



***Centennial Coal
Springvale
ANNUAL REVIEW***

March 2024

Annual Review Title Block

Name of Operation	Springvale Colliery
Name of Operator	Centennial Coal Pty Limited
Development Consent/ Project Approval #	SSD5594
Name of holder of Development Consent/ Project Approval	Centennial Springvale Pty Limited
Mining Lease #	ML1303, ML 1323, ML 1326, part ML 1424, ML 1537, ML 1588, ML 1670, ML 1727, ML1843, MLA 497, CL 377, MPL 314, EL 6974, AUTH 460
Name of Holder of Mining Lease	Centennial Springvale Pty Ltd and Boulder Mining Pty Ltd
Water License #	10WA118719 (WAL 36383) 10BL603519 (WAL 36383) 10BL602017 (WAL 36443) 10BL601863 (WAL 36446)
Name of Holder of Water License	Centennial Springvale Pty Ltd
MOP/RMP Start Date	June 2018 (MOP), 1 August 2022 (RMP)
MOP/RMP End Date	May 2025 MOP, N/A (RMP)
Annual Review Start Date	1 January 2023
Annual Review End Date	31 December 2023
I, Kyle Egan certify that this audit report is a true and accurate record of the compliance status of Centennial Springvale for the period 1 January to 31 December 2023 and that I am authorised to make this statement on behalf of Centennial Springvale. <i>Note:</i> a) <i>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.</i> b) <i>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).</i>	
Name of Authorised Reporting Officer	Kyle Egan
Title of Authorised Reporting Officer	Springvale Mining Engineering Manager
Signature of Authorised Reporting Officer	
Date	28 March 2024

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Plan Name	Plan Reference	2023 Plan Reference
Regional Location Plan	1	SVY08454.1
Mine Production	2	SVY08454.2
Borehole Locations-Proposed	3A	SVY08454.3A
Borehole Locations-Completed	3B	SVY08454.3B
Environmental Monitoring Locations	4	SVY08454.4
Proposed Rehabilitation	5	SVY08454.5
Pit Top Vectorized Mapping	6	SVY08454.6
Pit Top Aerial	7	SVY08454.7
Final Rehabilitation	8	Figure 6 RMP
Subsidence Monitoring Locations	9	SVY08454.9
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Springvale Water Transfer System	11	SVY08454.11
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Abbreviation Table

AR	Annual Review
BAM	Beta Attenuation Mass (BAM); real time air quality monitoring system.
BCS	Biodiversity, Conservation and Science Directorate, NSW DPE
BMWS	Blue Mountains Water Skink
BMP	Biodiversity Management Plan
BOM	Bureau of Meteorology
CEPSA	Consolidated Extraction Plan Study Area (comprises multiple EP Areas)
CL	Coal Lease
CILMP	Catchment Improvement and Land Management Plan (CILMP)
CRD	Cumulative Rainfall Departure (cumulative departure from the mean rainfall)
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPHI	Department of Planning, Housing and Infrastructure
DPIE	Former NSW Department of Planning, Industry and Environment (now DPHI)
DPE	Former NSW Department of Planning & Environment (now DPHI)
DRNSW-MEG	Department of Regional NSW – Mining, Exploration & Geosciences
EEC	Endangered Ecological Community
EMMA	Extended Monitoring and Management Area (in relation to an EP)
EP	Extraction Plan
EPA	Environmental Protection Authority
EPL	Environmental Protection Licence
GDE	Groundwater Dependent Ecosystem
HHMP	Historic Heritage Management Plan
IMP	Independent Monitoring Panel
LDP	Licensed Discharge Point
ML	Mining Lease
MOP	Mining Operations Plan
NPSS	Newnes Plateau Shrub Swamps
NPHS	Newnes Plateau Hanging Swamps
THPSS MMP	Temperate Highland Peat Swamps on Sandstone (THPSS) Monitoring and Management Plan (MMP)
TIA	Trigger Investigation Area
PA	Project Approval
SSA	Soil Surface Assessment
SSD	State Significant Development
TSS	Total Suspended Solids
WMP	Water Management Plan
WR- AQGHGMP	Western Region Air Quality and Greenhouse Gas Management Plan
WR-BMP	Western Region Biodiversity Management Plan
WR-BOS	Western Region Biodiversity Offset Strategy
WR-ACHMP	Western Region Aboriginal Cultural Heritage Management Plan
WR-NMP	Western Region Noise Management Plan

1 STATEMENT OF COMPLIANCE

A summary of compliance for Centennial Springvale for the year 2023 is provided in **Table 1-1** below. There were three non-compliances during the reporting period as detailed in **Section 11**.

Table 1-1: Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
Development Consent SSD5594	Yes
Environmental Protection Licence (EPL) 3607	No
EPBC 2011/5949	Yes
EPBC 2013/6881	Yes
SMP LW411-418 (04/1673)	Yes
Mining Lease 1303	No
Mining Lease 1323	No
Mining Lease 1326	No
Mining Lease 1424 (part)	No
Mining Lease 1537	No
Mining Lease 1588	No
Mining Lease 1670	No
Mining Lease 1727	No
Coal Lease 377	No
Mining Purpose Lease 314	No
Exploration Licence 6974	Yes
Authorisation 460	Yes
Water Access Licence 36383	No
Water Access Licence 36443	Yes
Water Access Licence 36446	Yes

Table 1-2: 2023 Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Where Addressed in Annual Review
EPL367	L2.4	Water Concentration limits	Non-Compliant	Water discharged at LDP006 was non-compliant with water concentration limits.	Section 7.3.2 and Section 11
WAL36383	2	Share Component	Non-Compliant	Over extraction of share component	Section 7.1 and Section 11
CL 377 ML1303 ML 1323 ML 1326 ML 1424 ML 1537 ML 1588 ML 1670 ML 1727 MPL 314	Schedule 8A, Mining Regulation 2016	Failure to submit Rehabilitation Cost Estimate and Annual Rehabilitation Report and Forward Program by the due date.	Non-Compliant	A large mine must submit an Annual Report and Forward Program, and a Rehabilitation Cost Estimate.	Section 11

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

Centennial Springvale Mine (Springvale) is an existing underground coal mine producing high quality thermal coal which is supplied to both domestic and international markets. It is located 15 kilometres to the northwest of the regional city of Lithgow and 120 kilometres west-northwest of Sydney in New South Wales (NSW), as shown on **Figure 2-1**.

Underground mining at Springvale first commenced in 1995. The current consolidated Development Consent for Springvale was approved on 21 September 2015 by the Department of Planning and Environment¹ (DPE), now the Department of Planning, Housing and Infrastructure (DPHI) as State Significant Development (SSD) Consent 5594. This superseded DA11/92, and has been modified on four (4) occasions (refer **Section 3**). The consent allows extraction of 5.5 million tonnes of run-of-mine (ROM) coal per calendar year until 2028, utilising longwall mining methods to extract coal from the Lithgow Seam. **Figure 2-2** and **Figure 2-3** illustrate approved consent and mining lease boundaries for the mine.

Springvale comprises an underground longwall mine, the pit top, and supporting infrastructure on Newnes Plateau within the Gardens of Stone State Conservation Area. The key components of the Springvale surface facilities area comprises of administration buildings, bathhouse, workshop, mine ventilation infrastructure and coal handling infrastructure. Operational areas are illustrated on **Figure 2-4** and **Figure 2-5**.

Current mining operations undertaken have approval until 31 December 2028. All mining operations are conducted in accordance with NSW Project Approval SSD5594 (as modified).

The current mining operations are also undertaken in accordance with a range of related approvals issued under both Commonwealth and NSW legislation as outlined further in **Section 3**.

2.1 SCOPE

This Annual Review (AR) details the compliance and environmental management performance of Springvale over the Period 1 January 2023 to 31 December 2023. It has been prepared to demonstrate the sites performance and community engagement activities. The AR has been prepared in accordance with the *Annual Review Guideline* (DPIE, 2015), and satisfies the following:

- Schedule 6, Condition 12(a-f) (Annual Review) of Consent SSD5594
- Related conditions 27(c) of Schedule 4, and conditions 6(b) and 15(a) of Schedule 6, SSD5594
- Reporting requirements of Extraction Plans and relevant Management Plans

¹ References to the former Department of Planning, Industry and Environment (DPIE) have been changed throughout this document to Department of Planning and Environment (DPE).

² Refer **Appendix 1** for a checklist of annual review reporting requirements and where they have been addressed in this Annual Review

2.2 MINE CONTACTS

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

Table 2-1: Centennial Site Environmental Contact Details

Name	Position	Contact Details
Kyle Egan	Mine Manager	T: (02) 6350 1699
		E: kyle.egan@centennialcoal.com.au
Natalie Gardiner	Environment & Community Superintendent	T: (02) 6350 1620
		E: natalie.gardiner@centennialcoal.com.au
Community Information and Complaints Line		(02) 6350 1640

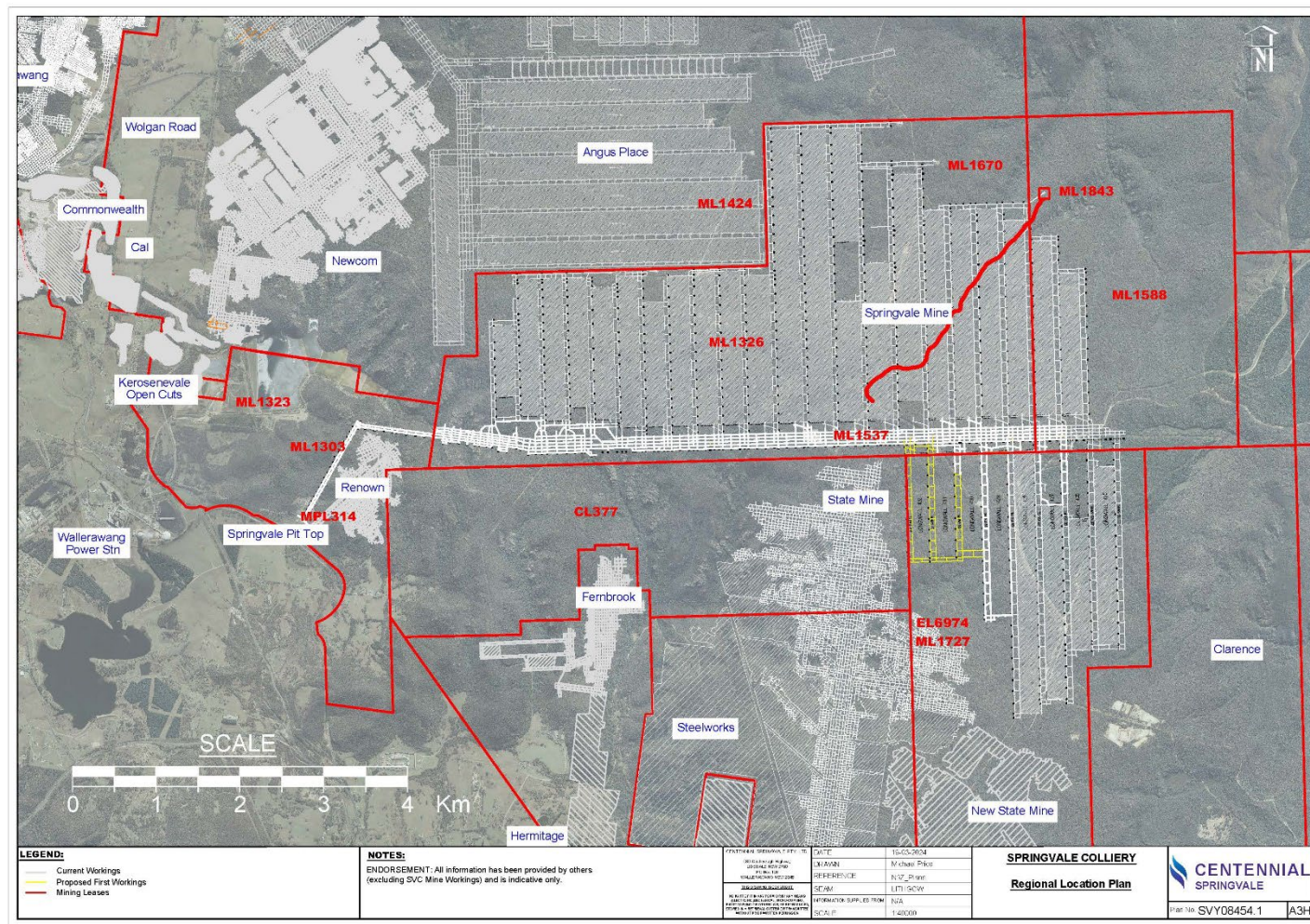


Figure 2-1. Regional Context

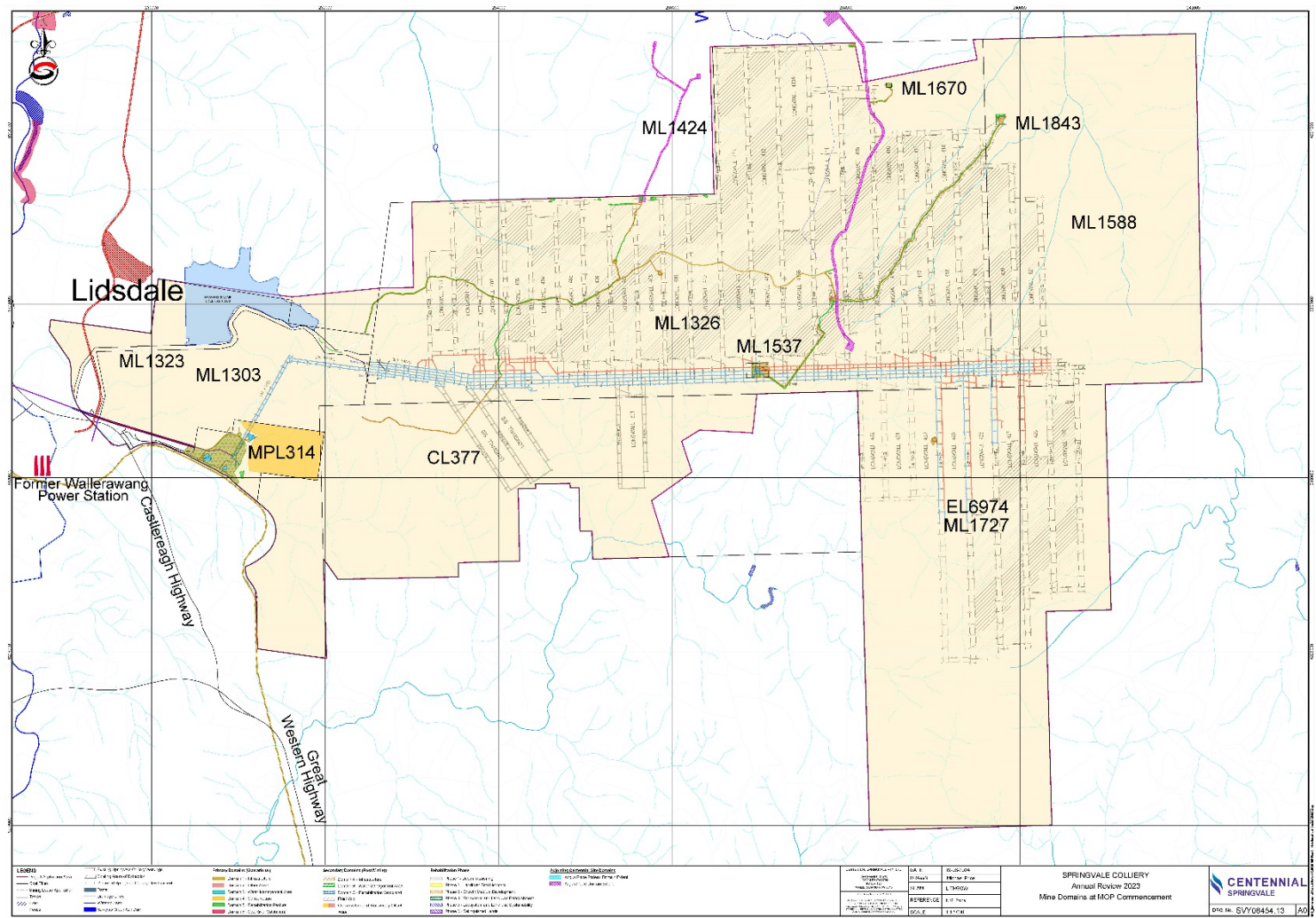


Figure 2-3. Mining Lease Boundaries

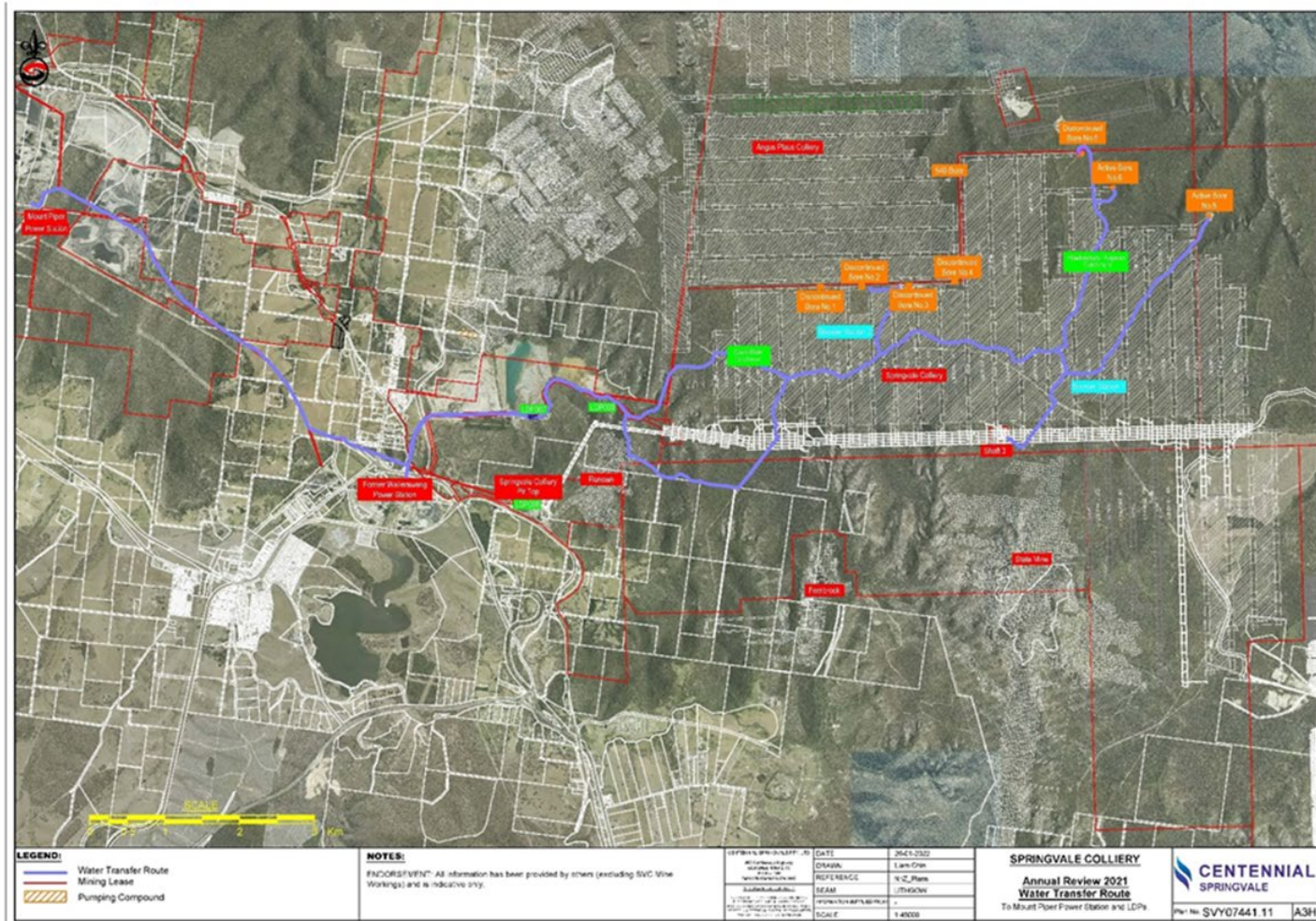


Figure 2-4. Newnes Plateau Operational Areas

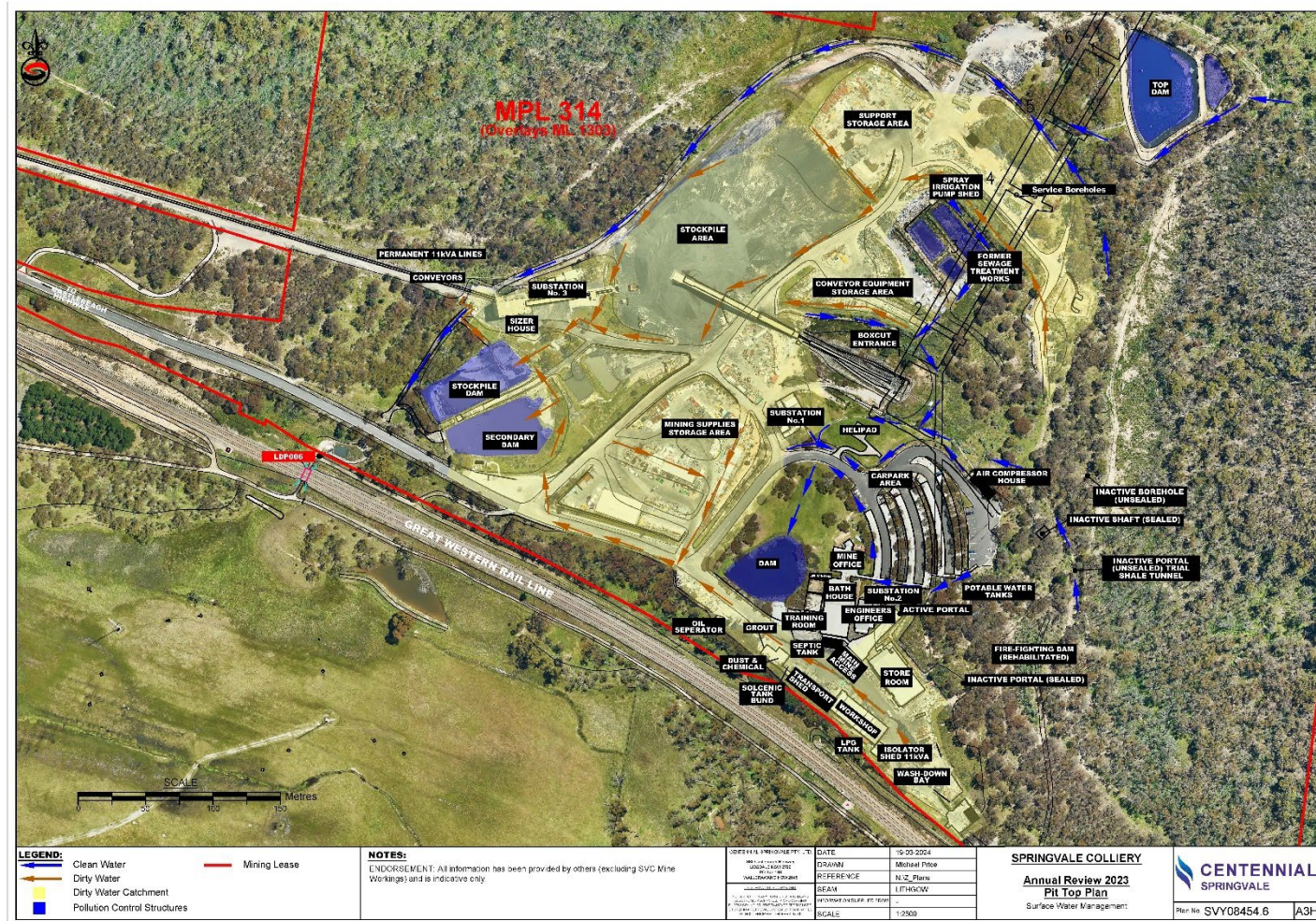


Figure 2-5. Springvale Pit Top Operational Area

3 APPROVALS

3.1 PROJECT APPROVALS, MINING AUTHORISATIONS, AND OTHER LICENCES

A summary of Project Approvals, Mining Authorisations, and other Licences relevant to Springvale is provided in **Table 3-1** and **Table 3-2** in **Section 3.1.3** provides a list of other additional related approvals. Current approvals information is available on the Centennial Springvale website³.

Development Consent SSD5594 was granted to Springvale on 21 September 2015 and has been modified four times as outlined further below. This consolidated consent supersedes Development Consent DA 11/92 which was voluntarily surrendered pursuant to section 4.63 of the Environmental Planning and Assessment Act 1979 and section 68 of the Environmental Planning and Assessment Regulation 2021 on 25 October 2023. SSD5594 has been modified on four occasions, most recently in November 2022:

- **Modification 1 (MOD1)** was approved on 19 April 2017 to allow for 450 Full Time Equivalent (FTE) personnel, ROM production of 5.5 Mtpa and a stockpile capacity of 200,000 tonnes.
- **Modification 2 (MOD2)** was approved on 19 June 2017 and relates to the development consent granted for the Springvale Water Treatment Project (SWTP) (SSD7592) in that it was required to defer the salinity limits until the SWTP is constructed and operational.
- **Modification 3 (MOD3)** was approved by the Director – Resource Assessments on 2 June 2021 to allow for the management of newly identified Aboriginal cultural heritage sites.
- **Modification 4 (MOD4)** was approved by the Director – Resource Assessments on 25 November 2022 to include rehabilitation reforms that have come into effect in 2021 for all new mining leases issued from that date, and 2 July 2022 for mining leases that were pre-existing prior to July 2021.

In addition to SSD5594, Springvale operates in accordance with federal approvals under the EPBC Act granted by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW since July 2022, formerly the Department of Agriculture, Water and Environment, Department of Energy and Environment, and former Department of Sustainability, Environment, Water, Population and Communities). Approval EPBC 2011/5949 was granted on the 14 March 2012 and allows Springvale to extract coal from Longwalls 415 – 417. A second approval (EPBC 2013/6881) was issued on 15 October 2015 to allow secondary extraction associated with the Springvale Mine Extension Project SSD5594.

Current Project Approvals, EPBC Approvals, Exploration Licences, and Mining Leases are available at the Centennial Springvale website.¹

³ <https://www.centennialcoal.com.au/operations/springvale/>

Table 3-1. Key Approvals held by Springvale

Approvals	Description	Issue Date (Grant, Renewal, Variation)	Expiry Date	Change to Approval during Reporting Period
Project Approvals				
SSD5594	Springvale Mine Extension Project	21 Sep 2015 (<i>last modified 22 Nov 2022 – MOD4</i>)	31 December 2028	N
EPBC Approvals				
EPBC 2011/5949	Mining of Longwalls 415 - 417	14 March 2012	19 March 2032	N
EPBC 2013/6881	Mining associated with the Springvale Mine Extension Project	15 October 2015, as varied 16 March 2022	October 2035	N
Mining Leases				
ML 1303	Mining Lease	15 December 1992, renewed 8 May 2014, varied 17 Oct 2022	15 December 2034	N
ML 1323 ¹	Mining Lease	3 August 1993, renewed 28 June 2014, varied 17 Oct 2022	3 August 2035	N
ML 1326	Mining Lease	28 September 1993, varied 17 Oct 2022	3 August 2024	N
ML 1424 (part)	Mining Lease	18 August 2003, varied 17 Oct 2022	18 August 2024	N
ML 1537	Mining Lease	15 June 2003, varied 17 Oct 2022	15 June 2024	N
ML 1588	Mining Lease	19 June 2006, varied 17 Oct 2022	19 October 2027	N
ML 1670	Mining Lease	17 February 2012, varied 17 Oct 2022	17 February 2033	N
ML 1727	Mining Lease	4 February 2016, varied 17 Oct 2022	4 February 2037	N
ML1843	Mining Lease	7 February 2023	4 February 2044	N
MPL 314	Mining Purposes Lease	3 August 1993, renewed 16 June 2014, varied 17 Oct 2022	3 August 2035	N
AUTH 460	Authorisation	7 July 1992, last renewed 24 September 2022	6 June 2025	N
Coal Leases				
CL 377	Coal Lease	24 February 1992, renewed 26 April 2022	20 July 2039	N

Approvals	Description	Issue Date (Grant, Renewal, Variation)	Expiry Date	Change to Approval during Reporting Period
Exploration Licenses				
EL 6974		11 December 2007, renewed 12 May 2014	13 December 2017*	N
Rehabilitation Management Plans				
Rehabilitation Management Plan (29 July 2022)	Rehabilitation of Springvale Colliery	1 August 2022 (commencement date)	Not Applicable	Y ³
Environmental Protection Licenses				
EPL 3607	Springvale Colliery	Current licence version date 8 May 2019	Reviewed Annually 1 January	N
Extraction Plans				
Longwall (LW) 419	Mining of LW 419	11 July 2016	-	N
LW 420-422	Mining of LW 420-422	21 April 2017	-	N
LW 424-427	Mining of LW 424-427	27 July 2018 (425-427 only, 424 removed from mine plan)	-	N
LW 428-432	Mining of LW 420-422	15 March 2022 ³	-	Y

¹ML 1323 part cancellation was submitted to the department 10 May 2016 to update the mining lease boundary. Approval took effect 2 December 2020. The part cancellation is outside the consent boundary for SSD5594.

²EL6974 renewal lodged 3 November 2017. To be relinquished.

³In March 2022, the LW428-432 EP was approved which included a number of supporting plans of management which consolidated and superseded previous existing plans across multiple EP Areas (for example including biodiversity, water and swamp monitoring programs).

Note: Prior to the LW 419 Extraction Plan, secondary extraction in panels 411-418 was regulated by the Subsidence Management Plan for LW411-418. LW Panel 418 extraction was completed in May 2016.

3.1.1 Changes During The Reporting Period

On 9 August 2023, DPHI approved Extraction Plan Amendment 1 for LW 428-432. Amendment 1 shortened the commencing end of LW 429 by approximately 1,160m (change from 27 cut through to 17 cut through), reducing the approved length of LW 429 to approximately 1,960m.

The following NSW Threatened Species Licence was issued to Springvale during the 2023 reporting period, as described in **Table 3-2**.

- Document No C0006669, issued 31 January 2023 (expiry 31 January 2025)
 - Repair and replace approximately 1.6km of the Bore 8 to Booster 1 water pipeline on the Newnes Plateau.

