CENTENNIAL

Centennial Coal
Western Coal Services
ANNUAL REVIEW

March 2023

Annual Review Title Block

Name of Operation	Western Coal Services (WCS)
Name of Operator	Springvale Coal Pty Ltd
Development Consent/ Project Approval #	SSD-5579
Name of holder of Development Consent/ Project Approval	Springvale Coal Pty Ltd
Mining Lease #	ML204, ML564, ML1319, ML1448, ML1352, CCL733, CL394, CL 361 & PLL133
Name of Holder of Mining Lease	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd
Water License #	Not Applicable
Name of Holder of Water License	Not Applicable
RMP Start Date	1 August 2022
Annual Review Start Date	1 January 2022
Annual Review End Date	31 December 2022

I, certify that this audit report is a true and accurate record of the compliance status of Centennial Western Coal Services for the period 1 January to 31 December 2022 and that I am authorised to make this statement on behalf of Centennial Springvale Coal Pty Ltd.

Note:

a) *The Annual Review is an 'environmental audit' for the purposes of s122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion) in an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.*

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

Name of Authorised Reporting Officer	Craig Gillard
Title of Authorised Reporting Officer	Managing Director & CEO
Signature of Authorised Reporting Officer	
Date	31/03/2023

Contents

1 STATEMENT OF COMPLIANCE 1

2 INTRODUCTION 3

2.1 SCOPE 3
2.2 MINE CONTACTS 3

3 APPROVALS 6

3.1 PROJECT APPROVALS, MINING AUTHORISATIONS, AND OTHER LICENCES 6
3.1.1 Mining Lease Variations 8
3.1.2 Rehabilitation Management Plan 8
3.2 ANNUAL REPORTING REQUIREMENTS 8

4 OPERATIONS SUMMARY 9

4.1 PRODUCTION 9
4.2 OTHER OPERATIONS 10
4.3 MINING OPERATIONS 11
4.4 EXPLORATION 11
4.5 LAND DISTURBANCE 11
4.6 CONSTRUCTION 11
4.7 NEXT REPORTING PERIOD 11

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW 12

6 ENVIRONMENTAL PERFORMANCE 13

6.1 METEOROLOGICAL SUMMARY 15
6.2 NOISE 16
6.2.1 Environmental Management 16
6.2.2 Environmental Performance 16
6.2.3 Comparison Against Predictions 19
6.2.4 Long Terms Analysis 19
6.2.5 Implemented / Proposed Improvements 20
6.2.6 Acquisitions and Mitigation Requests 20
6.3 BLASTING 20
6.4 AIR QUALITY 20
6.4.1 Environmental Management 20
6.4.2 Environmental Performance 21
6.4.3 Comparison Against Predictions 24
6.4.4 Long Terms Analysis 24
6.4.5 Implemented / Proposed Improvements 25
6.5 GREENHOUSE GAS MONITORING 25
6.5.1 Environmental Management 25
6.5.2 Environmental Performance 25
6.5.3 Comparison Against Predictions 25
6.5.4 Long Term Analysis 25
6.5.5 Implemented/Proposed Improvements 26
6.6 BIODIVERSITY 26
6.6.1 Environmental Management 26
6.6.2 Environmental Performance 26
6.6.3 Comparison Against Predictions 28
6.6.4 Implemented / Proposed Improvements 28
6.6.5 Biodiversity Offsets 28
6.7 HERITAGE 29
6.7.1 Environmental Management 29
6.7.2 Environmental Performance 29
6.7.3 Comparisons Against Predictions 29
6.7.4 Implemented / Proposed Improvements 29
6.8 OTHER MATTERS 30
6.8.1 Bushfire Management 30

6.8.2 Waste *30*
6.8.3 Residual Waste *31*
6.8.4 Visual Amenity *32*

7 WATER **33**

7.1 WATER MANAGEMENT 33
7.2 WATER LICENSES 33
7.3 WATER BALANCE 33
7.4 SURFACE WATER 34
7.4.1 Environmental Management *34*
7.4.2 Comparisons Against Predictions *35*
7.4.3 Environmental Performance *35*
7.4.4 Implemented / Proposed Improvements *40*
7.5 GROUNDWATER 40
7.5.1 Environmental Management *40*
7.5.2 Environmental Performance *40*
7.5.3 Comparison Against Predictions *44*
7.5.4 Implemented / Proposed Improvements *44*

8 REHABILITATION **45**

8.1 REHABILITATION PERFORMANCE DURING THE REPORTING PERIOD 45
8.1.1 Summary of Rehabilitation *45*
8.1.2 Rehabilitation Monitoring *46*
8.1.3 Decommissioning *48*
8.1.4 Other Rehabilitation and Land Management Activities *48*
8.1.5 Proposed Disturbance and Rehabilitation Activities *48*

9 COMMUNITY CONSULTATION **49**

9.1 COMMUNITY COMPLAINTS 49
9.1.1 Community Information Line *49*

10 INDEPENDENT ENVIRONMENTAL AUDIT **50**

10.1 ENVIRONMENTAL MANAGEMENT 50
10.2 ENVIRONMENTAL PERFORMANCE 50

11 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD **59**

12 ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD **61**

13 REFERENCES **62**

APPENDIX 1: WCS PLANS **71**

APPENDIX 2: COAL TRANSPORT RECORDS **80**

APPENDIX 3: METEOROLOGICAL **83**

APPENDIX 4: NOISE **86**

APPENDIX 5: AIR QUALITY **140**

APPENDIX 6: BIODIVERSITY **147**

APPENDIX 7: WASTE **166**

APPENDIX 8: WATER **170**

APPENDIX 9: REHABILITATION **320**

APPENDIX 10: ANNUAL REVIEW CHECKLIST **414**

List of Tables

TABLE 1-1: STATEMENT OF COMPLIANCE 1
TABLE 1-2: 2022 NON-COMPLIANCES 2

TABLE 21: CENTENNIAL WCS ENVIRONMENTAL CONTACT DETAILS 3
TABLE 3-1: ENVIRONMENTAL APPROVALS HELD BY CENTENNIAL WCS 7
TABLE 4-1: PRODUCTION SUMMARY & FORECAST 9
TABLE 4-2: OTHER OPERATIONS SUMMARY 10
TABLE 5-1: ACTIONS FROM PREVIOUS ANNUAL REVIEW 12
TABLE 6-1: METEOROLOGICAL CONDITIONS 15
TABLE 6-2: WESTERN COAL SERVICES NOISE CRITERIA 17
TABLE 6-3: WESTERN COAL SERVICES LAEQ (15MINUTE) DAY 17
TABLE 6-4: WESTERN COAL SERVICES LAEQ (15MINUTE) EVENING 18
TABLE 6-5: WESTERN COAL SERVICES LAEQ (15MINUTE) NIGHT 18
TABLE 6-6: WESTERN COAL SERVICES LA1 (1MINUTE) NIGHT 18
TABLE 6-7: CONVEYOR SYSTEM ANNUAL SOUND POWER LEVEL RESULTS @ 1M DB 19
TABLE 6-8: 2017-2022 WCS ATTENDED NOISE MONITORING EXCEEDANCES 20
TABLE 6-9: LONG TERM CRITERIA FOR DEPOSITED DUST 21
TABLE 6-10: SHORT TERM CRITERIA FOR PARTICULATE MATTER 21
TABLE 6-11: LONG TERM CRITERIA FOR PARTICULATE MATTER 21
TABLE 6-12: 2022 DEPOSITIONAL DUST RESULTS 22
TABLE 6-13: 2022 RESULTS PARTICULATE MATTER 23
TABLE 6-14: LONG TERM TRENDS FOR DEPOSITED DUST[1] 24
TABLE 6-15: EXCEEDANCES FOR PARTICULATE MATTER 24
TABLE 6-16 SUMMARY OF GHG EMISSIONS REPORTING FY2022 25
TABLE 6-17: RESIDUAL TRANSFER LIMITS AND PERFORMANCE 31
TABLE 7-1: SITE WATER BALANCE FOR WCS 33
TABLE 7-2: LDP001 WATER QUALITY SUMMARY 35
TABLE 7-3: LDP001 2022 DISCHARGE VOLUMES 36
TABLE 7-4: LDP002 WATER QUALITY SUMMARY 38
TABLE 7-5: 2022 UPSTREAM AND DOWNSTREAM WATER QUALITY RESULTS 39
TABLE 7-6: 2022 GROUNDWATER LEVEL TRIGGER & INVESTIGATIONS 2022 40
TABLE 7-7: 2022 GROUNDWATER MONITORING RESULTS 41
TABLE 8-1: REHABILITATION STATUS 45
TABLE 8-2 RMP REHABILITATION OBJECTIVES AND COMPLETION CRITERIA ASSESSMENT 47
TABLE 9-1: RECORD OF ANNUAL COMMUNITY COMPLAINTS FOR 2016 TO 2022 49
TABLE 10-1: 2021 IEA NON-COMPLIANCES AND RECOMMENDATIONS 51
TABLE 10-2: ADDITIONAL RECOMMENDATIONS FROM 2021 IEA 58
TABLE 11-1: SUMMARY OF REPORTABLE INCIDENTS AND REGULATORY ACTION 59
TABLE 11-2 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD 60
TABLE 12-1: FORECAST OPERATIONS FOR 2023 61

List of Figures

FIGURE 2-1: REGIONAL PROJECT LOCALITY 4
FIGURE 2-2: MINING LEASE 5
FIGURE 6-1: WCS WESTERN COAL SERVICES MONITORING LOCATIONS 14
FIGURE 6-2: 2022 RAINFALL SUMMARY 16
FIGURE 6-3: 2022 DEPOSITIONAL DUST RESULTS 22
FIGURE 6-4: 2022 DEPOSITIONAL DUST ANNUAL AVERAGE 22
FIGURE 6-5: 24HR AND ANNUAL AVERAGE PM_{10} 23
FIGURE 6-6 CARINYA OFFSET SITE & BIOMETRIC VEGETATION TYPES (BVTS) 27
FIGURE 6-7 2022 WASTE GENERATION 30
FIGURE 6-8: 2022 RESIDUALS TRANSFERRED TO WCS 31
FIGURE 7-1: WCS LDP001 PH 2022 36
FIGURE 7-2: WCS LDP001 TSS 2022 36
FIGURE 7-3: WCS LDP001 OIL & GREASE 2022 37
FIGURE 7-4: WCS LDP001 TURBIDITY 2022 37
FIGURE 7-5: LDP001 DISCHARGE VOLUME SUMMARY 2022 38

Plans

Plan Reference	Plan Name
1A	Project Locality
1B	Mining Leases
1C	Built Environment
2A	Primary Domains
2B	Secondary Domains
2C	Primary & Secondary Domains
3A	Environmental Monitoring
3B	Rehabilitation Monitoring

Appendices

Appendix No.	Appendix Name
1	Plans
2	Coal Transport Records
3	Meteorological
4	Noise
5	Air Quality
6	Biodiversity
7	Waste
8	Water
9	Rehabilitation
10	Annual Review Checklist

1 STATEMENT OF COMPLIANCE

The compliance of Western Coal Services (WCS) in 2022 is provided in **Table 1-1**. There were two non-compliances during the Reporting Period.

Non compliances applicable to the Reporting Period are summarised in **Table 1-2**.

Table 1-1: Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
Development Consent SSD-5579	No
Environmental Protection Licence 21229	No
Mining Lease (ML) ML204, ML564, ML1319, ML 1448, ML1352, CCL 733, CL 394, CL 361, PLL 133	Yes
Radiation License	Yes
Statement of Commitments	Yes

Table 1-2: 2022 Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Where Addressed in Annual Review
SSD-5579	Schedule 2, Condition 5C	WCS must not transfer more than 0.43ML/day in accordance with Condition 8A, Schedule 2 of SSD-5579.	Non-Compliant	A transfer exceedance was recorded on the 18th and 19th October 2022 of 0.441 ML and 0.434ML respectively. There was an unintentional additional transfer of service water being introduced into the residual pipeline system. Additional alarming is being incorporated as a preventative control to a repeat incident. This includes a notification when flow registers on flow meters but the pumps have stopped. Similarly, an additional SCADA alarm will also be implemented to alert operators when the daily discharge volume has reached 420m^3. This early warning will trigger the Alarm Management System to flash a reminder when alarms are active	Section 11
EPL21229	L4.1	Volume accepted must not exceed 0.35 ML/day(annual average) or 0.43 ML/day (daily maximum)			

Note: Compliance Status Key for Table 1-2

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

2 INTRODUCTION

Western Coal Services (WCS) is located to the west of the Blue Mountains in the Lithgow Local Government Area in New South Wales approximately 125 kilometres (km) from Sydney, 15 km north of city of Lithgow, 5 km north-northwest from the township of Wallerawang, and 4 km northwest of the village of Lidsdale.

The WCS includes the operation of infrastructure for the receipt, handling and processing of coal and reject materials from Springvale Mine (SSD-5594), Angus Place Colliery (SSD 06_0021) and other Centennial Coal Company Limited (Centennial) operations; and the transportation of this coal to Mount Piper Power Station (MPPS) (DA80/10060) and Lidsdale Siding (Development Consent 08_0223). WCS also receives and emplaces residual waste from the Springvale Water Treatment Project (SWTP) (SSD-7592). This waste stream is generated by the removal of suspended solid materials from raw mine water treated by SWTP and can be up to 2% solids.

Springvale Coal Services Site (SCSS) is a coal processing and storage facility that forms part of WCS. It is used for run-of-mine (ROM) coal handling and stockpiling, ROM coal beneficiation (washing), emplacement of coal reject material and emplacement of residual waste material from the SWTP. It connects to a network of conveyors which can transfer coal between Springvale Mine, Wallerawang Power Station (now closed), MPPS and Lidsdale Siding. The site is approved to receive and process up to 9.5 million tonnes per annum (Mtpa) of coal from Angus Place Colliery, Springvale Mine and other Centennial operations.

2.1 SCOPE

This Annual Review (AR) details the compliance and environmental management performance of WCS Site over the Period 1 January 2022 to 31 December 2022. The AR has been prepared in accordance with the Annual Review Guideline (DPIE 2015), and satisfies:

- Schedule 5, Condition 4 of the Development Consent SSD-5579; and
- Schedule 3 Condition 42 of the Development Consent SSD-5579.

2.2 MINE CONTACTS

The contact details for the personnel responsible for environmental management and community relations at WCS are provided in **Table 2-1** below.

Table 21: Centennial WCS Environmental Contact Details

Name	Position	Contact Details
Geoff Rapson	Mine Manager	T: (02) 6355 8035
		E: geoff.rapson@centennialcoal.com.au
William Olson	Environment & Community Graduate	T: (02) 6355 9509
		E: william.a.olson@centennialcoal.com.au
Community Contact Number	SCSO Control Room	T: (02) 6355 9500

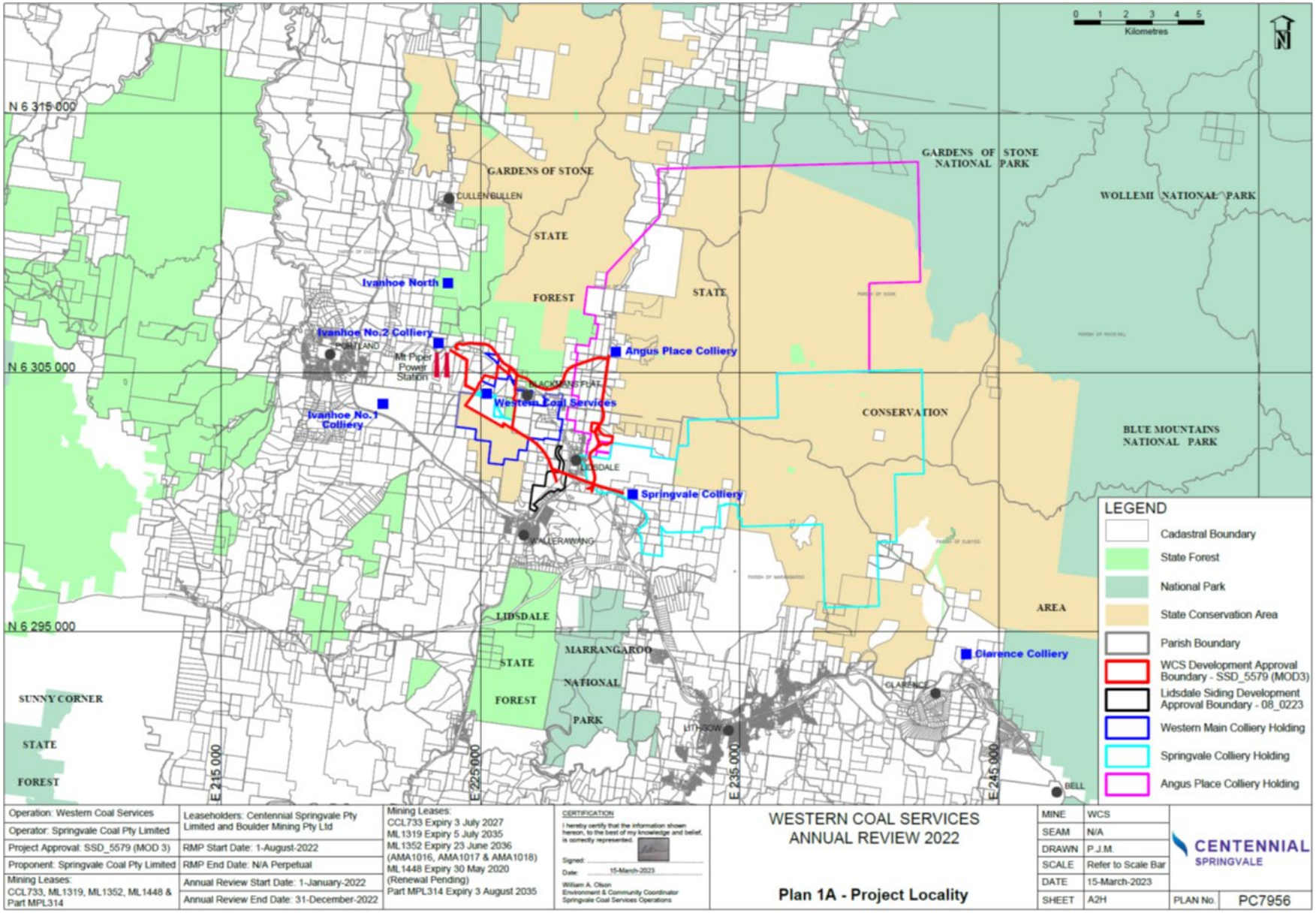


Figure 2-1: Regional Project Locality

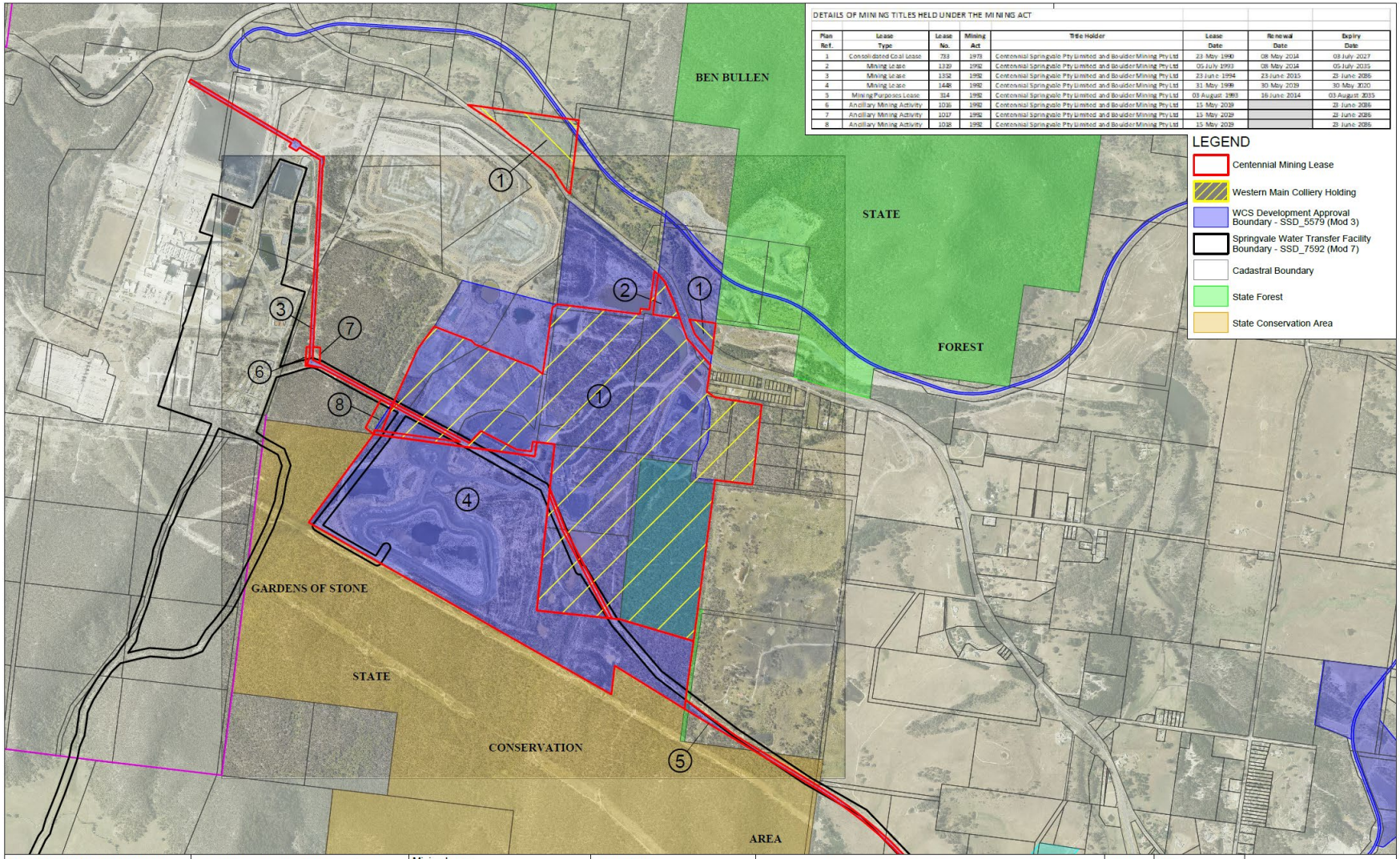


Figure 2-2: Mining Lease

3 APPROVALS

The Western Coal Services Development Consent SSD-5579 was granted in April 2014 and has been modified on four (4) occasions.

Modification 1 was approved in June 2017 and included the following scope:

- The receipt of residuals stream from the water treatment plant proposed in the Springvale Water Treatment Plant (WTP) and emplacement within the existing REA at the WCS; and
- Changes to the decommissioning and rehabilitation strategy approved in SSD-5579.

Modification 2 was approved in December 2017 and included the following scope:

- Changes to the applicability of noise criteria from noise generated by the operation of the overland coal conveyor, Wallerawang haul road or Mount Piper haul road (no longer applicable to this site); and
- Requirements to prepare and implement a Noise Reduction Study for the overland coal conveyor and SCSS.

Modification 3 was approved in August 2019 and included the following scope:

- Enable the transfer of coal from the Lidsdale Rail Siding back to the SCSS using the existing overland conveyor system that operates between the Lidsdale Rail Siding and the SCSS; and
- Increase the volume of coal that can be received at the SCSS from other sources (other than the Springvale Mine and Angus Place Colliery) from 1 million tonnes per annum (Mtpa) to 1.5 Mtpa.

Modification 4 was approved in October 2022 and included the following scope:

- Redesign of the site water management system and construction of a water transfer system to enable the transfer of water to McPhillamys Gold Project and Mount Piper Power Station, as well as the receipt of water from Angus Place Colliery; and
- Amendment of the rehabilitation conditions to align with the Rehabilitation Reforms introduced in 2022.

3.1 PROJECT APPROVALS, MINING AUTHORISATIONS, AND OTHER LICENCES

A summary of Project Approvals, Mining Authorisations, and other Licences relevant to Centennial WCS is provided in **Table 3-1**. Current Project Approval, EPL License and Mining Leases are available at the WCS website[1].

[1] https://www.centennialcoal.com.au/operations/springvale-coal-services/

Table 3-1: Environmental Approvals Held by Centennial WCS

Approval	Description	Expiry Date	Change to Approval during Reporting Period
Project Approval – NSW Department to Planning and Environment (DPE)			
Development Consent SSD-5579	Development Consent approval issued under the EP&A Act	30/06/2039	Yes (Section 3.0)
Radiation Plans – NSW Environment Protection Agency (EPA)			
Radiation Management Licence 5061304	Radiation Management Licence issued under the *Radiation Control Act 1990*	15/06/2023	No
Environmental Protection Licence – EPA			
Environment Protection Licence 21229	Environmental Protection Licence issued under the *Protection of the Environment Operations Act 1997* (POEO Act)	N/A	No
Mining Lease – NSW Resources Regulator (RR)			
ML 204	Mining Lease	27/05/2033	No
ML 1319	Mining Lease	05/07/2035	Yes (Section 3.1.1)
ML 564	Mining Lease	02/05/2023	No
CL 394	Coal Lease	27/05/2034	No
CCL 733	Consolidated Coal Lease	3/07/2027	Yes (Section 3.1.1)
CL 361	Coal Lease	16/07/2032	No
ML 1352	Mining Lease	23/06/2036	Yes (Section 3.1.1)
ML 1448	Mining Lease	31/05/2020#	Yes (Section 3.1.1)
PLL 133	Private Land Lease	10/08/2024	No
Rehabilitation Management Plan (RMP) – RR			
RMP	RMP as required by the Mining Amendment Regulation & SSD-5579.	29/07/2022 (Submission Date)	Yes (Section 3.1.2)
Annual Rehabilitation Report & Forward Program (ARR&FP) –RR			
ARR&FP	ARR&FP as required by the Mining Amendment Regulation	1/07/2024	Yes (Section 3.1.2)

Notes: # Renewal applications have been lodged and acknowledged for these titles however, no renewal offers have been received at the time of writing of this Annual Review.

3.1.1 Mining Lease Variations

On the 17 October 2022, variations to several mining authorisations held for Western Coal Services came into effect. The variations included the omission/variation of a number of conditions, renumbering, modernisation of wording and alignment with the prescribed standard conditions in the Mining Regulation 2016, Schedule 8A, Part 2.

The variations were received for the following mining leases:

- ML1319
- ML 1352
- ML 1448
- CCL 733

Changes of relevance to this Annual Review included (but not necessarily limited to):

- Omission of requirements for an 'Annual Environmental Management Report' (AEMR) in Condition 3 for ML 1448.
- Omission of requirements for an 'Environmental Management Report' (EMR) in Conditions 4, 5 and 6 for CCL 733.

Further, at the request of Centennial WCS cancellation, in part, of Consolidated Coal Lease 733 took effect on 16 June 2022.

3.1.2 Rehabilitation Management Plan

On 2 July 2021, the Department of Regional NSW - RR commenced its Rehabilitation Reforms through an amendment to the *Mining Regulations 2016* (Mining Regulations), via the *NSW Mining Amendment* (Standard Conditions of Mining Leases – Rehabilitation) *Regulation 2021* (Mining Amendment Regulation).

The Rehabilitation Reforms have effectively superseded the previous requirement under a Mining Lease to prepare a Mining Operations Plan (MOP) for any mining activity to be undertaken and to hold an appropriate security for the rehabilitation activities required to achieve the final landform.

To satisfy the Rehabilitation Reforms and Condition 45, Schedule 3 of SSD-5579, WCS prepared a Rehabilitation Management Plan (RMP). The RMP also satisfies the requirements of ML204, ML564, ML1319, ML1448, ML1352, CCL733, CL394, CL361 and PLL133.

The RMP was prepared in accordance with the NSW Resources Regulator (NSW RR) *Form and Way-Rehabilitation Management Plan for Large Mines (NSW RR, July 2021)* required under the *Mining Regulation 2016* and submitted on the 29 July 2022 via the NSW Resource Regulator's mine rehabilitation portal.

Annual reporting requirements in the RMP will be reported in the Annual Rehabilitation Report and Forward Program (ARR&FP) and submitted using the online form accessible via the NSW Resource Regulator's mine rehabilitation portal. The ARR&FP also sets out WCS the three-year forecast for both proposed surface disturbance and rehabilitation schedule.

3.2 ANNUAL REPORTING REQUIREMENTS

Appendix 10 provides a checklist of statutory reporting requirements and performance conditions addresses within the Annual Review. In accordance with Condition 11, Schedule 5 of SSD-5579 a copy of the 2022 Annual Review, once approved by the DPE, will be provided on the WCS website https://www.centennialcoal.com.au/operations/springvale-coal-services/

4 OPERATIONS SUMMARY

4.1 PRODUCTION

Details of coal processing and transportation operations at the WCS site for the Reporting Period is presented **Table 4-1**. Previous results and forecasted operations are also summarised within the table.

Table 4-1: Production Summary & Forecast

Material	Approved Limit (SSD-5579) (Tonnes)	Previous Reporting Period (2021) (Actual Tonnes)	This Reporting Period (2022) (Actual Tonnes)	Next Reporting Period (2023) (Forecast Tonnes)[1]
Waste Rock / Overburden	N/A	N/A	N/A	N/A
Total receipt of coal	9,500,000	2,555,504	2,682,525	3,297,071
Receipt of ROM coal from Springvale Mine	5,500,000	2,001,231	2,272,592	3,200,000
Receipt of ROM coal from Angus Place	4,000,000	0	0	0
Receipt of coal from sources other than Springvale Mine or Angus Place Colliery	1,500,000	554,273	409,933	97,071
Receipt of coal from Lidsdale Siding	1,500,000	554,273	409,933	97,071
Receipt of ROM coal from sources other than Springvale Mine or Angus Place Colliery	1,000,000	0	0	0
Processing of ROM coal	7,000,000	587,840	544,391	200,000
Coarse reject	N/A	232,213	89,182.5	30,000
Fine reject (Tailings)	N/A	232,213	89,182.5	30,000
Transport Lidsdale Siding (Rail)	6,300,000	193,946	353,218	200,000
Transport other parties (Mt Piper)	N/A	0	0	0

There were no inconsistencies between the approved limit and actual coal processing, transport for the Reporting Period as defined by Schedule 2 Condition 6, 7, 7, 8 and 8A of SSD-5579. Further detail regarding coal transportation and processing is presented in **Appendix 2.**

[1] As per (Springvale Coal Services Operations) SCSO budgeted forecast at 31/02/2023- Budgets subject to variation but will be conducted in accordance with approved operations.

4.2 OTHER OPERATIONS

Coal transportation is monitored in accordance with Development Consent SSD-5579, Schedule 3, Condition 39. A summary of operations relevant to WCS is provided in **Table 4-2** and **Table 4-3**. WCS compliance with residual waste limits of consent are discussed in **Section 6.8.2.**

There were no inconsistencies between the approved limit and actual processing or transportation limits for the Reporting Period. Further detail regarding coal transportation and processing is presented in **Appendix 2**.

Table 4-2: Other Operations Summary

Requirement	Approved Limit (SSD-5579)	Previous Reporting Period (2021) (Actual)	This Reporting Period (2022) (Actual)	Comment
Transport (Wallerawang Haul Road) (SSD-5579)	Truck movements restricted to the day period only prior to longwall extraction at the Angus Place Colliery. Max. 3 truck operating during the evening period following commencement of longwall extraction at Angus Place Colliery. No truck movements to occur during the night period.	No haulage undertaken	No haulage undertaken	Compliant
Transport (Mt Piper Haul Road) (SSD-5579)	Truck movements restricted to the day period only prior to longwall extraction at the Angus Place colliery. Max. 8 trucks operating during the evening period following the commencement of longwall extraction at Angus Place Colliery. Max. 2 trucks operating during the night period. No truck movements to occur in the night period during adverse meteorological conditions.	No haulage undertaken	No haulage undertaken	Compliant
Kerosene Vale Coal Stockpile Operations (SSD-5579)	During the day period only.	Stockpile management activities limited to haulage only all undertaken in day period	Stockpile management activities limited to haulage only all undertaken in day period	Compliant

Table 4-3: Coal Processing, Handling and Transport Summary (Mtpa)

Month	Product from Springvale Colliery (6.3 Mtpa limit)	Product to Energy Australia (Mt Piper)	Product from Lidsdale Siding (1.5 Mtpa limit)	Product to Lidsdale Siding
January 2022	38,844	24,775	6,280	0
February 2022	31,896	0	0	0
March 2022	27,388	96,086	54,844	0
April 2022	348,240	303,717	2,300	15,473
May 2022	380,736	240,711	0	113,757
June 2022	349,767	226,860	0	75,278
July 2022	239,561	372,293	90,829	14,647
August 2022	204,348	270,656	0	52,492
September 2022	213,944	227,582	46,606	0
October 2022	214,351	261,307	67,491	36,777
November 2022	78,204	108,880	60,572	9,554
December 2022	145,313	175,304	81,011	35,240
Total 2022 CY	**2,272,592**	**2,308,171**	**409,933**	**353,218**

4.3 MINING OPERATIONS

There were no mining activities undertaken during the Reporting Period.

4.4 EXPLORATION

There were no exploration activities undertaken during the Reporting Period.

4.5 LAND DISTURBANCE

There were no additional land disturbance activities undertaken during the Reporting Period.

4.6 CONSTRUCTION

There were no construction activities undertaken during the Reporting Period.

4.7 NEXT REPORTING PERIOD

WCS will continue to receive coal from Springvale and Lidsdale Siding. WCS will wash ROM coal as required for quality control to produce product coal for Energy Australia, and for export at Lidsdale Siding.

MOD4 was approved by the DPE on the 21 October 2022. A key focus for WCS in 2023 is securing the necessary post approvals required to commence the approved construction activities as outlined in MOD4 and implement the modifications to the water transfer and management system.

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

Table 5-1 summarises the outcomes of the 2021 Annual Review, including actions issued by the relevant government departments and actions taken by WCS.

The DPE provided feedback of the 2021 Annual Review regarding additional reporting requirements for future Annual Reviews to address community concern in relation to the status and management of biodiversity areas and the reporting of greenhouse gas management measures.

Table 5-1: Actions from Previous Annual Review

Action Required	Requested By	Action Taken	Where addressed in Annual Review
Report on the status of the long-term security arrangement for biodiversity offsets required by the development consent for the mine. Please include information on the type(s) of long-term security arrangements that have been implemented and/or are to be implemented for the mine.	DPE	Refer to **Section 6.6.6** (Biodiversity Offsets) in the Annual Review.	Section 6.6
Report on greenhouse gas emissions for the Reporting Period and include a comparison of actual greenhouse gas emissions against the predictions in the environmental assessment(s) for the mine. Please ensure that the method used to calculate the environmental assessment prediction(s) and annual emissions are calculated the same.	DPE	Refer to **Section 6.5.2** (emissions for the Reporting Period) and **Section 6.5.3** (comparison against the predictions) in the Annual Review.	Section 6.5
Report all reasonable and feasible steps undertaken during the Reporting Period to improve energy efficiency and reduce greenhouse gas emissions generated by the mine.	DPE	Refer to **Section 6.5.5** (implemented / proposed improvements) in the Annual Review.	Section 6.5

6 ENVIRONMENTAL PERFORMANCE

WCS implements an Environmental Management Strategy, as required by Condition 1, Schedule 5 of SSD-5579, including management plans, procedures and monitoring programs that provide a framework for managing environment and community risks and impacts.

To measure compliance with site approvals and licences, WCS undertakes a comprehensive monitoring program. The environmental monitoring program is shown in **Figure 6-1**.

This section provides a summary of environmental performance in the Reporting Period, including:

- Section 6.1 – Meteorological Summary
- Section 6.2 – Noise
- Section 6.3 – Blasting
- Section 6.4 – Air Quality
- Section 6.5 – Biodiversity
- Section 6.6 – Heritage
- Section 6.7- Other Matters

The environmental performance for surface water and groundwater, rehabilitation, and community aspects are reported in **Sections 7.0**, **8.0**, **9.0** and **10.0** respectively.

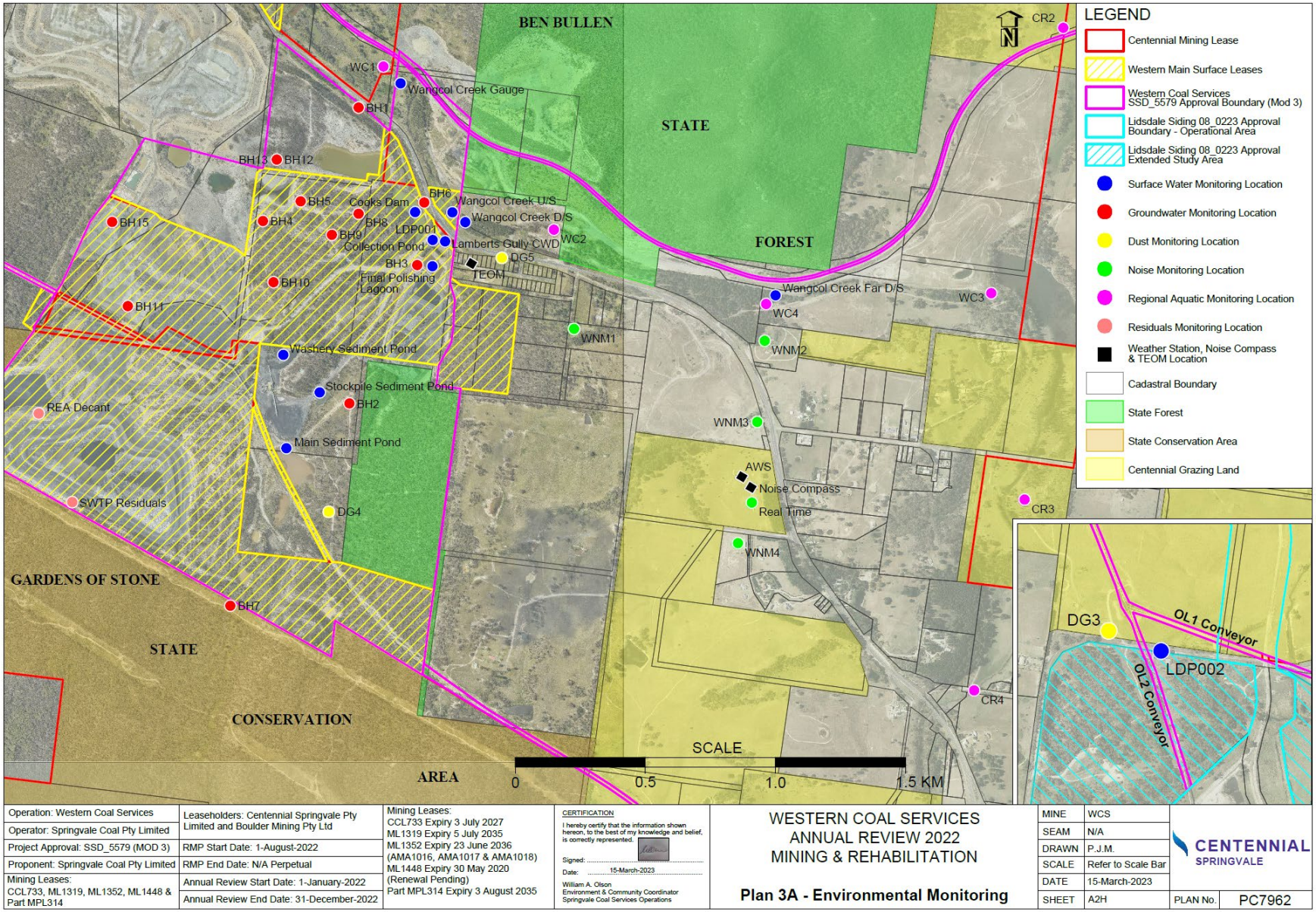


Figure 6-1: WCS Western Coal Services Monitoring Locations

6.1 METEOROLOGICAL SUMMARY

6.1.1 Environmental Management

WCS operates a meteorological monitoring station in accordance with SSD-5579 Schedule 3 Condition 18 of SSD-5579 and the Western Region Air Quality and Greenhouse Gas Management Plan (WRAQMP) (**Section 6.4**).

6.1.2 Environmental Performance

A summary of meteorological data collected throughout 2022 is presented in **Table 6-1**. WCS metrological station a recorded minimum temperature of -5.8°C in June, and a maximum temperature of 28.9°C in December. January received the highest amount of rainfall of 163.2mm during the Reporting Period. All months, with exception of June and December received rainfall greater than their respective long term monthly averages. June received the least amount of rainfall in the Reporting Period of 14mm. The cumulative rainfall for the Reporting Period of 1178.6mm was above the long-term annual average (**Figure 6-2**).

Wind speed and direction have been plotted in a wind rose in **Appendix 3**. Predominate winds were recorded from the Southeast during the Reporting Period.

Table 6-1: Meteorological Conditions

Month	Total Rainfall (mm)	Cumulative Rainfall (mm)	Minimum Temperature (^{0} C) @ 2m	Maximum Temperature (^{0}C) @ 2m
January 2022	163.2	163.2	9.8	28.2
February 2022	91.4	254.6	7.6	27.2
March 2022	160.2	414.8	6.3	25.3
April 2022	68.4	483.2	3.2	21.8
May 2022	62.4	545.6	-1.3	20
June 2022	14	559.6	-5.8	12.7
July 2022	127.6	687.2	-6.4	13.6
August 2022	76.4	763.6	-1.2	16.6
September 2022	120.4	884	-2.3	16.3
October 2022	144.4	1028.4	0.04	19.4
November 2022	94.4	1122.8	0.5	25
December 2022	26	1148.8	1.6	28.9

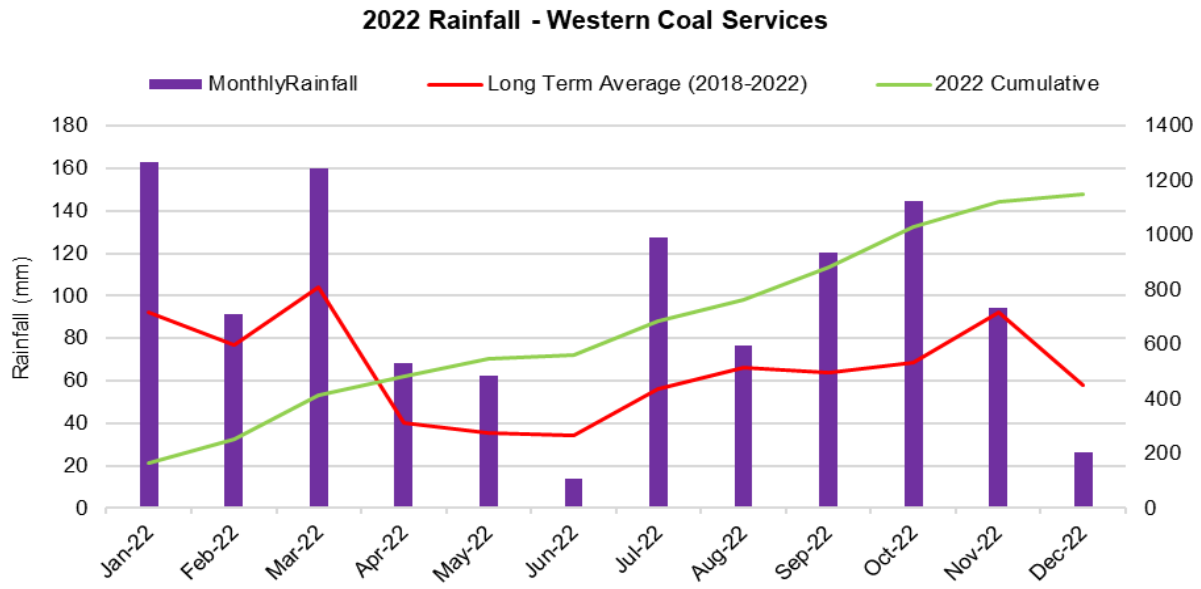


Figure 6-2: 2022 Rainfall Summary

6.2 NOISE

6.2.1 Environmental Management

WCS manages noise in accordance with the Western Region Noise Management Plan (WRNMP) dated February 2021. The WRNMP was approved by DPE on the 15 February 2021. The following sources of noise identified in the WRNMP are relevant for WCS operations:

- Operation of mobile equipment – e.g., trucks, loaders.
- Coal transporting activities – e.g., overland conveyors.
- Washing of ROM coal.

Noise mitigation measures for WCS are:

- Maintaining all plant and equipment to manufacturer specifications (ongoing).
- Operate mobile plant in a quiet, efficient manner and regular training of operators (ongoing).
- Installation of frequency modulated reversing alarms or “quakers” on mobile plant to replace reversing alarms (complete).
- Switching off vehicles and plant when not in use (ongoing).
- Low-noise design for transfer chutes on conveyor systems (complete).
- Low-noise idlers fitted to conveyors (complete and ongoing as required to ensure compliance).
- Limiting sound power levels for key noise sources such as conveyor drives and the stockpile dozer (complete).
- Partial enclosures on conveyors (complete).

Additional noise management and mitigation measures are outlined in the WRNMP.

6.2.2 Environmental Performance

Noise Criteria

Schedule 3, Condition 7 of SSD-5579 provides noise criteria for 14 identified locations. EPL 21229 condition L.5.1 specifies noise monitoring limits for 4 locations. **Table 6-2** presents the applicable noise criteria for SSD-5579, EPL21229, the attended noise monitoring locations required by EPL21229 and the long-term monitoring program, as approved in the WRNMP.

Table 6-2: Western Coal Services Noise Criteria

Monitoring location	EPA ID number	Receiver ID	Day LAeq (15 min) dBA	Evening LAeq (15 min) dBA	Night LAeq (15 min) dBA	Night LA1 (1min) dBA
WNM1	Point 8	B12	40	35	35	47
		B13	41	36	36	50
WNM2	Point 9	B14	41	35	35	55
WNM3	Point 10	B15	36	35	35	45
WNM4	Point 11	B16	35	35	36	45
-	-	B17	42	44	45	45
-	-	W1	37	37	41	45
-	-	W2	35	35	36	45
-	-	L1	42	35	35	45
-	-	L2	40	39	35	45
-	-	WR1	41	38	36	57
-	-	WR2	38	37	35	48
-	-	S3	36	36	39	45
-	-	All other privately owned residences	35	35	35	45

Note 1: Day is defined as the period from 7:00 am to 6:00 pm, evening is defined as the period from 6 pm to 10 pm and night time is defined as 10:00 pm to 7:00 am. Note 2: The noise criteria in ***Table 6-2*** *do not apply to noise generated by the operation of the overland coal conveyor, Mount Piper haul road or the Wallerawang haul road or if WCS has an agreement with the owner/s of the relevant residence or land to generate higher noise levels, and WCS has advised the Department in writing of the terms of this agreement. Note 3: The noise criteria in Table 3.1* are to apply under all meteorological conditions except the following:

(a) Average wind speed at microphone height exceeds 5 m/s

(b) Wind speeds greater than 3 m/s measured at 10 m above ground level

(c) Temperature inversion conditions greater than 3°C/100 m

Attended Noise Monitoring

In accordance with the long-term noise monitoring program, monthly attended noise surveys have been undertaken at 4 locations which have been selected to be representative of identified receiver locations in 2022. These locations are shown in **Figure 6-1**. Results for Day, Evening and Night LAeq (15-minute) are presented in **Table 6-3** to **Table 6-5**. Results for Night LAeq (1-minute) is presented in **Table 6-6**. There were no exceedance of the noise criteria during the Reporting Period.

Table 6-3: Western Coal Services LAeq (15minute) Day

Monitoring location	Day Limit LAeq (15min)	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	June 2022	July 2022	Aug 2022	Sept 2022	Oct 2022	Nov 2022	Dec 2022
WNM1	40	ND	ND	ND	ND	ND	34	ND	ND	ND	ND	ND	ND
WNM2	41	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WNM3	36	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WNM4	35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes: ND – *Not Discernible. When site only noise is noted as ND, there was no noise from the source of interest audible at the monitoring location.*

Table 6-4: Western Coal Services LAeq (15minute) Evening

Monitoring location	Evening Limit LAeq (15min)	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	June 2022	July 2022	Aug 2022	Sept 2022	Oct 2022	Nov 2022	Dec 2022
WNM1	35	ND	ND	ND	ND	ND	33	ND	ND	31	ND	ND	ND
WNM2	35	ND	ND	ND	ND	ND	ND	ND	ND	30	ND	ND	ND
WNM3	35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WNM4	35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes: ND – *Not Discernible. When site only noise is noted as ND, there was no noise from the source of interest audible at the monitoring location.*

Table 6-5: Western Coal Services LAeq (15minute) Night

Monitoring location	Night Limit LAeq (15min)	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	June 2022	July 2022	Aug 2022	Sept 2022	Oct 2022	Nov 2022	Dec 2022
WNM1	35	ND	ND	ND	ND	ND	34	ND	ND	28	33	ND	ND
WNM2	35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WNM3	35	ND	ND	ND	<30	ND	ND	ND	ND	ND	ND	ND	ND
WNM4	36	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	ND	ND

Notes: ND – *Not Discernible. When site only noise is noted as ND, there was no noise from the source of interest audible at the monitoring location.*

Table 6-6: Western Coal Services LA1 (1minute) Night

Monitoring location	Night Limit LAeq (1min)	Jan 2022	Feb 2022	Mar 2022	Apr 2022	May 2022	June 2022	July 2022	Aug 2022	Sept 2022	Oct 2022	Nov 2022	Dec 2022
WNM1	47	ND	ND	ND	ND	ND	37	ND	ND	28	33	ND	ND
WNM2	55	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WNM3	45	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WNM4	45	ND	ND	ND	ND	ND	40	ND	ND	ND	ND	ND	ND

Notes: ND – *Not Discernible. When site only noise is noted as ND, there was no noise from the source of interest audible at the monitoring location.*

WCS will continue to monitor potential impact at nearby noise sensitive receivers through the monthly operator-attended noise monitoring program of the WNMP.

Investigations of the five noise complaints received during the Reporting Period determined four complaints were related to faulty conveyor rollers, which were immediately or so after replaced. One nose complaint could not be verified as there were no WCS operational activities in the area at the time of the compliant.

Sound Power Levels

In accordance with the WRNMP sound power levels (SPL) monitoring was undertaken in 2022. Global Acoustics (now EMM) were engaged to conduct a SPL survey for the WCS

overland conveyor system, fixed and mobile plant in accordance with the Noise Reduction Study (NRS) contained in the WRNMP.

The SPL measurements of the overland conveyor system were made on 13 September 2022. Overland conveyor system measured SPL are provided in **Table 6-7** and **Appendix 4**. These levels are the average SPL measured across the entire length of each conveyor. Conveyors OL1 and OL3 were not operating during testing dates, therefore measurements of these conveyors were not undertaken in 2022.

Table 6-7: Conveyor System Annual Sound Power Level Results @ 1m dB

Item	LWA	LW
OL2 (Zones 3, 4, 6 and 7)	82	76

The SPL measures of fixed and mobile plant was undertaken on the 13 September 2022. The results are provided in **Appendix 4**. EMM concluded changes of 1 – 2 dB between 2021 and 2022 testing are considered minor and shouldn't warrant any further action. CW02 and TT07 Lw increased by 5 dB and should be checked for any obvious signs of maintenance or degradation.

Real Time Monitoring

In accordance with Schedule 3, Condition 8 (b), a noise management system is installed at WCS uses a combination of predictive meteorological forecasting and real time noise monitoring data to guide day to day planning of the Western Coal Services operations. As outlined in the WRNMP the system is installed for proactive management purposes only. During the Reporting Period the system was calibrated and operational. Further details for attended noise monitoring results in the Reporting Period are presented in **Appendix 4**.

6.2.3 Comparison Against Predictions

An Environmental Impact Statement (EIS) was prepared for the Western Coal Services Project by RPS Australia East Pty Ltd (RPS) in 2013. Modelled predictions indicate that WCS will comply with the Industrial Noise Policy (INP) Project Specific Criteria. Modelled predictions indicate that there will be likely residual noise impacts above the INP Project Specific Criteria at some receptors in the locality of Blackmans Flat (RPS, 2013).

EMM Consulting Pty Limited (EMM) were engaged by Springvale Coal to prepare a modification report for MOD4. A construction noise and vibration impact assessment (CNVIA) by EMM provided an assessment of the noise and vibration impacts associated with the proposed construction of the proposed modification. The CNVIA considered the potential for noise and vibration impacts from the proposed works and has been prepared in accordance with the methodology outlined in the NPfI (EPA 2017), ICNG (DECC 2009), as well as other relevant guidelines and standards. Noise levels generated by all works are expected to comply with the construction noise management levels under all scenarios. Noise levels at all receivers are expected to be well below the highly affected noise level under all scenarios (EMM, 2021).

6.2.4 Long Terms Analysis

Table 6-8 summarises the number of noise non-compliances at attended monitoring locations since 2017.

Table 6-8: 2017-2022 WCS Attended Noise Monitoring Exceedances

Location	2017			2018			2019			2020			2021			2022		
	D	E	N	D	E	N	D	E	N	D	E	N	D	E	N	D	E	N
WNM1	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WNM2	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WNM3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WNM4	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WNM5	0	0	0	0	0	0												
WNM6	3	5	6	0	0	0												
WNM7	4	6	4	0	0	0												
WNM8	0	0	0	0	0	0												
WNM9	0	0	0	0	0	0												
WNM10	0	0	0	0	0	0												
WNM11	0	0	0	0	0	0												

***D** = Day period (The period from 7am to 6pm on Monday to Saturday, and 8am to 6pm on Sundays and Public Holidays).*

***E** = Evening period (The period from 6pm to 10pm).*

***N** = Night period (The period from 10pm to 7am on Monday to Saturday, and 10pm to 8am on Sundays and Public Holidays).*

As shown in **Table 6-8** there have been no non-compliant attended noise monitoring measurements since 2018. The WCS attended noise monitoring moved to the long-term monitoring program in 2019 in accordance with the WRNMP requirement, to undertake monthly attended noise monitoring at WNM1, WNM2, WNM3, and WNM4.

6.2.5 Implemented / Proposed Improvements

Noise management controls are considered effective based upon compliance with the noise criteria. WCS will continue to implement the WRNMP. WCS will review and revise the WRNMP as required, in accordance with Schedule 5 Condition 5 of SSD-5579 during the next Reporting Period. WCS will continue to undertake periodic inspections and maintenance requirements of fixed and mobile plant during the next Reporting Period to minimise sound power levels.

6.2.6 Acquisitions and Mitigation Requests

In accordance with Schedule 3, Condition 1 of SSD-5579 upon receiving a written request for acquisition from the owner of Property B4, WCS must acquire the land in accordance with the procedures in Schedule 4, Condition 5 of SSD-5579. There were no written requests received for acquisition during the Reporting Period.

In accordance with Schedule 3, Condition 2 of SSD-5579 upon receiving a written request for noise mitigation measures from the owner of Property B4, WCS must implement these measures. There were no requests received for noise mitigation measures during the Reporting Period.

6.3 BLASTING

There were no blasting activities carried out at WCS during the Reporting Period.

6.4 AIR QUALITY

6.4.1 Environmental Management

WCS manages air quality in accordance with the Western Region Air Quality and Greenhouse Gas Management Plan (WRAQMP) dated April 2021. This plan was approved by DPE on the 10 May 2021. The following identified sources of dust emissions in the WRAQMP are relevant for WCS operations:

- Wind erosion from coal stockpiles;
- Wind erosion from disturbed areas and coal stockpiles;

- Wheel generated dust from vehicle movements;
- Fugitive emissions from coal handling and processing;
- Fugitive emissions during train loading operations;
- Coal transporting activities (i.e. conveyors and trains);
- Operation of mobile equipment.

Key dust mitigation measures for WCS are:

- Signage to display speed limits on all unsealed roads in the surface facilities area;
- Water sprays on unsealed areas during use or windy conditions;
- Water sprays (sprinkler system) on the coal product stockpile during dry and windy conditions; and
- Maintaining enclosures on conveyor systems.

Additional air quality management and mitigation measures are outlined in the WRAQMP. WCS undertakes air quality monitoring in accordance with the short-term program. The air quality monitoring locations are shown in **Figure 6-1**.

6.4.2 Environmental Performance

Air Quality Criteria

Schedule 3, Condition 13 of SSD-5579 provides the air quality criteria at any residence on privately owned land in **Table 6-9**, **Table 6-10** and **Table 6-11**.

Table 6-9: Long Term Criteria for Deposited Dust

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level [1]
[c] Deposited Dust	Annual	[b] 2 g/m^2/month4	[a] 4 g/m^2/month

Table 6-10: Short Term Criteria for Particulate Matter

Pollutant	Averaging Period	[d] Criterion
Particulate matter < 10 µm (PM_{10})	24-hour	[a] 50µg/m^3

Table 6-11: Long Term Criteria for Particulate Matter

Pollutant	Averaging Period	[d] Criterion
Total suspended particulate matter (TSP)	Annual	[a] 90µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	[a] 25µg/m^3

Notes: a Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources). b Incremental impact (i.e. incremental increase in concentrations due to the development on its own). c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method. d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary. e "Reasonable and feasible avoidance measures" includes, but is not limited to, the operational requirements in condition 17 to develop and implement a real-time air quality management system that ensures operational responses to the risks of exceedance of the criteria.

Dust Deposition

WCS maintain a network of dust depositional gauges as required by the WRAQMP (**Figure 6-1**). **Table 6-12** presents the dust depositional monitoring results obtained during the Reporting Period.

Table 6-12: 2022 Depositional Dust Results

Dust Gauge	Min (g/m²/month)	Mean (g/m²/month)	Max (g/m²/month)
WCSDG3	0.47	2.2	4.68
WCSDG4	0.27	1.4	8.5[1]
WCSDG5	0.08	0.7	2.27

Notes: [1]June 2022 result. WCSDG4 is located internally and not in the vicinity of sensitive receivers. WCS completed an investigation on the determining there were no know contributing factors to elevated result.

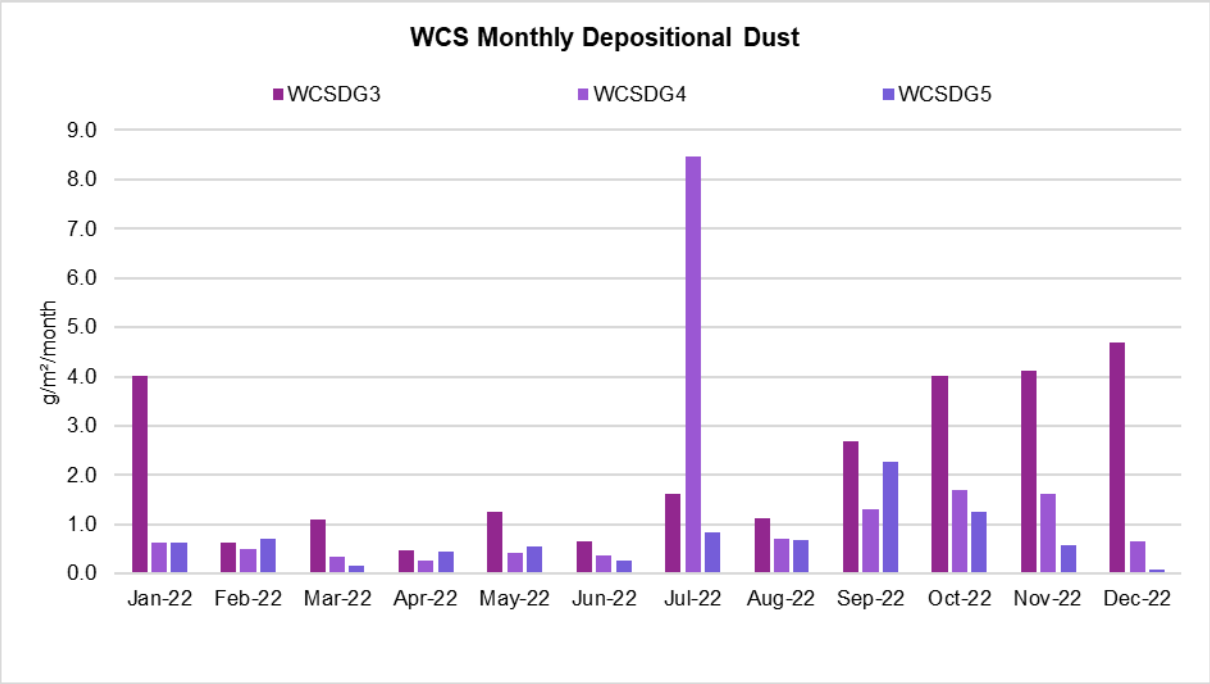


Figure 6-3: 2022 Depositional Dust Results

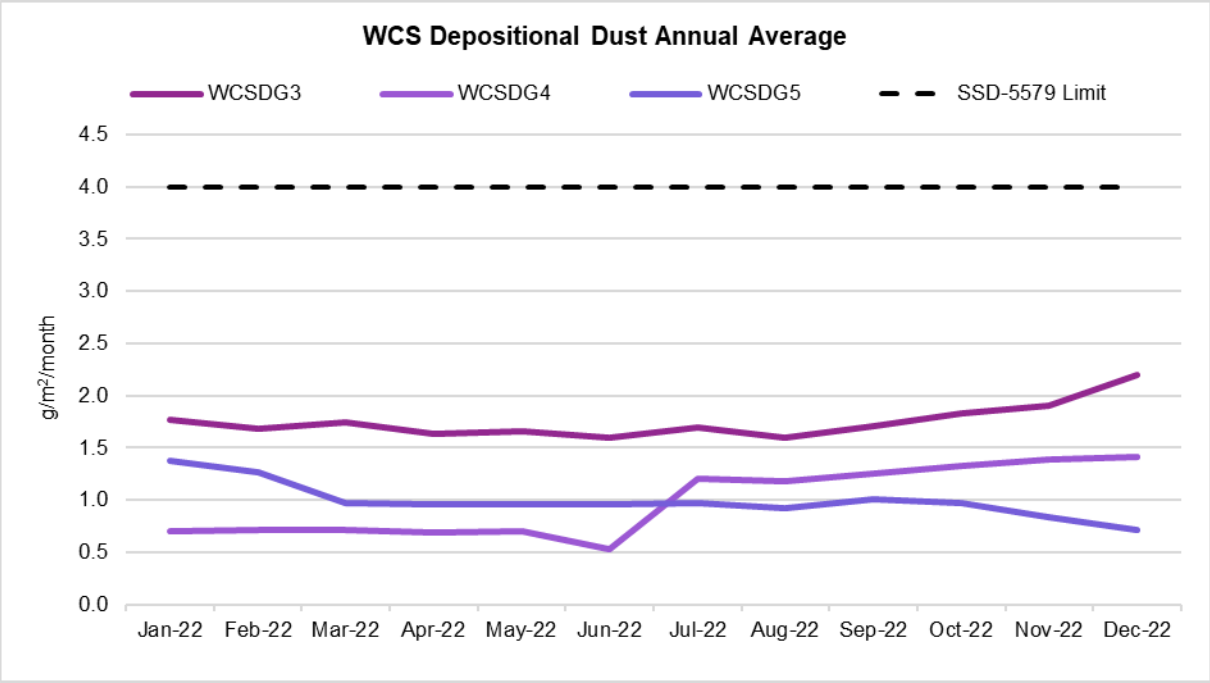


Figure 6-4: 2022 Depositional Dust Annual Average

The annual averages for deposited dust are below the annual criterion of 4g/m^2/month (**Table 6-12** and **Figure 6-4**) and remain complaint with the limits in the SSD-5579 and the WRAQMP. Further results for depositional dust monitoring during the Reporting Period are provided in **Appendix 5.**

PM_{10} and TSP

Real time air quality monitoring for PM_{10} utilises a TEOM unit (**Figure 6-1**). A ratio of PM_{10} and TSP is used to estimate TSP contributions. For WCS a conservative ration of 0.43 is used to calculate compliance with the TSP criteria from the PM_{10} data. **Table 6-13** presents the PM_{10} and TSP monitoring results obtained during the Reporting Period.

Table 6-13: 2022 Results Particulate Matter

	Criteria (µg/m^3)	Maximum (µg/m^3)	Mean (µg/m^3)
24hr PM_{10} (short term)	50	18.5	N/A
PM_{10} (long term)	25	N/A	7.72
Estimated TSP[1]	90	N/A	17.96

Notes: [1]Calculated TSP concentration estimate (PM_{10} annual average divided by 0.43).

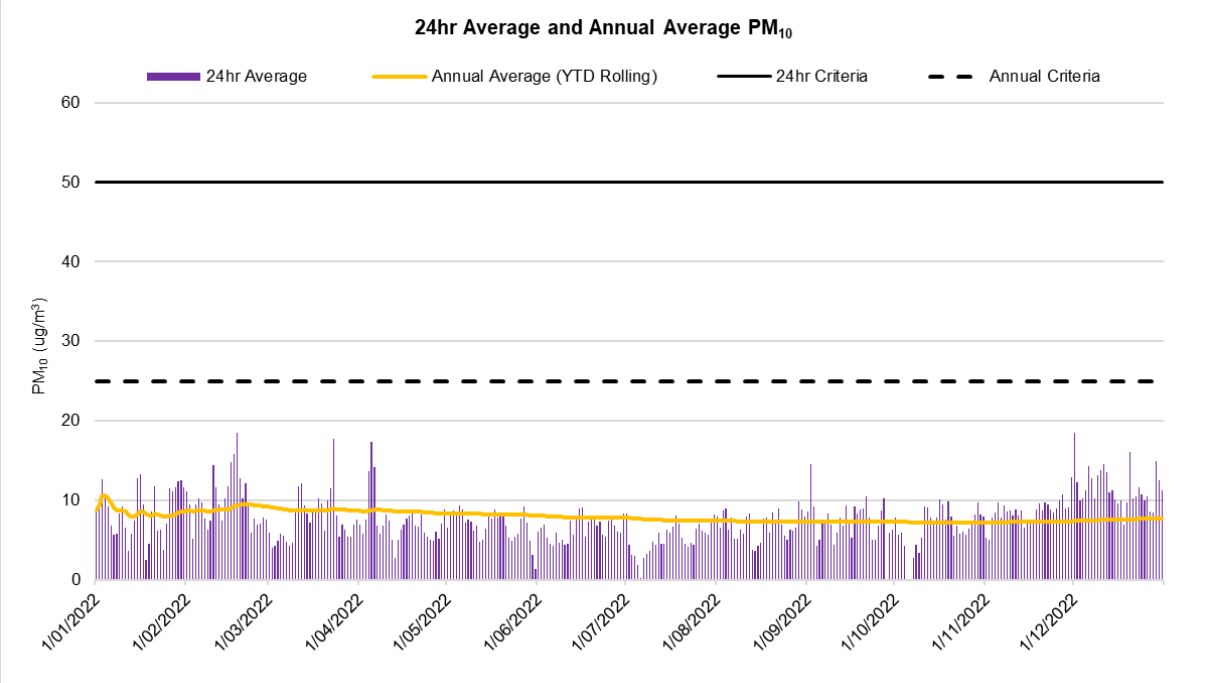


Figure 6-5: 24hr and Annual Average PM_{10}

The 24hr average and annual average results for PM_{10} are below the criterion of 50µg/m^3 and 25µg/m^3 respectively (**Table 6-13** and **Figure 6-5**) and remain complaint with the limits in the SSD-5579 and the WRAQMP.

The annual average results for TSP are below the criterion of 90µg/m^3 (**Table 6-13**) and remain complaint with the limits in the SSD-5579 and the WRAQMP. The TEOM unit PM_{10} data capture rate was 100% during the Reporting Period. Further results for PM_{10} and TSP monitoring during the Reporting Period are provided in **Appendix 5**.

6.4.3 Comparison Against Predictions

An air quality impact assessment (AQIA) was completed for the original *Western Coal Services Project - Environmental Impact Statement* (RPS 2013). The AQIA quantified emissions of particulate matter, specifically:

- Total suspended particulate matter (TSP);
- Particulate matter less than 10 microns in aerodynamic diameter (PM_{10}); and
- Particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$).

Detailed modelling was conducted to assess whether the Project would adversely impact any privately owned residencies located within the vicinity of the Project Application Area. The assessment included predictions of air quality impacts from the Project in isolation as well as the potential cumulative impacts of other sources. The modelling indicates that the nearest sensitive receptors at Blackmans Flat are unlikely to experience dust concentrations above the EPA's air quality assessment criteria (RPS, 2013).

EMM Consulting Pty Limited (EMM) were engaged by Springvale Coal to prepare a modification report for MOD4. An assessment of construction air quality impacts was prepared by EMM to assess any potential dust impacts resulting from MOD4. The assessment followed the *Guidance on the Assessment of Dust from Demolition and Construction* (IAQM 2014). Air quality impacts during the ongoing operation of SCSS and other components of WCS were not anticipated to change as a result of the proposed modification. Consequently, an assessment of air quality impacts associated with the ongoing operation of SCSS and other components of WCS was not considered necessary (EMM, 2021).

PM_{10}, TSP and Depositional Dust Results for the Reporting Period were within EIS and MOD4 predictions.

6.4.4 Long Terms Analysis

The annual average long-term trends for depositional dust and PM_{10}/TSP are summarised in **Table 6-14** and **Table 6-15** respectively.

Table 6-14: Long Term Trends for Deposited Dust[1]

	2017 g/m2/month	2018 g/m²/month	2019 g/m²/month	2020 g/m²/month	2021 g/m²/month	2022 g/m²/month
WCSDG3	1.35	0.63	1.13	1.72	1.66	2.2
WCSDG4	0.61	0.98	1.15	1.01	0.69	1.4
WCSDG5	0.46	0.73	2.04	1.44	1.37	0.7

Notes: [1] Annual Averages

Table 6-15: Exceedances for Particulate Matter

	2017	2018	2019	2020	2021	2022
24hr PM_{10} (short term)	0	0	0[1]	0[1]	0	0
PM_{10} (long term)	0	0	0	0	0	0
TSP	0	0	0	0	0	0

Notes: [1] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, or any other activity agreed by the Secretary as described in the 2019 and 2020 Annual Reviews per Schedule 3 Condition 15.

Air quality monitoring during the Reporting Period confirmed dust deposition, TSP and PM_{10} results were below their respective 24hr and annual average criteria and are consistent with long term data trends and predications.

6.4.5 Implemented / Proposed Improvements

Dust emission controls are considered effective based upon compliance with the air quality criteria during the Reporting Period. WCS will continue to implement the WRAQMP. WCS will review and revise the WRAQMP as required, in accordance with Schedule 5, Condition 5 of the SSD-5579.

6.5 GREENHOUSE GAS MONITORING

6.5.1 Environmental Management

Greenhouse gas (GHG) reporting and management measures are provided in the WRAQMP. GHG emissions from the WCS will continue to be monitored and reported annually in accordance with the *Commonwealth Government National Greenhouse and Energy Reporting scheme* (NGERS).

6.5.2 Environmental Performance

Table 6-16 reports the Scope 1 Emissions (Direct) and Scope 2 Emissions (Indirect) in tonnes CO2-e produced for the current period and compares these against EIS predictions[3].

Table 6-16 Summary of GHG Emissions Reporting FY2022

Emission Sources	Estimated Emissions (tonnes CO_{2-e})[4]					Predicted Emissions (tonnes CO_{2-e})
	FY 18	FY 19	FY 20	FY 21	FY 22	
Scope 1 Emissions (direct emissions)	59,317	49,335	18,823	31,628	19,256	26,633
Scope 2 Emissions (indirect emissions)	83,934	80,077	75,080	72,337	72,824	78,560
Combined Greenhouse Gas Emissions (Scope 1 and 2)	**143,251**	**129,412**	**93,903**	**103,965**	**92,080**	**105,193**

6.5.3 Comparison Against Predictions

During the 2022 Reporting Period the combined calculated Scope 1 and Scope 2 GHG emissions for WCS and Springvale Mine were 19,256 (t CO_2-e) and 72,824 (t CO_2-e) respectively and approximately -11.45% less than the combined total GHG emissions of 105,193 (t CO_2-e) as predicted in the EIS.

6.5.4 Long Term Analysis

Table 6-16 presents a summary of GHG emissions reported over the last five (5) financial years. Based on the information reported, GHG emissions have been below EIS estimates for the project.

[3] (EIS 2014) *Environmental Impact Statement Springvale Mine Extension Project 2014* by Golder Associates Pty Ltd

[4] GHG data and reporting for Springvale Coal Services (SCS) is included in Springvale dataset. For the purposes of NGER's reporting, SCS and Springvale are considered one facility and therefore all data is combined.

6.5.5 Implemented/Proposed Improvements

Mitigation measures to minimise to the greatest extent practicable GHG emissions from WCS included regular maintenance of plant and equipment to minimise fuel consumption and consideration of energy efficiency in plant and equipment selection/phase.

6.6 BIODIVERSITY

6.6.1 Environmental Management

WCS manages biodiversity in accordance with the Western Region Biodiversity Management Plan (WRBMP). During the Reporting Period, Centennial prepared several revisions of the WRBMP.

At the time of preparing this 2022 Annual Review, the WRBMP was still under consideration with DPE. Management measures within the WRBMP specific to WCS include, but not limited to access management, bushfire management, erosion control, salinity management, pre clearance surveys and waste management.

The WRBMP, once approved, will require monitoring and reporting program to document the condition and extent of Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland EEC and document the condition and extent of individual *Eucalyptus aggregate*.

WCS manages their biodiversity offset area “Carinya” (**Figure 6-6**), in accordance with the Western Region Biodiversity Offset Strategy (WRBOS) developed by Centennial to fulfill the requirements of Schedule 3 Condition 25 of SSD-5579.

The WRBOS (Version 8) was approved by DPE on 17 November 2020. To offset the loss of 10.67 ha of vegetation clearing required for MOD2, constituting the requirement for 695 ecosystem credits, the following has been provided as an offset (**Figure 6-6**):

- 292 ecosystem credits from HN534 - Moderate/Good Carinya Offset site; and
- 403 ecosystem credits from HN544 – Moderate/Good Carinya Offset site.

6.6.2 Environmental Performance

Aquatic ecology monitoring is undertaken in accordance with the requirements of the Upper Coxs River Action and Monitoring dated March 2020 as required by the Water Management Plan for Lidsdale Siding (WMP 2022). Relevant to WCS, Section 3 of the 2022 Upper Coxs River Catchment (UCRC) Aquatic Ecology report is summarised and provided in **Appendix 6**.

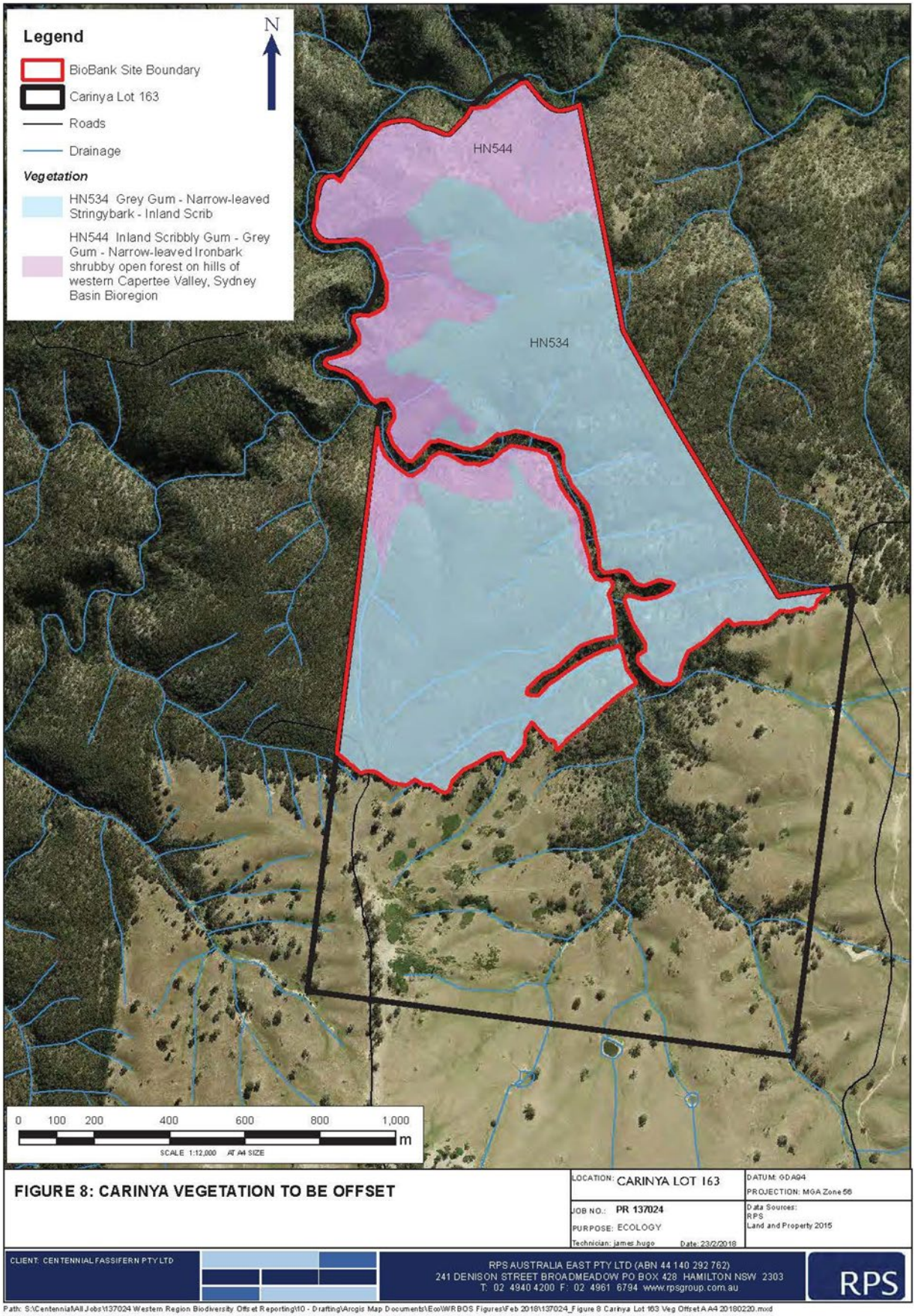


Figure 6-6 Carinya Offset Site & BioMetric Vegetation Types (BVTs)

6.6.3 Comparison Against Predictions

The 2013 EIS predicted that:

- There are no significant impacts on adjacent aquatic habitats as impacts will be satisfactorily managed and mitigated via construction and operational Environmental Management Plans (EMPs).
- There are no significant impacts on the ecology of the Springvale Coal Services Site, including vegetation communities, threatened flora and fauna or endangered ecological communities that are known or expected to occur.
- There are no significant impacts on threatened species or Endangered Ecological Community (EECs) listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act 1995), or Matters National Environmental Significance (MNES) under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

A biodiversity development assessment report (BDAR) was completed by RPS to assess any potential biodiversity impacts resulting from the proposed construction envelope for MOD4. The BDAR project area for MOD4 is the construction envelope and encompasses approximately 30 ha. MOD4 will result in the clearing of 15.18 ha of native vegetation (including 0.24 ha of potential Bathurst Copper Butterfly habitat) and the removal of 32 Black Gum individuals from within the construction envelope. A total of 376 ecosystem credits and 72 species credits are required to offset the direct impacts of the proposed modification. These offset liabilities will be met by Springvale Coal prior to the commencement of construction of each modification element and may be staged to match construction staging (EMM, 2021).

As MOD 4 was only approved in October 2022, construction activities had not yet commenced, therefore no impacts to biodiversity as a result of WCS operational activities during the Reporting Period. During the Reporting Period there has been no additional disturbance or clearing associated with WCS.

6.6.4 Implemented / Proposed Improvements

Monitoring and inspections during the next Reporting Period will be undertaken to assess the effectiveness of the management measures for WCS in accordance with the revised WRBMP, subject to its approval from the DPE.

Further consultation with DPE regarding the latest revision to the WRBMP (Version 6) that was revised to align with MOD4, will be undertaken during the next Reporting Period. Revision of the WRBMP and WRBOS to be undertaken in the next Reporting Period as required.

6.6.5 Biodiversity Offsets

The conservation agreement for Carinya Lot 163 (**Figure 6-6**) was finalised in October 2020. Springvale submits an Annual Management report to BCS for the Carinya offset area as required by the WRBOS.

A draft Conservation Bond calculation was submitted to the Secretary with the WRBOS. The Conservation Bond is proposed to include the completion of management actions for the first 10 years of the WRBOS. The site has no active restoration. Management activities are limited to limiting human disturbance and maintaining site security, weed management, pest management and ecological monitoring.

6.7 HERITAGE

6.7.1 Environmental Management

WCS manages Aboriginal heritage in accordance with the Western Region Aboriginal Cultural Heritage Management Plan (WRACHMP) dated September 2021. The WRACHMP was approved by DPE in 2021. WCS manages European heritage in accordance with the Historic Heritage Management Plan (HHMP) dated June 2018. The HHMP was approved by DPE in 2018.

6.7.2 Environmental Performance

Prior to MOD4, the WRACHMP identified thirteen registered Aboriginal Heritage Information Management System (AHIMS) items within the WCS development consent boundary.

An Aboriginal Cultural Heritage Assessment (ACHA) was completed by RPS and with WCS's registered Aboriginal parties (RAPs) in accordance with the relevant guidelines for MOD4 regarding the proposed construction envelope for MOD4. The ACHA identified an additional five Aboriginal heritage items during the survey for MOD 4, including two artefact scatters (45-1-2823 and 45-1-2845) and three isolated finds (45-1-2848, 45-1-2847 and 45-1-2846) (EMM, 2021).

There are no European heritage items located within the WCS development consent boundary (HHMP). There were no disturbances of Aboriginal heritage sites during the Reporting Period.

6.7.3 Comparisons Against Predictions

The likelihood of any impact on Aboriginal Heritage has been assessed as low by the CHA. There are no cumulative impacts or foreseeable risk of harm arising from the proposed works on the Springvale Coal Services Site. Best practice mitigation measures have been suggested for the management of identified Aboriginal sites. It was also concluded by the CHA report that there were no non-Aboriginal Heritage constraints. It is considered that the Springvale Coal Services Site is well removed from any listed Heritage Items and the proposed works will have no impact upon them (RPS, 2013).

As agreed with the RAPs the five new sites will be salvaged prior to construction works commencing. Prior to salvage, the sites will be added to the Western Region ACHMP. The sites will be salvaged in accordance with the methodology presented in Section 6.4.1 of the Western Region ACHMP (EMM, 2021). As MOD 4 was only approved in October 2022, construction activities had not yet commenced, therefore no salvage activities regarding the five recently identified Aboriginal heritage items were undertaken during the Reporting Period.

6.7.4 Implemented / Proposed Improvements

The Western Region Aboriginal Cultural Heritage Committee (ACHC) Meetings were held in May and October 2022. WCS will continue to undertake Western Region ACHC Meetings in the next Reporting Period.

As required by the ACHA for MOD4, the five Aboriginal cultural heritage sites identified within the construction envelope will be salvaged prior to construction works, in consultation with the RAPs and the WRACHMP. The salvage status of these five Aboriginal cultural heritage sites identified within the construction envelope, will be provided in the next Annual Review.

The pre-clearance permit systems in the WRAHMP provides the land disturbance due diligence process, implemented by the site and is considered appropriate for the management of Aboriginal heritage items.

6.8 OTHER MATTERS

6.8.1 Bushfire Management

WCS manages bushfire management in accordance with the SCSO Bushfire Management System. Fire control equipment was inspected monthly as part of normal operational maintenance. No fires occurred in the WCS approval boundary area that required Rural Fire Services assistance during the Reporting Period.

6.8.2 Waste

Waste management at WCS is managed in accordance with the Waste Management Plan for Springvale Coal Services Operations (SCSO) dated April 2019. This section provides an overview of waste minimisation and management measures as required under Schedule 3 Condition 42 of SSD-5579.

There are four main forms of waste generated by the Western Coal Services Project and in particular the Springvale Coal Services Site. These include coal reject material produced from the washery, recyclable materials, workshop wastes, and domestic wastes. Coal reject was utilised in the construction of the Reject Emplacement Area (REA), and for landform completion works for Area 4 in accordance with the WCS RMP.

The following items are collected to minimise waste to landfill including, waste oil, paper and cardboard packaging, metals, other recyclables (e.g. glass and plastics) and timber pallets. All general waste is collected by licensed waste contractor for disposed at Licensed land fill site. **Figure 6-7** provides a summary of waste generated in 2022 at the WCS site. Further details on waste management is presented in **Appendix 7.**

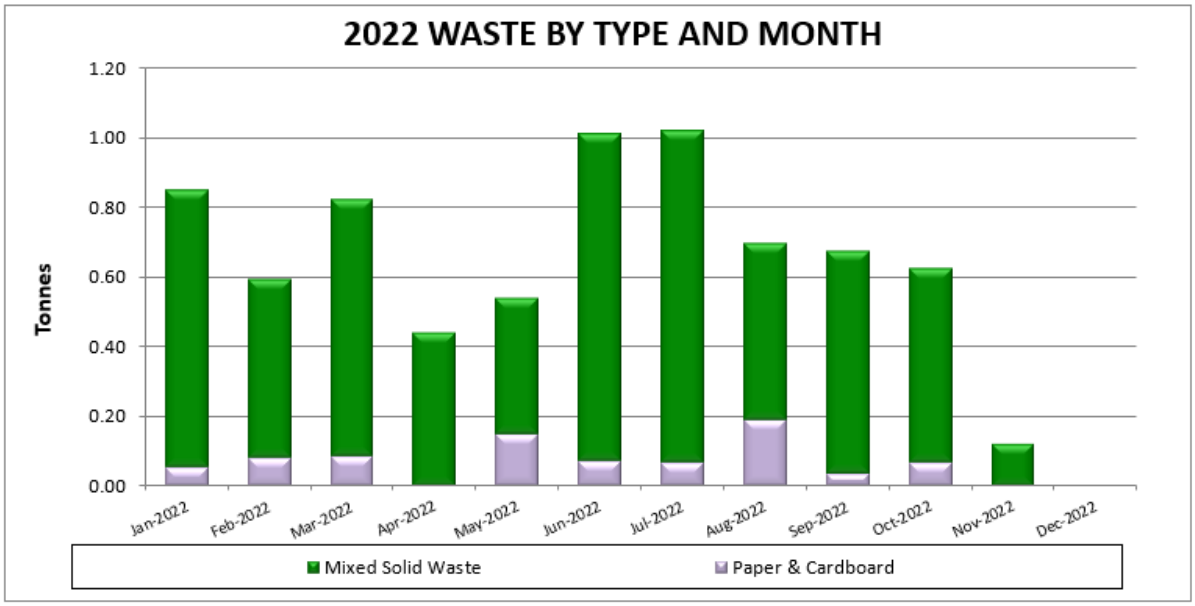


Figure 6-7 2022 Waste Generation

In 2022, 53.98 tonnes of waste was sent offsite for disposal with 37.775 tonnes of steel recycled, at a yield recycling rate of 69.98%. This compares to a recycling rate of 23.33% in 2020 and 24.3% in 2021.

6.8.3 Residual Waste

Schedule 2 Condition 8A of SSD-5579 specifies the limits associated with the transfer of residual wastewater from the Springvale Water Treatment Project (SWTP). The wastewater transfer limits are presented in **Table 6-15**, alongside the 2022 volumes transferred during the Reporting Period.

Table 6-17: Residual Transfer Limits and Performance

Performance Criteria	Limit	2022 Results
Annual Average	0.35 Megalitres/Day	0.25 ML/day
Daily Maximum	0.43 Megalitres/Day	0.44 ML/day[1]

Notes: [1]A transfer exceedance was recorded on the 18th and 19th October 2022. 18th October shows a transfer of 0.441 ML and on 19th October of 0.434 ML, against conditional limit of 0.43 ML/day. Refer to **Section 11** for further details.

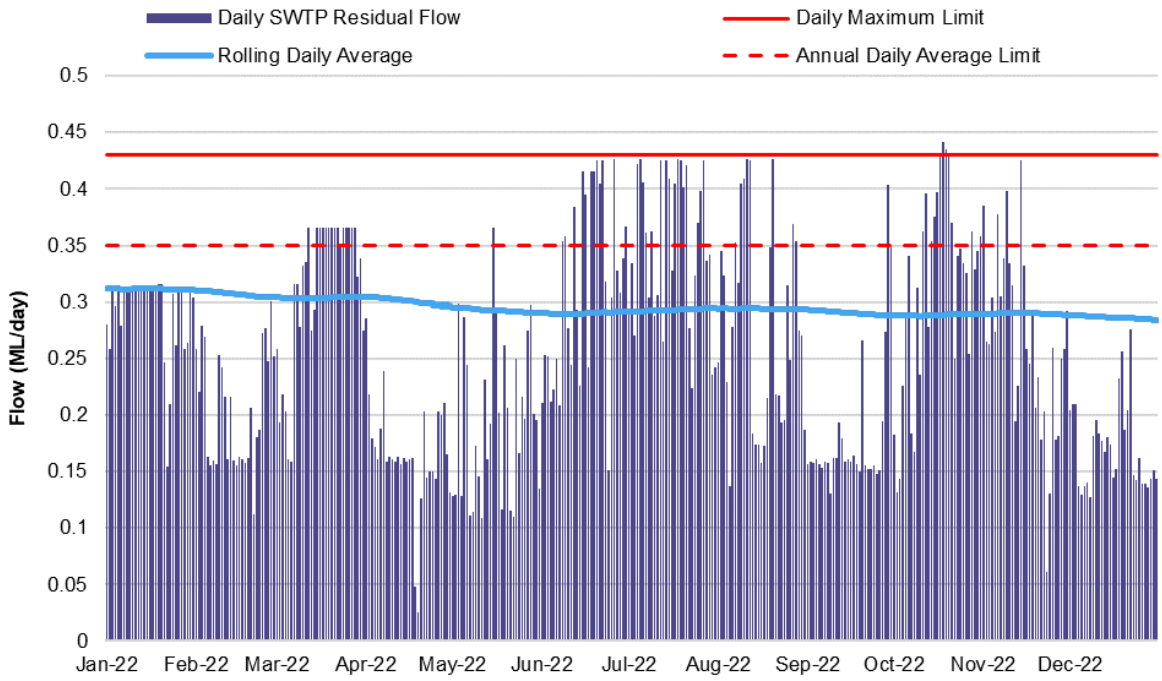


Figure 6-8: 2022 Residuals Transferred to WCS

With the exception of two days in October 2022, WCS complied with the daily maximum limit of 0.43ML/day. The annual average limit of 0.35ML/day was not exceeded during the Reporting Period.

The unintentional additional transfer of service water is not considered to have caused any actual or potential harm to the environment nor has in impacted the integrity of the regulatory system.

The details of the exceedance on the 18th and 19th October 2022 were provided to the DPE in an investigation report issued on the 16 November 2022 (**Section 11**).

6.8.4 Visual Amenity

WCS manages visual impacts in accordance with the Development Consent SSD-5579, Schedule 3, Condition 40. There are no fixed outdoor lights or mobile lighting rigs shined above the horizontal.

The 2021 IEA confirmed that all external lighting associated with the development complied *with Australian Standard AS4282*. A lighting audit against AS4282 was completed for SCS in November 2016 and the site was found to be compliant. No changes to external lighting since have occurred since the 2021 IEA.

The IEA 2021 also confirmed the visual appearance of all buildings, structures, facilities or works (including paint colours and specifications) was adequate.

During the Reporting Period no complaints were received in relation to the visual amenity of the site.

7 WATER

7.1 WATER MANAGEMENT

WCS manages both surface water and groundwater in accordance with the Water Management Plan (WMP) dated August 2014. The WMP has been updated on several occasions and resubmitted for approval in 2017, 2019, 2020 and 2022 which included addressing actions from the 2021 IEA. During the Reporting Period the WMP (Version 6) was revised again to align with the approved MOD4.

To date, the above-mentioned revisions to WMP have not been approved by the DPE. Further consultation with DPE regarding the latest revision to the WMP (Version 6) will be undertaken during the next Reporting Period.

Management measures used during the operational phase include:

- The use of higher grades of mechanical equipment across the facility to reduce downtime and increase the efficiency of the water management system;
- The management of water discharged from site;
- Storage and use of chemicals/ fuel on site in accordance with Technical guidelines;
- The use of sprinklers and water carts on coal stockpiles and compacted coal reject;
- The removal of coal spillage on ground;
- Visual, acoustic and water management bunds around maintenance;
- Drainage lines maintenance; and
- Ponds and Sediment Detention Basins maintenance.

7.2 WATER LICENSES

WCS do not require water licences for the extraction of surface water or groundwater under the *Water Act 1912* and *Water Management Act 2000*.

7.3 WATER BALANCE

Table 7-1: Site Water Balance for WCS

	Existing conditions	Future conditions (EMM 2022)
INPUTS		
Catchment Runoff into storages	652	556
Groundwater recharge	299	159
SWTP residuals	128	128
Flocculant makeup	0	11
ROM coal moisture	20	22
Seepage from Mount Piper Ash Repository	454	354
Transfer from Angus Place Colliery	-	99
TOTAL INPUTS	**1,644**	**1,329**

	Existing conditions	Future conditions (EMM 2022)
OUTPUTS		
Evaporation	145	97
Dust suppression	55	55
Coarse coal reject moisture	5	2
Product coal moisture	13	20
Discharge via LDP001 to Wangcol Creek (SCSS)	1053	4
Overflow from Final Polishing Lagoon to Wangcol Creek	302	291
Seepage from DML Dam and Cooks Dam to Wangcol Creek	204	49
Transfer to Pond D at MPPS	-	810
Discharge via LDP002 to Coxs River (conveyor at Brays Lane)	0	0
TOTAL OUTPUTS	**1,779**	**1,328**
CHANGE IN STORAGE		
Surface water storages	-113	0
Underground storage	-22	0
TOTAL CHANGE IN STORAGE	**-135**	**0**
BALANCE		
Inputs – outputs – change in storage	**0**	**1**

7.4 SURFACE WATER

7.4.1 Environmental Management

The water management systems at WCS are comprised of clean and dirty water. Sources of water include minimal potable water supply, rainfall, runoff and groundwater inflow to the open cut areas and Cooks Dam. WCS is also approved to receive residual waste from the SWTP (**Section 6.7.3**), and transfer water from Angus Place Colliery to the proposed McPhillamys Gold Project, and to and from Mount Piper Power Station. The primary water demands are for surface dust suppression, coal washing activities and staff amenities.

As required by the current WMP, off-site surface water monitoring sites include Wangcol Creek Gauge, Wangcol Creek US, Wangcol Creek DS and Wangcol Creek Far DS was undertaken during the Reporting Period (**Figure 6-1**). On site water quality monitoring of WCS's internal water management system is also undertaken.

Discharged water quality is monitored monthly during discharge events as per the requirements of EPL 21229 and the WMP at Licenced Discharge Point (LDP) LDP001 and LDP002. The locations of LDP001 and LDP002 are shown in **Figure 6-1**.

Site Specific Guideline Values (SSGVs) for several analytes are provided in WMP and in subsequent draft revisions not yet approved. The SSGVs form the basis of the trigger action response plans (TARPs). Applicable results from the 2022 surface water monitoring program are assessed against their respective SSGV, with the implementation of TARPs as required.

7.4.2 Comparisons Against Predictions

Overall, the development will provide an opportunity to improve the water management system for the Springvale Coal Services Site by incorporation of water recycling systems, separating the operation from clean water passing through the Site and constructing an additional 15 Ml of dirty water storage. The Project is likely to result in beneficial outcomes for Wangcol Creek by reducing process water discharges, improved dirty water storage and recycling capacity and maintaining clean water flow through the site from upstream undisturbed areas (RPS, 2013).

EMM Consulting Pty Limited (EMM) were engaged by Springvale Coal to prepare a modification report for MOD4. The proposed modification is predicted to reduce the volume and frequency of discharges to Wangcol Creek via LDP001 and result in a significant reduction in the pollutant load of discharges to the receiving environment. The proposed modification is therefore assessed to have at least a neutral or beneficial effect on water quality within the Sydney drinking water catchment area (EMM 2021).

7.4.3 Environmental Performance

Discharge Water (LDP001)

As required by EPL 21229 conditions, water discharged from LDP001 is tested monthly during discharging for pH, Total Suspended Solids (TSS), Electrical Conductivity (EC), Turbidity (NTU) and Oil and Grease.

Concentration limits during discharge events are provided in EPL 21229 and displayed in **Table 7-2.** The concentration limits specified under EPL 21229 do not apply when the discharge occurs soley as a result of rainfall measured at the premises which exceeds a total of 56 millimetre of rainfall over any consecutive 5-day period.

A summary of LDP001 water quality sampling results from discharge events during the Reporting Period are presented in **Table 7-2** and presented in **Figure 7-1** to **Figure 7-4**. Long term water quality monitoring results and trends for LDP001 are provided in **Appendix 8**.

Table 7-2: LDP001 Water Quality Summary

Parameter	Unit of Measure	Lowest Sample Value	Mean of sample	Highest sample value	EPL limit
pH	pH units	6.5	7.0	7.8	6.5-8.5
TSS	mg/L	5	9.0[2]	20	30
EC	µS/cm	2120	2485	2920	-
Oil & Grease	mg/L	<5	<5[2]	<5	10
Turbidity	NTU	2.5	11.9	56[1]	50

Notes: [1] Days when discharges occurred within 5-day period following >56mm, EPL Limits do not apply. [2]For averaging purposes, when a sample result is reported below the laboratory limit of reporting (LOR), half the LOR value is used for the result where 50% of the total samples are less than the LOR. Otherwise the result is reported as zero.

LDP001 discharge summary for the 2022 Reporting Period is presented in **Table 7-3** and **Figure 7-5.**

Table 7-3: LDP001 2022 Discharge Volumes

Unit of Measure	Frequency	No. of measurements made	Lowest daily volume	Mean daily volume	Highest daily volume	Total annual volume
Megalitres (ML)	Daily during any discharge	365	1.6	8.8	118.0	3219.2

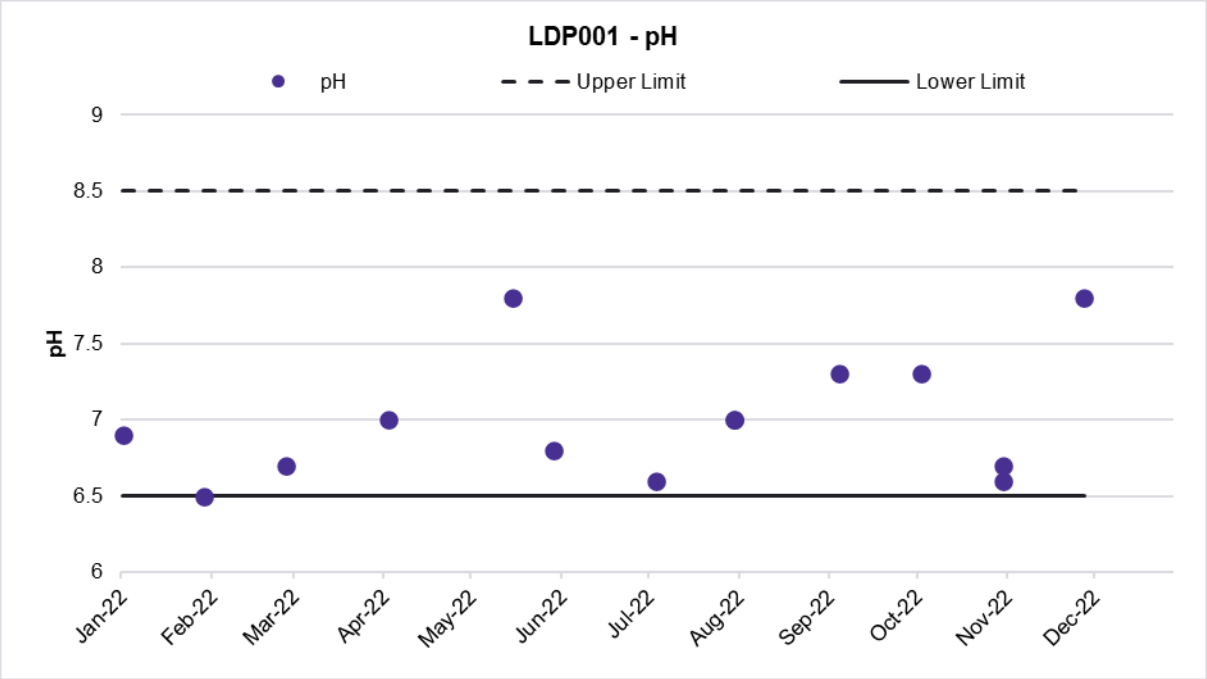


Figure 7-1: WCS LDP001 pH 2022

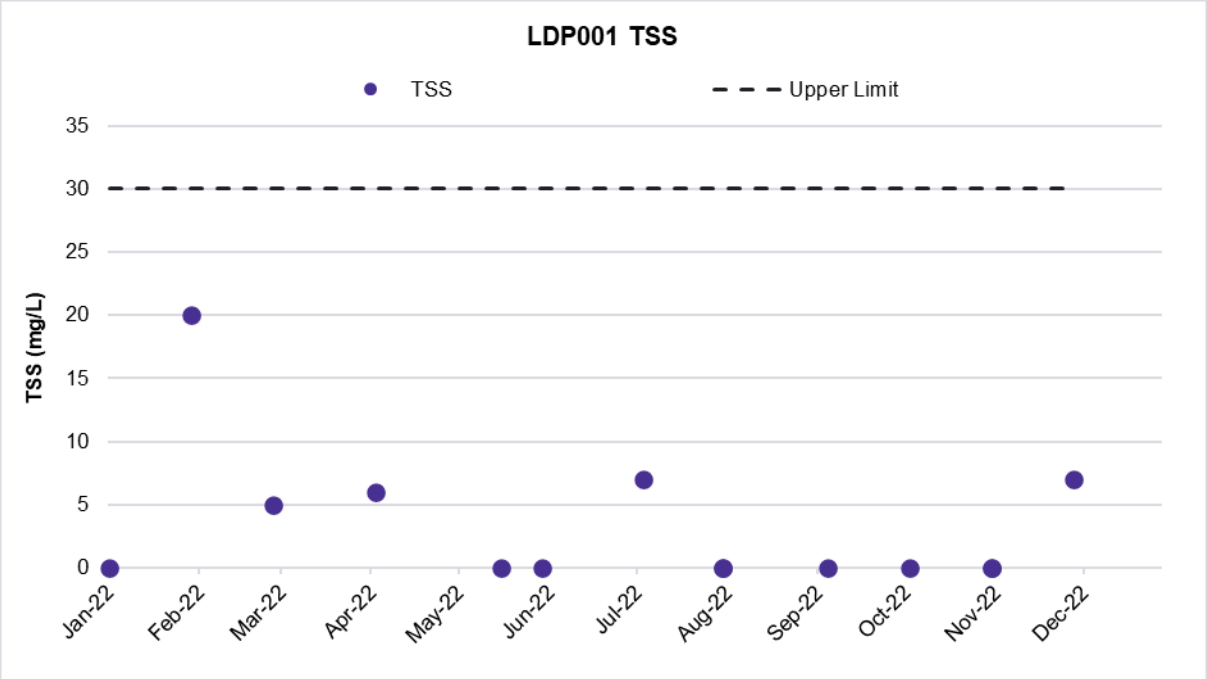


Figure 7-2: WCS LDP001 TSS 2022

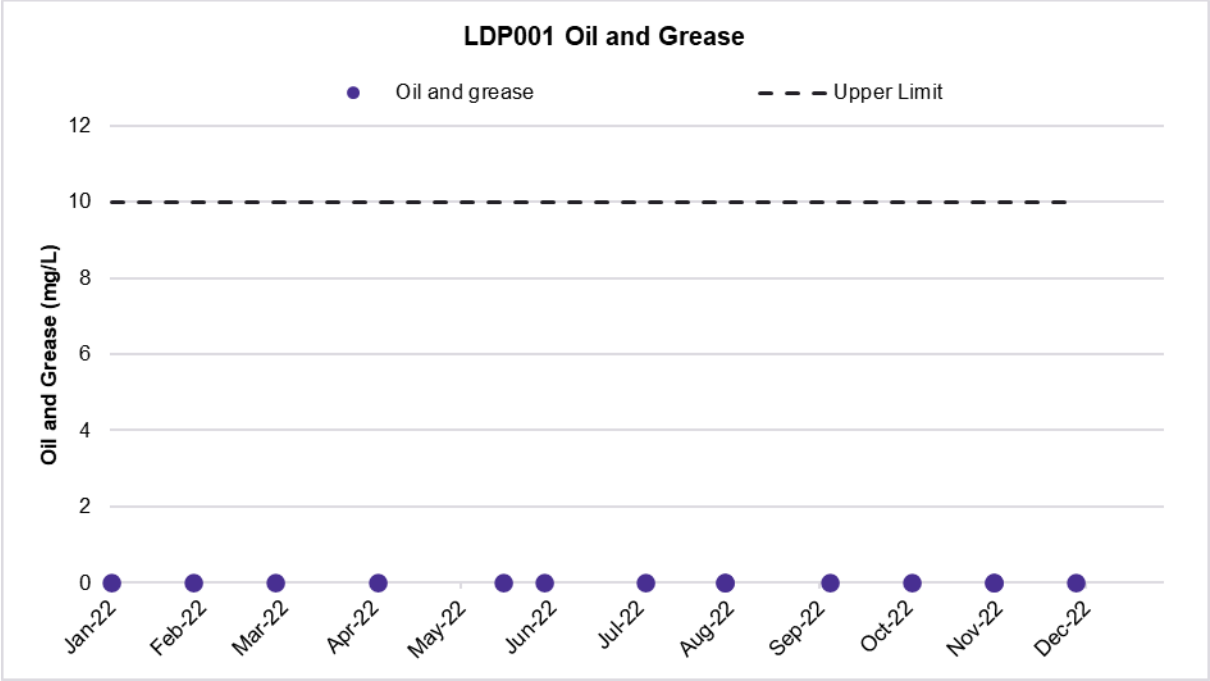


Figure 7-3: WCS LDP001 Oil & Grease 2022

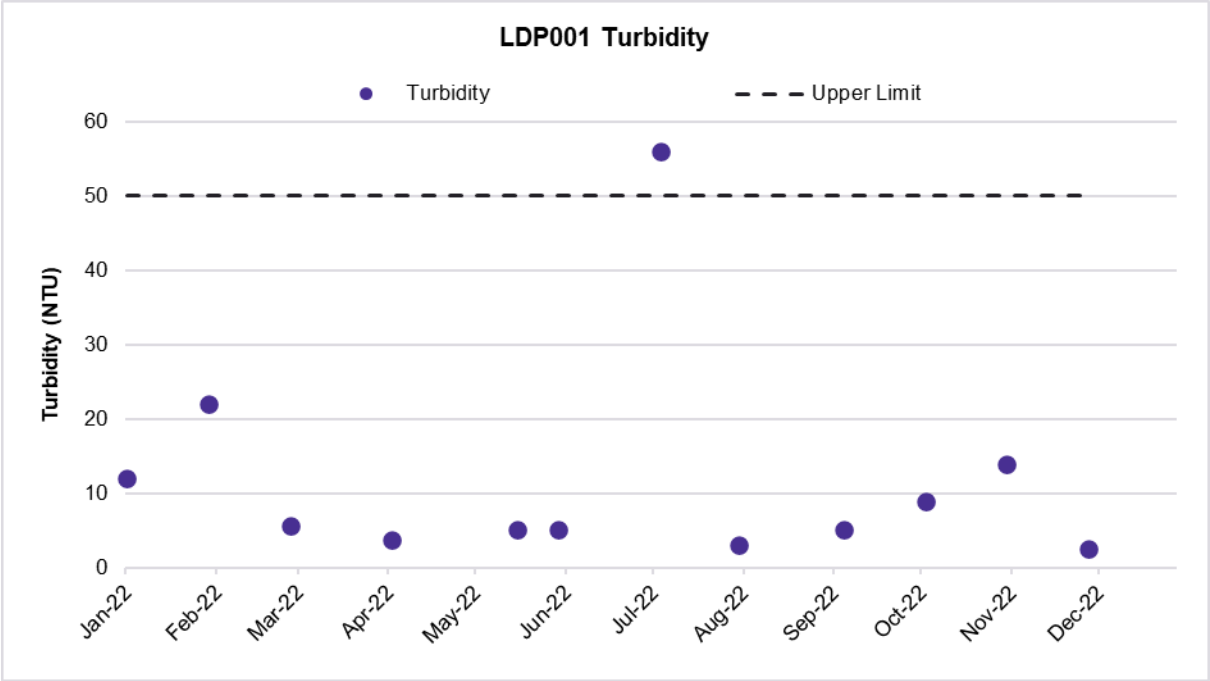


Figure 7-4: WCS LDP001 Turbidity 2022

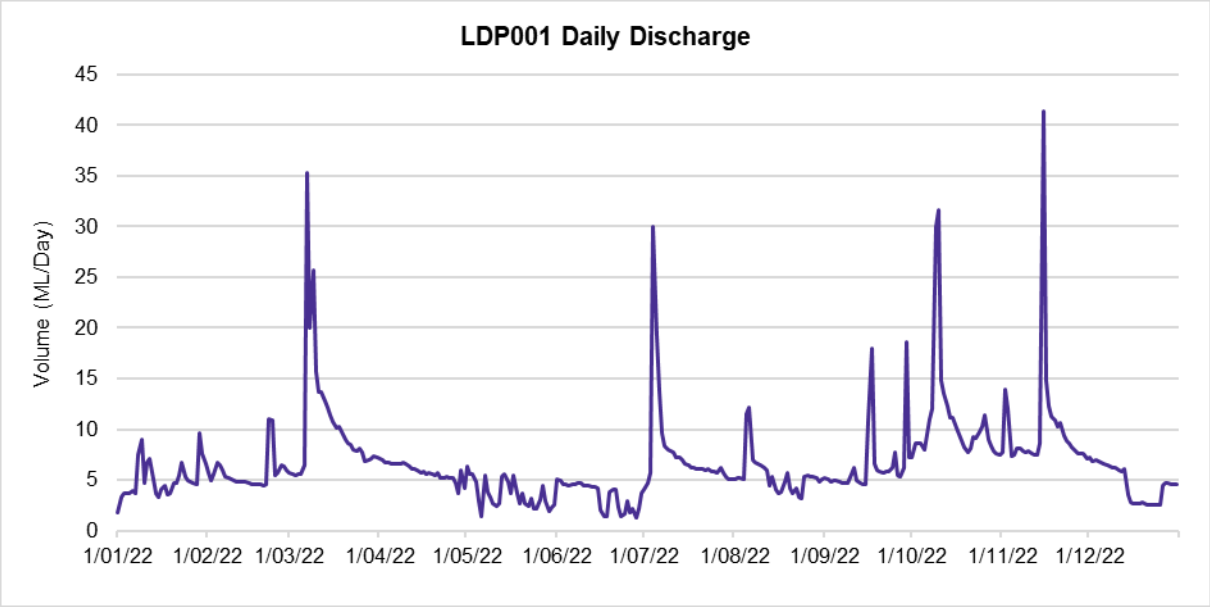


Figure 7-5: LDP001 Discharge Volume Summary 2022

During the Reporting Period water quality monitoring for LDP001 has been undertaken in accordance with EPL 21229 and the WMP. LDP001 complied with EPL limits during the Reporting Period.

Discharge Water (LDP002)

There was only one discharge that occurred at LDP002 during the Reporting Period on the 2 March 2022. The EPL concentration limits and parameters for LDP001 also apply to LDP002.The results from the one discharge event at LDP002 are presented in **Table 7-4**.

Table 7-4: LDP002 Water Quality Summary

Parameter	Unit of Measure	Results	EPL limit
pH	pH units	6.7	6.5-8.5
TSS	mg/L	5	30
EC	µS/cm	2570	-
Oil & Grease	mg/L	<5	10
Turbidity	NTU	5.6	50

During the Reporting Period water quality monitoring for LDP002 has been undertaken in accordance with EPL 21229 and the WMP. LDP002 complied with EPL limits during the Reporting Period.

Surface Water

Surface water monitoring sites within Wangcol Creek were established to assess potential impact from site discharges via LDP001. Water quality monitored downstream of WCS at Wangcol Creek Far DS is assessed against SSGVs as provided in the WMP and subsequent revisions (**Table 7-5**). A multi-tiered TARP within the WMP is to manage any possible adverse impacts to either surface water or groundwater at the WCS site. The TARP outlines response actions to be implemented in the event that exceedances of trigger values are identified onsite. The results from water quality monitoring upstream and downstream within Wangcol Creek are presented in **Table 7-5**. Refer to **Appendix 8** for further water quality results and analysis by GHD in the *Western Coal Services Annual Water Report 2022* (GHD March 2023).

Table 7-5: 2022 Upstream and Downstream Water Quality Results

Parameter	Units	SSGV (Far DS)[3]	Wangcol Creek Gauge		Wangcol Creek US		Wangcol Creek DS		Wangcol Creek Far DS	
			Max	Mean	Max	Mean	Max	Mean	Max	Mean
Physicochemical										
EC	µS/cm	NA	2761	837	1546	605	2120	1165	166	995
pH	pH units	6.5-9.0	8	7.5	8.1	7.4	8	8	8	8
TDS	mg/L	NA	1980	647	981	457	2060	893	1720	795
TSS	mg/L	25	18	6.5	22	7.2	20	6	49[2]	9
Turbidity	NTU	35	102	14	99	13.2	101	14	116[2]	15
Nutrients										
Ammonia	mg/L	0.04	0.05	0.020	0.160	0.028	0.040	0.020	0.07[2]	0.026
Nitrate	mg/L	NA	0.11	0.041	7.570	0.958	1.820	0.425	1.150	0.135
Nitrite	mg/L	NA	0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Nitrate + nitrite	mg/L	NA	0.11	0.041	7.570	0.958	1.820	0.425	1.150	0.135
Total Kjeldahl nitrogen	mg/L	NA	0.80	0.342	1.200	0.400	0.700	0.354	0.500	0.292
Total nitrogen	mg/L	0.5	0.90	0.383	8.800	1.346	2.300	0.777	1.60[2]	0.415
Total Phosphorus	mg/L	0.08	0.09	0.024	0.100	0.020	0.090	0.022	0.09[2]	0.019
Major ions										
Bicarbonate alkalinity	mg/L	NA	108	65	104	59	129	75	123	70
Carbonate alkalinity	mg/L	NA	1	1	1	1	1	1	1	1
Hydroxide alkalinity	mg/L	NA	1	1	1	1	1	1	1	1
Total alkalinity	mg/L	NA	108	65	104	59	129	75	123	70
Calcium	mg/L	NA	105	38	60	30	102	51	87	47
Chloride	mg/L	NA	142	52	81	39	156	74	141	67
Magnesium	mg/L	NA	77	29	45	23	85	41	74	37
Potassium	mg/L	NA	35	11	18	7	30	17	31	15
Sodium	mg/L	NA	332	93	167	60	360	153	298	131
Sulphate	mg/L	NA	912	336	298	214	959	584	872	488
Total hardness	mg/L	NA	467	235	246	188	605	370	522	268
Dissolved metals										
Aluminium	mg/L	0.24	0.040	0.015	0.120	0.035	0.080	0.017	0.190	0.054
Boron	mg/L	0.37	0.820	0.185	0.400	0.118	0.660	0.328	0.58[2]	0.281
Cadmium	mg/L	0.0026	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Iron	mg/L	0.31	0.360	0.113	0.390	0.133	0.200	0.080	0.370[1]	0.115
Manganese	mg/L	1.9	1.250	0.394	0.651	0.302	1.240	0.554	1.120	0.558
Nickel	mg/L	0.125	0.166	0.048	0.087	0.031	0.160	0.076	0.126[2]	0.065
Selenium	mg/L	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Zinc	mg/L	0.091	0.068	0.017	0.024	0.010	0.071	0.030	0.038	0.024
Other										
Oil and grease	mg/L	NA	6	5	5	5	5	5	6	5

Notes: N/A (Not Applicable) [1]Elevated but no trigger, continue monitoring in accordance with WMP. [2] Trigger event and investigation (**Appendix 8**). [3] Recommended SSGV from WMP. For further analysis and investigations during the Reporting Period refer to *Western Coal Services – Annual Water Report 2022* by GHD March 2023 (GHD 2023) in **Appendix 8**.

7.4.4 Implemented / Proposed Improvements

MOD4 was approved by the DPE on the 21 October 2022. A key focus for WCS in 2023 is securing the necessary post approvals required to commence the approved construction activities as outlined in MOD4, to implement the modifications to the water transfer and management system.

MOD4 provides resolution of the SCSI Pollution Reduction Program seeking a volume limitation on LDP001 into Wangcol Creek. MOD4 aims to achieve the following objectives:

- 99% reduction of discharge volume (616ML/yr down to 5ML/yr); and
- 99% reduction in average salt load (1932 tpa to less than 10 tpa).

Further consultation with DPE regarding the latest revision to the WMP (Version 6) that was revised to align with MOD4, will be undertaken during the next Reporting Period.

Undertake a review of the recommendations for surface water provided by WCS water specialist (**Appendix 8**) during the next Reporting Period. The site will continue to focus on the maintenance of water management structures and soil and erosion controls to ensure ongoing compliance with the performance criteria and EPL limits applicable to WCS.

7.5 GROUNDWATER

7.5.1 Environmental Management

Groundwater monitoring is undertaken in accordance with the WMP and includes monitoring bores BH01, BH02, BH03, BH04, BH05, BH06, BH07, BH08, BH09, BH10, BH12, BH13 and BH15. Groundwater level trigger values (or 'SSGVs') are based on an exceedance of the 95th percentile historical observed groundwater level. Groundwater quality SSGVs have been developed with reference to baseline monitoring data. Groundwater quality trigger values are based on the 80th percentile historical concentrations. For pH, a range of trigger values are used based on the 20th percentile and 80th percentile historical values.

7.5.2 Environmental Performance

WCS monitoring both groundwater level and quality across a network of boreholes. Groundwater levels trends are summarised in **Table 7-6**.

Table 7-6: 2022 Groundwater Level Trigger & Investigations 2022

Monitoring well	Trigger Level (m AHD)	Maximum level, Q1 2022 (m AHD)	Maximum level, Q2 2022 (m AHD)	Maximum level, Q3 2022 (m AHD)	Maximum level, Q4 2022 (m AHD)	Triggered (Y/N)
BH01	909	908.52	908.21	908.49	908.59	N
BH02	900	899.41	895.53	Dry	Dry	N
BH03	904	904.0	903.86	903.88	905.05	Y
BH04	909	909.41	912.71	913.49	914.41	Y
BH05	909	908.37	908.79	907.81	910.5	Y
BH06	901	900.73	901.9	901.3	901.8	Y
BH07	909	909.64	911.29	914.89	909.99	Y
BH08	909	910.63	908.83	913.23	910.42	Y
BH09	910	912.51	911.75	917.3	910.5	Y
BH10	-	-	-	-	928.94	N/A
BH13	910	909.95	909.54	909.6	Dry	N/A
BH15	930	Dry	Dry	Dry	Dry	N/A

Groundwater quality trends are presented in **Table 7-7**. BH10 and BH12 have been dry since August 2018. BH15 has been dry since January 2021. Further details of groundwater level and quality triggers and investigations by GHD in the *Western Coal Services Annual Water Report 2022* (GHD March 2023) provided in **Appendix 8**.

Table 7-7: 2022 Groundwater Monitoring Results

Parameter	Units	BH01		BH02		BH03		BH04	
		Max	Mean	Max	Mean	Max	Mean	Max	Mean
Physicochemical									
EC	µS/cm	2210	1536	1065	869	1512[1]	1213	2626[1]	551
pH	pH units	7.4[1]	5.8	7.2[1]	6.8	5.6[1]	4.0	6.9[1]	6.4
TDS	mg/L	872	804	714	635	1230	1056	350	267
TSS	mg/L	14	11	42	29	94	49	158[1]	57
Nutrients									
Nitrate	mg/L	1.46	0.76	1.14	0.413	6.4	1.21	1.75	0.478
Nitrite	mg/L	0.01	0.01	0.25	0.062	0.04	0.02	0.09	0.023
Nitrate + nitrite	mg/L	1.46	0.77	1.39	0.465	6.44	1.22	1.84	0.494
Total phosphorus	mg/L	0.02	0.02	0.07	0.038	0.09	0.03	0.24	0.055
Major ions									
Bicarbonate alkalinity	mg/L	28	27	413	347	1	1	187	147.9
Carbonate alkalinity	mg/L	1	1	1	1	1	1	1	1.0
Hydroxide alkalinity	mg/L	1	1	1	1	1	1	1	1.0
Total alkalinity	mg/L	28	27	413	347	1	1	187	147.9
Calcium	mg/L	19	18	110	103.3	59	55	44	36.0
Chloride	mg/L	122	112	66	43	96	89	19	13.3
Magnesium	mg/L	56	51	53	47	66	62	19	16.4
Potassium	mg/L	3	3	18	14	7	6	15	10.0
Sodium	mg/L	178	166	34	27	61	56	19	16.0
Sulfate	mg/L	508	484	138	109	697	632	50	29.3
Hardness	mg/L	278	252	483	450	412	390	188	157
Dissolved metals									
Iron	mg/L	0.08	0.07	1.19[1]	0.525	85.4[1]	70.14	3.52[1]	1.240
Manganese	mg/L	1.8	1.63	0.951[1]	0.755	8.07[1]	7.37	0.771[1]	0.329
Nickel	mg/L	0.373	0.335	0.032	0.016	0.337[1]	0.299	0.027[1]	0.009
Zinc	mg/L	0.479	0.424	0.097[1]	0.048	1.04[1]	0.94	0.105[1]	0.063
Total metals									
Aluminium	mg/L	0.17	0.140	0.6	0.293	16.9	12.17	1.99	0.54
Boron	mg/L	0.1	0.10	0.08	0.06	0.05	0.050	0.050	0.050
Cadmium	mg/L	0.0002	0.0002	0.0001	0.0001	0.0006	0.0004	0.0001	0.0001
Iron	mg/L	0.36	0.30	2.25	1.13	98.9	81.1	7.1	2.8
Manganese	mg/L	1.9	1.74	0.986	0.796	9.38	7.9	1.0	0.4
Selenium	mg/L	0.01	0.01	0.01	0.01	0.01	0.010	0.010	0.010
Zinc	mg/L	0.514	0.454	0.094	0.065	1.22	0.969	0.198	0.102

Parameter	Units	BH05		BH06		BH07		BH08	
		Max	Mean	Max	Mean	Max	Mean	Max	Mean
Physicochemical									
EC	µS/cm	2400[1]	537.2	1860	1523	2700	1795	3660	2797.3
pH	pH units	7.9[1]	6.7	7.0[1]	6.4	6.8[1]	5.7	6.8[1]	6.4
TDS	mg/L	2600	434.2	2031	1333	2540	1705	3574	2482.3
TSS	mg/L	152[1]	70.0	69	39	142	60	353[1]	86.3
Nutrients									
Nitrate	mg/L	0.81	0.416	0.08	0.029	1.61	0.30	1.59	0.313
Nitrite	mg/L	0.07	0.017	0.01	0.01	0.1	0.03	0.08	0.017
Nitrate + nitrite	mg/L	0.83	0.426	0.08	0.029	1.61	0.30	1.59	0.323
Total phosphorus	mg/L	0.32	0.068	0.06	0.04	0.1	0.05	0.21	0.050
Major ions									
Bicarbonate alkalinity	mg/L	198	150.3	132	117.2	139	56	285	166
Carbonate alkalinity	mg/L	1	1	1	1	1	1	1	1
Hydroxide alkalinity	mg/L	1	1	1	1	1	1	1	1
Total alkalinity	mg/L	198	150.3	132	117.2	139	56	285	166
Calcium	mg/L	121	41	103	90.0	174	141	146	121
Chloride	mg/L	191	32.5	138	116.6	157	117	255	201
Magnesium	mg/L	84	23.0	67	57.8	206	140	112	91
Potassium	mg/L	55	11.9	22	19.3	18	7	120	65
Sodium	mg/L	386	47.3	229	196.6	180	84	557	432
Sulfate	mg/L	1330	134.6	752	652.1	1700	1007	1580	1308
Hardness	mg/L	648	197.3	533	462.7	1280	928	826	676.0
Dissolved metals									
Iron	mg/L	2.98[1]	1.07	10	6.50	128	52.85	7.98[1]	1.35
Manganese	mg/L	4.16[1]	1.17	2.03	1.72	4.34	2.76	4.09	3.14
Nickel	mg/L	0.263[1]	0.04	0.107	0.094	0.75	0.32	0.339	0.28
Zinc	mg/L	0.239	0.06	0.108[1]	0.043	2.24	0.756	0.313	0.23
Total metals									
Aluminium	mg/L	1.97	0.53	0.56	0.219	1.19	0.49	1.27	0.42
Boron	mg/L	1	0.129	0.69	0.50	0.43	0.08	1.85	1.08
Cadmium	mg/L	0.0002	0.0001	0.0001	0.0001	0.001	0.0003	0.0004	0.0002
Iron	mg/L	4.88	2.24	11.7	8.74	134	59	12.4	3.29
Manganese	mg/L	3.56	1.22	2.19	1.77	4.59	2.95	4.66	3.36
Selenium	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Zinc	mg/L	0.267	0.110	0.181	0.060	2.29	0.82	0.431	0.267

Parameter	Units	BH09		BH13		BH15	
		Max	Mean	Max	Mean	Max	Mean
Physicochemical							
EC	µS/cm	2860	2100.5	2920	2315	1989	1989
pH	pH units	6.8	6.3	7.5[1]	6.4	6.4	6.4
TDS	mg/L	2320	1773.3	2200	1853	-	-
TSS	mg/L	804	102.0	61	32	-	-
Nutrients							
Nitrate	mg/L	4.07	0.79	2.8	0.46	-	-
Nitrite	mg/L	0.01	0.01	0.02	0.01	-	-
Nitrate + nitrite	mg/L	4.07	0.79	2.82	0.46	-	-
Total phosphorus	mg/L	0.35	0.06	0.06	0.03	-	-
Major ions							
Bicarbonate alkalinity	mg/L	294	146	414	238	-	-
Carbonate alkalinity	mg/L	1	1	1	1	-	-
Hydroxide alkalinity	mg/L	1	1	1	1	-	-
Total alkalinity	mg/L	294	146	414	238	-	-
Calcium	mg/L	126	99	114	101	-	-
Chloride	mg/L	192	127	167	134	-	-
Magnesium	mg/L	90	73	116	87	-	-
Potassium	mg/L	60	33	46	34	-	-
Sodium	mg/L	415	305	406	329	-	-
Sulfate	mg/L	1240	939	1140	956	-	-
Hardness	mg/L	685	547	750	611	-	-
Dissolved metals							
Iron	mg/L	0.790	0.275	4.44	1.28	-	-
Manganese	mg/L	3.120	1.467	4.3	3.04	-	-
Nickel	mg/L	0.272	0.196	0.237	0.188	-	-
Zinc	mg/L	0.478	0.235	0.167	0.118	-	-
Total metals							
Aluminium	mg/L	1.430	0.315	0.72	0.235	-	-
Boron	mg/L	1.060	0.604	1.09	0.65	-	-
Cadmium	mg/L	0.0003	0.0001	0.0002	0.0001	-	-
Iron	mg/L	13.90	3.59	6.31	3.02125	-	-
Manganese	mg/L	3.40	1.54	4.2	3.24	-	-
Selenium	mg/L	0.010	0.010	0.01	0.01	-	-
Zinc	mg/L	0.515	0.277	0.206	0.145	-	-

Notes: BH15 was dry throughout 2022. [1] Trigger event and investigation (**Appendix 8**). For further analysis and investigations during the Reporting Period refer to *Western Coal Services – Annual Water Report 2022* by GHD March 2023 (GHD 2023) in **Appendix 8**.

7.5.3 Comparison Against Predictions

Section 9.5.4.3 of the EIS presents details in the impacts predicated for the WCS project and shall be referred to for additional detail. Key findings from the water management assessment include:

- Predicted groundwater levels in the shallow aquifer and the Lithgow Seam indicate negligible impact from the Project.
- the Project would not impact on any groundwater users in the area.
- The water quality observed at LDP 006 is impacted by groundwater seepages to DML and Cooks Dams
- Apart from the increase in inflow to dams on the Springvale Coal Services Site over the life of the Project, there will be no other impacts to aquifer systems. •
- No sensitive GDEs have been identified within the Springvale Coal Services Site. Any potential ecosystems associated with the Wangcol Creek would not be impacted by the Project both in relation to water quality and quantity.

EMM Consulting Pty Limited (EMM) were engaged by Springvale Coal to prepare a modification report for MOD4. The proposed modification is predicted to reduce the volume and frequency of discharges to Wangcol Creek via LDP001 and result in a significant reduction in the pollutant load of discharges to the receiving environment. The proposed modification is therefore assessed to have at least a neutral or beneficial effect on water quality within the Sydney drinking water catchment area.

7.5.4 Implemented / Proposed Improvements

As noted by the predications, an interrelationship between surface and groundwater exists. MOD4 outlined in **Section 7.1.5** will benefit water quality discharging from the site.

Further consultation with DPE regarding the latest revision to the WMP (Version 6) that was revised to align with MOD4, will be undertaken during the next Reporting Period.

Undertake a review of the recommendations for groundwater provided by WCS water specialist (**Appendix 8**) during the next Reporting Period.

8 REHABILITATION

WCS manages rehabilitation in accordance with the Rehabilitation Management Plan (RMP).

The RMP was prepared in accordance with the NSW Resources Regulator (NSW RR) Form and Way-Rehabilitation Management Plan for Large Mines (NSW RR, July 2021) required under the Mining Regulation 2016 and submitted on the 29 July 2022 via the MSW RR Portal.

The RMP also satisfies Condition 45, Schedule 3 of SSD-5579, and the requirements of ML 204, ML 564, ML 1319, ML 1448, CCL 733, CL 394, CL 361 and PLL 133.

The RMP describes the management of rehabilitation at the WCS. The RMP is available on the WCS website https://www.centennialcoal.com.au/operations/springvale-coal-services/

The Forward Program sets out WCS the three-year forecast for both proposed surface disturbance and rehabilitation schedule.

This section addresses the annual rehabilitation reporting requirements for the Annual Review as required by Condition 4, Schedule 5 of SSD-5579 and relevant WCS Mining Leases (**Section 3.2**).

Annual reporting requirements in the RMP will be reported in the Annual Rehabilitation Report and Forward Program (ARR&FP) and submitted using the online form accessible via the NSW Resource Regulator's mine rehabilitation portal.

8.1 REHABILITATION PERFORMANCE DURING THE REPORTING PERIOD

8.1.1 Summary of Rehabilitation

Table 8-1: Rehabilitation Status

Mine Area Type	Previous Reporting Period (Actual) 2021 (ha)	This Reporting Period (Actual) 2022 (ha)	Next Reporting Period (Forecast) 2023 (ha)
A. Total mine footprint[1]	185.1	185.1	185.1
B. Total active disturbance[2]	185.1	185.1	185.1
C. Land being prepared for rehabilitation[3]	60.2	43.8	43.8
D. Land under active rehabilitation[4]	60.2	43.8	4.38
E. Completed rehabilitation[5]	0	0	0

Notes: [1] **Total Mine Footprint:** includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands. Please note that subsidence remediation areas are excluded. [2] **Total Active Disturbance:** includes all areas requiring rehabilitation [3] **Land being prepared for rehabilitation:** includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development. [4] **Land under active rehabilitation:** includes areas under rehabilitation and being managed to achieve relinquishment – includes 'ecosystem and land use establishment' and 'ecosystem and land use sustainability [5] **Completed rehabilitation**: requires formal sign off from DRE that the area has successfully net the rehabilitation land use objectives or completion criteria

As provided in Figure 6 of the RMP, the proposed post mining land use for the site varies across the Development Consent area includes:

- Native ecosystem;
- Agricultural – grazing;
- Industrial;
- Water management areas;
- Energy Australia Ash Emplacement; and
- Lithgow City Council Waste Emplacement.

8.1.2 Rehabilitation Monitoring

SLR Consulting Australia Pty. Ltd. (SLR) was commissioned by Springvale Coal Services Pty. Ltd. (SCS) to undertake the 2022 annual rehabilitation monitoring at the SCS land (Plan 3B in **Appendix 1**). The SCS rehabilitation monitoring program has been designed to measure the progress of rehabilitation against the objectives and completion criteria developed for the SCS Rehabilitation Management Plan for Large Mines (the RMP). In accordance with the RMP criteria, results are presented according to the three main attributes of the Biodiversity Assessment Method (BAM), namely: composition, structure and function.

Composition

Total native plant diversity was the highest recorded since 2018, with 91 native plants recorded. However, plant diversity was lower in all rehabilitation sites and at one of the control sites since 2021. In addition, the proportion of exotic species at most rehabilitation monitoring sites increased. Although native plant diversity was lower, the mean native plant diversity across the rehabilitation sites remains only slightly below that of the control sites.

Structure

Native tree and shrub cover continues an ascending trend since 2019; however tree cover remains below that of the control sites and the benchmark values for the corresponding plant community (PCT 3747). Mean shrub cover score for rehabilitation sites increased substantially and is higher than control and benchmark values at most rehabilitation sites. Grass cover was mixed across the rehabilitation sites, with four sites within the benchmark and four sites below benchmark. Cover scores for 'native groundcover – forbs, ferns and other', are within benchmark for most sites, with only R4 and R5 below.

Function

Litter cover across all rehabilitation sites ranges from 24 % to 40 %; however the only rehabilitation site to record a litter score similar to control sites was R2. Second generation tree regeneration was also observed across all rehabilitation, although differed greatly between rehabilitation sites, with R4 recording just one steam while R8 recorded 28.

Soil chemistry analysis shows that the rehabilitation sites have favourable growth media for native vegetation, with no deficient or toxic factors for the growth of native vegetation. In terms of soil microbiology, the results show no significant difference between the rehabilitation and control sites. However, Trichoderma colonies are low at R6. It is likely that Trichoderma levels will increase naturally with increase in organic matter over time.

A range of common native bird, reptile and mammal species was observed. However, a drove of feral pigs (*Sus scrofa*) was observed near the R8 and R9 rehabilitation sites. A total of four

High Threat Exotics (HTEs) and three Priority Weed species were recorded, with infestations of Blackberry (*Rubus fruticosus aggregate*), African Lovegrass (*Eragrostis curvula*) and Serrated Tussock (*Nassella trichotoma*) observed near the rehabilitation areas along the access road. No erosion was observed with in any rehabilitation areas.

Assessment Against Completion Criteria

The current status of rehabilitation sites (R1, R2, R3, R4, R5, R6, R8 and R9) against the rehabilitation objectives and completion criteria is summarised in **Table 8-2**. Overall, the rehabilitation sites generally comply with the physical landform rehabilitation objectives, including land surface stability and drainage performance. Each site is also free from erosion and hazardous or polluting materials. The ecosystem health completion criteria have been met at R2; however, the ecosystem composition and structural characteristics have not yet progressed sufficiently to be considered complete (SLR, 2023).

Table 8-2 RMP Rehabilitation Objectives and Completion Criteria Assessment

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	R1	R2	R3	R4	R5	R6	R7	R8	R9
Vegetation composition recognisable as target vegetation community	Native plant species are characteristic of the target vegetation community(s)									
Vegetation structure recognisable as, or is trending towards target vegetation community	Cover and abundance of native plant growth forms are characteristic of target vegetation community type(s)									
Ecosystem function demonstrates rehabilitation is self-sustainable	Litter cover is within 10th -90th percentile variation range of reference sites/data									
	Minimal erosion that would require moderate to significant ongoing management and maintenance. No visual signs of land instability such as mass movement									
	Second generation individuals of trees are within the 10th - 90th percentile variation range of reference sites									
	Foliage cover of 'high threat exotic' (HTE) weeds is within 10th -90th percentile variation range of reference sites									
	Soil chemistry Total organic carbon is within 10th - 90thpercentile variation range of reference sites; Soil analytes ECe (salinity) and ESP (sodicity) at rehab sites are similar to reference sites									
	Soil microbiology Decomposer microbial populations in the soils are similar to those of reference sites, using a metric that distinguishes soils at different stages of and in different types of mine rehabilitation. The specific parameters of the metric are:									

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	R1	R2	R3	R4	R5	R6	R7	R8	R9
	1) the actinomycete: bacteria ratio (lower values are associated with increased soil disturbance), 2) the proportion of copiotrophic bacteria (higher values are associated with increased labile soil organic carbon), and 3) the presence of the fungus Trichoderma (an indicator of significant amounts of plant cellulosic substrates in soils).									
	Resilience to drought and fire									
	Vertebrate pest species – presence and damage is recorded and controlled.									
	Domesticated stock - presence and damage is recorded and controlled.									
	Native fauna activity – evidence of fauna habitation and/or utilisation of rehabilitation areas over time									

Further details on WCS rehabilitation results are presented in **Appendix 9**.

8.1.3 Decommissioning

There were no decommissioning activities at WCS during the Reporting Period.

8.1.4 Other Rehabilitation and Land Management Activities

Proposed landform rehabilitation was postponed due to requirements for the prioritisation of handover of areas of Energy Australia land (known as Area 4D). Centennial are proposing to relinquish 21 ha (Area 4D) to Energy Australia in 2023 (refer to Plan 2B in **Appendix 1**).

8.1.5 Proposed Disturbance and Rehabilitation Activities

As identified by the BDAR for MOD4, 15.18 ha of native vegetation is required within the construction envelope. As MOD 4 was only approved in October 2022, construction activities had not yet commenced, therefore the additional disturbance required for MOD4 had not commenced.

A key focus for WCS in 2023 is securing the necessary post approvals and additional offsets required to commence the approved construction activities as outlined in MOD4 and implement the modifications to the water transfer and management system. The status of MOD4 construction will be provided in the next Annual Review

WCS will review the recommendations provided by SLR from the 2022 annual rehabilitation monitoring and provide a status update of implementation in the next Annual Review.

9 COMMUNITY CONSULTATION

WCS consults with the community through forums such as, the Centennial Western Region Community Consultative Committee and community organised events. Meetings of the Centennial Western Region Community Consultative Committee (CCC) were held on:

- 11 May 2022
- 17 August 2022
- 23 November 2022

Representatives of the appointed community representatives, relevant government organisations and company representatives attended the meetings. A detailed presentation was provided to attendees at each CCC meeting on the operational activities at the site. Key agenda items discussed in 2022 in relation to WCS were:

- Ongoing inspection, monitoring, reporting and compliance activities;
- Updates on actions from the 2021 IEA;
- Updates of any non-compliances and community complaints;
- Site Environmental and Community program implementation;
- Area 4 hand back to Energy Australia; and
- Modification 4 of SSD-5579.

WCS will continue to engage with the local community through the CCC during the next Reporting Period.

9.1 COMMUNITY COMPLAINTS

There were five community complaints at WCS during the Reporting Period in regard to noise. Long terms trends in complaints are presented in **Table 9-1.** A complaint register is made publicly available on the Centennial Coal website in accordance with Schedule 5 Condition 11 of SSD-5579 https://www.centennialcoal.com.au/operations/springvale-coal-services/

Table 9-1: Record of Annual Community Complaints for 2016 to 2022

Community Complaints						
Year	**Air**	**Water**	**Noise**	**Waste**	**Other**	**Total**
2017	0	0	0	0	0	0
2018	0	1	61	0	0	62
2019	0	0	20	0	0	20
2020	0	0	0	0	0	0
2021	0	0	0	0	0	0
2022	0	0	5	0	0	5

Refer to **Section 6.2.2** regarding investigations and remedial actions of the five noise complaints received during the Reporting Period.

9.1.1 Community Information Line

A community information line was maintained for WCS to receive calls from the local community. The community information line (**ph:6355 9500**) operates 24 hours a day, 7 days a week.

10 INDEPENDENT ENVIRONMENTAL AUDIT

10.1 ENVIRONMENTAL MANAGEMENT

WCS undertakes an Independent Environmental Audit (IEA) in accordance with Schedule 5, Condition 9 of SSD-5579 every three years from December 2015.

10.2 ENVIRONMENTAL PERFORMANCE

Centennial completed the 2021 Independent Environmental Audit (IEA) for WCS on the 7 to 9 December 2021.

In accordance with Schedule 5, Condition 9 of SSD-5579, a copy of the 2021 IEA Report and Centennial's response to the audit recommendations (RAR) was submitted to the Department in March 2022.

A copy of the RAR is provided https://www.centennialcoal.com.au/operations/springvale-coal-services/

The actions from the 2021 IEA that were not completed at the time of submitting the RAR in March 2022 were provided alternative timeframes for completion during the 2022 Reporting Period. **Table 10-1** presents a progress of those outstanding actions as identified for completion in 2022 in the RAR.

Table 10-2 provides the WCS responses to the IEA recommendations relating to Additional Recommended Actions from the 2021 IEA. In accordance with Schedule 5 Condition 9 of SSD-5579 the next IEA will be conducted in 2024.

