respectively and *Acacia decurrens* which dropped from 50 stems in 2019 to 15 stems in 2022.

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level. There was no measurement taken as the soil under the frame had been disturbed by a burrow (**Plate 9**).

Plate 9: Quadrat 8 showing animal burrow under the H frame negating the soil loss measurement

Table 15: Quadrat 8 20m x 10m quad flora results

Species	Number	Ht (approx) (m)	Girth (mm)	Comments
Acacia decurrens	16	Tag No. 1 = 7m	250	
		Tag No. 4	-	Unable to locate tag
Acacia implexa	3	Tag No. 9 = 7m	184	
Angophora costata	1	Tag No. 11 = 8m	400	
Corymbia gummifera	2	Tag No. 7 = 5m	192	
Corymbia maculata	50	Tag No. 3 = 8m	283	
		Tag No. 5 = 4m	137	
		Tag No. 6 = 9m	342	
Eucalyptus moluccana	13	Tag No. = 8m	236	
		Tag No. 8 = 9m	324	
Eucalyptus punctata	1	Tag No. 10 = 5m	400	
Eucalyptus crebra	4			saplings
Allocasuarina torulosa	3			seedlings
Pultenaea retusa	2			
Eucalyptus tereticornis	3			
**Andropogon virginicus*				
Austrostipa pubescens				
Billardiera scandens				
Cassytha glabella				
**Conyza bonariensis*				
**Cortaderia selloana*				Listed weed species
Cyperaceae spp.				
Dodonaea triquetra				
Entolasia marginata				
Entolasia stricta				
Glycine clandestina				
Glycine tabacina				
Lobelia purpurascens				
**Megathyrsus maximus*				
Microlaena stipoides				
Pultenaea villosa				

Table 16: Quadrat 8 2m x 2m plot flora data

2m x 2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	nil		*Entolasia stricta*	80
			Billardiera scandens	1
			Megathyrsus maximus	2
			Glycine clandestina	1
			Leaf Litter	16
B	*Corymbia maculata*	1	*Austrostipa pubescens*	5
	Pultenaea villosa	1	*Entolasia stricta*	70
			Billardiera scandens	5
			Soil, Logs & Rocks	1
			Leaf Litter	19
C	*Corymbia maculata*	2	*Entolasia marginata*	10
			Entolasia stricta	40
			Lobelia purpurascens	10
			Andropogon virginicus	2
			Austrostipa pubescens	5
			Soil, Logs & Rocks	1
			Leaf Litter	32
D	*Corymbia maculata*	4	*Entolasia marginata*	20
	Eucalyptus crebra	1	*Entolasia stricta*	40
			Microlaena stipoides	1
			Billardiera scandens	5
			Soil, Logs & Rocks	1
			Leaf Litter	33
E	*Acacia decurrens*	1	*Entolasia marginata*	40
	Corymbia gummifera	1	*Billardiera scandens*	1
	Corymbia maculata	1	*Entolasia stricta*	30
			Glycine clandestina	2
			Soil, Logs & Rocks	2
			Leaf Litter	25

3.1.9 Quadrat 9

Quadrat 9 is located at the southern end of the 2014 rehabilitation area and was seeded in 2014, making this area eight years old. As such the canopy has not yet grown high enough to close in resulting in very open revegetation (**Plate 10**). This quadrat had a very large number of *C. maculata* (70) including seedlings and saplings which will self-thin with time. Other canopy species recorded included *E. moluccana* (11), *E. crebra* (10), *C. gummifera* (2) and *E. globoidea* (1). Midstorey species were relatively dense with *A. torulosa* (7), *A. decurrens* (6), *Notelaea microcarpa* and *G. ferdinandi* (1 each). Shrub numbers were very high with good diversity – five species. There were 27 *A. longifolia* and 20 *P. villosa,* the highest numbers encountered during the monitoring. This area, due to its openness also recorded a higher number of weed species (7) including Lantana. A number of Pampas Grass plants were observed when travelling to the quadrat, located in the drains between native vegetation.

Plate 10: Quadrat 9 monitoring photos. Top 9A, Bottom 9B

Canopy cover over the 20m centreline – 20%.

Average annual height increment (tagged trees): 2022 – 4.4m (2019 – 2.9m). A net increase of 1.5m.

Annual average girth increment (tagged trees): 2022 – 180mm (2019 – 76mm). A net increase of 104mm or 35mm/year.

Stems/ha calculation: 2022 – 8, 200 stems/ha. 2019 – 7, 500 stems/ha. This equates to an increase of 700 stems/ha. The increase in stem density is accounted for with an increase in *C. maculata* from 65 stems in 2019 to 70 stems in 2022, and in increase in *Acacia longifolia* from 0 in 2019 to 27 in 2022, counterbalanced against a reduction in *Dodonaea triquetra* numbers from 45 stems in 2019 to 0 in 2022.

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level = 345mm. This equates to a calculated soil loss of 150 tonnes/ha since the 2019 survey (2019 – 330mm).

Table 17: Quadrat 9 20m x 10m flora results

Species	Number	Ht (approx) (m)	Girth (mm)	Comments
Acacia decurrens	6	Tag No. 3 = dead	-	Seedlings
		Tag No. 5 = dead	-	
Acacia falcata	1	Tag No. 7		Unable to locate tag
Acacia implexa	2	Tag No. 9 = 4.5m	212	New Tree
Allocasuarina torulosa	7	Tag No. 4 = 4.5	105	
Corymbia maculata	70	Tag No 1		Unable to locate tag
		Tag No 2 = 6m	240	
		Tag No 8		Unable to locate tag
		Tag No 11 = 4.0	192	New Tree
		Tag No 13 = 4.5	192	New Tree
Eucalyptus globoidea	1	Tag No 10 = 4.5	211	New Tree
Eucalyptus moluccana	11	Tag No 6 = 4	108	
		Tag No 12 = 3.5	180	New Tree
Acacia longifolia	27			
Angophora costata	1			
Dillwynia retorta	1			
Eucalyptus crebra	10			
Corymbia gummifera	2			
Glochidion ferdinandi	1			
Melaleuca ericifolia	2			
Notelaea microcarpa	1			
Ozothamnus diosmifolius	1			
Pultenaea villosa	20			
**Andropogon virginicus*				
Austrostipa pubescens				
Bidens pilosa				
Cassytha glabella				
Cheilanthes sieberi				
**Conyza bonariensis*				
Dichondra repens				
**Facilis retusa*				
**Gamochaeta americana*				
Hypochaeris glabrata				
Imperata cylindrica				
Kennedia rubicunda				
**Lantana camara*				
Lobelia purpurascens				
Lomandra longifolia				
**Senecio madagascariensis*				
**Taraxacum officinale*				
Wahlenbergia gracilis				

Table 18: Quadrat 9 2m x 2m plot flora data

2m x 2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	*Acacia decurrens*	1	*Imperata cylindrica*	35
	Acacia falcata	1	*Andropogon virginicus*	45
	Allocasuarina torulosa	1	*Gamochaeta americana*	2
			Senecio madagascariensis	1
			Taraxacum officinale	2
			Soil, Logs & Rocks	10
			Leaf Litter	5
B	*Acacia longifolia*	1	*Imperata cylindrica*	70
	Corymbia maculata	2	*Andropogon virginicus*	20
			Gamochaeta americana	2
			Cyperaceae spp	1
			Soil, Logs & Rocks	
			Leaf Litter	7
C	*Acacia longifolia*	1	*Imperata cylindrica*	80
	Pultenaea villosa	1	*Andropogon virginicus*	5
			Gamochaeta americana	1
			Austrostipa pubescens	2
			Soil, Logs & Rocks	5
			Leaf Litter	7
D	*Acacia longifolia*	2	*Andropogon virginicus*	35
	Corymbia gummifera	1	*Imperata cylindrica*	10
	Corymbia maculata	2	*Gamochaeta americana*	2
	Eucalyptus moluccana	1	*Senecio madagascariensis*	2
			Taraxacum officinale	1
			Soil, Logs & Rocks	20
			Leaf Litter	30
E	*Acacia longifolia*	1	*Andropogon virginicus*	40
	Corymbia maculata	2	*Imperata cylindrica*	20
	Pultenaea villosa	3	*Hypochaeris glabrata*	5
			Dichondra repens	2
			Gamochaeta americana	2
			Taraxacum officinale	2
			Soil, Logs & Rocks	5
			Leaf Litter	24

3.1.10 Quadrat 10

Quadrat 10 is located in the northern section of the 2014 rehabilitation area (**Figure 3**). This section was seeded in 2013 resulting in the vegetation being more developed than Q9 (Plate 10) with tree

heights up to 8m. The quadrat was still dominated by *C. maculata* (57) with *E. moluccana* (10), *A. costata* and *E. crebra* (2 each) and a single *C. gummifera.* Midstorey species included *A. torulosa* (4), *A. decurrens* and *L. polygalifolium,* 1 each. Eight shrub species were recorded, with *Dodonaea triquetra* (Large-leaf Hop-Bush), having a massive seeding event with an estimated 200 plus plants observed. Lantana was recorded in the quadrat and in the surrounding areas.

Plate 11: Quadrat 10 monitoring photos. Top 10A, Bottom 10B

Canopy cover over the 20m centreline – 30%.

Average annual height increment (tagged trees): 2022 – 6.44m (2019 – 5.25m). A net increase of 1.19m.

Annual average girth increment (tagged trees): 2022 – 238mm (2019 – 178mm). A net increase of 60mm or 20mm/year.

Stems/ha calculation: 2022 – 14, 650 stems/ha. 2019 – 7, 000 stems/ha. This a substantial increase of 7, 650 stems accounted for by a huge increase of *D. triquetra* stems 26 in 2019 to an estimated 200 in 2022.

Erosion – there was no active erosion over the 50m transect.