3.1.2 Extraction Plans

As summarised in **Table 3-1** Extraction Plans (EP) approved under Schedule 3, Condition 10 of SSD5594 include:

- **LW 419** (approved 11 July 2016, extraction in LW419 completed May 2016)
- **LW 420-422** (approved 21 April 2017, extraction in LW422 completed in June 2018)
- **LW 424-427** (approved 2018, extraction in LW427 completed in January 2022)
- **LW 428-432** – (approved March 2022 and amended 9 August 2023, extraction in LW428 commenced 26 March 2022).

Monitoring activities undertaken under EP approvals are currently reported quarterly in accordance with Condition 5 of the LW428-432 EP approval and summarised the Annual Review in accordance with Schedule 6, Condition 12 of SSD5594.

3.1.3 Other Related Approvals

The Gardens of Stone State Conservation Area (SCA) was formally proclaimed on 6 May 2022. The SCA encompasses the Newnes Plateau (as Newnes State Forest), Ben Bullen State Forest, Wolgan State Forest as well as other crown lands. The Swamp Offset Deed was signed in July 2022.

Springvale also holds several Section 95 Certificates and Threatened Species Licences as issued by the Biodiversity and Conservation Division (BCD), formerly the Office of Environment and Heritage (OEH) within DPHI.

Table 3-2 summarises other related approvals held by Springvale Mine relevant to the Annual Review.

Table 3-2: Other Related Approvals

Approval	Description	Expiry Date	Change to Approval during Reporting Period (Y/N)
NPWS Approvals			
March 2023	Bore 8 to Booster 1 Project (ML 1843 Pipeline Installation)	6 October 2023	N
April 2023	Springvale LW 431-432 and 500 Area Exploration Program	31 May 2024 (varied 2 November 2023 DOC23/937286-1)	Y
April 2023	SIS Drilling Program	1 December 2023	N
September 2023	Vegetation Management Nearby Powerlines (inspection, maintenance and emergency works)	18 September 2028	N
October 2023	Booster 1 to Booster 2 Pipeline Upgrade	31 May 2024	N
NSW Biodiversity and Conservation Approvals and Licences			
Document No C0000077	Section 95 Certificate	30 June 2024	N
Document No C0006077	Threatened Species Licence	31 December 2028	N
Document No C0006298	Threatened Species Licence	31 December 2028	N
Document No C0006026	Threatened Species Licence	31 December 2028	N
Document No C0003184	Threatened Species Licence	31 December 2028	N
Document No C0005809	Threatened Species Licence	31 December 2028	N
Document No C0006026	Threatened Species Licence	31 December 2028	N
Document No C0006096	Threatened Species Licence	31 December 2028	N
Document No C0006185	Threatened Species Licence	31 December 2028	N
Document No C0006242	Threatened Species Licence	31 December 2028	N
Document No C0003546*	Threatened Species Licence	9 April 2023	Y
Document No C0003839	Threatened Species Licence	12 July 2028	N
Document No C0003684	Threatened Species Licence	31 December 2028	N
Document No C0006265	Threatened Species Licence	31 December 2024	N
Document No C0004842	Threatened Species Licence	31 December 2028	N
Document No C0006649	Threatened Species Licence	30 November 2024	N
Document No C0006488	Threatened Species Licence	31 December 2028	N
Document No C0006669	Threatened Species Licence	31 January 2025	N

*TS Licence C0003546 has now expired as remediation work in Sunnyside Swamp is complete.

3.2 ANNUAL REPORTING REQUIREMENTS

This Annual Review is prepared in accordance with Schedule 6, Condition 12 of SSD5594, and several related conditions of the consent, primarily associated with annual reporting requirements/commitments within associated management plans, and in the project Statements of Commitment (Appendix 3 to SSD5594). **Appendix 1** provides a checklist of reporting requirements and performance conditions addressed within the Annual Review.

In accordance with the requirements of SSD5594 (Schedule 6, Conditions 12 and 15), a copy of the Annual Review is provided to DPHI and subject to its approval, is made available on the *Springvale* website¹. A copy of the Annual Review is also provided to DCCEEW as per the Statement of Commitments in SSD5594.

¹ www.centennialcoal.com.au/operations/springvale/

4 OPERATIONS SUMMARY

4.1 PRODUCTION

Details of production and associated waste generated by the site for the report period and next reporting is provided in **Table 4-1**. There were no inconsistencies between the approved limit and actual production for the reporting period.

Table 4-1: Production Summary & Forecast

Material	Approved Limit	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
Waste Rock / Overburden	NIL	Not Applicable	Not Applicable	Not Applicable
ROM Coal¹	5.5 million tonnes per calendar yr.	2,323,893 t	2,265,373 t	2,682,109 t
Coarse reject	NIL	Not Applicable	Not Applicable	Not Applicable
Fine reject (tailings)	NIL	Not Applicable	Not Applicable	Not Applicable
Saleable Product	NIL	Not Applicable	Not Applicable	Not Applicable

1. receive, handle or process, SSD5594 (Schedule 2, Cond 6).

A summary of the other operations and coal processing, handling and transport relevant to Centennial Springvale is provided in **Table 4-2**. There were no inconsistencies between the hours of operation and transport limits during the reporting period.

Table 4-2: Other Operations

Approved Operation	Approved Limit	Previous Reporting Period (Actual)	This Reporting Period (Actual)
<i>Hours of operation</i>	24 hours a day, 7 days a week ¹	24 hours a day, 7 days a week	24 hours a day, 7 days a week
<i>Transport (rail)</i>	NIL	Not applicable	Not applicable
<i>Transport (road)</i>	50,000 tonnes of ROM Coal per calendar year ²	0 t	0 t

¹ SSD5594 (Schedule 2, Cond 7)

² SSD5594 (Schedule 2, Cond 8)

4.2 MINING OPERATIONS

Mining activities undertaken during the 2023 reporting period were as follows:

- First Workings for mine development in preparation for secondary extraction were undertaken within the LW 428-432 EP Area in accordance with the approved Extraction Plan.
- Secondary Extraction was undertaken within longwall panel LW428.
- Coal processing of ROM product presented in Table 4.1.

It is noted that a range of adaptive management measures have been implemented for the current mine plan since the granting of SSD5594 to mitigate potential for impact. These include, but are not necessarily limited to, the following key measures:

- Removing LW 422, 423 and 424 from the proposed mine plan.
- Shortening LW 421, 425 and 427 to avoid mining through major lineaments, and
- Reduction in longwall lengths to both LW 429, 430, 431 and 432.

4.3 EXPLORATION

The SIS exploration site SIS19S2 was completed in April 2023 within Title ML1727. This was the final SIS directional drill hole for that drill site.

A surface to seam partly cored exploration program commenced in April 2023. This program consists of seven partly cored exploration boreholes to investigate the Lithgow/Lidsdale seam within titles CL377 and ML1727. Select boreholes were converted to groundwater monitoring following drilling. In 2023 six holes were completed and the remaining hole will be completed in 2024.

Exploration in the Springvale West Project Area commenced in 2023 under ML 1323, ML 1303 and CL 377 to further define coal resources. Three of the four holes proposed were completed in 2023. The remaining hole will be completed in 2024.

4.4 LAND DISTURBANCE

In 2023 maintenance activities were undertaken on the Newnes Plateau on the approved Springvale Water Transfer. The pipeline installed was found to be deficient in withstanding the existing operating pressures of the Springvale Water Transfer Scheme (SWTS) therefore Springvale proactively replaced sections of the pipeline to ensure ongoing safe dewatering of the mine. The maintenance activity was undertaken in two stages:

- Between Bore 8 to Booster Station 1: Replacement of 1600m of pipeline. This project was undertaken between March 2023 and July 2023 and accordingly has been rehabilitated.
- Between Booster 1 and Booster 2: Replacement of 3200m of pipeline. This project commenced in November 2023 and as of 31 December 2023 was ongoing. Testing and commissioning of the replaced pipeline will be completed in 2024.

Licences and Consents associated with the activity have been included with **Section 3.1.3**.

4.5 CONSTRUCTION

There was **no** construction or demolition undertaken during the 2023 reporting period.

4.6 NEXT REPORTING PERIOD

In the next reporting period Springvale will complete LW 428 and commence LW 429. First workings for future longwalls are planned to continue in accordance with approved mine layouts and the related EP for LW 428-432.

Two partly cored exploration boreholes are proposed for the LW 500 area for 2024.

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

Table 5-1 summarises the outcomes of the 2023 Annual Review, including actions issued by Regulators and actions outlined by Springvale.

Table 5-1: Actions from Previous Annual Review

Action Required	Requested By	Action Taken	Where addressed in Annual Review
Regulator Requirements			
Annual review upload onto website within 1 month of date of letter (03 May 2023)	DPHI	Published on the centennial Springvale Website 22 May 2023 (https://www.centennialcoal.com.au/operations/springvale/)	N/A
Improvement Actions			
Continue to implement Monitoring requirements for the Extraction Plan	Springvale	Ongoing monitoring and reporting undertaken in accordance with approved extraction plans	Section 6
Continue to undertake actions required under the IEA	Springvale	Ongoing review and implementation of recommendations	Section 10
SIS Drilling	Springvale	Completed	Section 4.3
Exploration Drilling	Springvale	Completed	Section 4.3
Continue to undertake land management works at Coss River and Biodiversity Offset sites	Springvale	Ongoing-Focus on Weed management	Section 6.5.6 And Section 6.5.5.1
Management Plan Revisions			
Seek Approval of revised Western Region Biodiversity Management Plan	Springvale	Submitted July 2023 and under assessment.	Section 6.5
Seek Variation UCRAMP	Springvale	Revised Upper Coss River Action and Monitoring Plan approved June 2023.	Section 7.1
Condition Triggers			
Undertake revisions to Management Plans within 3 Months of IEA and Annual Review Submission	Springvale	See <i>Regulator Requirements</i> above. Revised Submission Date of 30 June 2023. EMS approved February 2024. AQMP, WMP, BMP under assessment.	Sections 3, 6 and 7

6 ENVIRONMENTAL PERFORMANCE

Centennial Springvale implements an Environmental Management Strategy (EMS), 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, Centennial Springvale undertakes a comprehensive monitoring program. Environmental monitoring locations are shown in **Figure 6-1** and **Figure 6-3**.

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**– Air Quality
- **Section 6.4**– Greenhouse Gas Emissions
- **Section 6.5** – Biodiversity
- **Section 6.6** – Heritage
- **Section 6.7** – Mine Subsidence
- **Section 6.8** – Waste
- **Section 6.9** – Other Matters
 - Bushfire

The environmental performance for **water, rehabilitation and community aspects** are reported in **Sections 7, 8, and 9** respectively.

Within each Extraction Plan, Springvale has developed Trigger Action Response Plans (TARPs) using the performance indicators for subsidence impacts relevant to each component Management Plan. The TARP provides a process of tiered/escalating trigger levels for contingency measures should measurements and impacts be greater than predicted/approved. Relevant monitoring sections summarise the triggers reported during the reporting period. The Extraction Plan should be referred to for additional detail.

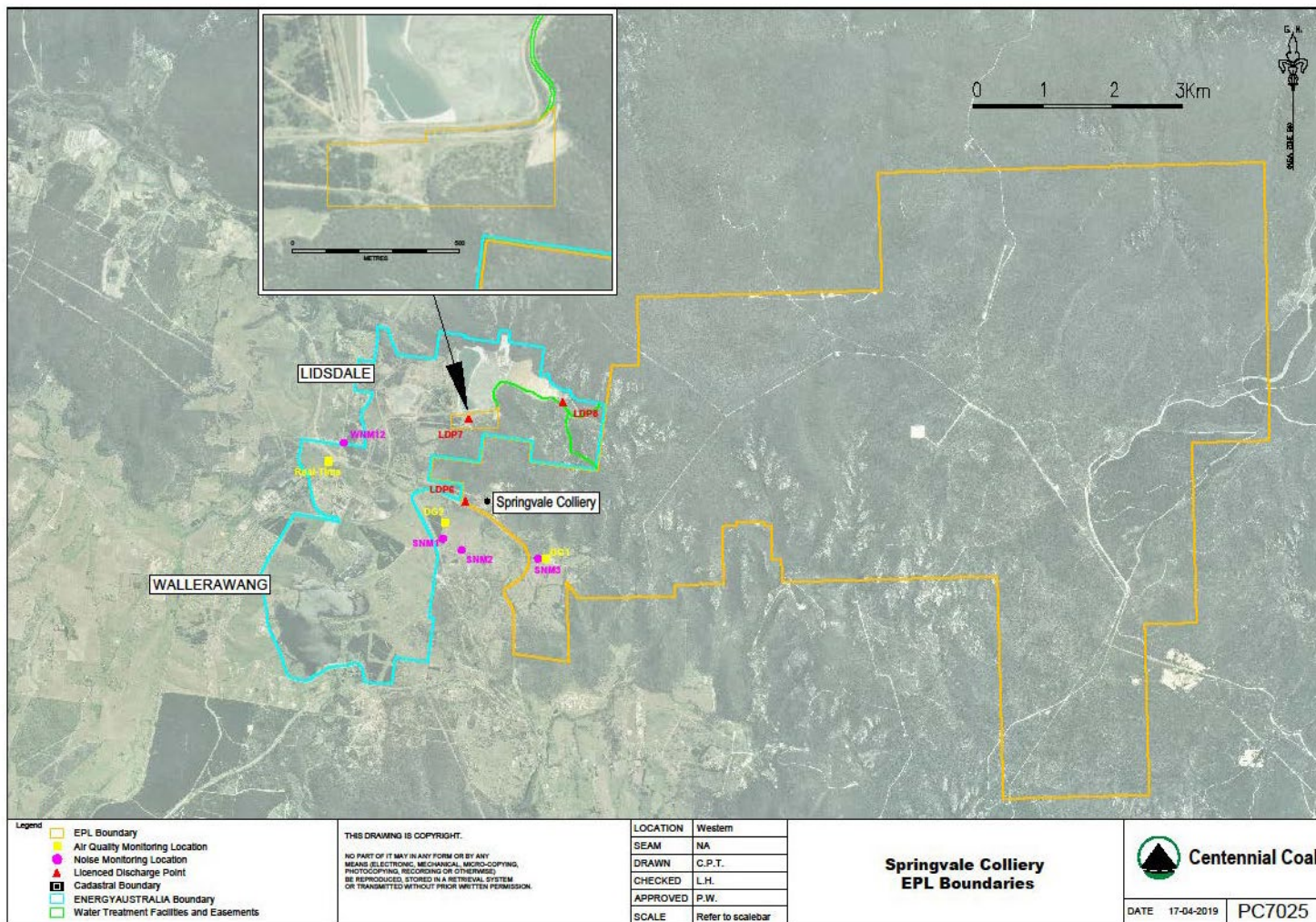


Figure 6-1: Springvale Operational Monitoring Locations

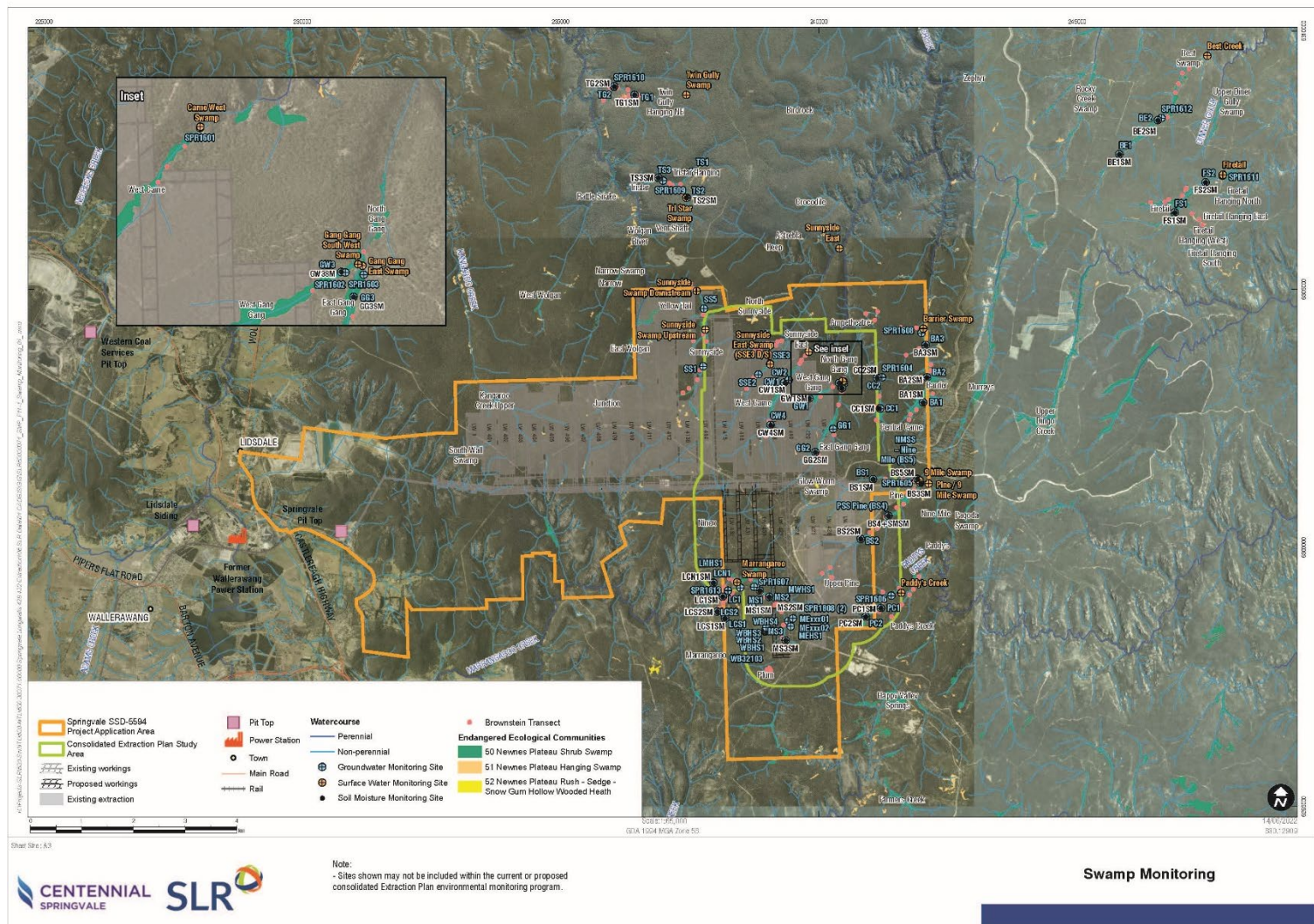


Figure 6-2 Springvale Extraction Plan Monitoring Locations

6.1 METEOROLOGICAL SUMMARY

Meteorological monitoring is undertaken near the pit top, at an onsite Automatic Weather Station (AWS) since 2012, in accordance with the requirements of EPL 3607 (Condition M4.1) and SSD5594 (Schedule 4, Condition 8). Meteorological parameters recorded by the AWS include temperature, rainfall, relative humidity, evaporation, wind speed and wind direction. A summary of rainfall and temperature data collected from Springvale Mine during 2023 is presented in **Table 6-1** and illustrated on **Figure 6-3**.

A total of 624.6 mm of rain was recorded in 2023, which is below both the average and 90th percentile ('wet year') rainfall conditions used in the water balance in the site Water Management Plan (2020). January had the highest rainfall (114 mm) and February had the lowest (3.6 mm). The minimum temperature recorded on site during the reporting period was -5.04°C in June 2023. The maximum temperature recorded was 33.98°C in February 2023.

Table 6-1. Meteorological Summary at Springvale Mine – 2023

Month	Rainfall (mm)	Cumulative rainfall (mm)	Min Temperature @2m	Max Temperature @2m
Jan-23	114.0	114.0	6.81	32.30
Feb-23	30.6	144.6	6.33	33.98
Mar-23	65.0	209.6	6.27	22.45
Apr-23	61.4	271.0	3.41	13.47
May-23	3.6	274.6	-2.97	12.39
Jun-23	27.2	301.8	-5.04	11.16
Jul-23	14.2	316.0	-4.52	9.91
Aug-23	42.4	358.4	-1.30	7.73
Sep-23	19.2	377.6	-1.69	15.05
Oct-23	42.2	419.8	3.16	20.64
Nov-23	93.2	513.0	6.01	18.19
Dec-23	111.6	624.6	9.31	20.04

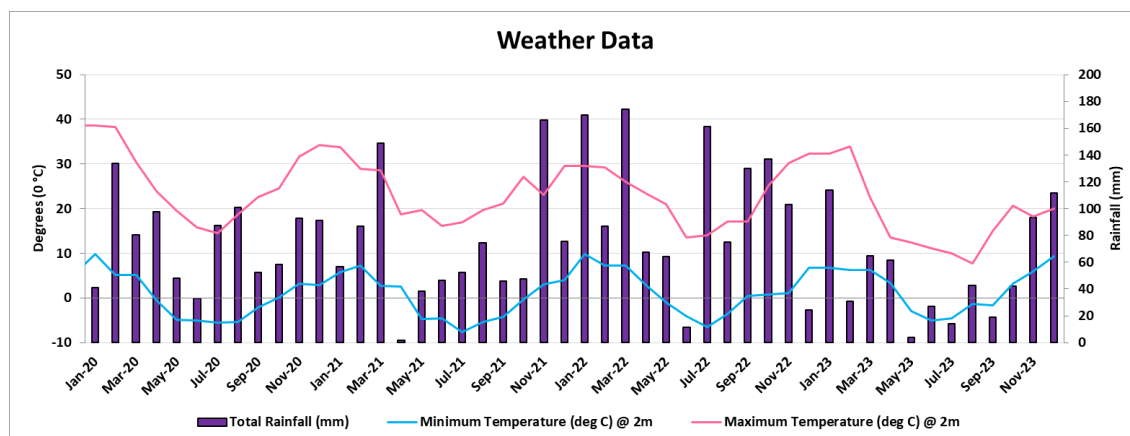


Figure 6-3. Annual temperature and rainfall from Jan 2020 to Dec 2023

An annual wind and velocity direction wind rose is presented in **Figure 6-4** below.

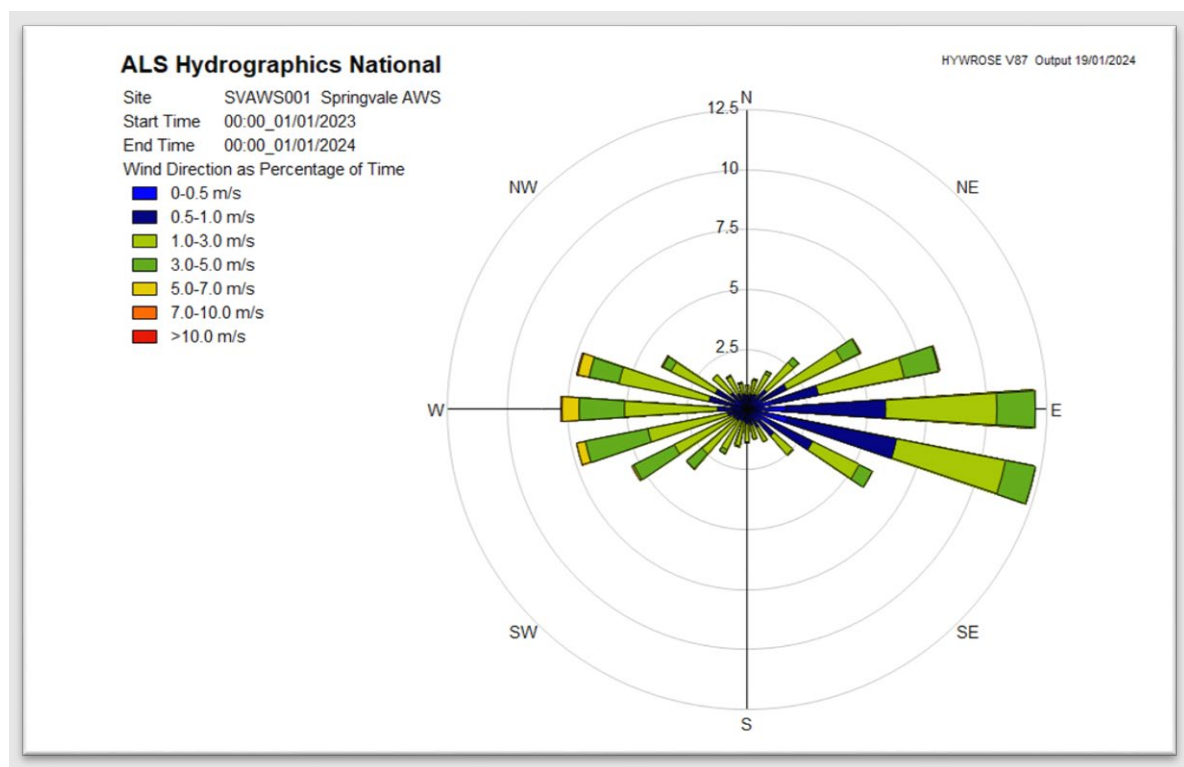


Figure 6-4: Wind Rose (2023)

6.2 NOISE

6.2.1 Environmental Management

Springvale manages noise in accordance with the *Western Region Noise Management Plan (WR-NMP)*. The WR-NMP is periodically revised in accordance with review requirements of Schedule 6, Condition 6 of SSD5594. The current approved version of the WR-NMP is dated November 2021. The WRNMP identifies sources of noise relevant to Springvale Mine operations, which include:

- Operation of mobile equipment – e.g. trucks, dozers, loaders.
- Coal handling/processing plant – e.g. conveyors, washery, screens and hopper filling.
- Coal transporting activities – e.g. overland conveyors, haul trucks.
- Ventilation fans.

Key Noise mitigation measures for Springvale Mine operations are:

- Maintaining all plant and equipment to manufactures 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).
- Installing acoustic enclosures around processing plants (ongoing as required to ensure compliance).
- Switching off vehicles and plan when not in use (ongoing).

Additional noise management measures are outlined the WRNMP.

6.2.2 Environmental Performance

Noise Criteria

Schedule 4, Condition 2 of SSD5594 provides noise criteria for three specified locations, and for all other privately-owned land. Condition L4.2 of EPL 3607 specifies noise limits at “*the nearest or most affected residence to determine compliance with L4.1*”.

Table 6-2 Noise Criteria

Receiver ID	Day LAeq (15 min)	Evening LAeq (15 min)	Night LAeq (15 min)	Night LA1 (1min)
S1	44	44	42	52
S2	43	43	43	53
S3	35	35	35	60
All other privately owned land	35	35	35	45

Attended Noise Monitoring

Quarterly noise monitoring surveys were undertaken during the 2023 reporting period in accordance with the WR-NMP. Attended noise surveys were undertaken at five locations shown on **Figure 6.1**, which have been selected to be representative of identified receiver locations. Results for day, evening and night are presented in **Table 6.3**.

The monitoring results identified zero non compliances during the 2023 reporting period. The Springvale ventilation fan was not observed to be audible during the reporting period.

Table 6-3: 2023 Noise Results

EPL Location	Project Approval Location	Q1	Q2	Q3	Q4	Criteria Limit
Estimated Springvale Day (LAeq(15 minute)) Contribution (dBA) Results						
EPL ID No. 3	S1	Inaudible	<40	Inaudible	Inaudible	44
EPL ID No. 4	S2	Inaudible	<40	<35	<30	43
Not Applicable	S3	Inaudible	Inaudible	Inaudible	Inaudible	35
EPL ID No. 5	S4	Inaudible	<35	Inaudible	Inaudible	35
Not Applicable	S5	Inaudible	<35	Inaudible	Inaudible	35
Estimated Springvale Evening (LAeq(15 minute)) Contribution(dBA) Results						
EPL ID No. 3	S	<35	<36	33	<40	44
EPL ID No. 4	S2	<37	<40	33	42	43
Not Applicable	S3	Inaudible	Inaudible	Inaudible	Inaudible	35
EPL ID No. 5	S4	<30	<35	<33	<30	35
Not Applicable	S5	Inaudible	<35	<33	<30	35
Estimated Springvale Night (LAeq (15 minute)) Contribution(dBA) Results						
EPL ID No. 3	S1	Inaudible	38	40	<30	42
EPL ID No. 4	S2	<36	40	40	<40	43
Not Applicable	S3	Inaudible	Inaudible	Inaudible	Inaudible	35
EPL ID No. 5	S4	Inaudible	33	<35	<30	35
Not Applicable	S5	Inaudible	33	<33	<30	35
Estimated Springvale Night (LA) (1 minute)) Contribution (dBA) Results						
EPL ID No. 3	S1	Inaudible	<43	47	<40	52
EPL ID No. 4	S2	<36	<48	48	50	53
Not Applicable	S3	Inaudible	Inaudible	Inaudible	Inaudible	60
EPL ID No. 5	S4	Inaudible	38	39	<30	45
Not Applicable	S5	Inaudible	38	38	<30	45

6.2.3 Comparison against Predictions

Table 6-4 summarises the approved predictions for construction and operational noise, and performance against those for the 2023 reporting period.

Table 6-4. Summary of EIS Noise Predictions and Performance during 2023

EIS Predictions– Summary of Environmental Impacts	Performance During the Current Reporting Period
Construction Noise: Noise from construction of Newnes State Forest surface infrastructure will be within the project specific noise limits.	There was no construction activities undertaken within the 2023 reporting period.
Operational Noise: Pit top noise will be within the project specific noise limits following the staged implementation of a wide range of mitigation measures that will reduce existing noise levels. The consequence of the implementation of the Project mitigation measures will be the reduction in the historic noise exceedances for residential receivers along Springvale Lane. Noise modelling for the EIS predicted noise to exceed project-specific intrusive and amenity noise levels by up to 4 dba during the night-time period in adverse meteorological conditions.	- No recorded exceedances of noise criteria in quarterly monitoring assessments since 2019, as summarized in Table 6.4. - No noise complaints recorded from sensitive receptors S1-S3 during 2023 reporting period. - There was one noise complaint received during the reporting period and is discussed in Section 9.3.

6.2.4 Long Terms Analysis

Table 6-5 shows the number of noise non-compliances recorded by Centennial Springvale during the period from 2019 to 2023.

Since 2019 there have been **no** recorded non-compliances in the quarterly noise assessments.

Table 6-5 Long Term Attended Noise Monitoring Trends (reported non-compliances)

Project Approval Location	2019	2020	2021	2022	2023
S1	0	0	0	0	0
S2	0	0	0	0	0
S3	0	0	0	0	0
S4	0	0	0	0	0
S5	0	0	0	0	0

6.2.5 Implemented / Proposed Improvements

Noise management controls are considered effective based upon compliance with the noise criteria. Springvale will continue to implement the WRNMP.