Table 10-1: 2021 IEA Non-Compliances and Recommendations

Schedule and Condition Number	Condition	Compliance Status	Details	2021 IEA Recommendations	RAR March 2022	2022 AR Update
SSD-5579 and SoC						
Sch 3, Con 8	The Applicant must: (a) implement best management practice to minimise the construction, operational and road noise of the development; (b) operate a comprehensive noise management system that uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day-to-day planning of coal transport and processing operations, and the implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this consent; (c) minimise the noise impacts of the development during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 5); (d) co-ordinate noise management on site with the noise management of other approved developments and/or projects on or in the vicinity of the site to minimise cumulative noise impacts; and (e) carry out regular monitoring to determine whether the development is complying with the relevant conditions of this consent, to the satisfaction of the Secretary.	Low Non-Compliance	(a) No construction during the audit period. Operational noise is managed through the Noise Management Plan and monitored. Road noise is monitored quarterly along the Wallerawang Haul Road and noise mitigation measures are outlined in the driver Code of Conduct. No noise exceedances or complaints during the audit period. (b) Site operates a noise management system that predicts temperature inversions. Noise is discussed in the morning meetings. Noise compass wind directions/temperature inversions used as a predictive tool for operations. Uses a traffic light system for risk level. (c) Site operates a manual system of checking daily weather forecasts to determine days when meteorological criteria may not apply (e.g. during wind speeds and temperature inversions). No evidence was provided to show that site are alerted in real time. Improvement recommendation has been made for use of real time alerts. (d) There are regular consultation meetings with Energy Australia (minutes provided), however no evidence was provided to verify that cumulative noise impacts are coordinated between the two sites. Therefore low non-compliance. (e) Noise monitoring is carried out monthly at the site, and quarterly at the Wallerawang Haul Road. No exceedances of noise criteria during the audit period	NC REC 1: Include cumulative noise management as a regular item on the agenda for the Energy Australia consultation meetings. IMP REC 2: To cover Condition 8(c), implement a system where alerts are sent to site when meteorological conditions mean that noise limits in do not apply (e.g. high wind speeds, temperature inversions).	R1 WCS IEA 2021: Centennial will liaise with Energy Australia regarding ongoing cumulative noise management. R2 WCS IEA 2021: Centennial will develop in consultation with relevant suppliers a metrological alert system which will notify the site when noise limits do not apply	R1: 15/08/2022 Centennial commented with noise management in weekly Energy Australia meetings R2: 7/9/2022 Completed

Schedule and Condition Number	Condition	Compliance Status	Details	2021 IEA Recommendations	RAR March 2022	2022 AR Update
Sch 3, Con 16	The Applicant must: (a) implement best practice management to minimise the off-site odour, fume and dust emissions of the development; (b) implement all reasonable and feasible measures to minimise the release of greenhouse gas emissions from the site; (c) minimise the surface disturbance of the site; d) minimise any visible off-site air pollution generated by the development; (e) operate a comprehensive air quality management system that uses a combination of predictive meteorological forecasting, predictive air dispersion modelling and air quality monitoring data to guide the day-to-day planning of coal transportation and processing operations and implementation of both proactive and reactive air quality mitigation measures to ensure compliance with the relevant conditions of this consent; and (f) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see note d to Tables 7-9 above), to the satisfaction of the Secretary.	Low Non-Compliance	(a) No instances of offsite odour, fume or dust emissions from the project. No complaints. No exceedances of criteria or non-compliance. Site inspection observed dust to be managed well. No odour/fume observed while on site. (b) Greenhouse gas emissions are limited to mobile plant, which are only operated as required. Emissions are reported though the NGERs program. (c) Surface disturbance is largely restricted to existing operations. No clearing of undisturbed areas during the audit period. (d) No visible offsite air pollution observed during the site inspection. No complaints relating to visual impact or air quality. (e) • Predictive meteorological forecasting is used to generate daily Dust Risk Reports, which are presented in the morning meetings (minutes provided). Water carts and stockpile sprays are implemented on high risk days. Stockpile sprays are automatic, through CITECT. • No predictive air dispersion modelling. Therefore low non compliance. • Air quality monitoring data is collected at the site. TARP relates to PM10 triggers. No exceedances/non-compliances during the audit period. (f) Evidence was provided to show that during extraordinary events (e.g. 2019 bushfires) additional water carts were implemented to minimise air quality impacts of the development.	NC REC 2: In consultation with an air quality specialist develop and implement a system of predictive air dispersion modelling as required under Condition 16(e).	R3 WCS IEA 2021: Centennial has discussed upgrades to the implemented air modelling system and has engaged a supplier to implement a predicative air dispersion modelling system	R3: 7/9/2022 Completed
Sch 3, Con 24	The Applicant must prepare and implement a Water Management Plan for the development to the satisfaction of the Secretary. This plan must: (a) be prepared in consultation with the EPA, WaterNSW, DPIE – Water, LCC,		Three versions of the Western Coal Services Water Management Plans (WMP) have been developed for the site. August 2014 version (unapproved), October 2017 version (unapproved - submitted for approval 18/10/17) and	IMP REC 3: Complete maintenance works for areas of erosion identified along conveyor route during	R5 WCS IEA 2021: Centennial have engaged a contractor to undertake road maintenance along Overland Conveyor 2	R5: 30/05/2022 Completed

Schedule and Condition Number	Condition	Compliance Status	Details	2021 IEA Recommendations	RAR March 2022	2022 AR Update
	Forestry Corporation of NSW and Energy Australia by suitably qualified and experienced person/s whose appointment has been approved by the Secretary; (b) be submitted to the Secretary for approval within 4 months of the date of this consent, unless otherwise agreed by the Secretary; and (c) include a: (i) Site Water Balance, that: • includes details of: o sources and security of water supply, including contingency supply for future Reporting Periods; o water use and management on site; o any off-site water discharges; and o reporting procedures, including the preparation of a site water balance for each calendar year; and • investigates and implements all reasonable and feasible measures to minimise potable water use and to reuse and recycle water;" (ii) Surface Water Management Plan, that includes: • detailed baseline data on water flows and quality in the watercourses that could potentially be affected by the development; • a detailed description of the SCSS water management system, including the: o clean water diversion systems; o erosion and sediment controls; and o mine-water management systems; • detailed plans, including design objectives and performance criteria for: o design and management for the emplacement of coal reject materials and potential acid-forming or sulphategenerating materials; o management of sodic and dispersible soils; o reinstatement of appropriate drainage lines on the rehabilitated areas of the site; and o		February 2019 (unapproved - submitted for approval 15/03/2019). This audit has only assessed the 2014 version. Preparation (2014 Version) - a) Consultation outlined in Section 1.4 of WMP. b) WMP submitted in August 2014 (within required submission timeframe). c) (i) Site Water Balance provided in Section 7, and annual updates provided for 2020 and 2021. (ii) • Surface Water Management Plan included in the following section 6., baseline data in Section 9, triggers in Section 11, Monitoring and reporting included as Section 10 & 12. (iii) Baseline Groundwater Data Section 3, Groundwater Criteria Section 10.1, Groundwater monitoring Section 8, Validation Section 10 & 12.3, exceedances of criteria Section 11. (iv) Protocol for managing cumulative impacts Section 12.4. Implementation • Non - compliance for implementation. No evidence of Lamberts Gully Creek monitoring or channel stability monitoring (refer NC REC 3 above). • Some other minor improvement recommendations have been made in relation to water management observed during the site inspection. • Annual water and salt balance provided for 2020 and 2021. • Vista Data Vision shows current water level in dams, flow rate, water quality specs, etc. • Water quality trigger levels are included in the 2014 and 2019 Water MPs. Site completes monitoring and implements TARPs as per the 2019 MP, noting that this goes above and beyond commitments made in the 2014 Water MP. TARP includes notification	site inspection (refer photo 1 in audit report).		
				MP REC 4: Complete repair works along 50m of drainage line (refer Figure 5 in audit report)	R6 WCS IEA 2021: Centennial have engaged a contractor to undertake drainage repair.	R6: 30/05/2022 Completed
				IMP REC 5: Clean out areas of rock drains near the boundary of EA and Centennial (refer Figure 7 in audit report)	R7 WCS IEA 2021: Centennial have engaged a contractor to undertake drain maintenance.	R7: 30/05/2022 Completed
				IMP REC 8: Remove coal in dirty water drain adjacent to main haul road and clean water drain (refer Photo 25 in audit report)	R10 WCS IEA 2021: Centennial have engaged a contractor to undertake drain maintenance.	R10: 30/05/2022 Completed
				IMP REC 9: Desilt Stockpile Sediment Pond as it is at over 50% capacity (refer Photo 26 in audit report).	R11 WCS IEA 2021: Centennial have engaged a contractor to undertake the removal of material in the dam to re-establish capacity.	R11: 30/09/2022 Completed
				IMP REC 10: Consider the use of coir logs in area of failed sediment fence at Kerosene Vale site (refer photo 28 in audit report)	R12 WCS IEA 2021: Centennial is currently obtaining a quote from contractor to establish coir logs in the area identified. Works will be scheduled to be undertaken as required	R12: 30/06/2022 Completed
				IMP REC 11: Remove coal from drain near LDP003 at Kerosene Vale (refer Photos 30 and 31 in audit report)	R13 WCS IEA 2021: Centennial is currently obtaining a quote from a contractor to complete maintenance of the drain	R13: 30/7/2022 Completed

Schedule and Condition Number	Condition	Compliance Status	Details	2021 IEA Recommendations	RAR March 2022	2022 AR Update
	control of any potential water pollution from the rehabilitated areas of the site; • performance criteria for the following, including trigger levels for investigating any associated potentially adverse impacts: o SCSS water management system; o downstream surface water quality; and o stream and riparian vegetation health for the Wangcol and Lamberts Gully Creeks; • a program to monitor and report on: o effectiveness of the SCSS water management system; and o surface water flows and quality in the watercourses potentially affected by the development; and • reporting procedures for the results of the monitoring program; and • a plan to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the development;" (iii) Groundwater Management Plan that includes: • detailed baseline data of groundwater levels, yield and quality on the SCSS and surrounds that could be affected by the development, including any licensed privately -owned groundwater bores; • groundwater impact assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts; • a program to monitor and report on: o groundwater inflows to former open cut pits; o the seepage/leachate from water storages, emplacements of power station ash and/or coal rejects, and former open cut voids; o background changes in groundwater yield/quality against changes induced by the development; and o impacts of the development on: -		requirements to various agencies (Water NSW, DPIE, EPA, etc.) • Noted that a new WMP is currently being prepared. • Copies of PowerPoint presentations from Area 4 Rehabilitation (Feb & Oct 2020) and Hydrogeology Model provided. • Annual Reviews include surface and groundwater monitoring data and analysis. • Water MP notes that there are no GDEs in the vicinity.		at Kerosene Vale. Works will be scheduled to be undertaken as required.	
				IMP REC 12: Reinstall coir log at LDP003 (refer Photo 38 in audit report).	R14 WCS IEA 2021: Centennial is currently obtaining a quote from a contractor to reinstall the coir log at LDP003. Works will be scheduled to be undertaken as required.	R14: 30/06/2022 Completed
				IMP REC 13: Re - hydromulch area at Western Coal (refer Photo 40 in audit report).	R15 WCS IEA 2021: Centennial has discussed the scope of works with various contracting companies and is currently awaiting quotations for the hydromulching. Works will be scheduled to be undertaken as required.	R15: 30/7/2022 Completed

Schedule and Condition Number	Condition	Compliance Status	Details	2021 IEA Recommendations	RAR March 2022	2022 AR Update
	regional and local (including alluvial) aquifers; - groundwater supply of any potentially affected private landowners; and -any potentially affected groundwater dependent ecosystems and riparian vegetation; • a program to validate the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions; and • a plan to respond to any exceedances of the performance criteria; and (iv) protocol that has been prepared in consultation with the owners of nearby power generation or mining developments to: • minimise cumulative water quality impacts; • review opportunities for water sharing/water transfers between these developments; • co -ordinate water quality monitoring programs as far as practicable • undertake joint investigations/studies in relation to complaints/exceedances of trigger levels where cumulative impacts are considered likely; and • co-ordinate modelling programs for validation, re-calibration and re-running of groundwater and surface water models."					

Schedule and Condition Number	Condition	Compliance Status	Details	2021 IEA Recommendations	RAR March 2022	2022 AR Update
Sch 3, Con 36	Within 3 months of the date of consent, until coal transportation ceases on each respective haul road, unless otherwise agreed by the Secretary, the Applicant must maintain the surface of the haul roads from Angus Place to Mount Piper and Wallerawang power stations with a smooth sealed surface, effectively free of potholes, indentations or other unevenness of the surface that would cause noise levels from traffic travelling on the road to exceed the sleep disturbance criteria in Table 3, to the satisfaction of the Secretary.		• No inspections of haul roads are completed. Condition of haul roads unable to be assessed as part of this IEA. Previous evidence however outside of audit period. Site advised minimal use of the haul road (evidenced by trucking records 2018-2021). • Haul road observed during the audit had no significant issues visible to the auditors	NC REC 4: To cover the requirements of Condition 36-38, contact DPIE regarding the requirements to undertake an independent inspection and condition report of the surface of the haul roads from Angus Place to Mount Piper and Wallerawang power stations, by an independent road maintenance expert	R16 WCS IEA 2022: Coal transportation is currently not being undertaken on the haul road. Centennial will consult with the Department regarding maintenance requirements under the current business plan for Western Operations	R16: 30/08/2022 Completed
				NC REC 5: Maintain records of any repair of haul roads if required.	R17 WCS IEA 2022: Centennial will identify, and document repair works of haul roads in the future.	R17: System for identifying and documenting haul road repairs has been developed and implemented. Completed (and ongoing)

Schedule and Condition Number	Condition	Compliance Status	Details	2021 IEA Recommendations	RAR March 2022	2022 AR Update
SoC 3.1	Removal of the northern two thirds of the existing Co-Disposal REA at the Springvale Coal Services Site within five years of Project Approval.		Has not been completed during the audit period. Noted that this is in the MOP and is planned for completion. HRA has been completed for this work	NC REC 6: Details of the co-disposal works referenced in Statement of Commitments 3.1 to be included in the RMP.	R18 WCS IEA 2022: Centennial will include details of the co-disposal works in the RMP	R18: 2/7/2022 Completed

Table 10-2: Additional Recommendations from 2021 IEA

Aspect	Condition	Improvement REC Number	2021 IEA Recommendations	RAR March 2022	2022 AR Update
Consultation	SSD-5579 Schedule 2 Condition 17	IMP REC 1	Centennial to consult with Energy Australia and Council as part of the RMP preparation.	R19 WCS IEA 2022: Centennial will incorporate Energy Australia and Council into the RMP Stakeholder Engagement Strategy .	R19: 2/7/2022 Completed
Ecology	SSD-5579 Schedule 3 Condition 27	IMP REC 14	Follow up with DPIE to get the 2017 RHCIP Approved.	R20 WCS IEA 2022: Centennial will re-submit the RHCIP for Approval in the DPIE portal.	R20: 30/6/2022 Completed
Waste/Carbonaceous Material	SSD-5579 Schedule 3 Condition 42	IMP REC 15	Remove areas of coal spill identified under conveyors during site inspection (refer photos 2, 3 and 6 in audit report).	R21 WCS IEA 2022: Centennial have engaged a contractor to undertake cleaning under over-land conveyors.	R21: 30/5/2022 Completed
		IMP REC 16	Remove area of coal spill identified at the base of hill below conveyor during site inspection (refer photo 10 in audit report).	R22 WCS IEA 2022: Centennial have engaged a contractor to undertake removal of coal at the base of the hill.	R22: 30/5/2022 Completed
Rehabilitation	SSD-5579 Schedule 3 Condition 44	IMP REC 17	Angus Place RMP to include removal of derelict buildings at Kerosene Vale (refer Photos 33, 35, 37 in audit report)	R23 WCS IEA 2022: Centennial will include the removal of derelict buildings into the RMP	R23: 2/7/2022 Completed
	SSD-5579 Schedule 3 Condition 45	IMP REC 18	In the next revision of the MOP/RMP add an extra column to Table 14 (see existing MOP) to show where each of the Regulatory requirements is met in the document	R24 WCS IEA 2022: Centennial will include regulatory requirements in the RMP.	R24: 2/7/2022 Completed
Surface Water	EPL 21229 Condition L2.4	IMP REC 19	Investigate options to detect discharges at LDP002 i.e. level sensor for volume. Other option is quarterly water testing to get an understanding of water quality	R25 WCS IEA 2022: Centennial have obtained a quote and is liaising with contractors to install a level sensor at LDP002.	R25: 31/10/2022 Completed
	EPL 21229 Condition O5.3	IMP REC20	Stockpile Sediment Pond to be desilted to retain design capacity	R11 WCS IEA 2021: Centennial have engaged a contractor to undertake the removal of material in the dam to re-establish capacity.	R11: 30/09/2022 Completed

11 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

This section refers to non-compliances and incidents reported during the Reporting Period. The IEA period non-compliances have been discussed in **Section 10**.

A summary of incident and regulatory action is presented in **Table 11-1. Table 11-2** presents the non-compliance for the Reporting Period.

Table 11-1: Summary of Reportable Incidents and Regulatory Action

Compliance Type	Agency	Number
Incidents	DPE/ EPA	1
Caution Notices	0	0
Warning Letters	0	0
Penalty Notices	0	0
Prosecutions	0	0

Note: This table includes actions taken by DPE, Resources Regulator and the EPA during the Reporting Period.

Table 11-2 Incidents and Non-Compliances during the Reporting Period

Compliance	Overview of incident/non-compliance	Description of incident/non-compliance	Actions	Status of Actions
Non-Compliant	WCS must not transfer more than 0.43ML/day in accordance with Condition 8A, Schedule 2 of SSD-5579. Volume accepted must not exceed 0.35 ML/day(annual average) or 0.43 ML/day (daily maximum) in accordance EPL21229, Condition L4.1. A transfer exceedance was recorded on the 18th and 19th October 2022 shows a transfer of 0.441ML and 0.434 ML, respectively.	On 18 October 2022, the volume discharged was 441.5 m^3 and on 19 October 2022, the volume discharged was 434.6 m^3 due to the additional 11.5m^3 and 4.6 m^3 respectively of service water being transferred as a result of the partial passing of a closed valve. The unintentional additional transfer of service water on 18th October shows a transfer of 0.441 ML and on 19th October of 0.434 ML, against conditional limit of 0.43 ML/day. Although the pumped transfer of residuals was stopped at 425 m3/d as per normal operating procedures, adjacent flushing activities and the partial passing of a closed valve resulted in service water being introduced to the residuals transfer pipeline and a volume greater than the residuals limit of 430 m3/d was transferred. .	Investigations have found that a flushing line had been set up at the time. The location of the flushing water injection was before the valves and it was found that the valves were passing flow when they were closed. A review of the valve is that it is suitable for solids handling, but is likely to pass clean water that has a sustained pressure. The SCADA control worked as intended by shutting off the transfer pump, closing the valve and interlocking the system at 425 m3 The manual method of flushing that caused the additional volume to be transferred is no longer used. This has been communicated to the operators via the shift handover notes, pre start meetings and supervisor interactions. A review of the valve confirmed that it is suitable for solids handling, but is likely to pass clean water that has a sustained pressure from flushing Additional alarming is being incorporated as a preventative control to a repeat incident. This includes a notification when flow registers on flowmeters but the pumps have stopped. Similarly, an additional SCADA alarm will also be implemented to alert operators when the daily discharge volume has reached 420 m3. This early warning will trigger the Alarm Management System to flash a reminder when alarms are active	Complete

12 ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

Table 12-1 presents activities that are currently planned for the next Reporting Period.

Table 12-1: Forecast Operations for 2023

Improvement Actions
• Progress the necessary post approvals to allow the commencement of MOD4 • Review and where applicable address recommendations for noise, surface water and groundwater specialist.
Management Plan Revisions
• Follow up with DPE with the approval status of the most recent versions of WMP and WRBMP • A construction environmental management plan (CEMP) to manage potential noise, dust, biodiversity, soil and water impacts during construction prior to the commencement of MOD4 construction activities.
Condition Triggers
• In accordance with Condition 5(a) in Schedule 5 of SSD-5579 strategies, plans, and programs required under the consent will be reviewed within three months of the submission of this annual review. Where this review leads to revisions in any such document, then within 4 weeks of the review the revised document will be submitted for the approval of the Secretary. • Revise the WCS Water Management Plan • Revise the WRBMP • Revise the ACHMP

It is noted that changes to production activities may trigger changes to planned activities.

13 REFERENCES

RPS (2013) *Western Coal Services Project – Environmental Impact Statement*

EMM (2021) *Western Coal Services Project – Modification Report for Modification to SSD-5579*

EMM (2023) *Overland Conveyor Sound Pressure Level Testing*

EMM (2022) *Sound Power Survey*

GHD (2022) *January to December 2022 Monitoring Reports*

GHD (2023) *Western Coal Services – Annual Water Report 2022*

GHD (2023) *UCRC Aquatic Ecology Springvale Coal Services and Lidsdale Siding site summaries from 2022 monitoring*

Global Acoustics (2023) *Lidsdale Siding Sound Power Survey 2022*

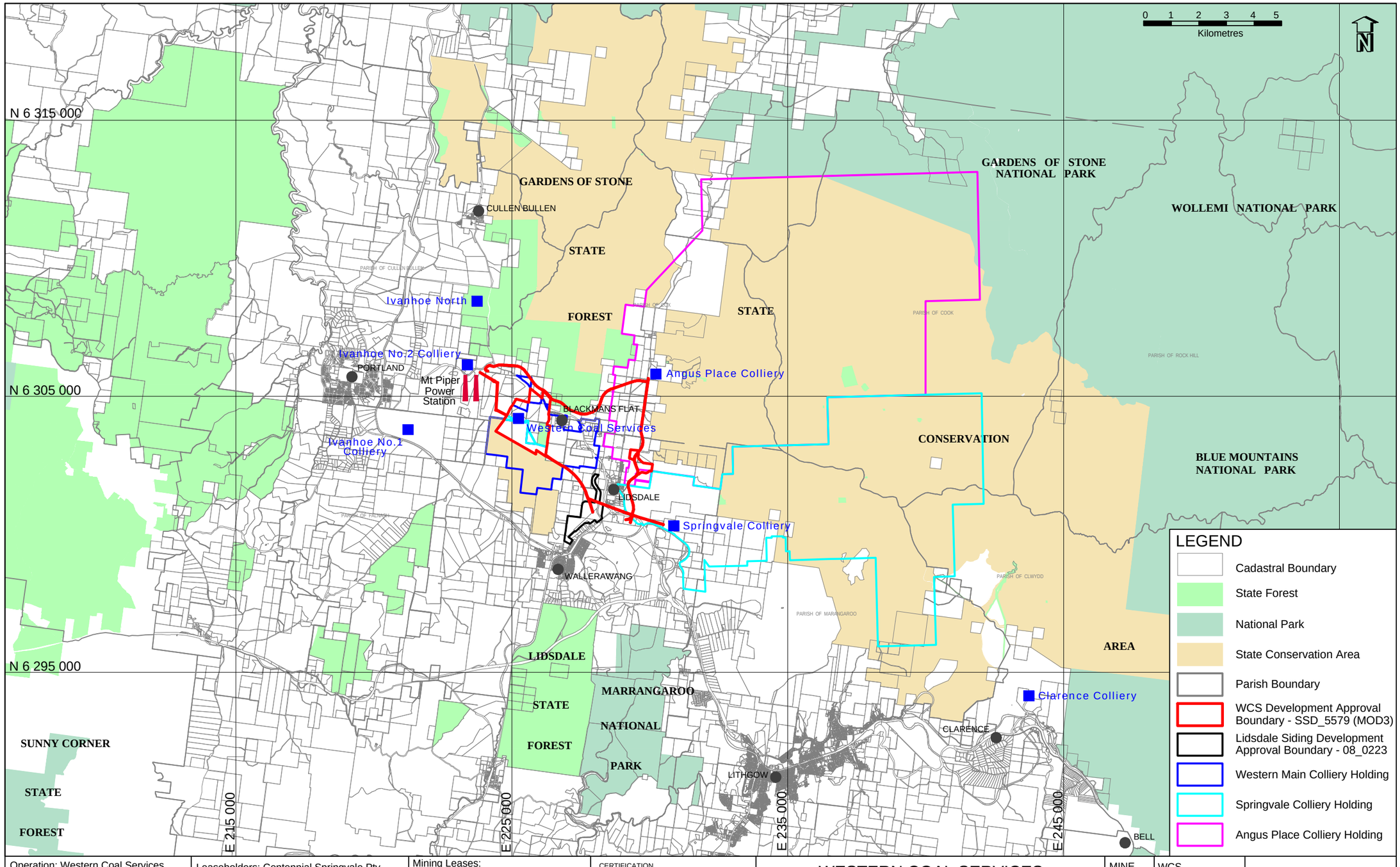
JR Richards (2022) *Total Waste Management Report Western Coal Services*

SLR (2023) *Springvale Coal Services (SCS) – Annual Rehabilitation Monitoring Report 2022*

IEMA (2022) *Western Coal Services Independent Environmental Audit 2021*

APPENDICES

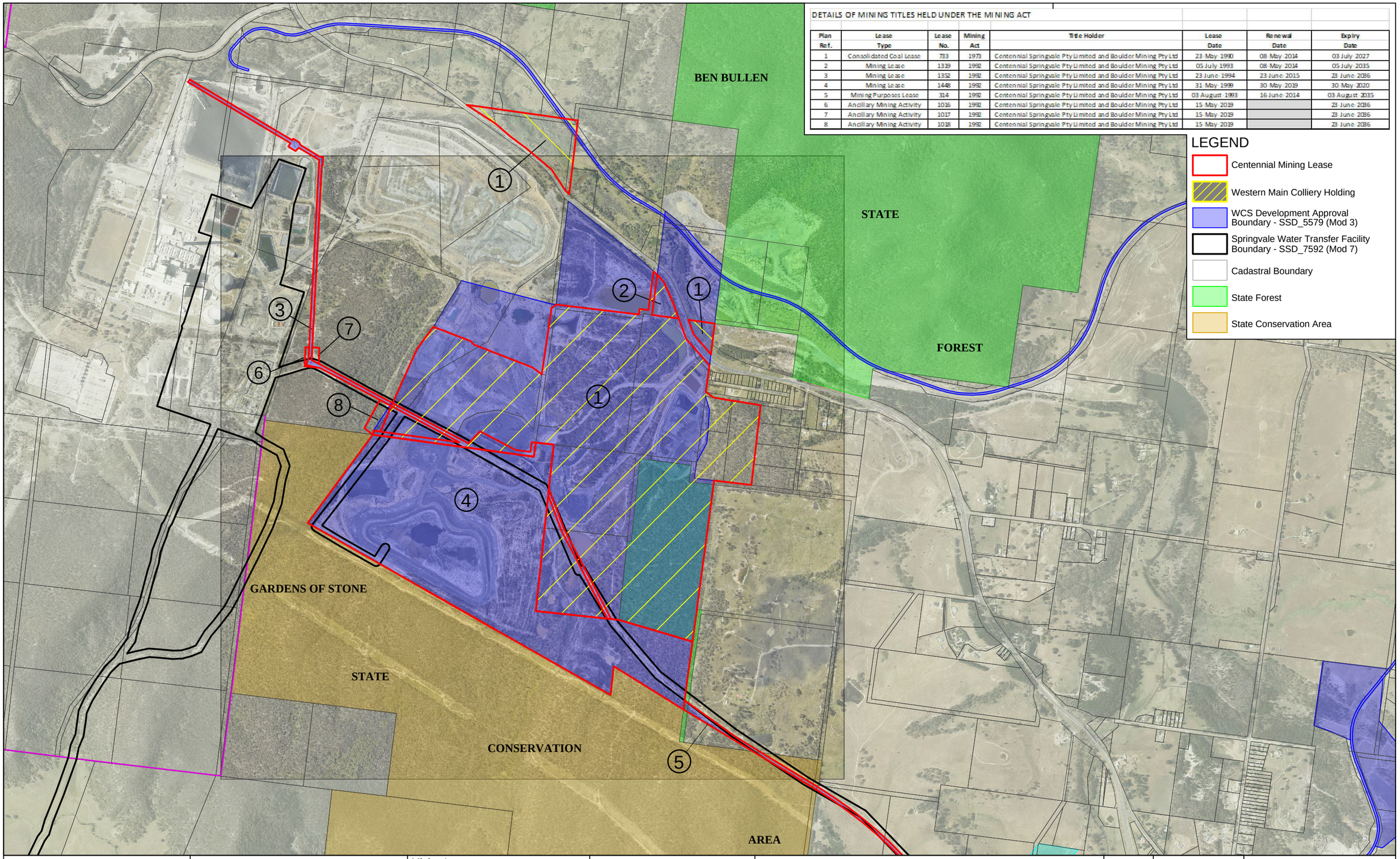
APPENDIX 1: WCS PLANS



Operation: Western Coal Services	Leaseholders: Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	Mining Leases: CCL733 Expiry 3 July 2027 ML1319 Expiry 5 July 2035 ML1352 Expiry 23 June 2036 (AMA1016, AMA1017 & AMA1018) ML1448 Expiry 30 May 2020 (Renewal Pending) Part MPL314 Expiry 3 August 2035	CERTIFICATION I hereby certify that the information shown hereon, to the best of my knowledge and belief, is correctly represented. Signed: ..... Date: 15-March-2023 William A. Olson Environment & Community Coordinator Springvale Coal Services Operations	WESTERN COAL SERVICES ANNUAL REVIEW 2022 **Plan 1A - Project Locality**	MINE	WCS
Operator: Springvale Coal Pty Limited					SEAM	N/A
Project Approval: SSD_5579 (MOD 3)	RMP Start Date: 1-August-2022				DRAWN	P.J.M.
Proponent: Springvale Coal Pty Limited	RMP End Date: N/A Perpetual				SCALE	Refer to Scale Bar
Mining Leases: CCL733, ML1319, ML1352, ML1448 & Part MPL314	Annual Review Start Date: 1-January-2022				DATE	15-March-2023
	Annual Review End Date: 31-December-2022				SHEET	A2H

CENTENNIAL SPRINGVALE

PLAN No. PC7956



DETAILS OF MINING TITLES HELD UNDER THE MINING ACT

Plan Ref.	Lease Type	Lease No.	Mining Act	Title Holder	Lease Date	Renewal Date	Expiry Date
1	Consolidated Coal Lease	733	1973	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	23 May 1990	08 May 2014	03 July 2027
2	Mining Lease	1319	1992	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	05 July 1993	08 May 2014	05 July 2035
3	Mining Lease	1352	1992	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	23 June 1994	23 June 2015	23 June 2036
4	Mining Lease	1448	1992	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	31 May 1999	30 May 2019	30 May 2020
5	Mining Purposes Lease	314	1992	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	03 August 1993	16 June 2014	03 August 2035
6	Ancillary Mining Activity	1016	1992	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	15 May 2019		23 June 2036
7	Ancillary Mining Activity	1017	1992	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	15 May 2019		23 June 2036
8	Ancillary Mining Activity	1018	1992	Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	15 May 2019		23 June 2036

LEGEND

- Centennial Mining Lease
- Western Main Colliery Holding
- WCS Development Approval Boundary - SSD_5579 (Mod 3)
- Springvale Water Transfer Facility Boundary - SSD_7592 (Mod 7)
- Cadastral Boundary
- State Forest
- State Conservation Area

Operation: Western Coal Services	Leaseholders: Centennial Springvale Pty Limited and Boulder Mining Pty Ltd
Operator: Springvale Coal Pty Limited	
Project Approval: SSD_5579 (MOD 3)	RMP Start Date: 1-August-2022
Proponent: Springvale Coal Pty Limited	RMP End Date: N/A Perpetual
Mining Leases: CCL733, ML1319, ML1352, ML1448 & Part MPL314	Annual Review Start Date: 1-January-2022
	Annual Review End Date: 31-December-2022

Mining Leases:
CCL733 Expiry 3 July 2027
ML1319 Expiry 5 July 2035
ML1352 Expiry 23 June 2036
(AMA1016, AMA1017 & AMA1018)
ML1448 Expiry 30 May 2020
(Renewal Pending)
Part MPL314 Expiry 3 August 2035

CERTIFICATION

I hereby certify that the information shown hereon, to the best of my knowledge and belief, is correctly represented.

Signed: .....

Date: 15-March-2023

William A. Olson
Environment & Community Coordinator
Springvale Coal Services Operations

WESTERN COAL SERVICES
ANNUAL REVIEW 2022

Plan 1B - Mining Leases

MINE	WCS
SEAM	N/A
DRAWN	P.J.M.
SCALE	Refer to Scale Bar
DATE	15-March-2023
SHEET	A2H

CENTENNIAL SPRINGVALE

PLAN No. PC7957

LEGEND

- WCS Development Approval Boundary - SSD_5579 (Mod 3)
- Springvale Water Treatment Facility Boundary - SSD_7592 (Mod 7)
- Centennial Mining Lease Boundary
- Western Main Colliery Holding
- Abandoned Mine Workings Open Cut Limit of Extraction
- Abandoned Mine Workings Lithgow Seam
- Abandoned Mine Workings Irondale Seam
- Abandoned Mine Workings Lidsdale Seam
- Cadastral Boundary
- State Forest
- State Conservation Area
- Centennial Land
- Private Freehold Land
- Crown Land
- GPM Land
- Energy Australia (NSW) Land
- Lithgow City Council Land
- Buildings

CULLEN MAIN WEST OPEN CUT (Abandoned)
IVANHOE NORTH OPEN CUT (Abandoned)
CULLEN MAIN EAST OPEN CUT (Abandoned)
INVINCIBLE (Abandoned)
ML1352
RED SPRINGS No.1 OPEN CUT (Abandoned)
CCL712
INVANHOE No.2 (Discontinued)
IVANHOE No.2 (IRONDALE SEAM) (Abandoned)
ML1352
WALLERAWANG (Abandoned)
RED SPRINGS No.3 OPEN CUT (Abandoned)
RED SPRINGS No.2 OPEN CUT (Abandoned)
MPL314
MAIN RANGE (LIDSDALE SEAM) (Abandoned)
HUON No.3 EXTENDED (Abandoned)
HUON No.1 (Abandoned)
HUON No.1 EXTENDED OPEN CUT (Abandoned)
MT PIPER POWER STATION
INVANHOE No.1 (Abandoned)
HUON No.2 OPEN CUT (Abandoned)
WESTERN MAIN OPEN CUT (Abandoned)
ROWSELLS (Abandoned)
PORTLAND (Abandoned)
CCL712
INVANHOE No.1 OPEN CUT (Abandoned)
HUON No.4 EXTENDED (Abandoned)
PINEDALE OPEN CUT (Abandoned)
COMMONWEALTH OPEN CUT No.2 (Abandoned)
NEWPORT OPEN CUT (Abandoned)
COMMONWEALTH OPEN CUT No.3 (Abandoned)
ENHANCE OPEN CUT (Abandoned)
LAMBERTS GULLY OPEN CUT (Abandoned)
BUNNYONG OPEN CUT (Abandoned)
IRONDALE No.2 (Abandoned)
WESTERN MAIN (Abandoned)
EASTERN MAIN (Abandoned)
COMMONWEALTH (Abandoned)
CAL (Abandoned)
COMMONWEALTH OPEN CUT No.4 (Abandoned)
KEROSENEVALE OPEN CUT (Abandoned)
IRONDALE No.1 IRONDALE SEAM (Abandoned)
JOHNSDALE OPEN CUT (Abandoned)

SCALE
0 0.5 1.0 1.5 KM

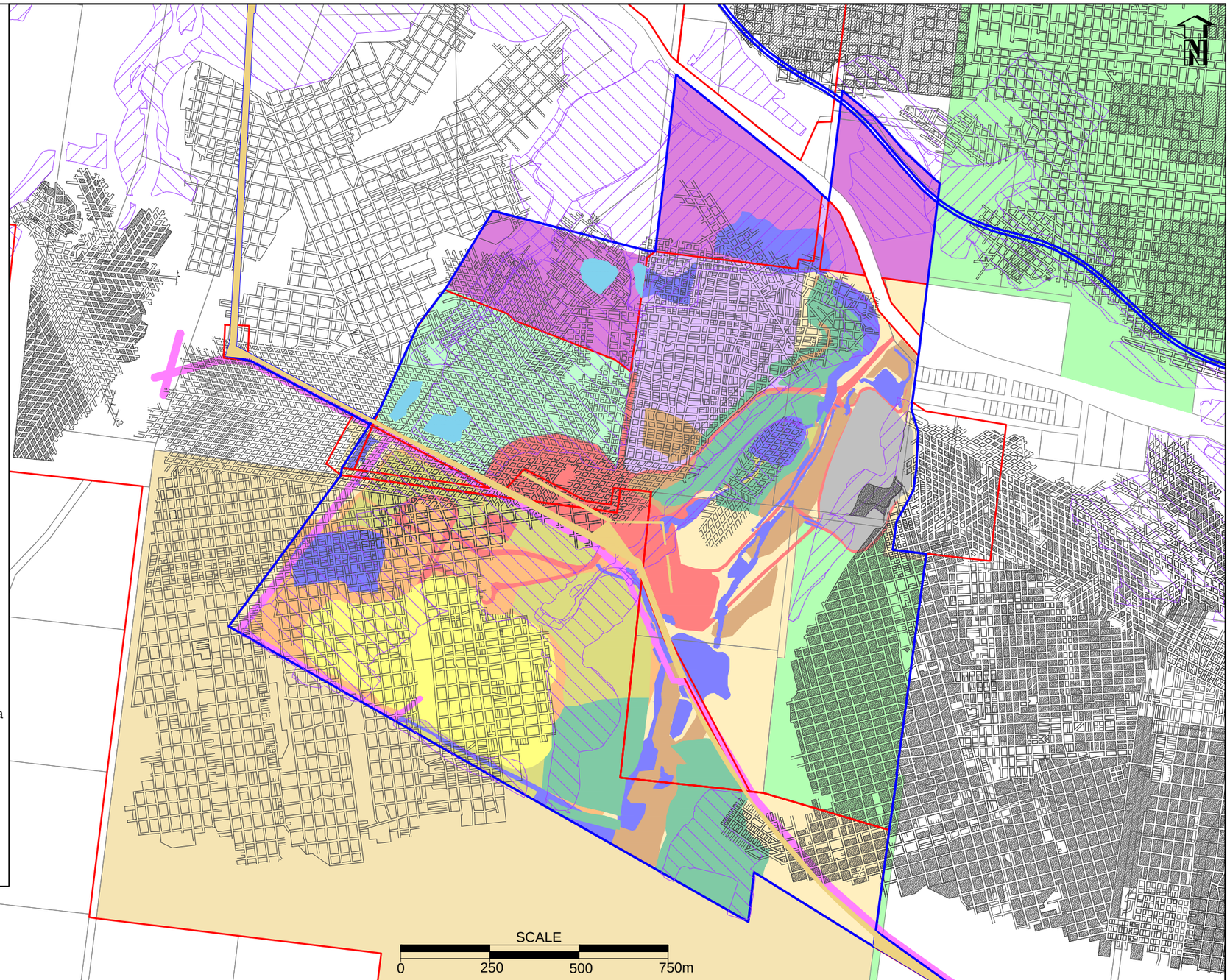
Operation: Western Coal Services	Leaseholders: Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	Mining Leases: CCL733 Expiry 3 July 2027 ML1319 Expiry 5 July 2035 ML1352 Expiry 23 June 2036 (AMA1016, AMA1017 & AMA1018) ML1448 Expiry 30 May 2020 (Renewal Pending) Part MPL314 Expiry 3 August 2035	CERTIFICATION I hereby certify that the information shown hereon, to the best of my knowledge and belief, is correctly represented. Signed: ..... Date: 15-March-2023 William A. Olson Environment & Community Coordinator Springvale Coal Services Operations	WSETERN COAL SERVICES ANNUAL REVIEW 2022 **Plan 1C - Built Environment**	MINE	WCS
Operator: Springvale Coal Pty Limited					SEAM	N/A
Project Approval: SSD_5579 (MOD 3)	RMP Start Date: 1-August-2022				DRAWN	P.J.M.
Proponent: Springvale Coal Pty Limited	RMP End Date: N/A Perpetual				SCALE	Refer to Scale Bar
Mining Leases: CCL733, ML1319, ML1352, ML1448 & Part MPL314	Annual Review Start Date: 1-January-2022				DATE	15-March-2023
	Annual Review End Date: 31-December-2022				SHEET	A2H

CENTENNIAL SPRINGVALE

PLAN No. PC7958

LEGEND

- Centennial Mining Lease Boundary
- Western Coal Services Approval Boundary - SSD_5579
- Abandoned Mine Workings Open Cut Limit of Extraction
- Abandoned Mine Workings Lithgow Seam
- Abandoned Mine Workings Irondale Seam
- State Forest
- State Conservation Area
- Cadastral Boundary
- Primary Domain 1 - Washery, Coal Handling & Roads
- Primary Domain 2 - REA
- Primary Domain 3 - Co-Disposal REA
- Primary Domain 4 - Water Management
- Primary Domain 5 - Current Rehabilitation
- Primary Domain 6 - Overburden Emplacement
- Primary Domain 7 - Conservation Sites
- Primary Domain 8 - Sealed Haul Roads & Conveyors
- Primary Domain 9 - EA Land
- Primary Domain 10 - EA Land & Area 4D
- Primary Domain 11 - EA Ash Water Management Area
- Primary Domain 12 - Lithgow City Council Land
- Primary Domain 13 - Capping Material Stockpile
- Primary Domain 14 - SWTS Infrastructure
- Primary Domain 15 - Other Lands



Operation: Western Coal Services	Leaseholders: Centennial Springvale Pty Limited and Boulder Mining Pty Ltd
Operator: Springvale Coal Pty Limited	
Project Approval: SSD_5579 (MOD 3)	RMP Start Date: 1-August-2022
Proponent: Springvale Coal Pty Limited	RMP End Date: N/A Perpetual
Mining Leases: CCL733, ML1319, ML1352, ML1448 & Part MPL314	Annual Review Start Date: 1-January-2022
	Annual Review End Date: 31-December-2022

Mining Leases:
CCL733 Expiry 3 July 2027
ML1319 Expiry 5 July 2035
ML1352 Expiry 23 June 2036
(AMA1016, AMA1017 & AMA1018)
ML1448 Expiry 30 May 2020
(Renewal Pending)
Part MPL314 Expiry 3 August 2035

CERTIFICATION

I hereby certify that the information shown hereon, to the best of my knowledge and belief, is correctly represented.

Signed: .....

Date: 15-March-2023

William A. Olson
Environment & Community Coordinator
Springvale Coal Services Operations

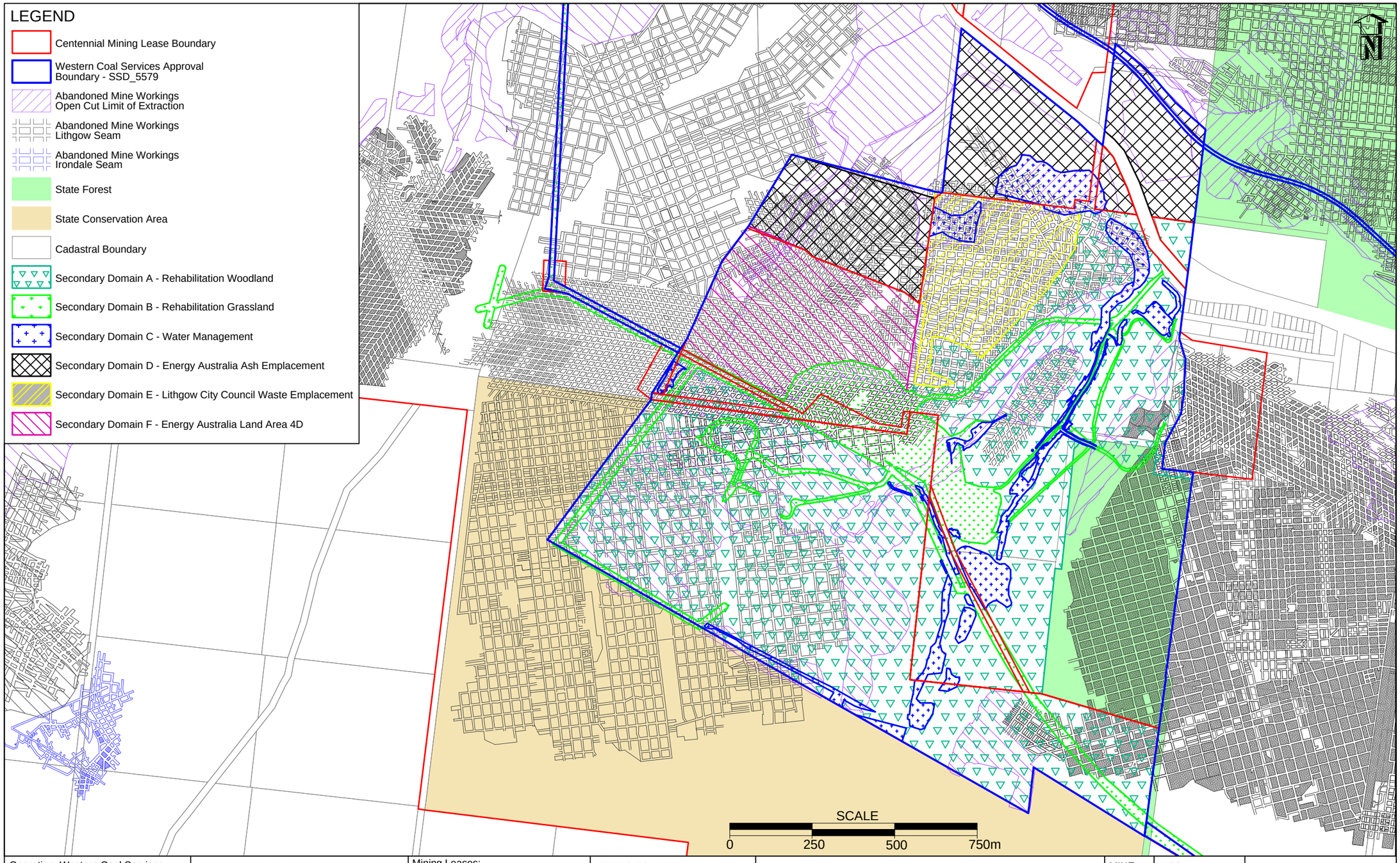
WESTERN COAL SERVICES
ANNUAL REVIEW 2022
MINE DOMAINS

Plan 2A - Primary Domains

MINE	WCS
SEAM	N/A
DRAWN	P.J.M.
SCALE	Refer to Scale Bar
DATE	15-March-2023
SHEET	A2H

CENTENNIAL SPRINGVALE

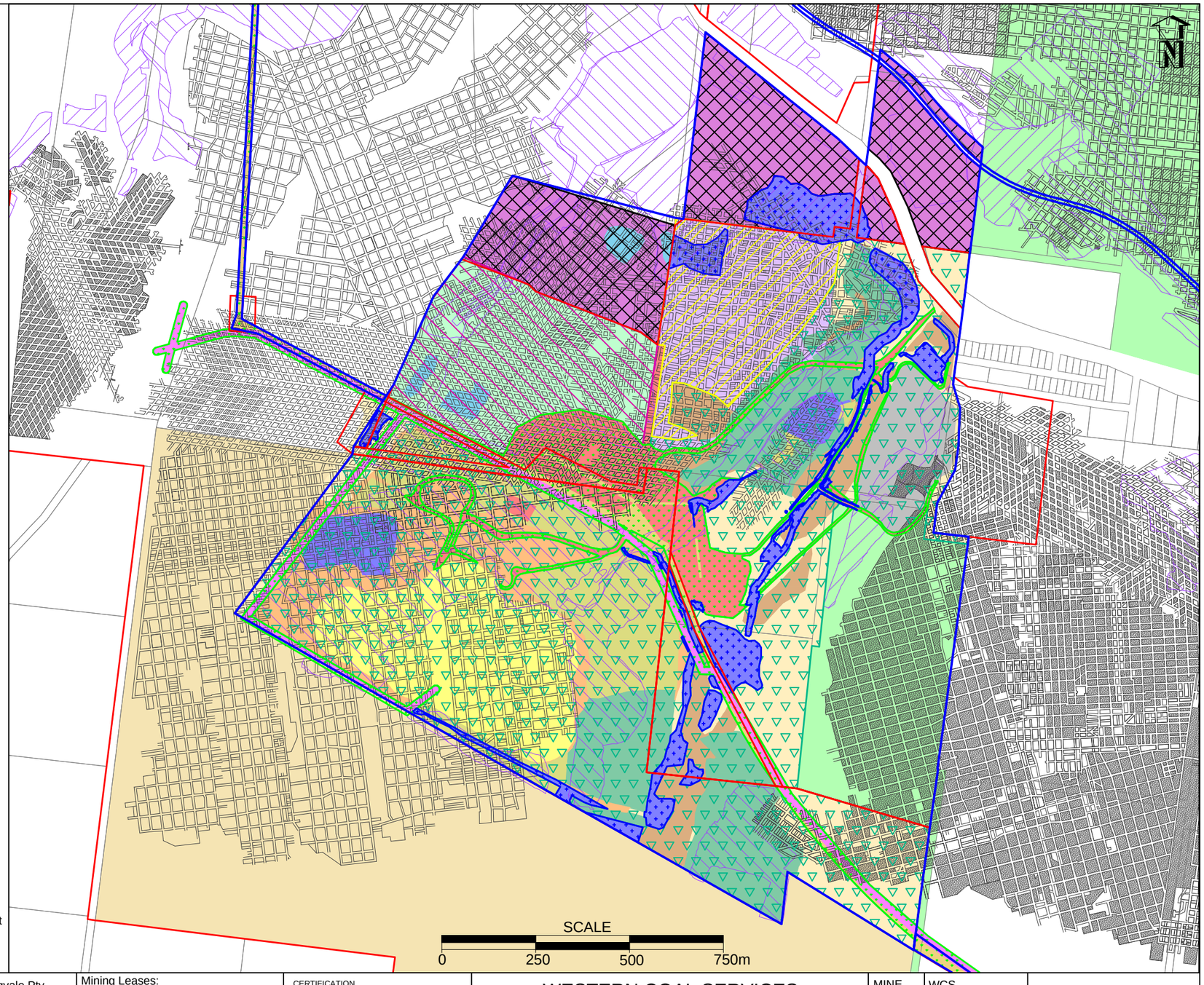
PLAN No. PC7959



Operation: Western Coal Services	Leaseholders: Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	Mining Leases: CCL733 Expiry 3 July 2027 ML1319 Expiry 5 July 2035 ML1352 Expiry 23 June 2036 (AMA1016, AMA1017 & AMA1018) ML1448 Expiry 30 May 2020 (Renewal Pending) Part MPL314 Expiry 3 August 2035	CERTIFICATION I hereby certify that the information shown hereon, to the best of my knowledge and belief, is correctly represented. Signed: ..... Date: 15-March-2023 William A. Olson Environment & Community Coordinator Springvale Coal Services Operations	WESTERN COAL SERVICES ANNUAL REVIEW 2022 MINE DOMAINS **Plan 2B - Secondary Domains**	MINE: WCS SEAM: N/A DRAWN: P.J.M. SCALE: Refer to Scale Bar DATE: 15-March-2023 SHEET: A2H	CENTENNIAL SPRINGVALE PLAN No. PC7960
Operator: Springvale Coal Pty Limited	RMP Start Date: 1-August-2022					
Project Approval: SSD_5579 (MOD 3)	RMP End Date: N/A Perpetual					
Proponent: Springvale Coal Pty Limited	Annual Review Start Date: 1-January-2022					
Mining Leases: CCL733, ML1319, ML1352, ML1448 & Part MPL314	Annual Review End Date: 31-December-2022					

LEGEND

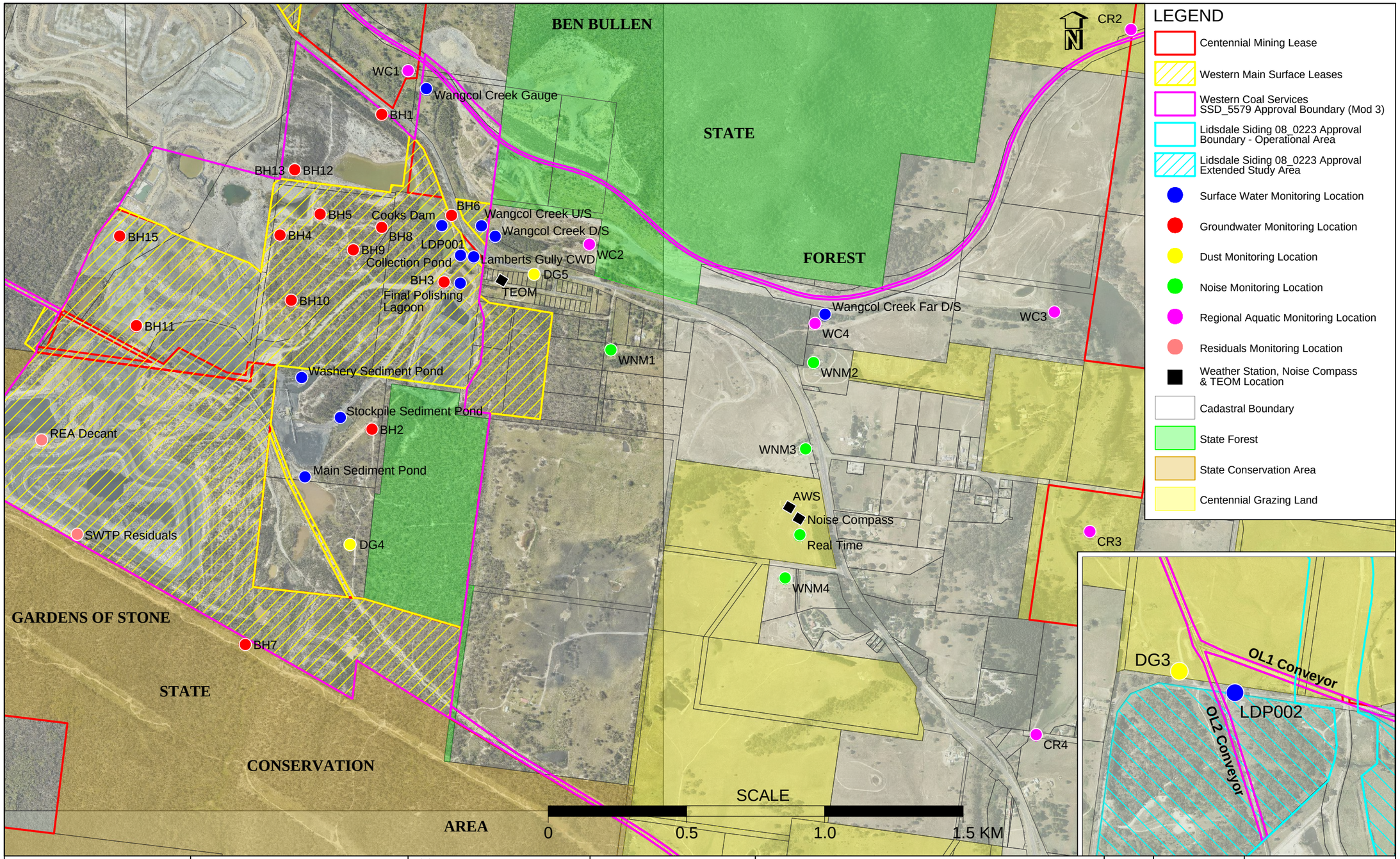
- Centennial Mining Lease Boundary
- Western Coal Services Approval Boundary - SSD_5579 (Mod 3)
- Abandoned Mine Workings Open Cut Limit of Extraction
- Abandoned Mine Workings Lithgow Seam
- Abandoned Mine Workings Irondale Seam
- State Forest
- State Conservation Area
- Cadastral Boundary
- Primary Domain 1 - Washery, Coal Handling & Roads
- Primary Domain 2 - REA
- Primary Domain 3 - Co-Disposal REA
- Primary Domain 4 - Water Management
- Primary Domain 5 - Current Rehabilitation
- Primary Domain 6 - Overburden Emplacement
- Primary Domain 7 - Conservation Sites
- Primary Domain 8 - Sealed Haul Roads & Conveyors
- Primary Domain 9 - EA Land
- Primary Domain 10 - EA Land & Area 4D
- Primary Domain 11 - EA Ash Water Management Area
- Primary Domain 12 - Lithgow City Council Land
- Primary Domain 13 - Capping Material Stockpile
- Primary Domain 14 - SWTS Infrastructure
- Primary Domain 15 - Other Lands
- Secondary Domain A - Rehabilitation Woodland
- Secondary Domain B - Rehabilitation Grassland
- Secondary Domain C - Water Management
- Secondary Domain D - Energy Australia Ash Emplacement
- Secondary Domain E - Lithgow City Council Waste Emplacement
- Secondary Domain F - Energy Australia Land Area 4D



Operation: Western Coal Services	Leaseholders: Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	Mining Leases: CCL733 Expiry 3 July 2027 ML1319 Expiry 5 July 2035 ML1352 Expiry 23 June 2036 (AMA1016, AMA1017 & AMA1018) ML1448 Expiry 30 May 2020 (Renewal Pending) Part MPL314 Expiry 3 August 2035	CERTIFICATION I hereby certify that the information shown hereon, to the best of my knowledge and belief, is correctly represented. Signed: ..... Date: 15-March-2023 William A. Olson Environment & Community Coordinator Springvale Coal Services Operations	WESTERN COAL SERVICES ANNUAL REVIEW 2022 MINE DOMAINS **Plan 2C - Primary & Secondary Domains**	MINE	WCS
Operator: Springvale Coal Pty Limited					SEAM	N/A
Project Approval: SSD_5579 (MOD 3)	RMP Start Date: 1-August-2022				DRAWN	P.J.M.
Proponent: Springvale Coal Pty Limited	RMP End Date: N/A Perpetual				SCALE	Refer to Scale Bar
Mining Leases: CCL733, ML1319, ML1352, ML1448 & Part MPL314	Annual Review Start Date: 1-January-2022				DATE	15-March-2023
	Annual Review End Date: 31-December-2022				SHEET	A2H

CENTENNIAL SPRINGVALE

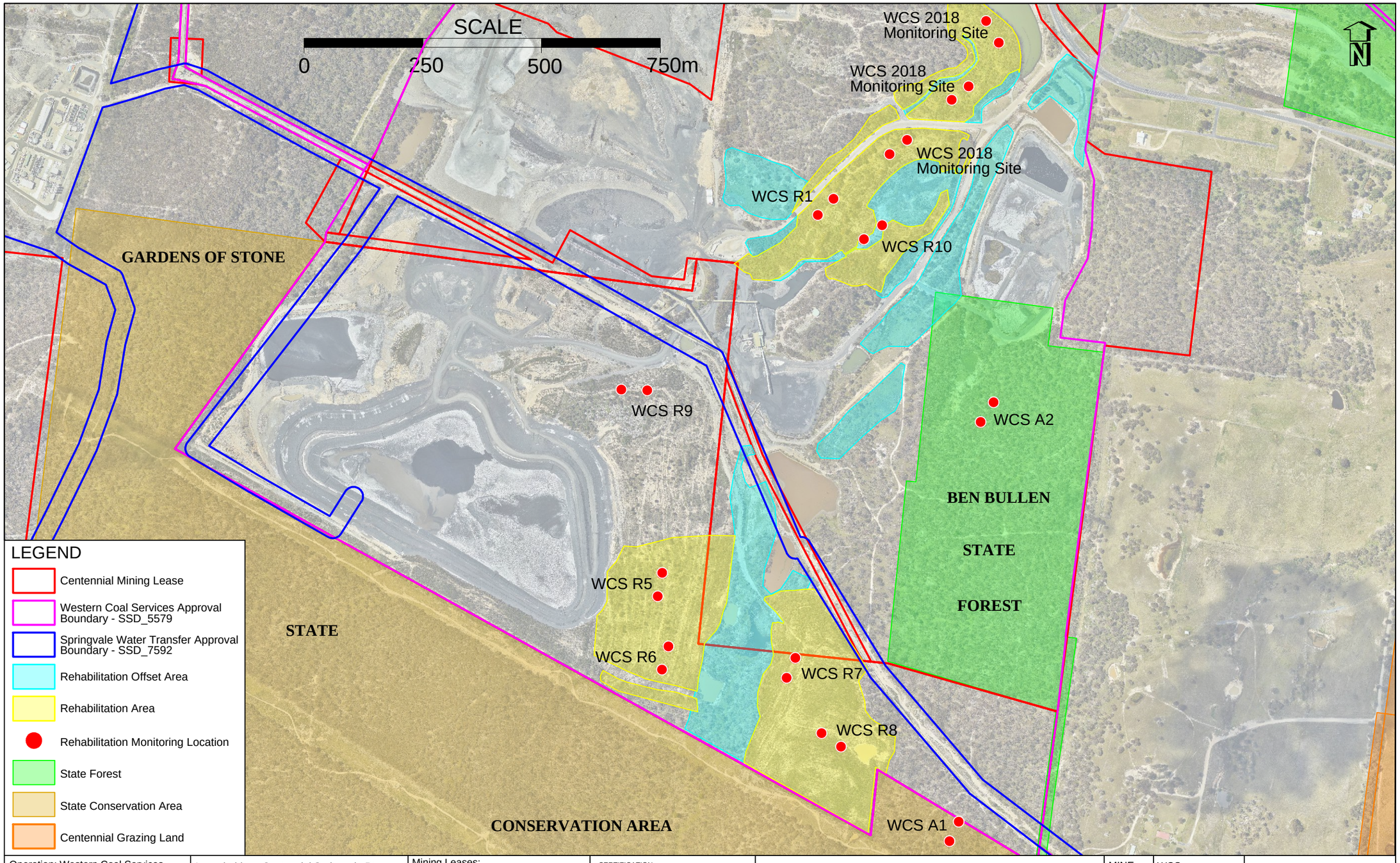
PLAN No. PC7961



Operation: Western Coal Services	Leaseholders: Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	Mining Leases: CCL733 Expiry 3 July 2027 ML1319 Expiry 5 July 2035 ML1352 Expiry 23 June 2036 (AMA1016, AMA1017 & AMA1018) ML1448 Expiry 30 May 2020 (Renewal Pending) Part MPL314 Expiry 3 August 2035	CERTIFICATION I hereby certify that the information shown hereon, to the best of my knowledge and belief, is correctly represented. Signed: ..... Date: 15-March-2023 William A. Olson Environment & Community Coordinator Springvale Coal Services Operations	WESTERN COAL SERVICES ANNUAL REVIEW 2022 MINING & REHABILITATION **Plan 3A - Environmental Monitoring**	MINE	WCS
Operator: Springvale Coal Pty Limited	RMP Start Date: 1-August-2022				SEAM	N/A
Project Approval: SSD_5579 (MOD 3)	RMP End Date: N/A Perpetual				DRAWN	P.J.M.
Proponent: Springvale Coal Pty Limited	Annual Review Start Date: 1-January-2022				SCALE	Refer to Scale Bar
Mining Leases: CCL733, ML1319, ML1352, ML1448 & Part MPL314	Annual Review End Date: 31-December-2022				DATE	15-March-2023
					SHEET	A2H

CENTENNIAL SPRINGVALE

PLAN No. PC7962



Operation: Western Coal Services	Leaseholders: Centennial Springvale Pty Limited and Boulder Mining Pty Ltd	Mining Leases: CCL733 Expiry 3 July 2027 ML1319 Expiry 5 July 2035 ML1352 Expiry 23 June 2036 (AMA1016, AMA1017 & AMA1018) ML1448 Expiry 30 May 2020 (Renewal Pending) Part MPL314 Expiry 3 August 2035	CERTIFICATION I hereby certify that the information shown hereon, to the best of my knowledge and belief, is correctly represented. Signed: ..... Date: 15-March-2023 William A. Olson Environment & Community Coordinator Springvale Coal Services Operations	WESTERN COAL SERVICES ANNUAL REVIEW 2022 MINING & REHABILITATION **Plan 3B - Rehabilitation Monitoring**	MINE	WCS
Operator: Springvale Coal Pty Limited	RMP Start Date: 1-August-2022				SEAM	N/A
Project Approval: SSD_5579 (MOD 3)	RMP End Date: N/A Perpetual				DRAWN	P.J.M.
Proponent: Springvale Coal Pty Limited	Annual Review Start Date: 1-January-2022				SCALE	Refer to Scale Bar
Mining Leases: CCL733, ML1319, ML1352, ML1448 & Part MPL314	Annual Review End Date: 31-December-2022				DATE	15-March-2023
					SHEET	A2H

CENTENNIAL SPRINGVALE

PLAN No. PC7963

APPENDIX 2: COAL TRANSPORT RECORDS

Table 2A-1 2022 Production Summary

2022 PRODUCTION SUMMARY																		
					Clearance	SPJ & Airly	Airly	CPP in	CPP out				Airly	Export			UG	
	U/G Prod	SP01	SP02	ROM Total	OL1	Mt Piper	Mt Piper	ROM	Product	Yield	SP03	SP04	Railed	Railed	Reject	50/50	Avg Ash	Springvale to EA
Jan-22	29,575	39,826	14,753	54,579	38,844	24,775	6,280	17,477	10,302	58.9	2,127	0	0	0	7,175	3,588	34.0%	18,495
Feb-22	2,627	2,557	46,649	49,206	31,896	0	0	0	0		2,127	0	0	0	0	0	23.6%	0
Mar-22	52,360	27,529	32,795	60,324	27,388	96,086	54,844	0	0		2,127	0	55,170	0	0	0	23.58%	41,242
Apr-22	389,701	69,845	91,688	161,533	348,240	303,717	2,300	20,424	14,412	70.6	5,630	15,473	0	0	6,012	3,006	20.00%	301,417
May-22	355,854	24,963	30,909	55,872	380,736	240,711	0	200,804	147,792	73.6	39,665	29,700	0	99,530	53,012	26,506	22.81%	240,711
Jun-22	386,826	62,022	83,424	145,446	349,767	226,860	0	72,850	49,784	68.3	14,171	38,148	0	66,830	23,066	11,533	25.28%	226,860
Jul-22	212,139	16,310	115,963	132,273	239,561	372,293	90,829	0	0		2,367	41,265	92,842	7,730	0	0	23.42%	281,464
Aug-22	203,706	11,168	0	11,168	204,348	270,656	0	70,976	47,019	66.2	0	15	0	93,742	23,957	11,979	27.55%	270,656
Sep-22	307,599	104,823	34,968	139,791	213,944	227,582	46,606	0	0		0	0	76,073	0	0	0	29.35%	180,976
Oct-22	148,521	243	23,374	23,617	214,351	261,307	67,491	60,384	35,726	59.2	1,161	1,458	53,091	35,319	24,658	12,329	30.90%	193,816
Nov-22	102,484	24,037	39,235	63,272	78,204	108,880	60,572	14,035	7,792	55.5	0	0	47,315	11,812	6,243	3,122	25.33%	48,308
Dec-22	132,555	11,279	8,179	19,458	145,313	175,304	81,011	87,441	53,199	60.8	17,959	7,996	81,771	30,718	34,242	17,121	30.00%	94,293
Total	**2,323,947**				**2,272,592**	**2,308,171**	**409,933**	**544,391**	**366,026**	**67.2**			**406,262**	**345,681**	**178,365**	**89,183**		**1,898,238**

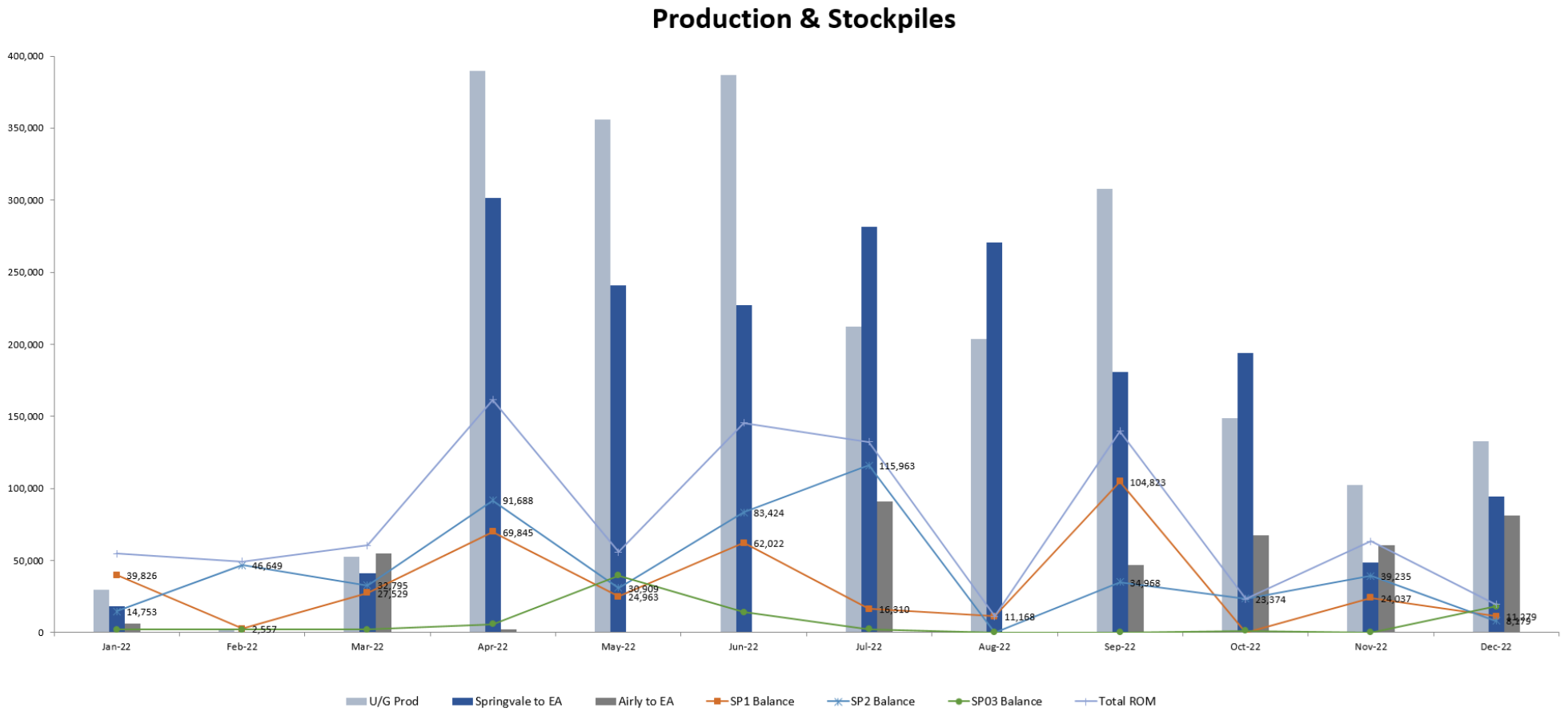


Table 2A-2 2022 Production & Stockpile Levels

APPENDIX 3: METEOROLOGICAL

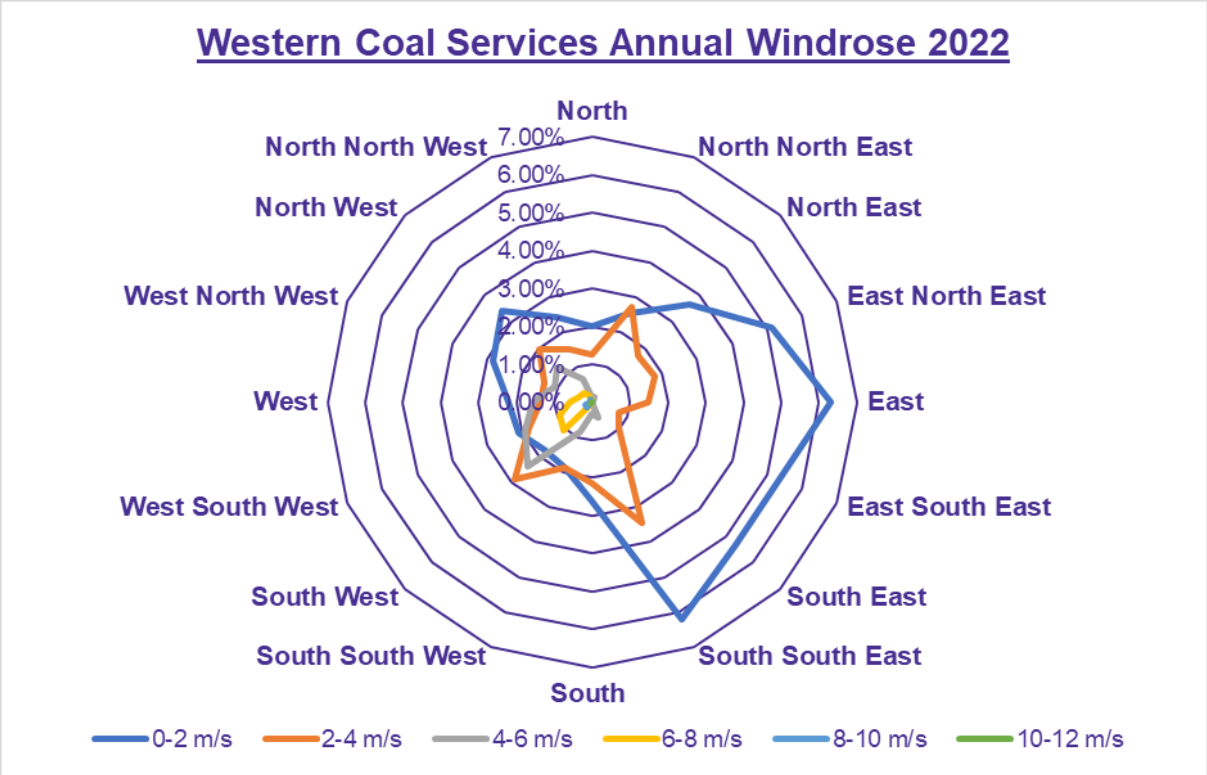


Table 3A-1 2022 WCS Annual Windrose

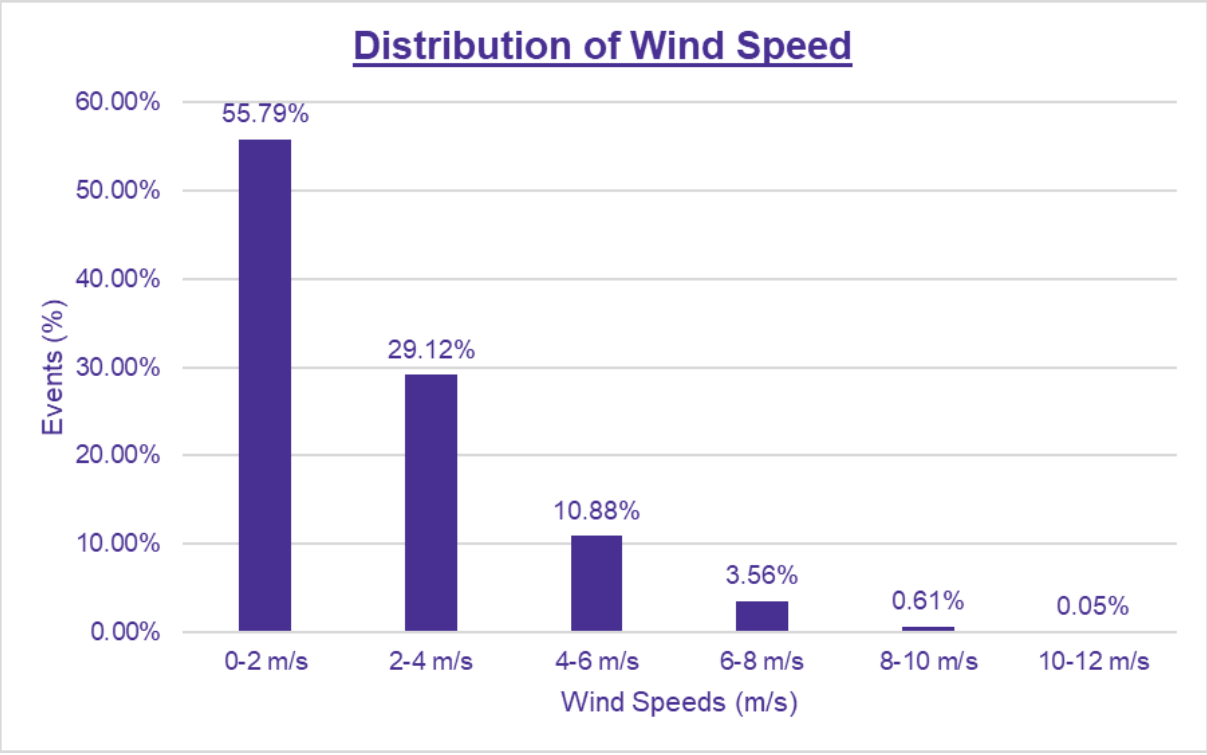


Table 3A-2 2022 Distribution of Windspeed

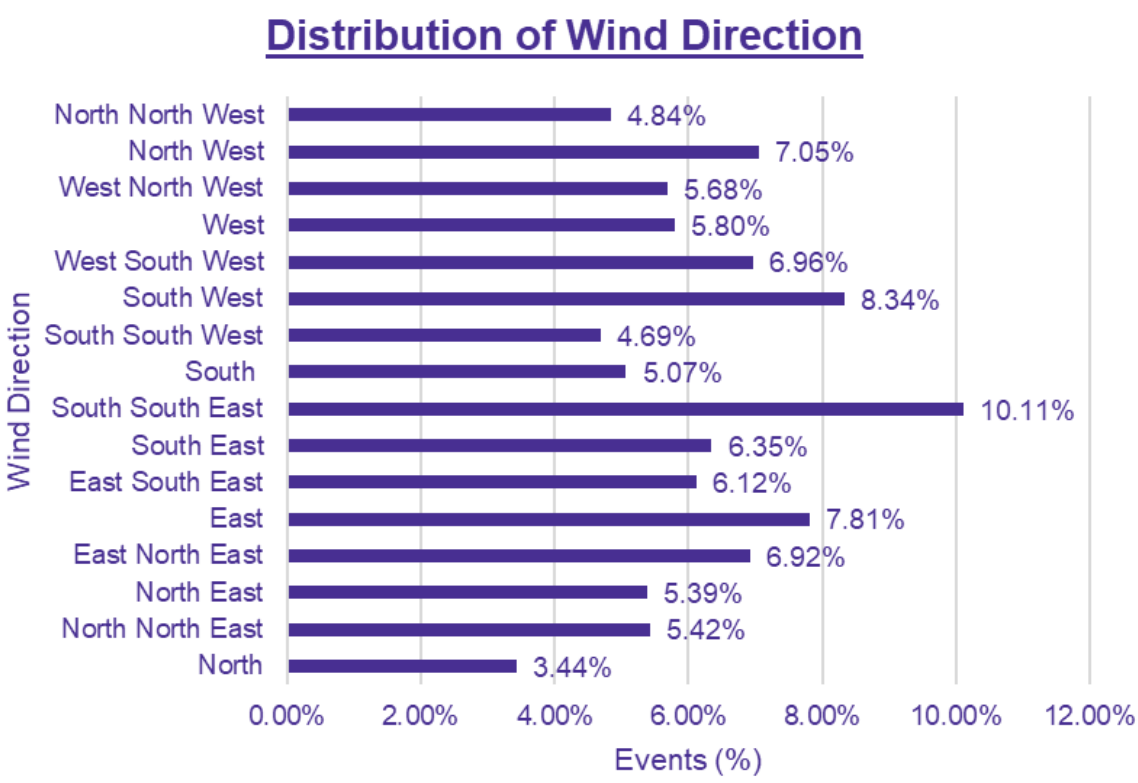


Table 3A-2 2022 Distribution of Wind Direction

APPENDIX 4: NOISE

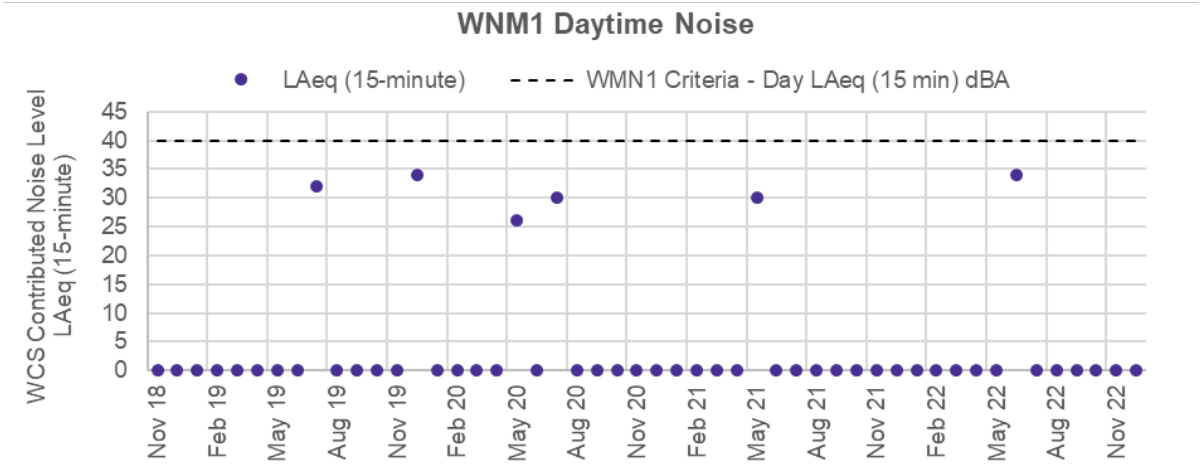


Figure 4A-1: Daytime WNM1 Noise Result (Laeq 15min)

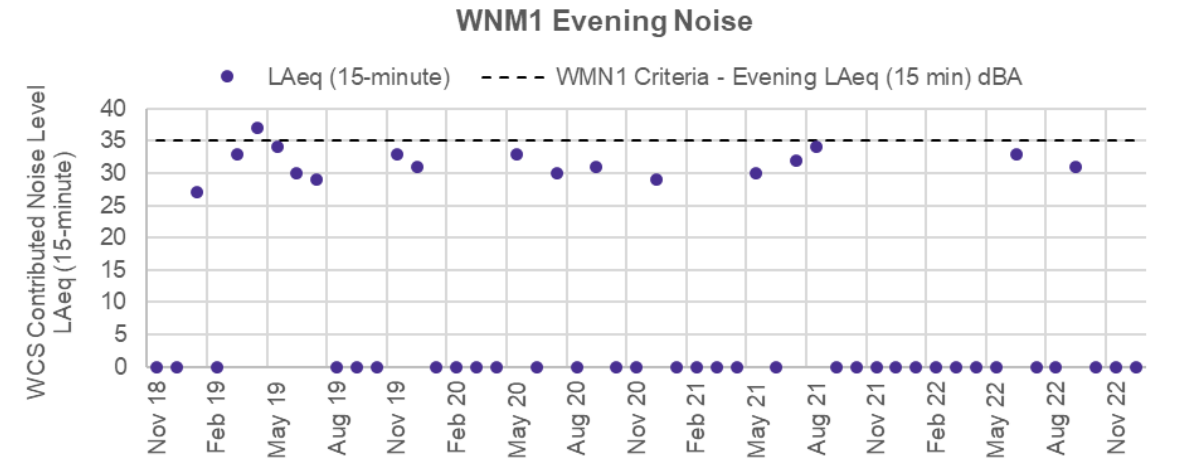


Figure 4A-2: Evening WNM1 Noise Result (Laeq 15min)

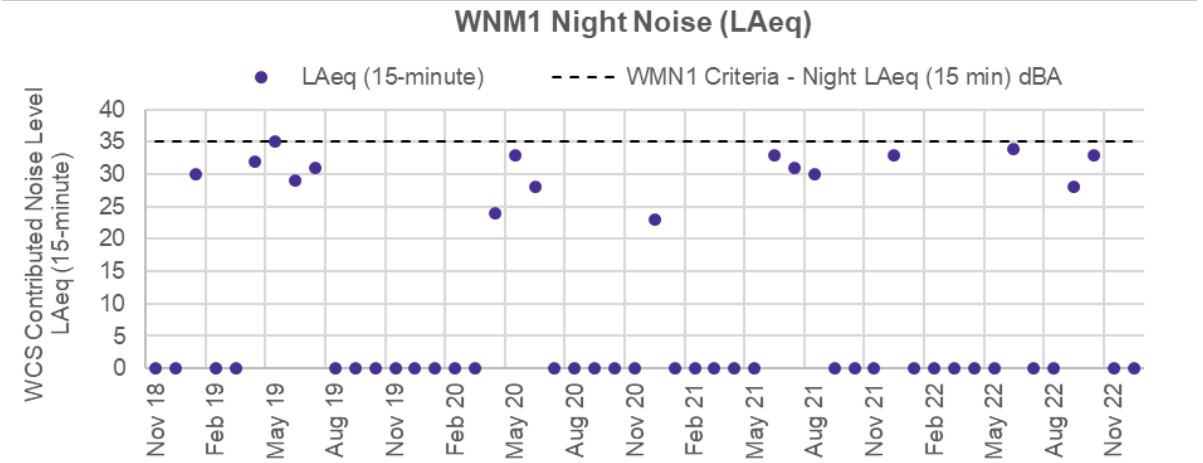


Figure 4A-3: Night WNM1 Noise Result (Laeq 15min)

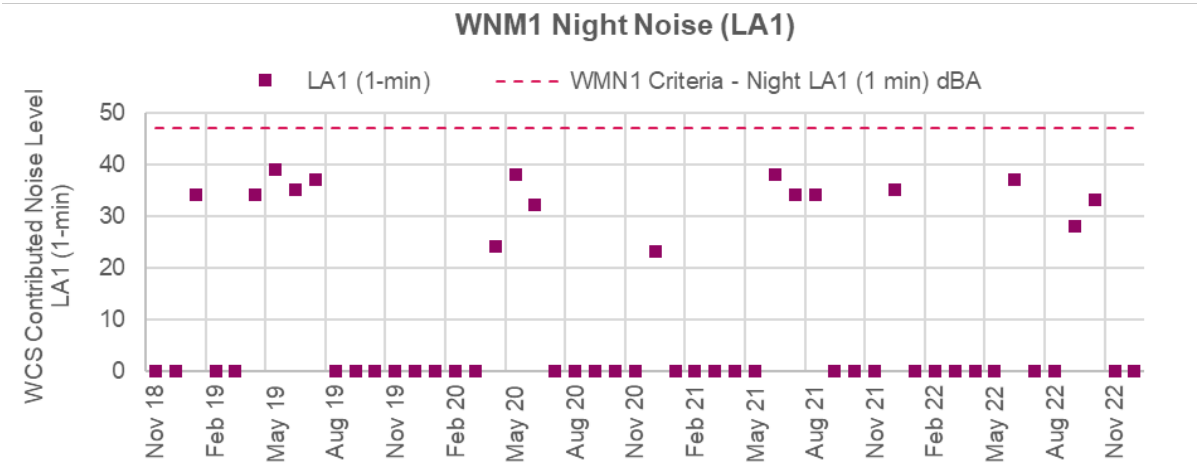


Figure 4A-4: Night WNM1 Noise Result (Laeq 1min)

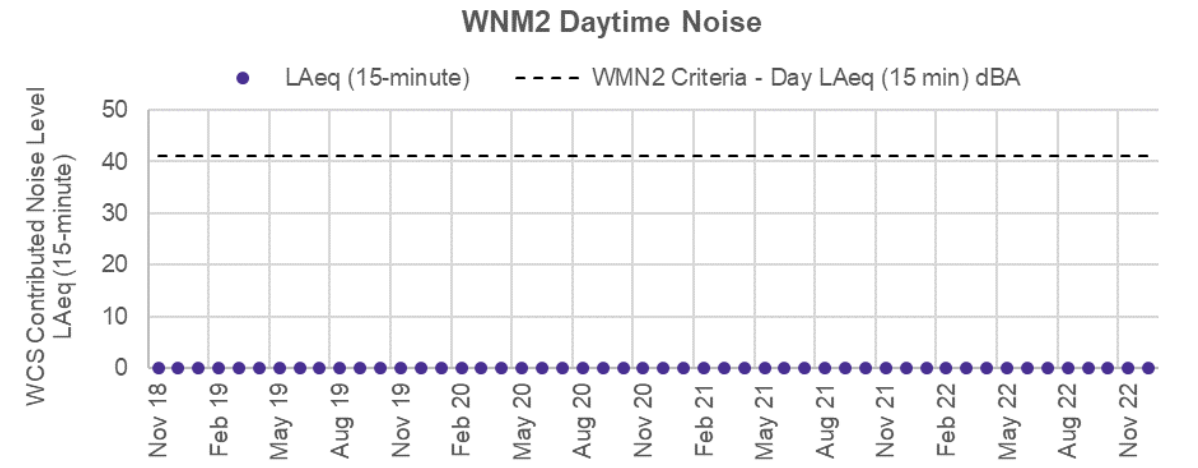


Figure 4A-5: Daytime WNM2 Noise Result (Laeq 15min)

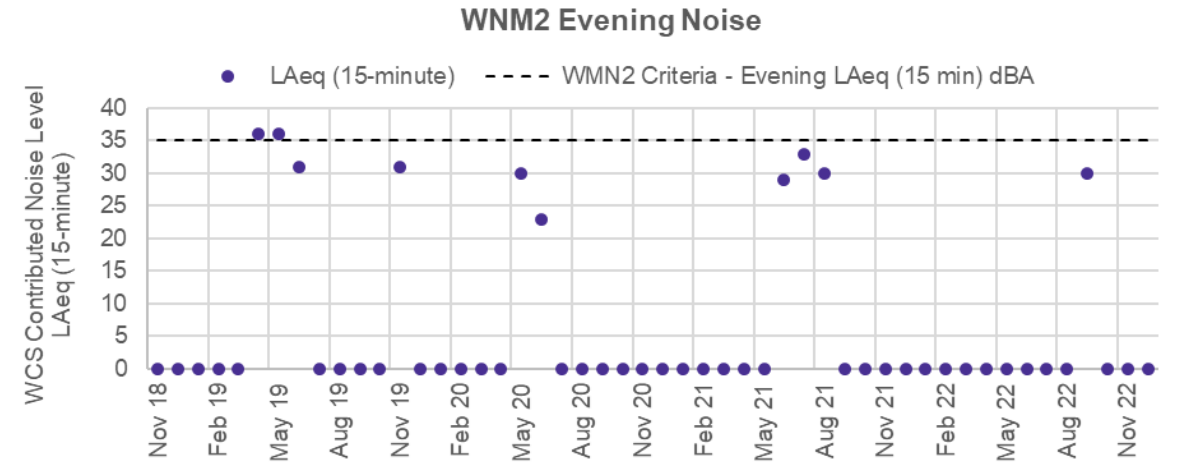


Figure 4A-6: Evening WNM2 Noise Result (Laeq 15min)

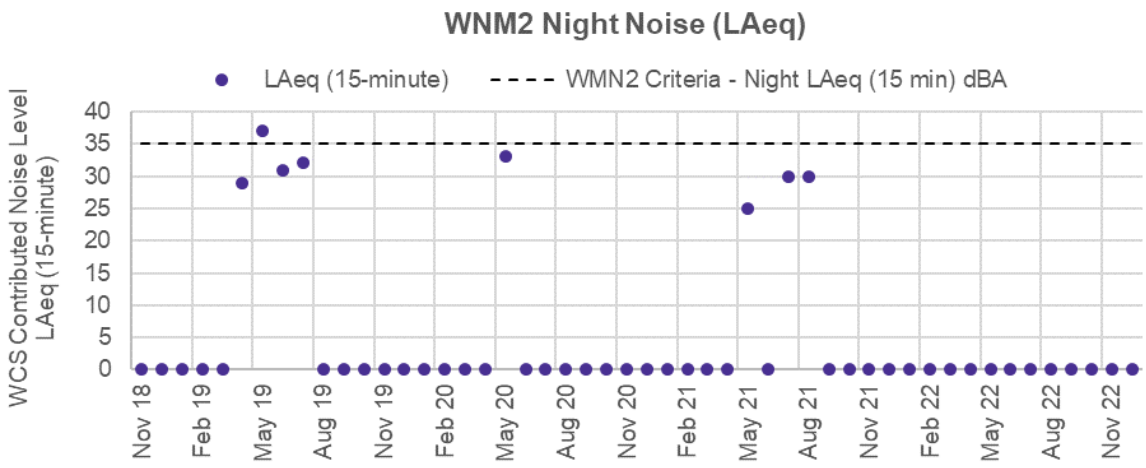


Figure 4A-7: Night WNM2 Noise Result (Laeq 15min)

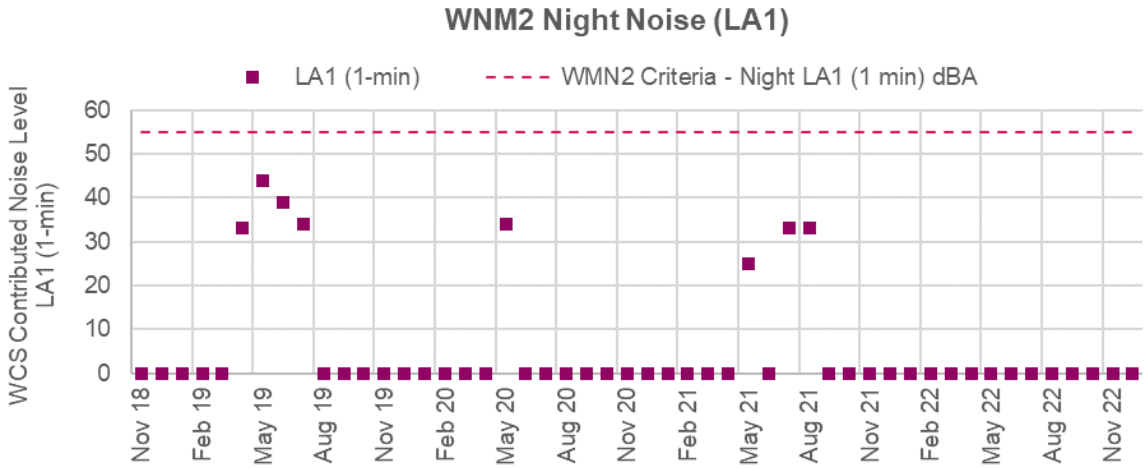


Figure 4A-8: Night WNM2 Noise Result (Laeq 1min)

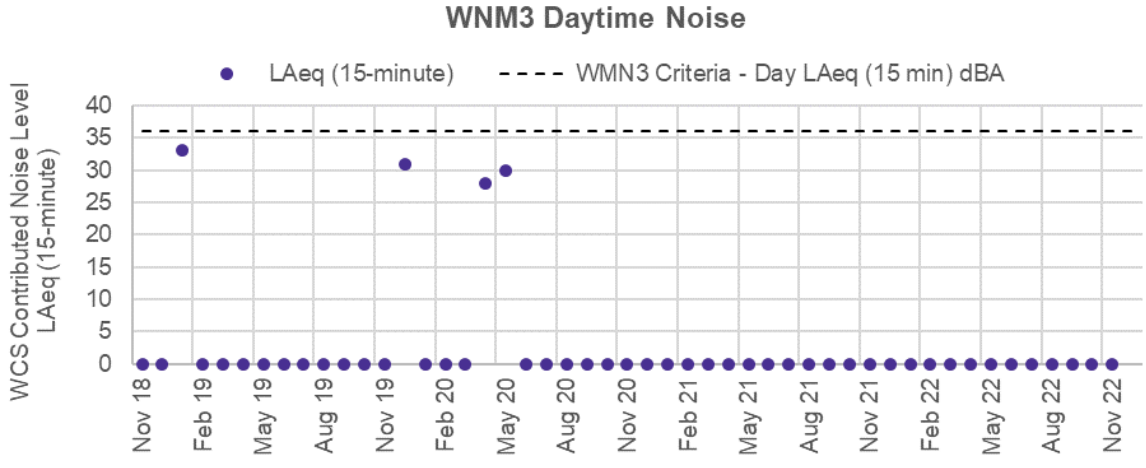


Figure 4A-9: Daytime WNM3 Noise Result (Laeq 15min)

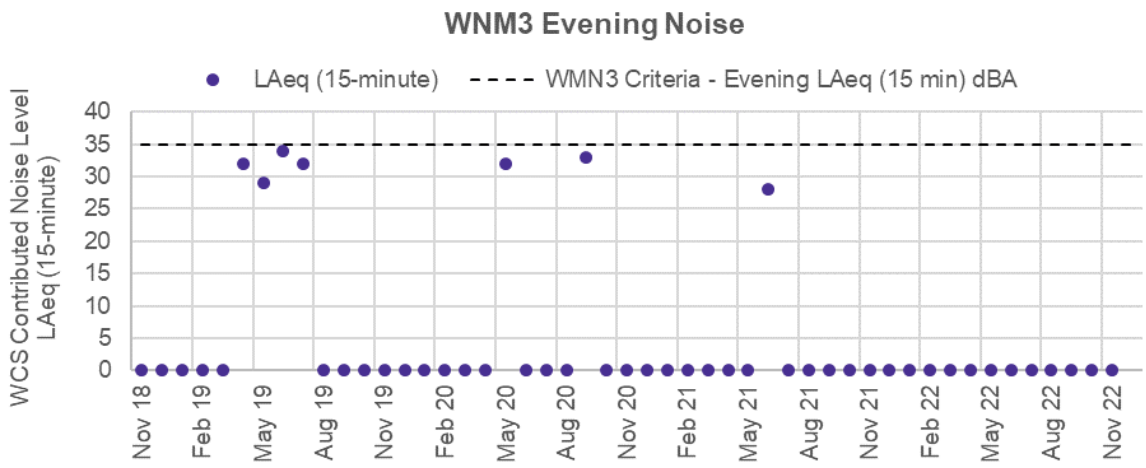


Figure 4A-10: Evening WNM3 Noise Result (Laeq 15min)

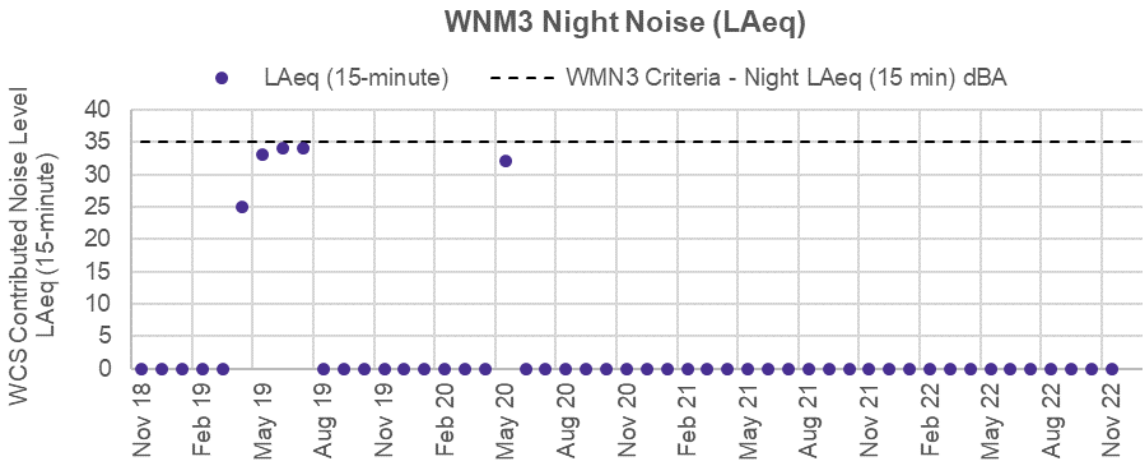


Figure 4A-11: Night WNM3 Noise Result (Laeq 15min)

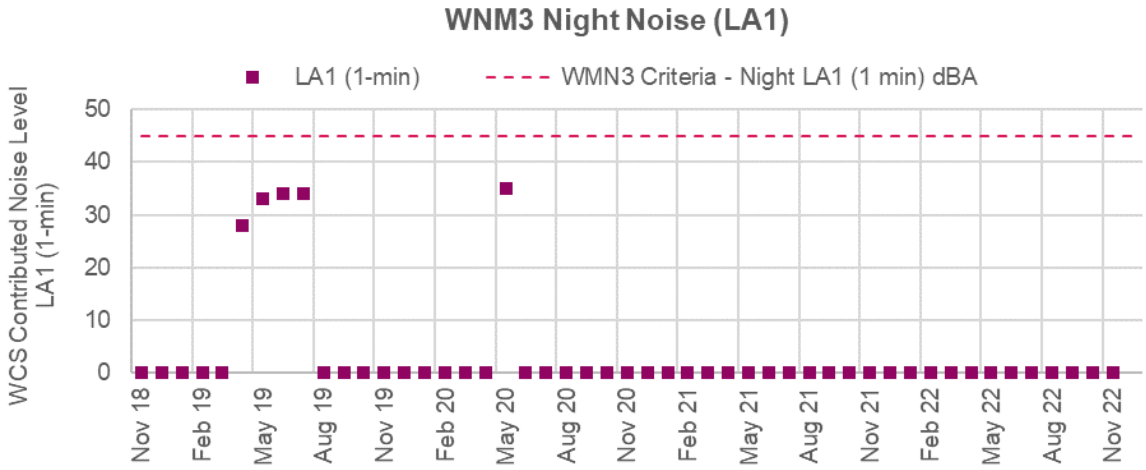


Figure 4A-12: Daytime WNM3 Noise Result (Laeq 1min)

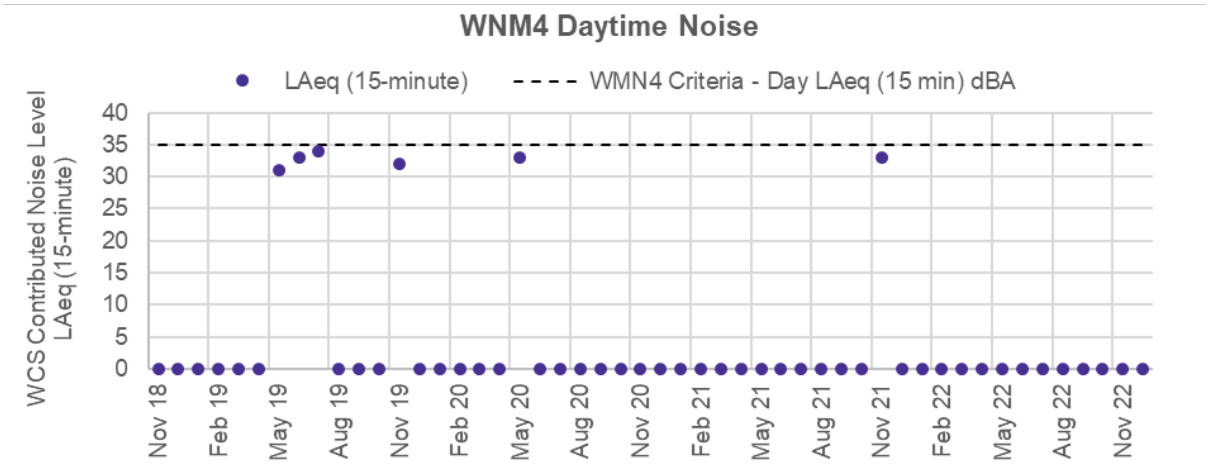


Figure 4A-13: Daytime WNM4 Noise Result (Laeq 15min)

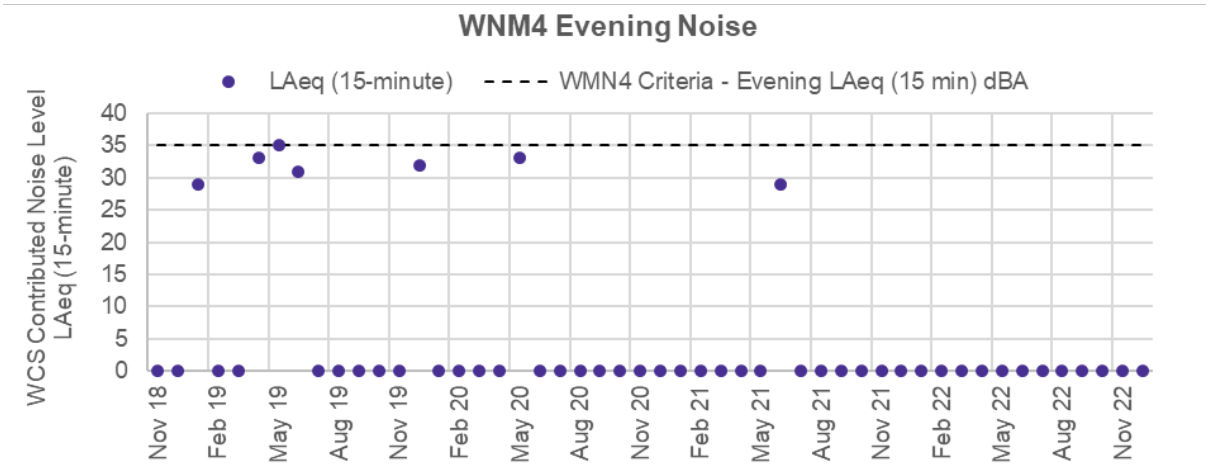


Figure 4A-14: Evening WNM4 Noise Result (Laeq 15min)

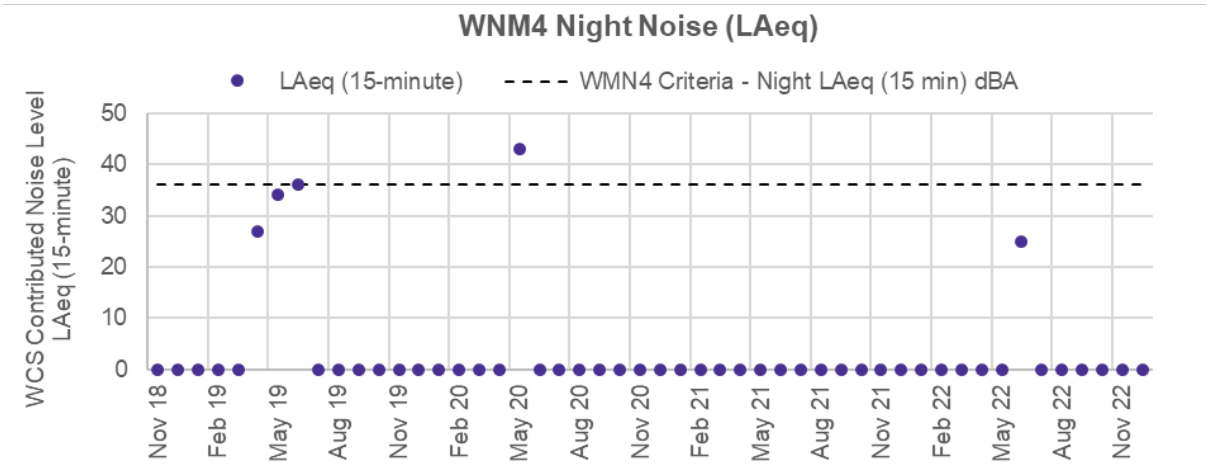


Figure 4A-14: Night WNM4 Noise Result (Laeq 15min)

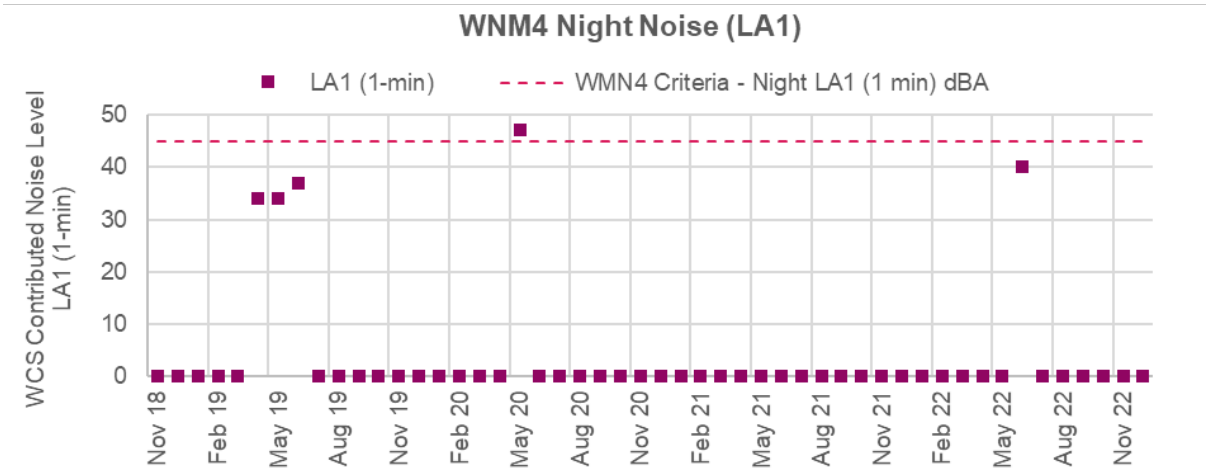


Figure 4A-16: Night WNM4 Noise Result (Laeq 1min)

Table 4A-1: Historical sound pressure levels (@ 1m, dB) of WCS Conveyor System

	Pre LNI		Post LNI		Aug-18		Apr-19		Dec 19 / Jan 20		Nov-20		Dec-21		Sep-22		Recent change	
Zone	Linear	Awt	Linear	Awt	Linear	Awt	Linear	Awt	Linear	Awt	Linear	Awt	Linear	Awt	Linear	Awt	Linear	Awt
Zone 1	79	74	71	64	82	74	78	70	79	70	75	67	78	69	-	-	-	-
Zone 2	79	75	70	64	81	76	76	69	77	68	71	67	71	66	-	-	-	-
Zone 3	81	78	70	65	76	72	76	72	71	67	73	69	75	71	82	76	7	5
Zone 4	82	79	80	72	80	72	81	73	78	69	79	73	76	70	82	76	6	6
Zone 5	-	-	-	-	84	79	82	78	81	77	82	79	79	75	-	-	-	-
Zone 6	-	-	-	-	82	73	82	75	79	71	80	74	82	74	82	76	0	2
Zone 7	-	-	-	-	84	77	84	78	84	77	80	75	80	75	82	76	2	1
Zone 8	-	-	-	-	80	73	83	74	84	72	83	72	-	-	-	-	-	-
Zone 9	-	-	-	-	85	79	81	72	82	72	82	74	-	-	-	-	-	-

Notes: Linear – Linear sound pressure level. Awt – A-weighted sound pressure level

Table 4A-2: Fixed Plant Sound Pressure Results dB

Item	2021		2022		Change	
	L_W	L_{WA}	L_W	L_{WA}	L_W	L_{WA}
CW01	89	78	88	77	-1	-1
CW02	76	71	81	73	5	2
CW03	94	89	96	90	2	1
CW07	84	79	86	80	2	1
CW08	-	-	87	81	-	-
CW09	85	79	85	79	0	0
TT05	115	105	114	107	-1	2
TT07	103	95	108	96	5	1

Notes: L_W = Sound Pressure Level. L_{WA} = A-weighed sound pressure level.

Table 4A-3: Mobile Plant Sound Pressure Results dB

	2022	
	L_W	L_{WA}
DZ04 stationary	117	104
DZ04 1st gear forward	118	111
DZ04 1st gear reverse	120	109
DZ14 stationary	123	111
DZ14 1st gear forward	124	115
DZ14 1st gear reverse	125	117
WL04 stationary	116	109
WL04 1st gear forward	116	110
WL04 1st gear reverse	116	110
WL02 stationary	112	107
WL02 1st gear forward	112	108
WL02 1st gear reverse	113	109

Notes: L_W = Sound Pressure Level. L_{WA} = A-weighed sound pressure level.

Global Acoustics

NOW PART OF EMM

creating opportunities

Western Coal Services

Overland Conveyor Sound Pressure Level Testing

Prepared for Springvale Coal Pty Ltd

November 2022

Western Coal Services

Overland Conveyor Sound Pressure Level Testing

Springvale Coal Pty Ltd

22064 RP01

November 2022

Version	Date	Prepared by	Approved by	Comments
1.0	29/11/2022	Thomas Maddock	Robert Kirwan	Final
2.0	16/01/2023	Thomas Maddock	Robert Kirwan	Revised

Approved by



Robert Kirwan
Associate Acoustic Consultant
30/11/2022

Level 3 175 Scott Street
Newcastle NSW 2300

This report has been prepared in accordance with the brief provided by Springvale Coal Pty Ltd and has relied upon the information collected at the time
and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of Springvale Coal Pty Ltd and no responsibility will be taken for its use by other parties. Springvale Coal Pty Ltd may, at its discretion, use the report to inform regulators and the public.

© Reproduction of this report for educational or other non-commercial purposes is authorised without prior written permission from EMM provided the source is fully acknowledged. Reproduction of this report for resale or other commercial purposes is prohibited without EMM's prior written permission.

TABLE OF CONTENTS

1 Introduction **1**

1.1 Terminology 1

2 Methodology **2**

2.1 Sound Pressure Level 2

2.2 Measurement Equipment 2

2.3 Weather Conditions 2

3 Results **1**

3.1 Overall Sound Pressure Level 1

4 Summary **1**

Appendices

Appendix A Third Octave Graphs A.1

Appendix B Calibration Certificates B.1

1 Introduction

Global Acoustics was engaged by Springvale Coal Pty Ltd (Springvale) to conduct a sound pressure level (SPL) survey for the Western Coal Services (WCS) overland conveyor system in accordance with the Noise Reduction Study (NRS) contained in the Centennial Coal Western Region Noise Management Plan (CCWRNMP).

The most recent SPL measurements of the overland conveyor system were made on 13 September 2022.

1.1 Terminology

Definitions of terminology which may be used in this report are provided in Table 1.1.

Table 1.1 Terminology and Abbreviations

Descriptor	Definition
dB	Decibels. Relative unit of measurement on a logarithmic scale used extensively in the field of acoustics.
dB(A)	Decibels adjusted using the "A"-weighting scale to consider human response to sound.
Hertz (Hz)	SI unit of frequency, used to measure fluctuations in pressure. Most sounds are a combination of many frequencies together.
$L_{Aeq,t}$	The average A-weighted sound energy during a measurement period of time (t).
SPL	Sound pressure level. Measured as 10 times the logarithmic ratio of pressure fluctuations relative to a reference level of 20 micropascals.
L_W	Sound power level. Measured as 10 times the logarithmic ratio of power of a source relative to a reference level of one picowatt.
L_{WA}	A-weighted sound power level.

2 Methodology

2.1 Sound Pressure Level

Overall, octave and one-third octave SPL were measured generally in accordance with:

- ISO 3744-2010 'Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane'; and
- ISO 3746-2010 'Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane'.

Measurements were taken along accessible sections of the overland conveyors. Conveyors and their respectable zones are detailed in Figure 1.1 and 1.2. All measurements were taken at 1 meter from the conveyor.

2.2 Measurement Equipment

Equipment used to measure and record noise levels are listed in Table 2.1. Calibration certificates are provided in Appendix B.

Table 2.1 Sound Level Measurement Equipment

Model	Serial Number	Calibration Due Date
SVAN 958 noise and vibration analyser	20880	06/04/2024
Pulsar 105 sound level calibrator	96080	07/10/2023

2.3 Weather Conditions

Weather conditions at the time of testing are presented in Table 2.2.

Table 2.2 Atmospheric Conditions

Date	Temperature (◦C)	Wind Speed (m/s)	Relative Humidity (%)
13/09/2022	12	0-1	60

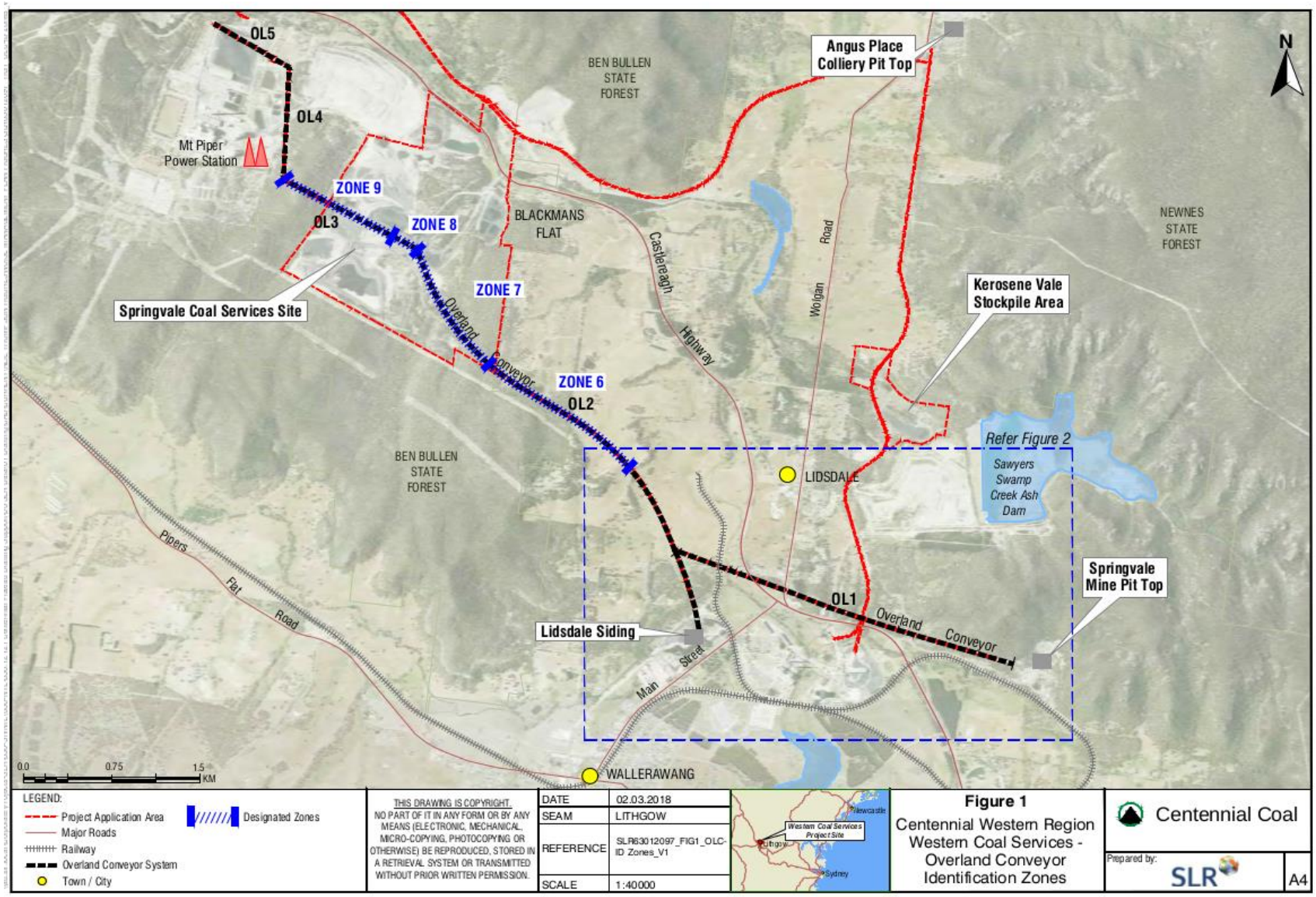


Figure 1.1 Overland Conveyor System (Zone 6 – 9)

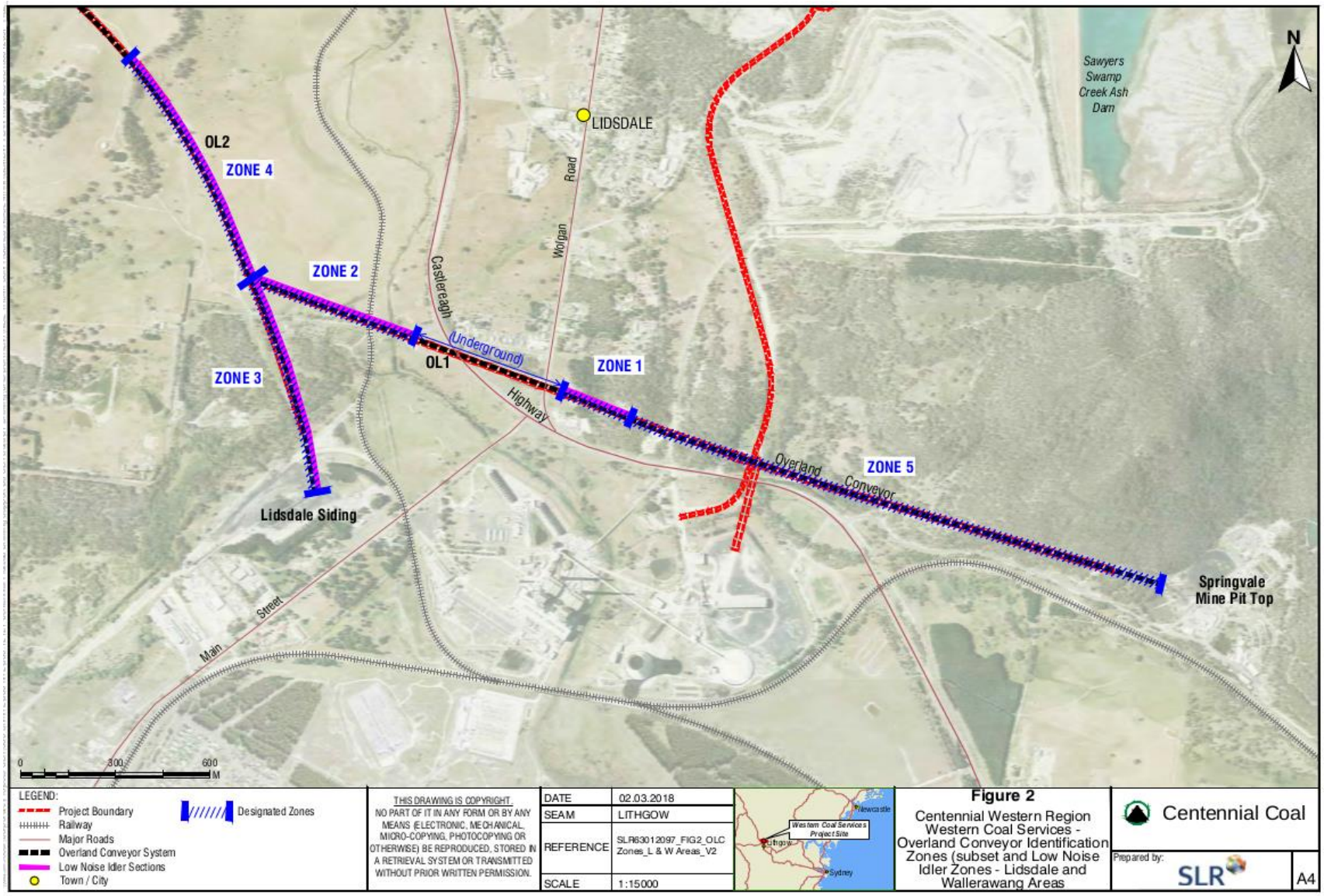


Figure 1.2 Overland Conveyor System (Zones 1 – 5)

3 Results

3.1 Overall Sound Pressure Level

Overland conveyor system measured SPL are provided in Table 3.1. These levels are the average SPL measured across the entire length of each conveyor. Third octave graphs are provided in Appendix A. Conveyors OL1 and OL3 were not operating during testing dates, therefore measurements of these conveyors were not undertaken in 2022.

Table 3.1 Overall Sound Pressure Level @ 1m dB

Item	Date	L_W	L_{WA}
OL2 (zones 3, 4, 6 and 7)	13/09/2022	82	76

3.2 Historical Comparison

Historical overland conveyor system measured SPL for each zone are provided in Table 3.2.

Table 3.2 Historical comparison of sound pressure levels @ 1m, dB

Item	Date	Linear	Awt	Date	Linear	Awt	Date	Linear	Awt	Date	Linear	Awt	Date	Linear	Awt	Date	Linear	Awt
Zone 1	28/08/18	82	74	10/04/19	78	70	18/12/19	79	70	10/11/20	75	67	22/12/21	78	69	-	-	-
Zone 2	22/10/18	81	76	10/04/19	76	69	18/12/19	77	68	10/11/20	71	67	22/12/21	71	66	-	-	-
Zone 3	28/08/18	76	72	10/04/19	76	72	18/12/19	71	67	10/11/20	73	69	22/12/21	75	71	13/09/22	82	76
Zone 4	22/10/18	80	72	10/04/19	81	73	18/12/19	78	69	10/11/20	79	73	22/12/21	76	70	13/09/22	82	76
Zone 5	28/08/18	84	79	10/04/19	82	78	18/12/19	81	77	10/11/20	82	79	22/12/21	79	75	-	-	-
Zone 6	28/08/18	82	73	10/04/19	82	75	18/12/19	79	71	10/11/20	80	74	08/12/21	82	74	13/09/22	82	76
Zone 7	28/08/18	84	77	10/04/19	84	78	24/01/20	84	77	10/11/20	80	75	08/12/21	80	75	13/09/22	82	76
Zone 8	28/08/18	80	73	10/04/19	83	74	24/01/20	84	72	10/11/20	83	72	-	-	-	-	-	-
Zone 9	28/08/18	85	79	10/04/19	81	72	24/01/20	82	72	10/11/20	82	74	-	-	-	-	-	-

4 Summary

Global Acoustics was engaged by Springvale Coal Pty Ltd (Springvale) to conduct a sound pressure level (SPL) survey for the Western Coal Services (WCS) overland conveyor system in accordance with the Noise Reduction Study (NRS) contained in the Centennial Coal Western Region Noise Management Plan (CCWRNMP).

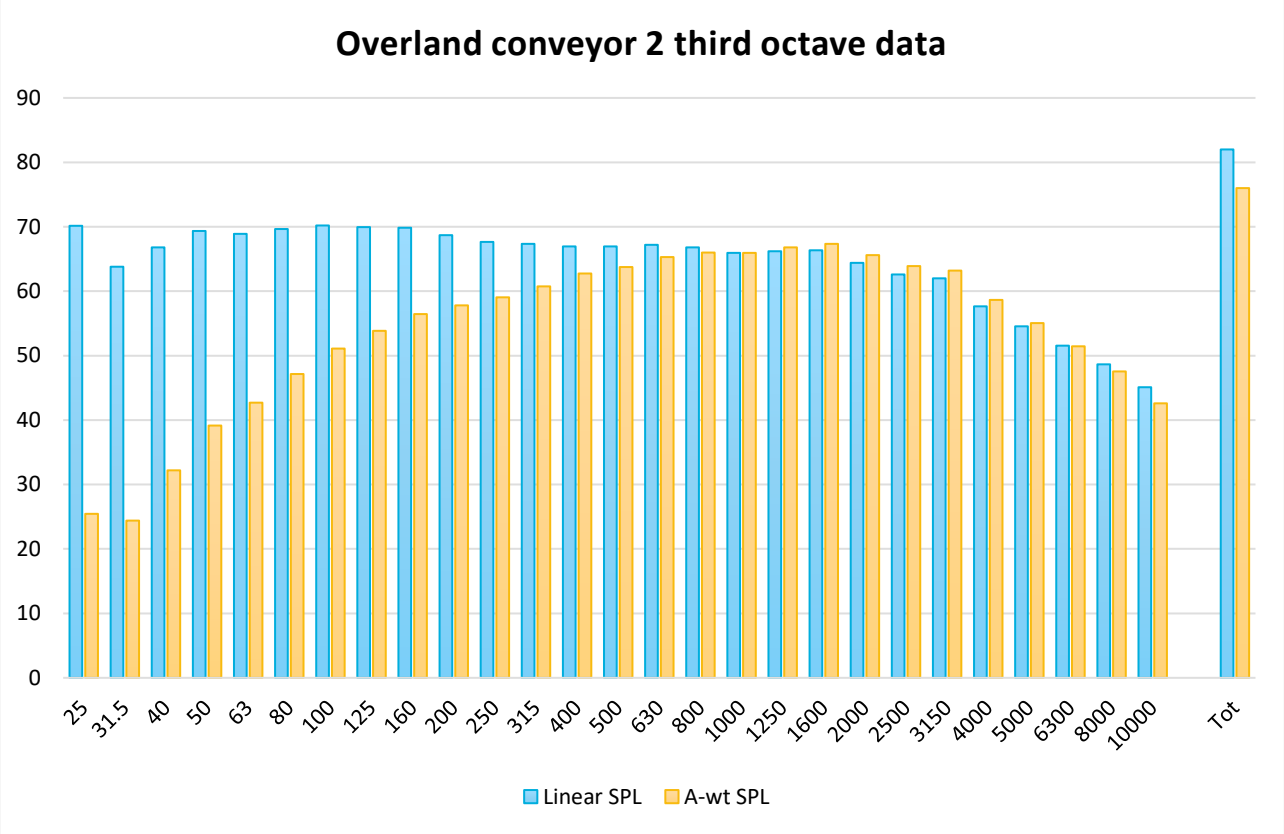
The most recent SPL measurements of the overland conveyor system were made on 13 September 2022.

We trust this information is per your requirements. Please contact us if you require further details or advice.

Appendix A
Third Octave Graphs

EMM
creating opportunities

A.1 Third Octave Graphs



Appendix B
Calibration Certificates

EMM
creating opportunities

B.1 Calibration Certificates

Acoustic Research Labs Pty Ltd
Unit 36/14 Loyalty Rd
North Rocks NSW AUSTRALIA 2151
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
IEC 61672-3:2013

Calibration Certificate

Calibration Number C22209

Client Details	Global Acoustics Pty Ltd 12/16 Huntingdale Drive Thornton NSW 2322
Equipment Tested/ Model Number :	SVANTEK SVAN 958
Instrument Serial Number :	20880
Microphone Serial Number :	17132
Pre-amplifier Serial Number :	24298

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	24.9°C	**Ambient Temperature :**	23.8°C
Relative Humidity :	59.4%	**Relative Humidity :**	53.7%
Barometric Pressure :	100.8kPa	**Barometric Pressure :**	100.78kPa

Calibration Technician : Lucky Jaiswal — **Secondary Check:** Shaheen Boaz
Calibration Date : 6 Apr 2022 — **Report Issue Date :** 6 Apr 2022

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	*Pass*	17: Level linearity incl. the level range control	*Pass*
13: Electrical Sig. tests of frequency weightings	*Pass*	18: Toneburst response	*Pass*
14: Frequency and time weightings at 1 kHz	*Pass*	19: C Weighted Peak Sound Level	*Pass*
15: Long Term Stability	*Pass*	20: Overload Indication	*Pass*
16: Level linearity on the reference level range	*Pass*	21: High Level Stability	*Pass*

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
125Hz	*±0.13dB*	*Temperature*	*±0.2°C*
1kHz	*±0.13dB*	*Relative Humidity*	*±2.4%*
8kHz	*±0.14dB*	*Barometric Pressure*	*±0.015kPa*
Electrical Tests	*±0.10dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - Calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

PAGE 1 OF 1

Acoustic Research Labs Pty Ltd
Unit 36/14 Loyalty Rd
North Rocks NSW AUSTRALIA 2151
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Calibrator

IEC 60942-2017

Calibration Certificate

Calibration Number C21661

Client Details Global Acoustics Pty Ltd
12/16 Huntingdale Drive
Thornton, NSW, 2322

Equipment Tested/ Model Number : Pulsar Model 105
Instrument Serial Number : 96080

Atmospheric Conditions
Ambient Temperature : 22.7°C
Relative Humidity : 40.4%
Barometric Pressure : 99.8kPa

Calibration Technician : Lucky Jaiswal **Secondary Check:** Matthew Calleja
Calibration Date : 07 Oct 2021 **Report Issue Date :** 7 Oct 2021

Approved Signatory : Ken Williams

Characteristic Tested	Result
Generated Sound Pressure Level	Pass
Frequency Generated	Pass
Total Distortion	Pass

Nominal Level	Nominal Frequency	Measured Level	Measured Frequency
94	1000	93.85	1000.30

The sound calibrator has been shown to conform to the class 1 requirements for periodic testing, described in Annex B of IEC 60942:2017 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed.

Least Uncertainties of Measurement -

Specific Tests		Environmental Conditions	
Generated SPL	±0.15dB	Temperature	±0.2°C
Frequency	±0.1Hz	Relative Humidity	±2.4%
Distortion	±0.5%	Barometric Pressure	±0.015kPa

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

* The tests < 1000 kHz are not covered by Acoustic Research Labs Pty Ltd NATA accreditation.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Suite 2.04 Level 2
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8
454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9
109 St Georges Terrace
Perth WA 6000
T 08 6430 4800

Canada

TORONTO
2345 Yonge Street Suite 300
Toronto ON M4P 2E5
T 647 467 1605

VANCOUVER
60 W 6th Ave
Vancouver BC V5Y 1K1
T 604 999 8297

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au

Global Acoustics

NOW PART OF EMM

creating opportunities

Western Coal Services

Sound Power Survey

Prepared for Springvale Coal Pty Ltd

November 2022

Western Coal Services

Sound Power Survey

Springvale Coal Pty Ltd

22064 RP02

November 2022

Version	Date	Prepared by	Approved by	Comments
1.0	22/11/2022	Thomas Maddock	Robert Kirwan	Final
2.0	16/01/2023	Thomas Maddock	Robert Kirwan	Revised

Approved by



Robert Kirwan
Acoustic consultant
6 December 2022

Level 3 175 Scott Street
Newcastle NSW 2300

This report has been prepared in accordance with the brief provided by Springvale Coal Pty Ltd and has relied upon the information collected at the time
and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of Springvale Coal Pty Ltd and no responsibility will be taken for its use by other parties. Springvale Coal Pty Ltd may, at its discretion, use the report to inform regulators and the public.

© Reproduction of this report for educational or other non-commercial purposes is authorised without prior written permission from EMM provided the source is fully acknowledged. Reproduction of this report for resale or other commercial purposes is prohibited without EMM's prior written permission.

TABLE OF CONTENTS

1 Introduction **1**

1.1 Terminology 1

2 Methodology **2**

2.1 Overview 2

2.2 Test Standard 2

2.3 Measurement Equipment 4

2.4 Weather Conditions 4

3 Results **1**

3.1 Overall Sound Pressure Level 1

3.2 Discussion 2

4 Summary **3**

Appendices

Appendix A Third Octave Graphs A.1

Appendix B Calibration Certificates B.15

Appendix B

1 Introduction

Global Acoustics was engaged by Springvale Coal Pty Ltd (Springvale) to determine sound power (LW) data for plant operating at Western Coal Services.

All mobile equipment was tested using the reduced scope screening methodology. More detail is provided in Section 2.

Noise level measurements were made on 13 September 2022.

1.1 Terminology

Definitions of terminology which may be used in this report are provided in Table 1.1.

Table 1.1 Terminology and Abbreviations

Descriptor	Definition
dB	Decibels. Relative unit of measurement on a logarithmic scale used extensively in the field of acoustics.
dB(A)	Decibels adjusted using the “A”-weighting scale to consider human response to sound.
Hertz (Hz)	SI unit of frequency, used to measure fluctuations in pressure. Most sounds are a combination of many frequencies together.
$L_{Aeq,t}$	The average A-weighted sound energy during a measurement period of time (t).
SPL	Sound pressure level. Measured as 10 times the logarithmic ratio of pressure fluctuations relative to a reference level of 20 micropascals.
L_W	Sound power level. Measured as 10 times the logarithmic ratio of power of a source relative to a reference level of one picowatt.
L_{WA}	A-weighted sound power level.

2 Methodology

2.1 Overview

Overall, octave and one-third octave sound power levels were determined from measured sound pressure levels (SPL).

2.2 Test Standard

Measurement and calculation was conducted generally in accordance with:

- AS 2012.1-1990 'Acoustics – Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors – Stationary test condition – Determination of Compliance With Limits for External Noise';
- ISO 3744-2010 'Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane';
- ISO 3746-2010 'Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane';
- ISO 6393:2008(E) 'Earth-moving machinery – Determination of sound power level – Stationary test conditions'; and
- ISO 6395:2008(E) 'Earth-moving machinery – Determination of sound power level noise emissions – Dynamic test conditions'.

SPL measurements for the conveyors were undertaken at a distance of 1 metre while walking along accessible pathways next to each conveyor. The CPP was not running on the days that fieldwork was conducted.. Measurements of other fixed plant were taken at known distances.

All mobile equipment was tested using a reduced scope screening methodology of the above standards. The reduced scope uses fewer microphone positions than specified in the standards, with only ground positions used. The rationale being to increase mobility of the testing team, to provide flexibility in choice of testing location, to test as many plant items as possible, and to minimise disruption to mining production.

The test is mainly used as a screening tool. A more precise equipment sound power that would result from full adherence to the above standards was not required. A minimum of two test runs were recorded for each plant item with the aim to have less than 1.5 dB difference between results. It is considered that the results are of sufficient accuracy and repeatability for the purpose of this survey.

Typical test areas are presented in Figure 1 and Figure 2. The majority of tests for mobile plant were undertaken using a dynamic test only, where the plant item passes through the test area shown in Figure 1 under full power on level ground. In some cases, stationary tests were conducted for dozers, wheel dozers, and loaders in order to determine engine noise in the absence of track noise and reverse alarms. The measurement is commenced and completed when the plant item (centre of) passes between microphone positions 2 & 3 and 1 & 4 respectively.

Typically for mobile plant items the test area radius (“R” in Figure 1 and 2) was 16-20m depending on equipment size and test area limitations. Engine cooling fan speed was uncontrolled on equipment with variable speed fans.

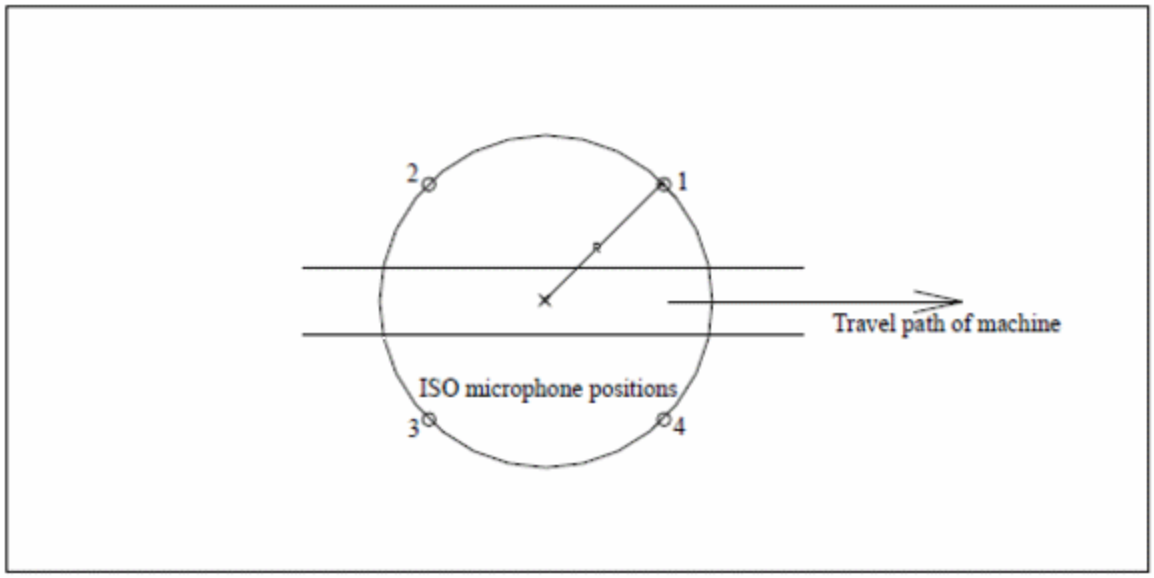


Figure 1 Sound Power Microphone Positions

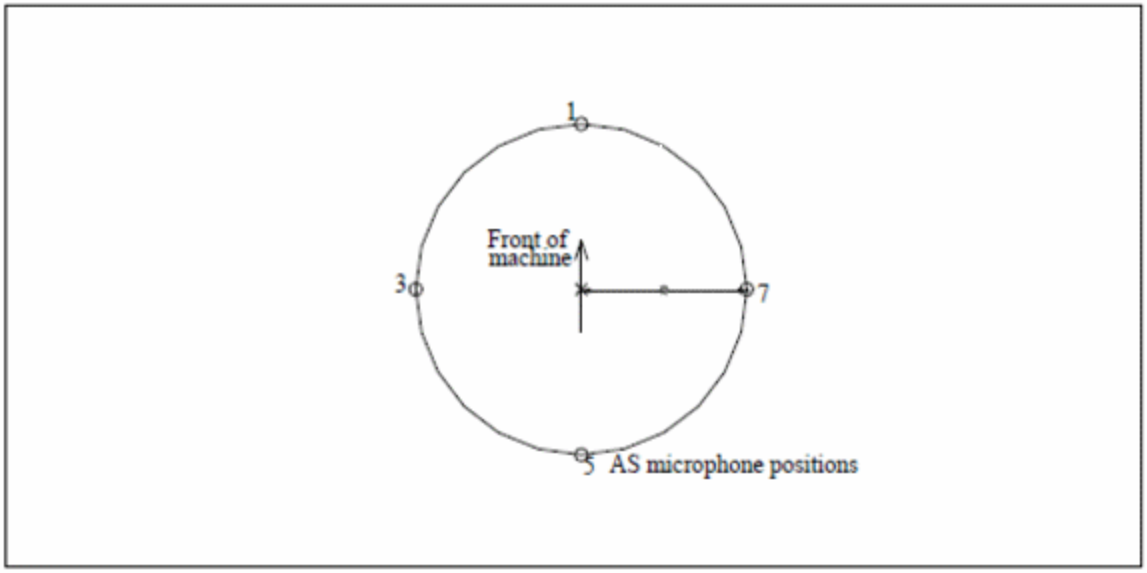


Figure 2 Alternate Stationary Sound Power Microphone Positions

2.3 Measurement Equipment

Equipment used to measure and record noise levels are listed in Table 2.1. Calibration certificates are provided in Appendix B.

Table 2.1 Sound Level Measurement Equipment

Model	Serial Number	Calibration Due Date
SVAN 958 noise and vibration analyser	20880	06/04/2024
Pulsar 105 sound level calibrator	96080	07/10/2023

2.4 Weather Conditions

Weather conditions at the time of testing are presented in Table 2.2.

