Wongawilli Colliery
Nebo Area Project Approval (MP 09_161)

ANNUAL REVIEW/ANNUAL ENVIRONMENTAL MANAGEMENT REPORT
(1 JULY 2020 – 30 JUNE 2021)

TITLE BLOCK

Name of Operation	Wongawilli Colliery
Name of Mine Operator	Wongawilli Coal Pty Limited
Project Approval	Nebo Area Project (MP09_0161)
Name of Holder of Project Approval	Wongawilli Coal Pty Limited
Mining Leases	ML 1596, ML 1565 and CCL 766
Name of Holder of Mining Lease	Wongawilli Pty Limited
Water Licence	WAL36487
Name of Holder of Water Licence	Wongawilli Coal Pty Limited
MOP Start Date	27 November 2020
MOP End Date	02 July 2022
Annual Review Start Date	1 July 2020
Annual Review End Date	30 June 2021

I, Richard Sheehan, certify that this audit report is a true and accurate record of the compliance status of Wongawilli Colliery for the period 1 July 2020 to 30 June 2021 and that I am authorised to make this statement on behalf of Wollongong Coal Limited.

Name of Authorised Reporting Officer	Richard Sheehan
Title of Authorised Reporting Officer	Group Environment and Approvals Manager
Signature of Authorised Reporting Officer	
Date	30/09/2021

GLOSSARY OF TERMS AND ABBREVIATIONS

Abbreviations	
AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
BAM	Beta Attenuation Monitors
CCC	Community Consultative Committee
CCL	Consolidated Coal Lease
CO_2-e	carbon dioxide equivalent
DPIE	NSW Department of Planning, Industry and Environment
DRG	Division of Resources and Geoscience
DSNSW	Dams Safety NSW
EA	Environmental Assessment
EP	Extraction Plan
EPA	Environment Protection Agency
EEC	Endangered Ecological Community
EM	Environmental Manager
EO	Environmental Officer
EOM	End of Mine
EP&A Act	Environmental Planning and Assessment Act, 1979
EP&A Reg.	Environmental Planning and Assessment Regulation, 2000
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act, 1999
EPL	Environment Protection Licence
FY	Financial Year
GQC	Groundwater Quality Criteria
HIL	Health Investigation Levels
IEA	Independent Environmental Audit
IWMP	Integrated Wastewater Management Plan
LEP	Local Environment Plan
LGA	Local Government Area
LW	Longwall
km	kilometre
m	metre
mg/L	milligram per litre
ML	Mining Lease
ML/day	megalitre per day
MOP	Mine Operations Plan
MPL	Mining Purposes Lease
mm/m	millimetres per metre
Mtpa	Million tonnes per annum
NGER	National Greenhouse and Energy Reporting
NMP	Noise Management Plan
NRE	Gujarat NRE Coking Coal Ltd

Abbreviations	
NSW	New South Wales
PAH	Polycyclic Aromatic Hydrocarbons
PCA	Private Certifying Authority
PCB	Polychlorinated Biphenyl
PKCT	Port Kembla Coal Terminal
PIL	Pollution Limit Levels
PM_{10}	particulate matter less than 10 microns in size
REF	Review of Environmental Factors
RIM	Rail Infrastructure Manager
RR	Resources Regulator
ROM	Run-of-Mine
SEPP	State Environmental Planning Policy
SMP	Subsidence Management Plan
TARP	Trigger Action Response Plan
TSR	Total Species Richness
WCC	Wollongong City Council
WCL	Wollongong Coal Limited
WWC	Wongawilli Colliery
%	percent
0	degree

Term	Definition
Alluvial	A general term for clay, silt, sand and gravel transported by water and deposited, on the bed of a flood plain, river or stream.
Baseline monitoring	Monitoring conducted over time to collect a body of information to define specific characteristics of an area (e.g., species occurrence or noise levels) prior to commencement of a specific activity.
Coking Coal	Self-coking coal with ash of less than 10% and volatile matter of 21-23%, excellent capacity for carrying 'soft' coking coals in a blend.
Continuous miner	A remote-controlled, tracked, electrically powered coal cutting and loading machine used to form mine roadways and extract coal pillars.
Conveyor	Fixed mechanical apparatus consisting of a continuous moving belt used to transport coal from one place to another.
Driveage	A horizontal or inclined heading or roadway in the process of construction. The roadway will be used to access a new mining area within the lease.
Dyke	A sheet like vertical intrusion of igneous rock cutting across the strata of older rocks.
Ecosystem	An interacting system of animals, plants, other organisms and non-living parts of the environment.
Fault	Major fracture of the earth's crust caused by the relative movement of the rock masses on either side.
First Workings	Involves the development headings or roadways which will provide access to the coal resource. They are developed using continuous miners with

Term	Definition
	integrated roof and rib bolting rigs. First workings leave the coal pillars intact and the overlying strata fully supported
Gate roads (main-gates and tailgates)	An underground roadway (tunnel) that provides access to a working longwall for continuous mining.
Goaf (or goafing)	The space left following extraction of the coal seam where the roof material is allowed to collapse.
Greenhouse gases	Gases with potential to cause climate change (e.g., methane, carbon dioxide and non-methane volatile organic compounds). Usually expressed in terms of carbon dioxide equivalent.
Groundwater	All waters occurring below the land surface; the upper surface of the soils saturated by groundwater in any particular area is called the water table.
Habitat	The particular local environment occupied by an organism.
Infrastructure	The supporting installations and services that supply the needs of the Project.
Longwall	A secondary extraction method of mining coal that continuously removes the coal from the working face onto a series of conveyors that transfer the coal to the surface. As the coal is cut away (a 'shear'), both the longwall machine (known as a 'shearer') and the hydraulic roof supports advance forward ready for the next shear.
Permeability	The ability of a rock or soil to allow fluid to pass through it.
Pillar Extraction	A continuous miner system of mining whereby coal pillars are systematically extracted.
Pillar Run	A large scale progressive collapse of coal pillars in a short period of time.
Potable water	Water of quality suitable for human consumption.
Project Approval	Nebo Area Project Approval (MP 09_0161)
Rehabilitation	The restoration of a landscape and especially the vegetation following its disturbance.
Run-of-mine (ROM)	Raw coal that is stockpiled and/or prior to being processed through a coal preparation plant.
Strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points.
Subsidence	The deformation of the ground mass due to the mining activity, including both vertical and horizontal displacement, tilt, strain and curvature.
Terrestrial	Living or growing on the land.
Tilt	The difference in subsidence between two points divided by the horizontal distance between the points.
Upsidence	Relative upward movement, or uplift, created by the horizontal compression and buckling behaviour of the rock strata in the vicinity of a valley floor
Valley closure	A phenomenon whereby one or both sides of a valley move horizontally towards the valley centreline, due to changed stress conditions beneath the valley and its confining land masses

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 STATEMENT OF COMPLIANCE

The compliance status of Wongawilli Colliery at the end of reporting period is provided in **Table 1.1**.

Table 1.1: Statement of Compliance

Were all conditions of the relevant approvals complied with?	
MP 09_0161	Yes
ML 1565	Yes
ML 1596	Yes
CCL 766	Yes
EPL 1087	No
EPL 12442	Yes

2 INTRODUCTION

Wongawilli Coal Pty Ltd operates the Wongawilli Colliery in the Southern Coalfield of New South Wales. Wongawilli Coal Pty Ltd is a wholly owned subsidiary of Wollongong Coal Limited (**WCL**). Wongawilli Colliery is located approximately 14 km south-west of Wollongong (**Figure 2.1**), within the Wollongong and Wingecarribee Local Government Areas (**LGAs**). **Figure *2.2*** shows WCL's Wongawilli Colliery Assets and Leases which includes the Avondale site which is decommissioned (**Figure *2.3***).

The Wongawilli Pit Top contains the main mine portal and caters for personnel, mining equipment, vehicle and machinery maintenance, mine supplies, administration, coal transport to the surface, a 100,000 tonne capacity coal stockpiling facility and rail transportation facilities to load and transport coal to the PKCT. An overview of the Wongawilli Colliery operational areas and infrastructure is shown on **Figure 2.4** and **Figure 2.5**. A modification (MOD1) to MP 10_0046 was approved on 27 November 2015, authorising the continuation of mining operations until 31 December 2020. The Mine ceased production of coal on 13th March 2019, to then being placed into Care and Maintenance in May 2019.

Figure 2.1: Location of Wongawilli Colliery

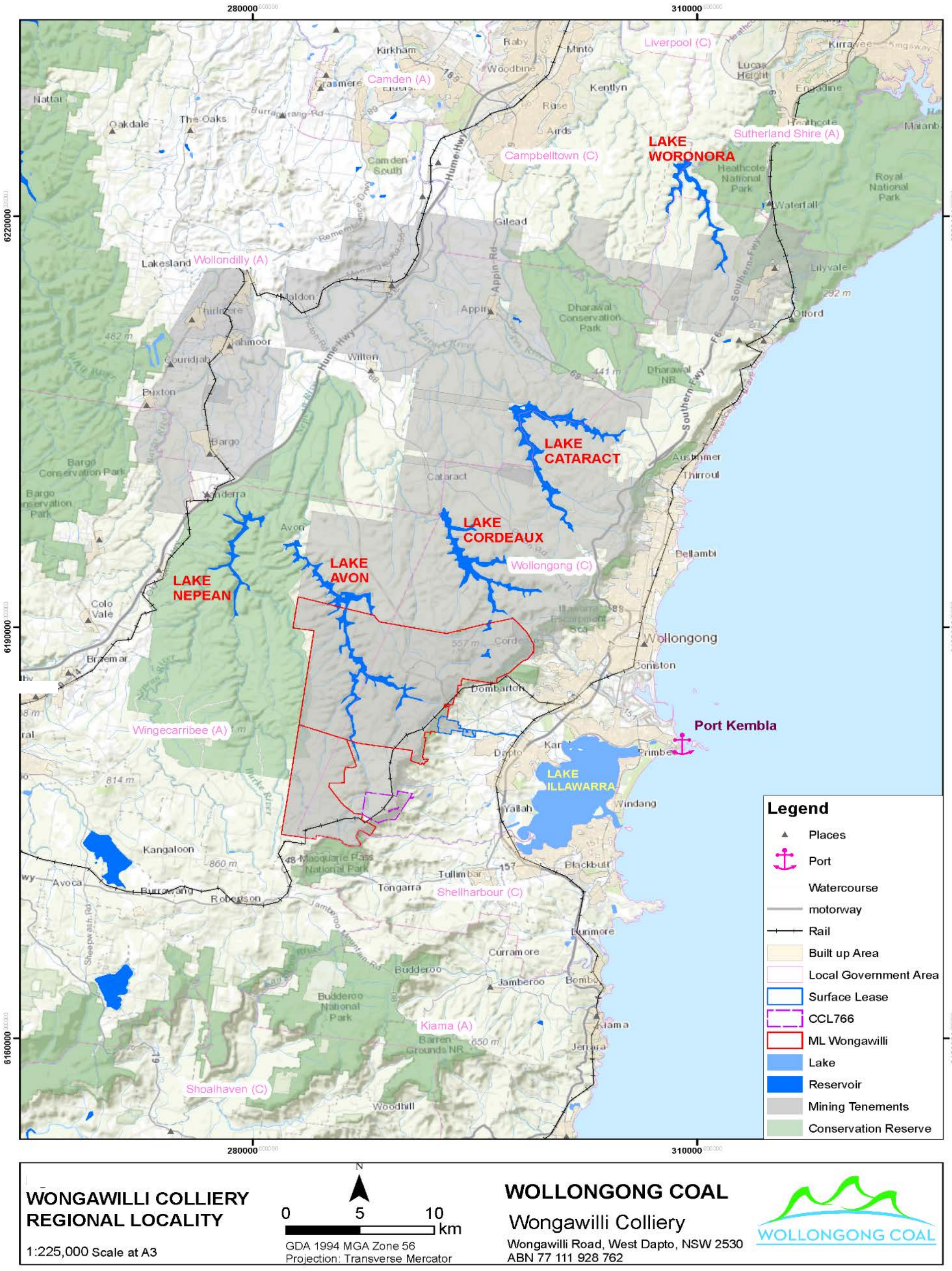
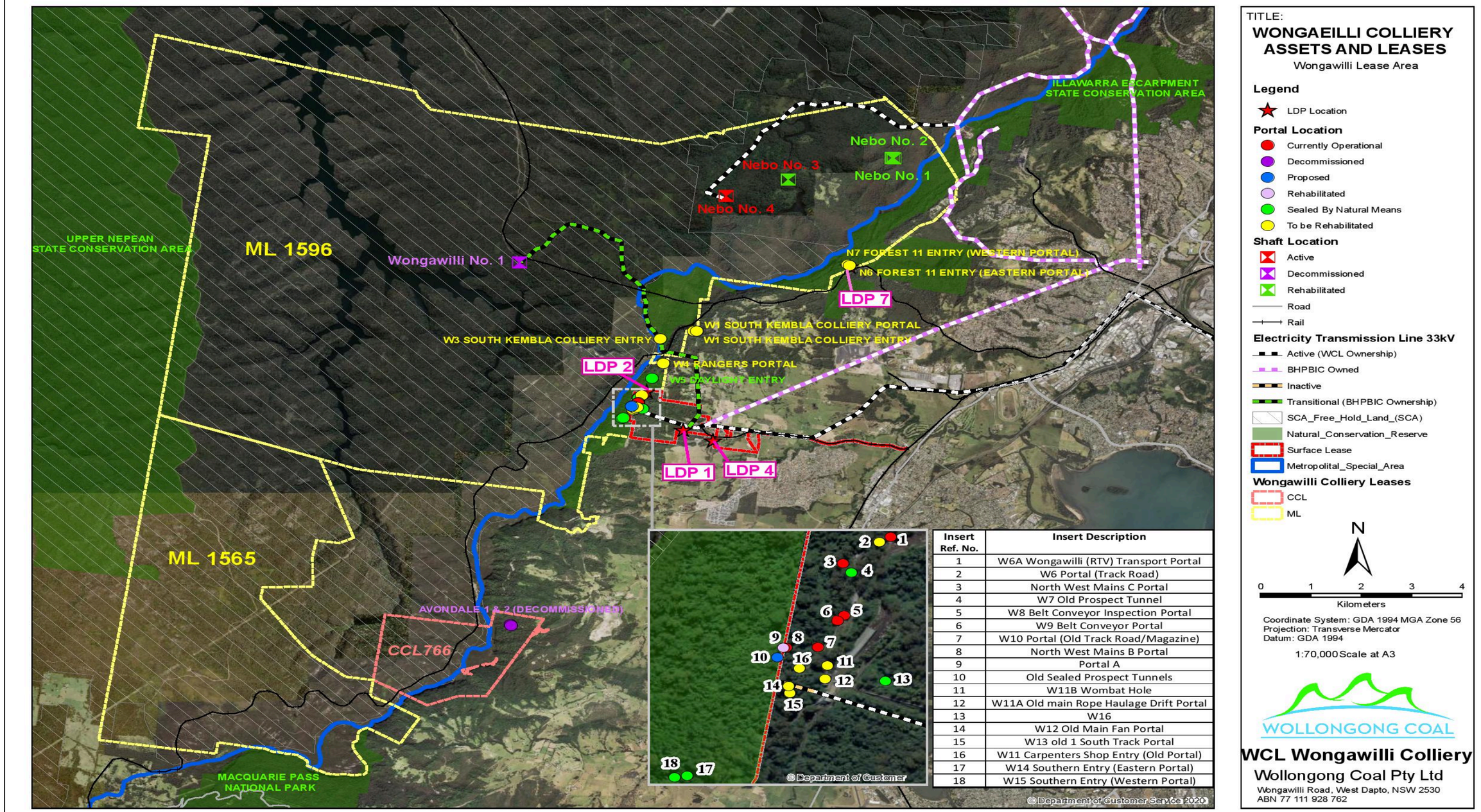


Figure 2.2: Wongawilli Assets and Leases



Insert Ref. No.	Insert Description
1	W6A Wongawilli (RTV) Transport Portal
2	W6 Portal (Track Road)
3	North West Mains C Portal
4	W7 Old Prospect Tunnel
5	W8 Belt Conveyor Inspection Portal
6	W9 Belt Conveyor Portal
7	W10 Portal (Old Track Road/Magazine)
8	North West Mains B Portal
9	Portal A
10	Old Sealed Prospect Tunnels
11	W11B Wombat Hole
12	W11A Old main Rope Haulage Drift Portal
13	W16
14	W12 Old Main Fan Portal
15	W13 old 1 South Track Portal
16	W11 Carpenters Shop Entry (Old Portal)
17	W14 Southern Entry (Eastern Portal)
18	W15 Southern Entry (Western Portal)

TITLE:

WONGAEILLI COLLIERY ASSETS AND LEASES

Wongawilli Lease Area

Legend

LDP Location

Portal Location

- Currently Operational
- Decommissioned
- Proposed
- Rehabilitated
- Sealed By Natural Means
- To be Rehabilitated

Shaft Location

- Active
- Decommissioned
- Rehabilitated
- Road
- Rail

Electricity Transmission Line 33kV

- Active (WCL Ownership)
- BHPBIC Owned
- Inactive
- Transitional (BHPBIC Ownership)
- SCA_Free_Hold_Land_(SCA)
- Natural_Conservation_Reserve
- Surface Lease
- Metropolital_Special_Area

Wongawilli Colliery Leases

- CCL
- ML

N

0 1 2 3 4

Kilometers

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

1:70,000 Scale at A3

WOLLONGONG COAL

WCL Wongawilli Colliery

Wollongong Coal Pty Ltd

Wongawilli Road, West Dapto, NSW 2530
ABN 77 111 928 762

Figure 2.3: Avondale Site (Decommissioned)

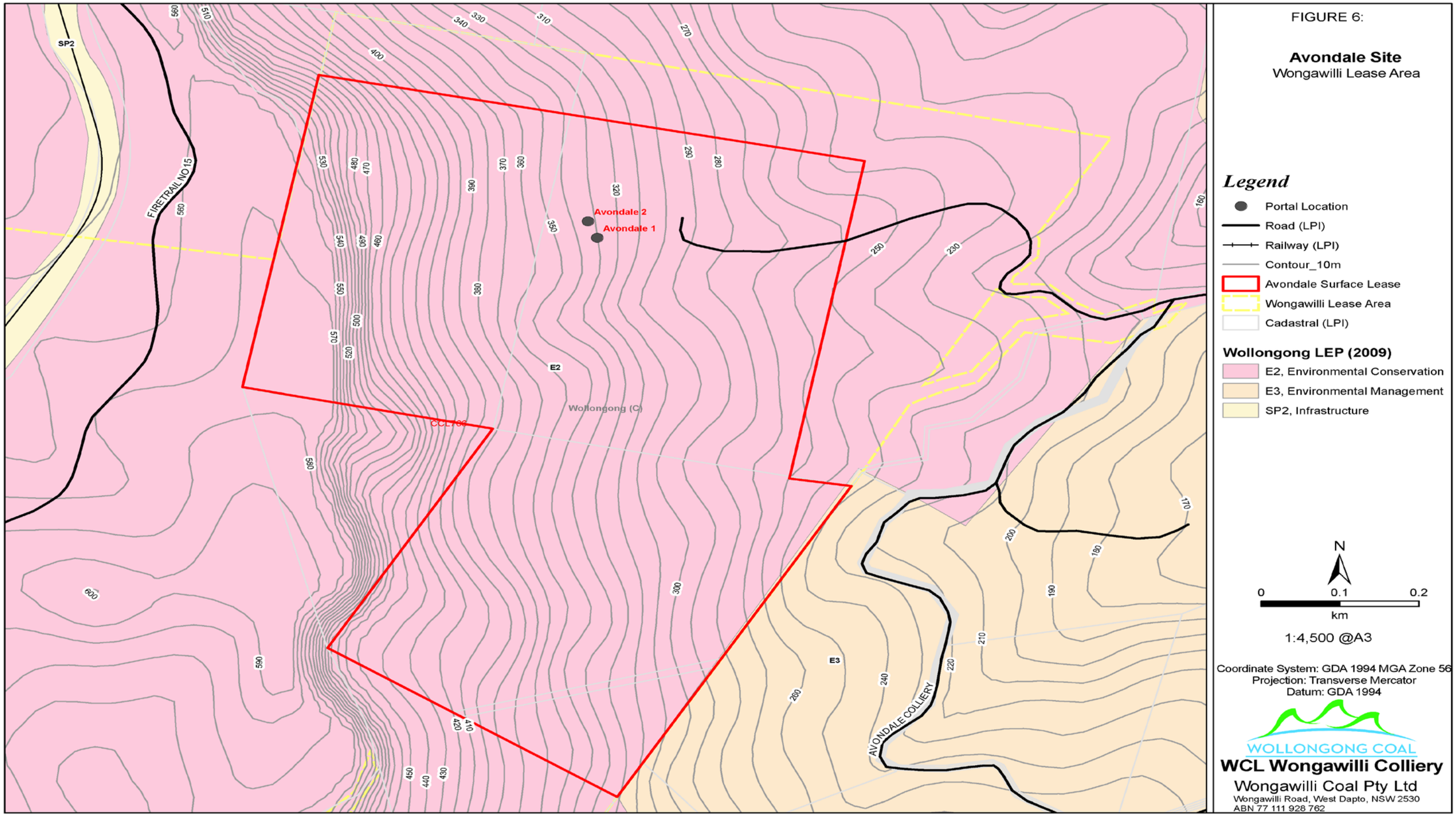
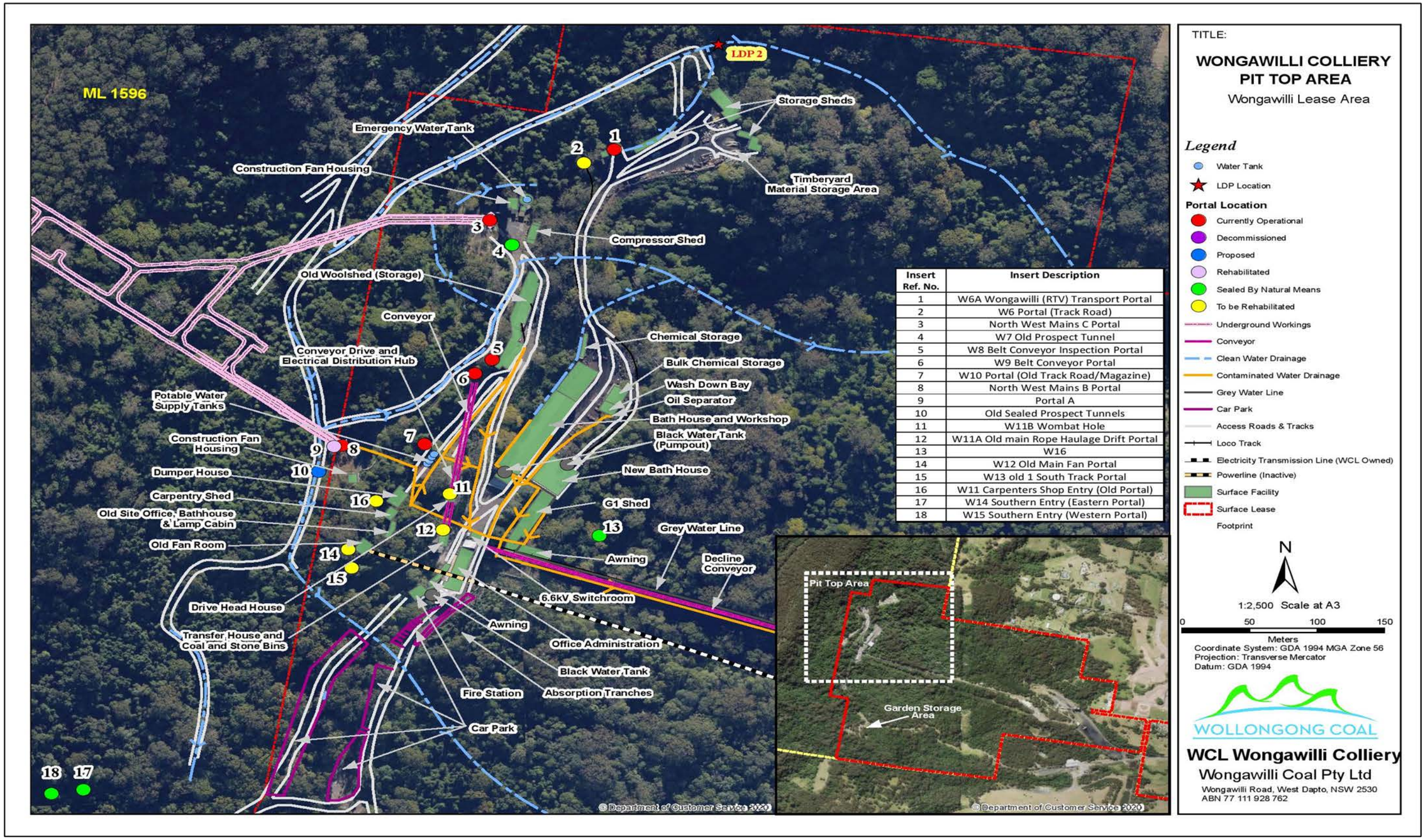


Figure 2.4 Wongawilli Colliery Pit Top



Insert Ref. No.	Insert Description
1	W6A Wongawilli (RTV) Transport Portal
2	W6 Portal (Track Road)
3	North West Mains C Portal
4	W7 Old Prospect Tunnel
5	W8 Belt Conveyor Inspection Portal
6	W9 Belt Conveyor Portal
7	W10 Portal (Old Track Road/Magazine)
8	North West Mains B Portal
9	Portal A
10	Old Sealed Prospect Tunnels
11	W11B Wombat Hole
12	W11A Old main Rope Haulage Drift Portal
13	W16
14	W12 Old Main Fan Portal
15	W13 old 1 South Track Portal
16	W11 Carpenters Shop Entry (Old Portal)
17	W14 Southern Entry (Eastern Portal)
18	W15 Southern Entry (Western Portal)

TITLE:

WONGAWILLI COLLIERY PIT TOP AREA

Wongawilli Lease Area

Legend

- Water Tank
- LDP Location

Portal Location

- Currently Operational
- Decommissioned
- Proposed
- Rehabilitated
- Sealed By Natural Means
- To be Rehabilitated
- Underground Workings
- Conveyor
- Clean Water Drainage
- Contaminated Water Drainage
- Grey Water Line
- Car Park
- Access Roads & Tracks
- Loco Track
- Electricity Transmission Line (WCL Owned)
- Powerline (Inactive)
- Surface Facility
- Surface Lease
- Footprint

N

1:2,500 Scale at A3

0 50 100 150

Meters

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

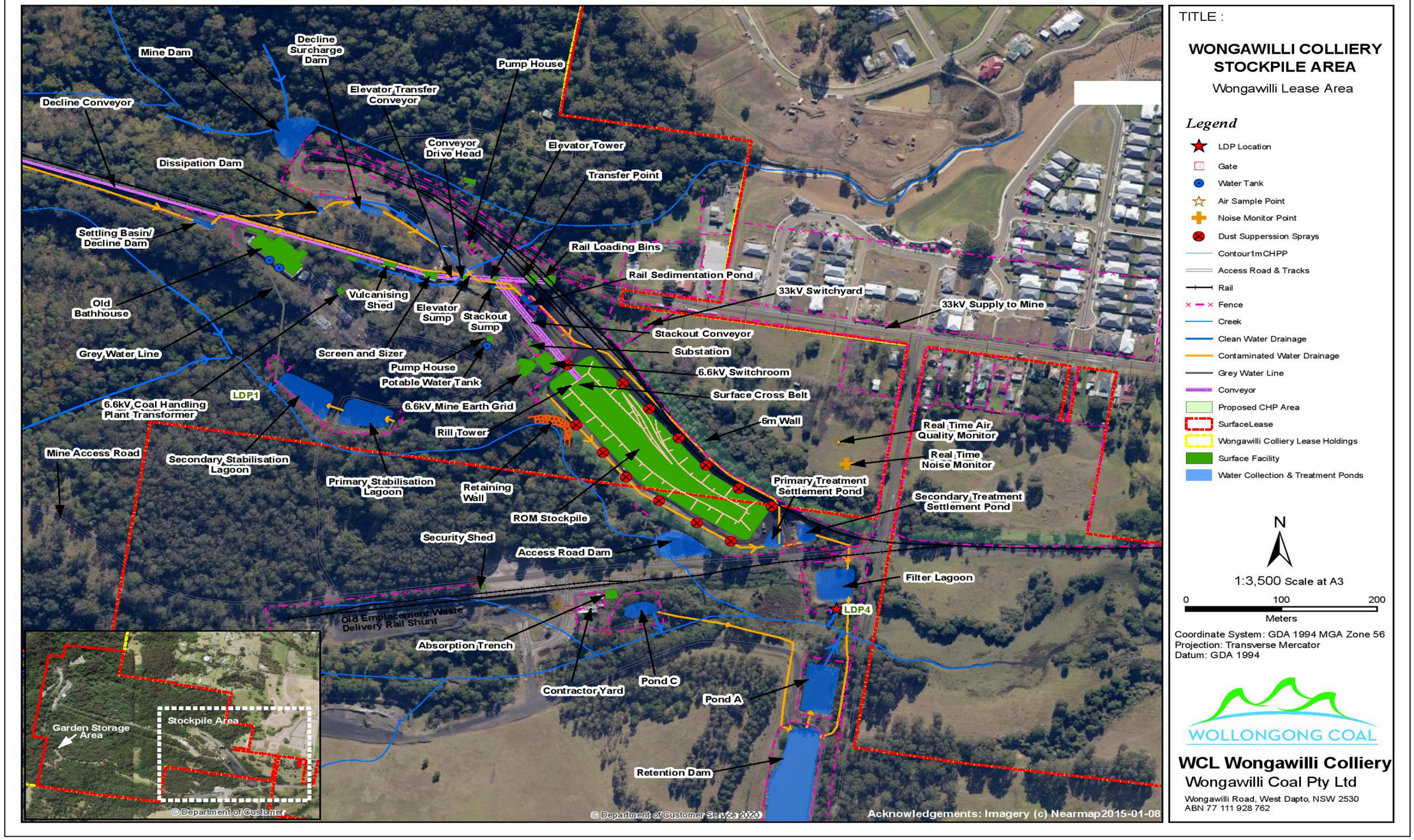
WOLLONGONG COAL

WCL Wongawilli Colliery

Wongawilli Coal Pty Ltd

Wongawilli Road, West Dapto, NSW 2530
ABN 77 111 928 762

Figure 2.5: Wongawilli Colliery Lower Western Area



The Wongawilli Colliery currently operates under Project Approval (**MP 09_0161**) dated 02 November 2011. The project approval allows:

- Continued use of the surface infrastructure at the Wongawilli Pit Top as currently operated;
- Coal production at the historic level of up to 2 million tonnes per annum (mtpa);
- Longwall mining in the Nebo area in the north east corner of the lease area;
- Continued development and construction of the Western Drive;
- Continued transportation of run of mine coal from the Colliery to Port Kembla Coal Terminal (PKCT) by rail; and
- Rehabilitation of the site.

MOD1 authorised the continuation of mining operations until 31 December 2020, however, the mine ceased production in March 2019 and was placed in care and maintenance in May 2019. The mine is currently in this care and maintenance phase. A second modification (MOD2) to MP 09_0161 to continue mining operations is currently process to apply for authorisation of continued mining operations.

Condition 3 of Schedule 6 of the Project Approval requires Wongawilli Colliery to prepare an Annual Review report.