Springvale will review and revise, if necessary, the WRNMP in accordance with Schedule 6, Condition 6 of SSD5594.

6.2.6 Acquisition

There have been no requests received or actions undertaken during the reporting period.

6.2.7 Blasting

There was no blasting carried out at the Springvale site during the 2023 reporting period.

6.3 AIR QUALITY

6.3.1 Environmental Management

Centennial Springvale manages air quality in accordance with the Western Region Air Quality and Greenhouse Gas Management Plan (WR-AQGHGMP) required by Schedule 4 , Condition 7 of SSD5594. The WR-AQGHGMP is progressively updated in accordance with Schedule 6, Condition 6 of SSD5594. The current version (V6) was approved by DPHI in October 2022.

The following sources of dust emissions were identified in the WR-AQGHGMP relevant to Springvale Mine 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 through mine ventilation fans as a result of underground mining operations;
- Coal transporting activities; and
- Operation of mobile equipment.

Key dust mitigation measures for Springvale Mine operations 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; and
- Water sprays (sprinkler system) on the coal product stockpile as required.

The air quality monitoring under the WR-AQGHGMP comprises a '**short term**' and '**long term**' program. Springvale transitioned to the long term program in 2022. Specific monitoring locations are not prescribed under SSD5594 but are described under the WR-AQGHGMP prepared in accordance with Schedule 4, Condition 7 of SSD5594. A commitment for a real time monitoring installation for monitoring regional air quality was made under the Statement of Commitments for SSD5594. This is captured in the long term monitoring program. Two monitoring locations for depositional dust are also prescribed in Condition P1.1 of EPL3607. The air quality monitoring locations assessed under the WR-AQGHGMP are shown in **Figure 6-1**.

6.3.2 Environmental Performance

Air Quality Criteria

Air quality is assessed against the performance criteria as per Schedule 4, Condition 5 of SSD5594. The relevant air quality criteria is displayed in **Table 6-6**. Springvale undertakes air quality monitoring in accordance the WR-AQGHGMP.

Table 6-6: Air Quality Criteria as per SSD5594 (Cond 5, Sch 4)

Pollutant	Averaging period	Criterion	
Total suspended particulate (TSP) matter	Annual	90 µg/m ³ (a,d)	
Particulate matter < 10 µm (PM ₁₀)	Annual	25 µg/m ³ (a,d)	
Particulate matter < 10 µm (PM ₁₀)	24 hour	50µg/m ³ (a)	
		Max. rolling average increase	Max. annual average
Deposited Dust	Annual	2 g/m ² /month (b)	4 g/m ² /month (a,d)

Notes:

a Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).

b Incremental impact (i.e. increase in concentrations due to the development alone, with zero allowable exceedances of the criteria over the life of the development).

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, 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 conditions 6 and 7 to develop and implement an air quality management system that ensures operational responses to the risks of exceedance of the criteria.

In 2022 Springvale transitioned from the short-term monitoring program to the long-term monitoring program as detailed in correspondence to DPHI dated 15 June 2022. Accordingly the short term monitoring network for suspended dusts has been subsequently retired. The long term dust monitoring network consists of two dust deposition gauges (DG1 and DG2) and one real-time PM10 monitoring station.

Dust Deposition

The annual dust deposition results are presented in **Table 6-7** below and graphically in **Appendix 3**. The annual averages for deposited dust are below the predicted ranges and remain compliant with the performance criteria.

Table 6-7: Summary of Dust Deposition Results (2023)

Dust Deposition Gauge		Insoluble Solids (g/m ² /month)			Air Quality Criteria ¹
Site ID	General Location	Min	Mean	Max	
DG 1	Off Springvale Lane within Lot 73 DP 751651 midway along southern boundary of allotment	0.15	0.76	1.44	4 (total) 2 (Maximum increase annual average)
DG 2	Off Millers Road within Lot 1 DP 856879 south west corner of allotment	<0.10	0.40	1.08	

¹ Annual Average insoluble solids (g/m²/month) as per Condition 5, Schedule 4 of SSD5594.

Real Time Monitoring

Real time air quality monitoring for PM₁₀ utilises a BAM unit (**Figure 6-1**). A ratio of PM₁₀ and TSP is used to estimate TSP contributions. As also used for Lidsdale Siding, a conservative ratio of 0.45 is used to calculate compliance with the TSP criteria from the PM₁₀ data.

The 24hr average and annual average real time results for PM₁₀ are presented in **Table 6-8** and **Appendix 4**. The results were compliant with the goals of the WR-AQGHGMP of 50µg/m³ and 25µg/m³ respectively. The annual average real time results for TSP were also below the goal of 90µg/m³ (refer **Table 6-8**) within the WR-AQGHGMP.

The BAM unit PM₁₀ data capture rate was 100% during the 2023 Reporting Period.

Table 6-8: Real Time Results for Particulate Matter

	Criterion (µg/m ³)	Maximum (µg/m ³)	Mean (µg/m ³)
24hr PM ₁₀ (short term)	50	32.73	N/A
PM ₁₀ (long term)	25	N/A	13.8
Estimated TSP ¹	90	N/A	30.8

Notes: ¹ Calculated TSP concentration estimate (PM₁₀ annual average divided by 0.45)

6.3.3 Comparison against Predictions

Predicted dust levels from the project (as approved) were expected to meet relevant air quality criteria for TSP, PM₁₀, PM_{2.5} and dust deposition. Dust deposition, TSP and PM₁₀ as monitored were compliant during the reporting period, which is consistent with EIS predictions that dust levels are expected to meet relevant air quality criteria listed in SSD5594 for TSP, PM₁₀ and depositional dust.

6.3.4 Long Terms Analysis

Table 6-9 provides a summary of air quality monitoring annual averages for the five years from 2019 to 2023 for the following:

- Deposition dust (insoluble solids)
- PM₁₀
- TSP

Generally, since 2021 the depositional dust levels at DG 1 and DG 2 have been stable. HVAS results are consistent with previous years. All long-term results meet the relevant air quality criteria.

Table 6-9: Long term trends for Deposited Dust, PM10 and TSP (2019-2023)

Monitoring Location	Annual Averages					Development Consent Criteria (Annual Average) ¹
	2019	2020	2021	2022	2023	
Depositional Dusts - Insoluble						
DG1	1.49	1.53	0.74	0.70	0.76	4 g/m ² /month
DG2	1.55	1.44	0.53	0.42	0.40	
Suspended Dust - PM ₁₀ (µg/m ³)						
HVAS / BAM	11.41 ¹	9	6.25	12.9 ²	13.8²	25 µg/m ³
Suspended Dust - TSP (µg/m ³)						
HVAS / BAM	24.18*	20	12.51	28.7 ²	30.8	90 µg/m ³

¹ As per footnote (d) of Schedule 4 Condition 5, the criteria **exclude** extraordinary events such as fires. Data from the long term reporting period has therefore been excluded where bushfire occurred (e.g. the Gosper Fire of 2019-2020).

² During 2022 suspended dust monitoring transitioned to the long term network. Accordingly, averages presented for 2022 are from BAM real time monitoring of PM₁₀. TSP is estimated on a ratio basis as detailed further in **Section 6.3.2** above.

6.3.5 Implemented / Proposed Improvements

Dust emission controls are currently considered effective based upon compliance of suspended and depositional dust with air quality criteria.

Springvale will continue to implement the WR-AQGHGMP and will review and revise the WR-AQGHGMP in accordance with Schedule 6, Condition 6 of SSD5594 as required.

6.4 GREENHOUSE GAS EMISSIONS

6.4.1 Environmental Management

Springvale manages, monitors, and reports Greenhouse Gas (GHG) Emissions in accordance with the Western Region Air Quality and Greenhouse Gas Management Plan (WR-AQGHGMP).

Direct GHG emissions (Scope 1) and indirect GHG emissions (Scope 2) from Springvale continue to be monitored and reported annually in accordance with the Commonwealth Government National Greenhouse and Energy Reporting System (NGERS). An Energy and Greenhouse Management System is used to monitor and report energy usage. Key Performance Indicators (KPIs) are tracked, which include energy demand and GHG emissions per tonne of ROM coal produced.

6.4.2 Environmental Performance

Table 6-10 reports the Scope 1 Emissions (Direct) and Scope 2 Emissions (Indirect) in tonnes CO₂-e produced for the last five reporting periods including the current period and compares these against EIS/EIA predictions. It is noted that this is *inclusive* of Springvale Coal Services too, due to being collectively considered as one 'facility' for the purposes of NGERS reporting.

During the reporting period, electricity consumption and fuel combustion were reduced. In general, total GHG emissions decreased over 5% in comparison to FY22.

Table 6-10: Summary of GHG Emissions Reporting for 2019-2023 Financial Years

Emission Sources	Estimated Emissions (tonnes CO ₂ -e) ²					Predicted Emissions (as modified ¹)
	FY19	FY20	FY21	FY22	FY23	
Scope 1 Emissions (direct emissions)						
Fuel combustion	4,881	4,006	3,346	3,228	2,389	6,322
Petroleum Based Oils and Greases (PBOG) ³	403	272	262	272	456	180
SF ₆	13	14	14	13	13	-
Fugitive Emissions – CH ₄	39,550	12,193	22,985	11,801	11,257	28,496
Fugitive Emissions – CO ₂	8,725	3,647	5,021	3,942	3,286	
Total Fugitive	48,275	15,840	28,005	15,742	14,543	
Total Scope 1 ²	53,572	20,132	31,628	19,256	17,402	34,998
Scope 2 Indirect Emissions						
Electricity Consumption	80,077	75,080	72,337	72,824	69,589	97,997
Total Scope 2 ²	80,077	75,080	72,337	72,824	69,589	97,997
Combined Greenhouse Gas Emissions (Scope 1 and 2)						
Scope 1 and Scope 2 Emissions ²	133,649	95,212	103,965	92,080	86,991 -5.527%	132,995

¹ as per approved modifications to SSD5594. GHG was varied only by MOD1 (2016), approved April 2017.

² This is inclusive of Springvale Coal Services (considered as one 'facility' for NGERS reporting).

³ 2022 Annual review presented LPG only. Historic data has been corrected and this year's data includes LPG, Oil and Grease usage.

6.4.3 Comparison Against Predictions

Table 6-10 summarises greenhouse gas emissions predicted for the project, with comparison to actual emissions during the current and previous reporting period. Comparatively, GHG emissions during the current reporting period remained below predictions.

Total Scope 1 (direct) emissions during the 2023 reporting period (17,402 CO₂-e) represented a **5% decrease** from the previous reporting period and remains below predictions. Scope 2 (indirect) emissions generated during the 2023 reporting period also remained lower than predictions.

Fugitive emissions generated during 2023 were also below predictions.

6.4.4 Long Term Analysis

Table 6-10 presents a summary of GHG emissions reported over the last five financial years. Based on the information reported, GHG emissions have been below predictions for the project since 2020, with Scope 2 emissions below predictions since 2018. Further measures to reduce and minimise GHG emissions are discussed in **Section 6.4.5** below.

6.4.5 Implemented / Proposed Improvements

Springvale implements measures to minimise GHG emissions to the greatest extent practicable and will continue to implement emission reduction measures in accordance with the WR-AQGHGMP.

Centennial has been investigating potential mitigation measures to reduce and minimise GHG for a number of years. The following key sources of GHG emissions have been identified relevant to the Centennial operations:

- Energy usage (fuel and electricity)
- Ventilation Air Methane (VAM), which is the release of dilute methane gas from ventilation fans to the atmosphere.

Additional emissions reduction measures implemented as per the management plan include:

- Cost effective measures to improve energy efficiency.
- Regular maintenance of plant and equipment to minimise fuel consumption, and
- Consideration of energy efficiency in plant and equipment selection.

6.5 BIODIVERSITY

6.5.1 Environmental Management

Management and monitoring of biodiversity at Springvale is undertaken in accordance with a number of management plans required under conditions of both state and commonwealth approvals as outlined below.

- The Western Region Biodiversity Management Plan (WR-BMP) has been prepared to address the requirements of Schedule 4, Condition 18 (Biodiversity Management Plan), of SSD5594. The WR-BMP is periodically revised and updated in accordance with Schedule 6, Condition 6 of SSD5594 and following other triggers for review by participating mines under the WR-BMP. In 2023 Revision 6 of the WR-BMP was submitted in February 2023 to address the requirements of Western Coal Services Modification. BCS Feedback was incorporated into Revision 7 in July 2023 and is currently under assessment by DPHI.
- Management of potential subsidence-related impacts on biodiversity within underground mining areas (extraction areas) is undertaken in accordance with:
 - Biodiversity Management Plans (BMP) and Swamp Monitoring Programs (SMP) developed as part of Extraction Plans (EP) progressively approved as mining moves through the development consent area, in accordance with Schedule 4, Conditions 10h(iv) and 10h(v) of SSD5594.
 - Specific conditions of Commonwealth approvals under the EPBC Act - including requirements to develop specific management, monitoring and research plans for biodiversity protected at national level, as outlined further below.

In addition to the above management plans, biodiversity at Springvale is further managed by:

- Biodiversity offsetting requirements under conditions of SSD5594 and EPBC approvals - including relevant impact swamps EEC and associated threatened species, is managed in accordance with:
 - Western Region Biodiversity Offset Strategy (WR-BOS); and
 - Springvale Swamp Offset Strategy, as detailed further in **Section 6.5.5.1**.
- Threatened Species Licences and (former) Section 95(2) Certificates - issued under the *NSW Biodiversity Conservation Act* and (former) *NSW Threatened Species Conservation Act* respectively as detailed further in **Section 3**.
- Springvale also implements a Catchment Improvement and Land Management Plan (CILMP) for dedicated lands located within the Cocks River catchment in accordance with Condition 18a, Schedule 2 of consent SSD5594. The CILMP (October 2017) was initially approved by DPIE (now DPHI) on 8 March 2018 as detailed further in **Section 6.5.5.1**.

Trigger Action Response Plans (TARPs) are developed and appended to relevant plans of management as required. Monitoring against TARP triggers and reporting (notifications) of trigger exceedances is undertaken in accordance with the related plan of management and reported in relevant sections of this Annual Review.

Monitoring undertaken in relation to relevant management plans discussed above is discussed in **Section 6.5.2**. Management and monitoring of biodiversity offset areas is detailed in **Section 6.5.5.1**. Related surface and groundwater monitoring relevant to biodiversity is detailed in **Section 7**.

This section of the Annual Review focuses on the active extraction area of Springvale mine.

6.5.2 Environmental Performance

This section presents the performance measures and criteria applicable to, and results of, biodiversity monitoring undertaken during the 2023 reporting period. Preliminary discussion to provide broader context is provided immediately below.

Context to biodiversity impacts resulting from the 2019-2020 wildfires:

During 2019-2020 the Gospers Mountain fire extensively impacted the surface environment within and significantly beyond the mining lease at Springvale. This resulted in significant impacts to biodiversity (flora and fauna) that is expected to take a number of years (and in cases decades) to recover. Accordingly, monitoring programs include consideration and discussion in this context as appropriate.

Context to approved offsets for swamps impacted by mining:

Biodiversity management and monitoring at Springvale includes a focus on Temperate Highland Peat Swamps on Sandstone (THPSS) and associated threatened species. Within the mining lease THPSS is comprised of Newnes Plateau Shrub Swamps (NPSS) and Newnes Plateau Hanging Swamps (NPHS). NPSS 'impact swamps' identified within the mining area that have or may be impacted by existing and future mining (detailed further in **Section 6.5.2.2**) have been offset under approved strategies in accordance with the requirements of SSD5594 and EPBC approvals, as detailed in **Section 6.5.5.1**. Impact swamps continue to be monitored as required under related swamp monitoring programs discussed in **Section 6.5.2.2**.

6.5.2.1 Performance Measures

SSD5594 and EPBC conditions of approval prescribe performance measures for Springvale mine in relation to biodiversity. Impact swamps have approved offsets as required under SSD5594 and commonwealth EPBC approvals, as detailed in **Section 6.5.5.1** of this annual review.

Springvale has established performance indicators with escalating triggers and levels of investigation via TARPs within each EP. Specific floristic triggers for swamp monitoring are prescribed in Table 9.3 of the LW 415-432 BMP.

A summary of control swamps and potential impact swamps by longwall mining area as relevant to SSD5594 is presented in **Table 6-11**.

Table 6-11 List of Impact Swamps and Control Swamps

Longwalls	Newnes Plateau Shrub Swamps (NPSS) (MU50)		Newnes Plateau Hanging Swamps (NPHS) (MU51)	
	Impact Swamps	Control Swamps	Impact Swamps	Control Swamps
413A/413B - 414	Sunnyside	Barrier Best Carne Central Firetail Twin Gully Tristar	-	Amphitheatre Firetail Twin Gully
415-417	Carne West Sunnyside Sunnyside East		Sunnyside East	
418	Carne West Sunnyside East		-	
419	Gang Gang East Gang Gang West Carne West Sunnyside East		-	
420-422	Nine Mile Sunnyside East Carne West		-	
424-427	Pine Marrangaroo Paddys Creek Nine Mile		Pine	
428-432	Marrangaroo Lost City Lost City North Lost City South		Marrangaroo Lost City Lost City North Lost City South Plum Ninox Wishbone	

The sections further below provide details for specific aspects of monitoring undertaken during the 2023 reporting period, including further discussion in relation to triggers. For the purpose of providing a summary in the Annual Review, results have been grouped by the monitoring methodology prescribed in the relevant Extraction Management Plans.

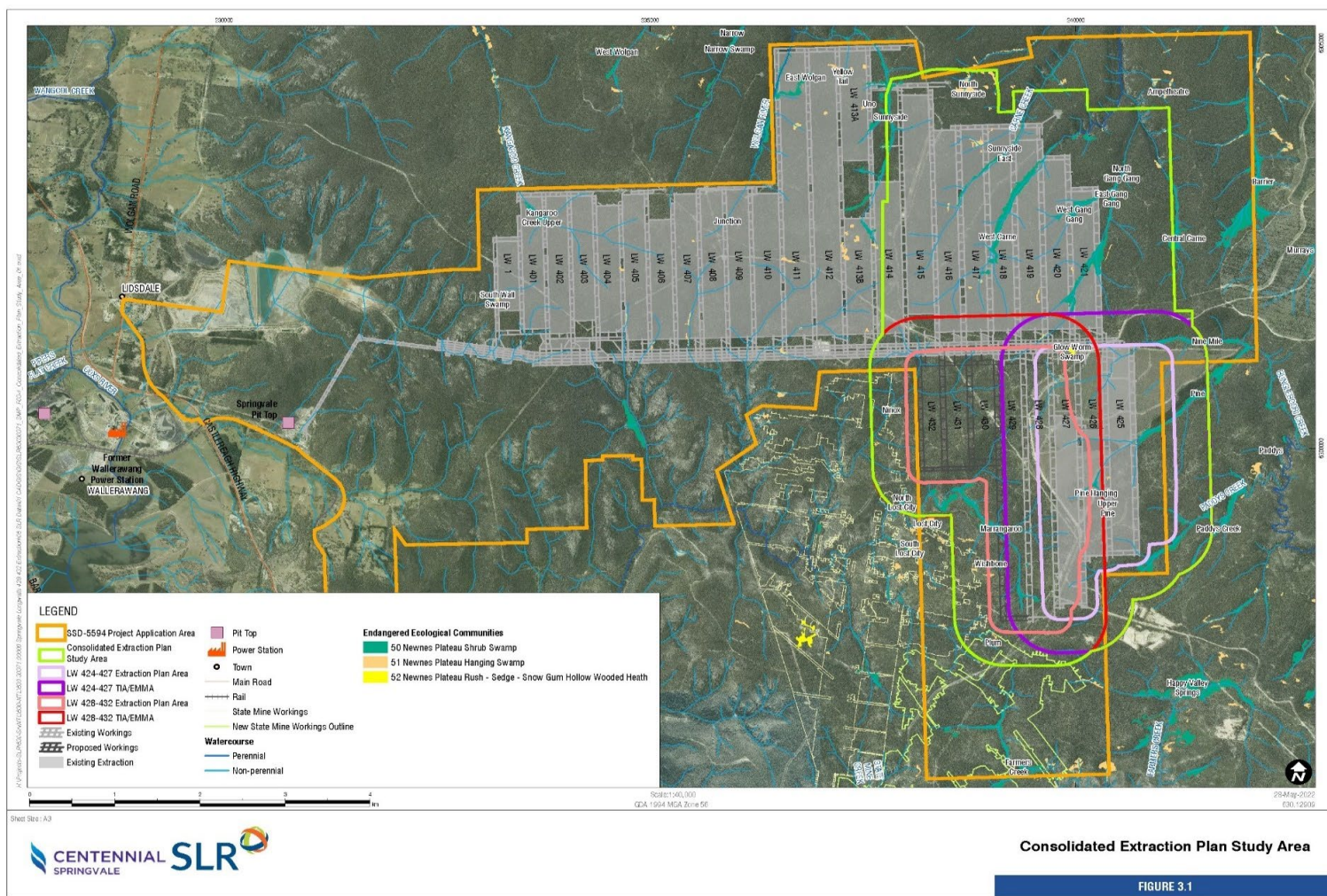


Figure 6-5: Springvale Consolidated Extraction Plan Study Area (CEPSA)

6.5.2.2 Swamps / Flora Monitoring

The following sections discuss 2023 monitoring results and context to performance indicators in associated TARPs as applicable to approved management and monitoring plans.

The Temperate Highland Peat Swamps on Sandstone (THPSS) Monitoring and Management Plan (MMP) (LW 415-417) prescribes the requirements for monitoring the effects of mining on THPSS located above LW 415-417. The applicable Swamp Monitoring Programs (SMP) as detailed in **Section 6.5.1** prescribe the requirements for monitoring THPSS in all other extraction areas, including swamp-obligate species such as the Blue Mountains Water Skink (BMWS) and Giant Dragonfly.

Flora monitoring for THPSS for LW 415 – 417 and LW 418 are methodologically identical. Flora monitoring for LW 419, LW 420-422, LW 424 – 427 and LW 428-432 are methodologically identical but apply to different swamps with varying baseline and trigger levels.

LW 415-418 Flora Monitoring - THPSS MMP Nested Transect Monitoring

The monitoring for this program consists of established 20m x 20m flora quadrats, within which transects occur with 0.5m point intercepts. Trigger analysis for this program against the related TARP are summarised in Table 6-12.

LW419-432 Flora Monitoring - Brownstein et al flora monitoring

The Brownstein et al flora monitoring methodology is conducted for swamps within the investigation area for LW 419-428. The seasonal component of Brownstein et al flora monitoring within the surveyed areas included an analysis of aerial imagery using a Soil Adjusted Vegetation Index, and field validation using Ground Control Point (GCP) flora data.

On 12 December 2023 Springvale notified DPHI of a calibration error affecting the Soil Adjusted Vegetation Index (SAVI) data reported for 2022 and 2023 for Springvale Mine. Springvale committed to providing GCP data while the consultant is correcting the data. This approach was acknowledged by the Department on 12 December 2023. SAVI data is therefore not contained in this Annual Review.

No new flora triggers have been detected during the current reporting period.

Table 6-12 Longwall 415-418 Transect Monitoring

Performance Indicator	Parameter Measured	Trigger Level*	Summer 2022/21	Autumn 2023	Winter 2023	Spring 2023
Change in species assemblage	Change in diversity of native species	A change in the number of species of greater than 30 % for a given site within a three year period.	One impact site (SSE01) and two reference sites (TRI02 and BS01) experienced a repeat exceedance of the upper trigger. One reference site excluded from analysis breached the lower trigger for species richness (LGG01).	One impact site (SSE01) and three reference sites (TRI01, TRI02 and BS01) experienced an exceedance of the upper trigger. All except TRI01 were repeated triggers.	Four reference sites (TG01, TRI01, TRI02 and BS01) experienced an exceedance of the upper trigger. All except TG01 were repeated triggers.	One impact site (WC03) and three reference sites (TRI01, TRI02 and BS01) experienced a trigger exceedance. WC03 and TRI01 were lower trigger exceedances. All triggers in reference sites were repeated triggers.
	Recruitment of eucalypt species	An increase in eucalypts in an impact site compared to reference sites of more than three individual plants within a one year period.	Two impact sites recorded a recurring trigger from previous surveys (WC01 and WC04). One reference site excluded from analysis also exceeded trigger levels (LGG01).	Two impact sites recorded a recurring trigger from previous surveys (WC01 and WC04) and two impact sites recorded a new trigger (WC03 and SSE01). One reference site recorded a new trigger exceedance (TRI02).	Three impact sites recorded a recurring trigger (WC01, WC03 and WC04). One reference site recorded a recurring trigger exceedance (TRI02) and one recorded a new trigger exceedance (TG01).	One reference site recorded a recurring trigger exceedance (TG01) and one recorded a new trigger exceedance (BS01).
Change in condition	Condition of key species	A decline in condition score at an impact site compared to the average condition score at un-impacted sites within a one year period.	Four impact sites and one reference site excluded from analysis showed a recurring and worsening decline in condition beyond the trigger level for <i>Gleichenia dicarpa</i> (WC01, WC02, WC03 and WC04) (LGG01), and three impact sites for <i>Baumea rubiginosa</i> (WC01, WC02 and WC04) and one reference site excluded from analysis (CCS01).	Four impact sites and one reference site excluded from analysis showed a recurring and worsening decline in condition beyond the trigger level for <i>Gleichenia dicarpa</i> (WC01, WC02, WC03 and WC04) (CCS01), and four impact sites for <i>Baumea rubiginosa</i> (WC01, WC02, WC03 and WC04).	Four impact sites (WC01, WC02, WC03 and WC04) showed a recurring and worsening decline in condition beyond the trigger level for <i>Gleichenia dicarpa</i> . Three impact sites showed worsening decline beyond the trigger level for <i>Machaerina rubiginosa</i> (WC01, WC02 and WC04).	Four impact sites (WC01, WC02, WC03 and WC04) showed a recurring and worsening decline in condition beyond the trigger level for <i>Gleichenia dicarpa</i> . All five impact sites showed worsening decline beyond the trigger level for <i>Baumea rubiginosa</i> (WC01, WC02, WC03, WC04 and SSE01).
	Non-live ground cover	An increase of bare ground of more than 100m ² in a site within a three year period.	No impact or reference sites exceeded the trigger level for non-live ground cover.	No impact or reference sites exceeded the trigger level for non-live ground cover.	No sites exceeded the trigger level for non-live ground cover.	No sites exceeded the trigger level for non-live ground cover. However, this variable is affected by past bushfires that

Performance Indicator	Parameter Measured	Trigger Level*	Summer 2022/21	Autumn 2023	Winter 2023	Spring 2023
						caused high non-live in both impact and reference swamps.
	Non-native weeds	An increase in non-native weed species of more than 4 in a monitoring site (each having a cover of greater than 5%) compared to the average number in reference sites within a one year period.	No sites showed an increase in weed species beyond the trigger level.	No sites showed an increase in weed species beyond the trigger level.	No sites exceeded the trigger level for non-native weeds.	No sites exceeded the trigger level for non-native weeds.

Longwall 419

Both impact and control swamps are still recovering from the summer 2019-2020 fires. This is evident by overall mean live vegetation cover trending towards pre-fire levels. In general, control shrub swamps appear to be recovering at a faster rate than impact shrub swamps. This is excluding Sunnyside East which displays drastic variations in live vegetation cover of up to 45% since spring 2021. Control hanging swamps are comparable to impact hanging swamps. Control swamps display an overall positive trend over time that is relatively stable between monitoring periods and have increased in live vegetation cover since the 2019/20 Gaspers Mountain fire event. Noteworthy consistent increases to live vegetation cover have been observed at Firetail Hanging and Gang Gang East in 2023. It is evident from overall neutral trends that impact swamps, Carne West and Gang Gang West are not recovering effectively from the fire event, with live vegetation cover sitting below 20% and 30% respectively.

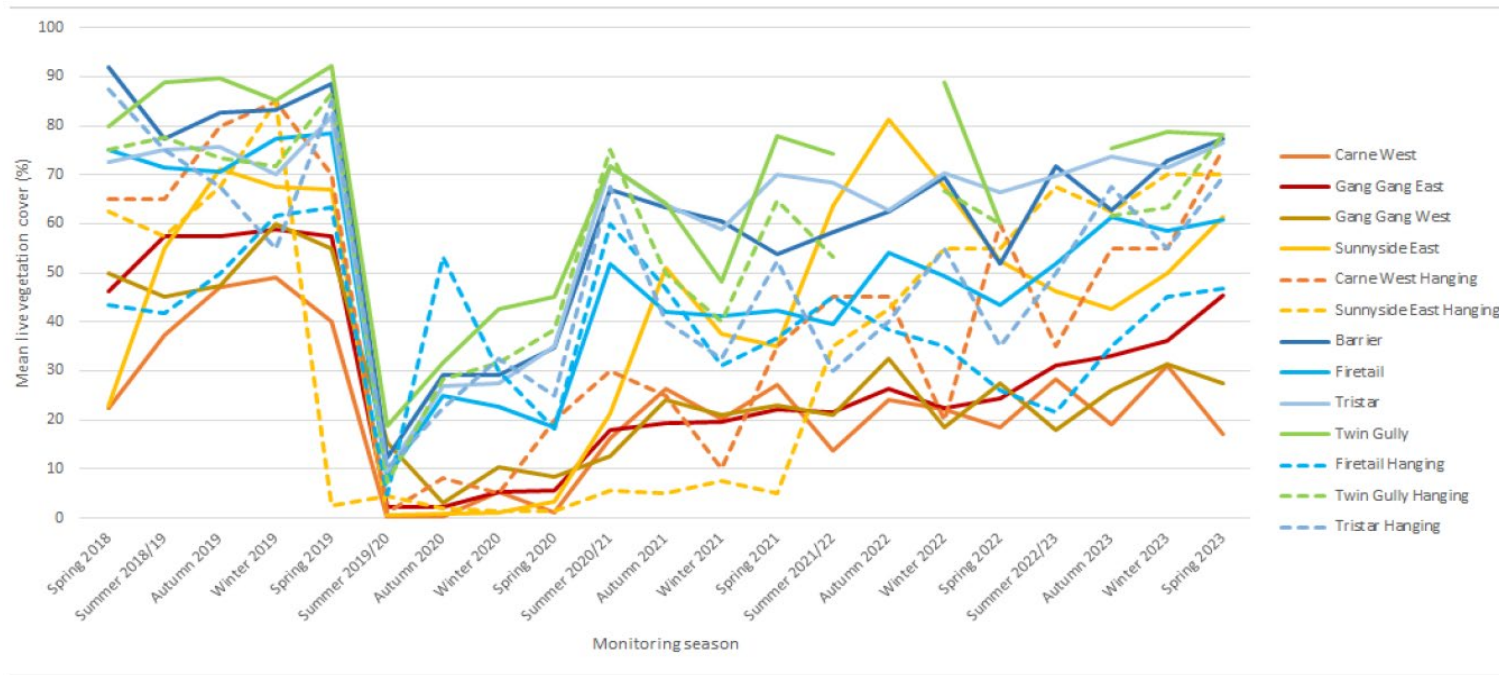


Figure 6-6 Average ratio of live vegetation cover (%), in relation to the baseline live vegetation cover, per swamp since spring 2018 for LW 419 TIA

Longwall 420-422

Impact shrub swamps have displayed an overall slight increase in live vegetation cover since the previous monitoring season. However, live vegetation trends are overall neutral, with two impact shrub swamps, Gang Gang West and Carne West recording declines in live vegetation. Live vegetation cover within impact hanging swamps is comparable to control hanging swamps and increases in live vegetation cover have been recorded in impact hanging swamps since the previous season. Control shrub swamps have displayed an overall increase in live vegetation cover.