Table 2.2 Atmospheric Conditions

Date	Temperature (◦C)	Wind Speed (m/s)	Relative Humidity (%)
13/09/2022	12	0-1	60

3 Results

3.1 Overall Sound Pressure Level

Sound powers determined from measured SPL are provided in Table 3.1 and Table 3.2. One-third-octave graphs are provided in Appendix A. 2021 testing results are also provided for comparison. None of the mobile plant tested in 2022 were also tested in 2021.

It should be noted that some plant was not tested due to interference from other nearby plant or restricted access. Coal was not present on any conveyors.

CW04 could not be run during measurement of TT05. All conveyor sound power results are per 1m.

Table 3.1 Fixed plant sound power results dB

Item	2021		2022		Change	
	L_W	L_{WA}	L_W	L_{WA}	L_W	L_{WA}
CW01	89	78	88	77	-1	-1
CW02	76	71	81	73	5	2
CW03	94	89	96	90	2	1
CW07	84	79	86	80	2	1
CW08	-	-	87	81	-	-
CW09	85	79	85	79	0	0
TT05	115	105	114	107	-1	2
TT07	103	95	108	96	5	1

Table 3.2 Mobile plant sound power results dB

Item	2022	
	Lw	LwA
DZ04 stationary	117	104
DZ04 1st gear forward	118	111
DZ04 1st gear reverse	120	109
DZ14 stationary	123	111
DZ14 1st gear forward	124	115
DZ14 1st gear reverse	125	117
WL04 stationary	116	109
WL04 1st gear forward	116	110
WL04 1st gear reverse	116	110
WL02 stationary	112	107

Item	2022	
	Lw	LwA
WL02 1st gear forward	112	108
WL02 1st gear reverse	113	109

3.2 Discussion

Changes of 1 – 2 dB between 2021 and 2022 testing are considered minor and shouldn't warrant any further action. CW02 and TT07 Lw increased by 5 dB and should be checked for any obvious signs of maintenance or degradation.

4 Summary

Global Acoustics was engaged by Springvale Coal Pty Ltd to determine sound power data for CHPP plant operating at Western Coal Services.

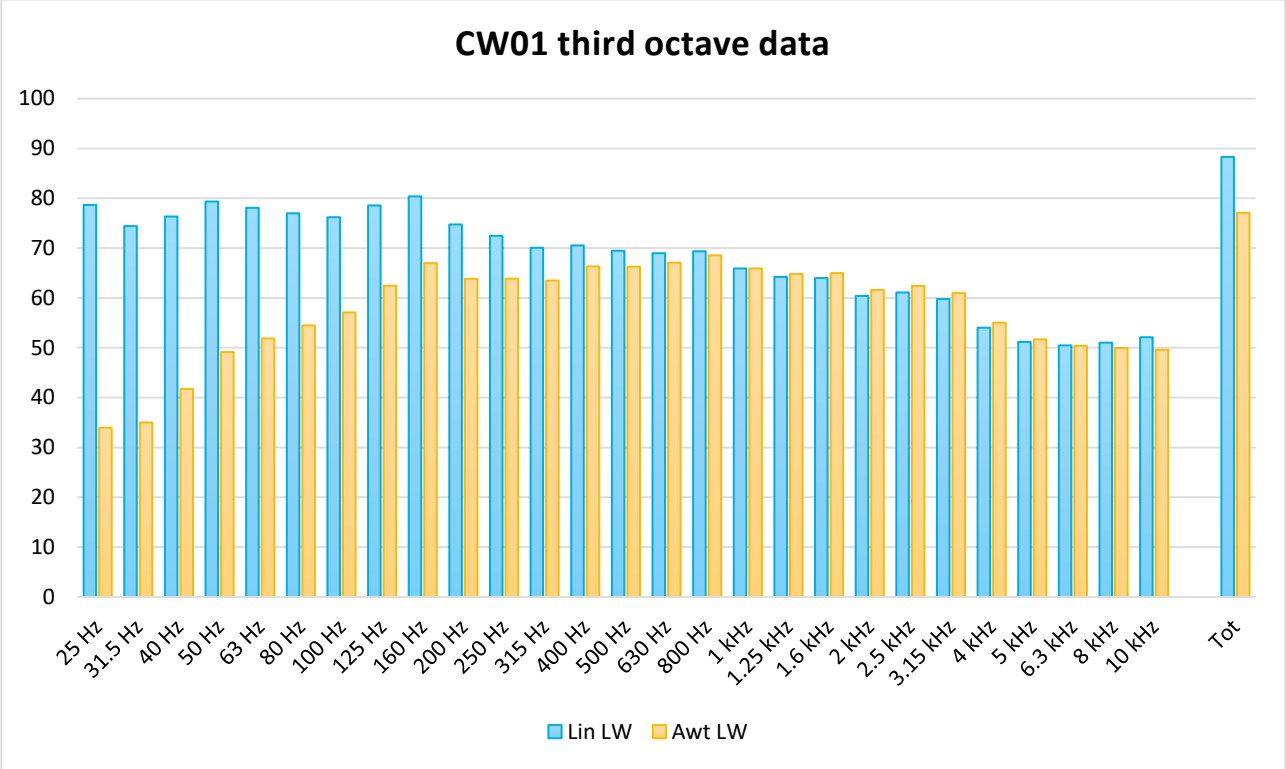
Noise level measurements were made on 13 September 2022.

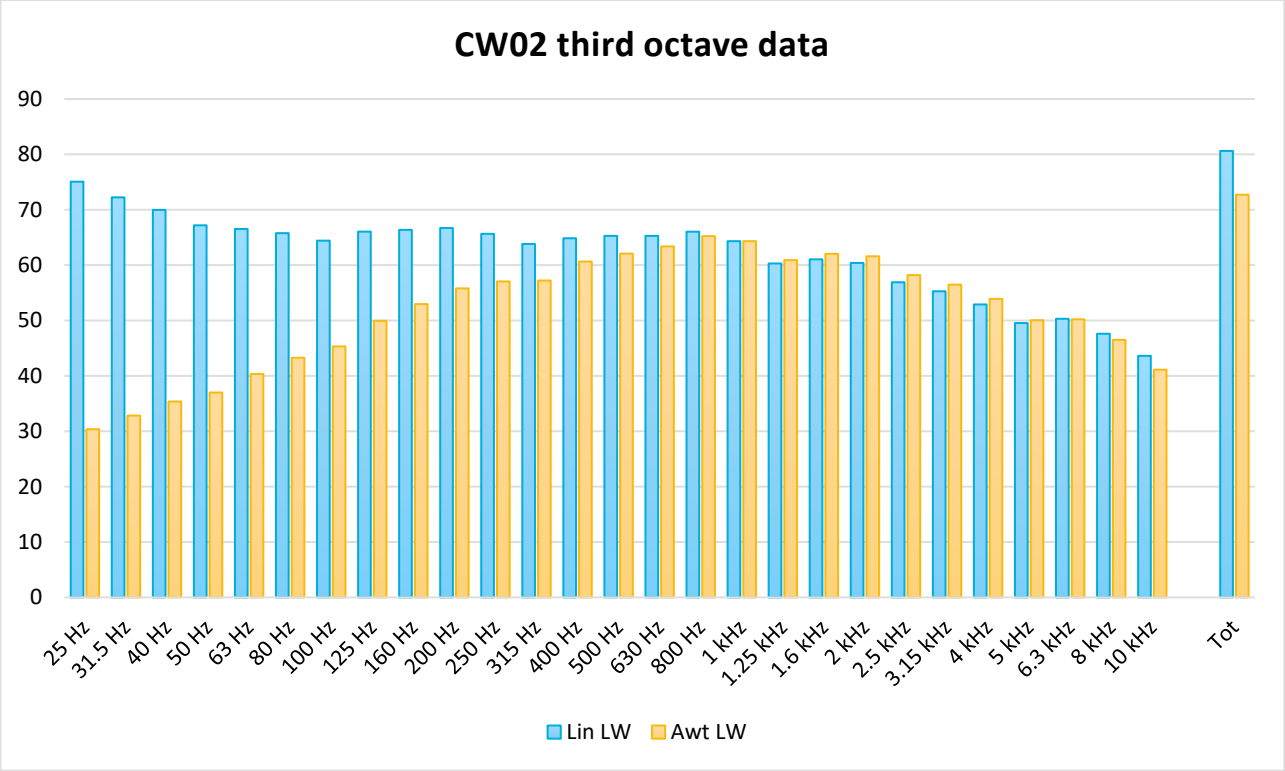
We trust this information is per your requirements. Please contact us if you require further details or advice.

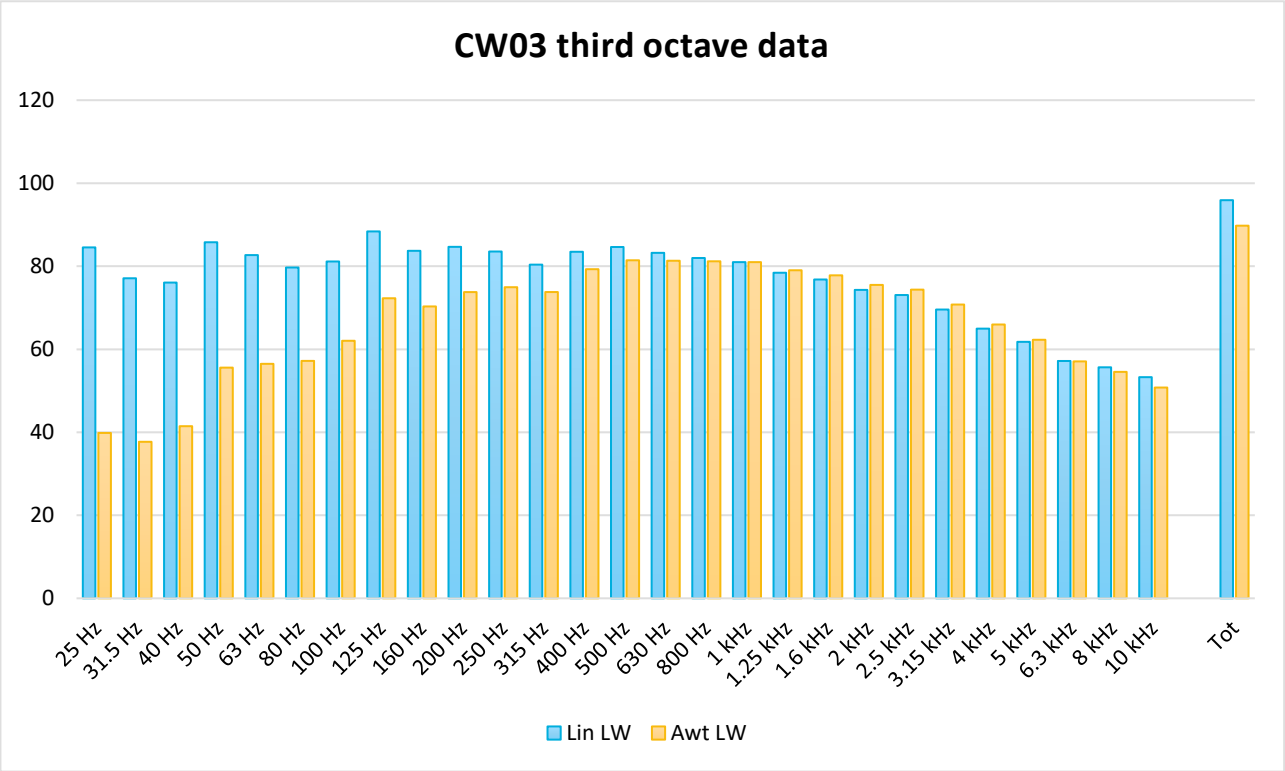
Appendix A
Third Octave Graphs

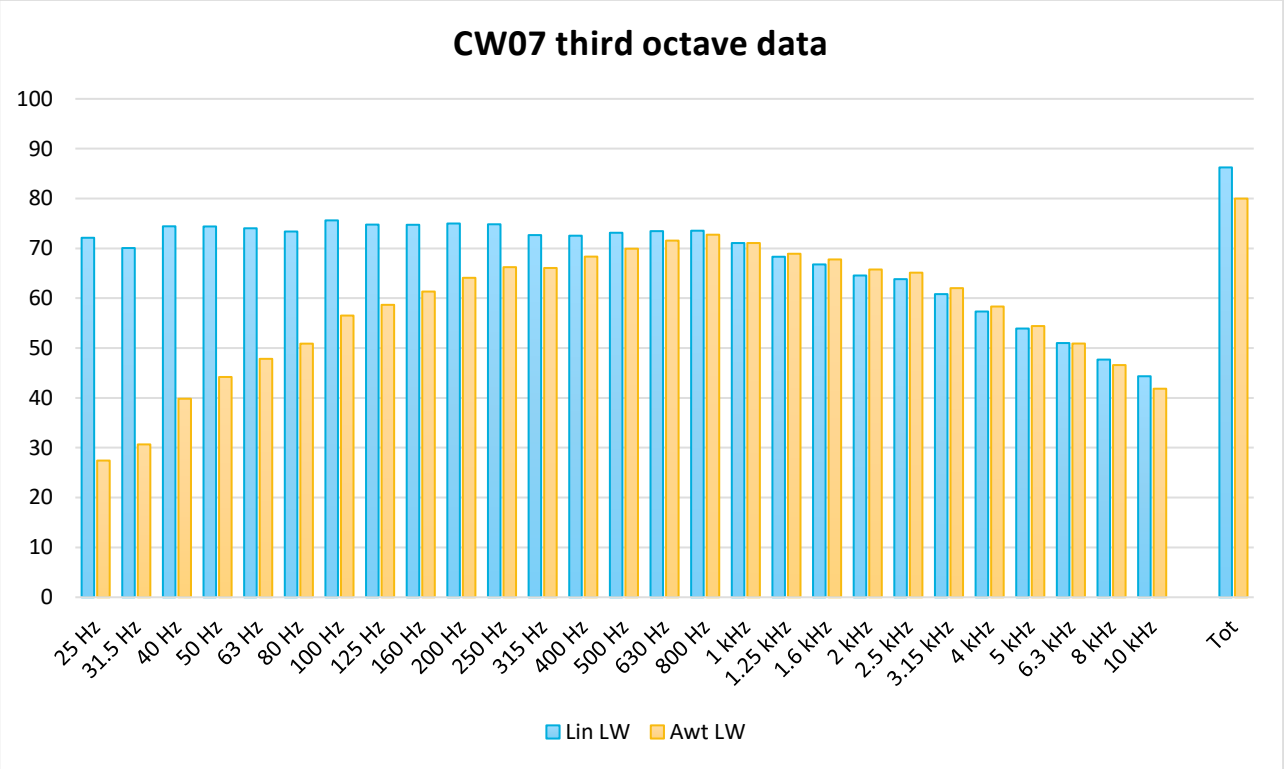
EMM
creating opportunities

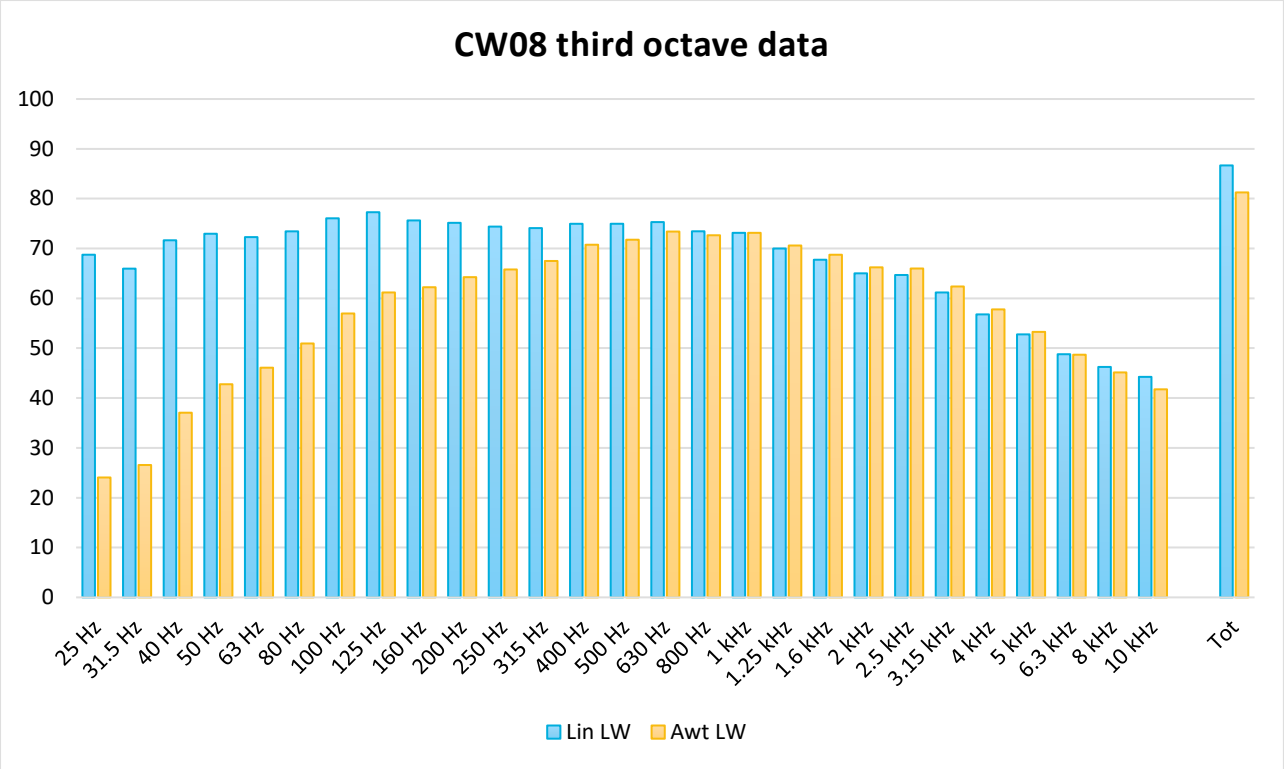
A.1 Third Octave Graphs

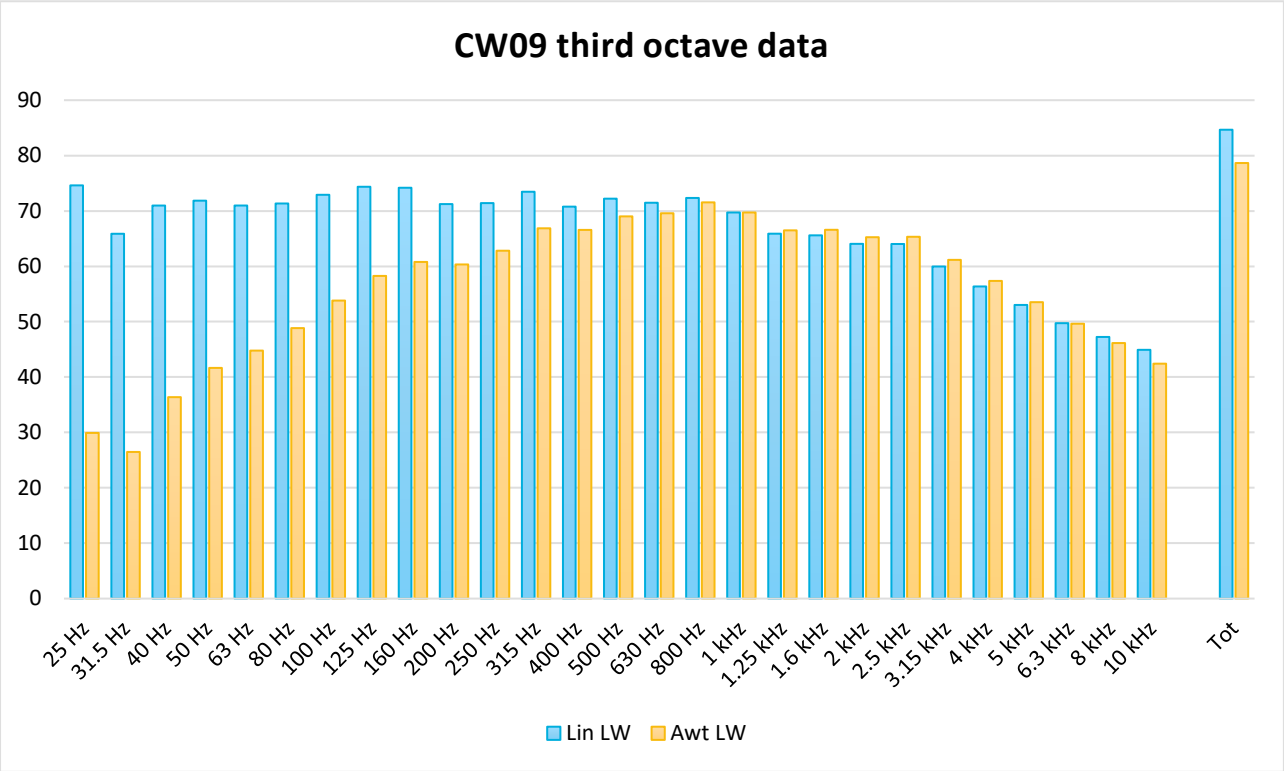


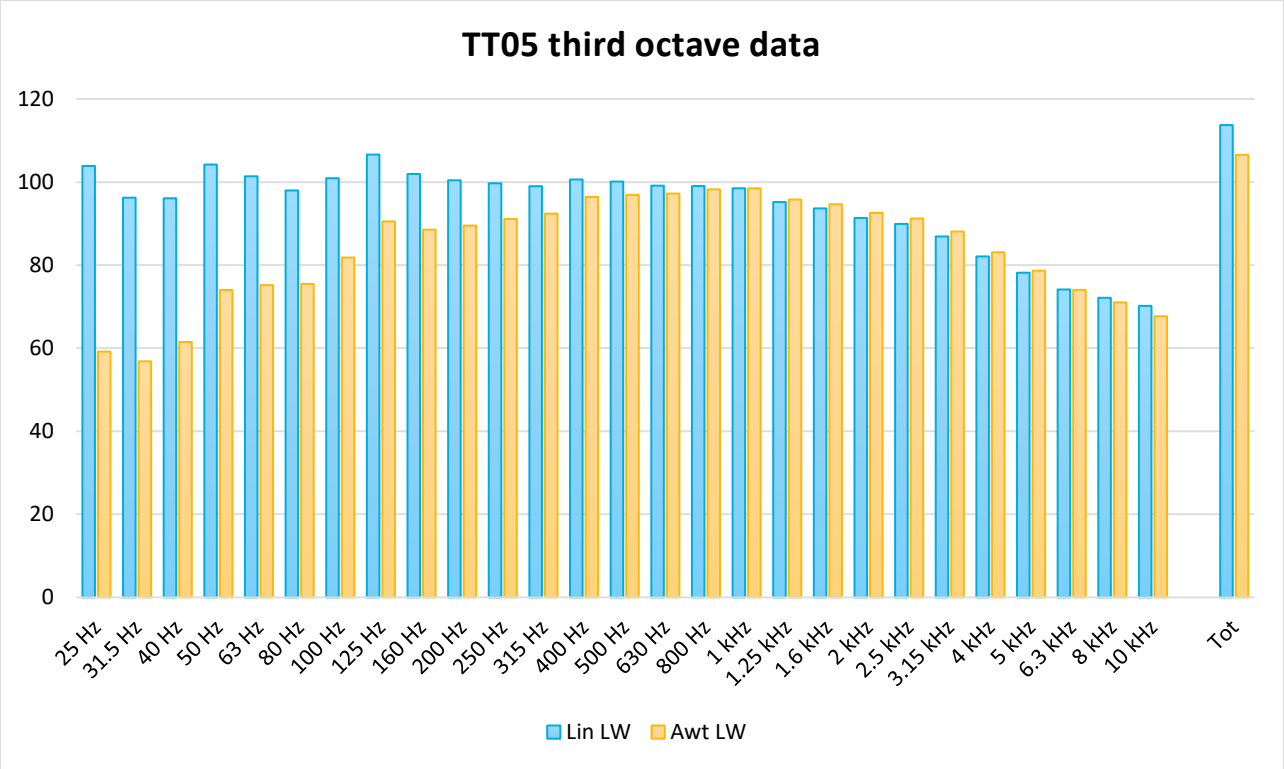

CW02 third octave data
90
80
70
60
50
40
30
20
10
0
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1 kHz
1.25 kHz
1.6 kHz
2 kHz
2.5 kHz
3.15 kHz
4 kHz
5 kHz
6.3 kHz
8 kHz
10 kHz
Tot
Lin LW
Awt LW

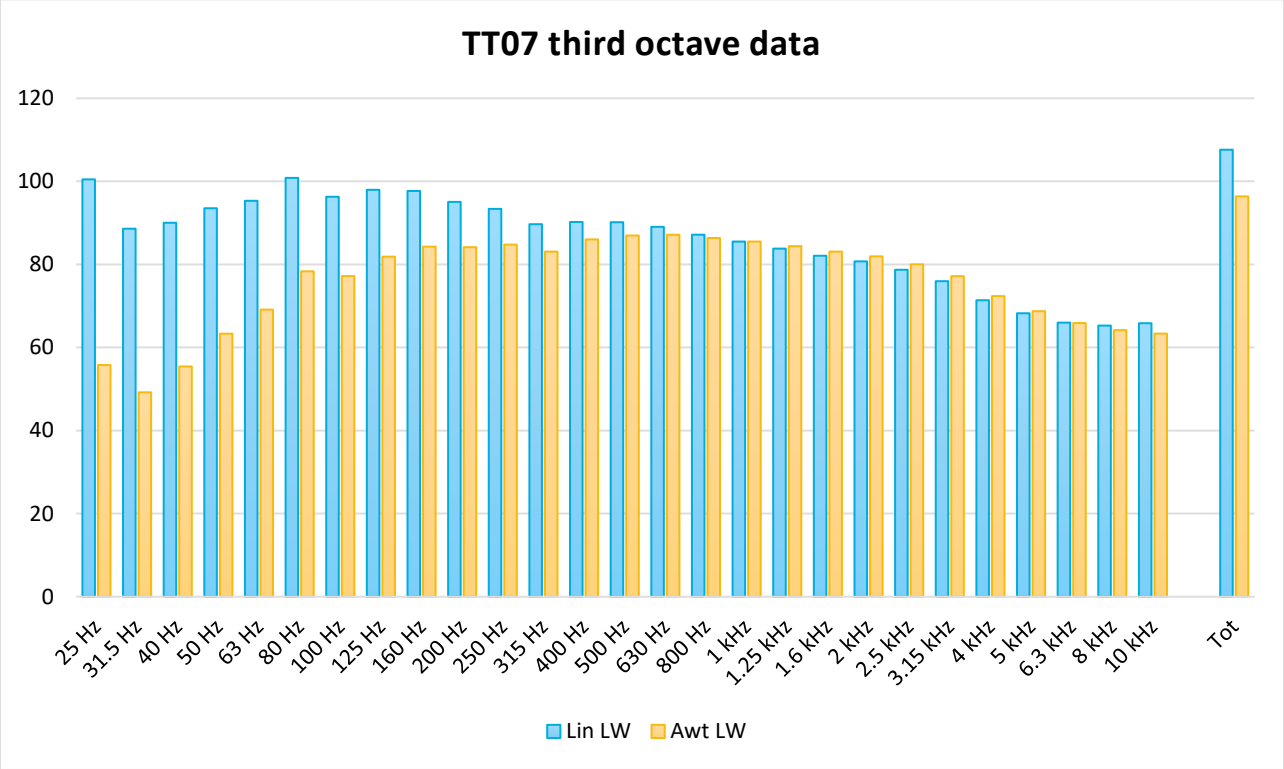

CW03 third octave data
120
100
80
60
40
20
0
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1 kHz
1.25 kHz
1.6 kHz
2 kHz
2.5 kHz
3.15 kHz
4 kHz
5 kHz
6.3 kHz
8 kHz
10 kHz
Tot
Lin LW
Awt LW


CW07 third octave data
100
90
80
70
60
50
40
30
20
10
0
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1 kHz
1.25 kHz
1.6 kHz
2 kHz
2.5 kHz
3.15 kHz
4 kHz
5 kHz
6.3 kHz
8 kHz
10 kHz
Tot
Lin LW
Awt LW


CW08 third octave data
100
90
80
70
60
50
40
30
20
10
0
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1 kHz
1.25 kHz
1.6 kHz
2 kHz
2.5 kHz
3.15 kHz
4 kHz
5 kHz
6.3 kHz
8 kHz
10 kHz
Tot
Lin LW
Awt LW

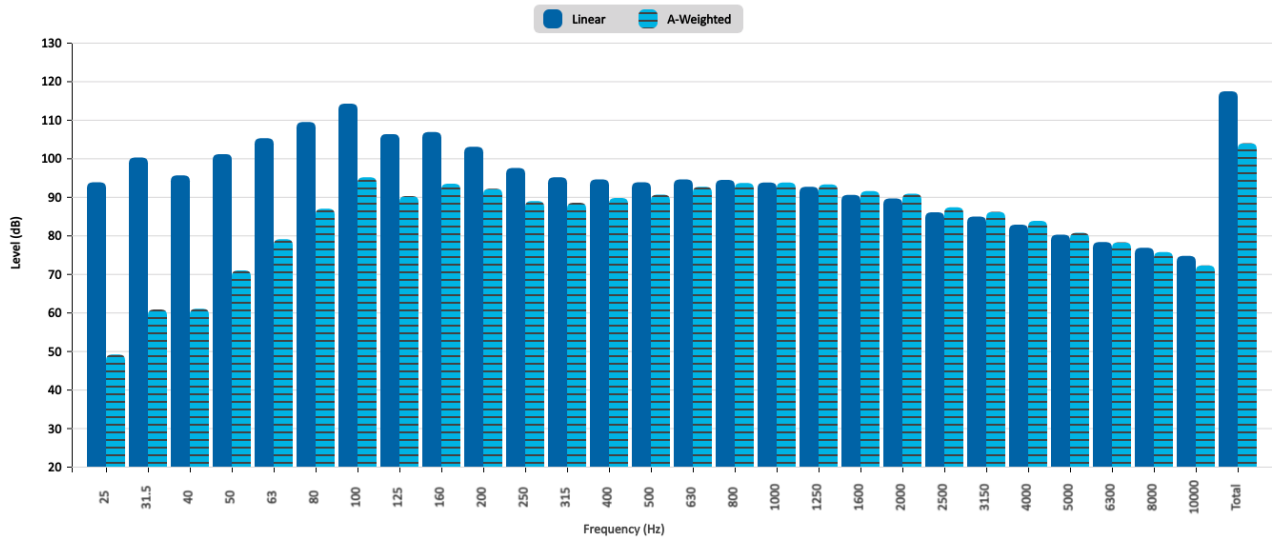

CW09 third octave data
90
80
70
60
50
40
30
20
10
0
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1 kHz
1.25 kHz
1.6 kHz
2 kHz
2.5 kHz
3.15 kHz
4 kHz
5 kHz
6.3 kHz
8 kHz
10 kHz
Tot
Lin LW
Awt LW


TT05 third octave data
120
100
80
60
40
20
0
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1 kHz
1.25 kHz
1.6 kHz
2 kHz
2.5 kHz
3.15 kHz
4 kHz
5 kHz
6.3 kHz
8 kHz
10 kHz
Tot
Lin LW
Awt LW


TT07 third octave data
120
100
80
60
40
20
0
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1 kHz
1.25 kHz
1.6 kHz
2 kHz
2.5 kHz
3.15 kHz
4 kHz
5 kHz
6.3 kHz
8 kHz
10 kHz
Tot
Lin LW
Awt LW

Komatsu D475A-8 - DZ04

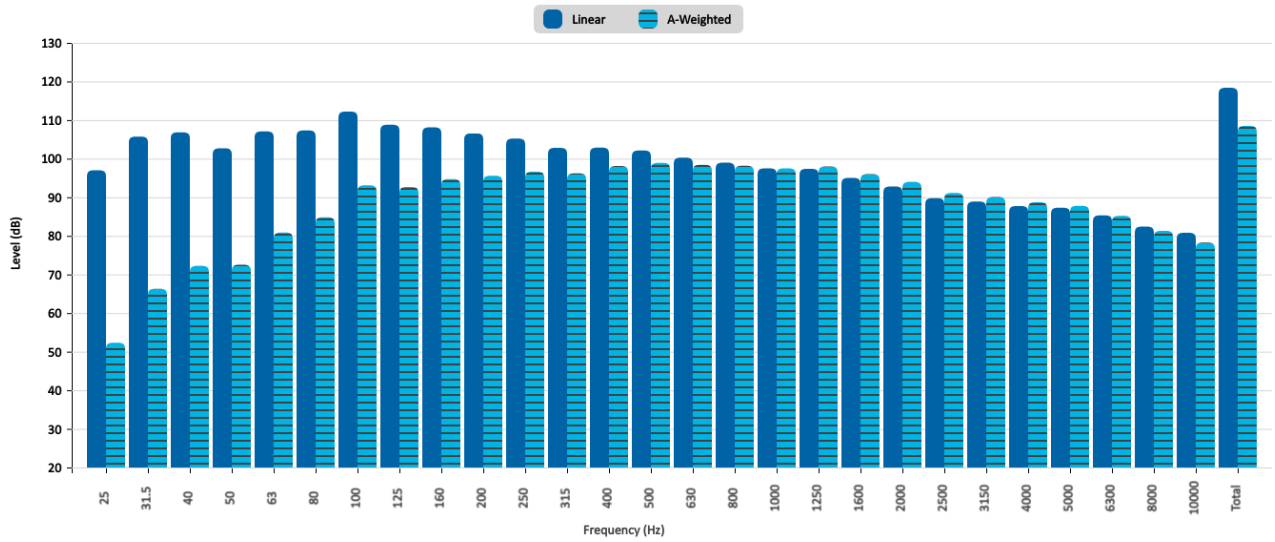
Stationary Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	94	100	96	101	105	109	114	106	107	103	98	95	95	94	95	94	94	93	91	90	86	85	83	80	78	77	75	**117**
A-Weighted	49	61	61	71	79	87	95	90	93	92	89	89	90	91	93	94	94	93	92	91	87	86	84	81	78	76	72	**104**

Komatsu D475A-8 - DZ04

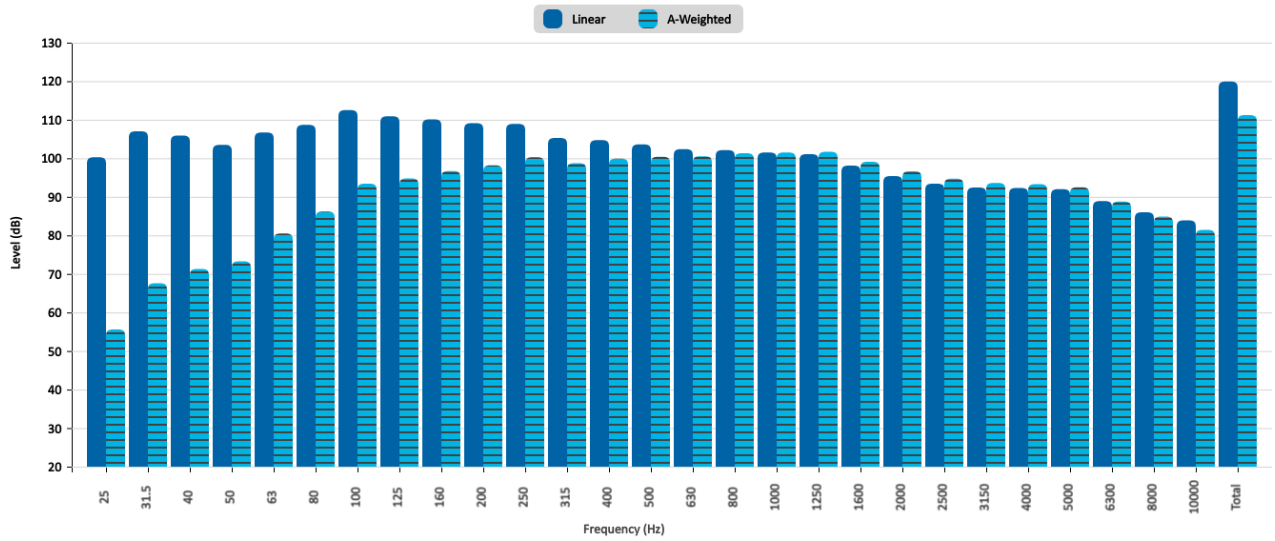
Dynamic, 1st Gear Forward Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	97	106	107	103	107	107	112	109	108	107	105	103	103	102	100	99	98	97	95	93	90	89	88	87	85	82	81	**118**
A-Weighted	52	66	72	73	81	85	93	93	95	96	97	96	98	99	98	98	98	98	96	94	91	90	89	88	85	81	78	**109**

Komatsu D475A-8 - DZ04

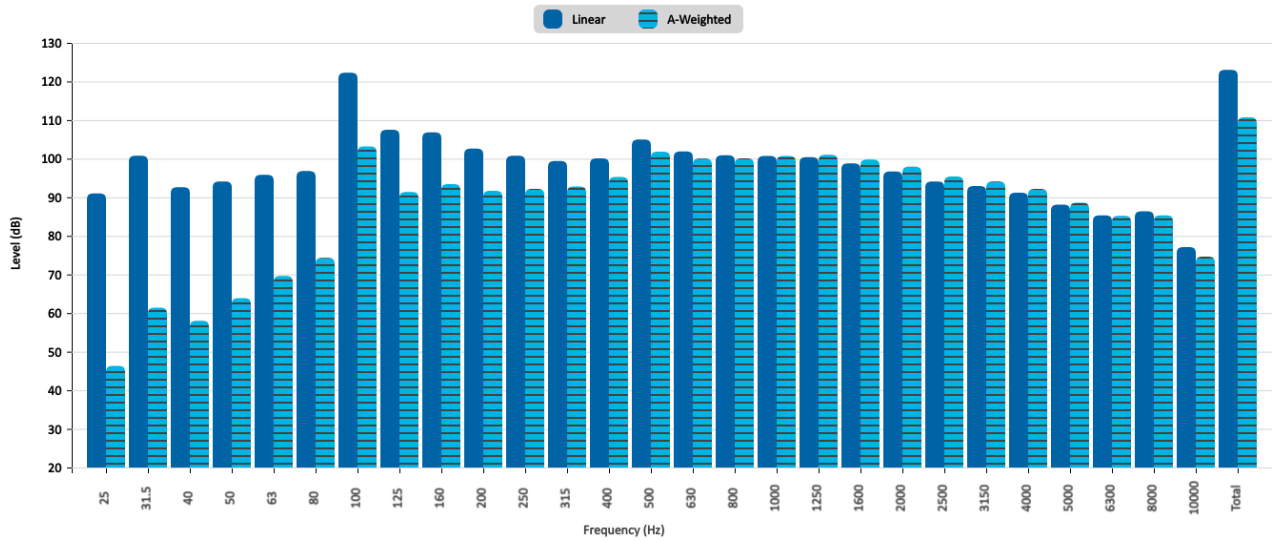
Dynamic, 1st Gear Reverse Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	100	107	106	104	107	109	113	111	110	109	109	105	105	104	102	102	102	101	98	95	93	92	92	92	89	86	84	**120**
A-Weighted	56	68	71	73	81	86	93	95	97	98	100	99	100	100	101	101	102	102	99	97	95	94	93	93	89	85	81	**111**

Komatsu D475A-8 - DZ14

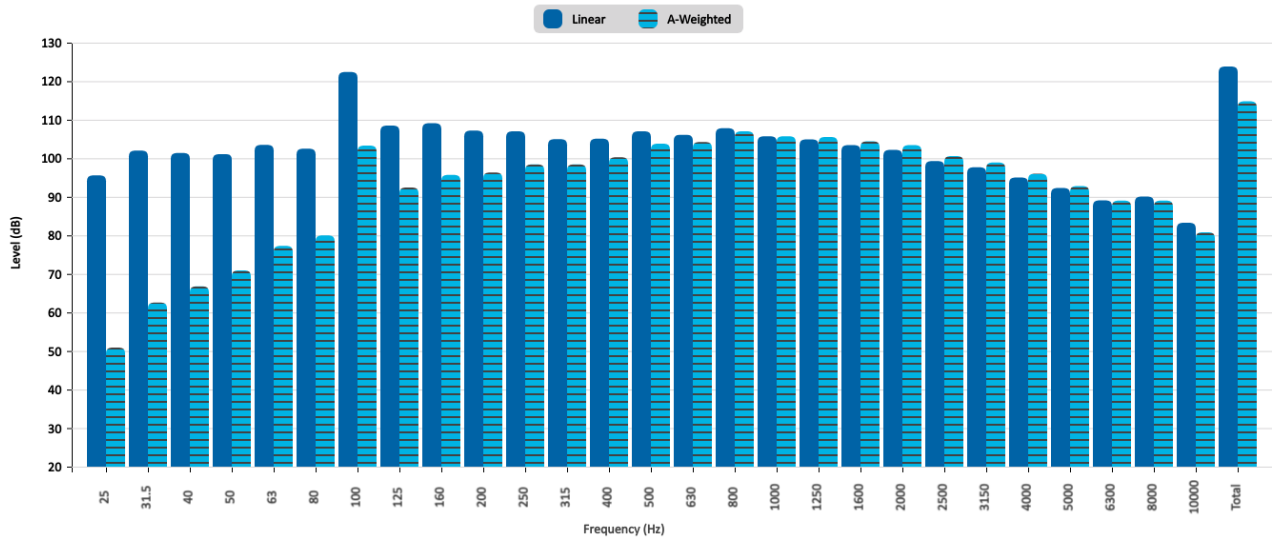
Stationary Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	91	101	93	94	96	97	122	108	107	103	101	99	100	105	102	101	101	100	99	97	94	93	91	88	85	86	77	**123**
A-Weighted	46	61	58	64	70	74	103	91	93	92	92	93	95	102	100	100	101	101	100	98	95	94	92	89	85	85	75	**111**

Komatsu D475A-8 - DZ14

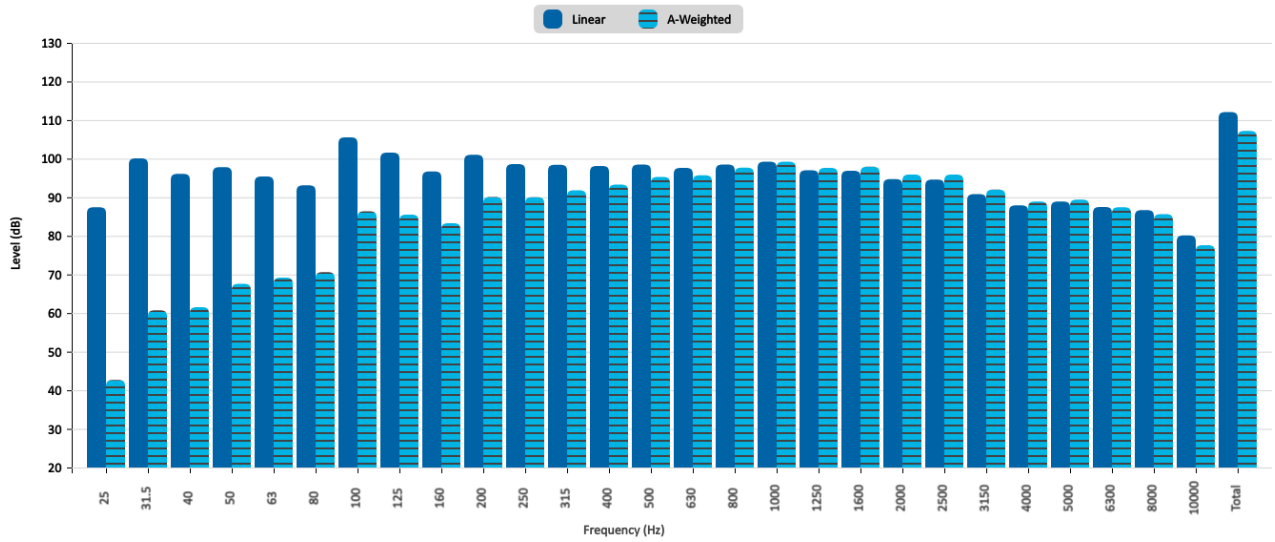
Dynamic, 1st Gear Forward Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	96	102	101	101	104	103	122	109	109	107	107	105	105	107	106	108	106	105	103	102	99	98	95	92	89	90	83	**124**
A-Weighted	51	63	67	71	77	80	103	92	96	96	98	98	100	104	104	107	106	106	104	103	101	99	96	93	89	89	81	**115**

Caterpillar 980M - WL02

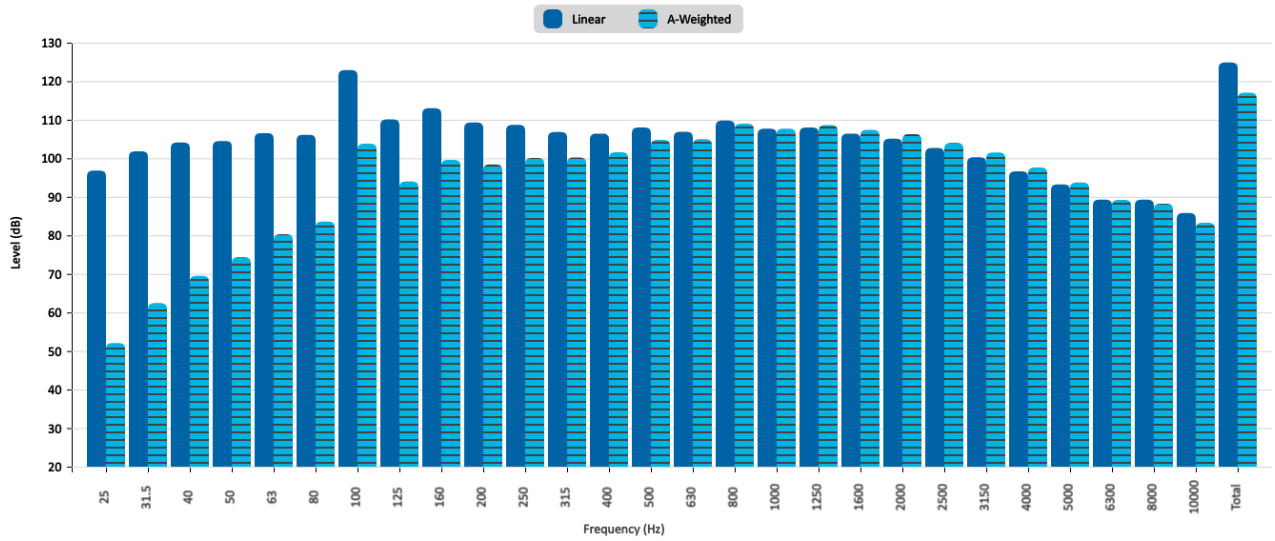
Stationary Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	87	100	96	98	95	93	106	102	97	101	99	98	98	99	98	99	99	97	97	95	95	91	88	89	88	87	80	**112**
A-Weighted	43	61	61	68	69	71	86	86	83	90	90	92	93	95	96	98	99	98	98	96	96	92	89	89	87	86	78	**107**

Komatsu D475A-8 - DZ14

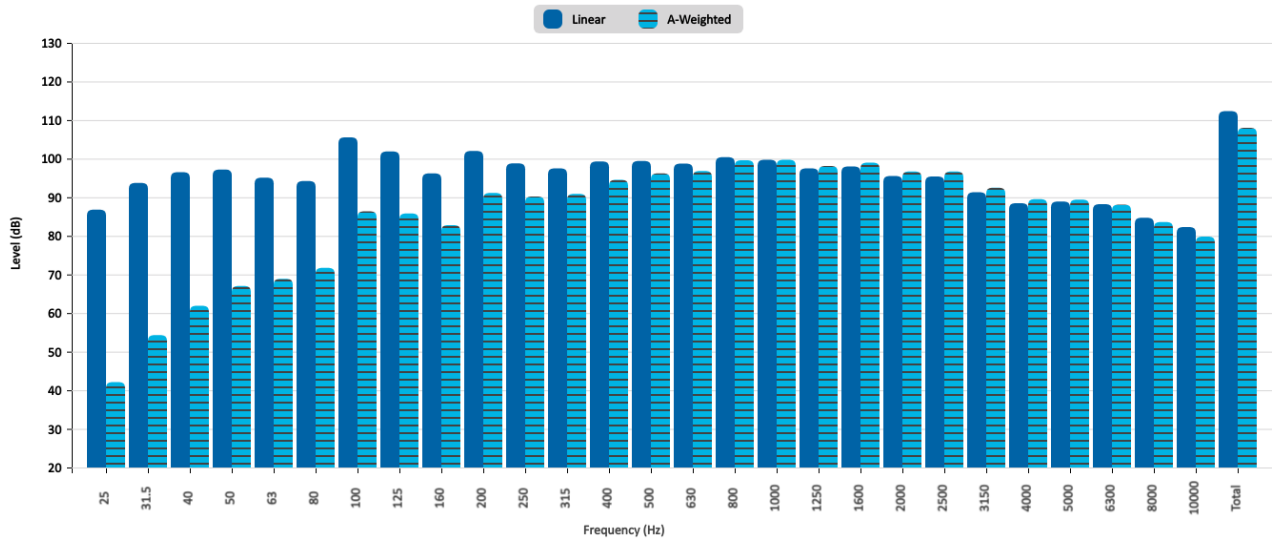
Dynamic, 1st Gear Reverse Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	97	102	104	105	107	106	123	110	113	109	109	107	106	108	107	110	108	108	106	105	103	100	97	93	89	89	86	**125**
A-Weighted	52	62	70	74	80	84	104	94	100	98	100	100	102	105	105	109	108	109	107	106	104	102	98	94	89	88	83	**117**

Caterpillar 980M - WL02

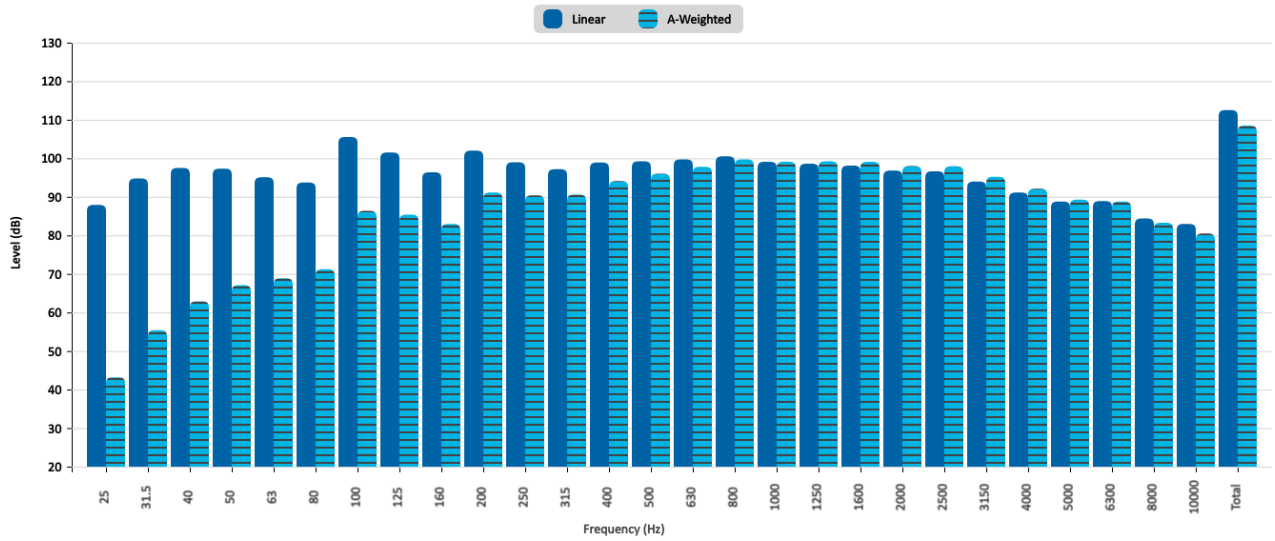
Dynamic, 1st Gear Forward Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	87	94	97	97	95	94	106	102	96	102	99	98	99	99	99	100	100	98	98	96	95	91	89	89	88	85	82	**112**
A-Weighted	42	54	62	67	69	72	86	86	83	91	90	91	95	96	97	100	100	98	99	97	97	93	90	89	88	84	80	**108**

Caterpillar 980M - WL02

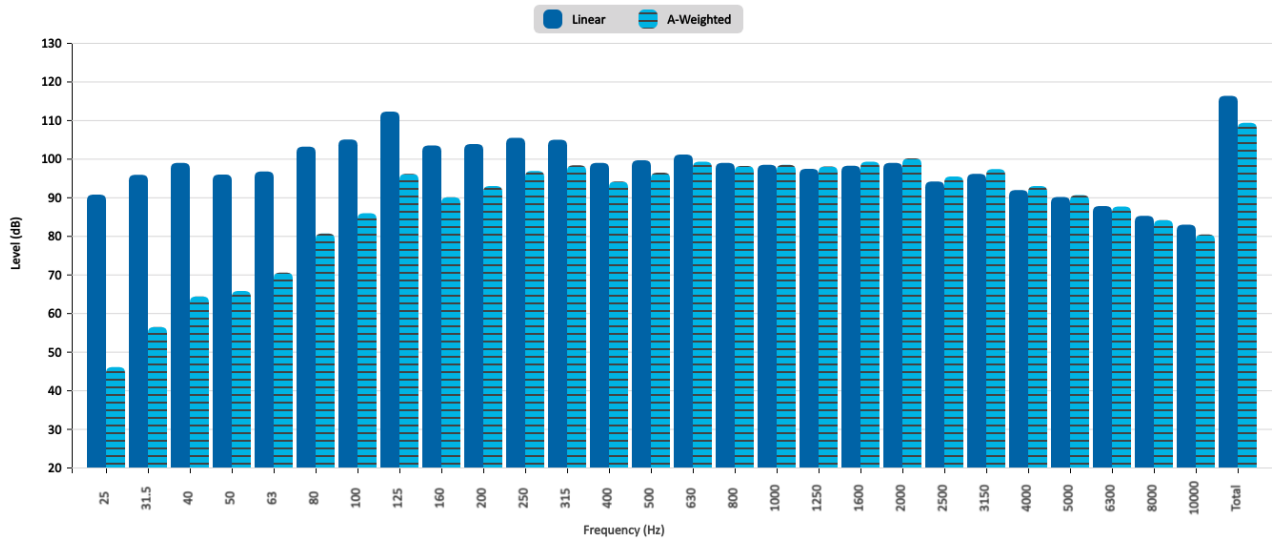
Dynamic, 1st Gear Reverse Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	88	95	98	97	95	94	106	102	96	102	99	97	99	99	100	101	99	99	98	97	97	94	91	89	89	84	83	**113**
A-Weighted	43	55	63	67	69	71	86	85	83	91	90	91	94	96	98	100	99	99	99	98	98	95	92	89	89	83	81	**109**

Caterpillar 988F - WL04

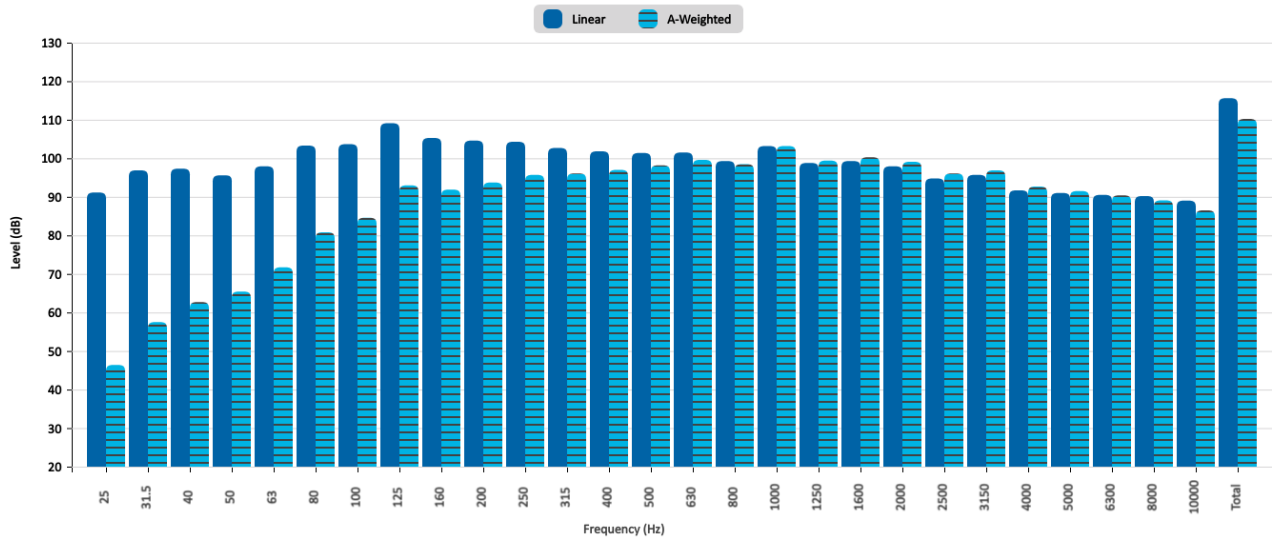
Stationary Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	91	96	99	96	97	103	105	112	103	104	105	105	99	100	101	99	98	97	98	99	94	96	92	90	88	85	83	**116**
A-Weighted	46	56	64	66	71	81	86	96	90	93	97	98	94	96	99	98	98	98	99	100	95	97	93	91	88	84	80	**109**

Caterpillar 988F - WL04

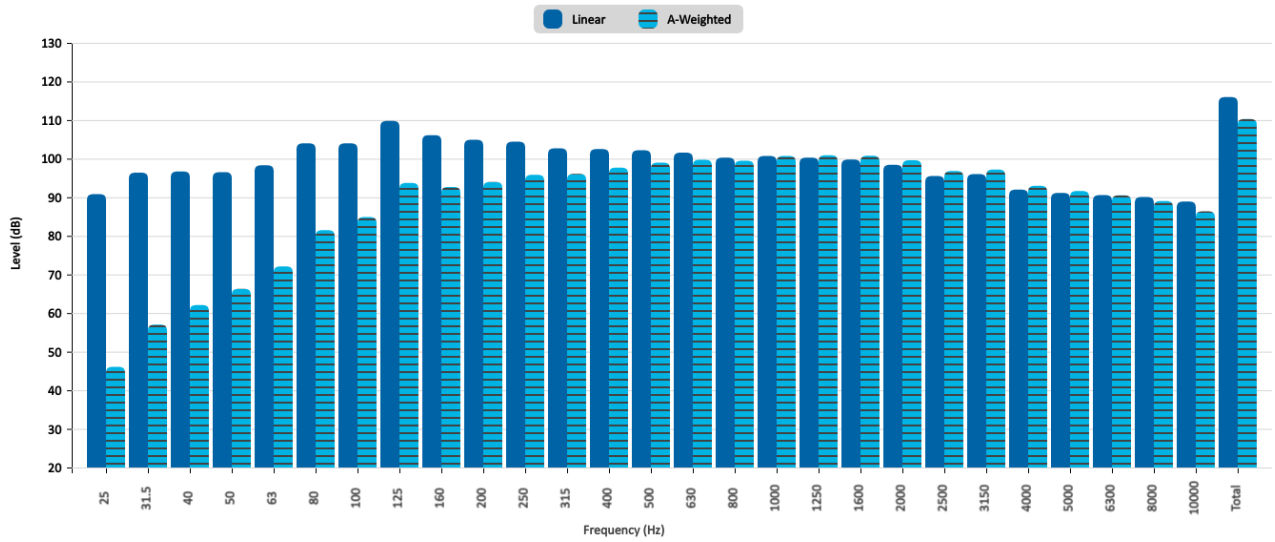
Dynamic, 1st Gear Forward Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	91	97	97	96	98	103	104	109	105	105	104	103	102	101	102	99	103	99	99	98	95	96	92	91	91	90	89	**116**
A-Weighted	46	58	63	65	72	81	85	93	92	94	96	96	97	98	100	99	103	99	100	99	96	97	93	92	90	89	87	**110**

Caterpillar 988F - WL04

Dynamic, 1st Gear Reverse Sound Power Test, 13 September 2022



	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	Total
Linear	91	96	97	97	98	104	104	110	106	105	104	103	103	102	102	100	101	100	100	98	96	96	92	91	91	90	89	**116**
A-Weighted	46	57	62	66	72	82	85	94	93	94	96	96	98	99	100	100	101	101	101	100	97	97	93	92	91	89	86	**110**

Appendix B
Calibration Certificates

EMM
creating opportunities

B.1 Calibration Certificates

Acoustic Research Labs Pty Ltd
Unit 36/14 Loyalty Rd
North Rocks NSW AUSTRALIA 2151
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
IEC 61672-3:2013

Calibration Certificate

Calibration Number C22209

Client Details	Global Acoustics Pty Ltd 12/16 Huntingdale Drive Thornton NSW 2322
Equipment Tested/ Model Number :	SVANTEK SVAN 958
Instrument Serial Number :	20880
Microphone Serial Number :	17132
Pre-amplifier Serial Number :	24298

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	24.9°C	**Ambient Temperature :**	23.8°C
Relative Humidity :	59.4%	**Relative Humidity :**	53.7%
Barometric Pressure :	100.8kPa	**Barometric Pressure :**	100.78kPa

Calibration Technician :	Lucky Jaiswal	**Secondary Check:**	Shaheen Boaz
Calibration Date :	6 Apr 2022	**Report Issue Date :**	6 Apr 2022

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	*Pass*	17: Level linearity incl. the level range control	*Pass*
13: Electrical Sig. tests of frequency weightings	*Pass*	18: Toneburst response	*Pass*
14: Frequency and time weightings at 1 kHz	*Pass*	19: C Weighted Peak Sound Level	*Pass*
15: Long Term Stability	*Pass*	20: Overload Indication	*Pass*
16: Level linearity on the reference level range	*Pass*	21: High Level Stability	*Pass*

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
125Hz	*±0.13dB*	*Temperature*	*±0.2°C*
1kHz	*±0.13dB*	*Relative Humidity*	*±2.4%*
8kHz	*±0.14dB*	*Barometric Pressure*	*±0.015kPa*
Electrical Tests	*±0.10dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - Calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

PAGE 1 OF 1

Acoustic Research Labs Pty Ltd
Unit 36/14 Loyalty Rd
North Rocks NSW AUSTRALIA 2151
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Calibrator

IEC 60942-2017

Calibration Certificate

Calibration Number C21661

Client Details Global Acoustics Pty Ltd
12/16 Huntingdale Drive
Thornton, NSW, 2322

Equipment Tested/ Model Number : Pulsar Model 105
Instrument Serial Number : 96080

Atmospheric Conditions
Ambient Temperature : 22.7°C
Relative Humidity : 40.4%
Barometric Pressure : 99.8kPa

Calibration Technician : Lucky Jaiswal **Secondary Check:** Matthew Calleja
Calibration Date : 07 Oct 2021 **Report Issue Date :** 7 Oct 2021

Approved Signatory : Ken Williams

Characteristic Tested	Result
Generated Sound Pressure Level	Pass
Frequency Generated	Pass
Total Distortion	Pass

	Nominal Level	Nominal Frequency	Measured Level	Measured Frequency
	94	1000	93.85	1000.30

The sound calibrator has been shown to conform to the class 1 requirements for periodic testing, described in Annex B of IEC 60942:2017 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed.

Least Uncertainties of Measurement -

Specific Tests		Environmental Conditions	
Generated SPL	*±0.15dB*	*Temperature*	*±0.2°C*
Frequency	*±0.1%*	*Relative Humidity*	*±2.4%*
Distortion	*±0.5%*	*Barometric Pressure*	*±0.05kPa*

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

* The tests < 1000 kHz are not covered by Acoustic Research Labs Pty Ltd NATA accreditation.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

Page 1 of 1

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Suite 2.04 Level 2
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8
454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9
109 St Georges Terrace
Perth WA 6000
T 08 6430 4800

Canada

TORONTO
2345 Yonge Street Suite 300
Toronto ON M4P 2E5
T 647 467 1605

VANCOUVER
60 W 6th Ave
Vancouver BC V5Y 1K1
T 604 999 8297

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au

APPENDIX 5: AIR QUALITY

Table 5A-1: 2022 Monthly Depositional Monitoring

	WCSDG3	WCSDG4	WCSDG5
	g/m²/moth		
24/01/2022	4.0	0.6	0.6
23/02/2022	0.6	0.5	0.7
23/03/2022	1.1	0.4	0.2
22/04/2022	0.5	0.3	0.5
24/05/2022	1.3	0.4	0.6
25/06/2022	0.7	0.4	0.3
26/07/2022	1.6	8.5	0.8
26/08/2022	1.1	0.7	0.7
26/09/2022	2.7	1.3	2.3
26/10/2022	4.0	1.7	1.3
25/11/2022	4.1	1.6	0.6
23/12/2022	4.7	0.7	0.1

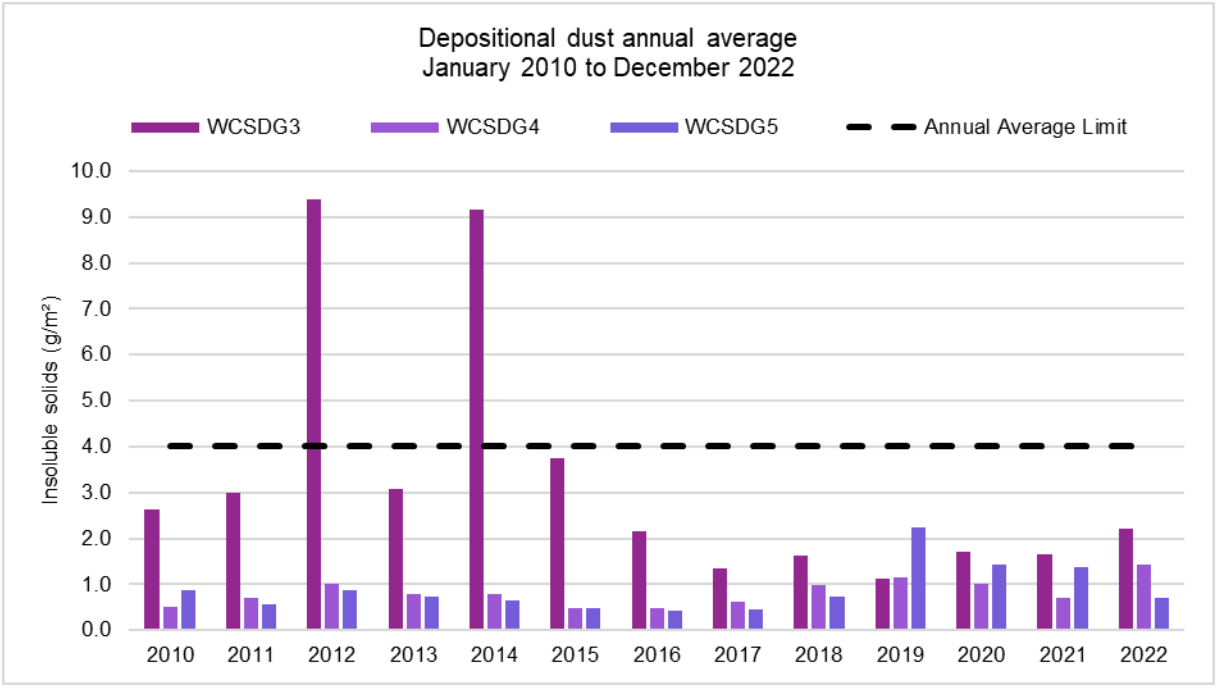


Figure 5A-1: Long Term Annual Averages

Table 5A-2: 2022 24hr PM_{10} Results

Date	PM_{10} (ug/m^3)	Date	PM_{10} (ug/m^3)	Date	PM_{10} (ug/m^3)
2/01/2022	10.1	2/02/2022	9.43	2/03/2022	4.06
3/01/2022	12.6	3/02/2022	5.15	3/03/2022	4.32
4/01/2022	10.8	4/02/2022	9.42	4/03/2022	4.9
5/01/2022	9.25	5/02/2022	10.3	5/03/2022	5.83
6/01/2022	6.8	6/02/2022	9.7	6/03/2022	5.55
7/01/2022	5.71	7/02/2022	7.68	7/03/2022	4.83
8/01/2022	5.84	8/02/2022	6.27	8/03/2022	4.28
9/01/2022	8.33	9/02/2022	7.47	9/03/2022	4.61
10/01/2022	9.27	10/02/2022	14.4	10/03/2022	8.73
11/01/2022	6.54	11/02/2022	11.6	11/03/2022	11.8
12/01/2022	3.64	12/02/2022	9.44	12/03/2022	12.1
13/01/2022	5.77	13/02/2022	7.44	13/03/2022	9.4
14/01/2022	7.43	14/02/2022	10.2	14/03/2022	8.35
15/01/2022	12.8	15/02/2022	11.8	15/03/2022	7.21
16/01/2022	13.3	16/02/2022	14.8	16/03/2022	8.54
17/01/2022	9.52	17/02/2022	15.8	17/03/2022	8.83
18/01/2022	2.55	18/02/2022	18.5	18/03/2022	10.2
19/01/2022	4.56	19/02/2022	12.8	19/03/2022	9.61
20/01/2022	8.64	20/02/2022	10.2	20/03/2022	6.24
21/01/2022	11.8	21/02/2022	12.2	21/03/2022	9.96
22/01/2022	6.13	22/02/2022	9.22	22/03/2022	11.5
23/01/2022	6.37	23/02/2022	5.92	23/03/2022	17.7
24/01/2022	3.72	24/02/2022	7.75	24/03/2022	8.03
25/01/2022	7.1	25/02/2022	6.92	25/03/2022	5.41
26/01/2022	11.5	26/02/2022	7.1	26/03/2022	6.89
27/01/2022	11.1	27/02/2022	7.82	27/03/2022	6.29
28/01/2022	11.7	28/02/2022	7.59	28/03/2022	5.42
29/01/2022	12.4			29/03/2022	5.44
30/01/2022	12.5			30/03/2022	6.98
31/01/2022	11.7			31/03/2022	7.63

Date	PM_{10} (ug/m^3)	Date	PM_{10} (ug/m^3)	Date	PM_{10} (ug/m^3)
1/04/2022	6.99	1/05/2022	6.54	1/06/2022	6.07
2/04/2022	5.78	2/05/2022	8.26	2/06/2022	6.51
3/04/2022	7.54	3/05/2022	8.68	3/06/2022	7
4/04/2022	13.7	4/05/2022	8.33	4/06/2022	5.34
5/04/2022	17.3	5/05/2022	9.41	5/06/2022	4.59
6/04/2022	14.2	6/05/2022	8.84	6/06/2022	4.23
7/04/2022	6.83	7/05/2022	7.14	7/06/2022	5.87
8/04/2022	5.82	8/05/2022	7.55	8/06/2022	4.7
9/04/2022	6.82	9/05/2022	7.32	9/06/2022	5.03
10/04/2022	8.24	10/05/2022	6.18	10/06/2022	4.37
11/04/2022	7.4	11/05/2022	6.83	11/06/2022	4.48
12/04/2022	5.01	12/05/2022	4.76	12/06/2022	7.46
13/04/2022	2.79	13/05/2022	5.09	13/06/2022	5.74
14/04/2022	5.07	14/05/2022	6.47	14/06/2022	7.79
15/04/2022	6.28	15/05/2022	8.22	15/06/2022	8.99
16/04/2022	6.97	16/05/2022	7.7	16/06/2022	9.11
17/04/2022	7.66	17/05/2022	8.85	17/06/2022	5.48
18/04/2022	8.12	18/05/2022	7.88	18/06/2022	7.28
19/04/2022	8.48	19/05/2022	8.19	19/06/2022	7.57
20/04/2022	6.8	20/05/2022	8.47	20/06/2022	7.73
21/04/2022	6.69	21/05/2022	6.78	21/06/2022	6.85
22/04/2022	8.25	22/05/2022	5.26	22/06/2022	7.32
23/04/2022	5.88	23/05/2022	4.88	23/06/2022	5.68
24/04/2022	5.37	24/05/2022	5.4	24/06/2022	5.4
25/04/2022	5	25/05/2022	5.76	25/06/2022	7.39
26/04/2022	4.87	26/05/2022	7.68	26/06/2022	8.09
27/04/2022	6.04	27/05/2022	9.2	27/06/2022	6.88
28/04/2022	5.16	28/05/2022	7.15	28/06/2022	6.12
29/04/2022	7.11	29/05/2022	4.89	29/06/2022	5.88
30/04/2022	8.9	30/05/2022	3.09	30/06/2022	8.4
		31/05/2022	1.39		

Date	PM_{10} (ug/m^3)	Date	PM_{10} (ug/m^3)	Date	PM_{10} (ug/m^3)
1/07/2022	8.32	1/08/2022	8.02	1/09/2022	8.6
2/07/2022	4.36	2/08/2022	6.61	2/09/2022	14.5
3/07/2022	3.17	3/08/2022	8.78	3/09/2022	9.29
4/07/2022	2.99	4/08/2022	8.93	4/09/2022	4.32
5/07/2022	1.9	5/08/2022	6.28	5/09/2022	5.08
6/07/2022	0.28	6/08/2022	7.8	6/09/2022	7.02
7/07/2022	2.77	7/08/2022	5.23	7/09/2022	7.53
8/07/2022	3.31	8/08/2022	5.2	8/09/2022	8.4
9/07/2022	3.71	9/08/2022	6.26	9/09/2022	6.92
10/07/2022	4.8	10/08/2022	5.77	10/09/2022	4.47
11/07/2022	4.45	11/08/2022	7.95	11/09/2022	5.89
12/07/2022	5.96	12/08/2022	8.33	12/09/2022	7.81
13/07/2022	4.56	13/08/2022	3.76	13/09/2022	6.78
14/07/2022	4.55	14/08/2022	3.68	14/09/2022	9.41
15/07/2022	6.29	15/08/2022	4.34	15/09/2022	7.09
16/07/2022	5.91	16/08/2022	4.71	16/09/2022	5.24
17/07/2022	6.63	17/08/2022	7.75	17/09/2022	9.2
18/07/2022	8.06	18/08/2022	7.82	18/09/2022	8.33
19/07/2022	7.03	19/08/2022	5.94	19/09/2022	8.9
20/07/2022	5.32	20/08/2022	8.47	20/09/2022	8.97
21/07/2022	4.58	21/08/2022	7.47	21/09/2022	10.5
22/07/2022	4.17	22/08/2022	9	22/09/2022	7.81
23/07/2022	4.6	23/08/2022	6.89	23/09/2022	5.07
24/07/2022	4.47	24/08/2022	5.56	24/09/2022	5.06
25/07/2022	6.5	25/08/2022	5.04	25/09/2022	6.79
26/07/2022	7.08	26/08/2022	6.25	26/09/2022	8.77
27/07/2022	6.2	27/08/2022	6.14	27/09/2022	10.2
28/07/2022	5.89	28/08/2022	6.6	28/09/2022	0
29/07/2022	5.63	29/08/2022	9.92	29/09/2022	5.91
30/07/2022	7.18	30/08/2022	8.81	30/09/2022	6.3
31/07/2022	8.22	31/08/2022	7.94		

Date	PM_{10} (ug/m^3)	Date	PM_{10} (ug/m^3)	Date	PM_{10} (ug/m^3)
1/10/2022	7.77	1/11/2022	5.34	1/12/2022	18.5
2/10/2022	5.64	2/11/2022	5.06	2/12/2022	12.3
3/10/2022	5.87	3/11/2022	7.78	3/12/2022	9.97
4/10/2022	4.25	4/11/2022	8.45	4/12/2022	10.3
5/10/2022	0	5/11/2022	9.72	5/12/2022	11.3
6/10/2022	0	6/11/2022	7.8	6/12/2022	14.3
7/10/2022	2.77	7/11/2022	9.34	7/12/2022	12.8
8/10/2022	4.47	8/11/2022	8.64	8/12/2022	10.2
9/10/2022	3.42	9/11/2022	8.67	9/12/2022	13.2
10/10/2022	5.24	10/11/2022	8.15	10/12/2022	13.8
11/10/2022	9.22	11/11/2022	8.82	11/12/2022	14.5
12/10/2022	9.06	12/11/2022	8.06	12/12/2022	13.6
13/10/2022	7.79	13/11/2022	8.67	13/12/2022	11
14/10/2022	7.17	14/11/2022	6.57	14/12/2022	11.3
15/10/2022	7.86	15/11/2022	7.19	15/12/2022	10.1
16/10/2022	10.1	16/11/2022	7.28	16/12/2022	9.61
17/10/2022	9.42	17/11/2022	7.42	17/12/2022	9.94
18/10/2022	7.6	18/11/2022	8.8	18/12/2022	6.99
19/10/2022	9.89	19/11/2022	9.56	19/12/2022	9.73
20/10/2022	8	20/11/2022	8.73	20/12/2022	16.1
21/10/2022	5.58	21/11/2022	9.73	21/12/2022	10.3
22/10/2022	6.8	22/11/2022	9.46	22/12/2022	10.5
23/10/2022	5.81	23/11/2022	8.88	23/12/2022	11.6
24/10/2022	6.05	24/11/2022	8.44	24/12/2022	10.7
25/10/2022	5.68	25/11/2022	8.95	25/12/2022	10
26/10/2022	6.42	26/11/2022	9.94	26/12/2022	10.5
27/10/2022	7	27/11/2022	10.8	27/12/2022	8.65
28/10/2022	8.18	28/11/2022	8.92	28/12/2022	8.45
29/10/2022	9.75	29/11/2022	9.14	29/12/2022	15
30/10/2022	8.27	30/11/2022	12.9	30/12/2022	12.5
31/10/2022	7.97			31/12/2022	11.2

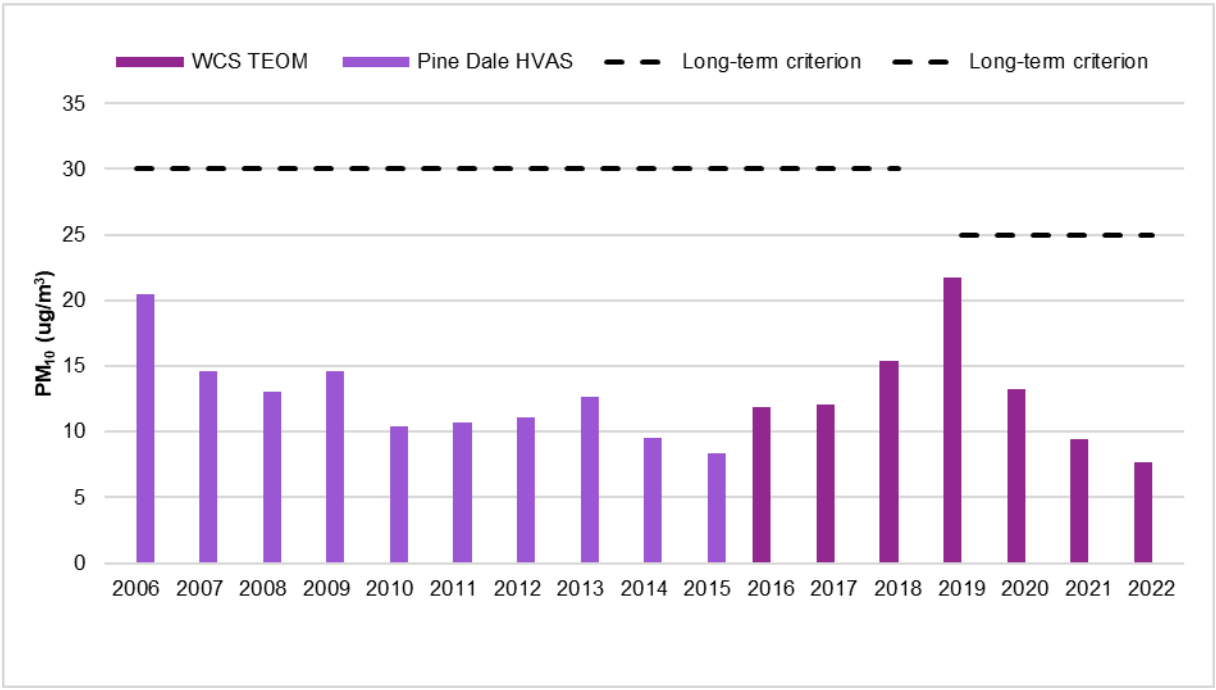


Figure 5A-2: Long Term PM_{10} Annual Averages

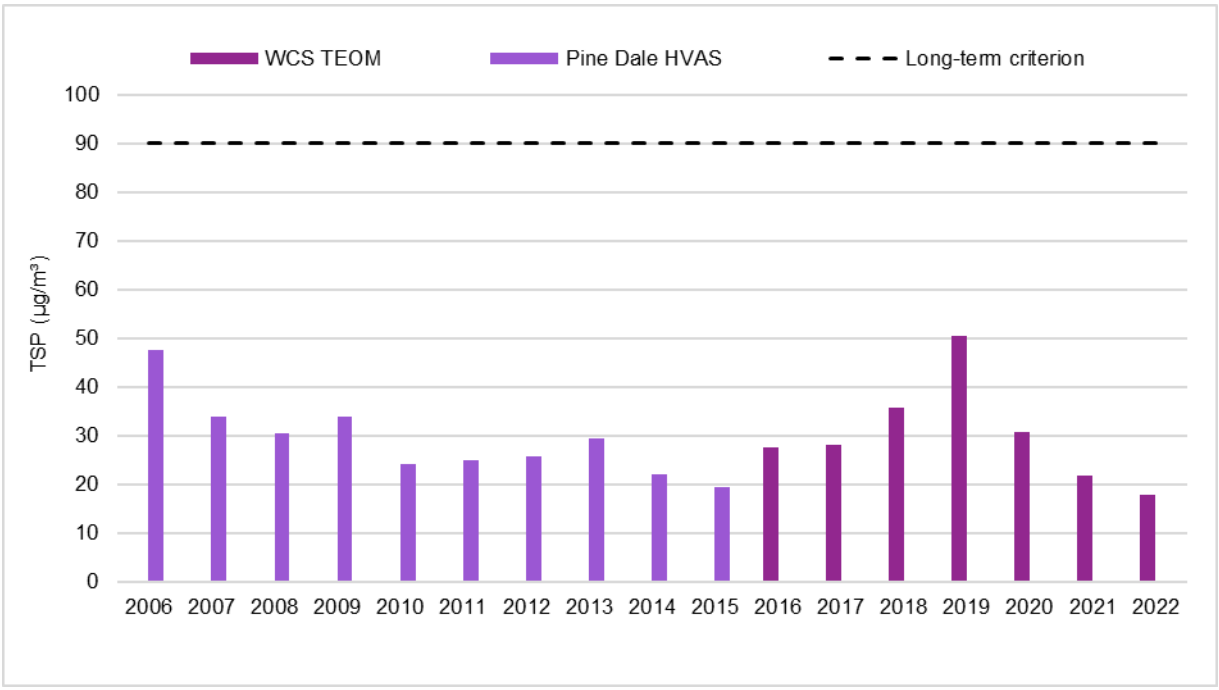


Figure 5A-3: Long Term TSP Annual Averages

APPENDIX 6: BIODIVERSITY

UCRC Aquatic Ecology

Springvale Coal Services and Lidsdale Siding site summaries from 2022 monitoring

Centennial Coal Company Ltd

07 February 2023

→ **The Power of Commitment**



GHD Pty Ltd | ABN 39 008 488 373
GHD Tower, Level 3, 24 Honeysuckle Drive
Newcastle, New South Wales 2300, Australia
T +61 2 4979 9999 | **F** +61 2 9475 0725 | **E** ntlmail@ghd.com | **ghd.com**

Document status

	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	T. Hopwood	Z. Lagerroth		Z. Lagerroth		07/02/2023

© GHD 2023

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Contents

1. Introduction **1**

1.1 Scope and limitations 1

2. Upper Cox River catchment **2**

3. Springvale Coal Services **3**

3.1 Methods 3

3.1.1 Sampling sites 3

3.1.2 Data analysis 3

3.2 Summary of results – Wangcol Creek (LDP1) 4

4. Lidsdale Siding **9**

4.1 Methods 9

4.1.1 Sampling sites 9

4.1.2 Data analysis 9

4.2 Summary of results – Pipers Flat Creek (LDP4) 10

5. References **14**

Table index

Table 3.1 Macroinvertebrate monitoring locations associated with Springvale Coal Services in autumn and spring 2022 3

Table 4.1 Macroinvertebrate monitoring locations associated with Lidsdale Siding in autumn and spring 2022 9

Figure index

Figure 3.1 Taxa richness in Wangcol Creek samples in 2022 5

Figure 3.2 EPT richness in Wangcol Creek samples in 2022 6

Figure 3.3 SIGNAL-2 in Wangcol Creek samples in 2022 6

Figure 3.4 Taxa richness in Coxs River samples associated with Springvale Coal Services in 2022 7

Figure 3.5 EPT richness in Coxs River samples associated with Springvale Coal Services in 2022 7

Figure 3.6 SIGNAL-2 in Coxs River samples associated with Springvale Coal Services in 2022 8

Figure 4.1 Taxa richness in Pipers Flat Creek samples in 2022 11

Figure 4.2 EPT richness in Pipers Flat Creek samples in 2022 11

Figure 4.3 SIGNAL-2 in Pipers Flat Creek samples in 2022 12

Figure 4.4 Taxa richness in Coxs River samples associated with Lidsdale Siding in 2022 12

Figure 4.5 EPT richness in Coxs River samples associated with Lidsdale Siding in 2022 13

Figure 4.6 SIGNAL-2 in Coxs River samples associated with Lidsdale Siding in 2022 13

1. Introduction

This report contains a summary of aquatic ecology monitoring conducted by GHD in 2022 in connection with Springvale Coal Services (SCS) and Lidsdale Siding. As requested, the report outlines the following:

– Monitoring objectives
– Monitoring events completed
– Succinct summary of monitoring results
– Where appropriate, graphical presentation of results

The results of macroinvertebrate sampling conducted in autumn and spring 2022 and presented in this summary report are preliminary only. Results will be interpreted in more detail in the UCR annual report along with water and sediment quality results collected by GHD. While water quality has been used in this report in some cases to assist in the interpretation of macroinvertebrate results, assessment of discharge quality, or compliance with concentration limits, has not been undertaken in this summary report. This more in-depth assessment of water quality is required in order to appreciate the potential impacts from Centennial operations to macroinvertebrates in the Upper Coxs River catchment (UCRC) and will be in the UCRC Aquatic Ecology Monitoring Program (AEMP) 2022 annual report.

1.1 Scope and limitations

This report: has been prepared by GHD for Centennial Coal Company Ltd and may only be used and relied on by Centennial Coal Company Ltd for the purpose agreed between GHD and Centennial Coal Company Ltd as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Centennial Coal Company Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has not been involved in the preparation of the Annual Review and has had no contribution to, or review of the Annual Review other than in this summary report. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the Annual Review.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Upper Cox River catchment

The Upper Coxs River catchment is a highly modified environment due to historical and current primary production and industrial activities.

In 2017, a coordinated, catchment-wide approach for aquatic ecology monitoring was implemented with the aim of understanding the overall health of the Upper Coxs River catchment (UCRC). The monitoring program, known as the UCRC Aquatic Ecology Monitoring Program (AEMP; GHD 2016), addresses the aquatic ecology monitoring requirements of Centennial operations and the Springvale Upper Coxs River Action and Monitoring Program (UCRAMP; 2020).

The UCRC AEMP allows for identification of impacts (positive and negative) within the catchment due to mine water discharge from Centennial operated licensed discharge points (LDPs) on the ecosystem health of waterways in the UCRC (GHD 2016).

3. Springvale Coal Services

3.1 Methods

3.1.1 Sampling sites

Macroinvertebrate samples were collected by GHD during autumn 2022 (18/05/2022-27/05/2022) and spring 2022 (07/11/2022-11/11/2022) at the sites indicated in Table 3.1. Water and sediment quality were tested in conjunction with macroinvertebrate monitoring, the results of which will be provided in the UCRC AEMP 2022 annual report.

Table 3.1 Macroinvertebrate monitoring locations associated with Springvale Coal Services in autumn and spring 2022

Site	Easting MGA 56H	Northing MGA 56H	Description	Site Type	Dates sampled
Wangcol Creek					
WC1	226147	6305131	Located approximately 700 m upstream of SCS LDP1.	Background	24/05/22, 08/11/2022
WC2	226586	6304550	Located approximately 350 m downstream of SCS LDP1.	Impact	24/05/22, 08/11/2022
WC3	228325	6304303	Lower Wangcol Creek downstream of SCS LDP1. 250 m upstream of confluence with the Coxs River.	Impact	24/05/22, 08/11/2022
Coxs River					
CR0	229753	6309404	Upstream of all Centennial LDPs	Background	26/05/22, 07/11/22
CR1	229828	6307311	Upstream of all Centennial LDPs	Background	26/05/22, 09/11/22
CR2	228767	6305326	Located at the Mount Piper Haul Road crossing, approximately 1 km downstream of Angus Place LDP1 (decommissioned). Downstream of Kangaroo Creek and Angus Place LDP2. Upstream of Wangcol Creek and SCS LDP1.	Upstream	24/05/22, 09/11/22
CR3	228471	6303525	Located downstream of Wangcol Creek and SCS LDP1, upstream of Sawyers Swamp Creek confluence.	Impact	25/05/22, 10/11/22
CR6	228512	6297751	Coxs River directly downstream of Lake Wallace, on the downstream side of Rocky Waterhole Drive. Downstream of all Centennial LDPs.	Recovery	18/05/22, 08/11/22
CR7	228926	6292637	Located in the Marrangaroo National Park approximately 5 km downstream of the Lake Wallace dam wall. Downstream of all Centennial LDPs.	Recovery	27/05/22, 11/11/22

3.1.2 Data analysis

The following macroinvertebrate metrics were calculated for the purpose of this summary report:

– **Taxa richness**: the number of different families/groups collected in a sample. This metric provides a measure of macroinvertebrate community diversity.

– **EPT richness**: the number of taxa belonging to the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) families. These groups of macroinvertebrates have been found to be particularly sensitive to changes in their environment (Karr and Chu 1999) and, therefore, can be used to assess impacts due to chemical and physical changes (Plafkin *et al*. 1989).

– **SIGNAL-2 Biotic Index**: pollution sensitivity of the macroinvertebrates collected in a sample, expressed as an average (Chessman 2003). 1 = greatest pollution tolerance, 10 = greatest pollution sensitivity.

Results of macroinvertebrate samples collected from Wangcol Creek sites have been compared to long-term medians calculated from data collected at background sites WCup/WC1 between 2010 and 2021. Results from Coxs River sites have been compared to long-term medians calculated from data collected upstream site CR2 between 2010 and 2021.

Water and sediment quality samples were collected in conjunction with macroinvertebrate samples. Water quality results were compared to the ANZECC (2000) physical and chemical stressor default guideline values (DGVs) for upland waterways and ANZG (2018) toxicant DGVs for 95% species protection. Sediment quality results were compared to the sediment quality DGVs outlined in ANZG (2019). Key exceedances of these DGVs are discussed below in relation to potential impacts to aquatic organisms only. The purpose of this report is not to address compliance with EPL concentration limits.

3.2 Summary of results – Wangcol Creek (LDP1)

In Wangcol Creek, taxa richness results in autumn 2022 were similar between sites, though results at WC3 were variable between replicates (Figure 3.1). In spring 2022, taxa richness results were higher than autumn results at all sites, with results similar at background site WC1 and impact site WC2, and lower at downstream impact site WC3. All taxa richness results in 2022 were equal to or above the WCup/WC1 long-term median except for one replicate from WC3 in autumn.

Similar to taxa richness results, EPT richness was similar at background site WC1 and impact site WC2 and was lower at impact site WC3 in both autumn and spring 2022 (Figure 3.2). Results at all sites were similar between sampling events. All EPT richness results were equal to or higher than the WCup/WC1 long-term median except for one replicate collected from WC3 in spring 2022. Ephemeroptera (mayfly) and Trichoptera (caddisfly) taxa were collected from all sites (but not all replicates) during both sampling events, while Plecoptera (stonefly) taxa were not collected from WC3 in spring.

SIGNAL-2 scores were fairly similar between sites and sampling events in 2022, though scores were slightly higher in spring than autumn except for one replicate from WC2 which was highest in autumn (Figure 3.3). SIGNAL-2 scores ranged from 3.94 to 5.00 (both autumn replicates from WC2), indicating a high degree of within-site variability at WC2 in autumn 2022. All SIGNAL-2 results in 2022 were above the WCup/WC1 long-term median.

Analysis of water quality results from the aquatic ecology monitoring events identified concentrations of several dissolved metals that were sufficiently high to affect aquatic biota (ANZG 2018) at some Wangcol Creek sites. Concentrations of dissolved cobalt, nickel and zinc were elevated above the ANZG (2018) DGVs at both impact sites in both sampling events. At background site WC1, results for cobalt and zinc were below the laboratory limit of reporting in both sampling events. Nickel concentrations exceeded the DGV at WC1 but were much lower than those observed at impact sites. Despite these elevated metals concentrations at impact sites, the pattern in water quality was not reflected in the macroinvertebrate results, which indicated few differences between sites in 2022.

Concentrations of nickel and zinc were also elevated in the sediment of Wangcol Creek sites in 2022. Nickel concentrations were elevated at background site WC1 and impact site WC3, exceeding the GV-high (ANZG 2019) at both sites in autumn and WC3 only in spring, while in spring the nickel concentration at WC1 exceeded the DGV. The GV-high for zinc was also exceeded in both seasons at impact site WC3 only. There were no exceedances for any sediment metal in 2022 at WC2, the impact site immediately downstream of LDP1 discharges. The elevated concentrations of these metals at background site WC1 indicate that there are some influences in the catchment upstream of SCS discharges, though concentrations are higher at sites downstream of SCS. The exceedance of these DGVs at WC1 and WC3 indicates the potential for biological effects (ANZG 2019).

Overall, the results of sensitivity metrics (EPT richness and SIGNAL-2) suggest that the macroinvertebrate communities of WC2, located downstream of LDP1, were generally in a good condition in 2022 compared with historical results and in similar condition background site WC1. There was evidence of some macroinvertebrate community impairment at impact site WC3, which is located approximately two kilometres downstream of LDP1, potentially reflecting the higher concentrations of some aqueous and sediment metals at this site.

There is evidence to suggest that ash within the MPPS Ash Repository influences groundwater quality in the vicinity and that the ash-influenced water is discharged to Wangcol Creek downgradient of the Ash Repository (including in the vicinity of WC1 and WC2). Ash-influenced water likely reports to Cooks Dam, and through this mechanism, discharges from LDP1 may also be influenced by the MPPS Ash Repository. Therefore, it is difficult to accurately determine the influence of SCS operations on the water quality within Wangcol Creek. Analysis of discharge quality and volume of water from LDP1 will be undertaken in the UCRC AEMP 2022 annual report and compared to the results of the 2022 aquatic ecology monitoring to further investigate the potential contribution of SCS discharges to the adverse water / sediment quality or macroinvertebrate impairment observed in Wangcol Creek during 2022 aquatic ecology monitoring. Potential seepage from the Pine Dale mine areas were also observed adjacent to Wangcol Creek at site WC2 in spring 2022. Any impact from this potential seepage will also been assessed in the UCRC AEMP 2022 annual report.

The UCRC AEMP also included a site on the Coxs River upstream (CR2) and downstream (CR3) of the Wangcol Creek confluence. Taxa richness was low at downstream site CR3 compared to upstream site CR2, and well below the CR2 long-term median, though in spring, results were much higher and were similar between sites and higher than the long-term median (Figure 3.4). EPT richness results were also high in spring, with the results at CR3 the equal highest of all sites (Figure 3.5). EPT richness results at CR3 in autumn were lower but were comparable to background and upstream sites. SIGNAL-2 scores at CR3 were higher than those at CR2 in both autumn and spring, with similar results between sampling events and results well above the CR2 long-term median (Figure 3.6). Overall, the macroinvertebrate results for the Coxs River indicated a macroinvertebrate community of similar condition at CR3, downstream of the Wangcol Creek confluence, to the community at CR2, located upstream of the Wangcol creek confluence. This does not suggest a strong influence of SCS LDP1 discharges on the macroinvertebrate community of the Coxs River in 2022.

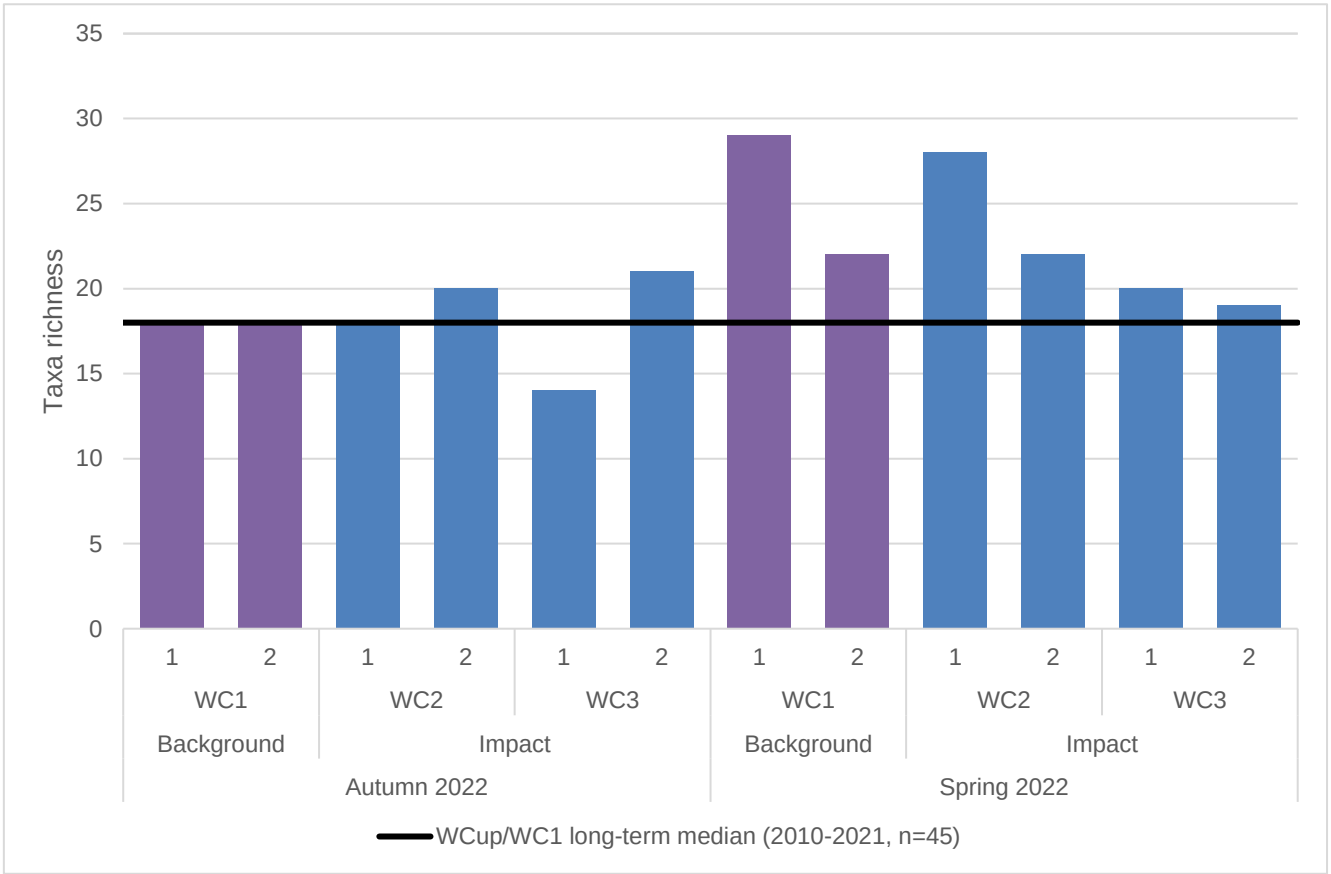


Figure 3.1 Taxa richness in Wangcol Creek samples in 2022

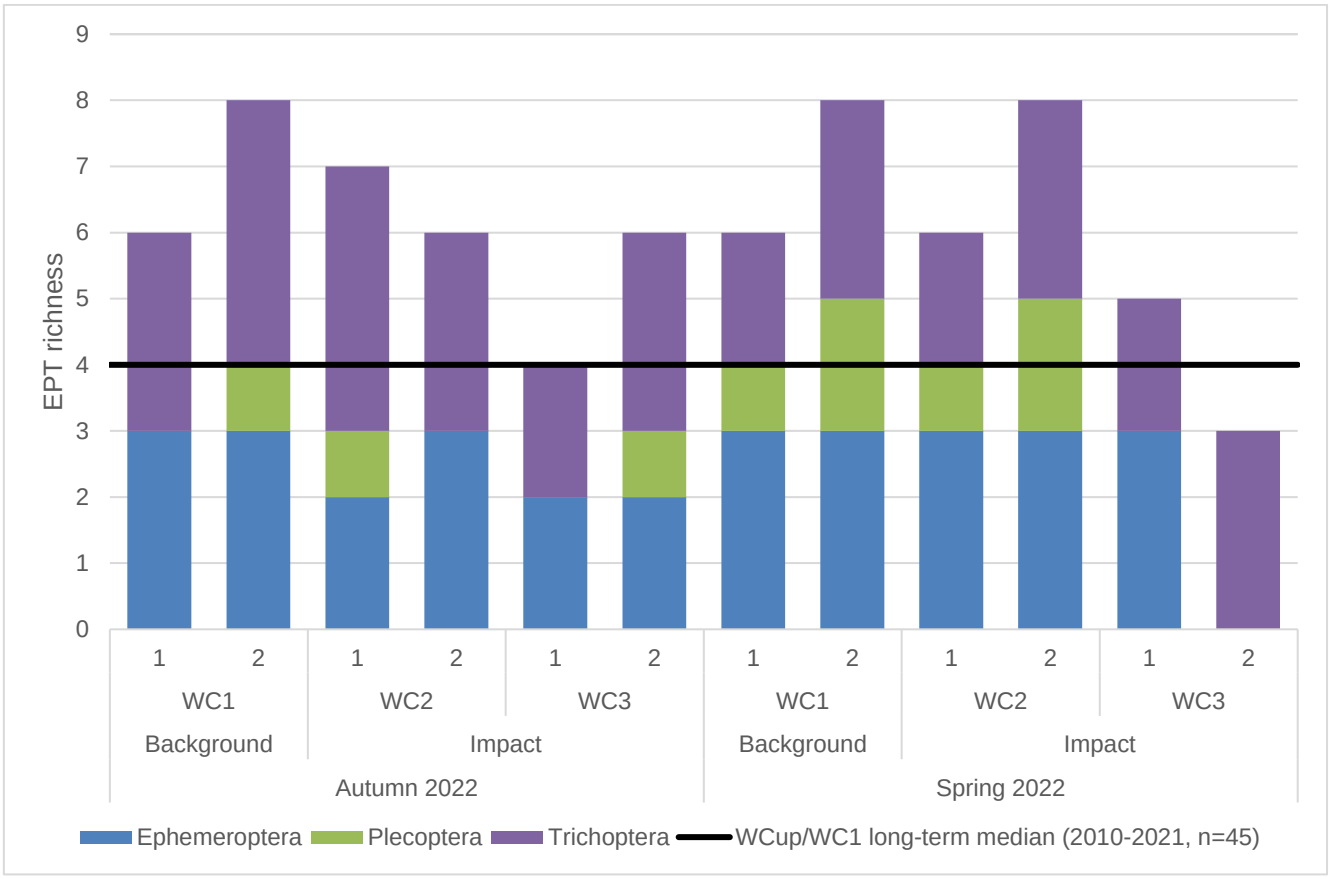


Figure 3.2 EPT richness in Wangcol Creek samples in 2022

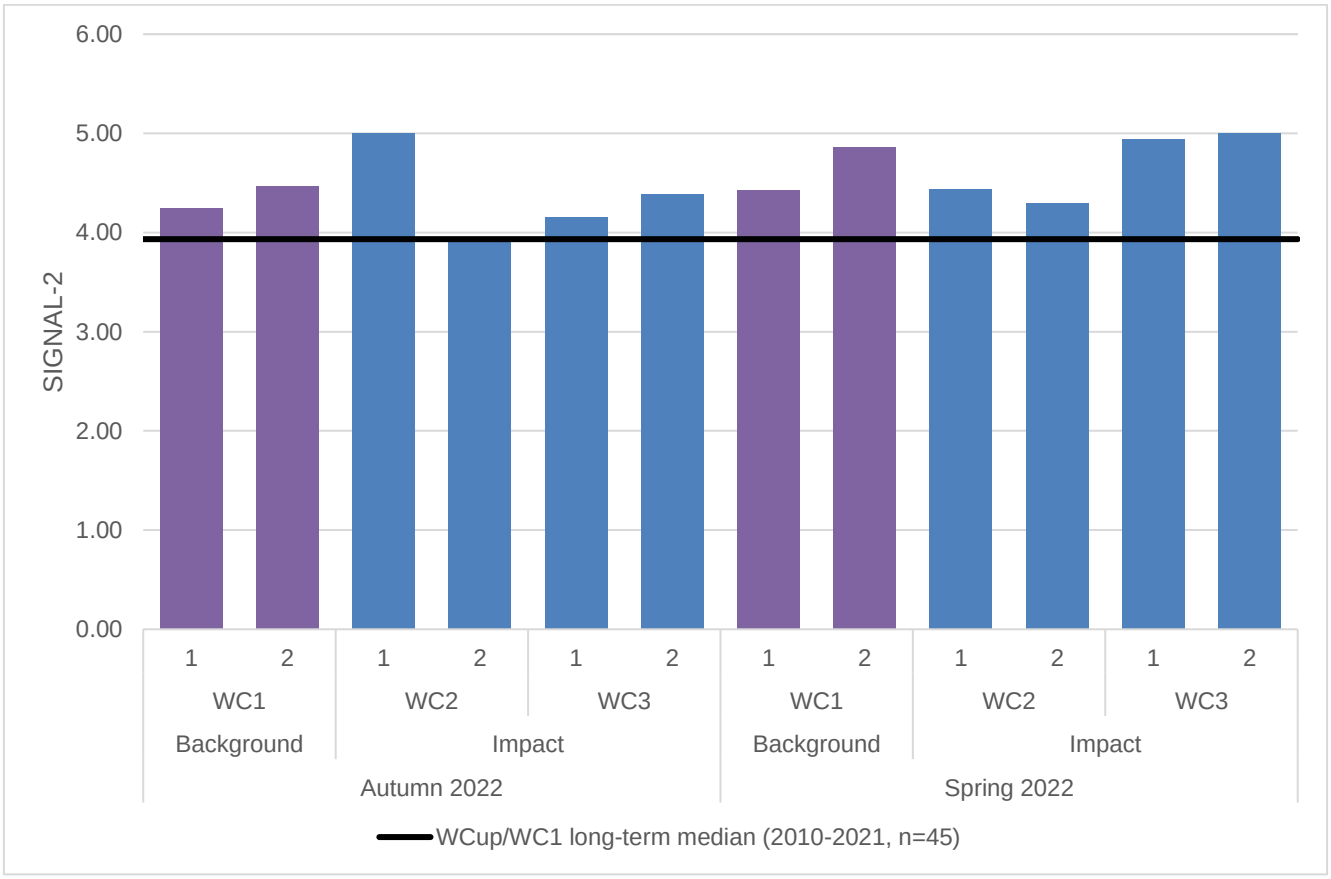


Figure 3.3 SIGNAL-2 in Wangcol Creek samples in 2022

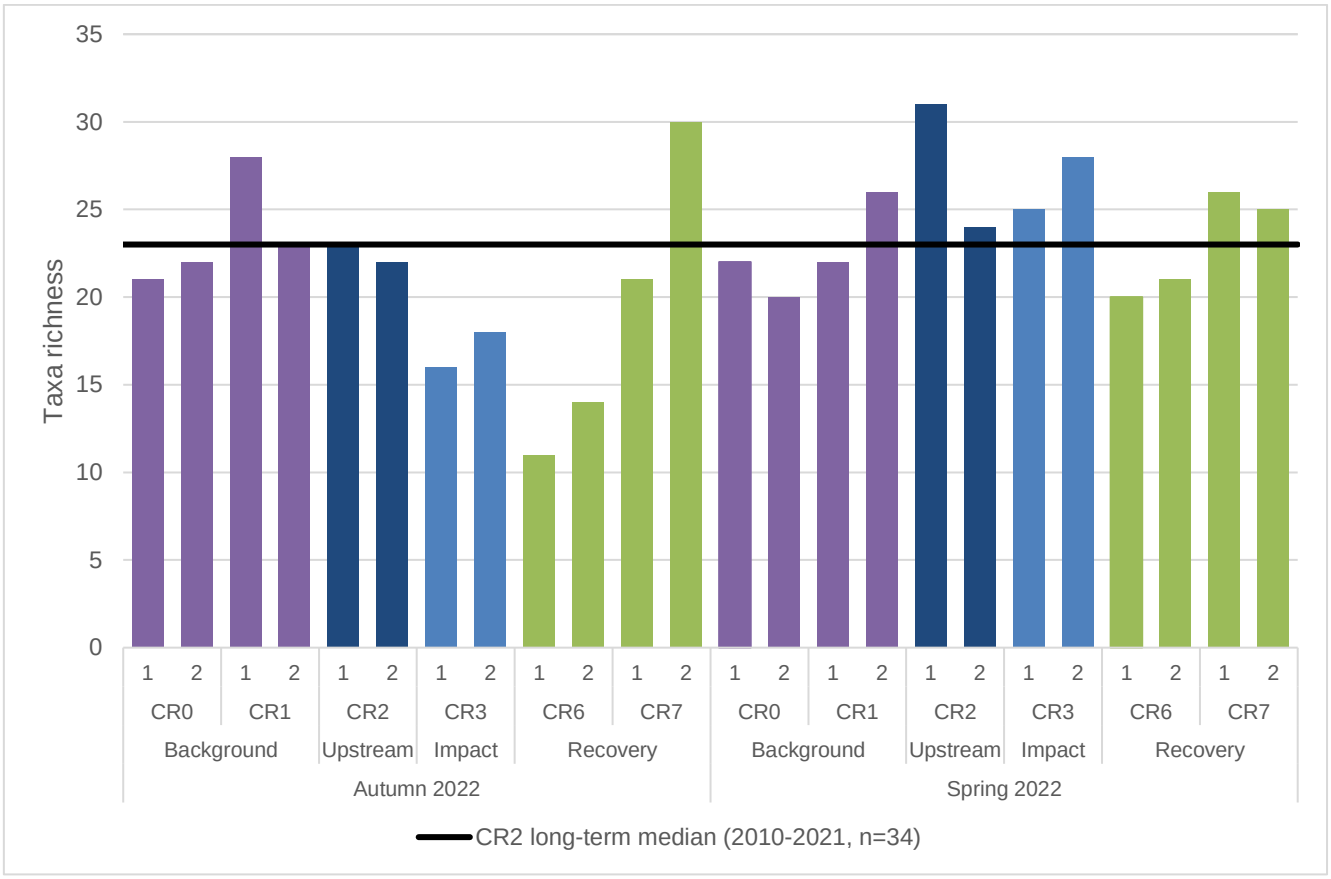


Figure 3.4 ***Taxa richness in Coxs River samples associated with Springvale Coal Services in 2022***

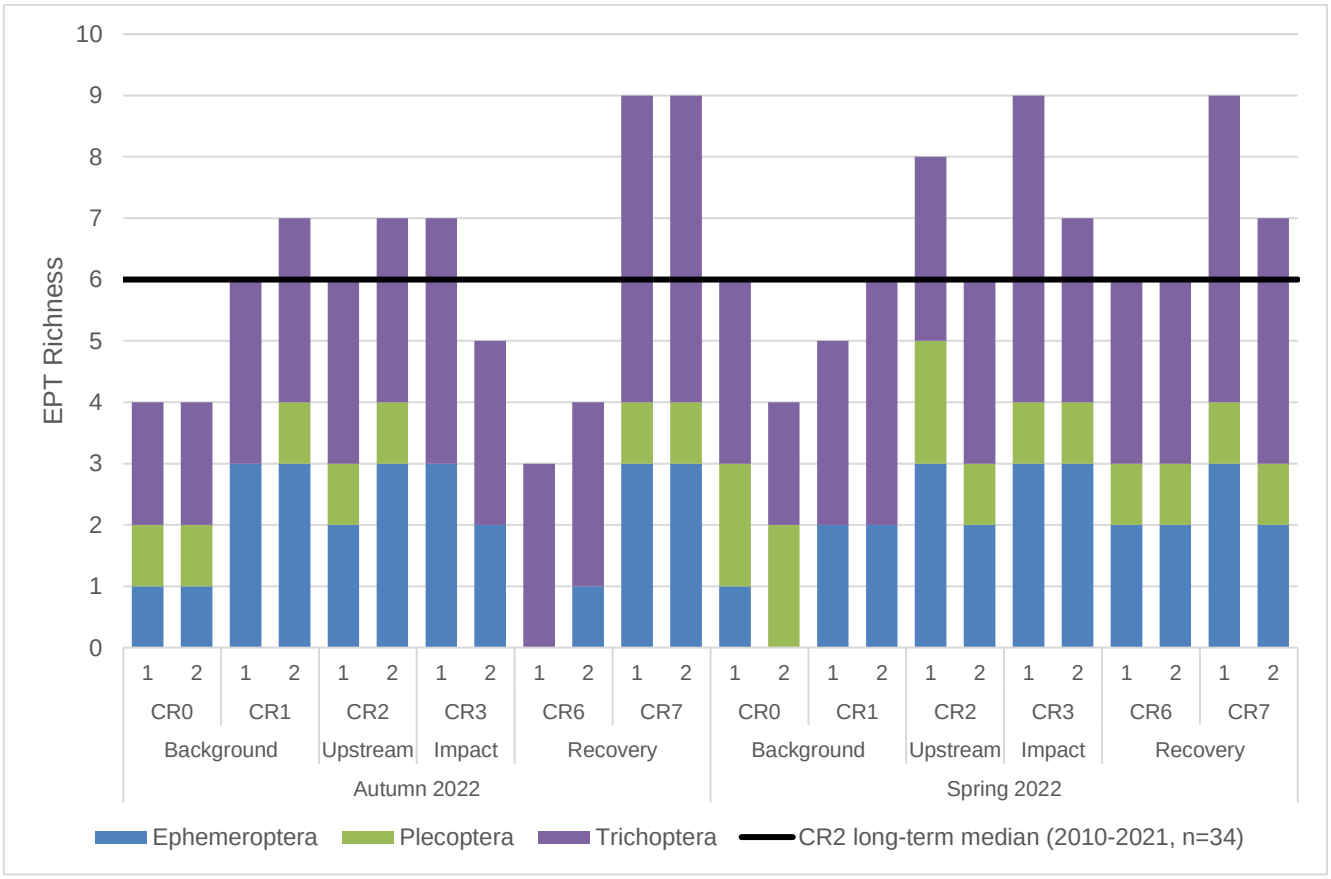


Figure 3.5 ***EPT richness in Coxs River samples associated with Springvale Coal Services in 2022***

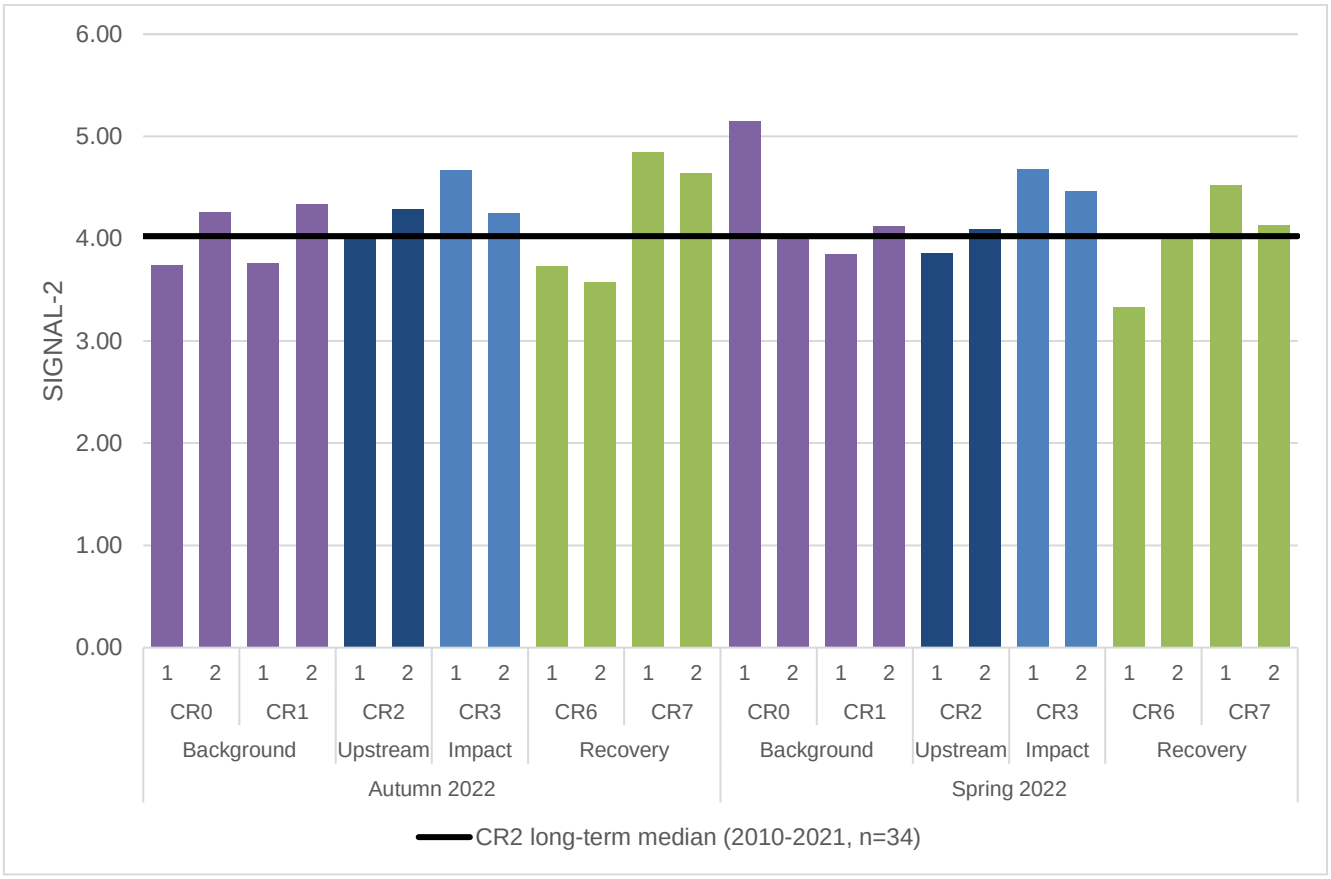


Figure 3.6 SIGNAL-2 in Coxs River samples associated with Springvale Coal Services in 2022

4. Lidsdale Siding

4.1 Methods

4.1.1 Sampling sites

Macroinvertebrate samples were collected by GHD during autumn 2022 (18/05/2022-27/05/2022) and spring 2022 (31/10/2022-11/11/2022) at the sites indicated in Table 4.1. Water and sediment quality were tested in conjunction with macroinvertebrate monitoring, the results of which will be provided in the UCRC AEMP 2022 annual report.

Table 4.1 Macroinvertebrate monitoring locations associated with Lidsdale Siding in autumn and spring 2022

Site	Easting MGA 56H	Northing MGA 56H	Description	Site Type	Dates sampled
Pipers Flat Creek					
PFup	227730	6300755	Located around 650 m upstream of the confluence with the Coxs River.	Background	18/05/22, 31/10/22
PFdn	228172	6300993	Located 90 m upstream of the confluence with Coxs River, where Lidsdale Siding LDP4 discharges into Pipers Flat Creek.	Impact	18/05/22, 31/10/22
Coxs River					
CR0	229753	6309404	Upstream of all Centennial LDPs.	Background	26/05/22, 07/11/22
CR1	229828	6307311	Upstream of all Centennial LDPs.	Background	26/05/22, 09/11/22
CR4	228339	6302781	Located at the Maddox Lane road crossing downstream of Angus Place LDP1 (decommissioned), Springvale LDP7 (inactive) and SCS LDP1, upstream of Lidsdale LDP4.	Upstream	27/05/22, 11/11/22
CR5	228521	6300768	Located at the Main Street road crossing downstream of Angus Place LDP1 (decommissioned), Springvale LDP7 (inactive), SCS LDP1 and Lidsdale LDP4. Upstream of Springvale LDP6.	Impact	18/05/22, 07/11/22
CR6	228512	6297751	Coxs River downstream monitoring site located below Lake Wallace, on the downstream side of Rocky Waterhole Drive. Downstream of all Centennial LDPs.	Recovery	18/05/22, 08/11/22
CR7	228926	6292637	Located in the Marrangaroo National Park approximately 5 km downstream of the Lake Wallace dam wall. Downstream of all Centennial LDPs.	Recovery	27/05/22, 11/11/22

4.1.2 Data analysis

The following macroinvertebrate metrics were calculated for the purpose of this summary report:

– **Taxa richness**: the number of different families/groups collected in a sample. This metric provides a measure of macroinvertebrate community diversity.

– **EPT richness**: the number of taxa belonging to the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) families. These groups of macroinvertebrates have been found to be particularly sensitive to changes in their environment (Karr and Chu 1999) and, therefore, can be used to assess impacts due to chemical and physical changes (Plafkin *et al*. 1989).

– **SIGNAL-2 Biotic Index**: pollution sensitivity of the macroinvertebrates collected in a sample, expressed as an average (Chessman 2003). 1 = greatest pollution tolerance, 10 = greatest pollution sensitivity.

Results of macroinvertebrate samples collected at Pipers Flat Creek sites have been compared to long-term medians calculated from data collected at background site PFup between 2010 and 2021. Results from Coxs River sites have been compared to long-term medians calculated from data collected upstream site CR4 between 2010 and 2021.

Water and sediment quality samples were collected in conjunction with macroinvertebrate samples. Water quality results were compared to the ANZECC (2000) physical and chemical stressor default guideline values (DGVs) for upland waterways and ANZG (2018) toxicant DGVs for 95% species protection. Sediment quality results were compared to the sediment quality DGVs outlined in ANZG (2019). Key exceedances of these DGVs are discussed below in relation to potential impacts to aquatic organisms only. The purpose of this report is not to address compliance with EPL concentration limits.

4.2 Summary of results – Pipers Flat Creek (LDP4)

Taxa richness in Pipers Flat Creek was higher at impact site PFdn than at background site PFup in both 2022 sampling events, and was higher in spring than autumn at both sites (Figure 4.1). All taxa richness results in 2022 were below the PFup long-term median except for both samples collected from PFdn in spring 2022.

EPT richness results were similar between the Pipers Flat Creek sites in both autumn and spring 2022, with EPT richness ranging between five and eight in all samples (Figure 4.2). Plecoptera (stonefly) taxa were collected in all spring 2022 samples but were not found in any sample in autumn 2022. EPT richness results were higher than the long-term PFup median in all samples in 2022.

SIGNAL-2 scores in autumn 2022 were higher at background site PFup than at impact site PFdn, while results in spring 2022 indicated greater difference in SIGNAL-2 scores between replicates than between sites (Figure 4.3). SIGNAL-2 scores were equal to or above the long-term PFup median in all samples, except for one sample at PFdn in autumn 2022, which was slightly below the long-term median.

Water and sediment quality were similar at PFup and PFdn during sampling in autumn and spring 2022. The only exceedances of any water quality toxicant guideline value at Pipers Flat Creek sites in 2022 were dissolved aluminium at both sites (autumn and spring) and dissolved zinc at PFup (spring only). There were no exceedances of any sediment quality DGV at any Pipers Flat Creek site in 2022. Lidsdale Siding LDP4 discharged into Pipers Flat Creek frequently in 2022, including discharge events each month except December 2022 (Centennial 2022). The volume and water quality of these discharges will be assessed and compared to the results of the AEMP in the UCRC AEMP 2022 annual report.

Taxa richness results at Coxs River sites in 2022 were variable between seasons (Figure 4.4). In autumn, taxa richness at impact site CR5 was low compared to background sites CR0 and CR1, and upstream site CR4, and the CR4 long-term median. In spring, taxa richness results at CR5 were much higher, and were similar to results at background and upstream sites. The richness in one replicate in spring was well above the long-term median while the richness in the other replicate was just below the long-term median. EPT richness (Figure 4.5) and SIGNAL-2 results (Figure 4.6) in the Coxs River were similar at sites upstream (CR4) and downstream (CR5) of the Pipers Flat Creek confluence in both autumn and spring, with all results equal to or above long-term medians.

Results of all macroinvertebrate metrics at CR5 were higher than those at Coxs River recovery site CR6 during both sampling events of 2022. Overall, the 2022 aquatic ecology monitoring does not indicate impacts of discharges from Lidsdale Siding on the aquatic ecology of Pipers Flat Creek or the Coxs River.

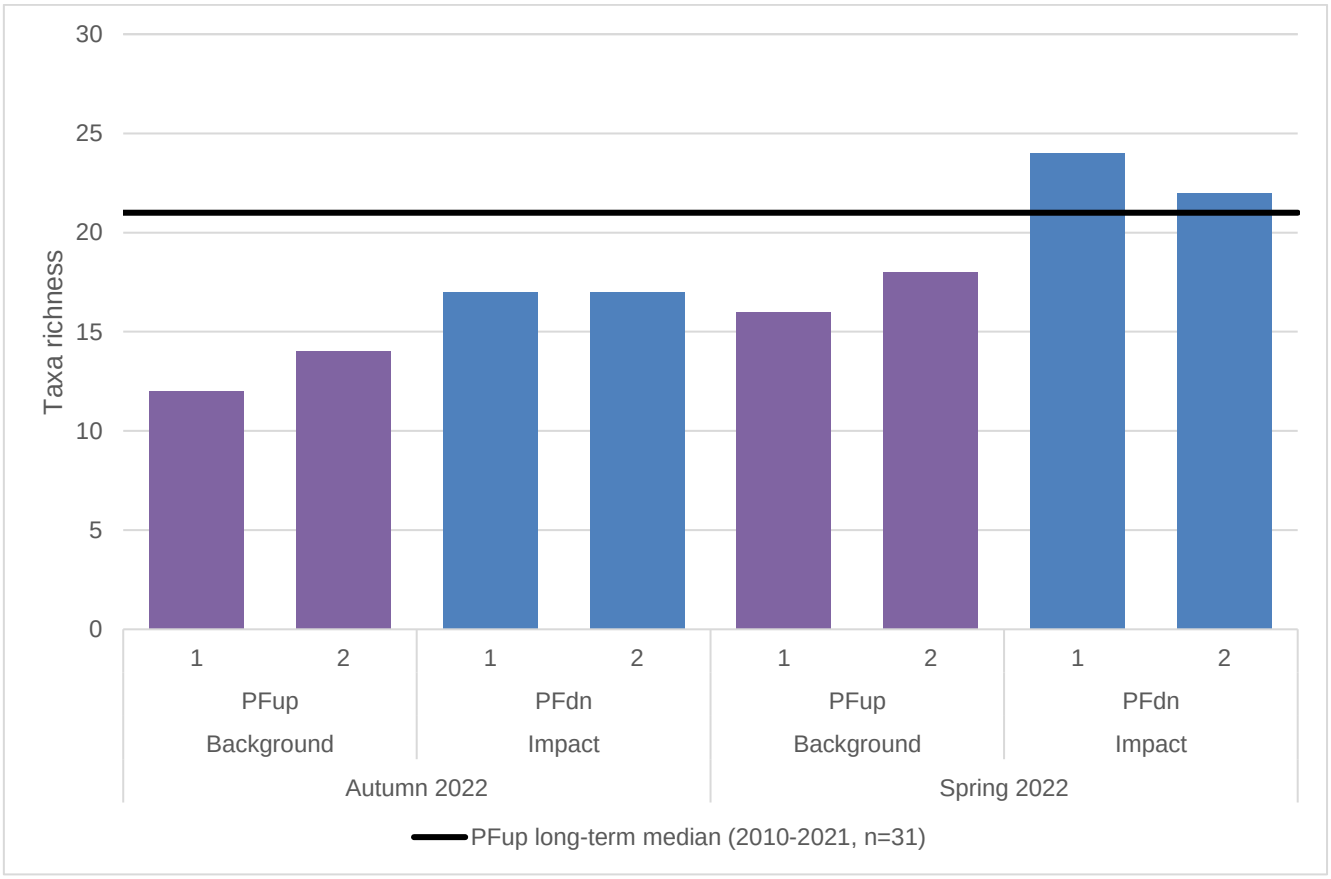


Figure 4.1 ***Taxa richness in Pipers Flat Creek samples in 2022***

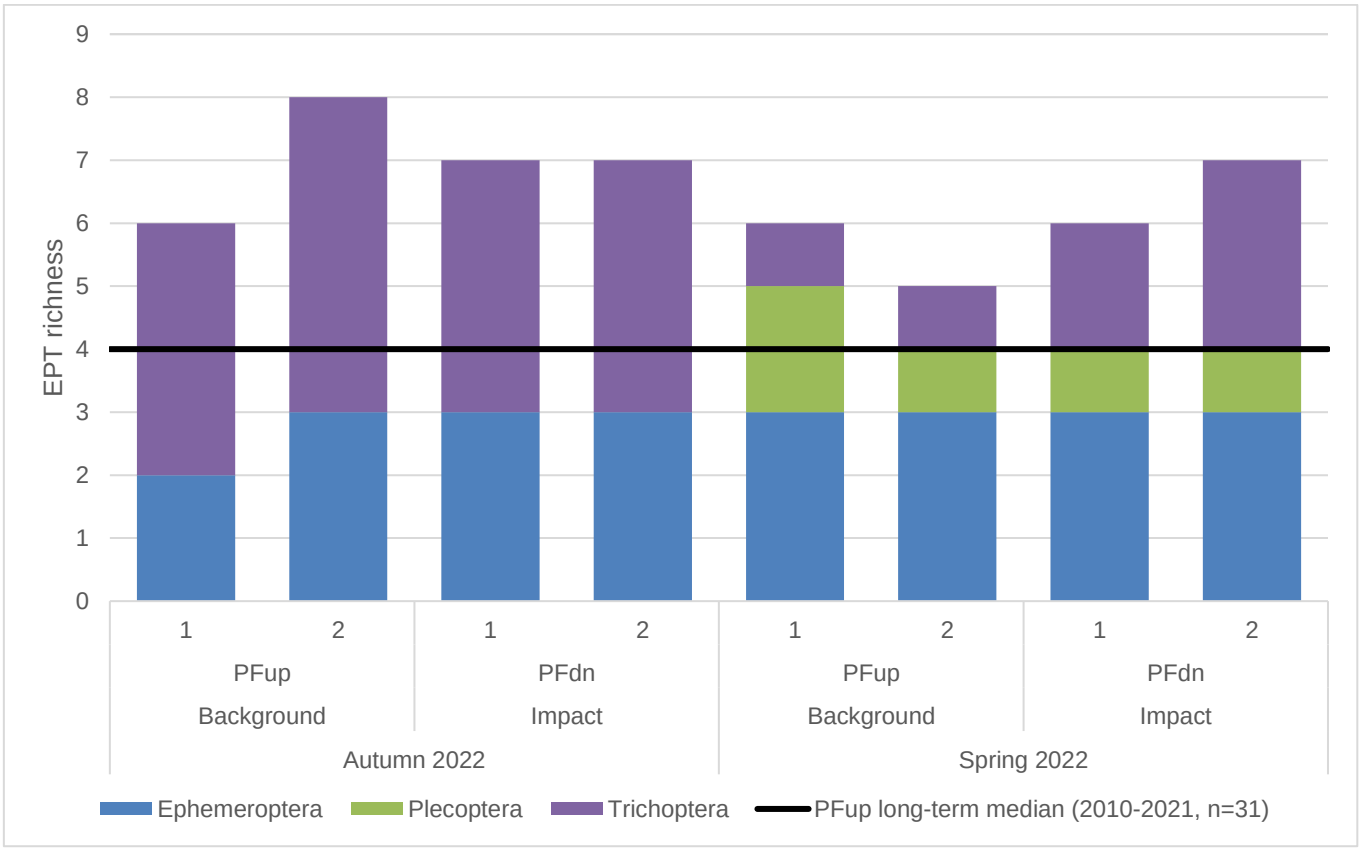


Figure 4.2 ***EPT richness in Pipers Flat Creek samples in 2022***

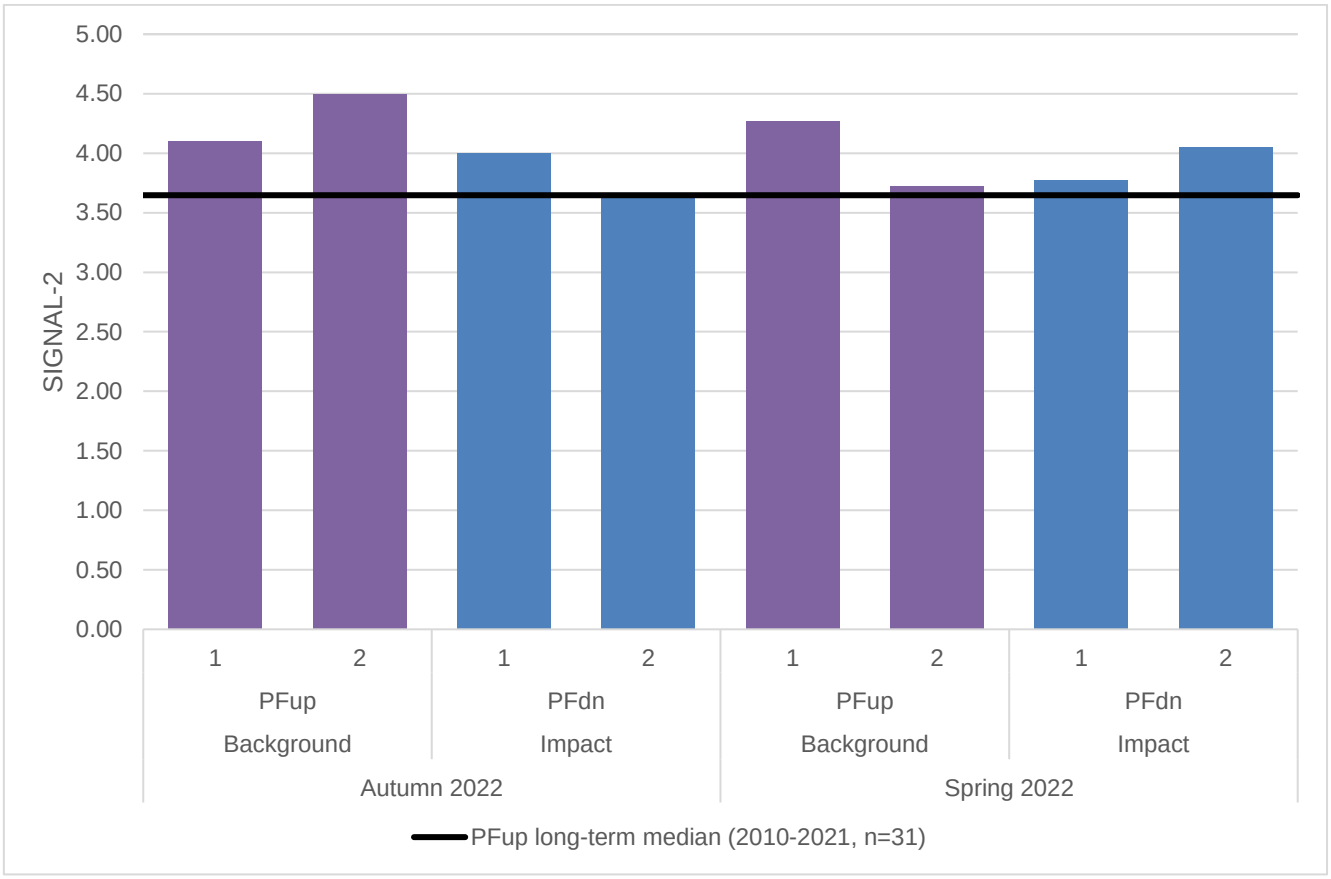


Figure 4.3 SIGNAL-2 in Pipers Flat Creek samples in 2022

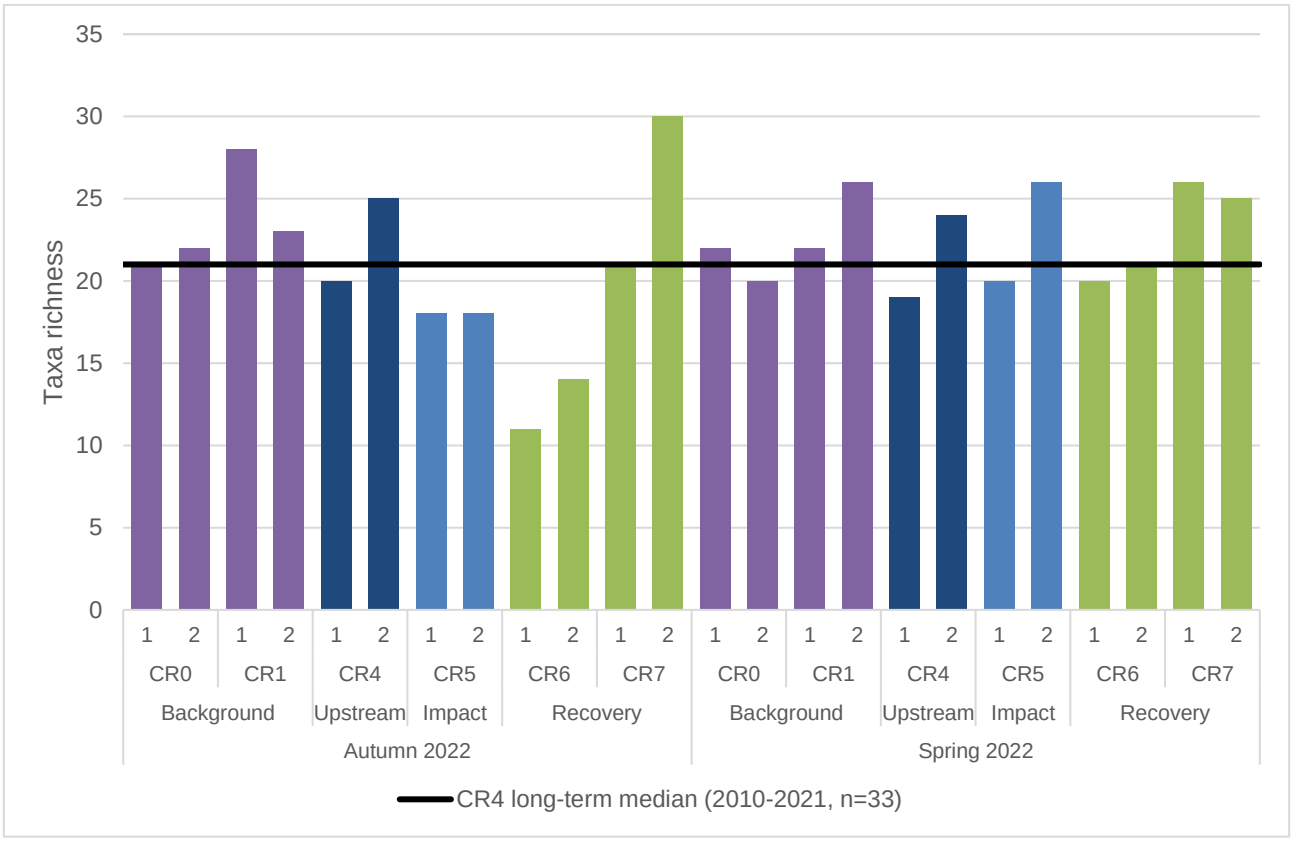


Figure 4.4 Taxa richness in Coxs River samples associated with Lidsdale Siding in 2022

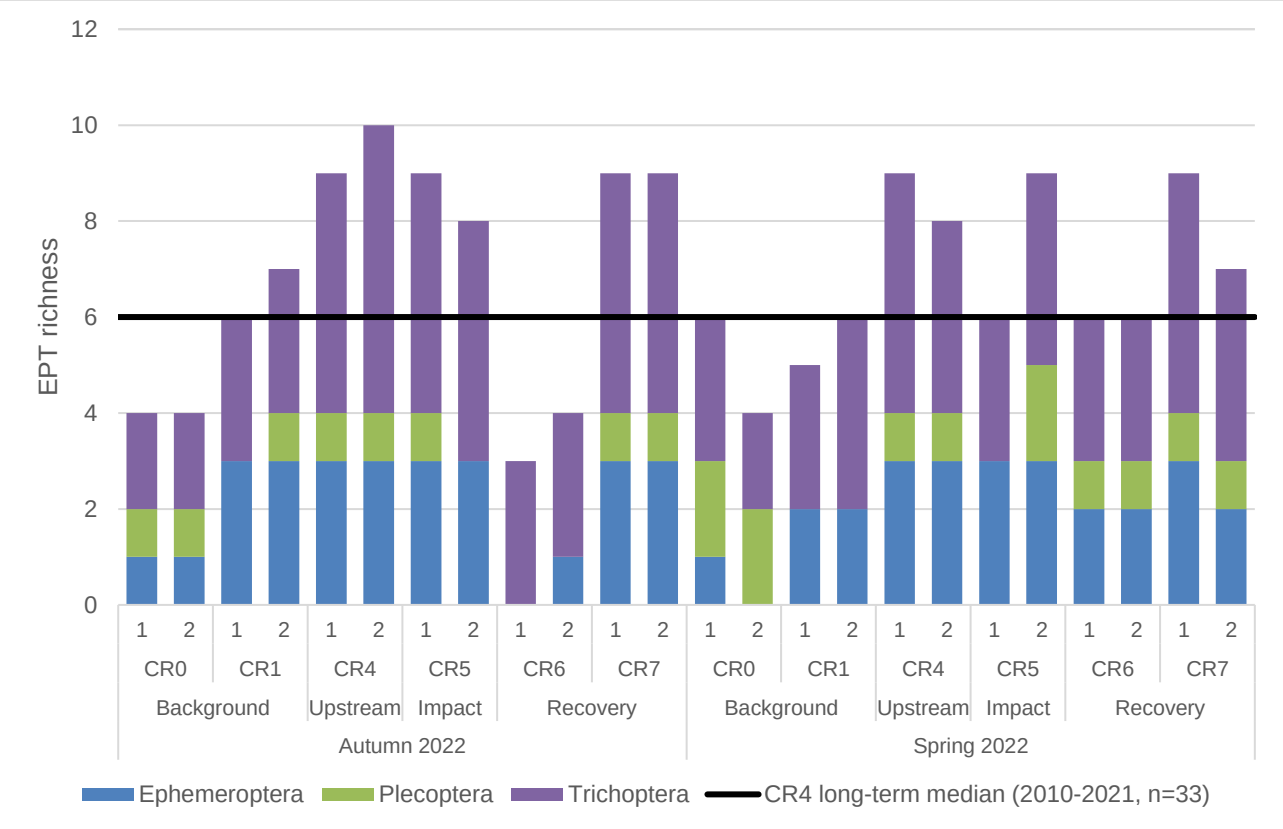


Figure 4.5 EPT richness in Coxs River samples associated with Lidsdale Siding in 2022

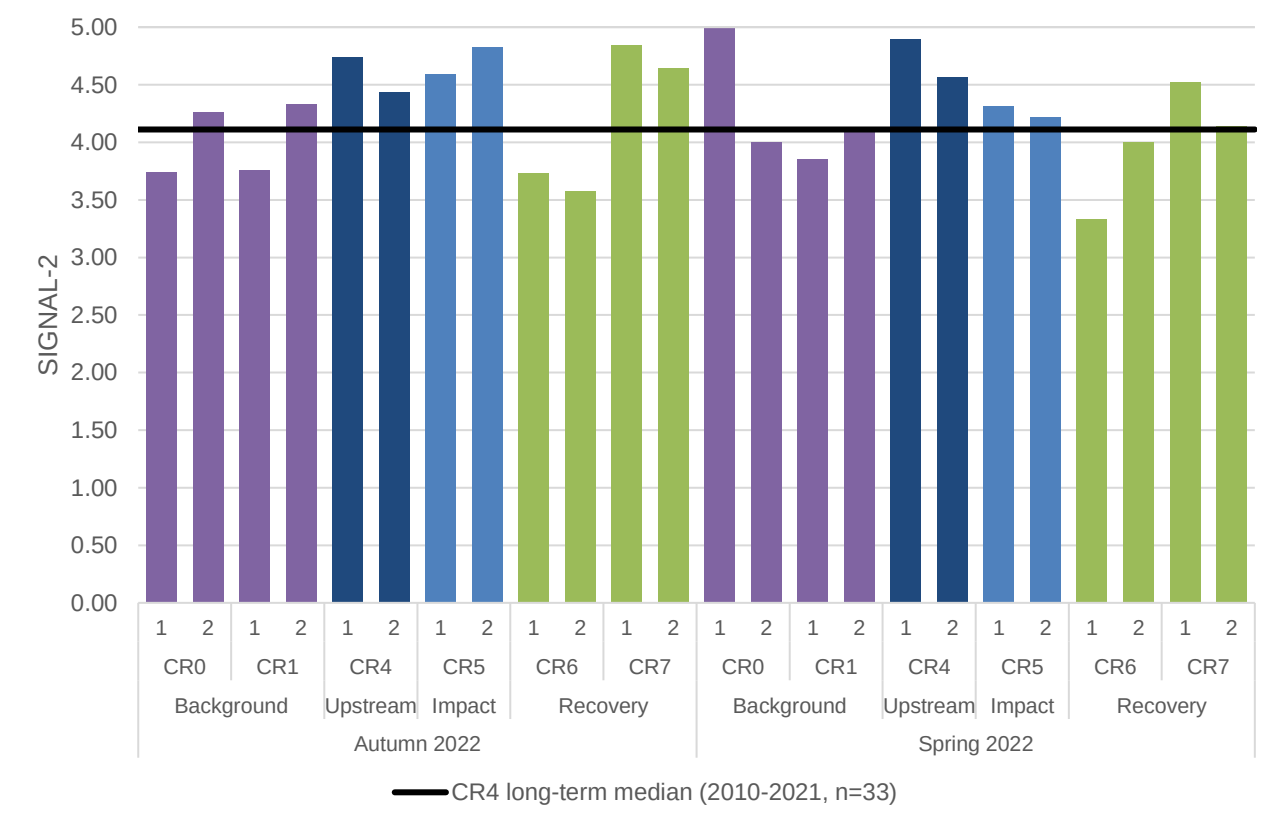


Figure 4.6 SIGNAL-2 in Coxs River samples associated with Lidsdale Siding in 2022

5. References

ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Governments and Australian state and territory governments.