This Annual Review / Annual Environmental Management Report (**AR/AEMR**) is for the period 1 July 2020 to 30 June 2021. This AR/AEMR has been compiled, in accordance with the NSW Government Annual Review Guideline (NSW Government, 2015).

2.1 Background

Wongawilli Colliery is an underground coal mine owned and operated by Wongawilli Coal Ltd. The mine site is located approximately 14 km south-west of Wollongong on the Illawarra escarpment at West Dapto (Wongawilli village). The total lease area covered by Wongawilli Colliery is 14,767 hectares.

Mining was proposed in the Wongawilli area in 1906 and began in 1912. Wongawilli Colliery was purchased by Hoskins in 1916 and the coal produced was washed and coked on site before being transported to the Lithgow Iron and Steel Plant. A blast furnace was commissioned by Hoskins at Port Kembla in 1927 and Australian Iron and Steel (**AIS**) was formed in 1928. Broken Hill Proprietary Company Ltd (**BHP**) acquired AIS in 1935.

The Elouera Colliery was formed from the merger of the Wongawilli and Nebo Collieries in 1993. These mines operated separately in adjoining reserves and mining had occurred in both the Bulli and Wongawilli seams. BHP became BHP Billiton Pty Ltd in 2000. The Colliery was operated by BHP Billiton Illawarra Coal (**BHPBIC**) until June 2005 and contract miner Delta commenced mining in October 2005. NRE acquired the mining lease in December 2007 and the site was renamed NRE Wongawilli Colliery. NRE was subsequently renamed Wollongong Coal Limited during 2014.

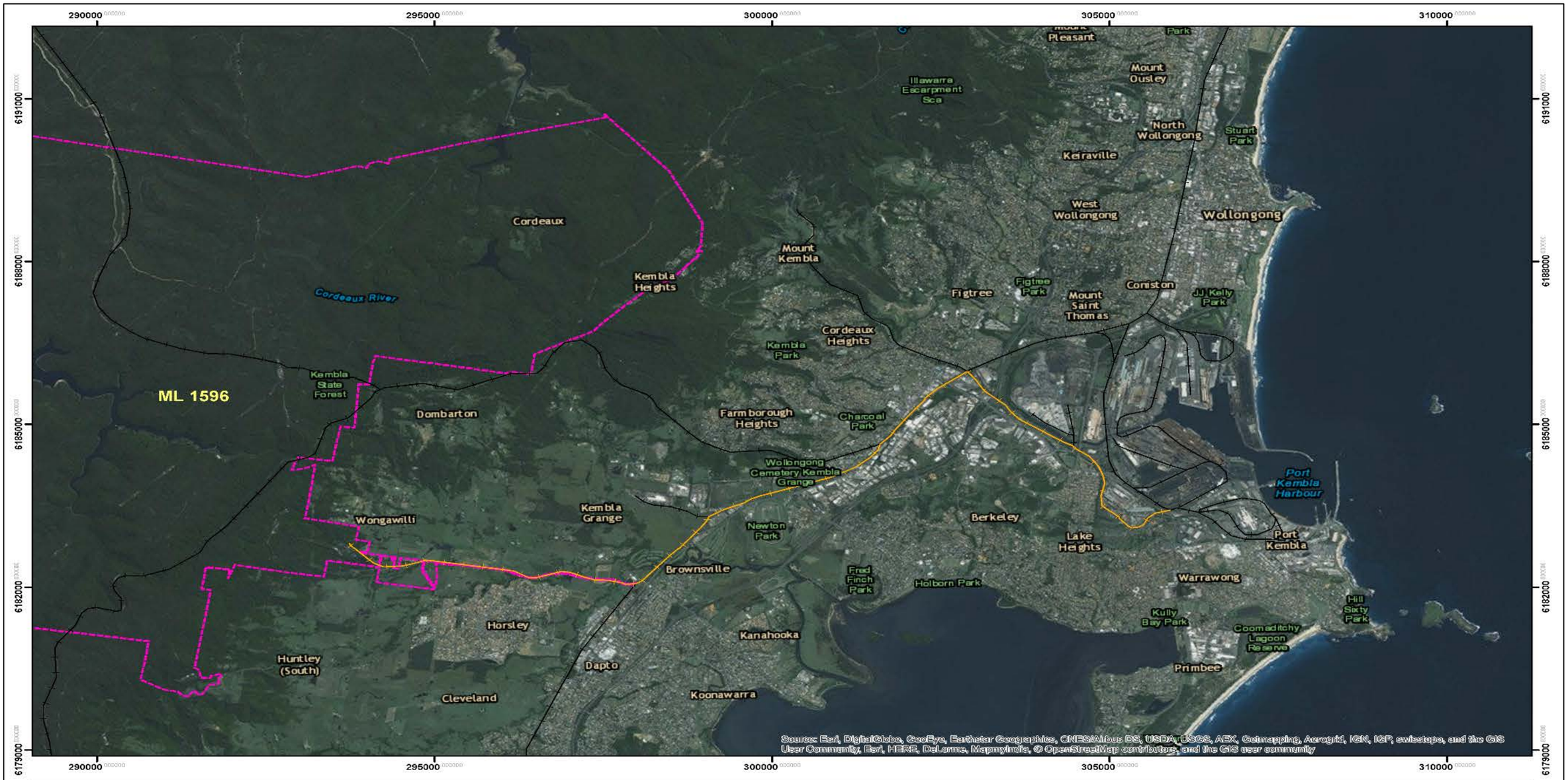
Historically, coal from the Colliery was transferred by rail to the Port Kembla Steelworks Coal Preparation Plant (**Figure 2.6**). Washed coal was used either in the steelworks or transferred to the Port Kembla Coal Terminal (PKCT) for shipping to both domestic and international markets. Coal wash reject from the washery was railed back to the Wongawilli emplacement area adjacent to the Wongawilli Pit Top.

The emplacement area ceased its operations in November 2005 and has been rehabilitated.

Mining of the Wongawilli Coal Seam reserves in the area has been undertaken for more than 80 years. Prior to mining within the Wongawilli Coal Seam, initial mining in the area was undertaken in the Bulli Coal Seam. As of May 2019, the Wongawilli Colliery site has gone into care and maintenance and mining has ceased in the Nebo Area.

A typical stratigraphic section of the Illawarra Coal Measures with indicative depths of cover is shown in **Figure 2.7.**

Figure 2.6: Wongawilli Coal Haulage Route



WONGAWILLI COLLIERY COAL HAULAGE ROUTE

Legend
- Rail Route to Port Kembla
- Rail Network
- WCL Leases

N

0 1 2 3 4 5
Kilometers

1:55,000
Scale at A3

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WCL Wongawilli Colliery
Wollongong Coal Pty Ltd
Wongawilli Road, West Dapto, NSW 2530
ABN 77 111 928 762

Figure 2.7: Typical Stratigraphic Section

AGE	GROUP	SUB-GRP	CODE	FORMATION & MEMBERS	
TRIASSIC	WIANAMATTA GROUP			BRINGELLY SHALE	
			WMSH	MINCHINBURY SANDSTONE	
				ASHFIELD SHALE	
				MITTAGONG FORMATION	
			HBSS	HAWKSBURY SANDSTONE	
	NARRABEEN GROUP	GOSFORD		NEWPORT FORMATION	
			GRFM	GARIE FORMATION	
		CLIFTON	BACS	BALD HILL CLAYSTONE	
			BGSS	BULGO SANDSTONE	
			SPCS	STANWELL PARK CLAYSTONE	
			SBSS	SCARBOROUGH SANDSTONE	
			WBCS	WOMBARRA CLAYSTONE	
			CCSS	COAL CLIFF SANDSTONE	
PERMIAN	ILLAWARRA COAL MEASURES	SYDNEY	BUSM	BULLI COAL	
			UNM1	LODDON SANDSTONE	
			BASM	BALGOWNIE COAL	
			LRSS	LAWRENCE SANDSTONE	
				BURRAGORANG CLAYSTONE	
			CHSM	ECKERSLEY FORMATION	CAPE HORN
			UNM2		UNNAMED MEMBER 2
					HARGRAVE COAL
					WORONORA COAL
					NOVICE SANDSTONE
			WW01-11	WONGAWILLI COAL	
			KBSS	KEMBLA SANDSTONE	
			ACSM	ALLANS CREEK FORMATION	AMERICAN CK. COAL
			APFM	DARKES FOREST SANDSTONE (APPIN FORMATION)	
				BARGO CLAYSTONE	HUNTLEY CLAYST.
					AUSTIMER SANDST.
			TGSM	TONGARRA COAL	
			WTFM	WILTON FORMATION	
				WOONONA COAL MEMBER	
				ERINS VALE FORMATION	
		CUMBERLAND		PHEASANTS NEST FORMATION	FIGTREE COAL
					UNANDERRA COAL
					BERKELEY LATITE
					MINNAMURRA LATITE
					CALDERWOOD LATITE
					FIVE ISLANDS LATITE
	SHOALHAVEN GROUP			BROUGHTON FORMATION	
				BERRY SILTSTONE	
				NOWRA SANDSTONE	
				WANDRAWANDIAN SILTSTONE	
				SNAPPER POINT FORMATION	
				PEBBLEY BEACH FORMATION	
	TALATERANG			CLYDE COAL MEASURES	
UNDIFFERENTIATED PALAEOZOIC (DEVONIAN, SILURIAN & ORDOVICIAN) ROCKS OF THE BASIN BASEMENT					
Information Sourced From - "Geological Survey Report No. GS1998/277 - R.S. Moffitt"					

The Wongawilli Colliery site contains the main mine portal and caters for personal, mining equipment, vehicle and machinery maintenance, mine supplies, administration, coal transport to the surface, and a 100,000 tonne capacity coal stockpiling facility and rail transportation facilities to transport coal to the PKCT.

There are currently two main transport entries into the mine, namely a roadway for rubber tyred vehicles and the other for rail mounted equipment. The rubber tyred vehicles are the primary transport system that services the mine. Coal is transported from the workings to the surface of the mine via an inclined conveyor approximately 2.5km in length.

2.2 Mine Contacts

The key contacts for Wongawilli Colliery are outlined in **Table 2.1.**

Table 2.1: Mine Contacts at Wongawilli Colliery

Contact	Position	Contact Details
Wawrick Lidbury	Chief Executive Office	Mobile: 0488 597 870
Chris Maher	General Manager (WWC)	Mobile: 0426 246 597
Richard Sheehan	Group Environment and Approvals Manager	Mobile: 0428 960 987
Rebecca O'Brien	Environment Coordinator (WWC)	Mobile: 0426 015 028

2.3 Distribution

Copies of this AR/AEMR will be distributed to the following stakeholders:

- Department of Planning, Industry & Environment (DPIE);
- Resources Regulator
- WaterNSW; and
- Wollongong City Council

WCL will make this AR/AEMR available on its website. A hard copy will also be kept at the Wongawilli Colliery, Jersey Farm Road, via Wongawilli Road, West Dapto, NSW 2530.

Any revisions undertaken will be the responsibility of WCL and any notifications will be sent accordingly. WCL will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on WCL's computer system, website, and hard copy at the Wongawilli Colliery, Jersey Farm Road, via Wongawilli Road, West Dapto, NSW 2530.

3 CONSENTS, LEASES & LICENCES

During the reporting period, Wongawilli Colliery held approvals for a variety of activities. These approvals include mining leases and related approvals (MOP and SMP), complying development certificates, development consents, major project approvals, environmental protection licences and a variety of other approvals. These are outlined in **Table 3.1**.

Table 3.1: Consents, Leases & Licences relevant to mining activities at Wongawilli Colliery

Licence and/or Approval	Document Number	Issue Date	Expiry Date
Mining Lease (DRG)	ML 1596	03/02/2012	07/10/2029
Mining Lease (DRG)	ML 1565	02/08/2006	9/10/2015 (Renewal Pending)
Consolidated Coal Lease (DRG)	CCL 766	27/06/2005	9/10/2015 (Renewal Pending)
Mine Operations Plan (DRG)	MOP	27/11/2020	02/07/2022
Project Approval – Nebo Area Project (DPIE)	MP 09_0161	02/11/2011	31/12/2020
Complying Development Certificate for Temporary Stacker Conveyor (PCA)	CDC392/10	26/02/2010	NA
Complying Development Certificate for a ROM Coal Screening and Sizing Plant (PCA)	CDC272/09	24/02/2010	NA
Project Approval for the Construction of a New Bath House and Office Extensions (DPE)	MP 09_0030	03/02/2012	07/10/2029
Environmental Protection Licence - WCL Wongawilli Colliery (EPA)	EPL 1087	1st October (Anniversary Date)	NA
Environment Protection Licence WCL -Avondale Colliery (EPA)	EPL 12442	31 March	NA

Licence and/or Approval	Document Number	Issue Date	Expiry Date
		(Anniversary Date)	
Radiation Control Licence/Registration (EPA)	5061480	-	13/08/2022
WaterNSW Special Areas Access Mining Consent (WaterNSW)	F2020/3092	04/03/2021	03/03/2026
WC_WONGAWILLI_1 (WCC)	16/1925	19/01/2016	30/06/2025
Surface Disturbance Notice (DRG)	06/3092	24/02/2010	NA
Surface Disturbance Notice (DRG)	11/19 & 06/3052	05/01/2011	NA
Water Access Licence (DPIE – Water)	WAL 36487	01/07/2013	15/01/2028
License to Store (Class 1.1B & 1.1D Explosives)	XSTR200001	09/01/2017	13/12/2021

4 OPERATIONS DURING REPORTING PERIOD

The Wongawilli Colliery currently operates under Project Approval (MP 09_0161) dated 02 November 2011. A modification (MOD1) to MP 10_0046 was approved on 27 November 2015. MOD1 authorised the continuation of mining operations until 31 December 2020. Modification 2 (MOD2) is currently in process to apply for authorisation of continued mining operations.

In March 2017 WCL sought to vary the Extraction Plan approved under Condition 7 of Schedule 3 of the Project Approval for the Nebo Area Project (09_0161). The amended plans were submitted to the Department on 27 April 2017 and were granted on 5 September 2017. Mining operations recommenced in a reduced capacity in October 2017.

Wongawilli Mine ceased the production of coal on 13 March 2019 in accordance with directions from inspectors of the DPIE. On 31 May 2019 WWC was placed into Care and Maintenance. From June 2019 the site workforce was reduced and site security has been increased. With provision of the MOD2 approval, WWC is due to increase site workforce with the intention to begin mining operations early 2022.

4.1 Exploration

No exploration program for Wongawilli was undertaken during this reporting period.

4.2 Land Preparation

There were no new areas of land prepared for mining or mining related activities.

4.3 Construction

During the reporting period no construction activities were undertaken.

4.4 Mining

Mining ceased in March 2019, WWC was placed into Care and Maintenance in May 2019. No mining or mining activities have been conducted during the reporting period. The total run-of-mine (ROM) annual coal production for period July 2020 - June 2021 is outlined in **Table 4.1**.

Table 4.1: Wongawilli Colliery Annual ROM Coal Production during the Period

Year Ending	ROM Tonnes
July 2020 - June 2021	0

4.5 Mineral Processing

During the reporting period there were no mineral processing activities undertaken.

4.6 Waste Management

All rubbish from the surface operations is collected in portable skip bins and removed regularly from site to a licensed waste disposal depot.

Waste material on site is separated into general waste, cardboard/paper, wood, steel, waste oil and oily water. The correct use of onsite waste management facilities is an expectation of all workers. General housekeeping for all areas of the site is checked during Environmental Inspections. Any housekeeping deficiencies are discussed and communicated to the workforce using Toolbox Talks.

A humiceptor unit is installed at the workshop wash-down bay. This unit is maintained by utilising a sucker truck from a licenced waste removal provider to remove sludge and sediment from within the unit which is then removed from site by the provider. Waste oil and oily water that is generated or captured on site in tanks, holding pits, sumps or bunds is removed from site by an authorised oil recycling/disposal contractor.

During the reporting period clean-up activities were undertaken on the Pit Top. This is an ongoing process to ensure the Pit Top is clean and tidy.

No major waste management activities occurred at the Avondale Colliery site during the reporting period.

Table 4.2 provides the waste streams and quantities generated at Wongawilli Colliery.

Table 4.2: Waste Streams at Wongawilli Colliery

Waste Stream	Volume/Weight	Contractor
Cardboard/Paper	365 kilograms	REMONDIS Australia Pty Ltd
Oily Water	Nil	Cleanaway / National Wide Oils
Waste Oil	Nil	Cleanaway / National Wide Oils
Transformer Waste Oil	11,000 Litres	Southern Oil
General Wastes	15.09 tonnes	REMONDIS Australia Pty Ltd
Scrap Metal	213.96 tonnes	East West Metal Trading
Black Water Waste	121 Kilolitres	REMONDIS Australia Pty Ltd

4.7 Ore & Product Stockpiles

The mine is currently under Care and Maintenance and there has been no coal mined or brought out of the mine and stockpiled on the surface during the reporting period.

4.8 Hazardous Material Management

Fuels

Wongawilli Colliery uses low emission fuels with sulphur content less than 0.02%. Diesel fuel is brought to site by fuel tankers and is stored on site in a 25,000 L tank. This tank is situated under a roof within secondary containment, with fire-fighting facilities in close proximity. Fuel is pumped from this main storage tank into smaller transportable containment vessels for use underground and on the surface. During this reporting period 1,600 Litres of diesel fuel was consumed.

Substance/Chemicals

Wongawilli Colliery maintains a register of Safety Data Sheets (SDS) for all chemicals used on site. This register is located in the Control Room.

Explosives

An explosives magazine is located at the Pit Top area of the colliery. The explosive magazine utilises a sealed disused portal entrance and is used to safely store explosive products required for use underground. All dangerous goods are stored in accordance with the WorkCover NSW Notification of Dangerous Goods requirements. The storage facility is under constant CCTV surveillance. No explosives were used in underground operations during the current reporting period.

Other

Other dangerous goods kept at Wongawilli Colliery include compressed gases, flammable fluids, combustible liquids, poisonous substances and corrosive substances, none of which exceed the acceptable holding limits.

4.9 Other Infrastructure Management

Coal Stockpile and Rail Corridor

Management of the coal stockpile facilities and the rail corridor includes sediment, vegetation, dust, waste and water management. This will continue on a reduced scale during the C&M period. The WCL Logistics Manager acts as the Rail Infrastructure Manager (RIM).

The WCL Logistics Manager is responsible for the management of the rail line in both the stockpile and rail corridor areas. Periodic maintenance has continued throughout the 2020_21 reporting period as required.

5 ENVIRONMENTAL MANAGEMENT AND PERFORMANCE

5.1 Actions from Previous Annual Review / AEMR's

Table 5.1: Actions from Previous Reporting Periods

Action Required	Requested by	Section in Report
1. Undertake necessary measures to address surface water management in the timber yard.	DPIE	Section 5.3
2. Undertake necessary measures to address rubbish and loose material behind the perimeter in the Timber Yard	DPIE	Section 4.6
3. Undertake ongoing actions to address recommendations of the 2019 WolfPeak Independent Environmental Risk Assessment	RR	Section 10.3
4. Assess options to progressively rehabilitate unused equipment and facilities. Include options identified and specific timeframes in the next version of the Wongawilli Colliery Mining Operations Plan	RR	Section 7.5

To ensure Wongawilli Colliery achieves regulatory compliance with the Project Approval, and EPL 1087, WCL have developed a number of approved management plans in consultation with the Regulators and other relevant stakeholders.

Management plans currently in place at Wongawilli Colliery include:

- Air Quality & Greenhouse Gas Management Plan;
- Bushfire Management Plan;
- Extraction Plan;
- Environmental Management Strategy;
- Heritage Management Plan;
- Integrated Wastewater Management Plan;
- Noise Management Plan;
- Surface Water Management Plan;
- Biodiversity Management Plan;
- Mining Operations Plan; and
- Pollution Incident Response Management Plan (PIRMP).

The above plans have been approved by DPIE as required by the conditions of the MOD 1 approval and WCL continues to manage the Wongawilli Colliery in accordance with the approved Management Plans.

5.2 Air Pollution

Environmental Management

Wongawilli Colliery Pit Top

Air quality is monitored in accordance with the approved Air Quality & Greenhouse Gas Management Plan.

Dust control measures applied to surface activities during care and maintenance include:

- Use of the stockpile and stacker convey or water sprays system are activated when wind speed exceeds a pre-determined speed. Note that the stacker converter sprays are not required to be activated when the stacker is not operational.
- Use of a water truck to wet down operational areas of the mine if required.
- Regular inspections of the site to ensure control measures are maintained.

Air quality monitoring will continue to be undertaken in accordance with EPL1087 dust deposition requirements. The sampling period for dust is 30 ± 2 days and the first day starts at the beginning of the month. Analysis is conducted by a NATA certified laboratory.

In addition to dust deposition monitoring an extensive real time air and noise monitoring system is installed on site via the Beta Attenuation Monitors (BAMs).

This system allows the Colliery to continuously monitor weather conditions and alter Pit Top operations where appropriate. Wongawilli Colliery's real time air and noise monitoring system includes the follow:

- Continuous monitoring for PM_{10} and $PM_{2.5}$ using Beta Attenuation Monitors (BAMs); and
- Operation of a single automated weather station.

These systems are managed by Wollongong Coal employees with consultant input when maintenance is required.

Avondale Pit Top

There are no mining activities at the Avondale Pit Top area. All access and former haul roads, laydown and operational area are grassed therefore not generating any airborne dust.

SMP and Catchment Lease Areas

The activities in the catchment during the period that could impact on air quality are related to vehicle movements associated with monitoring, inspections and the maintenance of ventilation shafts. No exploration drilling has occurred during this reporting period.

The possible impacts from these activities are:

- Road dust from travelling on catchment roads; and
- Particulate emissions from motor vehicles and other fuel powered machinery; and

Environmental Performance

Wongawilli Colliery Pit Top

Monitoring results for dust deposition, as shown in **Table *5.2*,** indicate compliance with EPA's dust deposition requirements according to Environment Protection Licence (EPL) 1087 and Annual Averaging Period criteria (4 g/m2/month) stated in MP 09_0161 approval Condition 11/Schedule 4.

A potential exceedance of the EPA guideline of 4g/m²/month was recorded during August 2020 with both Ash (8.4) and Insoluble solids (10.4) max results above the required limit. However, a review of the lab analysis noted that as the sample consisted of 90% dirt, <5% coal, <5% insects and 10% vegetation. The likely cause of the elevated readings was the adjacent land clearing and was not attributed to the mine.

Table 5.2: Wongawilli Colliery Dust Monitoring Results

EPL Monitoring Point	Analyte	Min *(g/m²/month)*	Annualised Average *(g/m²/month)*	Max *(g/m²/month)*	Annualised Yearly Average (EPA Guideline, *g/m²/month*)
9	Ash	0.1	0.3	0.7	4
	Combustible Matter	0.1	0.3	0.6	
	Insoluble Solids	0.1	0.6	1.2	
10	Ash	0.1	0.3	0.6	4
	Combustible Matter	0.1	0.2	0.4	
	Insoluble Solids	0.3	0.5	0.9	
11	Ash	0.1	0.4	0.8	4
	Combustible Matter	0.1	0.3	0.6	
	Insoluble Solids	0.2	0.7	1.4	
12	Ash	0.1	0.3	0.6	4
	Combustible Matter	0.1	0.2	0.4	
	Insoluble Solids	0.2	0.5	0.8	
13	Ash	0.3	2.1	8.4*	4
	Combustible Matter	0.3	0.8	2.0	
	Insoluble Solids	0.6	2.9	10.4*	

**Ash (8.4) and Insoluble solids (10.4) max results were above the EPA guideline of 4g/m²/month during August 2020. Visual lab analysis concluded that the sample consisted of 90% dirt, <5% coal, <5% insects and 10% vegetation.*

Real time air quality monitoring system has been in use onsite since December 2015. Monitoring results for PM_{10} are shown in **Table 5.3:** Wongawilli Colliery PM10 Monitoring Results (July 2020 to June 2021)

below. For PM_{10}, the real time air quality monitor recorded a 24 hour average above the criteria (50 µg/m³) stated in MP 09_0161 approval Condition 11/Schedule 4 on 16 occasions for the period July 2020 to June 2021. The real time quality monitoring system has presented technical issues relating to power supply during the months of May and June 2021. The cause of the issues was investigated in order to mitigate the problem for future monitoring.

Table 5.3: Wongawilli Colliery PM10 Monitoring Results (July 2020 to June 2021)

Month	BAM
	Monthly Average PM_{10} (µg/m3)
July 2020*	4.7
Aug 2020*	6.7
Sep 2020*	9.6
Oct 2020**	10.3
Nov 2020**	14.7
Dec 2020**	11.5
Jan 2021***	12.2
Feb 2021***	11.3
Mar 2021***	10.0
Apr 2021****	12.1
May 2021****	9.2
Jun 2021****	1.5

** The data recovery rate was >95% and there was 0 days over the criteria in the quarter.*
*** The data recovery rate was >75% and there were 0 days over the criteria in the quarter.*
**** The data recovery rate was >75% and there were 0 days over the criteria in the quarter.*
***** The data recovery rate was >55% and there were 0 days over the criteria in the quarter.*

Avondale Pit Top

No air quality monitoring is conducted at Avondale Pit Top as there are no mining activities at the Avondale Pit Top, and all access and former haul roads, laydown and operational area are grassed.

SMP and Catchment Lease Areas

The only activities that WCL have undertaken during this reporting period has been water monitoring which has negligible impact on air quality. There has been no air quality monitoring conducted in the SMP or catchment.

5.3 Erosion & Sediment

Environmental Management

Wongawilli Colliery Pit Top

The steep gradient from the Pit Top makes it difficult to manage erosion and sediment. A number of permanent erosion and sediment control measures are in place and they involve the use of a number of settlement sumps and dams. These structures were cleaned out in November 2020 and continue to be monitored to identify further action as required.

Actions as identified in the Timber Yard works program by DPIE, surface water management has been addressed in the formation of toe drains to direct surface water flow to existing drains. Regrading of this area continues to be progressively addressed. During this reporting period, intermediate regrading using existing onsite materials occurred.

Avondale Pit Top

There are no mining activities at the Avondale Pit Top and all access and haul roads, laydown and operational area have a good covering of grasses therefore there is no erosion issue on site.

Monitoring was conducted on a bi-monthly basis and there were no erosion or sediment issues during this reporting period.

SMP and Catchment Lease Areas

As part of SMP monitoring, Wongawilli Colliery conducts regular inspections for impacts above the old longwall extraction areas that may have been affected by mine subsidence. Areas inspected that may experience soil erosion due to mine subsidence are generally restricted to rock outcrops, steep slopes and cliff lines, unpaved roads or tracks, creeks or streams and general soil cracking. These areas are checked regularly as part of the visual inspection monitoring program.

The exploration program REF's address the following potential erosion and sediment risks as applicable to the activity being undertake:

- Disturbance to rock outcrops due to vehicle movements, access track clearance and borehole site preparation;
- Soil disturbance and compaction as a result of vehicle movements;
- Erosion and sedimentation and a result of vegetation clearance along borehole access tracks and borehole site preparation; and

- Alteration or disturbance of water courses due to access track crossings and associated vehicle movements.

The following sediment controls are implemented during drilling activities:

- Drill sites to be as flat as possible;
- Minimise the disturbance footprint at drilling sites;
- Clean water run-off diverted around the drill sites using diversion practices such as bunds or catch-drains;
- Directing drilling process water to tanks so that drilling fluids can be removed from site;
- Use of filtration materials such as sediment fence to stop fine silt where necessary; and
- After completion of drilling, rehabilitate the site in accordance with WNSW requirements.

Environmental Performance

Wongawilli Colliery Pit Top

During the reporting period a number of activities were undertaken to improve / maintain erosion and sediment infrastructure on site. An excavator was used to do the required work.

Decline Dam: This dam at the base of the decline has been cleaned out several time during this reporting period. This is an ongoing activity.

Railyard Dam: This dam was cleaned out at the same time as the Decline Dam and is an ongoing activity.

Decline Dam: This dam was cleaned out along with the Railyard Dam and is an ongoing activity.

Primary Treatment Settlement Pond: his pond was cleaned out to reclaim coal that had accumulated within the pond in November 2020. This is an ongoing activity.

Timber Yard: Up until May 2019 the Timber Yard has been a storage area for underground equipment, hence making it difficult to complete the yard clean up. Equipment and materials are being removed where possible or have been arranged in a tidy manner. Surface flows in the Timber Yard were addressed with the formation of controlled sumps on the eastern bunds.

The northern perimeter bund has been maintained and has proven to be effective in containing loose materials in the Timber Yard prior to removal and diverting water to established breaks in the bund. Disused equipment continues to be dismantled and

repurposed or removed from site. Depressions identified in the yards surface are repaired as required to prevent water from pooling of water. An extensive clean-up of rubbish was conducted in the previous reporting period and maintenance of this has continued into this reporting period. ***Figure 5.1*** and ***Figure 5.2*** depict the work conducted in the Timber Yard. Additional erosion and sediment control measured to address the surface water flow in the Timber Yard and reshaping the decline drain are being investigated.

Figure 5.1: Timber Yard 8 October 2020

Figure 5.2: Timber Yard 8 October 2020

Avondale Pit Top

There are no disturbed areas and as such there have been no issues with erosion and sediment control at Avondale Pit Top.

Monitoring was conducted on a bi-monthly basis and there were no erosion or sediment issues during this reporting period.

SMP and Catchment Lease Areas

Throughout periodic inspections there has been no soil erosion issues observed in the LW11-20 extraction area and Nebo N1-6 extraction area during the reporting period.

5.4 Contaminated and/or Polluted Land

Environmental Management

Wongawilli Colliery Pit Top

Douglas Partners completed the assessment in 2005 and comprised 22 test pit sites at various locations within the Colliery. Results for soil analysis showed that PAH, Pesticides and PCB levels were below HIL threshold levels and that no asbestos was detected. Arsenic, copper and zinc levels exceeded PIL guidelines but were under HIL threshold levels.

Avondale Pit Top

There are no potential contaminating substances stored at the Avondale Pit Top.

SMP and Catchment Lease Areas

Activities involving materials that have the ability to contaminate land are:

- The transport and weed management at the shaft sites of minor quantities of:
  - Herbicide;
  - Unleaded fuel for whipper snipper
- Diesel in vehicles accessing the ventilation shaft sites; and
- Hydrocarbon leaks from exploration activities.
- Hydrocarbon leaks from transformer maintenance

All hydrocarbon products that were previously located inside the fan house at Wongawilli 4 Shaft have been removed from site. Herbicide and gardening tools such as a whipper snippers are used to maintain site vegetation and reduce fire risk.

The only activities associated with the SMP areas involving materials that could potentially contaminate land are diesel fuel in vehicles accessing the SMP monitoring sites.

The exploration program REF's include management actions for pollution of soils and waterways as a result of oil and fuel spillages from vehicles and machines.

The following general management controls are implemented during drilling activities:

- Provision of spill kits during the drilling campaign;
- Bunding where required;
- Vehicle inspections;
- Environmental Inductions; and
- Site Inductions.

Environmental Performance

Wongawilli Colliery Pit Top

All potential contaminating substances are stored in bunded areas. Bunded pallets are also used for storing small quantities of contaminating substances. The surface oil storage facility continued to be used as the primary storage area for storing small quantities.

Avondale Pit Top

There has been no activity at the Pit Top nor are there any potentially contaminating substances stored at the site.

SMP and Catchment Lease Areas

During October 2017, contaminated soil was relocated to the WWC stockpile site from the Wongawilli No 1 Shaft and during November 2017 contaminated soil was relocated to WWC. The contaminated material from both these sites was stockpiled at WWC for bioremediation in accordance with Special Condition E1 of the EPL 1087. In December 2018 both the Nebo 3 site and the Wonga 1site were backfilled using VENM material.