"H" Frame – measurement taken from the top of the frame down to the soil level = 363mm. This equates to a calculated soil gain of 150 tonnes/ha since the 2019 survey (2019 – 378mm).

Table 19: Quadrat 10 20m x 10m quad flora data

Species	Number	Ht (approx) (m)	Girth (mm)	Comments
Acacia decurrens	1	Tag No. 3		Dead
		Tag No. 5		Dead
		Tag No 6		Dead
Allocasuarina torulosa	4	Tag No. 11 = 6m	140	New Tree
Angophora costata	2	Tag No. 10 = 2.6m	102	New Tree
Corymbia maculata	57	Tag No. 1 = 8m	337	
		Tag No. 2 = 9	394	
		Tag No. 4 = 6m	218	
		Tag No. 7 = 5.5m	215	Some die back
		Tag No 8		unable to locate tag
Eucalyptus moluccana	10	Tag No. 9 = 8m	260	New Tree
Acacia falcata	1			Fruit
Acacia longifolia	1			
**Bidens pilosa*				
Billardiera scandens				
Breynia oblongifolia	2			seedlings
Cheilanthes sieberi				
Corymbia gummifera	1			
Daviesia ulicifolia	1			Fruit
Dichondra repens				
Dillwynia retorta	2			
Dodonaea triquetra	200			Fruit
Entolasia stricta				
Eucalyptus crebra	2			Saplings
**Hypochaeris radicata*				
Kennedia rubicunda				
**Lantana camara*				
Leptospermum polygalifolium	1			
Leucopogon spp.	1			
Lobelia purpurascens				
**Megathyrsus maximus*				
Ozothamnus diosmifolius	2			
Pomax umbellata				
Pultenaea villosa	5			seedlings

Table 20: Quadrat 10 2m x 2m plot flora data

2m Plots				
Plot	Trees and Shrubs		Grasses and Cover	
	Species	Number	Species	Cover (%)
A	*Corymbia maculata*	1	*Entolasia stricta*	30
	Dodonaea triquetra	5	*Dichondra repens*	1
	Lantana camara	1	*Kennedia rubicunda*	2
			**Megathyrsus maximus*	2
			Soil, Logs & Rocks	5
			Leaf Litter	60
B	*Allocasuarina torulosa*	1	*Cheilanthes sieberi*	2
	Corymbia maculata	1	*Entolasia stricta*	50
	Dodonaea triquetra	1	*Lobelia purpurascens*	1
	Eucalyptus crebra	1	**Megathyrsus maximus*	2
	Lantana camara	1	Soil, Logs & Rocks	2
			Leaf Litter	43
C	*Corymbia maculata*	1	*Cheilanthes sieberi*	1
	Eucalyptus moluccana	1	*Entolasia stricta*	10
	Lantana camara	1	**Megathyrsus maximus*	1
	Ozothamnus diosmifolius	2	Soil, Logs & Rocks	5
	Pultenaea villosa	1	Leaf Litter	83
D	*Corymbia gummifera*	1	*Entolasia stricta*	20
	Corymbia maculata	2	*Hypochaeris radicata*	1
	Dodonaea triquetra	6	**Megathyrsus maximus*	1
	Eucalyptus moluccana	1	Soil, Logs & Rocks	10
	Lantana camara	2	Leaf Litter	68
	Pultenaea villosa	3		
E	*Corymbia maculata*	4	*Cheilanthes sieberi*	1
	Dodonaea triquetra	1	*Entolasia stricta*	45
	Pomax umbellata	1	*Lobelia purpurascens*	1
	Pultenaea villosa	2	**Megathyrsus maximus*	5
			Leaf Litter	48

3.2 SOILS

The main soil results have been summarised in **Table 21** and all commentary refers to this table. Historical data (previous to the 2022 monitoring), **Table 21** has been colour coded against the "critical limits" levels of soil parameters. This survey the results have been compared to the completion criteria and colour coded accordingly for quick reference.

3.2.1 Soil pH

Soil pH of the Analogue quadrat (Q1) was classed as acidic, and lower than the previous monitoring in 2019. The soil pH results for all quadrats shows a similar pattern this monitoring event with some quadrats almost a full pH unit more acidic than in 2019.

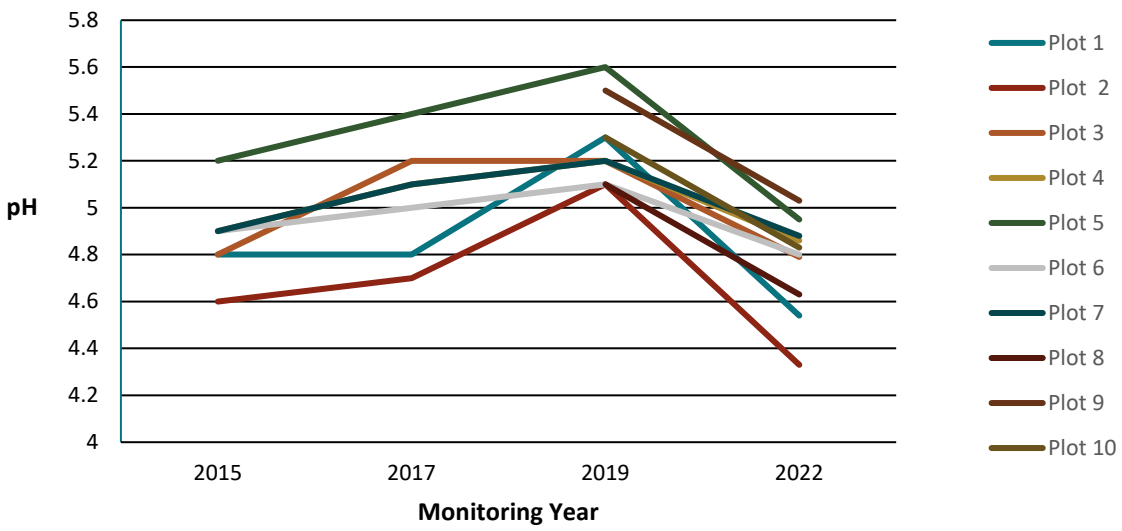


Chart 1: Historical comparison of Soil pH over the course of the monitoring

Soil pH has responded over the course of the monitoring almost in unison, indicating that environmental factors are exerting a strong influence (**Chart 1**). Acidic soils are found in areas of high rainfall, with the leaching effect of rainfall able to cause changes in pH. The below average rainfall experienced since 2015 culminating in 2019 with annual rainfall approximately half of the average may explain the observed variation.

Table 21:Summary of soil analysis results and comparison to previous monitoring results

Method	EC (µS/cm)			pH (1:5 water)			CEC (meq/100g soil)			ESP			Exchangeable K (meq/100g soil)			Exchangeable Ca (meq/100g soil)			Exchangeable Na (meq/100g soil)			Exchangeable Mg (meq/100g soil)			Total OM (%)			Avail. P (ppm)			Avail. N (ppm)		
Quad / Year	2017	2019	2022	2017	2019	2022	2017	2019	2022	2017	2019	2022	2017	2019	2022	2017	2019	2022	2017	2019	2022	2017	2019	2022	2017	2019	2022	2017	2019	2022	2017	2019	2022
Analogue	47	46	43.3	4.8	5.3	4.54	11.33	10.92	12.2	0.97	2.38	1.24	0.37	0.25	0.23	0.44	0.3	0.41	0.11	0.26	0.15	1.31	1.15	1.31	5.6	6.0	6.32	3.08	0.6	0.38	0.12	0.1	0.1
Quad 2	63	49	77.1	4.7	5.1	4.33	13.52	11.35	15.6	0.52	1.23	0.62	0.31	0.29	0.37	0.81	0.33	0.88	0.07	0.14	0.097	1.43	1.79	2.17	6.0	4.0	6.34	3.73	0.1	0.45	7.64	4.05	20
Quad 3	39	37	49.7	5.2	5.2	4.79	9.85	10.66	11.7	0.91	1.13	0.74	0.24	0.25	0.27	0.55	0.52	1.05	0.09	0.12	0.087	1.47	1.93	1.56	3.3	3.3	4.47	1.21	0.1	0.1	0.65	0.76	8.55
Quad 4	49	58	35.7	5.1	5.2	4.86	11.6	9.76	9.11	1.12	2.25	1.05	0.4	0.31	0.3	0.63	0.33	0.66	0.13	0.22	0.095	2.24	1.7	1.54	3.5	3	2.75	1.1	0.1	0.1	0.16	0.1	0.132
Quad 5	28	29	44.3	5.4	5.6	4.95	8.34	8.34	10.4	1.56	1.32	1.09	0.3	0.38	0.37	0.37	0.39	0.73	0.13	0.11	0.11	1.94	2.18	2.36	2.6	2.4	3.6	1.49	0.1	0.1	0.12	0.9	6.57
Quad 6	45	46	32	5	5.1	4.8	7.67	7.73	8.7	1.56	1.29	0.73	0.22	0.32	0.26	0.16	0.13	0.31	0.12	0.1	0.064	0.97	1.26	1.38	2.9	1.8	2.96	0.49	0.1	0.1	0.11	0.1	1.03
Quad 7	41	54	36.4	5.1	5.2	4.88	8.28	10.3	8.49	1.45	2.43	1.44	0.19	0.27	0.23	0.41	0.19	0.31	0.12	0.25	0.12	1.36	1.75	1.34	2.6	4.05	3.05	1	0.1	0.1	0.1	0.1	0.1
Quad 8	N/A	76	51.5	N/A	5.1	4.63	N/A	7.32	8.58	N/A	3.69	0.87	N/A	0.23	0.29	N/A	0.33	0.5	N/A	0.27	0.075	N/A	1.05	1.35	N/A	2.4	2.93	N/A	0.46	0.1	N/A	0.45	14.4
Quad 9	N/A	56	27.1	N/A	5.5	5.03	N/A	10.37	9.13	N/A	2.31	0.94	N/A	0.23	0.22	N/A	0.92	0.69	N/A	0.24	0.086	N/A	2.26	2.08	N/A	3.15	2.42	N/A	0.1	0.1	N/A	0.1	0.208
Quad 10	N/A	81	44.3	N/A	5.3	4.83	N/A	8.93	9.1	N/A	2.8	0.92	N/A	0.24	0.24	N/A	0.64	0.57	N/A	0.25	0.084	N/A	1.24	1.11	N/A	3.3	3.49	N/A	0.1	0.1	N/A	0.48	8.86
Completion Criteria	<900 µS/cm after 5 years			Surface Soil pH not <10% of Analogue after 5 years			CEC not <20% of Analogue after 5 years			<5 after 5 years			No Completion criteria for this parameter			No Completion criteria for this parameter			No Completion criteria for this parameter			No Completion criteria for this parameter			Within 20% of analogue value after 5 years			Not <20% of Analogue levels after 10 years			Not <20% of Analogue levels after 10 years		
Assessment Against Completion Criteria	Successful – all quadrats satisfy criteria			Successful – all quadrats satisfy criteria			Partially Successful – 3 quadrats Meet Criteria, 7 are below required limits			Successful – all quadrats satisfy criteria			No comment possible			No comment possible			No comment possible			No comment possible			Not successful – only 1 quadrat meets completion criteria			Not successful – only 1 quadrat meets completion criteria			Successful – all quadrats satisfy criteria		