ANZG (2019) *Toxicant default guideline values for sediment quality*, https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/sediment-quality-toxicants.

Centennial (2022) *Lidsdale Siding Monitoring Reports 2022 (Collated).*

Centennial (2020) *Springvale Mine: Upper Coxs River Action and Monitoring Plan*, updated from report prepared by GHD Pty Ltd (2017) for Centennial Coal Company Limited.

Chessman, B (2003) *SIGNAL 2. A scoring system for macroinvertebrate ('water bugs') in Australian rivers, Monitoring River Heath Initiative*, Technical Report no 31, Commonwealth of Australia, Canberra, viewed 26 July 2016 https://www.environment.gov.au/resource/signal-2iv-scoring-system-macroinvertebrates-water-bugs-australian-rivers.

GHD (2016) *Upper Coxs River Catchment Aquatic Ecology Monitoring Program*, prepared by GHD Pty Ltd for Centennial Coal Pty Ltd.

Karr, JR, Chu, EW (1999) *Restoring life in running waters: Better biological monitoring*, Island Press, Washington, D.C.

Plafkin, JL, Barbour, MT, Porter, KD, Gross, SK, Hughes, RM (1989) *Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish*, United States Environmental Protection Agency, Washington.

ghd.com

The Power of Commitment

APPENDIX 7: WASTE

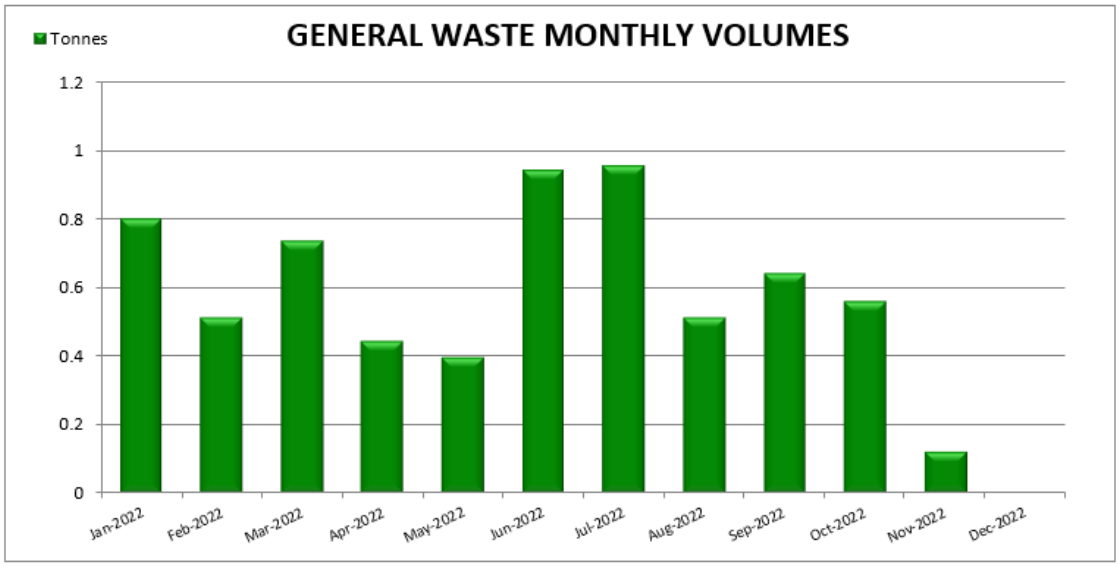


Figure 7A-1: WCS General Waste 2022

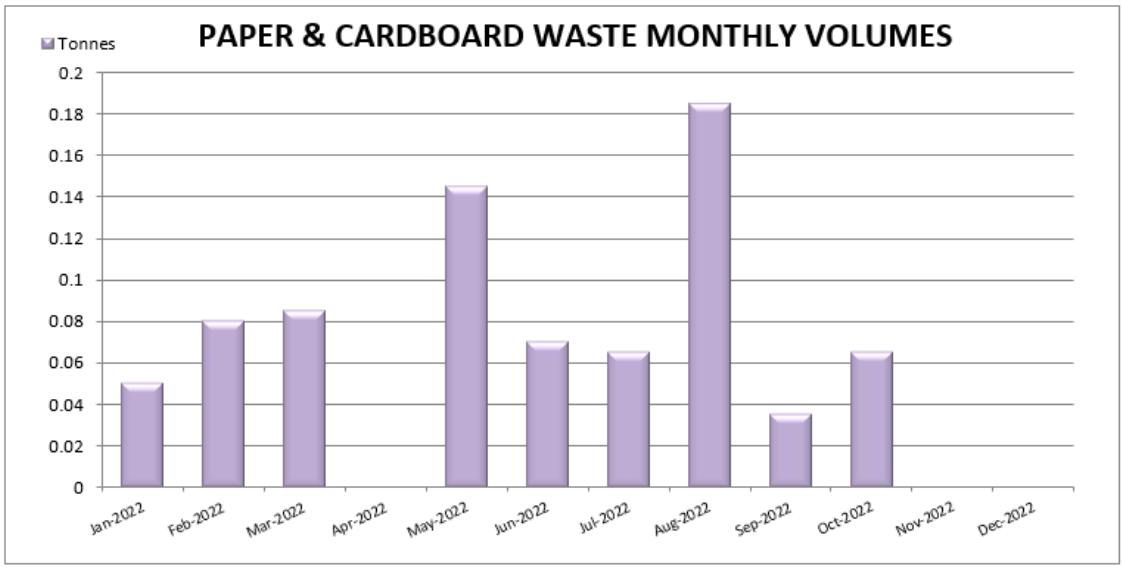


Figure 7A-2: WCS Paper & Cardboard 2022



Figure 7A-3: WCS Total Waste Volumes 2022

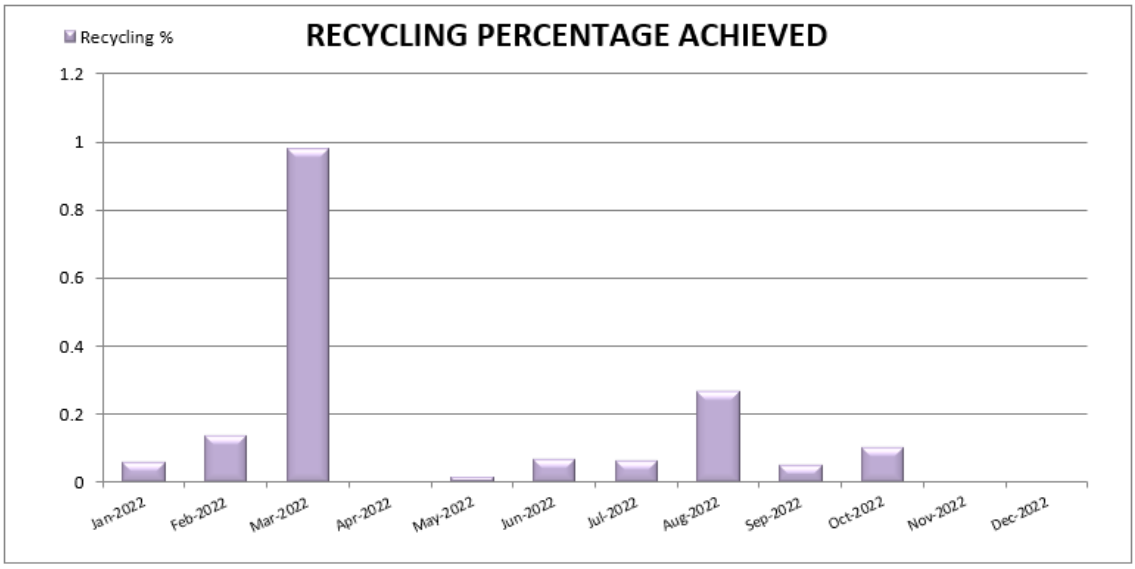


Figure 7A-4: WCS Recycling Percentage 2022

Table 7A-1: 2011-2022 Waste Quantities

	Hazardous Recycled				Non-hazardous Recycled		Hazardous Disposed	Non-hazardous Disposed	Totals		
	Waste oil (kL)	Oily water (kL)	Oil filters (Tonne)	Effluent (kL)	Paper & cardboard (Tonne)	Scrap steel (Tonne)	Oily rags / absorbents (Tonne)	Mixed solid waste (Tonne)	Total waste (Tonne)	Recycled waste (Tonne)	Percent recycled (%)
2011	-	-	-	-	0.73	-	-	2.55	3.28	0.73	22%
2012	1.50	-	-	-	2.90	-	-	6.61	11.01	4.40	40%
2013	-	-	-	-	2.12	-	-	6.85	8.97	2.12	24%
2014	-	-	-	-	1.79	-	-	15.51	17.30	1.79	10%
2015	-	0.62	-	-	2.17	-	-	36.72	39.51	2.79	7%
2016	-	-	-	-	2.12	-	-	20.14	22.26	2.12	10%
2017	1.45	-	-	-	1.96	-	-	12.11	15.51	3.41	22%
2018	1.10	-	-	-	1.96	-	-	18.91	21.96	3.06	14%
2019	0.70	-	-	-	1.72	-	-	5.65	8.07	2.42	30%
2020	1.80	-	-	-	0.90	-	-	8.88	11.58	2.70	23%
2021	-	-	-	-	0.405	-	-	6.345	6.75	0.405	6%
2022	-	-	-	-	0.855	36.920	-	7.325	53.980	37.775	69.98%

APPENDIX 8: WATER



Western Coal Services

Annual Water Report 2022

Springvale Coal Pty Limited

27 March 2023

The Power of Commitment

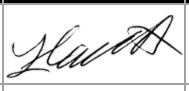
GHD Pty Ltd | ABN 39 008 488 373

66 Lord Street, Suite 7A

Port Macquarie, New South Wales 2444, Australia

T +61 2 6586 8700 | **F** +61 2 9475 0725 | **E** pqqmail@ghd.com | **ghd.com**

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	B Foster K Tyler	Z Lagerroth		Z Lagerroth		27/03/2023

© GHD 2023

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Contents

1. Introduction **1**
1.1 Purpose of this report 1
1.2 Scope of work 1
1.3 Limitations 1
2. Climate **2**
3. Groundwater **3**
3.1 Access 5
3.2 Condition review 6
3.3 Groundwater level 8
3.3.1 BH02 10
3.3.2 BH05 11
3.3.3 BH06 11
3.3.4 BH08 12
3.4 Groundwater quality 13
3.5 SSGV assessment 18
3.5.1 Level 18
3.5.2 Quality 21
4. Surface water **28**
4.1 Discharge flow 31
4.2 Water quality 31
4.2.1 Discharge 31
4.2.2 Onsite surface water storages 33
4.2.3 Wangcol Creek 38
4.2.4 SWTP residuals 43
5. Conclusions and recommendations **1**
5.1 Conclusions 1
5.1.1 Groundwater 1
5.1.2 Surface water 2
5.2 Recommendations 3
5.2.1 Access to groundwater bores 3
5.2.2 Flow / discharge events and water quality 3
5.2.3 Bore investigations 3
5.2.4 Data quality 4
6. References **5**

Table index

Table 3.1	Groundwater well details	3
Table 3.2	Access conditions for monitoring bores	5
Table 3.3	2022 groundwater well condition review	6
Table 3.4	Groundwater level observation, 2022	8
Table 3.5	Groundwater quality monitoring program	13
Table 3.6	Groundwater quality trends in reporting period	14
Table 3.7	Groundwater level triggers in 2022 reporting period	19
Table 3.8	Groundwater quality in 2022 SSGV Assessment	22
Table 4.1	Surface water monitoring locations	28
Table 4.2	LDP001 2022 flows	31
Table 4.3	LDP002 water quality results – 7 March 2022	33
Table 4.4	Wangcol Creek Far DS Trigger Events, 2022	41
Table 4.5	REA Decant - Trigger Events 2022	44
Table 5.1	Summary of groundwater review	1
Table 5.2	Summary of surface water review	2

Figure index

Figure 2.1	Historical average rainfall at Western Coal Services	2
Figure 3.1	Groundwater Monitoring Network	4
Figure 3.2	BH02 groundwater level	10
Figure 3.3	BH05 groundwater level	11
Figure 3.4	BH06 groundwater levels	12
Figure 3.5	BH08 groundwater level	13
Figure 4.1	Surface water monitoring locations	30
Figure 4.2	2022 LDP001 flow summary	31

Appendices

Appendix A	Water quality graphs
Appendix B	Groundwater level graphs
Appendix C	Site specific guideline values

1. Introduction

1.1 Purpose of this report

This report is a summary review of surface water and groundwater data obtained from the Western Coal Services (WCS) site monitoring network for the annual reporting period and is presented to Springvale Coal Services Operation (SCSO). Monitoring data have been reviewed against trigger values and Site Specific Guideline Values (SSGVs) outlined in the Western Coal Services Water Management Plan (WMP) and subsequent draft revisions (GHD, 2022a) not yet approved.

1.2 Scope of work

The scope of work for this report is to:

- Summarise the groundwater logger system observations and maintenance.
- Collate surface water quality, and groundwater quality and level data into one central spreadsheet.
- Compare data to 'triggers' sourced from the WMP for each site and identify results which have triggered the requirement for further investigation.
- Provide a discussion point on the potential cause for the trigger event.
- Flag trigger events that require further investigation into the source or causation.
- Refer to the WMP Trigger Action Response Plans (TARPs) to inform SCSO of their responsibility for action and notification under the Pollution Incident Response Management Plan (PIRMP) as required.
- Provide recommendations for any further investigations, if required.

1.3 Limitations

This report: has been prepared by GHD for Springvale Coal Pty Limited and may only be used and relied on by Springvale Coal Pty Limited for the purpose agreed between GHD and Springvale Coal Pty Limited as set out in Section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Springvale Coal Pty Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by Springvale Coal Pty Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Climate

Monthly rainfall data were obtained from the Scientific Information for Land Owners (SILO) database operated by the Queensland Government - Department of Science, Information Technology and Innovation (DSITI, 2022). SILO Patched Point Data is based on historical data from a particular Bureau of Meteorology (BoM) station with missing data 'patched in' by interpolating with data from nearby stations.

For this assessment, SILO data were obtained from the Lidsdale (Maddox Lane) station (station number 63132), which is located approximately 2 km north of Lidsdale Siding (LS). This station was chosen based on the length and quality of the data record and proximity to the site. The previous 11 years of data are presented in Figure 2.1 as a cumulative rainfall departure (CRD) curve.

A CRD curve presents the cumulative difference between the observed monthly rainfall and long-term average monthly rainfall of this dataset. The CRD curve only deviates from zero due to atypical (above and below average) rainfall. Increase in the CRD curve reflects above average rainfall while a decrease reflects below average rainfall.

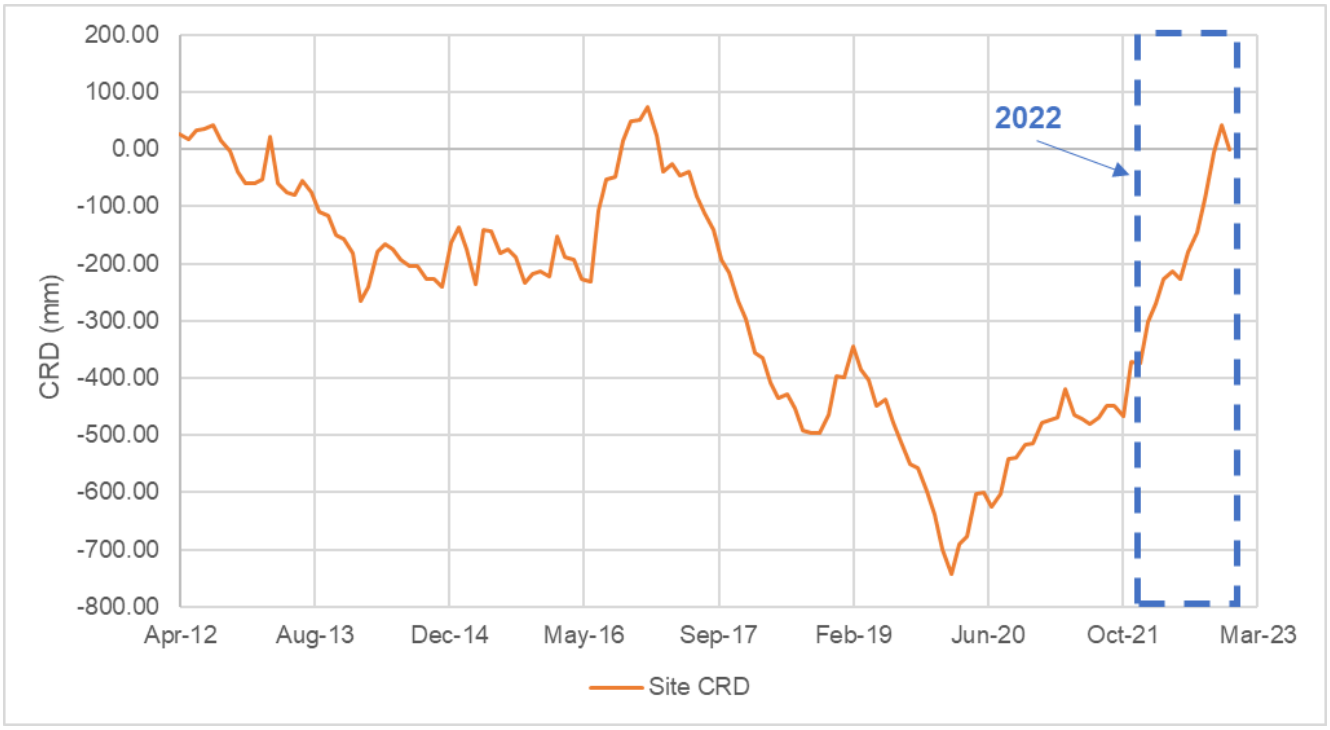


Figure 2.1 Historical average rainfall at Western Coal Services

From viewing Figure 2.1, WCS has experienced above average rainfall in 2022, continuing from similar rainfall conditions in 2020 and 2021. Such conditions have influence on surface water quality in Wangcol Creek (section 4.2.3), site discharge flow (section 4.1), and groundwater level (section 3.3).

3. Groundwater

The groundwater monitoring program at WCS includes manual sampling of groundwater bores for water level and water quality, and automated groundwater level logging through dataloggers placed in select wells. Monitoring location details are provided in Table 3.1, with locations shown in Figure 3.1. Manual groundwater levels are recorded fortnightly. Table 3.5 summarises the location, frequency and parameters of groundwater quality monitoring.

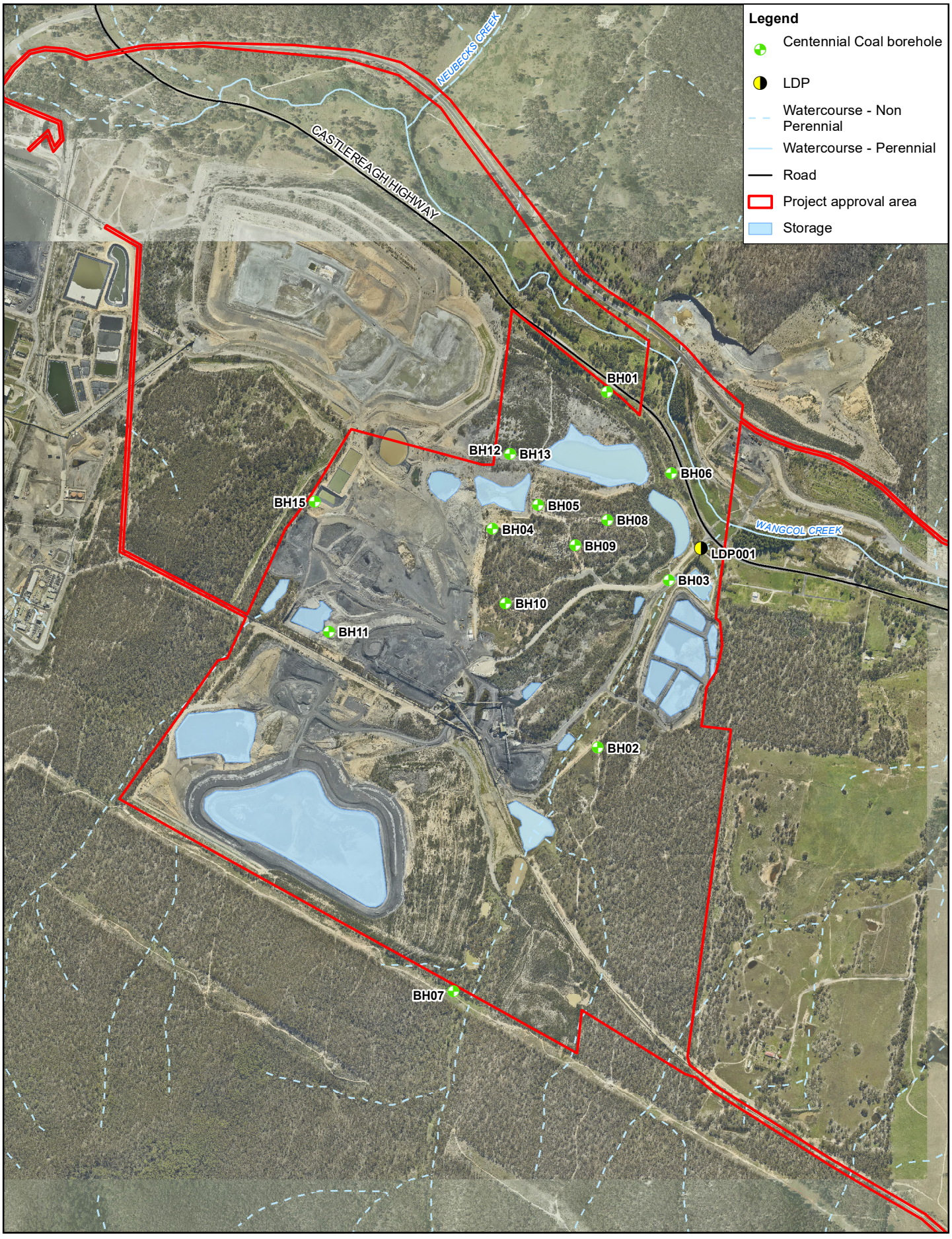
Loggers are installed in monitoring bores, BH03, BH07, BH08, BH13 as of December 2022. Groundwater levels and electrical conductivity (EC) are collected automatically at these bores and recorded every hour.

Table 3.1 Groundwater well details

Location	Coordinates (UTM zone 56H)	Collar RL (m AHD)	Description	Target aquifer
Western Coal Services				
BH01	225978E, 6305017S	912.96	Monitoring well between DML Dam and Wangcol Creek	Lithgow Seam (unmined)
BH02	225944E, 6303877S	916.87	Clean water quality upgradient of WCS mining operations	Marrangaroo Formation/Berry Siltstone
BH03*	226204E, 6304409S	906.02	Monitoring well between co-disposal ponds and Final Polishing Lagoon	Saturated overburden
BH04	225611E, 6304579S	930.68	Monitoring well on southwest corner of Lithgow City Council Pit	Lithgow Seam workings (void)
BH05	225757E, 6304656S	929.56	Monitoring well on east of Lithgow City Council Pit	Lithgow Seam (unmined pillar)
BH06	226234E, 6304651S	906.30	Site boundary water quality	Lithgow Seam
BH07*	225485E, 6303099S	925.09	Monitoring well on southern corner boundary. Upgradient of WCS in Lamberts Gully	Up-gradient saturated overburden
BH08*	225978E, 6304607S	928.23	Monitoring well upgradient of Cooks Dam in rehabilitation area	Lithgow Seam workings (void)
BH09	225876E, 6304526S	930.68	Historical underground mine groundwater	Lithgow Seam (void)
BH10	225653E, 6304342S	937.27	Lamberts Gully Open Cut	Lithgow Seam (void)
BH12	225669E, 6304820S	917.57	Western Main Open Cut	Marangaroo Formation
BH13*	225666E, 6304819S	917.6	Monitoring well between Mount Piper Power Station ash dam and DML Dam	General (paired site)
BH15	225033E, 6304574S	939.63	Huon Gully water quality	Up-gradient overburden

* Denotes a groundwater logger is installed in the monitoring well

m AHD metres Australian Height Datum



Paper Size ISO A4

0 0.075 0.15 0.3 0.45 0.6

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Western Coal Services
Water Report

Groundwater Monitoring Locations

Project No. **12571700**
Revision No. **0**
Date **15/03/2023**

Figure 3.1

\\ghdnet\ghd\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\WesternCoal\12571700\12571700_WR003_23_GWMonitoringNetwork_0.mxd Data source: Imagery - Centennial Coal, 2020; Roads, Watercourses - LPI, 2012; Created by: pfernandes

Whilst every care has been taken to generate this figure, GHD makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of this figure being inaccurate, incomplete or unsuitable in any way and for any reason.

3.1 Access

Access to boreholes during the annual monitoring period was varied due to increased average rainfall in the area, causing poor driving conditions. Some boreholes were accessed via walking when the tracks were un-drivable by car. Some boreholes did not have data collected for some quarterly monitoring rounds due to wet weather, although the data available were downloaded in Q1 2023 and are included in this annual report.

Table 3.2 shows instances where access to boreholes was difficult, or not possible due to restricting conditions.

Table 3.2 Access conditions for monitoring bores

Site access tracks	Reporting Period	Description
BH01	Q1	– BH01 was not accessed during the monitoring round as there was no logger in place.
	Q2	– Access to BH01 and BH13 was not possible during the June 2022 site visit due to access restrictions by the neighbouring power station. – A spoil bund constructed at the northern extent of the stockpile area made it impassable for vehicles to access these bores.
	Q3	– Access was only possible on foot to all monitoring locations due to wet weather
	Q4	– BH01 was not accessed during the monitoring round as there was no logger in place
BH04 BH05 BH08	Q1	– The access tracks leading to monitoring bores in the rehabilitation area (BH04, BH05 and BH08) were boggy with some ponding surface water due to the wet conditions preceding the site visit, making tracks impassable in a vehicle. BH05 and BH08 were accessed by foot from parking the vehicle near BH04. It is expected vehicle access will be possible in drier conditions however vehicular disturbance may have caused these boggy areas and may be worsened in future site visits. Emplacement of clean rock would improve the stability of the tracks in these boggy sections and hence improve access.
	Q2	– As above
	Q3	– As above
	Q4	– As above
BH07	Q1	– The powerline easement track leading to BH07 was increasingly difficult to drive with large ruts and steep angles. Discussions or an enquiry with the party responsible for easement track management (possibly TransGrid) could be instigated to upgrade the track for suitable access.
	Q2	– The track to BH07 was boggy and almost undriveable. In June during the site visit, a tree was down across the track which required moving. – The powerline easement track was increasingly difficult with large ruts and steep angles making four wheel driving difficult. Discussions or an enquiry with the party responsible for easement track management could be instigated to upgrade the track for suitable access.
	Q3	– As above
	Q4	– As above
BH13	Q1	– Access maintained
	Q2	– Access to BH01 and BH13 was not possible during the June 2022 site visit due to access restrictions by the neighbouring power station. – A spoil bund constructed at the northern extent of the stockpile area made it impassable for vehicles to access these bores.
	Q3	– Access was restored
	Q4	– Access maintained

3.2 Condition review

Following recommendations in the Q1 2022 Water Report (GHD, 2022b), all LevelSender telemetry equipment was removed from the groundwater monitoring wells. Groundwater monitoring loggers, which sit near the bottom of each well were kept in place and continued to be downloaded in subsequent site visits by GHD personnel. A condition review of each well during the 2022 annual reporting period, undertaken by GHD, is presented in Table 3.3.

Table 3.3 2022 groundwater well condition review

Monitoring location	Monitoring Round	Condition review and on-site action	Further action
BH01	Q1	– All logger equipment intact with the aerial connected. – Unable to download logger files, likely due to a malfunction in the optical eyes of the logger. Logger retrieved from site to perform diagnostics. Unable to solve download issue with diagnostics.	– Unable to solve download issue with diagnostics. Logger to be sent to supplier to download data and inform operational status of the logger.
	Q2	– No access	– Nil
	Q3	– Well cap was on the well – Logger was removed in Q1 monitoring event and sent for data retrieval	– Nil
	Q4	– Not Accessed – Logger was removed in Q1 monitoring event and sent for data retrieval	– Nil
BH02	Q2	– Well cap was missing from the PVC casing and was replaced during site visit	– Nil
BH03	Q1	– Cables intact – Logger downloaded and restarted	– Nil
	Q2	– The groundwater logger was downloaded and placed back in the well	– The logger is seemingly downloading however no new data is available. The logger will be removed in the following site visit round and run diagnostics
	Q3	– The well cap was not on the well – The groundwater logger was downloaded, restarted and placed back in the well	– Nil
	Q4	– The well cap was on – Logger was in well – Data was downloaded and cap secured post download	– Nil
BH04	Q1	– No equipment was replaced due to the likelihood of re-damaging by sampling contractors – Logger downloaded; no data displayed	– The logger is seemingly downloading however no new data is available. The logger will be removed in the following site visit round and run diagnostics
	Q2	– The groundwater logger was in the well – Data was downloaded and logger placed back in the well and cap secured	– Nil
	Q3	– Well cap was on the well on arrival. – The logger was either removed or had snapped off and was therefore not available for download since the previous monitoring event.	– Attempt to retrieve logger may be undertaken on subsequent site visit.

Monitoring location	Monitoring Round	Condition review and on-site action	Further action
			– Logger replacement will be required if logger retrieval is unsuccessful.
	Q4	– Accessed and attempted to retrieve logger but was unsuccessful	– Replace logger in next site visit.
BH05	Q1	– Logger had broken off hanging cable likely due to lack of care when lowering the logger by the sampling contractor. A magnet was used to attempt to retrieve the logger but was unsuccessful.	– Nil
	Q2	– The groundwater logger broke off during a previous monitoring event potentially due to lack of care by other contractors. – The logger was not replaced. – The well cap was missing and was replaced.	– Nil
	Q3	– As above	– Nil
	Q4	– Not accessed during the Q4 monitoring round	– Replace logger in next site visit.
BH07	Q1	– Cap was on – Logger was in the bore hole – Logger was downloaded and placed back into the bore	– Nil
	Q2	– The groundwater logger was downloaded and placed back in the well	– Nil
	Q3	– The well cap was not on the well on arrival. – The groundwater logger was downloaded and placed back in the well. – The well cap was replaced following download.	– Nil
	Q4	– No cap on well – Logger in bore hole – Data downloaded and cap secured post download	– Nil
BH08	Q1	– Unable to download logger files, likely due to a malfunction in the optical eyes of the logger. Logger retrieved from site to perform diagnostics. Unable to solve download issue with diagnostics.	– Logger was sent to supplier to download data and inform operational status of the logger.
	Q2	– New groundwater logger was installed – The well cap was missing and was replaced	– Nil
	Q3	– New groundwater logger was installed – The well cap was missing and was replaced	– Nil
	Q4	– Cap was on – Logger in well – Data downloaded and cap secured post download	– Nil
BH09	Q1	– No logger was currently installed at BH09	– Nil
BH13	Q1	– Logger downloaded successfully	– Nil
	Q2	– Access was not possible to BH13 in Q2	– Nil
	Q3	– Well cap was on the well on arrival – Logger was download successfully – Replaced well cap following logger download	– Nil
	Q4	– Cap was on – Logger was in the well – Data downloaded and cap secured post download	– Nil

3.3 Groundwater level

Groundwater levels at each monitoring well at WCS (listed in Table 3.1) are recorded both manually gauged, and automatically recorded by groundwater loggers. Observations of levels through data and trend analysis are provided in Table 3.4, with further assessment provided for those wells showing a greater than 1 m change in level over the quarterly period. Wells with water level SSGV exceedances are further investigated in section 3.5.1. Groundwater level hydrographs are provided in Appendix B, with their location presented in Figure 3.1. Note there are discrepancies between manually gauged groundwater levels and logger measurements. Recommendations are made in section 5.2 to rectify the discrepancies.

Table 3.4 Groundwater level observation, 2022

Monitoring well	Level observation in Q1 2022 period	Level observation in Q2 2022 period	Level observation in Q3 2022 period	Level observation in Q4 2022 period
BH01	Slight increase in level from 907.8 mAHD to 908.5 mAHD	Level decrease from 908.19 mAHD to 907.78 mAHD	Level decrease from 908.15 mAHD to 907.5 mAHD	Slight level increase from 907.4 mAHD to 908 mAHD
BH02	Large decrease in level from 899.4 mAHD to 894.6 mAHD	Relatively large decrease in level from 895.53 mAHD to 892.27 mAHD (refer analysis below)	Well dry since June 2022	Large level increase from dry to 898.3 mAHD, then back to dry again
BH03	Steady level at approximately 903.3 mAHD	Steady level at approximately 902.8 mAHD to 902.17 mAHD	Level variability, ranging from 903.6 mAHD to 902.8 mAHD	Level variable between 902.8 mAHD and 903.6 mAHD
BH04	Slight increase in level from 908.8 mAHD to 909.4 mAHD	Level increases from 906.4 mAHD to 912.17 mAHD (likely measurement error)	Large level decreases from 913.49 mAHD to 907.3 mAHD (outliers, refer to Appendix A for timeseries).	Large fluctuation highest reading was 914.4 mAHD and the last reading for the quarter was 908.6 mAHD
BH05	Steady level at approximately 907.2 mAHD	Level increases from 904.56 mAHD to 908.79 mAHD	Generally steady level at 907.8 mAHD, (however one outlier in July (914.54 mAHD)	Large variations between 905.6 mAHD to 910.5 mAHD
BH06	Steady level at approximately 900.4 mAHD	Steady level at approximately 901.9 mAHD	Decreasing level from 901.3 mAHD to 899.8 mAHD	Level steady at approximately 900.7 mAHD
BH07	Slight increase in level from 908.5 mAHD to 909.0 mAHD	Steady level at approximately 909.21 mAHD	Steady level at 909.6 mAHD (However data entry/outlier at 913.68 mAHD, refer to Appendix A for timeseries).	Level increase from 906.8 mAHD to 910 mAHD
BH08	Steady level at approximately 906.9 mAHD	Level variability ranging from 906.47 mAHD to 903.15 mAHD to 908.87 mAHD	Large level increase from 904.43 mAHD to 908.2 mAHD (and one outlier in September 926.13 mAHD).	Level decrease from 910.6 mAHD to 907.1 mAHD
BH09	Slight increase in level from 906.9 mAHD to 907.3 mAHD	Level variability ranging from 907.3 mAHD to 903.8 mAHD to 911.75 mAHD	Level decrease from 917.3 mAHD to 906.6 mAHD to 911.75 mAHD	Level decrease from 910.1 mAHD to 907.5 mAHD
BH10	Dry since August 2018	Dry since August 2018	Dry since August 2018	Dry since August 2018

Monitoring well	Level observation in Q1 2022 period	Level observation in Q2 2022 period	Level observation in Q3 2022 period	Level observation in Q4 2022 period
BH12	Well decommissioned in June 2021	Well decommissioned in June 2021	Well decommissioned in June 2021	Well decommissioned in June 2021
BH13	Steady level at approximately 911.6 mAHD	Not accessed	Level variability from 908.1 mAHD to 909.6 mAHD	Large level decrease from 914.6 mAHD to 909 mAHD
BH15	Dry since January 2021	Dry since January 2021	Dry since January 2021	Dry since January 2021

Groundwater levels generally showed small variations over the quarterly period, likely due to the rainfall experienced (see Section 2), with noteworthy observations discussed in the following sub-sections.

3.3.1 BH02

BH02 was previously reported as dry (888.68 mAHD) for a period from July 2020 until it was next reported to have water in September 2021 (897.55 mAHD), which was an increase in groundwater level of around eight metres, as shown in Figure 3.2. In Q1 2022, BH02 demonstrated a substantial level decrease of approximately five metres (from 899.4 mAHD to 894.6 mAHD). During Q2 2022, a level decrease of approximately 3.2 metres was observed. In Q3 2022, the sampling contractor reported the bore as “blocked” on 11 July 2022, with subsequent monitoring in that quarter reporting the well as “dry”. In Q4 2022, a single reading taken on 5 December reported the water at 898.3 mAHD, but two days later it was again reported as dry.

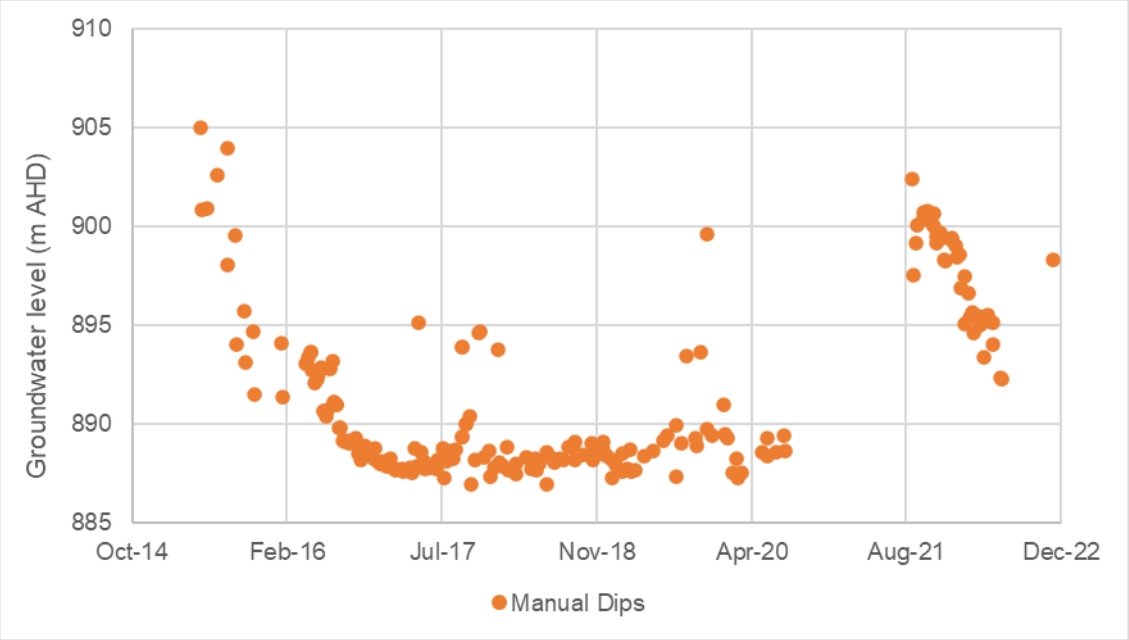


Figure 3.2 BH02 groundwater level

An explanation for the 2022 observations is that BH02 was not monitored for an unknown reason and was instead reported as being ‘dry’. During GHD’s Q1 2022 inspection, it was noted that a well cap was missing from BH02. While this would allow rainwater filling of the well, a sudden eight-metre rise is not likely to be attributable to rainwater infiltration alone.

Following construction and development of BH02 in May 2015, the well showed a substantial decrease in level from 904.99 m AHD to 887.72 m AHD in May 2017. Groundwater levels at BH02 showed no definite response to above average rainfall in 2016, the drought in 2018-2019, nor recently during the above average rainfall received in Q1 2022. This suggested the groundwater is either extremely slow to recover or that the well was not functioning i.e., blocked screen or representative of stagnant water and not the aquifer itself.

During the site visit in June 2022, an attempt was made to purge the well using multiple bailer drops. Approximately 9 L was purged from the well. After approximately 6 L was purged, the water quality became silty, turbid and had a stagnant odour. Some water level recovery was observed during the purge. The SWL recorded following the purge was 23.99 m below top of casing, while the total depth of the well is 29 m, (including casing). No groundwater samples were collected.

It is recommended to undertake further investigations at BH02 to confirm if the well is functional or if the screen is blocked. The proposed method would be to undertake groundwater pumping to purge the well, while monitoring field water quality to attempt to identify conditions in the surrounding aquifer. It is recommended to obtain laboratory samples during this process. Alternatively, a submersible borehole inspection camera could be used to view the condition of the bore to advise of any impeding objects or blockages.

Given that BH02 was installed to represent background groundwater conditions (non-mine impacted), it is important this groundwater well is functioning. This is especially important when considering future groundwater impact assessments to inform rehabilitation efforts. If the well is confirmed to be out of service, it would be recommended to either repair the well or re-drill BH02 to retrieve accurate groundwater data.

3.3.2 BH05

Groundwater level measurements at BH05 in 2022 were variable between 904.6 and 914.6 mAHD (Figure 3.3). However, on further inspection of the groundwater level chart, the datapoint recorded at 914.6 m AHD in July 2022 presents as an outlier (highlighted in black) and it is likely that the level was read or recorded incorrectly in the field during sampling and no further investigation is required.

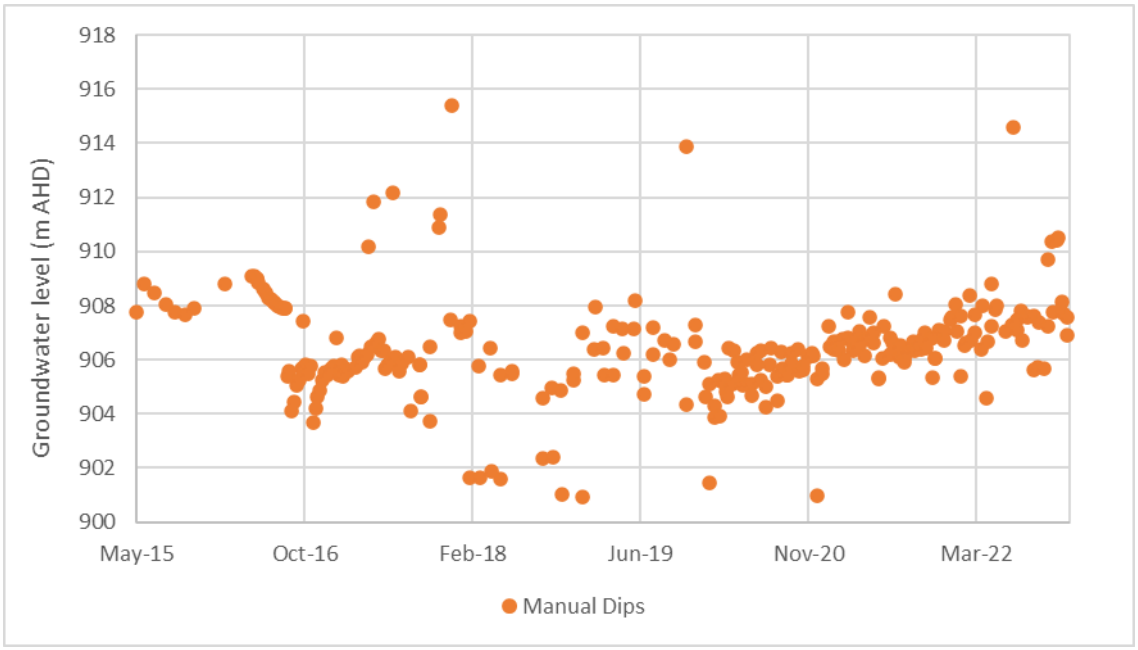


Figure 3.3 BH05 groundwater level

BH05 is installed in an unmined pillar of the Lithgow Seam. Longer-term trends between Jan 2020 and Dec 2022 indicate a gradual increase in average groundwater levels, likely correlated with the high volumes of rainfall throughout this period. Shorter-term groundwater level variation at BH05 is likely associated with groundwater monitoring events, which involves purging of the well, and hence a lowering of groundwater levels. Subsequent short-term recovery of groundwater levels is attributed to slow recovery rates, due to either the hydrogeology of the Lithgow Seam or potential clogging of the well screen.

3.3.3 BH06

Longer-term trends at BH06 between Jan 2020 and Dec 2022 indicate an initially large increase in average groundwater levels prior to a plateauing of levels between Jan 2021 and Dec 2022, likely correlated with sustained high rainfall volumes throughout this period (Figure 3.4). This is similar to the trend observed at the nearby BH05. The plateau in the water level at BH06 may be due to a fully saturated aquifer.

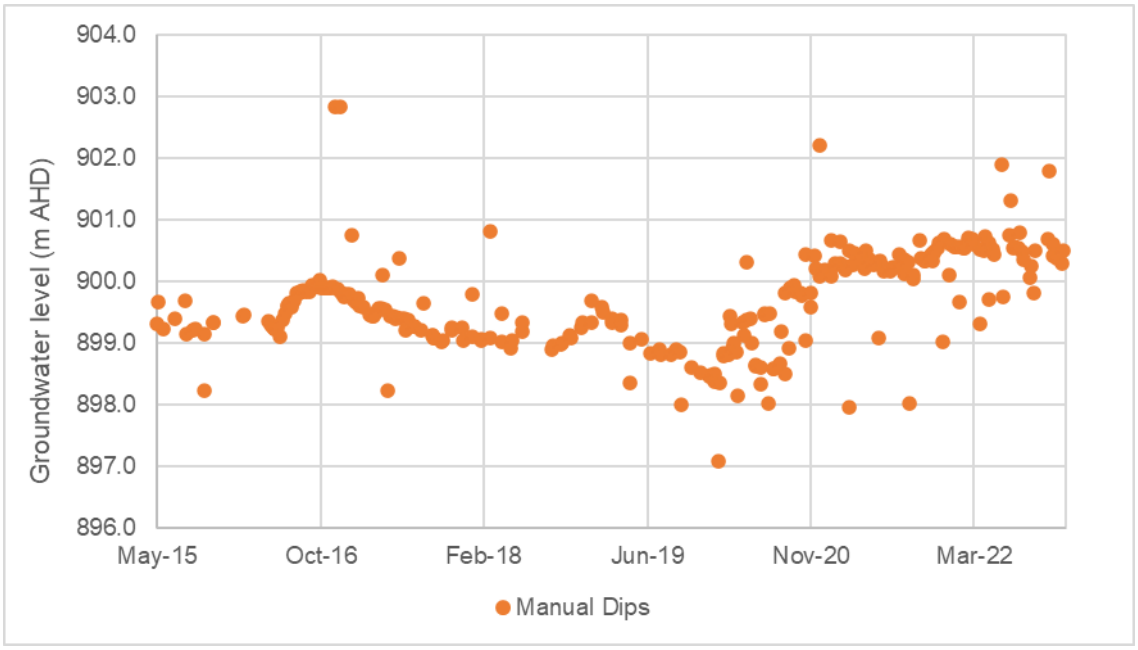


Figure 3.4 BH06 groundwater levels

3.3.4 BH08

Purging of BH08 took place on 12 September, while monthly sampling occurred on 15 September. Water levels were recorded at 926.2 m AHD (2.1 m depth to water) on 12 September, while water levels were recorded at 906.8 m AHD (21.4 m depth to water) on 15 September. It is likely that a data entry error occurred on 12 September (see Figure 3.5).

In addition, during monthly sampling between 10:45 am and 11:45 am on 15 September, the water level at BH08 reportedly decreased from 906.6 m AHD to 905.1 m AHD. It appears that either the logger was not replaced correctly in the well or that the cable has been shortened during monthly water sampling. This will be investigated during the next site visit conducted by GHD.

Subsequent manual groundwater level gauging in Q4 shows water levels decreased from a peak of 910.6 mAHD on 27 Oct to 907.1 mAHD on 22 Dec. Longer-term trends at BH08 between Jan 2020 and Dec 2022 indicate a minor increase in average groundwater levels over time between Jan 2021 and Dec 2022, likely correlated with sustained high rainfall volumes throughout this period. While this trend is similar to that discussed above for bores BH05 and BH06, the relative increase in water height throughout this time is much lower at BH08.

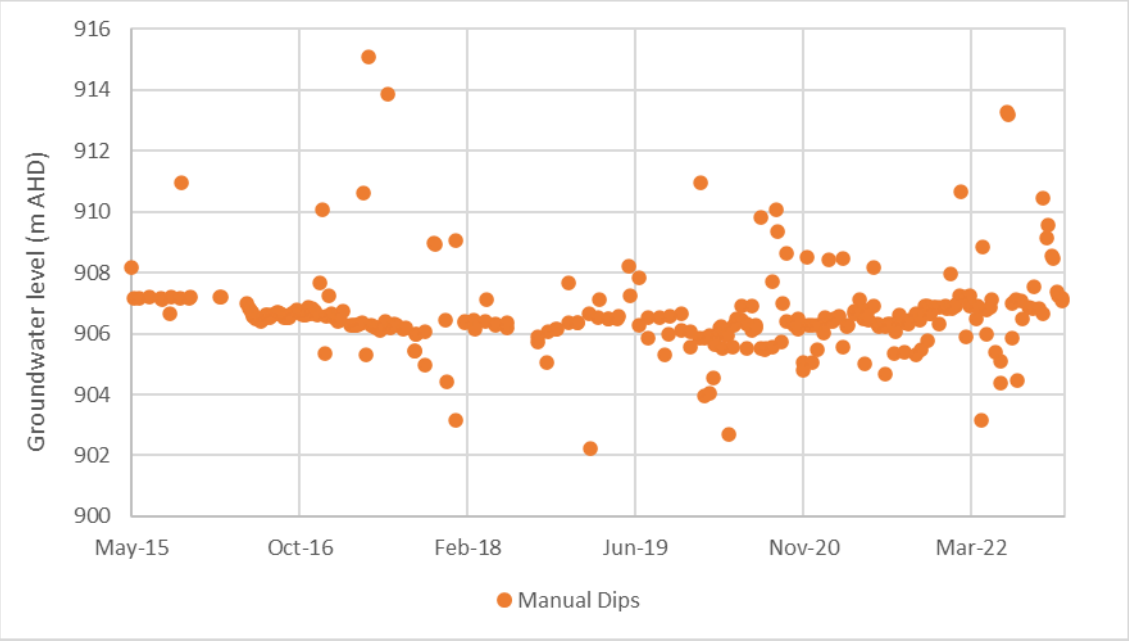


Figure 3.5 BH08 groundwater level

3.4 Groundwater quality

Groundwater is monitored for quality parameters as listed in Table 3.5. Groundwater quality plots for the reporting period are presented in Appendix A.

Table 3.5 Groundwater quality monitoring program

Location	Frequency	Parameters
BH01 BH02 BH03	Fortnightly	**Physicochemical**: EC, pH, temperature.
	Monthly	**Physicochemical**: TDS, TSS **Major ions**: alkalinity (bicarbonate, carbonate, hydroxide, total), calcium, chloride, magnesium, potassium, sodium, sulfate, total hardness **Nutrients**: nitrate, nitrite, nitrate + nitrite, total phosphorus **Dissolved metals**: iron, manganese, nickel, zinc **Total metals**: aluminium, boron, cadmium, iron, manganese, selenium, zinc
	Biannually	**Total Metals**: chromium, lead, copper
BH04 BH05 BH06 BH07 BH08 BH09 BH10 BH11 (when replaced) BH12 BH13 BH15	Fortnightly	**Physicochemical**: EC, pH, temperature
	Monthly	**Physicochemical**: TDS, TSS **Major ions**: alkalinity (bicarbonate, carbonate, hydroxide, total), calcium, chloride, magnesium, potassium, sodium, sulfate, total hardness **Nutrients**: nitrate, nitrite, nitrate + nitrite, total phosphorus **Dissolved metals**: iron, manganese, nickel, zinc **Total metals**: aluminium, boron, cadmium, iron, manganese, selenium, zinc

A review of the monitoring data related to analytes listed in Table 3.5 and plots in Appendix A has been undertaken. Table 3.6 identifies any trends or notable results observed in groundwater quality monitoring data during the monitoring period.

Table 3.6 Groundwater quality trends in reporting period

Monitoring well	Identified trend Q1 2022	Identified trend Q2 2022	Identified trend, Q3 2022	Identified trend, Q4 2022
BH01	– pH decreased throughout the monitoring period from 6.7 pH units in January to 5.8 pH units in March. – Results remained within the SSGV range. – The increase in pH was not considered environmentally harmful as it remained circumneutral.	– pH decreased from the previous quarter to 5.5 pH units which was below the SSGV. – Increases in pH to within the SSGVs occurred in May and June. pH was generally steady at BH01 albeit slightly more acidic than at other locations.	– pH increased throughout the quarter (from 5.9 pH units in July to 6.4 pH units in September.	– TSS increasing over the quarter from 7 mg/L in September to 14 mg/L in December. – EC showed an increasing trend during Q4 from 1170 µS/cm to 1565 µS/cm.
BH02	– Bicarbonate alkalinity increased throughout the period from 254 mg/L in January to 413 mg/L in March. – pH steady at the circumneutral range throughout the quarter.	– pH steady at the circumneutral range throughout the quarter. – Dissolved iron increased throughout the quarter, from 0.15 mg/L to 0.62 mg/L.	– Borehole dry since 09/06/2023	– Dry
BH03	– Outlier nitrate result in March at 6.44 mg/L. Historical average is 0.02 mg/L. – Decreasing pH trend from 3.9 pH units in January to 3.5 pH units in March. – Decreasing dissolved nickel trend at BH07, decreasing from 0.75 mg/L in January to 0.467 mg/L in March.	– Increasing trend in pH occurring during the monitoring period, becoming less acidic. – Elevated concentrations of dissolved manganese at BH03 compared to any other site (ranging 7.06 mg/L to 7.6 mg/L). – Slight decreasing trend in dissolved zinc, from 1.04 mg/L to 0.872 mg/L.	– Variable trend in pH occurring during the monitoring period ranging from 3.9 pH units to 4.6 pH units. – Elevated concentrations of dissolved manganese at BH03 compared to any other site (increasing from to 7.02 in July to 7.6 mg/L in September).	– Variable trend for dissolved manganese, between 7.62 – 6.92 mg/L during the months September to December. – Slight decreasing trend for total aluminium from 10.8 mg/L in October to 8.53 mg/l in December. – Slight increase of nitrite from 0.01 to 0.04 mg/L.
BH04	– No ongoing trends. Analyte concentrations were variable throughout the quarter.	– pH was consistently circumneutral. – Increasing trend in dissolved zinc during the quarter, from 0.03 mg/L in April to 0.104 mg/L in June.	– pH increased towards neutral conditions from 6.1 pH units to 6.7 pH units. – Dissolved zinc concentrations variable throughout the quarter, ranging 0.066 mg/L in July to 0.071 mg/L in August, and 0.044 mg/L in September.	– Elevated results of dissolved iron in November (3.32 mg/L) and December (3.52 mg/L) compared to the long-term median (1.15 mg/L). – Increased EC during the quarter from 442 µS/cm to 2,626 µS/cm. – Slight increase of nitrite from 0.01 to 0.02 mg/L.

Monitoring well	Identified trend Q1 2022	Identified trend Q2 2022	Identified trend, Q3 2022	Identified trend, Q4 2022
BH05	– Notably higher concentration of dissolved metals manganese, nickel, and zinc in February.	– Substantial increases in dissolved iron during the quarter, from 0.05 mg/L to 2.98 mg/L. – Substantial increase in dissolved manganese during the quarter from 0.028 mg/L to 4.1 mg/L. – Elevated result of dissolved nickel in May at 0.263 mg/L. – Elevated result of dissolved zinc in May at 0.267 mg/L.	– Decreasing trends in dissolved iron during the quarter, from 2.92 mg/L in July to 0.54 mg/L in September. – Decreasing trend in dissolved manganese from 1.81 mg/L in July, 1.01 mg/L in August and 0.409 mg/L in September.	– Increasing trend in nitrate + nitrite levels from 0.2 mg/L in July to 0.83 mg/L in December. – Decrease in phosphorus from 0.05 to 0.01 mg/L.
BH06	– Slight increase in electrical conductivity through the quarter, ranging 1704 µS/cm in January to 1860 µS/cm in March. – Slight increase in dissolved iron throughout the quarter.	– pH trending towards neutral at BH06, recorded at 6.5 pH units in June. – Increasing concentrations in dissolved iron from 0.019 mg/L to 0.082 mg/L.	– pH was slightly acidic to neutral at BH06, recorded at 6.7 pH units in July, 6.2 pH units in August and 7.0 pH units in September. – Decreased concentrations of dissolved iron were observed in September. Dissolved iron was less than the limit of reporting (<0.05 mg/L) in September, significantly lower than July (6.29 mg/L) and August (7.4 mg/L).	– pH is slightly acidic at BH06, recorded at 6.4-6.5 pH units in Q4. – Decreased concentrations of dissolved iron (5.5-5.68 mg/L) were observed in Q4 compared to most earlier 2022 results (6.29-7.4 mg/L), excluding result below LOR in Q3) and long-term median (7.76 mg/L).
BH07	– pH has showed an increase from historical lows in 2021 (pH = 2.0). pH averaged 5.2 in Q1 which is still less than the SSGV lower limit of 5.4. – Decrease in dissolved metals of iron, manganese, nickel, zinc over the quarter. – Decrease in total cadmium and zinc throughout the quarter.	– pH has showed an increase from historical lows in 2021 (pH = 2.0). pH averaged 5.2 in Q1. This quarter, pH averaged 5.75 pH units, which is within the range of the SSGVs. – Decrease in dissolved metals including iron, manganese, nickel, zinc over the quarter. – Decrease in total cadmium and zinc throughout the quarter (below the LOR in June).	– pH showed an increase from historical lows in 2021 (pH = 2.0). pH has steadily become more neutral, increasing from 5.0 pH units in January 2022 to 6.1 pH units in July 2022. For the remainder of the quarter, pH was relatively stable, varying between 5.8 pH units and 6.1 pH units. – Dissolved iron increased throughout the quarter, from 28.7 mg/L in July to 36.6 mg/L in September. – Dissolved manganese slightly increased from 2.39 mg/L in July to 2.69 mg/L in September. General decreasing trends had been occurring since December 2021.	– Dissolved iron showed a decreasing trend from 36.6 mg/L in September to 28.7 mg/L in December.

Monitoring well	Identified trend Q1 2022	Identified trend Q2 2022	Identified trend, Q3 2022	Identified trend, Q4 2022
BH08	– Increase in EC throughout the quarter, ranging 3,020 µS/cm in January to 3,200 µS/cm.	– General decreasing trends in EC since October 2021. Decreasing from 2931 µS/cm in April to 1920 µS/cm in June. – Slight increasing trend in pH by approximately 1 pH unit during the quarter, becoming circumneutral. – Increasing trends in dissolved nickel, from 0.126 mg/L in April to 0.272 mg/L in June.	– General decreasing trends in EC since October 2021 (3,560 µS/cm October 2021 to 1,920 µS/cm in June 2022). EC was more saline in July 2022 (3,460 µS/cm) but subsequently decreased throughout the quarter to 2,460 µS/cm in September. – Elevated results in TSS throughout the quarter. – pH stable varying from 6.7 pH units in July to 6.5 pH units in September. – Approximately steady trends in dissolved nickel, at 0.0626 mg/L, 0.274 mg/L and 0.23 mg/L in July, August and September 2022 respectively.	– Chloride showed a decreasing trend in concentration from 195 mg/L to 180 mg/L. – Potassium decreasing during the quarter from 78 mg/L to 53 mg/L. – Increase in nitrite from 0.01 to 0.08 mg/L.
BH09	– Concentrations of all major ions decreased throughout the reporting period.	– pH generally increased throughout the quarter becoming circumneutral. – General decreasing trends in EC, from 2,190 µS/cm in April to 1,930 µS/cm in June. One low result in May at 939 µS/cm. – Increasing trends in dissolved iron from 0.46 mg/L in May to 0.79 mg/L in June. – Increasing trends in dissolved nickel from 0.126 mg/Lin April to 0.272 mg/L in June.	– pH stable varying from 6.6 pH units in July to 6.4 pH units in September. – Variable EC concentrations from 2,100 µS/cm in July to 2,670 µS/cm in September. – Decreasing trends in dissolved iron from 0.79 mg/L in June to less than the limit of reporting (<0.05 mg/L) in September. – Variability in dissolved nickel with concentrations of 0.154 mg/L in July and 0.237 mg/L in September.	– Increased cadmium trend during the quarter from 0.0001 to 0.0003 mg/L.

Monitoring well	Identified trend Q1 2022	Identified trend Q2 2022	Identified trend, Q3 2022	Identified trend, Q4 2022
BH13	– Concentrations of total metals decreased throughout the quarter, including aluminium, iron, boron.	– Concentrations of total metals decreased throughout the quarter, including aluminium, iron, boron. – Decreasing trends in EC from 1,934 µS/cm to 1,446 µS/cm during the quarter.	– Decreasing trends in EC from 2,305 µS/cm to 1,942 µS/cm during the quarter.	– pH circumneutral between 6.0 and 6.4 one outlier result of 7.5 in November. – Slightly increasing trend in EC from 1,942 µS/cm in September, reaching a high of 2,920 µS/cm during the quarter in November. – Slightly increasing trend in chloride concentration from 101 mg/L in September to 150 mg/L in December. – Slight increasing trend in dissolved nickel from 0.171 mg/L in September and 0.202 mg/L in December.

3.5 SSGV assessment

3.5.1 Level

Groundwater level trigger values (or 'SSGVs') are based on an exceedance of the 95th percentile historical observed groundwater level. With no active mining at the site, depressurisation leading to potential impacts is highly unlikely. Changes in water management or emplacement of material has the potential to elevate groundwater levels leading to new or changes to existing surface groundwater interactions. Table 3.7 shows the maximum level in the reporting period and whether it has exceeded the trigger level. Groundwater level graphs are provided in Appendix B.

Table 3.7 Groundwater level triggers in 2022 reporting period

Monitoring well	Trigger Level (m AHD)	Maximum level, Q1 2022 (m AHD)	Maximum level, Q2 2022 (m AHD)	Maximum level, Q3 2022 (m AHD)	Maximum level, Q4 2022 (m AHD)	Triggered (Y/N)	Investigation
BH01	909	908.52	908.21	908.49	908.59	N	N/A
BH02	900	899.41	895.53	Dry	Dry	N	N/A
BH03	904	904.0	903.86	903.88	905.05	Y	A manual reading of 905.05 mAHD on 09/11/2023 was recorded and on the same day logged groundwater level was approximately 903.3 mAHD. The manual reading is likely erroneous. No further investigation was required.
BH04	909	909.41	912.71	913.49	914.41	Y	The following investigations are for manual gauging data throughout 2022: – The Q1 909.41 mAHD recorded level was from manual measurement on 23/03/2022. The previous recorded level on 21/03/2022 was 908.49 mAHD and the following recorded level on 11/04/2022 was 908.25 mAHD. This represents an increase and decrease of ~1 m in a ~3-week period. – The Q2 917.71 mAHD level was recorded on 20/06/2022. The previous recorded level on 06/06/2022 was 909.19 mAHD and the following recorded level on 23/06/2022 was 908.26 mAHD. This represents an increase and decrease of ~3-4 m in a ~2.5-week period. – The Q3 913.49 mAHD level was recorded on 11/07/2022. The previous recorded level on 23/06/2022 was 908.26 mAHD and the following two recorded levels on 14/07/2022 and 25/07/2022 were 913.21 mAHD and 908.95 mAHD, respectively. This represents an increase and decrease of ~5 m in a ~2.5-week period. – The Q4 914.41 mAHD level was recorded on 10/10/2022. The previous recorded level on 29/09/2022 was 908.81 mAHD and the following recorded level on 13/10/2022 was 907.61 mAHD. This represents an increase and decrease of ~5.5-6.5 m in a ~3.5-week period. On comparison with hourly logged data, no such magnitude of rise has been recorded for the historical dataset. Some level rises in 2022 are in the order of 8 m over a period of 3 days which is highly unlikely for the mine void targeted groundwater. Therefore, it is most likely that the large fluctuations are due to manual measurement error, rather than actual rises and falls in groundwater level. No further investigation was required. It is recommended that the sampling contractor is to perform data quality assurance checks when recording groundwater levels and when transferring the data to a digital form. Also recommended is to review the historical dataset for manually gauged levels to remove outliers based on comparison with logged groundwater levels where available.

Monitoring well	Trigger Level (m AHD)	Maximum level, Q1 2022 (m AHD)	Maximum level, Q2 2022 (m AHD)	Maximum level, Q3 2022 (m AHD)	Maximum level, Q4 2022 (m AHD)	Triggered (Y/N)	Investigation
BH05	909	908.37	908.79	907.81	910.5	Y	Three manually gauged results of around 910.4 mAHD were recorded in November 2022. There has been a steady increasing trend of groundwater level at BH05 since January 2020, aligning with above average rainfall conditions in this time, meaning the triggers will be more frequent due to natural recharge of the aquifer. There are no SCSO operational activities around BH05 that would influence groundwater level, so no further investigation was required.
BH06	901	900.73	901.9	901.3	901.8	Y	Upon review of the dataset each of the Q2, Q3, and Q4 trigger events appear to be outliers with all other gauging levels less than 900.8 m AHD with levels typically fluctuating ±0.4 m. These outliers are likely due to measurement error, and therefore no further investigation was required.
BH07	909	909.64	911.29	914.89	909.99	Y	Manually gauged results showed trigger events for each quarter. Upon review of the dataset, each of the Q1, Q2, Q3, and Q4 trigger events appear to be outliers with levels typically fluctuating ±0.5 m between 907 and 908 mAHD. Whilst the level remained above the trigger level for much of 2022, it is unlikely caused by SCSO operational activity as BH07 is a background monitoring location upgradient of Lamberts Gully water management structures. Therefore, the consistent level rise since January 2020 is contributable to rainfall recharge of the target aquifer.
BH08	909	910.63	908.83	913.23	910.42	Y	Manually gauged results showing trigger events for Q1, Q3, and Q4 appear to be outliers with levels typically fluctuating ±0.5 m between 907 and 908 mAHD. On comparison with logged levels, these outliers are likely due to measurement error, and therefore no further investigation was required.
BH09	910	912.51	911.75	917.3	910.5	Y	Manually gauged results showing trigger events for Q1, Q2, Q3, and Q4 appear to be outliers with levels typically fluctuating ±1 m between 906 and 908 mAHD. On comparison with logged levels, these outliers are likely due to measurement error, and therefore no further investigation was required.
BH10					928.94	N/A	N/A
BH13	910	909.95	909.54	909.6	Dry	N	N/A
BH15	930	Dry	Dry	Dry	Dry	N	N/A

3.5.2 Quality

Groundwater quality trigger values have been developed with reference to baseline monitoring data. The triggers have been recalculated for the Q1 2022 report based on total dataset up until March 2022. Groundwater quality trigger values are based on the 80th percentile historical concentrations. For pH, a range of trigger values are used, based on the 20th percentile and 80th percentile historical values.

Groundwater quality SSGVs from the WMP are presented in Appendix C. Groundwater quality trigger events exceeding the criteria are displayed in Table 3.8.

Table 3.8 Groundwater quality in 2022 SSGV Assessment

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
BH01	pH	5.6 – 5.9	Q1	Jan	6.7	pH result was trending toward the pH circumneutral range and therefore was not considered environmentally harmful.
			Q2	Apr	5.5	pH result was previously trending towards the circumneutral range throughout the first quarter of 2022. During Q2, pH was decreased slightly below the SSGV in April, but in May was within the range of the SSGVs. Most other bores demonstrated an increase towards pH circumneutral conditions. No further investigation was undertaken given the result was within device measurement error.
			Q3	Sep	6.4	During Q3, pH increased, from 5.9 pH units to 6.4 pH units. The increase in pH was consistent with neutralising observations at other bores. As such, no further investigation is required.
			Q4	Nov	7.4	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
BH02	pH	6.4 - 6.8	Q1	Jan	7.0	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
			Q2	Mar	7.0	
			Q2	Jun	7.2	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
	Dissolved iron	0.65 mg/L	Q1	Feb	1.19 mg/L	BH02 was reported dry since January 2020, until September 2021. It is possible during this time that water existed within BH02 accumulating concentrated dissolved metals. Alternatively, if the bore was dry during this period, previously adsorbed metals may have been dissolved as groundwater entered the bore. BH02 was again reported as dry throughout all of Q3 and most of Q4.
	Dissolved manganese	0.759 mg/L	Q1	Feb	0.951 mg/L	
			Q2	Jun	0.769 mg/L	
	Dissolved zinc	0.085 mg/L	Q1	Jan	0.09 mg/L	
			Q2	Jun	0.097 mg/L	
BH03	pH	3.6 – 4.5	Q3	July	4.6	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
			Q4	Nov	5.6	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
	EC	1,270 µS/cm	Q3	Jul	1,444 µS/cm	Average EC was 1,502 µS/cm in 2021. During 2022, concentrations have generally decreased, with a 2022 average of 1,255 µS/cm, with a range between 1,512 and 884 µS/cm. Although values are above the SSGV, they are generally becoming less saline, presumably due to dilution by the high rainfall throughout 2022. Therefore, the potential for environmental harm is reducing and no further investigation is required.
			Q3	Jul	1,349 µS/cm	
			Q3	Aug	1,342 µS/cm	
			Q3	Sep	1,279 µS/cm	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
			Q4	Oct	1,413 µS/cm	
			Q4	Oct	1,485 µS/cm	
			Q4	Nov	1,344 µS/cm	
			Q4	Nov	1,512 µS/cm	
			Q4	Dec	1,369 µS/cm	
			Q4	Dec	1,283 µS/cm	
	Dissolved manganese	7.48 mg/L	Q1	Feb	8.07 mg/L	Reviewing level data, groundwater surrounding BH03 is suspected to be influenced by surrounding surface water storages of the Final Polishing Lagoon and the Co-disposal Ponds given the sharp fluctuations in groundwater level appearing through the historical dataset, potentially caused by dewatering events. An investigation should be launched into the groundwater quality influence at BH03, taking into consideration: – Hydrogeology – Level analysis – Bore construction logs – Climate – Groundwater contours – Major ion chemistry analysis – Dewatering records This would assist in identifying potential sources of elevated dissolved metals results at BH03.
			Q1	Mar	7.88 mg/L	
			Q2	Jun	7.6 mg/L	
			Q3	Sep	7.62 mg/L	
			Q4	Oct	7.5 mg/L	
	Dissolved iron	77.1 mg/L	Q1	Jan	79.6 mg/L	
			Q1	Feb	85.4 mg/L	
			Q1	Mar	79.3 mg/L	
	Dissolved nickel	0.319 mg/L	Q1	Jan	0.326 mg/L	
			Q1	Feb	0.327 mg/L	
			Q2	Apr	0.337 mg/L	
			Q2	Jun	0.333 mg/L	
	Dissolved zinc	1.02 mg/L	Q1	Feb	1.03 mg/L	
			Q2	Apr	1.04 mg/L	
BH04	TSS	118 mg/L	Q1	Feb	158 mg/L	TSS is highly dependent on the sampling method and environmental influences. Investigations cannot definitively determine the source of elevated TSS concentrations.
	pH	6.3 – 6.7	Q2	May	6.8	Monitoring results at BH04 have consistently been reported within the circumneutral range. The results observed in the current quarter are within the historical range, are approximately neutral and therefore not considered inherently environmentally harmful.
			Q2	Jun	6.9	
	EC	516 µS/cm	Q4	Oct	1,688 µS/cm	Groundwater surrounding BH04 is under investigation in the joint EnergyAustralia (EA) and Centennial groundwater investigation. It is believed that groundwater near BH04 is
			Q4	Dec	2,626 µS/cm	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
	Dissolved iron	2.60 mg/L	Q1	Mar	2.95 mg/L	influenced by seepage through historical mine workings, as it is installed within the Lithgow seam void. However, elevated results are potentially a combination of WCS and Mount Piper Power Station (MPPS) impacts, given that concentrations there have been numerous trigger events throughout 2022. It is possible that fluctuations in dissolved zinc concentrations are due to impacted groundwater seepage from either WCS or EA into the surrounding historical mine workings void. Further investigation should be launched into the source of the elevated dissolved metal concentrations (see recommendations).
			Q4	Nov	3.32 mg/L	
			Q4	Dec	3.52 mg/L	
	Dissolved nickel	0.011 mg/L	Q2	May	0.027 mg/L	
	Dissolved manganese	0.515 mg/L	Q2	May	0.771 mg/L	
	Dissolved zinc	0.053 mg/L	Q1	Jan	0.076 mg/L	
			Q1	Mar	0.074 mg/L	
			Q2	May	0.057 mg/L	
			Q2	Jun	0.104 mg/L	
			Q3	Jul	0.066 mg/L	
			Q3	Aug	0.071 mg/L	
			Q4	Oct	0.105 mg/L	
BH05	pH	6.4 – 6.8	Q1	Jan	7.0	The pH at BH05 was highly variable in 2022, ranging from pH 6.2 to 7.9 with a mean of 6.68. The 7.9 pH recorded in September 2022 was the most alkaline result on record, and still within the circumneutral range. A review of pH data will be undertaken in the subsequent annual review to determine if there is a trend of increasing pH at BH05.
			Q2	Jun	7.0	
			Q3	Jul	7.6	
			Q3	Sep	7.9	
	EC	656 µS/cm	Q2	May	2,400 µS/cm	Salinity has remained consistent throughout the historical record, typically fresh and remaining below 800 µS/cm. Despite these two observations of high EC, the mean EC during 2022 was below the SSGV at 537.2 µS/cm.
			Q3	Sep	1,518 µS/cm	
	TSS	122 mg/L	Q1	Feb	152 mg/L	TSS is highly dependent on the sampling method and environmental influences. Investigations cannot definitively determine the source of elevated TSS concentrations.
			Q1	Mar	137 mg/L	
	Dissolved manganese	0.823 mg/L	Q1	Jan	0.959 mg/L	Groundwater surrounding BH05 is under investigation in the joint EnergyAustralia (EA) and Centennial groundwater investigation. It is believed that groundwater near BH05 is influenced by seepage through historical mine workings, as it is installed within the Lithgow seam void. However, elevated results are potentially a combination of WCS and Mount Piper Power Station (MPPS) impacts, given that concentrations there have been numerous trigger events throughout 2022.
			Q1	Feb	1.48 mg/L	
			Q2	May	2.93 mg/L	
			Q2	Jun	4.16 mg/L	
			Q3	Jul	2.92 mg/L	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
			Q3	Aug	1.01 mg/L	It is possible that fluctuations in dissolved zinc concentrations are due to impacted groundwater seepage from either WCS or EA into the surrounding historical mine workings void. Further investigation should be launched into the source of the elevated dissolved metal concentrations (see recommendations).
	Dissolved iron	0.24 mg/L	Q2	May	0.71 mg/L	
			Q2	Jun	2.98 mg/L	
			Q3	Jul	1.81 mg/L	
			Q3	Aug	2.71 mg/L	
			Q3	Sep	0.54 mg/L	
			Q4	Nov	1.51 mg/L	
	Dissolved nickel	0.023 mg/L	Q1	Feb	0.032 mg/L	
	Dissolved zinc	0.059 mg/L	Q1	Feb	0.103 mg/L	
			Q4	Oct	0.103 mg/L	
BH06	pH	6.1 – 6.5	Q1	Feb	6.9	Despite these observations being above the upper SSGV, they are close to, or within, the circumneutral range and therefore are not considered environmentally harmful.
			Q2	May	6.6	
			Q3	Jul	6.7	
			Q3	Sep	7.0	
	Dissolved zinc	0.079 mg/L	Q2	Jun	0.082 mg/L	BH06 is installed in the Lithgow Seam. Exceedances of dissolved zinc have been infrequent. BH06 is downgradient of Cooks Dam and may receive seepage from either the dam, where concentrations of dissolved zinc recorded in May were also recorded at 0.082 mg/L, or the old underground workings. Further investigation may be required if dissolved metal exceedances of SSGVs become more frequent.
			Q4	Oct	0.108 mg/L	
BH07	pH	5.8 – 6.6	Q1	Jan	5.1	pH was variable throughout 2022, ranging from 5 to 6.8 with a mean 5.72, which is below the lower SSGV. It is possible that BH07 pH is influenced by the WCS REA groundwater seepage, or that high rainfall throughout 2022 has impacted the pH within BH07. pH increased in Q3 and Q4 into the pH circumneutral range.
			Q1	Feb	5.3	
			Q1	Mar	5.5	
			Q2	Apr	5.7	
			Q4	Oct	6.8	
BH08	pH	5.9 – 6.2	Q1	Feb	6.6	Despite these observations being above the upper SSGV, they are close to, or within, the circumneutral range and therefore are not considered environmentally harmful.
			Q1	Mar	6.3	
			Q2	May	6.4	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
			Q2	Jun	6.8	
			Q3	Jul	6.7	
			Q3	Aug	6.6	
			Q3	Sep	6.5	
			Q4	Oct	6.5	
			Q4	Nov	6.4	
			Q4	Nov	6.5	
			Q4	Dec	6.2	
			Q4	Dec	6.3	
	Dissolved iron	3.62 mg/L	Q3	Jul	7.98 mg/L	Dissolved iron concentrations have historically been elevated (ranging between 0.05 mg/L to 19.2 mg/L since February 2016). Similar trends were initially observed in early 2022, however, decreasing trends were observed during the latter two quarters, decreasing from 7.98 mg/L in July to 0.09 mg/L in December 2022.
	TSS	60 mg/L	Q1	Jan	80 mg/L	As TSS is highly dependent on the sampling method and environmental influences, investigations cannot definitively determine the source of elevated TSS concentrations.
			Q2	May	93 mg/L	
			Q3	Jul	146 mg/L	
			Q3	Aug	64 mg/L	
			Q3	Sep	353 mg/L	
			Q4	Nov	61 mg/L	
BH09	pH	5.9 – 6.2	Q1	Feb	6.8	Despite these observations being above the upper SSGV, they are close to, or within, the circumneutral range and therefore are not considered environmentally harmful.
			Q1	Mar	6.4	
			Q2	May	6.4	
			Q2	Jun	6.6	
			Q3	Jul	6.6	
			Q3	Aug	6.6	
			Q3	Sep	6.5	
			Q4	Oct	6.4	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
			Q4	Nov	6.8	
			Q4	Nov	6.4	
	TSS	260 mg/L	Q3	Sep	804 mg/L	As TSS is highly dependent on the sampling method and environmental influences, investigations cannot definitively determine the source of elevated TSS concentrations.
BH13	pH	6.1 - 6.5	Q4	Nov	7.5	Despite this observation being above the upper SSGV, it was within the circumneutral range and therefore was not considered environmentally harmful.

4. Surface water

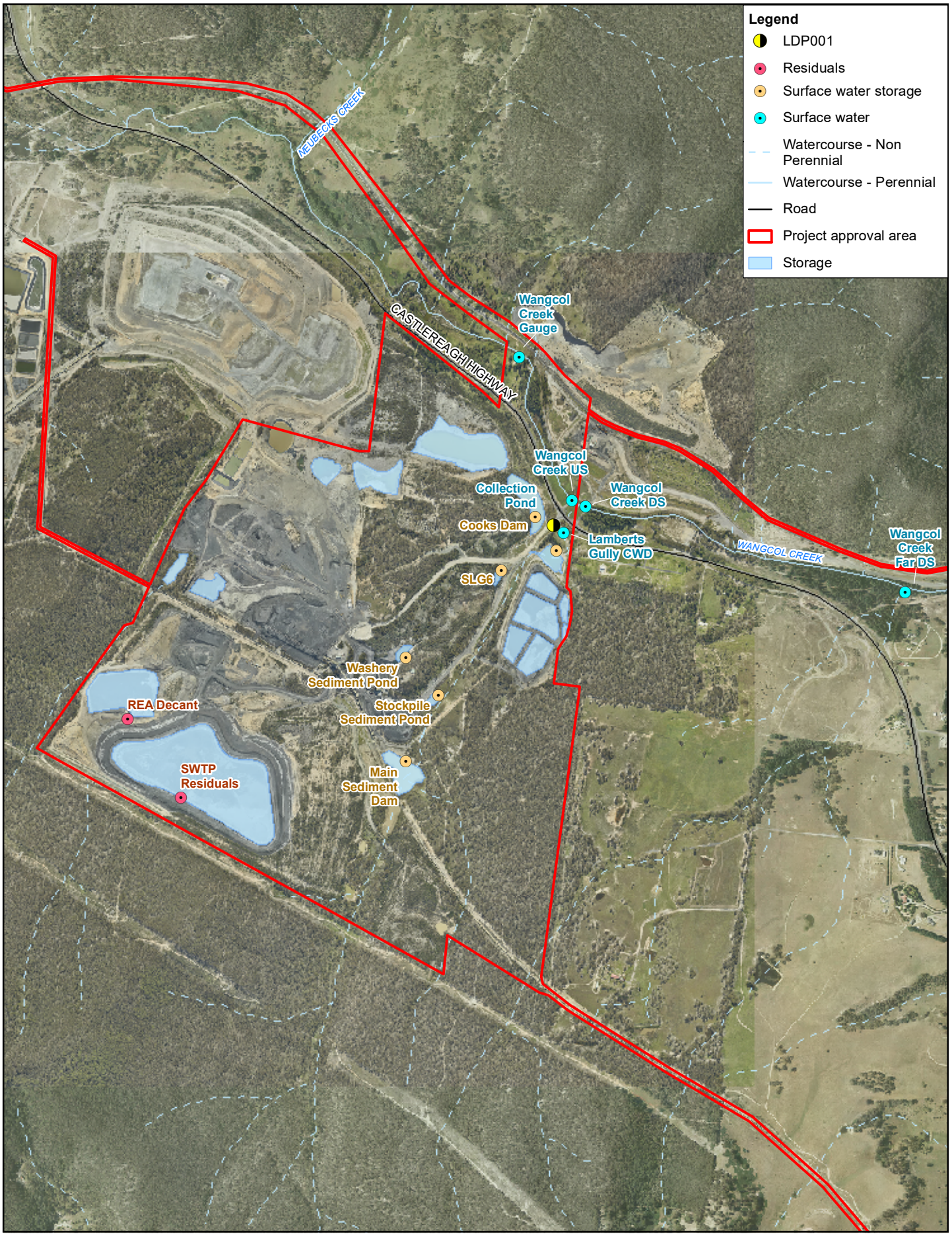
Surface water is monitored at a number of on-site water storages and off-site receiving waters at WCS. Discharge water quality is also monitored monthly during discharge as per the requirements of EPL 21229 and the WCS Water Management Plan (WCS WMP) at Licensed Discharge Points (LDP) LDP001 and LDP002.

Surface water monitoring locations are shown in Figure 4.1 and Table 4.1 provides a description of the monitoring location, monitoring frequency and parameters.

Table 4.1 Surface water monitoring locations

Location	Description	Monitoring frequency	Parameters
Cooks Dam	On site water storage. Receives dirty water surface inflows from the SCSS and groundwater inflow from historical mining voids on both the SCSS and MPPS sites. Discharges to LDP001.	Fortnightly	Physicochemical: EC, pH, TSS, turbidity. Dissolved metals: iron, manganese. Other: oil and grease.
		Quarterly	Major ions: alkalinity (bicarbonate, carbonate, hydroxide, total), calcium, chloride, magnesium, potassium, sodium, sulfate, total hardness. Nutrients: nitrate, nitrite, nitrate + nitrite. Dissolved metals: aluminium, boron, cadmium, nickel, selenium, zinc. Total metals: nickel, zinc.
LDP001	LDP001 is monitored during discharges from the collection pond, immediately downstream of Cooks Dam. Monitoring is a requirement of EPL 21229 and the WCS Water Management Plan.	Monthly	Physicochemical: EC, pH, TSS, turbidity. Dissolved metals: iron, manganese, nickel and zinc. Other: Oil and grease.
LDP002	LDP002 located at the Duncan Street coal conveyor transfer drain from the final filter lagoon. Monitoring is a requirement of EPL 21229 and the WCS Water Management Plan.	Monthly	Physicochemical: EC, pH, TSS, turbidity. Other: Oil and grease.
Final Polishing Lagoon	On site water storage. Receives clean water from the clean water diversion system. Discharges to the Clean Water Diversion discharge point (CWD).	Monthly	Physicochemical: EC, pH, TSS. Other: oil and grease.
Main Sediment Dam	On site water storage. Receives clean water from the REA rehabilitation areas and upstream Lamberts Gully sediment ponds. Discharges to the clean water diversion.	Quarterly	Physicochemical: EC, pH, TSS. Other: oil and grease.
Stockpile Sediment Pond	On site water storage. Receives dirty water runoff from the SP02 product coal stockpile. Discharges to the dirty water diversion system.		
Washery Sediment Pond	On site water storage. Receives dirty water from the CHPP and surrounding operational areas. Discharges to the dirty water diversion system.		
Collection Pond	Small weir pool immediately upstream of LDP001. Receives water from Cooks Dam overflows prior to site discharge through LDP001.	Monthly	Physicochemical: EC, pH, TSS, turbidity. Dissolved metals: iron, manganese. Other: oil and grease.

Location	Description	Monitoring frequency	Parameters
Wangcol Creek Gauge	Wangcol Creek approximately 600 m upstream of LDP001 discharge from the SCSS.	Quarterly	Physicochemical: EC, pH, TDS, TSS, turbidity. Major ions: alkalinity (bicarbonate, carbonate, hydroxide, total), calcium, chloride, magnesium, potassium, sodium, sulfate, total hardness. Nutrients: ammonia, nitrate, nitrite, nitrate + nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus. Dissolved metals: aluminium, boron, cadmium, iron, manganese, nickel, selenium, zinc. Total metals: nickel, zinc. Other: oil and grease.
Wangcol Creek U/S	Wangcol Creek immediately upstream of LDP001 discharge from the SCSS.		
Wangcol Creek D/S	Wangcol Creek immediately downstream of LDP001 discharge from the SCSS.		
Wangcol Creek Far DS	Wangcol Creek approximately 1 km upstream of the confluence with the Coxs River.		
Lamberts Gully CWD	Located on Lamberts Gully, downstream of the Final Polishing Lagoon.		
SWTP Residuals	Springvale Water Treatment Plant residuals stream to WCS REA.	Monthly	Physicochemical: EC, pH, TSS, turbidity. Major ions: alkalinity (bicarbonate, carbonate, hydroxide, total), calcium, chloride, magnesium, potassium, sodium, sulfate, total hardness. Nutrients: nitrate, nitrite, nitrate + nitrite. Dissolved metals: aluminium, boron, cadmium, iron, manganese, nickel, selenium, zinc. Total metals: nickel, zinc. Other: oil and grease.
REA Decant	Water decanted from WCS REA to A-Pit.	Monthly	Physicochemical: EC, pH, TSS, turbidity. Major ions: alkalinity (bicarbonate, carbonate, hydroxide, total), calcium, chloride, magnesium, potassium, sodium, sulfate, total hardness. Dissolved and total metals: aluminium, boron, cadmium, iron, lead, manganese, nickel, selenium, zinc. Other: oil and grease.



Paper Size ISO A4

0 0.075 0.15 0.3 0.45 0.6

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Western Coal Services
Water Report

Surface Water Monitoring Locations

Project No. 12571700
Revision No. 0
Date 14/03/2023

Figure 4.1

\\ghdnet\ghd\AU\Newcastle\Projects\22\0105001\GIS\Maps\Deliverables\Western\WesternCoal\12571700\12571700_WR004_23_SWMonitoringNetwork_0.mxd

Data source: Imagery - Centennial Coal, 2020; Roads, Watercourses - LPI, 2012. Created by: pfernandes

Whilst every care has been taken to generate this figure, GHD makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of this figure being inaccurate, incomplete or unsuitable in any way and for any reason.

4.1 Discharge flow

LDP001 discharge volume flows at WCS are logged continuously. A summary of the 2022 LDP001 flows is presented in Table 4.2 with daily discharge flows shown in Figure 4.2.

Table 4.2 LDP001 2022 flows

Unit of Measure	Frequency	No. of measurements made	Min daily volume (ML)	Mean daily volume (ML)	Max daily volume (ML)	Total volume (ML)
Megalitres (ML)	Daily during any discharge	365	1.6	8.8	118.0	3214.4

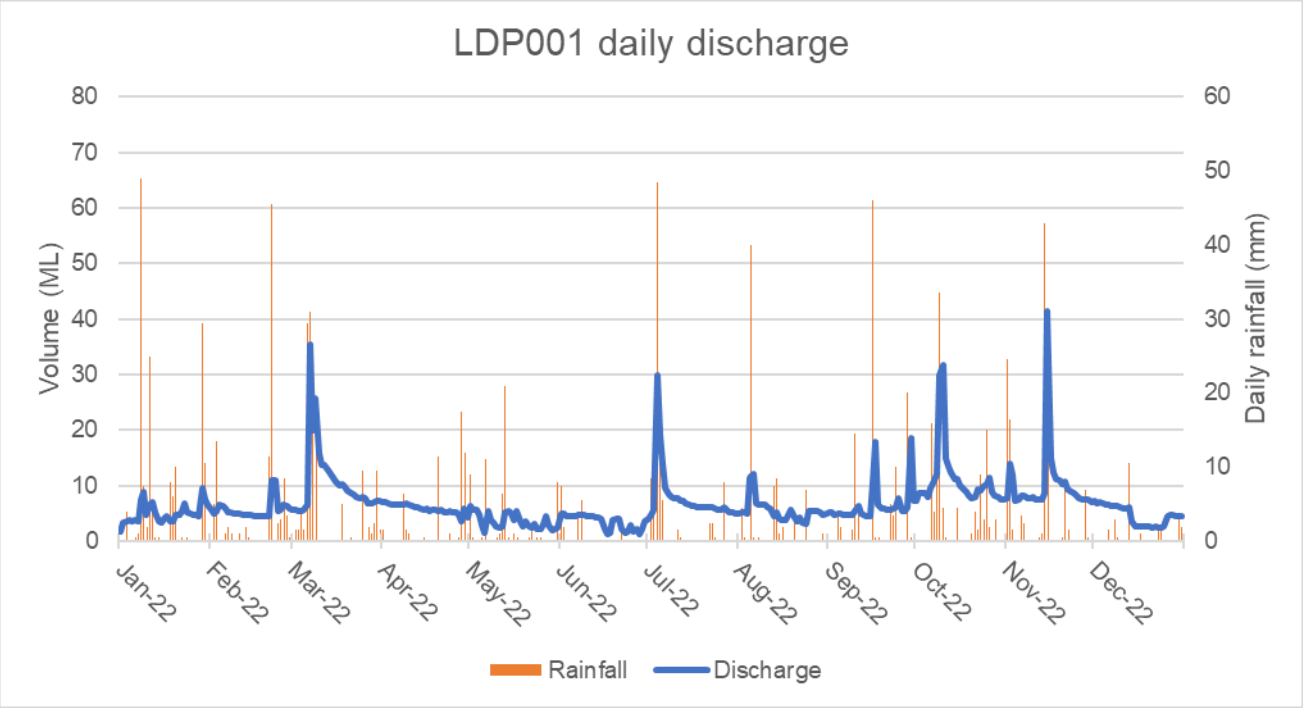


Figure 4.2 2022 LDP001 flow summary

As shown in Figure 4.2, discharges through LDP001 were fairly consistent (less than 10ML/day) during the quarter. Several large discharge events (as represented by peaks in the Figure 4.2 'Discharge' series) occurred during 2022 and aligned with rainfall events experienced at WCS.

Feedback is sought from SCSO with regards to potential dam dewatering events, with records to be maintained by SCSO and provided for future reports.

No flows were recorded through the monitoring period at LDP002.

4.2 Water quality

4.2.1 Discharge

Discharge water quality is monitored monthly during flow as per the requirements of EPL 21229 and the WMP at LDP001 and LDP002 (see Figure 4.1 for the location of LDPs). For compliance with EPL 21229 conditions M1 to M7, LDP discharge monitoring is reported monthly, and non-compliances are reported by SCSO via website reporting.

4.2.1.1 LDP001

LDP001 is located at the site boundary weir in the drain from the overflow point of Cooks Dam to Wangcol Creek. LDP001 discharged consistently throughout the reporting period, as shown in Figure 4.2. Discharge from LDP001 was monitored for the EPL quality parameters described in Table 4.1. Water quality data for LDP001 through the reporting period are presented graphically in time series to show compliance with licence limits, in Appendix A.

Review of the timeseries has identified the following notable water quality trends at LDP001:

First Quarter

– Salinity of discharges through LDP001 was decreasing. A decreasing trend in EC was observed since August 2018. This trend continued throughout the quarter with EC slightly decreasing from 2,670 µS/cm in January 2022 to 2,570 µS/cm in March 2022.
– Dissolved manganese concentrations have historically been variable, with periods of distinct increasing and decreasing trends. A minor decreasing trend has emerged since September 2021 which has continued throughout 2022.

Both of these trends are consistent with water quality observations recorded at upgradient sites Cooks Dam, the Washery Sediment Pond and the Stockpile Sediment Pond.

Second Quarter

– A notable decreasing trend in EC was observed between August 2018 and April 2022. However, during the quarter an increasing trend was observed, with EC increasing from 2,269 µS/cm in April to 2,660 µS/cm in June. Concentrations are currently similar to those reported in December 2021.
– Dissolved manganese concentrations have historically been variable, with periods of distinct increasing and decreasing trends. A minor decreasing trend emerged in September 2021 which continued throughout the year to April 2022 (1.57 mg/L). In May, concentrations increased to 1.71 mg/L, while in June, concentrations were recorded at 2.24 mg/L.

Third Quarter

– A notable decreasing trend in EC has been observed between August 2018 and April 2022. EC has been variable between March 2022 and September 2022. Increasing trends in EC occurred from July (2,220 µS/cm) to September (2,920 µS/cm), the most saline result this year. Concentrations are similar to those reported since late 2021.
– Dissolved manganese concentrations have historically been variable, with periods of distinct increasing and decreasing trends. A minor decreasing trend emerged in September 2021 which continued throughout the year to April 2022 (1.57 mg/L). Concentrations increased to 1.71 mg/L in May 2022, and 2.24 mg/L in June. This quarter, concentrations decreased to 1.34 mg/L in July, 1.42 mg/L in August and 1.36 mg/L in September.

Both of these trends are consistent with water quality observations recorded at upgradient sites Cooks Dam, the Washery Sediment Pond and the Stockpile Sediment Pond.

Fourth Quarter

– A notable decreasing trend for EC is remaining consistent with previous monitoring rounds. During the fourth quarter, the lowest recording was 2,120 µS/cm in October, which was also the lowest result for the year.
– Total phosphorus was elevated at 0.40 mg/L in Q4 2022 and was the second highest recording for LDP001 in the available dataset.
– Dissolved manganese concentrations showed a decreasing trend in Q4 2022. During Q4 2022, the lowest recorded concentration since November 2015 of 1.07 mg/L was recorded in December 2022.
– Similar to dissolved manganese, dissolved nickel concentrations showed a decreasing trend in Q4 2022 compared with historical results, with concentrations ranging between 0.14 and 0.183 mg/L, well below the historical median of 0.251 mg/L.

4.2.1.2 LDP002

LDP002 is located at the Duncan Street coal conveyor transfer drain from the final filter lagoon (sediment basin) on a drainage channel adjacent to Overland Conveyors 1 and 2 Transfer Tower on Brays Lane. The point currently receives runoff from the pad area surrounding the conveyor and transfer system.

LDP002 discharged on one occasion on 7 March 2022, during the reporting period with the results shown in Table 4.3. LDP002 has not frequently discharged, therefore no water quality time series figures are provided.

Table 4.3 LDP002 water quality results – 7 March 2022

Parameter	EPL 21229 concentration limit	Result
pH	6.5-8.5	7.6
Total Suspended Solids	30 mg/L	9 mg/L
Electrical Conductivity	* no limit	274 µS/cm
Oil and grease	10 mg/L	<5 mg/L
Turbidity	50 NTU	35 NTU

4.2.2 Onsite surface water storages

Water quality results at onsite surface water storages are presented in Appendix A. SSGVs are not applied to site surface water storages as the water in these locations is contained and does not directly impact on the offsite environment. Despite this, available data at Cooks Dam and Collection Pond provide indication of the risk of exceeding SSGVs at LDP001. Onsite Clean and Dirty Water Diversions alongside the onsite surface water storages work to prevent uncontrolled discharges of surface water to the offsite environment.

4.2.2.1 Main Sediment Dam

The Main Sediment Dam receives water from the REA rehabilitation areas and the upstream Lamberts Gully sediment ponds. Water and sediment from these areas settles within the Main Sediment Dam, before discharging to the onsite CWD.

First Quarter

There were no notable trends within the monitored physicochemical parameter suite during the quarter. EC remained stable throughout the reporting period, continuing the previous observed trends in 2020 and 2021. pH within the Main Sediment Dam has historically varied between 6.0 pH units and 8.8 pH units. pH was circumneutral during all monitoring events within the reporting period, ranging 7.6 pH units in February 2022 to 6.5 pH units in March 2022. Concentrations of oil and grease remained below the LOR.

Second Quarter

There were no notable trends within the monitored physicochemical parameter suite during the quarter. EC remained relatively stable throughout the reporting period, continuing the previous observed trends in 2020 and 2021 ranging from 126 µS/cm to 164 µS/cm. pH within the Main Sediment Dam has historically varied between 6.0 pH units and 8.8 pH units. pH was circumneutral to slightly basic during all monitoring events within the reporting period, ranging 7.5 pH units in May 2022 to 8.4 pH units in June 2022.

There were some trends of concern within the dissolved metals suite. Dissolved manganese concentrations previously became more elevated midway through 2020. Elevated concentrations have been reported since this time. Concentrations of dissolved manganese decreased during the quarter, from 0.469 mg/L to 0.35 mg/L but are still elevated compared to mid-2020 concentrations. Similarly, dissolved iron concentrations have been increasing since midway through 2020. Reported concentrations occurring throughout the quarter were variable, with one historically elevated result occurring in May 2022 at 1.47 mg/L. Concentrations of oil and grease remained below the LOR during the quarter.

Third Quarter

There were no notable trends within the monitored physicochemical parameter suite during the quarter. EC remained relatively stable throughout the reporting period, continuing the previous observed trends in 2020 and 2021 ranging from 98 µS/cm to 172 µS/cm. pH within the Main Sediment Dam has historically varied between 6.0 pH units and 8.8 pH units. pH was circumneutral to slightly basic during all monitoring events within the reporting period, ranging from 6.5 pH units in September, to a maximum of 8.3 pH units.

Concentrations of dissolved iron were more reduced in comparison to the previous quarter, likely associated with increased rainfall received near site. Decreasing trends in dissolved iron were observed during the quarter, from 0.49 mg/L in July, 0.48 mg/L in August and 0.21 mg/L in September.

Fourth Quarter

During the fourth quarter, when compared to historical data, water quality at the Main Sediment Dam showed changes that were consistent with elevated rainfall, such as increased turbidity (mean 41 NTU vs historical median of 17 NTU) and TSS (mean 19 mg/L vs historical median of 7 mg/L), and reduced EC (mean 121 µS/cm vs historical median of 284 µS/cm). Concentrations of dissolved iron continued to fluctuate during Q4, reaching a high of 0.97 mg/L in November and a low of 0.07 mg/L in December, with the large fluctuation potentially due to a laboratory error or the high rainfall during the quarter. Dissolved manganese also fluctuated during Q4, with a high of 0.68 mg/L in December and a low of 0.26 mg/L in October.

4.2.2.2 Final Polishing Lagoon

The Final Polishing Lagoon receives clean water from the clean water diversion system, downstream of the Main Sediment Dam. Discharges from the Final Polishing Lagoon are to the Clean Water Diversion Discharge point.

First Quarter

There were no major trends for the recorded physicochemical parameters during the quarter. pH ranged 6.2 pH units to 7.2 pH units, consistent with historical trends. Between June 2021 and December 2021, salinity within the Final Polishing Lagoon had become increasingly fresh, likely attributable to the above average rainfall received throughout 2021, (refer Section 2). Throughout the current monitoring period, recorded EC was highly variable, ranging from 102 µS/cm in January to 1,910 µS/cm in February, before decreasing in March to 137 µS/cm. Similar spikes in EC within the Final Polishing Lagoon had been previously observed in March 2021 and June 2020.

Second Quarter

There were no major trends for the recorded physicochemical parameters during the quarter. pH ranged 7.2 pH units to 7.9 pH units, consistent with historical trends. Between June 2021 and December 2021, water quality within the Final Polishing Lagoon had become increasingly fresh, likely attributable to the above average rainfall received throughout 2021 (refer Section 2). Throughout the current monitoring period, EC remained fresh, ranging from 409 µS/cm in April, 215 µS/cm in May to 385 µS/cm in June.

Third Quarter

There were no major trends for the recorded physicochemical parameters during the quarter. pH ranged widely from 6.6 pH units in September to 8.8 pH units in July, with the July result recorded above the historical record. Between June 2021 and December 2021, water quality within the Final Polishing Lagoon had become increasingly fresh, likely attributable to the above average rainfall received throughout 2021 (refer Section 2). Throughout the current monitoring period, EC remained fresh, ranging from 285 µS/cm in July 329 µS/cm in August, 292 µS/cm in early September, however decreased to 107 µS/cm in late September. The EC was recorded consistently above that of the Main Sediment Dam.

Fourth Quarter

During Q4, pH levels remained between 6.8 to 7.8 pH units during the quarter, indicating that relatively neutral pH may be becoming more consistent at this location. EC levels remained low, consistent with previous monitoring rounds showing water quality is remaining relatively fresh with EC levels ranging between 85 and 339 µS/cm. Oil and grease showed a slight increase during the quarter, with a result of 6 mg/L in November, with the December observation returning to <5 mg/L.

4.2.2.3 Lamberts Gully CWD

Lamberts Gully CWD is located downstream of the Final Polishing Lagoon and is monitored quarterly at the point of discharge from the site CWD. Three samples from Lamberts Gully CWD were collected during discharges in each quarter.

First Quarter

No discharges were recorded during the reporting period.

Second Quarter

There were no major trends in physicochemical parameters during the quarter, remaining generally consistent with those recorded upstream at the Final Polishing Lagoon. EC was greater than Final Polishing Lagoon levels in early May, at 729 µS/cm. EC of the discharge reported in June was comparable to the Final polishing Lagoon, recorded at 375 µS/cm. pH of the discharges ranged between 6.4 pH units in June to 7.9 pH units in May. pH reported in June was slightly lower than the reported pH on the same day in the Final Polishing Lagoon (7.6 pH units). No elevated results were recorded for nutrients during the discharge events, except for nitrate. Nitrate was recorded at 3.16 mg/L in late May but was decreased to 0.03 mg/L in June. Elevated results of dissolved metals were recorded during the quarter. Dissolved aluminium was recorded at a concentration of 0.13 mg/L in May and decreased to 0.04 mg/L in June. Dissolved zinc increased during the quarter, from 0.007 mg/L to 0.019 mg/L in June. Similar increases were reported in total zinc during the quarter. Dissolved and total zinc concentrations were generally lower during the quarter than compared to concentrations observed in 2020 and 2021.

Third Quarter

There were no major trends in physicochemical parameters during the quarter, remaining generally consistent with those recorded upstream at the Final Polishing Lagoon. EC was generally consistent with the reported discharge concentrations from the Final Polishing Lagoon, reported at 169 µS/cm in July, 281 µS/cm in August and 253 µS/cm in September. No elevated results were recorded for nutrients during the discharge events, except for nitrate, which was elevated at 1.77 mg/L in July. Nitrate concentrations of discharges were reduced, recording 0.03 mg/L in August and less than the limit of reporting (<0.01 mg/L) in September. Dissolved aluminium was recorded at a concentration of 0.38 mg/L in August. Dissolved zinc increased during the quarter, from 0.009 mg/L to 0.02 mg/L in August. In September, concentrations were decreased to 0.01 mg/L.

Fourth Quarter

EC was below the historical median for the first two monitoring events in Q4, before recording a historical high of 1,461 µS/cm in December. pH remained consistently circumneutral with values ranging from 7.3 to 7.8 pH units. Dissolved iron showed an increasing trend during Q4, with values increasing from 0.31 mg/L in October, to 0.88 mg/L in November, then 0.72 mg/L in December. Dissolved manganese also fluctuated in a similar manner to iron, with 0.188 mg/L observed in October, 0.457 mg/L in November, and 0.316 mg/L in December. As with iron and manganese, dissolved aluminium also fluctuated between a low concentration (0.08 mg/L), a high concentration (0.47 mg/L) and then an intermediate concentration (0.09 mg/L).

4.2.2.4 Stockpile Sediment Pond

The Stockpile Sediment Pond receives dirty water runoff from the SP02 product coal stockpile and discharges to the dirty water diversion system, upgradient of Cooks Dam. General decreasing trends in EC have been observed within the Stockpile Sediment Pond since September 2018.

First Quarter

General decreasing trends in EC have been observed within the Stockpile Sediment Pond since September 2018. Throughout the reporting period, EC was variable, ranging 622 µS/cm to 1,295 µS/cm, both in February. A gradual decreasing trend in pH emerged within the Stockpile Sediment Pond, occurring since November 2021. pH was circumneutral and remained stable through the reporting period. No trends of concern were observed in concentrations of TSS. Oil and grease remained below the LOR.

Second Quarter

Throughout the reporting period, EC was variable, ranging 1,081 µS/cm in April to 813 µS/cm in May. pH was circumneutral and remained stable through the reporting period, ranging between 5.8 pH units to 7.1 pH units. No trends of concern were observed in concentrations of TSS. Oil and grease remained below the LOR.

Third Quarter

Throughout the reporting period, EC was widely variable, ranging 130 µS/cm in July to 1,012 µS/cm in September. The fresh result reported in July may be a result of excess rainfall. Alternatively, it may be associated with a data entry error.

pH was circumneutral and remained stable through the reporting period, ranging between 6.9 pH units to 7.9 pH units. Concentrations of dissolved manganese have been historically variable but generally decreasing since February 2019, and during the quarter were reported up to 2.25 mg/L in September 2022. Variable concentrations of dissolved iron have been reported since February 2021. The maximum recorded dissolved iron concentration during the quarter was 1.46 mg/L in September 2022. No trends of concern were observed in concentrations of TSS. Oil and grease remained below the LOR.

Fourth Quarter

During the fourth quarter, EC remained well below the historical median (1,620 µS/cm) and ranged between 387 and 960 µS/cm with a mean of 703 µS/cm. pH was close to the historical median and ranged between 6.8 to 7.6, within the circumneutral range. Dissolved manganese was considerably lower than the historical median (2.8 mg/L), ranging from 0.69 mg/L to 1.43 mg/L, with a mean of 1.04 mg/L.

4.2.2.5 Washery Sediment Pond

The Washery Sediment Pond receives dirty water from the washery and operational areas and discharges to the dirty water diversion system, upgradient of Cooks Dam. General decreasing trends in EC have been observed within the Washery Sediment Pond since September 2018.

First Quarter

Throughout the reporting period, EC decreased from 1,465 µS/cm in January to 857 µS/cm in March. pH decreased slightly throughout the reporting period, however remained circumneutral.

Similar trends in EC and pH are observed within the Washery Sediment Pond and the Stockpile Sediment Pond. The dirty water discharging into these storages is associated with product coal (stockpile and the washery process water). Dirty water is pumped from Cooks Dam to the Washery Pond and Stockpile Sediment Pond, for reuse in the washery. EC and pH are generally more increased within the Washery Sediment Pond in comparison to the Stockpile Sediment Pond. TSS concentrations recorded in the Washery Sediment Pond were lower in comparison to the Stockpile Sediment Pond.

Second Quarter

In Q2, EC increased from a historically low result of 93.3 µS/cm in April to 1,569 µS/cm in June. Low results may be evident of a data entry error, rather than instances of extreme freshening. Similar historically low results of pH occurred in April at 5.7 pH units. pH increased to 7.9 pH units by June.

Similar trends in EC and pH are observed within the Washery Sediment Pond and the Stockpile Sediment Pond. EC and pH are generally more increased within the Washery Sediment Pond in comparison.

Third Quarter

In Q3, EC was variable, increasing from 133 µS/cm and 1,768 µS/cm in July, decreasing slightly in August to 1,600 µS/cm and 1,391 µS/cm and to 1,673 µS/cm in September. The low result reported in July may be associated with a data entry error, rather than extreme freshening. pH ranged from 7.4 pH units in July to 8.1 pH units in August and 7.7 pH units in September.

Fourth Quarter

In Q4, EC was reduced in comparison to the previous quarter, and varied between 500 µS/cm and 1,150 µS/cm. pH remained between 7 and 7.7 and within the circumneutral range. Dissolved manganese was substantially below the historical median (1.9 mg/L), ranging from 1.53 mg/L to 0.39 mg/L.

4.2.2.6 Cooks Dam

Cooks Dam receives dirty water surface inflows from the dirty water network and groundwater inflows from historical workings. Cooks Dam is located downgradient of the Washery Sediment Pond and the Stockpile Sediment Pond. Overflows from Cooks Dam are discharged into the Collection Pond, and then on through LDP001.

First Quarter

Decreasing trends in EC, concentrations are more elevated than within the Washery Sediment Pond and the Stockpile Sediment Pond. pH circumneutral throughout reporting period with no trends of concern.

General increasing trends in bicarbonate alkalinity have been occurring since June 2014. Decreasing trends in total hardness. This includes a decrease in calcium, sodium and sulfate.

General decreasing metals concentration trends had been observed from September 2018 and continued throughout the quarter for dissolved zinc, dissolved boron and total nickel. Total zinc has been generally decreasing since monitoring began in August 2011.

Second Quarter

Data were available for Cooks Dam in May and June only this quarter. General decreasing trends in EC have occurred since late 2018 and continued during the previous quarter. This quarter, EC increased during May and June, from 2,190 µS/cm to 2,760 µS/cm. In the second half of June, EC had decreased to 1,990 µS/cm. pH was circumneutral throughout reporting period with no trends of concern.

General increasing trends in bicarbonate alkalinity have been occurring since June 2014. Decreasing trends in total hardness are noted, as well as a decrease in calcium, sodium, manganese and sulfate. General decreasing metals concentration trends had been observed from September 2018 and continued throughout the quarter for dissolved zinc, dissolved boron, dissolved nickel and total nickel.

Third Quarter

General decreasing trends in EC have occurred since late 2018 and continued up until May 2022. Salinity within Cooks Dam was variable during the quarter, ranging from 2,190 µS/cm in July to 3,030 µS/cm in September.

General increasing trends in bicarbonate alkalinity have been occurring since June 2014. Decreasing trends in total hardness are noted, as well as a decrease in calcium, sodium, manganese and sulfate in mid-2018. General decreasing metals concentration trends had been observed from September 2018 and continued throughout the quarter for dissolved zinc, dissolved boron, dissolved nickel and total nickel. Total zinc has been generally decreasing since monitoring began in August 2011, which continued throughout the quarter.

Fourth Quarter

In Q4, EC was below the historical median (3,855 µS/cm), ranging between 1,811 µS/cm and 2,860 µS/cm with a mean of 2,211 µS/cm. Dissolved manganese was below the historical median (4.2 mg/L), ranging between 0.966 mg/L and 1.64 mg/L with a mean of 1.19 mg/L.

4.2.2.7 Collection Pond

The Collection Pond is a small weir pool located immediately upstream of LDP001. The Collection Pond receives water from Cooks Dam overflows prior to offsite discharge through LDP001.

First Quarter

Similarly, to Cooks Dam, EC recorded within the Collection Pond had been decreasing since September 2018. EC continued to decrease over the quarter, from 2,990 µS/cm in January to 1,896 µS/cm in March. Throughout the reporting period, pH remained circumneutral. Dissolved metals iron and manganese demonstrated decreasing trends throughout the monitoring period, consistent with previous observations occurring since August 2021.

Second Quarter

Similarly, to Cooks Dam, EC recorded within the Collection Pond had been decreasing since September 2018. However, in contrast to the increasing trends observed in Cooks Dam, EC in the Collection Pond decreased this quarter, from 2,680 µS/cm in April to 1,826 µS/cm in June. pH remained circumneutral throughout the reporting period, ranging 7.0 to 7.3 pH units. Dissolved manganese demonstrated decreasing trends throughout the monitoring period, consistent with previous observations in the previous quarter, occurring since August 2021. Dissolved iron also decreased throughout the quarter, except for the June monitoring event, where concentrations increased slightly.

Third quarter

Similarly, to Cooks Dam, EC recorded within the Collection Pond has been decreasing since September 2018. However, in contrast to the increasing trends observed in Cooks Dam, EC in the Collection Pond decreased this quarter, from 2,870 µS/cm in July to 2,420 µS/cm in September. pH remained circumneutral throughout the reporting period, decreasing slightly from 7.7 pH units in July to 6.8 pH units in August. Dissolved manganese remained consistent throughout the monitoring period, ranging 1.36 mg/L to 1.28 mg/L. Dissolved iron was reported below the LOR during the quarter.

Fourth Quarter

In Q4, EC ranged between 1,919 µS/cm and 2,730 µS/cm during the quarter, which has been consistent since April 2021. pH remained circumneutral between 6.8 to 7 pH units. Dissolved metals continued the decreasing trend since March 2021 and remained substantially lower than the historical median.

4.2.3 Wangcol Creek

Surface water monitoring sites on Wangcol Creek are monitored to assess potential impact from site discharges through LDP001. Details of the Wangcol Creek monitoring locations are provided in Table 4.1 and time series water quality graphs are provided in Appendix A. SSGV criteria in graphs for Wangcol Creek only apply to monitoring location Wangcol Creek Far DS, as per the requirements of the WMP.

4.2.3.1 Wangcol Creek Gauge

The Wangcol Creek Gauge is located approximately 600 m upstream of LDP001.

First Quarter

EC results were generally lower throughout the quarter than in previous monitoring events recorded throughout 2021. EC remained variable throughout the reporting period, ranging 569 µS/cm in January to 1,958 µS/cm in March. pH was circumneutral throughout the reporting period, continuing previous decreasing trends since an elevated result was recorded in October 2021.

No trends of concern in nutrients, total metals or dissolved metals were identified at the Wangcol Creek Gauge. Elevated results in dissolved metals (recorded above the Wangcol Creek Far DS SSGV) included dissolved boron (0.51 mg/L in March), dissolved iron (0.36 mg/L in January) and dissolved nickel (0.15 mg/L in March).

Second Quarter

The decreasing trend in pH occurring throughout the previous two quarters was not observed. No trends of concern in nutrients, total metals or dissolved metals were identified at the Wangcol Creek Gauge.

Third Quarter

EC results were generally consistent with results in the previous quarter, ranging 563 µS/cm to 2,761 µS/cm. EC reported in September 2022 was consistent with elevated historical concentrations periodically observed throughout 2021. pH was variable throughout the monitoring period, ranging 7.3 pH units to 8.0 pH units. No trends of concern in nutrients, total metals or dissolved metals have been identified at the Wangcol Creek Gauge. Turbidity was reported at 102 NTU in July, however, it decreased to 2 NTU in August and 3 NTU in September. Dissolved nickel was reported at 0.17 mg/L in September, while dissolved boron was reported at 0.82 mg/L. Total nitrogen was elevated 0.9 mg/L in July, however, was reduced in both August and September recording 0.3 mg/L.

Fourth Quarter

In Q4, EC ranged between 256 µS/cm and 567 µ/cm. pH remained circumneutral, ranging between 7.4 and 7.49 pH units. Dissolved metals showing no notable trends for the quarter. All other results were consistent with previous monitoring rounds.

4.2.3.2 Wangcol Creek US

The Wangcol Creek US monitoring point is located immediately upstream of the LDP001 discharge point to Wangcol Creek. During the reporting period, water quality trends at Wangcol Creek US were similar to the trends identified at the Wangcol Creek Gauge, except for:

First Quarter

pH was slightly higher at the Wangcol Creek US site in March 2022.

Concentrations of nitrate, total nitrogen and total Kjeldahl nitrogen were far more elevated at the Wangcol Creek US site in March 2022.

Second Quarter

pH was slightly higher at the Wangcol Creek US site compared to the historical median, although observations were similar to the Wangcol Creek Gauge.

Concentrations of dissolved aluminium were more elevated at the Wangcol Creek US site than at the Wangcol Creek Gauge in May and June. Similarly, concentrations of dissolved iron were more elevated in June in comparison to the Wangcol Creek Gauge. Concentrations of nitrate, and nitrate + nitrite were elevated at the Wangcol Creek Upstream site, equal to concentrations observed at the Wangcol Creek Gauge.

Third Quarter

pH was slightly higher at the Wangcol Creek US site compared to the historical median, although observations were similar to the Wangcol Creek Gauge. Turbidity was elevated at the Wangcol Creek US site in July at 99 NTU.

Concentrations of dissolved iron were more elevated at the Wangcol Creek US site in September, reported at 0.1 mg/L. Concentrations of dissolved zinc were more elevated in August at Wangcol Creek US site, reported at 0.016 mg/L.

Concentrations of nitrate, and nitrate + nitrite were elevated at the Wangcol Creek US site, far greater than concentrations observed at the Wangcol Creek Gauge and up to 7.57 mg/L in August. This was reflected in elevated concentrations of total nitrogen (8.8 mg/L) and nitrate (7.57 mg/L) at Wangcol Creek US. This result was not observed at downstream locations.

Fourth Quarter

pH was slightly higher at the Wangcol Creek US site compared to the historical median (6.90), ranging from 7.3 to 8.1, although observations were similar to the Wangcol Creek Gauge. Turbidity was elevated at the Wangcol Creek US site, exceeding the historical median (3 NTU) in October (18 NTU) and November (16 NTU). The December observation was below the median at 2.33 NTU.

One elevated result for Ammonia above the historical median (0.01 mg/L) was reported in December (0.16 mg/L). Total phosphorus had elevated results above the historical median (0.01 mg/L) in November and December, both reading 0.03 mg/L.

Dissolved metals have shown increasing trends in aluminium from 0.01 mg/L in October and a high of 0.11 mg/L in November. Likewise, dissolved iron has shown an increasing trend from 0.06 mg/L in October to 0.34 mg/L in December.

4.2.3.3 Wangcol Creek DS

Wangcol Creek DS is located immediately downstream of the LDP001 discharge point to Wangcol Creek.

First Quarter

EC was more elevated at the Wangcol Creek DS site in comparison to the upstream sites. EC has generally been decreasing at the Wangcol Creek DS site, reflecting a combination of reduced discharge volumes through LDP001 and increased rainfall throughout 2021-2022. Concentrations of nitrate, total nitrogen and Total Kjeldahl Nitrogen were lower in comparison to the Wangcol Creek US site. Metals concentrations were more elevated within Wangcol Creek DS than at the upstream sites. Concentrations of dissolved boron and nickel are generally decreasing. Concentrations of these analytes recorded in January and March were elevated above the upstream sites, likely reflecting the influence of the discharge events from LDP001. Concentrations of total nickel and zinc were elevated during March, contrasting the previous decreasing trends observed since November 2021.

Second Quarter

Concentrations of total nitrogen and nitrate were far more elevated in May and June at Wangcol Creek DS in comparison to the upstream sites. Total nickel and dissolved boron were recorded above the concentrations recorded in the upstream sites and greater than the Wangcol Creek Far DS SSGVs. These elevated concentrations likely reflect the influence of the discharge events through LDP001. In June, the concentration of dissolved iron recorded at Wangcol Creek DS was less than at the upstream sites.

Third Quarter

EC was more elevated at the Wangcol Creek DS site in comparison to Wangcol Creek DS. EC was highly variable during the quarter, ranging from 338 µS/cm to 1,022 µS/cm. EC has generally been decreasing at the Wangcol Creek DS site since late 2017, reflecting a combination of reduced discharge volumes through LDP001 and increased rainfall throughout the 2022 period. pH has generally been increasing at all Wangcol Creek water quality monitoring sites since August 2019, though has remained circumneutral to slightly basic during the year. pH was variable at the Wangcol Creek DS site throughout the quarter ranging from 7.1 to 8.0.

Concentrations of total nitrogen and nitrate were far more elevated in the Q3 monitoring events at Wangcol Creek US in comparison to the Wangcol Creek DS site. Concentrations of dissolved manganese, nickel and zinc were reported above the Wangcol Creek US site in July and August. These concentrations likely reflect the influence of the discharge events through LDP001.

Fourth Quarter

Similar to Wangcol Creek US site, turbidity was elevated in Q4, exceeding the historical median (3 NTU) in October (18 NTU) and November (17 NTU), with turbidity returning below the median in December. EC continued a decreasing trend as observed in previous monitoring rounds and ranged between 615 µS/cm and 1,446 µS/cm with mean 909 µS/cm during Q4. pH was circumneutral during the quarter, ranging between 7.4 and 7.87 pH units. Dissolved metals did not produce any notable trends of concern.

4.2.3.4 Wangcol Creek Far Downstream - SSGV assessment

SSGVs have been derived in the WMP from water quality data results at location SW1 (upstream of the LDP001 discharge point on Wangcol Creek), which is no longer monitored. Data at SW1 ranges between March 2012 and February 2015, and upon comparison with recommended ANZECC (2000) Default Guideline Values (DGVs). Surface water SSGVs apply to the Wangcol Creek Far DS monitoring location.

Analyte concentrations were generally equal to or less than the observed concentrations and trends at the Wangcol Creek DS site. Exceedances of SSGVs recorded during the reporting period at Wangcol Creek Far Downstream site are investigated in Table 4.4.

Table 4.4 Wangcol Creek Far DS Trigger Events, 2022

Parameter	Exceedance occurrence (SSGV)	Investigation
TSS	49 mg/L, July (25 mg/L)	Concentrations of TSS were recorded above the SSGV following approximately 117 mm of rainfall in the 5 days prior to the sample being collected. Concentrations of TSS were not as elevated on the same day of sampling at the Wangcol Creek DS site (recorded at 20 mg/L). Concentrations reported further upstream were similar, reporting 22 mg/L. Concentrations of TSS are therefore considered to be associated with excess sediment laden runoff occurring downstream of discharges through LDP001, driven by high rainfall.
Turbidity	July, 116 NTU (35 NTU)	Concentrations of turbidity were elevated in July following the rainfall event (117 mm rainfall recorded in 5 days prior to sample being collected). Turbidity was recorded at 99 NTU upstream of LDP001 at the Wangcol Creek US site, while at the Wangcol Creek DS site, turbidity was recorded approximately 101 NTU. Discharges reported through LDP001 were approximately 56 NTU. Therefore, the impact of discharges on turbidity at the downstream site are considered negligible, with potential of increased sediment associated with catchment runoff.
Dissolved nickel	January, 0.126 mg/L (0.125 mg/L)	There was no evidence of elevated dissolved nickel upstream of LDP001. LDP001 was discharging at the time of monitoring within Wangcol Creek. The elevated dissolved nickel was therefore likely to have been influenced by discharges from WCS through LDP001 with a discharged concentration recorded at 0.23 mg/L.
Ammonia (mg/L)	January, 0.07 mg/L (0.04 mg/L)	Ammonia concentrations were also elevated at the Wangcol Creek Gauge, Wangcol Creek US and Wangcol Creek DS, (each at 0.04 mg/L) though slightly lower than at Wangcol Creek Far DS. Therefore, discharge from LDP001 may not be the source of influence on concentrations of ammonia at the Wangcol Creek Far downstream site and may be related to other seepage events further downstream of Wangcol Creek DS.
	October 0.06 mg/L (0.04 mg/L)	Ammonia concentrations at upstream locations did not have elevated results. Therefore, the source of influence on concentrations of ammonia at the Wangcol Creek Far downstream site and may be related to other seepage events further downstream of Wangcol Creek DS.
Nitrogen (total)	April 0.6 mg/L (0.5 mg/L)	Nitrogen (total) was elevated in the Wangcol Creek DS monitoring events (2.3 mg/L) in April. Concentrations were not elevated at sites upstream of LDP001. Monitoring of total nitrogen was not undertaken at any onsite surface water storage locations during April. No other elevated concentrations were recorded. Less than 1 mm of rainfall was recorded in the 5 days prior to monitoring near the site.
	July, 1.6 mg/L (0.5 mg/L)	In July, concentrations of nitrogen were more elevated at the Wangcol Creek Far DS site, in comparison to the Wangcol Creek D/S location (0.8 mg/L) and further upstream at Wangcol Creek U/S location (0.9 mg/L). Nitrogen (total) is not screened for in LDP001 discharges. However, given concentrations of nitrogen were also elevated upstream of LDP001 (above the SSGV at Wangcol Creek U/S), it is not likely that discharges influenced concentrations of nitrogen (total) downstream.
Phosphorus	July, 0.09 mg/L (0.08 mg/L)	Concentrations of phosphorus were more elevated upstream at Wangcol Creek U/S on the same day of monitoring (recorded at 0.1 mg/L). Therefore, elevated phosphorus concentrations are unlikely to be associated with discharges through LDP001.

Parameter	Exceedance occurrence (SSGV)	Investigation
Dissolved Boron (mg/L)	January, 0.58 mg/L (0.37 mg/L)	There was no evidence of elevated dissolved boron at sites upstream of LDP001. LDP001 was discharging at the time of monitoring within Wangcol Creek. The elevated dissolved boron is potentially caused by discharges from WCS through LDP001 and seepages from surround operations through historical mine workings. Only 2.6 mm of rainfall was received in the 10 days prior to sampling.
	March, 0.44 mg/L (0.37 mg/L)	There was no evidence of elevated dissolved boron upstream of LDP001. LDP001 was discharging at the time of monitoring within Wangcol Creek. The elevated dissolved boron is potentially influenced by discharges from WCS through LDP001 and seepages from surroundings operations through historical mine workings. In addition, there was 61.6 mm of rain received in the 9 days prior to sampling, which may have impacted the time available for settlement and adsorption to sediment of dissolved boron within Cooks Dam.
	April (0.53 mg/L) June (0.43 mg/L) (0.37 mg/L)	The elevated dissolved boron is potentially influenced by discharges from WCS through LDP001 and seepages from surroundings operations through historical mine workings. There was no evidence of elevated dissolved boron upstream of LDP001. LDP001 was discharging at the time of monitoring within Wangcol Creek. Concentrations of dissolved boron at Wangcol Creek DS were elevated above the SSGVs in April and June. Elevated concentrations of dissolved boron were recorded in May during monitoring of dissolved metals in Cooks Dam and LDP001. It would be beneficial to monitor dissolved boron during LDP001 discharge events given that the parameter has exceeded the Wangcol Creek Far DS SSGV in each quarter since at least early 2020. In the 5 days prior to the exceedance in April, only 1 mm of rain was recorded, while in June prior to the exceedance approximately 18 mm of rainfall was recorded near the site. It is unlikely that the exceedances are rainfall related (or passive discharge related, exceeding the containment capacity of the dam before settlement could occur).

4.2.4 SWTP residuals

Monitoring of decant water and residuals from the Springvale Water Treatment Plant (SWTP) commenced following the commissioning of the residuals pipeline in June 2019. With this, SWTP residuals stream to the REA and water decanted from the REA is monitored for water quality on a monthly basis. Residuals water quality results are shown in Appendix A. A review of the time series indicates that there are no major trends of concern within either the SWTP Residuals waste stream or the REA Decant monitoring locations.

New trigger values had been developed for the most recent revision of the WMP (2022, not yet approved). Monitored water quality of the decant water from the REA was assessed against triggers with reference to monitoring data from the REA Decant. Trigger values are based on an exceedance of the 80th percentile historical concentrations (based on three years of data from June 2019 to April 2022) as tabulated in Appendix C. For pH, a range of trigger values are used, based on the 20th percentile and 80th percentile historical values.

Water quality results are compared to the new triggers with investigation in Table 4.5.

Table 4.5 REA Decant - Trigger Events 2022

Parameter	Occurrence (SSGV)	Investigation
pH (pH units)	February, 8.9 pH units (Upper limit: 8.5 pH units)	In January, pH within the REA Decant monitoring location was more alkaline than in the SWTP Residuals stream. The result in February is similar to the pH of both the REA Decant and the SWTP stream in previous monitoring events following May 2020. The increased pH should continue to be monitored as REA Decant is discharged to A-Pit through a fill and spill design and is then assumed to migrate through the underground workings and reports to Cooks Dam. Discharges from Cooks Dam discharges through LDP001, and so has potential for environmental harm.
	March, 7.3 pH units (Lower limit: 7.4 pH units)	In March, pH was lower in the REA Decant monitoring location than within the SWTP Residuals stream, falling below the lower trigger value. The result in March is circumneutral and therefore has limited potential for environmental harm.
	May 9.0 pH units (Upper limit: 8.5 pH units)	In May, pH within the REA Decant monitoring location was more alkaline than in the SWTP Residuals stream. pH is widely variable in the REA Decant, with pH levels reported below the STP Residuals in June. The instances of pH variability (above and below the trigger value) should continue to be monitored as REA Decant is discharged to A-Pit through a fill and spill design. The discharge is then assumed to migrate through the underground workings that report to Cooks Dam. Cooks Dam discharges through LDP001, and so alkaline pH has potential for environmental harm.
	July 9.0 pH units (Upper limit: 8.5 pH units)	In July, pH within the REA Decant monitoring location were more alkaline than in the SWTP Residuals stream (7.7 pH units). pH is widely variable in the REA Decant, with pH levels reported below the STP Residuals in August and September (and were approximately circumneutral). The instances of pH variability (above and below the trigger value) should continue to be monitored as REA Decant is discharged to A-Pit through a fill and spill design. The discharge is then assumed to migrate through the underground workings that report to Cooks Dam. Cooks Dam discharges through LDP001, and so alkaline pH has potential for environmental harm.
TSS (mg/L)	January, 7,076 mg/L (5,066 mg/L)	In January in the two-week period prior to the sampling event, more than 97 mm of rainfall was received, with subsequent increased discharges from the SWTP potentially disturbing the sediment and elevating TSS concentrations.
	March, 14,310 mg/L (5066 mg/L)	Similar to the exceedance recorded in January, TSS concentrations were highly elevated in March, again likely due to increased rainfall received throughout the two-week period prior to sampling, where 134 mm of rain fell.
	April, 5,580 mg/L (5,066 mg/L)	Concentrations of TSS were elevated in April, however, were unlikely to be rainfall related due to less than 12 mm of rainfall being received in the prior 5 days of monitoring. The cause of elevated TSS in dry conditions should be investigated.

Parameter	Occurrence (SSGV)	Investigation
	June, 21,190 mg/L (5,066 mg/L)	Concentrations of TSS in the REA Decant were comparable to the concentrations recorded in the SWTP Residuals. The sample was noted to be “very thick” in the field observations. Similar to the exceedance recorded in April, TSS concentrations were highly elevated in June but were unlikely to be rainfall related due to no rainfall being received in the prior 5 days of monitoring. TSS concentrations were low (67 mg/L) in May. TSS concentrations have been generally increasing in the SWTP residuals since January 2021. TSS concentrations in the REA Decant has been generally above the trigger since they were derived in the previous quarter. The cause of elevated TSS in dry conditions should be investigated.
	July, 24,900 mg/L (5,066 mg/L)	Concentrations of TSS were elevated in July, however, are unlikely to be rainfall related due to less than 2 mm of rainfall being received in the 5 days prior to sampling. Concentrations of TSS in the REA Decant were less than concentrations recorded in the SWTP Residuals (35,900 mg/L). The cause of elevated TSS in dry conditions should be investigated.
	August, 39,960 mg/L (5,066 mg/L)	Concentrations of TSS in the REA Decant were less than concentrations recorded in the SWTP Residuals (67,880 mg/L). The sample was noted to be “cloudy” in the field observations. Similar to the exceedance recorded in April, TSS concentrations were highly elevated in August and are unlikely to be rainfall related given only 18 mm of rainfall was received in the prior 5 days of monitoring. The cause of elevated TSS in dry conditions should be investigated.
	September 18,500 mg/L (5,066 mg/L)	Approximately 22 mm of rainfall was received in the 5 days prior to the monitoring event. Recorded values of TSS in the SWTP Residuals were far lower, reported at 314 mg/L. TSS concentrations have been generally increasing in the SWTP residuals since January 2021 (except for the September result). TSS concentrations in the REA Decant has been above the trigger since they were derived in the previous quarter.
	October 22,900 mg/L (5,066 mg/L)	9 days prior to the monitoring event 44 mm of rain was received, as well as a cumulative10 mm of rain received the day before and during monitoring. Elevated results of TSS may be caused by the increased rainfall leading up the monitoring event.
	November 27,460 mg/L (5,066 mg/L)	Leading up the monitoring event, 10 days prior there was a cumulative 45 mm of rain, although this does not explain the increasing trend in TSS at the residual’s location. Further investigation would be useful to manage the increasing trend of TSS within the decant.
Turbidity (NTU)	March, >4,000 NTU (2,800 NTU)	Turbidity within the REA Decant were similar to the values within the SWTP residuals stream. The samples collected are generally not representative of water but may additionally contain bulk sediment.
	April, >4,000 NTU (2,800 NTU)	
	June, >4,000 NTU (2,800 NTU)	

Parameter	Occurrence (SSGV)	Investigation
	July, >4,000 NTU (2,800 NTU)	
	August, >4000 NTU (2,800 NTU)	
	October >4,000 NTU (2,800 NTU)	
	November >4000 NTU (2,800 NTU)	
Aluminium (Dissolved) (mg/L)	February, 0.21 mg/L (0.158 mg/L)	Aluminium concentration recorded in February was far more elevated within the REA Decant than the SWTP Residual sample (0.01 mg/L). In the 5 days prior to the sample, only 8.6 mm of rainfall had been received.
Iron (Dissolved) (mg/L)	March, 1.35 mg/L (1.08 mg/L)	Very similar concentrations of both dissolved iron and zinc in both the REA Decant and the SWTP Residuals stream have been recorded since September 2021. Concentrations within the REA Decant were more elevated in March only. In March in the 14 days prior to sampling 134 mm of rainfall was received.
Zinc (Dissolved) (mg/L)	March, 0.3 mg/L (0.233 mg/L)	
Oil and Grease (mg/L)	January, 6 mg/L (5 mg/L)	Oil and grease concentrations recorded within the SWTP residuals were below the Limit of Reporting (LoR). Concentrations within the REA Decant are therefore not reflected in the water quality samples in the SWTP Residuals stream.
	April, 6 mg/L (5 mg/L)	Oil and grease concentrations recorded within the SWTP residuals were above the LoR (8 mg/L in April and 7 mg/L in June). Concentrations of oil and grease in the REA Decant are therefore reflected in the water sampled from the SWTP residuals stream during the quarter.
	June, 10 mg/L (5 mg/L)	

5. Conclusions and recommendations

5.1 Conclusions

5.1.1 Groundwater

A summary of findings for groundwater level and quality is presented in Table 5.1.

Table 5.1 Summary of groundwater review

Monitoring location	Findings	
	Level	Quality
BH01	Level steady throughout 2022 with no triggers.	pH fluctuated outside the trigger range, though levels were not considered environmentally harmful.
BH02	The level trends at BH02 are very abnormal and do not follow trends associated with rainfall recharge of groundwater with a large drop in groundwater level over 2022.	There were some trigger events for dissolved metal concentrations which may be due to low water levels in the well.
BH03	Level steady throughout 2022 with a likely erroneous trigger event in Q4.	There were numerous EC and dissolved metals trigger events in 2022, potentially caused by seepage from the Co-Disposal Ponds and/or dewatering of the Final Polishing Lagoon.
BH04	Level trigger events were reported for each quarter with fluctuations in manually read levels far greater than logged levels.	There were numerous dissolved metals trigger events in 2022, potentially caused by seepage through historical mine workings from WCS and/or MPPS water management systems.
BH05	Level steadily increasing since Jan-2020 due to high rainfall, also causing trigger events.	There were numerous dissolved metals trigger events in 2022, potentially caused by seepage through historical mine workings from WCS and/or MPPS water management systems.
BH06	Level steady throughout 2022 with likely erroneous trigger events in Q2, Q3, and Q4	Some dissolved zinc trigger events occurred in 2022, though the frequency was not of concern.
BH07	Level steady throughout 2022 with likely erroneous trigger events in each quarter.	Some low pH results in 2022. This follows extremely low pH, and high dissolved metals in 2021.
BH08	Level increased throughout 2022 with Q4 levels showing multiple trigger events that are potentially erroneous.	No noteworthy findings.
BH09	Level steady throughout 2022 with likely erroneous trigger events in each quarter.	No noteworthy findings.
BH13	No noteworthy findings.	No noteworthy findings.
BH15	No noteworthy findings.	No noteworthy findings.

5.1.2 Surface water

A summary of findings for surface water is presented in Table 5.2.