The Remediation of the soil as removed from the WaterNSW Special Area was frequently sampled and a subsequent validation report was submitted to the EPA for review and approval in August 2020. The soil samples were all below the 95 UCL, complying with the assessment criteria.

In November 2020, the EPA accepted the validation report, further issuing a notice for variation of licence #1087. The EPA accepted that licence requirements of special condition E1 were met. The remediated soil has been deemed suitable for re-use on the premises for rehabilitation purposes.

5.5 Threatened Flora

Environmental Management

Wongawilli Colliery Pit Top

Threatened flora is managed in accordance with the approved Biodiversity Management Plan. Ongoing operations in historically disturbed areas of the Pit Top site have no potential effects on threatened aquatic or terrestrial vegetation as none have been identified close to these areas. Over the entire history of its operation, the majority of the Wongawilli Pit Top area has been disturbed to some degree or another, resulting in large areas of native vegetation regrowth interspersed with introduced tree and weed species.

For activities that involve potential impacts on vegetation that is not covered by the Biodiversity Management Plan, an REF is undertaken. The outcome of the REF process is to establish that no areas on site that contain endangered aquatic or terrestrial species or communities are disturbed in construction processes without the proper assessment.

Wongawilli Colliery undertakes Pit Top vegetation management in the following manner as required:

- Vegetation risk assessments;
- Removal of dead, dying or dangerous trees;
- Removal of dangerous limbs from trees;
- Removal of regrowth trees that are beginning to pose a risk to machinery, buildings or other operational areas such as pipelines, dams, stockpiles etc;
- Removal of weeds and non-native groundcovers, bushes and trees;
- Approved bushfire management clearing; and
- Removal of vegetation beneath powerlines in accordance with guidelines for safe distances.

Avondale Pit Top

There are no mining activities at the Avondale Pit Top and there has been no vegetation disturbance at the site.

SMP and Catchment Lease Areas

Vegetation clearing around the firebreaks at the shaft sites involves management of regrowth areas only and doesn't impact on threatened species. An REF for approval to conduct ongoing vegetation management around Wongawilli Colliery infrastructure in the Catchment Lease Area remains in place with WaterNSW.

Areas potentially affected by mine subsidence associated with previous mining were assessed for threatened flora and are being monitored in accordance with SMP and EP approval requirements to determine if there are any impacts from subsidence.

This work was established as part of the baseline studies needed for preparation of the SMPs for the extraction of Elouera LW11-20 and Nebo N1-N6 extraction panels. The ecological monitoring for Elouera LW11-20 extraction panels has ceased and the mining approvals for that project expired on the 31 December 2017.

Environmental Performance

Wongawilli Colliery Pit Top

No impacts on any threatened flora have occurred in the reporting period.

Avondale Pit Top

There has been no activity at the Pit Top and thus no impacts on threatened vegetation communities.

SMP and Catchment Lease Areas

Terrestrial and aquatic monitoring programs requirements were fulfilled in autumn of the last reporting period. The 2020 autumn report was not included in the previous reporting period due to the completed report date. The terrestrial and aquatic monitoring program reports for autumn 2020 are attached in **APPENDIX A** - Biosis Nebo Terrestrial Ecological Autumn 2020 Report and **APPENDIX B** - Biosis Nebo Aquatic Ecological Autumn 2020 Report**.** The monitoring requirements for one year post mining operations have now ceased for the Nebo Area. No impacts to threatened flora were identified as a result of mining in the Nebo Area as outlined in the EoP reports.

5.6 Threatened Fauna

Environmental Management

Wongawilli Colliery Pit Top

Threatened fauna is managed in accordance with the approved Biodiversity Management Plan. Ongoing operations in historically disturbed areas of the site have no potential effects on threatened fauna habitat as none have been identified close to these areas.

For any mining / construction activities that may involve potential impacts on habitat a REF is undertaken and a construction environmental management plan is developed for the activity if required.

The Sporting Shooters Association of NSW did not undertake a deer culling program at Wongawilli Colliery. During this reporting period, Wongawilli Colliery has put the Sporting Shooters Association of NSW's deer culling program on hold, following a community complaint regarding personal health and safety. The management of the deer populations on site is being reassessed. The purpose of the program is to reduce the overall population of deer at the Colliery. WCL record the number, approximate age, sex and species of deer removed in the program these results are displayed in **Table 5.4.**

Table 5.4: Deer Control Program Results (2020 – 2021)

Month/Year	Number of Deer Culled	Species/Sex/Age
July 2020	No attendance	Nil
August 2020	No attendance	Nil
September 2020	No attendance	Nil
October 2020	No attendance	Nil
November 2020	No attendance	Nil
December 2020	No attendance	Nil
January 2021	No attendance	Nil
February 2021	No attendance	Nil
March 2021	No attendance	Nil
April 2021	No attendance	Nil
May 2021	No attendance	Nil
June 2021	No attendance	Nil
Total	**0**	

Avondale Pit Top

There have been no mining activities on site and hence no impact on threatened fauna from mining.

SMP and Catchment Lease Areas

There have been no mining activities on site and hence no impact on threatened fauna from mining. Monitoring requirements for one year post mining of the Nebo area have been met and monitoring has ceased.

Environmental Performance

Wongawilli Colliery Pit Top

All activities have been assessed for fauna and habitat impacts and have been implemented in accordance with approvals. Bat friendly portal/adit seals are currently under investigation for the sealing of disused mine entrances.

SMP and Catchment Lease Areas

There were no observations of dead or injured fauna at the ventilation shaft sites. Terrestrial and aquatic monitoring programs requirements were fulfilled in autumn of the last reporting period and monitoring of these elements has since ceased. The autumn report was not included in the previous AEMR/AR or reporting period due to the completion date of the Biosis autumn report. The 2019_20 autumn terrestrial and aquatic monitoring program reports are attached in **APPENDIX A** - Biosis Nebo Terrestrial Ecological Autumn 2020 Report and APPENDIX B - Biosis Nebo Aquatic Ecological Autumn 2020 Report. The monitoring requirements for one year post mining operations have now ceased for the Nebo Area.

A map showing aquatic monitoring points in the Nebo Area is shown on ***Figure 5.3***. A map showing terrestrial monitoring points in the Nebo Area is shown on **Figure 5.4**

No impacts to threatened fauna were identified as a result of mining in the Nebo Area.

Figure 5.3: Aquatic Ecology Monitoring

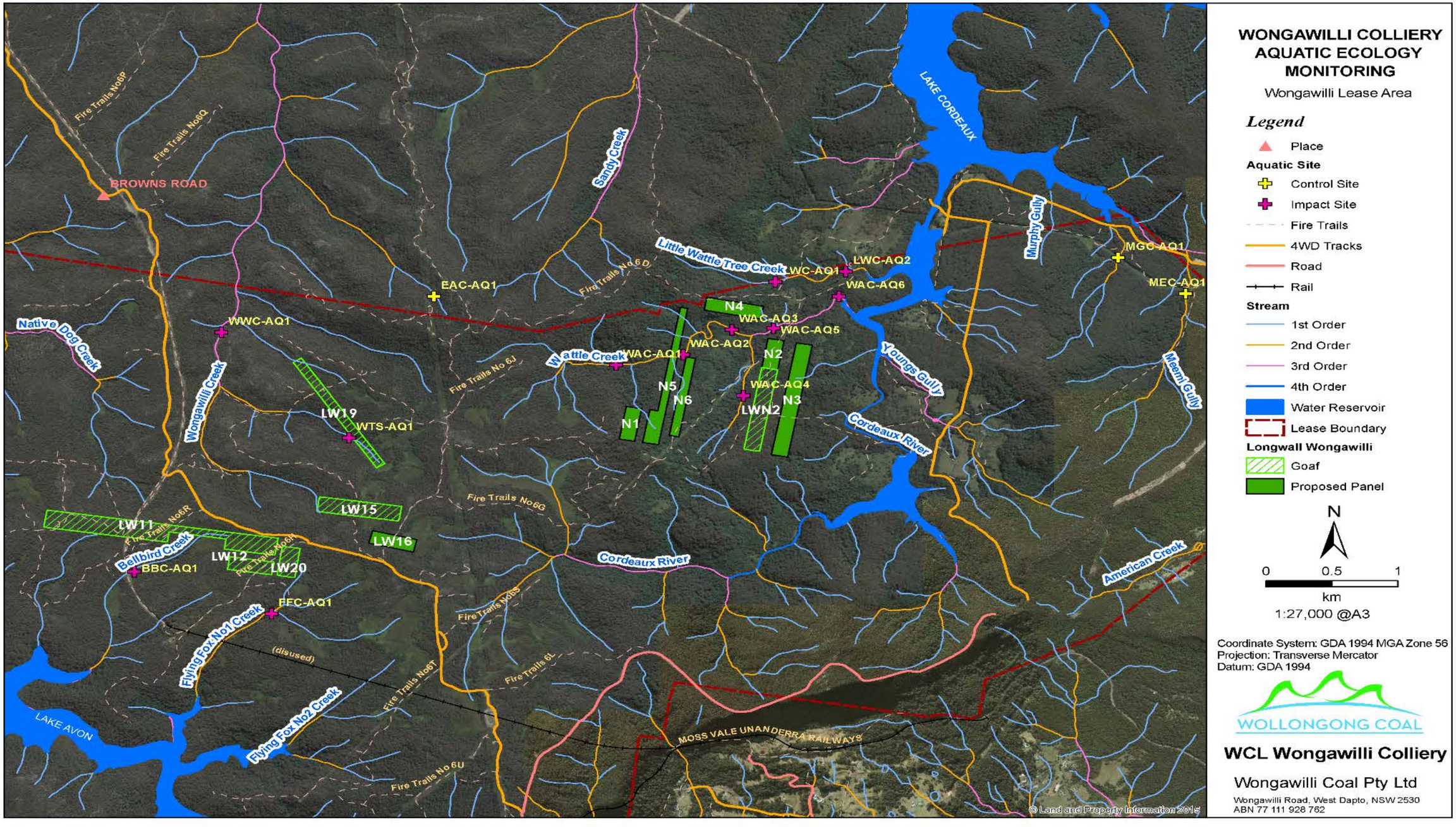
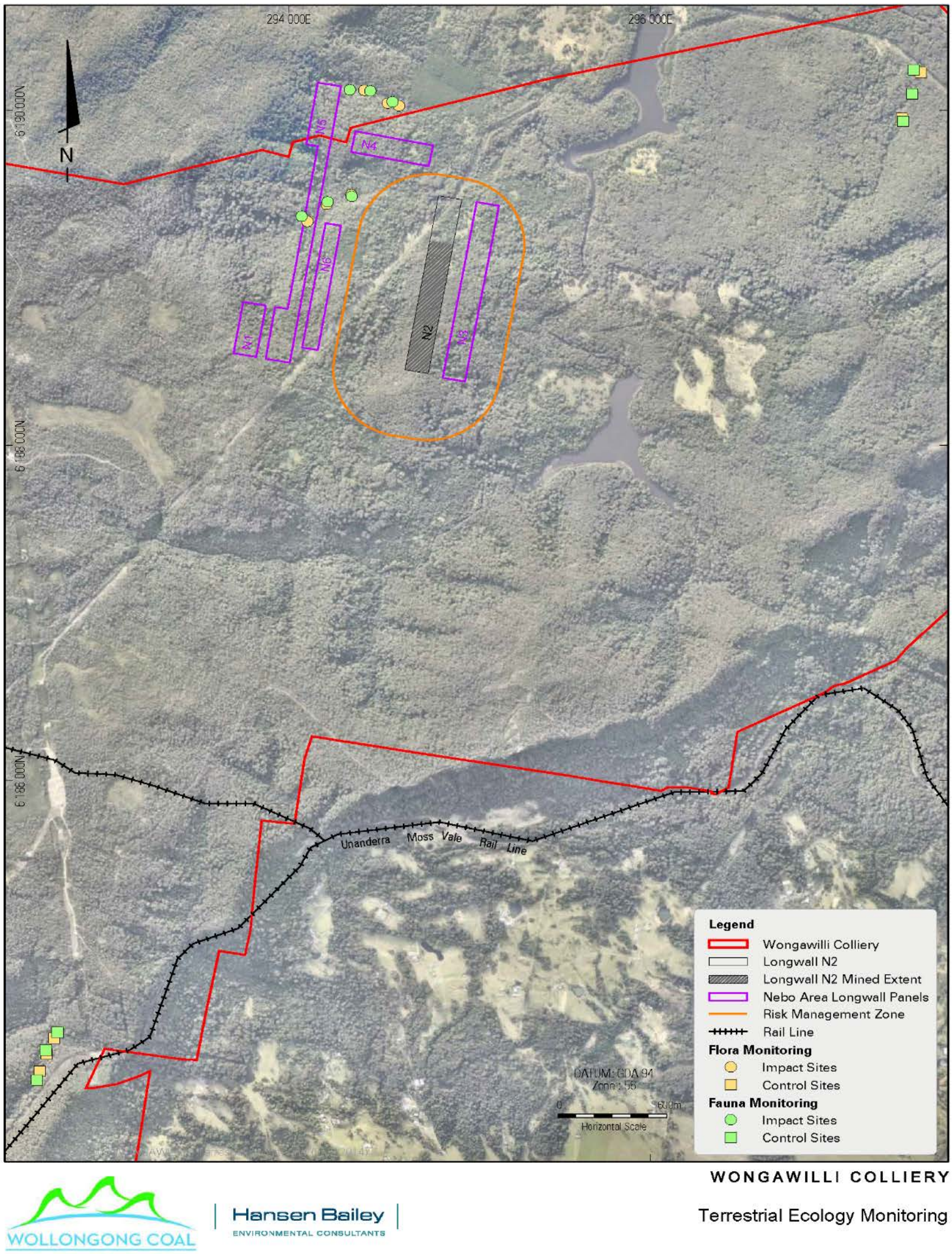


Figure 5.4: Terrestrial Ecology Monitoring



5.7 Weeds

Environmental Management

Wongawilli Colliery Pit Top

Wongawilli Colliery has worked with the Illawarra District Noxious Weeds Authority (**IDWNA**) to manage weeds at its Pit Top and also regular inspections for noxious weeds. During the reporting period WWC conducted its own weed management activities on site. A combination of physical control and spraying was undertaken at the Pit Top (***Figure 5.5***) and also near the stockpile area (***Figure 5.6***).

Avondale Pit Top

No major weed management activities occurred at Avondale during the reporting period. The areas that were utilised for operational activities in the past are relatively clear. Some minor physical weed removal occurred during 2-monthly monitoring and site inspections within this reporting period.

SMP and Catchment Lease Areas

During routine site inspections at the Wongawilli No 1 shaft, some time was spent hand pulling Crofton weeds. During a site visit to the Nebo No 3 Shaft a few small Crofton weed plants were physically removed.

Figure 5.5: Pit Top Weed Management

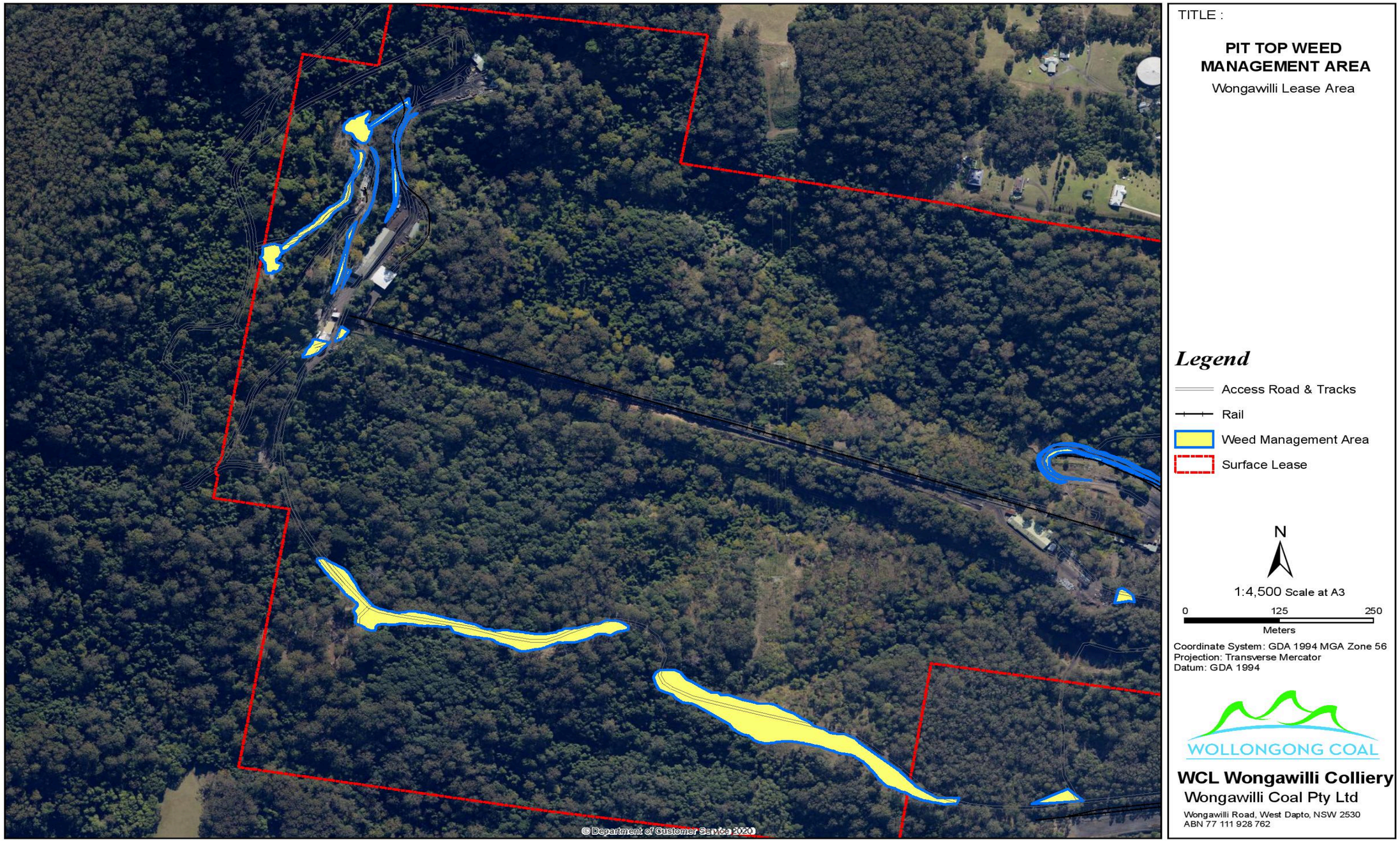


Figure 5.6: Stockpile Area Weed Management

TITLE :

STOCKPILE WEED MANAGEMENT AREA

Wongawilli Lease Area

Legend

- Access Road & Tracks
- Rail
- Weed_Management_Area_bec
- SurfaceLease

N

1:4,000 Scale at A3

0 110 220

Meters

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

WCL Wongawilli Colliery

Wongawilli Coal Pty Ltd

Wongawilli Road, West Dapto, NSW 2530
ABN 77 111 928 762

5.8 Blasting

Small scale blasting (known as Shot Firing) occurs underground as the need arises. There have been no underground blasting activities undertaken during this reporting period.

5.9 Operational Noise

Environmental Management

Wongawilli Colliery Pit Top

There have been no noise complaints during the reporting period. Noise impacts are managed in accordance with the Noise Management Plan.

Generally, management procedures for noise control include:

- Continuous unattended real time noise monitors with audio capture and real time alerts;
- Operator attended noise monitoring at surrounding sensitive receivers on a quarterly basis;
- A six metre high concrete wall that separates the nearest residences from the coal Stockpile Area. This wall was constructed some years ago and provides both a visual benefit and noise attenuation benefits;
- A three metre high, 250 metre long earth bund adjacent to the rail line to the east of Jersey Farm Road. This bund was constructed to provide noise attenuation for local residents from the Jersey Farm Road rail crossing;
- During operations, the hours of operation within the Stockpile Area in terms of heavy machinery loading trains is limited to 7am to 6pm Monday to Friday and 8am to 4pm Saturday and no loading on Sundays and Public Holidays;
- Front end loaders and dump trucks operating in the Stockpile Area have exhaust systems that meet manufacturer specifications;
- Truck drivers are directed to drive slowly and have regard for Wongawilli residents' amenity; and
- Regular maintenance of the decline overland conveyor system.

Avondale Pit Top

There have been no noise generating activity at Avondale Pit Top during the reporting period.

SMP and Catchment Lease Areas

Due to the absence of potentially affected receivers in the SMP and catchment areas, noise is not an issue.

Environmental Performance

Wongawilli Colliery Pit Top

Attended noise monitoring is used to determine compliance with the Project Approval noise criteria and will be used to verify data collected from real time noise monitoring. The real time monitoring is used as a noise management tool and can provide 'early warning' information to inform WCL environmental personnel, providing the opportunity to review its activities and respond proactively.

The attended noise monitoring is undertaken at the site on Quarterly basis. Attended noise monitoring was undertaken during September 2020, November 2020, March 2021 and June 2021. The compliance monitoring found that the Project is operating within its required noise limits. The results from real time and attended noise monitoring for the period January 2016 to June 2021 are available on WCL website.

SMP and Catchment Lease Areas

Due to the absence of potentially affected receivers in the SMP and catchment areas, noise is not an issue.

5.10 Visual and/or Stray Light

Environmental Management

Wongawilli Colliery Pit Top

The lights from Wongawilli Colliery are visible due to its location on the escarpment. In the last reporting period, an internal lighting audit was undertaken for the site due to the Care and Maintenance operational status, site lighting was and has maintained at a reduced capacity into this reporting period.

Avondale Pit Top

There is no infrastructure, lighting or power at the Avondale site.

SMP and Catchment Lease Areas

The lights at the ventilation shaft were only turned on when required. Other WCL infrastructure in the catchment does not emit light as there is no longer a power supply and therefore, does not impact the community.

Environmental Performance

Wongawilli Colliery Pit Top

There is no monitoring of stray light or visual impact. The community has not raised the issue of stray light from, or the visual impact of the mine site facilities or mobile equipment as being a matter for concern.

Avondale Pit Top

There is no activity at the site and therefore no monitoring for stray light or visual impact.

SMP and Catchment Lease Areas

There are no sensitive receivers in catchment areas that would be impacted by stray light or visual impact.

5.11 Aboriginal Heritage

Environmental Management

Wongawilli Colliery Pit Top

The Wongawilli Colliery Pit Top is listed in the Wollongong LEP 2009 and the Wollongong LEP (West Dapto) 2010 as having heritage significance, including Aboriginal heritage. The Heritage Management Plan draws on the Heritage Constraints Report completed during the 2010-2011 reporting period. This plan identifies what impacts the listing on the Wollongong LEP 2009 and Wollongong LEP (West Dapto) 2010 will has on current and future activities at the Colliery and contains management plans for the management of heritage related aspects for these activities. ***Figure 5.7*** shows Wongawilli Colliery Heritage Monitoring Locations.

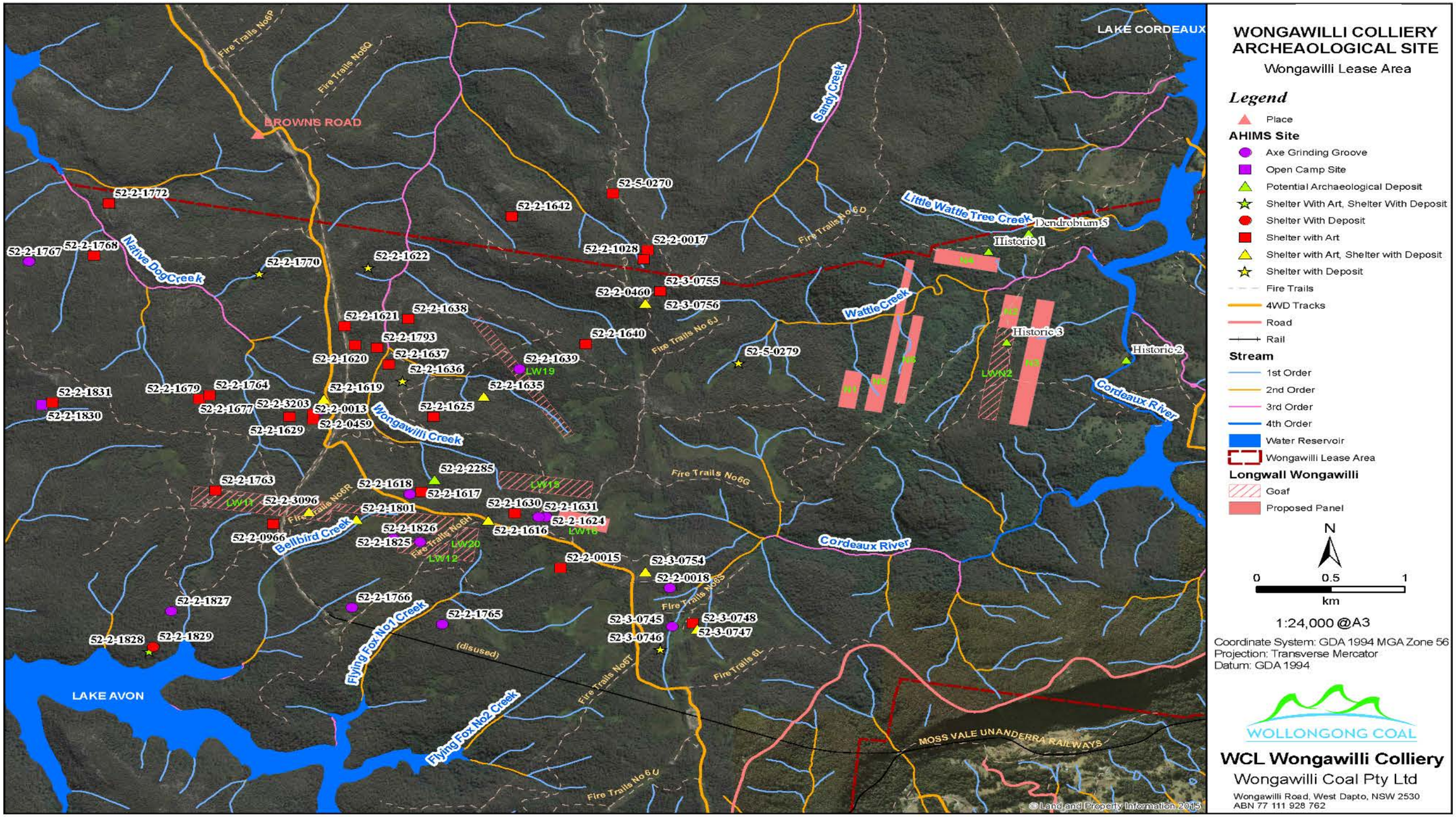
Avondale Pit Top

There has been no activity at the Avondale Pit Top and hence no impact on Aboriginal Heritage.

SMP and Catchment Lease Areas

Aboriginal heritage monitoring is undertaken in mining and catchment lease areas of Nebo N1-N6 in accordance with SMP and EP approval requirements as shown in ***Figure 5.7***.

Figure 5.7: Wongawilli Colliery - Heritage Monitoring



Environmental Performance

Wongawilli Colliery Pit Top

No construction activities have been undertaken and thus there has been no potential disturbance to Aboriginal heritage.

Avondale Pit Top

There has been no activity at the Avondale Pit Top in this reporting period.

SMP and Catchment Lease Areas

There has been no subsidence impacts observed to the Aboriginal heritage site.

5.12 Spontaneous Combustion

In the past there has been occurrences of low levels of oxidisation of coal, however, there has never been instances of spontaneous combustion events recorded at Wongawilli Colliery.

5.13 Bushfire

Environmental Management

Wongawilli Colliery Pit Top

A Bushfire Management Plan was developed and submitted to DPE for approval as required by the project approval (MP 09_0161).

Ongoing clearing of undergrowth and weeds has been undertaken around site infrastructure during the reporting period to help reduce the risk of bushfires affecting the operational areas of the mine surface.

A firefighting water main is also provided on the mine site, which is boosted by a pressure pump, to provide the means to manually fight any bushfire that may threaten the site. The road verges of the Pit Top access road are periodically slashed to ensure the emergency evacuation route remains safe. WCL has a designated fire officer who liaises closely with local RFDS Brigade. Personnel are trained in firefighting and the practical use of fire extinguishers is conducted during site inductions. There is also a large supply of readily available water and firefighting equipment throughout the site.

Avondale Pit Top

There are no mining activity happening on the site that may ignite a fire and no infrastructure that can be impacted by a bushfire.

SMP and Catchment Lease Areas

A firebreak that has been cleared around the site perimeter fence line of the main ventilation shaft site provides an asset protection zone and catchment bushfire protection. Periodic maintenance of vegetation inside perimeter fences is carried out.

Environmental Performance

Wongawilli Colliery Pit Top

There have been no fires reported onsite during the reporting period.

A annual inspection was conducted prior to the beginning of bushfire season with local firefighting division representatives to assist with site familiarisation, the sites firefighting facilities and emergency water resources.

Avondale Pit Top

There have been no fires reported onsite during the reporting period. There has been no monitoring of the effectiveness of the bushfire management activities.

5.14 Mine Subsidence

Environmental Management

SMP and Catchment Lease Areas

Mine subsidence is an important consideration in the ongoing operations at Wongawilli Colliery.

The potential for subsidence impacts on natural and man-made features has been assessed for areas which may potentially be affected by mine subsidence and a number of protection and monitoring measures have been implemented in these areas.

The SMP also included an approved subsidence monitoring and management plan. This plan covered:

Natural Features:

- Declared Special Metropolitan Catchment lands controlled and managed by WNSW;
- Creeks;
- Threatened and protected species; and
- Natural Vegetation.

Man-made features:

- Roads (particularly dirt roads and fire trails);

- Rail cuttings;
- Exploration boreholes; and
- Survey control marks.

Nebo Area

During this reporting period there has been no mining in the Nebo area. As a result, monitoring of mine subsidence was completed as reported in the 2019-20 AEMR.

5.15 Hydrocarbon Contamination

Environmental Management

Wongawilli Colliery Pit Top

All potential contaminating substances are stored in bunded areas to prevent the potential for leakage to contaminate soil or water. There are absorbent materials, booms and other control materials stored in a variety of high activity areas around site to allow rapid response to small and large hydrocarbon spills.

Oil and grease drums are stored within secondary containment. The majority of oils are stored in the surface hydrocarbon storage facility within bunded trays under permanent cover.

Avondale Pit Top

There are no hydrocarbons stored at Avondale Pit Top.

SMP and Catchment Lease Areas

There are no hydrocarbons stored in the SMP and Catchment Lease Areas.

Vehicles that access the site for purposes such as servicing shafts, for exploration related activities or SMP monitoring contain oil, diesel, petrol and/or other hydrocarbons which could potentially contaminate soil and water. Vehicles are inspected for damage or leakages prior to entering the SMP or Catchment lease areas.

Environmental Performance

Wongawilli Colliery Pit Top

Hydrocarbon management is under constant review by operational staff. Due to the current Care and Maintenance status of the mine, there has been minimal use of hydrocarbons during this reporting period.

The following work has been undertaken to continue improved hydrocarbon management at the site:

- Engagement of Nationwide Oils to remove waste oils and miscellaneous oils that are no longer required as needed.
- Engagement of Southern Oils, to remove transformer waste oils that are no longer required.
- Unused drums of oil are placed in a controlled bunded area.
- Unwanted drums of oil are emptied and removed as waste oil.
- The old petrotac bund is still being used to drain drums before disposal, this is where the drums are placed after they have been emptied in the bunded oil waste bin.
- Unused Transformer equipment from the Pit Top area were emptied out and removed as waste oil. There was 11,000lt of transformer waste oil was removed from site this reporting period.