Historical Key

Green	Meeting criteria - within 20% of desirable level
Orange	Almost meeting criteria - within 40% of desirable level
Red	Not meeting criteria - outside 40% of desirable level

2022 Key

Green	Meeting Criteria
Red	Not Meeting Criteria

3.2.2 Total Organic Matter (TOM) (%)

The 2022 monitoring event recorded considerable variation between quadrats, with Quad 2 recording the same TOM as Quad 1, the Analogue for the first time over the course of the monitoring. (**Chart 2**).

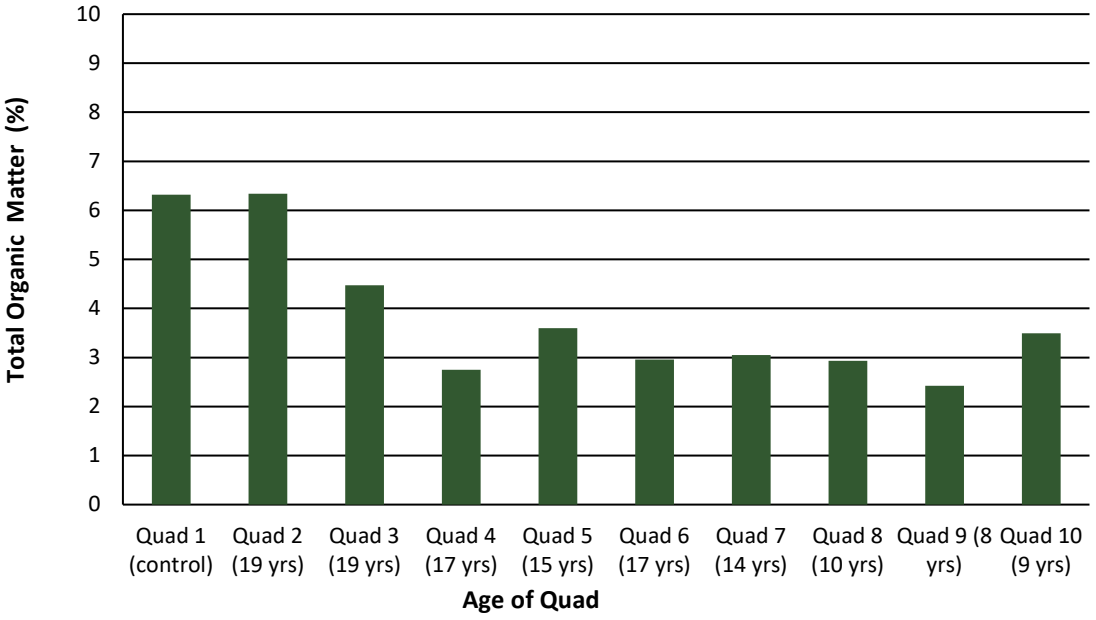


Chart 2: Total Organic Matter of the surface soil for the 2022 monitoring

The organic matter of the surface soil generally increases with time as vegetation matures, sheds litter and pioneer species (e.g., *Acacias)*, dieback and become compost. With rehabilitation the density and seeding mix will also influence the rate of litter production with higher stem densities increasing leaf litter and self-thinning producing larger quantities of woody debris. Litter breakdown and incorporation into the soil as organic matter is also highly influenced by climatic factors such as temperature and rainfall. The 2022 monitoring shows that seven of the ten quadrats increased TOM from the previous 2019 monitoring, albeit that Quads 8 to 10 have only been monitored twice. Historically there has been considerable variation in TOM between monitoring events (**Chart 3**). This indicates that individual monitoring events may not show overall trends in TOM accumulation with increasing age. This is clearly shown for Quad 1, which as the analogue in undisturbed vegetation is the oldest and most stable in terms of changes to vegetation structure and therefore any changes in TOM (**Chart 4**). Considerable variation in TOM from survey to survey is apparent from chart, with the overall trend showing a very modest increase.

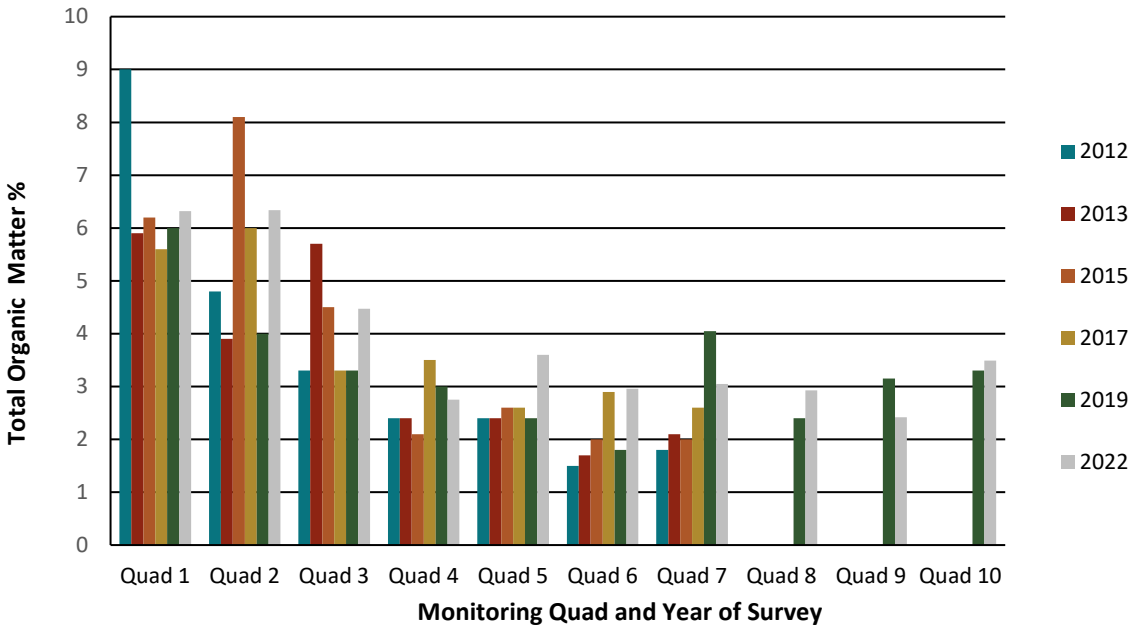


Chart 3: Comparison of Soil Surface TOM over the course of the rehabilitation monitoring

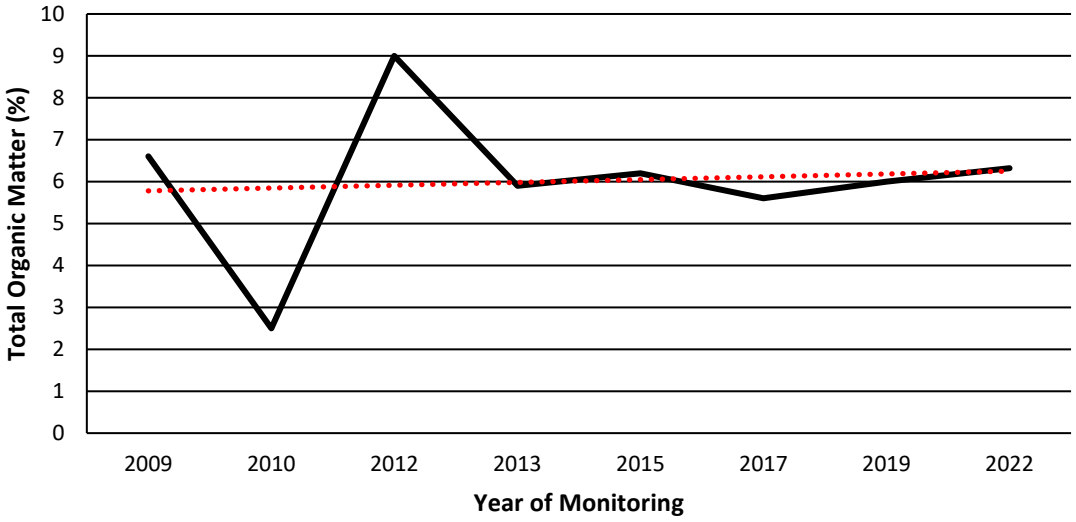


Chart 4: TOM for Quad 1 over the course of the monitoring showing variation between monitoring events but overall, a stable level with a modest increase in TOM.