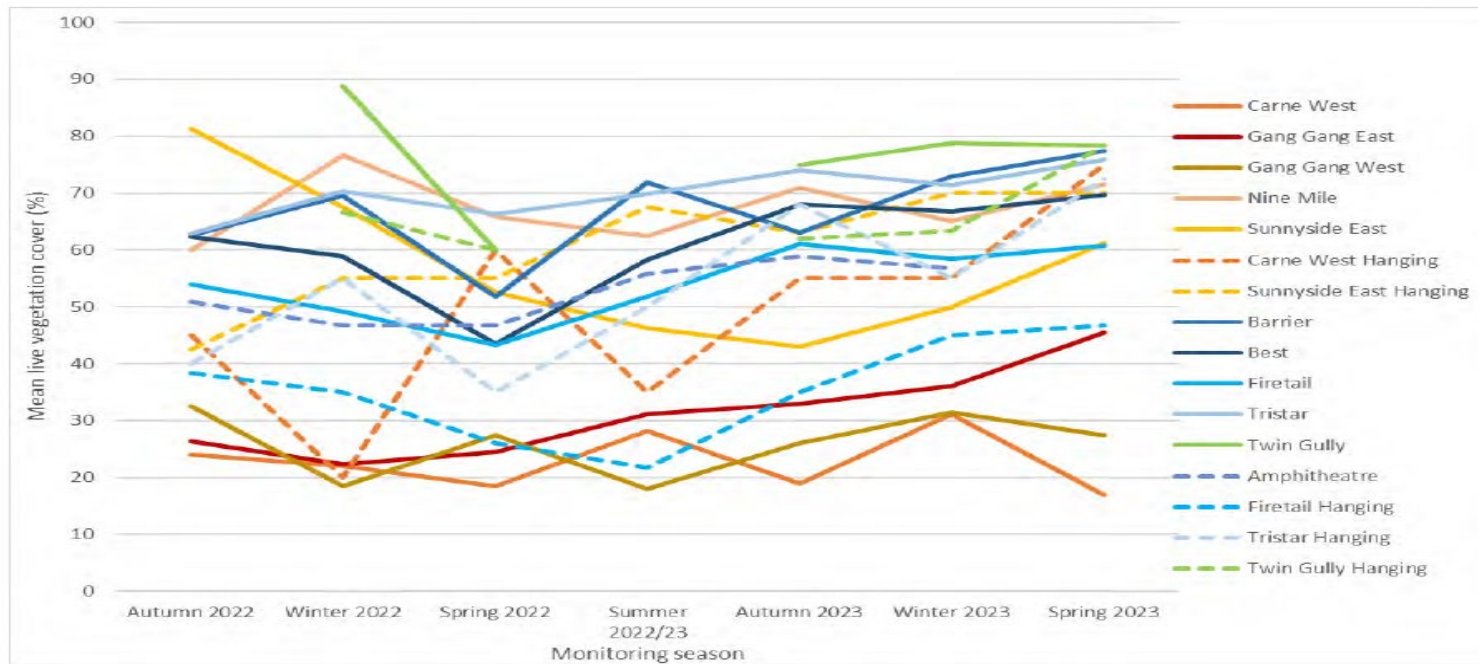


Figure 6-7 Average ratio of live vegetation cover (%), in relation to the baseline live vegetation cover, per swamp since spring 2018 for LW 420-422 TIA

Longwall 424-427

Both impact and control swamps generally displayed lower average live vegetation cover (%) compared to their respective pre-fire levels, with the exception of Pine Hanging, Nine Mile, Twin Gully Hanging and Tristar Hanging which have surpassed their pre-fire live vegetation cover. Despite this, most swamps depict an increasing trend in mean live vegetation cover following the summer 2019-2020 Gospers Mountain fire event, depicted by the steep decline in live vegetation in Summer 2019-2020. The mean live vegetation cover for 14 of 16 swamps falls between 64-88%. The outliers include impact swamp Gang Gang East and control swamp Firetail Hanging which display low live green cover.

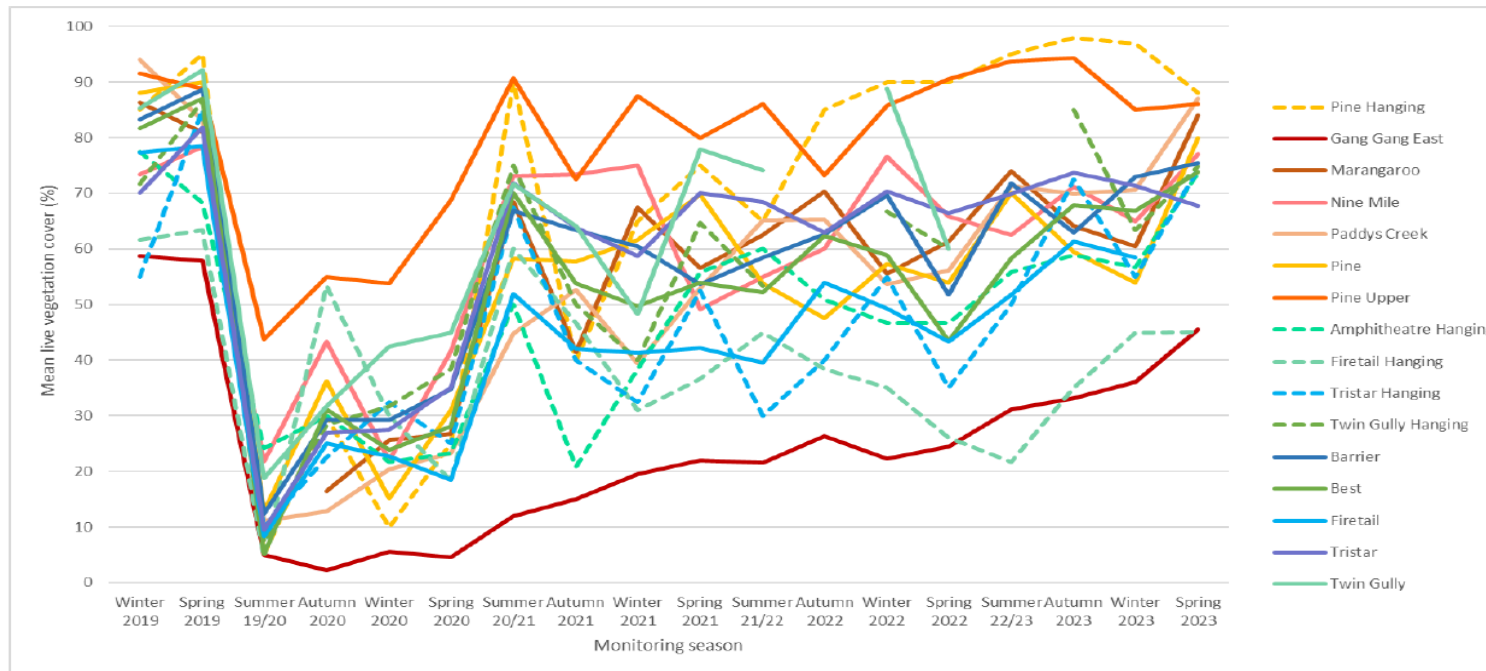


Figure 6-8 Mean live vegetation cover (%) per GCP since winter 2019 for LW 424-427 TIA

Longwall 428-432

In comparison to pre-fire baseline (winter 2017 to autumn 2019), decreased live green cover below baseline was recorded within 13 of 19 (68 %) impact GCPs (Marrangaroo Shrub only) and 42 of 82 (51 %) control GCPs. This is a substantial difference when compared to the results in swamps assessed by the post-fire baseline (spring 2019 to summer 2022), where no GCPs displayed live green cover below the baseline threshold. This is expected because the vegetation levels were already reduced in the baseline by fire.

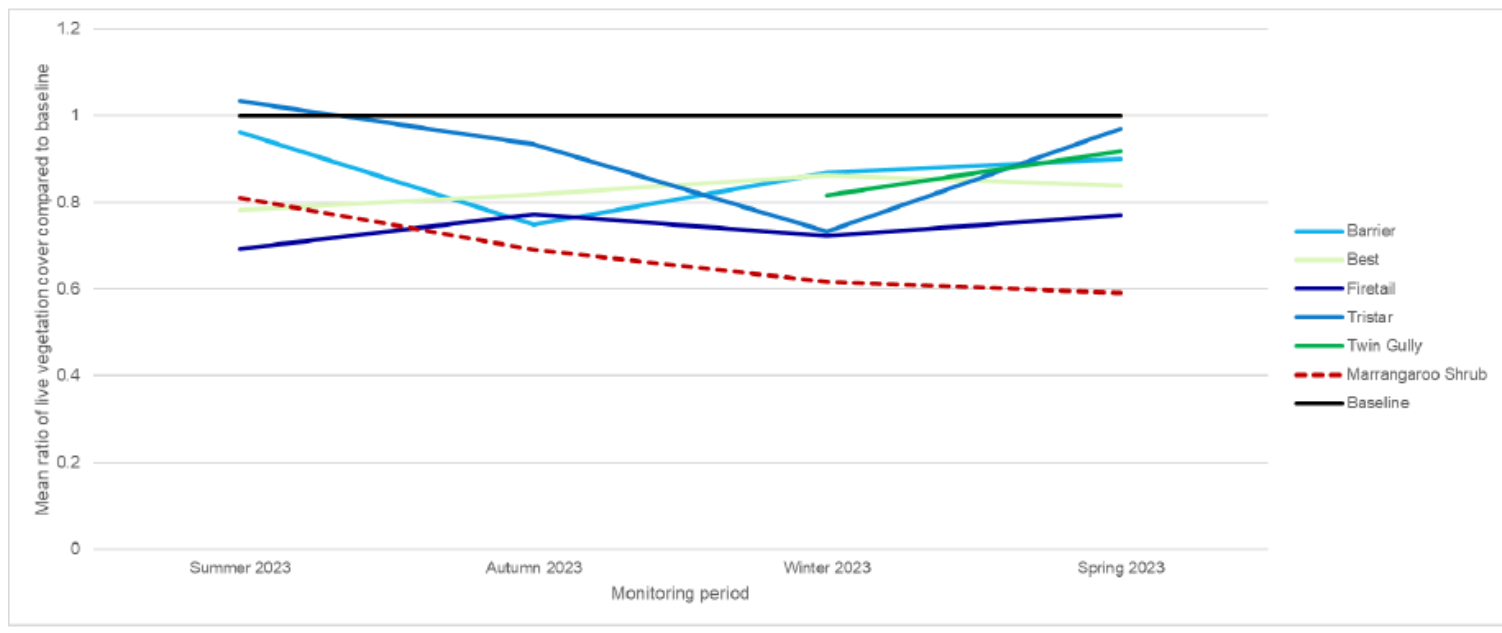


Figure 6-9 Mean ratio of GCP live vegetation cover (%) by swamp and treatment, pre-fire for Longwall 428-432

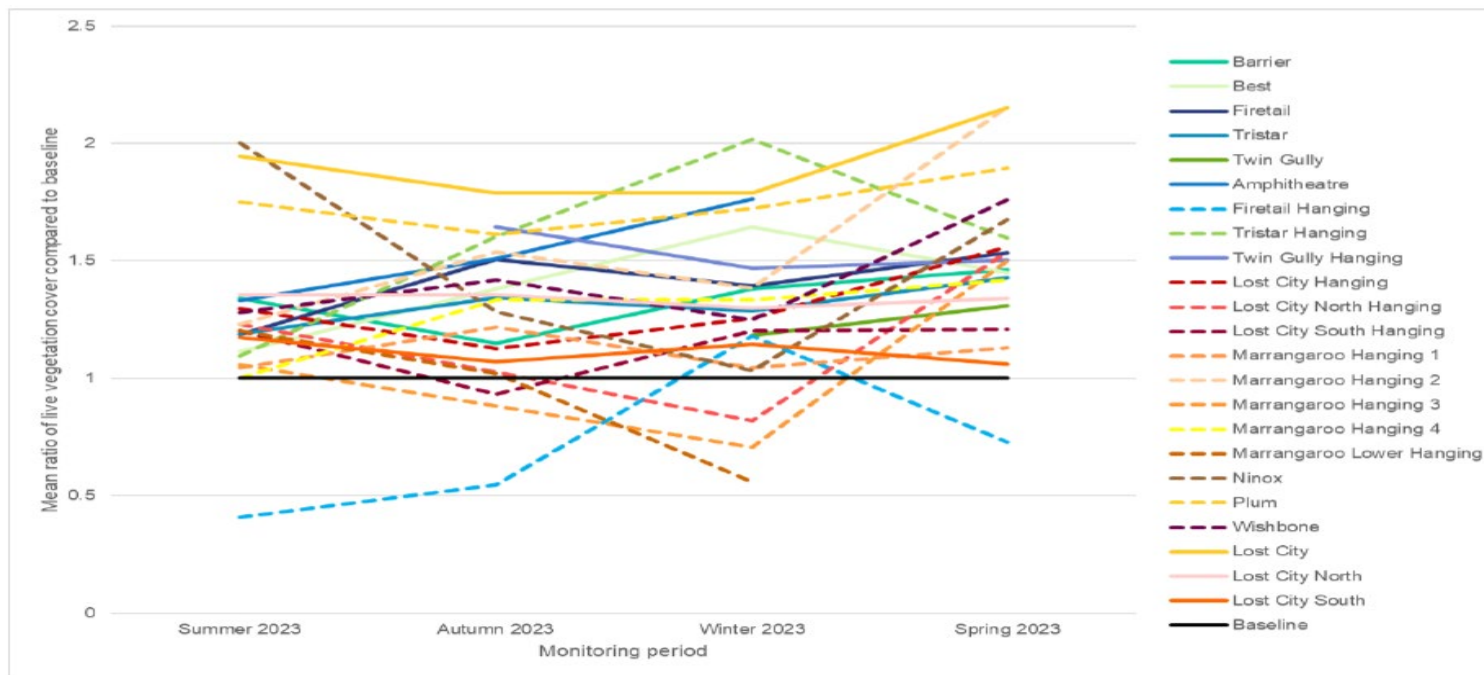


Figure 6-10 Mean ratio of GCP live vegetation cover (%) by swamp and treatment, post-fire baseline

Trigger Update

On 29 September 2022, Springvale notified DPHI of a repeat exceedance of flora thresholds for LW 415-418 at Carne West and Sunnyside East Swamps. Impacts to these swamps had previously been investigated and reported in 2016. In 2023, Springvale reviewed the TARP and provided a copy of the investigation to the report on 28 April 2024. Mining impacts have been recognized in the Swamp Offset Strategy for both Carne West and Sunnyside East Swamps. The Swamp Monitoring Program being reviewed as part of Amendment 2, LW 428-432 Extraction Plan.

East Wolgan Swamp

Annual review of East Wolgan swamp groundwater levels is required in accordance with approval conditions of Section 95(2) Certificates issued under the former NSW Threatened Species Conservation Act (now Biodiversity Conservation Act).

Discussion of the results of water monitoring for East Wolgan Swamp during 2023 reporting period is presented in **Section 7.4** (Water monitoring in Extraction Areas) of this Annual Review.

6.5.2.3 Threatened Species Monitoring - *Boronia deanei*

Monitoring requirements for threatened species including *Boronia deanei* is detailed within the LW 415-432 Swamp Monitoring Program (*Boronia deanei* Research and Monitoring Program). Monitoring locations for threatened species targeted within the SMP is shown on **Figure 6-11**.

Trigger Update

On 25 August 2022, Springvale provided notification of a *Boronia Deanei* flora trigger. A response to the notification was provided by DPHI on 31 August 2022, which approved the collection of monitoring data for an additional 12 months prior to the completion of the investigation report.

On 2 June 2023 Springvale provided DPHI additional monitoring data which demonstrated recovery of swamp vegetation is occurring in most swamps following the bushfires in 2019-2020 however no individual *Boronia Deanei* species have been identified in West Gang Gang Swamp. A decline in population size is also observed between the 2021 and 2022 monitoring events at Carne Central Swamp.

The *Boronia Deanei* Monitoring Program is associated with the subsidence performance measures for swamp ecosystem functionality. Mining Impacts to NPSS are recognised in the approved Swamp Offset Strategy which includes both Gang Gang West and Carne Central Swamp.

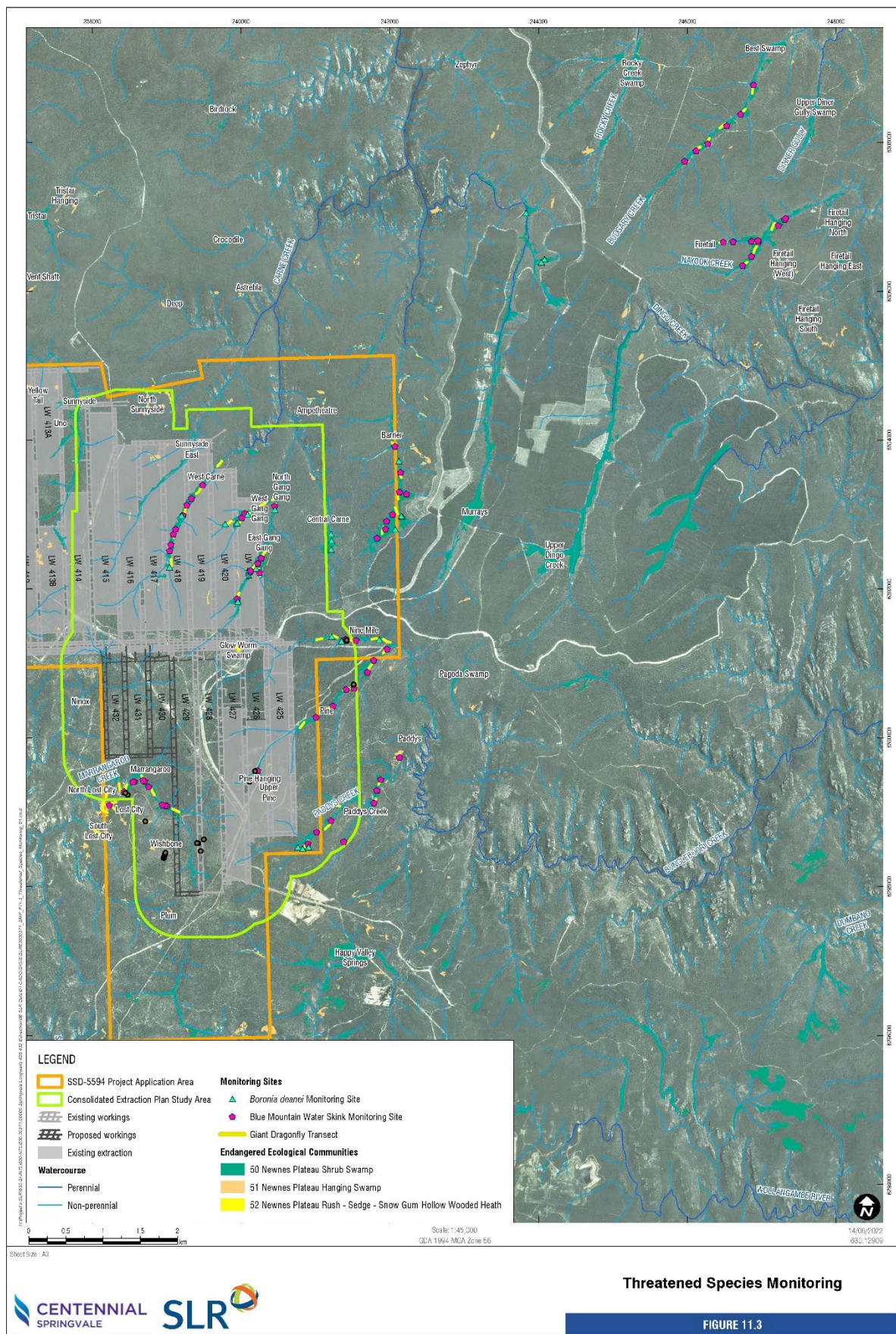


Figure 6-11. Threatened Species Monitoring Locations

6.5.2.4 Threatened Species Monitoring - Giant Dragonfly

Monitoring of the Giant Dragonfly (*Petalura gigantea*) is undertaken in accordance with the requirements of the Giant Dragonfly Research and Management Program required under Section 11.4 of the LW 415-432 Swamp Monitoring Program (SMP).

Before and After Control Impact (BACI) monitoring is undertaken annually between January and February at six impact swamps and three control swamps (refer **Figure 6-11** for no less than five years post-mining in respective panels for LW 418-432). Following the severe 2019-2020 Gospers Mountain fire, the following was included in the program: Post-fire condition assessment; remnant post fire habitat surveys; and a pilot study for sampling of 'environmental DNA' in larval sheddings within its habitat.

2022-23 Summary

Overall, the 2022-2023 Giant Dragonfly observations and habitat values within impact swamps reflect similar trends to control swamps when compared to their corresponding baselines. In total, there were 31 Giant Dragonfly individuals observed within impact swamps (five individuals within LW 419-427 and zero in LW 428-432) and control swamps (26 individuals). Giant Dragonfly observations were generally associated with areas of high habitat values (i.e., higher burrow count, open water availability and soil moisture content) within THPSS environments. Impact swamps continue to exhibit the lowest habitat values (i.e., low burrow count, open water availability and soil moisture content). In the 2019-2020 monitoring event, an increase in Giant Dragonfly activity was observed following the Gospers Mountain fire which resulted in a pulse breeding event (RPS 2022a). Giant Dragonfly observations and habitat have since returned to pre-fire levels for both impact and control swamps.

Therefore, it is considered that there has been negligible change to the composition and distribution of Giant Dragonflies in swamps within this monitoring program.

6.5.2.5 Threatened Species Monitoring - Blue Mountains Water Skink

Monitoring of the Blue Mountains Water Skink (BMWS) (*Eulamprus leuraensis*) is undertaken in accordance with the BMWS Research and Management Program (2015), as approved by DCCEEW on 27 November 2015. The BMWS Research and Management Program satisfied Condition 13 of EPBC 2013/6881. The program is interrelated with the LW 415-432 Swamp Monitoring Program (s11.4.2 BMWS Research and Monitoring Program) and the LW 415-432 Biodiversity Management Plan prepared under SSD5594.

Within the 2022-2023 monitoring period, fewer BMWS' were captured in predicted impact swamps than control non-impact swamps. This occurred for both the spatial and population monitoring programs. A summary of the key findings include:

- Within the population monitoring program, the predicted impact swamps yielded zero BMWS captures for the period, while 21 BMWS were captured in control swamps;
- In both impact and control swamps, there was a decrease in captures across the spatial monitoring program for the 2022/23 period when compared to previous years;
- Barrier Swamp yielded the highest number of neonates during the 2022/23 program with five captures. Additionally, two neonates were caught each in Best and Firetail, and one in Paddy's Creek;
- Morph type 1 (i.e., dark scales over more than half of the ventral surface and a black edge on individual scales) was not observed in juvenile BMWS (i.e., ~1 year old individuals), and morph type 2 (i.e., dark scales up to half of the ventral surface with faint black edges on belly scales) was only observed in individuals >1 year old;
- Blue throats were observed across all age categories of skinks. All skinks of a middle range weight and age (and therefore middle age, i.e., 1-2 years old) had blue throats;
- A total of 45 non-target species were captured within impact swamps across both spatial and population studies, whereas 21 other species were caught in the control swamps; and

- There are four subclusters of genetically different individuals on the Newnes Plateau. Limited dispersal is occurring between swamps (distance travelled by individuals is less than 50 metres). Genetic variation is quite low and there is a positive correlation between isolation and genetic variation.

6.5.2.6 Fauna and Habitat Monitoring

Fauna monitoring at Springvale is currently undertaken in accordance with the Western Region Biodiversity Management Plan (WR-BMP). A Biodiversity and Water Management Plan is also prepared for DCCEEW. The Plan was prepared in accordance with relevant conditions of EPBC Approval 2013/6881. The also considered relevant requirements of the LW 415-432 Biodiversity Management Plan and Water Management Plan which were prepared in accordance with Development Consent SSD5594 and approved in March 2022.

EPBC Act pre-clearance surveys targeting Matters of National Environmental Significance (MNES) that may occur within the area were performed prior to longwall development using methods consistent with relevant Commonwealth threatened species survey guidelines. The LW 428 pre-mining survey (including the Extended Monitoring and Management Area (EMMA)) was completed in November 2021, with no EPBC listed species identified. Copies of the LW 428-432 EPBC pre-mining survey by RPS and the SLR LW 428 pre-mining survey are appended the LW 428-432 Biodiversity and Water Management Plan (March 2022).

As required under EPBC 2013/6881 (as varied 2022) Condition 12e, additional pre mining surveys for LW 429, 430, 431 and 432 were completed in November-December 2022 and March 2023

A wide variety of fauna was encountered during all work phases, including five native amphibians, 23 native birds, one native fish, one native insect, 10 native mammals and two exotic mammals.

A total of seven threatened fauna species were detected during surveys, as summarised in **Table 6-13**.

Table 6-13 Summary of threatened Fauna Encountered During Surveys

Common Name	Scientific Name	BC Act	EPBC Act	Notes
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Vulnerable	Endangered	Single individual seen flying and perching within the Study Area during the November 2022 survey
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	Vulnerable	-	Recorded at all Anabat survey locations in the December 2022 and March 2023 survey
Greater Glider	<i>Petauroides volans</i>	Endangered	Endangered	Presumed single adult individual observed on multiple nights in the same location during the December 2022 survey
Large Bentwing-bat	<i>Miniopterus orianae oceanensis</i>	Vulnerable	-	Recorded at all Anabat survey locations in the December 2022 and March 2023 surveys
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Vulnerable	Vulnerable	Recorded at one Anabat survey location in the December 2022 survey and at all four in the March 2023 surveys
Yellow-bellied Glider	<i>Petaurus australis</i>	Vulnerable	Vulnerable	Multiple adult and sub-adult individuals seen throughout the Study Area during the December 2022 and March 2023 surveys
Yellow-bellied Sheath-tailed bat	<i>Saccolaimus flaviventris</i>	Vulnerable	-	Recorded at one Anabat survey location in the March 2023 survey

Two of the target fauna species were encountered in the Longwall 428 subsidence area. Target species are any species susceptible to subsidence within the surface footprint of Longwalls 428-432 and surrounding lands within a 600m as per the Longwall 415-432 Biodiversity Management Plan required under EPBC 2013/6881 Condition 12. Both species identified were microchiropteran bats ('microbats') and identified by call analysis. These species are listed below and : shown graphically in Figure 6-12.

- Large Bentwing-bat.
- Large-eared Pied Bat.

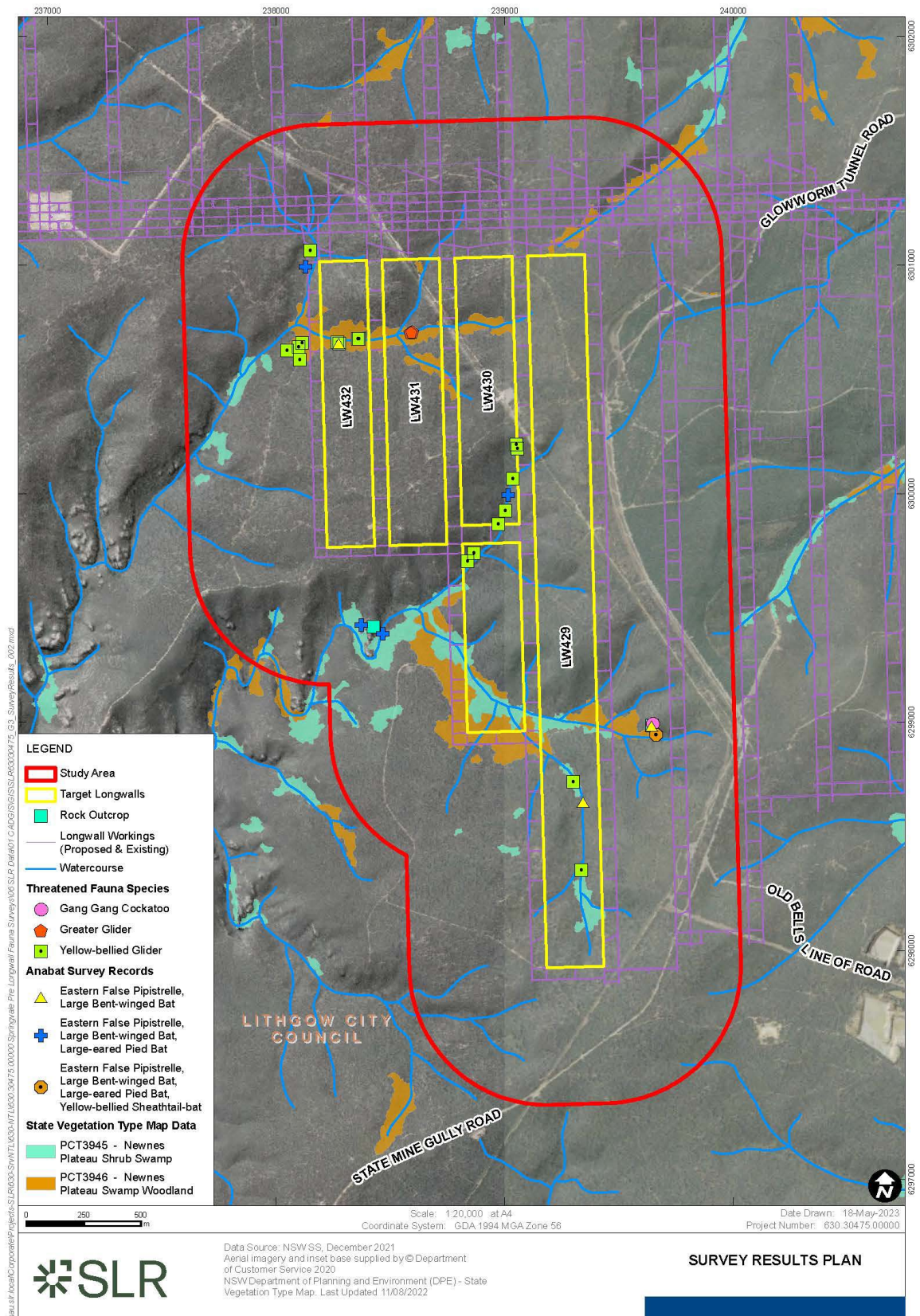


Figure 6-12 Survey Result Plan

6.5.2.7 Aquatic Ecology

Monitoring of aquatic ecology at Springvale is comprised by:

- **Newnes Plateau Swamps** (swamp monitoring, associated with extraction areas)
- **Upper Cocks River Catchment (UCRC)** (creek monitoring, associated with surface operations areas)

Aquatic ecology monitoring for Newnes Plateau Swamps is detailed below. Aquatic ecology monitoring associated with surface operations and the UCRC is detailed in **Section 7.4.2** (Water). Aquatic ecology monitoring associated with extraction areas, including surface waters and groundwater (stygo fauna), is addressed separately in **Section 7.4**.