Table 5.2 Summary of surface water review

Monitoring location	Finding
Discharge water	
LDP001	– Discharges through LDP001 increased as a response to above average rainfall – EC and dissolved metals showed decreasing trends likely due to rainfall dilution effects. pH was variable in the circumneutral range
LDP002	– One compliant discharge was recorded through LDP002 in March
Onsite surface water storages	
Cooks Dam	– EC and dissolved metals showed decreasing trends likely due to rainfall dilution effects. pH was variable in the circumneutral range – Alkalinity showed an increasing trend
Final Polishing Lagoon	– EC generally remained low (median = 193 µS/cm); pH remained in the circumneutral range
Lamberts Gully CWD	– EC and dissolved metals showed decreasing trends likely due to rainfall dilution effects. pH was variable in the circumneutral range
Main Sediment Dam	– EC generally remained low (median = 132 µS/cm); pH remained in the circumneutral range
Stockpile Sediment Pond	– EC showed a decreasing trend likely due to rainfall dilution effects. pH was variable in the circumneutral range
Washery Sediment Pond	– EC showed a decreasing trend likely due to rainfall dilution effects. pH was variable in the circumneutral range
Collection Pond	– EC showed a decreasing trend likely due to rainfall dilution effects. pH was variable in the circumneutral range
Wangcol Creek	
Wangcol Creek Gauge	– EC was variable but generally recorded results < 1000 µS/cm – pH showed a variable trend between 7 and 8, following an increasing trend from early 2020, that was likely rainfall driven – Dissolved boron showed a generally decreasing trend
Wangcol Creek US	– EC showed a slightly decreasing trend – pH showed a variable trend between 7 and 8, following an increasing trend from early 2020, that was likely rainfall driven – Alkalinity had a decreasing trend – Dissolved boron showed a generally decreasing trend
Wangcol Creek DS	– EC showed a slightly decreasing trend – pH showed a variable trend between 7 and 8, following an increasing trend from early 2020, that was likely rainfall driven – Dissolved boron and sulfate showed generally decreasing trends
Wangcol Creek Far DS	– EC showed a slightly decreasing trend – pH showed a variable trend between 7 and 8, following an increasing trend from early 2020, that was likely rainfall driven – Dissolved boron and total nickel showed generally decreasing trends – SSGV assessment showed that dissolved boron trigger events were potentially influenced by discharges from WCS through LDP001 and seepages from surroundings operations through historical mine workings

Monitoring location	Finding
SWTP residuals	
SWTP residuals	– EC showed a slightly increasing trend – pH was variable in the circumneutral range – Turbidity was high and commonly recorded >4000 NTU, due to the sample matrix being of a slurry nature
REA Decant	– EC was variable around 1000 µS/cm – pH was generally in the circumneutral range but did show some results > 8.5 – Oil and grease showed detectable results > 5 mg/L – SSGV assessment showed that turbidity, TSS, and pH recorded trigger events on multiple occasions. High turbidity and TSS are somewhat expected given the sample matrix is typically turbid. pH levels were above the SSGV on three occasions, with potential for alkaline water to be discharged to Wangcol Creek

5.2 Recommendations

5.2.1 Access to groundwater bores

Several conditions on site were restricting access or will restrict access in the future to monitoring locations. Refer to Section 3.1. The following items are recommended:

– Clearing of overhanging vegetation, regrading, and emplacement of clean rock in boggy sections of tracks in the rehabilitation area (access to BH04, BH05 and BH08). The wet weather conditions have resulted in several of the tracks being impassable by vehicle.
– Regrading of the powerline easement track leading to BH07 necessary for continued access. Enquiry is required with party responsible for track maintenance. Also tracks leading to the powerline easement should be reinstated by emplacement of clean rock in boggy areas.

5.2.2 Flow / discharge events and water quality

In order to differentiate water quality impacts arising from discharges and dewatering events through LDP001, feedback is sought from SCSO with regards to potential dewatering events, with records to be maintained by SCSO and provided for future reports.

It is also recommended to monitor and manage dissolved boron discharged through LDP001, given this parameter has exceeded the Wangcol Creek Far DS SSGV multiple times over the past two years of monitoring.

5.2.3 Bore investigations

Results exceeding triggers in the WMP are required to be further investigated as per the WMP trigger action response plans (TARPs), specifically here for groundwater quality and level. The following are recommendations to undertake further investigation to determine if the trigger exceedances are influenced by WCS operational activity:

– Review of the monitoring groundwater level data for BH02, and site visits conducted by GHD personnel, indicates that the bore may be potentially dysfunctional. It is recommended that BH02 is either:
  - Purged until dry by groundwater pump to confirm if the bore is dysfunctional, or
  - The bore is inspected with a borehole inspection camera to assess the bore's condition.

  If the well is confirmed to be out of service, it would be recommended to either repair the well or re-drill BH02 to retrieve accurate groundwater data since it is an important background site.

– Based on the suspected groundwater influence on the surrounding surface water storages, an investigation should be launched into the groundwater quality influence at BH03, taking into consideration:
    - Hydrogeology
    - Level analysis
    - Bore construction logs
    - Climate
    - Groundwater contours
    - Major ion chemistry analysis
    - Dewatering records

  This would assist in identifying potential sources of elevated dissolved metals results at BH03.
– It is recommended to consult with MPSS on the Shared Groundwater Study between Centennial and Energy Australia for investigation results pertaining to groundwater at BH04 and BH05.
– At present, it is uncertain what influences groundwater levels at BH07. It is recommended to fully purge BH07 to determine if monitored groundwater quality at BH07 is representative of actual groundwater quality. Investigation should be launched into the level influence at BH07, taking into consideration:
    - EIS predictions
    - Hydrogeology
    - Level analysis
    - Bore construction logs
    - Climate
    - Groundwater contours
    - Major ion chemistry analysis

  This was brought to the attention of Centennial - Manager Water Engineering in May-2021 with initial feedback that rainfall may be driving a connection between BH07 groundwater and the REA. It is recommended that further investigation information completed (if any) in 2021 is sought from the appropriate Centennial representative(s).

5.2.4 Data quality

As many WCS groundwater bores appear to be showing groundwater level and quality, the following is recommended to avoid poor data quality, and further, to avoid reporting incorrect conclusions:

– Conduct a sitewide review of the groundwater network which includes inspection of the bore condition to ascertain whether they are functioning as intended.
– Confirm the importance of data quality to the sampling contractor. Many manual level gauging results were reported as erroneous during 2022, which makes it increasingly difficult to reconcile which results are reliable, and which are not. This can be extended to the water quality spreadsheets received which often contain results placed in the incorrect cells which create misleading trends and unnecessary exceedances of SSGVs, requiring further investigation.
– Further to the above, SCSO should consider undertaking a review of the quality assurance procedures of the sampling contractor, inclusive of a site audit to review sampling and purging techniques for groundwater sample collection.

6. References

ANZECC (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra

Department of Science, Information Technology and Innovation (DSITI) (2022), *SILO Data Drill*, Queensland Government. Retrieved from http://www.longpaddock.qld.gov.au/silo/ on 2 May 2022

GHD (2022a) *Draft Centennial Western Coal Services Project Water Management Plan*, Draft report prepared for Springvale Coal Pty Ltd, June 2022

GHD (2022b) *Draft Centennial Western Coal Services Q1 2022 Water Report*, Draft report prepared for Springvale Coal Pty Ltd, June 2022

RPS (2014) *Centennial Western Coal Services Project Water Management Plan*, report prepared for Springvale Coal Pty Ltd, August 2014