3.2.3 Cation Exchange Capacity (CEC)

This survey, the results for soil CEC show that the oldest areas of rehabilitation (Quadrat 2 and 3, now 19 years old) have CEC levels that are above or near analogue levels (**Chart 5**).

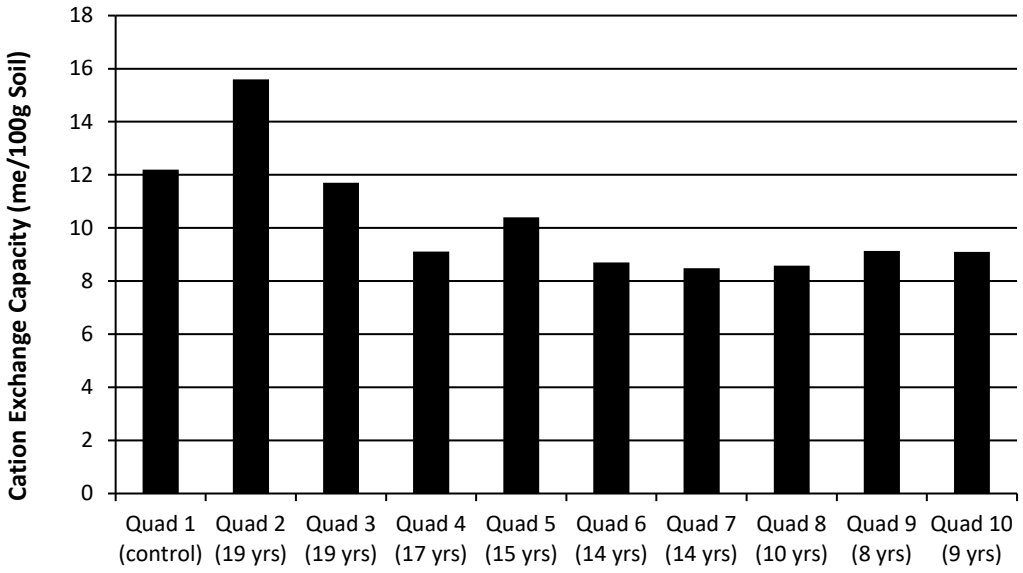


Chart 5: Soil CEC levels for the 2022 survey by monitoring quadrat

As for other parameters there are survey to survey variations, but the overall trend is for CEC to increase over time as organic matter in soils increases (**Chart 6**). For quadrats 1 – 7, where there is sufficient data for comparison it can be seen that this year's survey recorded increased results from the 2015 survey. There are two exceptions. Quadrat 2 where CEC levels are lower than the 2015 survey but are still well above the Analogue quadrat. Quadrat 4 has recorded a steady decline over the course of the surveys and this area may warrant more detailed monitoring.

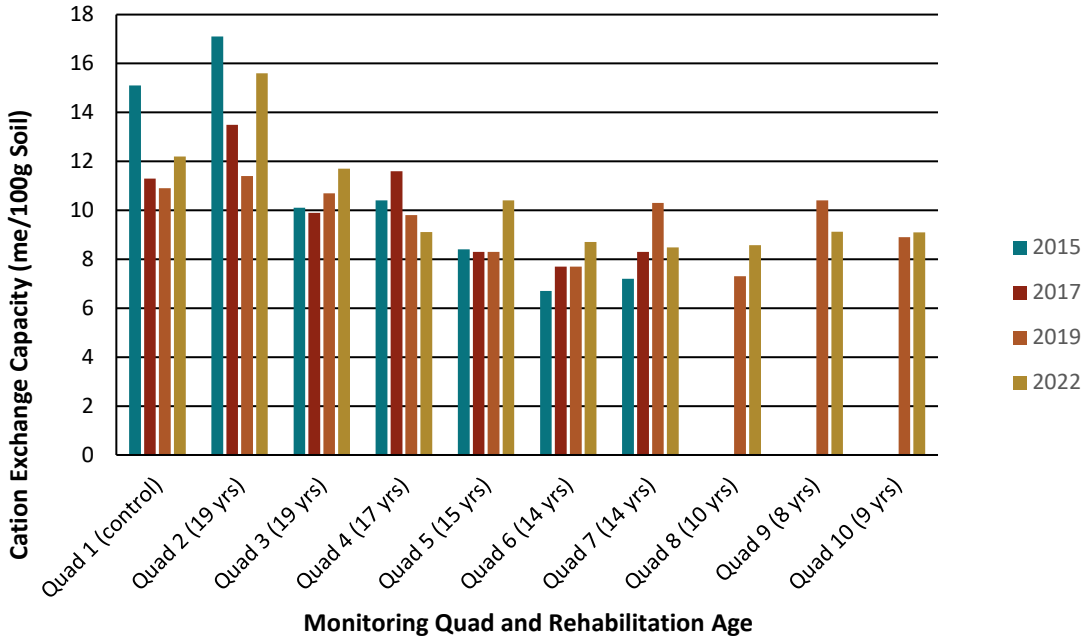


Chart 6: Soil CEC levels by survey year and monitoring quadrats showing age of rehabilitation

3.2.4 Salinity (EC)

Salinity levels (data not shown - refer to **Table 21**) are very similar to previous surveys and similar to the Analogue quadrat (43.3 µS/cm), varying from a low of 27.1 µS/cm for Quad 9 to a high of 77.1 µS/cm for Quad 2. Additionally, EC levels are very much under the completion criteria level of <900 µS/cm after 5 years.

3.2.5 Exchangeable Sodium Percentage (ESP)

ESP levels have all decreased form the 2019 survey (**Table 21**) and again all quadrat levels are below the completion criteria of <5% after 5years. The Analogue quadrat recorded ESP of 1.24% with the rehabilitation quadrants recording between 0.62% for Quad 2 to 1.44% for Quad 7. As noted in the 2019 monitoring report (GSS, 2019), the build-up of exchangeable sodium may be dependent upon such seasonal and environmental variables such as rainfall with the increased levels experienced since the 2019 survey acting to leach exchangeable sodium from the soil surface layers.

3.2.6 Available Macronutrients

3.2.6.1 Nitrogen

Available N results recorded this survey were the highest recorded since the 2015 survey – the limit of historical data provided and by a considerable margin (**Chart 7**). The Analogue quadrat returned very low available N levels (0.1 ppm – the level of detectability), which has been consistent for the

last previous two surveys (2017 and 2019). Quadrats 4, 7 and 9 also recorded very low levels of available N, while the remaining quadrats recorded large increases in this macronutrient. There does not appear to be an obvious pattern to these results.

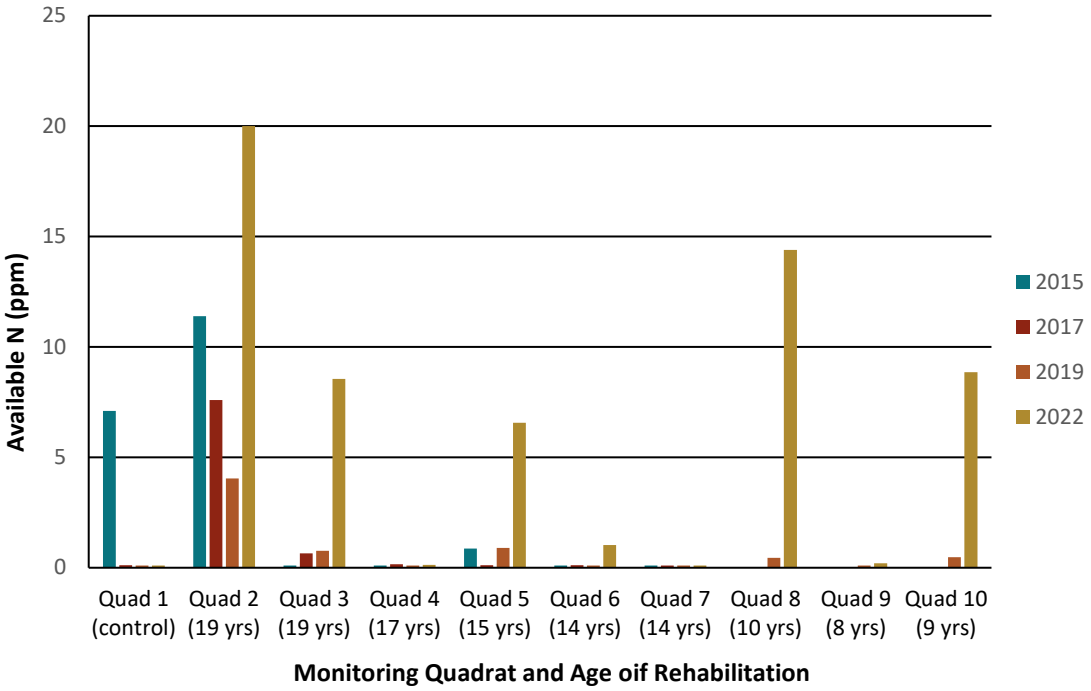


Chart 7: Available N levels from 2015 to 2022 surveys

3.2.6.2 Available Phosphorus (P)

Available P levels were low across eight of the ten monitoring quadrats. Only the Analogue and Quad 2 recorded levels above 0.1 ppm (the limit of detectability) (**Chart 8**). Examination of the data presented in **Chart 8** shows that that 2017 survey appears anomalous and many times higher than data collected in the previous and subsequent surveys.