Avondale Pit Top

There are no hydrocarbons at Avondale Colliery.

SMP and Catchment Lease Areas

Environmental workplace inspections are conducted on WWC infrastructure in the catchment and hydrocarbon management on these sites are part of site compliance.

5.16 Energy, Greenhouse Gases, Methane Drainage & Ventilation

A Ventilation Control Plan is in use at Wongawilli Colliery. The Ventilation Control Plan has the prime objectives of ensuring critical safety risks posed by gas emissions and other hazards related to ventilation at Wongawilli Colliery can be effectively controlled.

Associated management positions and accountabilities are contained in the Plan with resources allocated to ensure such Plan is current and fully implemented.

The highest desorbable gas content recorded for the Wongawilli Coal Seam, from exploration samples is approximately 12m^3/tonne (at 20°C, 101.3kpa). The gas is generally composed of 70% Methane and 30% Carbon Dioxide. The monitoring of gas and triggers for actions are detailed in the mine's Ventilation Control Plan.

In previously mined areas, based upon typically low gas content information from exploration boreholes, of approximately 2 - 4m^3/tonne, methane drainage is not currently considered warranted. Since the mine closure in May 2019, the Nebo No.4 Fan Shaft was de-energized and all monitoring at this location has ceased.

5.17 Public Safety

Environmental Management

Wongawilli Colliery Pit Top

Wongawilli Colliery Pit Top sites have established perimeter fencing with entry gates that are locked during periods of non-operation to secure the sites against unauthorised access and the consequential risk to public safety.

Surveillance cameras are installed around site that covers the main operational areas and infrastructure at the mine. The footage from the cameras is streamed directly to the Colliery Control Room.

Signage is in place that identifies:

- Mine site entry gates;
- The type and nature of chemicals stored or used;
- The voltage level of electrical equipment within protected enclosures;
- Personal protective equipment requirements;
- Authorised access areas; and
- Contents of pipelines e.g.: gases, water compressed air etc.

Avondale Pit Top

The site is maintained in a safe and stable condition, with existing portals secured to prevent unauthorised access.

SMP and Catchment Lease Areas

The land above the underground workings is primarily natural bushland environment with access restricted to authorised persons only. The land is covered by the Metropolitan Special Area, a WaterNSW Catchment Schedule 1 Area. Mining activities on the land above the underground workings have negligible implications for public safety over the present and proposed underground workings or in the areas where mine infrastructure is established.

Access into the WaterNSW Catchment Area is via locked gates. Areas on catchment land and on the mine site that have individual security and controlled access include:

- Fan sites;
- Hazardous materials storage compounds;
- Compressed gases storage compounds;
- Rooms, compounds and enclosures containing electrical equipment;

- All electricity substations; and
- Gates accessing the Catchment area.

Monitoring of public safety issues in relation to mine subsidence is as follows:

- Regular visual inspection of cliffs and steep slopes, fire roads, 4WD tracks, rocky outcrops and cuttings are undertaken during monitoring activities.

Environmental Performance

Wongawilli Colliery Pit Top

There have been no observed public safety incidents during the reporting period. Security guards ensure unauthorised access is kept to a minimum.

Avondale Pit Top

There have been no observed public safety incidents during the reporting period at Avondale Pit Top.

SMP and Catchment Lease Areas

There have been no observed public safety incidents during the 2020-2021 reporting period.

6 WATER MANAGEMENT

Wongawilli Colliery have had a number of licensed discharge points under Section 55 of the *Protection of the Environment Operations Act 199*7. They are:

- LDP1 – Secondary Stabilisation Lagoon (bathhouse water);
- LDP2 – Underground mine water discharge from Wongawilli Colliery;
- LDP4 – Overflow from the stockpile Filter Lagoon; and
- LDP7 – Underground mine water discharge at N6 Forest 11 entry (Eastern Portal).
- LDP8 – N7 Forest 11 entry (Western Portal)

Refer to ***Figure 2.4*** and ***Figure 2.5*** show these discharge points. The monitoring results for these points are available on WCL website.

6.1 Water Supply and Use

There are two separate supplies of water for Wongawilli Colliery, being potable water and groundwater. The town water supply feeds into the surface water tanks and is supplied for office and bathhouse facilities.

All water that is used for underground mining operations is recycled within the underground environment. Mine de-watering is undertaken as required to ensure access and ventilation is maintained. Discharge water is via LDP2 which is located near the Timber Yard laydown area. There has been no discharge from LDP2 during this reporting period.

The mine water is moderately alkaline and the dissolved solids content is predominantly in the form of sodium bicarbonate. This is characteristic of the groundwater quality in the underground mines in the Illawarra. Wongawilli Colliery mine water quality is not expected to vary significantly because the water quality is primarily determined by the hydrogeology of the region rather than the activities of the mine.

6.2 Surface Water Management

Environmental Management

Wongawilli Colliery Pit Top

Surface water is managed in accordance with the approved Surface Water Management Plan. A system of stormwater diversion drains are established up-slope (west) of the mine site facilities to capture stormwater run-off from the escarpment, diverting water away from operational areas of the mine site and into local watercourses. The clean water drains on the site are generally open channels that are grassed or concrete lined. The system carries the water from the mine site to discharge through areas of bushland and via unnamed watercourses into tributaries of Robins Creek.

Dirty water drainage systems are provided on the mine site where the potential exists for run-off water to be contaminated by surface operations. Operations that normally contribute to contaminated water run-off include coal handling and stockpiling, rail loading, workshops, store yard areas and associated operational roads. The drainage systems have been constructed to minimise erosional impacts. The control measures in place include grass or concrete lining of open drains and concrete sub-surface pipes and pits.

The dirty water drainage system at Wongawilli Colliery includes a number of settling ponds and sumps to capture sediment and provide retention of dirty water to allow soil particles to settle as the dirty water moves through the system. Each pond or sump is provided with access for the removal of silt by mobile equipment. The sumps are located toward the bottom of the decline corridor, at the foot of the decline east of the elevator building, adjacent to the coal storage bins and southeast of the ROM coal stockpile.

Cleaning of these ponds and sumps is undertaken as required to maintain the efficiency of the water treatment facilities.

Runoff from the conveyor decline flows down the slope in an open unlined channel and into a large settling and sediment retention basin located near the bottom of the decline slope. This water then flows into further settling basins located on the north-western end of the stockpile area.

Dirty water runoff from the stockpile area and the settling basin to the north-west of the stockpile enters through two gabion wall sediment ponds in series and a sand bed Filter Lagoon. Overflow from the lagoon may enter Robins Creek via LDP4 in accordance with EPL 1087 licence conditions.

Once the water level in this lagoon is greater than 30% it is transferred to the Retention Dam in the emplacement area where further settling can occur. Water from the Retention dam may then be used for spray irrigation and/or dust suppression or may discharge via Pond A weir.

An estimate of the volume of dirty water stored on site at the end of the reporting period is provided in **Table 6.1**.

Table 6.1: Wongawilli Colliery Stored Water

	Volumes Held (ML)		
	Start of Reporting Period	At End of Reporting Period	Storage Capacity
Water Storage			
Primary Sediment Pond	0.00	0.00	0.5
Secondary Sediment Pond	0.8	0.5	1.2
Filter Lagoon	0.0	1.0	5.8
Pond C	1.2	1.8	2.2
Retention Dam	18.0	26.5	29.2
Pond A	1.9	3.0	3.2
Mine Dam	2.8	3.0	3.1
Primary Stabilisation Lagoon	0.2	0.0	3.2
Secondary Stabilisation Lagoon	0.0	0.0	3.4

Note: Storages that make up a relatively small contribution to onsite stored water volumes of less than 1 ML have not been included. This includes the Decline Dam, Surcharge Dam, Rail Sedimentation Pond and Primary Sediment Pond.

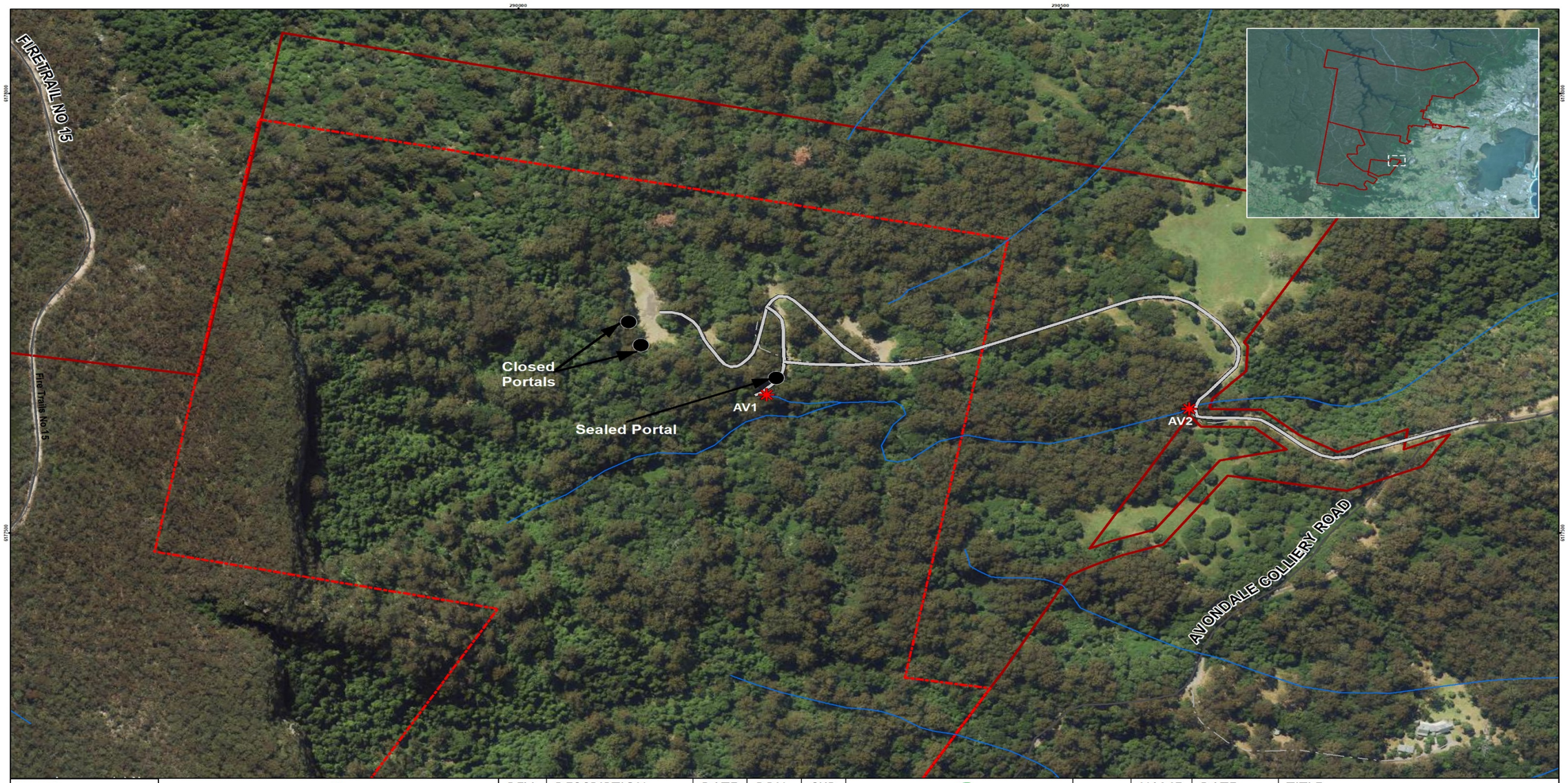
Avondale Pit Top

There is one licensed discharge point, LDP1, identified in EPL 12442. There is no requirement in the licence to monitor this discharge point. During ongoing site inspections, no mine water was seen to be discharging from LDP1 during this reporting period. While there is no requirement to monitor water from this point, WCL has recommenced water monitoring at two locations on site, If water is being discharged from the mine water samples are taken. ***Figure 6.1*** shows the location of these monitoring sites, and when results are received they are uploaded on the WCL website.

SMP and Catchment Lease Areas

The surface water monitoring requirement of one year post mine operation has been fulfilled in the last reporting period. Surface water quality monitoring is no longer required within the SMP and Catchment area.

Figure 6.1: Water Monitoring Map (Avondale)



Legend
- Surface Water Monitoring Site
- Portal Location (Decommissioned)
- Access Road
- Road
- Creek
- Avondale Surface Lease
- Current Lease CCL766

N

0 100 200

Meters

Coordinate System: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994

REV	DESCRIPTION	DATE	DRN	CKD

WOLLONGONG COAL

WCL WONGAWILLI COLLIERY
WONGAWILLI COAL PTY LTD

	NAME	DATE	TITLE	
DRN	RT	15/10/18	LOCATION PLAN	
CKD			AVONDALE SITE	
APP				
SCLAE	1:3,500 @A3		DRAWING NUMBER	REV
~~NTS~~			WWC-	0

Environmental Management

Wongawilli Colliery Pit Top

Under EPL 1089 surface water is analysed at LDP1 and LDP7 only when water is being discharged. There has been no discharge from LDP1 or LDP7 during this period. WCL undergoes regular visual inspections of ponds, sumps, dams and dirty water transfer systems and regular services of pumps.

Mine water discharge via LDP2 in the reporting year is summarised in **Table 6.2.** Under EPL 1087, surface water is analysed at LDP2 and monitoring is required for pH, total suspended solids and Oil and Grease. There has been no discharge from LDP2 during this reporting period, which is summarised in ***Table 6.3***.

Table 6.2: LDP2 Discharge Volumes (2020-2021)

Month	Total Amount Discharged (KL)	Daily Discharged (KL)
July 2018	0.0	0.0
August 2018	0.0	0.0
September 2018	0.0	0.0
October 2018	0.0	0.0
November 2018	0.0	0.0
December 2018	0.0	0.0
January 2019	0.0	0.0
February 2019	0.0	0.0
March 2019	0.0	0.0
April 2019	0.0	0.0
May 2019	0.0	0.0
June 2019	0.0	0.0
Yearly Total	0.0	0.0

Table 6.3: LDP2 Water Quality Monitoring Results (2020-2021)

Month	Pollutant	Result
July 2020	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
August 2020	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
September 2020	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
October 2020	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
November 2020	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
December 2020	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
January 2021	Oil and Grease(mg/L)	*
	pH	*

Month	Pollutant	Result
	Total Suspended Solids(mg/L)	*
February 2021	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
March 2021	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
April 2021	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
May 2021	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*
June 2021	Oil and Grease(mg/L)	*
	pH	*
	Total Suspended Solids(mg/L)	*

** Unable to sample as the site was dry. Due to the mine not operating since March 2019, mine-water discharge has been very low to nil.*

Avondale Pit Top

There have been no surface water pollution incidents at Avondale Pit top during the reporting period.

SMP and Catchment Lease Areas

There have been no identified impacts on surface water quality due to mining activities during the reporting period. The reporting requirement of one year post mine operation has been fulfilled in the last reporting period. Surface water quality monitoring is no longer required within the Nebo Area.

6.3 Groundwater Management

Environmental Management

Wongawilli Colliery Pit Top

Ground water is managed in accordance with the approved Surface Water Management Plan. Groundwater is collected in pits and sumps underground and is used in mining activities as much as possible. The primary use of captured groundwater is dust suppression at the operating coal face or on transport roadways and conveyor systems.

Water from the Mine Dam is used for dust suppression in the stockpile area, in the case of overflow from the Mine Dam, the water discharges to Robins Creek. Periodic inspections of LDP 7 were conducted, as result of these inspections there was no water identified as discharging from this location. Groundwater will continue to be managed in this manner during the next reporting period.

Avondale Pit Top

During site visits to Avondale LDP 1, no water has been discharged from this site. WCL undergoes water monitoring at two points on site. LDP 1 (AV1) is at the discharge point and AV2 is further down the creek as identified in **Figure 6.1.**

SMP and Catchment Lease Areas

Ground Water monitoring was undertaken in SMP and catchment lease areas of Wongawilli Colliery on a regular basis in accordance with SMP and EP approval requirements. As reporting requirements have been fulfilled, monitoring of these areas has transitioned to a program to support future mining proposals.

Environmental Performance

Wongawilli Colliery Pit Top

There has been no monitoring of groundwater impacts at Wongawilli Colliery Pit Top during the reporting period.

Avondale Pit Top

There has been no monitoring of groundwater impacts at Avondale Pit Top during the reporting period.

SMP and Catchment Lease Areas

The reporting requirement of one year post mine operation has been fulfilled and groundwater quality monitoring in these areas has transitioned to a program to support future mining proposals.

6.4 Sewage Treatment / Disposal

Greywater from the upper Pit Top flows through a PVC pipe down the decline to the Primary Stabilisation Lagoon which when full flows into the Secondary Stabilisation Lagoon. Allowance has been made in EPL 1087 for discharge from the Secondary Stabilisation Lagoons which is via LDP1. There has been no discharge from LDP1 during the reporting period.

Blackwater from the upper Pit Top is directed to three septic tanks which are regularly pumped out by licensed contractors. When the mine is operational, port-a-loos from the underground workings are routinely serviced by a licensed contractor for disposal at an approved facility.

The contractor's area toilet, located adjacent to the main access road close to the site entrance, has an in-ground concrete septic pit and an absorption trench system. This is pumped out as required by a licensed contractor for disposal at an approved facility. This facility has not been used during this reporting period.

7 REHABILITATION

7.1 Buildings

There have been no buildings demolished or rehabilitated during the period.

7.2 Rehabilitation of Disturbed Land

There has been no rehabilitation activity undertaken during the reporting period at Wongawilli Colliery. The summary and current status of disturbed areas and proposed rehabilitation is detailed in **Table 7.1** and **Table 7.2**.

Table 7.1: Rehabilitation Summary

	Cumulative Area Affected (hectares)		
	To date	Last report	Next Report (estimated)
A: Mine Lease Area			
A1 Mine Lease (s) Area	14,767ha	14,767ha	14,767ha
B: Disturbed Areas			
B1 Infrastructure area (other disturbed areas to be rehabilitated at closure including facilities, roads)	36.85ha	36.85ha	36.85ha
B2 Active Mining Area (excluding items B3 – B5 below)	0	0	0
B3 Waste emplacements, (active/unshaped/in or out-of-pit)	0	0	0
B4 Tailings emplacements,(active/unshaped/uncapped)	0	0	0
B5 Shaped waste emplacement (awaits final vegetation).	0	0	0
All Disturbed Areas	36.85ha	36.85ha	36.85ha
C: Rehabilitation Progress			
C1 Total Rehabilitated area (except for maintenance).	14ha	14ha	14ha
D: Rehabilitation On Slopes			

D1 10 to 18 degrees	0	0	0
D2 Greater than 18 degrees	0	0	0
E: Surface Of Rehabilitated Land			
E1 Pasture and grasses	0	0	0
E2 Native forest/ecosystems	14	14	14
E3 Plantation and crops	0	0	0
E4 Other (include non-vegetative outcomes)	0	0	0

Table 7.2: Maintenance Activities on Rehabilitated Land

Nature of Treatment	Area Treated (Ha)		Comment/Control Strategies/ Treatment Detail
	Report Period	Next Period	
Additional erosion control works (drains re-contouring, rock protection)	0	0	See Section 5.3
Re-covering (detail – further topsoil, subsoil sealing etc)	0	0	See Section 5.3
Soil treatment (detail – fertilizer, lime, gypsum etc)	0	0	N/A
Treatment/Management (detail – grazing, cropping, slashing etc)	0	0	N/A
Adversely Affected by Weeds (detail – type and treatment)	See Section 5.6	See Section 5.6	See Section 5.7
Feral animal control (detail – additional fencing, trapping, baiting etc)	32.6ha	32.6ha	See Table 5.4, Section 5

In the past, rehabilitation completed within Wongawilli lease holdings has been limited to areas at both the Avondale Colliery Pit Top and Nebo Pit Top.

7.3 Other Infrastructure

There was no rehabilitation of other infrastructure undertaken during the reporting period.

The only infrastructure remaining at the Avondale Colliery is two portals, an access track and associated gates and fencing.

The two remaining portals are fenced off to restrict access by unauthorised persons into the old workings. The remaining portals may be utilised in the future to provide ventilation to new workings. The access track is maintained to achieve access to the remaining portals and fencing and gates will remain for security purposes.

7.4 Rehabilitation Trials & Research

There have been no rehabilitation trials or research undertaken during the period.

7.5 Final Rehabilitation Plan

Pursuant to Condition 3 of ML1596, Condition 2 of ML1565 and Condition 2 of CCL766, the Mining Operation Plan (MOP) was prepared and submitted on 27 November 2020. The MOP was approved until 31 December 2021and has subsequently been extended to 02 July 2022.

8 COMMUNITY RELATIONS

8.1 Complaints Procedure

All complaints received are recorded and documented in accordance with the EPL conditions.

8.2 Environmental Complaints

During this reporting period there have been no environmental complaints. The complaints are summarised in the **Table 8.1**. The complaints register is publicly available on the WCL website.

Table 8.1: Environmental Complaints Summary

Date	Complainant	Nature of Complaint	Investigation/Action Taken/Follow - up
N/A	Nil	N/A	N/A

8.3 Community Consultation

WCL has established a Community Consultative Committee (CCC) in accordance with the requirements of the Condition 5 of Schedule 6 of the Approved Project (MP 09_0161) which has the following objectives:

- To develop this CCC with its community;
- To outline what is planned for WCL and its mine sites; and
- To share information with the CCC to date.

Four CCC meetings were held during the reporting period on 2 September 2020, 2 December 2020, 3 March 2021 and 2 June 2021.The key outcomes of the meetings are included into meeting minutes. The CCC meeting minutes are publicly available on the WCL website.

8.4 Agency Consultation

Consultation with key NSW State Government agencies in relation to Wongawilli Colliery will continue as required.

Generally, WCL's consultation is undertaken to ensure that all aspects of the proposed project are conveyed and any issues identified are addressed. Mitigation, monitoring and management measures can also be discussed and included in detail within the respective plans of management and Trigger Action Response Plans (TARPs) accordingly. With regard to MOD2, there has been and continues to be agency consultation.

9 INDEPENDENT AUDIT

WCL commissioned Wolfpeak Pty Ltd to conduct an Independent Environmental Audit (IEA) of the Wongawilli Colliery operations in accordance with the Project approval (MP09_0161) **Condition 8/Schedule 6**, during the 2019_20 reporting period. The audit assessed the compliance status of Wongawilli Colliery against the project approval and other relevant environmental approvals and licences for the period of 1 July 2016 to 30 June 2019. WCL continues to address the actions of the IEA as outlined in the Wongawilli Colliery Independent Audit Action Plan, February 2020, as provided in the 2019_20 AEMR.

10 INCIDENTS AND NON-COMPLIANCES

The reportable incidents and non-compliances identified with the Project Approval and other relevant environmental approvals and licences are detailed in Sections 10.1 and 10.2.

10.1 Incidents

There were no reportable incidents for the 2020-2021 reporting period.

10.2 Non-compliances

The non-compliances identified with the Project Approval and other relevant environmental approvals and licences during the reporting period are detailed below in **Table 10.1, Table 10.2** and **Table 10.3.**

Table 10.1: Non Compliances with Project Approval (09_161)

Condition	Non-Compliance	Risk Level
MP 09_161	Nil	

Table 10.2: Non Compliances with EPL 1087

Condition	Non-Compliance	Risk Level
M8.1	Reports during this period indicate data recovery below 95%. *The real time quality monitoring system has presented technical issues relating to power supply during the months of May and June 2021. The cause of the issues was investigated in order to mitigate the problem for future monitoring.*	**Low**

Table 10.3: Non Compliances with EPL 12442

Lease	Non-Compliance	Risk Level
Avondale	Nil	

10.3 DPIE Notice NTCE0003189 Completed Actions

In 2019 WolfPeak undertook a comprehensive independent risk assessment for WCL of all the infrastructure located in the catchment special areas in accordance with NTCE0002044. WCL was subsequently served with NTCE0003189 (the notice) under section 240 of the Mining Act 1992 directing the company to complete all the recommended controls/ corrective actions and regularly report on the progress of these actions.

During the 2020/21 reporting period WCL closed out and completed all the remaining recommended controls/corrective actions required under the notice. On the 22 April 2021 WCL provided the RR with the evidence of the completed works and requested that the RR close the notice. On the 29 July 2021, the RR advised WCL that following an assessment of the information provided, the RR had determined that the requirements of the notice had been addressed satisfactorily and the notice has been closed.

The following is a summary of the actions relating to the notice, which were completed during the reporting period.

Direction 1: Complete all recommended controls and implementation program identified in the Independent Environmental Risk Assessment.

Item 24 – 27, 29 – 33 were all completed in the previous reporting period. Details of these actions are outlined in the 2019_20 AEMR/ AR.

Item 28 – during the last reporting period, item 28 was partially addressed. Shaft 4 substation transformer bunds and storage tank were reviewed against the Australian Standards and found to be compliant with no upgrade of bunding being required. The CCTV monitors were installed.
During the reporting period, the remaining action from item 28 was completed. The oil filled equipment at the No 4 Shaft Substation had the oil removed before the end of September 2020. This has eliminated the risk of an oil spill from transformers in the Catchment resulting in the installation of utility service specified security fencing no longer required.

Direction 2: Six monthly independent audit program of completed actions.

The July 2020 independent audit, covering actions completed in the six month period leading up to and including June 2020, was completed on the 6/8/2020 and the audit report was submitted to the regulator on the 10/8/2020. The February 2021 independent audit, covering actions completed in the six month period leading up to and including December 2021, was completed on the 8/2/2021 and the audit report was submitted to the regulator on the 8/2/2021.

Direction 3: Quarterly update reports detailing completed works.

2020 Q2 report was completed and submitted to the regulator on the 10/08/2021 covering the three month period leading up to and including June 2020.

2020 Q3 report was completed and submitted to the regulator on the 10/11/2020 covering the three month period leading up to and including September 2020.

2020 Q4 report was completed and submitted to the regulator on the 8/2/2021 covering the three month period leading up to and including December 2020.

2021 Q1 report was completed and submitted to the regulator on the 12/5/2021 covering the three month period leading up to and including March 2021.

11 ACTIVITES PROPOSED IN THE NEXT REPORTING PERIOD

11.1 Activities Proposed

Activities proposed during the next reporting period are outlined in **Table 11.1**.

Table 11.1: Activities Proposed during the next Reporting Period

Activity	Details	Proposed Timing
Care & Maintenance Operations	WCL continues to operate under Care and Maintenance and the current Mining Operating Plan (MOP)	July 2021 – June 2022
MOD2	Currently at a response to submissions phase. Once consent from the regulatory authority is granted under EPA legislation, further activities will be commenced in accordance with these consent conditions.	Ongoing throughout the 2021-22 reporting period.
Rehabilitation	Continue rehabilitation activities in accordance with the MOP	Ongoing throughout the 2021-22 reporting period.
Management Plans Review	Review of existing approved management plans	Within the 3 months after AEMR submission. Note WCL intends to conduct a Management Plan review in accordance with post approval MOD2 conditions.
Management of old mine portals	Sealing of old mine portal's to continue	Ongoing

12 REFERENCES

Australian Standard AS/NZS 4360:2004 Risk Management.

Biosis (2020), Nebo Aquatic Ecological Autumn Report

Biosis (2020), Nebo Terrestrial Ecological Autumn Report

Commonwealth Government (1999), Environment Protection and Biodiversity Conservation Act 1999.

Department of Housing (2004), Managing Urban Stormwater: Soils and Construction (4th Edition), NSW Government.

Hazelton, P.A., and Tille, P.J. (1990) Soil Landscapes of the Wollongong-Port Hacking 1:100,000 Sheet, Soil Conservation Service NSW, Sydney

WCL (2020), Independent Environmental Audit Action Plan

Wolfpeak (2020) Wongawilli Colliery Independent Audit Report

Wongawilli Colliery (2015), Care and Maintenance Mining Operation Plan.

Wollongong City Council (2009), Wollongong Local Environmental Plan 2009.

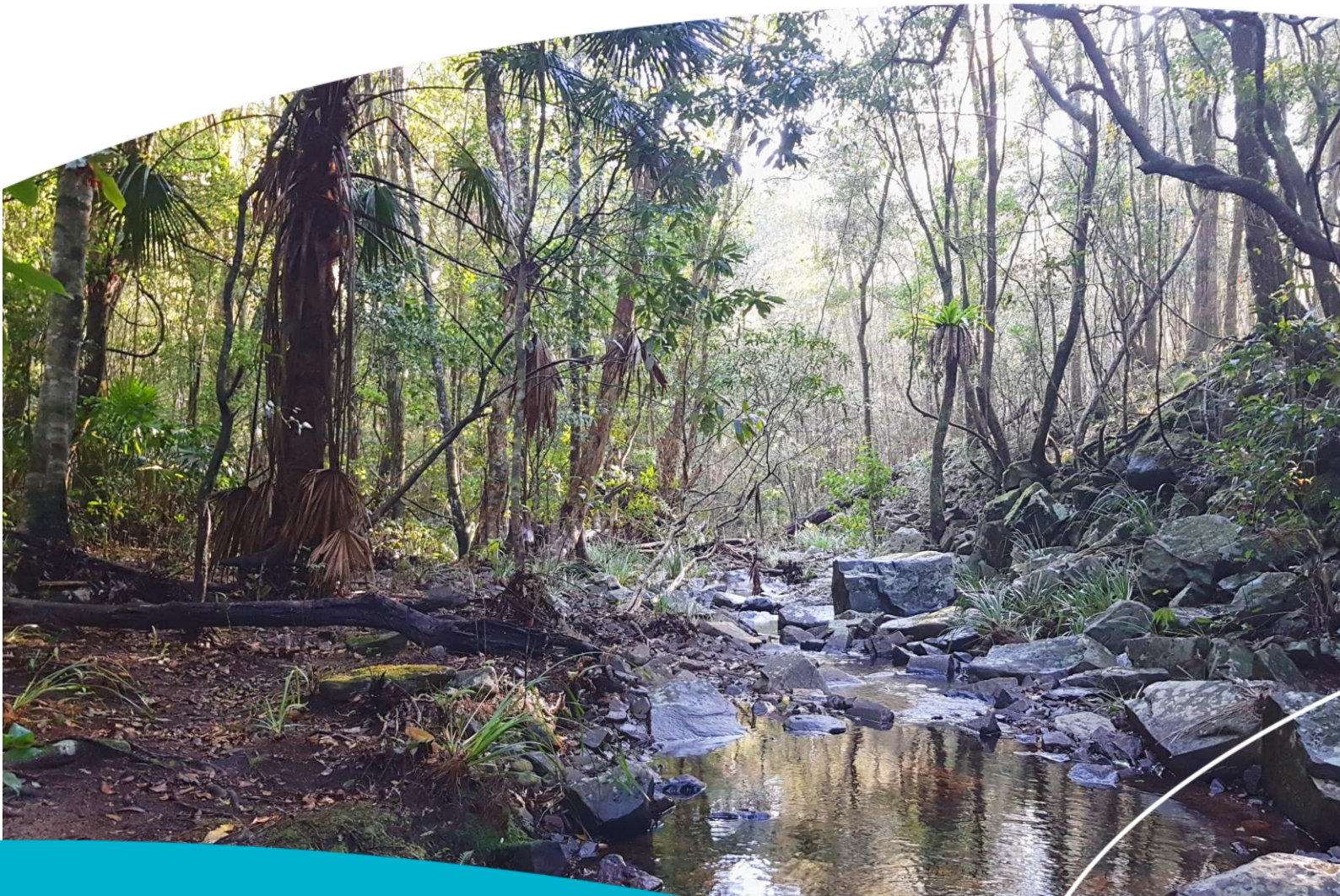
13 CONTROL AND REVISION HISTORY

PROPERTY	VALUE
Approved by	Group Environment and Approvals Manager
Document Owner	Environment Coordinator
Effective Date	30/09/2021

REVISIONS

VERSION	DATE REVIEWED	REVIEW TEAM (CONSULTATION)	NATURE OF THE AMENDMENT
1	30/09/2021	Richard Sheehan, Rebecca O'Brien, Sasa Cugalj	Final

APPENDIX A - BIOSIS NEBO TERRESTRIAL ECOLOGICAL AUTUMN 2020 REPORT



Nebo terrestrial ecological monitoring program: report for Autumn 2020

FINAL REPORT

Prepared for Wollongong Coal Ltd

28 September 2021

Biosis offices

NEW SOUTH WALES

Albury
Phone: (02) 6069 9200
Email: albury@biosis.com.au

Newcastle
Phone: (02) 4911 4040
Email: newcastle@biosis.com.au

Sydney
Phone: (02) 9101 8700
Email: sydney@biosis.com.au

Wollongong
Phone: (02) 4201 1090
Email: wollongong@biosis.com.au

VICTORIA

Ballarat
Phone: (03) 5304 4250
Email: ballarat@biosis.com.au

Melbourne
Phone: (03) 8686 4800
Email: melbourne@biosis.com.au

Wangaratta
Phone: (03) 5718 6900
Email: wangaratta@biosis.com.au

Document information

Report to:	Wollongong Coal Ltd
Prepared by:	Luke Stone Paul Price
Biosis project no.:	31687

File name: 31687.Nebo.TerrestrialEcology.2020CY.DFT01.20210106.docx

Citation: Biosis 2021. Nebo ecological monitoring program: report for autumn 2021. Report for Wollongong Coal.