Newnes Plateau Swamps Aquatic Ecology

Aquatic ecology monitoring is undertaken on the Newnes Plateau in accordance with the Biodiversity Management Plans (BMPs) approved under related Extraction Plans. These include monitoring of Newnes Plateau swamps and associated waterways, including macroinvertebrate sampling and aquatic habitat assessments. Monitoring location sites are summarised in **Table 6-14** below.

Table 6-14: Aquatic Monitoring Locations of Newnes Plateau

Site	Site Type	Catchment Area	Description
CC1	Undermined	Carne Creek	Located downstream of Sunnyside East Swamp.
CC2	Undermined	Carne Creek	Located at the downstream end of Carne West Swamp.
CC3	Undermined	Carne Creek	Located at the downstream end of Gang Gang Swamp, below the confluence of two swamp flow channels.
CC4	Reference	Carne Creek	Located at the downstream end of a hanging swamp adjacent to Barrier Swamp.
CC5	Undermined	Carne Creek	Located below confluence of upper catchment tributaries draining CC1 and CC2-CC3.
BCN2	Undermined	Bungleboori Creek (Nine Mile Creek)	Located on the northern unnamed drainage to Bungleboori Creek tributary that drains Pine Swamp.
MC1	Undermined	Marrangaroo Creek	Located in upper Marrangaroo Creek.
PC1	Undermined	Paddys Creek	Located midway along Paddys Creek below two swamps.

¹ Approved swamp offset under related offset strategies approved under SSD5594 and EPBC conditions of approval as detailed in Section 6.5.6.2 of this annual review.

Aquatic ecology macroinvertebrate sampling and aquatic habitat assessments were undertaken by GHD in 2023. Aquatic ecology monitoring was conducted at eight swamp sites in autumn and spring 2023, including:

- One reference site, which will not be impacted by mining
- Seven potentially influenced sites, the headwaters of which have been undermined

CC2 and CC3 were dry in autumn and spring 2023 and were consequently not able to be sampled for water, sediment, or macroinvertebrates in 2023. Water at swamp sites was dilute, and dissolved aluminium was the only parameter observed in concentrations likely to cause biological effects to aquatic species in autumn and spring 2023. The similarity in dissolved aluminium concentrations between sites, including the reference site, indicates that the local lithology is the source of the aluminium. There were no other toxicants observed in concentrations that may cause biological effects in 2023. There were also no sediment metals that were observed in concentrations high enough to cause biological effects at any site in either autumn or spring 2023. Based on these results, there is no evidence of impacts from Springvale mining on the water or sediment quality of the assessed Newnes Plateau Swamps. Historically elevated concentrations of NO_x and dissolved cobalt, copper and zinc observed

at some of the monitoring locations was attributed to impacts from the 2019-2020 Gospers Mountain bushfire.

There was no indication of impacts from undermining on the macroinvertebrate communities in 2023, notwithstanding, the previously observed loss of the macroinvertebrate community from CC2 and CC3. Differences observed in macroinvertebrate results between sites are most likely due to differences in habitat and flow conditions, given the similar water and sediment quality observed at all sites in 2023. Results in 2023 showed improvement at all sites compared to 2020 to 2021 results, indicating continued improvement following the end of drought conditions and regeneration of vegetation following the bushfire. Only results at MC1 in autumn 2023 showed any impairment compared to historical results, though conditions were much improved in spring 2023. Although mining commenced in 2022 in LW 428, located under the headwaters of Marrangaroo Creek Swamp, macroinvertebrate results at MC1 in 2022 and 2023 were in better condition than those observed in 2021, prior to any mining influence, suggesting that other factors including high flows and habitat availability may be contributing to the impairment observed in the autumn 2022 to autumn 2023 macroinvertebrate results.

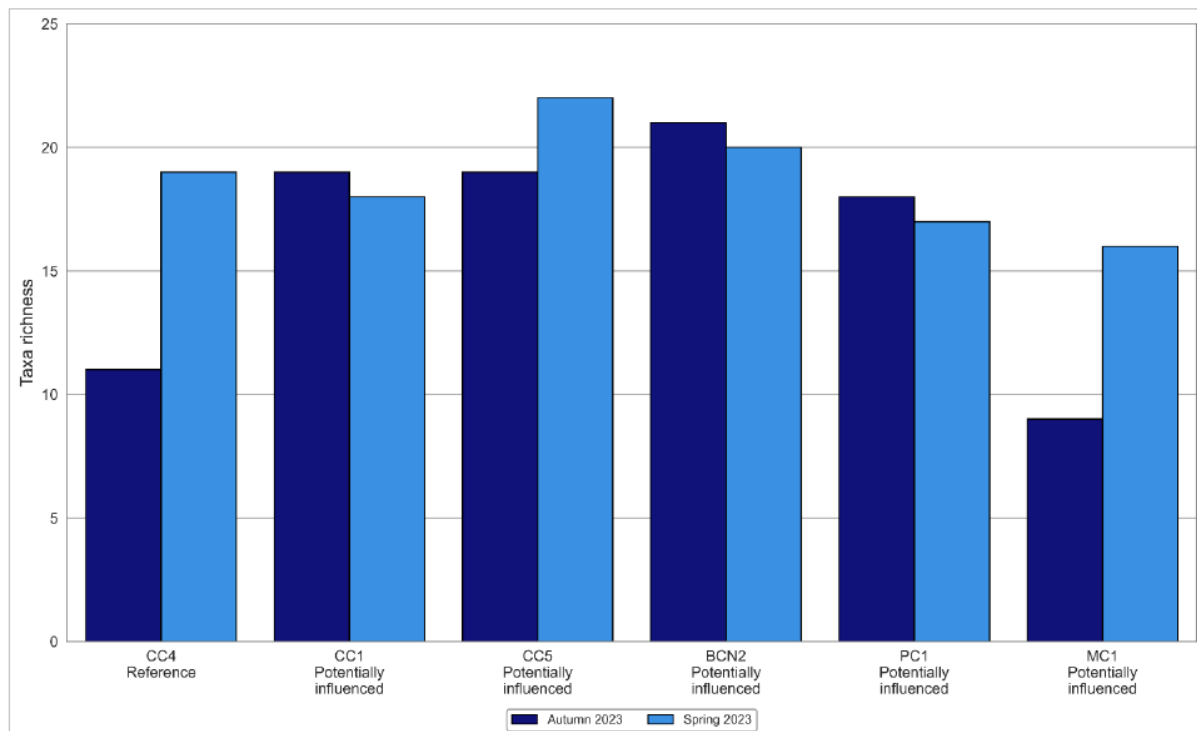


Figure 6-13: Taxa richness in Newnes Plateau swamp site samples, autumn and spring 2023.

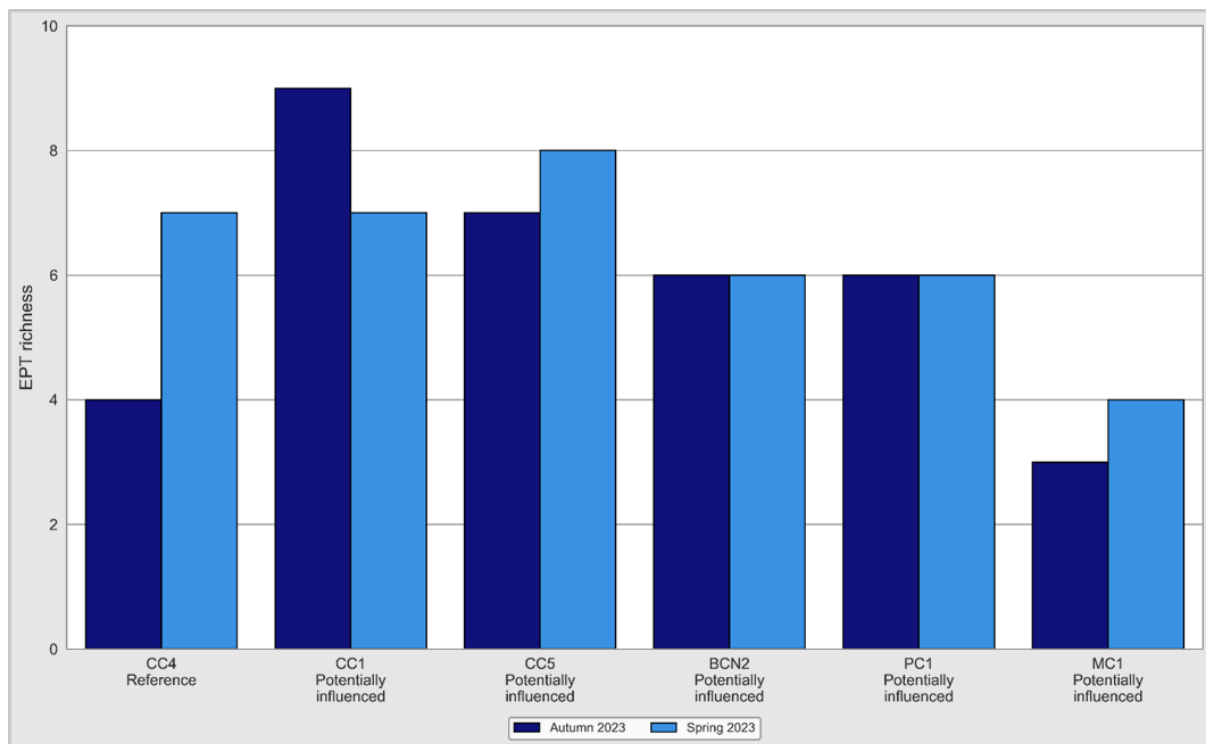


Figure 6-14: EPT richness in Newnes Plateau swamp site samples, autumn, and spring 2023.

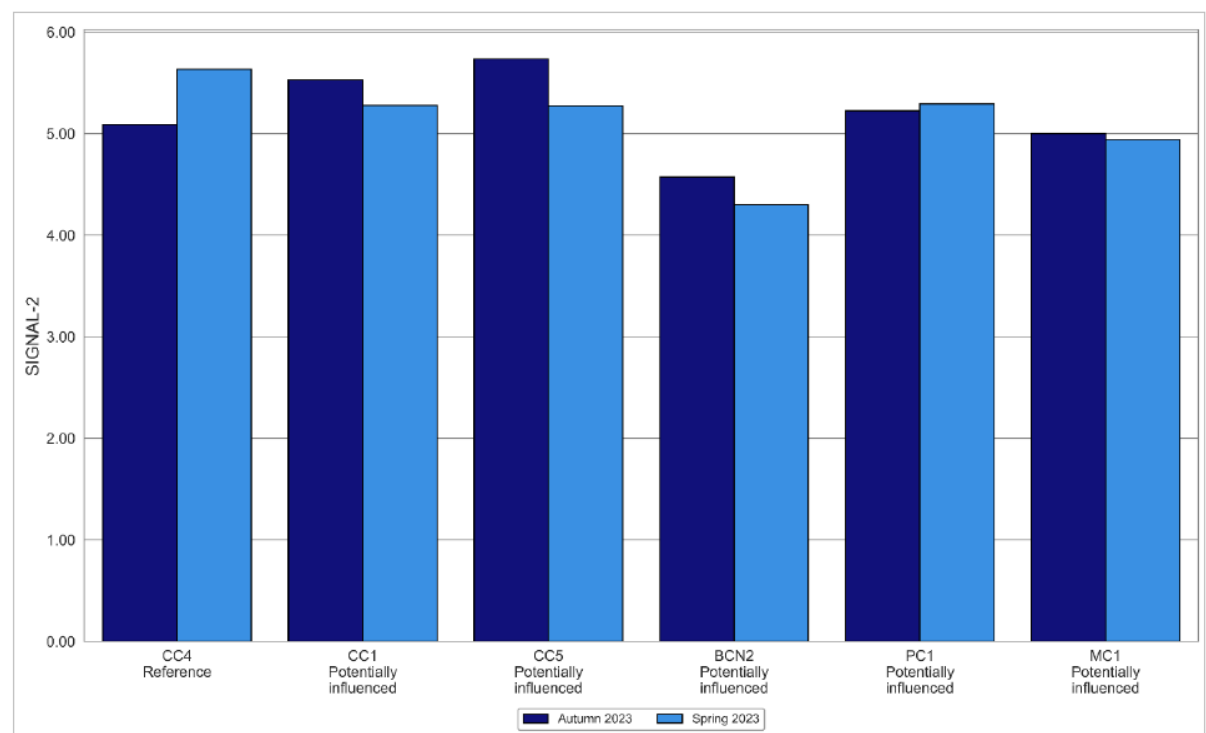


Figure 6-15: SIGNAL-2 in Newnes Plateau swamp site samples, autumn, and spring 2023.

Aquatic Ecology - Upper Cocks River Catchment

Detailed discussion of aquatic ecology monitoring in the UCRC undertaken in accordance with the Upper Cocks River Aquatic Ecology Monitoring Program (AEMP) is provided separately in **Section 7.3.2.2** of this Annual Review.

6.5.3 Comparison against Predictions

An interrelationship exists between the conditions of approval and impacts predicated in the subsidence and environmental assessments which form components of approved Extraction Plans. To ensure information is not misrepresented in the summary presented in the Annual Review, both the Approval and Extraction Plans available on the website shall be referred to for detail on the predictions for the Project.

Approved performance measures of SSD5594 and EPBC approvals and related predictions are used to establish the staged triggers of TARPs in approved management and monitoring plans for the project, including BMPs and SMPs among others. Approved offsets for biodiversity including impact swamps are detailed in **Section 6.5.6**.

6.5.4 Long Terms Analysis

Historical performance by previous mining activities in areas prior to LW 428-432 Area (current EP Area) have been reported in past annual reviews available on the Centennial Springvale website. In accordance with the approved Springvale Swamp Offset Strategy identified NPSS impact swamps have secured appropriate offsets satisfying both state and Commonwealth requirements.

Since the granting of the SSD5594 development consent, and as the understanding of how NPSS were impacted by mining, further adaptive management measures have been committed to by Springvale Coal to minimise the risk or extent of impacts to NPSS. These measures included:

- Removing LW 422, 423 and 424 from the proposed mine plan.
- Shortening LW 421, 425 and 427 to avoid mining through major lineaments.
- Reduction in longwall lengths to both longwalls 429, 430, 431 and 432.

The adaptive management mine plan changes resulted in the sterilisation of approximately 8.8 million tonnes of coal resource and a three year reduction in the production life of Springvale. Despite the measures taken to minimise the risk of impacts to NPSS through adaptive management mine plan changes, changes to groundwater levels in NPSS have been measured that can be attributed to Springvale's previous mining activities. Accordingly, greater than negligible impacts to NPSS from past and future mining have been **offset** in accordance with SSD5594 and EPBC conditions of approval, as detailed further in **Section 6.5.6**.

6.5.5 Implemented / Proposed Improvements

- Centennial Springvale will continue to monitor and manage biodiversity in accordance with the relevant management plans, strategies, and approvals.
- In accordance with the Springvale Swamp Offset Strategy approved by DPHI and DCCEE, Springvale will continue to prepare a detailed Environmental Monitoring Report for each THPSS within the Consolidated Approval Area that provides an analysis of monitoring data, identifies if impacts are mining related and assess the extent of any impact to NPSS and associated threatened species.
- In accordance with Condition 12e under EPBC 2013/6681 (as varied 2022), additional pre mining surveys for LW 429, 430, 431 and 432 was completed by March 2023.

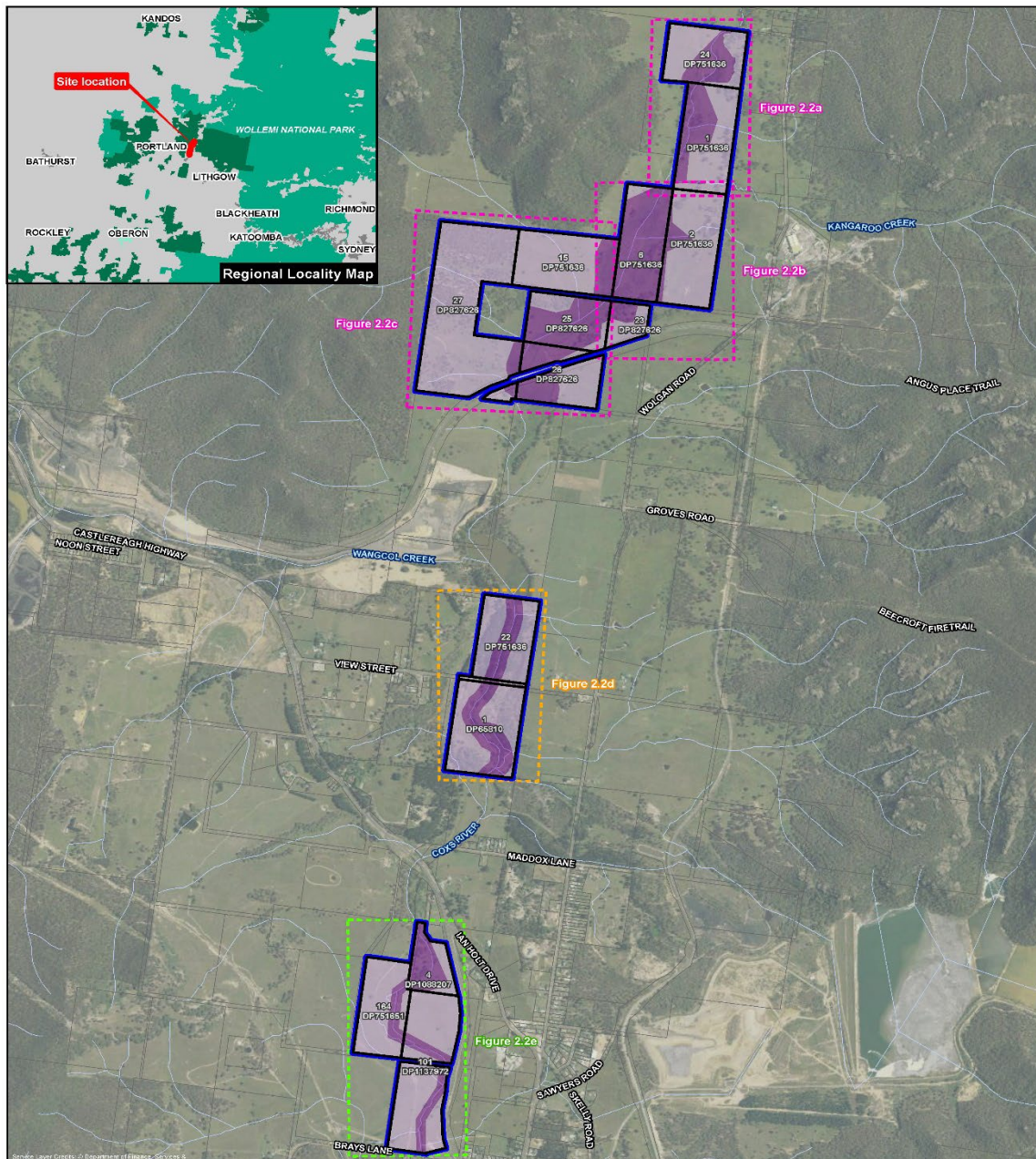
6.5.5.1 Coxs River Land Management

Monitoring of catchment improvements targeted under the CILMP are undertaken in accordance with Section 3.5 of the CILMP, which requires the Annual Review to report monitoring and management activities undertaken. Sections 4 and 5 of the CILMP describes the schedule of works for each year and completion criteria subject to reporting. The location of the two management areas and three component sites is presented in **Figure 6-16**.

Monitoring works required under Section 3.5 of the CILMP include:

- Annual photo monitoring
- Quarterly routine site inspections
- Biannual and annual reporting
- Water quality monitoring as described in the UCRAMP (Upper Coxs River Action and Monitoring Plan), reported in **Section 7** of this Annual Review and
- Annual and 3-yearly review of the CILMP

The above monitoring requirements were all completed during the current reporting period. The work plan is currently being undertaken by a bush regeneration specialist. The status of management works is presented in **Table 6-15**.



LEGEND

Project Site	Centennial Owned Lots	CILMP North
Riparian Management Area	Cadastre	CILMP Central
Land Management Area	Waterways	CILMP South

Scale: 0 200 400 800 Metres Map Projection: Transverse Mercator Horizontal Datum: GDA 1994 Grid: GDA 100M MGA Zone 58	 	Centennial Coal Pty Ltd Cox's River RHCIP Cox's River CILMP Site Location	Job Number: 22-19098 Revision: A Date: 26 Sep 2017 Figure 2.1
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 Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydney@ghd.com.au W www.ghd.com.au
 © 2017. Whilst every care has been taken to prepare this map, GHD and NSW Department of Lands, Centennial Coal, SELLmaps 2017. Centennial Coal Australia make 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 errors, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.
 Data source: General topo - NSW LPI DT09 2015 & 2012; Aerial Imagery - SELLmaps 2017; Vegetation mapping & Cox's River Lots - Centennial Coal; Inset map - Geoscience Australia. Created by jplie

Figure 6-16. Cocks River Land Improvement Management Site Location

Table 6-15: CILMP Management Activities

Site	Management Works	Status	Year Complete
CILMP North	Fence Installation	New fencing installed on the eastern side 2020 is in good condition. Cattle are still accessing the riparian management area, cattle movements in the northern section are absent.	2020
	Cattle crossing stabilisation and bank stabilisation and flows control	Reviewed in 2023 - The river base is rocky and is stable. Rescheduled as unable to bring in excavator into the site to undertake earthworks and rock work.	Ongoing
	Environmental and noxious weed control	Primary weed control carried out and completed. Secondary control weed control rescheduled to H1 2024: the site has not been accessible to vehicles due to the wet conditions and surface water.	Ongoing
	Revegetation: shrub/canopy mid-upper banks	Completed in 2021 – Reviewed in 2023. Plants established well. Planting numbers are in accordance with the plan. Success rates have met target survival rates.	2021
	Revegetation: instream/bank stabilisation	Reviewed in 2023 due to site not being accessible to vehicles due to wet conditions and surface water. Work to be rescheduled.	Ongoing
	Revegetation: Revegetation watering and maintenance	Reviewed in 2023 - Plants have established. Some eucalypts observed to be over 2m in height.	Ongoing
	Mountain Hollow Grassy Fen re-wetting	Reviewed in 2023 - Work has been successful in southern section. Northern section to be rescheduled.	Ongoing
CILMP Central	Environmental and noxious weed control	Reviewed in 2023 - Weed management rescheduled to H1 2024: the site has not been accessible to vehicles due to the wet conditions and surface water.	Ongoing
	Revegetation: shrub/canopy mid-upper banks	Reviewed in 2023 - Rescheduled for 2024: the site has not been accessible to vehicles due to the wet conditions and surface water.	Ongoing
	Revegetation: Revegetation Watering and Maintenance	Reviewed in 2023 - Rescheduled for 2024: the site has not been accessible to vehicles due to the wet conditions and surface water.	Ongoing
CILMP South	Fence Installation	Fence in good condition.	2020
	Environmental and Noxious Weed Control	Primary weed control carried out and completed. Secondary control weed control rescheduled to H1 2024: the site has not been accessible to vehicles due to the wet conditions and surface water.	2021
	Bank Stabilisation and Flow Controls	Reviewed in 2023 - Rescheduled as unable to bring in excavator into the site to undertake earthworks and rock work.	Ongoing
	Revegetation: shrub/canopy mid-upper banks	Reviewed in 2023 - Planting completed.	Ongoing
	Revegetation: In-stream/bank stabilisation	Reviewed in 2023 - instream growth of macrophytes has increased with silt deposits being colonised by sedges and rushes. It is not considered necessary to undertake additional planting. Carex and juncus species naturally regenerating on the edge of the Coss River. Blechnum fern growing on the river bank, frequently observed along the river.	Ongoing
	Revegetation: Revegetation watering and maintenance	Forestry tube stock planted supplied by Lithgow community nursery.	2021

6.5.6 Biodiversity Offsets

Springvale mine manages biodiversity offsets in accordance with the Western Region Biodiversity Offset Strategy for surface disturbance offsets, and the Springvale Swamp Offset Strategy for subsidence-related offsets relating to underground mining. These are discussed separately in the following sections.

6.5.6.1 Western Region Biodiversity Offset Strategy

Management of offsets relating specifically to applicable surface clearing disturbance for Springvale Mine is undertaken in accordance with the Western Region Biodiversity Offset Strategy (WR-BOS). Version 8 of the WR-BOS (Nov 2020) was approved by DPHI on 27 January 2021.

In accordance with the NSW Framework for Biodiversity Assessment (FBA), the WR-BOS addresses vegetation impacts specifically related to surface clearing of vegetation only. Accordingly, the WR-BOS was prepared to offset 8.94ha of surface disturbance associated with the Springvale Mine Extension Project including Springvale Bore 8, satisfying Conditions 15, 16 (Schedule 3) and 5 (Schedule 4) of SSD5594. For clarity and completeness the WR-BOS also offsets the Springvale Water Treatment Plant under a separate consent SSD7592, which is reported under a separate Annual Review.

Under the WR-BOS, supporting plans of management for each offset area prescribe monitoring and reporting requirements to the NSW Biodiversity Conservation Trust (BCT). These include:

Conservation Agreement Sites:

- Carinya Biodiversity Offset Management Plan (Carinya BOMP) CA292

BioBanking Sites:

- Pipers Flat Lot 5 Biodiversity Offset Management Plan (PF-BOMP) BA448
- Springvale Lot 125 Biobanking Management Plan (SVL125-BBMP) BA425
- Wolgan Road Lot 56 Biobanking Offset Management Plan (WRL56-BBMP) BA427

Figure 6-17 shows the Biodiversity Offset sites for the Western Region applicable under the WR-BOS.

In 2023 management activities have focused on weed management using a vehicle mounted spray rig where possible.

- CA292: Target species were Prickly Pear, Blackberry and St Johns Wort. St Johns wort and Prickly Pear were found in medium densities in open areas, while blackberry was located in creek/gully areas in low-medium density.
- BA448: Target species were Blackberry and Sweet Briar with low-medium densities treated in southern portions of property. Plants were mostly found in low lying areas and gullies as well as on banks of nearby lake/dam. Northern parts of the property (higher elevation) were found to be weed free.
- BA425: Target species was blackberry. A knapsack was required to be used at this site as vehicle access is not possible.
- BA427: Target species were Blackberry and Sweet Briar. Blackberry was found in high density below timbered areas, encroaching on mostly weed-free river flats. St John's Wort was found in medium density in the same areas, with sweet briar occurring throughout in lesser quantities.

Springvale has submitted Annual Management Reports to BCT for these sites to address reporting requirements for the sites.

In addition to formal registered offsets, the WR-BOS also includes **Supplementary Offset Measures** whereby research funding contributions are made to assist a number of threatened species where actions for recovery can be supported by additional investment in research, including for *Persoonia hindii*; and *Caesia parviflora var. minor* as outlined below.

Persoonia hindii

Schedule 2, Condition 19C of Springvale's Development Consent 11/92 which required the development of a *Persoonia Hindii* Management and Research Program to mitigate impacts to *Persoonia hindii* (*P. hindii*) from the development of Bore 8. No translocation was required for Bore 8 project as project management was able to locate the pipeline away from plant colonies during project execution.

P. hindii monitoring, management and research programs are now reported under Angus Place project approval MP06_0021, Condition 24A to address residual offset requirements for the loss of *P. hindii* as a result of the Angus Place Ventilation Shaft.

Caesia parviflora var. minor

The project highlights documented in The Conservation genomics of *Caesia parviflora var. minor* in support of management and translocation activities Report (August 2022) are:

- *Caesia parviflora var. minor* is genetically akin to *C. parviflora var. parviflora* such that both should be lumped as one taxonomic entity and the endangered status of *C. parviflora var. minor* should be reassessed;
- More intensive sampling of *C. parviflora var. minor* and *var. parviflora* is recommended to ascertain the geographic extent of the taxon that encompasses both *C. parviflora var. minor* and *var. parviflora*;
- Low genetic variability is present at the Newnes population indicating that genetic rescue through mixing with nearby *C. parviflora var. minor* or *var. parviflora* populations is likely to be beneficial.