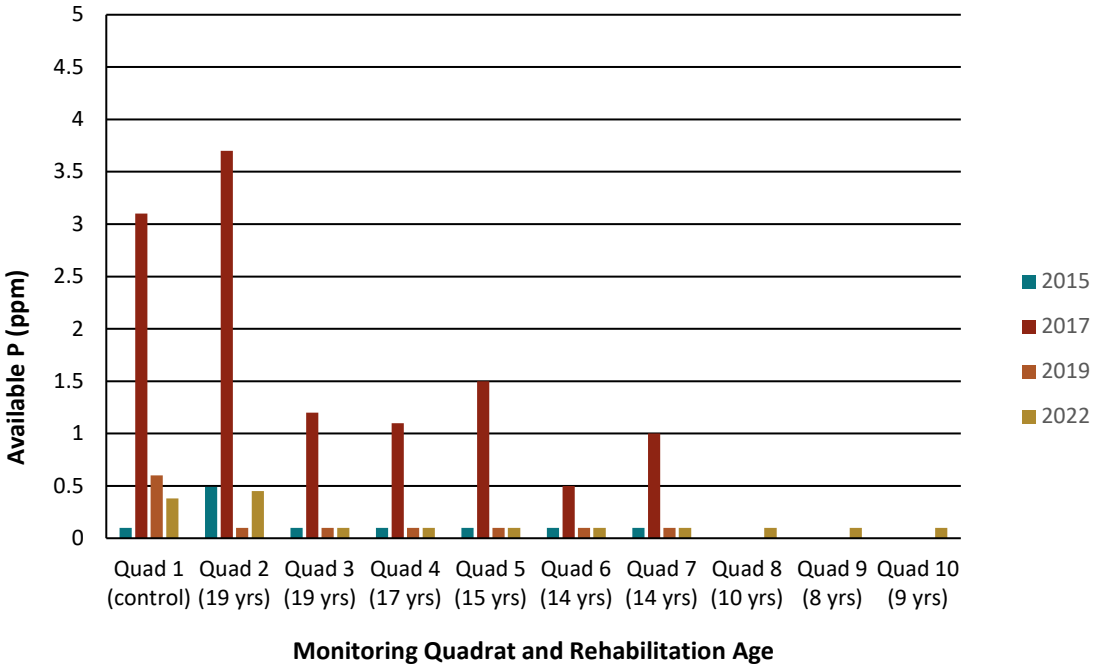


Chart 8: Available P levels for the 2015 to 2022 surveys

3.2.7 Other Soil Parameters Measured Against Completion Criteria

Three additional soil parameters are outlined for comparison in the completion criteria. These are –

- *The surface layer to be free of any hazardous material to a depth of 1m*. This parameter was not measured during this or the previous survey. No excavations were undertaken, but the 2019 Monitoring Report states that no hazardous material was observed during deep ripping.
- *Runoff water quality to less than 1000 µS/cm after 5 years.* Again, this parameter was not measured as part of this survey.
- *Soil loss to be less than 60 tonnes/ha/year after 5 years.* All quadrats are now greater than 5 years old and based on the results reported in **Table 22**, four of the quadrats have accumulated soil since the 2019 survey, with the analogue quadrat increasing substantially. Only a single quadrat, Quad 3 has not met the completion criteria of soil loss. The average soil loss/gain over the eight quadrats is a gain of 31 tonnes of soil per hectare since 2019 and hence this parameter can be considered to have been met.

Table 22: Soil loss/gain calculations for the monitoring quadrats in 2022

Quadrat	Quadrat Age	Soil Loss/Gain Since 2019 (tonnes/ha)	Soil/ Loss per Year (tonnes/ha/yr)
1	Analogue	+670	223
2	19	-	-
3	19	-450	-150
4	17	-130	-43
5	15	-40	-13
6	14	+130	43
7	14	+70	23
8	10	-	-
9	8	-150	-50
10	9	+150	50

3.3 VEGETATION

3.3.1 Growth Rates

Average height has generally continued to increase, as would be expected for relatively young vegetation (**Chart 9**). Three exceptions were recorded with Quadrats 1 and 6 decreasing in average height this survey while the trees in Quadrat 2 were not measured. Decreases in these two quadrats can be explained by death of trees within the quadrats and/or loss of height due to crown damage. The remaining quadrats have increased in height at varying rates and appears to be consistent across all ages of rehabilitation indicating that favourable climatic factors – rainfall – may have resulted in improved growth.

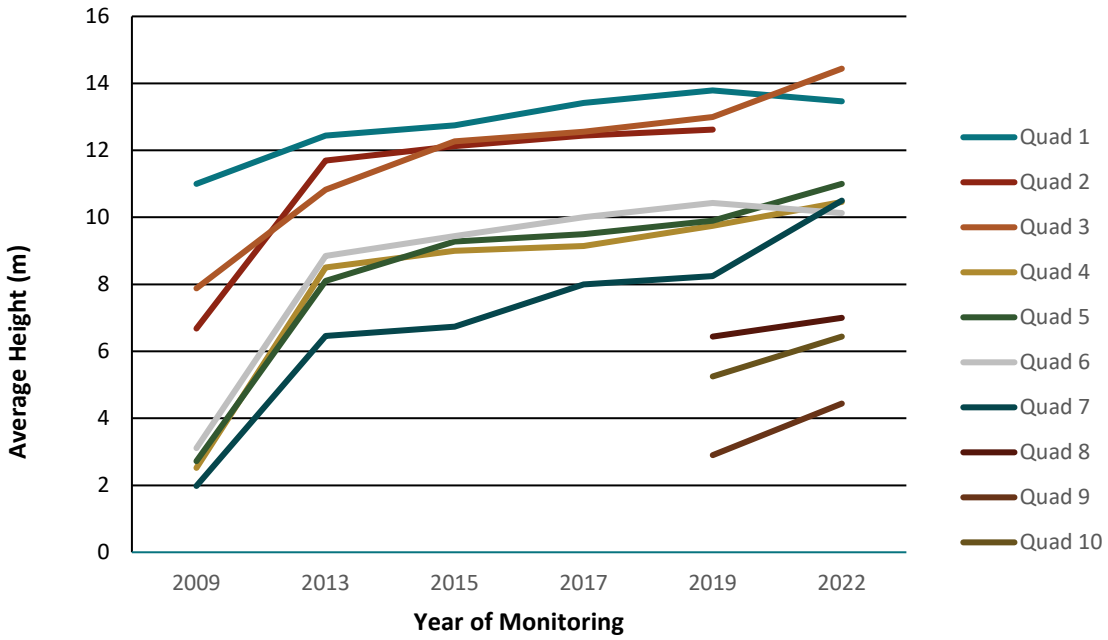


Chart 9: Comparison of Average Height of the monitoring quadrats for the 2009 to 2022 surveys

3.3.2 Species Diversity

A summary of the native flora species recorded in each quadrat is shown in **Table 23** below. Species diversity has increased across the monitoring quadrats this survey, when compared to the previous survey, except for Quadrat 2. When compared to Quadrat 1, the Analogue, the rehabilitation areas tend to have a higher number of "overstorey" species and fewer understorey species. For this survey, overstorey species were defined as species that at maturity would be canopy (*Eucalyptus, Corymbia* and *Angophora* species), midstorey (*Allocasuarina* and *Leptospermum*) or tall shrubs (e.g., *Acacia parvipinnula, Acacia decurrens* and *Breynia oblongifolia*). The increase in species recorded this survey is an excellent result for the rehabilitation and was no doubt influenced by the increased rainfall experienced over the previous year.

Completion criteria specifies a minimum of two overstorey and understorey species in each quadrat after five years which has been satisfied.

Table 23: Summary of native flora species recorded in each monitoring quadrat for the 2019 and 2022 surveys.

Quadrat	Quadrat Age	Stratum	No of Native Flora Species	
			2019	2022
1	Analogue	Overstorey Understorey	5 11	8 23
2	19	Overstorey Understorey	6 5	Not Monitored
3	19	Overstorey Understorey	6 13	10 17
4	17	Overstorey Understorey	5 9	9 14
5	15	Overstorey Understorey	6 6	6 13
6	14	Overstorey Understorey	9 10	14 20
7	14	Overstorey Understorey	5 10	13 15
8	10	Overstorey Understorey	6 5	11 14
9	8	Overstorey Understorey	4 7	15 12
10	9	Overstorey Understorey	4 4	12 12

3.3.3 Stem Density

Stem densities for the 2022 survey were generally lower than the 2019 survey, but still above the analogue quadrat (**Table 24**). Two exceptions to this were Quadrats 9 and 10 which both recorded an increase in stem density, in the case of Quadrat 10 almost doubling. Examination of Quadrat 10 flora data (**Table 19**) shows that an estimated 200 stems of *Dodonaea triquetra* (Large-leaf Hop-bush) were recorded this survey, but this species was not recorded in 2019. This is a quick growing pioneer species that has obviously established in this area of the rehabilitation and has responded to favourable conditions and will die back. Responses to changes in climatic conditions and/or changes to physical conditions such as light will allow opportunistic species such as *D. triquetra* or indeed many native legumes to germinate in large numbers before gradually dying back.

The overall trend in the rehabilitation quadrats has been for stem densities to decline with age – a normal result of rehabilitation as the combination of seeding and residual seed bank germination results in higher than analogue densities (**Chart 10**). This can be attributed to the continuing self-thinning of certain species, with *C. maculata* the main species where numbers recorded in the quadrats fell dramatically, sometimes by 50%. In addition, it should be noted that this survey, a number of species were excluded from the stem count in the monitoring quadrats that had been included in the previous survey and this has reduced the stem density for several quadrats. These

were non-woody species that are not considered to be tree or shrub species according to the Biodiversity Assessment Method (DPIE, 2020).

Table 24: Comparison of native woody stem densities for the 2019 and 2022 surveys.