Document control

Version	Internal reviewer	Date issued
Draft version 01	Rebecca Dwyer	06/01/2021
Final version 01	Luke Stone	06/09/2021
Final version 02	Luke Stone	27/09/2021

Acknowledgements

Biosis acknowledges the contribution of the following people and organisations in undertaking this study:

- Sasa Cugalj of Wollongong Coal Ltd
- Joanne Potts of The Analytical Edge Statistical Consulting for statistical analysis.

Biosis staff involved in this project were:

- Samantha McCann, Paul Gadsby and Kayla Asplet (assistance in the field)
- Erin Baldwin (data entry)
- Lauren Harley (mapping)

Contents

Tables

Figures

Summary

This document reports on the terrestrial ecological-monitoring program for the Nebo Area during the autumn 2020 monitoring period. This annual report incorporates data collected between spring 2010 and autumn 2020.

Baseline monitoring of impact sites within the Nebo Area commenced in spring 2010 and monitoring at paired control sites commenced as early as autumn 2011. Following the completion of Longwall N2 in February 2014, Wongawilli Coal discontinued mining in the Nebo Area. Subsequently, all related terrestrial ecological monitoring ceased, on the condition from the regulator that baseline monitoring was to restart six months prior to the recommencement of mining. In addition, data analysis should not show a significant change in condition over the intervening period. Baseline monitoring within the Nebo Area recommenced in spring 2015, ahead of the proposed extraction of Longwall N4, which commenced in August 2016. Data collected and presented herein represents the findings of the monitoring undertaken in autumn of 2020, which is compared to previous years of monitoring and represent post/during mining findings at impact sites.

The trends identified in autumn 2020, and in previous iterations of the terrestrial monitoring programs are generally consistent with those observed during the recommencement of mining in the Nebo Area. And are summarised below. The results are considered nominal for these systems under the environmental conditions at the time of survey. As a result, all impact monitoring sites are considered to be consistent with the 'Normal' or 'Within prediction' Trigger Action Response Plans trigger levels (Niche 2012).

Amphibian monitoring

Data collected over the whole monitoring program illustrates a level of seasonal and annual variation and includes a high proportion of monitoring events that record either one species or no species of frogs at individual monitoring transects.

The assessment of the mean number of frog species detected at Wattle Creek indicates that results from the impact monitoring site during the autumn 2020 period are comparable to those recorded at the control sites in the same year, and are within the range of values previously recorded as part of the monitoring program. In summary, no impacts associated with mining during the autumn 2020 monitoring period are identified through a visual inspection of the monitoring data.

Riparian vegetation

The total species richness (TSR) value was found to be higher at impact sites than control sites. However, this difference has been present since before mining occurred, and has remained consistent, indicating that this is a natural trend unrelated to mining. 'Year' has been identified as the key factor explaining significant change in TSR and in species composition. Comparisons of TSR data on the basis of 'treatment' (control and impact) and pre-post (pre and post mining) alone were not found to be best fit to the data. A pre-post effect was also found to be significant for species composition analysis at the impact sites, at a lower significance level than 'Year'. This is attributed to environmental change at the sites rather than mining. This is in consideration of the lack of any impacts detected in any other monitoring (including amphibian, stream health, groundwater and surface water monitoring) and any observations of deterioration in the vegetation present.

1 Introduction

1.1 Nebo area

The mining domain of the Nebo Area is located within the Metropolitan Special Area and Southern Coalfield of New South Wales (NSW) (Figure 1). On 16 July 2009 Wongawilli Coal (previously Gujurat NRE – Wonga Pty Ltd) received Project Approval from the *NSW Department of Planning and Infrastructure* under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to extract coal from the Wongawilli seam (MP09_0161). A variation to include mining of Longwalls N1 to N6 within Nebo Colliery (hereafter referred to as the Nebo Area) was approved on 2 November 2011. An Extraction Plan was developed to satisfy the requirements of Schedule 3, Condition 7 (h) and (i) of the Project Approval. This plan, includes a Subsidence Management Plan (SMP) required by the Division of Resources and Energy (DRE), NSW Trade & Investment that addresses Schedule 3 Condition 7 (e) and (f) of the project approval for the ecological monitoring programs (DTIRIS 2013).

The Nebo Area includes natural features located above Longwalls N1 through to N6 (Figure 1). The mine complex at Nebo includes longwalls (N1, N2, N3, N4, N5 and N6) that are situated beneath the catchments of Wattle Creek and Little Wattle Tree Creek within the greater catchment of Lake Cordeaux. Extraction of coal has been completed at each of the longwalls, with End of Panel (EoP) reports prepared for each (Table 1). These EoP reports did not identify the exceedance of any TARP triggers relevant to ecological features, surface water or groundwater during extraction.

Table 1 Details of mining completed to date

Panel	Extraction period	Ecology EoP report reference	Surface water and groundwater EoP report reference
N1	May 2017 to September 2018.	Biosis (2019a)	GeoTerra (2019a)
N2	June 2013 to February 2014.	Biosis (2014)	GeoTerra (2014)
N3	October 2016 to March 2019.	Biosis (2019b)	GeoTerra (2019b)
N4	August 2016 to May 2017.	Biosis (2017)	GeoTerra (2018)
N5	March 2017 to January 2019.	Biosis (2019b)	GeoTerra (2019c)

Biosis understands that the planned extraction from Longwall N6 will now not occur. As extraction ceased in March 2019, Biosis understands that the Nebo terrestrial ecological monitoring program is not required beyond the autumn 2020 season and has fulfilled Wollongong Coal's minimum requirements regarding ecological monitoring.

1.2 Ecological monitoring

Natural features with Risk Management Zone (RMZ's) located within the subsidence impact footprint of the Nebo Area require monitoring for a minimum of two years prior to the start of longwall mining (the 'impact' event). Monitoring focusses on ecological features that are sensitive to geological changes to the landscape, including: valley closure, upsidence, strains and fracturing. This is in accordance with recommendations made by the former Department of Planning (now Department of Planning Infrastructure and Environment) (DoP 2008). Mining beneath watercourses in steep valleys can result in localised water losses from creek lines

immediately above the mine due to water permeating into fractures within the bedrock (DPI 2006). The water usually returns to the surface further downstream, but may be altered chemically by leaching of the newly exposed minerals from within the rock strata (DPI 2006). Sites are referred to as pre-impact, until the closest point of secondary extraction is located within RMZ of the ecological feature, then are referred to as post-mining impact sites.

Baseline terrestrial ecological monitoring of impact sites within the Nebo Area commenced in spring 2010 and monitoring at paired control sites commenced as early as autumn 2011. Following the completion of Longwall N2 in February 2014, Wongawilli Coal discontinued mining in the Nebo Area. Subsequently, all related terrestrial ecological monitoring ceased, on the condition from the regulator, that baseline monitoring was to restart six months prior to the recommencement of mining. In addition, data analysis should not show a significant change in condition over the intervening period. Baseline monitoring within the Nebo Area recommenced in spring 2015, ahead of the proposed extraction of Longwall N4.

The adopted Trigger Action Response Plans (TARPs) (Niche 2012) for the Nebo Area require monitoring and impact assessment to be undertaken for a minimum of one year following the completion of mining activities. If an impact is detected, post-mining monitoring may be required to be collected for a period determined to be satisfactory by WaterNSW and the former Office of Environment & Heritage (now Environment, Energy and Science).

To determine whether subsidence related effects associated with longwall mining result in impacts to terrestrial flora and fauna features located above the longwalls, Biosis has designed and implemented a Before-After Control-Impact (BACI) experimental design, looking at how sites that have been mined beneath change over time (Before-After) and comparing this to control sites that have not been mined beneath (Control-Impact).

The Extraction Plan for longwalls within the Nebo Area, developed in May 2012 (Niche 2012) identified that the extraction of Longwalls N4, N5 and N6 will result in a subsidence footprint that occurs within the RMZ for sensitive ecological features. Ecological features at greatest risk of impact from subsidence effects are considered to be those features reliant on groundwater or surface water. The ecological features which are relevant (Niche 2012) and currently being monitored prior to the recommencement of mining, and since mining recommenced in August 2016 in Nebo, include plant communities (species) and frogs (presence/absence) along two creeks.

The Nebo Terrestrial Ecological Monitoring program was developed using protocols established for the Southern Coalfield in 2003, consultation with Wongawilli Coal and the outlined Chapter 3 Subsidence Management Measures in the Nebo Longwalls N1-N6 Extraction Plan (Niche 2012).

1.3 Aims of this report

This report provides a summary of the results of the autumn 2020 monitoring period of the Nebo terrestrial ecological monitoring program. The aims of this monitoring report are to:

- Describe ecological monitoring undertaken in the Nebo area up to and including the autumn 2020 monitoring period.
- Present the monitoring results recorded during autumn 2020 in the context of the results of the program since its inception.
- Examine the potential impacts of subsidence on riparian vegetation and frogs in creek environments in the Nebo Area.
- Relate the ecological monitoring results to the TARPs (Niche 2012) for Longwalls N1-N6 (Appendix 1).

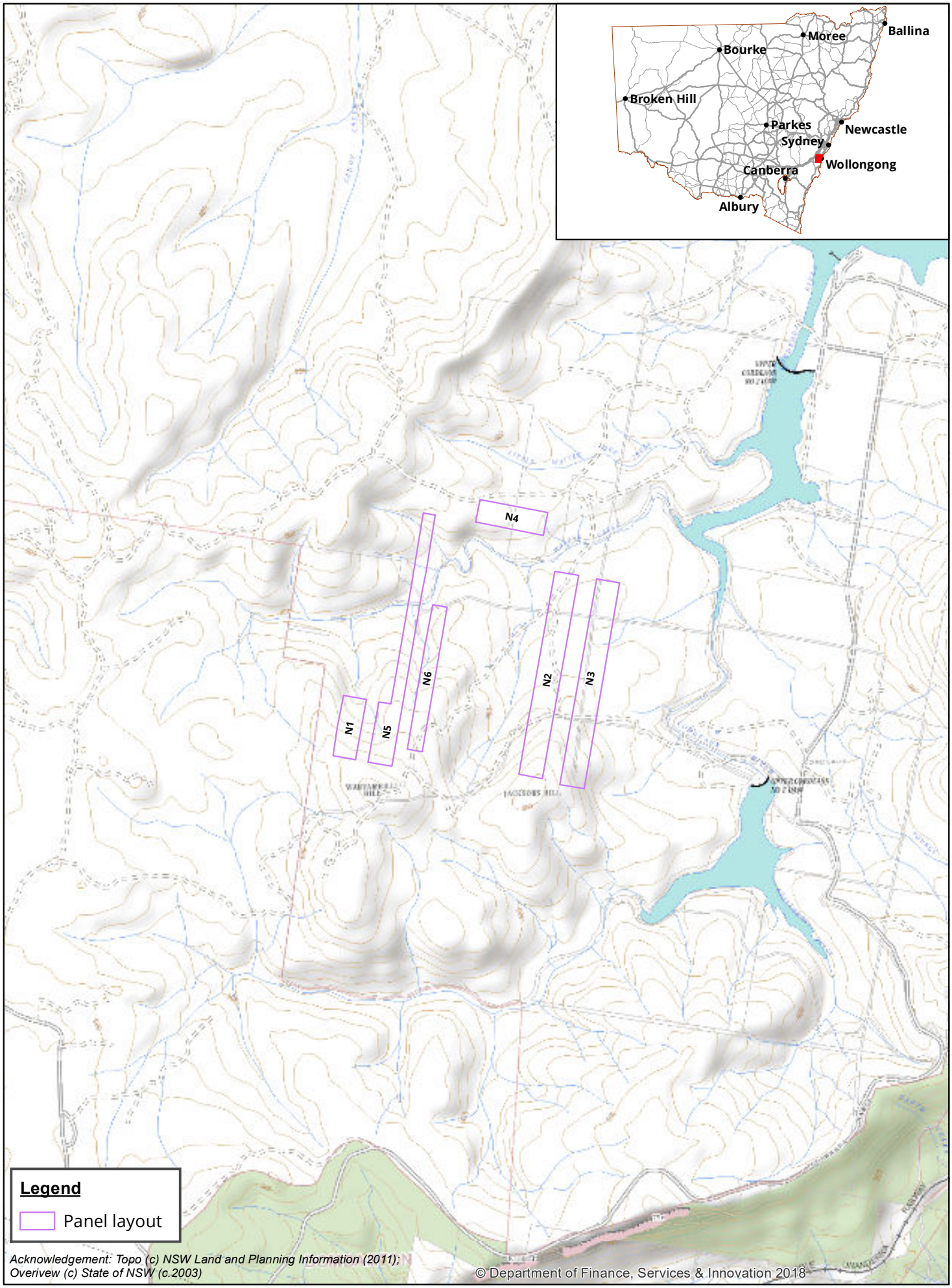


Figure 1 Location of the study area in a regional context

Matter: 31687
Date: 18 December 2020,
Checked by: LS, Drawn by: LH, Last edited by: lharley
Location:P:\31600s\31687\Mapping\

0 200 400 600 800 1,000
Metres

N

Scale 1:25,000 @ A4, GDA 1994 MGA Zone 56

Biosis Pty Ltd
Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

2 Methods

2.1 Survey sites and monitoring periods

A summary of the monitoring sites is provided in Table 2. This table details impact and control site pairing and monitoring periods. All components of the ecological monitoring programs are to be undertaken in both spring and autumn of each year. The monitoring periods and survey dates are provided in Table 2 and Appendix 2. All impact monitoring sites are considered to be in a 'post mining' (within RMZ) condition during the autumn 2020 monitoring period. The locations of the impact and control monitoring sites for each monitoring program are displayed in Figure 2 and Figure 3. The number of monitoring sites has been reduced in the autumn 2020 monitoring report to only those required to identify any impacts associated with Panels N3 and N5 (for which extraction ceased in 2019) at the request of Wollongong Coal. As such no monitoring of Little Wattle Tree Creek has been undertaken in autumn 2020.

Table 2 Monitoring sites and periods

Area	Site	Monitoring period	Control sites
Riparian vegetation monitoring	Wattle Creek (WTC)	Spring 2010 to Autumn 2014 Spring 2015 to Spring 2017 Spring 2018 to Autumn 2020	Moran's Gully (MG) Flying Fox Creek No. 3 (FFC)
Amphibian monitoring	Wattle Creek (WTC)	Spring 2010 to Autumn 2014 Spring 2015 to Autumn 2018 Autumn 2020	Moran's Gully (MG) Flying Fox Creek No. 3 (FFC)

Trends or changes in the ecological metrics used to record and interpret the data for vegetation and frog species monitoring may be due to mining impacts or unrelated landscape effects; for example, local climate changes or bushfire. As such a BACI (Underwood 1991) experimental design has been employed to increase confidence in the interpretation of observed changes.

Each site is analysed based on the following impact treatments:

- Control: sites not mined beneath and not at risk of mining related impacts.
- Impact: the 400 m risk management zone (RMZ) will experience mining of Nebo Panels and the site is considered to potentially be at risk of mining related impacts.

Control sites selected for analysis were chosen for impact sites based on ecological and structural similarity to impact sites in the field, and their geographical location. These sites were then compared using exploratory data analysis to confirm that the data were statistically suitable and available for the same period of time as impact sites.

Legend

Flora monitoring site

▲ Flora creek impact site

Fauna monitoring site

✚ Fauna creek impact site

Survey area

▭ Panel layout

Figure 2 Location of impact terrestrial monitoring sites in the Nebo Area

0 100 200 300 400

Metres

Scale: 1:7,500 @ A3

Coordinate System: GDA 1994 MGA Zone 56

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 31687
Date: 18 December 2020,
Checked by: LS, Drawn by: LH, Last edited by: lharley
Location:P:\31600s\31687\Mapping
31687_F2_NeboImpact

Legend

Flora monitoring site

▲ Flora creek control site

Fauna monitoring site

✚ Fauna creek control site

Survey area

▭ Panel layout

Figure 3 Location of control terrestrial monitoring sites in the Nebo Area

0 200 400 600 800 1,000

Metres

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 31687
Date: 18 December 2020,
Checked by: LS, Drawn by: LH, Last edited by: lharley
Location:P:\31600s\31687\Mapping
31687_F3_NeboControl

2.2 Amphibian monitoring

Field data collection

Frog surveys along the identified creek lines ('sites') are conducted along three 50 metre transects within each creek (Figure 2, Figure 3). These three transects per creek are referred to collectively as a monitoring site and represent units of suitable frog habitat along each waterway that are repeat surveyed (two surveys per season in both autumn and spring). An initial five minute listening period is followed by active searching of all natural features including rocks, vegetation and leaf litter within the transect for an additional 25 person minutes. The presence and abundance of all frog species within each transect is recorded. Additional physical data is also collected to describe the transects at the time of survey.

Data analysis

The six data points for each monitoring site per season are considered as a group (three transects per site, surveyed twice). The species richness (number of distinct species detected) of frog species observed for each transect on each survey is first calculated, from which the mean average species richness per site for each season is then calculated. These data are plotted on line graphs by year and treatment for each site surveyed. The plotted data are then visually assessed to identify any trends in increasing or decreasing observations of frog species. This analysis is supported by the visual observations of changes in habitat features (e.g. water level or vegetation change) that may drive change in the species of frog detected over time and any findings (e.g. changes in water quality) from the aquatic ecological monitoring program.

Impacts to frog populations are likely to occur as declines in population numbers or disruption of species breeding cycle following changes to key breeding habitat features. This may in turn be manifested as a change in the number of individuals for a creek frog species present and / or a change in the composition of species found at a site if some species are more sensitive to habitat change than others. Given the inherent variability in fauna data, particularly frog detection and variation in seasonal timing of some surveys, the analysis focuses on comparisons of the mean species richness at each site to identify any changes in the frog species assemblage within each creek rather than abundance. This is considered to be the more reliable indicator, although any significant changes in frog abundance are reported and discussed.

2.3 Riparian vegetation monitoring

Field data collection

Vegetation surveys within creeks are undertaken at three 20 by 20 metre (400 square metre) quadrats per creek (Figure 2, Figure 3). These three quadrats per creek are considered to be a single monitoring site and are analysed as a group. Within each quadrat, subjective cover and abundance scores are given to each species occurring within the quadrat using a modified Braun-Blanquet scale.

Data analysis

The Analytical Edge Statistical Consulting Pty Ltd was commissioned by Biosis to undertake statistical analyses of flora data collected at creek sites and has refined the statistical analysis design methods used in the monitoring program (The Analytical Edge 2020). The Analytical Edge has undertaken the statistical analysis for the autumn 2020 monitoring period data. The analysis provides a statistical comparison of impact and control sites with the aim to identify, understand and manage any mining impacts.

Impacts to vegetation may be manifested as a change in the number of species at different sites, or an overall change in the species composition (as some species may be more or less affected than other species to

impacts associated with mining). In affected areas, these impacts are likely to be manifested and detectable through statistical analysis the following ways:

- Change in floristic total species richness (TSR): the number of individual species present.
- Changes in the floristic species composition: the assemblage or identity of different individual plant species that make up a vegetation community.

A change in TSR or species composition following mining at a potential impact site that does not occur at a control site may indicate an impact. In order to detect changes in indicator variables, particular trends must be identified. These trends may occur suddenly, as a pulse event, or more likely, gradually over time.

Statistical methods

To avoid the Braun-Blanquet categories resulting in an inappropriate weighting of species abundance, the data utilised in the statistical analysis was transformed to presence-absence data. All vegetation data refers to presence-absence data only.

TSR data were plotted by year and treatment (control or impact), pooled across all quadrats and creeks surveyed within a year (autumn and spring data combined), and also for each creek line surveyed. TSR data was graphically displayed using box plots to enable a visual comparison of flora data between sites and years. Box plots allow for a detailed visual presentation of the median distribution including the underlying variability and distribution of the metrics. The box of a box plot contains the central 50 % of the distribution; from the first quartile to the third quartile (quartiles split the distribution into four parts, each containing one quarter, 25 %). Lines extending from the boxes represent the rest of the data and any points beyond these are considered outliers.

To formally quantify whether trends detected visually represent actual changes in TSR, generalised linear mixed models (Bolker et al. 2009) were tested for all sites. The models tested the influence of season, year and mining status (pre, post or mined beneath) on TSR. Season allows us to look for any cyclical trends; calendar year allows us to look for trends in time across all sites, while mining status allows us to see if observed trends are different at mining and non-mining sites. Analysis of variance (ANOVA) was used to formally test the significance of explanatory variables (i.e., 'year', 'season' and mining status) on species composition. If the mining status' explanatory variable was found to be significant, univariate or other tests were completed to determine which individual species were driving the change in flora community composition.

Assumptions and models

An assumption of generalised linear mixed models is that observations are independent, which here is clearly violated both temporally (since sites are visited multiple times) and spatially (since some sites within regions are closer together). That is, it would be expected that observations collected at the same creek, regardless of year or season, would be more similar than observations collected at different creeks; and similarly, observations collected at creeks near each other would be more similar to observations collected at creeks further away. To account for this correlation within sites and the nesting of sample points within the area, a random-effect term was included. Akiake's Information Criteria (AIC) was used to select between competing models, whereby the model with the lowest AIC was considered the 'best' of all models fitted, and models that had an AIC less than or equal to two from the AIC of the best model were considered equivalent.

Six generalised linear mixed models (GLMMs) were fit to the TSR data for sites within the Nebo Area. The model definitions are:

- M0 – Null model. No change in TSR between impact and control sites, across year, or pre- and post-impact

- M1 – Pre/post model. Difference between pre- and post-treatment.
- M2 - Year model. Year effect only.
- M3 - Additive model. Difference between impact and control sites with the additive effect of year.
- M4 - Interaction model. Year effect that changes depending on whether site is an impact or control site.
- M5 – Treatment. Difference between impact and control site.
- M6 – Season. Difference between autumn and spring data collection.

All modelling and the creation of graphs were completed in the statistical software program R, by the Analytical Edge Statistical Consultants (2020). Generalised linear mixed models of TSR were fitted using the 'glmer' function in the 'lme4' package. The 'manyglm' function in the 'mvabund' package (in the program R), were used to fit presence-absence models to each detected species. These models correct the correlation between species (thus violating an assumption of standard generalised linear models) by using generalized estimating equations.

2.4 Limitations

Ecological monitoring surveys should be undertaken during the programmed seasons and be consistent across years. Biosis has undertaken monitoring surveys as part of this monitoring program following approval dates by Wollongong Coal. As such some seasons of data have been completed outside the programmed seasons or under conditions that are not optimal for ecological survey. The survey dates for all monitoring periods are provided in Appendix 3. Interpretations of data that have been collected substantially outside the monitoring period must be treated with caution. As these data are likely to have been collected under considerably different seasonal conditions to the programmed seasons they are intended to represent. As such, these data may not be directly comparable to previous seasons data or representative of the ecological biota that would be present during the programmed season. A considerable number of seasons of baseline data have been collected providing a comprehensive basis to interpret data. Interpretations are further supported by the use of control sites and observations regarding any impacts associated with mining, such as surface deformation, cracking or leachate.

Given the complexity that arises with cryptic flora species, such as those that are inconspicuous unless flowering or in fruit, or located high in the vegetation canopy; plant species complexes have been developed that link plant species that are known to be easily confused in the field. These linked species have been treated as one species complex in the data as they represent sympatric species and occupy a similar ecological niche. Species complexes have been developed based on site specific experience over many years.

Like many fauna surveys, the frog species dataset is not normally distributed and is skewed by a high number of zero counts. It is not possible to sufficiently estimate a measure of detectability for the frog species monitoring. Therefore the difference between a true absence record (i.e. the species does not occur at the site) and a false absence record (i.e. the species does occur at the site but was not detected) cannot be established, a common feature of such monitoring programs. Therefore, the amphibian monitoring data has been transformed to presence-absence data. Two rounds of survey are completed in each season to increase confidence in the data, given the high degree of variability encountered in the monitoring of amphibians. Data collection prior to 2013 appears to have been collected in a different format than the current program, as such this data is not included in the graphed comparisons to ensure valid comparisons are made.

Ecological monitoring programs may be confounded by varying responses of ecological communities or populations responding to impacts or environmental conditions in differing ways. Therefore, monitoring and interpretation of data with a 'one size fits all' approach must be treated with caution. As such, a number of parameters including both qualitative and quantitative metrics are recorded to establish multiple lines of evidence to inform the interpretation of results. Biosis is committed to the continual review of our programs to provide options for improvement.

3 Results

One round of riparian vegetation and amphibian data was collected for the autumn 2020 monitoring season. It is noted that the riparian vegetation and amphibian data was collected outside the autumn season under more 'winter-like' conditions (Appendix 2), following the methodology detailed in section 2.

3.1 Rainfall

Rainfall in the period preceding the autumn 2020 surveys has been below the median following extended drought conditions. Below average rainfall occurred between 2017 and 2020, with 2019 representing the lowest total annual rainfall in recent years (Figure 4). More rainfall was recorded in 2020, up to the dates of field surveys in June, than in the whole of 2019.

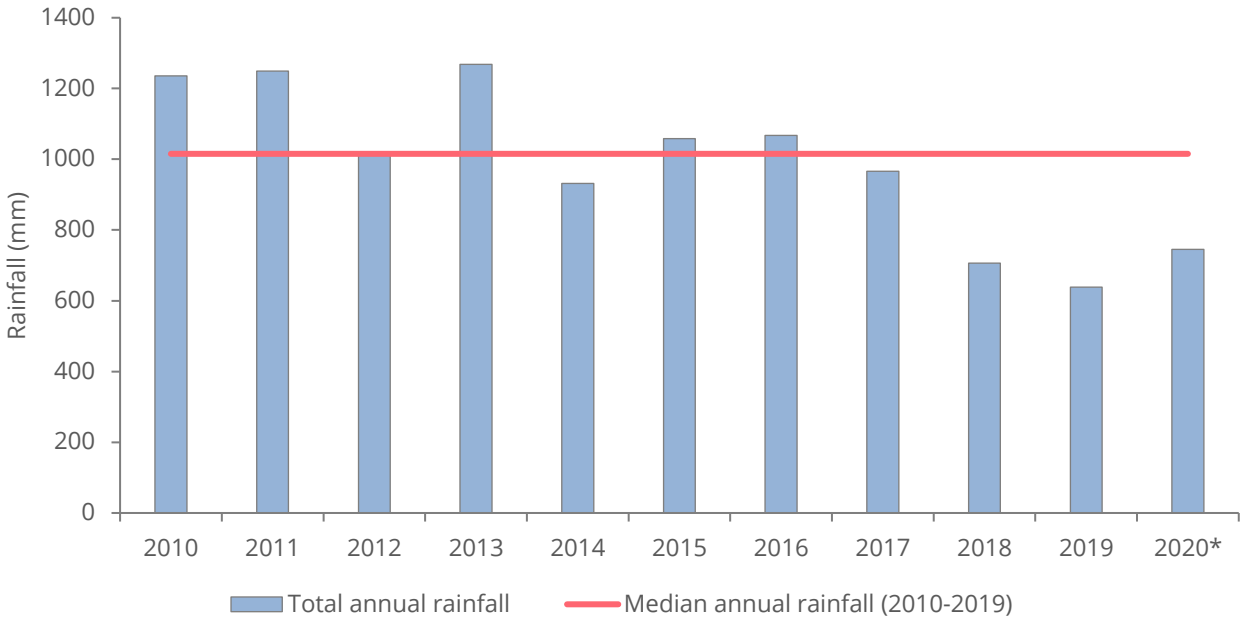


Figure 4 Total annual rainfall recorded between 2010 and 2020 (Janrary – June), recorded from grid point -34.40, 150.75 (Longpaddock 2020)

In the months preceding the autumn 2020 field surveys completed in June, for the majority of months rainfall was somewhat below average (Figure 5). The exceptions being February, which recorded rainfall levels significantly above the average, with above average rainfall also falling in May of 2020. The rainfall data indicate that while conditions at the Nebo monitoring sites are likely to reflect the extended drought that has persisted for a number of years, the months preceding the autumn survey have on the whole received a significant amount of rainfall in comparison to recent years. As such there is likely to have been a greater degree of water availability at all sites during the autumn surveys in 2020 than in recent years.

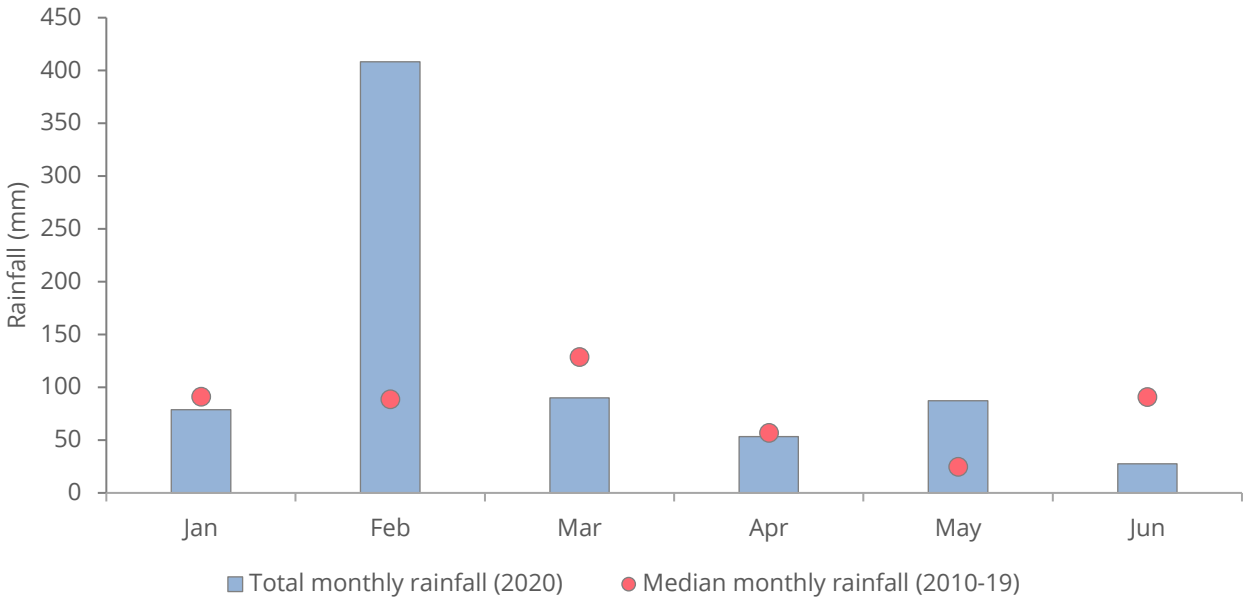


Figure 5 Total monthly rainfall recorded in 2020 (Janurary – June), recorded from grid point -34.40, 150.75 (Longpaddock 2020)

3.2 Amphibian monitoring

The amphibian monitoring field surveys were undertaken in mid to late June 2020, under conditions considered to be more 'winter-like' than 'autumn-like'. As such the findings of the amphibian monitoring are considered in the context of sub optimal conditions for survey. Only five individual frogs were recorded across the two repeat surveys of the three monitoring sites in autumn 2020, reflecting the poor conditions for survey. These low numbers present a limitation to the ability to detecting and interpret any change in environmental conditions that may be associated with potential impacts, if any.