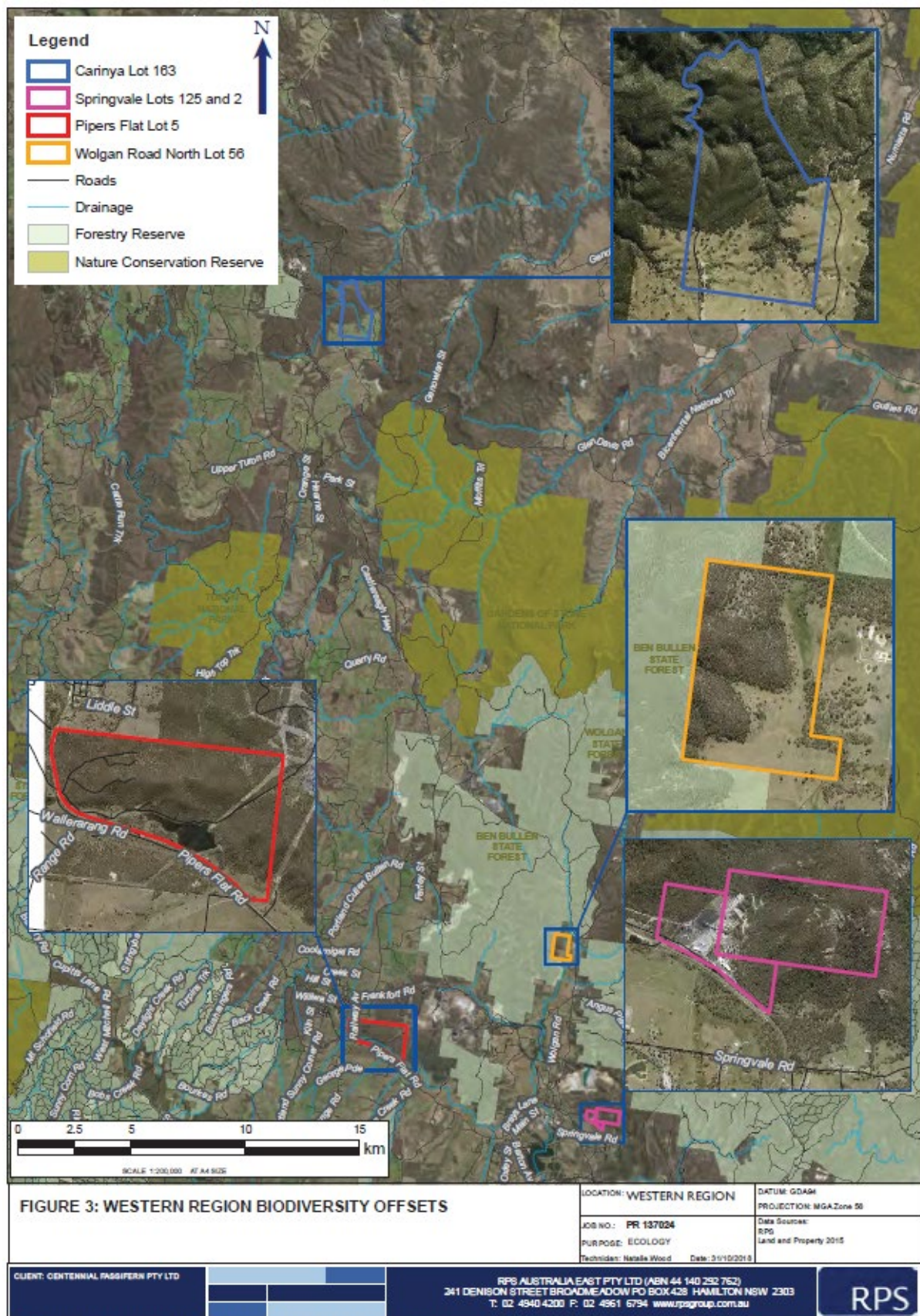


Figure 6-17: Western Region Biodiversity Offset

6.5.6.2 Springvale Swamp Offset Strategy

The Springvale Swamp Offset Strategy was developed to satisfy EPBC and SSD5594 approval requirements (including Conditions 3, 4 and 5 of Schedule 3 in SSD5594) for offsets to be secured should greater than negligible impacts to THPSS and associated threatened species be realised due to mine subsidence.

The Springvale Swamp Offset Strategy was revised during the 2022 reporting period and Version 8 (Feb 2022) was conditionally approved by DPHI on 28 March 2022. Following a minor amendment V8.1 (April 2022) was submitted to the Commonwealth Department of Agriculture Water and the Environment (now DCCEEW) in relation to EPBC approvals 2011/5949 and 2013/6881 for LW 415-417 and was approved on 27 April 2022.

The strategy was revised in August 2022 (V9) to include details of the payments and bank guarantees set out in the executed offset deed and was submitted to DPE and now DCCEEW for approval on 5 August 2022. DPHI approved the revised offset strategy on 16 August 2022.

6.6 HERITAGE

6.6.1 Environmental Management

Springvale manages Aboriginal Heritage in accordance with the Western Region Aboriginal Cultural Heritage Management Plan (WR-ACHMP) which was approved by DPHI on 14 October 2021. This followed MOD3 to SSD5594 on 2 June 2021 to address two recently identified Aboriginal Cultural Heritage sites identified during due diligence surveys undertaken in accordance with the WR-ACHMP.

European Heritage is managed in accordance with the Historic Heritage Management Plan (HHMP) dated June 2018. The plan was approved by DPHI on 4 July 2018. Heritage management is also included within each Extraction Plan. The Springvale HHMP is also supported by the Western Region Historic Heritage Management Plan (WR-HHMP). Rev 4 (Sep 2021) of the WR-HHMP.

The management of heritage items within specific EP Areas (longwall mining areas) is also included within each Extraction Plan, including the *Land Management Plan for LW428-432*.

6.6.2 Environmental Performance

Indigenous Heritage

Aboriginal cultural heritage sites located within LW 428-432 EP Area are illustrated on **Figure 6-18**, including existing registered sites located over LW 427 (45-1-2805, grinding grooves) and LW 428 (45-1-002, grinding groove – axe) as relevant to secondary extraction undertaken during the 2023 reporting period.

Five registered sites are located in the LW 428-432 EP Area in total, two of which are in the extended area within 600m of longwall panels. Other registered sites located within these EP Areas and over previously mined longwalls (including site 45-1-005 over LW 426) are also illustrated on **Figure 6-18**.

Potential impacts to 45-1-005 and 45-1-2805 have been avoided due to the longwall being shortened as shown in **Figure 6-18**.

On 15 March 2023 a 3D laser scanning survey was undertaken at AHIMS Site 45-1-0002 which is a grinding groove. Representatives from Wellington Valley Wiradjuri Aboriginal Corporation, Warrabinga Native Title Claimants Aboriginal Corporations and North-East Wiradjuri Corporation attended the baseline survey.

This site was originally recorded in 1977 as a “grinding groove site on a large flat outcropping of sandstone with pooling of water after rainfall”. Twelve grinding grooves on a flat rock surface were recorded on the original site card. However, three clusters and eight grooves were located during the site visit due to damage from recreational activities and leaf litter. The grinding grooves were visible within a total area of 12 metres by four metres.

Access to the site has been restricted through the placement of large trees however it is evident some recreational users of the park are still accessing the site.

The Phase 2 Survey has been scheduled for Q1 2024 due to timing of undermining.

European Heritage

No heritage items listed on the Commonwealth Heritage Register, the NSW State Heritage Register (SHR), and the s170 registers (state owned items) have been identified in the Springvale lease boundary from searches conducted in January 2016. Additionally, no unlisted heritage items have been identified to date within the Springvale Lease Boundary, including by specialist assessments undertaken for the EIS and subsequent extraction plans.

The Lithgow City Council LEP, Schedule 5 – Environmental Heritage identifies three (3) heritage items of local significance within the Springvale Lease Boundary. One site is located within the LW 428-432 Extraction Plan Area (Wolgan Valley Railway Corridor associated with

the Zig Zag railway). The railway is managed in accordance with procedures outlined in the LMP.

No impacts to heritage sites were identified by subsidence and environmental monitoring undertaken during the 2023 reporting period, as presented in associated quarterly Extraction Plan reporting.

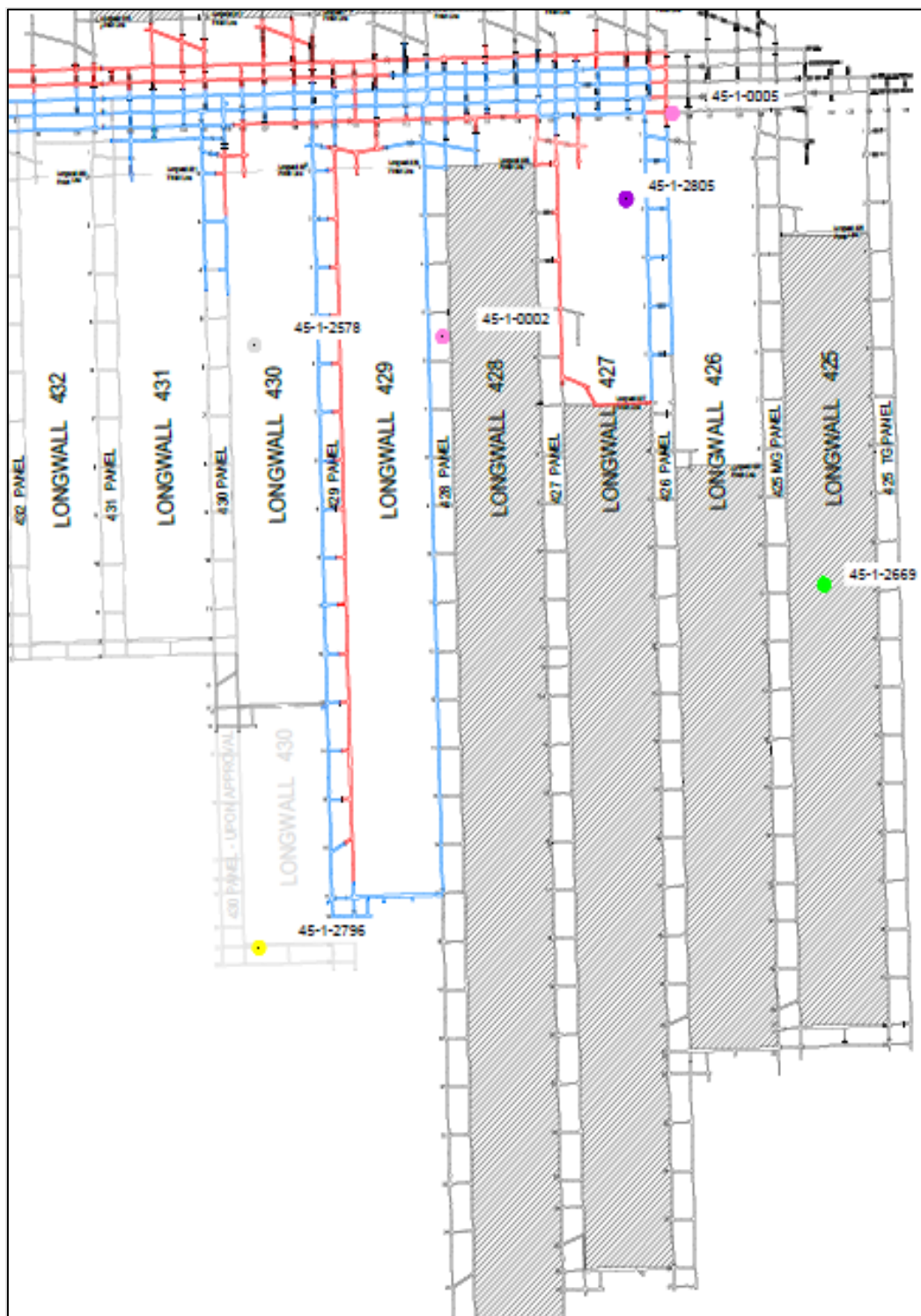


Figure 6-18 Springvale Southern Longwall Blocks Area with AHIMS Sites

6.6.3 Comparisons against Predictions

The report by MSEC (2020) prepared for Modification 3 of SSD5594 provides subsidence predictions for all sites (Aboriginal and European), providing maximum predicted tilt, curvature and strain with predicted values based on the EIS layout.

Table 6-16 below provides a summary of EIS predictions for potential impact to indigenous and historic heritage, and performance during the 2023 reporting period. There has been no impact due to mining operations observed to Indigenous or European heritage identified by monitoring during the 2023 reporting period.

Table 6-16. Summary of Heritage Impact Predictions and Performance during 2023

Summary of Predicted Environmental Impacts	Performance During the Current Reporting Period
Aboriginal Cultural Heritage: - Of the 34 Aboriginal cultural heritage sites recorded within the original EIS Project Area, three sites were predicted to experience subsidence >20mm as follows: - Predicted subsidence at sites 45-1-0005 (50mm) and 45-1-0065 (25mm) is not expected to damage these two sites. Tilts, strains and curvature are predicted to be negligible at these two sites. - Subsidence at site 45-1-0002 may cause the sandstone where the grinding groove is or was located to fracture and damage the site should it still remain. The recent survey was unable to find any evidence remaining of the site, probably due to the extensive vehicle traffic. - Two newly identified ACH sites were also included under MOD3 to SSD5594, with potential impact predicted as: - AHIMS 45-1-2805: Fracturing of bedrock in the vicinity of the site, typically between 10 mm and 50 mm wide, however potentially up to 200 mm wide. Likelihood that fracturing would coincide with site 45-1-2805 is low (less than 10%). - AHIMS 45-1-2796: Minor surface cracking in vicinity of site. Artefact unlikely to be impacted. MSEC (2020) predicted: - Sagging curvature slightly increases for artefact site 45-1-2669, however predicted hogging curvature for this site decreases. Potential for surface cracking in this location does not change. It is unlikely that artefact scatter sites would experience adverse impacts due to surface cracking - Unlikely that grinding groove sites and rock shelters would experience adverse impacts due to their distances from the longwalls.	Subsidence and associated monitoring undertaken during 2023 indicates no significant impact due to mining operations.
European Heritage: - No historic heritage items or areas have been identified within the Project Area and accordingly no historic heritage consequences are predicted. - The nearest conservation reserve, the Gardens of Stone National Park (part of the larger National Heritage Place and World Heritage Area) will not experience any measurable subsidence movements as a result of the Project.	Not applicable (no sites with potential for impact).

6.6.4 Long Term Analysis

Table 6-17 summarises heritage impact performance over the last five reporting periods for any exceedances above approved impacts / TARP condition red.

Table 6-17: Long Term Heritage Monitoring Trends (recorded impacts exceeding approved conditions/TARP exceedances)

Project Approval Location	2019	2020	2021	2022	2023
Historic Heritage sites	0	0	0	0	0
Aboriginal and Cultural Heritage sites	0	0	0	0	0

6.6.5 Implemented / Proposed Improvements

Springvale will continue to monitor and implement mitigation and management measures (as triggered) to ensure inadvertent harm to sites can be avoided.

Western Region Heritage Committee Meetings were held on 15 March 2023 and 13 September 2023.

The land disturbance due diligence process implemented by site is considered appropriate for the management of heritage items.

6.7 MINE SUBSIDENCE

6.7.1 Environmental Management

During the 2023 reporting period, secondary extraction was undertaken in LW 428 as described further in **Section 6.7.2**.

Subsidence Monitoring Programs (SMP) are developed for each Extraction Plan. The Extraction Plans approved under SSD5594 to date are listed in **Section 3.1.2** of this Annual Review. Results pertaining to the Subsidence Monitoring Program (including built features and public safety are listed as follows:

- Unsealed roads and culverts;
- Cliffs, minor cliffs and pagodas;
- Steep slopes and rock outcrops;
- Heritage items; including:
 - Five Aboriginal sites registered on the Aboriginal Heritage Information Management System (AHIMS); and
 - The Wolgan Valley Railway Corridor
- Drainage lines; and
- Surface cracking;
- Groundwater bores, with locations obtained from the National Groundwater Information System;
- Two permanent survey control marks (SS 19176 and SS 21304); and
- Mine related exploration boreholes (noting these are not shown on figures).
- 11kV and 66kV powerlines

Monitoring summaries associated with other environmental aspects (including but not limited to water, biodiversity and heritage) are presented separately in other relevant sections of this Annual Review (sections 6 and 7).

Monitoring of subsidence within the LW 428-432 EP Area includes:

- Visual inspection program
- Photographic monitoring
- Conventional survey of subsidence lines above extracted longwall panels
- LIDAR remote surface survey monitoring

Further details including method and frequency are detailed in the approved monitoring programs available on the Springvale website.

6.7.2 Environmental Performance

Performance Measures

Subsidence performance measures prescribed within SSD5594 relevant to subsidence impact and performance are presented in **Table 6-18: Heritage, Natural, Built Features & Public Safety Performance** below.

Table 6-18: Heritage, Natural, Built Features & Public Safety Performance Measures

Heritage and Natural Features (Cond1, Sch3)	Performance Measure
Water Resources	
Wolgan River, and other watercourses located outside the site	Negligible subsidence impacts or environmental consequences including: - Negligible diversion of flows or changes in the natural drainage behavior of pools; - Negligible reduction in water quality - Negligible increase in bank erosion or sediment load.
Carne Creek, Marrangaroo Creek and Paddys Creek	No greater subsidence impacts or environmental consequences than predicted in the EIS
All other watercourses	No greater subsidence impacts or environmental consequences than predicted in the EIS
Swamps	
Shrub swamps. Sunnyside and Nine Mile	Negligible environmental consequences including: - Negligible change to the shallow groundwater regime when compared with control swamps - Negligible erosion of the surface of the swamp - Negligible change in the size of the swamp - Negligible change in the ecosystem functionality of the swamp - Negligible change to the composition or distribution of species within the swamp - Negligible change to the structural integrity of the bedrock base or any controlling rockbar/s of the swamp
Hanging swamps	Negligible environmental consequences including: - Negligible change in the size of the swamp; - Negligible change in the ecosystem functionality of the swamp; and - Negligible change to the composition
Land	
Cliffs, minor cliffs, steep slopes and pagoda formations	No greater subsidence impacts or environmental consequences than predicted in the EIS.
Biodiversity	
Threatened species, populations or their habitats and EECs (except Sunnyside East, Carne West, Gang Gang South West, Gang Gang East, Pine, Pine Upper, Paddys, Marangaroo Creek and Marrangaroo Creek Upper Swamps)	Negligible environmental consequences

Heritage Features	
Aboriginal heritage sites identified in Appendix 6 (except sites 45-1-002, 4-1-005, 45-1-2805 and 45-1-0065)	Negligible subsidence impact or environmental consequences.
Aboriginal heritage sites 45-1-002, 45-1-005, 45-1-2805 and 45-1-065	No greater subsidence impact or environmental consequences than predicted in the EIS.
Historic heritage sites	Negligible subsidence impact or environmental consequences.
Mine Workings	
First workings beneath any feature where performance measures in this table require negligible subsidence impact or environmental consequences. First workings within a 26.5 degree angle of draw cliffs.	To remain long-term stable and non-subsiding
Second workings	To be carried out only in accordance with an approved Extraction Plan.
Built Features & Public Safety (Cond7, Sch3)	
Key public infrastructure: Lithgow Water Supply Dam	No damage or additional risk
Power transmission lines and associated towers, unsealed roads and road culverts, fire trails, other public infrastructure, fences and other built features	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repairable and must be fully repaired or else replaced or fully compensated.
Public Safety	
Public safety	Negligible additional risk

Survey Results

During the 2023 reporting period, coal was extracted from LW 428.

Extraction of LW 428 commenced on 26 March 2022. LW 428 has a total length of 3135 metres (m) a void width of 259.9 m (including first workings) and a maximum cutting height of up to 3.4 m. The total chainage of LW 428 was 3115 at 31 December 2023.

Development (1st workings) continued within the EP Area including for LW 429 and 430.

Photographic survey monitoring was undertaken for:

- LW 428 quarterly monitoring during extraction (baseline was completed 2020); and
- Baseline LW 429 was completed between June and August 2022

LIDAR monitoring of the EP Area is undertaken at the completion of each longwall panel. Accordingly, LIDAR monitoring for LW 427 was undertaken during the first quarter of the 2022 reporting period.

Table 6-19 presents the results of subsidence lines surveyed for LW 428 during the 2023 reporting period against relevant trigger values. **Table 6-20** in **Section 6.7.3** summarises trigger values for conventional subsidence survey.

Table 6-19 Subsidence Survey Results for LW 428 During 2023 Reporting Period

Subsidence Line	Required Survey Frequency (LW428)	Survey date	Subsidence		Tilt		Strain		TARP Trigger
			(mm)		(mm/meter)		(mm/meter)		
			Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger Value	
Powerline	CH 1520	18/1/2023	889	1350	1.4	13	1.4	8.3	No
Z line	CH 902	23/5/2023	330	1350	5.5	13	9.6	8.3	Yes
	CH 302	25/10/2023	372	1350	5.6	13	9.1	8.3	
Zx Line	CH 302	1/11/2023	68	1350	3.7	13	15.4	8.3	Yes
AA Line	CH 1661	23/4/2023	1055	1350	15.6	13	7.9	8.3	Yes
MCS Line	CH 2402	8/3/2023	227	1350	1.2	13	0.9	8.3	No

² Z and Zx lines are traversed survey lines (not levelled survey lines).

Z and Zx Trigger

Survey results for Z and Zx Lines are presented in Figure 6-19 to 6-22. Z141 is within the EMMA for Extraction Plan 428-432 while Zx29 is located outside the EMMA.

The isolated exceedances of the pegs appear to be influenced by factors other than mining due to their close proximity to tracks. In accordance with the Trigger Action Response Monitoring Program outlined in the LW 428-432 Subsidence Management Plan, the subsidence predication model will be reviewed at the completion of the longwall as required and will be provided in the 2024 Annual Review and Quarterly Extraction Plan Reports.

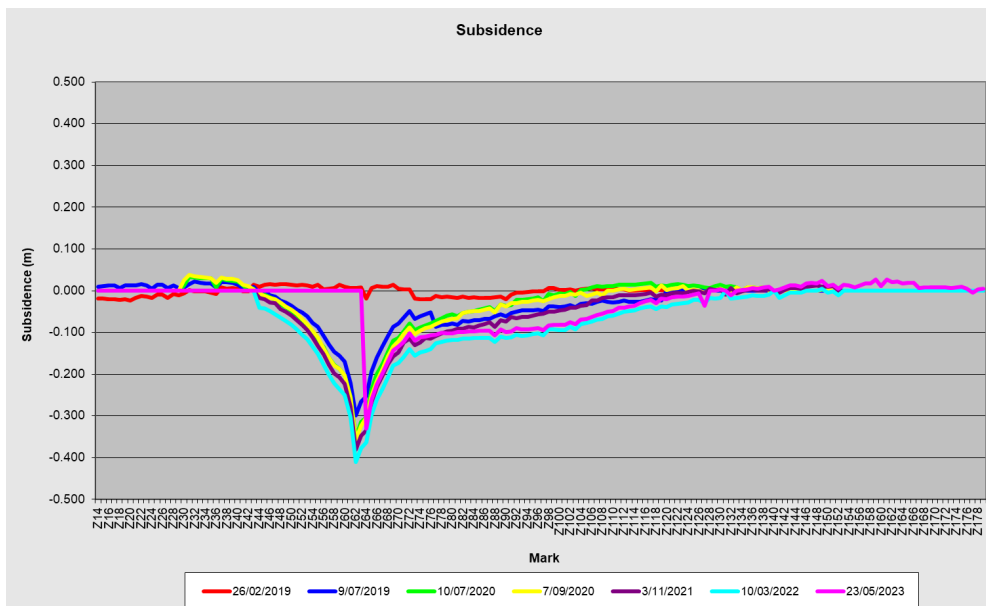


Figure 6-19 Z Line Subsidence Results

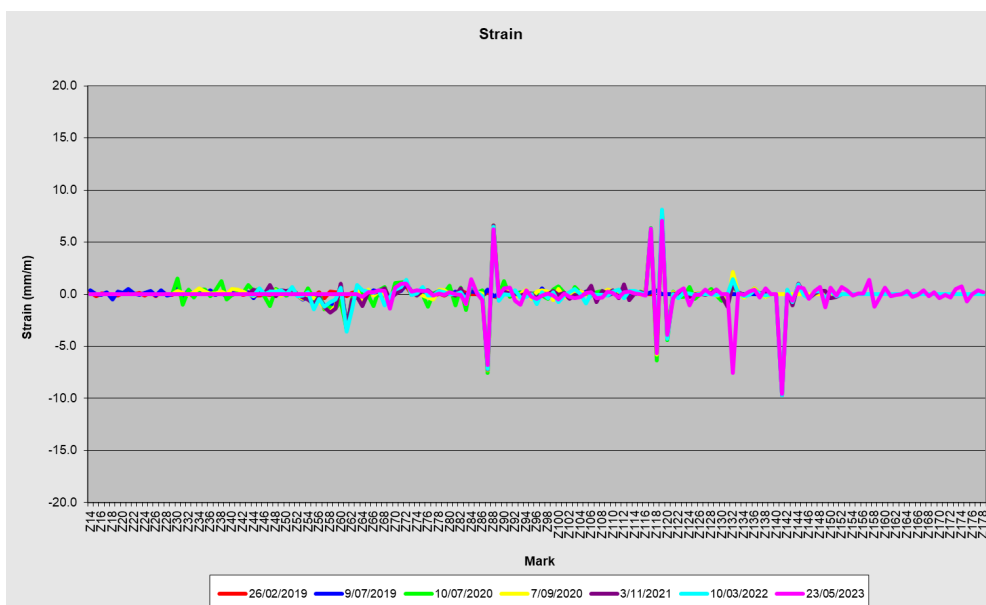


Figure 6-20 Z Line Strain Results

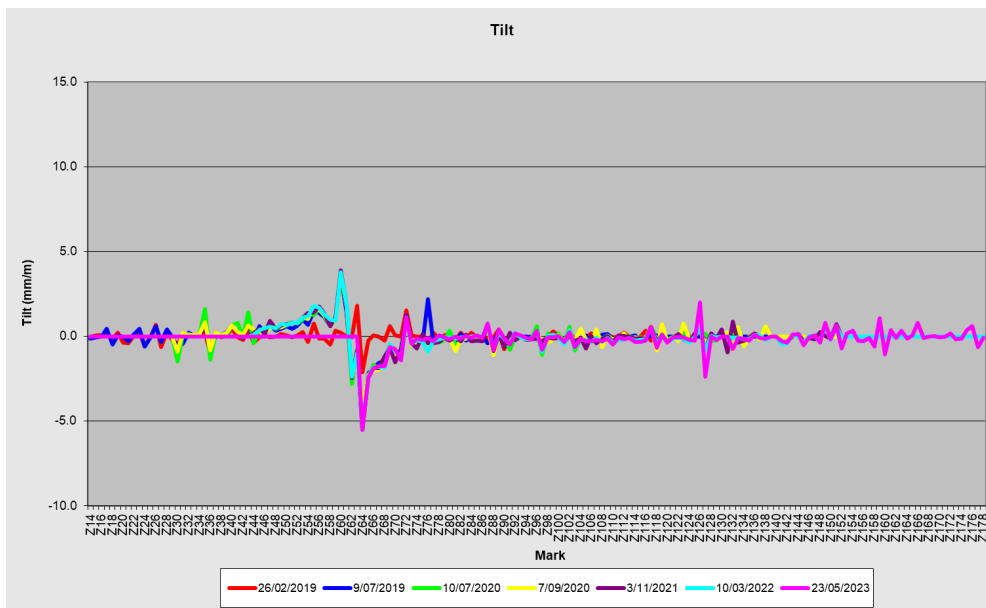


Figure 6-21 Z Line Tilt Results

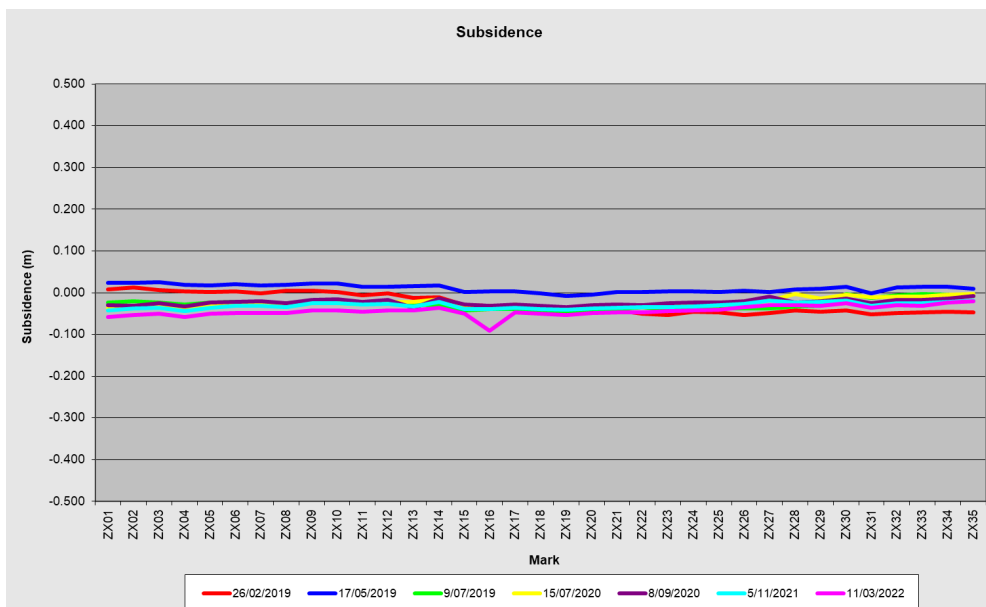


Figure 6-22 Zx Line Subsidence Results

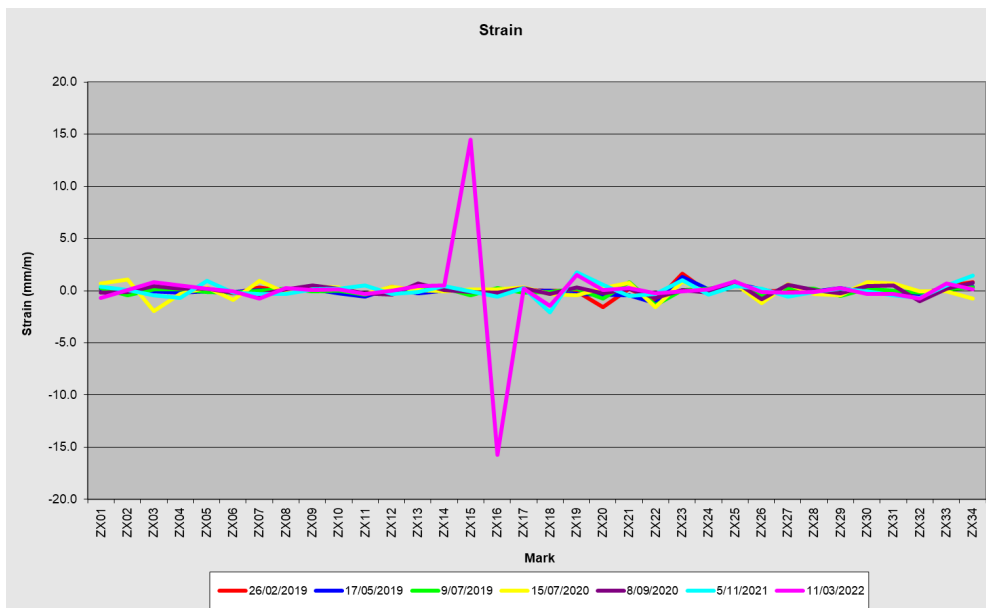


Figure 6-23 Zx Line Strain Results

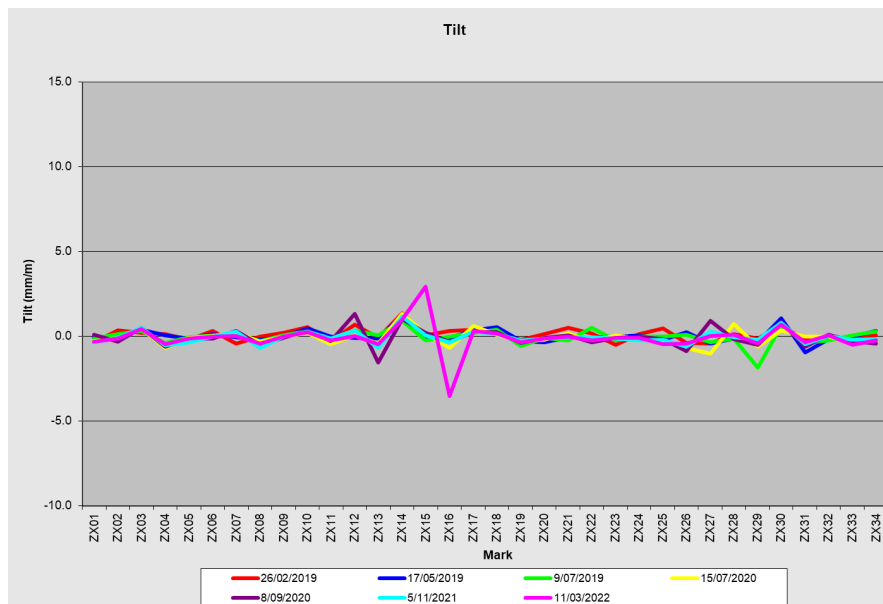


Figure 6-24 Zx Line Tilt Results

2023 AA Line Trigger Update

The isolated peg movements on the AA line were reported in the 2022 Annual Review. A resurvey was conducted in April 2023 in conjunction with visual inspections which confirmed no evidence of ground movement. Results are shown in **Figure 6-25 to 6-29**.