Quadrat	Quadrat Age	Woody Stem Densities (stems/ha)	
		2019	2022
1	Analogue	6,600	3,100
2	19	2,400	-
3	19	3,450	2,650
4	17	10,150	5,250
5	15	6,050	3,350
6	14	8,500	4,200
7	14	11,100	7,150
8	10	7,100	4,900
9	8	7,500	8,200
10	9	7,000	14,650
Rehabilitation average (Quadrats 2-10 for 2019 and 3-10 for 2022)		7,028	6,294

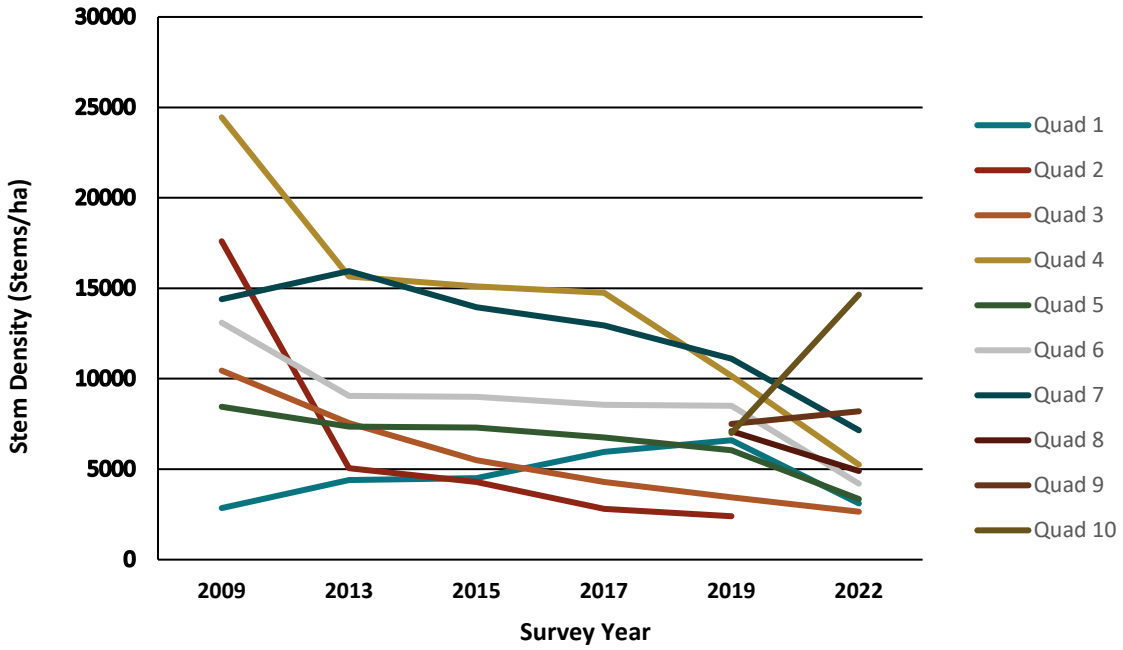


Chart 10: Stem density comparison from the 2022 survey and the previous five surveys showing the decline in stem density over time in the rehabilitation quadrats

3.3.4 Natural Regeneration

Evidence of natural regeneration was evident in all quadrats including the analogue with seedlings and saplings apparent, indicating more than one round of germination. Species that were observed were from all strata, including canopy species such as *C. maculata*, *E. globoidea, A. torulosa, B. oblongifolia,* and *P. villosa.* Flowers and fruit were also observed on many more species. The increase in species recorded in this survey compared to the 2019 survey also indicates that species have been introduced to the rehabilitation by natural seed vectors such as wind and fauna and/or have survived in the soil seed bank and responded to favourable conditions as mentioned previously. Section 5 Walkover Survey also notes recruitment of flora species outside of the monitoring quadrats.

3.3.5 Weeds

Exotic and weed species were recorded in several of the quadrats, but the distinction should be made between the categories. Exotic species are considered to be species that will colonise an area but not threaten revegetation efforts such as *Senecio madagascariensis* (Fireweed) or *Taraxacum officinale* (Dandelion) that will become naturalised and reduce in numbers as shading by canopy increases or other native species are able to compete and limit their total numbers. However, weed species that can threaten the revegetation effort through competition, such as Lantana and Pampas Grass, are regarded as requiring control works.

Lantana was recorded in five quadrats (Quadrats 3, 5, 7, 9 and 10), while Quadrat 2 was completely overrun by Lantana and unable to be survey this year. It was also noted in all areas of the rehabilitation while travelling between quadrats. Pampas Grass was only recorded in a single quadrat (Quadrat 8), but was observed scattered throughout the rehabilitation area, often with spent seed heads indicating the likelihood of further germinations (**Plate 11**).

Plate 12: Pampas Grass with spent seed heads observed in the vicinity of Quadrat 2

4. DISCUSSION

Overall, the rehabilitation on the Donaldson Open Cut spoil emplacement is progressing satisfactorily with many of the completion criteria having been met. Completion criteria for the flora are listed as –

- Diversity – presence of at least two overstorey and two understorey species in each 20m x 10m quadrat,
- Stem densities – a minimum tree/shrub density of 1, 500 stems/ha at 5 years and 1, 000 stems/ha at 10 years,
- Natural Regeneration – evidence of natural regeneration at Year 10 for at least two species.

Eight of the 10 monitoring quadrats are greater than 10 years old – Quadrats 9 and 10 are nine and eight years old respectively. With the exception of Quadrat 2 all quads meet the above criteria. While Quadrat 2 was not monitored this survey, given the level of lantana observed to be covering this area – well beyond the actual quadrat - it can be postulated that this area will only partially meet the above criteria with two overstorey species within the quadrat, observed from outside the lantana infestation. Quadrats 9 and 10 have successfully met the criteria for 5-year-old revegetation.

Natural thinning of the stem densities is still occurring in the majority of the quadrats (Quadrats Q3 to Q8), mainly as a result of the continued reduction in *C. maculata* numbers. Other species have also continued to self-thin and/or senesce as they have reached the end of their lifespan such as *A. decurrens* (Quadrat Q8). The change in methodology regarding stem counts has also contributed to the apparent reduction in stem density, especially in the analogue quadrat. Only counting species that are considered trees or shrubs more closely aligns with the wording of the completion criteria.

Natural regeneration and recruitment were observed within the various quadrats with saplings and seedlings of several species including canopy, midstorey, shrub and subshrub species of both seeded species and additional species that were not a part of the original seeding mix. This is a very pleasing result with additional species providing further structure and complexity to the revegetation. As an example, the shrubs *Leucopogon juniperinus* (Prickly Beard-heath) and *Ozothamnus diosmifolius* were recorded in Quadrat 3 and Quadrat 10 respectively. *L. juniperinus* is a low shrub that typically flowers from May - October (PlantNET), while *O. diosmifolius* is a much taller shrub, that typically flowers from late winter to spring (PlantNET). Such self-recruitment bodes well for the long-term rehabilitation of the spoil emplacement.

The soil completion criteria were detailed in **Table 21** and show mixed results across the monitoring quadrats.

Seven of the eleven soil parameters measured in the soil analysis have completion criteria levels stipulated. Of these four of the parameters meet the criteria for all quadrats. These are soil pH, electrical conductivity, exchangeable sodium percentage, and available nitrogen. Three of the soil parameters have not successfully satisfied the completion criteria. Cation Exchange Capacity has only been successful in three quadrats (Quadrats Q2, Q3 and Q4). Total Organic Matter and Available Phosphorus satisfy the criteria for Quadrat Q2 only.

Australian soils are generally considered to be of low fertility (Handreck, 1997) and the soil analysis confirms that the soils at Donaldson are generally of low fertility with low cation exchange capacity (a general marker of fertility) and low nitrogen and phosphorus. Despite this there would appear to be no major concerns with the ability of the of the soil to support revegetation given the flora results.

The soil loss/gain data appears to show a net gain of soil over the period since the last survey in 2019. This can only be attributed to an accumulation of organic material as leaf litter. The replacement of H frames that are either missing (actually or maybe not sighted due to being overgrown) or in the case of Quadrat Q8 where the soil underneath the frame has been disturbed by fauna activity needs to be considered. Soil loss/gain as measured from these frames would become useful in two surveys time, given that next survey would be a first-time measurement in the new position and may be of only limited use for future monitoring. However, for consistency of data collection, it is suggested that they be re-installed.

5. WALKOVER SURVEY OF THE NORTHERN EMPLACEMENT 2004 AND 2005 REHABILITATION

A component of the monitoring conducted in 2022 was an investigation into the suitability of the northern, oldest area of the rehabilitation for relinquishment - this area comprised the 2004 and 2005 rehabilitation areas (referred to here as the Northern Emplacement Area or NEA). A walkover style survey was conducted noting features of the vegetation indicating suitability for surrender such as structure (presence of native species from the ground layer, shrub, midstory and canopy strata), natural recruitment such as seedlings and saplings and weeds and erosion. Tracks and observation locations are shown in **Figure 4**.

5.1 RESULTS

The results of the walkover survey reveal that the NEA can be separated into a number of zones based on the density of weeds, primarily Lantana. These can be summarised as:

- Dense Lantana where physically walking through the area was extremely difficult. This was estimated to be between 80% and 100% cover.
- Moderate Lantana where individual plants were beginning to become intermixed. Cover was estimated to be between 50% and 80%.
- Sparse Lantana where plants were scattered but were common and density varied from individual plants to clumps of up to an estimated 10 individuals.
- Successful Native rehabilitation where none-the-less, smaller, scattered individual lantana plants were observed. It should be noted here that Pampas Grass (*Cortaderia selloana)* was recorded throughout all areas of the NEA.

5.2 DENSE LANTANA

Two large areas of dense lantana were recorded located in the western and north-eastern sections of the NEA together incorporating an area of 17 ha (33% of the NEA) – the entire NEA is approximately 51 ha. Essentially these areas are covered in a layer of continuous lantana, often starting to form high banks and climbing into the regenerating canopy (**Plate 12**, **Plate 13** and **Plate 14**). This dense lantana will have a negative impact on the revegetation of the NEA by physically preventing natural recruitment, hindering the growth of any already established native vegetation by smothering and acting as a source for future infestations.

Plate 13: Example of dense lantana at Point 1 in Figure 4.