The frog species detected at the monitoring sites in 2020 are common species that are repeatedly recorded as part of this program and are typical of the rocky creek and riparian habitats in the region. These include the Common Eastern Froglet *Crinia signifera*, Southern Stony-creek Frog *Litoria lesueuri* and species from the *Litoria nudidigita / Litoria phyllochroa* species complex. Native fish *Galaxias* sp. were recorded at both Wattle Creek, Flying Fox Creek and Morans Gully, indicating relatively good water quality at these sites. These sites all recorded reduced water levels throughout 2019, reflecting the extended drought conditions manifesting in that year. The impact site Wattle Creek appears to be the most resilient waterway to reduced rainfall with this site maintaining a relatively consistent level of flow, indicating a relatively high degree of groundwater influence or spring fed inputs from upstream. Small areas of flocculant along this waterway, typical of such waterways in the locality, support this interpretation. In autumn 2020, water levels at Wattle Tree Creek and Flying Fox Creek were observed to be more representative of nominal conditions (pre-drought) for those recorded throughout the monitoring program. Water levels were also observed to be somewhat increased at Morans Gully when compared to 2019, although not fully returned to nominal conditions.

Annual analysis and comparisons of the amphibian monitoring data focusses on the mean number of frog species detected each season. Figure 6 presents the mean number of frog species detected at the impact and paired control monitoring sites, during each season from 2013 to autumn 2020. A decline in the number of frog species detected at both impact sites is seen to occur in autumn 2017, before increasing in 2019 and then then declining again in autumn 2020. This is likely a factor of survey timing where these surveys were undertaken in more winter-like conditions, as such lower species activity and detection may be expected. This

pattern is also seen in the paired control sites, indicating that the conditions at the control sites are representative of those encountered at the impact monitoring sites and therefore do not indicate any impacts associated with mining.

The autumn 2020 results for Wattle Creek are generally consistent with the results recorded at the control sites and within the range of scores previously recorded at this site. The detection results for autumn 2020 are low, however this is consistent with survey results completed outside of the autumn season or under cold weather conditions. On the basis of these findings, and lack of any observed impacts, these results are considered nominal for this site. In summary, no impacts associated with longwall mining are observed in the autumn 2020 amphibian monitoring data.

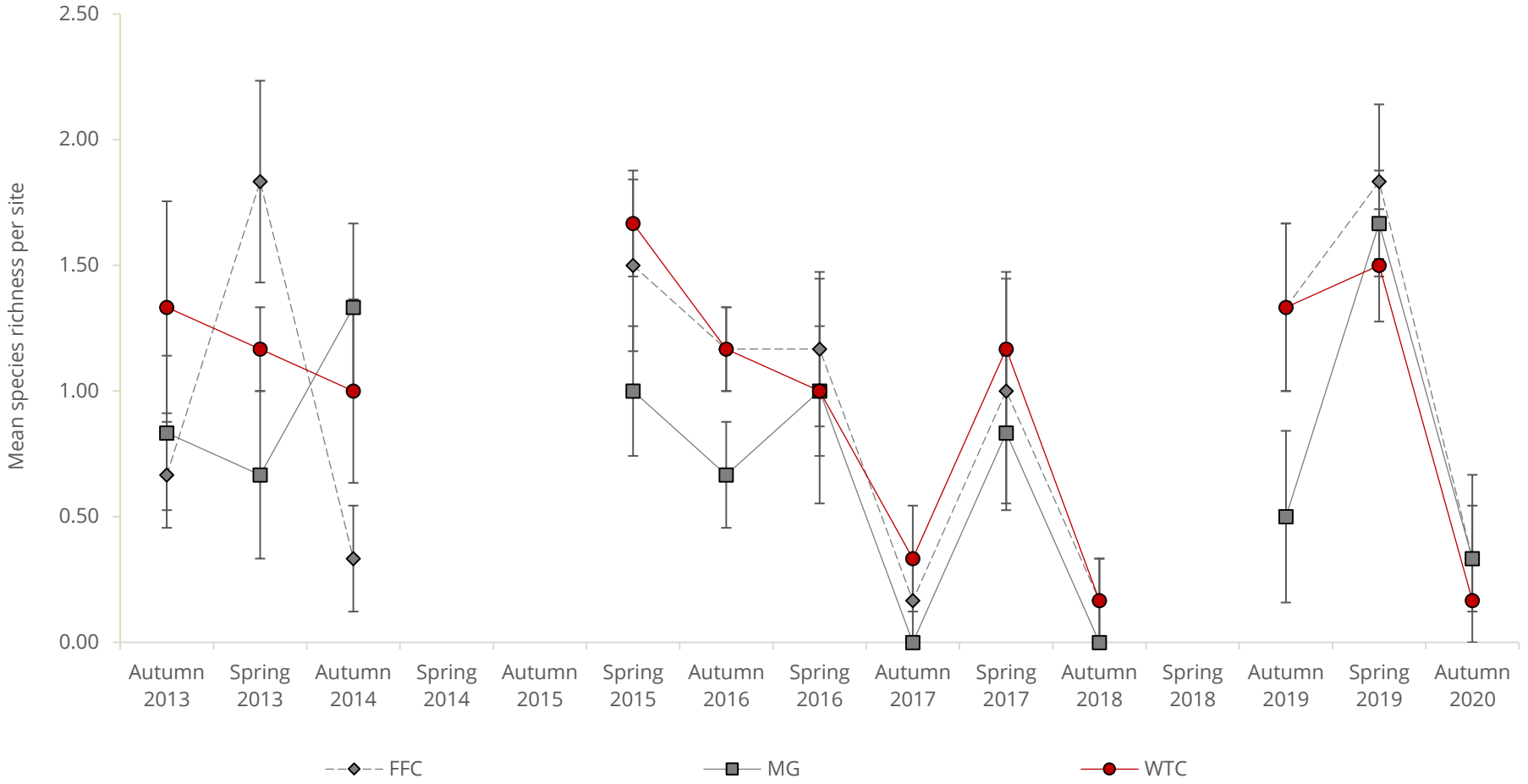


Figure 6 **Average amphibian species richness results recorded between 2013 and autumn 2020, showing impact site Wattle Creek in comparison to the control monitoring sites. Error bars show the standard error of the sample mean.**

3.3 Riparian vegetation monitoring

3.3.1 Total species richness

The results of exploratory analysis of the pooled TSR data collected at each control and impact site is presented in Figure 7. The solid line within the boxes of Figure 7 is the median (i.e., the 50th percentile), the margins of the box are the interquartile ranges (i.e., the 25th and 75th percentile) and the whiskers of the boxplot show the range of the data. The control monitoring sites are shaded white, pre-mining impact monitoring sites grey and post mining - within RMZ blue. Solid black points are the observations.

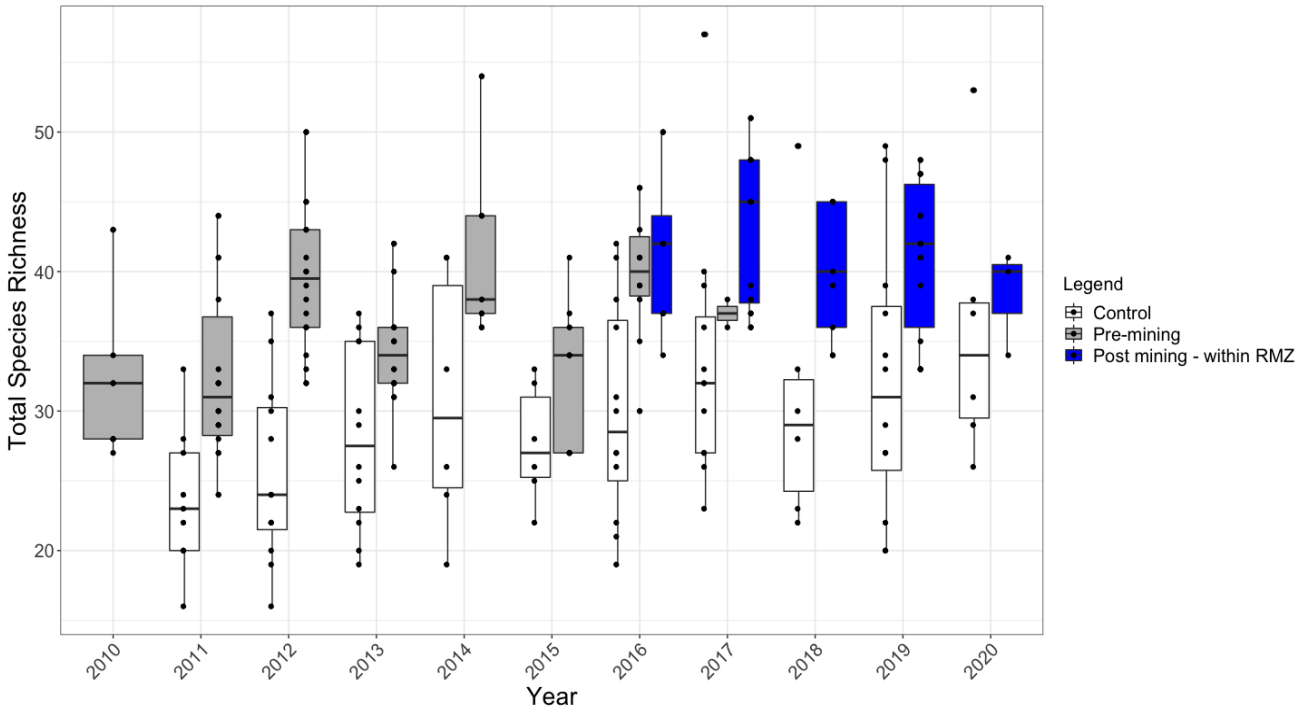


Figure 7 Boxplot showing pooled Total Species Richness for all monitoring sites over all monitoring periods: split by mining or control status

The pooled data for the control, pre-mining and post mining monitoring sites demonstrate a high degree of variability in TSR from year to year. TSR has consistently been higher at the impact sites, and this pattern has continued through to 2020. Both the control and impact sites appear to follow the same broad pattern of change over time with a broad trend of increasing TSR over time. The TSR results for the impact sites are represented by WTC alone in 2020. The TSR results for impact sites in all the other monitoring periods are represented by both WTC and LWTC. This is why there is a decreased range in the TSR score for impact sites in 2020. The TSR results for the impact monitoring site in the 2020 monitoring period are within the range of variability recorded during the pre-mining data collection period (2010 to 2016). Noting that in 2020, the post-mining results include WTC only.

The TSR results for individual control and impact monitoring sites across all monitoring periods are presented in Figure 8. The sites show a broad trend of increasing TSR over time at all monitoring sites. Flying Fox Creek and Little Wattle Tree Creek (up to 2019) both show a plateau in scores beginning in 2016 and then slight decline into 2019. In 2020 Flying Fox Creek then recorded an increase in TSR in 2020. Changes in TSR tended to be more pronounced in the 2018 and 2019 years, this may be attributed to the drought occurring in these years and 2018 being represented by a single autumn season of monitoring only. Wattle Creek and Morans Gully show similar patterns of change in TSR over time and comparatively similar TSR values. Broadly

speaking, the control sites reflect overall patterns observed at the impact sites, however it is noted that there are fine scale differences for all sites and that the same broad patterns are not necessarily seen at both impact or both control sites.

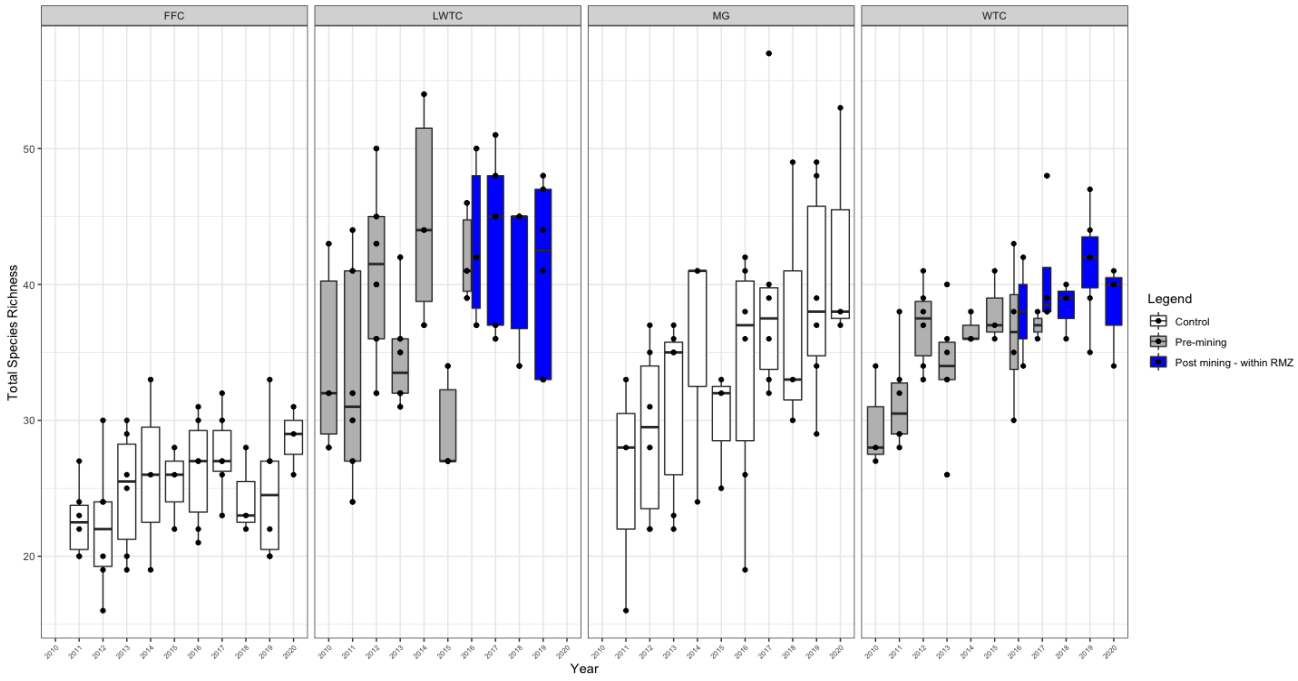


Figure 8 Boxplots of total species richness for each site, over time

When considered separately minor variations in the pattern of change among all sites can be observed. For example, differences can be observed between patterns of change at the Flying Fox Creek and Moran's Gully control sites. When the pre / post pattern of change is considered individually at the impact monitoring sites, Little Wattle Creek appears to show a trend of somewhat reducing TSR between 2017 and 2019 whereas Wattle Tree Creek is more variable. This trend at Little Wattle Creek would likely be attributed to the drought that has occurred during the same period, with site Little Wattle Creek appearing to be more reliant on surface water than Wattle Tree Creek and therefore likely to be subject to a greater degree of impact from the drought. This may indicate that while all sites are generally comparable, fine scale differences in conditions or processes may be operating at each site.

Generalised linear mixed model analysis

The results of GLMMs which were fit to the TSR data for sites within the Nebo Area are presented in Table 3. AIC is the Akiake's Information Criteria, and dAIC is the difference in AIC when compared to the model with the lowest AIC. The Additive model (M3) was the best fit for the data (lowest AIC). Indicating that both treatment (i.e., 'control' and 'impact') and year effects might influence the TSR in the creeklines surveyed. Based on M3 (Table 3), it is concluded that the yearly increase in TSR across all creeklines is very small (estimate = 0.03, SE = 0.004) but statistically significant at the α =0.05 level (p-value <0.001). Also, the impact creeklines have a slightly higher TSR than control creeks (estimate = 0.26, SE = 0.111, p-value = 0.02). However, there was moderate model selection uncertainty, as the next best fitting model (M4 – Interaction model) which included a treatment and year interaction effect, and the third model (M2 – Year model) which included only a year effect, both had a difference in AIC of less than 2, suggesting these three models (M2, M3 and M4) are essentially equivalent (Burnham and Anderson, 2003).

Table 3 Model results for the GLMM fit to the TSR data

Model	Df	AIC	dAIC
M3 - Additive model (Difference between impact and control sites with the additive effect of year)	4	1559.16	0.0
M4 - Interaction model (Year effect that changes depending on whether site is an impact or control site)	5	1559.65	0.49
M2 - Year model (Year effect only)	3	1560.66	1.50
M5 – Treatment (Difference between impact and control site)	3	1585.52	26.36
M6 – Season (Difference between autumn and spring data collection)	3	1602.77	43.61
M1 – Pre/post model (Difference between pre- and post-treatment)	3	1608.78	49.62
M0 - Null model (No change in TSR between impact and control sites, across year, or pre- and post-impact)	2	1609.92	50.76

The results suggest that while there may be a difference in pre / post mining data, or between control and impact site data, 'year' is the major contributor to all best fitting models identified (pers. comm Joanne Potts). This is supported in the other statistical outputs, with M2 (year model) being one of the equivalent models of best fit, whereas the M5 – Pre / post model (difference between pre- and post-mining data alone) and M1 – Treatment model (difference between control and impact sites alone) are not among these best fitting models.

3.3.2 Species composition

A large number of unique species were detected at each creek, the lowest being 102 at Flying Fox Creek and the highest being 157 at Little Wattle Tree Creek. The percentage of species that were detected only once, expressed as a proportion of the total number of species detected at each site, was low in the impact sites (14 % at Wattle Creek and 15.2 % at Little Wattle Tree Creek) and comparatively higher at the control sites (29.4 % at Flying Fox Creek and 17.4 % at Morans Gully). The results of the multivariate model analysis for species composition are presented in Table 4.

Table 4 Multivariate model summary results for riparian vegetation survey data

Site	Test	ANOVA test of full model	
		Wald value	Pr(>wald)
FFC	**Year**	12.997963	0.001
	Season	7.488593	0.204
MG	**Year**	19.41117	0.001
	Season	11.99970	0.001
LWTC	**Year**	15.500741	0.001
	Pre / post	9.150502	0.023
WTC	**Year**	19.64731	0.001
	Pre / post	11.10615	0.031

A yearly-trend was statistically significant at all creeks, regardless of whether it was a control or impact site (all p-values < 0.05). This is in line with the result of previous years of the monitoring program and it is reasonable to expect some natural turnover of species at sites each season and across years.

A pre / post mining effect was also found to be significant at both Wattle Creek and Little Wattle Tree Creek impact monitoring sites (Table 4), although at a lower significance level than the yearly effect. It is noted that the species composition analysis does not test for differences on a control and impact site basis, only pre and post effect.

The key species identified as changing at impact monitoring sites as part of the most significant yearly change (no mining effect) analysis are provided in Table 5 below. All of these species are shrub or small tree species typically found in rainforest or wet schlerophyll forest and may be associated with streams, all of which have been identified as increasing in their proportion. The exception to this is the herbaceous *Hydrocotyle peduncularis* at Little Wattle Creek, which has seen a proportional decrease.

Table 5 Key species identified as changing in flora composition at impact monitroing sites

Impact site	Species	Wald test statistic	P-value	Proportion before impact	Proportion after impact
LWTC	*Coprosma quadrifida*	3.1	0.01	0.47	0.78
LWTC	*Diospyros australis*	3.29	0.01	0.50	1.00
LWTC	*Hydrocotyle peduncularis*	3.05	0.02	0.80	0.11
LWTC	*Pittosporum multiflorum*	3.42	0.002	0.13	0.67
WTC	*Backhousia myrtifolia*	3.24	0.03	0.35	0.50
WTC	*Diospyros australis*	3.29	0.025	0.68	0.97
WTC	*Myrsine howittiana*	3.57	0.006	0.52	0.86

3.4 Field observations

Field observations noted a seasonal variation in the presence of newly germinating rainforest mid storey species and vines such as *Elaeodendron australe,* Native quince *Alectryon subcinereus* and Wonga Wonga Vine *Pandorea pandorana* subsp. *pandorana* were observed during the survey period. Whilst large proportions of seedlings have the potential to succumb to senescence eventuating death in their early developmental stages, the observed seedling reduction of the afore mentioned growth forms can be primarily attributed to opportunistic herbivory of feral ungulate populations within the study areas.

Minor surface and rill erosion occurrences were also evident within the survey areas. Whilst a distinct loss in vegetative cover was not observed, the noted soil disturbance can be attributed to localised increased water flows and natural processes within the two sub catchment areas.

4 Discussion

The following section discusses the results of the 2020 terrestrial ecological monitoring program in the context of all years of ecological monitoring completed to date and with specific reference to the relevant TARPs. An assessment against the relevant TARP trigger levels on the basis of this discussion is made in section 5.

4.1 Amphibian monitoring

The results of the amphibian monitoring do not indicate any differences between the impact and control monitoring sites in autumn 2020, or in any previous years of monitoring. Although the number of species detected in autumn 2020 was low, this is attributed to the necessity of monitoring being completed under 'winter-like' conditions. These low numbers are comparable to previous monitoring events that have taken place under similar conditions. As such these data do not indicate any impacts at Wattle Creek as a result of mining.

4.2 Riparian vegetation monitoring

The riparian vegetation monitoring has identified three significant differences in the floristic dataset in 2020.

Total species richness

The TSR analysis found that the Additive model was the best for to the data, indicating that both treatment (i.e., 'control' and 'impact') and year effects might influence the TSR in the creeklines. However there was moderate model uncertainty with the Interaction (treatment and year interaction effect) and Yearly models (year effect only) being essentially equivalent with the Additive model.

While these findings indicate that the yearly increase in TSR across all creeklines is very small but statistically significant, they do not necessarily indicate that it is as a result of mining as the results also found the yearly effect alone to be essentially equivalent with these models that combine the yearly effect with treatment or pre-post effects. The TSR analysis specifically addresses the floristic data on the basis of treatment (control and impact sites) as well as pre / post mining. When these factors are considered alone, neither model was found to be best fitting to the data. When taken together, these findings suggest that it is the yearly effect that is the primary factor explaining change in TSR among the sites surveyed.

Species composition

A yearly-trend was statistically significant at all control and impact creeks, in line with the results of previous years of the monitoring program and TSR findings detailed above. It is reasonable to expect some natural turnover of species at sites each season and across years, in particular give the period of extended drought that has occurred in recent years.

A pre / post mining effect was also found to be significant at both Wattle Creek and Little Wattle Tree Creek impact monitoring sites, although at a lower significance level than the yearly effect. This is the first time that the pre / post effect has been recorded as significant, although it has been increasing in recent years. It is noted that the statistical analysis for species composition does not test on a treatment (control vs impact) basis. This finding is discussed in the context of all other monitoring collected to date below.

Evaluation of significant change in the context of all monitoring

To date no impacts associated with mining have been detected as part of the EoP reports, aquatic or terrestrial ecological monitoring programs. As such, it is important to consider the significant finding of pre-post change at the impact monitoring sites in the riparian vegetation analysis, in the context of previous assessments and monitoring. In order to determine whether they represent impacts or if there may be confounding factors at play.

The following monitoring findings do not indicate any impacts associated with mining have occurred:

- The EoP reports did not identify the exceedance of any TARP triggers relevant to ecological features, surface water or groundwater during extraction between June 2013 and March 2019 across all longwalls (section 1.2).
- Surface water and groundwater monitoring data that has continued into early 2020 has been examined by Wollongong Coal and does not indicate any water loss associated with mining (pers. comm Sasa Cugalj 17/10/2020).
- To date no impacts through the amphibian monitoring have been detected.
- The aquatic ecological monitoring program has not detected any impacts to stream health throughout the annual monitoring completed to date, including in 2020 (Biosis 2020).
- No visual observations of any impacts such as surface deformation, acute water loss or high levels of flocculant have been recorded during field surveys as part of the aquatic or terrestrial ecological monitoring programs.

It is anticipated that if impacts associated with longwall mining were to manifest, they would be detected in one or more of these other monitoring methodologies. When taken together these factors suggest that the pre-post change in species composition detected may be reflective of factors other than mining.

It is noted that the baseline data collection period between 2010 and 2016 took place under years of generally average or above average rainfall conditions (section 3.1). As such, any baseline vegetation community responses to extended drought conditions at each site are not understood. Therefore it is difficult to evaluate the monitoring data collected under drought conditions in comparison to baseline conditions. It is clear from both the TSR and species composition analysis that the vegetation communities at all sites are subject to annual change regardless of any mining effect. It has also been noted that the TSR data may indicate fine scale differences in site conditions or processes operating at these sites which suggest the potential of these sites to respond differently to environmental change.

Field observations made during autumn 2020 identified evidence of grazing activity by feral ungulates and minor surface erosion from natural processes. No observed deterioration in vegetation, or impacts associated with longwall mining were observed.

Overall the data indicate that yearly effect is the strongest factor driving change detected in the total species richness and species composition detected at the impact monitoring sites. In consideration of the factors described above, it is concluded that the pre-post significant difference in community composition detected at the impact sites in 2020 is attributed to responses to environmental change rather than as a result of longwall mining. This is supported by the absence of impacts associated with mining being detected in aquatic or amphibian monitoring, groundwater and surface water monitoring and observational monitoring.

5 Assessment against Trigger Action Response Plans

Table 6 Assessment against Longwalls N1-N6 amphibian trigger levels (Niche 2012)

Trigger	Assessment against trigger levels
Normal	
No change as compared to baseline observed	**Consistent:** • The autumn 2020 amphibian species richness results are within the range of results recorded at the control sites collected in the same year (Wattle Creek only) and within the range of results previously recorded as part of the monitoring program. The results are considered nominal for these systems under the environmental conditions at the time of survey.
Within prediction	
Survey results within baseline variability	**Not triggered**
Exceeds prediction	
Observed physical impacts to habitat. **Statistically significant decrease in population numbers and/or species composition against baseline**	**Not triggered**

Table 7 Assessment against Longwalls N1-N6 riparian vegetation trigger levels (Niche 2012)

Trigger	Assessment against trigger levels
Normal	
No change as compared to baseline observed	**Not triggered**
Within prediction	
Survey results within baseline variability	**Consistent:** • Assessment of site-based vegetation monitoring TSR data indicates that the yearly model (no mining effects), additive model and interaction models are best fit to the data and are essentially equivalent. When considered alone the treatment and pre / post mining models are not best fit to the data. It is concluded that yearly effect is the primary factor explaining change in TSR among the sites. • A statistically significant change in species composition based on 'yearly' change (no mining effect) alone was identified at all impact and control monitoring sites. • A less statistically significant change was detected at the impact monitoring sites on the basis of pre-post mining comparison for the first time during the monitoring program.

Trigger	Assessment against trigger levels
	• Baseline data was collected during years of approximately average or above average rainfall making comparisons of data collected under extended drought conditions difficult. No change had been detected in aquatic or amphibian ecological monitoring, groundwater and surface water monitoring and observational monitoring throughout the programs. The significant pre-post change in species composition is therefore attributed to environmental change not as a result of mining.
Exceeds prediction	
Observed deterioration in vegetation health against baseline surveys	**Not triggered:** no observations of deteriorating vegetation health have been made.
Significant change/ decline in cover - abundance against baseline surveys.	**Not triggered:** TSR data suggest that it is the yearly effect that is the primary factor explaining change in TSR. When considered alone, neither treatment nor pre-post comparisons were best fit to the data.
Statistically significant change in species composition against baseline surveys	**Not triggered:** • A statistically significant change in species composition based on 'yearly' change (no mining effect) alone was identified. • A less statistically significant change was detected at the impact monitoring sites on the basis of pre-post mining comparison for the first time during the monitoring program. • Baseline data was collected during years of approximately average or above average rainfall making comparisons of data collected under extended drought conditions difficult. No change had been detected in aquatic or amphibian ecological monitoring, groundwater and surface water monitoring and observational monitoring throughout the programs. The significant pre-post finding is therefore attributed to environmental change not as a result of mining.

6 Conclusions

The monitoring data collected in autumn 2020 adds to the existing baseline dataset to provide a total of 17 seasons of terrestrial monitoring data between 2010 to 2020. The trends identified in previous iterations of the terrestrial ecological monitoring program are largely consistent with those observed during the recommencement of mining in the Nebo Area, continuing through to the autumn 2020 monitoring period.

An assessment against the TARP levels developed for Longwalls N1-N6 (Niche 2012) are provided in section 5. No impacts associated with mining have been identified as part of the terrestrial ecological monitoring program for the autumn 2020 monitoring period. No changes were observed when compared to baseline in the autumn 2020 data for amphibians, as such the site conditions are considered to align with the description of '*Survey results within baseline variability*' and as such fall into the '*Normal*' TARP level.

'Year' has been identified as the key factor explaining significant change in TSR and in species composition. While 'pre-post' change was also found to be significant for species composition analysis at the impact sites this is attributed to environmental change rather than mining. This is in consideration of the lack of impact detected in any other monitoring (including groundwater and surface water monitoring) and any observations of deterioration in the vegetation present. Although comparisons to baseline data are limited by the fact that these data were collected under average or above average rainfall, the data indicate that the sites align the '*Within Prediction*' TARP level.

Extraction from Panels N5 and N3 ceased in January and March 2019, respectively. With extraction from other Panels within the Nebo area being completed previous to 2019. As such, the autumn 2020 round of monitoring is the last season required to fulfil the minimum monitoring duration of one year post-mining, as part of the requirement for a *'minimum of one year post-mining (in consultation with key regulators) for Panels N3 and N4 as per the NRE Wongawilli Colliery Nebo Longwalls N1-N6 Extraction Plan*' (Niche 2012).

References

Analytical Edge Statistical Consulting 2020. Analysis of Nebo flora data for Biosis. Final report 06 November 2020. Author: Joanne M. Potts. Analytical Edge Statistical Consulting.

Biosis 2014. Nebo Longwall N2. End of Panel Report (Ecology). Report for Wollongong Coal Ltd. Authors: Misdale M, Cooper J, & Steelcable A. Biosis Pty Ltd. Project no. 18792

Biosis 2017. Nebo Area – Longwall N4: End of Panel Report (Ecology). Report for Wongawilli Coal Pty Ltd Authors: Misdale M & Cable A, Biosis Pty Ltd, Wollongong. Project no. 25100

Biosis 2019a. Nebo Area – Longwall N1: End of Panel Report (Ecology). Report for Wollongong Coal Pty Ltd Authors: Baus A & Cable A, Biosis Pty Ltd, Wollongong. Project no. 29884

Biosis 2019b. Nebo Area – Longwalls N3 and N5: End of Panel Report (Ecology). Report for Wollongong Coal Pty Ltd Authors: Baus A & Cable A. Biosis Pty Ltd, Wollongong. Project no. 30380

Biosis 2020. Nebo aquatic ecological monitoring program. Report for Wongawilli Coal. Biosis Pty Ltd, Wollongong.