Due to the proximity of the pegs to tracks the erroneous reading is attributed to external factors (Public assessable land and peg in close proximity to track).

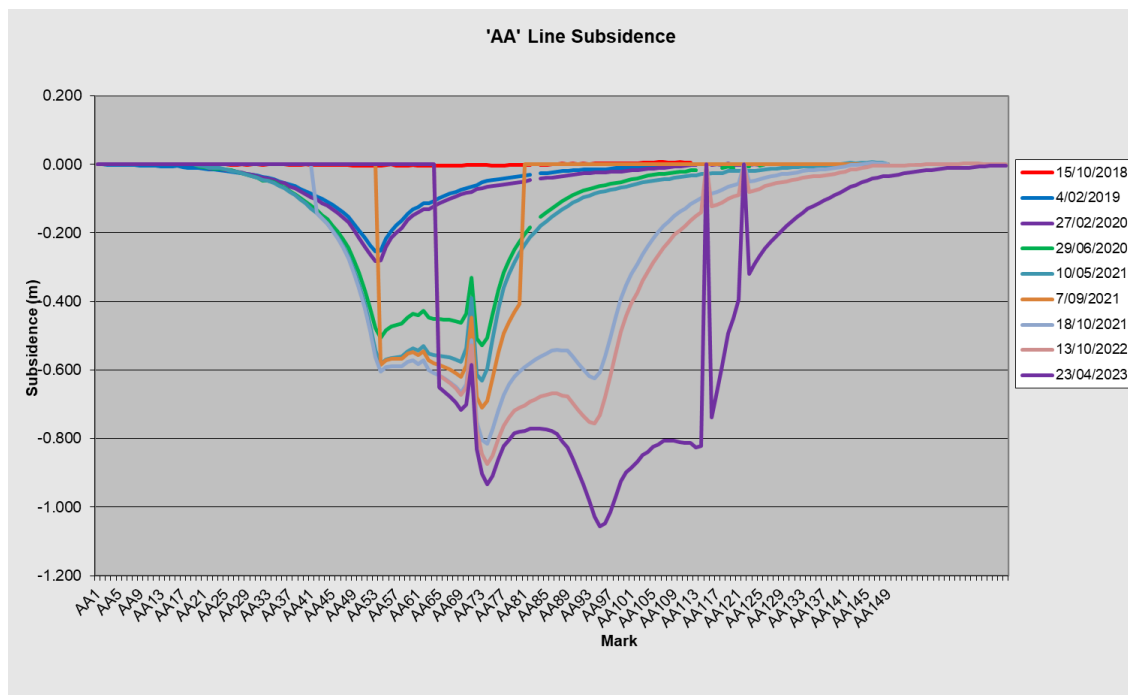


Figure 6-25 AA Line Subsidence Results

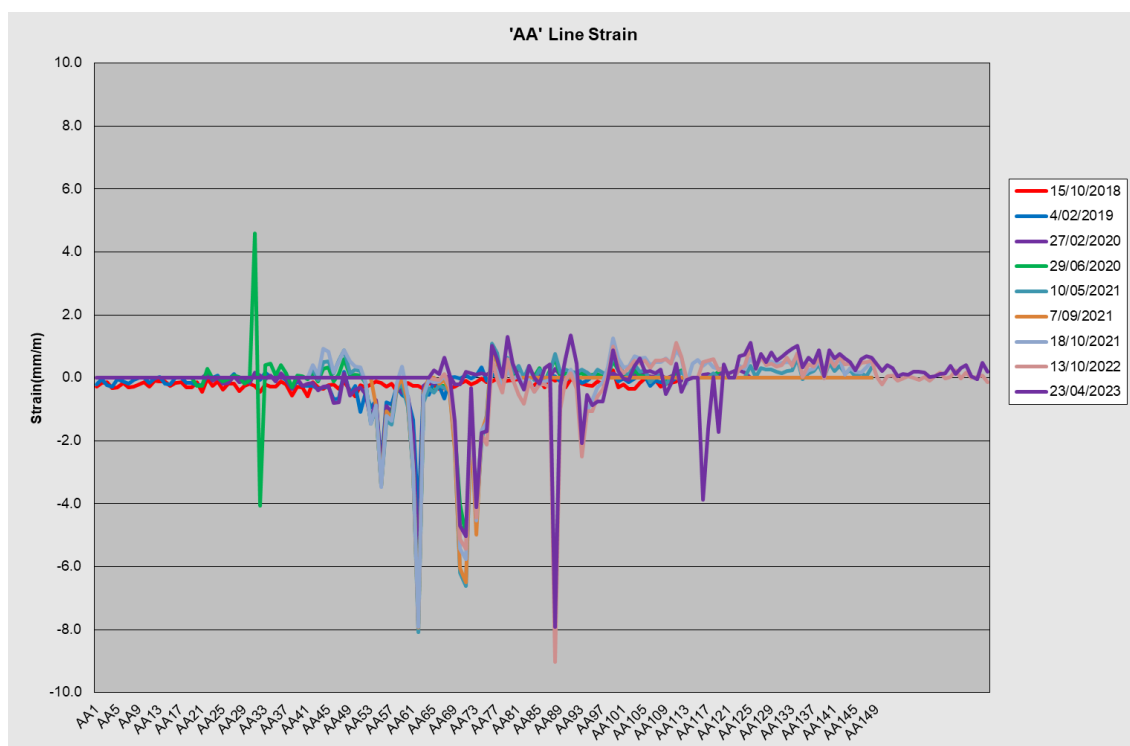


Figure 6-26 AA Line Strain Results

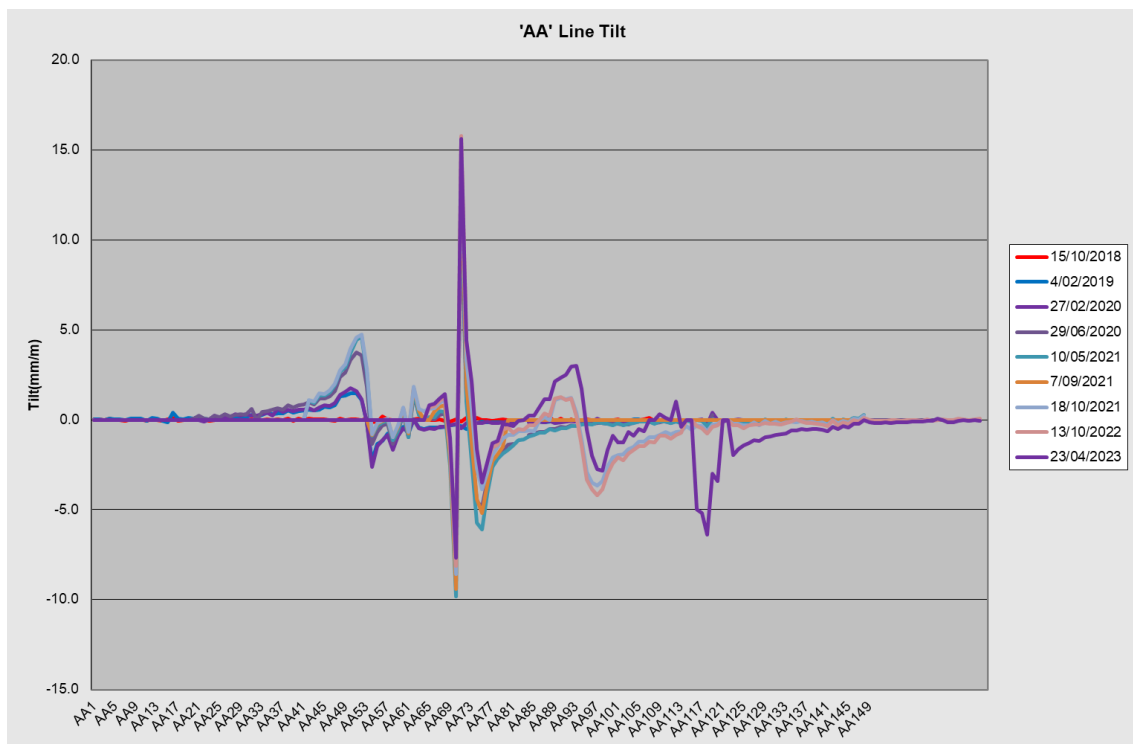


Figure 6-27 AA Line Tilt Result



Figure 6-28 AA Line Peg 73-72



Figure 6-29 AA Line Peg 88-89

6.7.3 Comparisons against Predictions

Subsidence reviews are undertaken as part of the Extraction Plan process. The following section compares observed subsidence with predictions, with reference to Extraction Plans for additional information.

The predicted maximum vertical subsidence after the completion of all the proposed longwalls is 1650 mm, which represents approximately 52% of the 3.2 m maximum extraction height. The predicted total tilt is 25 mm/m (i.e. 2.5%), which represents a change in grade of 1 in 40. The maximum predicted total curvatures are 0.60 km⁻¹ hogging and 0.60 km⁻¹ sagging, which represent minimum radii of curvature of 1.7 kilometres and 1.7 kilometres, respectively. Non-conventional subsidence has been predicted, in brackets, for subsidence above lineaments.

Maximum predicted subsidence parameters are summarised in **Table 6.20** (note – predicted subsidence shown in brackets is the cumulative maximum, if different to predicted maximum for any one panel as otherwise shown).

Table 6-20 Maximum predicted Total Conventional Subsidence

Longwall	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km ⁻¹)	Sagging Curvature (km ⁻¹)
LW416 to LW423	1,200 (1,450) ¹	10	0.15	0.20
LW424 to LW427	1,150 (1,150) ³	9.5	0.15	0.16
LW428 to LW432	1,350 (1,650) ^{1,2}	13	0.20	0.35
LW501	1,350	25	0.60	0.60
LW502 and LW503	1,650	25	0.60	0.60

¹ Values shown in brackets are the cumulative maximum subsidence (combined panels).

² Maximum predicted value for original EIS layout as approved. Extraction Plan prediction was lower (1550mm).

³ Maximum predicted value for vertical subsidence per LW424-427 Extraction Plan. Tilt and curvature per EIS.

6.7.4 Long Term Analysis

Table 6-21 summarises survey results reported for the past five Annual Reviews.

Table 6-21: Maximum vertical subsidence (all subsidence lines) – Last Five Reporting Periods

Longwall	Maximum Vertical Subsidence (mm)					Approved Predictions
	2019	2020	2021	2022	2023	
LW421	764 (GGSW Line)	993 (B line)	NA	NA	NA	1200 (1450)
LW425	299 (AA Line)	NA	NA	NA	NA	1150 (1150)
LW426	NA	527 (AA line)	NA	NA	NA	1,150 (1,150)
LW427	NA	NA	993 (B line)	875 (AA Line)	1055	1,150 (1,150)
LW428	NA	NA	NA	875 (AA Line)	1055	1,350 (1,650)

Note: Values shown in brackets are the cumulative maximum approved subsidence (combined panels).

6.7.5 Subsidence Correspondence

During the reporting period comment were received from the IMP via the DPHI in March, May and November 2023. An action plan to address these comments and requests are provided within the Quarterly Extraction Plan Reports.

Discussion on alterations to the approved Extraction Plan Layout for LW 428-432 commenced with DPHI and the Independent Monitoring Panel (IMP) in June 2023.

Amendment 1 was lodged with DPHI in July 2023. The amendment shortened the commencing end of LW 429 by approximately 1,160m (change from 27 cut through to 17 cut through). Amendment 1 was approved in August 2023.

Springvale is currently in the consultation phase for Amendment 2 which proposes the following changes:

- LW 430
 - Commencing (i.e. southern) end extended by 394 m.
 - Extended area extraction height to remain at LW2 band from 11ct – 14ct.
 - Increase in extraction height to the LW1 band from 11ct – 2ct.
- LW 431 and 432
 - Increase in extraction height to the LW1 band for the length of the proposed longwalls.

Consultation on Management Plans associated with LW 428-432 commenced in December 2023. Assessment on Amendment 2 is forecast to occur in 2024.

6.7.6 Implemented / Proposed Improvements

There are currently no further changes to the subsidence survey program proposed for 2023.

6.8 WASTE

6.8.1 Environmental Management

Waste minimisation and management measures at Springvale are monitored and reported in accordance with Schedule 4, Condition 27 (c) of SSD5594. General waste (non-production) at Springvale is disposed of to landfill by licensed waste contractors. Recyclable materials, such as, plastic, paper and cardboard products, are recycled whenever possible at the site. Oil drums and filters are recycled with other waste metals and are removed from site by a metal recycling company. Waste oil collected in the workshop is stored in an underground collection sump before being removed off site by a licensed contractor for recycling.

6.8.2 Environmental Performance

During the reporting period, 532.704 tonnes (39.08%) of waste was recycled, including, steel, timber, liquid waste, oils paper and cardboard, filters grease, oily rags and oil filters. This 30.13% improvement compared to 2022 is associated with scrap metal recycling A significant decrease in disposed material from 2022 was associated with not generating ballast and coal rejects while undertaking underground road maintenance activities.

6.8.3 Comparisons against Predictions

Table 6-22 provides a comparison of 2022 performance against EIS predictions for waste.

Table 6-22. Summary of Production Waste (last five reporting years)

EIS Prediction	Performance
No change to the annualised waste materials volumes due to the Project.	- Waste generation volumes (tonnages) have generally remained at similar levels with the exception of 2022 where disposal volumes altered due to disposal of ballast and coal reject from underground road maintenance activities. - In 2023, increase in recycled non-hazardous waste was associated with scrap metal (499.760 tonnes)
No production waste comprising reject materials from ROM coal processing (washing) will arise from the Project	Not Applicable to reporting period.

6.8.4 Long Term Analysis

Waste disposal and recycling for the last five (5) reporting periods is summarised in **Table 6-23**.

Table 6-23. Summary of Non-Production Waste Recycling and Disposal (last five years)

Waste Generation (tonnes)	Reporting Year				
	2019	2020	2021	2022	2023
Waste Recycling					
Hazardous Recycled (e.g. Waste Oil, Oily Water)	36.052	39.067	47.308	46.493	26.820
Recycled (Non-Hazardous) (e.g. Steel, Paper & Cardboard tonnes)	257.359	236.008	224.161	225.557	505.884

Waste Generation (tonnes)	Reporting Year				
	2019	2020	2021	2022	2023
Hazardous Disposal (e.g. Oily Rags / tonnes)	6.426	5.251	111.66	19.3	3.460
Non-Hazardous Disposal (e.g. Mixed Solid Waste / tonnes)	734.880	820.963	738.425	2,746.7	826.954
Total Waste Recycled (tonnes)	293.411	275.075	271.469	272.05	532.704
% Recycled vs disposed	28.35%	24.98%	24.20%	8.95%	39.08% +30.13%
Total Waste Disposed to landfill (tonnes)	741.306	826.105	850.304	2,767.6	1,363.118
% Disposed vs Recycled	71.65%	75.02%	75.80%	91.05%	60.92%

6.9 OTHER MATTERS

6.9.1 Bushfire

There were no bushfires during reporting period.

7 WATER MANAGEMENT

7.1 WATER MANAGEMENT

Springvale manages water in accordance with the Water Management Plan (WMP), Rev2.0, March 2020, prepared in accordance with Schedule 4, Condition 14 of SSD5594. The WMP was approved by DPHI on 19 February 2021. Springvale also implements water management and monitoring programs within mining areas approved under Extraction Plans, and in other areas in accordance with following documents:

- Environmental Protection Licence 3607 (EPL3607);
- Upper Cocks River Action and Monitoring Plan (UCRAMP), required by Condition 13, Schedule 4 of SSD5594. Revision 10 (June 2023) was approved by DPHI on 5 June 2023.
- Cocks River Catchment Improvement and Land Management Plan (CILMP), prepared in accordance with Condition 18A, Schedule 4 of SSD5594. Revision 2.0 was approved by DPE on 8 March 2018.
- Other related plans of management and monitoring for extraction plans, including for biodiversity (e.g. swamp monitoring programs) as outlined further in **Sections 7.3.1 and 7.4.1.**

7.1.1 Water Access Licenses and Extraction Volumes

Table 7-1 compares actual water demand against Water Access Licenses (WAL) held by Springvale for the water reporting period 1 July 2022 to 30 June 2023.

Table 7-1: Water Licenses and Take

Licence	Works Approvals	Water sharing plan, source and management zone	Entitlement (ML)	Passive take/inflows	Active pumping	TOTAL (ML)
WAL 36383	10WA118719 – Bore 6 and 8	Sydney Basin Richmond Groundwater Source 10WA118719– Bore 6 and 8	5,958	N/A	9096.2	9,096.2
WAL36449	10WA118719 – Bore 6 and 8		2,523	N/A	87.41	87.41
WAL 36446	10WA118752 – 24C/T to 8ML Dam	Sydney Basin Cocks River Groundwater Source	3,300	N/A	852.6	852.6
WAL 36443	10WA118754 – 85 C/T Pump Station		585	N/A	0	0

In the reporting year, Springvale exceeded its extraction limits in 2022/23 for the Richmond groundwater source while remaining significantly under our extraction limit for the Cocks River groundwater source. Additional information can be found in **Section 11**.

On 1 July 2023 the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023 commenced. As a result, the Sydney Basin Richmond Groundwater Source and Sydney Basin Cocks River Groundwater Source have been amalgamated to reflect their connectivity, now named the Sydney Basin West Groundwater Source.

Centennial is currently undertaking the necessary reviews of water access works approvals (Works approvals) to WALs in this newly formed groundwater source. Centennials compliance with the extraction limits for each groundwater source for is shown in **Table 7-2**.

Table 7-2 Centennial Amalgamated Groundwater licences and Take

Groundwater source	Total WAL volume (ML/Annum)	2022/23 Water Take (ML/Annum)
Sydney Basin Richmond Groundwater Source - Angus Place - Springvale - Clarence	15,139 ML/Annum	18,242.2 ML/Annum
Sydney Basin Cox's River Groundwater Source - Angus Place - Springvale - Clarence	9,152 ML/Annum	2,467 ML/Annum
Sydney Basin West Ground water source - Angus Place - Springvale - Clarence	24,256 ML/Annum	20,709.2 ML/Annum

7.1.2 Bore Water Quality

Water quality of water extracted from mine dewatering Bore 6 and Bore 8 is provided in **Table 7-3** below. Timeseries charts and tabulated statistics for water quality are also provided in groundwater appendices to the '2023 Annual Environmental Monitoring Review – Surface and Groundwater' presented in **Appendix 3** to this Annual Review.

Generally, both bores show variability consistent with previous years.

Table 7-3. Bore 6 and Bore 8 Groundwater Quality

Monitoring ID	Data Range	Analyte	Units	Minimum	Median	Maximum
Bore 6	4/09/2009 – present	pH	Units	6.11	7.43	11.82*
		EC	µS/cm	115	1,138.0	2,881
		Fe	mg/L	0.05	0.33	3.47
Bore 8	15/01/2013 - present	pH	Units	5.5	7.64	8.59
		EC	µS/cm	228	1,201.5	2,532
		Fe	mg/L	0.05	0.14	3.24

*Maximum in reporting period 7.6.

7.1.3 Water Balance

The site water balance model (2016) was developed to quantify transfers within the site under existing and future operational conditions using various rainfall patterns. The model was revised during the reporting period based on 2023 operational data and is presented in **Table 7-4**. An overview of Springvale's water management system is displayed below in **Figure 7-1**.

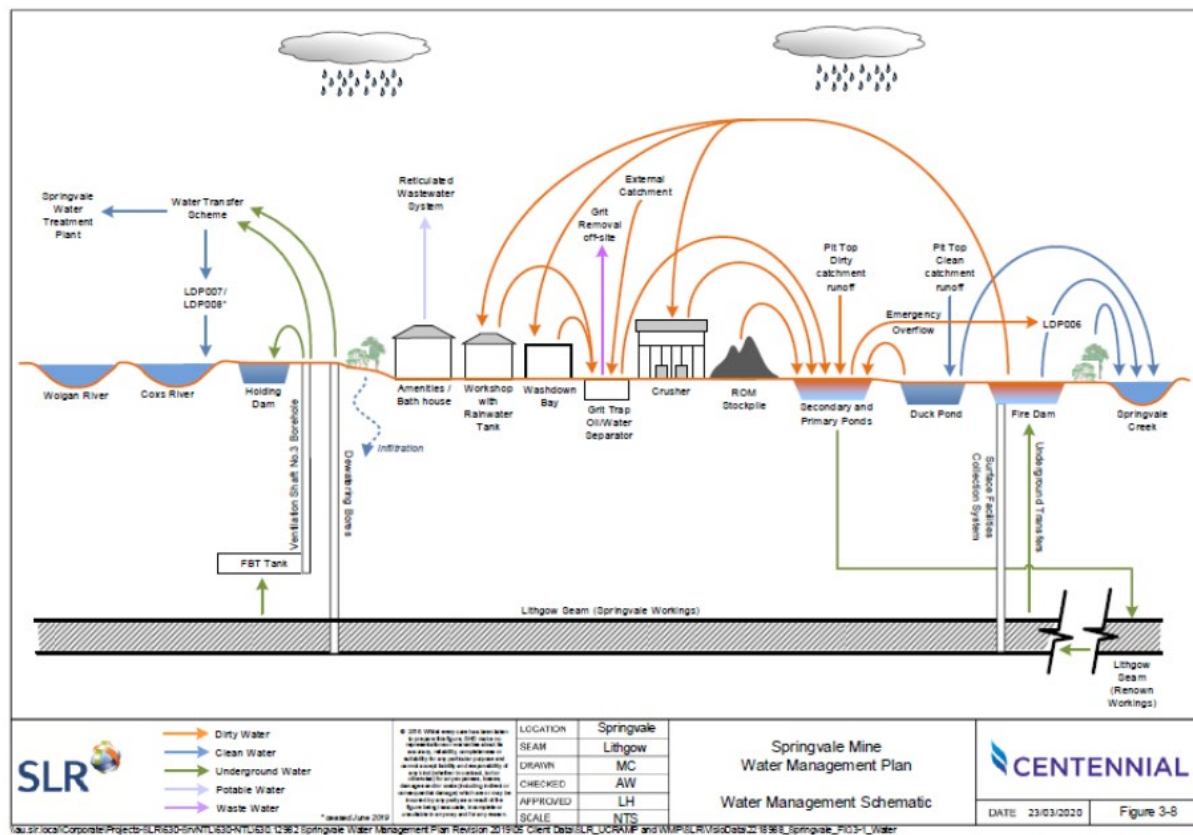


Figure 7-1 Water Balance Schematic

Table 7-4 presents output elements of the water balance in 2023 against the 2020 Springvale Water Management Plan predications and forecasts for 2025.

Table 7-4: Site Water Balance for Springvale

Input-Output	Element	Sub-Element	2023 Annual Total (GoldSim)	2025 predication (WMP)
Input	Surface Water	Runoff into Storages (clean)	33.53	173
		Runoff into Storages (disturbed)	24.33	
		Precipitation	6.22	
	Groundwater	Groundwater inflow	12,245.70	9,920
	Third Party Water	LCC Potable	103.96	16
	TOTAL INPUTS		12,413.74	10,109
Output	Surface Water discharge	Trade waste (grit removal)	0.09	0
		LDP discharges	145.63	589
	Task	Sewage System	103.96	16
	Third Party Water	MPPS Reuse/SWTP	11,426.16	9,420
	TOTAL DISCHARGES		249.68	
	Task	Task Loss (Dust suppression)	2.97	4
	Evaporation	Evaporation	12.53	13
	TOTAL CONSUMPTION		15.51	
Other	Task	Underground demand	221.35	Not Applicable
	Task	Washdown	108.15	Not Applicable
	Task	Crusher	230.84	Not Applicable
	Worked water	To_CT24	251.86	Not Applicable
	TOTAL CONSUMPTION		812.20	
Change in storage			-0.22	
Balance			0.00	

Surface inputs are below predictions due to below average rainfall conditions. Groundwater inflows have been greater than predicted due to mining near historic workings (State Mine). This is discussed further in **Section 7.2**. The 2023 third party water has been based on invoices from LCC, however these were estimates only and actual water usage is significantly lower. Discharges through LDP006 are below the modelled vales due to contributions from clean water catchment.

7.2 GROUNDWATER MODEL UPDATE

Groundwater models are updated every six months and a review is presented within the Annual Review in accordance with the project Statement of Commitments (Appendix 3 to SSD5594), and in accordance with conditional approval of Extraction Plans where applicable (e.g. Condition 7 of the LW428-432 EP approval from DPHI).

The long term and current data trends are presented in Figure 7-2 and Figure 7-3.

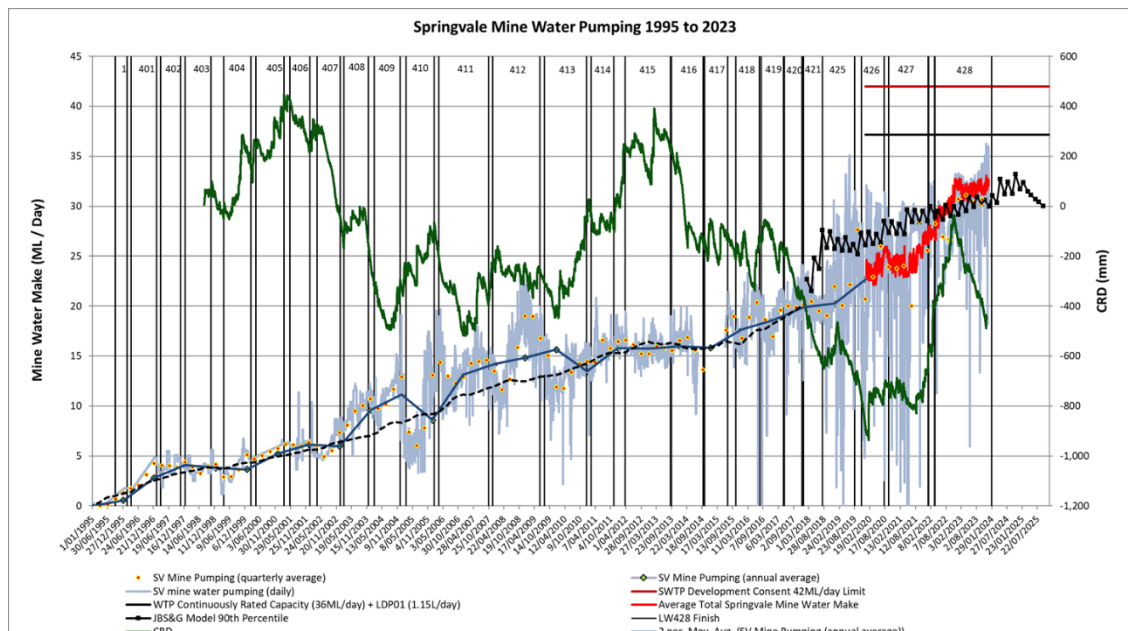


Figure 7-2 Springvale Mine Pumping Rates 1995 to 2024

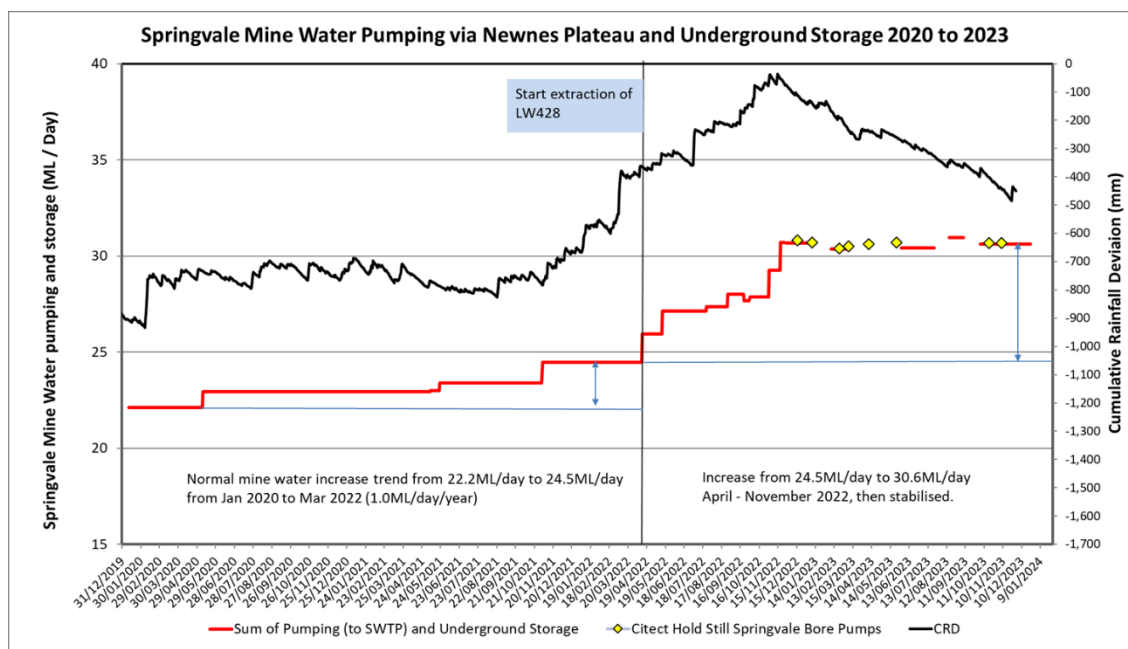


Figure 7-3 Springvale Mine Pumping Rates during LW428 Extraction

Data between January 2020 and March 2022 has shown a mine water inflow trend increase at approximately 1 ML/day. During this period mine inflows reached approximately 24 ML/day.