Appendices

Appendix A

Water quality graphs

Groundwater

Physicochemical

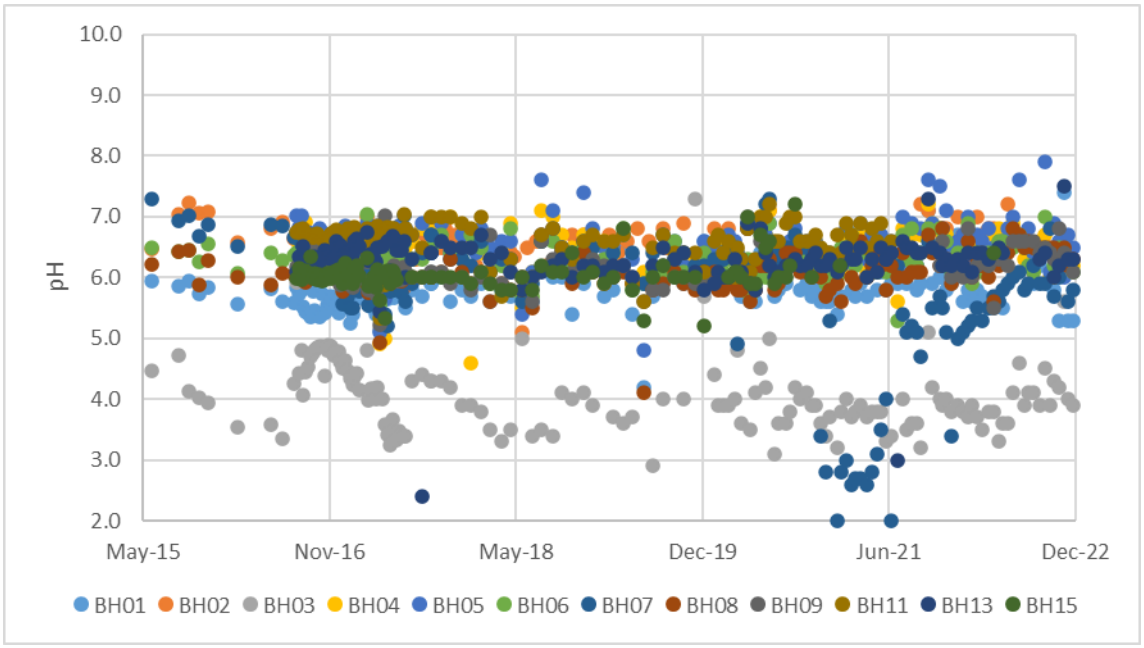


Figure A.1 Groundwater – pH

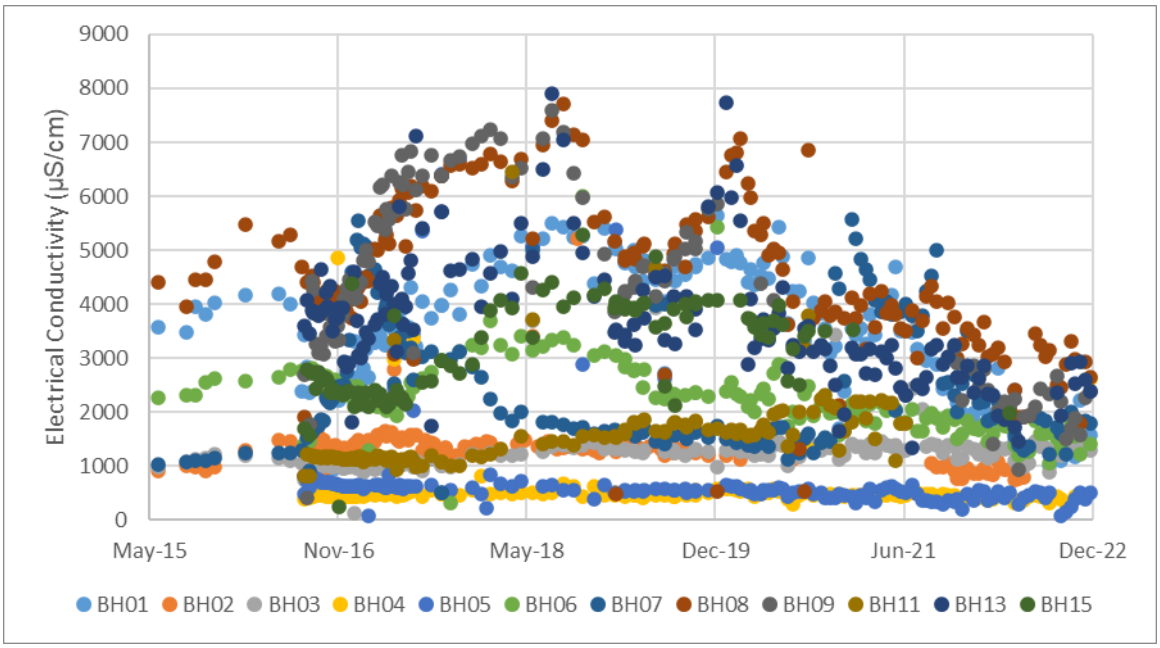


Figure A.2 Groundwater – EC

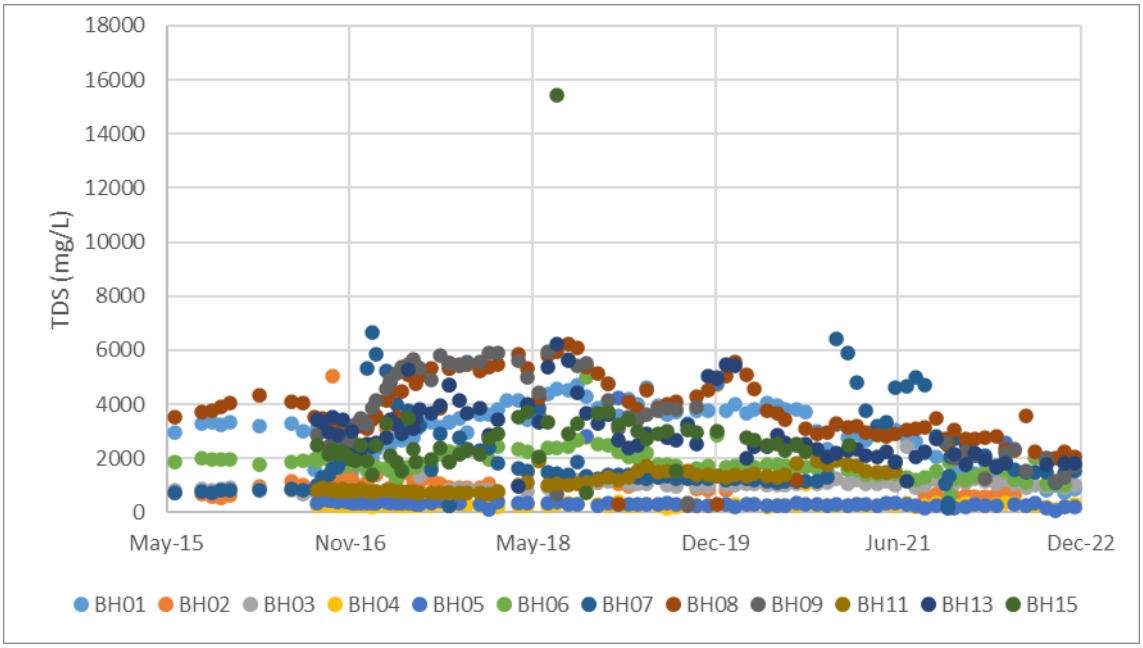


Figure A.3 *Groundwater – TDS*

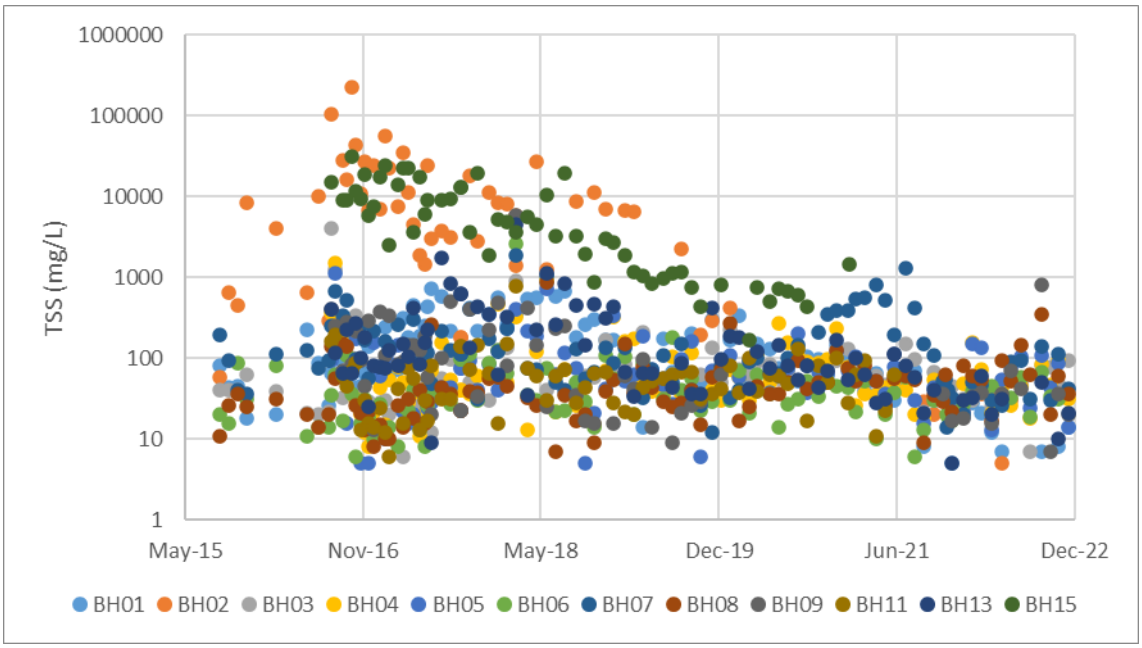


Figure A.4 *Groundwater – TSS*

Major ions

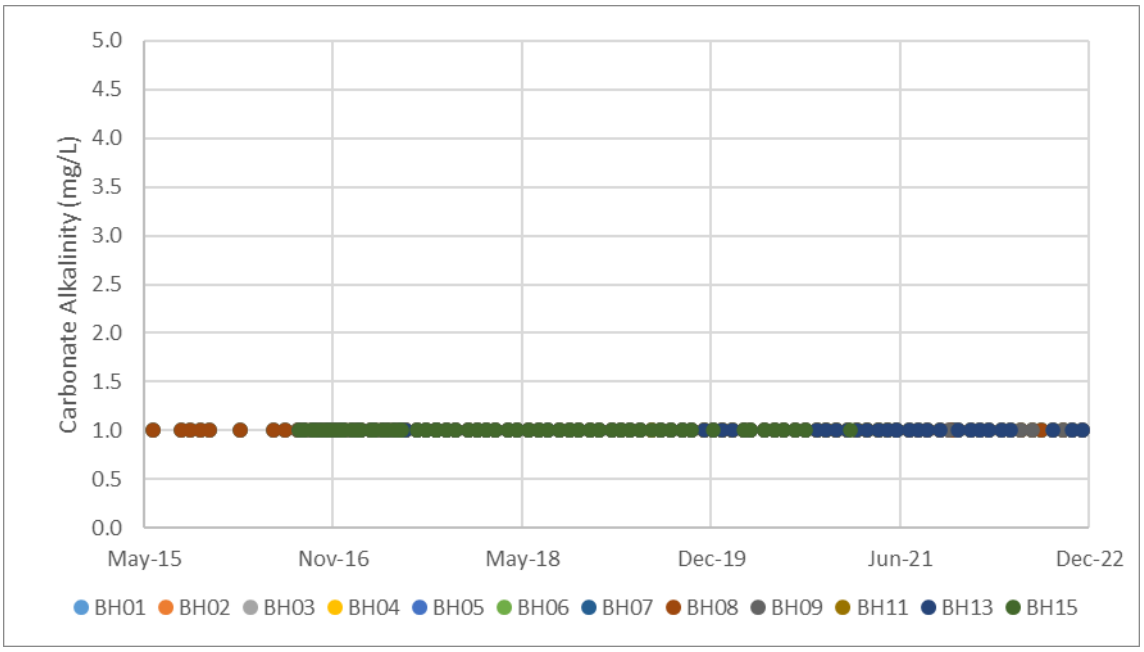


Figure A.5 *Groundwater – carbonate alkalinity*

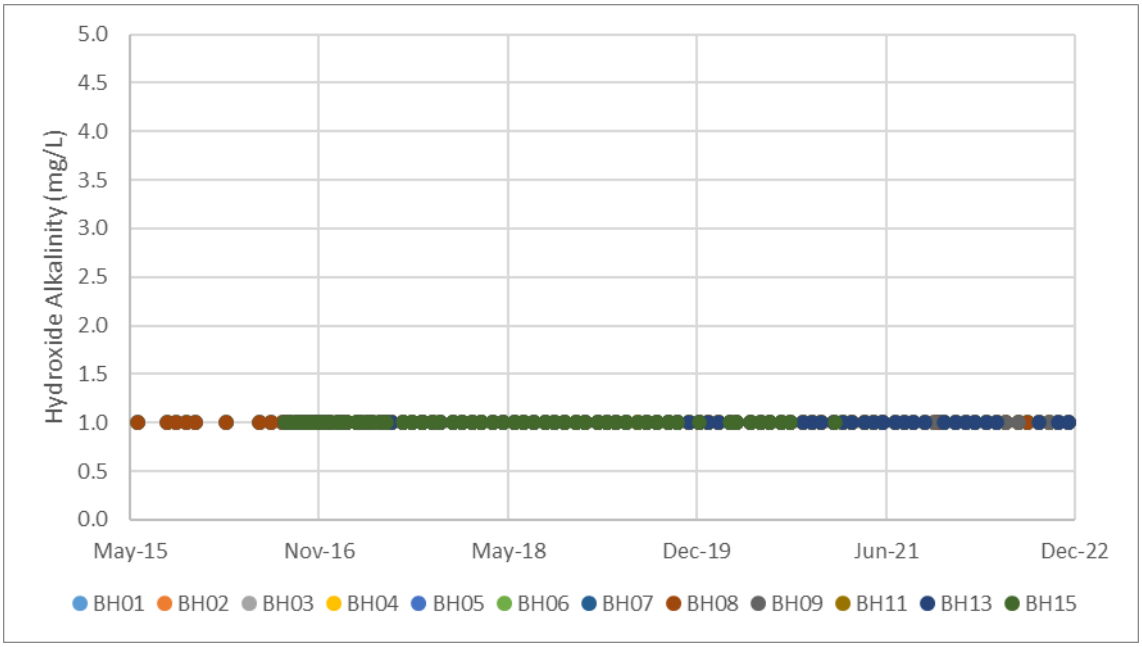


Figure A.6 *Groundwater – Hydroxide alkalinity*

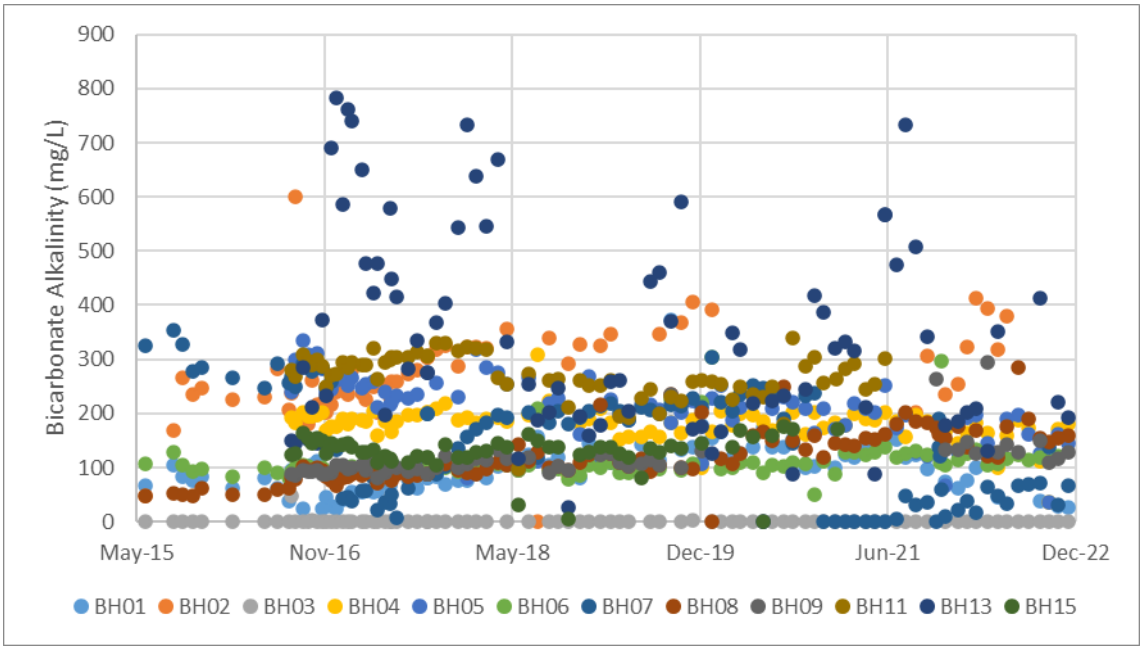


Figure A.7 *Groundwater – bicarbonate alkalinity*

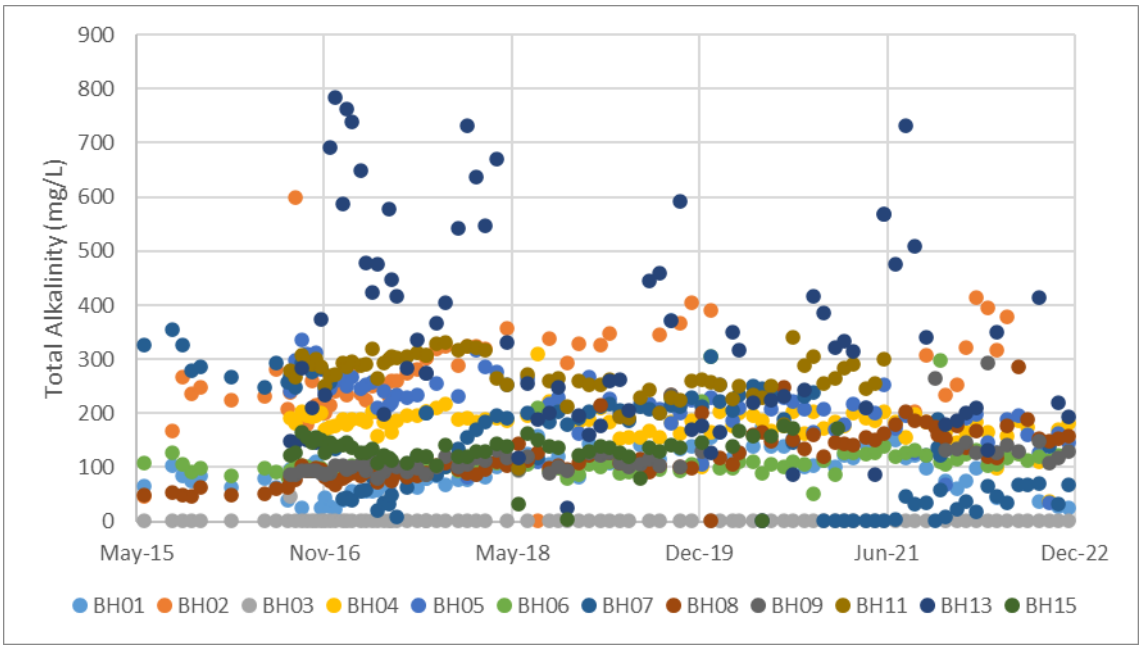


Figure A.8 *Total alkalinity*

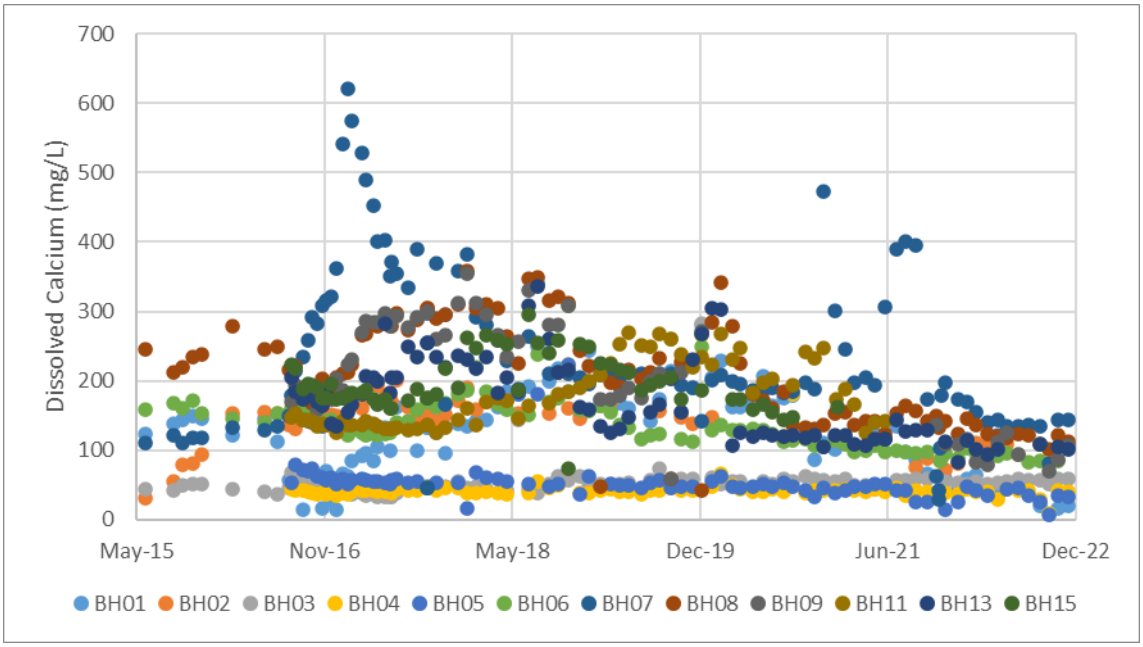


Figure A.9 Groundwater – dissolved calcium

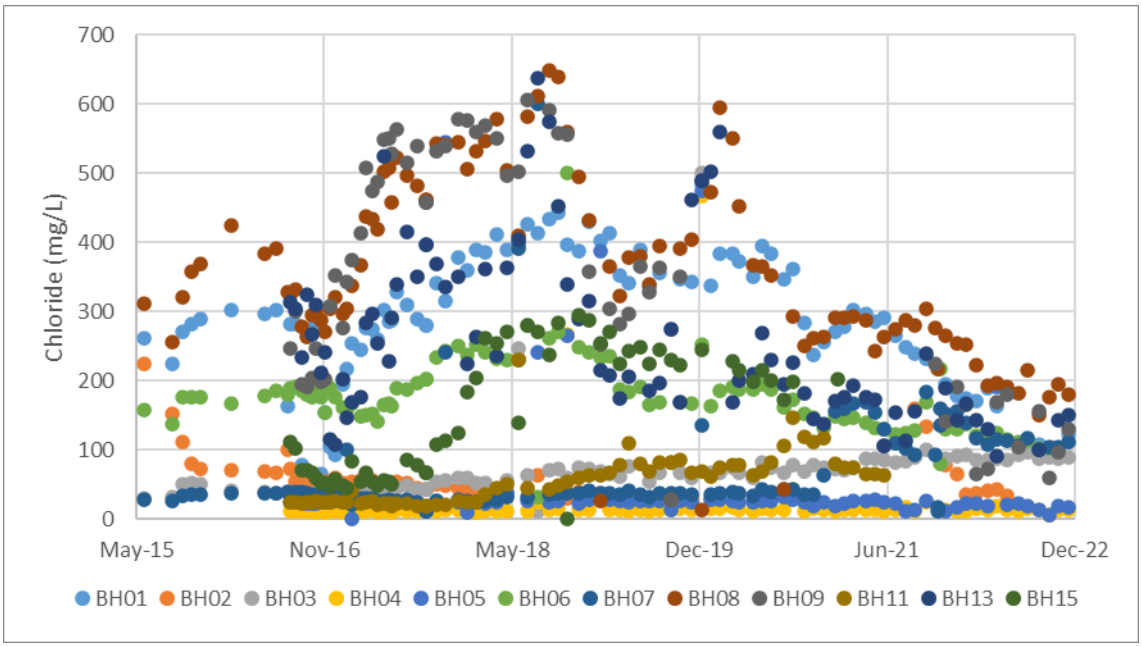


Figure A.10 Groundwater – chloride

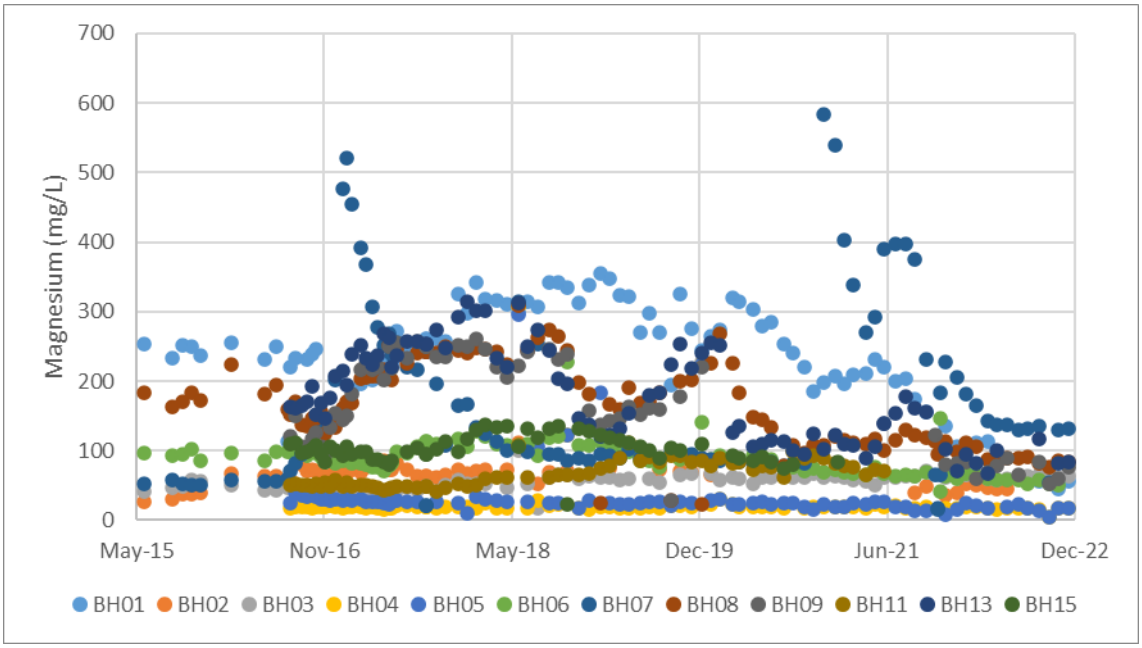


Figure A.11 Groundwater – magnesium

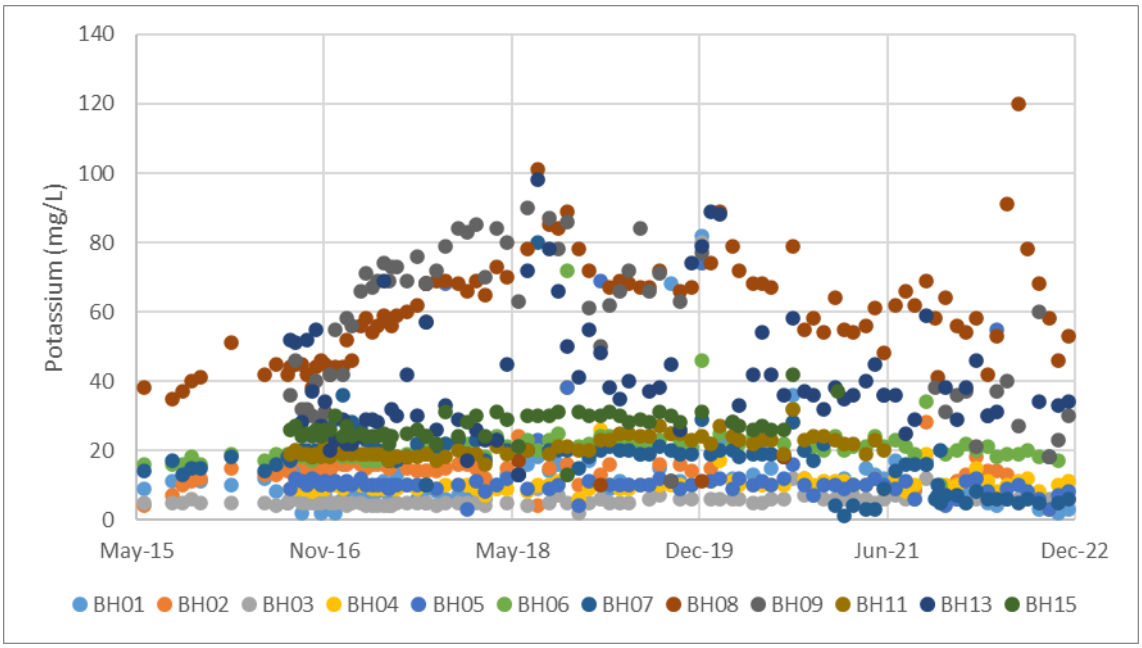


Figure A.12 Groundwater – potassium

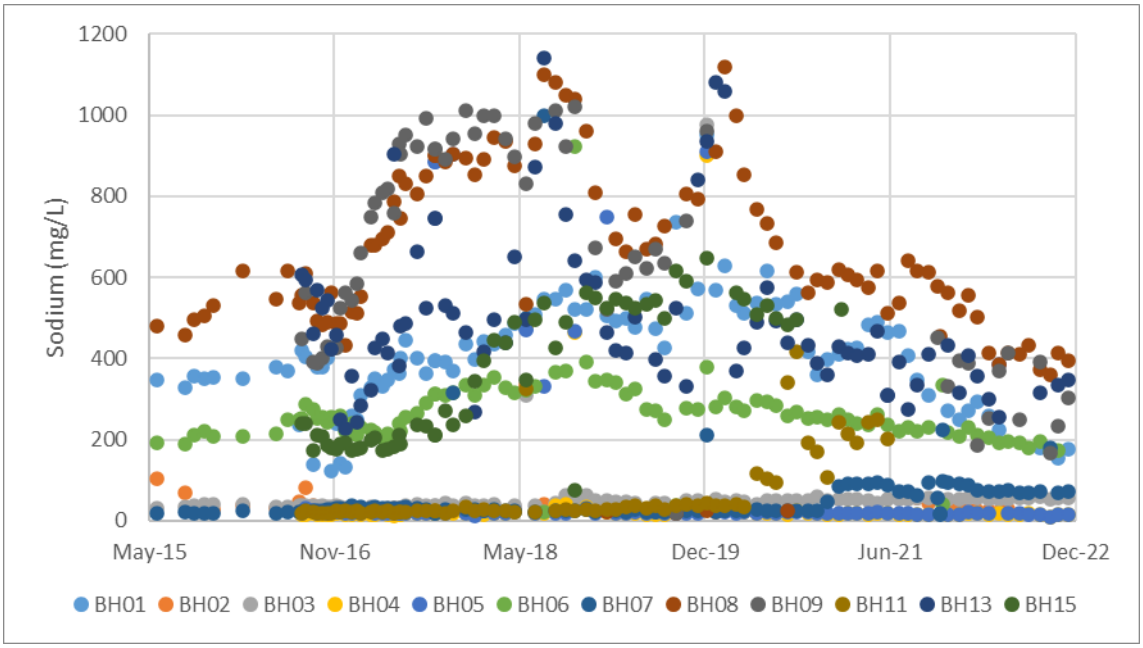


Figure A.13 Groundwater –sodium

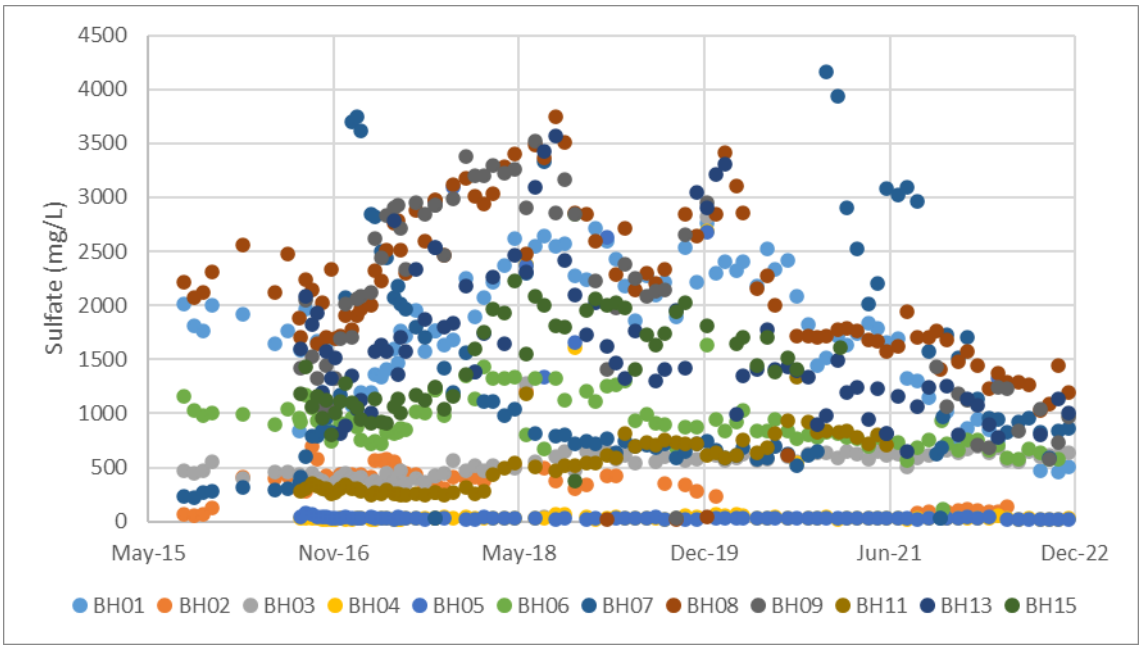


Figure A.14 Groundwater – sulfate

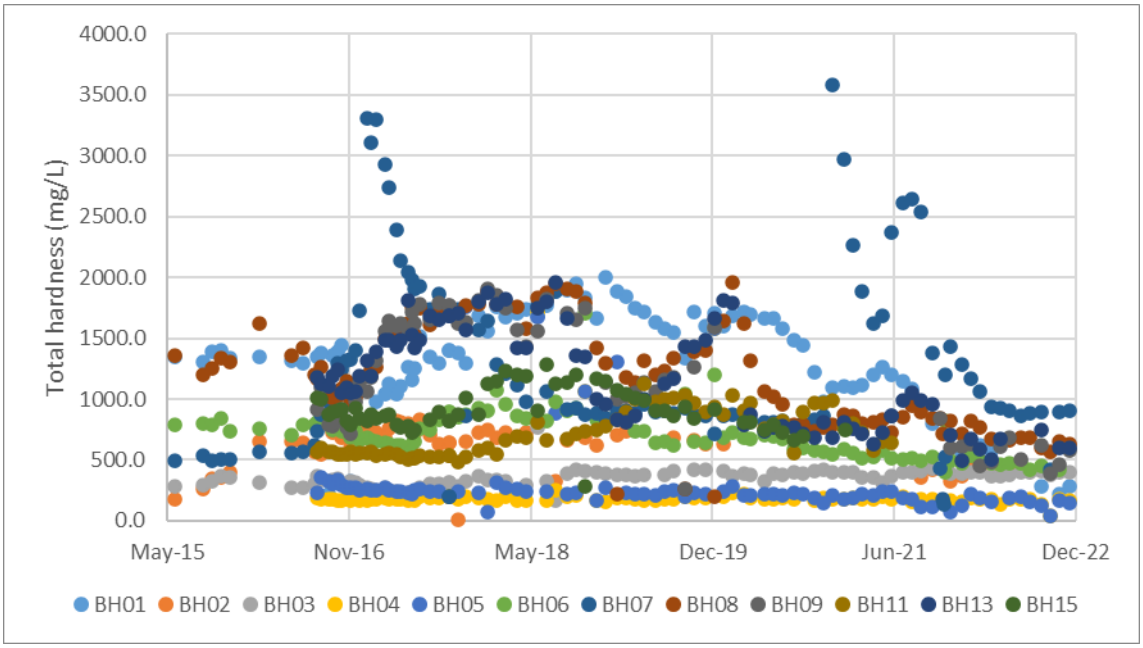


Figure A.15 Groundwater – total hardness

Nutrients

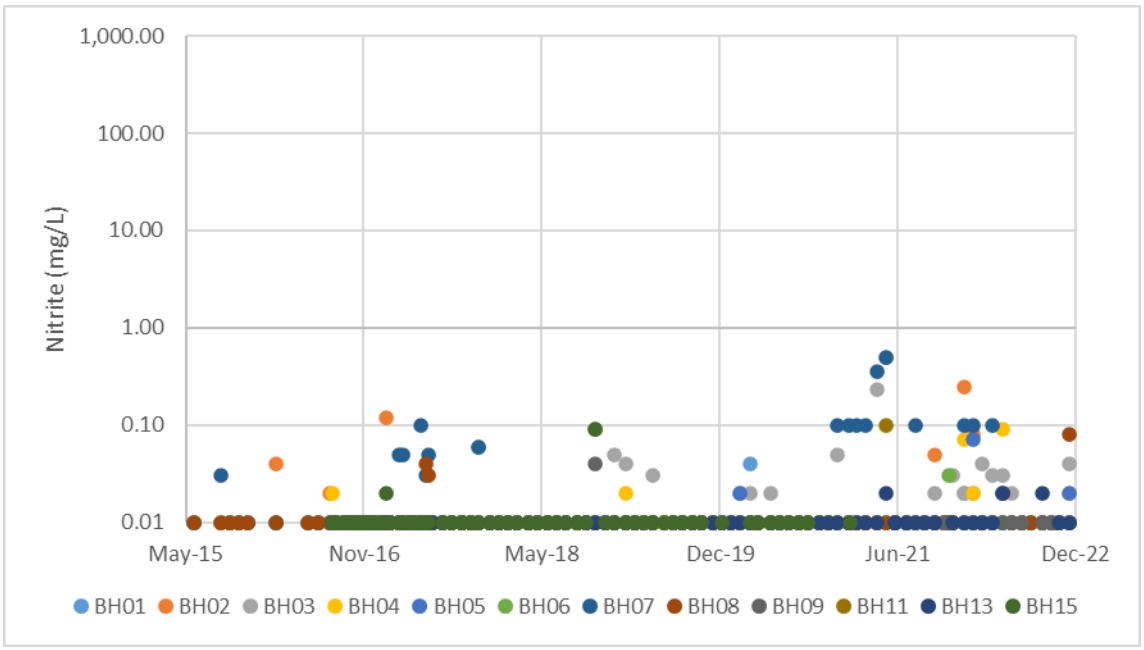


Figure A.16 Groundwater – nitrite

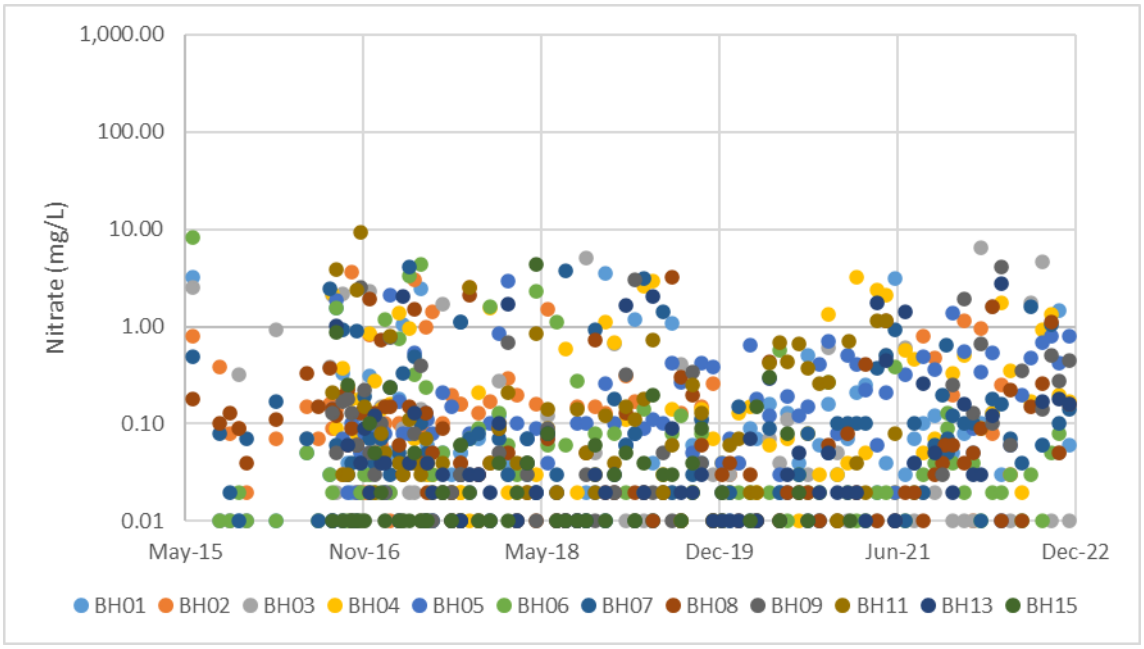


Figure A.17 Groundwater – nitrate

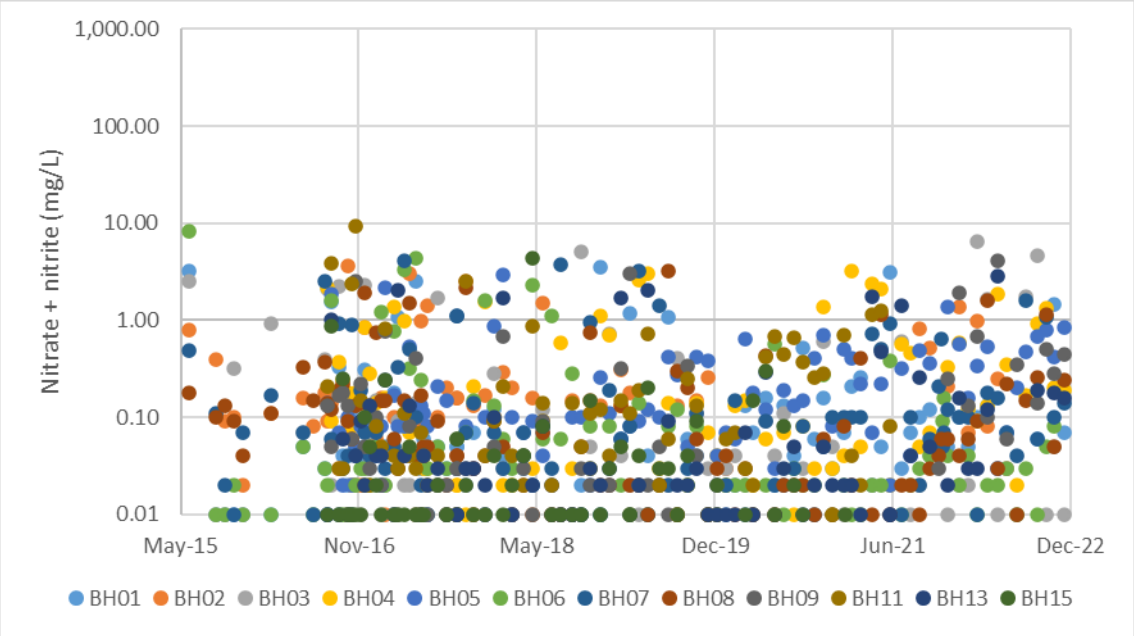


Figure A.18 Groundwater – nitrate + nitrite

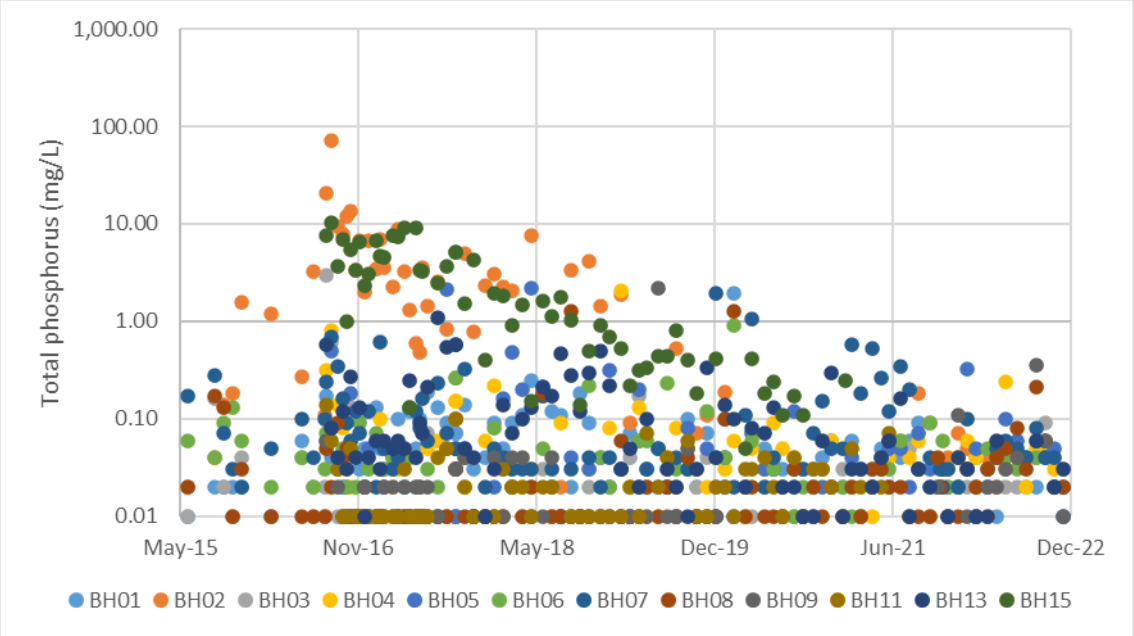


Figure A.19 Groundwater – total phosphorus

Dissolved metals

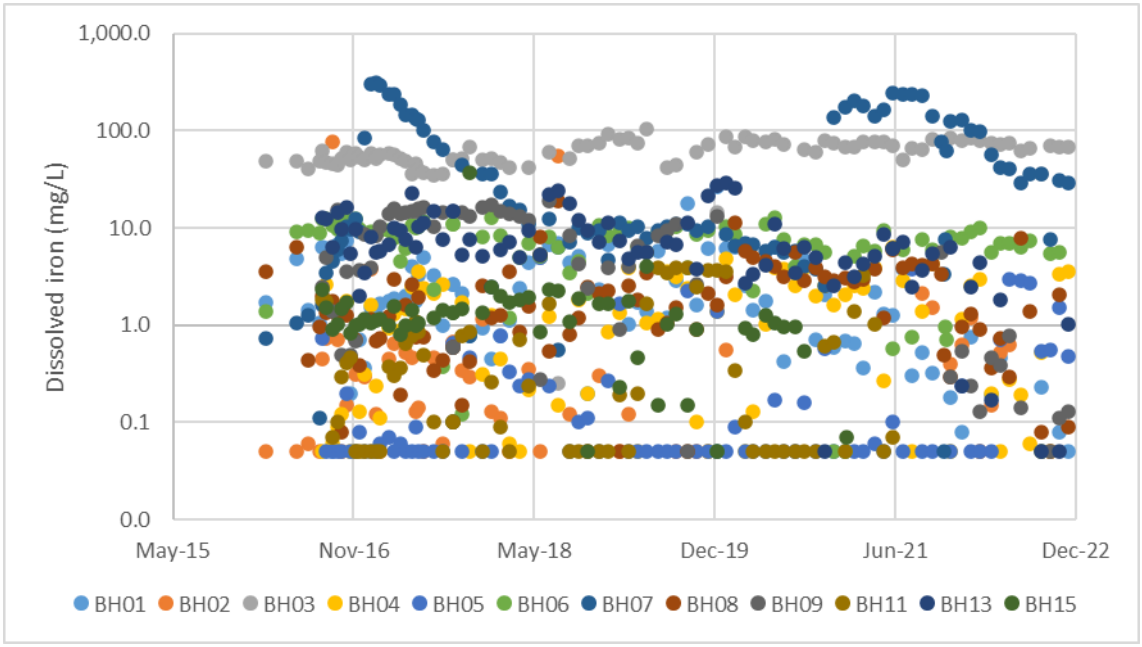


Figure A.20 Groundwater – dissolved iron

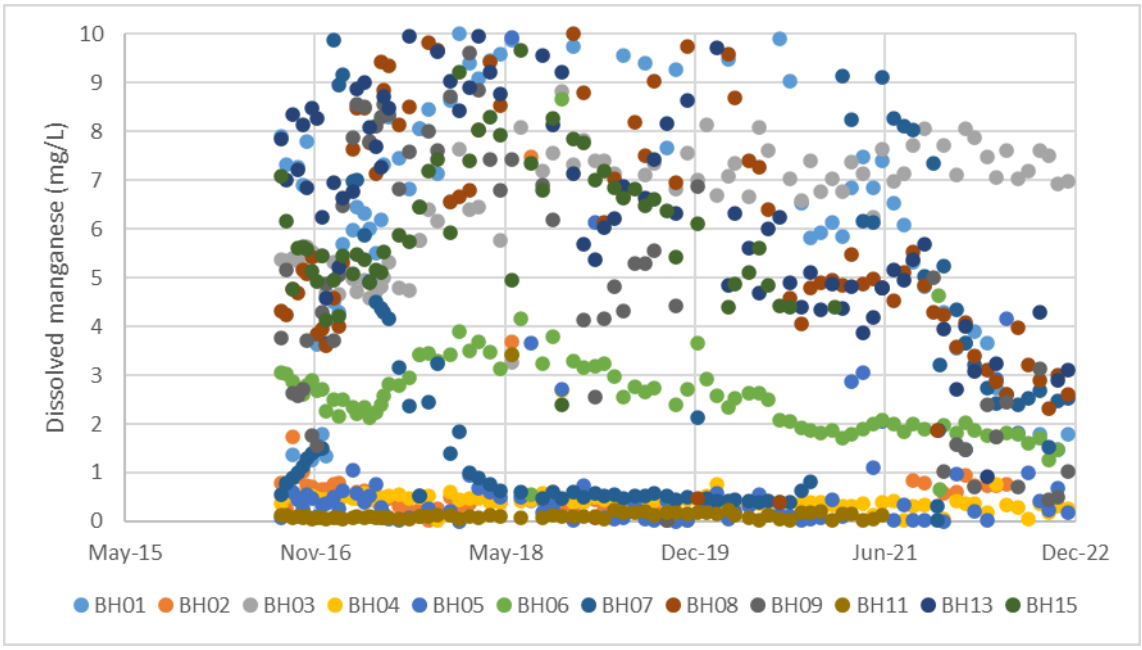


Figure A.21 Groundwater – dissolved manganese

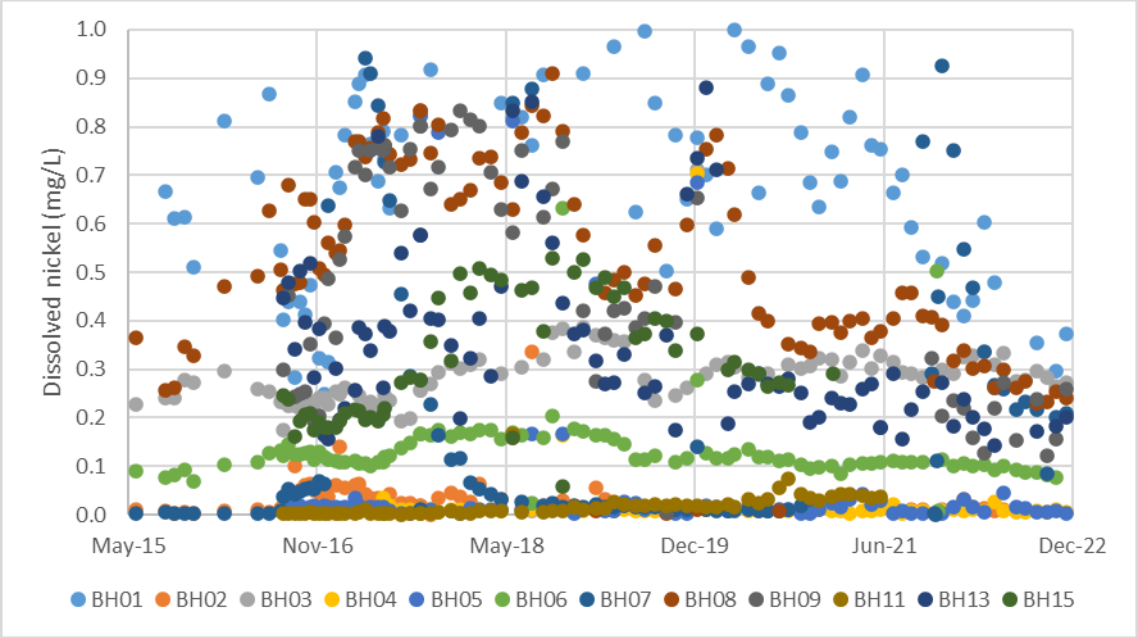


Figure A.22 Groundwater – dissolved nickel

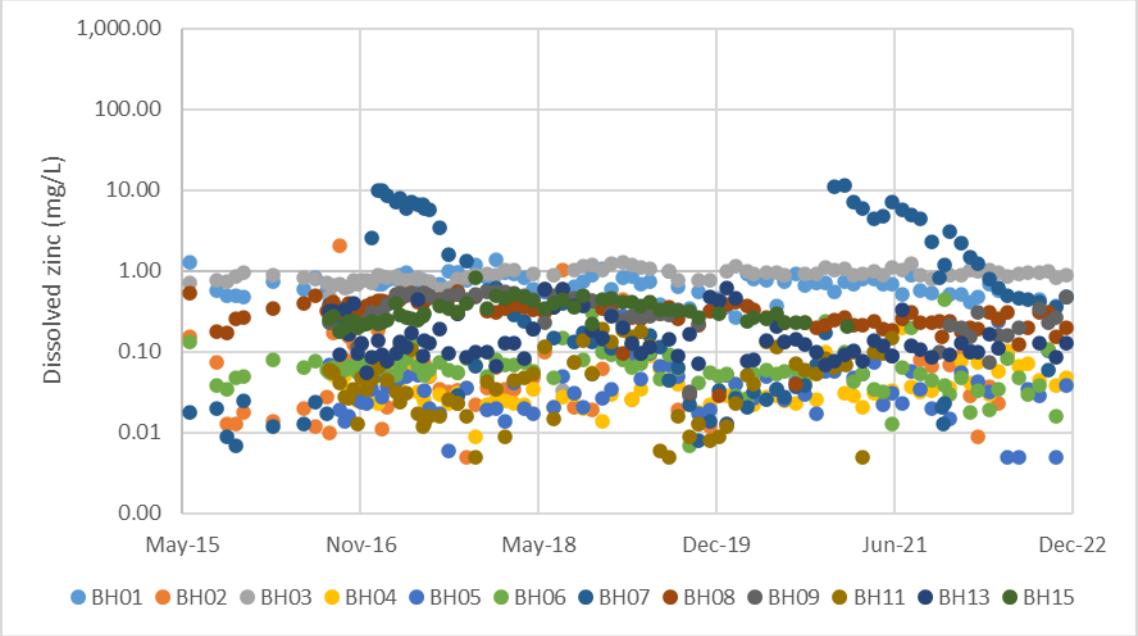


Figure A.23 Groundwater – dissolved zinc

Total Metals

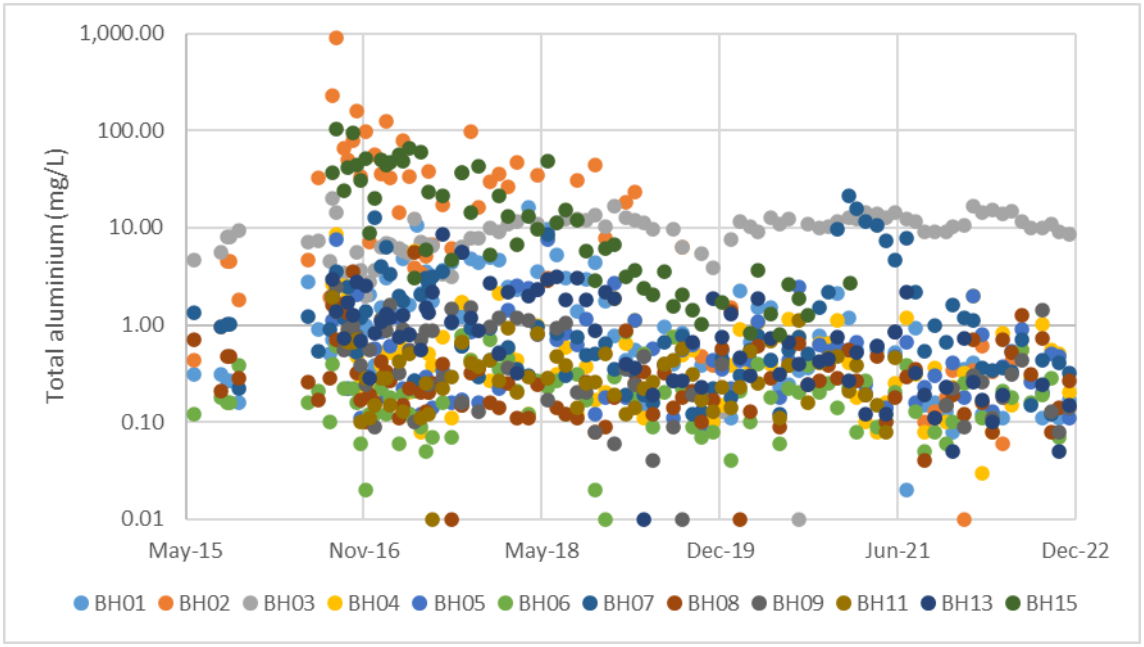


Figure A.24 Groundwater – total aluminium

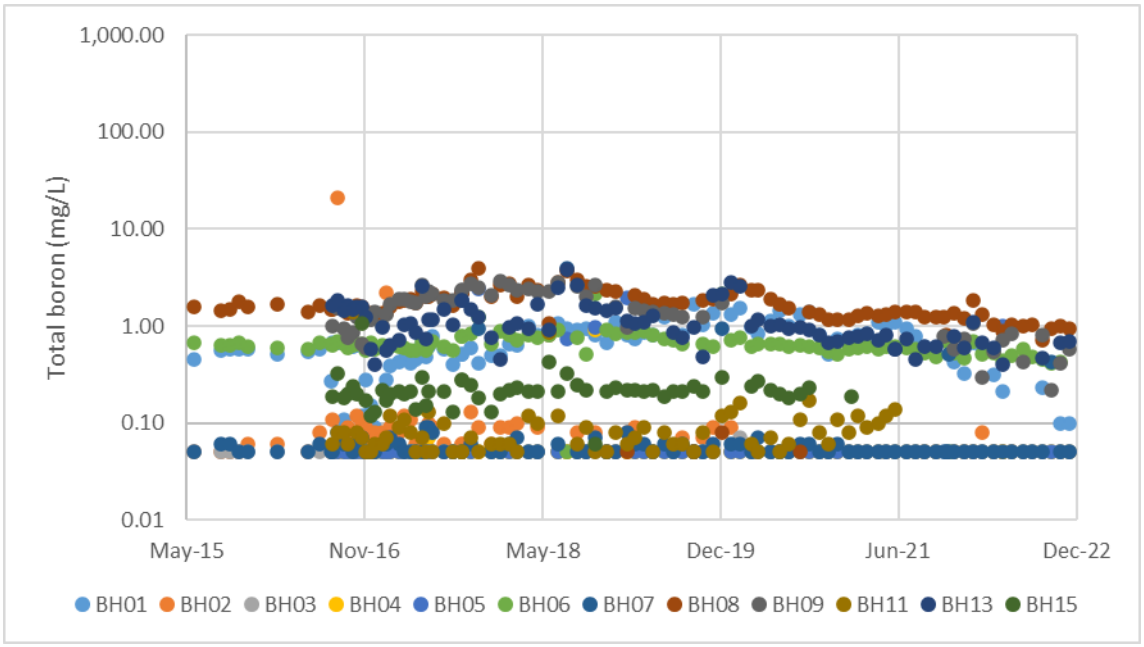


Figure A.25 Groundwater – total boron

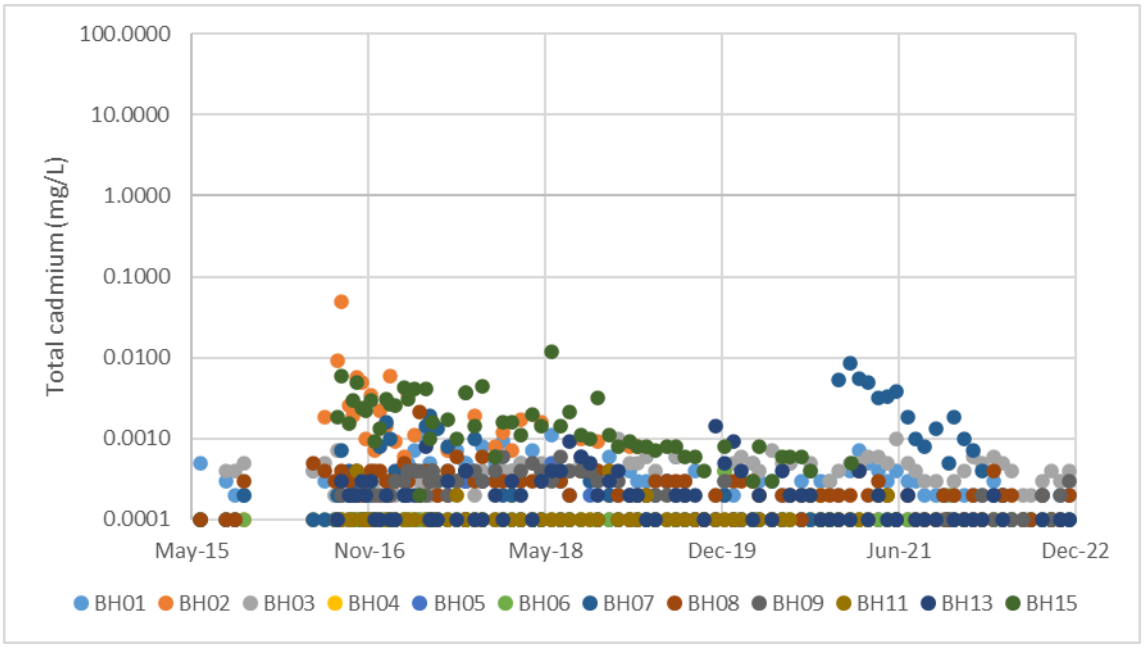


Figure A.26 Groundwater – total cadmium

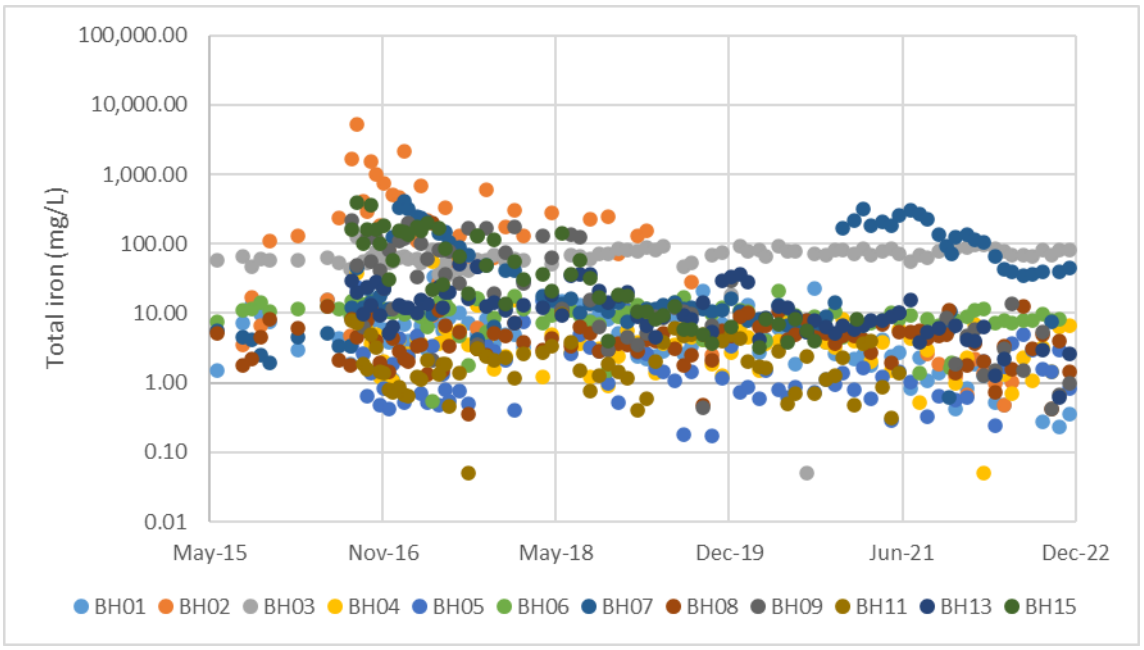


Figure A.27 Groundwater – total iron

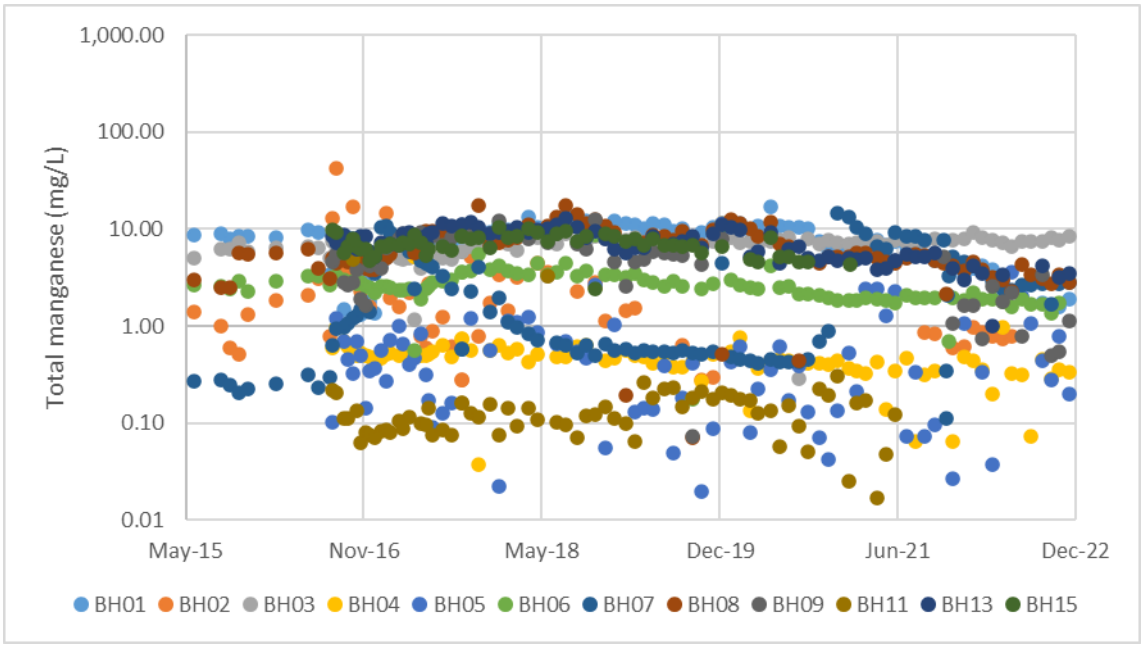


Figure A.28 *Groundwater – total manganese*

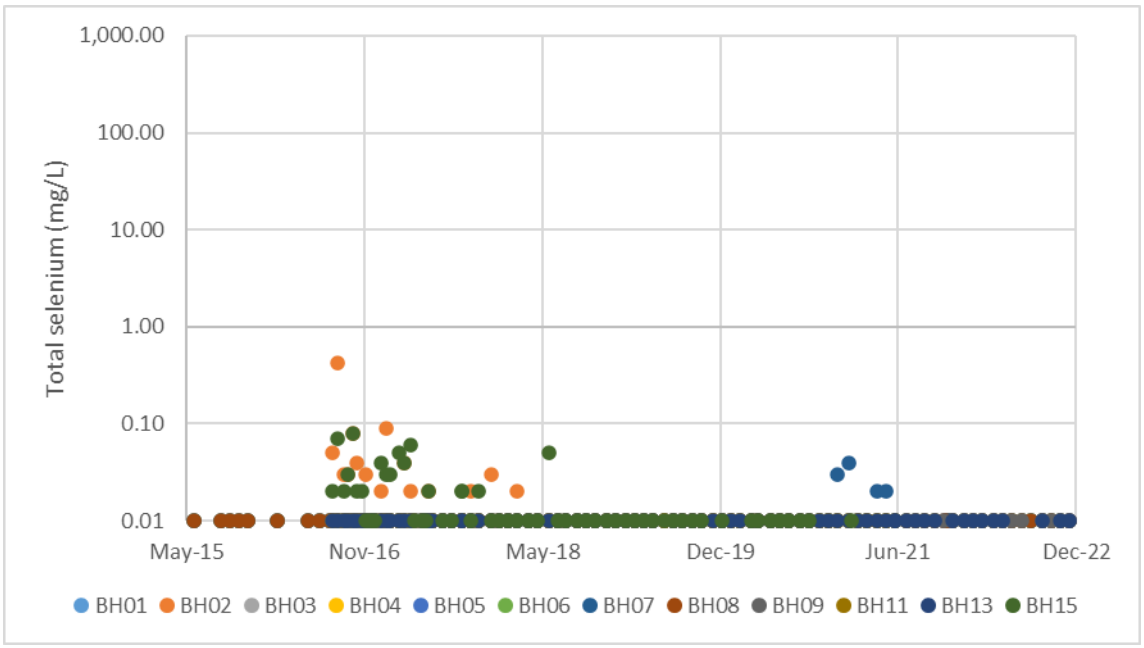


Figure A.29 *Groundwater – total selenium*

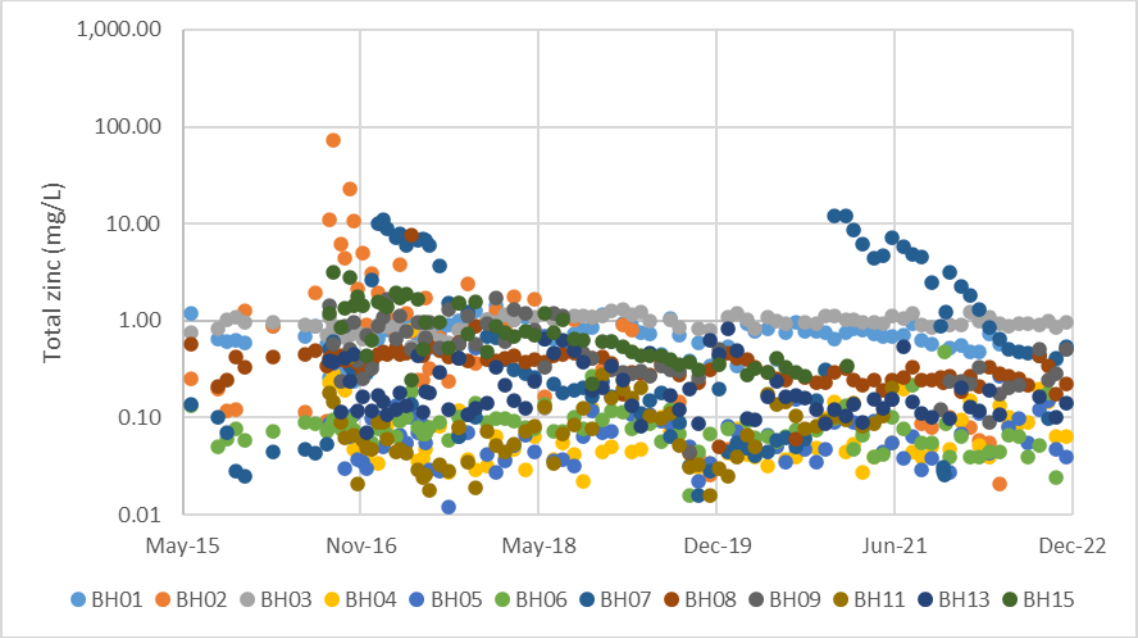


Figure A.30 Groundwater – total zinc

LDP001

Physicochemical

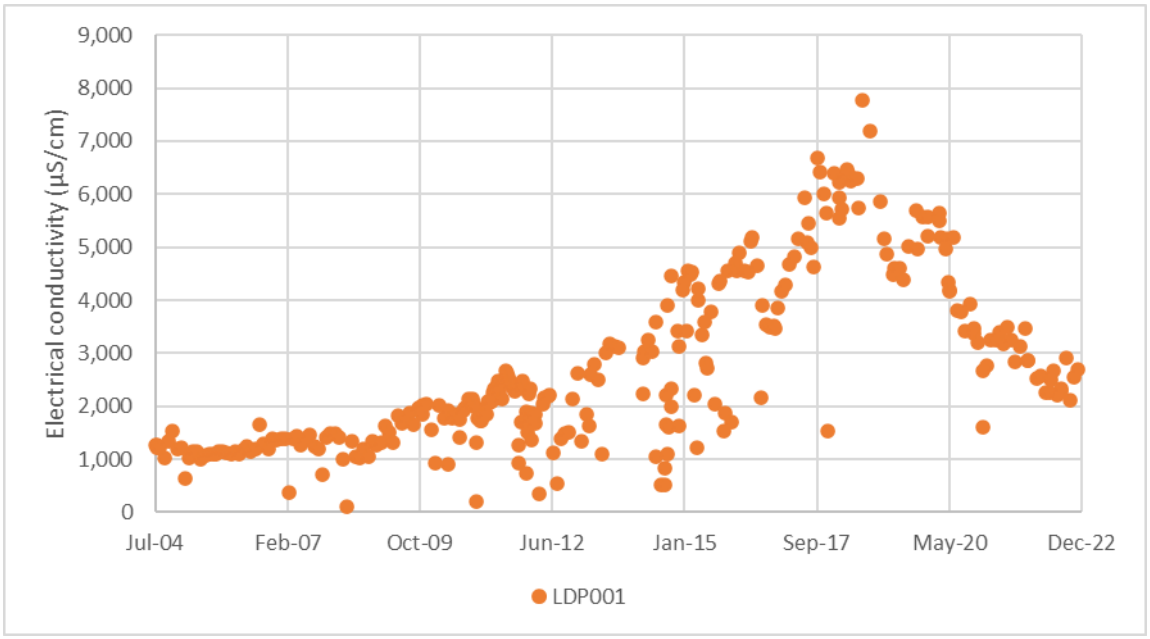


Figure A.31 LDP001 - EC

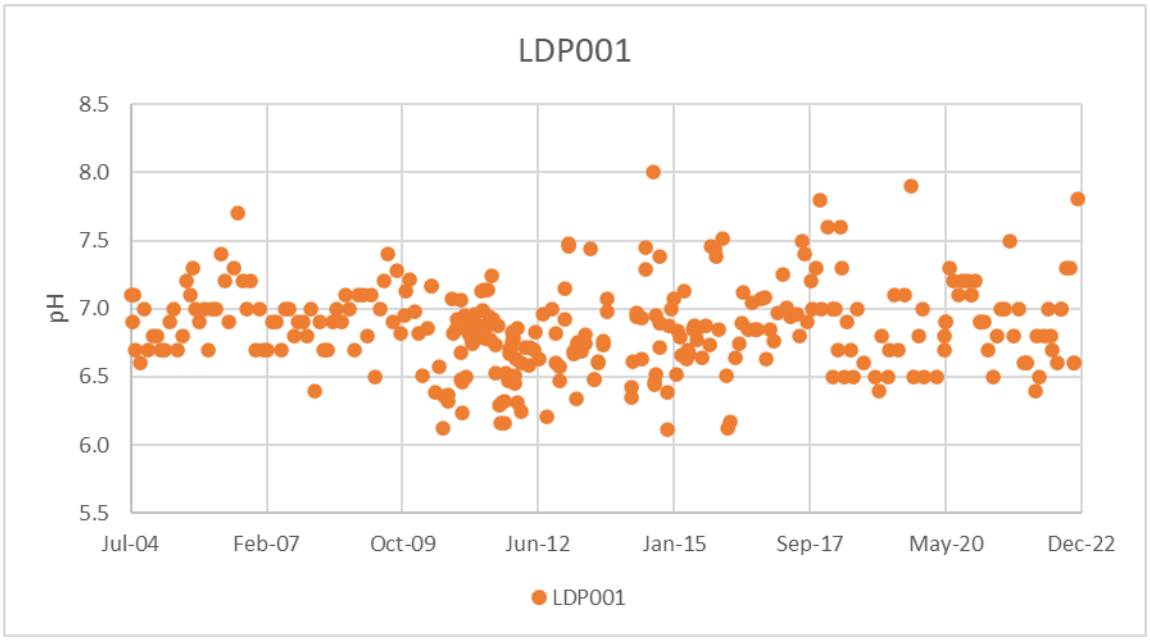


Figure A.32 LDP001 - pH

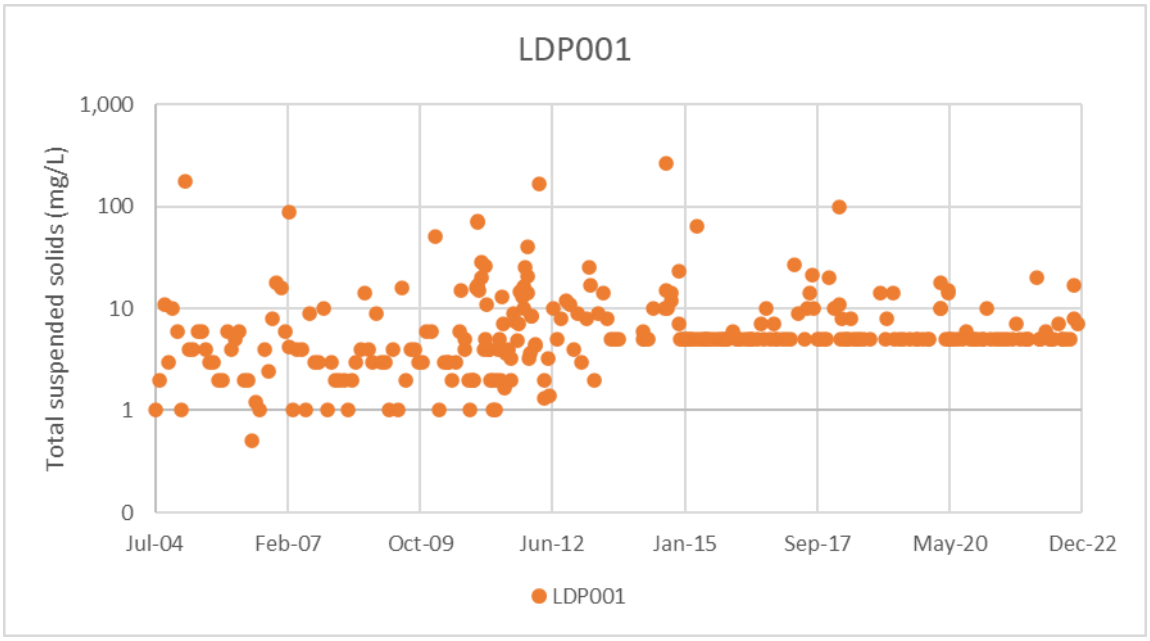


Figure A.33 LDP001 - TSS

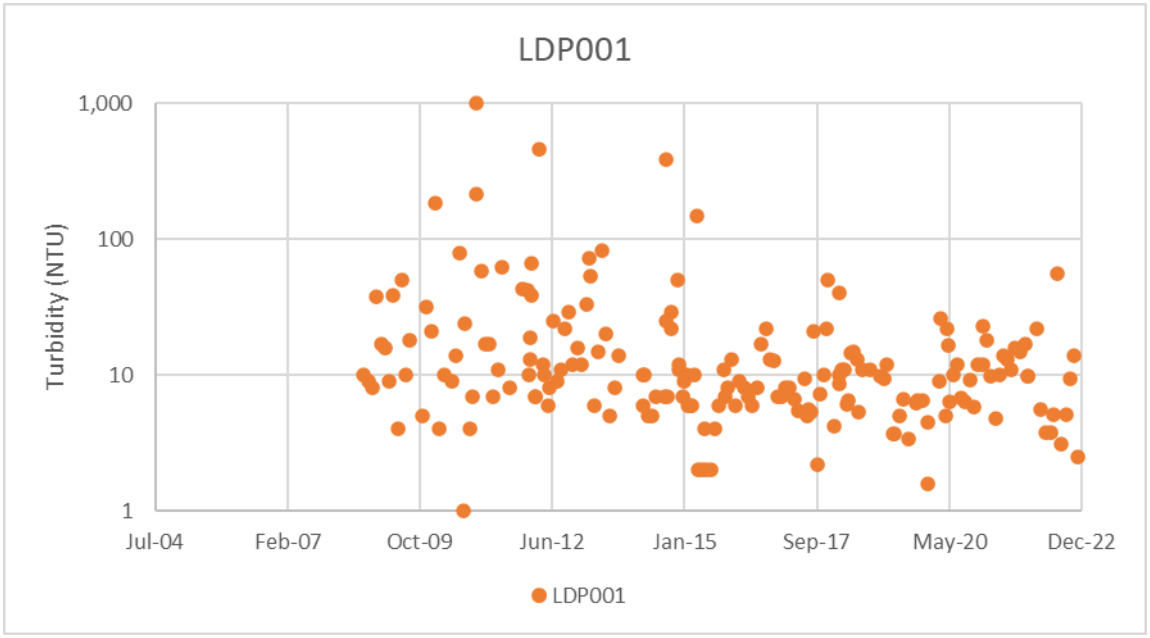


Figure A.34 LDP001 - Turbidity

Dissolved metals

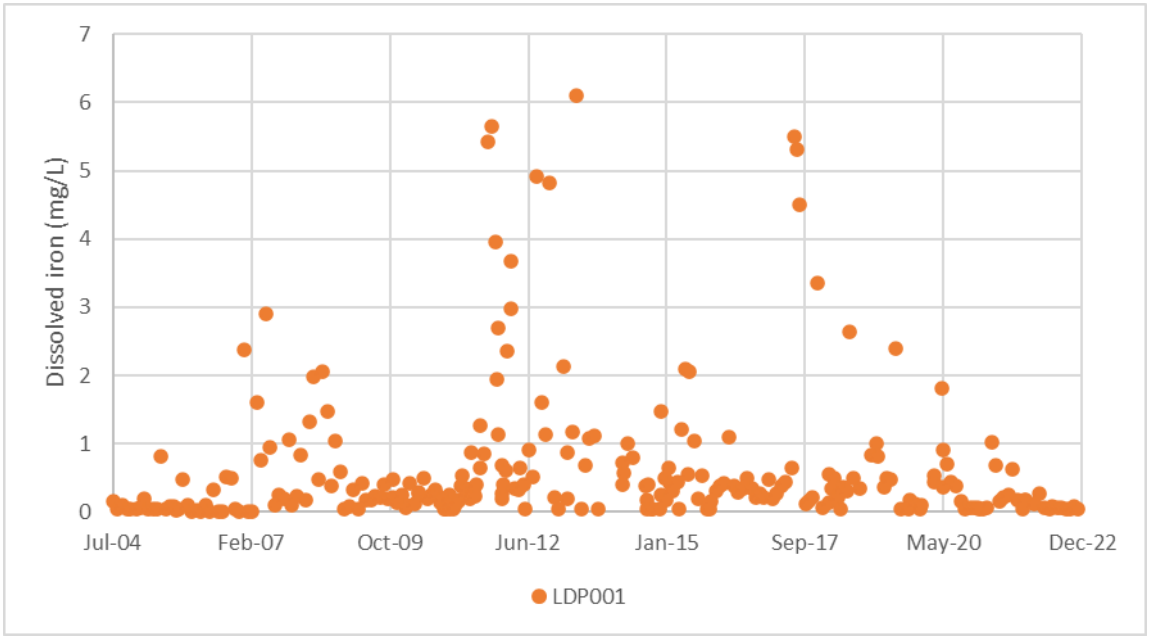


Figure A.35 LDP001 - dissolved iron

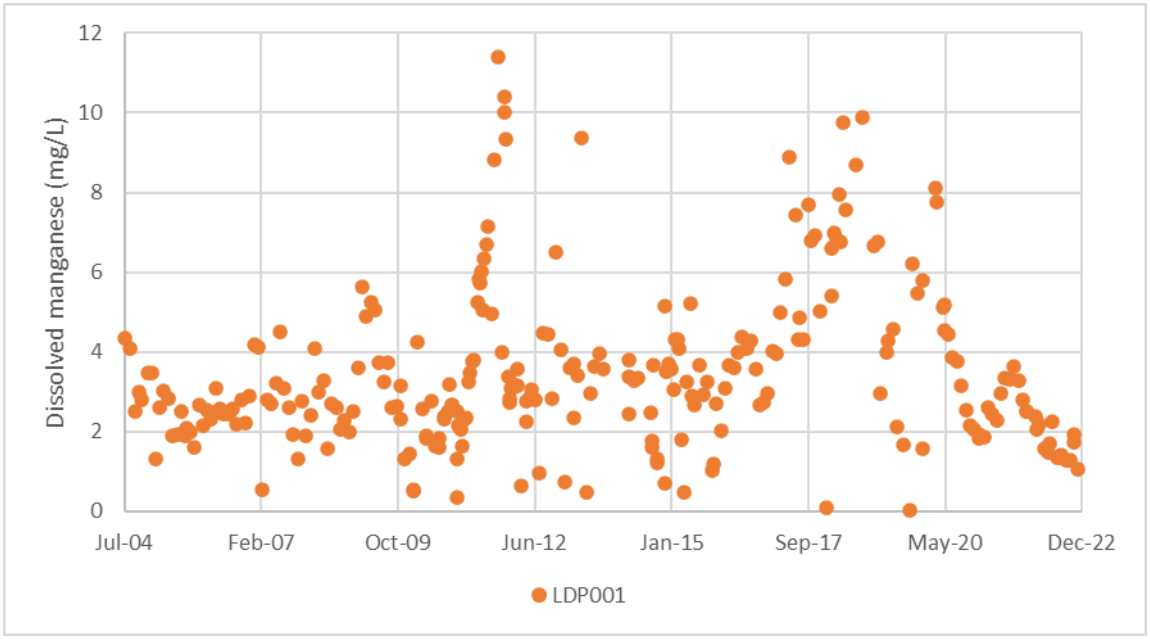


Figure A.36 LDP001 - dissolved manganese

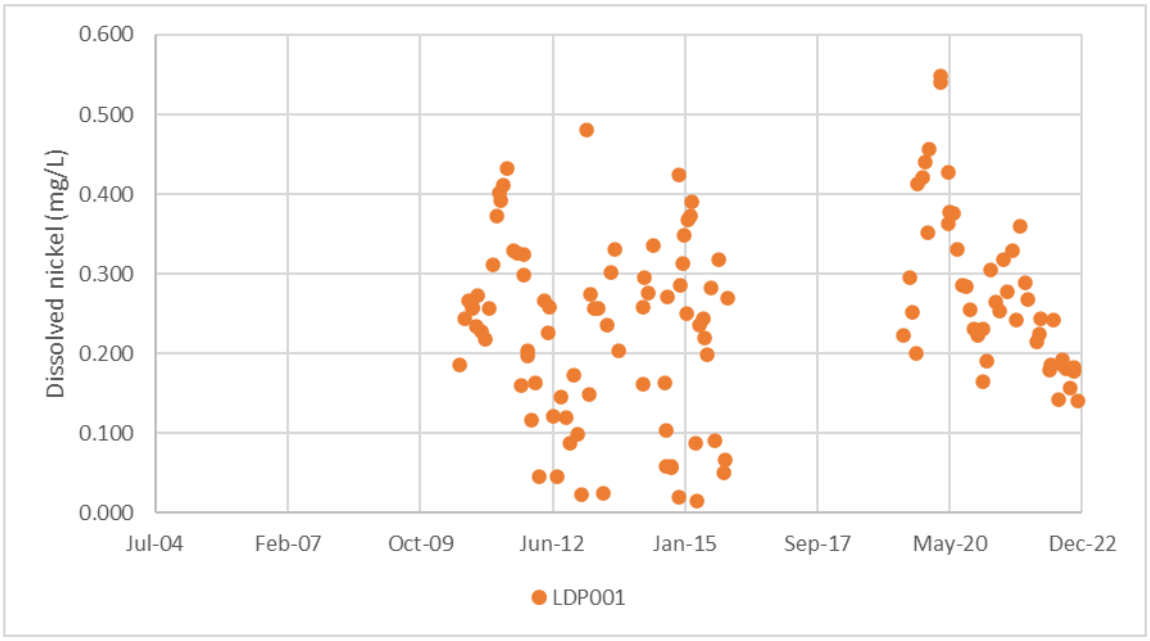


Figure A.37 LDP001 - dissolved nickel

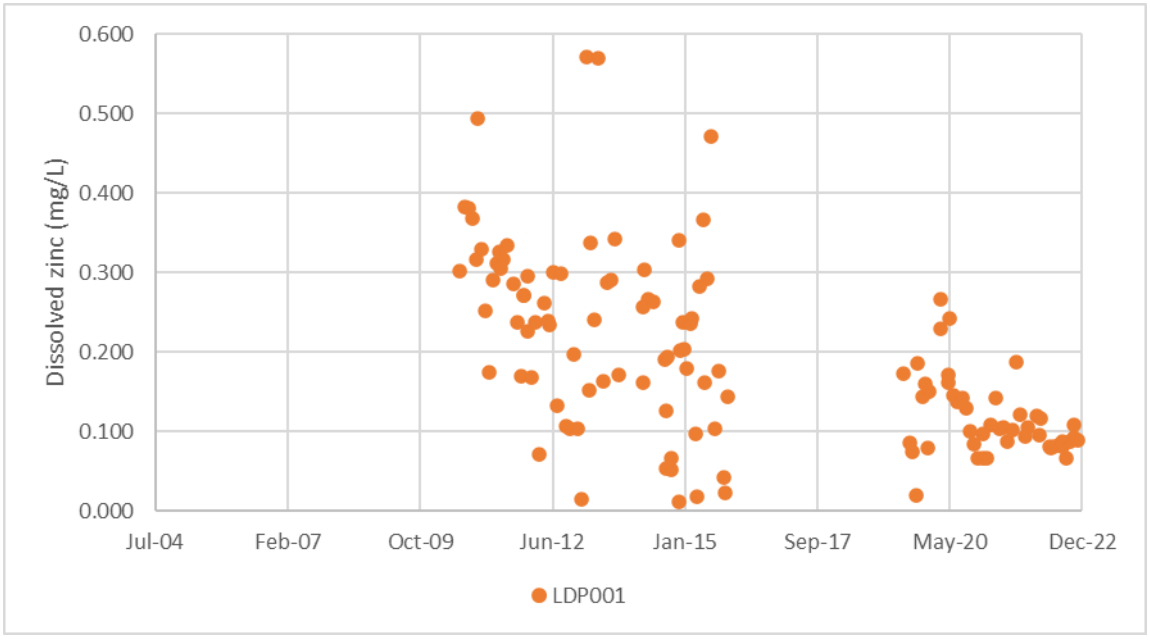


Figure A.38 LDP001 - dissolved zinc

Other

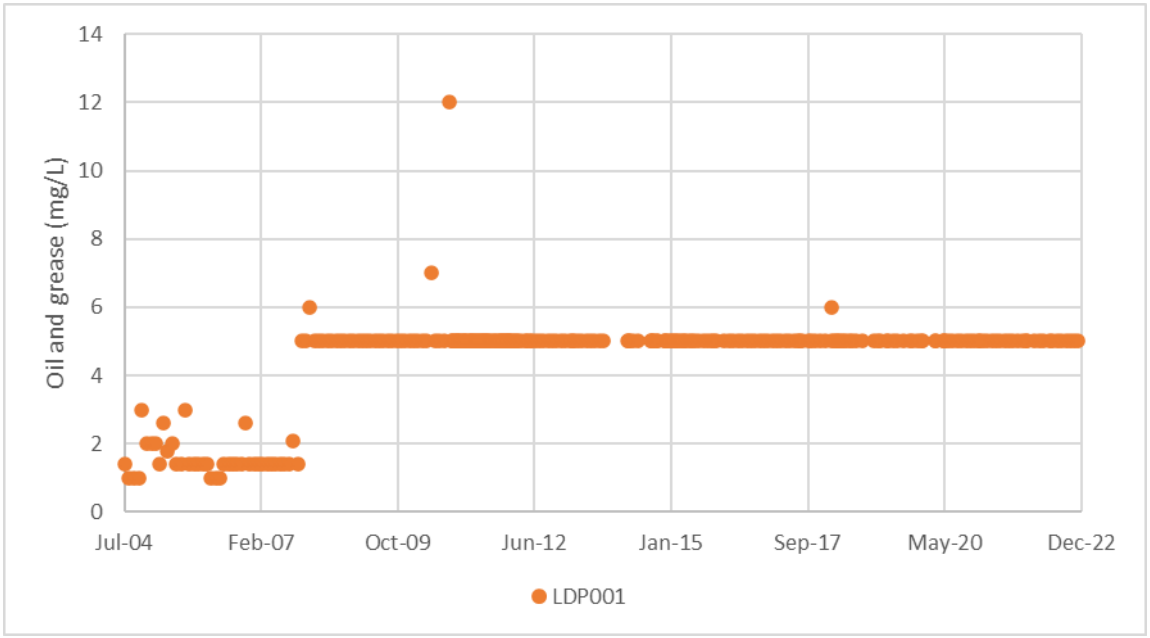


Figure A.39 LDP001 - oil and grease

On-Site Surface Water Storages

Physicochemical

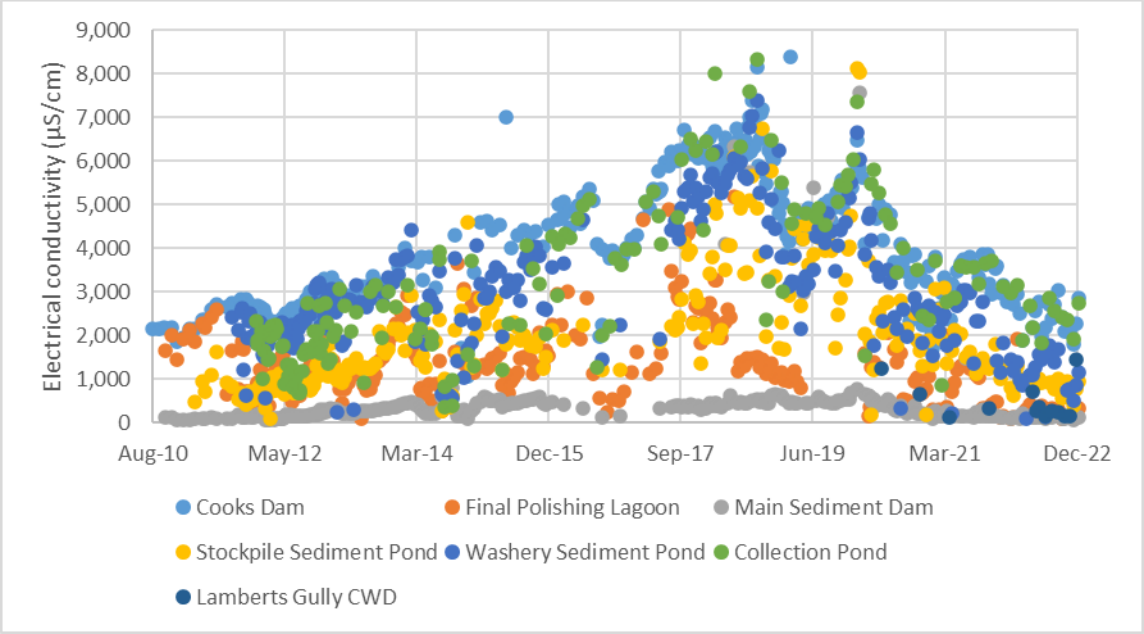


Figure A.40 *On-site storages – EC*

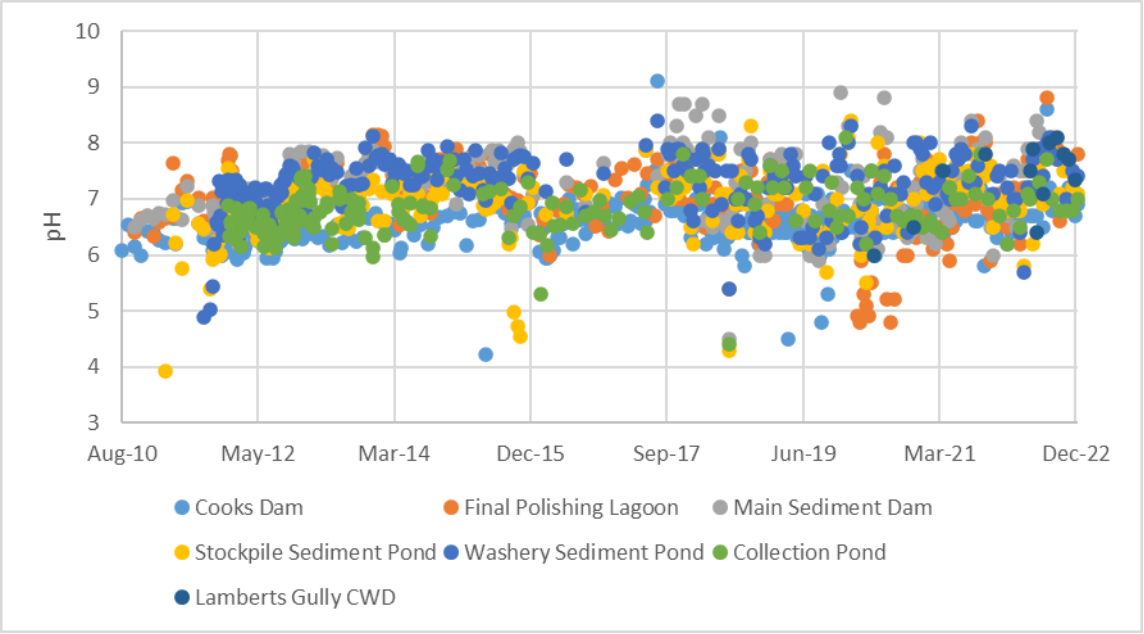


Figure A.41 *On-site storages – pH*

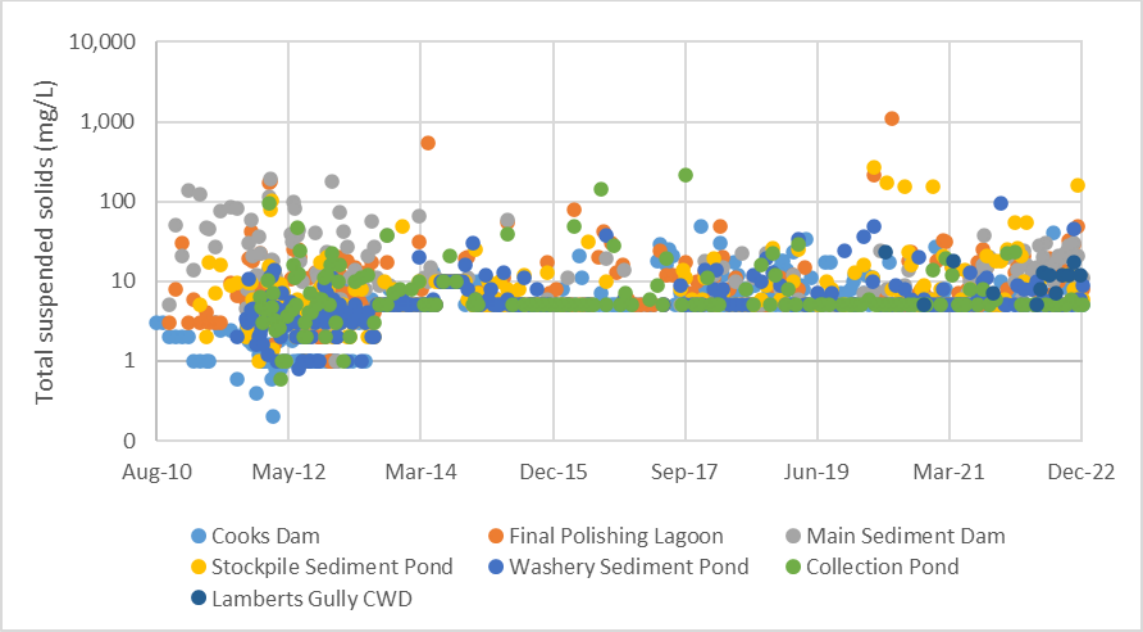


Figure A.42 On-site storages – TSS

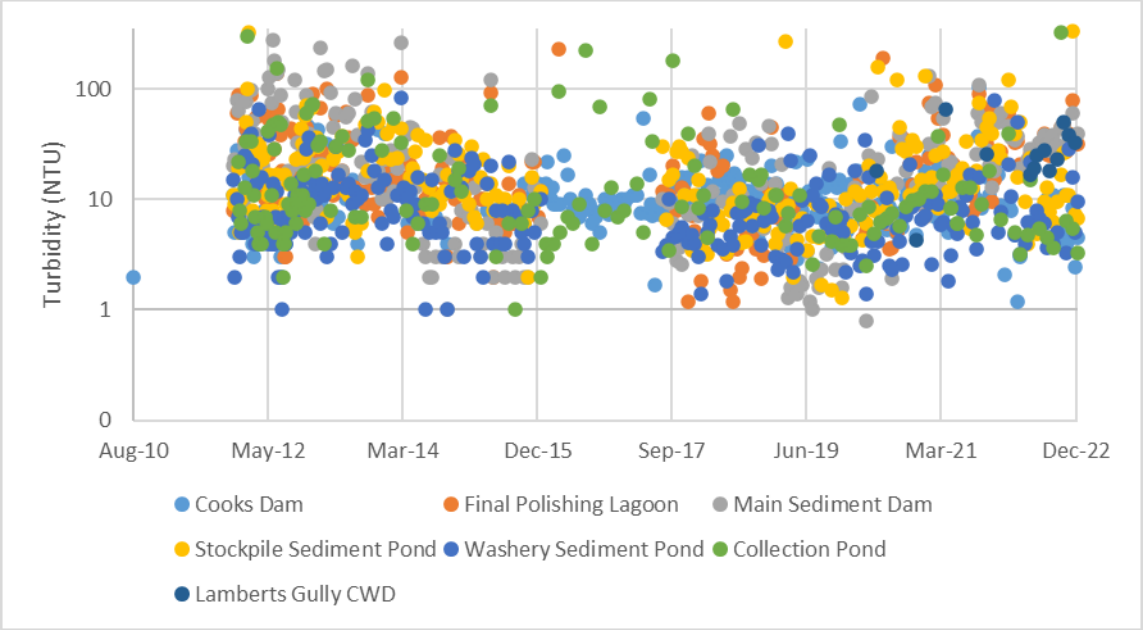


Figure A.43 On-site storages – turbidity

Major Ions

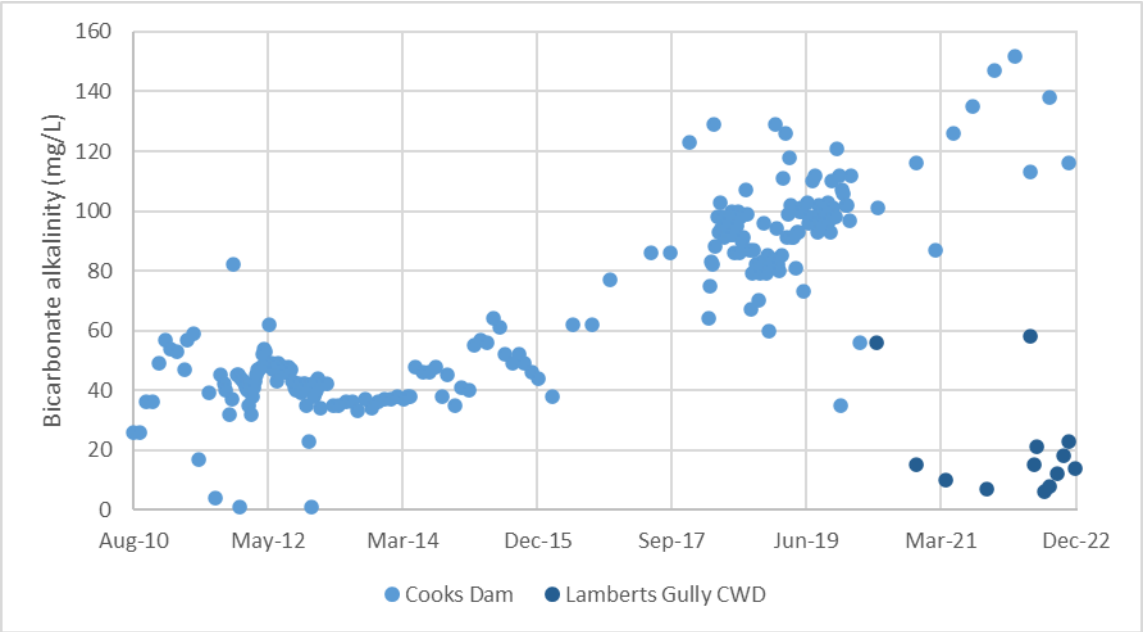


Figure A.44 On-site storages – bicarbonate alkalinity

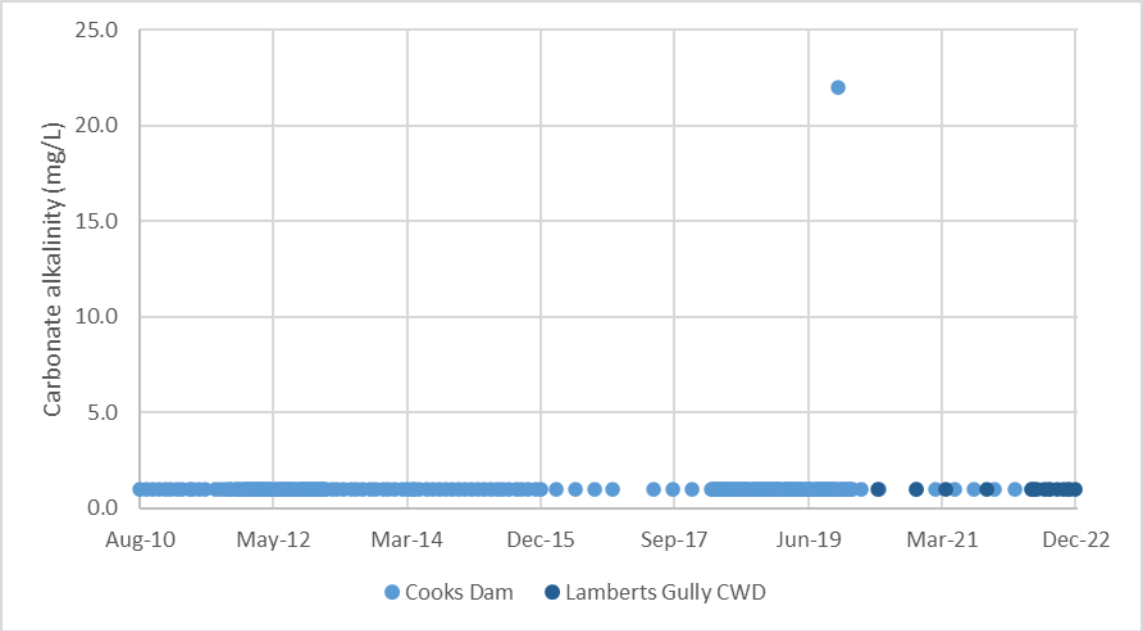


Figure A.45 On-site storages – carbonate alkalinity

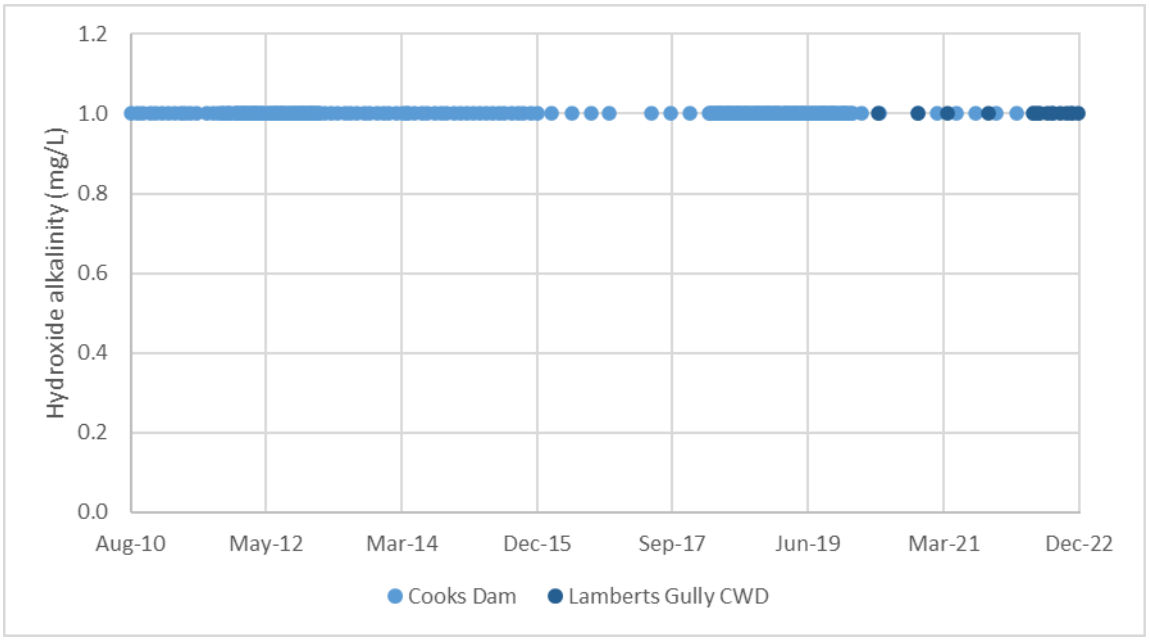


Figure A.46 On-site storages – hydroxide alkalinity

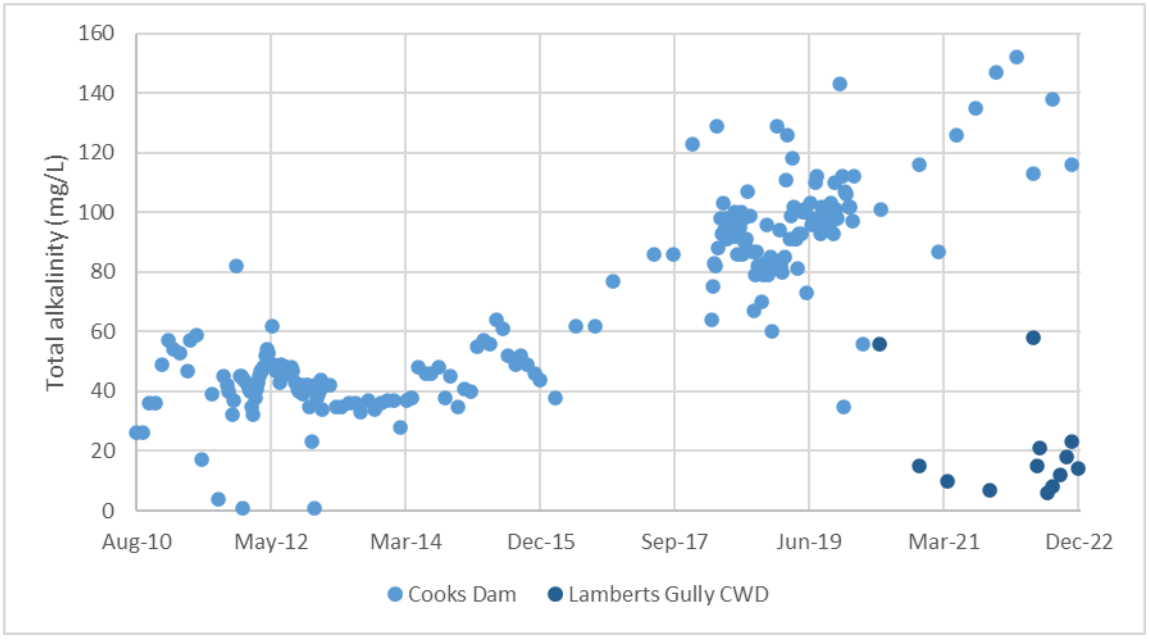


Figure A.47 On-site storages – total alkalinity

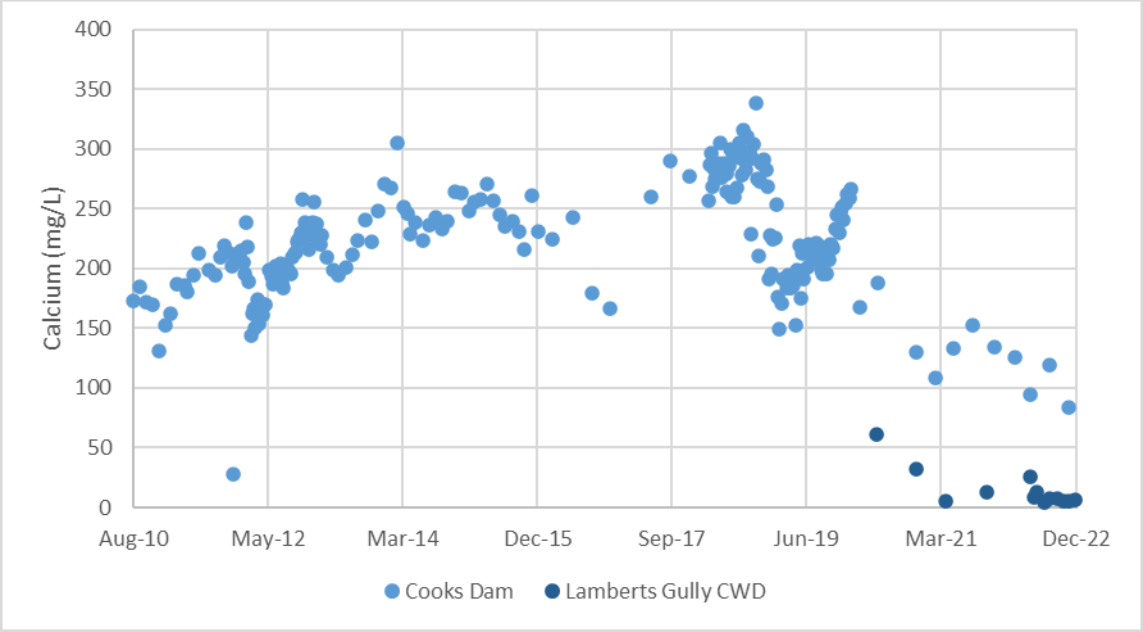


Figure A.48 On-site storages – calcium

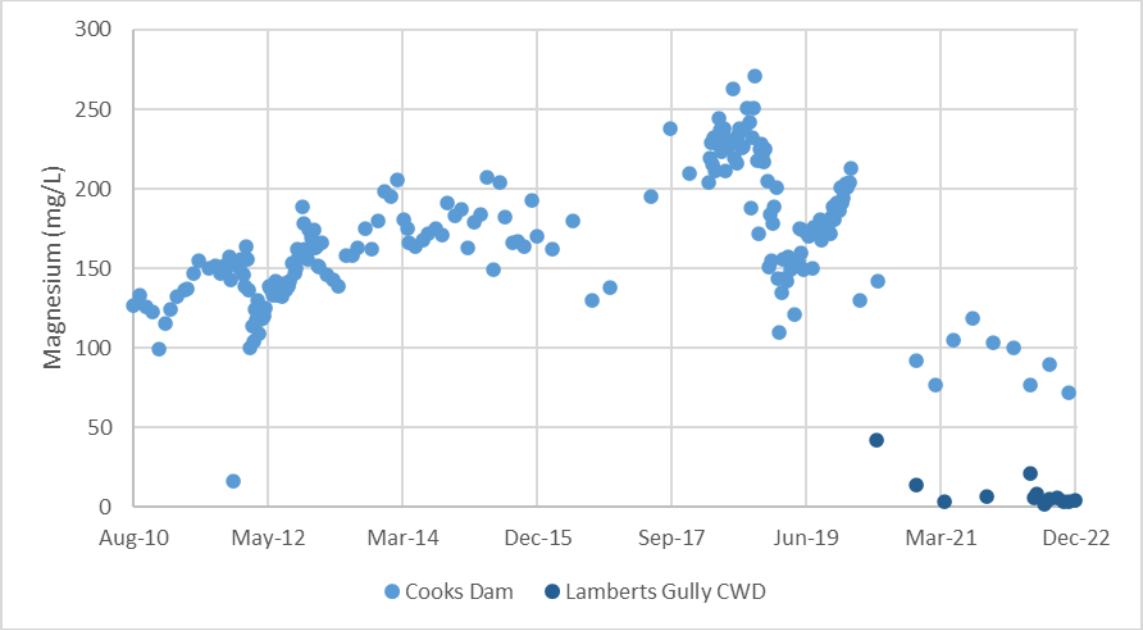


Figure A.49 On-site storages – magnesium

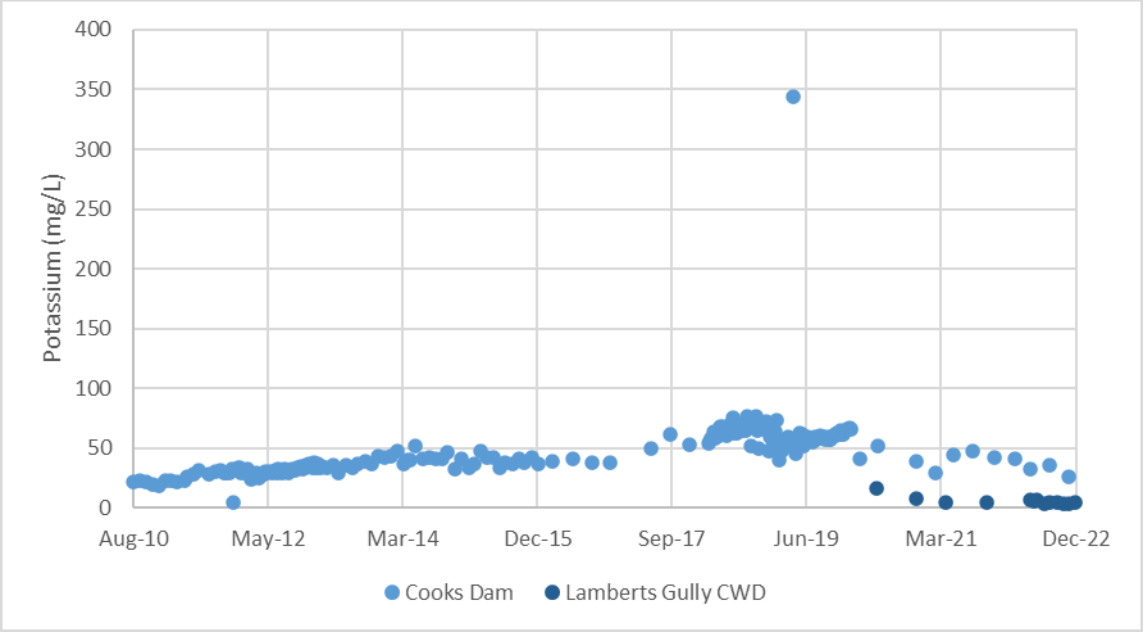


Figure A.50 *On-site storages – potassium*

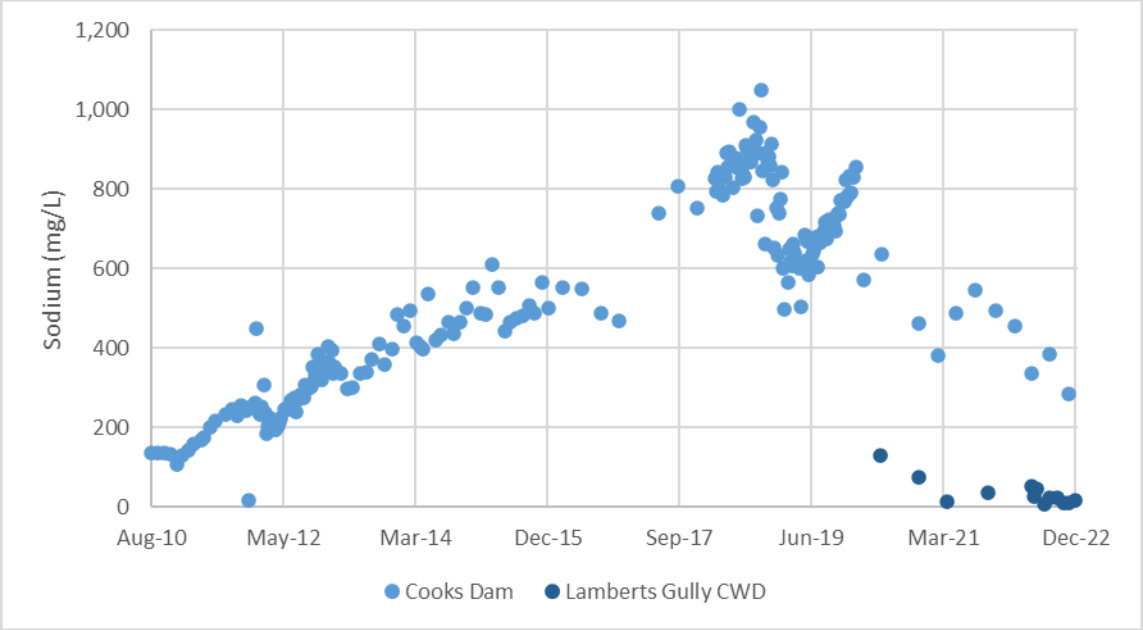


Figure A.51 *On-site storages – sodium*

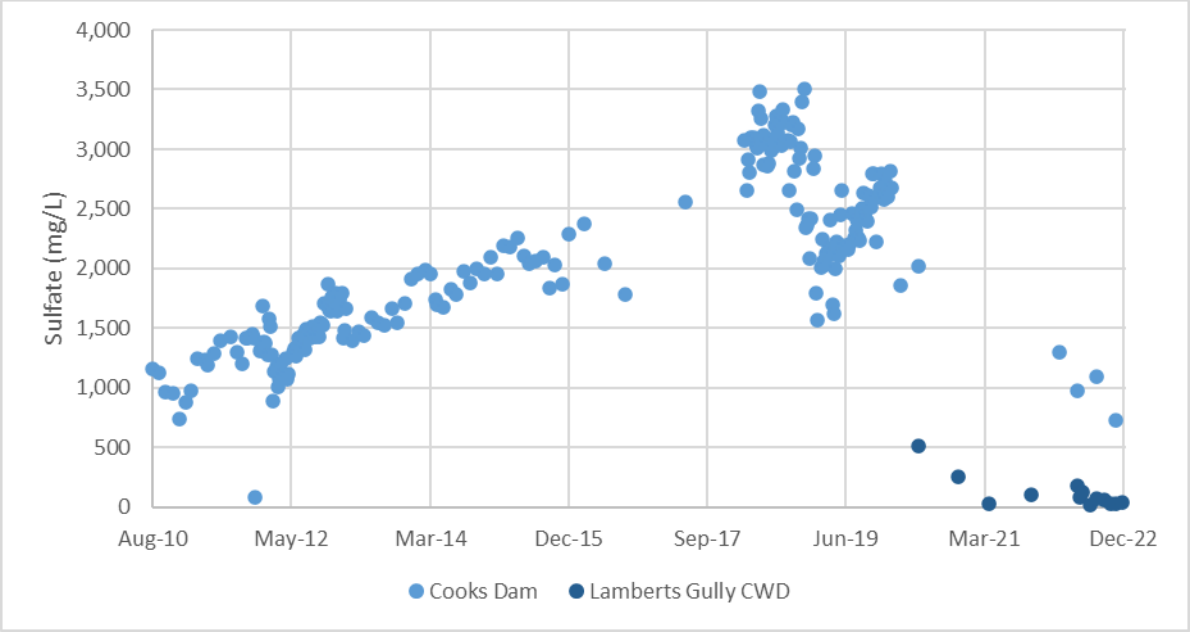


Figure A.52 On-site storages – sulfate

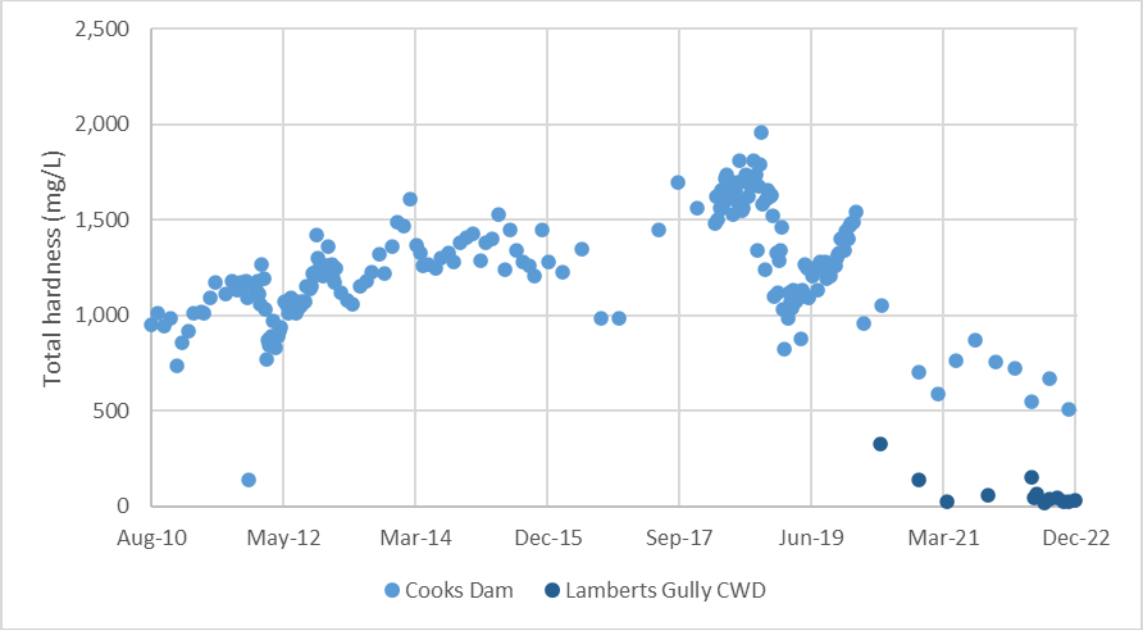


Figure A.53 On-site storages – total hardness

Nutrients

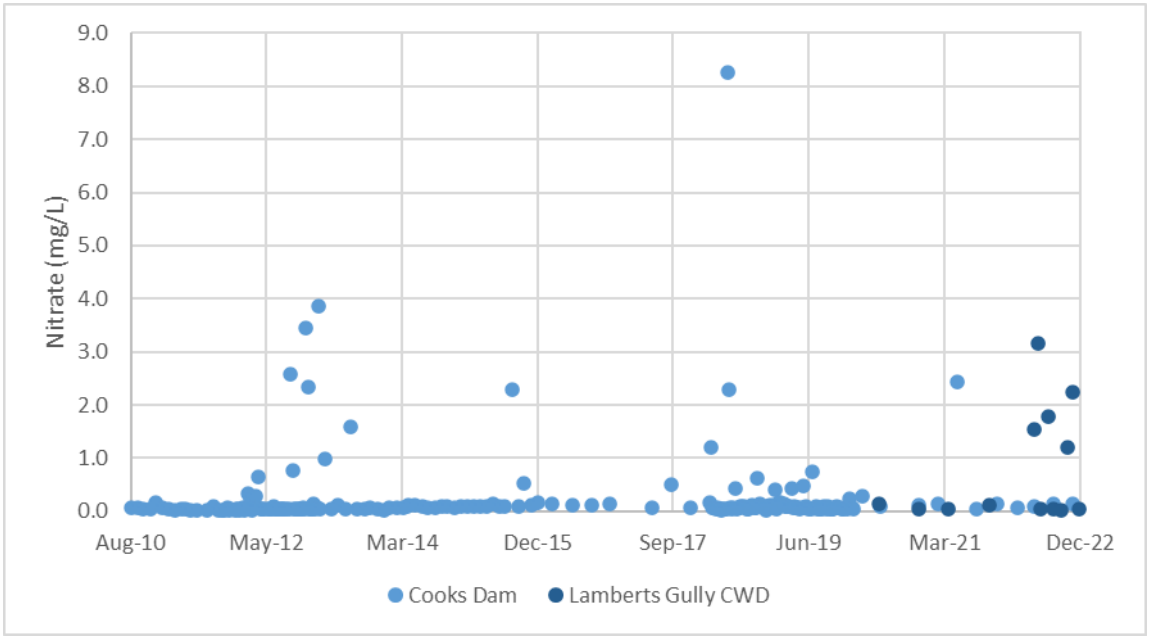


Figure A.6.54 On-site storages – nitrate

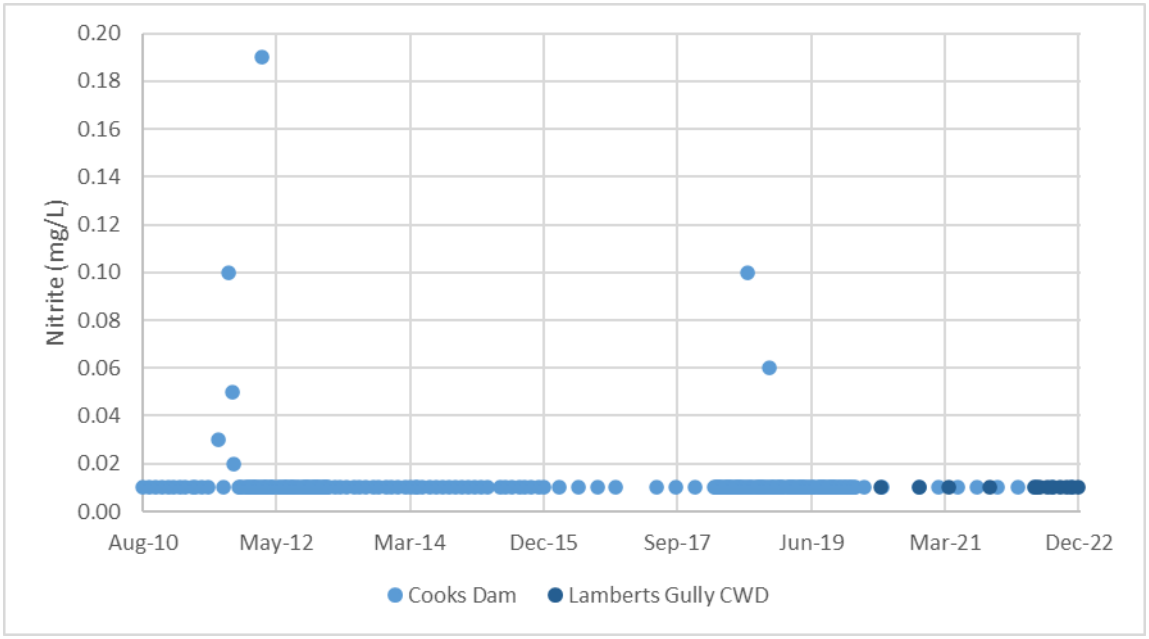


Figure A.55 On-site storages – nitrite

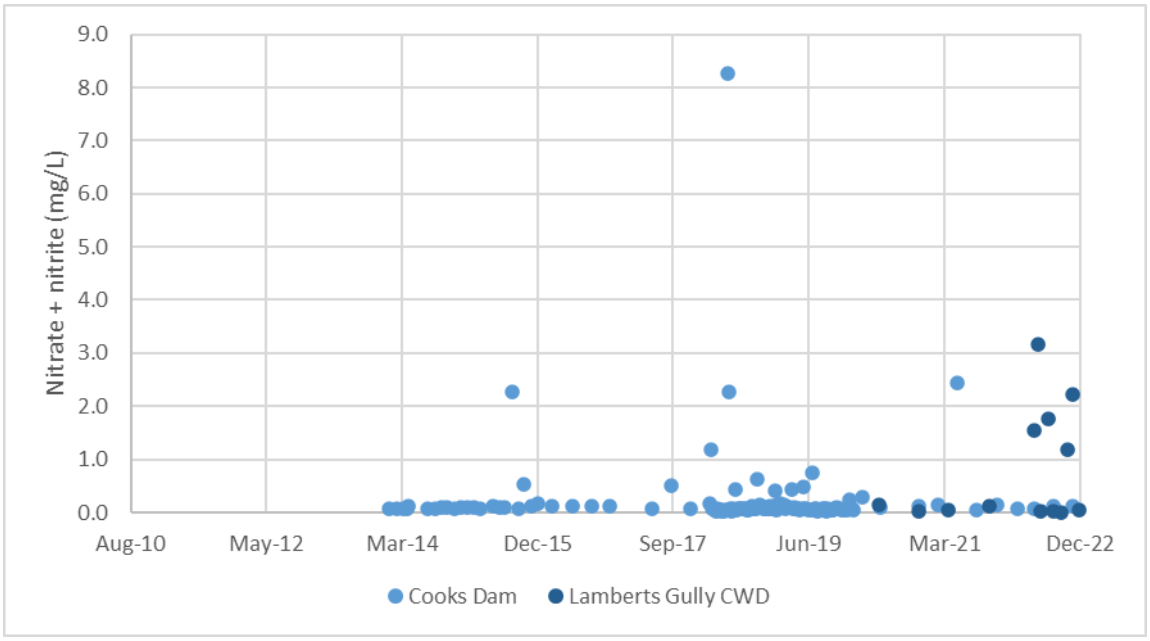


Figure A.56 ***On-site storages – nitrate + nitrite***

Dissolved Metals

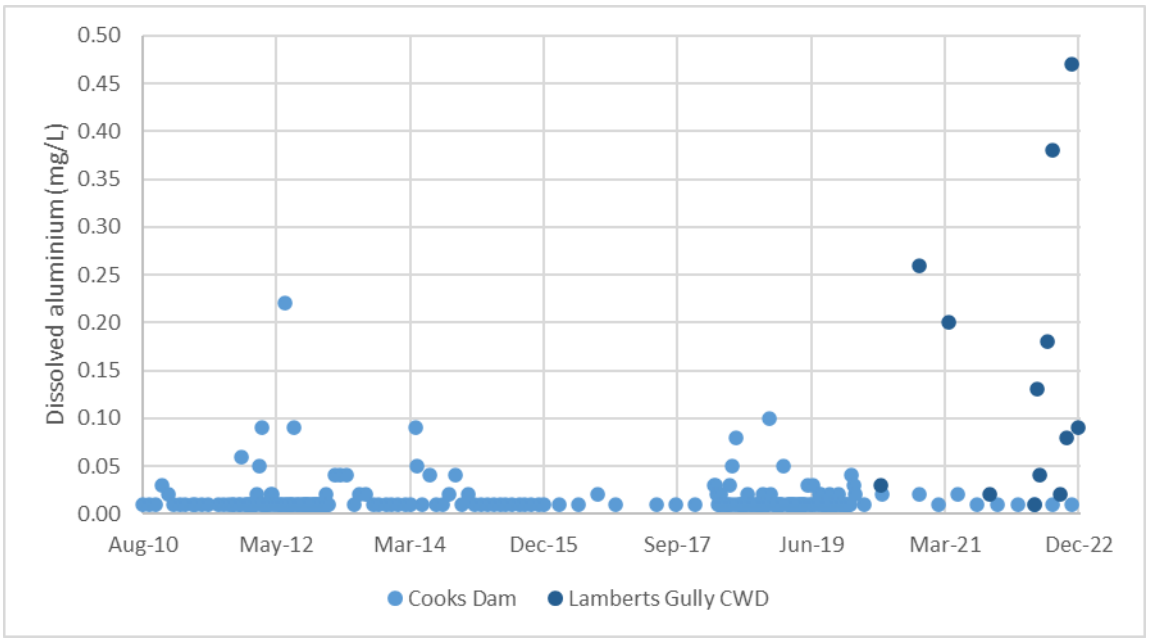


Figure A.57 On-site storages – dissolved aluminium

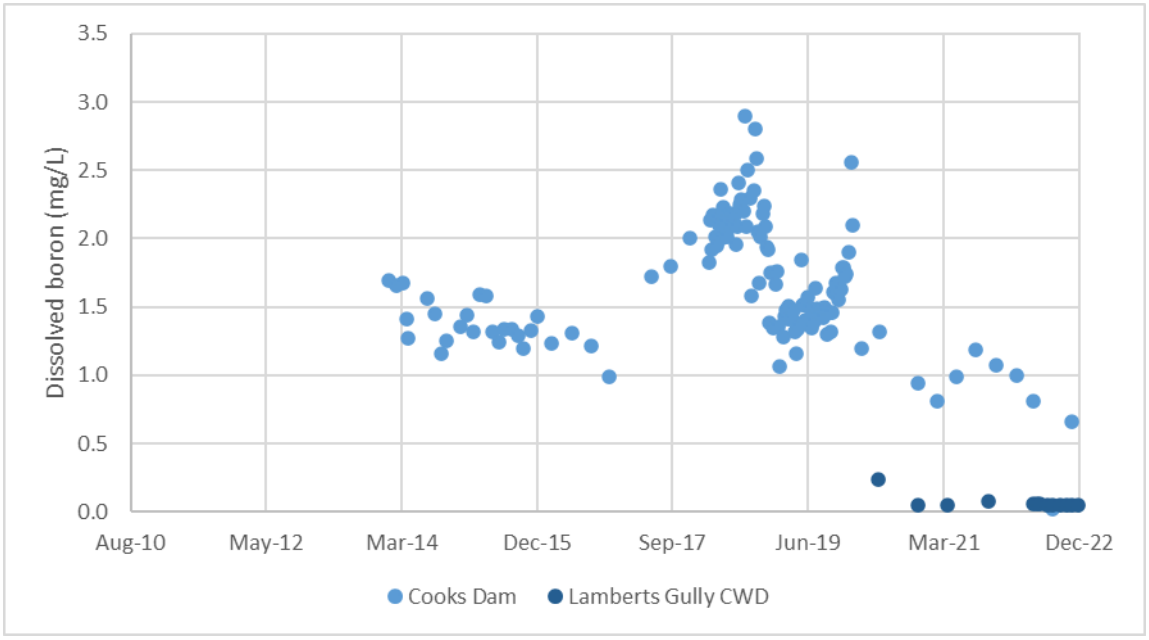


Figure A.58 On-site storages – dissolved boron

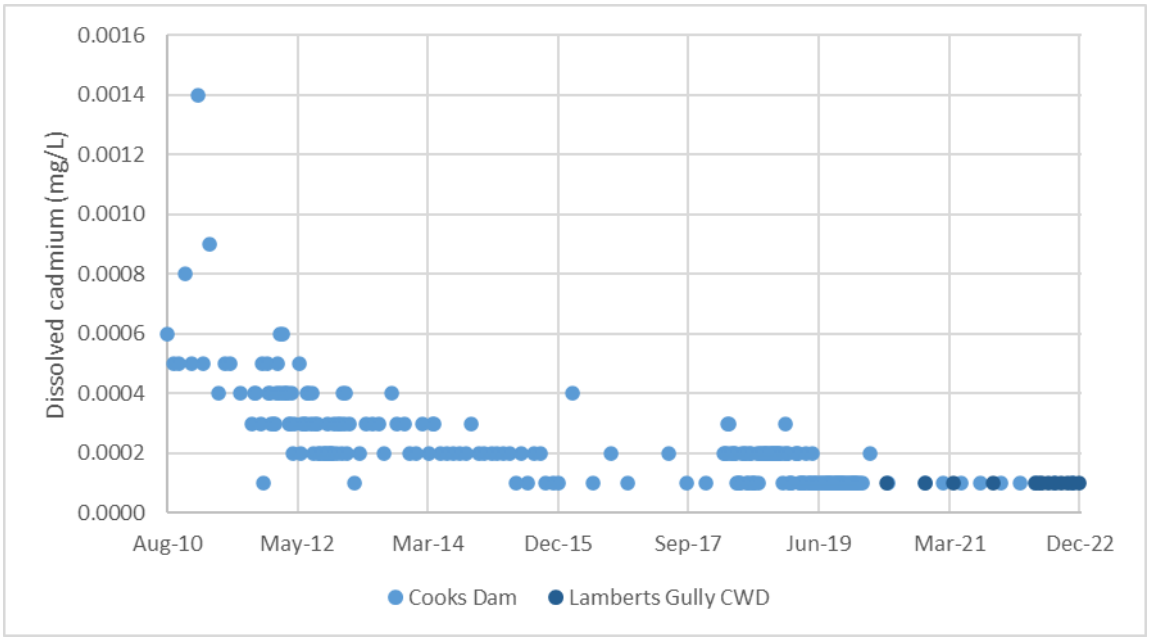


Figure A.59 *On-site storages – dissolved cadmium*

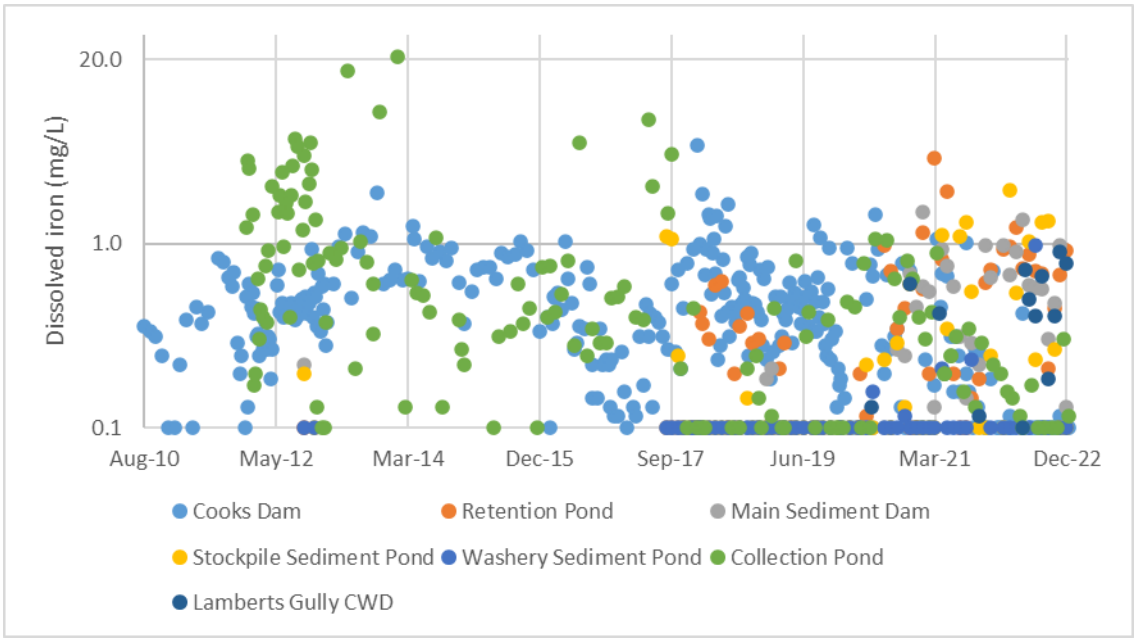


Figure A.60 *On-site storages – dissolved iron*

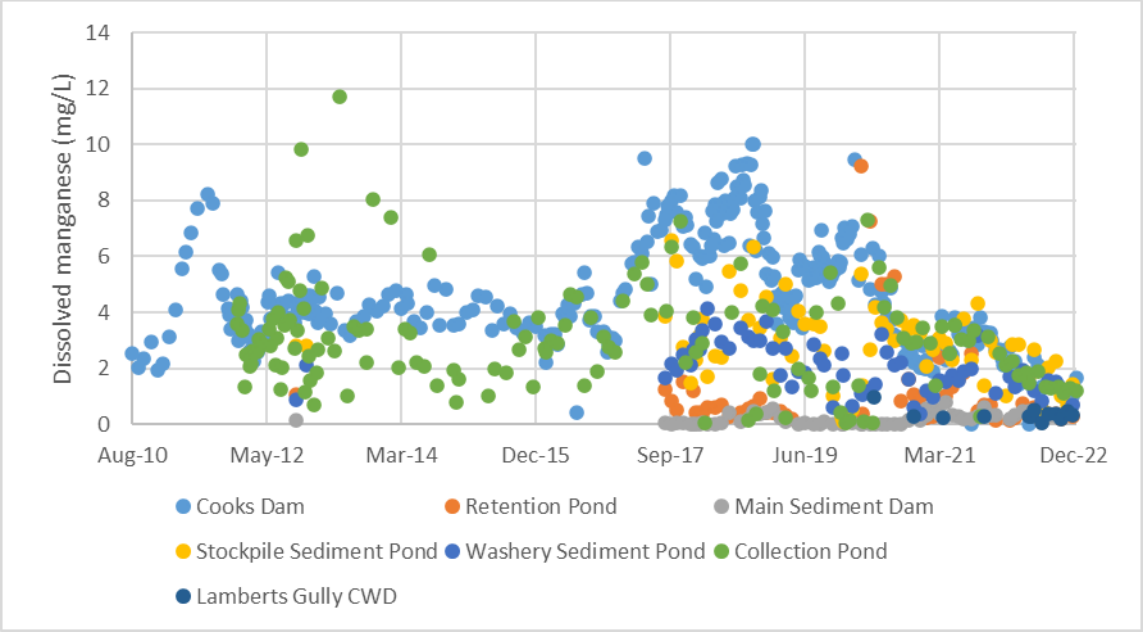


Figure A.61 On-site storages – dissolved manganese

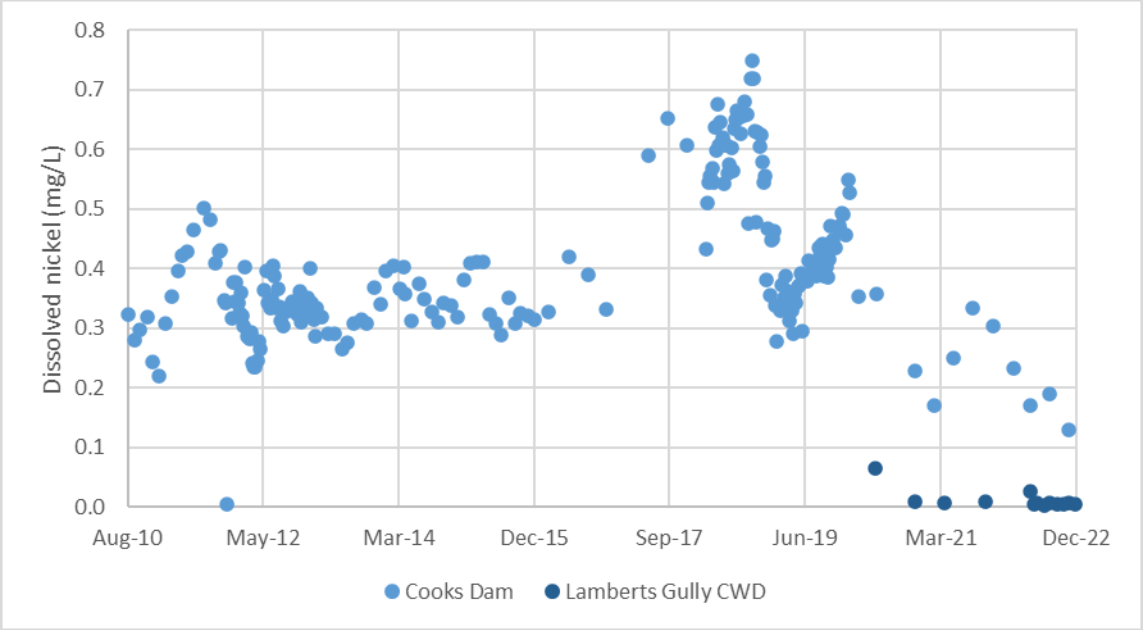


Figure A.62 On-site storages – dissolved nickel

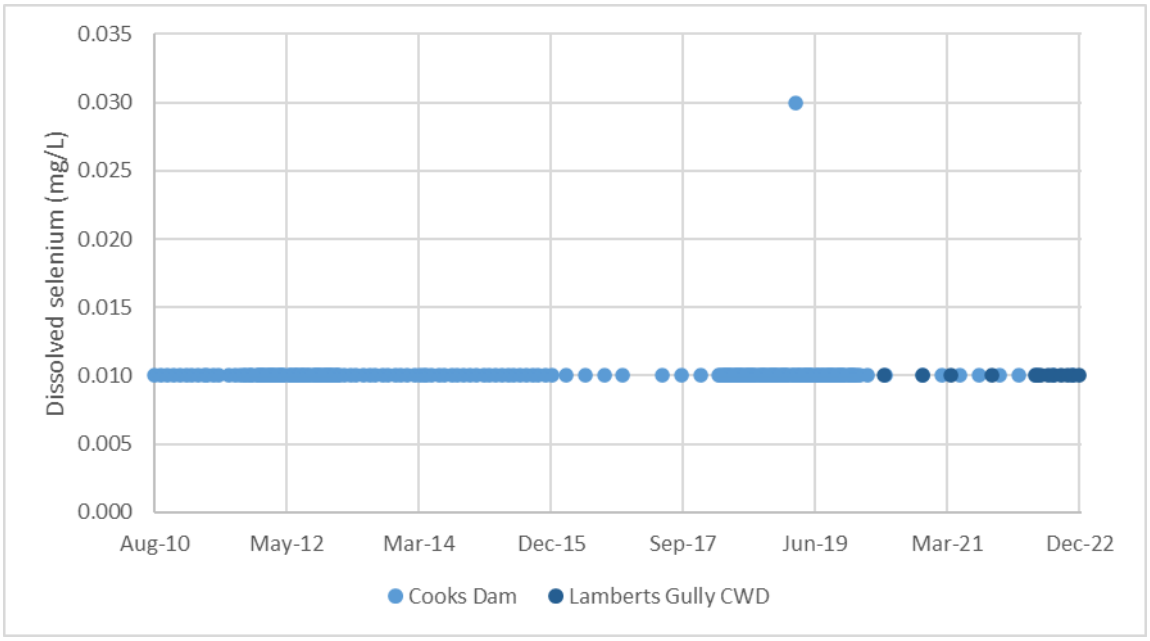


Figure A.63 On-site storages – dissolved selenium

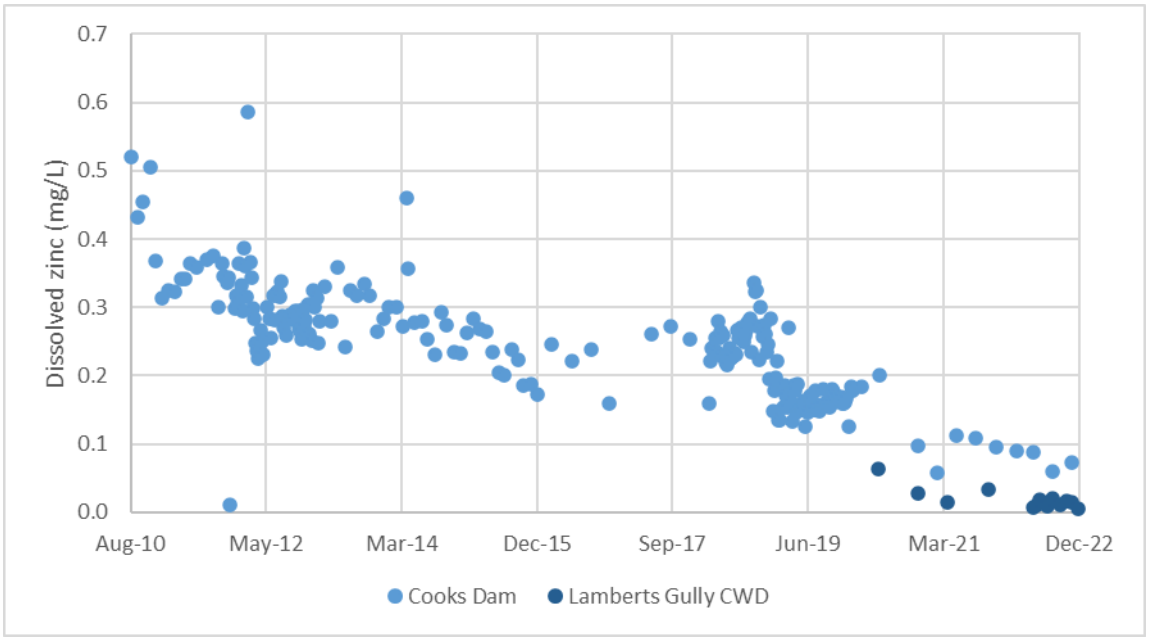


Figure A.64 On-site storages – dissolved zinc

Total Metals

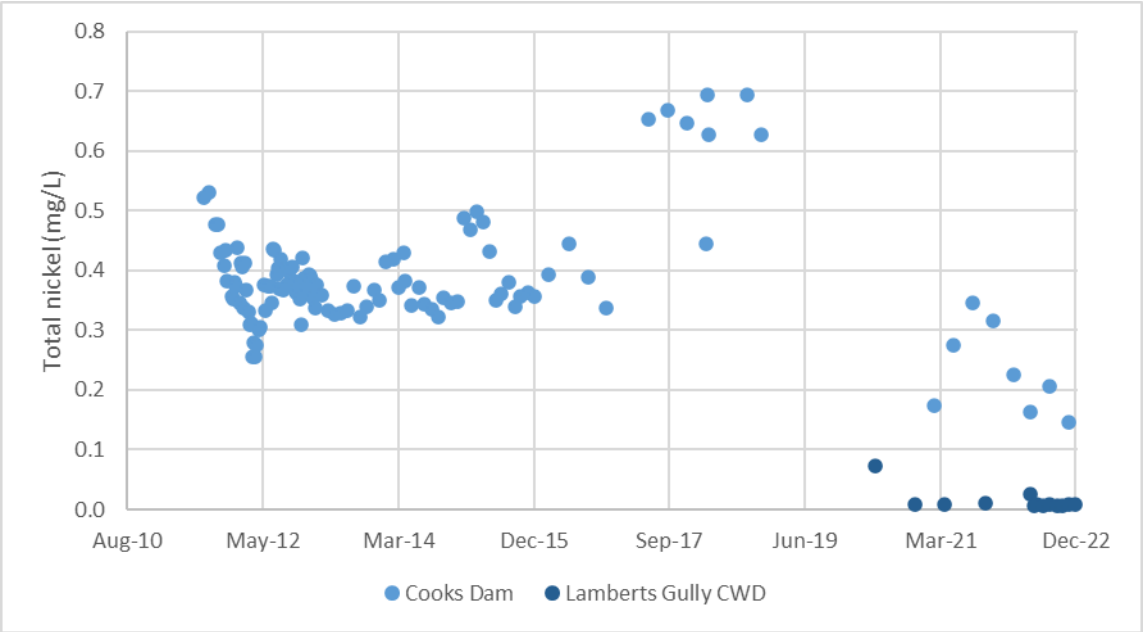


Figure A.65 *On-site storages - total nickel*

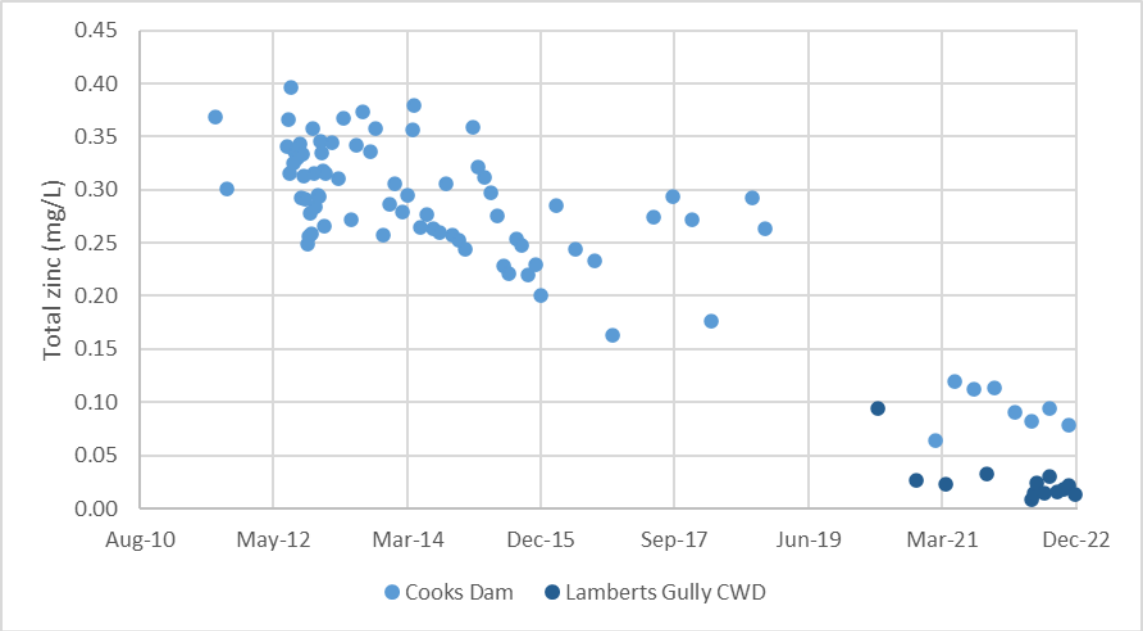


Figure A.66 *On-site storages - total zinc*

Other

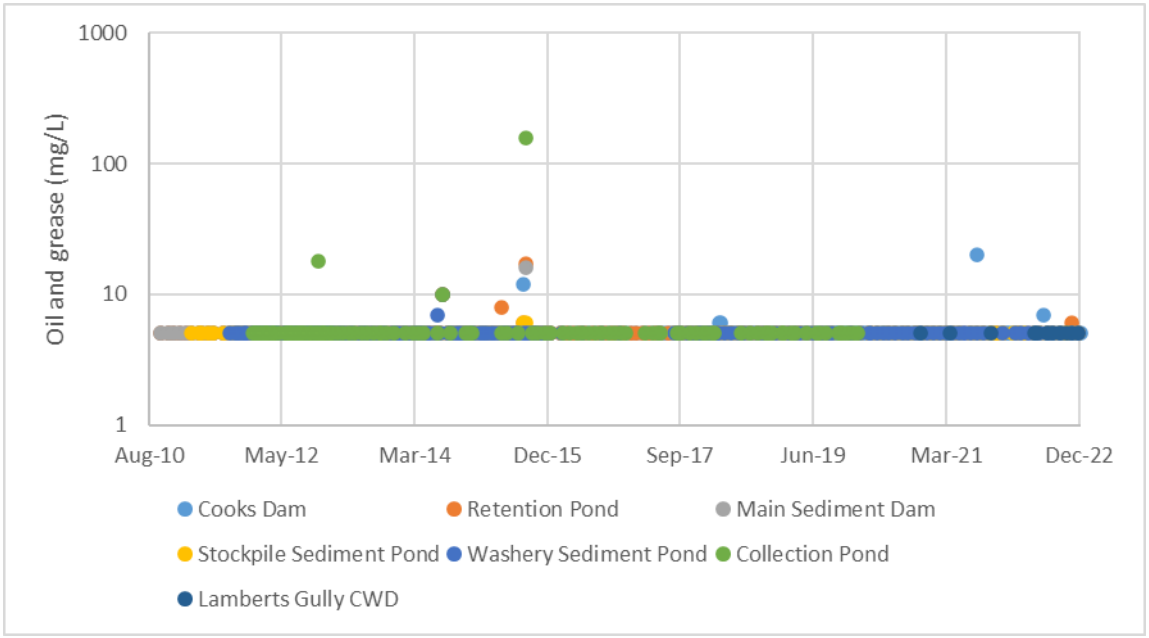


Figure A.67 *On-site storages - oil and grease*

Wangcol Creek

Physicochemical

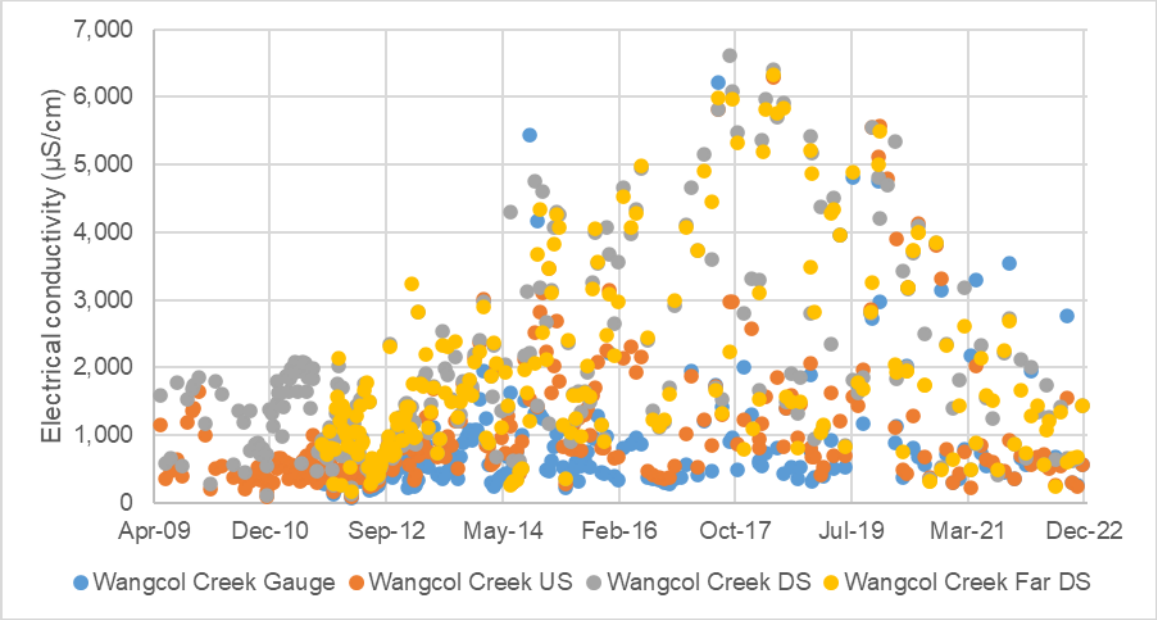


Figure A.68 Wangcol Creek - EC

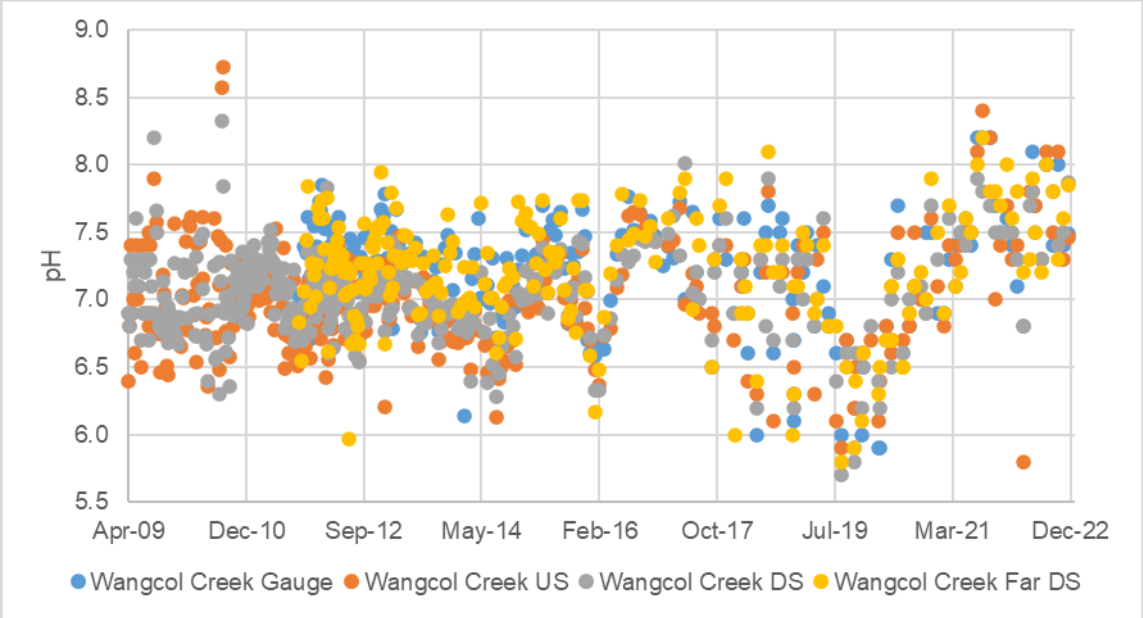


Figure A.69 Wangcol Creek - pH

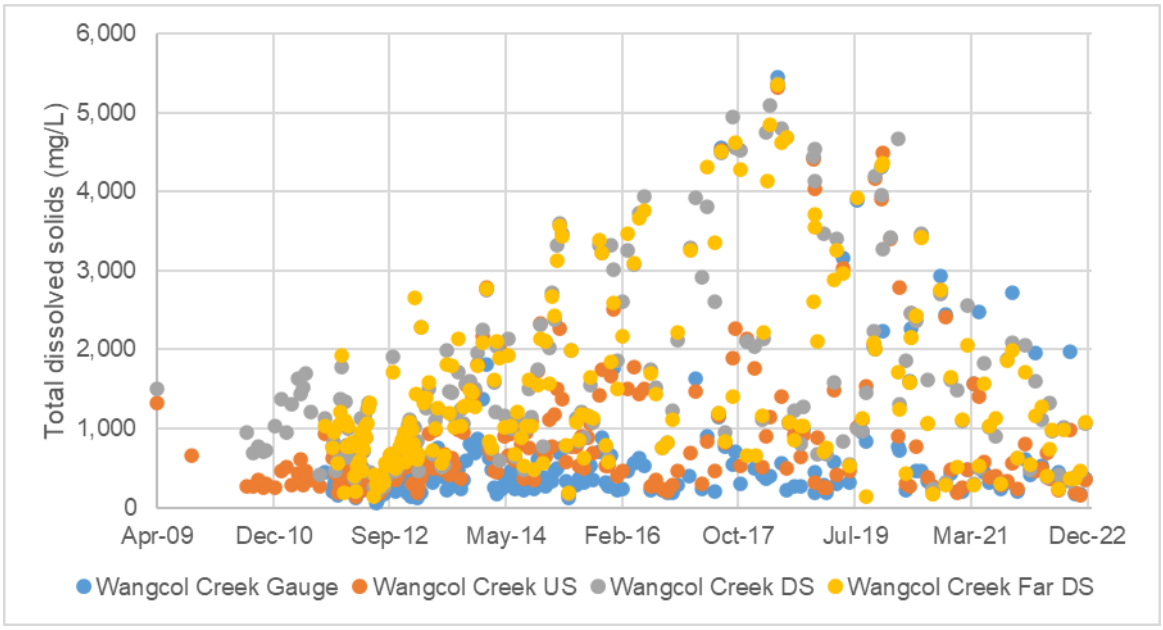


Figure A.70 *Wangcol Creek – total dissolved solids*

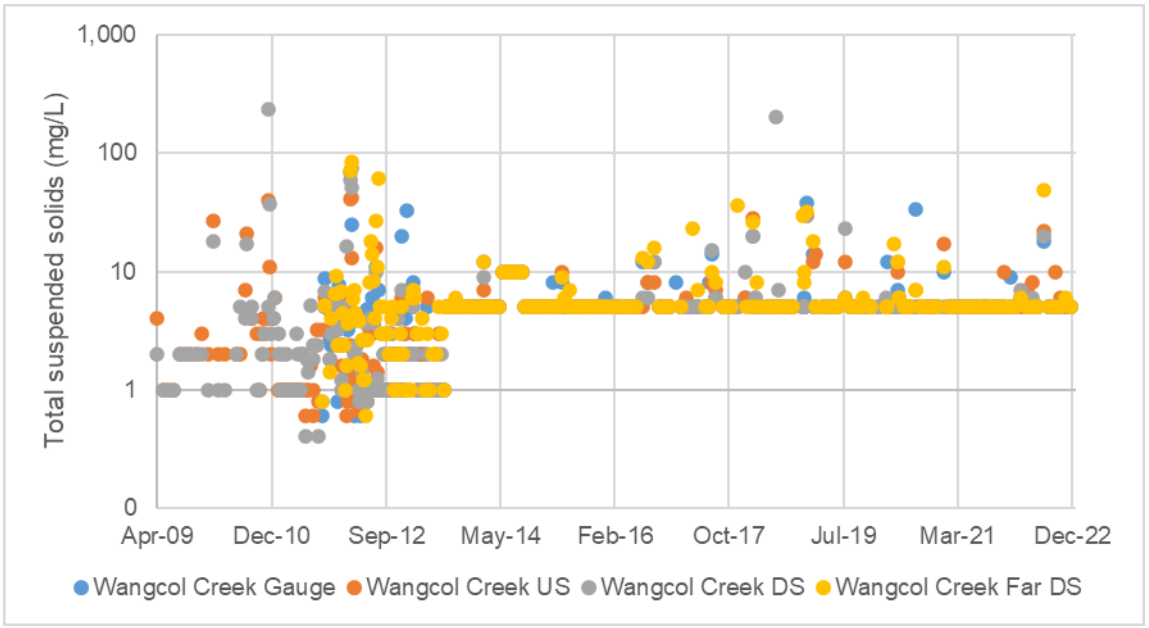


Figure A.71 *Wangcol Creek – total suspended solids*

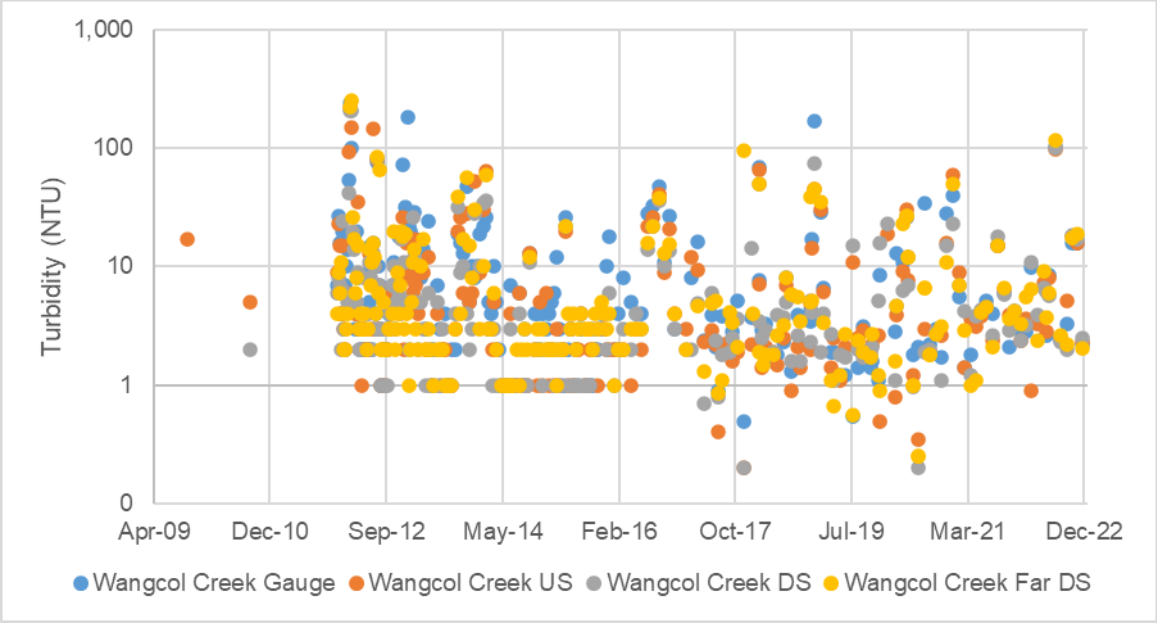


Figure A.72 Wangcol Creek - turbidity

Major Ions

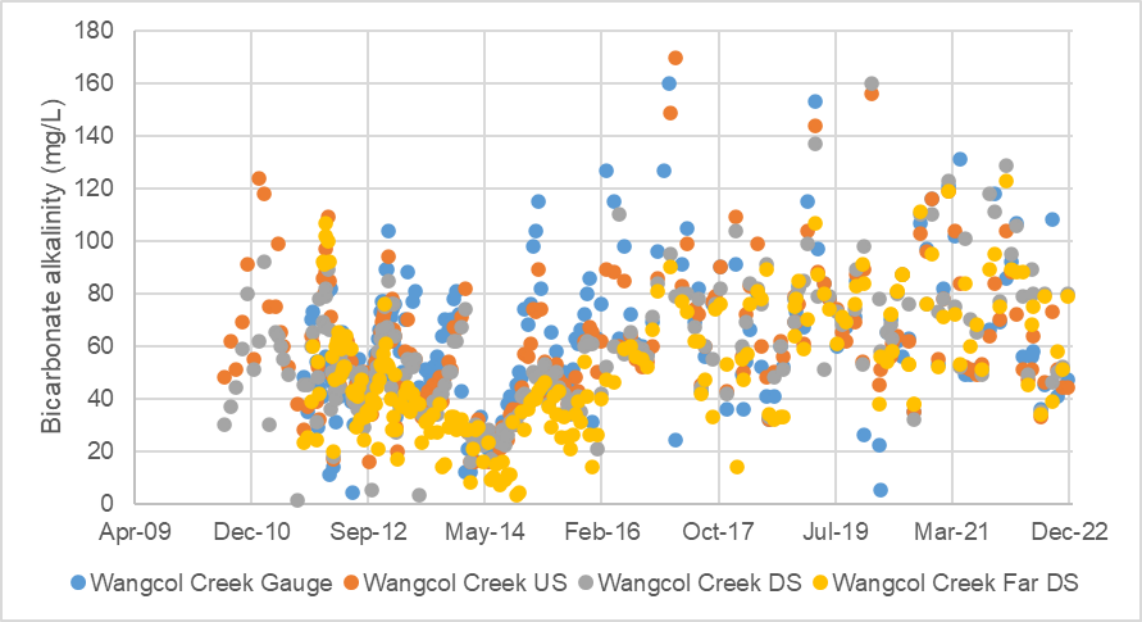


Figure A.73 *Wangcol Creek - Bicarbonate alkalinity*

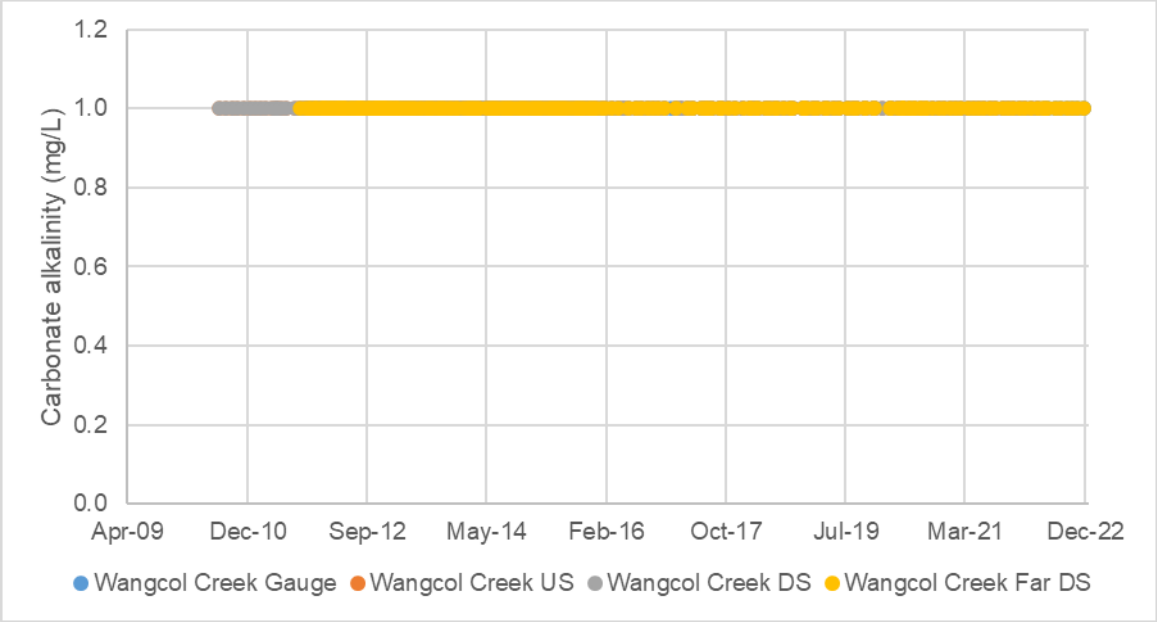


Figure A.74 *Wangcol Creek – carbonate alkalinity*

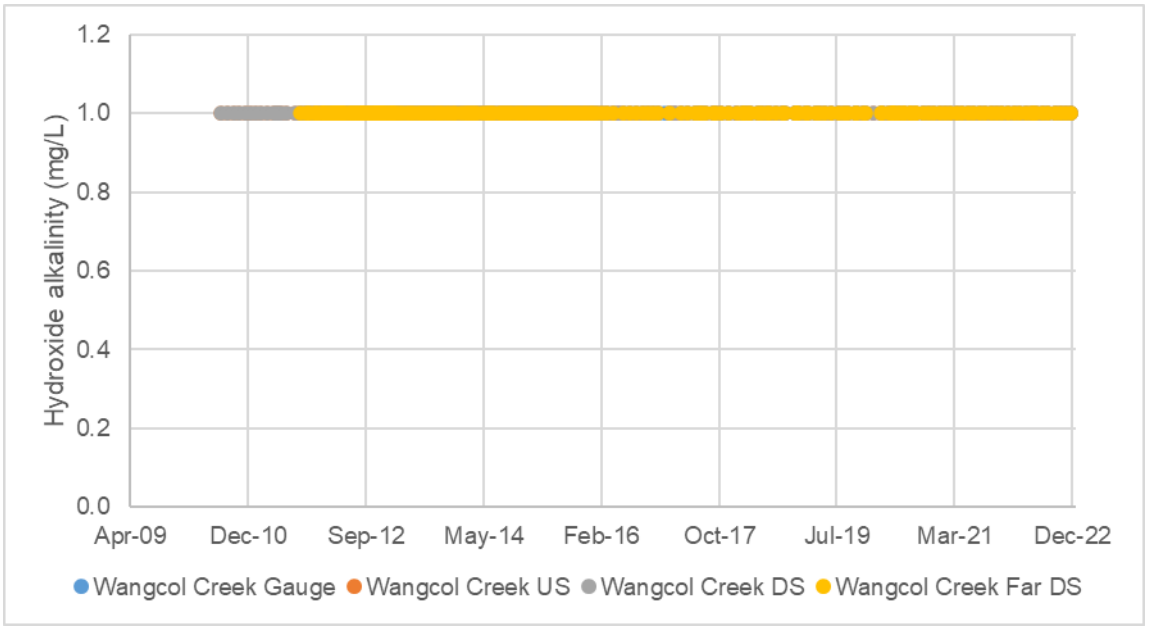


Figure A.75 Wangcol Creek – hydroxide alkalinity

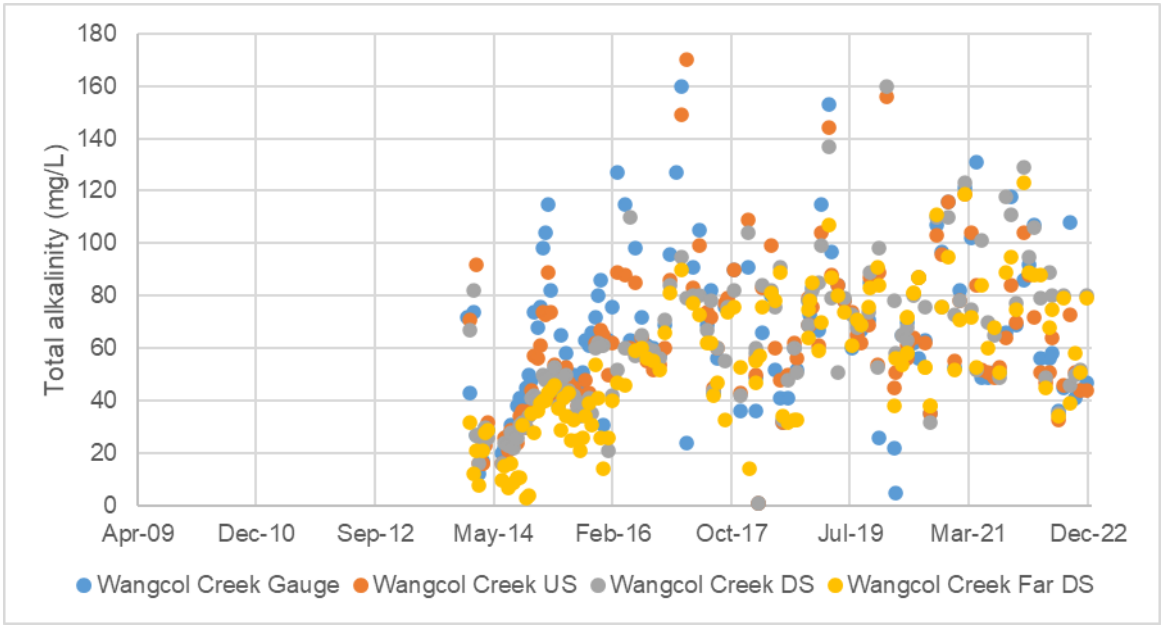


Figure A.76 Wangcol Creek – total alkalinity

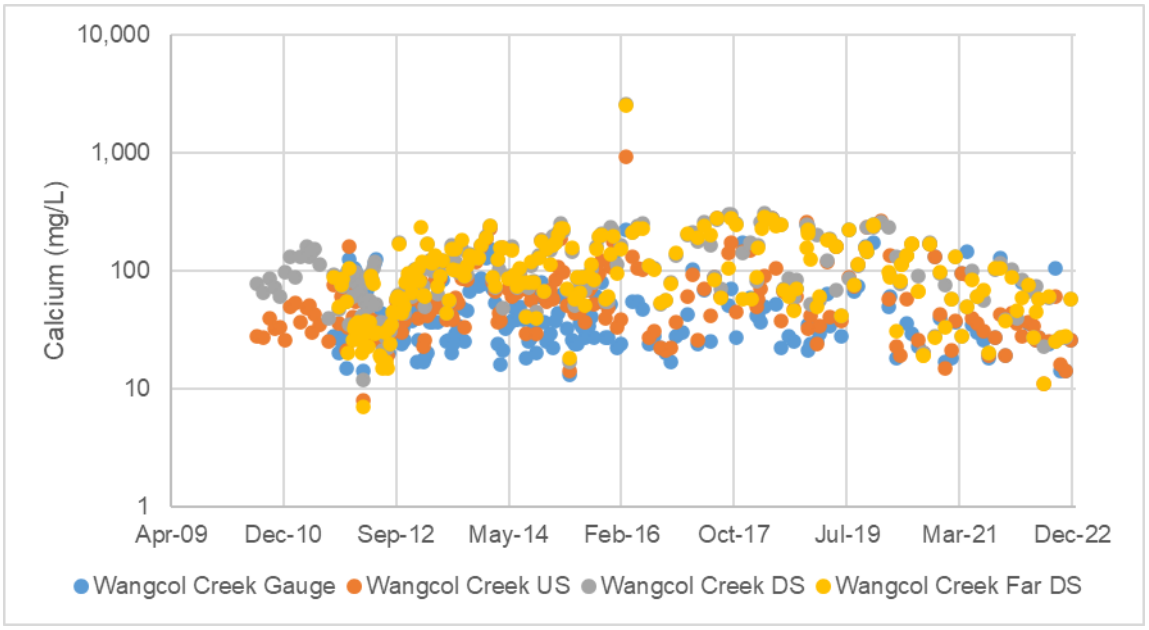


Figure A.77 Wangcol Creek - calcium

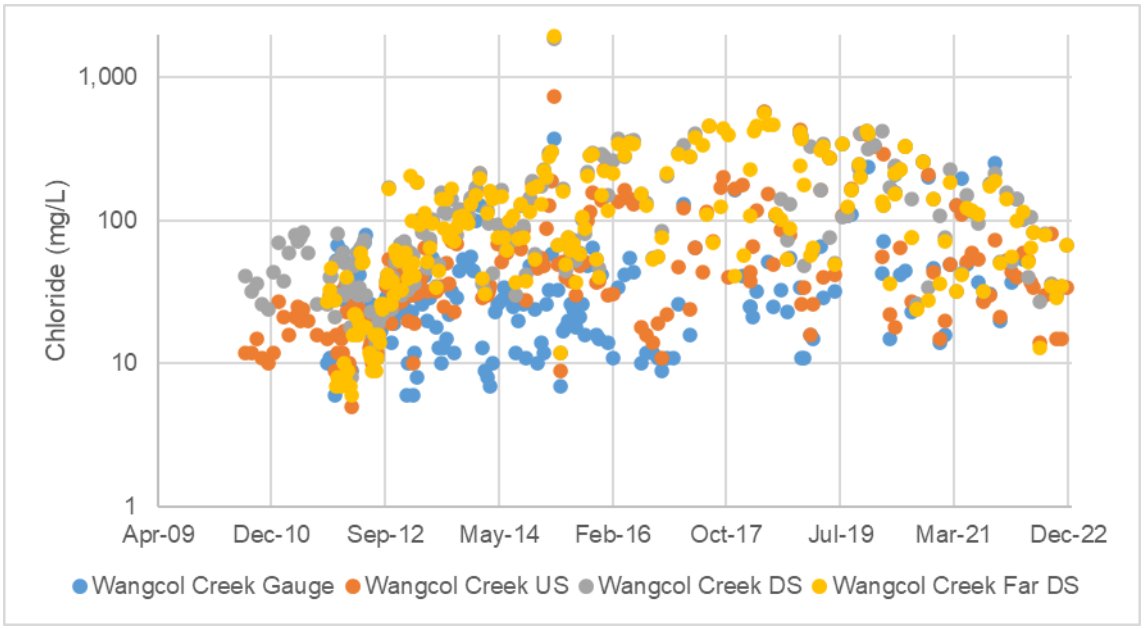


Figure A.78 Wangcol Creek - chloride

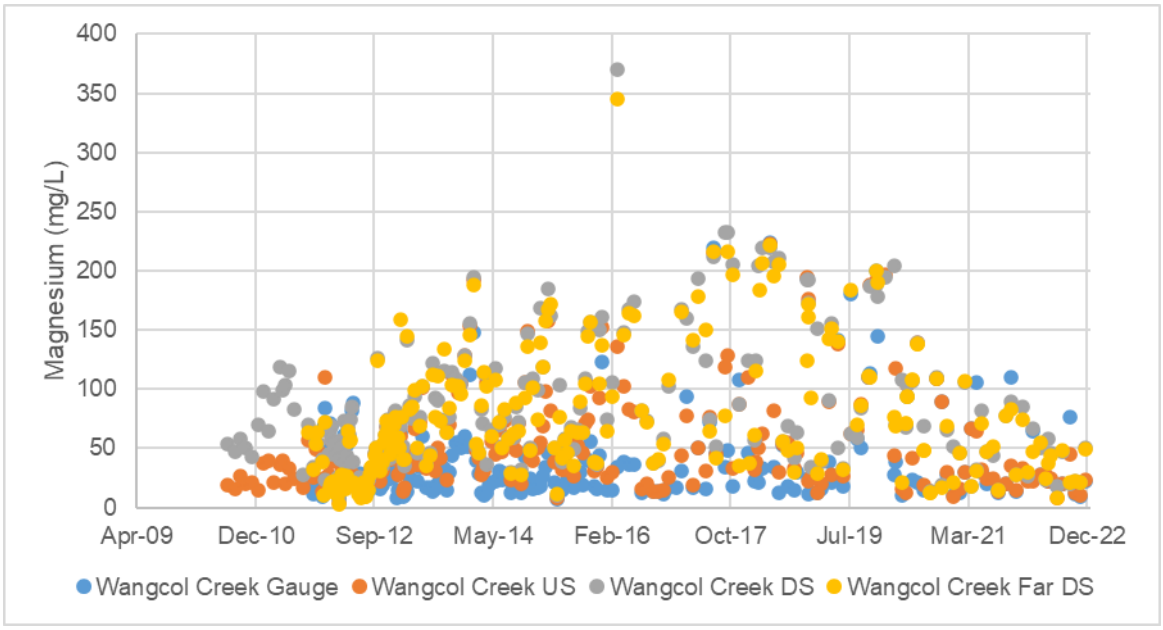


Figure A.79 *Wangcol Creek - magnesium*

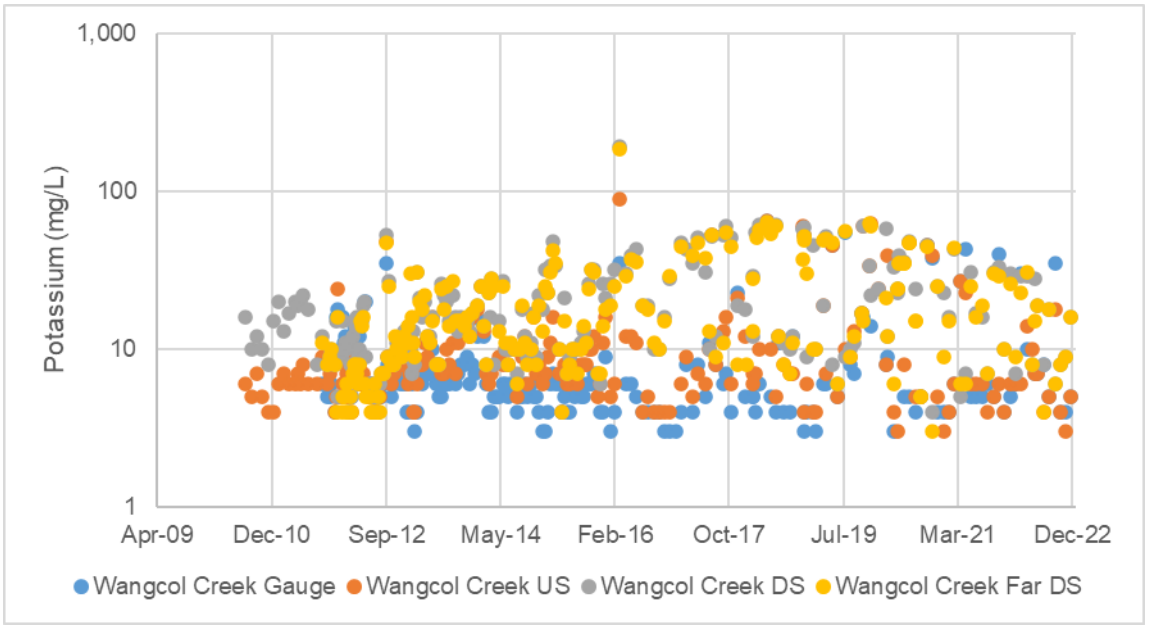


Figure A.80 *Wangcol Creek - potassium*

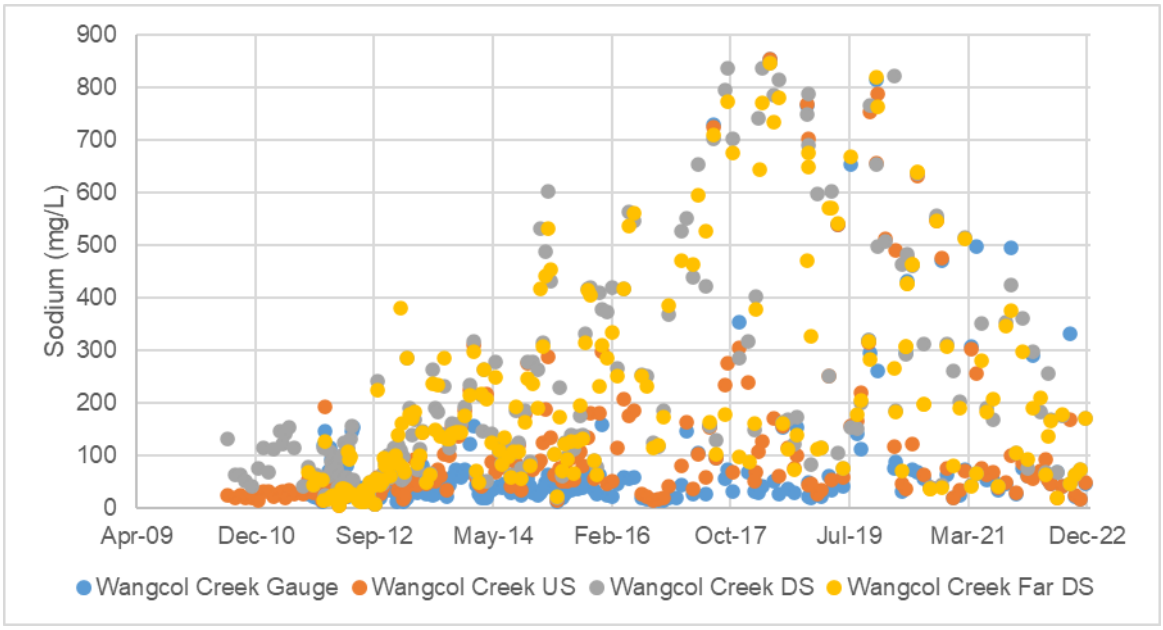


Figure A.81 Wangcol Creek - sodium

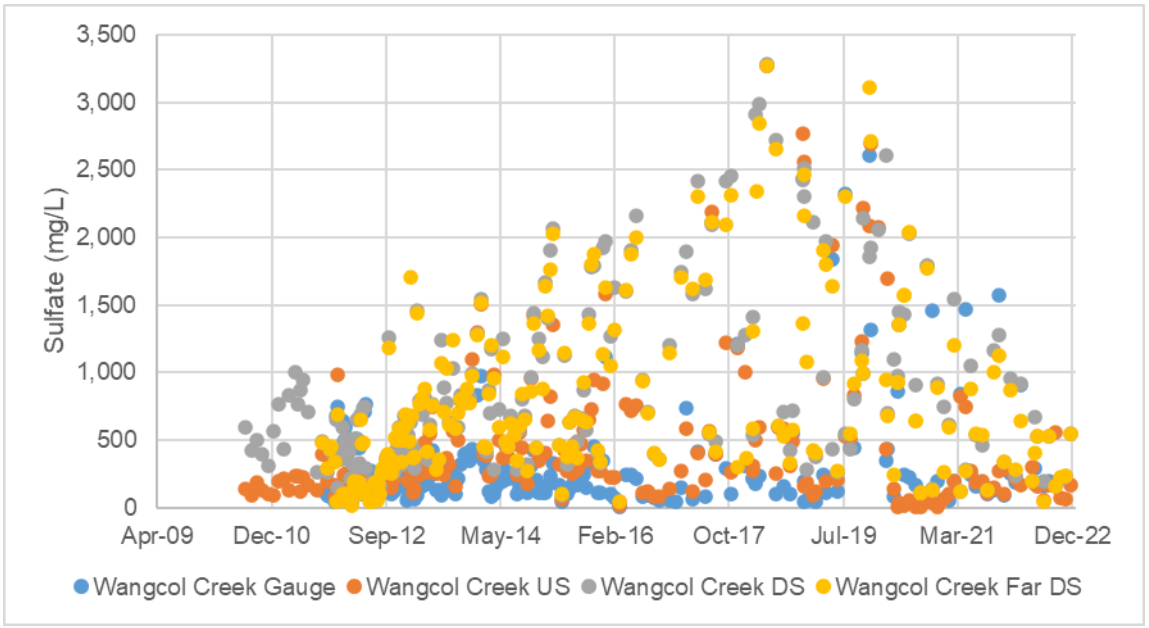


Figure A.82 Wangcol Creek - sulfate

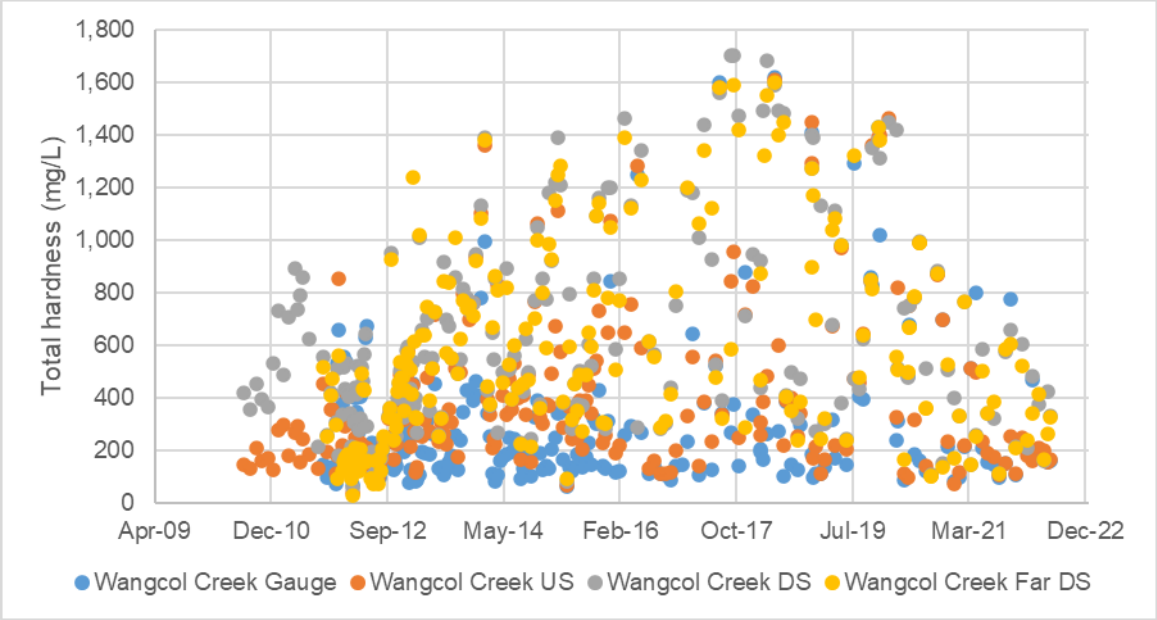


Figure A.83 Wangcol Creek -total hardness

Nutrients

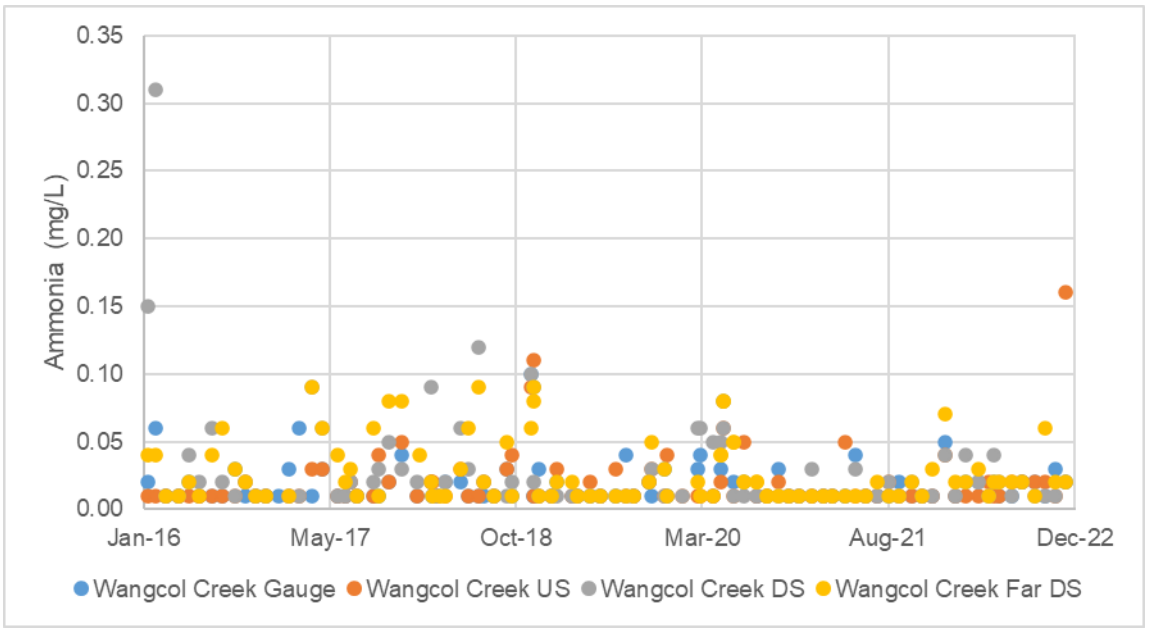


Figure A.84 *Wangcol Creek - ammonia*

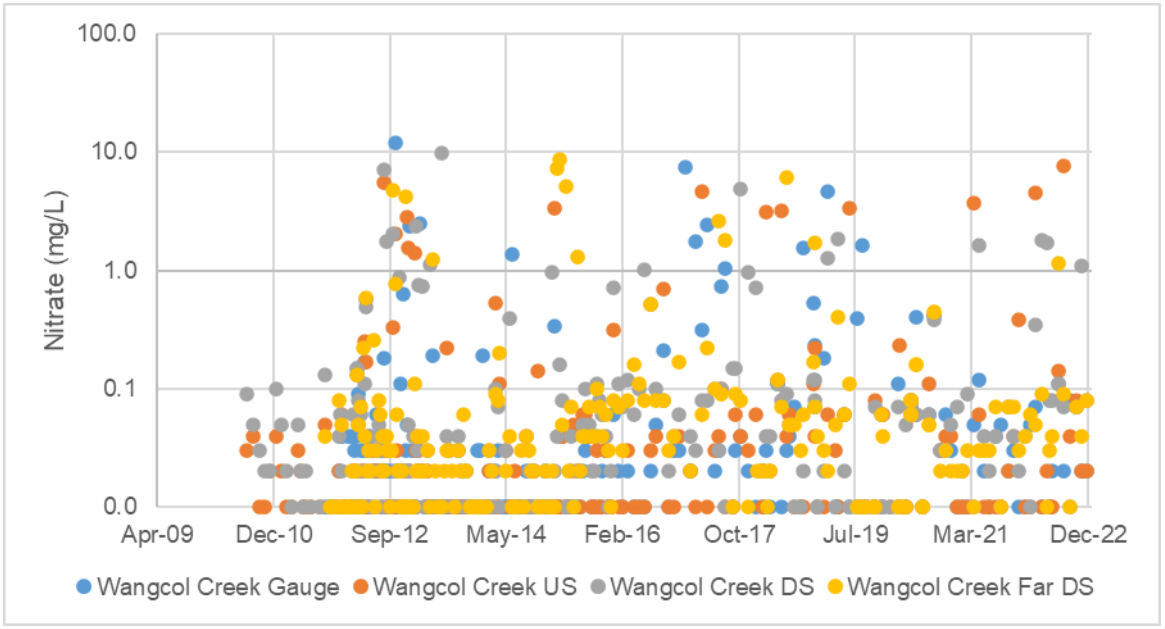


Figure A.85 *Wangcol Creek - nitrate*

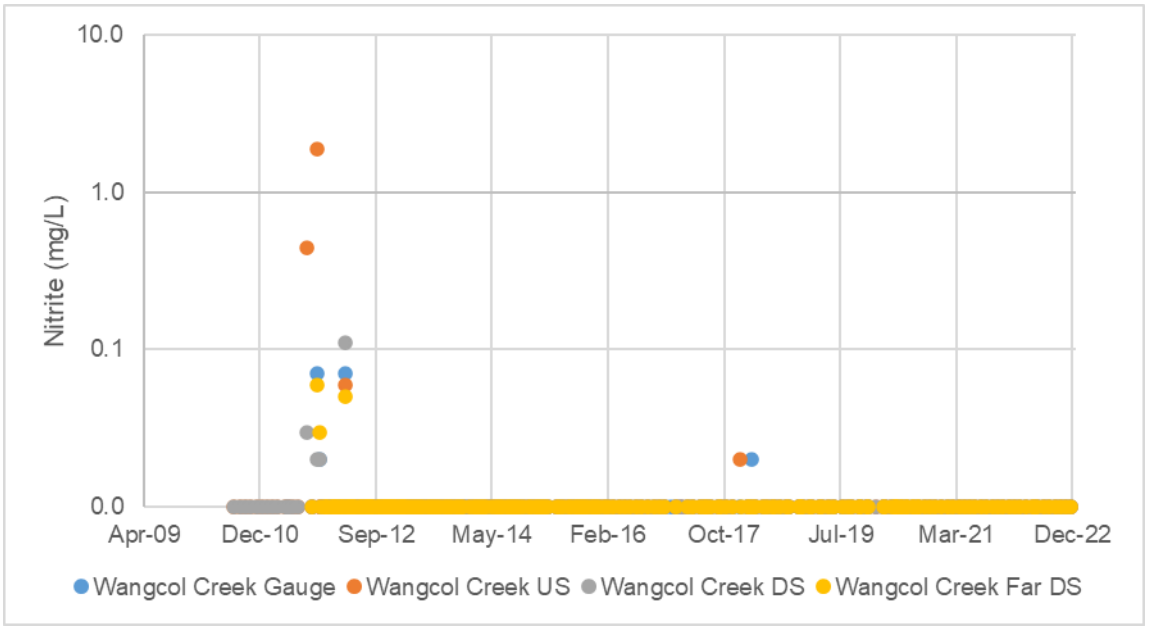


Figure A.86 *Wangcol Creek – nitrite*

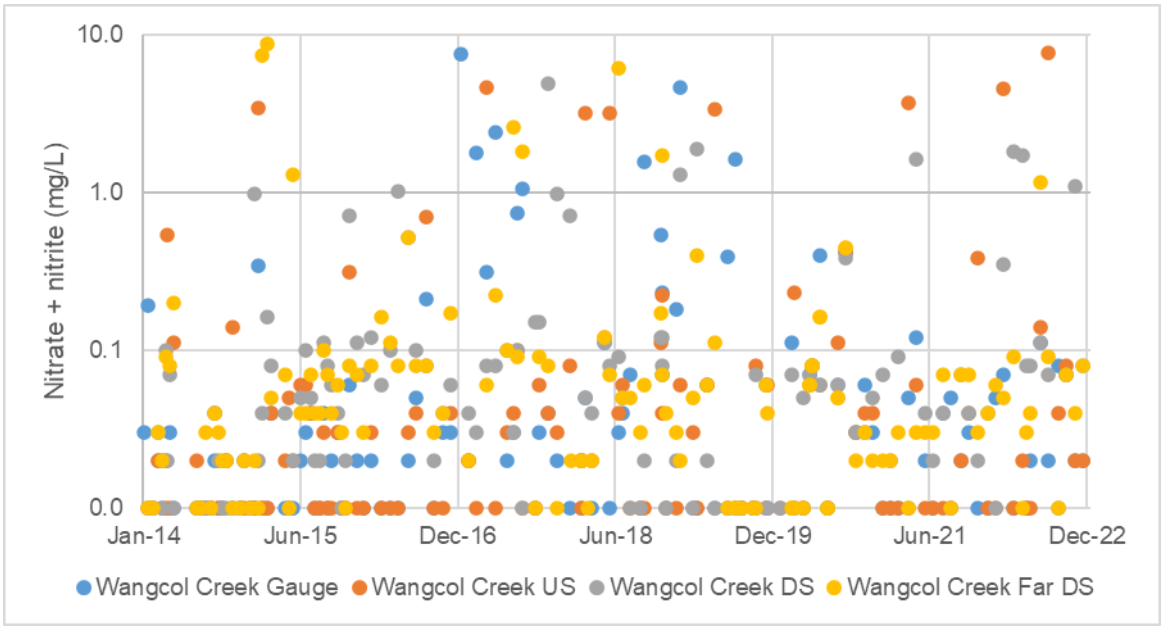


Figure A.87 *Wangcol Creek – nitrate + nitrite*

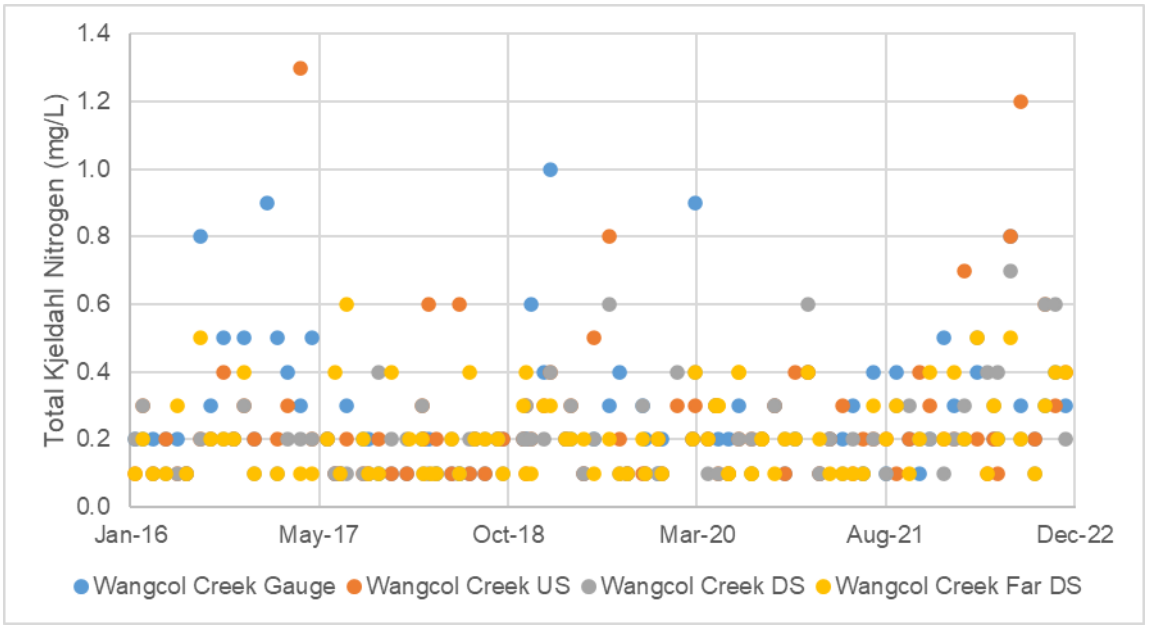


Figure A.88 Wangcol Creek - TKN

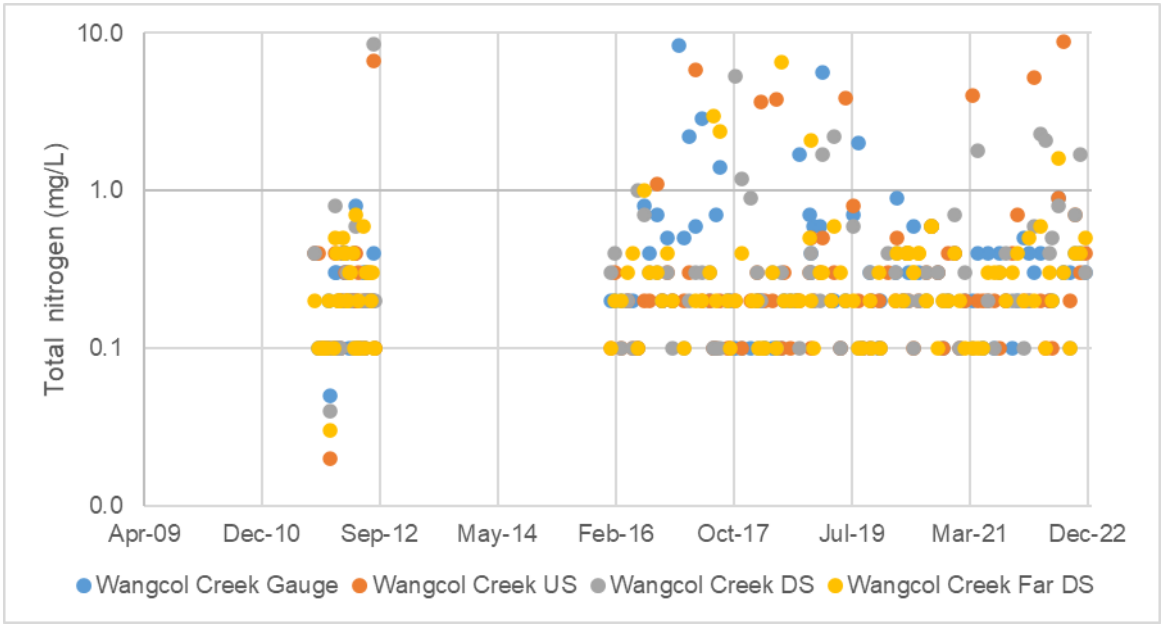


Figure A.89 Wangcol Creek – total nitrogen

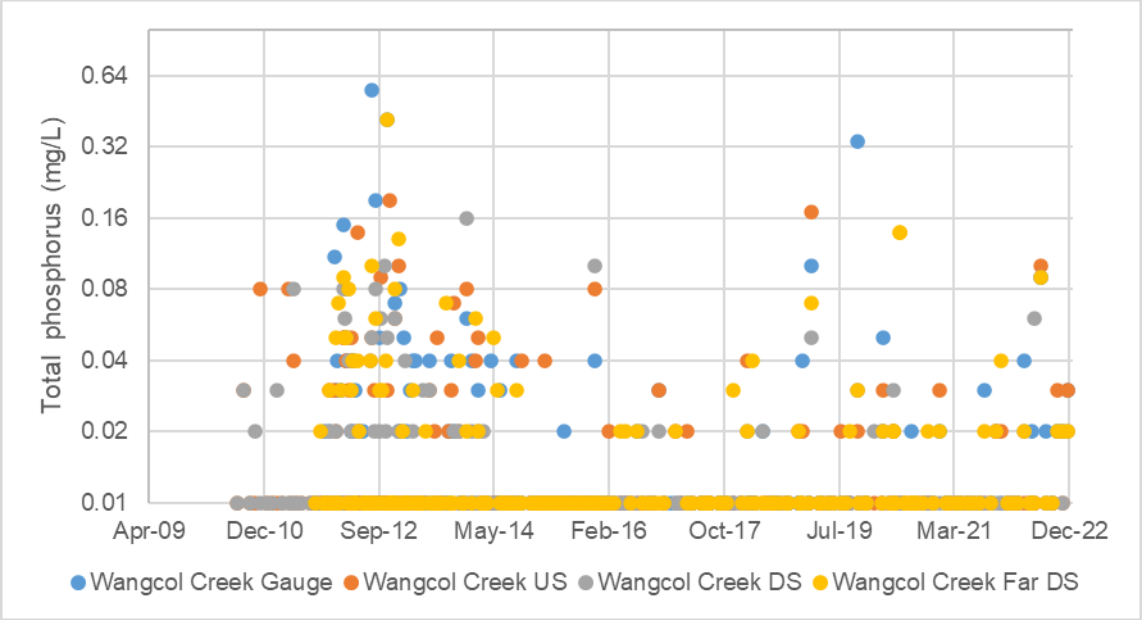


Figure A.90 Wangcol Creek – total phosphorus

Dissolved Metals

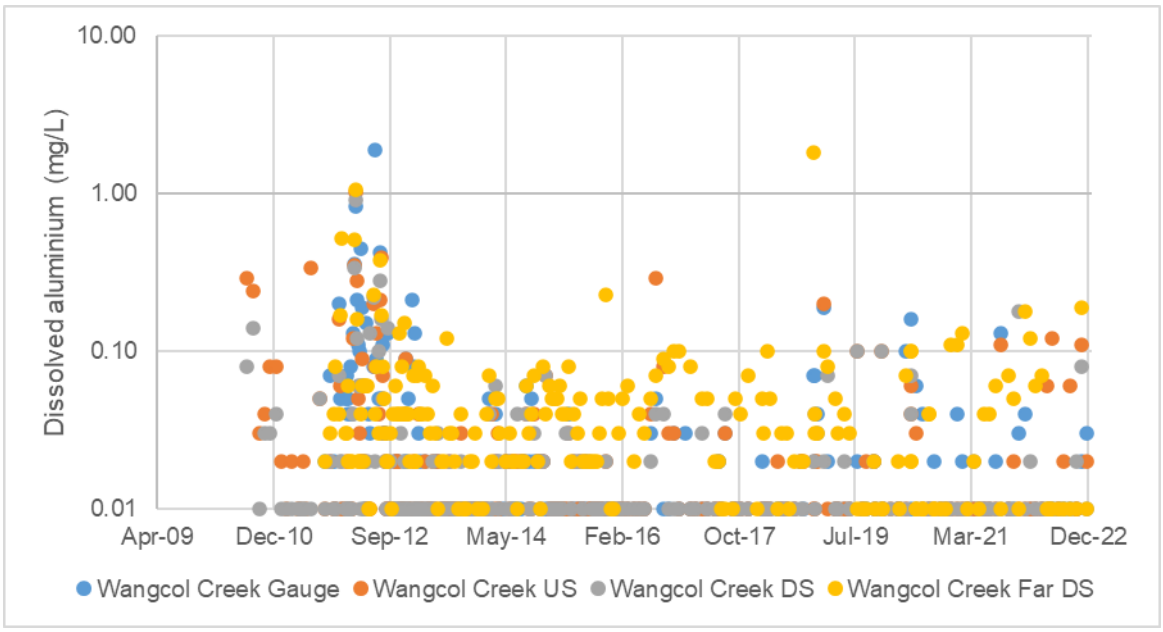


Figure A.91 Wangcol Creek – dissolved aluminium

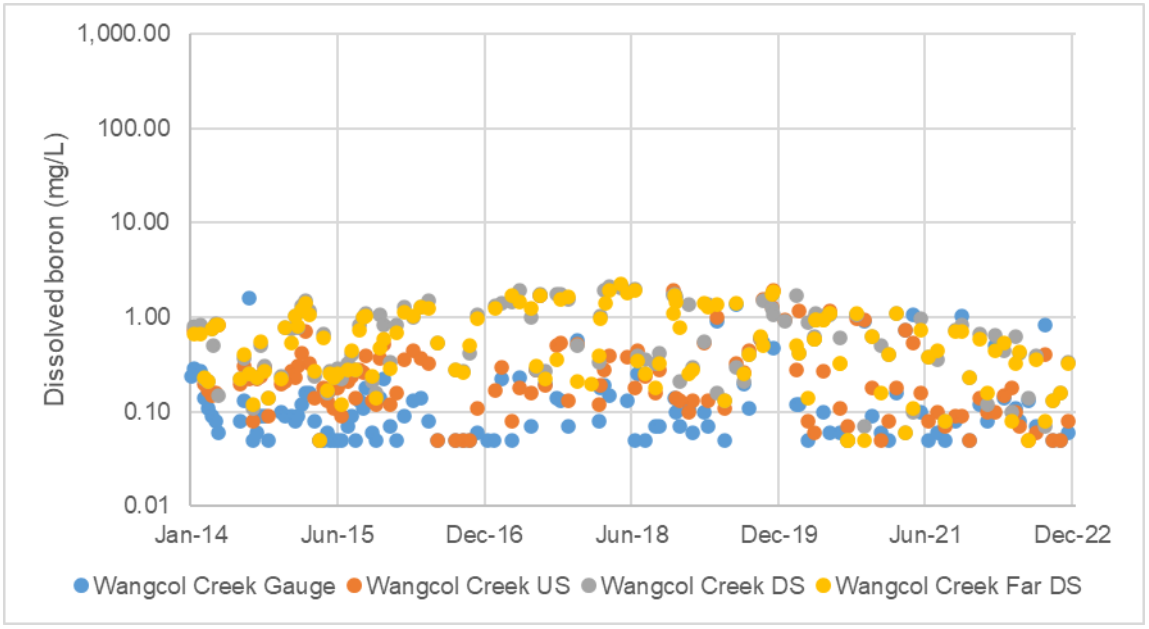


Figure A.92 Wangcol Creek -dissolved boron

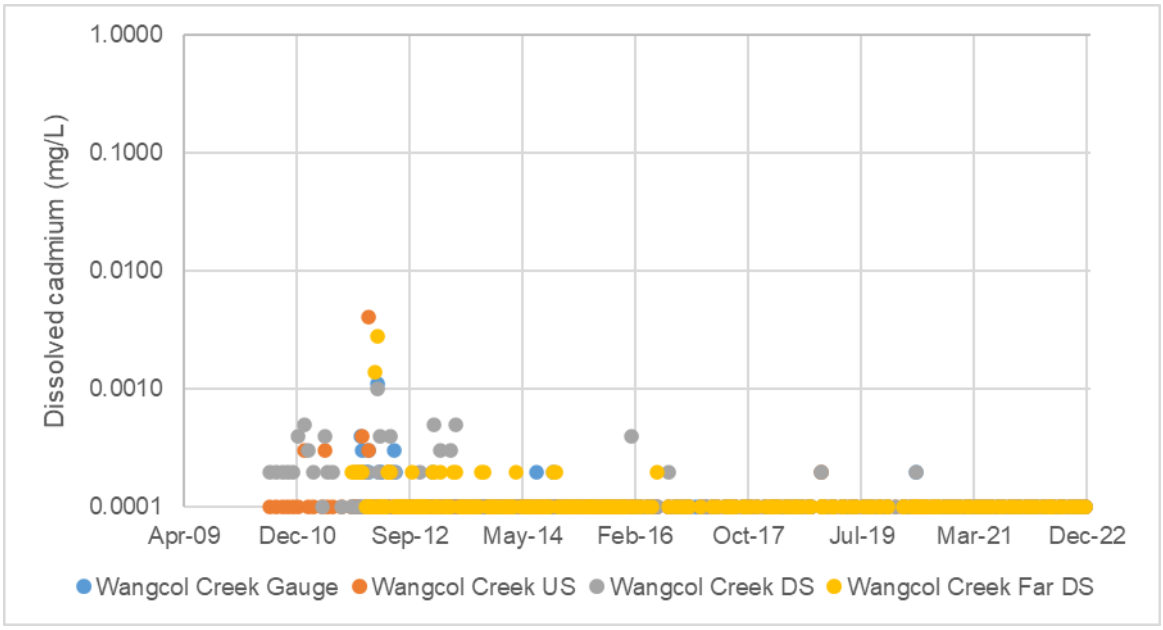


Figure A.93 Wangcol Creek – dissolved cadmium

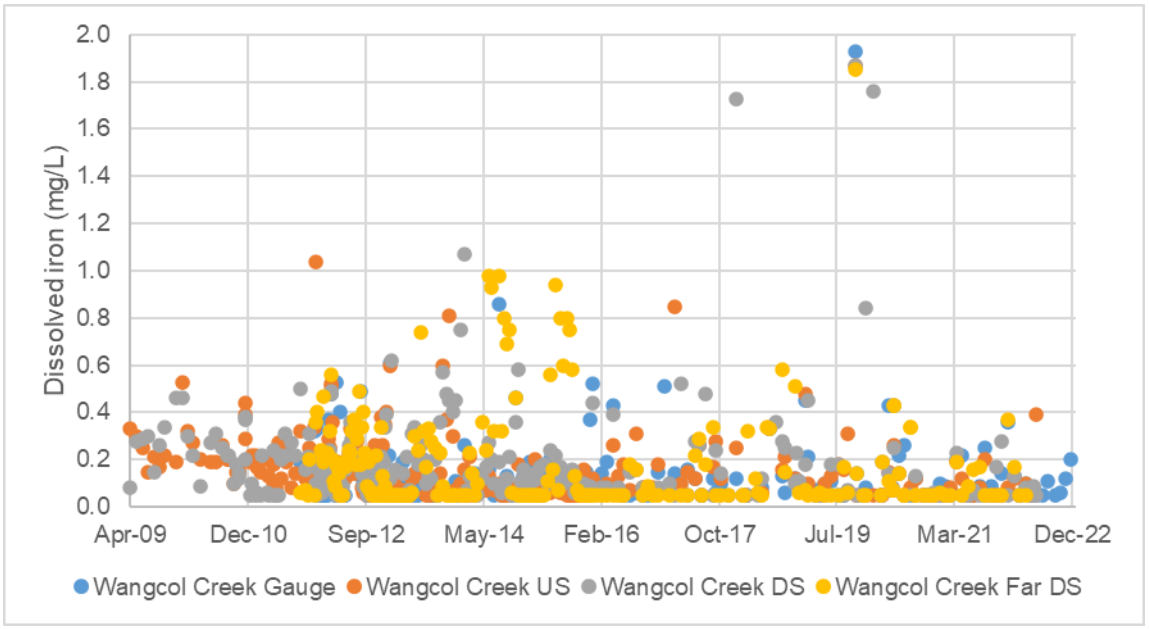


Figure A.94 Wangcol Creek – dissolved iron

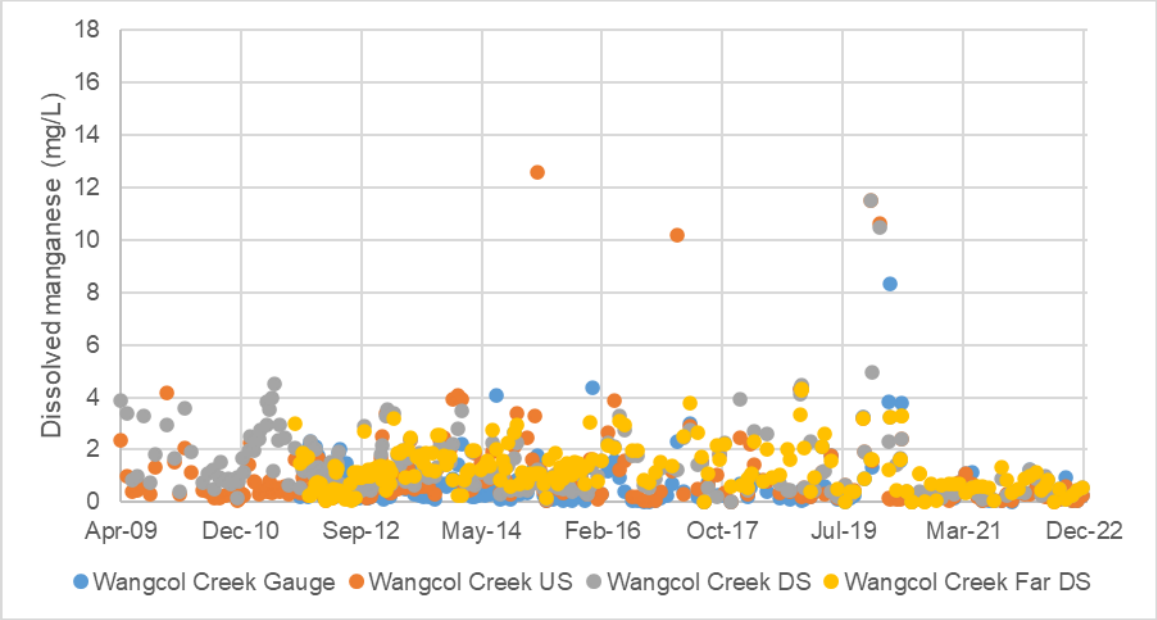


Figure A.95 Wangcol Creek – dissolved manganese

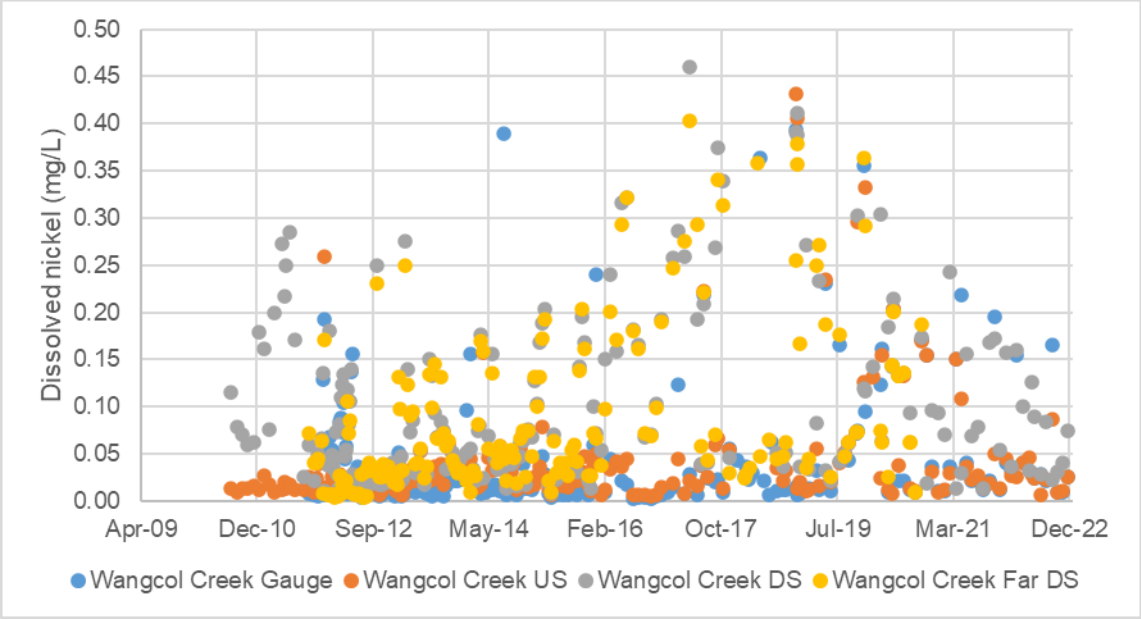


Figure A.96 Wangcol Creek – dissolved nickel

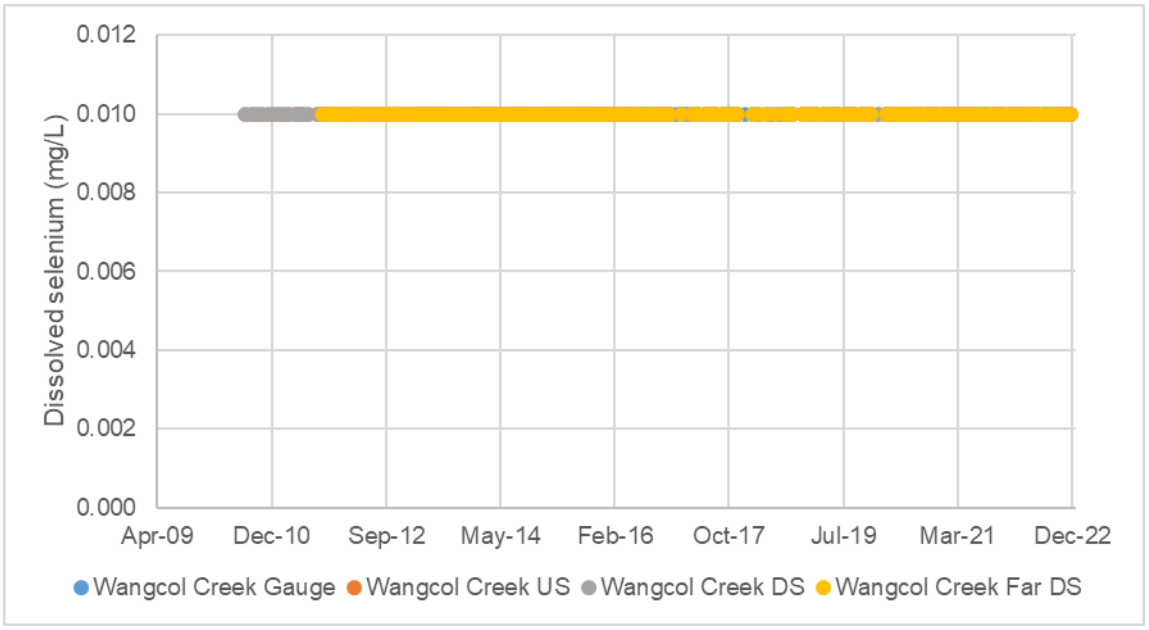


Figure A.97 Wangcol Creek - dissolved selenium

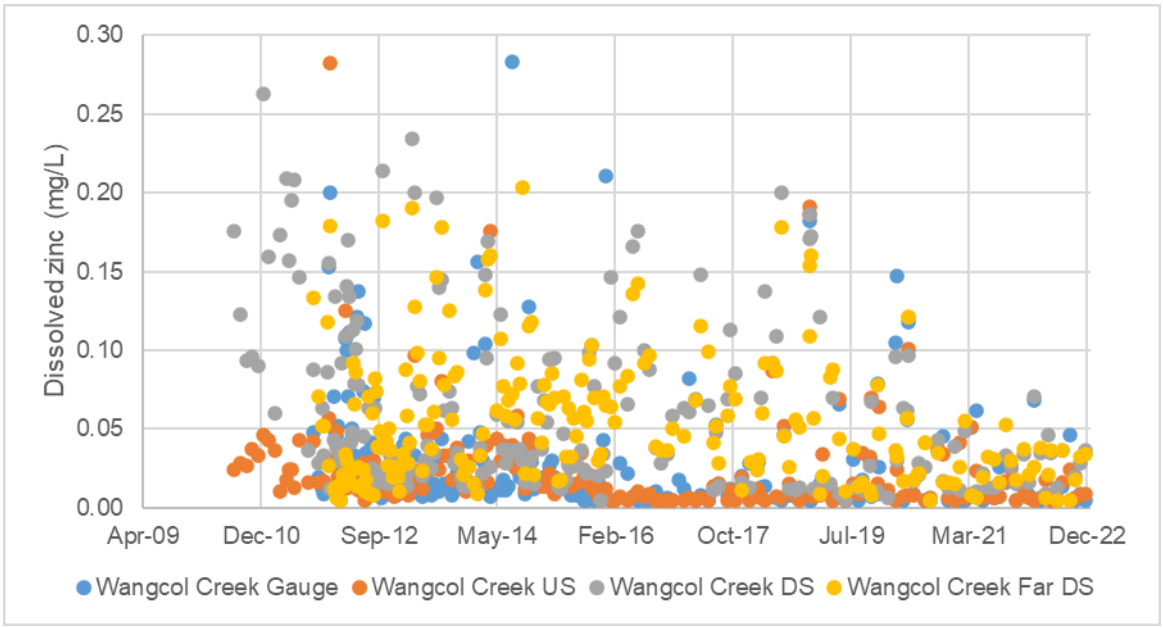


Figure A.98 Wangcol Creek – dissolved zinc

Total metals

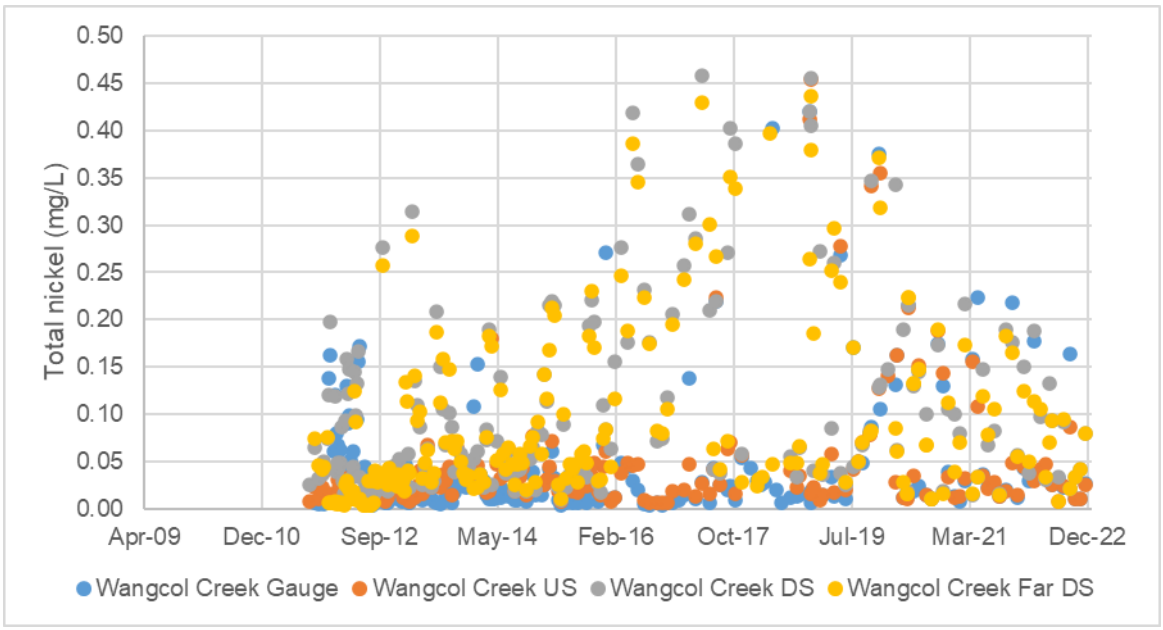


Figure A.99 Wangcol Creek – total nickel

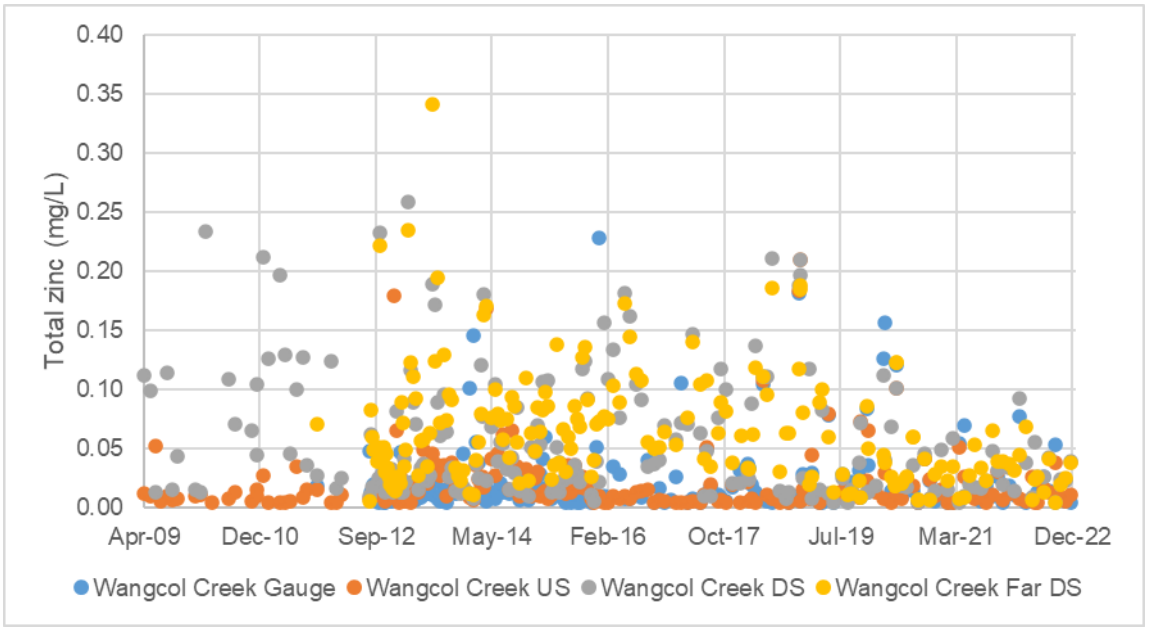


Figure A.100 Wangcol Creek – total zinc

Other

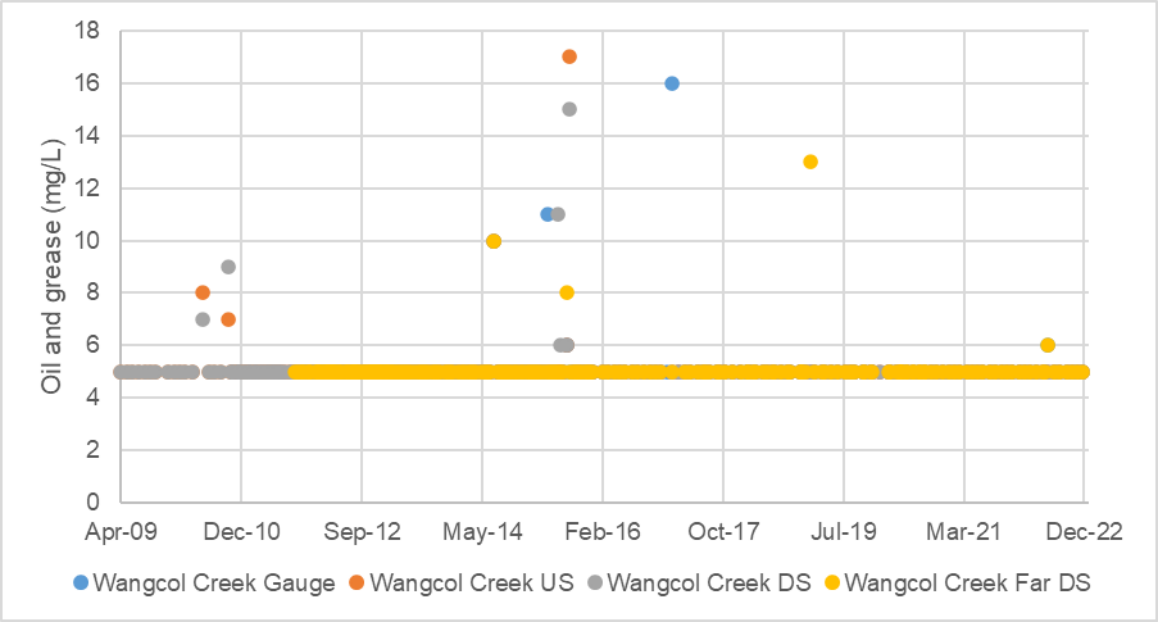


Figure A.101 Wangcol Creek – oil and grease

SWTP Residuals

Physicochemical

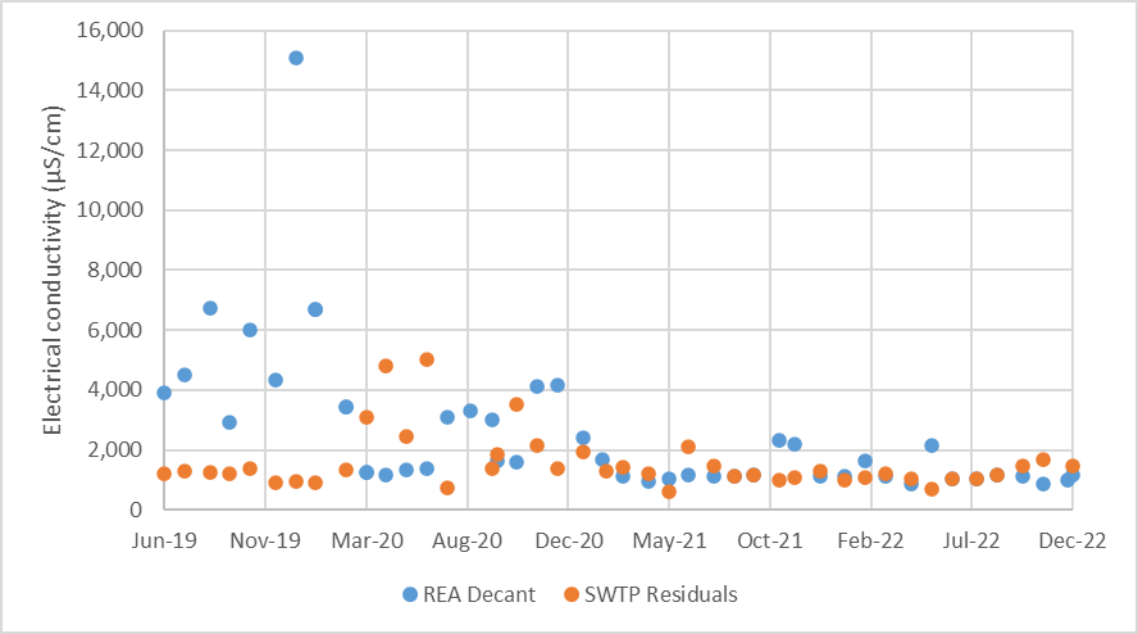


Figure A.102 SWTP Residuals - EC

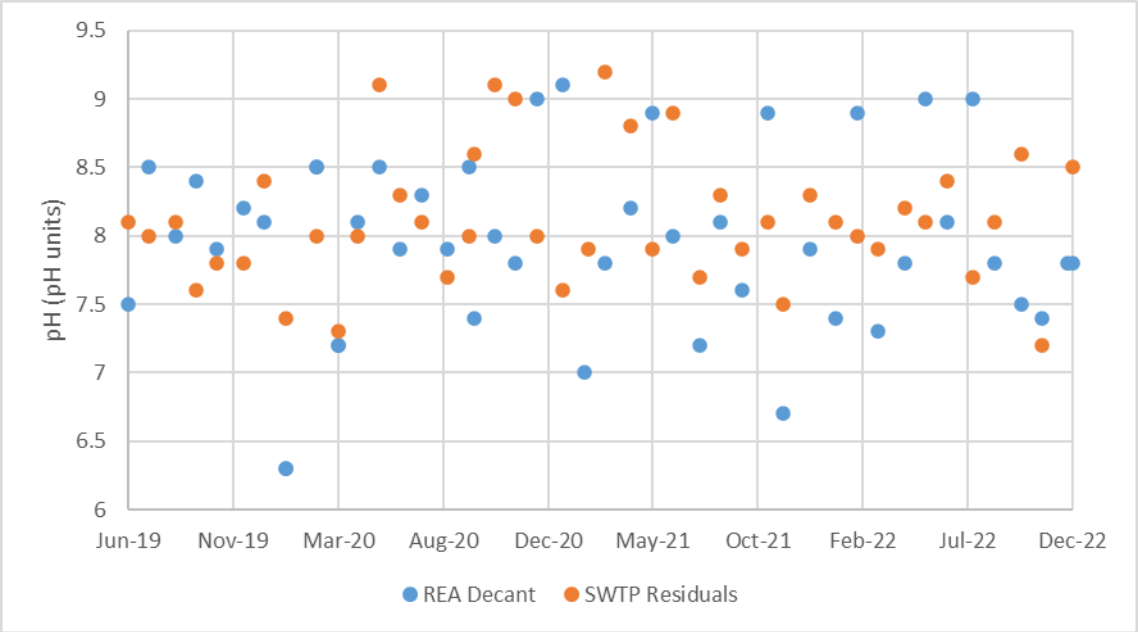


Figure A.103 SWTP residuals - pH

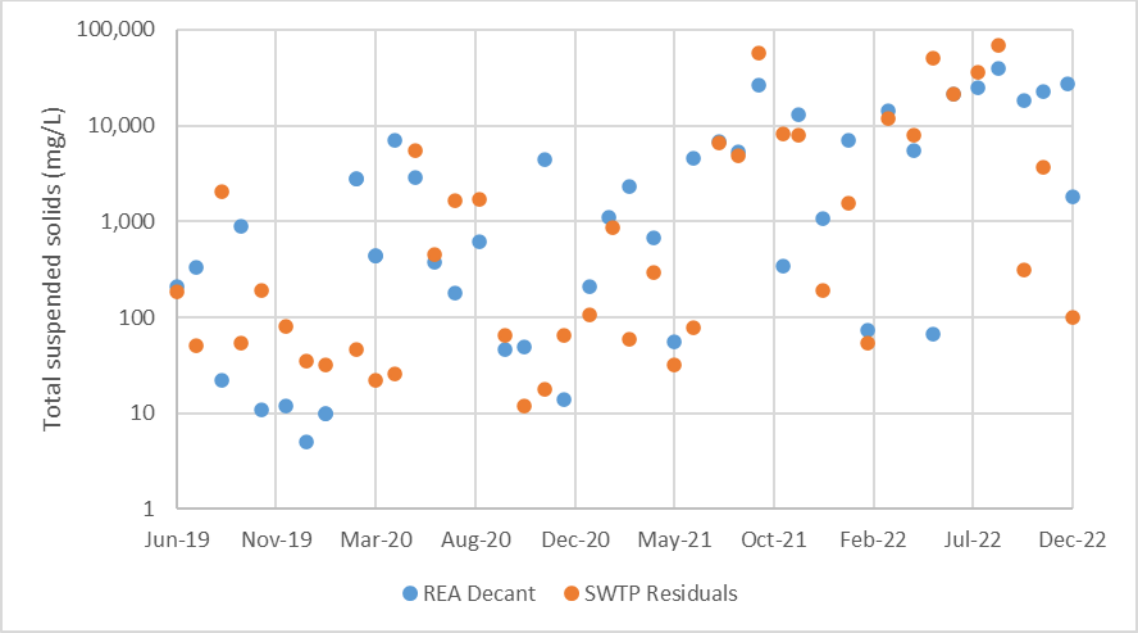


Figure A.104 SWTP residuals - TSS

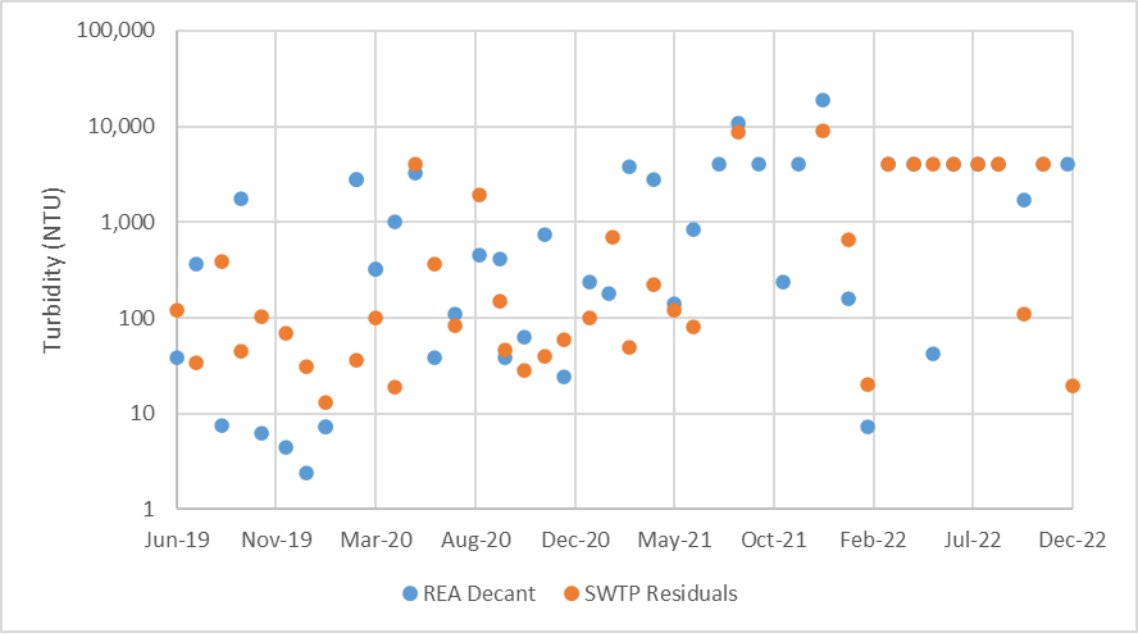


Figure A.105 SWTP residuals - turbidity

Major Ions

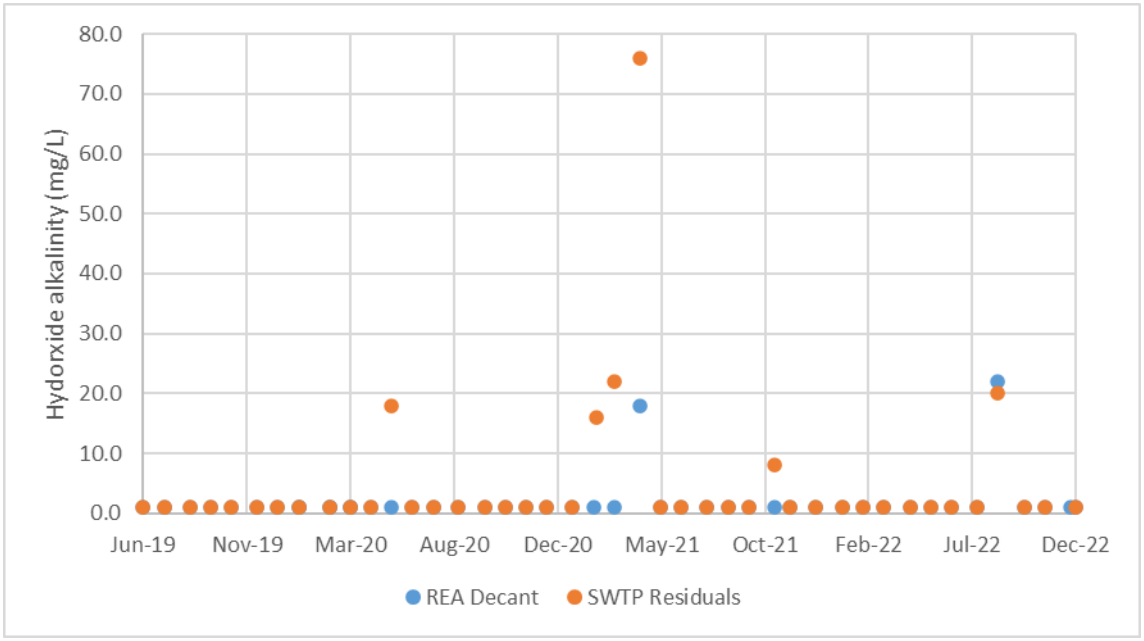


Figure A.106 SWTP residuals – hydroxide alkalinity

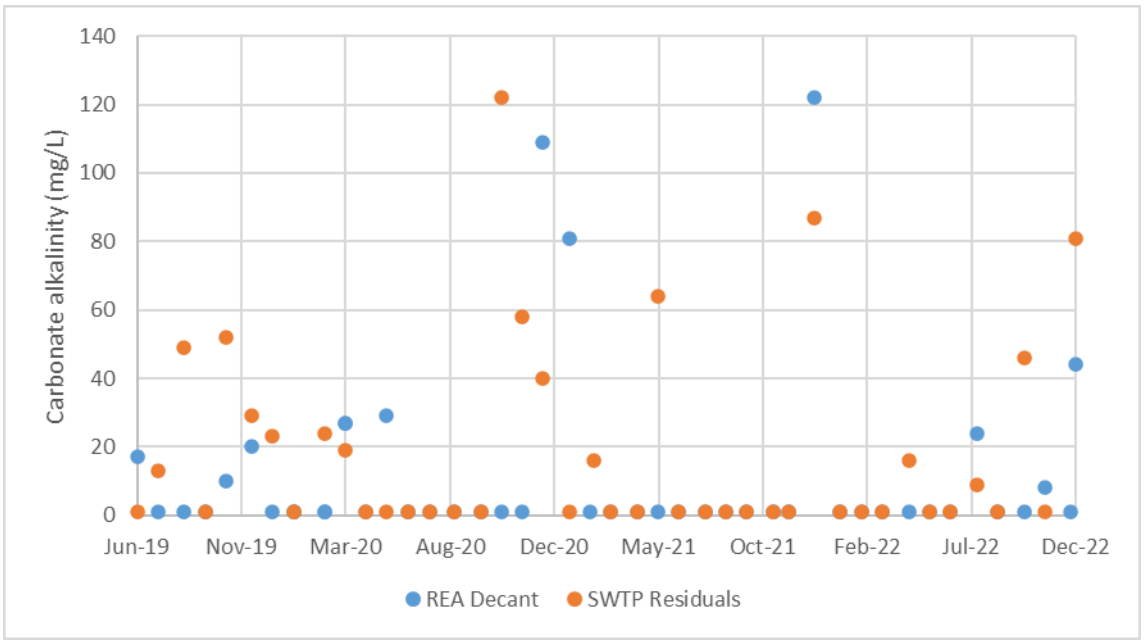


Figure A.107 SWTP residuals – carbonate alkalinity

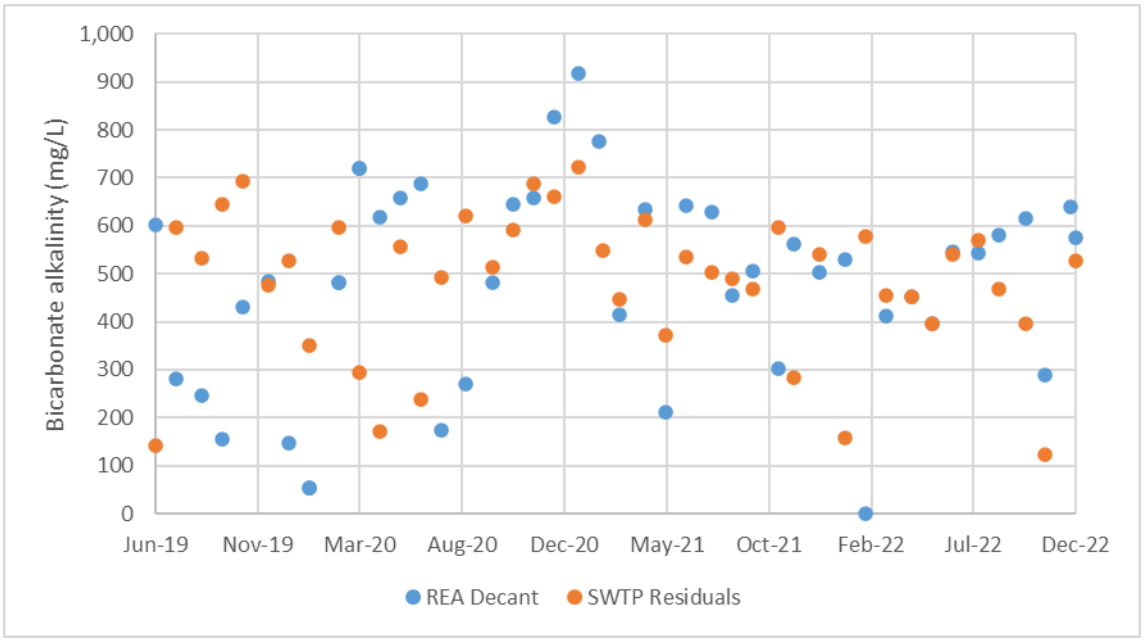


Figure A.108 SWTP residuals – bicarbonate alkalinity

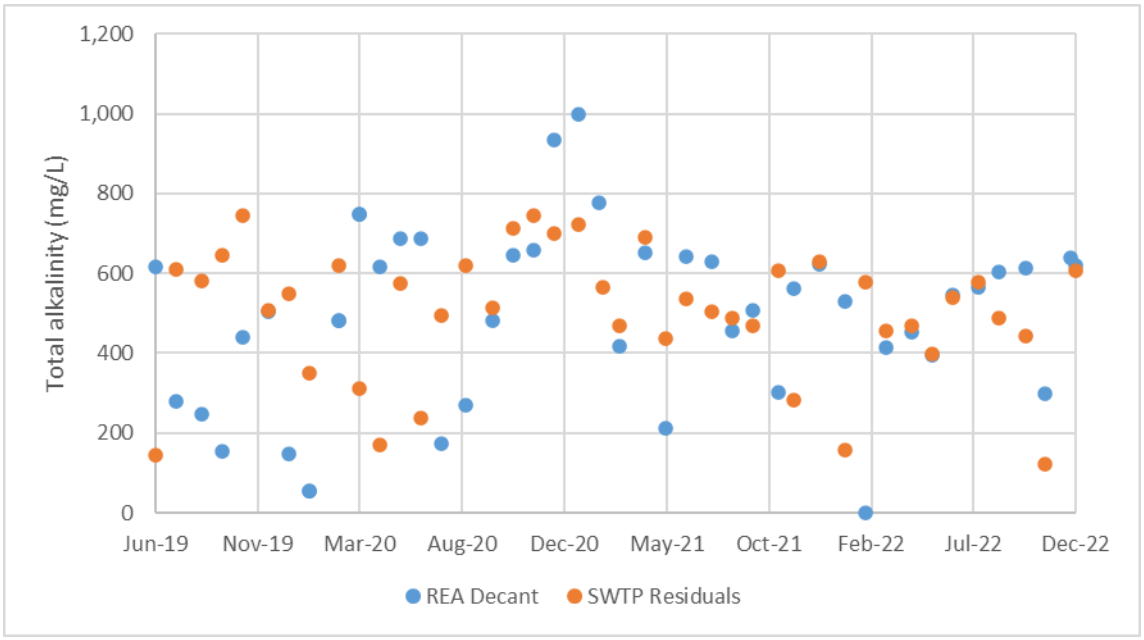


Figure A.109 SWTP residuals – total alkalinity

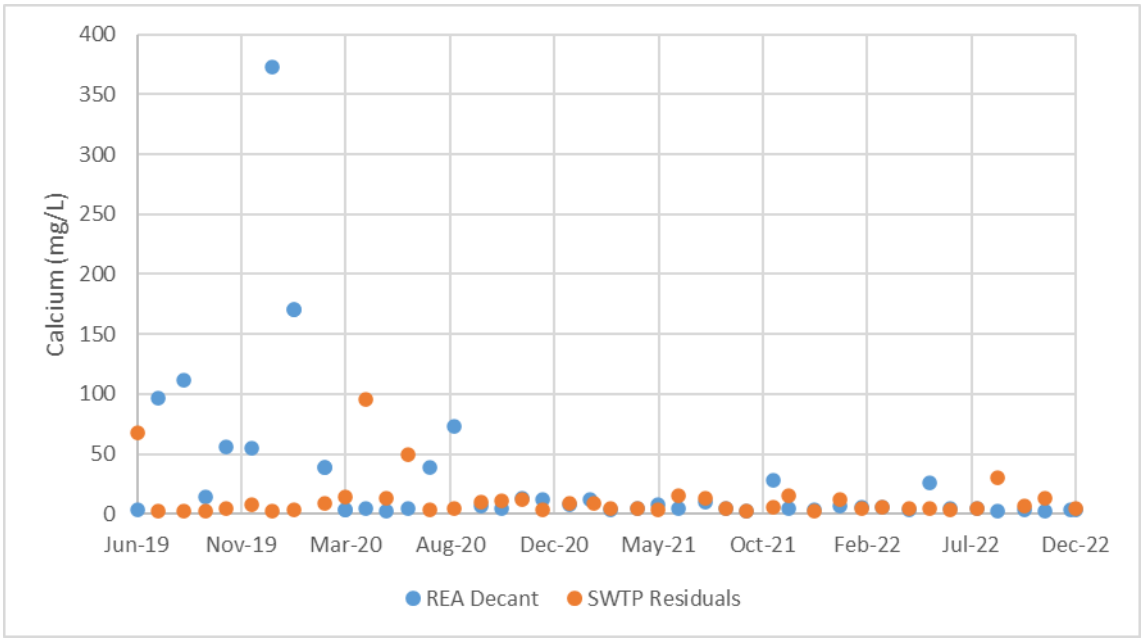


Figure A.110 SWTP residuals - calcium

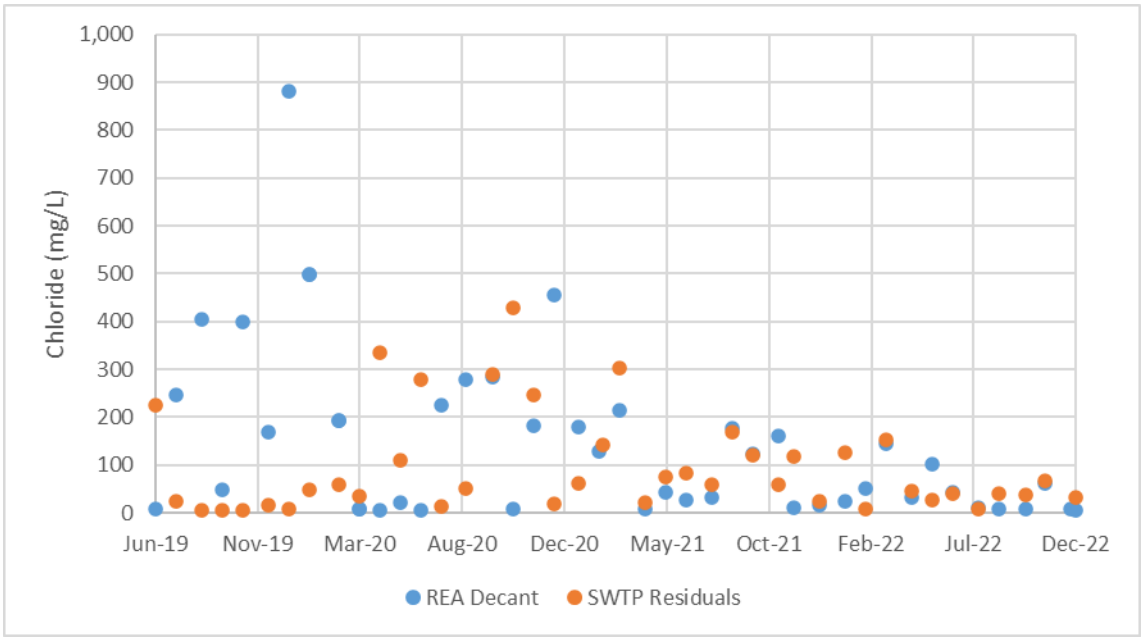


Figure A.111 SWTP residuals – chloride

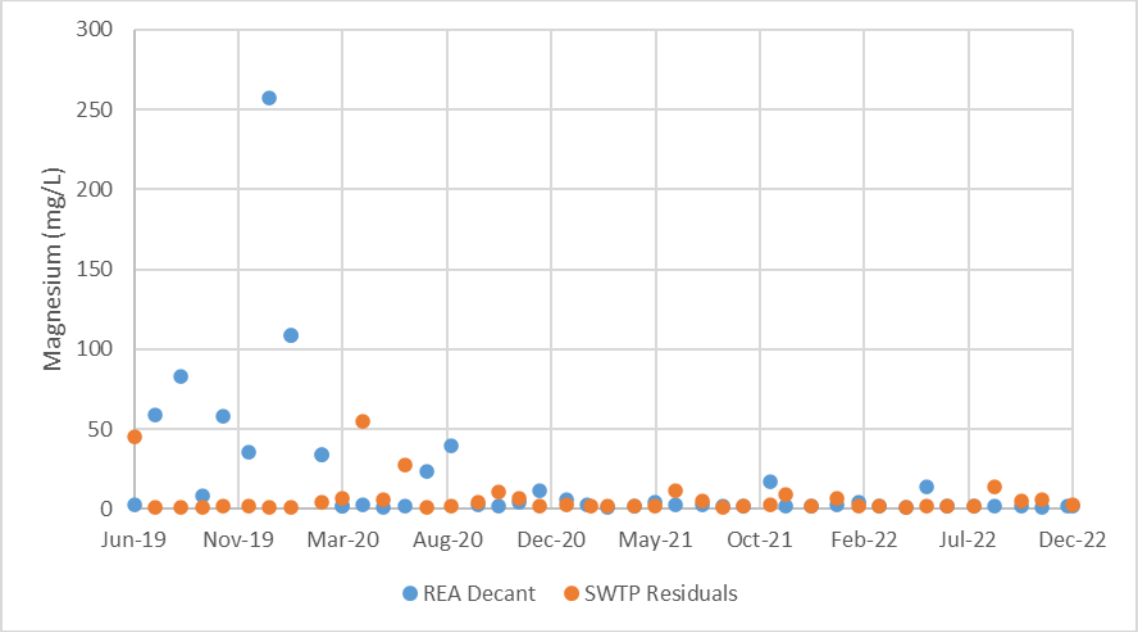


Figure A.112 SWTP residuals - magnesium

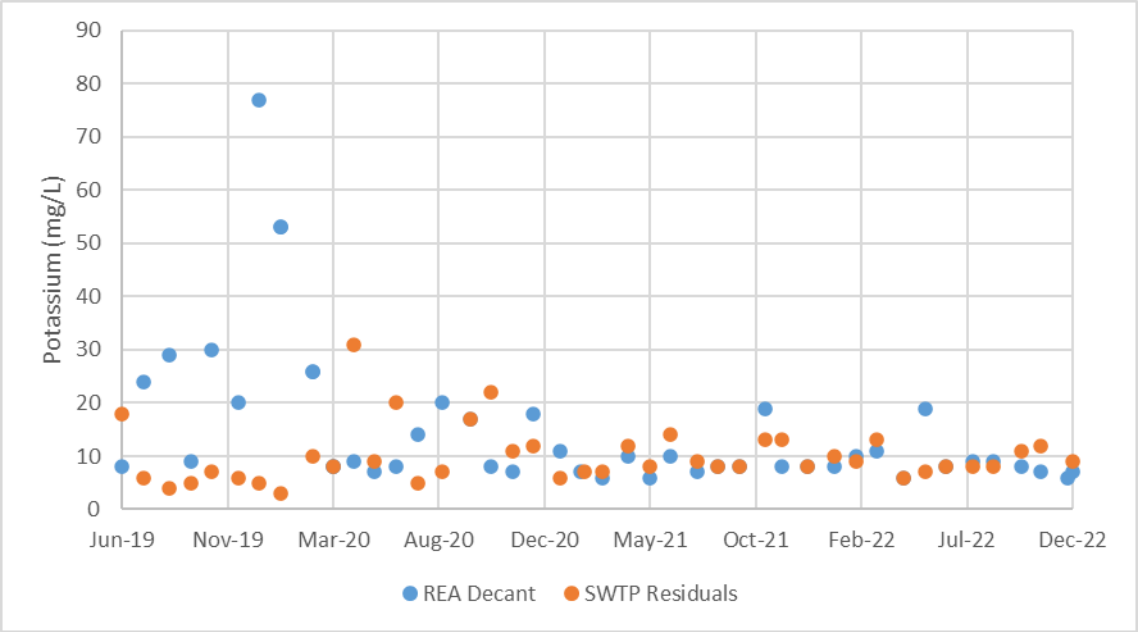


Figure A.113 SWTP residuals - potassium

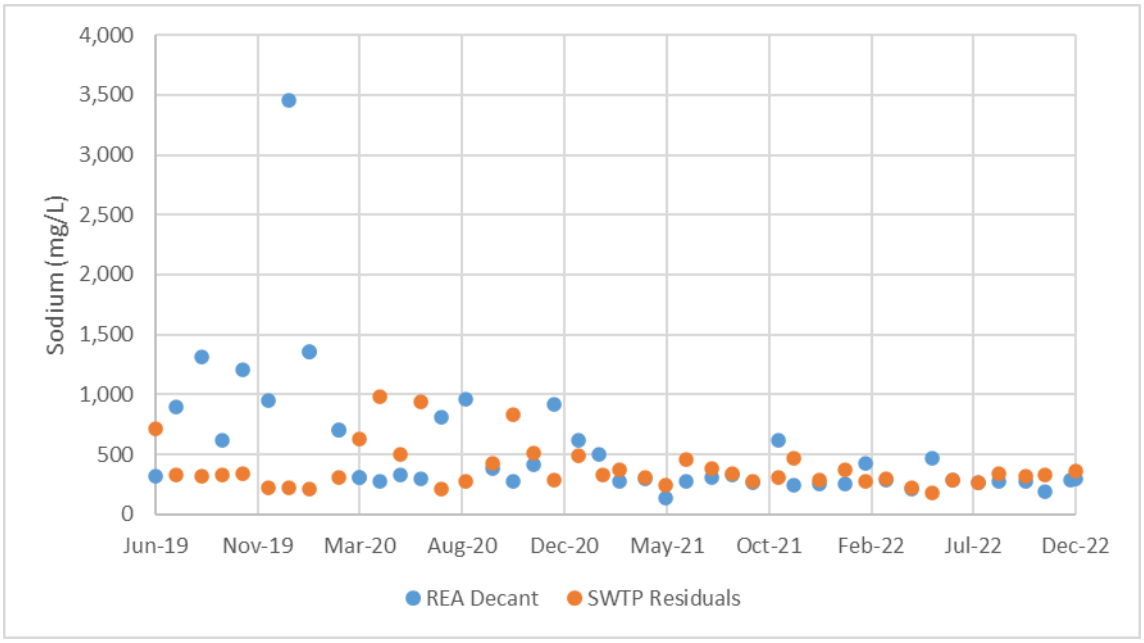


Figure A. 114 SWTP residuals – sodium

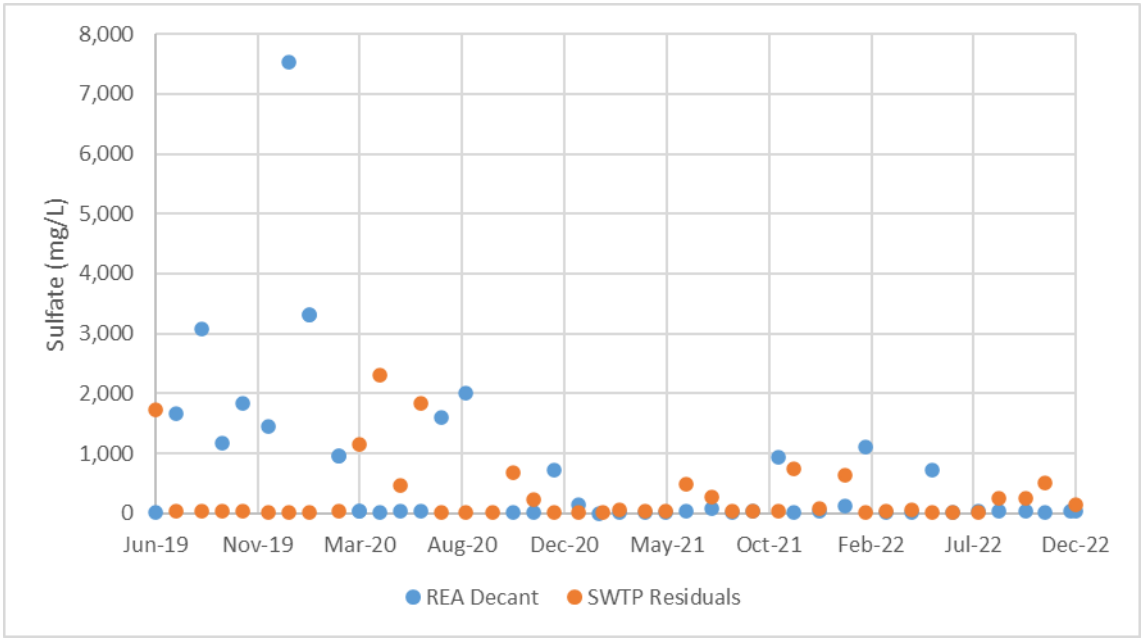


Figure A.115 SWTP residuals - sulfate

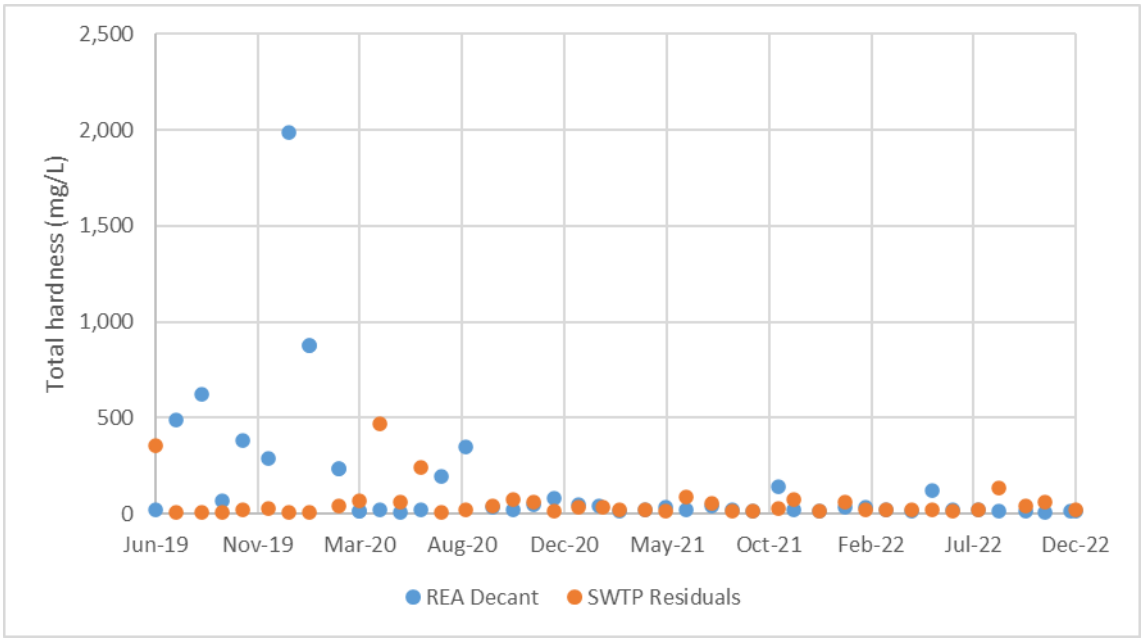


Figure A.116 SWTP residuals – total hardness

Nutrients

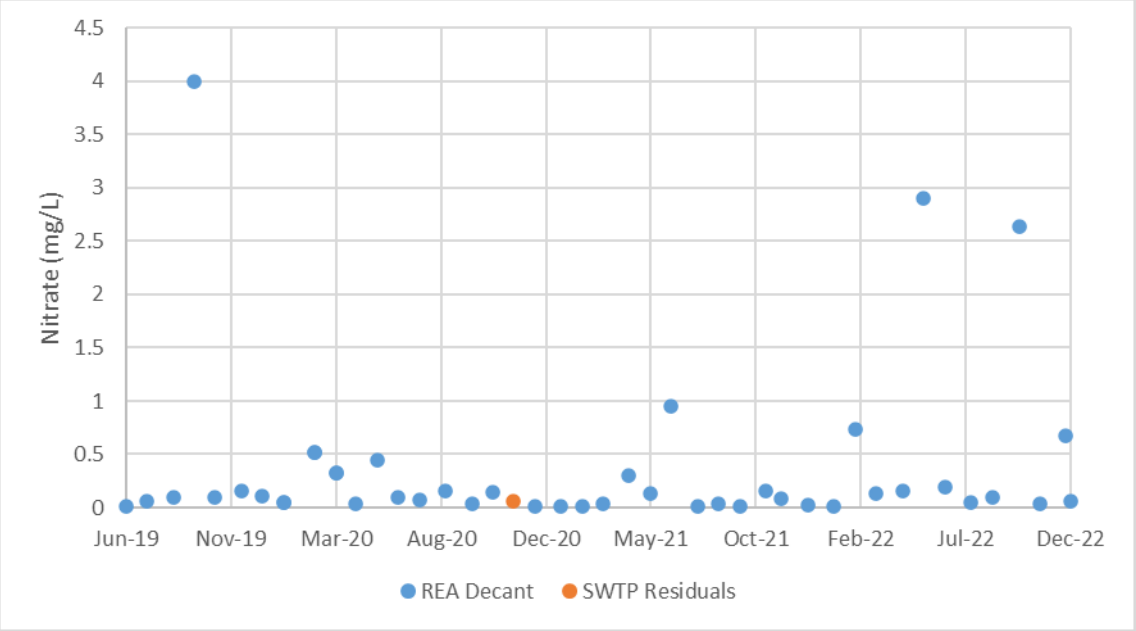


Figure A.117 SWTP residuals - nitrate

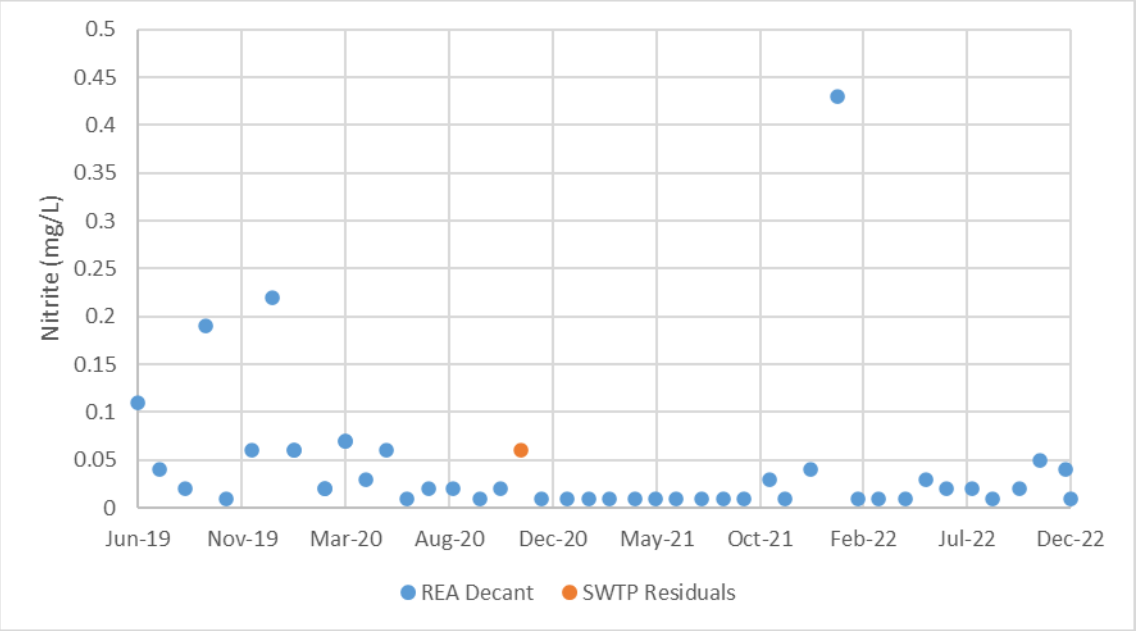


Figure A.118 SWTP residuals - nitrite

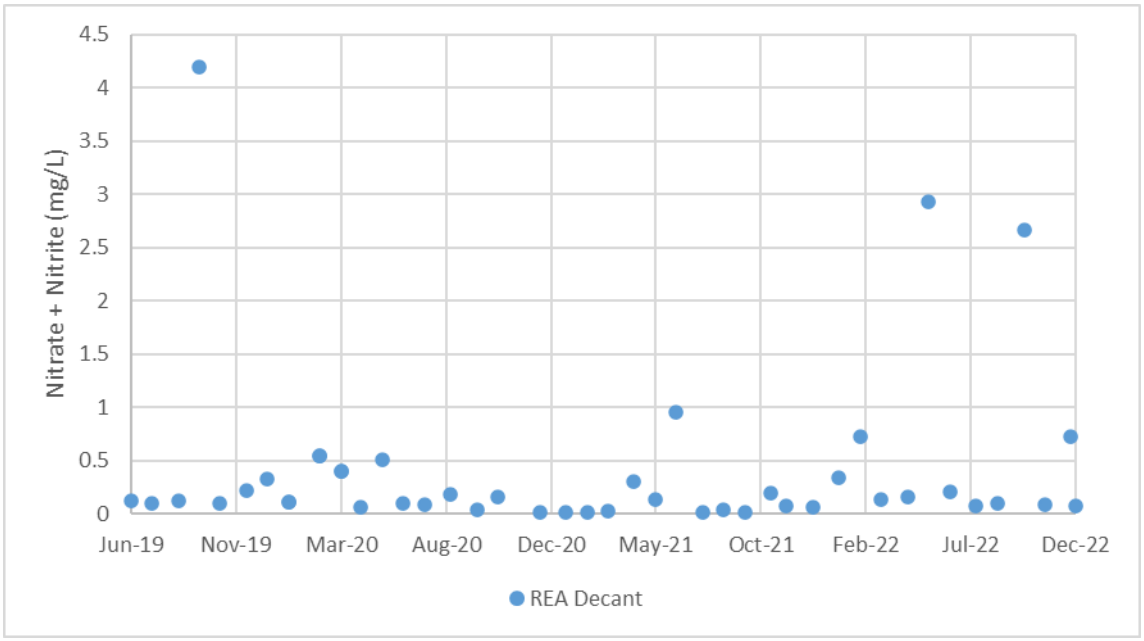


Figure A. 119 SWTP residuals - nitrate + nitrite

Dissolved metals

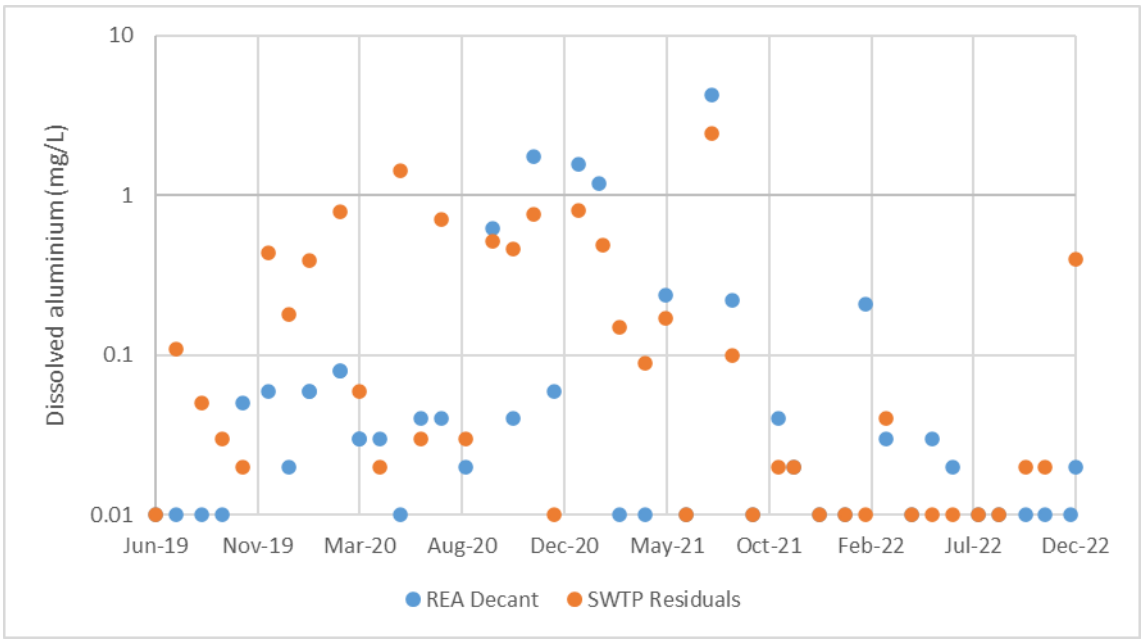


Figure A.120 SWTP residuals – dissolved aluminium

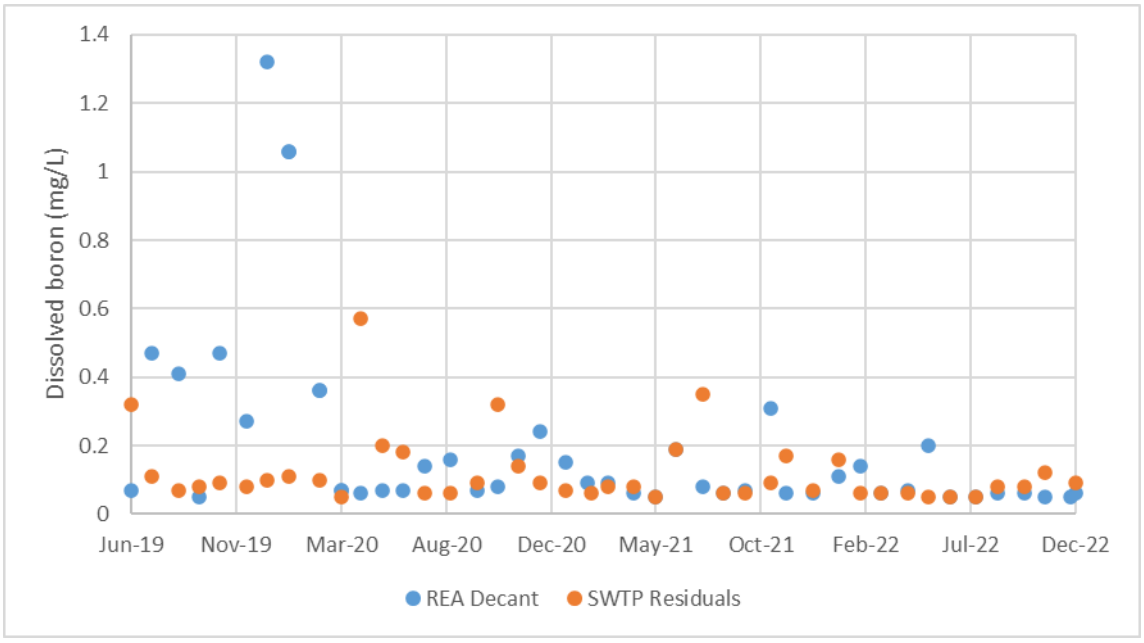


Figure A.121 SWTP residuals – dissolved boron

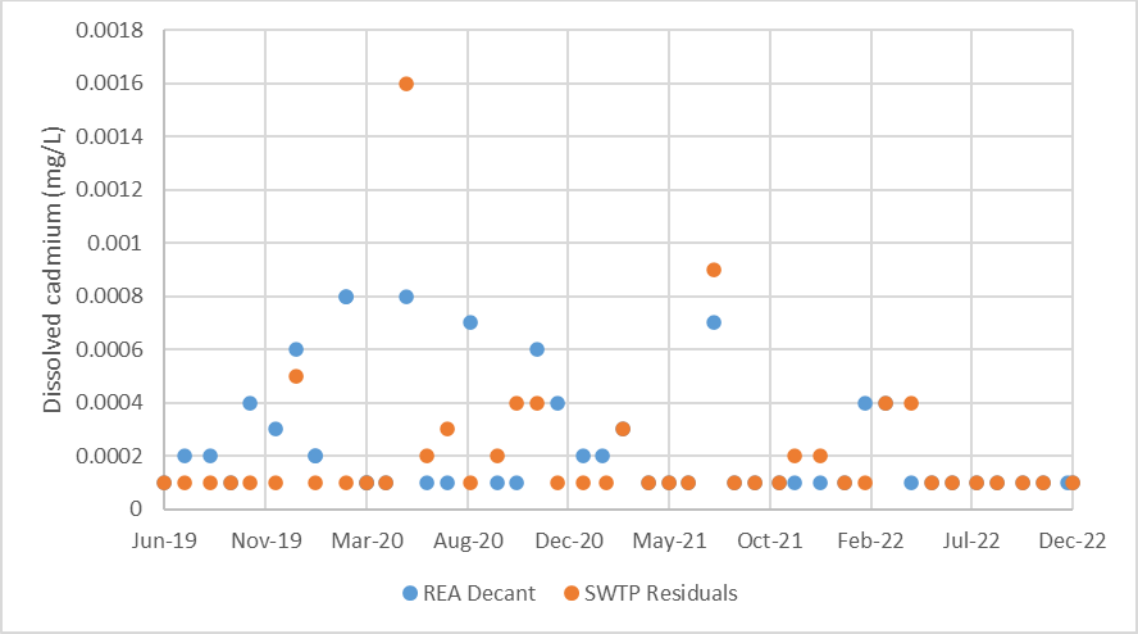


Figure A.122 SWTP residuals – dissolved cadmium

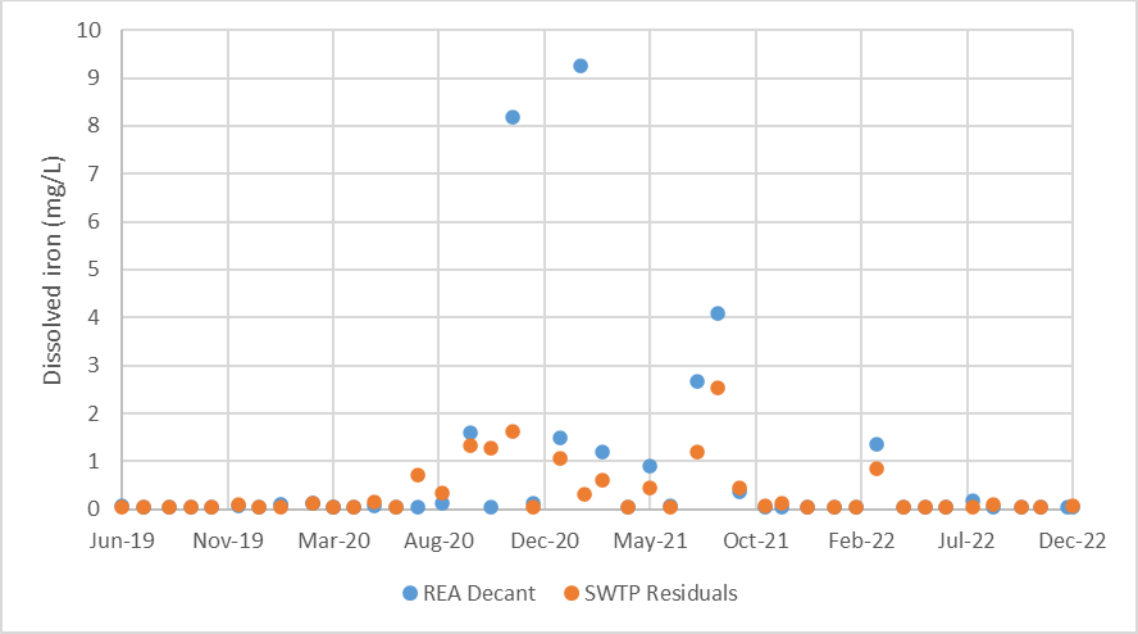


Figure A.123 SWTP residuals – dissolved iron

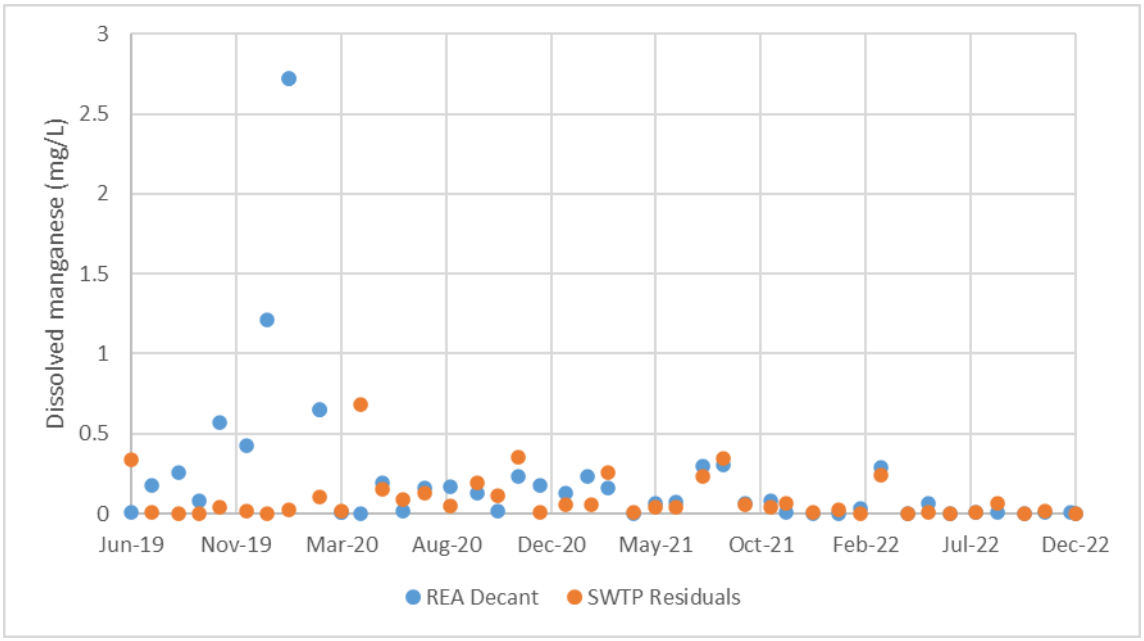


Figure A.124 SWTP residuals – dissolved manganese

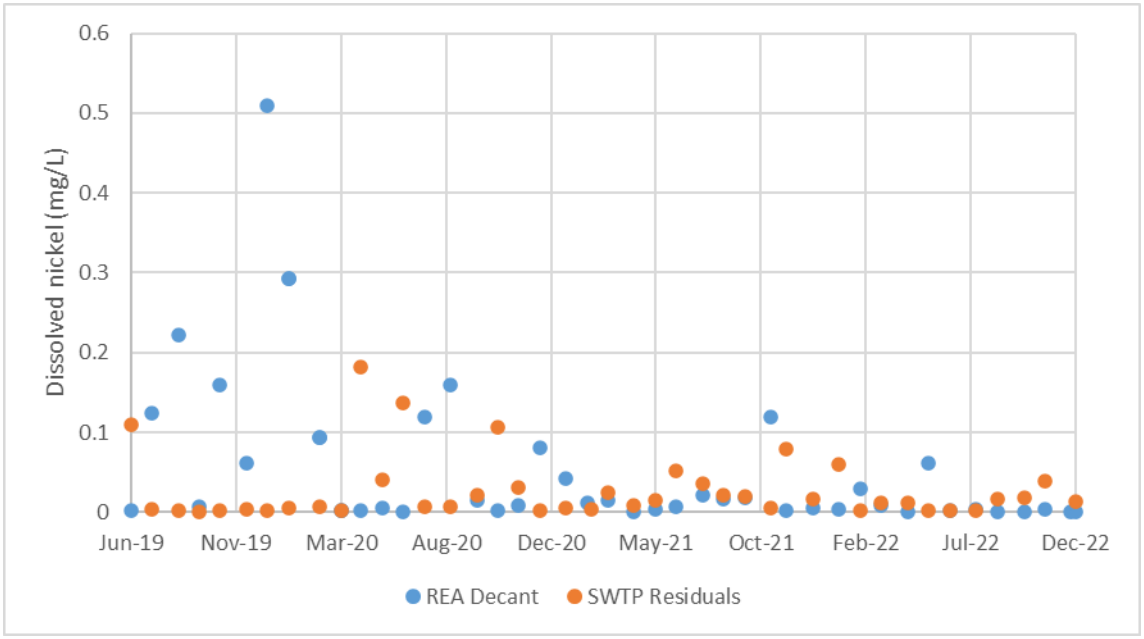


Figure A.125 SWTP residuals - dissolved nickel

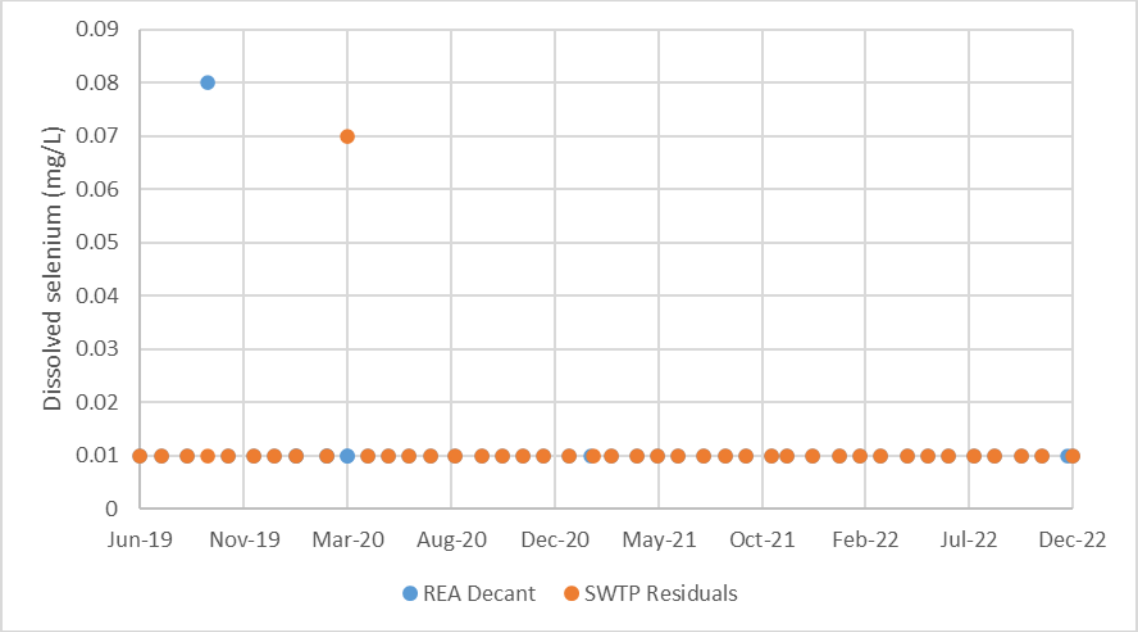


Figure A.126 SWTP residuals - dissolved selenium

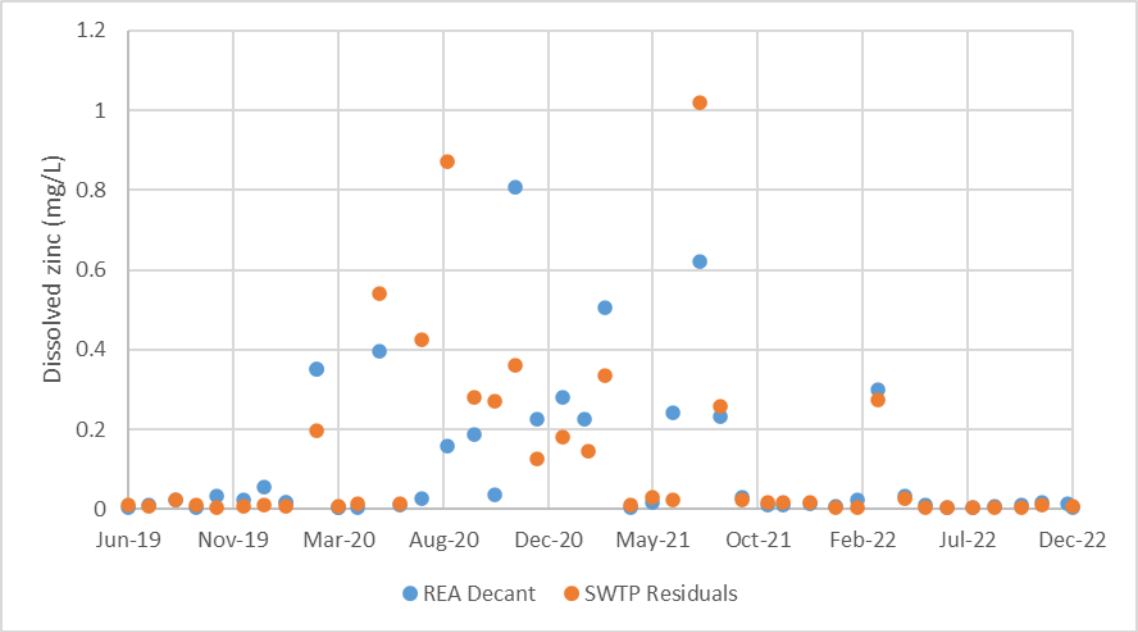


Figure A.127 SWTP residuals – dissolved zinc

Total metals

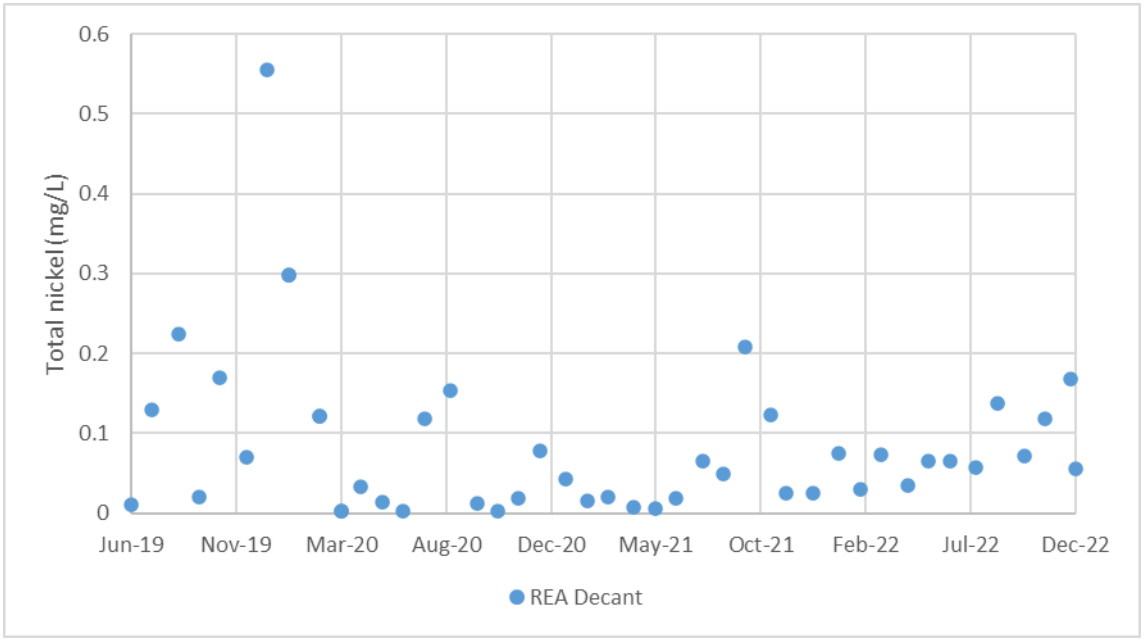


Figure A.128 SWTP residuals – total nickel

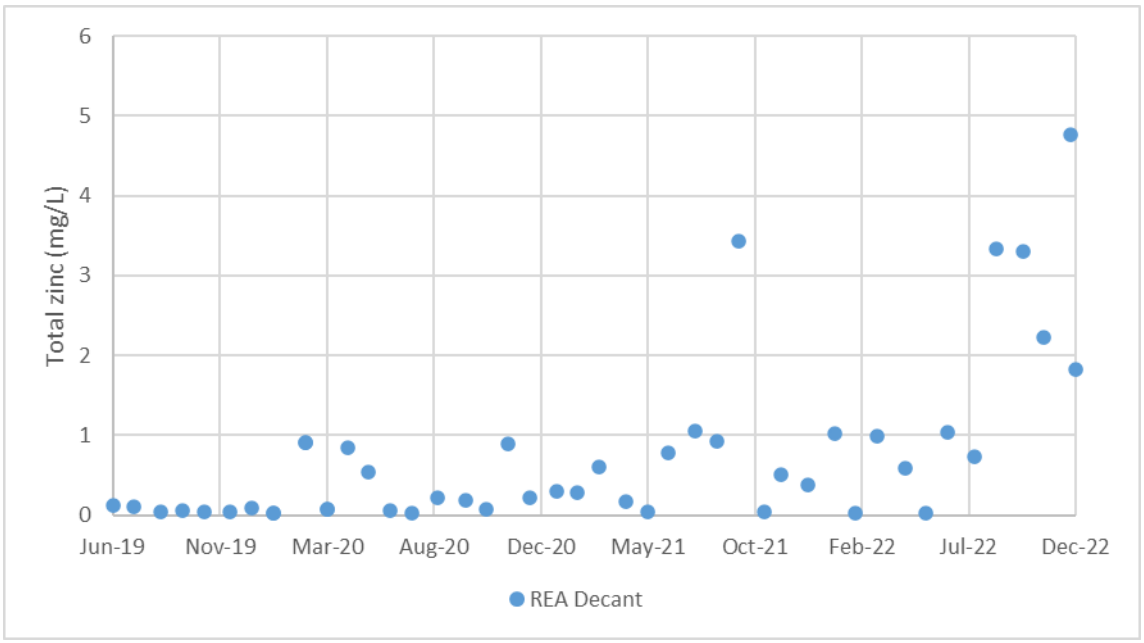


Figure A.129 SWTP residuals – total zinc

Other

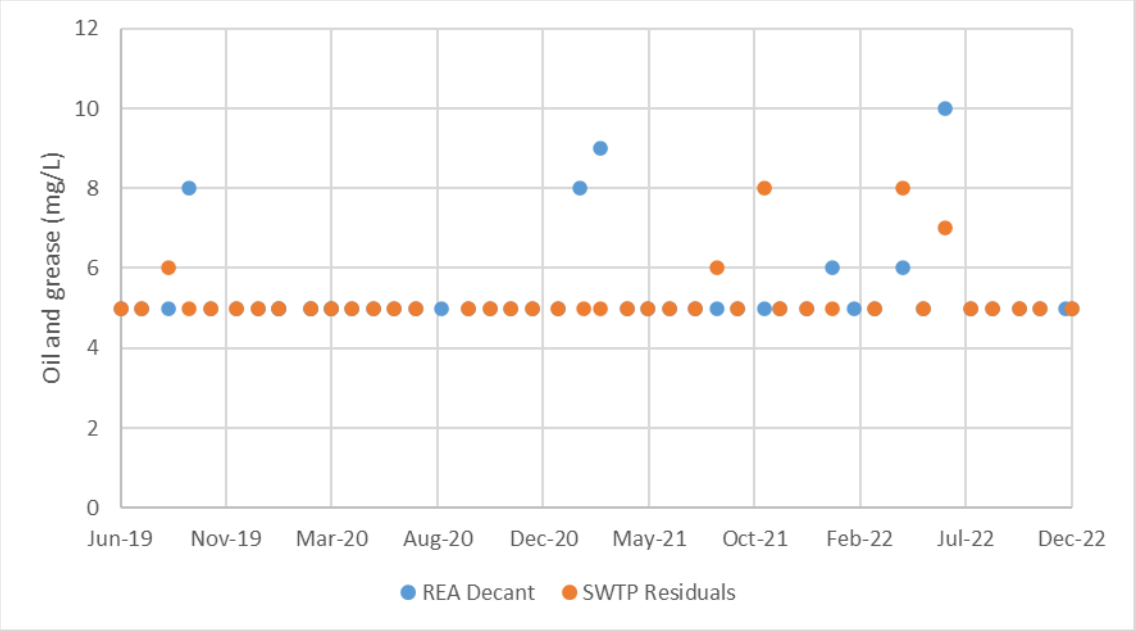


Figure A.130 SWTP residuals – oil and grease

Appendix B

Groundwater level graphs

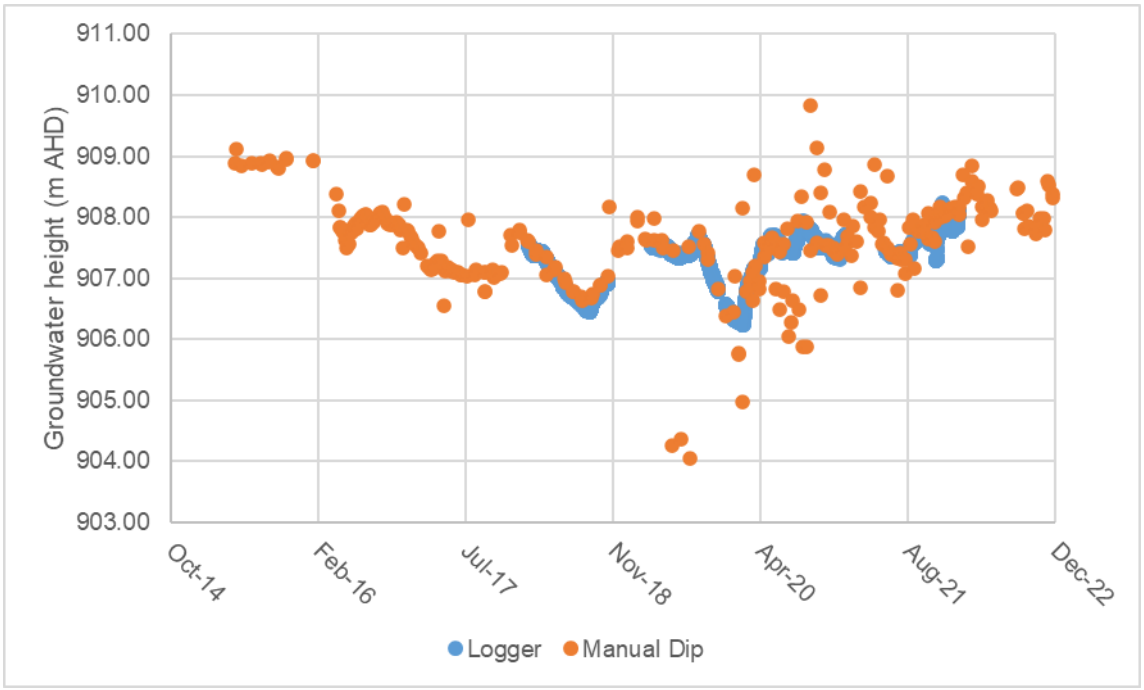


Figure B.1 *BH01 groundwater level*

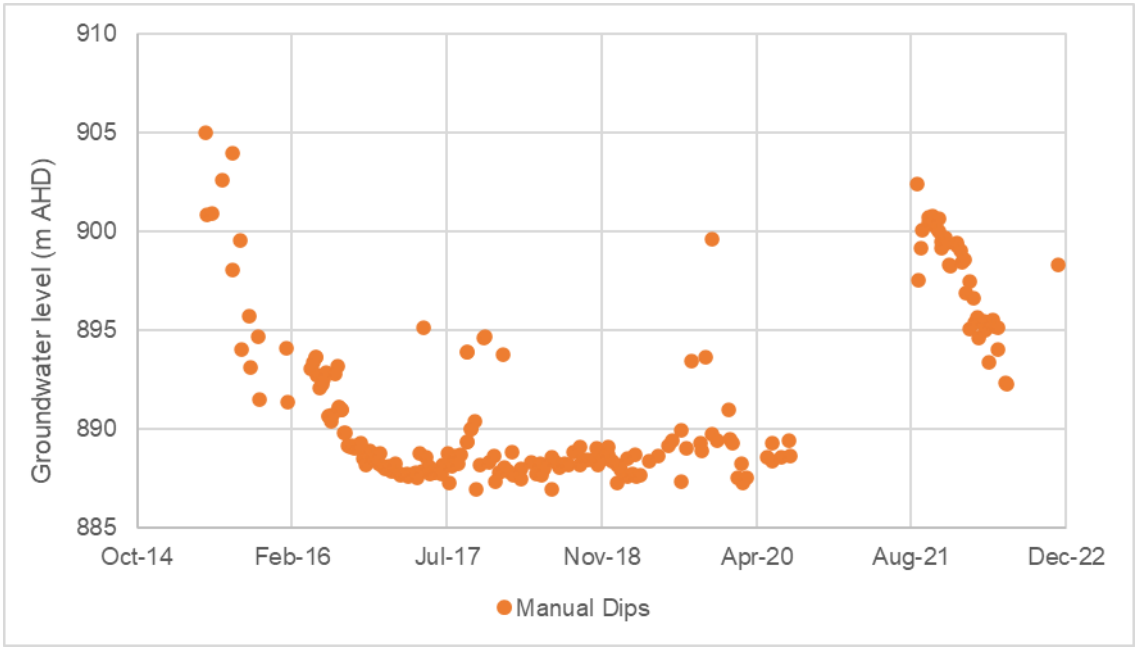


Figure B.2 *BH02 groundwater level*

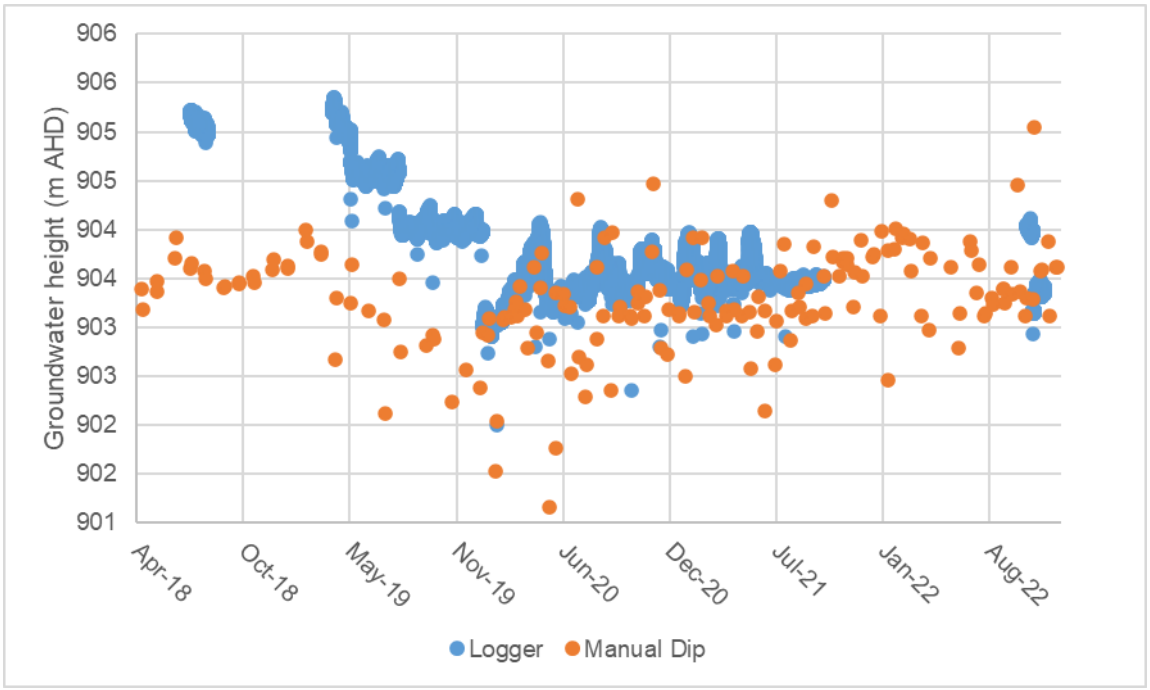


Figure B.3 *BH03 groundwater level*

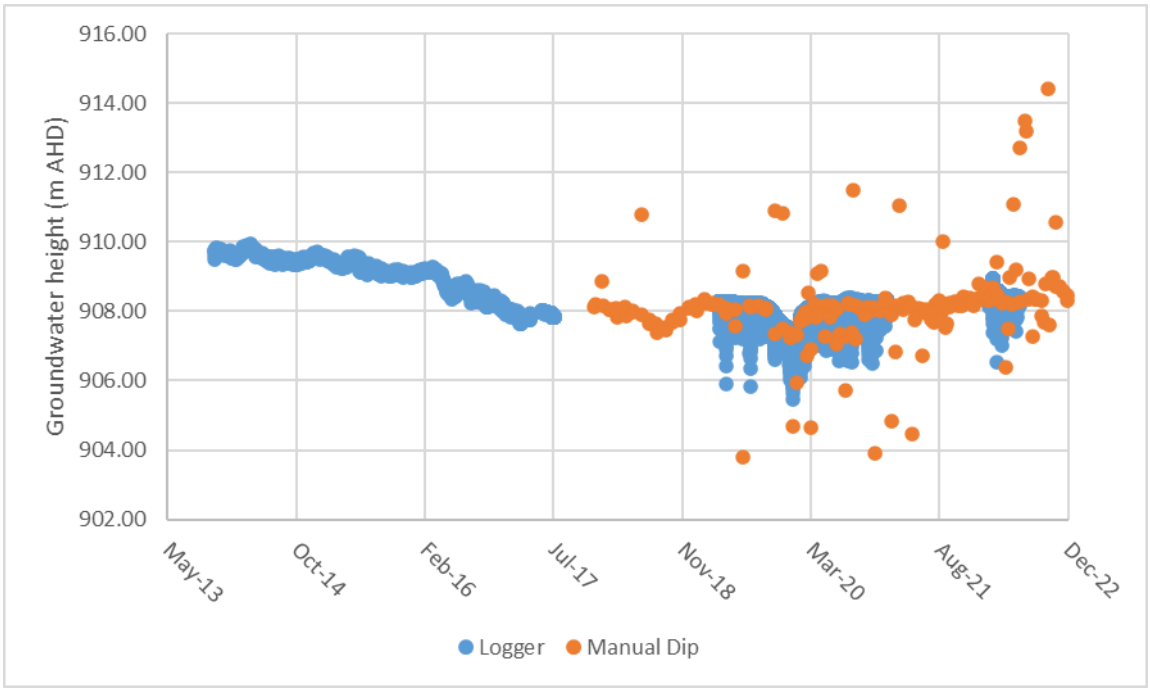


Figure B.4 *BH04 groundwater level*

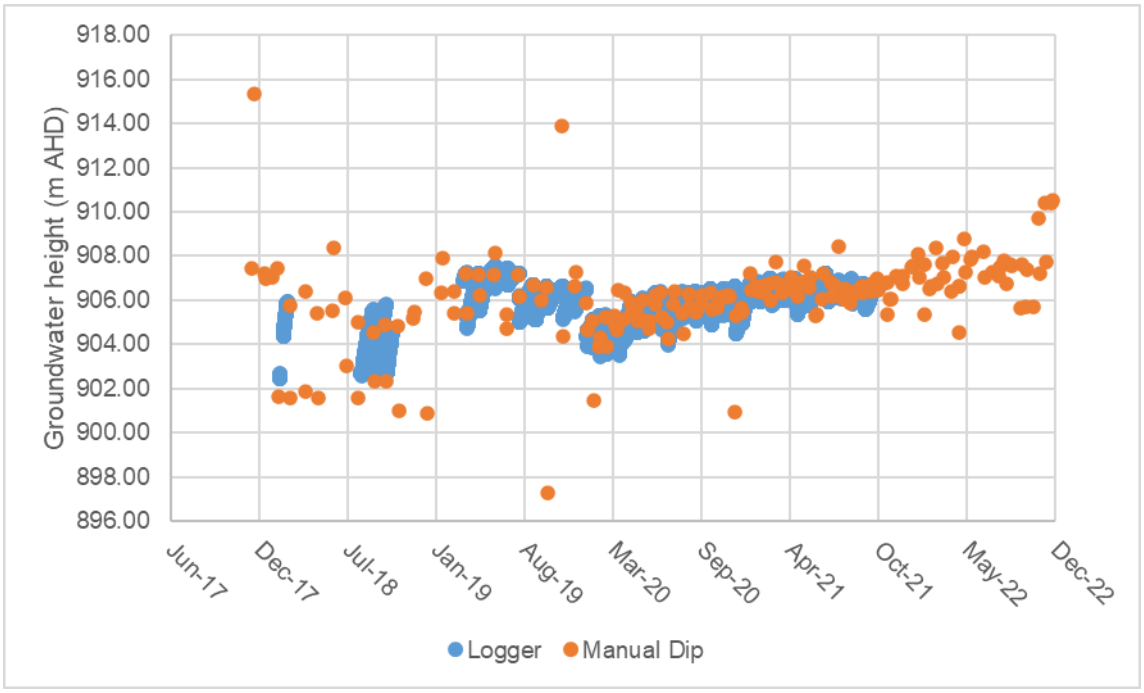


Figure B.5 *BH05 groundwater level*

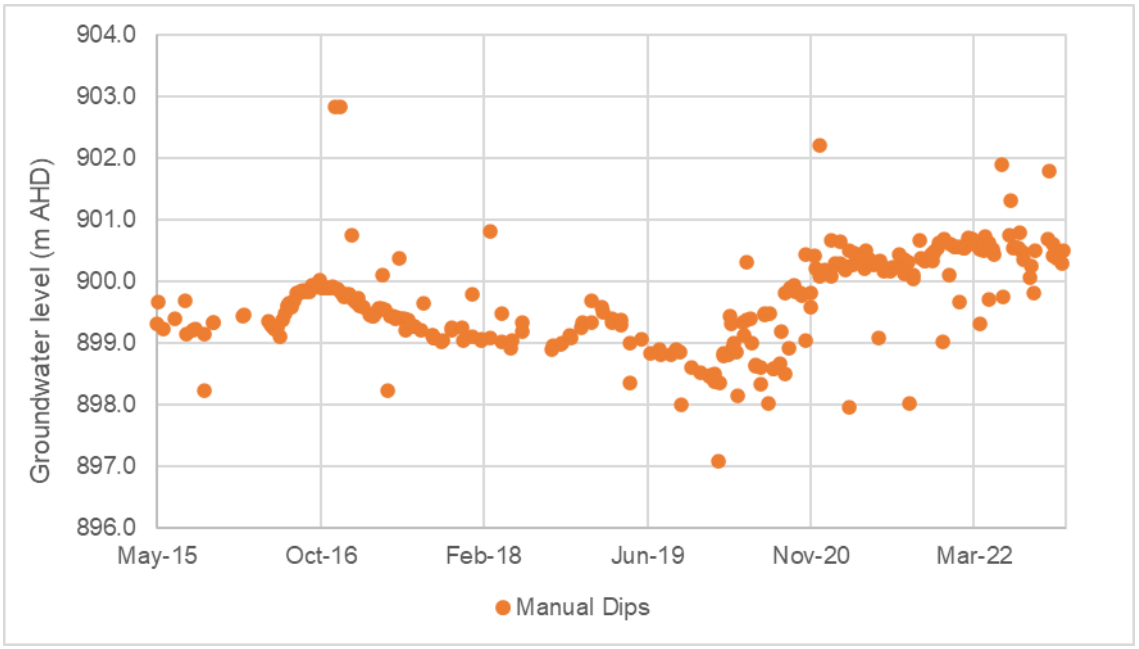


Figure B.6 *BH06 groundwater level*

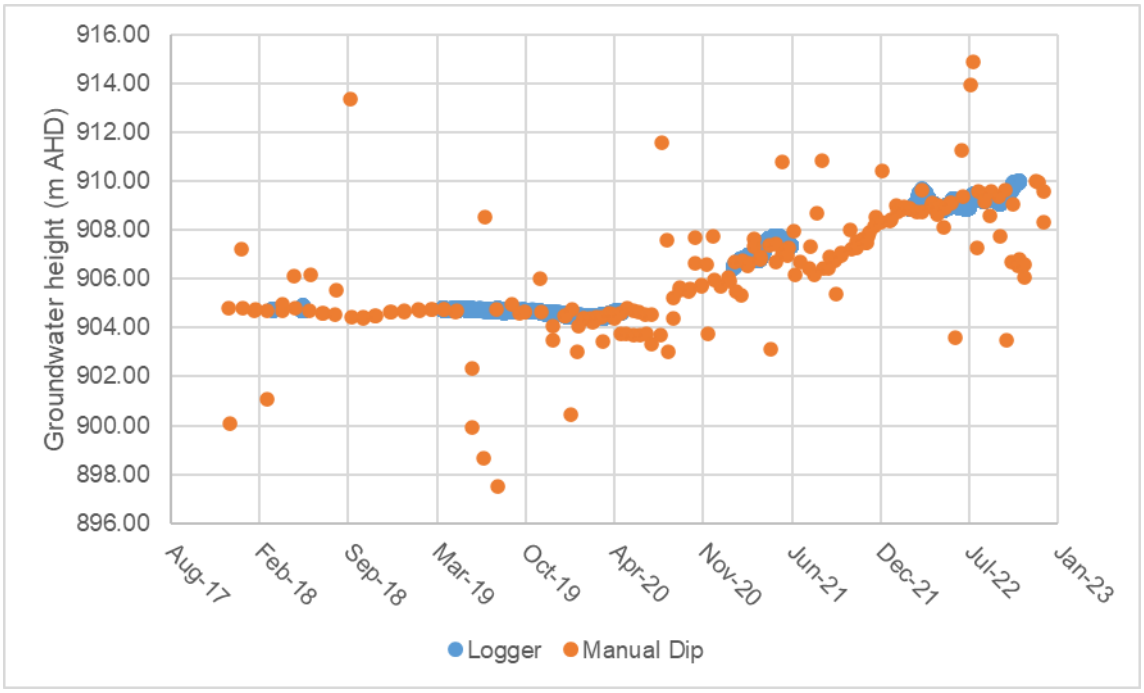


Figure B.7 *BH07 groundwater level*

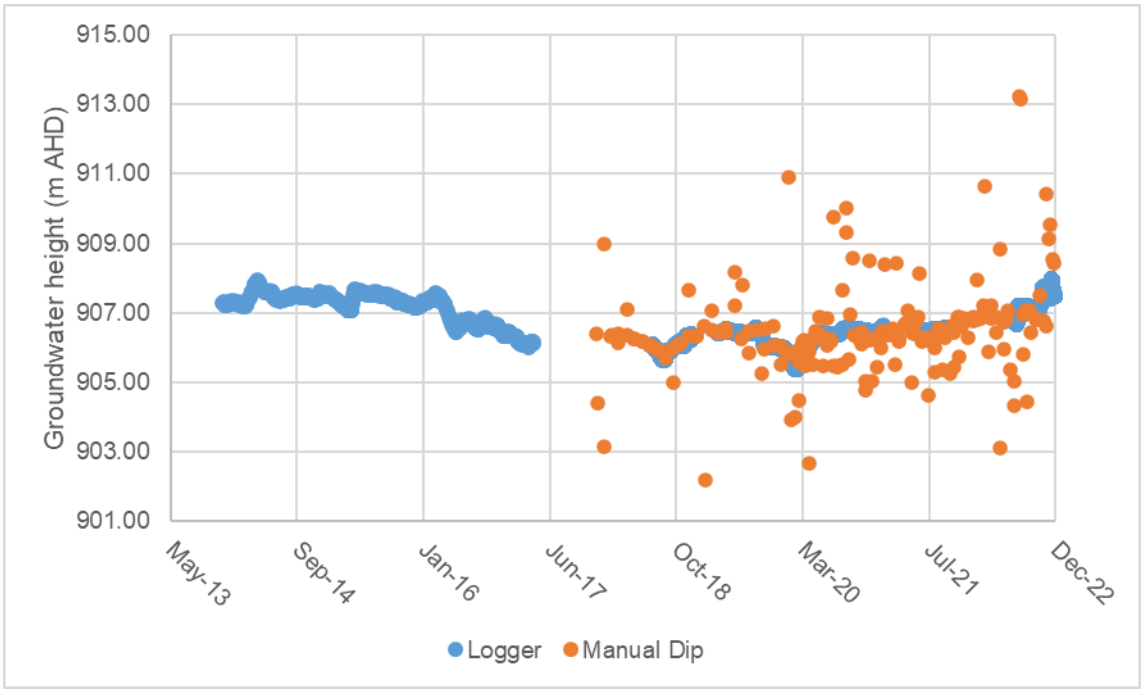


Figure B.8 *BH08 groundwater level*

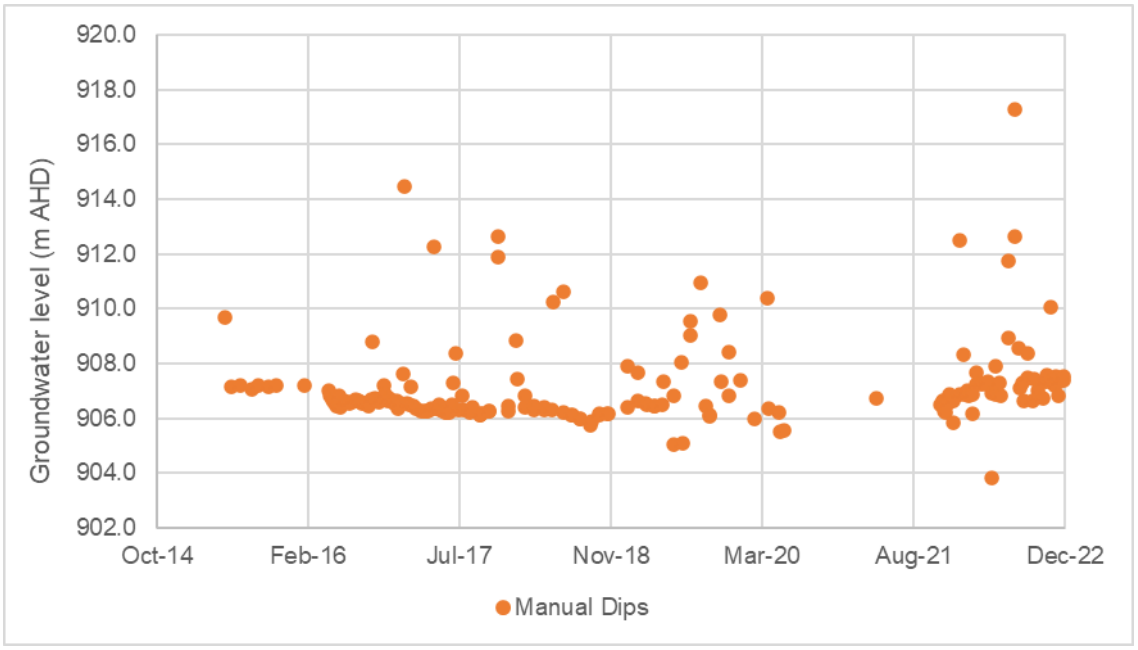


Figure B.9 *BH09 groundwater level*

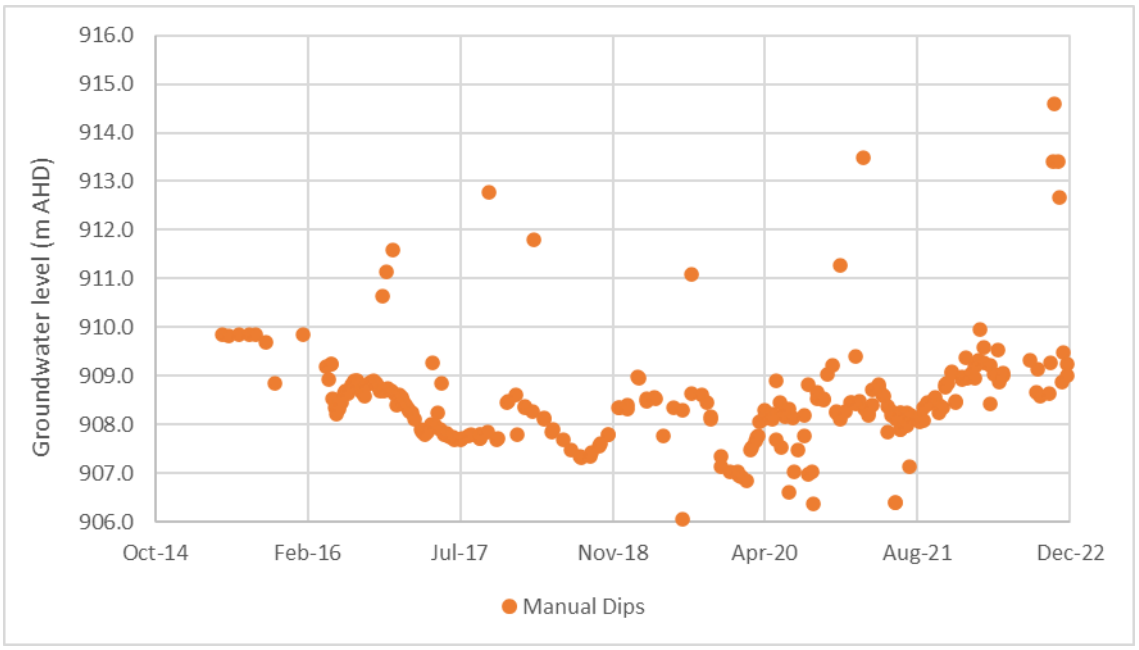


Figure B.10 *BH13 groundwater level*

Appendix C

Site specific guideline values

Table C.1 Groundwater quality SSGVs criteria (May 2022)

Monitoring bore	Parameter SSGVs							
	pH_L (pH units)	pH_U (pH units)	EC (µS/cm)	TSS (mg/L)	Dissolved Iron (mg/L)	Dissolved Manganese (mg/L)	Dissolved Nickel (mg/L)	Dissolved Zinc (mg/L)
BH01	5.5	5.9	4,706	354	5.53	10.1	1.03	0.89
BH02	6.4	6.7	1,479	23,380	0.65	0.759	0.06	0.098
BH03	3.6	4.8	1,270	89	61.52	7.48	0.31	0.971
BH04	6.3	6.7	516	148	2.34	0.515	0.012	0.054
BH05	6.4	6.8	745	155	0.32	0.823	0.023	0.069
BH06	6.1	6.5	2,998	83	10.7	3.23	0.166	0.08
BH07	5.8	6.6	3,634	220	84.2	6.14	0.647	2.61
BH08	5.9	6.1	6,082	56	2.49	9.42	0.761	0.451
BH09	5.9	6.2	6,382	260	14.72	8.38	0.752	0.521
BH11	6.5	6.8	1,644	76	1.68	0.153	0.016	0.072
BH13	6.1	6.5	4,676	431	14.5	9.11	0.539	0.32
BH15	5.9	6.1	3,990	14,332	1.78	7.20	0.468	0.419

Notes for Table C.1: pHL is the lower pH range limit and pHU is the upper pH range limit.

Table C.2 Decant water quality trigger values (May 2022)

Parameter	Units	Trigger value
Physicochemical parameters		
EC	µS/cm	4,135
pH	pH units	7.4[a]-8.5
TSS	mg/L	5,066
Turbidity	NTU	2,800
Dissolved metals		
Aluminium	mg/L	0.158
Boron	mg/L	0.34
Cadmium	mg/L	0.0004
Iron	mg/L	1.08
Manganese	mg/L	0.304
Nickel	mg/L	0.119
Selenium	mg/L	0.01
Zinc	mg/L	0.265
Other		
Oil and grease	mg/L	5

[a] 20th percentile value

Table C.3 WCS Wangcol Creek Far DS Recommended SSGVs (May 2022)

Parameter	Units	DGV (ANZECC 2000)	SW1 80th percentile	Recommended SSGV
Physicochemical				
pH	pH units	6.5–9.0	6.4[a]–7.1	6.5–9.0
TSS	mg/L	25	12	25
Turbidity	NTU	25	35	35
Nutrients				
Ammonia	mg/L	0.04	0.03	0.04
Total nitrogen	mg/L	0.2	0.5	0.5
Total phosphorus	mg/L	0.02	0.08	0.08
Dissolved metals				
Aluminium	mg/L	0.055	0.24	0.24
Boron	mg/L	0.37	0.05[c]	0.37
Cadmium	mg/L	0.0026[b]	0.0001[c]	0.0026
Iron	mg/L	0.3	0.31	0.31
Manganese	mg/L	1.9	0.150	1.9
Nickel	mg/L	0.125[b]	0.003	0.125
Selenium	mg/L	0.011	–	0.011
Zinc	mg/L	0.091[b]	0.032	0.091

[a] 20th percentile value.
[b] Guideline value modified for hardness.
[c] Limit of reporting.

ghd.com

→ The Power of Commitment

Table 8A-1 Summary of Wangcol Creek Far DS Trigger Events & Investigation 2022

Parameter	Exceedance occurrence (SSGV)	Investigation
TSS	49 mg/L, July (25 mg/L)	Concentrations of TSS were recorded above the SSGV following approximately 117 mm of rainfall in the 5 days prior to the sample being collected. Concentrations of TSS were not as elevated on the same day of sampling at the Wangcol Creek DS site (recorded at 20 mg/L). Concentrations reported further upstream were similar, reporting 22 mg/L. Concentrations of TSS are therefore considered to be associated with excess sediment laden runoff occurring downstream of discharges through LDP001, driven by high rainfall.
Turbidity	July, 116 NTU (35 NTU)	Concentrations of turbidity were elevated in July following the rainfall event (117 mm rainfall recorded in 5 days prior to sample being collected). Turbidity was recorded at 99 NTU upstream of LDP001 at the Wangcol Creek US site, while at the Wangcol Creek DS site, turbidity was recorded approximately 101 NTU. Discharges reported through LDP001 were approximately 56 NTU. Therefore, the impact of discharges on turbidity at the downstream site are considered negligible, with potential of increased sediment associated with catchment runoff.
Dissolved nickel	January, 0.126 mg/L (0.125 mg/L)	There was no evidence of elevated dissolved nickel upstream of LDP001. LDP001 was discharging at the time of monitoring within Wangcol Creek. The elevated dissolved nickel was therefore likely to have been influenced by discharges from WCS through LDP001 with a discharged concentration recorded at 0.23 mg/L.
Ammonia (mg/L)	January, 0.07 mg/L (0.04 mg/L)	Ammonia concentrations were also elevated at the Wangcol Creek Gauge, Wangcol Creek US and Wangcol Creek DS, (each at 0.04 mg/L) though slightly lower than at Wangcol Creek Far DS. Therefore, discharge from LDP001 may not be the source of influence on concentrations of ammonia at the Wangcol Creek Far downstream site and may be related to other seepage events further downstream of Wangcol Creek DS.
	October 0.06 mg/L (0.04 mg/L)	Ammonia concentrations at upstream locations did not have elevated results. Therefore, the source of influence on concentrations of ammonia at the Wangcol Creek Far downstream site and may be related to other seepage events further downstream of Wangcol Creek DS.
Nitrogen (total)	April 0.6 mg/L (0.5 mg/L)	Nitrogen (total) was elevated in the Wangcol Creek DS monitoring events (2.3 mg/L) in April. Concentrations were not elevated at sites upstream of LDP001. Monitoring of total nitrogen was not undertaken at any onsite surface water storage locations during April. No other elevated concentrations were recorded. Less than 1 mm of rainfall was recorded in the 5 days prior to monitoring near the site.

Parameter	Exceedance occurrence (SSGV)	Investigation
	July, 1.6 mg/L (0.5 mg/L)	In July, concentrations of nitrogen were more elevated at the Wangcol Creek Far DS site, in comparison to the Wangcol Creek D/S location (0.8 mg/L) and further upstream at Wangcol Creek U/S location (0.9 mg/L). Nitrogen (total) is not screened for in LDP001 discharges. However, given concentrations of nitrogen were also elevated upstream of LDP001 (above the SSGV at Wangcol Creek U/S), it is not likely that discharges influenced concentrations of nitrogen (total) downstream.
Phosphorus	July, 0.09 mg/L (0.08 mg/L)	Concentrations of phosphorus were more elevated upstream at Wangcol Creek U/S on the same day of monitoring (recorded at 0.1 mg/L). Therefore, elevated phosphorus concentrations are unlikely to be associated with discharges through LDP001.
Dissolved Boron (mg/L)	January, 0.58 mg/L (0.37 mg/L)	There was no evidence of elevated dissolved boron at sites upstream of LDP001. LDP001 was discharging at the time of monitoring within Wangcol Creek. The elevated dissolved boron is potentially caused by discharges from WCS through LDP001 and seepages from surround operations through historical mine workings. Only 2.6 mm of rainfall was received in the 10 days prior to sampling.
	March, 0.44 mg/L (0.37 mg/L)	There was no evidence of elevated dissolved boron upstream of LDP001. LDP001 was discharging at the time of monitoring within Wangcol Creek. The elevated dissolved boron is potentially influenced by discharges from WCS through LDP001 and seepages from surroundings operations through historical mine workings. In addition, there was 61.6 mm of rain received in the 9 days prior to sampling, which may have impacted the time available for settlement and adsorption to sediment of dissolved boron within Cooks Dam.
	April (0.53 mg/L) June (0.43 mg/L) (0.37 mg/L)	The elevated dissolved boron is potentially influenced by discharges from WCS through LDP001 and seepages from surroundings operations through historical mine workings. There was no evidence of elevated dissolved boron upstream of LDP001. LDP001 was discharging at the time of monitoring within Wangcol Creek. Concentrations of dissolved boron at Wangcol Creek DS were elevated above the SSGVs in April and June. Elevated concentrations of dissolved boron were recorded in May during monitoring of dissolved metals in Cooks Dam and LDP001. It would be beneficial to monitor dissolved boron during LDP001 discharge events given that the parameter has exceeded the Wangcol Creek Far DS SSGV in each quarter since at least early 2020. In the 5 days prior to the exceedance in April, only 1 mm of rain was recorded, while in June prior to the exceedance approximately 18 mm of rainfall was recorded near the site. It is unlikely that the exceedances are rainfall related (or passive discharge related, exceeding the containment capacity of the dam before settlement could occur).

Table 8A-2: Summary of 2022 Groundwater Level Trigger & Investigations 2022

Monitoring well	Trigger Level (m AHD)	Maximum level, Q1 2022 (m AHD)	Maximum level, Q2 2022 (m AHD)	Maximum level, Q3 2022 (m AHD)	Maximum level, Q4 2022 (m AHD)	Triggered (Y/N)	Investigation
BH01	909	908.52	908.21	908.49	908.59	N	N/A
BH02	900	899.41	895.53	Dry	Dry	N	N/A
BH03	904	904.0	903.86	903.88	905.05	Y	A manual reading of 905.05 mAHD on 09/11/2023 was recorded and on the same day logged groundwater level was approximately 903.3 mAHD. The manual reading is likely erroneous. No further investigation was required.
BH04	909	909.41	912.71	913.49	914.41	Y	The following investigations are for manual gauging data throughout 2022: – The Q1 909.41 mAHD recorded level was from manual measurement on 23/03/2022. The previous recorded level on 21/03/2022 was 908.49 mAHD and the following recorded level on 11/04/2022 was 908.25 mAHD. This represents an increase and decrease of ~1 m in a ~3-week period. – The Q2 917.71 mAHD level was recorded on 20/06/2022. The previous recorded level on 06/06/2022 was 909.19 mAHD and the following recorded level on 23/06/2022 was 908.26 mAHD. This represents an increase and decrease of ~3-4 m in a ~2.5-week period. – The Q3 913.49 mAHD level was recorded on 11/07/2022. The previous recorded level on 23/06/2022 was 908.26 mAHD and the following two recorded levels on 14/07/2022 and 25/07/2022 were 913.21 mAHD and 908.95 mAHD, respectively. This represents an increase and decrease of ~5 m in a ~2.5-week period. – The Q4 914.41 mAHD level was recorded on 10/10/2022. The previous recorded level on 29/09/2022 was 908.81 mAHD and the following recorded level on 13/10/2022 was 907.61 mAHD. This represents an increase and decrease of ~5.5-6.5 m in a ~3.5-week period. On comparison with hourly logged data, no such magnitude of rise has been recorded for the historical dataset. Some level rises in 2022 are in the order of 8 m over a period of 3 days which is highly unlikely for the mine void targeted groundwater. Therefore, it is most likely that the large fluctuations are due to manual measurement error, rather than actual rises and falls in groundwater level. No further investigation was required. It is recommended that the sampling contractor is to perform data quality assurance checks when recording groundwater levels and when transferring the

Monitoring well	Trigger Level (m AHD)	Maximum level, Q1 2022 (m AHD)	Maximum level, Q2 2022 (m AHD)	Maximum level, Q3 2022 (m AHD)	Maximum level, Q4 2022 (m AHD)	Triggered (Y/N)	Investigation
							data to a digital form. Also recommended is to review the historical dataset for manually gauged levels to remove outliers based on comparison with logged groundwater levels where available.
BH05	909	908.37	908.79	907.81	910.5	Y	Three manually gauged results of around 910.4 mAHD were recorded in November 2022. There has been a steady increasing trend of groundwater level at BH05 since January 2020, aligning with above average rainfall conditions in this time, meaning the triggers will be more frequent due to natural recharge of the aquifer. There are no SCSO operational activities around BH05 that would influence groundwater level, so no further investigation was required.
BH06	901	900.73	901.9	901.3	901.8	Y	Upon review of the dataset each of the Q2, Q3, and Q4 trigger events appear to be outliers with all other gauging levels less than 900.8 m AHD with levels typically fluctuating ±0.4 m. These outliers are likely due to measurement error, and therefore no further investigation was required.
BH07	909	909.64	911.29	914.89	909.99	Y	Manually gauged results showed trigger events for each quarter. Upon review of the dataset, each of the Q1, Q2, Q3, and Q4 trigger events appear to be outliers with levels typically fluctuating ±0.5 m between 907 and 908 mAHD. Whilst the level remained above the trigger level for much of 2022, it is unlikely caused by SCSO operational activity as BH07 is a background monitoring location upgradient of Lamberts Gully water management structures. Therefore the consistent level rise since January 2020 is contributable to rainfall recharge of the target aquifer.
BH08	909	910.63	908.83	913.23	910.42	Y	Manually gauged results showing trigger events for Q1, Q3, and Q4 appear to be outliers with levels typically fluctuating ±0.5 m between 907 and 908 mAHD. On comparison with logged levels, these outliers are likely due to measurement error, and therefore no further investigation was required.
BH09	910	912.51	911.75	917.3	910.5	Y	Manually gauged results showing trigger events for Q1, Q2, Q3, and Q4 appear to be outliers with levels typically fluctuating ±1 m between 906 and 908 mAHD. On comparison with logged levels, these outliers are likely due to measurement error, and therefore no further investigation was required.
BH10	-	-	-	-	928.94	N/A	N/A
BH13	910	909.95	909.54	909.6	Dry	N/A	N/A
BH15	930	Dry	Dry	Dry	Dry	N/A	N/A

Table 8A-3: Groundwater Quality Triggers & Investigations 2022

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
BH01	pH	5.6 – 5.9	Q1	Jan	6.7	pH result was trending toward the pH circumneutral range and therefore was not considered environmentally harmful.
			Q2	Apr	5.5	pH result was previously trending towards the circumneutral range throughout the first quarter of 2022. During Q2, pH was decreased slightly below the SSGV in April, but in May was within the range of the SSGVs. Most other bores demonstrated an increase towards pH circumneutral conditions. No further investigation was undertaken given the result was within device measurement error.
			Q3	Sep	6.4	During Q3, pH increased, from 5.9 pH units to 6.4 pH units. The increase in pH was consistent with neutralising observations at other bores. As such, no further investigation is required.
			Q4	Nov	7.4	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
BH02	pH	6.4 - 6.8	Q1	Jan	7.0	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
			Q2	Mar	7.0	
			Q2	Jun	7.2	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
	Dissolved iron	0.65 mg/L	Q1	Feb	1.19 mg/L	BH02 was reported dry since January 2020, until September 2021. It is possible during this time that water existed within BH02 accumulating concentrated dissolved metals. Alternatively, if the bore was dry during this period, previously adsorbed metals may have been dissolved as groundwater entered the bore. BH02 was again reported as dry throughout all of Q3 and most of Q4.
	Dissolved manganese	0.759 mg/L	Q1	Feb	0.951 mg/L	
			Q2	Jun	0.769 mg/L	
	Dissolved zinc	0.085 mg/L	Q1	Jan	0.09 mg/L	
			Q2	Jun	0.097 mg/L	
BH03	pH	3.6 – 4.5	Q3	July	4.6	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
			Q4	Nov	5.6	pH was trending within the pH circumneutral range and therefore is not considered environmentally harmful.
	EC	1,270 µS/cm	Q3	Jul	1,444 µS/cm	Average EC was 1,502 µS/cm in 2021. During 2022, concentrations have generally decreased, with a 2022 average of 1,255 µS/cm, with a range between 1,512 and 884 µS/cm. Although values are above the SSGV, they are generally becoming less saline,
			Q3	Jul	1,349 µS/cm	
			Q3	Aug	1,342 µS/cm	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
			Q3	Sep	1,279 µS/cm	presumably due to dilution by the high rainfall throughout 2022. Therefore, the potential for environmental harm is reducing and no further investigation is required.
			Q4	Oct	1,413 µS/cm	
			Q4	Oct	1,485 µS/cm	
			Q4	Nov	1,344 µS/cm	
			Q4	Nov	1,512 µS/cm	
			Q4	Dec	1,369 µS/cm	
			Q4	Dec	1,283 µS/cm	
	Dissolved manganese	7.48 mg/L	Q1	Feb	8.07 mg/L	Reviewing level data, groundwater surrounding BH03 is suspected to be influenced by surrounding surface water storages of the Final Polishing Lagoon and the Co-disposal Ponds given the sharp fluctuations in groundwater level appearing through the historical dataset, potentially caused by dewatering events. An investigation should be launched into the groundwater quality influence at BH03, taking into consideration: Hydrogeology Level analysis Bore construction logs. Climate Groundwater contours Major ion chemistry analysis Dewatering records. This would assist in identifying potential sources of elevated dissolved metals results at BH03.
			Q1	Mar	7.88 mg/L	
			Q2	Jun	7.6 mg/L	
			Q3	Sep	7.62 mg/L	
			Q4	Oct	7.5 mg/L	
	Dissolved iron	77.1 mg/L	Q1	Jan	79.6 mg/L	
			Q1	Feb	85.4 mg/L	
			Q1	Mar	79.3 mg/L	
	Dissolved nickel	0.319 mg/L	Q1	Jan	0.326 mg/L	
			Q1	Feb	0.327 mg/L	
			Q2	Apr	0.337 mg/L	
			Q2	Jun	0.333 mg/L	
	Dissolved zinc	1.02 mg/L	Q1	Feb	1.03 mg/L	
			Q2	Apr	1.04 mg/L	
BH04	TSS	118 mg/L	Q1	Feb	158 mg/L	TSS is highly dependent on the sampling method and environmental influences. Investigations cannot definitively determine the source of elevated TSS concentrations.
	pH	6.3 – 6.7	Q2	May	6.8	Monitoring results at BH04 have consistently been reported within the circumneutral range. The results observed in the current quarter are within the historical range, are approximately neutral and therefore not considered inherently environmentally harmful.
			Q2	Jun	6.9	
	EC	516 µS/cm	Q4	Oct	1,688 µS/cm	Groundwater surrounding BH04 is under investigation in the joint Energy Australia (EA) and Centennial groundwater investigation. It is believed that groundwater near BH04 is
			Q4	Dec	2,626 µS/cm	
	Dissolved iron	2.60 mg/L	Q1	Mar	2.95 mg/L	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
			Q4	Nov	3.32 mg/L	influenced by seepage through historical mine workings, as it is installed within the Lithgow seam void.
			Q4	Dec	3.52 mg/L	However, elevated results are potentially a combination of WCS and Mount Piper Power Station (MPPS) impacts, given that concentrations there have been numerous trigger events throughout 2022.
	Dissolved nickel	0.011 mg/L	Q2	May	0.027 mg/L	
	Dissolved manganese	0.515 mg/L	Q2	May	0.771 mg/L	It is possible that fluctuations in dissolved zinc concentrations are due to impacted groundwater seepage from either WCS or EA into the surrounding historical mine workings void. Further investigation should be launched into the source of the elevated dissolved metal concentrations (see recommendations).
	Dissolved zinc	0.053 mg/L	Q1	Jan	0.076 mg/L	
			Q1	Mar	0.074 mg/L	
			Q2	May	0.057 mg/L	
			Q2	Jun	0.104 mg/L	
			Q3	Jul	0.066 mg/L	
			Q3	Aug	0.071 mg/L	
			Q4	Oct	0.105 mg/L	
BH05	pH	6.4 – 6.8	Q1	Jan	7.0	The pH at BH05 was highly variable in 2022, ranging from pH 6.2 to 7.9 with a mean of 6.68. The 7.9 pH recorded in September 2022 was the most alkaline result on record, and still within the circumneutral range.
			Q2	Jun	7.0	
			Q3	Jul	7.6	A review of pH data will be undertaken in the subsequent annual review to determine if there is a trend of increasing pH at BH05.
			Q3	Sep	7.9	
	EC	656 µS/cm	Q2	May	2,400 µS/cm	Salinity has remained consistent throughout the historical record, typically fresh and remaining below 800 µS/cm. Despite these two observations of high EC, the mean EC during 2022 was below the SSGV at 537.2 µS/cm.
			Q3	Sep	1,518 µS/cm	
	TSS	122 mg/L	Q1	Feb	152 mg/L	TSS is highly dependent on the sampling method and environmental influences. Investigations cannot definitively determine the source of elevated TSS concentrations.
			Q1	Mar	137 mg/L	
	Dissolved manganese	0.823 mg/L	Q1	Jan	0.959 mg/L	Groundwater surrounding BH05 is under investigation in the joint Energy Australia (EA) and Centennial groundwater investigation. It is believed that groundwater near BH05 is influenced by seepage through historical mine workings, as it is installed within the Lithgow seam void.
			Q1	Feb	1.48 mg/L	
			Q2	May	2.93 mg/L	However, elevated results are potentially a combination of WCS and Mount Piper Power Station (MPPS) impacts, given that concentrations there have been numerous trigger events throughout 2022.
			Q2	Jun	4.16 mg/L	
			Q3	Jul	2.92 mg/L	It is possible that fluctuations in dissolved zinc concentrations are due to impacted groundwater seepage from either WCS or EA into the surrounding historical mine workings
			Q3	Aug	1.01 mg/L	
	Dissolved iron	0.24 mg/L	Q2	May	0.71 mg/L	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
			Q2	Jun	2.98 mg/L	void. Further investigation should be launched into the source of the elevated dissolved metal concentrations (see recommendations).
			Q3	Jul	1.81 mg/L	
			Q3	Aug	2.71 mg/L	
			Q3	Sep	0.54 mg/L	
			Q4	Nov	1.51 mg/L	
	Dissolved nickel	0.023 mg/L	Q1	Feb	0.032 mg/L	
	Dissolved zinc	0.059 mg/L	Q1	Feb	0.103 mg/L	
			Q4	Oct	0.103 mg/L	
BH06	pH	6.1 – 6.5	Q1	Feb	6.9	Despite these observations being above the upper SSGV, they are close to, or within, the circumneutral range and therefore are not considered environmentally harmful.
			Q2	May	6.6	
			Q3	Jul	6.7	
			Q3	Sep	7.0	
	Dissolved zinc	0.079 mg/L	Q2	Jun	0.082 mg/L	BH06 is installed in the Lithgow Seam. Exceedances of dissolved zinc have been infrequent. BH06 is downgradient of Cooks Dam and may receive seepage from either the dam, where concentrations of dissolved zinc recorded in May were also recorded at 0.082 mg/L, or the old underground workings. Further investigation may be required if dissolved metal exceedances of SSGVs become more frequent.
			Q4	Oct	0.108 mg/L	
BH07	pH	5.8 – 6.6	Q1	Jan	5.1	pH was variable throughout 2022, ranging from 5 to 6.8 with a mean 5.72, which is below the lower SSGV. It is possible that BH07 pH is influenced by the WCS REA groundwater seepage, or that high rainfall throughout 2022 has impacted the pH within BH07. pH increased in Q3 and Q4 into the pH circumneutral range.
			Q1	Feb	5.3	
			Q1	Mar	5.5	
			Q2	Apr	5.7	
			Q4	Oct	6.8	
BH08	pH	5.9 – 6.2	Q1	Feb	6.6	Despite these observations being above the upper SSGV, they are close to, or within, the circumneutral range and therefore are not considered environmentally harmful.
			Q1	Mar	6.3	
			Q2	May	6.4	
			Q2	Jun	6.8	
			Q3	Jul	6.7	
			Q3	Aug	6.6	

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
			Q3	Sep	6.5	
			Q4	Oct	6.5	
			Q4	Nov	6.4	
			Q4	Nov	6.5	
			Q4	Dec	6.2	
			Q4	Dec	6.3	
	Dissolved iron	3.62 mg/L	Q3	Jul	7.98 mg/L	Dissolved iron concentrations have historically been elevated (ranging between 0.05 mg/L to 19.2 mg/L since February 2016). Similar trends were initially observed in early 2022, however, decreasing trends were observed during the latter two quarters, decreasing from 7.98 mg/L in July to 0.09 mg/L in December 2022.
	TSS	60 mg/L	Q1	Jan	80 mg/L	As TSS is highly dependent on the sampling method and environmental influences, investigations cannot definitively determine the source of elevated TSS concentrations.
			Q2	May	93 mg/L	
			Q3	Jul	146 mg/L	
			Q3	Aug	64 mg/L	
			Q3	Sep	353 mg/L	
			Q4	Nov	61 mg/L	
BH09	pH	5.9 – 6.2	Q1	Feb	6.8	Despite these observations being above the upper SSGV, they are close to, or within, the circumneutral range and therefore are not considered environmentally harmful.
			Q1	Mar	6.4	
			Q2	May	6.4	
			Q2	Jun	6.6	
			Q3	Jul	6.6	
			Q3	Aug	6.6	
			Q3	Sep	6.5	
			Q4	Oct	6.4	
			Q4	Nov	6.8	
			Q4	Nov	6.4	
	TSS	260 mg/L	Q3	Sep	804 mg/L	As TSS is highly dependent on the sampling method and environmental influences, investigations cannot definitively determine the source of elevated TSS concentrations.

Monitoring bore	Parameter	SSGV	Quarter	Month	Trigger event	Investigation
BH13	pH	6.1 - 6.5	Q4	Nov	7.5	Despite this observation being above the upper SSGV, it was within the circumneutral range and therefore was not considered environmentally harmful.

APPENDIX 9: REHABILITATION

SPRINGVALE COAL SERVICES (SCS)

Annual Rehabilitation Monitoring Report 2022

Prepared for:

Springvale Coal Services Pty Ltd

PO Box 198

WALLERAWANG NSW 2845

SLR Ref: 630.30428.00000-R01
Version No: -v2.0
March 2023

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
10 Kings Road
New Lambton NSW 2305 Australia

T: +61 2 4037 3200 F: +61 2 4037 3201
E: newcastleau@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Springvale Coal Services Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.30428.00000-R01-v2.0	21-03-2023	Jarrid Beeton	Jeremy Pepper	

EXECUTIVE SUMMARY

Introduction

SLR Consulting Australia Pty. Ltd. (SLR) was commissioned by Springvale Coal Services Pty. Ltd. (SCS) to undertake the 2022 annual rehabilitation monitoring at the SCS land. The SCS rehabilitation monitoring program has been designed to measure the progress of rehabilitation against the objectives and completion criteria developed for the SCS *Rehabilitation Management Plan for Large Mines* (the RMP). In accordance with the RMP criteria, results are presented according to the three main attributes of the Biodiversity Assessment Method (BAM), namely: composition, structure and function.

Results

Composition

Total native plant diversity was the highest recorded since 2018, with 91 native plants recorded. However, plant diversity was lower in all rehabilitation sites and at one of the control sites since 2021. In addition, the proportion of exotic species at most rehabilitation monitoring sites increased. Although native plant diversity was lower, the mean native plant diversity across the rehabilitation sites remains only slightly below that of the control sites.

Structure

Native tree and shrub cover continues an ascending trend since 2019; however tree cover remains below that of the control sites and the benchmark values for the corresponding plant community (PCT 3747). Mean shrub cover score for rehabilitation sites increased substantially and is higher than control and benchmark values at most rehabilitation sites. Grass cover was mixed across the rehabilitation sites, with four sites within the benchmark and four sites below benchmark. Cover scores for 'native groundcover – forbs, ferns and other', are within benchmark for most sites, with only R4 and R5 below.

Function

Litter cover across all rehabilitation sites ranges from 24 % to 40 %; however the only rehabilitation site to record a litter score similar to control sites was R2. Second generation tree regeneration was also observed across all rehabilitation, although differed greatly between rehabilitation sites, with R4 recording just one steam while R8 recorded 28.

Soil chemistry analysis shows that the rehabilitation sites have favourable growth media for native vegetation, with no deficient or toxic factors for the growth of native vegetation. In terms of soil microbiology, the results show no significant difference between the rehabilitation and control sites. However, Trichoderma colonies are low at R6. It is likely that Trichoderma levels will increase naturally with increase in organic matter over time.

A range of common native bird, reptile and mammal species was observed. However, a drove of feral pigs (*Sus scrofa*) was observed near the R8 and R9 rehabilitation sites. A total of four High Threat Exotics (HTEs) and three Priority Weed species were recorded, with infestations of Blackberry (*Rubus fruticosus* aggregate), African Lovegrass (*Eragrostis curvula*) and Serrated Tussock (*Nassella trichotoma*) observed near the rehabilitation areas along the access road. No erosion was observed with in any rehabilitation areas.

EXECUTIVE SUMMARY

Discussion and Recommendations

Overall, the vegetation of the rehabilitation sites at SCS are performing well and on track to meet RMP criteria in the future. Any future vegetation works should focus on around R4, where low tree recruitment occurs. It is recommended that these areas be selectively thinned of dense acacias and reseeded with eucalypt species representative of the surrounding native forest (ie PCT 3747).

As the soil chemistry results show favourable growth mediums for all sites, no further soil amelioration is recommended at this time. The rehabilitation site R6 is not considered to be at a stage where their soil decomposer microbial community status approaches that of sites with native vegetation, but continued natural organic matter inputs from plant litter and root exudates as plant cover increases should drive change in this direction. No soil amelioration is considered necessary for R6 at this stage.

Blackberry and Serrated Tussock populations should be the focus of upcoming weed control works, particularly along the access road between R1 and R2. Feral animal control measures should be considered to manage feral pig, which have the potential to damage to rehabilitation areas as well as damage waterways and native fauna habitat located with SCS.

CONTENTS

1 INTRODUCTION 1
1.1 Background 1
1.2 Final Landform and Land Use 1
1.3 RMP and Rehabilitation Performance Criteria 1
1.4 Approach 2
2 REHABILITATION OBJECTIVES AND COMPLETION CRITERIA 4
2.1 Overview 4
2.2 BAM Rehabilitation Objectives and Completion Criteria 4
3 EXISTING ENVIRONMENT 6
3.1 Overview 6
3.2 Regional and Local Topography 6
3.3 Vegetation 6
4 METHODS 7
4.1 Monitoring Sites 7
4.2 Vegetation Composition and Structure (BAM Vegetation Assessment) 13
4.2.1 BAM Plot Layout 14
4.2.2 BAM Data 14
4.3 Ecosystem Function 16
4.3.1 Litter Cover (BAM) 16
4.3.2 Total Length of Fallen Logs (BAM) 16
4.3.3 Tree Regeneration (BAM) 16
4.3.4 Soil Chemistry Analysis 16
4.3.5 Soil Microbial Analysis 18
4.3.6 Fauna Activity Monitoring 19
4.4 Completion Criteria Assessment 19
4.5 Vegetation Integrity (VI) 19
5 MONITORING RESULTS 20
5.1 Overview 20
5.2 Vegetation Composition 20
5.2.1 Overview 20
5.2.2 Characteristic Species 20
5.2.3 Changes in Plant Species Diversity over time 21
5.3 Vegetation Structure (foliage cover) 26
5.3.1 Native Cover 26

CONTENTS

5.3.2 Native Shrub 27