Bolker, BM, Brooks, ME, Clark, CJ, Geange, SW, Poulsen, JR, Stevens, MH and White, JS 2009. Generalized linear mixed models: a practical guide for ecology and evolution. Trends in Ecology and Evolution, 24(3): 127–135.

Department of Planning 2008. Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield Strategic Review. NSW Department of Planning, Sydney.

DTIRIS 2013. Subsidence Management Plan Approval – NRE Wongawilli Colliery Nebo Longwalls N1-N6, (dated 25 January 2013, file no. 09/5341).

GeoTerra 2014. Nebo Colliery End of Panel N2 Surface Water and Groundwater Report. Wollongong Coal LTD. Wollongong, NSW. NEB4-R1A.

GeoTerra 2018. Nebo Colliery End of Panel N4 Surface Water and Groundwater Report. Wollongong Coal LTD. Wollongong, NSW. NEB5-R1A.

GeoTerra 2019a. Nebo Colliery End of Panel N1 Surface Water and Groundwater Report. Wollongong Coal LTD. Wollongong, NSW. NEB6-R1A.

GeoTerra 2019b. Nebo Colliery End of Panel N3 Surface Water and Groundwater Report. Wollongong Coal LTD. Wollongong, NSW. NEB6-R1A.

GeoTerra 2019c. Nebo Colliery End of Panel N5 Surface Water and Groundwater Report. Wollongong Coal LTD. Wollongong, NSW. NEB6-R1A.

Niche 2012. NRE Wongawilli Colliery Nebo Longwalls N1-N6 Extraction Plan. Prepared by Niche Environment and Heritage Illawarra/Southern NSW on behalf of Gujarat NRE FCGL Pty Ltd.

Underwood, 1991. Beyond BACI: Experimental designs for detecting human environmental impacts on temporal variation in natural population. Australia Journal of Marine Freshwater Research. 42: 569-687.

Appendix 1 - Trigger Action Response Plans

Table 8 Trigger Action Response Plan (TARP) table for Longwalls N1-N6 (Niche 2012)

Feature	Monitoring Program			TARPs	
	Prior to Mining	During Mining	Post mining and Future Monitoring	Trigger	Response
Riparian vegetation					
3 Monitoring sites on Wattle Creek **3 Monitoring sites on Little Wattle Tree Creek** **6 Reference sites**	Species inventory and modified Braun Blanquette cover - Abundance for each species. At least once prior to mining (conducted Autumn and Spring).	Species inventory and modified Braun Blanquette cover - Abundance for each species. Autumn and spring during entire extraction period. Started for LWTC, not started for WTC.	Species inventory and modified Braun Blanquette cover - Abundance for each species. Autumn and Spring for a minimum of one year post-mining (in consultation with key regulators). Not started.	**NORMAL** No change as compared to baseline observed **WITHIN PREDICTIONS** Survey results within baseline variability **EXCEEDS PREDICTIONS** Observed deterioration in vegetation health against baseline surveys Significant change/ decline in cover - abundance against baseline surveys. Statistically significant change in species composition against baseline surveys	Continue monitoring Report in end of panel report Continue monitoring Report in end of panel report Notification to SCA/DP&E/OEH immediately Proposal for management within 1 week if required Completion of management task following approval from agencies Additional monitoring as required by the relevant government agencies Report in end of panel report Reporting in Incident Reports and Annual Reviews

Feature	Monitoring Program			TARPs	
	Prior to Mining	During Mining	Post mining and Future Monitoring	Trigger	Response
Amphibians					
3 Monitoring sites on Wattle Creek 3 Monitoring sites on Little Wattle Tree Creek 6 Reference sites	Baseline ecological assessment. Observational monitoring–50 m nocturnal stream searches and tadpole surveys at three locations 150-200m apart along Wattle Creek and Little Wattle Tree Creek conducted Autumn and Spring. Baseline monitoring completed LWTC, ongoing WTC. Targeted Threatened Amphibian searches each Winter along Wattle Creek and Little Wattle Tree Creek.	Observational monitoring – 50 m nocturnal stream searches and tadpole surveys at three locations 150-200m apart along Wattle Creek and Little Wattle Tree Creek conducted Autumn and Spring during entire extraction period. Completed LWTC, not started WTC. Targeted Threatened Amphibian searches each Winter along Wattle Creek and Little Wattle Tree Creek. Not required.	Observational monitoring– Autumn and Spring for a minimum of one year post-mining (in consultation with key regulators). Not started. Targeted Threatened Amphibian searches in Winter period for a minimum of one year post-mining (in consultation with key regulators). Not required.	**NORMAL** No change as compared to baseline observed **WITHIN PREDICTIONS** Survey results within baseline variability **EXCEEDS PREDICTIONS** Observed physical impacts to habitat. Statistically significant decrease in population numbers and/or species composition against baseline	Continue monitoring Report in end of panel report Continue monitoring Report in end of panel report Notification to SCA/D&PE/OEH immediately Proposal for threatened species management within 1 week if required Completion of management task following approval from agencies Additional monitoring as required by the relevant government agencies Report in end of panel report Reporting in Incident Reports and Annual Reviews

Appendix 2 - Monitoring survey periods and survey dates

Table 9 Monitoring survey periods and monitoring survey dates

Period	Riparian vegetation	Amphibians
Spring 2010	01/10/10 (spring)	07/12/10 – 08/12/10 (spring - summer)
Autumn 2011	01/04/11 (autumn)	07/03/11 – 19/05/11 (autumn)
Spring 2011	01/10/11 (spring)	01/10/11 – 06/12/11 (spring – summer)
Autumn 2012	01/04/12 (autumn)	26/03/12 – 23/05/12 (autumn)
Spring 2012	09/11/12 – 14/11/12 (spring)	04/10/12 – 22/11/12 (spring)
Autumn 2013	12/04/13 – 07/06/13 (autumn)	14/03/13 – 20/05/13 (autumn)
Spring 2013	03/12/13 – 12/12/13 (spring – summer)	20/05/13 – 03/12/13 (spring – summer)
Autumn 2014	05/05/14 – 06/05/14 (autumn)	17/03/14 – 06/05/14 (autumn)
Spring 2014	-	-
Autumn 2015	-	-
Spring 2015	02/10/15 – 14/10/15 (spring)	15/10/15 – 26/11/15 (spring)
Autumn 2016	17/03/16 – 18/03/16 (autumn)	16/03/16 – 23/03/16 (autumn)
Spring 2016	23/01/17 – 27/01/17 (summer)	21/12/16 – 13/01/17 (summer)
Autumn 2017	25/05/17 – 26/05/17 (autumn)	25/05/17 – 30/05/17 (autumn)
Spring 2017	10/01/18 - 18/01/18 (summer)	23/01/18 – 25/01/18 (summer)
Autumn 2018	-	23/07/19 – 26/07/19 (winter)
Spring 2018	29/01/19 – 01/02/19 (summer)	-
Autumn 2019	17/04/19 – 30/04/19 (autumn)	11/06/19 – 13/06/19 (autumn – winter)
Spring 2019	05/09/19 – 11/09/19 (spring)	10/10/19 - 19/11/19 (spring)
Autumn 2020	02/06/20 – 11/06/20 (winter)	16/06/20 – 23/06/20 (winter)

APPENDIX B - BIOSIS NEBO AQUATIC ECOLOGICAL AUTUMN 2020 REPORT

Nebo aquatic ecological monitoring program: Autumn 2020 report

FINAL REPORT

Prepared for Wollongong Coal Ltd

18 December 2020

Biosis offices

NEW SOUTH WALES

Albury
Phone: (02) 6069 9200
Email: albury@biosis.com.au

Newcastle
Phone: (02) 4911 4040
Email: newcastle@biosis.com.au

Sydney
Phone: (02) 9101 8700
Email: sydney@biosis.com.au

Wollongong
Phone: (02) 4201 1090
Email: wollongong@biosis.com.au

VICTORIA

Ballarat
Phone: (03) 5304 4250
Email: ballarat@biosis.com.au

Melbourne
Phone: (03) 8686 4800
Email: melbourne@biosis.com.au

Wangaratta
Phone: (03) 5718 6900
Email: wangaratta@biosis.com.au

Document information

Report to:	Wollongong Coal Ltd
Prepared by:	Luke Stone
Biosis project no.:	33318

File name: 33318.Nebo.AquaticEcology.Autumn2020.FIN01.20201102

Citation: Biosis 2020. Nebo aquatic ecological monitoring program: Autumn 2020 report. Report for Wollongong Coal. Biosis project no. 33318.

Document control

Version	Internal reviewer	Date issued
Draft version 01	Jane Raithby-Veall	02/10/2020
Final version 01	Luke Stone	18/12/2020

Acknowledgements

Biosis acknowledges the contribution of the following people and organisations in undertaking this study:

- Sasa Cugalj of Wollongong Coal Ltd

Biosis staff involved in this project were:

- Samantha McCann (assistance in the field)
- Anne Murray (mapping)

Contents

Tables

Figures

Summary

This document reports on the Nebo aquatic ecological monitoring program during the autumn 2020 monitoring period, in the context of previous monitoring data collected since autumn 2011.

Baseline monitoring of impact sites within the Nebo Area commenced in spring 2010 and monitoring at paired control sites commenced as early as autumn 2011. Following the completion of Longwall N2 in February 2014, Wongawilli Coal discontinued mining in the Nebo Area. Subsequently, all related terrestrial ecological monitoring ceased, on the condition from the regulator that baseline monitoring was to restart six months prior to the recommencement of mining. In addition, data analysis should not show a significant change in condition over the intervening period. Baseline monitoring within the Nebo Area recommenced in spring 2015, ahead of the proposed extraction of Longwall N4, which commenced in August 2016. Data collected and presented herein represents the findings of the monitoring undertaken in autumn 2020, which is compared to previous years of monitoring and represent post/during mining findings at impact sites.

The findings of the aquatic ecological monitoring program identified a variable but generally high level of taxonomic diversity within the aquatic ecological communities occurring within the Nebo Area, across all creeks surveyed. Water quality among impact sites ranged between fair and very poor across the autumn 2020 monitoring period, demonstrating broad consistency with previous monitoring results and between impact and monitoring sites. Minor variations observed in the data are attributed to environmental variability at the time of sampling, not underground coal mining, given the results are within the range of results previously recorded for the sites and comparable results were recorded between the control and impact monitoring sites. Further, no leachate or changes in flow regime were observed during the monitoring period at any of the sites. Broadly speaking there was a relative increase detected in all stream health measures in autumn 2020 when compared to the most recent spring 2019 surveys during the peak of the drought. This relative increase is attributed to the elevated flow and water levels improving the condition and availability of aquatic habitats across the monitoring sites, as a result of rainfall occurring between the two survey periods.

The trends identified in autumn 2020, and in previous iterations of the aquatic ecological monitoring programs are consistent with those observed during the recommencement of mining in the Nebo Area.

The monitoring results for autumn 2020 are deemed to be consistent within the 'NORMAL' Trigger Action Response Plan (TARP) level for longwalls N1 to N6 (Niche 2012) as no impact monitoring sites recorded results below the defined trigger values for supplementary investigation. As such, no additional investigation is required. The completion of aquatic monitoring in the autumn 2020 monitoring period fulfils the minimum post-mining TARP monitoring requirements for longwalls N3 and N5.

1 Introduction

1.1 Project context

On 16 July 2009 Wongawilli Coal (previously Gujurat NRE – Wonga Pty Ltd) received Project Approval from the *NSW Department of Planning and Infrastructure* under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to extract coal from the Wongawilli seam (MP09_0161). A variation to include mining of Longwalls N1 to N6 within Nebo Colliery (hereafter referred to as the Nebo Area) was approved on 2 November 2011. An Extraction Plan was developed to satisfy the requirements of Schedule 3, Condition 7 (h) and (i) of the Project Approval. This plan, includes a Subsidence Management Plan (SMP) required by the Division of Resources and Energy (DRE), NSW Trade and Investment that addresses Schedule 3 Condition 7 (e) and (f) of the Project Approval for the ecological monitoring programs.

The Nebo Area includes natural features located above and within the 400 metre Risk Management Zones (RMZ) of Panels N1 through to N6. The impact sites included in the Nebo monitoring programs fall within the RMZ of Panels N3, N4 and N5. Mining completed to date includes the extraction of coal from:

- Panel N1 from May 2017 to September 2018.
- Panel N2 from June 2013 to February 2014.
- Panel N3 from October 2016 to March 2019.
- Panel N4 from August 2016 to May 2017.
- Panel N5 from March 2017 to January 2019.

Biosis understands that the planned extraction from Panel N6 will now not take place.

Aquatic ecological monitoring in the Nebo lease area commenced in autumn 2011 in order to collect pre-mining monitoring data, which also included the assessment of four control sites. Following the completion of Longwall N2 in February 2014, Wongawilli Coal discontinued mining in the Nebo Area. Subsequently, the Nebo aquatic ecological monitoring program was scaled back to the final post mining phase during the 2014/2015 financial year. As Wollongong Coal recommenced mining of the Nebo longwalls in early 2016, the aquatic ecological monitoring program has continued up to autumn 2020. Biosis understands that the Nebo aquatic ecological monitoring program is not required beyond this season and has fulfilled Wollongong Coal's minimum requirements regarding aquatic ecological monitoring.

1.2 Monitoring plan aims and objectives

The aim of Nebo Aquatic Ecological Monitoring Program is to identify any changes in the relative condition of aquatic ecological values during and post mining activity. It is a component of the biodiversity monitoring activities that conform to the instrument of approval within the Nebo Longwalls N1-N6 Subsidence Management Plan Approval (DTIRIS, 2013) and NRE Wongawilli Colliery – Nebo Area Project Approval (MP09_0161). The adopted Trigger Action Response Plans (TARPs) (Niche 2012) for the Nebo Area require monitoring and impact assessment to be undertaken for a minimum of one year following the completion of mining activities (Appendix 1). If an impact is detected, post-mining monitoring may be required to be collected for a period determined to be satisfactory by WaterNSW and NSW Environment, Energy and Science (formerly Office of Environment and Heritage).

This report provides a summary of the results of the autumn 2020 (final) season of the Nebo Aquatic Ecological Monitoring Program. The objectives of this monitoring report are to:

- Describe aquatic monitoring undertaken in the Nebo area up to and including the 2019 calendar year of the monitoring program.
- Present the monitoring results recorded during 2019 in the context of the results of the program since its inception.
- Examine the potential impacts of subsidence on stream health and aquatic ecological communities in the Nebo Area.
- Relate the ecological monitoring results to the TARPs (Niche 2012) for Longwalls N1 to N5 (Appendix 2).

2 Study area

The Nebo Area is located within the Cordeaux Catchment to the south of Cordeaux Reservoir. The study area includes an area of land which may be subject to surface movements associated with subsidence above Longwalls N1 to N6 (within a 400 metre Risk Management Zone (RMZ) (Figure 1).

The geographical locations of impact sites in Nebo Area are outlined in Table 1 below. A review of monitoring locations undertaken in 2015 identified the need to establish an additional monitoring site on Cordeaux River, with Longwall N3 within the RMZ for this waterway. An additional monitoring reach (COR-AQ1) has been established within the vicinity of Long wall N3, to ensure that any subsidence related impacts can be detected once mining commences. With this additional monitoring reach first monitored in 2016. The number of monitoring sites has been reduced in the autumn 2020 monitoring report to only those required to identify any impacts associated with Panels N3 and N5 (for which extraction ceased in 2019) at the request of Wollongong Coal.

Table 1 Impact monitoring sites within the Nebo Area

Location Code	Description	MGA Easting	MGA Northing
WAC-AQ2	Wattle Creek	294219	6189422
WAC-AQ3	Wattle Creek	294513	6189602
WAC-AQ4	Wattle Creek Tributary	294635	6188936
WAC-AQ5	Wattle Creek	294956	6189640
WAC-AQ6	Wattle Creek	295328	6189840
COR-AQ1	Cordeaux River	295416	6188683

Control sites are located in those areas that will not be mined beneath as a part of any current operations, and serve to provide data against which the ecological values above the Nebo Area may be compared. The geographical locations of control sites previously used for the Nebo Area and monitored during the 2019 period are provided in Table 2 below.

Table 2 Control monitoring sites used for Nebo Area

Location Code	Description	MGA Easting	MGA Northing
KEC-AQ1	Kentish Creek	299369	6194246
KCT-AQ1	Kentish Creek Tributary	298816	6194572
MGC-AQ1	Moran's Gully Creek	297404	6190073
MEC-AQ1	Meemi Gully Creek	298000	6189831

Legend

Panel layout

Aquatic monitoring locations

Control

Impact

Figure 1 Aquatic monitoring sites

0 200 400 600 800 1,000

Metres

N

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 30270,
Date: 26 August 2020,
Checked by: LS, Drawn by: AEDM, Last edited by: amurray
Location: P:\33300s\33318\Mapping\33318_F4_AqMonitoring.mxd

00

3 Methods

The autumn 2020 field survey was undertaken by Luke Stone (Consultant Aquatic Ecologist) and Samantha McCann (Project Ecologist) between 03/07/20 and 10/07/20. These survey dates are outside of the prescribed autumn monitoring period (Turak et al. 2004), as such the AUSRIVAS predictive models have not been run for this report. Analyses instead focussed on the Signal2 and number of taxa scores that are not subject to this seasonal limitation and allow for some comparison to previous year's results.

HABSCORES were completed at each site to provide a relative measure of aquatic habitat health when the site is dry and no AUSRIVAS assessment can be completed. HABSCORE is a visually based habitat assessment that evaluates the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour et al. 1999).

HABSCORES range from Poor to Optimal condition and generally reflect the current category condition of the water resource. Categories are derived from the sum of scores divided by the sum of the characters assessed. This provides an ecological indicator that produces information on the water resource when conditions preclude AUSRIVAS and Signal scores (i.e. dry conditions). HABSCORE assessments are based on the presence and condition of the following features:

- Pool substrate characterisation
- Pool variability
- Channel flow status
- Bank vegetation (score for each bank)
- Bank stability (score for each bank)
- Width of riparian zone (score for each bank)
- Epifaunal substrate / available cover

The aquatic habitat within the study area was described in terms of four category types (Barbour et al. 1999). The four categories used to evaluate habitat value were Optimal, Suboptimal, Marginal or Poor, as detailed below:

Optimal: Watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.

Suboptimal: Watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought although, become greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.

Marginal: Watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.

Poor: Watercourses or drainages that only flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

3.1 Physiochemical and biological assessments

3.1.1 Water quality measurements

Physicochemical water quality variables were measured at each reach, approximately 30 centimetres (cm) below the surface, using a Horiba Multiparameter Water Quality Meter. Variables measured included pH, dissolved oxygen (DO), temperature, turbidity and electrical conductivity (EC). Alkalinity was measured using a Hach Alkalinity Kit. Water quality measurements are compared against guidelines recommended by ANZECC (2000) for the protection of aquatic systems in South-eastern Australia. As the project falls within the area controlled by the Water NSW (previously controlled by the Sydney Catchment Authority), water quality objectives set by the Water NSW (formerly Sydney Catchment Authority [SCA]) apply and are also referred to within the report. Water quality data is collected to support macroinvertebrate and habitat assessments and is not a stand-alone record of long term water quality monitoring.

The water quality readings are compared with ANZECC (2000) guidelines for upland streams (altitude ≥150 m) in south-eastern Australia and guidelines defined by SCA, for raw water supplied at the Nepean Water Filtration Plant (WFP) (Table 3). The Nepean WFP receives raw water from the Cataract, Cordeaux, Avon and Nepean dams for which the water quality limits of the area are defined. SCA water quality guideline benchmarks are used for pH and alkalinity, with the remainder measured against ANZECC values.

Table 3 Water quality guidelines of ANZECC (2000) and the SCA (now WaterNSW)

Water quality variable	ANZECC Guidelines	SCA Guidelines
pH	6.5 – 7.5	4.8 – 7.7
Electrical Conductivity (µS/cm)	30 - 350	-
Dissolved Oxygen (%)	90 – 110	-

3.1.2 Aquatic macroinvertebrate sampling

Aquatic macroinvertebrate samples were collected at each monitoring reach where water was present, according to the techniques described in the NSW AUSRIVAS Rapid Assessment Method developed by the NSW Environment Protection Authority (Turak et al. 2004). This method involves the collection of samples from two types of aquatic habitats (where possible) within a monitoring reach using two sampling techniques: slow-flowing river edges (dip-net technique) and fast-flowing riffles (kick-net technique). In this study only sufficient edge habitat was available for sampling according to the AUSRIVAS methodology.

Macroinvertebrates were live-picked from the samples while in the field, preserved in 70% ethanol and later transferred to a laboratory for identification. Macroinvertebrates were identified to family level with the exception of; Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily) as outlined in the NSW AUSRIVAS Sampling and Processing Manual (Turak et al. 2004). All macroinvertebrates were identified using the taxonomic keys and names listed in Hawking (2000).

3.1.3 Data analysis

The defined seasonal dates for macroinvertebrate sampling are autumn: 15 March to 15 June and spring: 15 September to 15 December (Turak et al. 2004). AUSRIVAS sampling may occur outside of the AUSRIVAS defined seasonal dates where weather for the season falls within acceptable conditions to allow the samples to be representative of the season (pers comm Jan Miller OEH). Where weather conditions are not representative of appropriate seasonal conditions AUSRIVAS analyses are not conducted and OE50 scores and Band ratings are not reported for those seasons. In these seasons (such as autumn 2020) the stream health analysis relies on the un-weighted Signal2 methodology outlined by Chessman (2003) and number of taxa scores, as these indices are not seasonally dependent and still provide a reliable indicator of macroinvertebrate diversity and water quality.

Signal2 Index

The Signal2 (Stream Invertebrate Grade Number Average Level) biotic index score (Chessman 2003a) applies a revised sensitivity grade to macroinvertebrate families and, based upon the original Signal grade (Chessman 1995) and is considered a more accurate grading. The index is derived from the sum of scores divided by the sum of abundances and is calculated by the AUSRIVAS model, provided as the O0Signal score. The Signal2 index describes the tolerance of macroinvertebrate taxonomic families to pollution. The index provides a comprehensive ecological indicator that produces an average Signal2 score (Table 4) for each monitoring site (as an indication of the macroinvertebrate community's overall tolerance to pollution or disturbance.

Table 4 Signal2 biotic index classification system

Signal2 score	Impairment	Water quality status
Greater than 7	Unimpaired and rich in sensitive taxa	Excellent water quality
6 - 7	Unimpaired	Good water quality
5 - 6	Mildly impaired	Fair quality, possible mild pollution
4 - 5	Moderately impaired	Poor quality
Less than 4	Severely impaired	Very poor water quality

Trigger values

Impacts to waterways arising from longwall mining result in distinct changes to aquatic environments resulting in introduction of leachates, smothering of habitat or distinct reduction in water level. The trigger values for macroinvertebrates have been developed considering this level of impact and the highly variable before and control site results. The trigger values, developed for initiating supplementary investigations, for macroinvertebrate data analysis are Signal2 scores less than four and a number of taxa at a monitoring reach below 10.

The stream health criteria were developed following the biplot method described by Chessman (2003b). The biplots can be divided into four quadrants which indicate the relative condition of waterways and are described below. The borders of quadrant 4 along the top and right hand side form the stream health criteria with any sites plotted within this quadrant being subject to further scrutiny and investigation.

Signal Score -→	Quadrant 3 Sites plotted within this quadrant are representative of typical water quality, however harsh site conditions may be prevalent e.g. low water	Quadrant 1 Sites plotted within this quadrant are representative of stream health being within the ranges typically observed within the locality.
	Quadrant 4 Sites plotted within this quadrant are representative of poor stream health and macroinvertebrate community composition.	Quadrant 2 Sites plotted within this are representative of typical species diversity however high levels of salinity or nutrients may be present in the water.
	Number of taxa -→	

3.2 Limitations

Ecological monitoring surveys should be undertaken during the programmed seasons and be consistent across years as far as practicable. Biosis has undertaken monitoring surveys as part of this monitoring program following the approval by Wollongong Coal. Survey dates for all monitoring periods are provided in Appendix 2. Interpretations of data that have been collected substantially outside the monitoring period must be treated with caution. As these data are likely to have been collected under considerably different seasonal conditions to the programmed seasons they are intended to represent. As such, these data may not be directly comparable to previous season's data or representative of the ecological biota that would be present during the programmed season. A considerable number of seasons of baseline data have been collected providing a comprehensive basis to interpret data that has been collected outside of the prescribed season. Interpretations are further supported by the use of observations regarding any impacts associated with mining, such as surface deformation, cracking, surface water loss or leachate.

The aquatic ecological monitoring program is not considered subject to any significant limitations. The survey effort, combined with information available from other sources, is considered suitable to assess the overall aquatic ecological values of the sites. The supplementary physiochemical water quality parameters measured provide a snapshot of conditions at the time of sampling. Some of these parameters typically exhibit a high degree of temporal variation and can change substantially over short periods of time, particularly in response to significant rainfall events. These parameters are used to inform the macroinvertebrate analyses only.

Aquatic ecological monitoring programs may be confounded by varying responses of aquatic biota responding to impacts or environmental conditions in differing ways. Therefore, monitoring and interpretation of data with a 'one size fits all' approach must be treated with caution. As such, a number of parameters including both qualitative and quantitative metrics are recorded to establish multiple lines of evidence to inform the interpretation of results. Biosis is committed to the continual review of our programs to provide options for improvement.

4 Results and discussion

4.1 Aquatic habitats

The HABSCORE assessments for each aquatic ecological monitoring season is presented in Figure 2. In 2019 HABSCORE's were typically reduced when compared to previous results, with the spring scores also showing a general reduction when compared to those recorded in autumn 2019.These scores reflect the decline in rainfall during this period reducing the condition and availability of aquatic habitats. The majority of monitoring reaches continued to score grades of 'Suboptimal' during the autumn 2020 monitoring period. This is consistent with previous iterations of the monitoring program and within the range of values expected under the prevailing catchment scale environmental conditions at the time of survey.

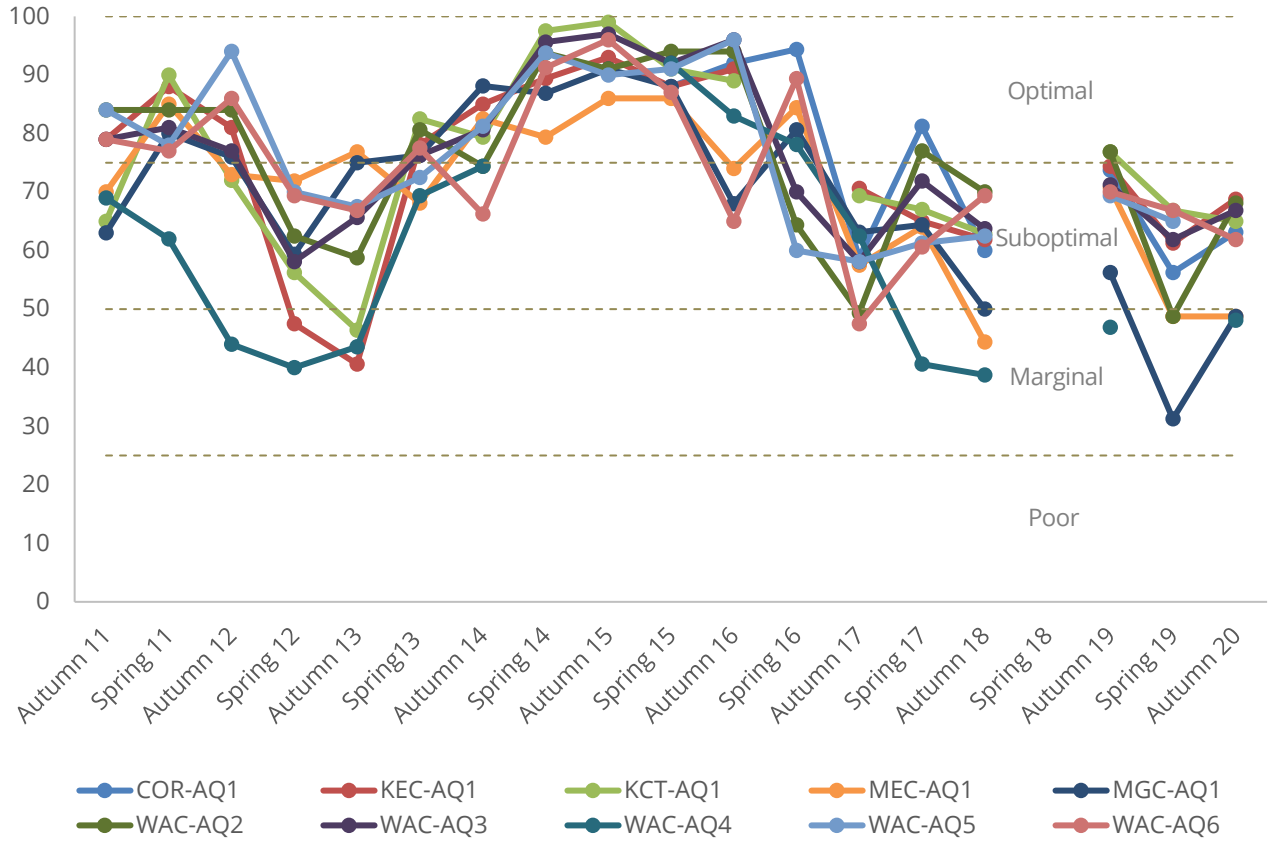


Figure 2 HABSCORE results for all monitoring periods

4.2 Water quality measurements

The key physicochemical water quality results collected during the autumn 2020 monitoring survey are presented in Table 5. Dissolved oxygen readings were outside of the relevant water quality guidelines for all monitoring sites. These readings are within the ranges of those previously recorded as part of the monitoring program, and as such are considered to be nominal for the locality. The very low pH readings recorded at a number of sites in spring 2019, compared to previous results, appear to have returned to more nominal conditions in autumn 2020. It was considered that the lower pH values were due to an increase in the relative influence of naturally low groundwater during the very dry conditions in spring 2019. This is supported by the

return to more nominal conditions in autumn 2020 following a relative increase in rainfall during the period between the two surveys. As these are recorded at control sites and impact sites it is inferred that these results are not associated with mining activities. The key physiochemical water quality readings are within the range of previous values recorded at these sites and are comparable between control and impact monitoring sites. As such, the results do not identify any acute water quality issues.

Table 5 Water quality readings collected during the autumn 2020 monitoring survey

Sites	pH	Electrical conductivity (µS/cm)	Dissolved oxygen (%)
Impact			
COR-AQ1	6.64	115	82.1
WAC-AQ2	6.73	131	88.7
WAC-AQ3	6.68	149	75.3
WAC-AQ4	6.57	199	63.9
WAC-AQ5	6.38	131	70.1
WAC-AQ6	6.62	129	86.6
Control			
KCT-AQ1	5.83	122	64.3
KEC-AQ1	5.65	121	71.2
MGC-AQ1	6.48	181	62.6
MEC-AQ1	6.37	187	65.3

4.3 Macroinvertebrate results

The results of macroinvertebrate data analysis for the autumn 2020 period are described in the following sections. Macroinvertebrate analysis results for all periods of monitoring are provided in Appendix 3.