Plate 14: Point 1 again showing dense lantana

Plate 15: Point 2 showing dense lantana ground cover

5.3 MODERATE AND SPARSE LANTANA

Areas of moderate and sparse lantana densities were observed adjacent to the denser areas and can be considered areas of advanced colonisation of the rehabilitation. Moderate density lantana covered an area of approximately 4 ha (7% of the NEA), while the sparse lantana area was calculated to cover 1.7ha (3% of the NEA). If left uncontrolled it can be expected that these areas will increase in density and spread into the successful rehabilitation area (**Plate 15** and **Plate 16**).

Plate 16: Example of moderate density lantana

Plate 17: Example of individual Lantana plant in sparser density areas

5.4 SUCCESSFUL REHABILITATION

Despite the prevalence of lantana over a considerable area of the NEA, there is a larger section that can be considered successful rehabilitation – approximately 28 ha or 55% of the of the NEA. As shown in **Figure 4** the successful rehabilitation area is largely in the south-eastern section of the NEA, and while this area does have some minor scattered weed issues, it consists of native

vegetation of varying densities. During the walkover it was observed that areas of high canopy density generally had sparser vegetative ground cover with a thick litter cover and considerable woody debris from self-thinned trees and trees/timber that had fallen as a result of high winds and storms (**Plate 17**). Towards the south-eastern section of the NEA, the canopy stems were not quite as dense, and this allowed greater light penetration and more developed shrub and groundcover strata (**Plate 18**).

Plate 18: Example of high canopy density in the "Successful Rehabilitation" area of the NEA. Note the litter and woody debris and relatively sparse vegetative groundcover

Plate 19: Example of more open area of the "Successful Rehabilitation" on the NEA. Note the greater coverage of grasses and forbs the groundcover stratum

Overall, canopy cover was good with a high density of several *Eucalyptus* species including saplings and seedling indicating multiple germinations. Vegetation structure is beginning to form with the midstorey species *Allocasuarina torulosa* frequently observed in addition to shrubs, subshrubs and native grasses. Many of these lower stratum species will be the result of natural recruitment and/or have become established and represent several generations (due to relatively short lifespans) of self-sustaining germination. Examples include *Acacia spp.* seedlings, *Isopogon anemonifolius*

(Broad-leaf Drumsticks), *Solanum prinophyllum* (Forest Nightshade) and *Hibbertia pedunculata*. Examples are shown in the following plates (**Plate 19**, **Plate 20**, **Plate 21**, **Plate 22** and **Plate 23**).

Plate 20: *Eucalyptus* spp. sapling

Plate 21: *Acacia spp.* seedling

Plate 22: *Isopogon anemonifolius* seedling

Plate 23: *Solanum prinophyllum* seedling

Plate 24: *Hibbertia pedunculata* with flower indicating natural recruitment

5.5 OTHER OBSERVATIONS

Areas with active erosion were not observed during the walkover, but two examples of historic erosion that may become active during high rainfall events were observed at O5 and O6.

Two larger areas of bare soil where vegetation has not been successful in establishing were also recorded at O7 and O14.

Plate 25: Currently inactive erosion notch at O6

Plate 26: Area of bare soil at O14

5.6 DISCUSSION

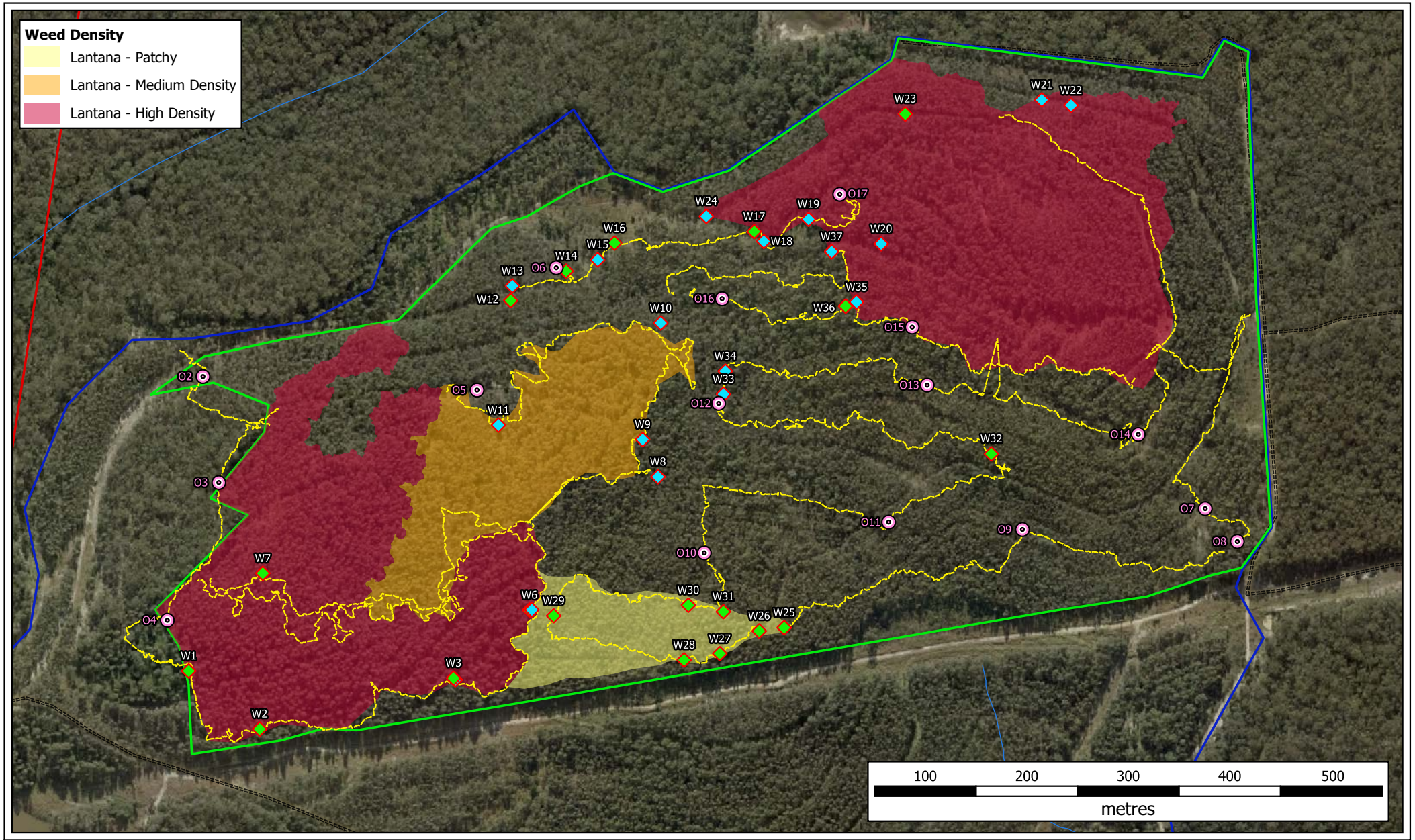
The addition of a walkover survey to the annual monitoring concentrating on the oldest section of the rehabilitation was designed to determine if this section was suitable/ready for relinquishment. The large area of high-density lantana, plus areas of moderate and scattered lantana would preclude surrender of this area without considerable amount of weed control work. Include the scattered but common occurrence of Pampas Grass and the NEA requires a sustained and consistent weed control program to bring the level of weed coverage to a level where it no longer effects the native vegetation. The spoil emplacement revegetation has entered the Ecosystem and Land Used Development stage of the rehabilitation, and as stated in accordance with the General Objectives as outlined in Section 3.2 of the 2019 Monitoring Report (GSS, 2019) there is to be a minimum presence of key weed species such as Pampas Grass, Lantana and Blackberry. With the estimation that 43% of the NEA is covered to some degree with lanata and the widespread but scattered presence of Pampas Grass it must be concluded that the NEA cannot be offered for relinquishment at this stage.

In the areas of the NEA dubbed “Successful Rehabilitation” the much lower levels of weeds and especially lantana, demonstrate what can been achieved. A good diversity of canopy species plus the presence of species from multiple strata, combined with evidence of natural recruitment, excellent litter and vegetation coverage of the soil surface preventing erosion, indicate revegetation that is demonstrably on trajectory for successful rehabilitation. The two areas of bare soil that were recorded – and other areas that may be present but not encountered this walkover – will require further monitoring to ensure that erosion does not become an issue. It is suggested that a drone flyover may be used to identify any such areas that can be targeted for future monitoring.

Suggestions for weed control works include:

1. Intensive weed spraying using vehicle mounted spray units and/or splatter guns. Overspray of herbicide onto native vegetation is always a risk with this method and would be of major concern in this context. This method would be suitable for the control of the Pampas Grass plants given their more localised, and generally isolated position in the rehabilitation areas.

2. Manual control of the lantana using cut and paint methodology. This is very labour intensive, and hence expensive and relatively slow.
3. A decision then must be made whether to leave the woody material *in situ* or to manually remove it from site. Leaving the material *in situ* poses a fire risk and makes follow up weed control (reshooting from stems and germinating from the seed bank – difficult. This must be balanced against the added cost incurred by disposal and the potential for damage to native vegetation that manual removal may cause.
4. Controlled, cool season burns have gained acceptance as a means of both controlling weeds, reducing fuel load and stimulating native seed germination. Reduction of the fuel load that has built up from both the self-thinning of the native vegetation and the build-up of the lantana makes this an attractive option.



Created by: KBlundell
Date: 08.02.2023

WEDGETAIL
PROJECT CONSULTING PTY LTD
https://wedgetail.com.au

Legend

- Donaldson Coal Mine Lease
- Rehab Area Boundary
- Relinquishment Area
- Survey Tracks
- Lantana
- Pampas grass
- General Observation

Relinquishment Area Walk-over Observations

Figure: **4**

Donaldson Coal
John Renshaw Drive
Black Hill NSW

N

Table 25: Attribution for the weed observations in Figure 4.