5.3.3 Native Groundcover – Grass and Grass-like 29
5.3.4 Native Groundcover – Forbs, Ferns and Other 29
5.3.5 Exotic Groundcover 30
5.4 Vegetation Assessment Summary 31
5.5 Ecosystem Function 32
5.5.1 Litter Cover 32
5.5.2 Total Length of Fallen Logs 33
5.5.3 Tree Regeneration 33
5.5.4 Weeds and High Threat Exotics 34
5.5.5 Soil Chemistry Analysis 36
5.5.6 Soil Microbial Analysis 37
5.5.7 Fauna Activity 40
5.5.8 General Observations of Rehabilitation Condition (including Erosion) 41
5.6 Vegetation Integrity Score (VIS) 41
6 DISCUSSION AND RECOMMENDATIONS 43
6.1 Overview 43
6.2 Assessment against Completion Criteria 43
6.3 Recommendations 45
6.3.1 Vegetation Composition 45
6.3.2 Vegetation Structure 46
6.3.3 Ecosystem Function 46
7 REFERENCES 48

CONTENTS

DOCUMENT REFERENCES

TABLES

Table 1 SLR Project Team for SCS Monitoring 2
Table 2 SCS Rehab Objectives, Completion Criteria and Monitoring Methods 4
Table 3 SCS Rehabilitation Monitoring Sites – Summary 10
Table 4 Description of monitoring SCS sites in 2022 10
Table 5 Assessment of respective performance criteria using the BAM 14
Table 6 Soil Chemistry Traffic Light Ratings 17
Table 7 Soil Analyte Ratings 17
Table 8 Total plant diversity recorded at SCS monitoring sites between 2018 and 2022 20
Table 9 Change in native plant diversity at monitoring sites since 2020. 23
Table 10 Proportion of exotic species at monitoring sites 2018 to 2022 23
Table 11 Laboratory Test Results 36
Table 12 Presences of Trichoderma on dilution plates. +/- Trichoderma = number of quadrats (+=1, ++=2, +++=3) where the fungus Trichoderma is present. Darker shading indicates higher values 39
Table 13 RMP Rehabilitation Objectives and Completion Criteria Assessment 44

FIGURES

Figure 1 Locality Plan 3
Figure 2 Rehabilitation Monitoring Sites and Vegetation Communities 8
Figure 3 Rehabilitation Areas 9
Figure 4 BAM Plot Layout 14
Figure 5 Plants species diversity for SCS monitoring sites between 2018 and 2022 22
Figure 6 Mean plant species diversity for SCS monitoring sites 2018 - 2022 24
Figure 7 Plant Species Diversity by Vegetation Strata Since 2018 25
Figure 8 Mean native tree cover at monitoring sites between 2019- 2022 26
Figure 9 Native canopy foliage cover across SCS monitoring plots between 2019 - 2022 27
Figure 10 Mean native groundcover – shrubs at monitoring sites between 2019 and 2022 28
Figure 11 Percentage of native groundcover – shrubs at monitoring sites 28
Figure 12 Percentage of native groundcover – Grass and Grass-like across SCS monitoring plots in 2022 29
Figure 13 Percentage of native groundcover – Forbs Ferns and Other across SCS monitoring plots in 2022 30
Figure 14 Exotic groundcover for all monitoring sites between 2018 and 2022 31
Figure 15 Exotic Weed and HTE Cover in 2022 31
Figure 16 Litter cover percentage across SCS in 2022 33
Figure 17 Tree regeneration (<5cm DBH) across SCS in 2022 34
Figure 18 Mean microbial numbers as colony forming units (CFU) per gram dry weight of soil as determined by plating samples onto selective isolation media (± standard error). 38
Figure 19 Actinomycete: Bacteria ratio (left) and the proportion of copiotrophic (rapidly growing) bacteria (right) (± standard error) 39

CONTENTS

Figure 20 Bubble chart of the soil microbial community status of the SCS sites in spring 2022 40
Figure 21 Vegetation Integrity scores of the across the monitoring sites 2022 42

PHOTOS

Photo 1 Dense patch of Serrated Tussock north of the R2 35
Photo 2 Blackberry thicket growing along access road between R1 and R2 35
Photo 3 Fresh soils at field moisture. A1 and WCS A2 sites (top, left to right). R1, R4, R6 and R9 sites (bottom, left to right) 38

APPENDICES

Appendix A Benchmark Data for Target Plant Community Type (PCT 3747)
Appendix B Target Plant Community Type Profile (PCT 3747)
Appendix C Monitoring Plots Floristics
Appendix D BAM Attribute Scores for Monititoring Plots
Appendix E Mircobial Soil Analysis
Appendix F Soil Chemistry Analysis

ACRONYMS

AHD	Australian Height Datum
BC Act	*Biodiversity Conservation Act 2016*
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
km	Kilometre
NSW	New South Wales
PA	Project Approval
RMP	Rehabilitation Management Plan
SCS	Springvale Coal Services Pty. Ltd
SLR	SLR Consulting Australia Pty. Ltd
WSC	Western Coal Services Pty. Ltd

1 Introduction

1.1 Background

SLR Consulting Australia Pty. Ltd. (SLR) was commissioned by Centennial Coal to undertake rehabilitation monitoring for Springvale Coal Services Pty. Ltd. (SCS) (previously known as Western Coal Services (WCS)). SCS is located west of the Blue Mountains in the Lithgow Local Government Area (LGA) in New South Wales approximately 125 kilometres (km) from Sydney and 15 km north of city of Lithgow (**Figure 1**). The facility processes coal received from Springvale Coal mine (located approximately 8 km to the south-east) utilising a screening and sizing plant, an overland conveyor system and a coal preparation plant. SCS was granted State Significant Development Consent (SSD 5579) on 04 April 2014. The consent was granted by the Planning Assessment Commission of New South Wales (NSW), as delegate of the then Minister of Planning and Infrastructure, under Section 89E of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) for a project life of 25 years. SSD 5579 consent allows operations to continue until June 2039.

The current rehabilitation monitoring program for the SCS sites is based on the closure criteria for 'Native Ecosystems' within the *Rehabilitation Objectives and Rehabilitation Completion Criteria Guideline* (the 'Guideline'; NSW Resources Regulator 2021). And as required by Schedule 3 – Condition 44 of SDD 5579, Springvale Coal Services undertakes progressive post-mining rehabilitation of the site, that is as soon as reasonably practicable following disturbance. SCS is required to rehabilitate the site to the satisfaction of the Department of Planning and Environment (Resources Regulator). This is undertaken with the aim to minimise the total exposed area at the site at any given time. Rehabilitation planning and activities at SCS are undertaken in accordance with the goals and objectives outlined in the Rehabilitation Management Plan (RMP) (Centennial Coal, 2022). This RMP has been prepared in accordance with the *Mining Exploration and Geoscience – Resource Regulator's (RR) Form and Way: Rehabilitation Management Plan for Large Mines* (RR, 2021) and associated guidelines.

1.2 Final Landform and Land Use

The approved final landform for SCS aims to provide a low maintenance, geotechnically stable and safe environment that is commensurate with the surrounding area. The intended post-mining land use is native woodland consistent with surrounding lands across the majority of the SCS site, grassland suitable for agriculture, industrial land at the pit top and water management and storage area to retain existing water management structures to provided water resources for native fauna and stock.

1.3 RMP and Rehabilitation Performance Criteria

The current monitoring program has been designed to monitor the progress of rehabilitation against the rehabilitation objectives/criteria developed for the SCS RMP (Centennial Coal, 2022). The Rehabilitation Management Plan (RMP) has been prepared in accordance with the Mining Exploration and Geoscience – Resources Regulator's (RR) Form and Way: Rehabilitation Management Plan for Large Mines (RR, 2021) and associated guidelines. Relevant objectives and completion criteria were further developed for Centennial Coal operations in the SLR (2022) *NSW Rehabilitation Reform Support Rehabilitation Monitoring Review and Proposed Method*. The applicable rehabilitation objectives and criteria from SLR (2022) are detailed in (refer **Section 2**).

In accordance with relevant RMP criteria, the rehabilitation monitoring focussed on the following key aspects:

- Evidence of any erosion or sedimentation.
- Success of initial establishment of grass cover and tree and shrub seeding / plantings.
- Natural regeneration of native species.
- Weed infestation, being the presence of (primarily noxious ('priority' (formerly noxious) weeds and high threat exotics (HTEs)).
- General stability of the rehabilitation areas.

1.4 Approach

The 2022 SCS rehabilitation assessment required input from three technical disciplines: Ecology, Soil Chemistry and Soil Microbiology. Individual assessments were completed by specialists within each of these disciplines. A summary of the role of each specialist is provided in **Table 1.**

Table 1 SLR Project Team for SCS Monitoring

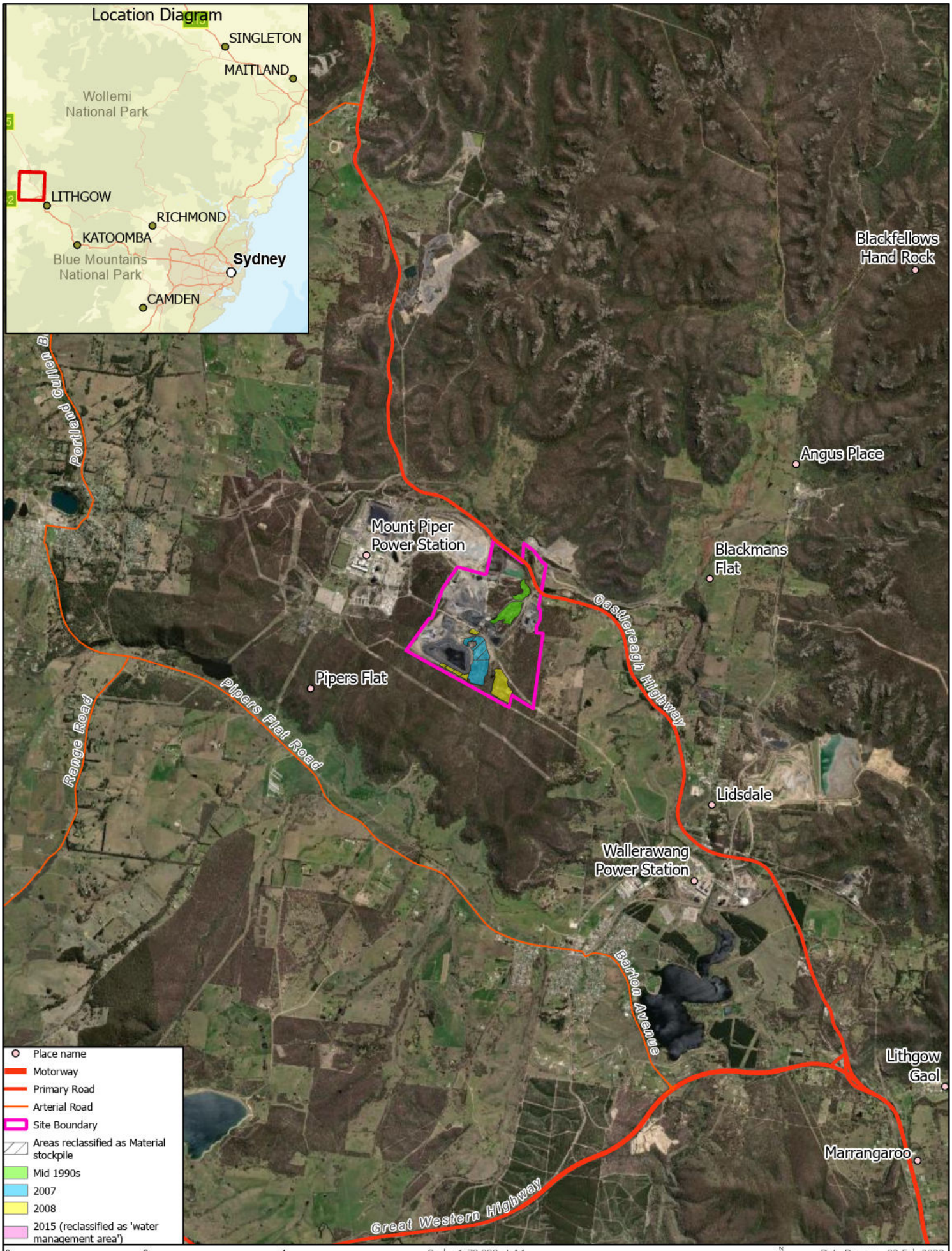
Personnel	Role
Jeremy Pepper - Technical Director (SLR)	Project Director
Jarrid Beeton – Project Consultant (SLR)	Ecological Assessment and Report Co-author
Hannah Centra – Project Consultant (SLR)	Ecological Assessment and Report Co-author
Murray Fraser – Principal Agronomist – Soil Science (SLR)	Soil Chemistry Assessment
Dr. Howard Wildman - Soil Microbiologist (Microbial Management Systems)	Soil Microbial Assessment

A summary of rehabilitation completion criteria is provided in **Section 2**, followed by a general overview of the existing environment within the SCS site in **Section 3**. The methods employed for the current monitoring event are presented in **Section 4**, followed by the resultant findings and a comparison against the completion criteria in **Section 5**.

Specialist assessment results are presented in terms of the three main rehabilitation objectives in **Section 2**, as follows:

- Vegetation Composition Assessment (**Section 5.2**).
- Vegetation Structure Assessment (**Section 5.3**)
- Ecosystem Function Assessment:
  - Litter Cover (**Section 5.5.1**)
  - Soil Chemistry (**Section 5.5.3**)
  - Soil Microbiology (**Section 5.5.4**)
  - Fauna activity, including feral animals, domestic stock and native species (**Section 5.5.7**)
  - General observations of the condition of the rehabilitated areas (**Section 5.5.8**)

Discussion and recommendations are presented in **Section 6.**



Earthstar Geographics, Esri, HERE, Garmin, FAO, NOAA, USGS

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

SLR

LOCALITY PLAN

FIGURE 1

Path: H:\Projects-SLR\630-SrvNTL\630-NTL\630.30428.00000 Springvale Coal Services Rehab Mon\06 SLR Data\01 CADGIS\GIS\630_30428_Pro\630_30428_Pro.aprx

2 Rehabilitation Objectives and Completion Criteria

2.1 Overview

2.2 BAM Rehabilitation Objectives and Completion Criteria

Example rehabilitation objectives and rehabilitation completion criteria for large mines are provided in the *Rehabilitation Objectives and Rehabilitation Completion Criteria* (NSW Resources Regulator 2021). These criteria have been adopted for the SCS rehabilitation monitoring program, noting that some criteria have been modified to ensure criteria are achievable and measurable. A criterion for fauna activity has also, as a means of demonstrating improvements to ecosystem function over time. The ecological rehabilitation objectives, rehabilitation completion criteria and data requirements for 'Native Ecosystems' across all domains for SCS are listed in **Table 2**.

Table 2 SCS Rehab Objectives, Completion Criteria and Monitoring Methods

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	Data Capture (Monitoring Method)
Vegetation composition recognisable as reference (control) vegetation	Native plant species are characteristic of the reference (control site) vegetation.	BAM plot data
Vegetation structure recognisable as, or is trending towards reference (control) vegetation	Cover and abundance of native plant growth forms are characteristic of adjacent vegetation in control sites.	BAM plot data
Ecosystem function Levels of ecosystem function have been established that demonstrate the rehabilitation is self- sustainable.	Litter cover score is within 10th-90^{th}percentile variation range of reference sites/data	BAM plot data
	Second generation individuals of trees are within 10th-90^{th}percentile variation range of reference sites.	BAM plot data (stem classes)
	Foliage cover of 'high threat exotic' (HTE) weeds is within 10th-90^{th}percentile variation range of reference sites	BAM plot data
	Soil Chemistry Total organic carbon is within 10th-90^{th}percentile variation range of reference sites; Soil analytes ECe (salinity) and ESP (sodicity) at rehab sites are similar to reference sites	Soil chemistry reports (inc. lab results)
	Soil Microbiology Decomposer microbial populations in the soils are similar to those of reference sites, using a metric that distinguishes soils at different stages of and in different types of mine rehabilitation. The specific parameters of the metric are: 1) the actinomycete: bacteria ratio (lower values are associated with increased soil disturbance) 2) the proportion of copiotrophic bacteria (higher values are associated with increased labile soil organic carbon)	Soil microbial assessment (inc. lab results)

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	Data Capture (Monitoring Method)
	3) the presence of the fungus *Trichoderma* (an indicator of significant amounts of plant cellulosic substrates in soils)	
	Resilience to drought and fire	Observations during monitoring inspections
	Erosion that would require moderate to significant ongoing management and maintenance. No visual signs of land instability, such as mass movement.	Observations during monitoring inspections
Native fauna are utilising rehabilitation areas	Native fauna activity – evidence of fauna usage of rehabilitation areas is recorded	Observations during monitoring inspections
Pest animal species and domesticated stock are appropriately controlled and do not present a risk to rehabilitation	Vertebrate pest species – presence and damage is recorded and controlled	Observations during monitoring inspections
	Domesticated stock - presence and damage is recorded and controlled	Observations during monitoring inspections

3 Existing Environment

3.1 Overview

The SCS is situated within the western foothills of the Gardens of Stone State Conservation Area on the eastern reaches of the Central Tablelands approximately 2 km west of Lidsdale and 15 km north of Lithgow (**Figure 1**). The site is currently operational as a coal stockpile facility fed from the surrounding Centennial operated coal mines within the locality.

3.2 Regional and Local Topography

The regional topography within the Project Site is variable featuring moderately undulating slopes and gullies associated with the unnamed creek line through the centre of the site. Beyond the SCS boundary, the site is located in a valley between Mount Piper to the west and the ridgeline escarpments of the Newnes Plateau to the east.

The elevation of the topography ranges from between 900 m AHD to 950 AHD within the SCS site. The topography of the SCS site has been high modified in parts where cut and fill displacement from mining operations has created land forming and benching throughout the rehabilitation areas.

3.3 Vegetation

Regional scale vegetation mapping of the *NSW State Vegetation Type Map* (SVMT) (DPE 2022) identifies the following four plant community types (PCT) within the SCS site boundaries:

- PCT 3747 – Southern Tablelands Western Hills Scribbly Gum Forest.
- PCT 3385 – Southern Tableland Creekflat Swamp Woodland.
- PCT 3369 – Central Tablelands Rangers Peppermint-Gum Grassy Forest.
- PCT 3367 – Central Tablelands Granites Grassy Box Woodland.

The target vegetation type for the rehabilitation areas is *PCT 3747- Southern Tablelands Western Hills Scribbly Gum Forest*. The reference control sites are located in areas mapped as PCT 3747 (see **Figure 2**). Floristics benchmarks for PCT 3747 are presented in **Appendix A** and the community profile is provided in **Appendix B**.

4 Methods

The SCS rehabilitation monitoring program has been designed to provide robust temporal and spatial information across the rehabilitation landforms to measure the progress of rehabilitation against the relevant objectives and completion criteria outlined in the RMP. To properly assess the rehabilitation sites performance, data was collected for a range of ecosystem parameters including vegetation structure, vegetation composition, ecosystem function and habitat character using the BAM. Soil stability, soil physical characteristics, fauna habitat and other indicators specific to the completion criteria were also assessed (see **Section 2**).

The relevant field data was collected from 10 monitoring sites during the site survey between 15th and 16th November 2022, by SLR Project Ecologists Jarrid Beeton and Hannah Centra. The field survey comprised four major components:

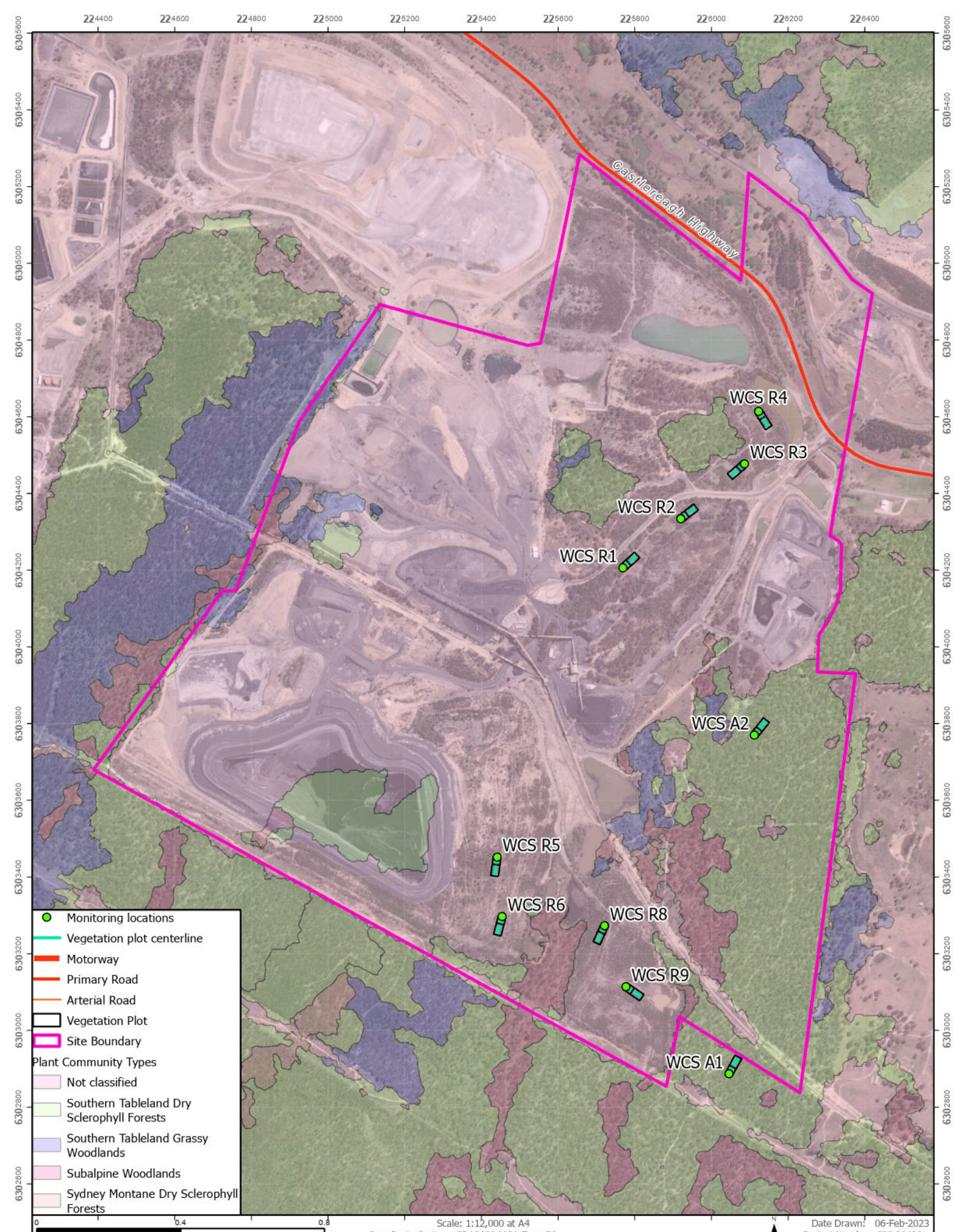
- Vegetation composition and structure attributes - Biodiversity Assessment Method ('BAM') plots and data collection see **Section 4.2**).
- Ecosystem function attributes:
  - litter cover, as per BAM (see **Section 4.3.1**)
  - fallen logs, as per BAM (see **Section 4.3.2**)
  - tree regeneration, as per BAM (see **Section 4.3.3**)
  - soil chemistry analysis (see **Section 4.3.4**)
  - soil microbial analysis (see **Section 4.3.5**)
  - Fauna activity monitoring (see **Section 4.3.6**)

Details on the monitoring sites and assessment methods are provided in below in **Section 4.1**.

4.1 Monitoring Sites

The rehabilitation monitoring sites used within the 2022 annual monitoring are consistent with the previous rehabilitation monitoring (Koru 2018, 2019, 2020 and 2021) and within proximity to the SCS disturbance footprint (**Figure 2**). Two control sites (A1 and A2) were also established by Koru in 2018 to compare against eight rehabilitated sites (R1, R2, R3, R4, R5, R6, R8 and R9)

Previous vegetation and rehabilitation area mapping by Koru (Koru 2018) for SCS has been used as a reference for this rehabilitation report (**Figure 3**). Data on location, rehabilitation age and future land use (i.e., RMP Domain) are listed for each monitoring site in **Table 3**. Summary of the key characteristics of each monitoring site is provided in **Table 5**.



Esri, HERE, Garmin, FAO, NOAA, USGS, Maxar

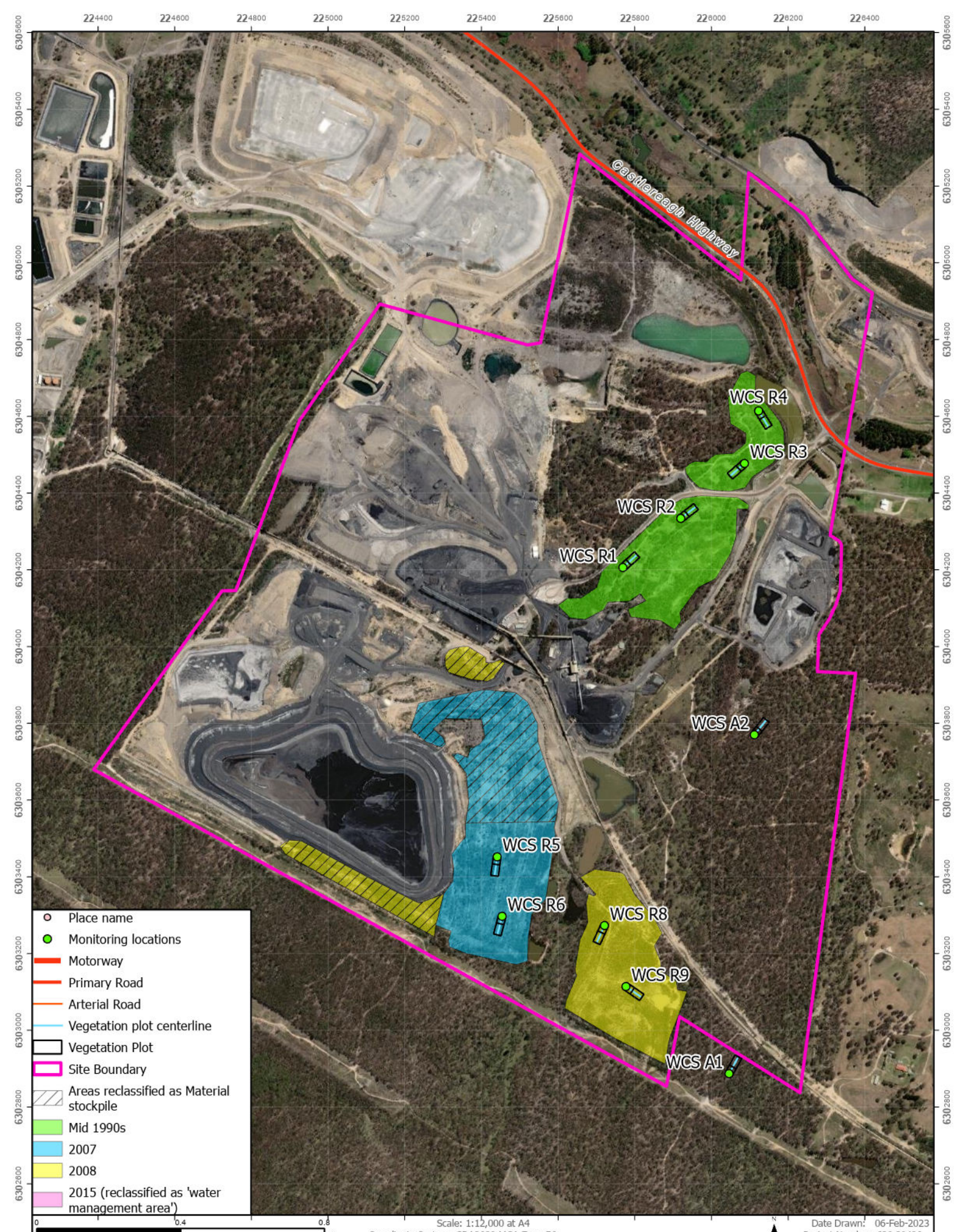
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

SLR

PLANT COMMUNITY TYPES AND MONITORING SITE LOCATION

FIGURE 2

Path: H:\Projects-SLR\630-SrvNTL\630-NTL\630.30428.00000 Springvale Coal Services Rehab Mon\06 SLR Data\01 CADGIS\GIS\630_30428_Pro\630_30428_Pro.aprx



Esri, HERE, Garmin, FAO, NOAA, USGS, Maxar

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

SLR

REHABILITATION AREAS

FIGURE 3

Path: H:\Projects-SLR\630-SrvNTL\630-NTL\630.30428.00000 Springvale Coal Services Rehab Mon\06 SLR Data\01 CADGIS\GIS\630_30428_Pro\630_30428_Pro.aprx

Table 3 SCS Rehabilitation Monitoring Sites – Summary

Site	Type	Location	Native Plant Community	Rehabilitation Establishment	Final landform target
R1	Rehabilitation	225769E 6304206N	-	Mid-1990's	Forest Rehabilitation
R2	Rehabilitation	225920E 6304334N	-	Mid-1990's	Forest Rehabilitation
R3	Rehabilitation	226086E 6304477N	-	Mid-1990's	Forest Rehabilitation
R4	Rehabilitation	226123E 6304614N	-	Mid-1990's	Forest Rehabilitation
R5	Rehabilitation	225441E 6303452N	-	2006	Forest Rehabilitation
R6	Rehabilitation	225454E 6303297N	-	2006	Forest Rehabilitation
R8	Rehabilitation	225777E 6303114N	-	2007	Forest Rehabilitation
R9	Rehabilitation	225721E 6303273N	-	2007	Forest Rehabilitation
A1	Control	226046E 6302887N	PCT 3747 - Southern Tableland Western Hills Scribbly Gum Forest	NA	NA
A2	Control	226112E 6303770N	PCT 3747 - Southern Tableland Western Hills Scribbly Gum Forest	NA	NA

Table 4 Description of monitoring SCS sites in 2022

Plot General Vegetation Description	Photographic Monitoring (start of 50m transect)
R1 Located on the eastern side of the access road within the rehabilitation area and established in the mid 1990s. Soil consists of a clay loam with a light layer of leaf litter. Canopy dominated by Black Gum and Brittle Gum, with midstorey of Red-stemmed Wattle.	**2022** 

Plot General Vegetation Description	Photographic Monitoring (start of 50m transect)
R2 Located in eastern side of the access road within the rehabilitation area and established in the mid 1990s. Soil consists of a clay loam with a cover of leaf litter and native grasses. Shrubby mid storey of Red-stemmed Wattle and Green Wattle	**2022** 
R3 Located in western side of the access road within the rehabilitation area and established in mid 1990s. Soil consists of a clay loam. Vegetation consists of a thin canopy of Broad-leaved Peppermint and Ribbon Gum with a midstorey of Silver Wattle and Red-stemmed Wattle.	**2022** 
R4 Located in western side of the access road within the rehabilitation area and established in the mid 1990s. Soil consists of a clay loam. Vegetation consists of a shrubby mid storey of Green Wattle, Silver Wattle and Red-stemmed Wattle and Dolly Bush.	**2022** 

Plot General Vegetation Description	Photographic Monitoring (start of 50m transect)
R5 Located in the southern area of the SCS site within rehabilitation area established in 2007. Soil consists of clay loam. Vegetation consists of a developing canopy of Grey Gum and Inland Scribbly Gum and a midstorey of Dolly Bush and ground cover of native grasses or Wallaby Grass and Weeping Grass.	**2022** 
R6 Located in the southern area of the SCS site within rehabilitation area established in 2007. Soil consists of light clay cover in light leaf litter and native grasses and forbs. Vegetation consists of a developing canopy of inland Scribbly Gum and Snow Gum with a midstorey of Red-stemmed Wattle and Dolly Bush.	
R8 Located in the southern area of the SCS site within rehabilitation area established in 2008. Soil consists of clay loam with a cover of leaf litter, native grasses, and forbs Vegetation consists of developing canopy of Inland Scribbly Gum, Snow Gum and Red Stringybark with a dense mid storey of Tantoon.	

Plot General Vegetation Description	Photographic Monitoring (start of 50m transect)
R9 Located in the southern areas of the SCS site within rehabilitation area established in 2008. Soil consists of clay loam with a cover of light leaf litter, native grasses and forbs. Vegetation consists of developing canopy of Snow Gum, Inland Scribbly Gum and Red Stringybark with a midstorey of Red-stemmed Wattle and *Allocasuarina gymnathera*.	
A1 Control plot located south of the southern SCS site boundary. Vegetation is PCT 3747 with a canopy of Scribbly Gum, Red Stringybark and Brittle Gum with an open midstorey and ground cover of native grasses and forbs	
A2 Control plot located in retained bushland within the eastern area of the site. Vegetation is PCT 3747 with a canopy of Broad-leaved Peppermint and Brittle Gum with an open midstorey of Dolly Bush and Rice Flower.	

4.2 Vegetation Composition and Structure (BAM Vegetation Assessment)

Vegetation composition and structure data were collected using a series of BAM plots at established monitoring stations across SCS, within both rehabilitation areas and within nearby bushland (ie control or control plots), as described above in **Section 4.1**. The specific methods for BAM plot data collection are described below.

4.2.1 BAM Plot Layout

All vegetation monitoring plots were surveyed following the methodology detailed in **Section 4.3.4** of the Biodiversity Assessment Method (BAM; OEH 2020). This involved a 20 x 20 m floristic plot to assess species diversity and ground cover, a 20 x 50 m structural attribute plot to collect tree stem size, large woody debris (LWD) and hollow-bearing tree data and five 1 m x 1 m plots to assess ground cover percentage (bare ground, cryptogram, leaf litter and rock), see **Figure 4**.

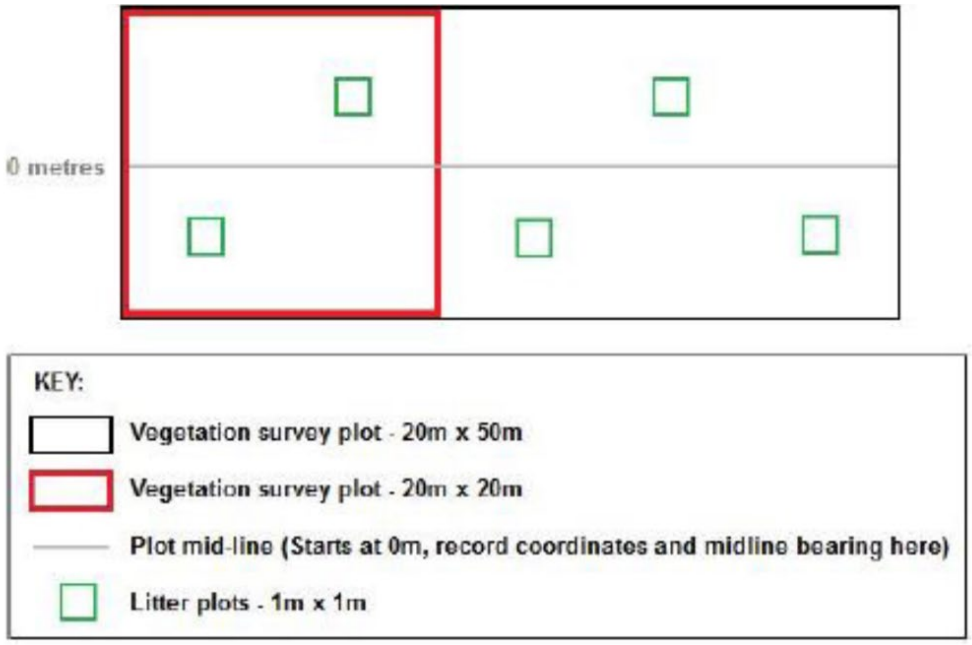


Figure 4 BAM Plot Layout

4.2.2 BAM Data

The following sections detail the various metrics assessed using the BAM. **Table 5** below provides a guide to how each performance criteria are assessed using this methodology and the sections below provide a short description of the various metrics and the specific methodology used to measure each in the BAM. Metrics which are not assessed though the BAM have been excluded from this table. These metrics are assessed through the soil chemistry, microbiology and/or by general observations.

Table 5 Assessment of respective performance criteria using the BAM

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	BAM metric
Vegetation composition recognisable as target vegetation community	Native plant species are characteristic of the target vegetation community(s)	Comparison of native species lists between control and rehabilitation plot data
Vegetation structure recognisable as, or is trending towards target vegetation community	Cover and abundance of native plant growth forms are characteristic of target vegetation community type(s)	Native plant species richness and cover scores for all six growth forms as below

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	BAM metric
Ecosystem function demonstrates rehabilitation is self-sustainable	Litter cover is within 10th-90th percentile variation range of reference sites/data	Comparison of litter cover scores (%) between control and rehabilitation
	Second generation individuals of trees are within the 10th-90th percentile variation range of reference sites	Comparison of tree regeneration scores between control and rehabilitation plot data
	Foliage cover of 'high threat exotic' (HTE) weeds is within 10th-90th percentile variation range of reference sites	Comparison of HTE cover scores between control and rehabilitation plot data

Native Plant Species Richness

Native plant species richness refers to the total number of native species recorded within each 20 m X 20 m plot. Native plant species are vascular species local to the area and, if planted, come from a local seed source. Each plot was systematically walked and the number of native plant species for all vascular plants was counted. A list of native plants was compiled for each plot and each species was given a cover (% plant coverage within each 400 m² plot) and abundance (number of plants within each 400 m² plot) score.

Native Tree Cover

Native tree cover is the tallest woody stratum present and under the BAM is determined with reference to 'growth form[1]'). Tree cover is estimated as the percentage of foliage cover, which is equivalent to the amount of shadow that would be cast on the ground if there were a light source directly overhead. It is calculated by estimating the percentage foliage cover of each species in the tree growth form group. These numbers are summed to get the overall estimated overstorey cover.

Native Grass and Grass-like Cover

This growth form includes all true grasses (family Poaceae) as well as groundcover species which are not forbs, ferns or other, and are identified by Growth Form. The percentage foliage cover of the grass and grass-like growth form is estimated as for the tree growth form group detailed above.

Native Shrub Cover

This growth form includes all woody native species which are not assigned to the tree growth form group. The percentage foliage cover of the shrub growth form is estimated as for the growth form groups detailed above.

Native Forb Cover

This growth form includes all native ground stratum species which are not grasses, grass-like, ferns or other. The percentage foliage cover of the forb growth form is estimated as for the growth form groups detailed above.

1 The Native Species by Growth Form spreadsheet (maintained by the NSW Department of Planning and Environment (DPE)

Native Fern Cover

This growth form includes all native ground stratum species which are not grasses, grass-like, forbs or other. The percentage foliage cover of the fern growth form is estimated as for the growth form groups detailed above.

Native Other Cover

This growth form includes all native ground stratum species which are not grasses, grass-like, forbs or ferns. The percentage foliage cover of the forb growth form is estimated as for the growth form groups detailed above.

Exotic Plant Cover

Exotic plants are vascular plants not native to Australia. Exotic plant cover is measured as total percent foliage cover of all exotics in all strata. Cover for exotic species is calculated as for the native growth form groups detailed above. Under the BAM, exotic species are classified as "High-threat Weed", or "Non-High-threat Weed". High-threat Weeds are as identified in the NSW DPE High-threat Weeds List spreadsheet. This list is distinct from the NSW priority weeds list (as per the NSW *Biosecurity Act 2015* (Bio Act).

All field data is collected in standard BAM field sheets.

4.3 Ecosystem Function

4.3.1 Litter Cover (BAM)

The litter cover is determined by calculating the mean percentage of the ground covered by litter n five 1 x 1 m plots (as well as bare ground, cryptogram and rock). These plots are evenly spaced and positioned parallel to the BAM central 50 m midline. Litter includes leaves, seeds, twigs, branchlets and branches (< 10cm in diameter). Litter from native and exotic species (combined) are recorded for this attribute. All plant material that is detached from a plant and forms part of a litter layer on the ground surface is included.

4.3.2 Total Length of Fallen Logs (BAM)

This is the total length of logs and fallen timber of at least 10 cm diameter and at least 0.5 m length within the 50 m x 20 m plot. The diameter is estimated with a measuring tape (or callipers if available) held horizontally immediately above the log and the length is estimated to the nearest metre by measuring with a tape, or pacing, along the part of the log that is at least 10 cm in diameter. Only those parts of logs/timber lying within the plot are measured.

4.3.3 Tree Regeneration (BAM)

Regeneration is measured as the presence or absence of tree growth form species with a Diameter at Breast Height (DBH) (140 cm above ground level) of less than 50mm within the 50 m x 20 m plot.

4.3.4 Soil Chemistry Analysis

Five soil samples were collected from each of the 20 m X 50 m vegetation monitoring plots. Soil was sampled using an Arborline push tube soil corer to collect 0 - 10 cm of soil at approximately 5 m intervals along the centreline of the plot at five separate sites. These samples were then consolidated into a single sample for all rehabilitation sites for analysis. Laboratory analysis of the samples included examining the following soil chemistry parameters:

- pH
- Electrical conductivity (salinity)
- Chloride and sulfate
- Exchangeable Ca/Mg/K/Na
- Cation exchange capacity
- Particle size analysis
- R1 dispersion index
- Available water capacity, 15 bar and field capacity
- Organic carbon
- Total nitrate and nitrogen
- Total and extractable phosphorus
- Copper, manganese and zinc

Soil test results were rated according to the "traffic light" system shown in **Table 6** to reflect suitability of analyte levels for optimal native vegetation growth. Analyte level ranges shown in **Table 7** were obtained from the following three reference texts:

- *A Guide to Managing Box Gum Grassy Woodland (Rawlings, Freudenberger & Carr, 2010).*
- *Interpreting Soil Test Results (Hazelton & Murphy, 2007).*
- *Nutrient Response in Eucalyptus grandis (Cromer, 1999).*

Table 6 Soil Chemistry Traffic Light Ratings

Colour	Rating
Green	Not limiting for growth of native vegetation, "green is good for growing"
Orange	Marginal level, possibly limiting for growth of native vegetation
Red	Deficient or toxic, limiting factor for growth of native vegetation

Table 7 Soil Analyte Ratings

Analyte	Unit	Traffic Light Rating		
pH	1:5 water	>5.9	<5.5	<5.0
Texture	PSA	> Loam	Sandy Loam	Loamy Sand[2]
Exchangeable Sodium (ESP)	%	<6	6-10	>10
Salinity (ECe)	dS/m	<2.0	2.0-8.0	>8.0
Cation Exchange Capacity	cmol/kg	>25	12-25	<12
Calcium to Magnesium (Ca: Mg)	Ratio	>3.0	1.0-3.0	<1.0

[2] PSA category & ESP % (dispersion) is associated with sodic dispersive topsoil/subsoil materials, i.e., the less clay in the soil the higher ESP % can be tolerated.

Analyte	Unit	Traffic Light Rating		
Phosphorus (Bray)	mg/kg	1.0-5.0	>5.0	>14
Extractable Phosphorus	%	<0.04	0.04-0.08	>0.08
Chloride	mg/kg	<350	350-500	>500
Sulfate	%	<0.3	0.3-7.0	>7.0
Extractable Sulfur	%	<0.1	0.1-0.5	>0.5
Copper	mg/kg	>0.4	<0.4	<0.2
Manganese	mg/kg	4-50	<4 or >50	<2 or >750
Zinc	mg/kg	>0.7	<0.7	<0.5
Organic Carbon	%	>2.0	2.0-1.5	<1.5
Carbon to Nitrogen (C:N)	Ratio	13.5-18.4	<13.5	<10.0
Field Capacity Moisture (0.3 Bar)	%	>25	10-25	<10
Wilting Point Moisture (15 Bar)	%	>15	5-15	<5
Available Water Capacity	%	>20	10-20	<10
R1 Dispersion Index	%	<30	30-65	>65
Total Nitrogen	%	Refer C:N		
Nitrate Nitrogen (KCl Extractable)	mg/kg	Refer C:N		

4.3.5 Soil Microbial Analysis

A number of soil cores were collected from three points along the 20 m centreline within vegetation monitoring plots. Soil was sampled using an Arborline push tube soil corer to collect 0 - 10 cm of soil. These samples were then consolidated into a single sample and stored in a cool place to be analysed later for microbial content.

SLR engaged the services of Microbial Management Systems (MMS) to conduct the 2022 microbial analysis. The microbial analysis comprised the following methods:

- Moisture contents were determined after drying several grams of the soil sample for three hours at 100°C. The soil moisture contents were used to adjust all microbial number counts to a standard count per gram dry weight of soil. Water activity measurements were also determined using a Decagon Devices Pawkit Water Activity Meter (Graintec Pty Ltd, Qld). Water requirements of microorganisms are defined in terms of the water activity (Aw), As the reduction of Aw has a marked effect on microbial growth.
- Standardised sample treatments and isolation media were utilised to distinguish the numbers of different populations of mesophilic and mesotolerant bacteria, actinomycetes and fungi. These microorganisms grow typically between 15 and 40°C. The dilution plating method was utilised.
- Viable bacterial and fungal populations were determined by plating the inoculum onto selective bacterial and fungal isolation media followed by incubation at 25°C. The microorganisms were grouped into broad ecological and taxonomic categories for analysis. The categories examined include copiotrophic (rapidly growing) and oligotrophic (resource-limited adapted) bacteria and actinomycetes (filamentous bacteria that are important for the decomposition of complex substrates), filamentous fungi and yeasts.

- All data analyses were undertaken using the SYSTAT 11 statistical package (SYSTAT Software Inc, Illinois, USA).

4.3.6 Fauna Activity Monitoring

In accordance with the performance criteria for ecosystem function listed in **Section 2**, the following observations on fauna activity were collected during the annual monitoring survey:

- Pest animal activity – visual observations of feral animals and/or domesticated stock (signs and damage) are recorded within each monitoring plot via photo evidence and note taking. Indirect evidence of feral animals, such as scats, tracks, diggings, regurgitated prey remains, scratching, burrows and dens, were also collected and documented, where present.
- Native fauna activity – observations were recorded as for feral animals (see point above); native fauna species were recorded opportunistically throughout the assessment.

4.4 Completion Criteria Assessment

Each of the rehabilitation monitoring sites was surveyed for indicators of the completion criteria listed in **Section 2** of this report. This task required physical observation of the total site area. The following items were assessed and noted:

- Functioning of drainage structures.
- Presence and extent of erosion or soil surface failure.
- Ecosystem health, composition and structure (assessed using the BAM methods – see **Section 4.2.2**).
- Local native plant species (assessed using the BAM methods – see **Section 4.2.2**).
- Habitat features for native fauna and presence absence of species (using the BAM methods – see **Section 4.2.2**).
- Presence of weeds and pest/feral animals (i.e. vertebrate feral pests).

Photographs were also taken to record the status of the rehabilitation at each monitoring site (**Table 4**).

4.5 Vegetation Integrity (VI)

A useful metric for comparison of vegetation results (derived from BAM plot data) between rehabilitation sites and control sites is the BAM score known as vegetation integrity (VI). The BAM defines vegetation integrity as "the condition of native vegetation assessed for each vegetation zone against the benchmark for the PCT". Vegetation integrity score is the quantitative measure of vegetation condition calculated in accordance with the BAM and is derived from the composition, structure and function data collected from each BAM plot within a vegetation zone. (Note: for the purposes of calculating VI score on rehabilitation areas, generally the entire rehabilitation area will be considered one vegetation zone).

VI score is calculated through creation of a new case in the public BAM Calculator (BAM-C) or BOAMs by an accredited BAM assessor and entry of relevant data, including PCT, vegetation zone and BAM plot data. The BAM-C calculates VI score for each vegetation zone entered (ie rehabilitation sites).

5 Monitoring Results

5.1 Overview

Overall, most of the rehabilitation sites are performing well with native plant diversity and cover on track to meet RMP criteria in future. However, the significant issue of weed infestation of Blackberry, Serrated Tussock and African Lovegrass, largely around R1 and R2, will require immediate attention. In addition, feral pigs were observed in land surrounding R8 and R9.

The full list of BAM attribute scores from the 2022 monitoring survey is presented in **Appendix D.**

5.2 Vegetation Composition

5.2.1 Overview

A total of 105 plant species were identified during the 2022 monitoring event, comprising 91 natives and 16 exotics (**Table 8**). This indicates an increase in species diversity compared to the 2021 monitoring results and the highest score for any year.

Table 8 Total plant diversity recorded at SCS monitoring sites between 2018 and 2022

Variable	2018	2019	2020	2021	2022
Exotic Plant Diversity	12	13	19	21	16
Native Plant Diversity	62	57	85	85	91
Total Plant Diversity	**74**	**70**	**104**	**106**	**107**

A complete list of all plant species and their relative cover/ abundance scores for the 2022 monitoring program is presented in **Appendix C**.

5.2.2 Characteristic Species

Native Forest Areas (Control Sites)

The dominant plant community type adjacent to the rehabilitation areas is commensurate with PCT 3747 - *Southern Tableland Western Hills Scribbly Gum Forest*, which generally has the following floristic characteristics:

- An open forest structure with a sparse shrub layer and a sparse groundcover dominated by grasses and herbs.
- A canopy dominated by Red Stringybark (*Eucalyptus macrorhyncha*), Inland Scribbly Gum (*E. rossii*), Red Spotted Gum (*E. mannifera*), with occasional Long-leaved box (*E. goniocalyx*).
- A midstorey dominated by Black Wattle (*Acacia decurrens)*, with occasional Australian Blackwood (*Acacia melanoxylon).*
- A sparse shrub layer consisting of an assemblage of native shrub species including *Hibbertia obtusifolia,* Narrow-leaf Bitter-pea (*Daviesia leptophylla*), Daphne Heath (*Brachyloma daphnoides*), *Monotoca scoparia* and Dogs Tooth Wattle (*Acacia gunnii*).

- A sparse to dense groundcover dominated with native grasses such as Wattle Mat-rush (*Lomandra filiformis),* Red-anther Wallaby Grass (*Rytidosperma pallidum*) and Grey Tussock Grass (*Poa sieberiana)*. Common herbs include Many-flowered Mat-rush (*Lomandra multiflora)*, Yellow Buttons (*Chrysocephalum apiculatum*), and Blueberry Lily (*Dianella revoluta).*

Rehabilitation Sites

The rehabilitation areas are dominated by a mix of eucalypt, acacia and other native shrub species, which are native to the locality. Many of these species are also represented within the surrounding native forest. The most common native species recorded within the rehabilitation areas during the 2022 monitoring survey include the following:

Shrubs

- *Acacia dealbata* (Silver Wattle).
- *Acacia decurrens* (Green Wattle).
- *Acacia rubida* (Red-stemmed Wattle)
- *Acacia filicifolia* (Fern-leaved Wattle)
- *Cassinia arcuata* (Dolly Bush)
- *Hibbertia obtusifolia* (Hoary Guinea Flower)

Trees

- *Eucalyptus dives* (Broad-leaved Peppermint).
- *Eucalyptus macrorhyncha* (Red Stringybark).
- *Eucalyptus mannifera* (Brittle Gum).
- *Eucalyptus viminalis* (Ribbon Gum).

5.2.3 Changes in Plant Species Diversity over time

The total diversity of native and exotic species recorded within each monitoring site since 2018 is presented in **Figure 5**. The results indicate that diversity of both native and exotic species across most monitoring sites in 2022 was lower than results from 2021, with the exception of site R8. Of the eight rehabilitation sites, four (R3, R6, R8 and R9) recorded plant diversity equal or higher than the control sites. Exotic plant species remained substantially lower than the native species across all sites; however, exotic plants were recorded for the first time in rehabilitation sites of R8 and R9 since 2018.

According to OEH (2016), the benchmark for native plant diversity for PCT 3747 is 37 species. Out of all rehabilitation and control sites the benchmark was only met by the rehabilitation site R9 in 2022 where it equalled the PCT 3747 benchmark with 37 native species.