Signal2 scores

Signal2 scores have been calculated for the recent monitoring seasons between autumn 2016 and spring 2019 where survey outside of the prescriptive AUSRIVAS seasonal conditions has occurred. These Signal2 scores are not restricted to these seasonal requirements and are presented in Figure 3 and Figure 4. When considered as a group, the Signal2 scores for autumn 2020 indicate a slight increase in water quality conditions when compared to spring 2019, tending to cluster in the Fair and Poor categories. However it is noted that the scores for autumn 2020 reflect relatively low scores when compared to those recorded between autumn 2016 and spring 2017. These trends are observed across both impact and control monitoring reaches, indicating that broad scale environmental influences are responsible for the relative declines in water quality, rather than any mining induced change.

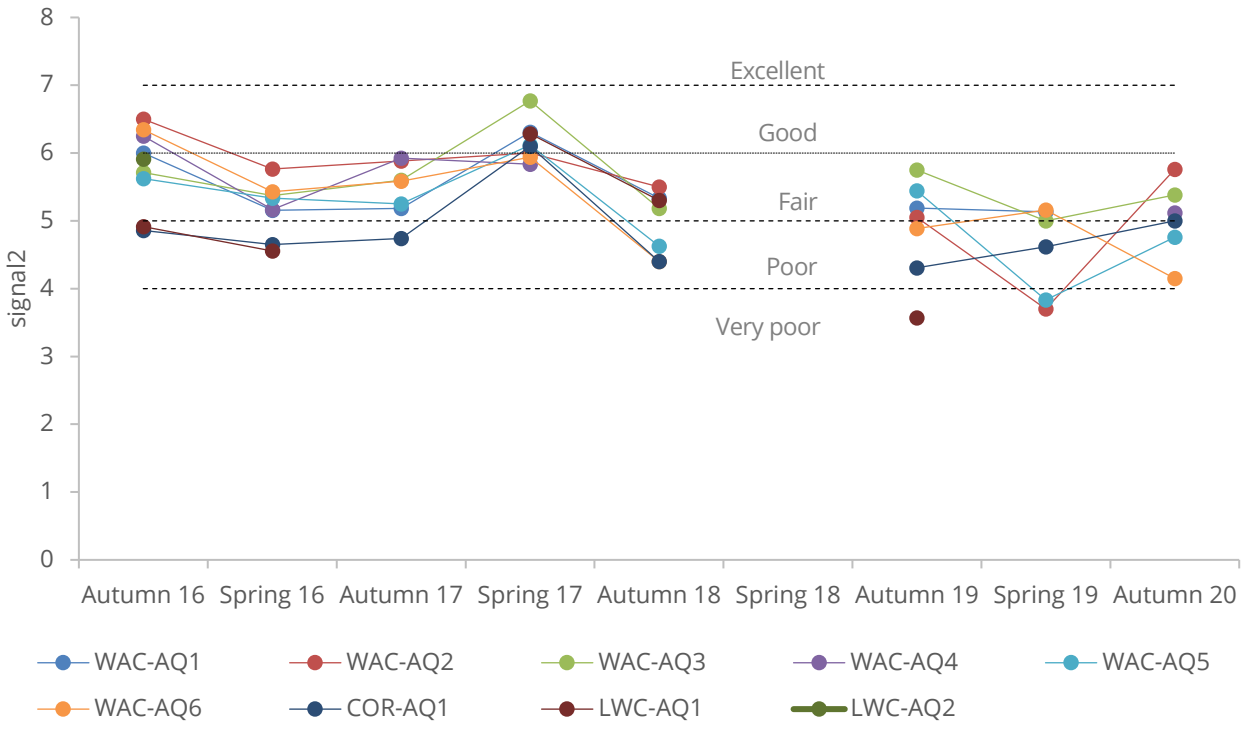


Figure 3 Signal2 scores for impact monitoring sites between autumn 2016 and spring 2019

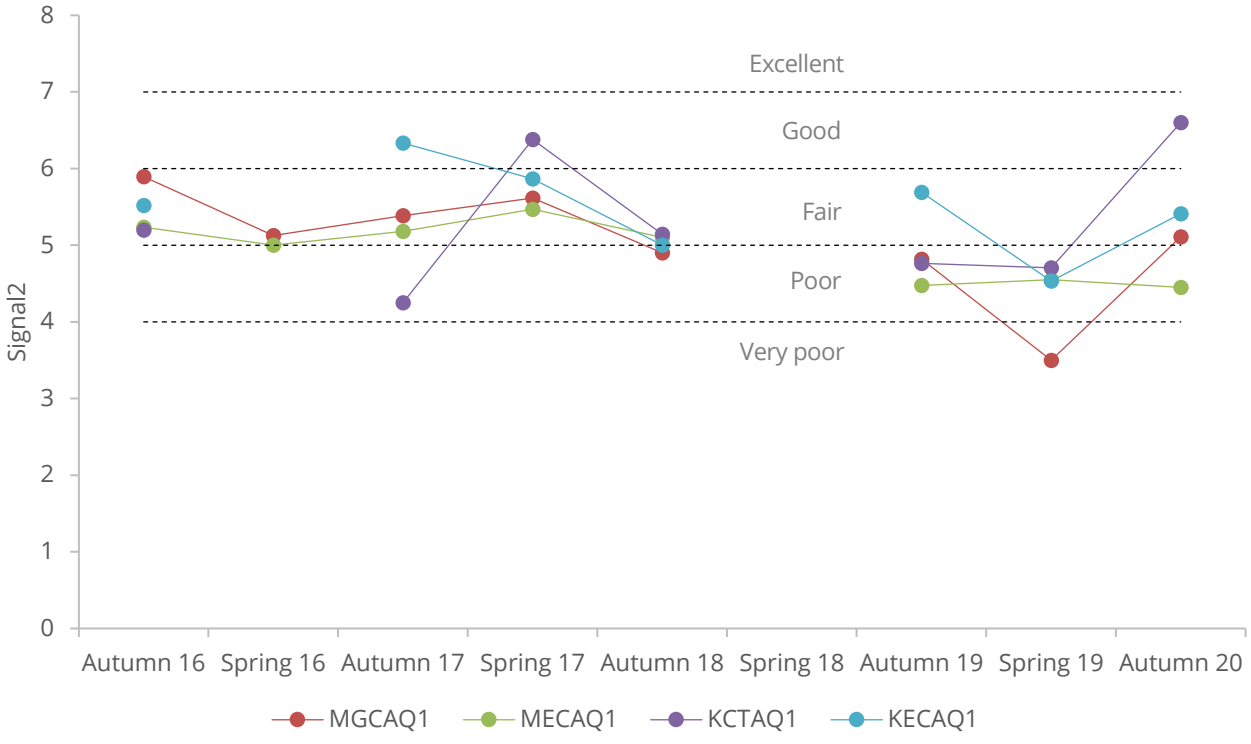


Figure 4 Signal2 scores for control monitoring sites between autumn 2016 and spring 2019

4.4 Trigger values

Trigger values have been defined on the basis of macroinvertebrate monitoring results recorded as part of the aquatic monitoring program, these are a number of taxa score of ten and Signal2 score of four. The assessment of the monitoring results of autumn 2020 are provided below.

In autumn 2020, the majority of monitoring sites fell within quadrant one of the biplot (Figure 5), indicating stream health conditions being within the ranges typically observed within the locality at these sites. Two control sites (KCT-AQ1 and MGC-AQ1) fell just outside of quadrant one, indicating slightly reduced stream health conditions at these sites in autumn 2020 when compared to those generally recorded in the locality. No monitoring sites fell into quadrant four and as such no further assessment is required.

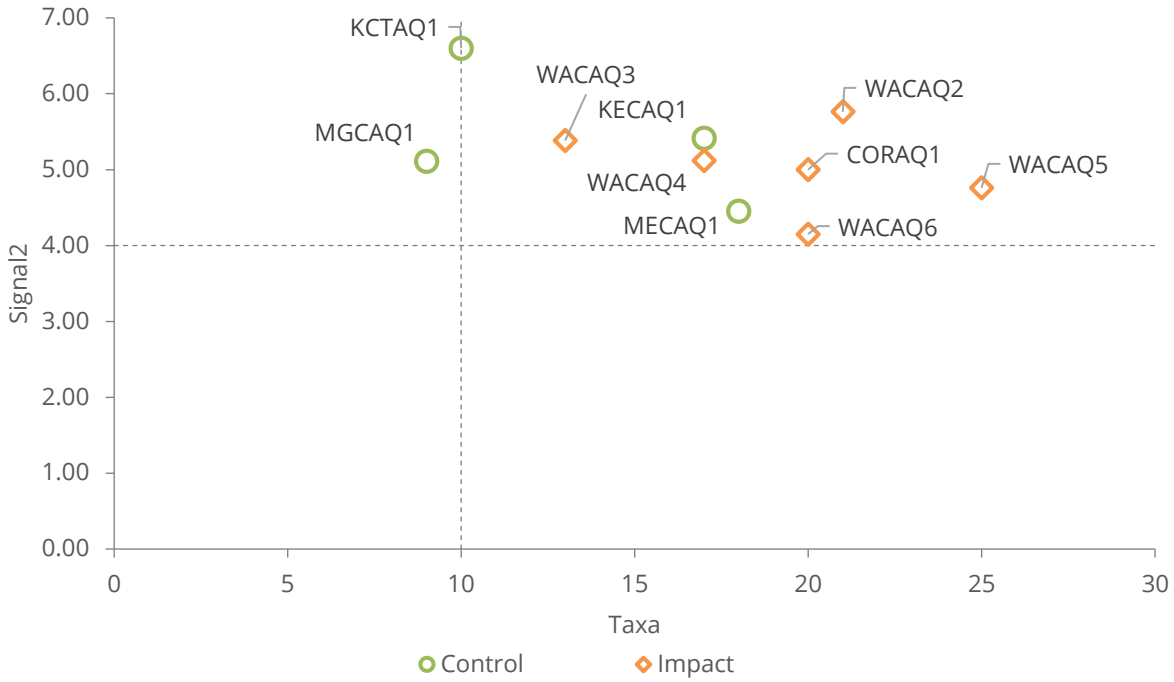


Figure 5 Trigger value biplot for the autumn 2020 monitoring period

5 Assessment against Trigger Action Response plans

Table 6 Trigger Action Response Plan (TARP) table for Longwalls N1-N6 (Niche 2012)

Longwalls N1-N6	Assessment against trigger levels
NORMAL	
No change in aquatic biota compared to baseline observed	**Consistent:** • All impact monitoring sites recorded values above the trigger levels for supplementary investigation in autumn 2020. • Multiple stream health indices have been used to examine water quality within the study area. The autumn 2020 results fall within the range of previous values recorded as part of the monitoring program indicating consistent conditions. Biological water quality results are consistent between the control and impact sites, indicating the impact sites are not subject to any mining related impacts. • The HABSCORE results for 2019 show sites are clustering around the marginal and suboptimal ranges. These results are consistent with the previous results of the monitoring program.
WITHIN PREDICTIONS	
Water flow and quality results within predictions. Survey results within baseline variability	**Not triggered**
EXCEEDS PREDICTIONS	
Water flow and quality results exceed predictions. Statistically significant change observed in survey results against baseline	**Not triggered**

6 Conclusions and recommendations

The findings of the previous monitoring reports have been used as an indicative baseline or benchmark, to which the monitoring results for autumn 2020 have been compared to. The number of monitoring sites for autumn 2020 has been reduced at the request of Wollongong Coal were to focus only on those required to identify any impacts associated with Panels N3 and N5 (for which extraction ceased in 2019). While the monitoring surveys had to be completed outside of the defined AUSRIVAS monitoring season dates for autumn sampling, the results obtained are considered to be a suitable basis upon which to carry out an assessment against the relevant TARPs.

The impact of the dry conditions were reflected in the relatively low water quality and HABSCORE results across the monitoring sites, although somewhat improved upon those recorded during the driest conditions in spring 2019. Following rainfall during the autumn monitoring period, the very low pH levels at a small number of sites in spring 2019 (attributed to an increase in the relative influence of groundwater which is naturally low in pH) appear to have been elevated to more nominal levels in autumn 2020. Water quality and HABSCORE conditions were within the ranges of previous results recorded and comparable between control and impact monitoring sites. As such the findings do not indicate any impacts as a result of underground coal mining.

The findings of the aquatic ecological monitoring program identified a variable but generally high level of taxonomic diversity with the aquatic ecological communities occurring within the Nebo Area, across all creeks surveyed. Water quality among impact and control sites tended to cluster within the very poor and fair categories. These results represent generally low overall water quality conditions when compared to the 2015 and 2016 years, but a slight increase on the findings of the spring 2019 monitoring surveys. These variations are attributed to environmental variability not underground coal mining, since the results are consistent between the impact and monitoring sites. Further, no leachate or changes in flow regime beyond that expected due to the somewhat reduced flow conditions due to low rainfall encountered during the monitoring period were observed at any of the sites.

The assessment against the TARPs developed for Longwalls N1-N6 (Niche 2012) concluded that conditions are normal for the autumn 2020 monitoring period. No impacts associated with mining have been identified as part of aquatic monitoring program for the autumn 2020 monitoring period. With no changes as compared to baseline observed.

Extraction from Panels N5 and N3 ceased in January and March 2019, respectively. With extraction from other Panels within the Nebo area being completed previous to 2019. As such, the autumn 2020 round of monitoring is the last season required to fulfil the requirement for a minimum of one year post-mining (in consultation with key regulators) for Panels N3 and N4 as per the NRE Wongawilli Colliery Nebo Longwalls N1-N6 Extraction Plan (Niche 2012). It is recommended that Wollongong Coal undertake consultation with key regulators in order to confirm a minimum of one year post-mining monitoring is acceptable.

References

ANZECC 2000. Australia Water Quality Guidelines for Fresh and Marine Waters. National Water Quality Management Strategy'. Australian and New Zealand Environment and Conservation Council, Canberra.

Barbour MT, Gerritsen J, Snyder BD, and Stribling JB 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish. U.S. Environmental Protection Agency, Office of Water, Washington, No. 841-B-99-002.

Chessman, BC 1995. Rapid assessment of rivers using macroinvertebrates: A procedure based on habitat-specific sampling, family level identification and a biotic index. Australian Journal of Ecology 20: 122-129.

Chessman, BC 2003a. New sensitivity grades for Australian river macroinvertebrates. Marine and Freshwater Research 54:95-103.

Chessman B, 2003b. SIGNAL 2 – A Scoring System for Macro-invertebrate ('Water Bugs') in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra.

Department of Planning 2008. Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield Strategic Review. NSW Department of Planning, Sydney.

DPI Primefacts (2006) Mine Subsidence, Primefact 21, Environmental Sustainability Branch.

DTIRIS 2013. Subsidence Management Plan Approval – NRE Wongawilli Colliery Nebo Longwalls N1-N6, (dated 25 January 2013, file no. 09/5341).

Hawking, JH 2000. Key to Keys. A guide to keys and zoological information to identify invertebrates from Australian inland waters. Identification Guide No. 2. Cooperative Research Centre for Freshwater Ecology.

Niche 2012. NRE Wongawilli Colliery Nebo Longwalls N1-N6 Extraction Plan. Prepared by Niche Environment and Heritage Illawarra/Southern NSW on behalf of Gujarat NRE FCGL Pty Ltd.

Turak, T, Waddell, N & Johnstone, G 2004. New South Wales (NSW) AUSRIVAS Sampling and Processing Manual. Department of Environment and Conservation (NSW).

Underwood, 1991. Beyond BACI: Experimental designs for detecting human environmental impacts on temporal variation in natural population. Australia Journal of Marine Freshwater Research. 42: 569-687.

Appendix 1 – Trigger Action response Plan (Aquatic ecology)

Table 7 Trigger Action Response Plan (TARP) table for Longwalls N1-N6 (Niche 2012)

Feature	Monitoring Program			TARPs	
	Prior to Mining	During Mining	Post mining and Future Monitoring	Trigger	Response
Aquatic Ecology					
6 Monitoring sites on Wattle Tree Creek 2 Monitoring sites on Little Wattle Tree Creek 4 Reference sites	Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime. Baseline monitoring completed for Longwall N4, ongoing as it relates to the Nebo Area. AUSRIVAS macroinvertebrate sampling of reference and impact sites. Descriptions of instream habitat, algal levels, riparian condition, presence/absence of litter, flow level and water quality (Biannually in Autumn and Spring).	Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime. Impact monitoring completed for this stage as it relates to the extraction of Longwall N4. AUSRIVAS macroinvertebrate sampling of reference and impact sites. Descriptions of instream habitat, algal levels, riparian condition, presence/absence of litter, flow level and water quality (Biannually in Autumn and Spring).	Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime for a minimum of one year post-mining (in consultation with key regulators). Monitoring ongoing for this stage as it relates to Longwall N4. AUSRIVAS macroinvertebrate sampling of reference and impact sites. Descriptions of instream habitat, algal levels, riparian condition, presence /absence of litter, flow level and water quality for a minimum of one year post-mining (in consultation with key regulators) (Biannually in Autumn and Spring).	**NORMAL** No change in aquatic biota compared to baseline observed. **WITHIN PREDICTIONS** Water flow and quality results within predictions. Survey results within baseline variability. **EXCEEDS PREDICTIONS** Water flow and quality results exceed predictions. Statistically significant change observed in survey results against baseline.	Continue monitoring. Report in end of panel report. Continue monitoring. Report in end of panel report. Notification to SCA/D&PE/OEH immediately. Proposal for any proposed additional monitoring and management measures within 1 week if required. Completion of agreed management task following approval from regulators. Additional monitoring as required by the relevant government agencies. Report in end of panel report. Reporting in Incident Reports and Annual Review.

Appendix 2 - Monitoring survey periods and survey dates

Table 8 Monitoring survey periods and monitoring survey dates

Period	Aquatic
Autumn 2011	10/05/11 – 10/06/11 (autumn)
Spring 2011	19/10/11 – 18/11/11 (spring)
Autumn 2012	29/05/12 – 31/05/12 (autumn)
Spring 2012	22/10/12 – 26/10/12 (spring)
Autumn 2013	18/03/13 – 22/03/13 (autumn)
Spring 2013	02/12/13 – 05/12/18 (spring – summer)
Autumn 2014	18/03/14 – 21/03/14 (autumn)
Spring 2014	07/10/14 – 10/10/14 (spring)
Autumn 2015	23/03/15 – 05/06/15 (autumn)
Spring 2015	22/09/15 – 25/09/15 (spring)
Autumn 2016	15/06/16 – 17/06/16 (autumn)
Spring 2016	22/12/16 – 23/12/16 (summer)
Autumn 2017	24/07/2017 – 27/07/17 (winter)
Spring 2017	17/01/18 – 01/02/18 (summer)
Autumn 2018	06/08/18 – 08/08/18 (winter)
Spring 2018	No survey commissioned
Autumn 2019	21/05/19 – 22/07/19 (autumn – winter)
Spring 2019	28/01/20 – 30/01/20 (summer)
Autumn 2020	03/07/20 – 10/07/20 (winter)

Appendix 3 - Aquatic macroinvertebrate catch data

Table 9 Aquatic macroinvertebrate catch data autumn 2020

Taxon	Signal2	COR-AQ1	KCT-AQ1	KEC-AQ1	MEC-AQ1	MOR-AQ1	WAC-AQ2	WAC-AQ3	WAC-AQ4	WAC-AQ5	WAC-AQ6
Ancylidae	**4**					1					
Atyidae	**3**	2								1	
Baetidae	**5**	3					1	12	1	3	1
Caenidae	**4**						5	4		2	1
Calamoceratidae	**7**	3									
Ceinidae	**2**									1	
Ceratopogonidae	**4**	3			5	3	1		3	5	3
Chironominae	**3**	23	12	4	16	18	10	5	5	7	6
Corixidae	**2**	1									
Corydalidae	**7**			1						1	
Culicidae	**1**				6	1	3		2	5	2
Curculionidae	**2**								1		
Dixidae	**7**		2		9	5		1	1	4	
Dytiscidae	**2**	1			2			1		1	
Dytiscidae (larva)	**2**	1			1						
Ecnomidae	**4**			1							
Elmidae (larva)	**7**				1		1				
Glossiphoniidae	**1**						1				
Gripopterygidae	**8**				3				1	2	1
Gyrinidae	**4**				2			4			1
Gyrinidae (larva)	**4**			1	1						
Helicopsychidae	**8**	1	1				1				

Taxon	Signal2	COR-AQ1	KCT-AQ1	KEC-AQ1	MEC-AQ1	MOR-AQ1	WAC-AQ2	WAC-AQ3	WAC-AQ4	WAC-AQ5	WAC-AQ6
Hydrachnidae	**7**	5	8	6	4		2	5	8	13	3
Hydraenidae	**3**				1				1		
Hydrobiosidae	**8**						1		4		1
Hydrochidae	**4**								1		
Hydropsychidae	**6**	2					3				
Hydroptilidae	**4**	1			1					4	2
Leptoceridae	**6**	23	10	20	7	1			3	4	5
Leptophlebiidae	**8**	26	24	23	39	32	51	19	45	28	34
Megapodagrionidae	**5**				1					1	1
Notonectidae	**1**				3			1		3	2
Odontoceridae	**7**	1		1			1				1
Oligochaeta	**2**	5		1							
Oniscigastridae	**8**	1		14						1	
Orthocladiinae	**4**	18		2						2	
Ostracoda		1			12						
Parastacidae	**4**			1							
Philopotamidae	**8**						1	1			1
Philorheithridae	**8**	7	2				1	1	1	1	2
Polycentropodidae	**7**						1				
Psephenidae	**6**			1							
Scirtidae	**6**		3	3	2		2		1		
Simuliidae	**5**	2					1			1	4
Sphaeriidae	**5**									1	
Tanypodinae	**4**	9	4	7	3	5	15	3	10	7	11
Telephlebiidae	**9**		2	1		4	1	1			1
Tipulidae	**5**						1			1	

Taxon	Signal2	COR-AQ1	KCT-AQ1	KEC-AQ1	MEC-AQ1	MOR-AQ1	WAC-AQ2	WAC-AQ3	WAC-AQ4	WAC-AQ5	WAC-AQ6
Veliidae	**3**			2	9				5	2	

Appendix 4 – Aquatic monitoring results 2011 - 2020

Table 10 Aquatic monitoring results 2011 – 2020

Site	Indices	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020
		Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Impact																				
WAC-AQ1	**O0Signal**	5.06	5.00	5.00	4.48	4.47	5.44	-	-	-	5.40	6.00	5.00	5.18	-	-	-	5.18	-	
	OE50	0.59	0.64	0.46	0.45	0.49	0.49	-	-	-	0.48	0.29	0.61	0.29	-	-	-	0.37	-	
	Band	B	B	C	C	B	C	-	-	-	C	C	B	C	-	-	-	C	-	NLM
	No. Taxa	16	16	7	10	10	9	-	-	-	11	11	13	11	14	12	-	17	15	
	Signal2	-	-	-	-	-	-	-	-	-	-	6.00	5.15	5.18	6.31	5.33	-	5.19	5.13	
WAC-AQ2	**O0Signal**	5.58	4.37	4.91	4.45	4.35	5.24	5.13	5.56	5.56	5.75	6.50	5.47	5.88	-	-	-	5.10	-	-
	OE50	0.64	0.66	0.50	0.75	0.51	0.50	0.46	0.59	0.44	0.59	0.23	0.50	0.29	-	-	-	0.51	-	-
	Band	B	B	B	B	B	C	C	B	C	B	C	C	C	-	-	-	B	-	-
	No. Taxa	12	19	11	14	9	17	9	21	16	19	16	17	17	18	17	-	19	14	21
	Signal2	-	-	-	-	-	-	-	-	-	-	6.50	5.76	5.88	6.00	5.50		5.05	3.70	5.76
WAC-AQ3	**O0Signal**	5.21	4.65	5.46	4.36	4.65	5.71	5.09	5.35	6.00	5.50	5.71	5.27	5.60	-	-	-	5.67	-	-
	OE50	0.80	0.72	0.67	0.91	0.36	0.55	0.54	0.70	0.37	0.70	0.66	0.48	0.29	-	-	-	0.39	-	-
	Band	B	B	B	A	C	B	B	B	C	B	B	C	C	-	-	-	C	-	-
	No. Taxa	15	21	13	15	7	13	11	20	11	20	21	16	15	14	11	-	9	13	13
	Signal2	-	-	-	-	-	-	-	-	-	-	5.71	5.38	5.60	6.77	5.18	-	5.75	5.00	5.38
WAC-AQ4	**O0Signal**	5.75	5.41	5.13	4.44	4.42	5.14	5.25	-	-	6.06	6.25	5.00	5.92	-	-	-	-	-	-
	OE50	0.45	0.61	0.46	0.50	0.55	0.56	0.49	-	-	0.67	0.31	1.10	0.37	-	-	-	-	-	-
	Band	C	B	C	C	B	B	B	-	-	B	C	B	C	-	-	-	-	-	-
	No. Taxa	12	17	9	10	12	14	16	-	-	17	12	12	13	7	-	-	-	-	17

Site	Indices	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020
		Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
	Signal2	-	-	-	-	-	-	-	-	-	-	6.25	5.17	5.92	5.83	-	-	-	-	5.12
WAC-AQ5	**O0Signal**	5.20	4.96	5.60	4.35	4.64	4.63	5.92	5.73	6.12	5.63	5.59	5.24	5.25	-	-	-	5.40	-	-
	OE50	0.60	1.06	0.44	0.88	0.74	0.71	0.68	0.74	0.58	0.73	1.03	0.70	0.44	-	-	-	0.48	-	-
	Band	B	A	C	A	B	B	B	B	B	B	B	B	C	-	-	-	B	-	-
	No. Taxa	15	26	10	18	18	18	12	23	25	31	17	18	16	18	15	-	10	14	25
	Signal2	-	-	-	-	-	-	-	-	-	-	5.63	5.33	5.25	6.12	4.63	-	5.44	3.83	4.76
WAC-AQ6	**O0Signal**	4.55	4.41	4.92	4.58	4.58	5.05	5.50	5.39	5.63	5.35	6.34	5.11	5.73	-	-	-	5.14	-	-
	OE50	0.97	1.00	0.71	0.79	0.92	0.77	0.53	0.82	0.51	0.92	0.51	0.67	0.37	-	-	-	0.58	-	-
	Band	A	A	B	B	A	B	B	B	B	A	B	B	C	-	-	-	B	-	-
	No. Taxa	20	27	14	16	21	19	13	22	16	22	29	21	11	18	18	-	20	19	20
	Signal2	-	-	-	-	-	-	-	-	-	-	6.34	5.43	5.58	5.94	4.40	-	4.89	5.16	4.15
COR-AQ1	**O0Signal**	-	-	-	-	-	-	-	-	-	5.35	4.86	4.53	4.77	-	-	-	4.36	-	-
	OE50	-	-	-	-	-	-	-	-	-	0.50	0.95	0.92	0.92	-	-	-	0.88	-	-
	Band	-	-	-	-	-	-	-	-	-	C	A	A	A	-	-	-	A	-	-
	No. Taxa	-	-	-	-	-	-	-	-	-	21	21	20	26	21	15	-	27	26	20
	Signal2	-	-	-	-	-	-	-	-	-	-	4.86	4.65	4.74	6.10	4.40	-	4.31	4.62	5.00
LWC-AQ1	**O0Signal**	4.76	4.29	5.42	-	4.46	4.67	-	-	-	5.75	4.92	4.50	-	-	-	-	4.13	-	NLM
	OE50	0.79	1.01	0.59	-	0.27	0.71	-	-	-	0.67	0.44	0.77	-	-	-	-	0.65	-	
	Band	B	A	B	-	C	B	-	-	-	B	C	B	-	-	-	-	B	-	
	No. Taxa	18	17	13	-	8	12	-	-	-	16	12	17	-	18	7	-	15	-	
	Signal2	-	-	-	-	-	-	-	-	-	-	4.92	4.56	-	6.29	5.30	-	3.57	-	
LWC-AQ2	**O0Signal**	5.89	4.73	5.31	4.43	4.68	4.06	-	-	-	5.26	5.91	-	-	-	-	-	-	-	NLM
	OE50	0.36	1.02	0.68	0.75	0.71	0.75	-	-	-	0.70	0.44	-	-	-	-	-	-	-	
	Band	C	A	B	B	B	B	-	-	-	B	C	-	-	-	-	-	-	-	
	No. Taxa	9	26	14	13	18	17	-	-	-	19	23	-	-	-	-	-	-	-	

Site	Indices	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020
		Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
	Signal2	-	-	-	-	-	-	-	-	-	-	5.91	-	-	-	-	-	-	-	
Control																				
MGC-AQ1	**O0Signal**	5.11	4.80	4.89	4.58	4.45	5.18	5.29	5.25	5.48	5.07	5.85	4.71	5.23	-	-	-	4.83	-	-
	OE50	0.80	0.75	0.46	0.42	0.49	0.59	0.44	0.84	0.62	0.53	0.37	0.77	0.37	-	-	-	0.44	-	-
	Band	B	B	C	C	B	B	C	A	B	B	C	B	C	-	-	-	C	-	-
	No. Taxa	18	15	10	8	13	17	14	23	21	17	19	16	12	14	13	-	12	8	9
	Signal2	-	-	-	-	-	-	-	-	-	-	5.89	5.13	5.38	5.62	4.90	-	4.82	3.50	5.11
MEC-AQ1	**O0Signal**	4.70	4.95	5.13	4.35	4.43	5.43	4.80	4.94	5.28	5.95	5.24	4.88	5.30	-	-	-	4.53	-	-
	OE50	0.62	1.00	0.77	0.66	0.54	0.63	0.67	0.70	0.73	0.66	0.37	0.63	0.44	-	-	-	0.59	-	-
	Band	B	A	B	B	B	B	B	B	B	B	C	B	C	-	-	-	B	-	-
	No. Taxa	10	20	17	17	17	14	16	19	25	21	16	17	10	18	14	-	19	19	18
	Signal2	-	-	-	-	-	-	-	-	-	-	5.24	5.00	5.18	5.47	5.10	-	4.47	4.55	4.45
KCT-AQ1	**O0Signal**	5.25	4.67	4.55	4.44	4.30	5.13	5.22	5.06	5.26	5.75	5.35	-	4.25	-	-	-	4.76	-	-
	OE50	1.02	1.31	0.79	1.01	0.88	0.88	0.55	0.77	0.74	0.44	0.71	-	0.45	-	-	-	0.66	-	-
	Band	A	X	B	A	A	A	B	B	B	C	B	-	C	-	-	-	B	-	-
	No. Taxa	17	24	11	17	11	15	9	16	19	18	19	-	8	22	14	-	17	17	10
	Signal2	-	-	-	-	-	-	-	-	-	-	5.20	-	4.25	6.38	5.14	-	4.76	4.71	6.60
KEC-AQ1	**O0Signal**	5.31	5.32	5.10	4.35	4.67	4.55	5.94	4.76	5.00	5.24	5.52	-	6.33	-	-	-	5.86	-	-
	OE50	0.81	0.96	0.58	0.86	0.36	0.47	0.71	0.88	1.07	0.88	0.74	-	0.36	-	-	-	0.44	-	-
	Band	B	A	B	A	C	C	B	A	A	A	B	-	C	-	-	-	C	-	-
	No. Taxa	17	25	10	14	9	11	16	18	25	24	27	-	9	16	13	-	14	15	17
	Signal2	-	-	-	-	-	-	-	-	-	-	5.52	-	6.33	5.87	5.00	-	5.69	4.53	5.41

**Note The AUSRIVAS model was not run for the spring 2017, autumn 2018, autumn 2020 data, as such the Signal2 scores have been calculated using the unweighted average method*

**NLM = no longer required for monitoring*