Point ID	Weed Species	Patch Size	Notes
1	Lantana	100s sq m	Extremely dense and widespread
2	Lantana	100s sq m	Dense thickets continues
3	Lantana	100s sq m	Solid continuous wall
4	Pampas grass	1	
5	Pampas grass	1	
6	Lantana	100s	Wall continues
7	Lantana	100s	Example of dense but patchy lantana
8	Pampas grass	1	
9	Pampas grass	1	
10	Pampas grass	1	Large plant
11	Pampas grass	1	
12	Lantana	4	
13	Pampas grass	1	
14	Lantana	5	
15	Pampas grass	2	
16	Lantana	5	
17	Lantana	1	Large
18	Pampas Grass	1	
19	Pampas grass	1	Very big plant with seed heads
20	Pampas Grass	1	Large plant with seed heads
21	Pampas Grass	1	
22	Pampas grass	1	spent seed heads
23	Lantana	Dense	
24	Pampas Grass	1	
25	Lantana	1	
26	Lantana	5	
27	Lantana	10	
28	Lantana	5	
29	Lantana	10	Juvenile lantana colonising good rehab
30	Lantana	2	
31	Lantana	2	
32	Lantana	1	Juvenile
33	Pampas Grass	-	
34	Pampas Grass	1	
35	Pampas Grass	2	
36	Lantana	7	Large and small plants
37	Pampas Grass	1	
38	Lantana	5	
39	Lantana	Dense large	
40	Pampas grass	1	
41	Pampas Grass	1	
42	Pampas grass	1	
43	Pampas Grass	1	
44	Pampas Grass	3	
45	Pampas Grass	1	
46	Pampas Grass	1	

Point ID	Weed Species	Patch Size	Notes
47	Pampas Grass	1	
48	Pampas Grass	2	
49	Pampas Grass	1	

6. REFERENCES

2019 Rehabilitation Monitoring Report, Donaldson Coal Mine (September 2019). A report prepared by Global Soil Systems on behalf of Donaldson Coal Pty Ltd.

Handreck, K. A, (1997), **Phosphorus requirements of Australian native plants.** *Aust. J. Soil Res.,* **35**, 241-89.

Nicholls, O.G. (2005), **Development rehabilitation criteria for native ecosystem establishment on coal mines in the Hunter Valley.** Australian Coal Association Research Project C13048.

Rehabilitation Management Plan for the Donaldson Coal Mine (August 2022). A report prepared by Donaldson Coal Pty Ltd and RW Corkery & Co Pty Ltd on behalf of Donaldson Coal Pty Ltd.

APPENDIX A: RAINFALL

Table 26: Historical rainfall for the Cessnock Airport AWS.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2003	2.6	115	38.2	66.6	59.2	12	29.4	43.6	0.2	68	71	64.2	**570**
2004	92.8	137.6	40.2	10.4	19.4	4.2	17.4	31.6	35.6	104.8	49.6	84.6	**628.2**
2005	55.4	156.2	101.4	19	55.2	79.8	12.6	3.2	36.8	77.6	73	13.2	**683.4**
2006	49.2	31.2	68.4	16.6	7.6	29.8	37.2	21.4	109.4	4.6	38	44.8	**458.2**
2007	14	79	48.8	44.8	49.2	352.2	15.4	78.2	20.8	7.4	144.8	119.8	**974.4**
2008	122.6	192	40.4	169.2	1.6	119	25.8	23	116	81.8	62.6	85.4	**1039.4**
2009	2.6	223.6	40.6	142.4	78.4	41.2	24.8	0.8	25.4	49.4	62.6	75	**766.8**
2010	118.8	109.8	89.6	36	52.6	79.6	58.2	22.2	20.4	58.6	142.2	68.8	**856.8**
2011	52.2	24.2	47	60.4	69.8	170.4	46.2	56.2	87.6	79.6	155.6	89.8	**939**
2012	48.6	154.4	107	45.2	7	80.4	33.2	8.8	32	4	43.4	38.4	**602.4**
2013	156	147.2	117.8	48.8	36.8	63.6	7.8	11.6	24.4	16.8	160.6	15.4	**806.8**
2014	14.4	61.4	135.8	62.6	14.8	14.6	22.6	77	24.2	37.8	24.6	172.4	**662.2**
2015	141.4	35.4	25.4	298.6	79.6	36.4	12.8	29.4	29.2	44.2	113	161	**1006.4**
2016	302.8	20.4	13.4	19.4	12.2	88.2	35.6	32.6	70.8	53.2	37.8	75.4	**761.8**
2017	66.2	41.8	145	49.4	21.4	51.8	2.4	8.4	8.6	97.2	89.4	66	**647.6**
2018	6	107.6	119.6	16.2	7	56.4	2.2	13.6	39.4	86.8	62.6	88	**605.4**
2019	46.8	41.4	121.4	12.8	13.4	22.2	10.2	44.6	56.8	2.8	10.4	1.6	**384.4**
2020	43.8	193.2	108.8	40.4	32.4	45.4	104.6	39.2	31	102.4	48	170.4	**959.6**
2021	58.8	85.4	279.8	32	15	51.2	19.4	48	13	82	231	66.6	**982.2**
2022	69.4	189	257.6	70.8	51.4	10	291.2	41.4	75.8	103.6	58.8	82.8	**1301.8**
Statistic	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	75.5	101.6	88.5	54.1	38.3	55	36.5	34.2	44	56	76	80.1	757.8

Station: Cessnock Airport AWS - 25 km west of Donaldson Coal Mine

Number: 61260

Lat: 32.79° S

Lon: 151.34° E

Elevation: 67 m

http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_stn_num=061260

Accessed on 3/1/2023

Appendix 7

Approval to Cease Independent Environmental Audits

(Total No. of pages including blank pages = 3)

From: Ann Hagerthy <Ann.Hagerthy@planning.nsw.gov.au>
Sent: Wednesday, 31 October 2018 3:02 PM
To: Phillip Brown
Cc: James Benson; Leah Cook
Subject: RE: Donaldson 2016/207 AR

Hi Phillip,

Thank you for your letter. The Department notes that Schedule 2, Condition 117 of DA 98/01173 and DA 118/698/22 states that Independent Environmental Audits (IEAs) are required at 3 yearly intervals and at the completion of mining, and notes that the consent for mining lapsed in 2013 with the last IEA completed in 2015. Please be advised that at this time the Department requires no future IEAs as required under Schedule 2, Condition 117 of DA 98/01173 and DA 118/698/22, unless otherwise directed by the Secretary.

Regards,

Ann Hagerthy, PMP
A/Team Leader
Compliance
Department of Planning & Environment | PO Box 3145 | Singleton NSW 2330
T 02 6575 3407 M 0428 976 540
E ann.hagerthy@planning.nsw.gov.au
compliance@planning.nsw.gov.au

NSW GOVERNMENT | Planning & Environment

From: Phillip Brown <Phillip.Brown@yancoal.com.au>
Sent: Thursday, 25 October 2018 2:02 PM
To: Ann Hagerthy <Ann.Hagerthy@planning.nsw.gov.au>
Cc: James Benson <James.Benson@yancoal.com.au>; Leah Cook <Leah.Cook@planning.nsw.gov.au>
Subject: RE: Donaldson 2016/207 AR

Hello Ann

Further to the email below, please find enclosed Donaldson's response.

Regards

Phillip Brown | ENVIRONMENT & COMMUNITY RELATIONS SUPERINTENDENT

Ashton Coal Operations Pty Ltd
SITE: Glennies Creek Road, Camberwell NSW 2330
POSTAL: PO Box 699 Singleton NSW 2330 Australia
PHONE: +61 2 6570 9219
MOBILE: 0439 909 952
EMAIL: Phillip.Brown@yancoal.com.au
WEBSITE: www.ashtoncoal.com.au

AshtonCoal
PART OF THE YANCOAL AUSTRALIA GROUP

From: Ann Hagerthy [mailto:Ann.Hagerthy@planning.nsw.gov.au]
Sent: Wednesday, 10 October 2018 1:02 PM
To: Phillip Brown <Phillip.Brown@yancoal.com.au>
Cc: James Benson <James.Benson@yancoal.com.au>; Leah Cook <Leah.Cook@planning.nsw.gov.au>
Subject: RE: Donaldson 2016/207 AR

Hi Phillip,

Please find attached the Department's response letter to the 2016-2017 Annual Review. Please note that a revision is due 27 November 2018.

Regards,

Ann Hagerthy, PMP
Senior Compliance Officer (Wed, Thu, Fri)
Compliance
Department of Planning & Environment | PO Box 3145 | Singleton NSW 2330
T 02 6575 3407 M 0428 976 540
E ann.hagerthy@planning.nsw.gov.au
compliance@planning.nsw.gov.au

From: Phillip Brown <Phillip.Brown@yancoal.com.au>
Sent: Thursday, 25 January 2018 12:44 PM
To: Ann Hagerthy <Ann.Hagerthy@planning.nsw.gov.au>; DPE PSVC Compliance Mailbox <compliance@planning.nsw.gov.au>
Cc: James Benson <James.Benson@yancoal.com.au>
Subject: Donaldson 2016/207 AR

Hello Ann

Please find enclosed the 2016/2017 Annual Review for Donaldson Coal.

Thanks

Phillip Brown | ENVIRONMENT & COMMUNITY RELATIONS SUPERINTENDENT

Ashton Coal Operations Pty Ltd
SITE: Glennies Creek Road, Camberwell NSW 2330
POSTAL: PO Box 699 Singleton NSW 2330 Australia
PHONE: +61 2 6570 9219
MOBILE: 0439 909 952
EMAIL: Phillip.Brown@yancoal.com.au
WEBSITE: www.ashtoncoal.com.au