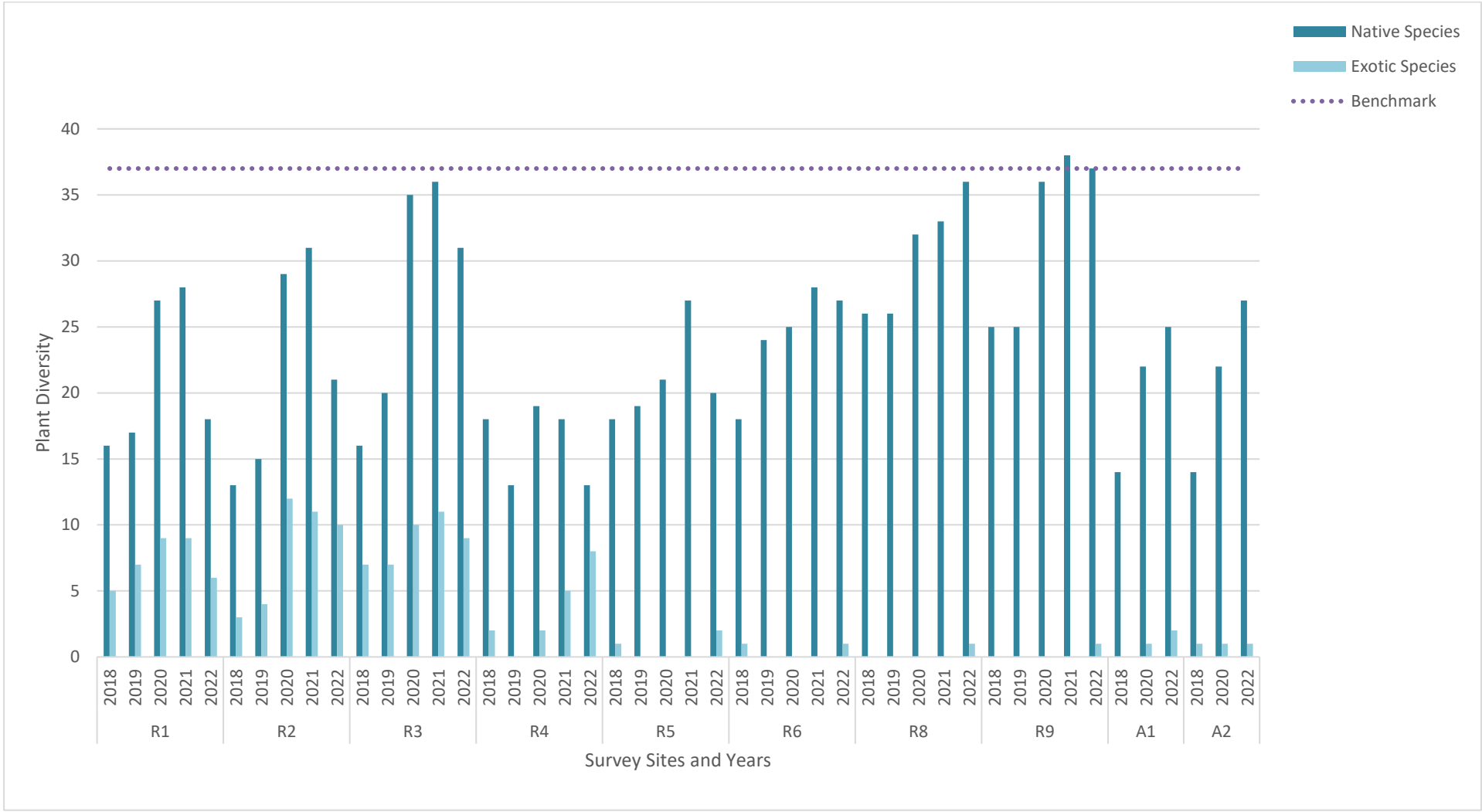


Figure 5 Plants species diversity for SCS monitoring sites between 2018 and 2022

The changes in native plant diversity at each monitoring site between the 2021 current 2022 survey period are summarised in **Table 9**. The results indicate that a decrease in native plant diversity was recorded at all rehabilitation monitoring sites (between -4 % at R6 and -36 % at R1). The control site, A1 was the only site to record an increase with 14 %.

Table 9 Change in native plant diversity at monitoring sites since 2020.

Monitoring Site	Total Native Species 2021	Total Native Species 2022	% Change
R1	28	18	-36
R2	31	21	-32
R3	36	31	-13
R4	18	13	-28
R5	27	20	-26
R6	28	27	-4
R8	39	36	-20
R9	38	37	-5
A1	22	25	14
A2	31	27	-13

As shown in **Table 10** below, exotic plant proportions increased across most monitoring plots with only R3 (rehabilitation) and A2 (control) recording a decrease on 2021 results. Rehabilitation plots of R9 and R8 also recorded the first observations of exotic plants occurring in either plot since monitoring began in 2018.

Table 10 Proportion of exotic species at monitoring sites 2018 to 2022

Monitoring Site	% Exotic Species in 2018	% Exotic Species in 2019	% Exotic Species in 2020	% Exotic Species in 2021	% Exotic Species in 2022	Recent Trend
R1	31.3%	41.2%	33.3%	32.1%	33.3%	↑
R2	23.1%	26.7%	41.4%	35.5%	47.6%	↑
R3	43.8%	35.0%	28.6%	30.6%	29.0%	↓
R4	11.1%	0.0%	10.5%	27.8%	61.5%	↑
R5	5.6%	0.0%	0.0%	0.0%	10.0%	↑
R6	5.6%	0.0%	0.0%	0.0%	3.7%	↑
R8	0.0%	0.0%	0.0%	0.0%	2.8%	↑
R9	0.0%	0.0%	0.0%	0.0%	2.7%	↑
A1	0.0%	NA	4.5%	NA	8.0%	↑
A2	7.1%	NA	4.5%	NA	3.7%	↓

The mean number of native plant species and the mean number of exotic species recorded across all monitoring sites are presented in **Figure 6**. The analysis shows that across all survey years all monitoring sites displayed a higher average of native species than exotic species.

The 2022 survey was the first year the mean diversity of native species was lower than that of the control sites. It was also the first year to record a decrease in mean native plant diversity across the rehabilitation sites from the year proceeding, resulting a reversal of the of the ascending trend. However, the mean native plant diversity during 2022 for the rehabilitation sites (24 species) was only slightly below the mean plant diversity of the control (26 species), as shown in **Figure 6**.

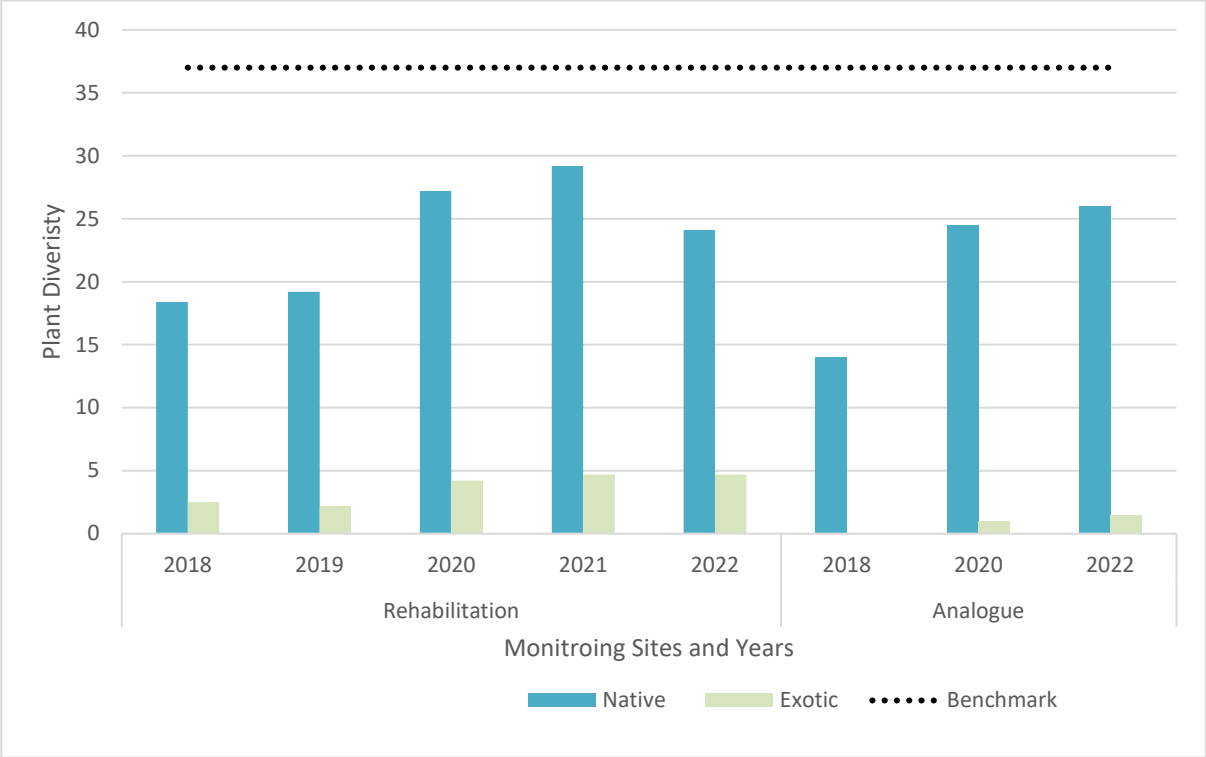


Figure 6 Mean plant species diversity for SCS monitoring sites 2018 - 2022

Plant Diversity within Vegetation Strata

Native plant diversity was further examined by analysing diversity within separate vegetation strata (**Figure 7**).

The diversity of trees and shrubs is comparable across all survey sites; however, there is a marked decrease between 2021 and 2022 results in the diversity of the two groundcover groups identified as 'native groundcover - other' and 'grass and grass-like' species at six of the eight rehabilitation sites (R1 to R6). The site of R8 saw a slight increase in groundcover while R9 resulting in a slight decline, however both sites comparable on previous years. This plant group is primarily composed of grasses, forbs, ferns and vines. Generally, this group is more diverse in the control sites compared to the rehabilitation sites (**Figure 7**).

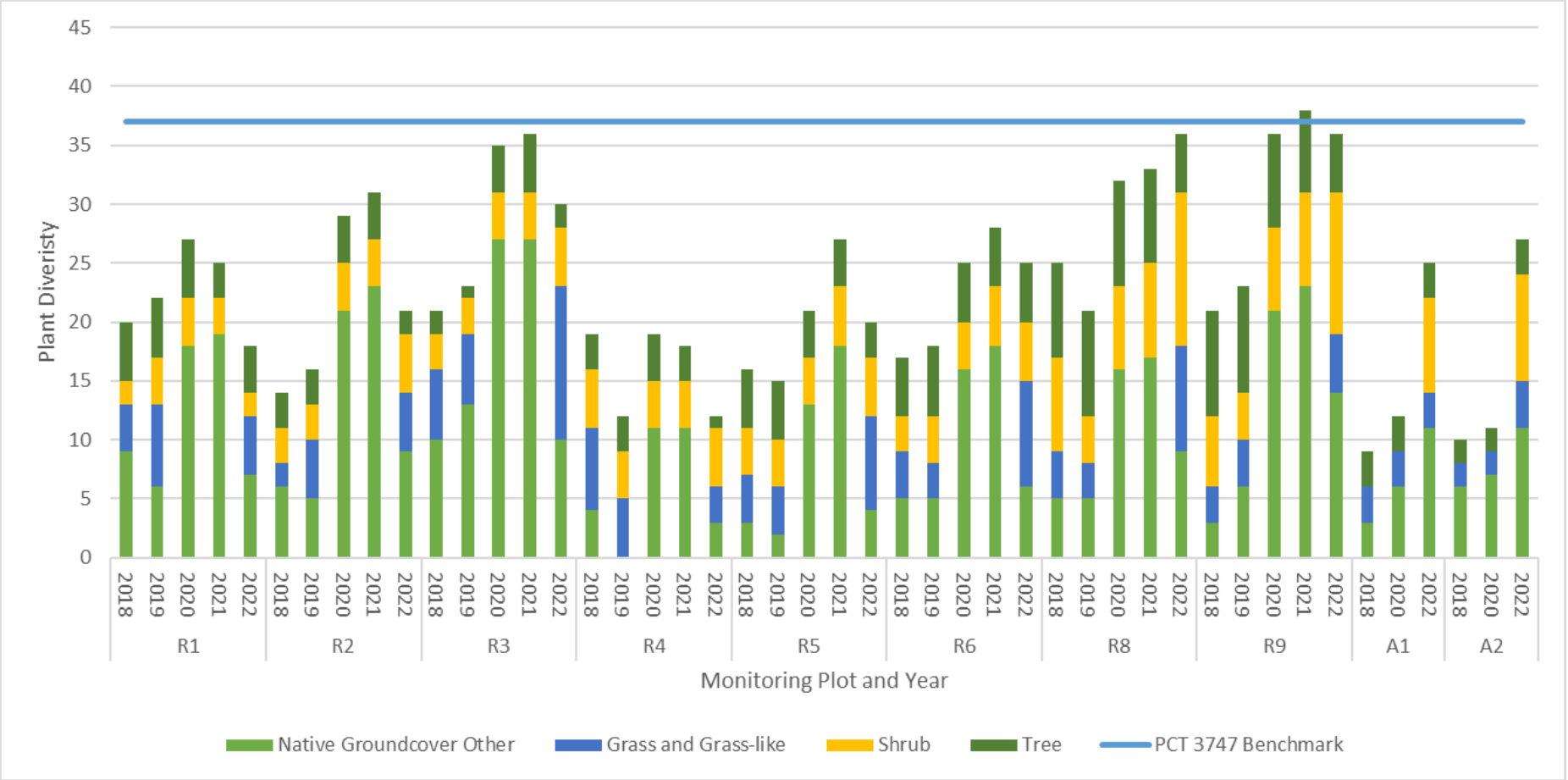


Figure 7 Plant Species Diversity by Vegetation Strata Since 2018[3]

[3] 'Native groundcover other' and 'grass and grass-like' species were not separated during the 2020 and 2021 monitoring. For these two monitoring years both vegetation strata is combined as 'native groundcover other'.

5.3 Vegetation Structure (foliage cover)

In accordance with the BAM and the rehabilitation performance criteria for vegetation structure (see **Section 2**), the vegetation within the rehabilitation and control sites was examined by analysing vegetation cover abundance scores for native tree cover, native shrub cover, native grass and grass-like cover, forb, fern and other cover (combined) and exotic plant coverage. field sheets are provided in **Appendix I**.

5.3.1 Native Cover

Mean tree cover of the rehabilitation sites in 2022 was 22.1 %, remaining below the mean tree cover of 28 % at the control sites and the respective benchmark values for PCT 3731, which range between 38 % and 52 % (**Figure 8**). This is expected, given the young age of the rehabilitation sites. However, the mean canopy cover at the rehabilitation sites has increased compared to 2021, up from 13.7 % and continues the ascending trend from 2019. The mean cover of the control sites has decreased from 31 % in 2020 to 28 % in 2022, as shown in **Figure 8**.

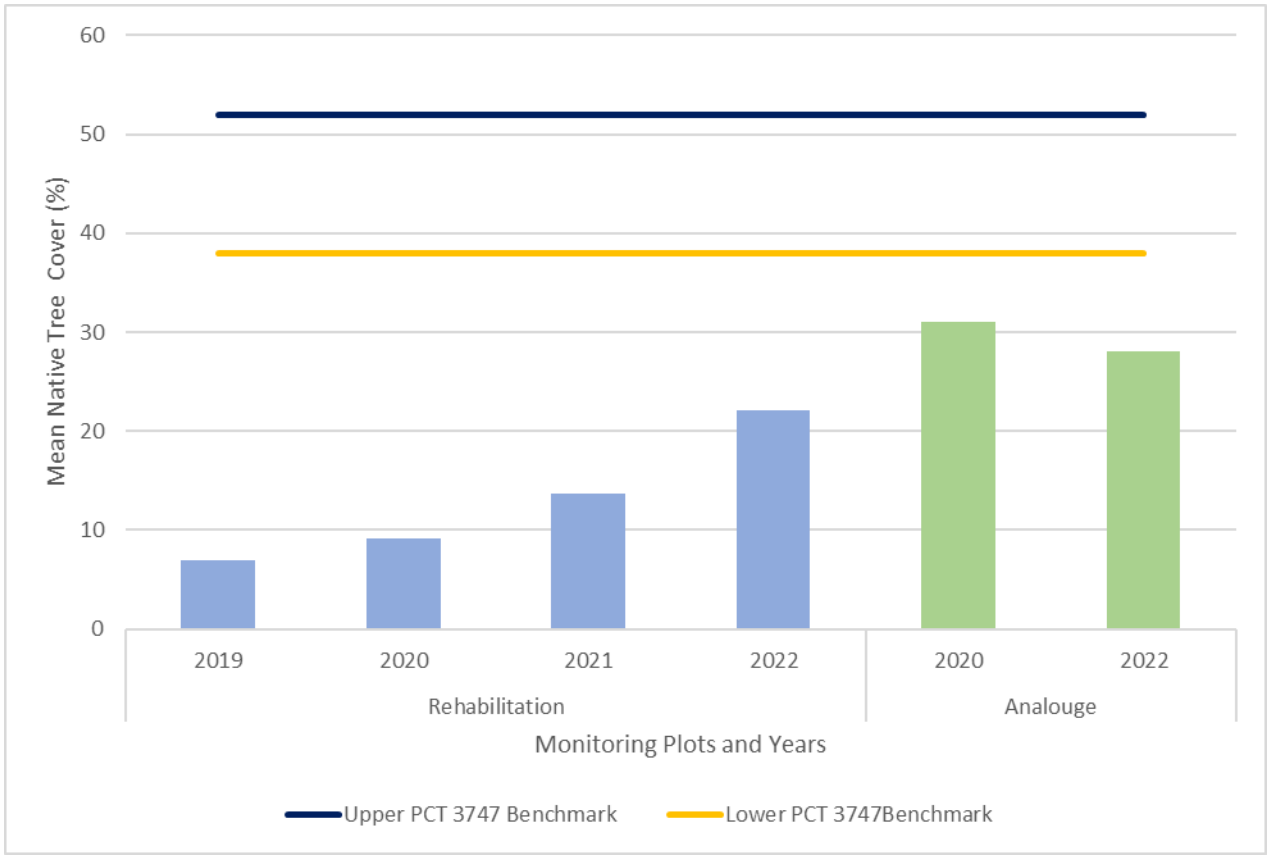


Figure 8 Mean native tree cover at monitoring sites between 2019- 2022

Native tree cover results for each monitoring site since 2019 are shown in **Figure 9**. The results show a continuation of an increasing trend in tree cover in most rehabilitation sites; however a decrease from 2021 results was recorded at R2 and R5. A slight decline was also recorded across both control sites of A1 and A2 in 2022.

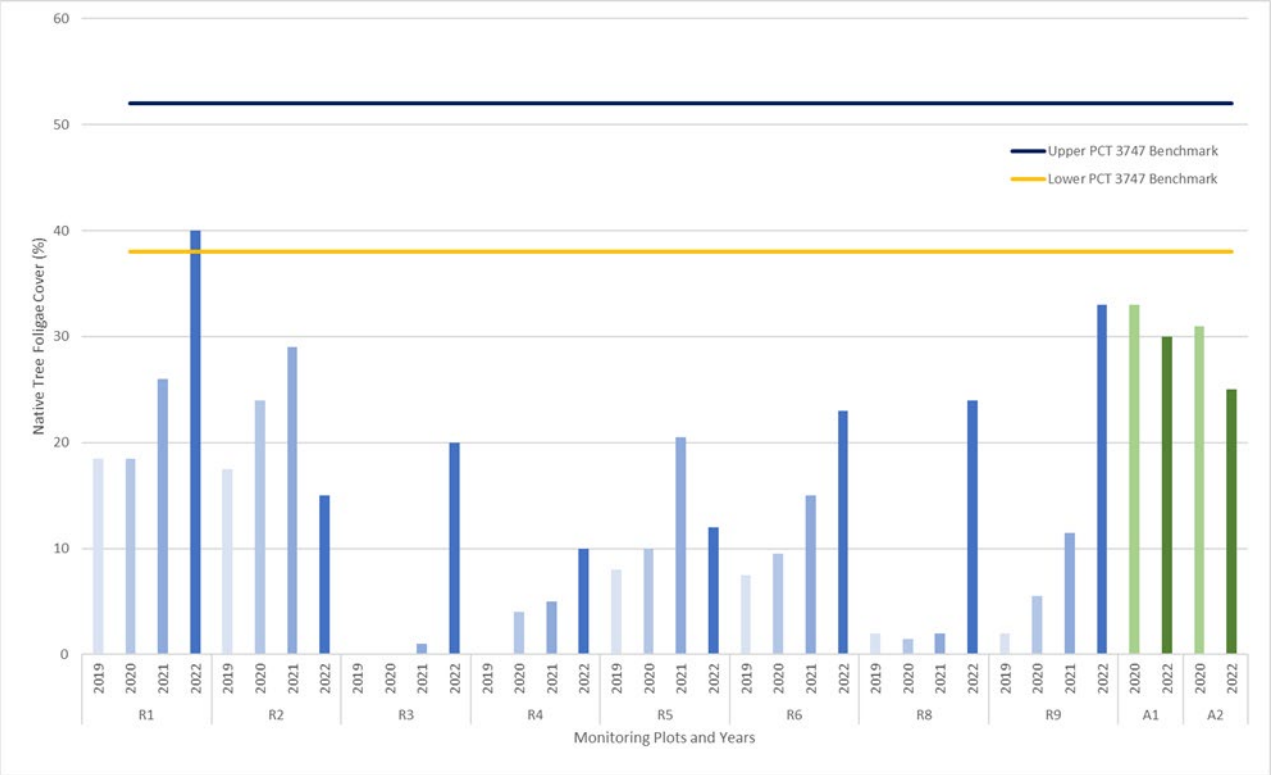


Figure 9 Native canopy foliage cover across SCS monitoring plots between 2019 - 2022

5.3.2 Native Shrub

The mean native shrub cover of the rehabilitation sites increased form 26.8 % in 2021 to 33.1 % in 2022 continuing the ascending trend since 2019. The mean shrub cover of rehabilitation sites also scored higher than the mean cover of the control sites in 2022 (see **Figure 10**). High values recorded across the rehabilitation sites are likely a result of the dense growth of shrubs (predominantly *Acacia* species), which have now grown into the shrub strata.

Most of the rehabilitation sites recorded an increased in shrub layer coverage, however R1, R2 and R8 decreased in cover compared to previous years (**Figure 11**). Most plots (with the exception of R2) were within benchmark for shrub cover. An extreme difference in shrub cover was recorded between the two control sites; A1 recorded a relatively low score of 8.5 %, while A2 displayed a substantially higher shrub cover of 34 %.

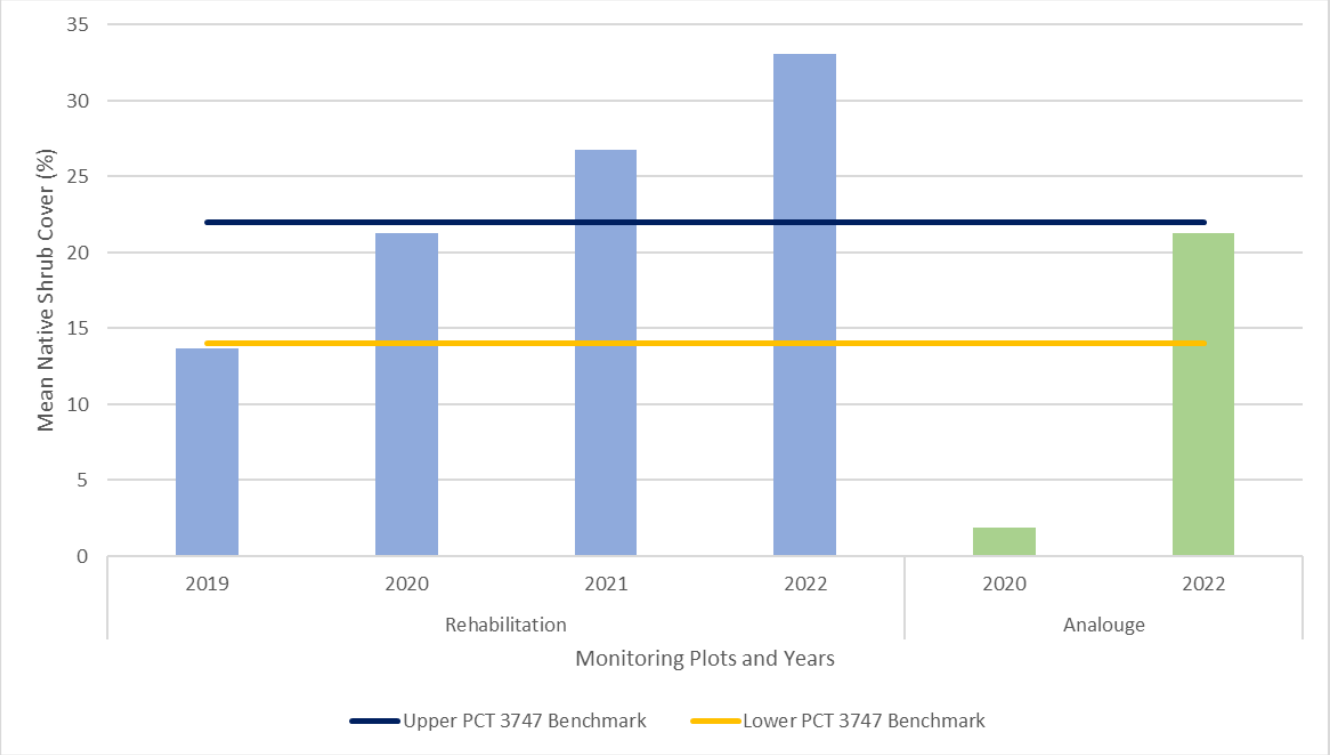


Figure 10 Mean native groundcover – shrubs at monitoring sites between 2019 and 2022

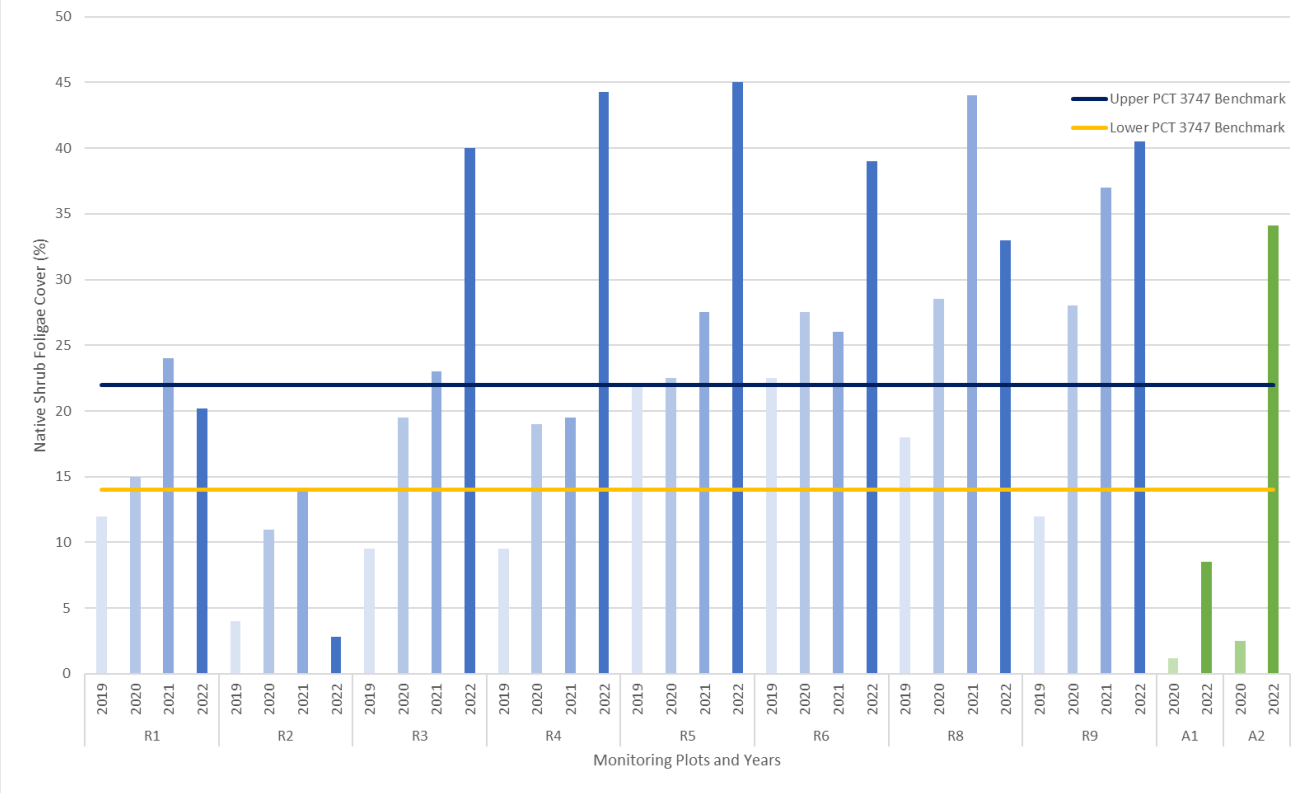


Figure 11 Percentage of native groundcover – shrubs at monitoring sites

5.3.3 Native Groundcover – Grass and Grass-like

Native 'grass and grass-like' cover scores vary across all rehabilitation sites in 2022, with three of the eight rehabilitation sites (R3,34.9 %, R4, 45 % and R5, 45.9 %) recording above both control sites (A1, 30 % and A2, 30.1 %). These three sites along with R6 (25 %) also scored above the lower PCT 3747 benchmark range or 24 % with 35 %, 45 %, 46 %, 25 % respectively. The remaining four rehabilitation sites (R1, R2, R8, R9) recorded below both control sites and benchmark values. (**Figure 12**).

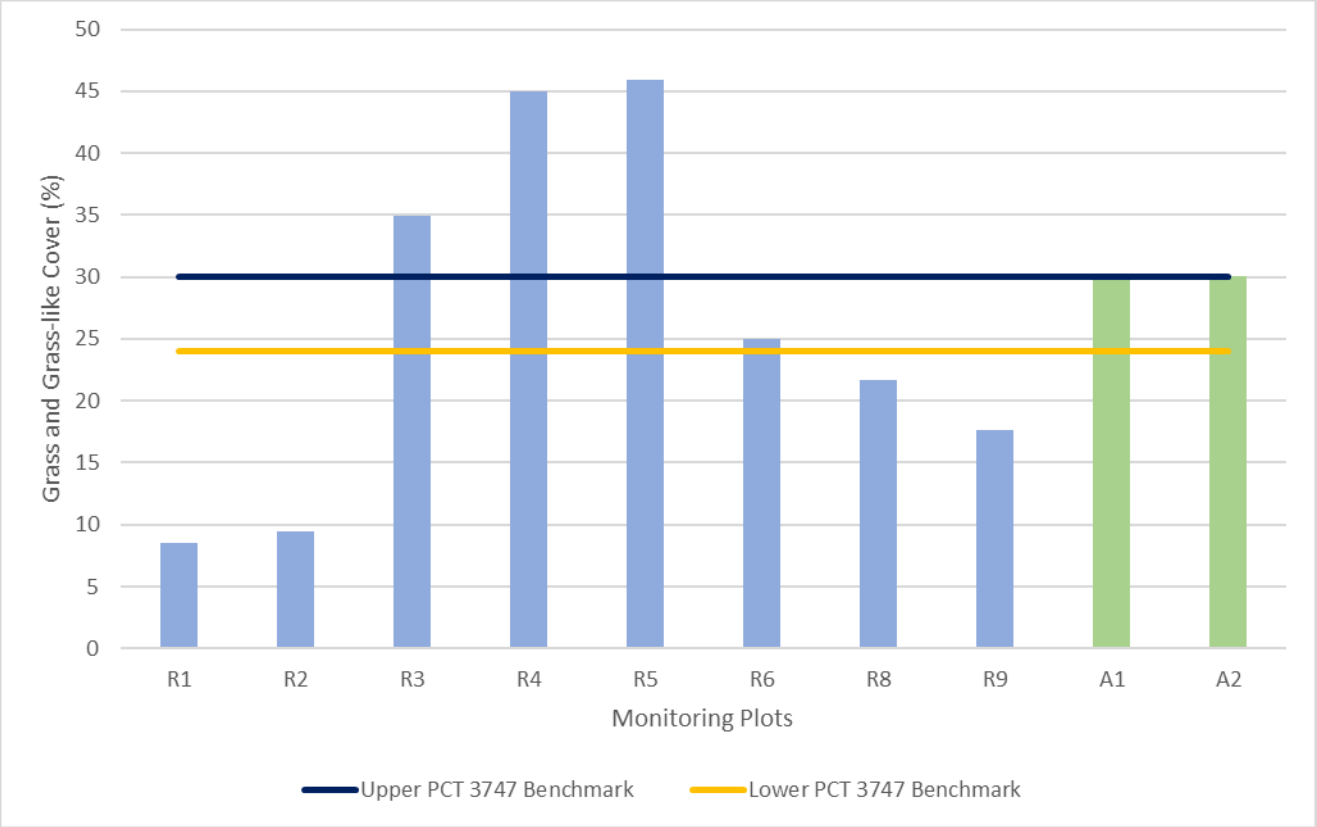


Figure 12 Percentage of native groundcover – Grass and Grass-like across SCS monitoring plots in 2022

5.3.4 Native Groundcover – Forbs, Ferns and Other

Mean groundcover score for 'forbs, ferns and others' native species (i.e., primarily herbs, ferns and vines) across most rehabilitation sites scored lower than either control site, with the exception of R9. The lowest values were recorded at R4 (3 %) and R5 (4 %), while R9 (14 %) recorded the highest, comparable to that of the control sites of A1 and A2 (14%, 13.6% respectively). This is likely attributable to timing and conditions of survey, as, of the growth form groups assessed, the diversity and cover of this growth form group is most dependent on these variables. Most monitoring sites were recorded within the upper (9 %) and lower (6 %) PCT 3747 benchmarks, with the exception of R4 and R5 (**Figure 13**).

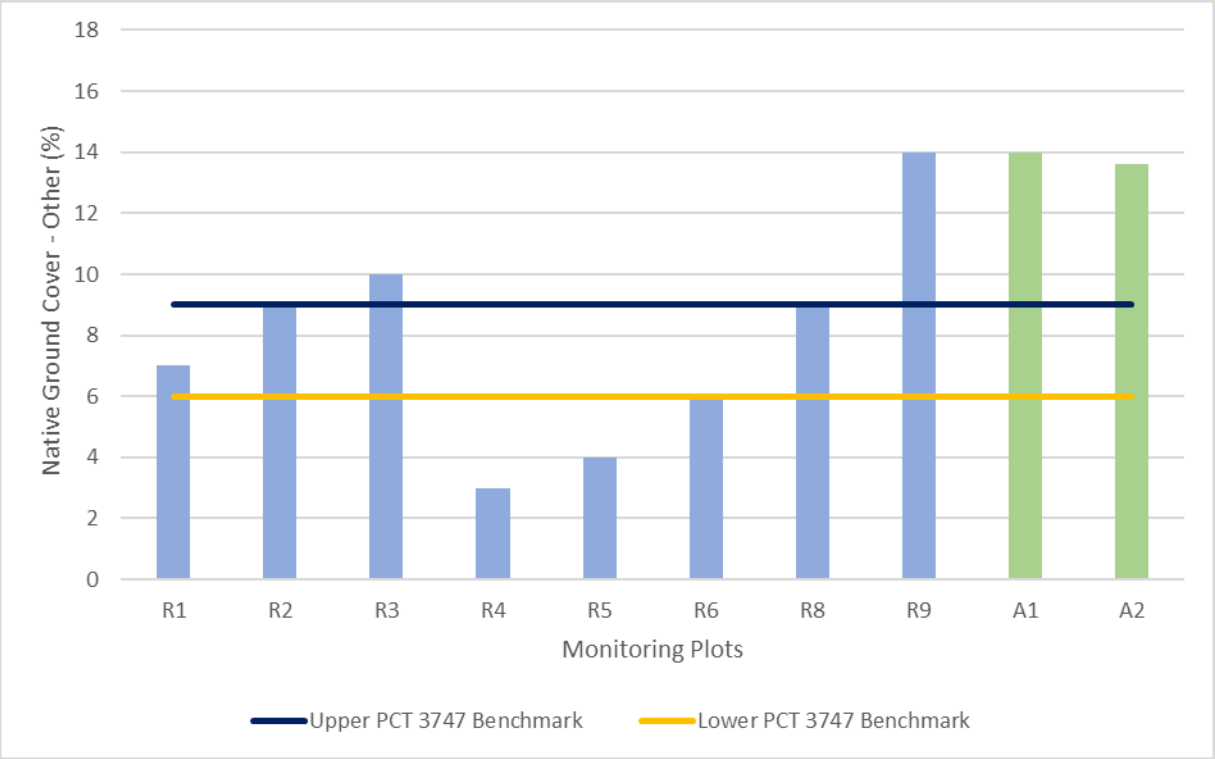


Figure 13 Percentage of native groundcover – Forbs Ferns and Other across SCS monitoring plots in 2022

5.3.5 Exotic Groundcover

All monitoring sites recoded an increase in exotic groundcover between the 2021 and 2022 surveys and most sites recording the highest cover results since monitoring began in 2018, with the exception of R3 (**Figure 14**). The first records of exotic species were observed at rehabilitation sites R6, R8 and R9, albeit very low cover scores (< 0.5 %). The overall exotic ground cover remains relatively low with all sites under 10 % and five of the six rehabilitation sites (R2, R5, R6, R8 and R9) under 5 % cover. The sites R5, R6, R8 and R9 also remained under the exotic cover scores as recorded at the two control sites (A1, 2 % and A2, 1 %).

Of the eight rehabilitation sites, four (R1, R2, R3 and R4) contain exotic species classified as HTE (**Figure 15**), with R4 containing both the highest cover of total exotic (7.7 %) and HTE species (3.6 %) These four sites are located in close proximity to each other near the access road within the northern parts of the SCS site. The four other rehabilitation sites (R5, R6, R8 and R9) are all located within the southern area of SCS site and all recorded low exotic cover of under 1 %, with no HTE cover.

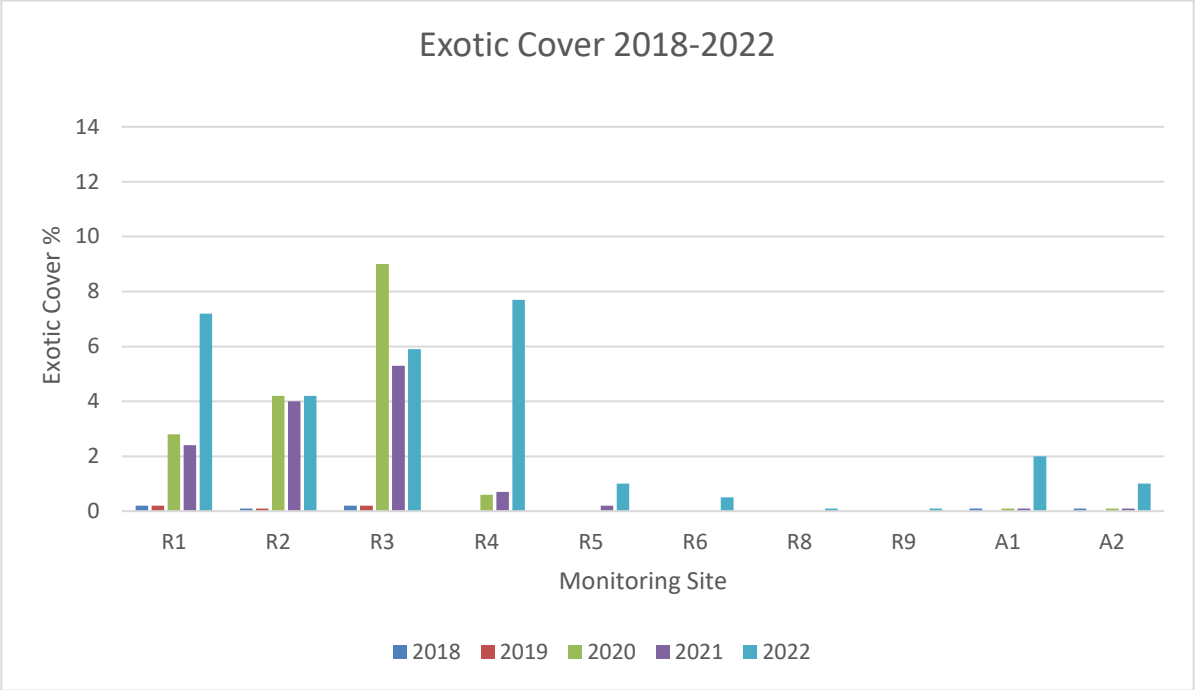


Figure 14 Exotic groundcover for all monitoring sites between 2018 and 2022

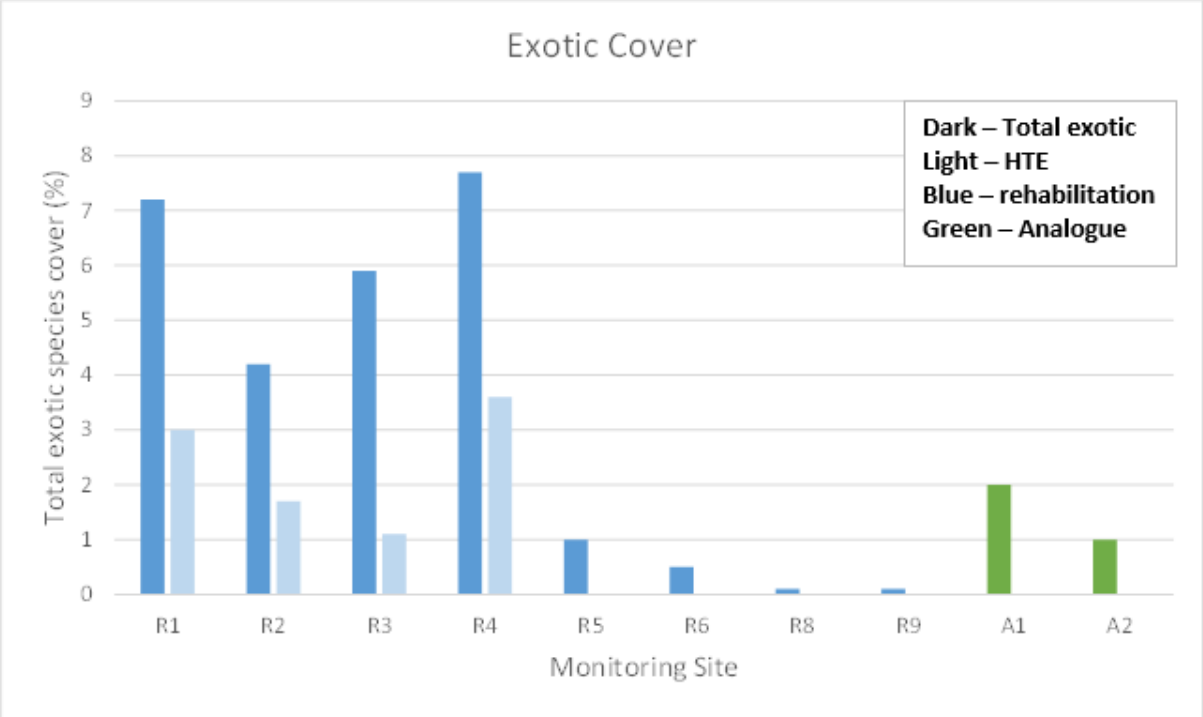


Figure 15 Exotic Weed and HTE Cover in 2022

5.4 Vegetation Assessment Summary

The current vegetation assessment results can be summarised as follows:

- Native plant diversity has decreased across all sites when compared with the 2021 survey period.

- Exotic foliage cover has increased across most of the SCS since 2021, including first records of exotic species occurrence at R6, R8 and R9. However, Exotic cover remains low with most sites recording under 5 % cover.
- R4 was the poorest performing rehabilitation site with lowest native plan diversity, lowest canopy coverage and highest exotic cover.
- Rehabilitation sites and control sites have comparable native plant coverage and diversity across most vegetation strata.

In terms of vegetation structure and foliage cover within rehabilitation sites:

- Mean native tree cover within the rehabilitation sites in 2022 was still below the mean for the control sites and below benchmark in all rehabilitation sites.
- Mean native shrub cover in 2022 has increased compared to the 2021 survey and is also above mean for the control sites. Shrub cover will above benchmark and comparable with the control results across most rehabilitation sites with the exception of R2.
- Native grass and grass-like cover is higher than control sites at three of the eight with a further one rehabilitation site meeting benchmark.
- Native ground cover other recorded above benchmark at six of the eight rehabilitations site and R9 equalling cover at the control site. It was noted that R4 and R5 which had the highest grass and grass-like cover scored the lowest for native ground cover other, this could be the result of grass cover out-competing other ground cover types species.
- Areas between R1 and R2 along the main entrance road contains dense growth of the HTE African Lovegrass, Serrated Tussock and Blackberry. These populations should be the focus of upcoming weed management works, as well as a more thorough survey of this area for additional populations.

5.5 Ecosystem Function

5.5.1 Litter Cover

Litter cover scores across monitoring sites were comparatively similar at SCS. The rehabilitation sites recorded relatively low litter cover scores at sites R3, R4 and R8 (24%, 27%, 29% respectively), whereas cover scores at R1 and R6 were slightly higher (**Figure 16**). R2, is the only rehabilitation site to have litter scores comparable to those of the control sites (**Figure 16**). All monitoring sites are below benchmark of 75 % littler cover.

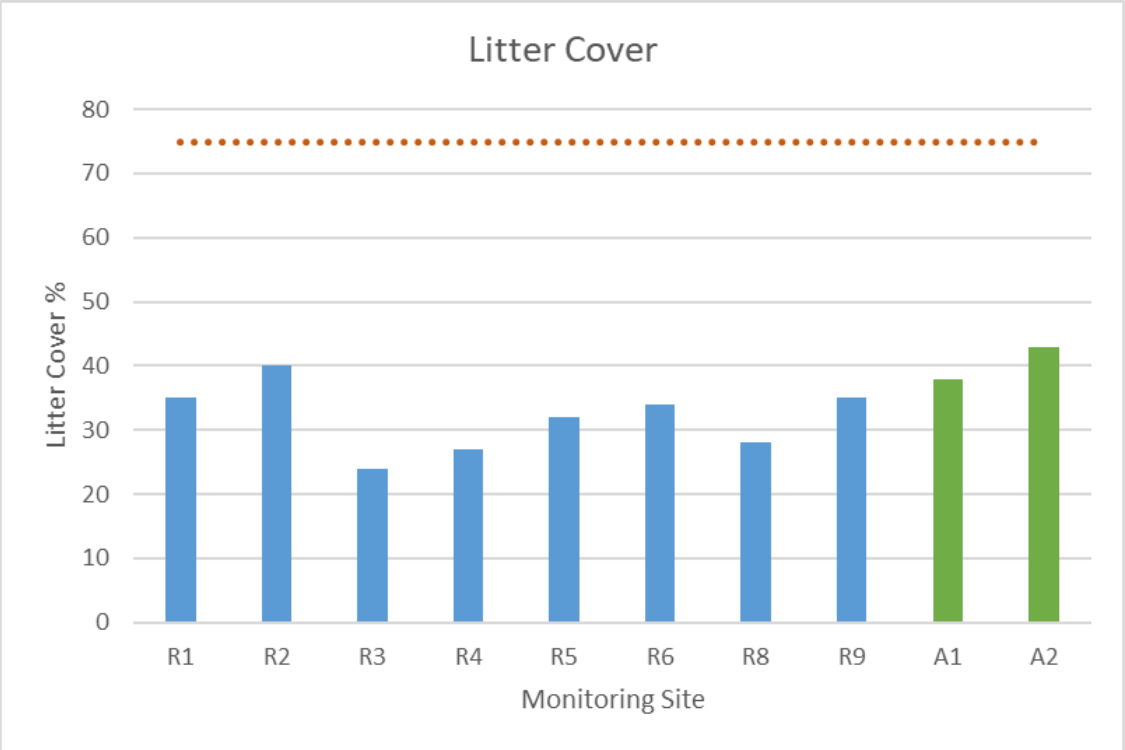


Figure 16 Litter cover percentage across SCS in 2022

5.5.2 Total Length of Fallen Logs

The rehabilitation sites recorded no logs across the 2022 monitoring survey, with the exception of Site R6 (2m), which is similar to the previous years' results. The length of fallen logs across the control sites is significantly higher than that of the rehabilitation sites, in line with previous monitoring results.

5.5.3 Tree Regeneration

Tree regeneration (tree stems with a DBH of <5cm measured at 140cm height) were observed in all control and rehabilitation plots. The 2022 results showed R4 recorded the lowest number of tree regeneration with just 1 stem, while R8 recorded the highest number of tree stems at 28 (**Figure 17**). Tree regeneration numbers in R6, R8 and R9 (24, 28 and 23 respectively) are comparable to those recorded at the control sites. The presence of tree regeneration suggests second generation recruitment of native plants is occurring in the rehabilitation areas.

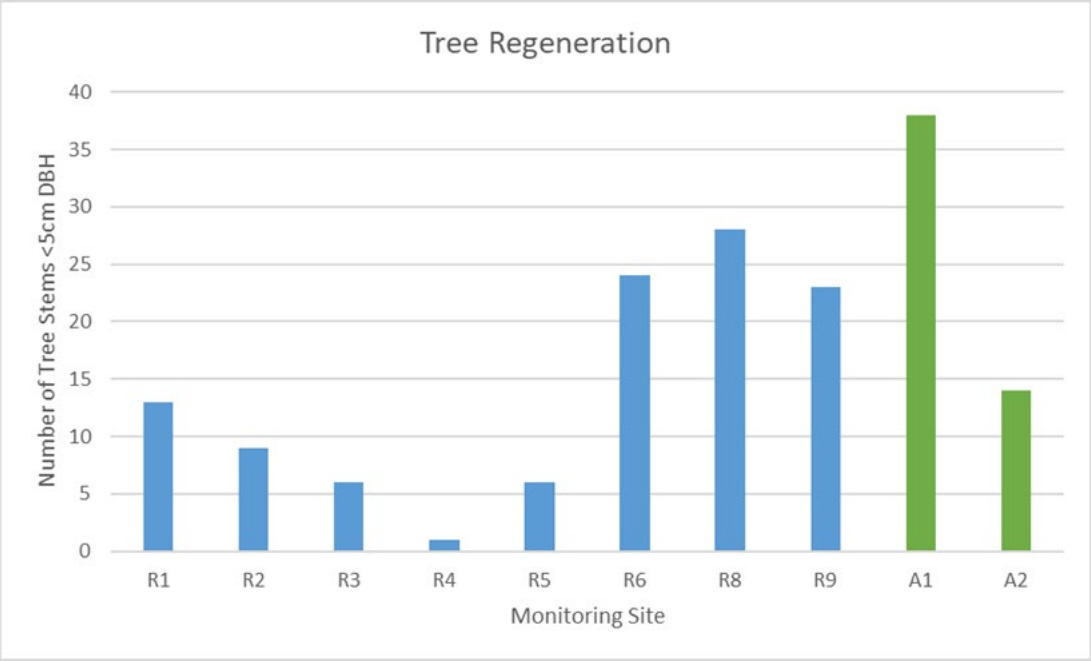


Figure 17 Tree regeneration (<5cm DBH) across SCS in 2022

5.5.4 Weeds and High Threat Exotics

A total of 16 exotic plant species were recorded, with 14 species recorded within rehabilitation areas and two recorded within control sites. The majority of exotic plant species identified within the site comprise species that are not priority weeds within the Lithgow Local Government Area (DPI 2023). Four HTE species and three priority weed species were recorded during the current survey. Most exotic species comprise grasses and forbs. The majority of these species are generally consistent with the species mix proposed to establish a stable groundcover with the aim of reducing erosion potential.

HTE species present in control plots:

- Blackberry (*Rubus fruticosus* aggregate).
- St John's Wort (*Hypericum perforatum*).
- African Lovegrass (*Eragrostis curvula).*
- Serrated tussock (*Nassella trichotoma).*

Three listed priority weed species were identified within the rehabilitation areas:

- Blackberry (*Rubus fruticosus* aggregate).
- St John's Wort (*Hypericum perforatum*).
- Serrated tussock (*Nassella trichotoma).*

These species were generally detected in low abundance in several areas (see **Appendix H**). However, R1 andR2 was observed to have higher abundance of St John's Wort (*Hypericum perforatum*).



Photo 1 Dense patch of Serrated Tussock north of the R2



Photo 2 Blackberry thicket growing along access road between R1 and R2

5.5.5 Soil Chemistry Analysis

Overview

Soil test results were rated for analyte levels needed for optimal growth of native vegetation according to the "traffic light" system shown in **Table 6** and the analyte level ranges shown in **Table 7**. In general, results from the laboratory analysis show that soil analytes are non-limiting for the growth of native vegetation.

In general, results from the laboratory analysis show that the rehab sites have favourable growth mediums for native vegetation, with no deficient or toxic factors for the growth of native vegetation. The main observations are summarised below:

- All rehab sites had adequate clay content (greater than 10%), ranging from clay loam to light clay texture, with control sites being loam and sandy loam.
- pH ranged from neutral to strongly acidic at rehab sites and very strongly acidic to strongly acidic at control sites.
- All sites were non sodic and non-saline, excepting R2 which was slightly saline.
- Organic carbon levels were moderate to very high at rehab sites and very high at control sites.

No further soil amelioration is recommended at this time for the rehab sites at Springvale Coal Services.

According to completion criteria in **Section 2,** soil health is suitable to sustain the target vegetation community and total organic carbon is within the 10th -90th percentile variation range of reference sites. Organic carbon levels at the control sites range from 3.1 % to 3.6 %, while the lowest organic carbon level among the rehab sites is 1.5 % at R6 and 1.6 % at R8, with the other rehab sites having organic carbon of greater than 2 %. Organic carbon is within the 10th-90th percentile variation range of control sites for 4 rehabilitation sites (R1, R2, R3 and R4) and meets the completion criteria. Organic carbon for remaining other 4 sites (R5, R6, R8 and R9) are below the 10th percentile of control sites and therefore do not meet the completion criteria.

However, it should be noted that organic carbon levels above 2 % are considered suitable for native vegetation establishment and growth (Cromer, 1999). Only sites R6 and R8 currently have organic carbon levels below 2 %. Organic carbon levels will continue to increase at R6 and R8 over time through the decay of organic matter both on the soil surface and in the top 10 centimetres of the soil profile.

All other soil analyte levels at rehab sites are suitable for the growth of native vegetation. Laboratory results are shown in **Table 11**.

Table 11 Laboratory Test Results

Site	Clay %	Soil Texture	Munsell Colour		pH (H20)		ESP %		ECe		OC %	
			Code	ASC	Value	Rating	Value	Rating	Value	Rating	Value	Rating
Springvale Coal Services Control												
A1	17	Loam	10YR 3/2	Black	4.7	Very Strongly Acidic	0.5	Non Sodic	0.3	Non-Saline	3.1	Very High
A2	17	Sandy Loam	7.5YR 4/3	Brown	5.2	Strongly Acidic	0.6	Non Sodic	0.5	Non-Saline	3.6	Very High

Site	Clay %	Soil Texture	Munsell Colour		pH (H20)		ESP %		ECe		OC %	
			Code	ASC	Value	Rating	Value	Rating	Value	Rating	Value	Rating
Springvale Coal Services Rehab												
R1	19	Clay Loam	10YR 2/1	Black	6.2	Slightly Acidic	0.3	Non Sodic	0.3	Non-Saline	4.9	Very High
R2	20	Clay Loam	7.5YR 2.5/1	Black	7.2	Neutral	0.4	Non Sodic	2.7	Slightly Saline	8.7	Very High
R3	17	Clay Loam	10YR 3/1	Black	6.1	Slightly Acidic	0.3	Non Sodic	0.4	Non-Saline	4.4	Very High
R4	26	Clay Loam	7.5YR 2.5/1	Black	5.5	Moderately Acidic	0.3	Non Sodic	0.5	Non-Saline	9.1	Very High
R5	24	Clay Loam	7.5YR 3/2	Black	5.6	Moderately Acidic	0.6	Non Sodic	0.2	Non-Saline	2.8	High
R6	25	Light Clay	10YR 4/2	Grey	5.3	Strongly Acidic	1.4	Non Sodic	0.2	Non-Saline	1.5	Moderate
R8	20	Clay Loam	10YR 5/3	Brown	5.4	Strongly Acidic	0.5	Non Sodic	0.1	Non-Saline	1.6	Moderate
R9	26	Clay Loam	10YR 4/3	Brown	5.3	Strongly Acidic	1.2	Non Sodic	0.3	Non-Saline	2.7	High

As this is the first year soil chemistry analysis has been applied to the SCS site, no comparisons to previous years' data can be made.

The full chemistry analysis report is provided in **Appendix E**.

5.5.6 Soil Microbial Analysis

This section describes the soil microbial assessment results and is based on the microbial assessment report prepared by Microbial Management Systems, which is presented in **Appendix F**. Monitoring sites within this section and appended report are referred to as WSC, SCS's former name.

Soil Characterisation and Moisture

The relationship between moisture content and water activity (Aw) is unique to each soil due to its physical and chemical nature and its organic matter content. The SCS soils had varying organic matter contents as can be seen by their different colours (Wills et al., 2007) (**Photo 3**), and varying soil textures as seen in their different sedimentation rates. The control soils had faster sedimentation rates than the rehabilitation soils which indicated their coarser soil texture.

The moisture content of the soils was high, due to above-average rains prior to sampling. The water activities of all soils were 1.00 indicating that they were not water limited at the time of sampling and their soil microbial communities would be expected to be growing and functional with respect to their undertaking ecosystem processes.



Photo 3 Fresh soils at field moisture. A1 and WCS A2 sites (top, left to right). R1, R4, R6 and R9 sites (bottom, left to right).

Microbial Community Measurements

There were significant differences in non-filamentous bacterial and fungal, but not actinomycete numbers between the soils (**Figure 18**).

Two primary indicators of the status of microbial populations in the soils are the ratio of actinomycetes to non-filamentous bacterial colonies on soil dilution plates and the proportion of copiotrophic (fast-growing) bacteria. There was no significant difference between the actinomycete: bacteria ratios of the soils, their values were below the 0.2 that might be expected in undisturbed soils (**Figure 19**). The decomposer microbial communities of the SCS rehabilitation site soils were thought to be similar to those of the control communities.

There was no significant differences in the proportion of copiotrophic bacteria between soils (**Figure 19**) and the values were in the range observed in some native vegetation, grassy woodlands and pasture soils.

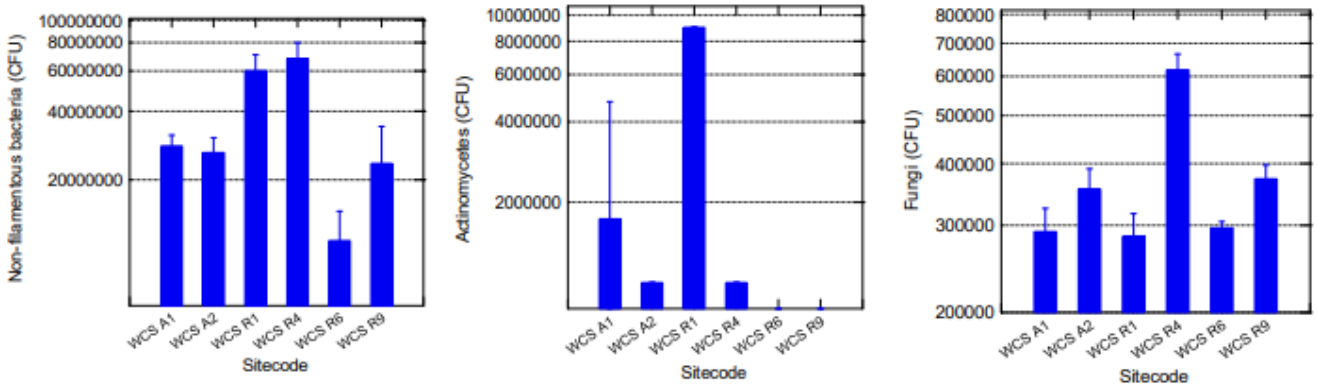


Figure 18 Mean microbial numbers as colony forming units (CFU) per gram dry weight of soil as determined by plating samples onto selective isolation media (± standard error).

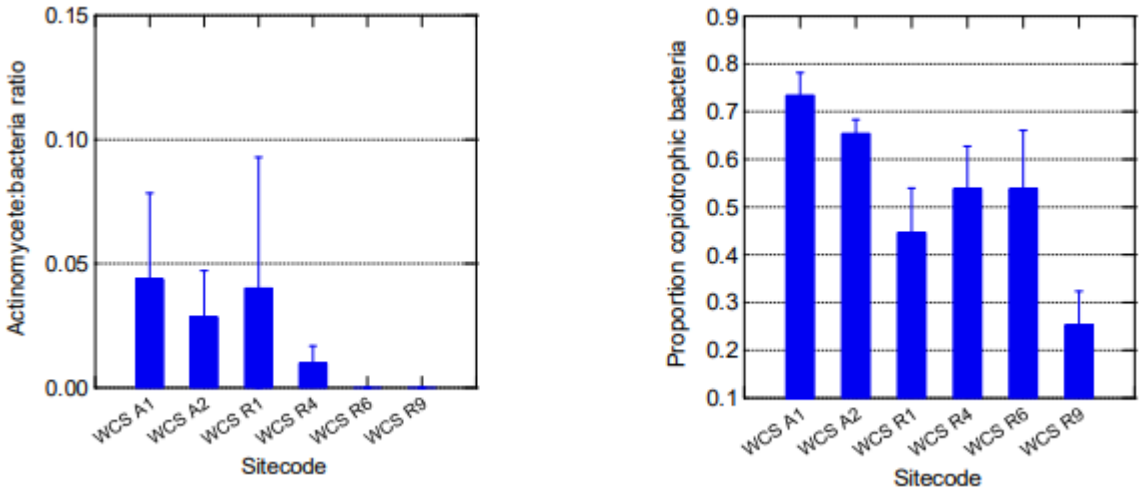


Figure 19 Actinomycete: Bacteria ratio (left) and the proportion of copiotrophic (rapidly growing) bacteria (right) (± standard error).

Trichoderma colonies were common in all the soils with the exception of the R6 site (**Table 12**) which may have lacked these organic matter inputs.

Table 12 Presences of Trichoderma on dilution plates. +/- Trichoderma = number of quadrats (+=1, ++=2, +++=3) where the fungus Trichoderma is present. Darker shading indicates higher values

Site Code	*+/- Trichoderma*
WCS A1	+++
WCS A2	+++
WCS R1	+++
WCS R4	+++
WCS R6	-
WCS R9	+++

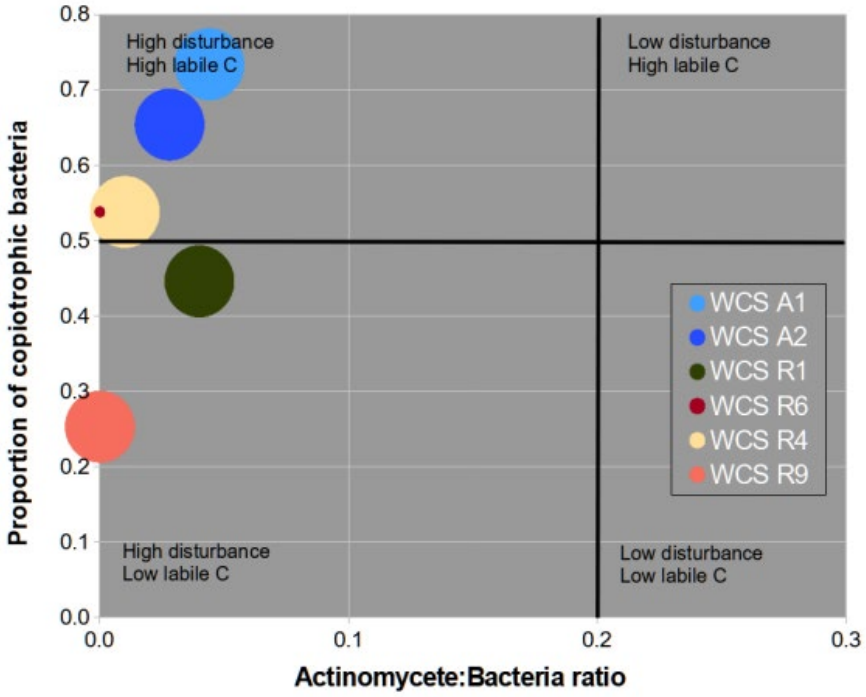


Figure 20 Bubble chart of the soil microbial community status of the SCS sites in spring 2022[4]

The three microbial bio-indicators ordinarily provide a clear separation of native and rehabilitating soils when plotted as a bubble chart (**Figure 20**) but the lack of separation between sites indicated that the decomposer microbial communities of the rehabilitation site soils were similar to those of the control soils.

The results also demonstrate the benefit of having multiple control sites and monitoring trends over time and show that the soil microbial communities in apparently stable vegetation zones can still vary to some degree under different environmental conditions.

5.5.7 Fauna Activity

Native Fauna Species and Habitat

The habitat assessment revealed that the rehabilitation sites varied in their suitability for fauna species due to the presence or absence of fauna habitat features.

All rehabilitation sites contain a complex vegetation structure with a mix of a ground and mid layer and a developing canopy along with woody debris to support a diverse abundance of native fauna. These habitat features are likely to encourage occupancy of birds, insects, reptiles and possibly small mammals over time.

Native animals species observed during the survey were primarily common species of birds, including Laughing Kookaburra (*Dacelo novaeguineae*), Yellow-tail Cockatoo (*Zanda funereal*), Crimson Rosella (*Platycercus elegans*) and Australian Magpie (*Gymnorhina tibicen*) along with macropods, namely the Common Wallaroo (*Macropus robustus*), Eastern Grey Kangaroo (*Macropus giganteus*), and Swamp Wallaby (*Wallabia*

[4] Bubble chart of the soil microbial community status of the SCS sites in s2022 using the metric measurements: 1) the actinomycete: bacteria ratio (lower values are associated with increased soil disturbance), 2) the proportion of copiotrophic bacteria (higher values are associated with increased labile soil organic carbon), and 3) the presence of the fungus Trichoderma (an indicator of significant amounts of plant cellulosic substrates in soils). The size of the bubble is proportional to the number of quadrats where Trichoderma was present.

bicolor). The rehabilitation areas provide a mosaic of habitat and foraging resources for these and other native mammal species.

Vertebrate Pests (Feral Animals)

Evidence of vertebrate pest animals during the 2022 survey were limited to Feral Pig (*Sus scrofa*) which was observed to be active as a drove of at least four animals nearby the rehabilitation sites R8 and R9. No other feral animals were observed during the surveys.

Domestic Stock

No domestic stock is run on or nearby SCS. No evidence of wandering stock (tracks, scat etc.) was observed on the SCS site in 2022.

5.5.8 General Observations of Rehabilitation Condition (including Erosion)

Observations of the general condition of the rehabilitation areas concluded that these areas are performing well overall, with a consistent cover of native vegetation throughout, limited bare areas and manageable densities of exotic species. Rehabilitation area around the access road (R1, R2 R3 and R4) continues to perform the poorest of the rehabilitation areas with a highest exotic cover and poor canopy cover, particularly at R4.

Overall landform within the rehabilitation areas appears to be stable with no erosion observed.

Drought and fire resilience are difficult to quantify. However, with reference to **Section 5.5.6** and **Section 5.5.1** above soil moisture content and leaf litter cover did differ between control and rehabilitation plots. This suggests the rehabilitation areas are less resilient to drought and fire than the control areas. Comparison of future scores should allow trends to be observed.

5.6 Vegetation Integrity Score (VIS)

As detailed in **Section 4.2.2** above, the BAM VIS has been used in this report as a measure of the cumulative indicator of the composition, function and structure of the vegetation assessed in the ten monitoring plots.

The vegetation integrity (VI) scores comparing the condition of each rehabilitation and control plots are shown below in **Figure 5**. Lower VI scores have been calculated at all eight rehabilitation sites, when compared with the two control sites (**Figure 5**). Although no rehabilitation sites have VI scores equivalent to those of the control sites, VI scores at R6, R8 and R9 are all above 60 and at R1 and R2 above 50. The rehabilitation plot R4 recorded the lowest VI score (39). Comparison of future VI scores with the current scores will be used to track rehabilitation performance over time.

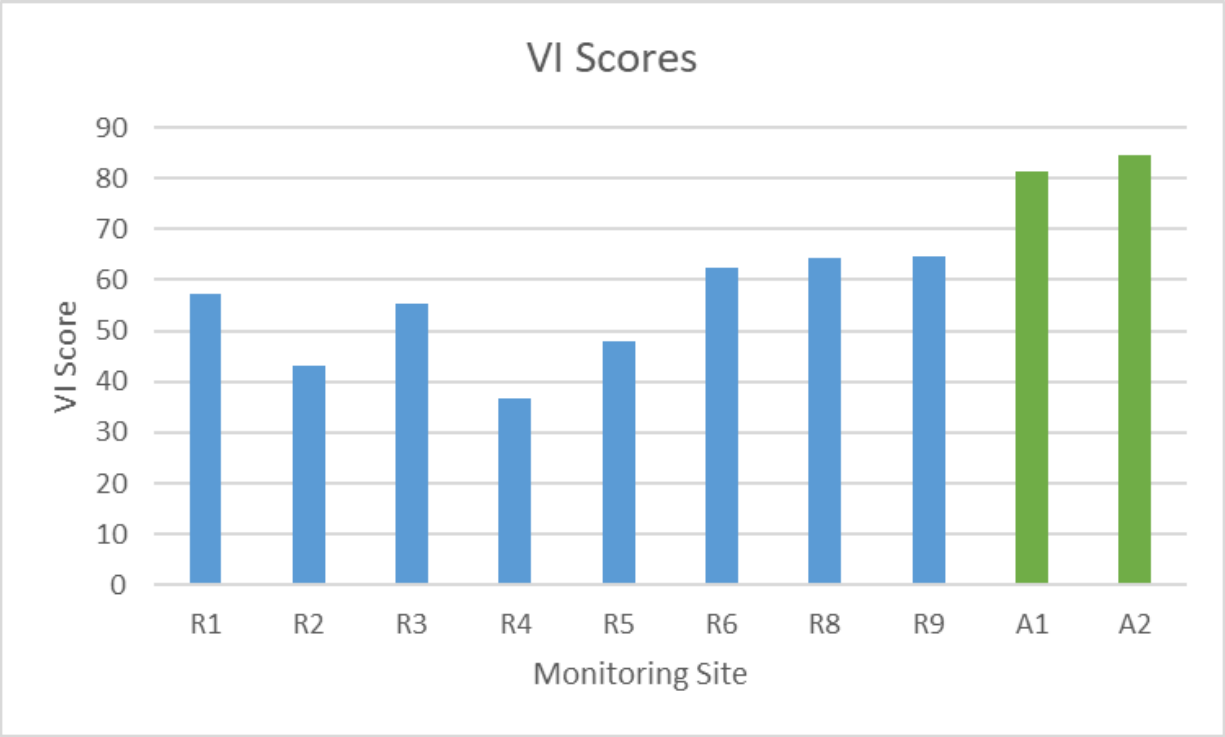


Figure 21 Vegetation Integrity scores of the across the monitoring sites 2022

6 Discussion and Recommendations

6.1 Overview

Minor issues within the rehabilitation areas were recorded during the 2022 monitoring period. Namely within the rehabilitating areas along the access road R3 where highest cover of weeds including HTE weeds occur. Tis includes infestations of Blackberry, Serrated Tussock and African Love Grass identified near R1 and R2. The rehabilitation site of R4 also contained high shrub cover with low cover of trees. Feral pigs were also observed near rehabilitation site R8 and R9.

The control of HTE populations of Blackberry, African Love Grass and Serrated Tussock populations should be the focus of upcoming weed control programs. In addition, vertebrate pest control should focus on the feral pig populations throughout SCS.

6.2 Assessment against Completion Criteria

Data collected during the current monitoring event has been assessed against the SCS performance criteria listed in **Section 2**. The current status of rehabilitation sites (R1, R2, R3, R4, R5, R6, R8 and R9) against the rehabilitation objectives and completion criteria is summarised in **Table 13**.

Species compositions are considered consistent with the rehabilitation objectives in all rehabilitation plots, however cover and abundance were only consistently met in R1 and R9 as all other rehabilitation plots recorded below the cover across growth forms compared to the control sites. Litter cover and second-generation recruitment is below reference site target scores in most rehabilitation plots; however, this is likely due to the current early stage of regeneration and should improve over time. Organic carbon scores are not within target reference site for R5, R6, R8 and R9. Sites R6 and R8 are also below 2 % organic carbon which is consider too low to support native vegetation establishment and growth. Soil microbial analysis saw actinomycete: bacteria ratio and proportion of copiotrophic bacteria comparable between the rehabilitation and control sites, however R6 recorded low Trichoderma counts outside the range as recorded within the control sites, this could be due to a lack of organic input at the site.

Resilience to fire and flood, exotic pest disturbance, domestic stock disturbance and native fauna activity were all considered similar to those observed at the reference sites.

Overall, the rehabilitation sites generally comply with the physical landform rehabilitation objectives, including land surface stability and drainage performance. Each site is also free from erosion and hazardous or polluting materials. The ecosystem health completion criteria have been met at R2; however, the ecosystem composition and structural characteristics have not yet progressed sufficiently to be considered complete (see **Table 13**).

Overall, the 2022 monitoring results are similar to those of 2020 and 2021; however, with significant reductions in vegetation diversity and cover in most plots. The vegetation, soils and ecosystem function at the rehabilitation monitoring sites is progressing and showing early stages of native woodland regeneration.

Assuming that the native vegetation that is currently established at the rehabilitation sites continues to develop, with associated improvements in soil function, it is likely that the ecosystem composition and structure will progress further towards completion criteria over the coming years.

Table 13 RMP Rehabilitation Objectives and Completion Criteria Assessment

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	R1	R2	R3	R4	R5	R6	R8	R9
Vegetation composition recognisable as target vegetation community	Native plant species are characteristic of the target vegetation community(s)								
Vegetation structure recognisable as, or is trending towards target vegetation community	Cover and abundance of native plant growth forms are characteristic of target vegetation community type(s)								
Ecosystem function demonstrates rehabilitation is self-sustainable	Litter cover is within 10th-90th percentile variation range of reference sites/data								
	Minimal erosion that would require moderate to significant ongoing management and maintenance. No visual signs of land instability such as mass movement								
	Second generation individuals of trees are within the 10th-90th percentile variation range of reference sites								
	Foliage cover of 'high threat exotic' (HTE) weeds is within 10th-90th percentile variation range of reference sites								
	Soil chemistry Total organic carbon is within 10th-90^{th}percentile variation range of reference sites; Soil analytes ECe (salinity) and ESP (sodicity) at rehab sites are similar to reference sites								
	Soil microbiology Decomposer microbial populations in the soils are similar to those of reference sites, using a metric that distinguishes soils at different stages of and in different types of mine rehabilitation. The specific parameters of the metric are:								

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	R1	R2	R3	R4	R5	R6	R8	R9
	1) the actinomycete: bacteria ratio (lower values are associated with increased soil disturbance), 2) the proportion of copiotrophic bacteria (higher values are associated with increased labile soil organic carbon), and 3) the presence of the fungus Trichoderma (an indicator of significant amounts of plant cellulosic substrates in soils).								
	Resilience to drought and fire								
	Vertebrate pest species – presence and damage is recorded and controlled.								
	Domesticated stock - presence and damage is recorded and controlled.								
	Native fauna activity – evidence of fauna habitation and/or utilisation of rehabilitation areas over time								

6.3 Recommendations

6.3.1 Vegetation Composition

The vegetation within the rehabilitation areas varies in native plant species diversity, cover (foliage projective cover) and structure depending on the rehabilitation age.

Native plant species diversity, in general, demonstrated a decrease in both the control and rehabilitation sites compared to 2021. However, this is not considered indicative of declining trend, with species diversity scores considered to be within the normal range of fluctuation based on previous years' data.

Generally, most rehabilitation areas generally contain vegetation with a complex structure to support a diversity native fauna. However, rehabilitation areas north of the access road (near R3 and R4) are subject to a higher exotic groundcover and a dominance of midstory shrubs (mainly acacias) rather than canopy species (i.e., eucalypts). Given the age of rehabilitation of the area (over 20 years), it would have been expected that acacia species from early rehabilitation would have die off to give way for eucalypts to form a healthy canopy cover, comparable to adjacent in tacked bushlands.

6.3.2 Vegetation Structure

Most of the rehabilitation sites are performing will in vegetation structure and is on track to develop structure comparable to control sites as rehabilitation areas mature. As noted above, the rehabilitation areas north of the access road, where R3 and R4 reside has high cover of tall shrubs, mainly acacias outcompeting canopy species (eucalypts). It is common practice to use high density of acacias species in rehabilitation as they are quick to establish and have a limited life span (< 15 years) where it is expected for the canopy to establish once the acacias die off. Given the age of the rehabilitation in this area it appears the acacias are in their second or third generation, resulting in the outcompeting of canopy eucalypt species. It is recommended that selective thinning of acacia species be undertaken throughout the area in conjunction with the revegetation or seeding of appropriate eucalypt species (*E. rossi, E. mannifera* and *E. macrorhyncha*). This in turn will allow light and space for other trees, shrubs and groundcovers to occupy the space in the forest structure, which over time promotes a diverse and structurally complex vegetation community.

6.3.3 Ecosystem Function

Fallen logs (ground fauna habitat)

Fallen or cut logs may be placed into rehabilitation areas to create fauna habitats as well as to increase VI scores. Fallen or cut logs may be sourced from local tree service companies or from areas where large fallen branches occur naturally in a non-bushland setting. Logs shall not be sourced from existing bushland.

Weeds and HTEs

Blackberry, African Lovegrass and Serrated Tussock populations should be the focus of upcoming weed control works, particularly within the rehabilitation areas near to R1 and R2.

Soil Chemistry

The rehabilitation sites have favourable growth mediums for native vegetation, with no deficient or toxic factors for the growth of native vegetation.

Current results indicate that soil nutrient levels are suitable to sustain the target vegetation community and total organic carbon is within the range of reference sites. High organic carbon levels were recorded at all control sites and most rehabilitation sites, with the exception of two rehabilitation sites that have organic carbon at less than 2 %. Organic carbon levels above 2 % are considered suitable for native vegetation establishment and growth (Cromer R., 1999). However, over time increased organic carbon levels from degrading plant matter will result in an even more desirable growing medium for native vegetation. No further soil amelioration is recommended at this time for the rehabilitation sites at the SCS site.

Soil Microbiology

The status of decomposer microbial communities of the rehabilitation site soils appears to be comparable to those seen with the control site as no significant differences in actinomycete: bacteria ratios and proportion of copiotrophic bacteria were observed. However, R6 recorded a low presence for Trichoderma. Low Trichoderma is linked to low organic matter within the soil, as the rehabilitation of R6 is relatively young with a developing canopy layer, it is likely that organic matter will improve natural over time as natural organic matter inputs from plant litter and root exudates as plant cover increases, boosting future Trichoderma within the soils. All other rehabilitation sites were observed to have equal levels of Trichoderma compared to the control sites.

Fauna and Feral Animals

A range of fauna species were identified within the rehabilitation areas. Many of these species appeared to be utilising the rehabilitation areas as part of a wider network of habitats. Generally, the number and diversity of fauna species recorded during the current survey was comparable to previous years.

Vertebrate pest control program should be implemented to control feral pig numbers across the SCS site.

Some rehabilitation areas contain large logs and other important habitat features, such as dense leaf litter and a more complex vegetation structure suitable for occupancy of fauna species. Conversely, some rehabilitation areas lack these habitat features. Accordingly, cut sections of trunks and branches of felled (or fallen) trees and/or existing logs (preferably hollow) should be placed across all rehabilitation areas. This will enhance refuge sites for ground dwelling fauna such as amphibians, reptiles and small mammals. Logs should be carefully placed in suitable areas (e.g., within open areas in close proximity to areas of dense ground/shrub cover) and aligned along the contours of rehabilitation areas (i.e. to assist with prevention of surface erosion). Where necessary, the placed logs should be pinned to secure them in place. As rehabilitation areas become utilised and occupied by small terrestrial species, this will eventually encourage the colonisation of predators and other fauna groups, which are also important components of a self-sustaining ecosystem.

Erosion and General Condition

Weed control, targeting HTEs of Blackberry, Serrated Tussock and African Lovegrass with the rehabilitation areas around the access road should be subject within upcoming weed control programs across SCS. No erosion issues were observed within the rehabilitation areas in 2022 as such no actions required.

7 References

Centennial Coal (2022) *Rehabilitation Management Plan, Springvale Coal Services*, Centennial Coal.

Cromer R. (1999) Nutrient Response in Eucalyptus grandis from Plants in Action Adaptation in Nature, Performance in Cultivation Edition 1

DPI (2018). The NSW Department of Primary Industries. Priority Weeds for the Lithgow Local Government Area. Available at https://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=89.

DPE (2023), *BioNet Vegetation Classification*, available at: https://www.environment.nsw.gov.au/NSWVCA20PRapp/ [Accessed February 2023]

DPE (2022), NSW State Vegetation Type Map, Department of Planning and Environment Sydney NSW

Hazelton P. & Murphy (2007) *Interpreting Soil Test Results Hazelton*. CSIRO Publishing

Hurlbert. S.H. (1984). *Pseudoreplication and the Design of Ecological Field Experiments*. Department of Biology, San Diego State University, San Diego, California.

Koru (2018) *Baseline Rehabilitation Monitoring, Western Coal Services*, Koru Environmental, Shortland NSW

Koru (2019) *Rehabilitation Monitoring, Western Coal Services*, Koru Environmental, Shortland NSW

Koru (2020) *Rehabilitation Monitoring, Western Coal Services*, Koru Environmental, Shortland NSW

Koru (2021) *Rehabilitation Monitoring, Western Coal Services*, Koru Environmental, Shortland NSW

NSW Resources Regulator. (2021) Rehabilitation Objectives and Rehabilitation Completion Criteria. Sydney: NS Resources Regulator.

Rawlings K, Freudenberger D. & Carr D. (2010). *A Guide to Managing Box Gum Grassy Woodland*. Greening Australia

Wildman H. (2014). *Improving mine rehabilitation success through microbial management*. Oil, Gas and Mining Vol 2. Issue 1. 15pp.

Wills SA, Burras CL & Sandor JA (2007). *Prediction of soil organic carbon content using field and laboratory measurements of soil colour.* Soil Science Society America Journal 71: 380-388

APPENDIX A:

Benchmark data for Target Plant Community Type (PCT 3747)

PCTID	Vegetation Class	IBRA	Benchmark Calculation Level	Benchmark Variation
3747	Southern Tableland Dry Sclerophyll Forests	South Eastern Highlands	Class/IBRA	monthly average, following AVERAGE RAINFALL year
3747	Southern Tableland Dry Sclerophyll Forests	South Eastern Highlands	Class/IBRA	monthly average, following WET RAINFALL year
3747	Southern Tableland Dry Sclerophyll Forests	South Eastern Highlands	Class/IBRA	monthly average, following DRY RAINFALL year
3747	Southern Tableland Dry Sclerophyll Forests	NSW South Western Slopes	Class/IBRA	monthly average, following AVERAGE RAINFALL year
3747	Southern Tableland Dry Sclerophyll Forests	NSW South Western Slopes	Class/IBRA	monthly average, following WET RAINFALL year
3747	Southern Tableland Dry Sclerophyll Forests	NSW South Western Slopes	Class/IBRA	monthly average, following DRY RAINFALL year

Rainfall Threshold	Default Condition	Tree Richness	Shrub Richness	Grass And Grass Like Richness	Forb Richness	Fern Richness	Other Richness
620 - 926	Yes	5	11	7	12	1	2
> 926	No	5	11	7	15	1	2
< 620	No	5	10	7	10	1	2
732 - 1076	Yes	5	9	7	11	1	2
> 1076	No	5	8	7	14	1	2
< 732	No	5	9	6	10	1	1

Tree Cover	Shrub Cover	Grass And Grass Like Cover	Forb Cover	Fern Cover	Other Cover	Total length of fallen logs	Litter Cover	Number of Large Tre
43.0	17.0	27.0	7.0	0.0	0.0	87	75	3.0
52.0	22.0	30.0	9.0	0.0	0.0	87	75	3.0
38.0	14.0	24.0	6.0	0.0	0.0	87	75	3.0
82.0	7.0	30.0	8.0	0.0	0.0	85	74	3.0
109.0	9.0	59.0	14.0	0.0	1.0	85	74	3.0
66.0	6.0	18.0	5.0	0.0	0.0	85	74	3.0

Large Tree Threshold Size	Benchmark Source	Benchmark Comments
50	Multiple methods	Composition-Structure Benchmark : Class/IBRA | Function: Logs-Class/IBRA; Litter-Class/IBRA; Large Trees-Formation
50	Multiple methods	Composition-Structure Benchmark : Class/IBRA | Function: Logs-Class/IBRA; Litter-Class/IBRA; Large Trees-Formation
50	Multiple methods	Composition-Structure Benchmark : Class/IBRA | Function: Logs-Class/IBRA; Litter-Class/IBRA; Large Trees-Formation
50	Multiple methods	Composition-Structure Benchmark : Class/IBRA | Function: Logs-Class; Litter-Class; Large Trees-Formation
50	Multiple methods	Composition-Structure Benchmark : Class/IBRA | Function: Logs-Class; Litter-Class; Large Trees-Formation
50	Multiple methods	Composition-Structure Benchmark : Class/IBRA | Function: Logs-Class; Litter-Class; Large Trees-Formation

Benchmark Reference Site	Benchmark Status	Benchmark Confidence
	Approved	Composition: High | Structure: Moderate | Function: Logs-High; Litter-High; Large Trees-Moderate
	Approved	Composition: High | Structure: Moderate | Function: Logs-High; Litter-High; Large Trees-Moderate
	Approved	Composition: High | Structure: Moderate | Function: Logs-High; Litter-High; Large Trees-Moderate
	Approved	Composition: High | Structure: Moderate | Function: Logs-High; Litter-Moderate; Large Trees-Moderate
	Approved	Composition: High | Structure: Moderate | Function: Logs-High; Litter-Moderate; Large Trees-Moderate
	Approved	Composition: High | Structure: Moderate | Function: Logs-High; Litter-Moderate; Large Trees-Moderate

APPENDIX B:

Target Plant Community Type Profile (PCT 3747)

PLANT COMMUNITY TYPE

Southern Tableland Western Hills Scribbly Gum Forest

ID 3747

FORMATION

Dry Sclerophyll Forests (Shrubby sub-formation)

VEGETATION CLASS

Southern Tableland Dry Sclerophyll Forests

BIO REGIONS

South Eastern Highlands >

South Western Slopes >

LOCAL GOVERNMENT AREAS

- Bathurst Regional
- Blayney
- Cabonne
- Cowra
- Goulburn Mulwaree
- Hilltops
- Lithgow
- Oberon
- Queanbeyan-Palerang Regional
- Upper Lachlan
- Yass Valley

DESCRIPTION

A mid-high to tall dry shrubby sclerophyll open forest of slopes and crests of dry, rocky tableland hills and ranges, at moderate altitudes across the central tablelands and northern parts of the southern tablelands.

This PCT is widely distributed from Mullions Range east to the slopes of Mount Vincent and Capertee in the north, south to Mundoonen Range, Bungonia, and Cuumbeun east of Queanbeyan in the south. It generally occurs at elevations of 550-1100 metres asl and in locations receiving 600-920 mm mean annual rainfall, commonly on quartz-rich sedimentary, acid volcanic and granitoid substrates, with scattered occurrences in areas mapped as shales or mudstones.

A sparse to mid-dense tree canopy very frequently includes Eucalyptus macrorhyncha and or Eucalyptus rossii, commonly with Eucalyptus mannifera and occasionally Eucalyptus goniocalyx. A sparse shrub layer very frequently includes Hibbertia obtusifolia, commonly with Daviesia leptophylla and Brachyloma daphnoides and occasionally Acacia gunnii, Monotoca scoparia or Melichrus urceolatus.

The ground layer is sparse to mid-dense, and very frequently includes large tussocks of Rytidosperma pallidum, which dominates with a high cover, and Lomandra filiformis, Poa sieberiana, Dianella revoluta, Gonocarpus tetragynus and Goodenia hederacea. Also common is Hovea linearis (most records likely to be Hovea heterophylla), with Lomandra multiflora subsp. multiflora occasional.

On lower slopes with increasing depth of accumulated soil, this community may grade into a variety of grassy open forest communities, such as PCT 3370 in relatively moist parts of its range or PCT 3372 in relatively dry parts. With decreasing rainfall and increasing temperatures it is replaced on similar rocky hills to the west by PCT 3353.

APPENDIX C:

Monitoring Plot Floristics

Table C1 Flora species list for R1, R2m R3, R4 and R5 during 2022 monitoring

GF Code	Species Name	N, HTE, Non-HTE	R1		R2		R3		R4		R5	
			Foliage Cv	Abundance	Foliage Cv	Abundance	Foliage Cv	Abundance	Foliage Cv	Abundance	Foliage Cv	Abundance
SG	*Acacia baileyana*	Non-HTW							2	1		
SG	*Acacia buxifolia subsp. buxifolia*	N										
TG	*Acacia dealbata*	N				10	15	5	5	5		
TG	*Acacia decurrens*	N	5	5								
SG	*Acacia rubida*	N	15	15		10	20	7	20	10	10	30
SG	*Acacia filicifolia*	N										
FG	*Acaena ovina*	N	1	5	2	10	2	15				
SG	*Allocasuarina gymnanthera*	N										
GG	*Aristida jerichoensis*	N	0.5	20			0.1	2			0.5	1
GG	*Austrostipa rudis subsp. nervosa*	N							30	100	15	100
GG	*Austrostipa sp*	N			0.5	3	0.5	2				
SG	*Bossiaea heterophylla*	N										
SG	*Brachyloma daphnoides*	N										
FG	*Brachyscome spathulata*	N										
OG	*Billardiera scandens*	N										

GF Code	Species Name	N, HTE, Non-HTE	R1		R2		R3		R4		R5	
FG	*Caladenia spp*	N										
SG	*Callistemum linearis*	N										
SG	*Cassinia aculeata*	N							20	100		
SG	*Cassinia arcuata*	N	5	30	1.6	30	10	30	1.8		25	100
SG	*Cassinia spp.*	N					4	10				
N/A	*Centaurium erythraea*	Non-HTW	1	30	0.2	20					0.5	
N/A	*Cirsium vulgare*	Non-HTW			0.3	6	0.5	5				
FG	*Coronidium scorpioides*	N										
N/A	*Conyza spp.*	Non-HTW	0.5	20	0.3				0.5	2		
SG	*Daviesia alata*	N										
N/A	*Dactylis glomerata*	Non-HTW					0.9		1	10		
GG	*Deyeuxia quadriseta*	N					1	3				
FG	*Dianella revoluta*	N										
FG	*Dianella spp.*	N										
SG	*Dillwynia phylicoides*	N			0.1		3	7			3	20
FG	*Diuris sulphurea*	N										
FG	*Diuris spp*	N										
FG	*Drosera peltata*	N										
N/A	*Eragrostis curvula*	HTW			0.5	1			0.1			

GF Code	Species Name	N, HTE, Non-HTE	R1		R2		R3		R4		R5	
TG	*Eucalyptus aggregata*	N	10	1								
TG	*Eucalyptus dives*	N										
TG	*Eucalyptus macrorhyncha*	N										
TG	*Eucalyptus mannifera*	N	5	1								
TG	*Eucalyptus pauciflora*	N										
TG	*Eucalyptus punctata*	N									2	1
TG	*Eucalyptus racemosa*	N									10	3
TG	*Eucalyptus stellulata*	N										
TG	*Eucalyptus viminalis*	N	20	5		7	5	3				
TG	*Eucalyptus sp.*	N									5	1
FG	*Euchiton sphaericus*	N	0.5		0.1	50						
FG	*Geranium solanderi*	N					0.5	1				
OG	*Glycine tabacina*	N							0.1	1		
SG	*Gompholobium huegelii*	N										
FG	*Gonocarpus tetragynus*	N	5	200	0.3	200	1		0.5	5	3	20
FG	*Goodenia bellidifolia*	N									0.5	1

GF Code	Species Name	N, HTE, Non-HTE	R1		R2		R3		R4		R5	
FG	*Goodenia hederacea*	N										
FG	*Haloragis heterophylla*	N			0.2	5						
OG	*Hardenbergia violacea*	N									2	4
SG	*Hibbertia sp*	N										
SG	*Hibbertia obtusifolia*	N					2	5	0.5	1		
FG	*Hovea heterophylla*	N					0.1					
FG	*Hydrocotyle laxiflora*	N					0.5	10				
FG	*Hypericum gramineum*	N										
N/A	*Hypericum perforatum*	HTW/Priority	2	50	0.1	40	0.1					
N/A	*Hypochaeris glabra*	Non-HTW										
N/A	*Hypochaeris radicata*	Non-HTW	2	100	0.6	60	3	50	0.1		0.5	3
FG	*Lagenophora gracilis*	N										
SG	*Leptospermum polygalifolium*	N									2	1
SG	*Lissanthe strigosa*	N										
GG	*Lomandra confertifolia*	N					0.1					
GG	*Lomandra glauca*	N					0.5					

GF Code	Species Name	N, HTE, Non-HTE	R1		R2		R3		R4		R5	
GG	*Lomandra filiformis*	N					0.1					
GG	*Lomandra multiflora*	N										
GG	*Lomandra spp.*	N										
N/A	*Lysimachia arvensis*	Non-HTW	0.5		0.1		0.1	5	0.5	10		
GG	*Microlaena stipoides var. stipoides*	N					2.1		5	60	5	50
SG	*Mirbelia platylobioides*	N			1	1						
N/A	*Nassella trichotoma*	HTW/Priority			1	30			0.5			
FG	*Opercularia diphylla*	N										
FG	*Oxalis perennans*	N	1		0.1	20	0.1					
FG	*Oxalis exilis*	N	1		1.1	20	0.1	20				
SG	*Ozothamnus diosmifolius*	N										
FG	*Patersonia sericea*	N										
N/A	*Plantago lanceolata*	Non-HTW					0.1					
SG	*Platysace ericoides*	N										
GG	*Poa labillardierei var. labillardierei*	N	2	10			2	20				
GG	*Poa sieberiana*	N	2	10	1	20	5	50			2	10

GF Code	Species Name	N, HTE, Non-HTE	R1		R2		R3		R4		R5	
FG	*Poranthera microphylla*	N			0.5	3					0.5	1
SG	*Pultenaea subspicata*	N			0.1	4					5	20
N/A	*Rubus fruiticosus*	HTW/Priority	1		0.1	5	1	10	3			
SG	*Rubus rosifolius*	N					1	10	0.1			
SG	*Rubus spp*	N										
GG	*Rytidosperma carphoides*	N	0.5									
GG	*Rytidosperma monticola*	N			2						20	200
GG	*Rytidosperma pallidum*	N					0.5					
GG	*Rytidosperma racemosum*	N			6.4		2.1					
GG	*Rytidosperma spp.*	N					1.7		10	100	0.3	
SG	*Rhytidosporum procumbens*	N										
GG	*Schoenus apogon*	N	2	30	0.1		1	20			2	30
FG	*Senecio diaschides*	N					0.2					
FG	*Senecio quadridentatus*	N	0.1		0.1	5						
N/A	*Sonchus asper*	Non-HTW					0.1					
FG	*Stylidium graminifolium*	N										
GG	*Themeda triandra*	N									1	10

GF Code	Species Name	N, HTE, Non-HTE	R1		R2		R3		R4		R5	
N/A	*Trifolium dubium*	Non-HTW					0.1					
FG	*Viola betonicifolia*	N					0.5	3				
FG	*Viola hederacea*	N										
FG	*Veronica calycina*	N	2	10	0.3	5	0.5	10	1	10		
N/A	*Vulpia bromoides*	Non-HTW	0.2		1							
FG	*Wahlenbergia communis*	N										
FG	*Xerochrysum bracteatum*	N										

Table C2 Flora species list for R6, R8, R9, A1 and A2 during 2022 monitoring

GF Code	Species Name	N, HTE, Non-HTE	R6		R8		R9		A1		A2	
			Foliage Cv	Abundance	Foliage Cv	Abundance	Foliage Cv	Abundance	Foliage Cv	Abundance	Foliage Cv	Abundance
SG	*Acacia baileyana*	Non-HTW										
SG	*Acacia buxifolia subsp. buxifolia*	N			1	2						
TG	*Acacia dealbata*	N	3	4							1	1
TG	*Acacia decurrens*	N			1	2	5	10				
SG	*Acacia rubida*	N	25	20	5	10	10	20				
SG	*Acacia filicifolia*	N			1	2	2	4				
FG	*Acaena ovina*	N										

GF Code	Species Name	N, HTE, Non-HTE	R6		R8		R9		A1		A2	
SG	*Allocasuarina gymnanthera*	N			10	30	10	30				
GG	*Aristida jerichoensis*	N	1	10	2	20						
GG	*Austrostipa rudis subsp. nervosa*	N	20	100	1	10						
GG	*Austrostipa sp*	N										
SG	*Bossiaea heterophylla*	N									0.1	1
SG	*Brachyloma daphnoides*	N					2	5			2	10
FG	*Brachyscome spathulata*	N							0.5	5	1	10
OG	*Billardiera scandens*	N	0.5	1							0.1	1
FG	*Caladenia spp*	N							1	5		
SG	*Callistemum linearis*	N			2	1	2	1				
SG	*Cassinia aculeata*	N										
SG	*Cassinia arcuata*	N	2		1	10	3	20	1	3	10	40
SG	*Cassinia spp.*	N										
N/A	*Centaurium erythraea*	Non-HTW										
N/A	*Cirsium vulgare*	Non-HTW										
FG	*Coronidium scorpioides*	N					1	10			2	30
N/A	*Conyza spp.*	Non-HTW										
SG	*Daviesia alata*	N			1	1						

GF Code	Species Name	N, HTE, Non-HTE	R6		R8		R9		A1		A2	
N/A	*Dactylis glomerata*	Non-HTW										
GG	*Deyeuxia quadriseta*	N										
FG	*Dianella revoluta*	N							5	50		
FG	*Dianella spp.*	N					0.5	2				
SG	*Dillwynia phylicoides*	N	3	15	5	10	2	10	1	3	5	50
FG	*Diuris sulphurea*	N							2	10		
FG	*Diuris spp*	N									0.5	2
FG	*Drosera peltata*	N	0.1	1								
N/A	*Eragrostis curvula*	HTW										
TG	*Eucalyptus aggregata*	N										
TG	*Eucalyptus dives*	N									25	10
TG	*Eucalyptus macrorhyncha*	N	3	1	5	1	3	2	10	3		
TG	*Eucalyptus mannifera*	N							10	10	20	7
TG	*Eucalyptus pauciflora*	N	5	1	10	15	10	5				
TG	*Eucalyptus punctata*	N										
TG	*Eucalyptus racemosa*	N	10	3	5	2	10	5	10	10		
TG	*Eucalyptus stellulata*	N	2	1								

GF Code	Species Name	N, HTE, Non-HTE	R6		R8		R9		A1		A2	
TG	*Eucalyptus viminalis*	N			3	4	5	3				
TG	*Eucalyptus sp.*	N										
FG	*Euchiton sphaericus*	N					0.5	10				
FG	*Geranium solanderi*	N										
OG	*Glycine tabacina*	N										
SG	*Gompholobium huegelii*	N	5	20							2	10
FG	*Gonocarpus tetragynus*	N			2	30	1	10	1	20	1	20
FG	*Goodenia bellidifolia*	N	2	30	1	20	1	10	1	10		
FG	*Goodenia hederacea*	N			0.1	1	2	40			1	30
FG	*Haloragis heterophylla*	N	2	4								
OG	*Hardenbergia violacea*	N			0.5	1	2	5	1	4		
SG	*Hibbertia sp*	N			0.5	1						
SG	*Hibbertia obtusifolia*	N					2	10	2	10	2	10
FG	*Hovea heterophylla*	N							0.5	1	2	20
FG	*Hydrocotyle laxiflora*	N										
FG	*Hypericum gramineum*	N					0.1	1	0.5	5		
N/A	*Hypericum perforatum*	HTW/Priority										

GF Code	Species Name	N, HTE, Non-HTE	R6		R8		R9		A1		A2	
N/A	*Hypochaeris glabra*	Non-HTW							1	10		
N/A	*Hypochaeris radicata*	Non-HTW	0.5		0.1		0.1		1		1	
FG	*Lagenophora gracilis*	N					0.1	1				
SG	*Leptospermum polygalifolium*	N	5	5	25	50	5	10				
SG	*Lissanthe strigosa*	N					0.5	1	1	1		
GG	*Lomandra confertifolia*	N			0.1							
GG	*Lomandra glauca*	N										
GG	*Lomandra filiformis*	N			1	5			10	100	5	100
GG	*Lomandra multiflora*	N			1	2						
GG	*Lomandra spp.*	N	1	5			0.1	1				
N/A	*Lysimachia arvensis*	Non-HTW										
GG	*Microlaena stipoides var. stipoides*	N	1	10	1	10	1	20				
SG	*Mirbelia platylobioides*	N	2	10	2	5	2	10	1	1	2	10
N/A	*Nassella trichotoma*	HTW/Priority										
FG	*Opercularia diphylla*	N			1	2	1	3			1	2
FG	*Oxalis perennans*	N										

GF Code	Species Name	N, HTE, Non-HTE	R6		R8		R9		A1		A2	
FG	*Oxalis exilis*	N					0.1	1				
SG	*Ozothamnus diosmifolius*	N									10	40
FG	*Patersonia sericea*	N	5	10	1	3	3	20			2	10
N/A	*Plantago lanceolata*	Non-HTW										
SG	*Platysace ericoides*	N							1	10		
GG	*Poa labillardierei var. labillardierei*	N										
GG	*Poa sieberiana*	N	10	100	10	50	15	100	20	100	5	20
FG	*Poranthera microphylla*	N			2	10	1	10	1	5	1	5
SG	*Pultenaea subspicata*	N	2	10	2	5	2	10	1	1	1	3
N/A	*Rubus fruiticosus*	HTW/Priority										
SG	*Rubus rosifolius*	N										
SG	*Rubus spp*	N							0.5	1		
GG	*Rytidosperma carphoides*	N										
GG	*Rytidosperma monticola*	N	10	40								
GG	*Rytidosperma pallidum*	N					1	5	20	100	20	100
GG	*Rytidosperma racemosum*	N	0.7									

GF Code	Species Name	N, HTE, Non-HTE	R6		R8		R9		A1		A2	
GG	*Rytidosperma spp.*	N			1	10						
SG	*Rhytidosporum procumbens*	N			0.1	1					0.1	1
GG	*Schoenus apogon*	N	1	30	2	20	0.5	5				
FG	*Senecio diaschides*	N										
FG	*Senecio quadridentatus*	N										
N/A	*Sonchus asper*	Non-HTW										
FG	*Stylidium graminifolium*	N	2	30	3	30	3	30				
GG	*Themeda triandra*	N	1	3								
N/A	*Trifolium dubium*	Non-HTW										
FG	*Viola betonicifolia*	N					0.5	10				
FG	*Viola hederacea*	N			0.5	5						
FG	*Veronica calycina*	N										
N/A	*Vulpia bromoides*	Non-HTW										
FG	*Wahlenbergia communis*	N							0.5	5		
FG	*Xerochrysum bracteatum*	N									2	30

APPENDIX D:

BAM Attribute Scores for SCS Monitoring Plots for 2022

Table D1 BAM attribute scores across SCS monitoring plots in 2022

	Rehabilitation								Control	
	R1	R2	R3	R4	R5	R6	R8	R9	A1	A2
Native plant species richness (total confirmed native species)	18	21	31	13	20	27	36	37	25	27
Number of Tree Species	4	2	2	1	3	5	5	5	3	3
Number of Shrub Species	2	5	5	5	5	6	13	12	8	10
Number of Grass grass like	5	5	13	3	8	9	9	5	3	3
Number of forb	7	9	10	2	3	5	8	13	9	10
Number of fern	0	0	0	0	0	0	0	0	0	0
Number other	0	0	0	1	1	1	1	1	1	1
Native over- storey cover (%)	40	15	20	10	12	23	24	33	30	26
Native shrub cover (%)	20.2	2.8	40	44.3	45	39	33	40.5	8.5	34.1
Native groundcover (grasses) (%)	8.5	9.5	34.9	45	45.9	25	21.7	17.6	30	30.1
Native forb cover (%)	9.4	4.7	5.2	1.5	4	13.2	10.6	16.8	13	13.5
Native fern Cover (%)	0	0	0	0	0	0	0	0	0	0
Native groundcover (other) (%)	0	0	0	0.1	2	0.5	6	2	1	0.1
Exotic plant cover %	7.2	4.2	5.9	7.7	1	0.5	0.1	0.1	2	1
Leaf Litter / Cryptogram / Rock %	56.2	55	24.4	33.2	46.4	59.6	55.4	45.6	58.2	49.4
Bare ground %	17.2	5.6	9.2	17.4	12.2	17.2	26	6.4	5.2	5.2
Trees with hollows	0	0	0	0	0	0	0	0	5	8

	Rehabilitation								Control	
	R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R8**	**R9**	**A1**	**A2**
Total length of fallen logs (m)	0	0	0	0	0	2	0	0	30	20
Over-storey regeneration	13	9	6	1	6	24	28	23	38	14
VI Scores	**57.1**	**43.1**	**55.4**	**36.8**	**48.1**	**62.5**	**64.4**	**64.6**	**81.4**	**84.7**

APPENDIX E:

Soil Chemistry Analysis

THE MICROBIAL CHARACTERISATION OF WESTERN (SPRINGVALE) COAL SERVICES – SPRING 2022





Report prepared for:
SLR Consulting Australia Pty. Ltd.

Report prepared by:
Dr Howard Wildman
Microbial Management Systems
6 Marion Crescent
Lapstone
NSW 2773
(www.microbeman.com.au)

11th December 2022

Microbial Management Systems

Building microbial communities

Table of Contents

1 Background....3
2 Scope of Work....3
3 Methods....3
4 Results....4
4.1 Soil Characterisation & Moisture....4
4.2 Microbial Community Measurements....6
5 Summary....9
6 References....9
7 Appendix....10

Disclaimer

The information contained in this document remains confidential as between Microbial Management Systems, SLR Consulting Australia Pty. Ltd. and Springvale Coal Pty. Ltd.

Any information provided in this document is provided having regard to the prevailing environmental conditions at the time of giving that information, the relevance and accuracy of which may be materially affected by a change in environmental conditions after the date that information was given. Microbial Management Systems disclaims any liability to any person in respect of anything or the consequences of anything done or omitted to be done in reliance upon the information contained in this document.

1 Background

The major goal of rehabilitating land subject to open-cut mining is the re-establishment of a self-sustaining vegetative cover. A successful vegetation cover will then provide source material for nutrient cycling. As decomposers, soil microbial communities mediate critical ecosystem processes, and microorganisms are an important element for successful reclamation because of their role in nutrient cycling, plant establishment, geochemical transformations and soil formation. A soil's microbiological status may be utilised as a primary indicator of its biological properties and of the overall soil quality development over time.

As indicators of soil biological health, the status of soil microbial populations at several of Centennial Coal's mines have been tracked since 2007 using a number of metrics which summarise the status of the microbial communities through measurements of microbial numbers and community functionality (Microbial Management Systems, 2012). Analyses of the accumulated data has allowed identification of a simple metric which readily distinguishes soils at different stages of and in different types of mine rehabilitation. This metric is a reliable and cost effective measure of the biological health and quality of rehabilitating mine soils. Furthermore, it can be augmented in subsequent years with more comprehensive microbial monitoring in order to confirm the soil microbial population stability and biological health over time.

2 Scope of Work

As a part of its ongoing rehabilitation commitments (Centennial Coal Rehabilitation Management Plan for Large Mines – Springvale Coal Services, 2022) soil microbial population monitoring was undertaken in spring 2022 to provide information on the decomposer microbial communities of the rehabilitation site soils at Western (Springvale) Coal Services. The sites examined are shown in Table 1 and photographs of the sites are provided in Figures A1 and A2 of the Appendix.

The rehabilitation sites had associated analogue site controls (Table 1).

Table 1: Western (Springvale) Coal Services soils sampled in spring 2022.

Western (Springvale) Coal Services sites	Sitecode
Analogue site 1	WCS A1
Analogue site 2	WCS A2
Rehabilitation site 1	WCS R1
Rehabilitation site 4	WCS R4
Rehabilitation site 6	WCS R6
Rehabilitation site 9	WCS R9

3 Methods

Soil samples were collected by SLR Consulting personnel on 15nd and 16rd November 2022.

Soil cores were collected from three points along the 50m centreline within the monitoring plots. The soil was sampled using an Arborline push tube soil corer to collect 0 – 10cm of soil. Cores were taken after scraping away any leaf litter, plant material or thatch covering the soil surface. These samples were then consolidated into a single sample and stored in zip-lock plastic bags in a cool place before processing to keep them field moist and to preserve biological properties. The soil samples were processed within 9 days of sampling.

Moisture contents were determined after drying several grams of the soil sample for 3 hours at 100°C. The soil moisture contents were used to adjust all microbial number counts to a standard count per gram dry weight of soil. Water activity measurements were also determined using a Decagon Devices pAwkit water activity meter (Graintec Pty Ltd, Qld). It is generally accepted that the water requirements of microorganisms should be defined in terms of the water activity (Aw) rather than the water content of their growth substrate. Aw is a thermodynamic parameter defined in relation to the chemical potential of water and represents the availability of water for reaction in the growth substrate. The reduction of Aw has a marked effect on microbial growth.

Standardised sample treatments and isolation media were utilized to distinguish the numbers of different populations of mesophilic and mesotolerant bacteria, actinomycetes and fungi. These microorganisms grow typically between 15 and 40°C. The dilution plating method was utilized as it is simple and rapid, gives repeatable results, and yields excellent comparable data. Although plate counts represent only a small portion of the total microorganisms in the sample, they provide a relative measure of cultivable microbial numbers between samples. Viable bacterial and fungal populations were determined by plating the inoculum onto selective bacterial and fungal isolation media followed by incubation at 25°C. The microorganisms were grouped into broad ecological and taxonomic categories for analysis. The categories examined include copiotrophic (rapidly growing) and oligotrophic (resource-limited adapted) bacteria and actinomycetes (filamentous bacteria that are important for the decomposition of complex substrates), filamentous fungi and yeasts.

All data analyses were undertaken using the SYSTAT 11 statistical package (SYSTAT Software Inc, Illinois, USA) and reported differences are statistically significant.

4 Results

4.1 Soil Characterisation & Moisture

The relationship between moisture content and water activity (Aw) is unique to each soil due to its physical and chemical nature and its organic matter content. The WCS soils had varying organic matter contents as can be seen by their different colours (Wills *et al.*, 2007) (Figure 1), and varying soil textures as seen in their different sedimentation rates (Figure 2). The analogue soils had faster sedimentation rates than the rehabilitation soils which indicated their coarser soil texture (Figure 2).

The moisture contents of the soils were high due to above-average rains prior to sampling (Figure 3).

In general, bacteria require higher values of water activity (Aw) for growth than fungi, thereby enabling fungi to compete more successfully at low Aw values. The majority of bacteria need water activity values greater than 0.98 for growth and few bacteria grow at less than 0.90. A number of fungi have minimum growth Aw values between 0.8 and 0.9. The water activities of all the soils were 1.00, indicating that they were not water limited at the time of sampling and that their soil microbial communities would be expected to be growing and functional with respect to their undertaking ecosystem processes.

Figure 1: Fresh soils at field moisture. WCS A1 and WCS A2 sites (top, left to right). WCS R1, WCS R4, WCS R6 and WSC R9 sites (bottom, left to right).



Figure 2: Soil sedimentation of a 10^{-1} dilution after several days settling. Left to right WCS A1, WCS A2, WCS R1, WCS R4, WCS R6 and WSC R9 sites .

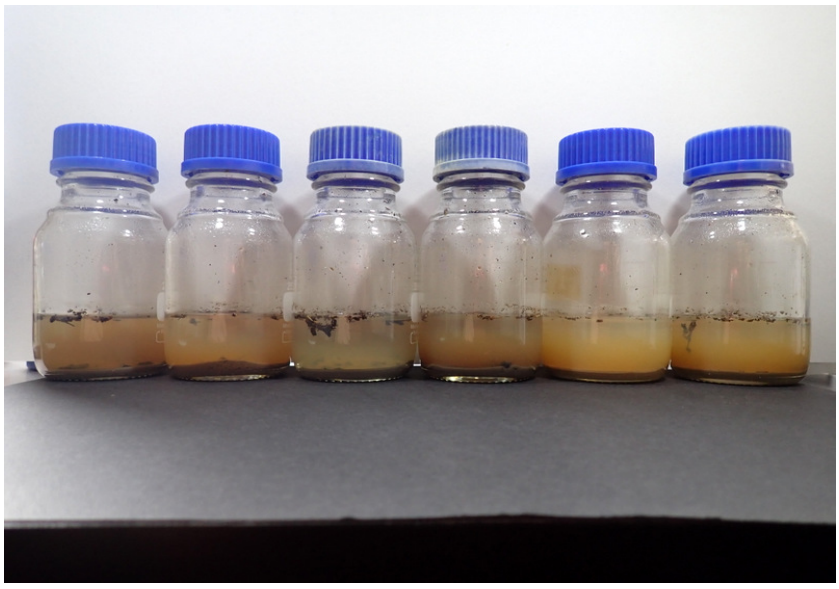
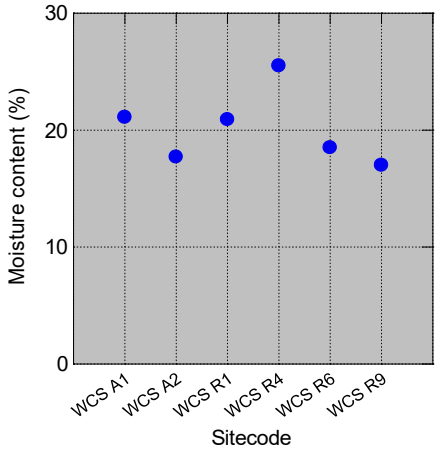


Figure 3: Scatter plot of moisture contents of WCS soil samples in spring 2022.



4.2 Microbial Community Measurements

There were greater differences in non-filamentous bacterial numbers between the soils than actinomycete and fungal numbers (Figure 4).

Two primary indicators of the status of microbial populations in the soils are the ratio of actinomycetes to non-filamentous bacterial colonies on soil dilution plates, a bio-indicator of the degree of soil disturbance; and the proportion of copiotrophic (fast-growing) bacteria, a bio-indicator of the level of labile soil organic carbon (Figure 5). Bacterial numbers often exhibit a rise with soil disturbance due to a flush of readily-utilisable nutrients associated with the disturbance; however actinomycete numbers can decline or remain unchanged with soil disturbance. Actinomycete: bacteria ratios of >0.2 are expected in undisturbed soils such as native vegetation, grassy woodlands or pasture soils, where values can often be >0.3. Labile carbon breaks down relatively quickly and is the major food source for soil microbes. Soils with a greater percentage of organic matter present as a labile pool are more biologically active with greater potential for nutrient turnover.

Figure 4: Mean microbial numbers as colony forming units (CFU) per gram dry weight of soil as determined by plating samples onto selective isolation media (± standard error).

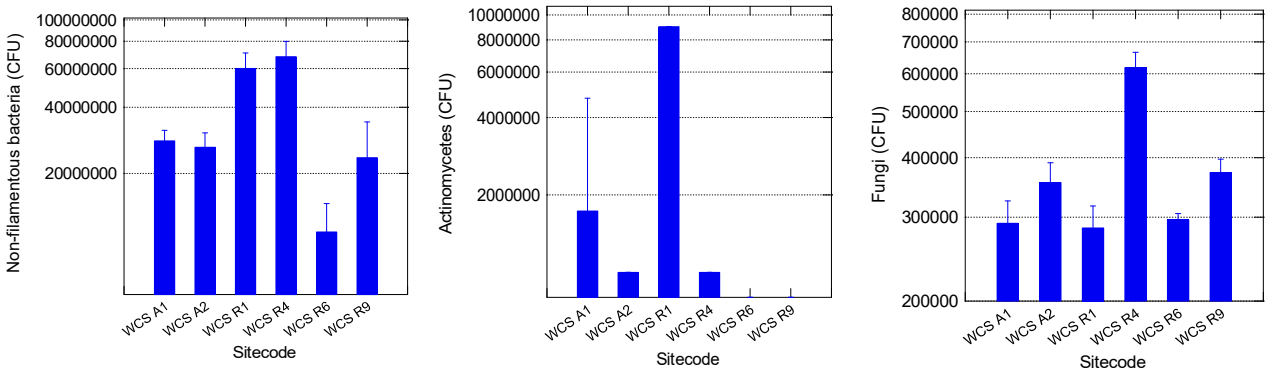
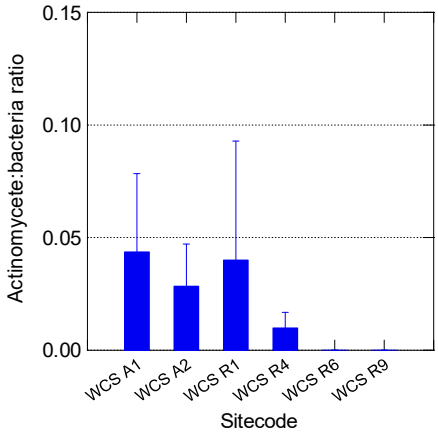
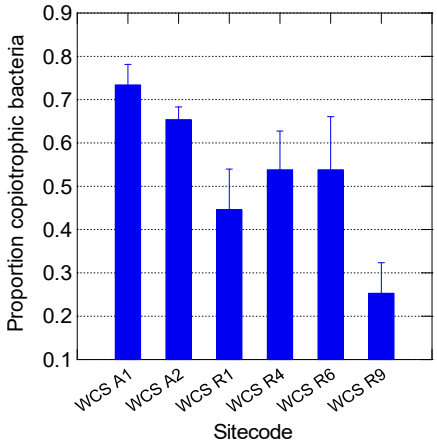


Figure 5: Actinomycete:Bacteria ratio (left) and the proportion of copiotrophic (rapidly growing) bacteria (right) (± standard error).





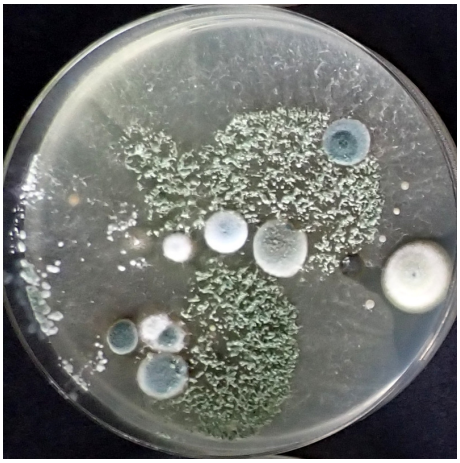
There was no significant difference between the actinomycete:bacteria ratios of the soils and their values were below the 0.2 that might be expected in undisturbed soils (Figure 5). However, during over 15 years of monitoring mine sites in NSW, it has been observed that in years when soil moisture contents are very high, as is the case on the WCS sites, that non-filamentous bacterial numbers in native soils can disproportionately increase relative to actinomycete numbers resulting in actinomycete:bacteria ratios being lower than expected. However, even in these circumstances the actinomycete:bacteria ratios of native soils are generally higher than those of disturbed rehabilitation sites. Thus the decomposer microbial communities of the WCS rehabilitation site soils were thought to be similar to those of the analogue communities.

There was no significant differences in the proportion of copiotrophic bacteria between soils (Figure 5) and the values were in the range observed in some native vegetation, grassy woodlands and pasture soils.

Table 2: Presence of *Trichoderma* on dilution plates. +/- Trichoderma = number of plates (-=0, +=1, ++=2, +++=3) where the fungus *Trichoderma* is present. Darker shading indicates higher values.

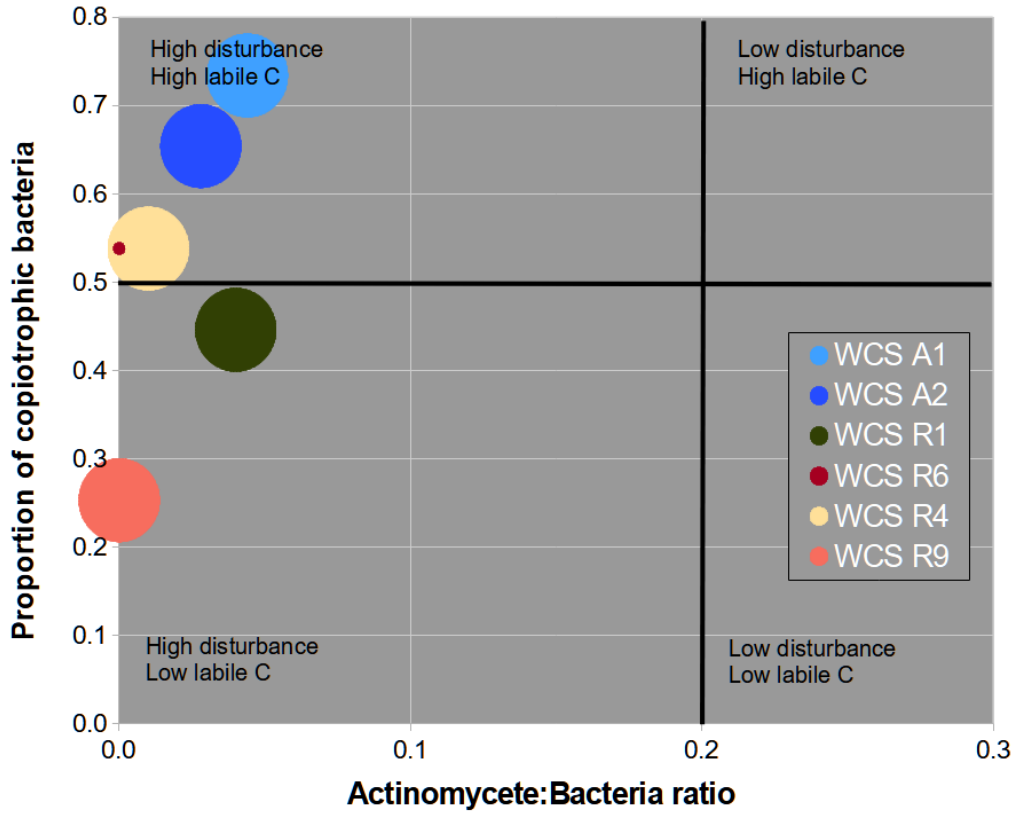
Site	+/- Trichoderma
WCS A1	+++
WCS A2	+++
WCS R1	+++
WCS R4	+++
WCS R6	-
WCS R9	+++

Figure 6: Photograph of 10^{-3} dilution plate after 6 days incubation at 25°C when plated onto MEA. *Trichoderma* is the large green colony covering the plate.



An increased presence of the fungus *Trichoderma* indicates significant amounts of plant cellulosic substrates in soils. In addition, *Trichoderma* is generally more common in native than rehabilitating soils due to their greater plant cellulosic substrate content from organic matter inputs in the form of leaf litter and/or increasing grass cover. *Trichoderma* colonies were common in all the soils with the exception of the WCS R6 site (Table 2 & Figure 6) which may have lacked these organic matter inputs (Figure A2).

Figure 7: Bubble chart of the soil microbial community status of the WCS sites in spring 2022 using the metric measurements:
1) the actinomycete:bacteria ratio (lower values are associated with increased soil disturbance),
2) the proportion of copiotrophic bacteria (higher values are associated with increased labile soil organic carbon), and
3) the presence of the fungus *Trichoderma* (an indicator of significant amounts of plant cellulosic substrates in soils). The size of the bubble is proportional to the number of plates where *Trichoderma* was present.



Monitoring of a number of mine sites and grazing pastures over many years has allowed identification of a simple metric which readily distinguishes soils at different stages of and in different types of mine rehabilitation (Figure 7). The graph can be divided into 4 sectors – High disturbance/High labile carbon, Low disturbance/High labile carbon, Low disturbance/Low labile carbon, and High disturbance/Low labile carbon. Native and revegetated sites are characterised as having undisturbed microbial communities and can have either high or low labile carbon characteristics depending on

their soil type and vegetation. Sites undergoing rehabilitation are usually characterised as having highly disturbed microbial communities and low labile carbon. The presence of the fungus *Trichoderma* as an indicator of the amount of plant cellulosic substrates in soils is overlaid on the graph.

The three microbial bio-indicators ordinarily provide a clear separation of native and rehabilitating soils when plotted as a bubble chart (Figure 7) but the lack of separation between sites indicated that the decomposer microbial communities of the rehabilitation site soils were similar to those of the analogue soils.

5 Summary

The moisture contents of the WCS soils were high due to above-average rains prior to sampling.

Microorganisms are often water limited in soils and rely on the windows of opportunity provided by rainfall to function. But the above-average rainfall prior to sampling ensured that all soils had maximum water activity values and the top 10cm of the soils was not considered to be water limited at the time of sampling. As such, their soil microbial communities would have been growing and functional with respect to their undertaking ecosystem processes.

A metric determining the status of the decomposer microbial communities of the rehabilitation site soils (WCS R1, WCS R4, WCS R6, WCS R9) showed them to be similar to those of the analogue site soils (WCS A1, WCS A2).

6 References

Centennial Coal Rehabilitation Management Plan for Large Mines – Springvale Coal Services (2022). 105pp.

Microbial Management Systems (2012). The microbial characterisation of soils at Charbon Coal Mine 2007- 2012. Report for Charbon Coal Pty. Ltd. 35 pp.

Wills, SA, Burras, CL & Sandor, JA (2007). Prediction of soil organic carbon content using field and laboratory measurements of soil color. Soil Science Society America Journal 71: 380-388.

7 Appendix

Figure A1: Pit Top sites WCS A1 (Control, left) and WCS A2 (Control, right).





Figure A2: WCS R1 (Rehab, top left), WCS R4 (Rehab, top right), WCS R6 (Rehab, bottom left) and WCS R9 (Rehab, bottom right).









APPENDIX F:

Microbial Soil Analysis

Southern Cross University
PO Box 157 Lismore NSW 2480
P: +61 2 6620 3678
E: eal@scu.edu.au
www.scu.edu.au/eal
ABN: 41 995 651 524

AGRICULTURAL SOIL ANALYSIS REPORT

10 samples supplied by SLR Consulting Australia Pty Ltd on 21/11/2022. Lab Job No.N4810

Analysis requested by Murray Fraser. Your Job: SLR 630.30428 Springvale Coal Services

10 Kings Road NEW LAMBTON NSW 2305

			Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
		Sample ID:	WCS R1	WCS R2	WCS R3	WCS R4	WCS R5
		Crop:	N/G	N/G	N/G	N/G	N/G
		Client:	Centennial	Centennial	Centennial	Centennial	Centennial
	Parameter	Method reference	N4810/1	N4810/2	N4810/3	N4810/4	N4810/5
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.17	7.15	6.08	5.51	5.55
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.033	0.319	0.047	0.053	0.025
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	7.3	17	7.5	6.5	1.8
	Exchangeable Calcium (kg/ha)		3,269	7,450	3,348	2,904	819
	Exchangeable Calcium (mg/kg)		1,459	3,326	1,495	1,297	366
	Exchangeable Magnesium (cmol+/kg)		2.1	3.1	2.8	2.4	1.2
	Exchangeable Magnesium (kg/ha)		572	838	774	661	316
	Exchangeable Magnesium (mg/kg)		255	374	345	295	141
	Exchangeable Potassium (cmol+/kg)		0.37	0.43	0.68	0.79	0.38
	Exchangeable Potassium (kg/ha)		324	373	600	692	331
	Exchangeable Potassium (mg/kg)		144	166	268	309	148
	Exchangeable Sodium (cmol+/kg)		<0.065	0.09	<0.065	<0.065	<0.065
	Exchangeable Sodium (kg/ha)		<33	44	<33	<33	<33
	Exchangeable Sodium (mg/kg)		<15	20	<15	<15	<15
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.01	0.01	0.01	0.51	1.4
	Exchangeable Aluminium (kg/ha)		2.5	2.0	2.5	103	287
	Exchangeable Aluminium (mg/kg)		1.1	<1	1.1	46	128
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.04	<0.01	0.04	0.20	0.48
	Exchangeable Hydrogen (kg/ha)		<1	<1	<1	4.5	11
	Exchangeable Hydrogen (mg/kg)		<1	<1	<1	2.0	4.8
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	9.8	20	11	10	5.3
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	74	82	68	62	34
	Magnesium (%)		21	15	26	23	22
	Potassium (%)		3.8	2.1	6.2	7.6	7.1
	Sodium - ESP (%)		0.45	0.43	0.12	0.30	1.2
	Aluminium (%)		0.13	0.05	0.11	4.9	27
	Hydrogen (%)		0.38	0.00	0.34	1.9	9.1
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	3.5	5.4	2.6	2.7	1.6
	Total Organic Carbon (%)	LECO Trumac Analyser - Inhouse S15b	4.86	8.71	4.36	9.05	2.77
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10YR 2/1 Black	7.5YR 2.5/1 Black	10YR 3/1 Very Dark Gray	7.5YR 2.5/1 Black	7.5YR 3/2 Dark Brown
	Mottles Munsell Colour		10YR 6/1 Gray	7.5YR 5/6 Strong Brown	..	..	..
	Degree of Mottling (%)		7	7	..	..	..

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 cmol+/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs).
17. This report was issued on 2/12/2022.

Quality Checked: Kris Saville
Agricultural Co-Ordinator KS

Accreditation No. 14960
Accredited for compliance with ISO/IEC 17025 - Testing

CRICOS Provider: 01241G

Southern Cross University
PO Box 157 Lismore NSW 2480
P: +61 2 6620 3678
E: eal@scu.edu.au
www.scu.edu.au/eal
ABN: 41 995 651 524

AGRICULTURAL SOIL ANALYSIS REPORT

10 samples supplied by SLR Consulting Australia Pty Ltd on 21/11/2022. Lab Job No.N4810
Analysis requested by Murray Fraser. Your Job: SLR 630.30428 Springvale Coal Services
10 Kings Road NEW LAMBTON NSW 2305

			Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
		Sample ID:	WCS R6	WCS R8	WCS R9	WCS A1	WCS A2
		Crop:	N/G	N/G	N/G	N/G	N/G
		Client:	Centennial	Centennial	Centennial	Centennial	Centennial
	Parameter	Method reference	N4810/6	N4810/7	N4810/8	N4810/9	N4810/10
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.25	5.38	5.26	4.65	5.20
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.022	0.011	0.033	0.036	0.035
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.60	0.70	1.6	1.5	2.5
	Exchangeable Calcium (kg/ha)		270	313	732	678	1,120
	Exchangeable Calcium (mg/kg)		120	140	327	303	500
	Exchangeable Magnesium (cmol+/kg)		0.88	1.6	2.4	0.56	0.65
	Exchangeable Magnesium (kg/ha)		239	443	661	153	178
	Exchangeable Magnesium (mg/kg)		107	198	295	68	80
	Exchangeable Potassium (cmol+/kg)		0.29	0.27	0.38	0.30	0.42
	Exchangeable Potassium (kg/ha)		252	239	336	259	369
	Exchangeable Potassium (mg/kg)		112	107	150	116	165
	Exchangeable Sodium (cmol+/kg)		0.09	<0.065	0.08	<0.065	<0.065
	Exchangeable Sodium (kg/ha)		44	<33	42	<33	<33
	Exchangeable Sodium (mg/kg)		20	<15	19	<15	<15
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	3.2	2.5	1.6	2.1	1.3
	Exchangeable Aluminium (kg/ha)		637	507	328	424	265
	Exchangeable Aluminium (mg/kg)		285	226	146	189	118
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.95	0.76	0.58	0.99	0.50
	Exchangeable Hydrogen (kg/ha)		21	17	13	22	11
	Exchangeable Hydrogen (mg/kg)		9.5	7.6	5.8	9.9	5.0
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	6.0	5.9	6.7	5.5	5.4
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	10	12	24	27	46
	Magnesium (%)		15	28	36	10	12
	Potassium (%)		4.8	4.6	5.7	5.4	7.8
	Sodium - ESP (%)		1.4	0.62	1.2	0.65	0.10
	Aluminium (%)		53	43	24	38	24
	Hydrogen (%)		16	13	8.6	18	9.3
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	0.68	0.43	0.67	2.7	3.8
	Total Organic Carbon (%)	LECO Trumac Analyser - Inhouse S15b	1.49	1.56	2.73	3.09	3.56
	Moist Munsell Colour	**Inhouse Munsell Soil Colour Classification	10YR 4/2 Dark Grayish Brown	10YR 5/3 Brown	10YR 4/3 Brown	10YR 3/2 Very Dark Grayish Brown	7.5YR 4/3 Brown
	Mottles Munsell Colour		7.5YR 6/6, 10YR 2/1 Reddish Yellow, Black	7.5YR 6/8, 10YR 3/1 Reddish Yellow, Very Dark Gray	..	..	7.5YR 3/1 Very Dark Gray
	Degree of Mottling (%)		1,5	7,10	..	..	25

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwoo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil resu
10. Conversions for 1 cmol+/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditio
17. This report was issued on 2/12/2022.

Quality Checked: Kris Saville
Agricultural Co-Ordinator KS

GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

10 soil samples supplied by SLR Consulting Australia Pty Ltd on 21st November, 2022 - Lab Job No. N4810
Analysis requested by Murray Fraser. Job Ref SLR 630.30428 Springvale Coal Services
10 Kings Road NEW LAMBTON NSW 2305

SAMPLE ID	Lab Code	MOISTURE CONTENT (% of water in sample)	TOTAL GRAVEL > 2 mm (% of total oven-dry equivalent)	GRAVEL > 4.75 mm (% of total oven-dry equivalent)	GRAVEL 2.00-4.75 mm (% of total oven-dry equivalent)	COARSE SAND 200-2000 µm (0.2-2.0 mm) (% of total oven-dry equivalent)	FINE SAND 20-200 µm (0.02-0.2 mm) (% of total oven-dry equivalent)	SILT 2-20 µm (% of total oven-dry equivalent)	CLAY < 2 µm (% of total oven-dry equivalent)
WCS R1	N4810/1	21.2%	19.3%	10.6%	8.7%	40.0%	9.2%	12.7%	18.9%
WCS R2	N4810/2	18.3%	18.3%	8.7%	9.6%	26.4%	22.6%	12.7%	19.9%
WCS R3	N4810/3	22.7%	30.1%	15.0%	15.2%	29.8%	11.9%	11.1%	17.0%
WCS R4	N4810/4	23.6%	13.4%	5.2%	8.2%	35.5%	15.1%	9.8%	26.1%
WCS R5	N4810/5	17.9%	16.9%	8.8%	8.1%	19.2%	29.7%	10.3%	23.9%
WCS R6	N4810/6	14.5%	27.0%	20.4%	6.6%	8.0%	36.3%	4.0%	24.7%
WCS R8	N4810/7	14.3%	17.5%	7.8%	9.7%	28.9%	20.8%	13.2%	19.6%
WCS R9	N4810/8	15.6%	19.9%	10.0%	9.9%	16.1%	26.6%	11.0%	26.5%
WCS A1	N4810/9	20.8%	9.6%	4.0%	5.6%	15.3%	46.2%	11.6%	17.4%
WCS A2	N4810/10	16.9%	20.0%	4.5%	15.6%	18.4%	38.0%	7.0%	16.5%

Note:

1: The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,
modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986),
in *Methods of Soil Analysis. Part 1* Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.

2: Australian Standard 1289.3.8.1-1997 (see attached)

3. Analysis conducted between sample arrival date and reporting date.

4. This report is not to be reproduced except in full. Results only relate to the item tested.

5. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal).

6. This report was issued on 06/12/22.



checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449
E: adelaide@slrconsulting.com

BRISBANE
Level 16, 175 Eagle Street
Brisbane QLD 4000
Australia
T: +61 7 3858 4800
E: brisbane@slrconsulting.com

CAIRNS
Level 1, Suite 1.06
14 Spence Street
Cairns QLD 4870
Australia
T: +61 7 4722 8090
E: cairns@slrconsulting.com

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
E: canberra@slrconsulting.com

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
E: darwin@slrconsulting.com

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516
E: goldcoast@slrconsulting.com

MACKAY
1/25 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300
E: mackay@slrconsulting.com

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
E: melbourne@slrconsulting.com

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
E: newcastleau@slrconsulting.com

PERTH
Level 1, 500 Hay Street
Subiaco WA 6008
Australia
T: +61 8 9422 5900
E: perth@slrconsulting.com

SUNSHINE COAST
Suite 2, 14-20 Aerodrome Rd
Maroochydore QLD 4558
Australia
T: +61 7 3858 4800
E: SunshineCoast@slrconsulting.com

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
E: sydney@slrconsulting.com

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
E: townsville@slrconsulting.com

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000
E: wollongong@slrconsulting.com

AUCKLAND
201 Victoria Street West
Auckland 1010
New Zealand
T: 0800 757 695
E: auckland@slrconsulting.com

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628
E: nelson@slrconsulting.com

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186
E: wellington@slrconsulting.com

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203
E: singapore@slrconsulting.com

APPENDIX 10: ANNUAL REVIEW CHECKLIST

Table 10A-1: Annual Review Requirements

Approval	Condition No	Requirement	Where addressed in Annual Review
SSD-5579	Schedule 5 Condition 4	By the end of March each year, or other timing as may be agreed by the Secretary, the Applicant must review the environmental performance of the development to the satisfaction of the Secretary. This review must:	This Document
		(a) describe the development that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year;	Section 4 Section 12
		(b) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, which includes a comparison of these results against the: • relevant statutory requirements, limits or performance measures/criteria; • the monitoring results of previous years; the relevant predictions in the EIS;	Section 6.0 to Section 10
		(c) identify any non-compliance over the past year, and describe what actions were (or are being) taken to ensure compliance;	Section 1 and 11
		(d) identify any trends in the monitoring data over the life of the development;	Section 6 to 10
		(e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and	Section 12
		(f) describe what measures will be implemented over the next year to improve the environmental performance of the development.	Section 12
	Schedule 3 Condition 42d	Monitor and report on the effectiveness of waste minimisation and management measures in the Annual Review.	Section 6.7.2
SSD-5579	SOC No. 5.11 Surface water, groundwater, geomorphology, and aquatic	To better understand the groundwater linkages, within 12 months of Project Approval, a baseline groundwater monitoring program will be established for the Springvale Coal Services Site. The baseline groundwater monitoring program will include: i. Quarterly monitoring of water levels from a network of monitoring bores following the completion of construction; ii. Six monthly sampling of monitoring bores for field analysis of pH, EC and temperature and laboratory analysis on major ions, pH, EC, TDS, dissolved arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc; and iii. An annual review so that its capacity as an accurate predictive tool can be assessed and maintained.	Section 7.5

Approval	Condition No	Requirement	Where addressed in Annual Review
	SOC No. 10.1 Rehabilitation	Within six months of Project Approval a single Rehabilitation Plan will be prepared for the entire PAA in consultation with the Department and will include the timeframes provided within this EIS, details of the rehabilitation methods, monitoring and reporting framework. Results arising from the implementation of the program will be reported each year in the Annual Review (currently referred to as the AEMR).	Section 8.0
ML 564 PLL 133	Condition 3 Annual Environmental Management Report	(1) Within 12 months of the commencement of mining operations and thereafter annually or, at such other times as may be allowed by the Director-General, the lease holder must lodge an Annual Environmental Management Report (AEMR) with the Director-General.	This Document
		(2) The AEMR must be prepared in accordance with the Director-General's guidelines current at the time of reporting and contain a review and forecast of performance for the preceding and ensuing twelve months in terms of: (a) the accepted Mining Operations Plan; (b) development consent requirements and conditions; (c) Environment Protection Authority and Department of Land and Water Conservation licenses and approvals;	
		(d) any other statutory environmental requirements; (e) details of any variations to environmental approvals applicable to the lease area; and (f) where relevant, progress towards final rehabilitation objectives.	
		(3) After considering an AEMR the Director-General may, by notice in writing, direct the lease holder to undertake operations, remedial actions or supplementary studies in the manner and within the period specified in the notice to ensure the operations on the lease area are conducted in accordance with sound mining and environmental practice.	
		(4) The lease holder shall, as and when directed by the Minister, cooperate with the Director-General to conduct and facilitate review of the AEMR involving other government agencies.	
CL 361	Condition 4 Environment Management Reporting	The lease holder must lodge Environmental Management Reports (EMR) with the Director-General annually or at dates otherwise directed by the Director-General.	This Document
	Condition 5	The EMR must: (a) report against compliance with the MOP;	
		(b) report on progress in respect of rehabilitation completion criteria;	
		(c) report on the extent of compliance with regulatory requirements; and	

Approval	Condition No	Requirement	Where addressed in Annual Review
		(d) have regard to any relevant guidelines adopted by the Director General;	
	Condition 6	Additional environmental reports may be required on specific surface disturbing operations or environmental incidents from time to lime as directed in writing by the Director-General and must be lodged as instructed.	
CL 394 ML 204	Condition 3 Mining Operation Plan and Annual Rehabilitation Report	(f) The lease holder must prepare a Rehabilitation Report to the satisfaction of the Minister. The report must:	Section 8
		(i) provide a detailed review of the progress of rehabilitation against the performance measures and criteria established in the approved MOP;	
		(ii) be submitted annually on the grant anniversary date (or at such other times as agreed by the Minister); and	
		(iii) be prepared in accordance with any relevant annual reporting guidelines published on the Department's website at www.resources.nsw.gov.au/environment.	

In accordance with Condition 11, Schedule 5 of SSD-5579 a copy of the 2022 Annual Review, once approved by the DPE, will be provided on the WCS website https://www.centennialcoal.com.au/operations/springvale-coal-services/



Centennial Coal Company Limited
P O Box 1000
Toronto NSW 2283
www.centennialcoal.com.au