There was a departure from the long-term inflow trend to approximately 6.6 ML/day in 2022. These inflows are now above the 90th percentile groundwater model predictions.

The increase in water make went from approximately 24 ML/day and has stabilised around 30.6 ML/day during LW 428 production (inbye third of block) and a period of very high rainfall (between April 2022 and November 2022). Inflows have been stable at 30.6 ML/day since November 2022.

Over the past 12 months, inflows have increased a further 1.5 ML/day to 32 ML/day. This increase is consistent with historical and is consistent with goaf area increase.

The identified cause of the anomalous increase in inflows is interpreted as high permeability flowpaths associated with geological fault zones (lineaments) in the barrier between State Mine and Springvale Mine or a result of elevated rainfall.

Adaptive management of mine workings has been implemented to prevent above trend mine water inflows in the future, with LW 429 installation face positioned at 17C/T rather than planned 26C/T.

Springvale has obtained reports from JBS&G and SCT on predictive mine water inflow model for future mine workings and SCT. Additionally, a peer review from SLR has been completed on a predictive mine water inflow model for future mine workings.

7.3 SURFACE OPERATIONS

This section presents water management and monitoring undertaken beyond secondary extraction areas, primarily associated with pit top mine water discharges, and receiving water environments, in line with the Springvale Water Management Plan (WMP) as discussed further below.

Water management and monitoring within extraction areas is discussed separately in **Section 7.4**.

7.3.1 Environmental Management

The surface water management systems at the pit top relies on the separation of clean and dirty water and the effective management of water through collection, treatment, and discharge. This is managed through several separate water systems including surface water dams and/or settling ponds, and clean water diversion channels.

Mine inflows, encountered during mining operations, require to be managed so that water levels can be kept at safe levels underground, and therefore operational risks can be reduced. Both clean and dirty water are generated underground. Clean water is water make from the goaf areas that do not experience machine movements. Dirty water comprises water that run along roadways and mine inflows from production panels. The dirty water is collected into portable staging tanks and pumped into the existing workings for the sediment to settle out before being diverted to the clean water system for transfer to the surface.

Discharges

Management and monitoring of mine water discharges is undertaken in accordance with EPL3607, the Springvale WMP, and Section 8 of the UCRAMP. Monitoring results for 2023 are presented in **Section 7.3.2.1**.

Receiving Waters

Management and monitoring of receiving surface waters in the UCRC is undertaken in accordance with the UCRAMP. Monitoring results for 2023 are presented in **Section 7.3.2.2**. Monitoring locations for the UCRAMP are shown on **Figure 7-4**.

A key management focus of the UCRAMP involved the cessation of discharges from LDP007 and LDP008, and subsequent monitoring of aquatic ecology for stream health. Management and monitoring of aquatic ecology within receiving waters of the UCRC is undertaken in accordance with the UCRC Aquatic Ecology Monitoring Program (AEMP), which addresses the specific aquatic ecology monitoring requirements of the broader UCRAMP. Monitoring results for 2023 are presented in **Section 7.3.2.2**.

7.3.2 Environmental Performance

7.3.2.1 Licenced Discharges

Discharge Volumes

Springvale measures daily discharge volumes against the criteria outlined in EPL3607. The annual discharge volumes are displayed in **Table 7-5** below.

Table 7-5: Licensed Discharge Points Volume

LDP	2023 lowest sample value (kL/day)	2023 Mean of sample (kL/day)	2023 Highest Sample Value (kL/day)	Total 2023 (kL/year)	EPL Limit (kL/day)
LDP006 (formally LDP001)	0	242.3884	1,434.173	88,471.78	10,000
LDP007 (formally LDP009)	No discharge				
LDP008 (formally LDP010)	No discharge				

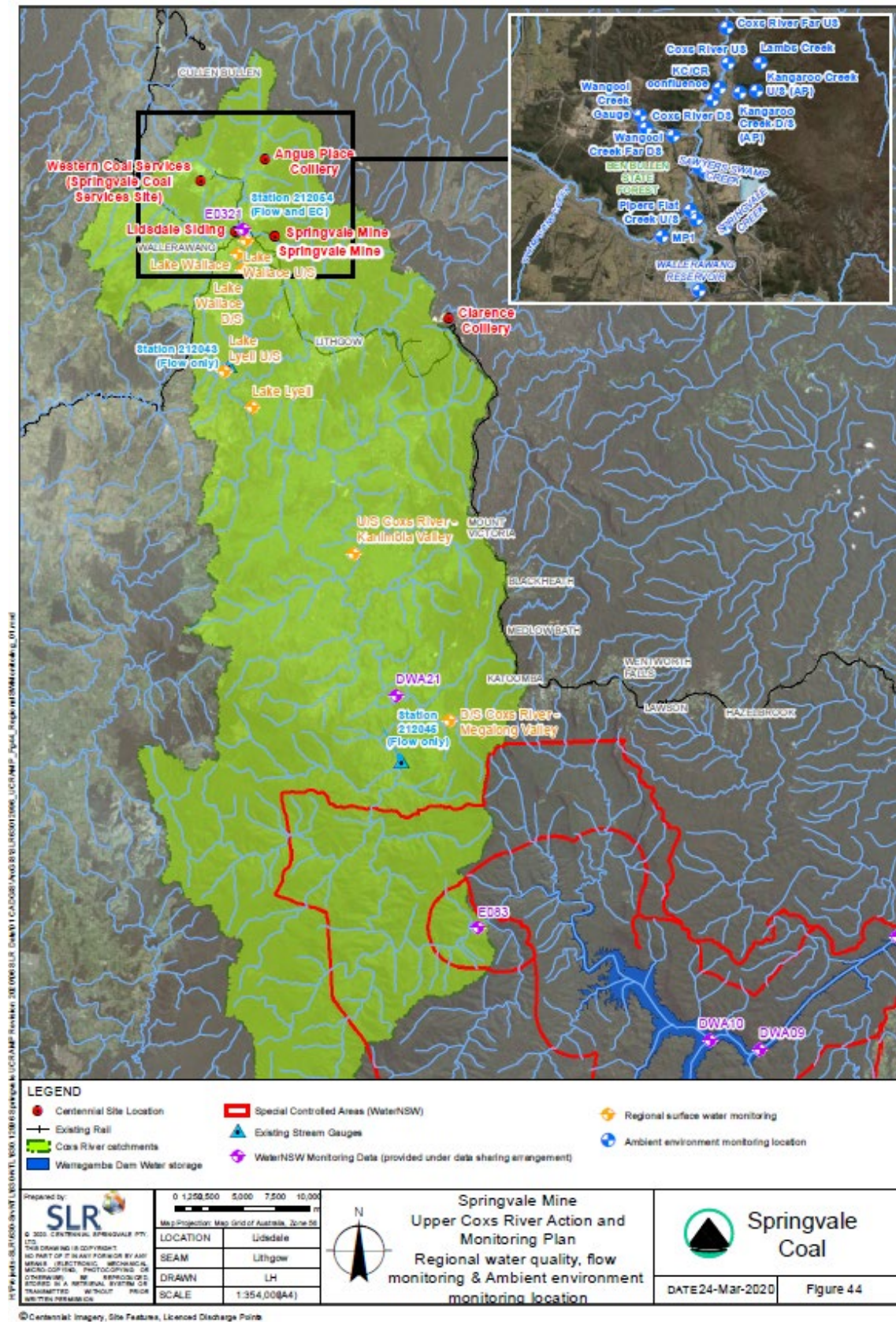


Figure 7-4: UCRAMP Monitoring Locations

Discharge Water Quality – LDP006

Surface water monitoring of licenced discharges is undertaken in accordance with EPL3607 and the WMP. Water quality results for LDP006 (formally LDP001) are presented in **Table 7-6** and graphically in **Appendix 3**. The Springvale Water Treatment Project (SWTP) is operational with offsite discharge to natural watercourses ceasing at LDP007 on 30 June 2019.

Table 7-6 LDP006 Water Quality Summary (2023)

Pollutant	No. of samples required by license	No. samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value	EPL3607 100 percentile concentration limit
Conductivity (µS/cm)	52	53	406	740	1246	NA
Filterable iron (mg/l)	52	53	<0.05	0.03	0.30	NA
Filterable manganese (mg/l)	52	53	<0.001	0.012	0.125	NA
Oil and Grease (mg/l)	52	52	<5	<5	<5	10
pH	52	53	6.9	8.25	9.8	6.5-9.0
Total suspended solids (mg/l)	52	53	<5	4	44	30
Turbidity (NTU)	52	53	1	8.2	160	50

Two samples were taken at LDP006 on 14 March 2023. Both results have been reported for all analytes with the exception of one of the Total Oil and Grease results as the sample was unable to be analysed due to the glass bottle breaking during transport.

There was one incident during the reporting period on 14 March 2023 at LDP006 which resulted in non-compliances with water concentration limits. Both the EPA and DPHI were notified at the time of this event. Further information is provided in **Section 11**.

7.3.2.2 Surface Water Quality - Upper Cocks River Catchment

Since the commencement of the UCRAMP, significant changes to catchment water management have occurred that have reduced the volume of mine water discharges to the Cocks River. Specific to Springvale:

1. Until June 2019, Springvale Mine discharged up to 30 ML/day from LDP007 (formerly LDP009) to the Coxs River via Sawyers Swamp Creek. Since June 2019, mine water is treated in the SWTP and transferred to MPPS for beneficial reuse.
2. Discharge of surface water runoff occurs through LDP006 (formerly LDP001) to the Coxs River via Springvale Creek in accordance with EPL 3607. The average discharge and the maximum daily during the study period is displayed in **Table 7-5** above.

The long-term water quality target for EC (salinity) in the Coxs River is 350 $\mu\text{S}/\text{cm}$. EC in the Coxs River is continuously monitored at stream gauge 202154 (Wallerawang Power Station). EC monitoring results and streamflow are shown in **Figure 7-5**. This timeseries indicates the impact of historical discharge from Springvale Mine LDP007 on salinity in the Coxs River. From the beginning of 2017 to the cessation of discharge in June 2019, average EC in the Coxs River was 1,200 $\mu\text{S}/\text{cm}$, with little variation over time.

Although EC in the Coxs River remained above the long-term target (350 $\mu\text{S}/\text{cm}$), it is generally lower following the cessation of discharge from LDP007 and shows increased variation with streamflow. Discharges from Western Coal Services LDP001 remain an influencing factor on catchment EC during times of low streamflow within Coxs River.

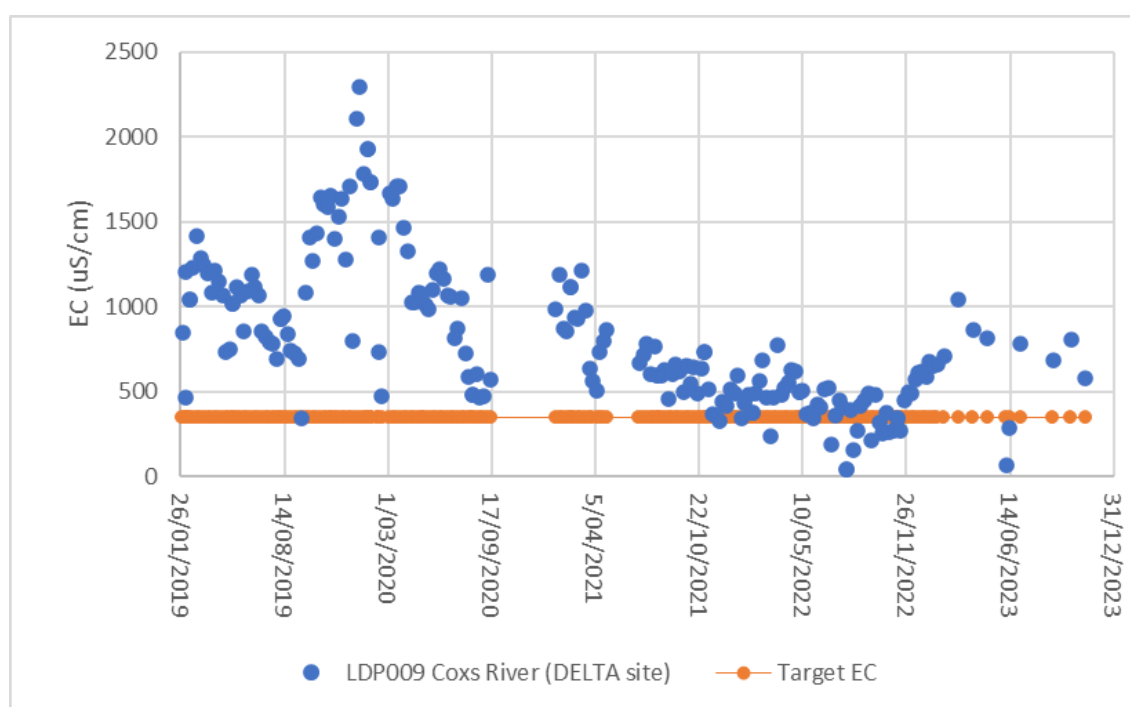


Figure 7-5 Cox River Water Quality Time Series for Electrical Conductivity

Aquatic Ecology - Upper Coxs River Catchment

The UCRC 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 was implemented with the aim of understanding the overall health of the UCRC. The monitoring program, known as the UCRC Aquatic Ecology Monitoring Program (AEMP), addresses the aquatic ecology monitoring requirements of Centennial operations and the Springvale Upper Coxs River Action and Monitoring Program (UCRAMP; 2020).

The AEMP allows for identification of both positive and negative impacts 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).

Monitoring Sites associates with Springvale are presented in **Table 7-7**.

Table 7-7: Aquatic Ecology Monitoring Sites

Site	Description	Site Type
Sawyers Swamp Creek		
SSCup	Upstream reference site in Sawyers Swamp Creek, located upstream of Sawyers Swamp Creek Ash Dam.	Background
DP9dn	Located downstream of Springvale LDP7 (inactive) within offline drainage channel receiving runoff from Sawyers Swamp Creek.	Historical impact
Springvale Creek		
MC2	Located on Marrangaroo Creek. Replacement background site for SCup.	Background
SCdn	Downstream from Springvale Mine pit top located at the railway crossing 200 m upstream of the Castlereagh Highway.	Impact
Coxs River		
CR0	Upstream of all Centennial LDPs	Background
CR1	Upstream of all Centennial LDPs	Background
CR3	Located downstream of Wangcol Creek and upstream of Sawyers Swamp Creek confluence.	Upstream (Sawyers Swamp Creek and LDP7 - inactive)
CR4	Located at the Maddox Lane road crossing downstream of Angus Place LDP1 (decommissioned), Springvale LDP7 (inactive) and SCS LDP1.	Historical impact (Sawyers Swamp Creek and LDP7 - inactive)
CR5	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.	Upstream (Springvale Creek and LDP6)
CR6	Coxs River directly downstream of Lake Wallace, on the downstream side of Rocky Waterhole Drive. Downstream of all Centennial LDPs.	Impact (Springvale Creek and LDP6)
CR7	Located in the Marrangaroo National Park approximately 5 km downstream of the Lake Wallace dam wall.	Recovery

Sawyers Swamp Creek

In spring 2023, Sawyers Swamp Creek background site SSCup was dry and macroinvertebrate, water and sediment samples were not able to be collected.

Taxa richness results in Sawyers Swamp Creek in 2023 were lower at historical impact site DP9dn than background site SSCup in autumn 2023, and were lower at DP9dn in spring 2023 than the autumn DP9dn results, particularly in the second replicate sample. All taxa richness results were above the long-term SSCup / SSWdn median, except the second replicate from DP9dn collected in spring 2023.

EPT richness results were also higher in autumn 2023 at background site SSCup (by up to two taxa) than impact site DP9dn. In spring 2023, EPT richness results at DP9dn were lower than the autumn results, particularly in the second replicate sample, which did not contain any EPT taxa. All other samples collected in 2023 contained EPT taxa equal to or above the long-

term median on two taxa. *Plecoptera* (stoneflies) were collected in both SSCup autumn 2023 samples, but were not observed in any sample from DP9dn in 2023.

In autumn 2023, SIGNAL-2 results were similarly high in both samples from background site SSCup and one sample from historical impact site DP9dn, while the SIGNAL-2 score of the second replicate sample from DP9dn in autumn 2023 was much lower. In spring 2023 at DP9dn, the highest SIGNAL-2 score was lower than observed at DP9dn in autumn, while the lower SIGNAL-2 score was equal between the two sampling events. The lowest SIGNAL-2 result from DP9dn in each sampling event were below the long-term median, while all other SIGNAL-2 results in 2023 were above the median.

Licensed discharges from LDP007 ceased during 2019 and, therefore, any differences in macroinvertebrate community health between Sawyers Swamp Creek sites, are not due to current LDP007 discharges, although, the influence of historical discharges cannot be ruled out. Analysis of water quality results collected during aquatic ecology sampling in autumn 2023 identified concentrations of dissolved cobalt and zinc in excess of the DGV at both SSCup and DP9dn, and therefore high enough that aquatic biota could be impacted (ANZG 2018). These metals were observed in very similar concentrations at both sites, with the cobalt concentration equal between the two sites, and the zinc concentration only slightly higher at the background site. There were no exceedances of any toxicant DGV at DP9dn in spring 2023. The similarity in dissolved metals concentrations at the background and impact site indicate influences upstream in Sawyers Swamp Creek.

In autumn 2023, the concentration of acid-extractable arsenic in the sediment at historical impact site DP9dn exceeded the DGV, while the acid-extractable concentration of nickel in the sediment exceeded the GV-high. At the background site SSCup in autumn 2023, there were no sediment metals observed in a concentration above the laboratory limit of reporting. In spring 2023, however, acid-extractable concentrations of all sediment metals at DP9dn were notably reduced from autumn 2023 concentrations, with all sediment metals now observed in concentrations below the DGVs.

Rainfall in the study area in 2023 was much lower than in recent years (2020 to 2022), particularly during the May to November 2023 period. This led to SSCup being dry in spring 2023, and the water level and flow at DP9dn being much lower than during all previous historical events except spring 2019, which was immediately following the cessation of discharges from LDP007 and during the extended drought period. The dry conditions led to reduced availability of aquatic habitat at DP9dn in spring 2023, as the water level had receded so that much of the channel's trailing vegetation was stranded. This is likely to be the primary reason for the poorer macroinvertebrate community condition in spring 2023, given the improvement in water and sediment quality observed at DP9dn between the two sampling events.

The poorer macroinvertebrate results observed at DP9dn in autumn 2023 compared to background site SSCup is likely influenced by differences in the aquatic habitats between the sites, with background site SSCup containing a more diverse instream habitat, including large woody debris, macrophytes and emergent grasses, trailing grasses and shrubs, and boulders, with a sandy substrate. This compares to the more homogenous habitats at DP9dn, including a patch of the macrophyte *Typha* sp., bare mud banks, some trailing grasses and a mostly bedrock substrate.

In 2023, results of macroinvertebrate metrics at Coxs River historical impact site CR4, downstream of the Sawyers Swamp Creek confluence, were generally consistent with results from background sites CR0 and CR1, and upstream site CR3. Taxa richness results indicated more variability between replicate samples at a single site, than between sites or sampling events. EPT richness and SIGNAL-2 scores at CR4 in autumn 2023 were slightly lower than those at upstream site CR3, though in spring 2023, both EPT richness and SIGNAL-2 at CR4 were equal to or higher than those at CR3. Only SIGNAL-2 results at CR4 in autumn 2023 contained both replicate samples with results below the long-term CR3 median, though one

replicate sample from both autumn and spring 2023 also contained taxa richness results below the long-term median. These results indicate that there has not been a notable negative impact on macroinvertebrate communities in the Coxs River due to the influence of Sawyers Swamp Creek in 2023.

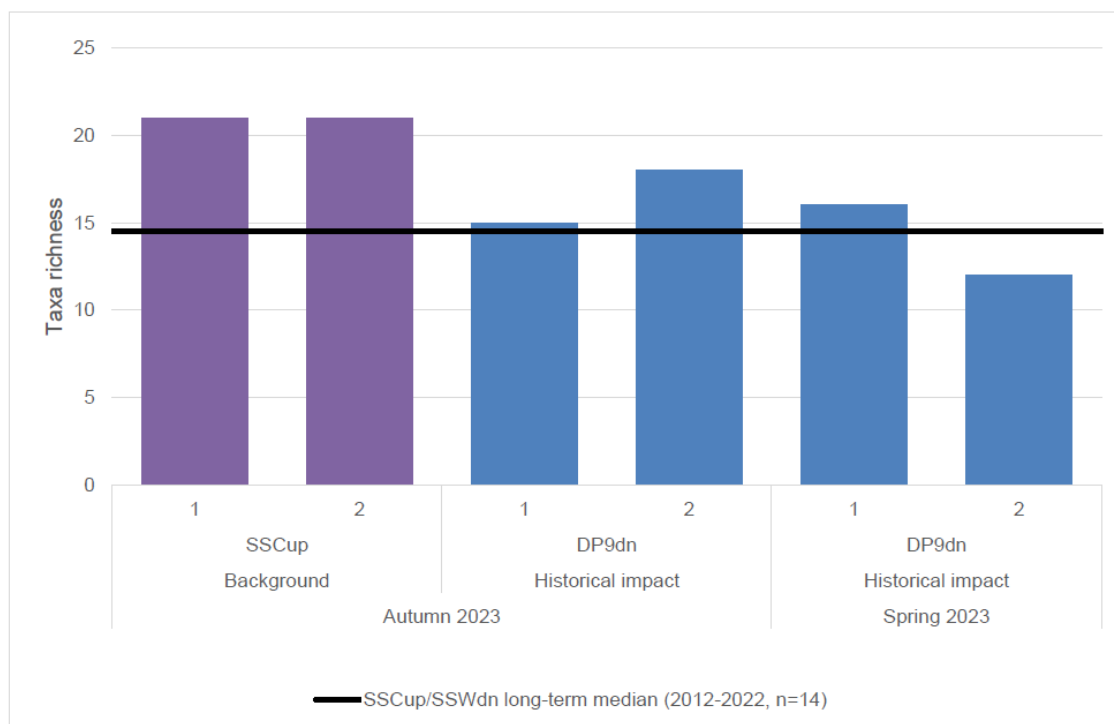


Figure 7-6: Taxa Richness in Sawyers Swamp Creek samples in 2023

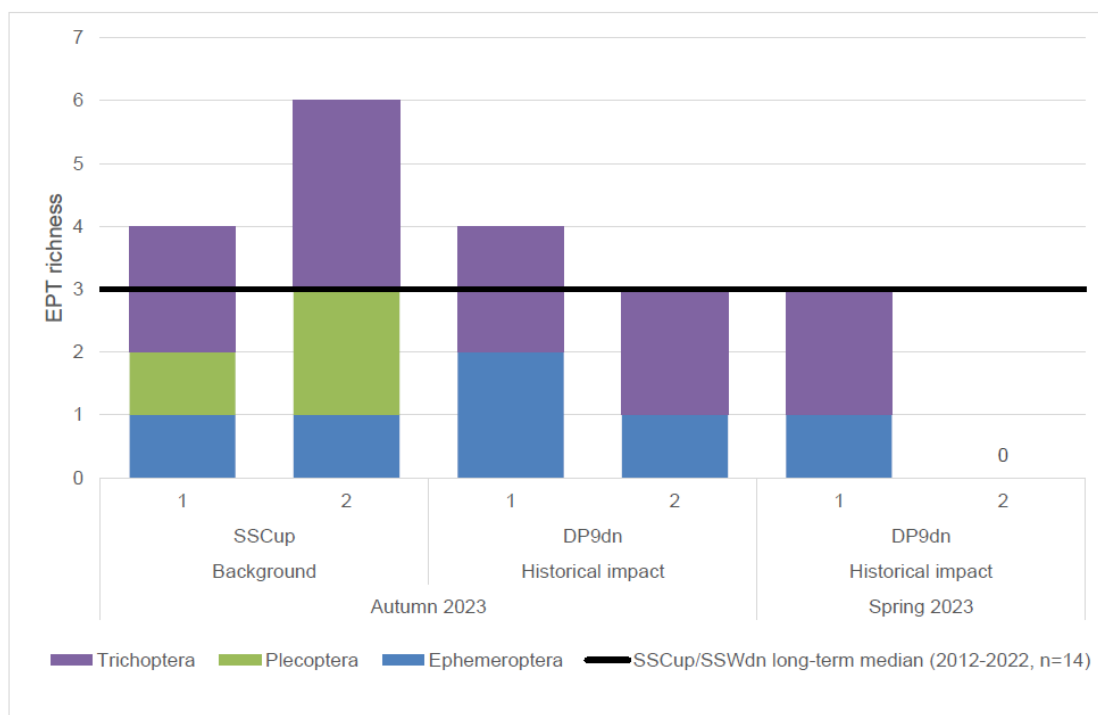


Figure 7-7: EPT Richness in Sawyers Swamp Creek samples in 2023

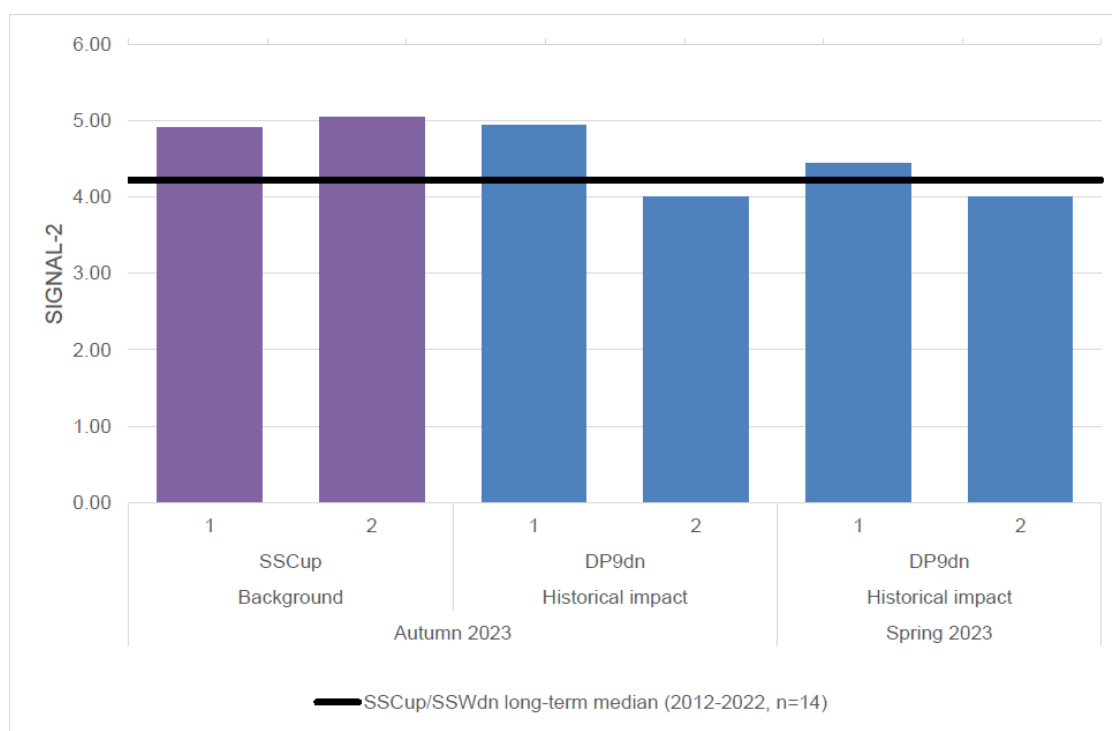


Figure 7-8: SIGNAL-2 in Sawyers Swamp Creek samples in 2023

Springvale Creek

In spring 2023, Springvale Creek impact site SCdn contained insufficient water for the collection of two macroinvertebrate samples. Only one macroinvertebrate sample was able to be collected, along with water and sediment samples.

Taxa richness results at background site MC2 (Marrangaroo Creek) and impact site SCdn (Springvale Creek) in 2023 were generally consistent, with more variability observed between replicates at a single site than between sites or sampling events. However, one fewer taxon was observed at impact site SCdn in spring 2023, likely due to the reduced water levels and limited macroinvertebrate habitat. All taxa richness results in 2023 were above the MC2 long-term median.

EPT richness results were much higher at background site MC2 than impact site SCdn in both autumn and spring 2023. All EPT richness results at MC2 in 2023 were above the long term MC2 median, while all SCdn results in 2023 were below the median. Ephemeroptera (mayflies) and *Trichoptera* (caddisflies) were collected in all samples in 2023, though Plecoptera (stoneflies) were collected only at MC2.

SIGNAL-2 was higher at MC2 than SCdn in both autumn and spring 2023. SIGNAL-2 scores were similar between seasons at both sites, though all SIGNAL-2 results were below the long-term median.

Water quality results indicated that the ionic composition was very different at SCdn compared to the dilute water observed at MC2. In addition to this, there were several dissolved metals that were observed at impact site SCdn in concentrations above the aquatic ecosystem protection DGVs (ANZG 2018), including dissolved copper in autumn 2023, and dissolved manganese and zinc in spring 2023. The elevated water hardness at SCdn in spring 2023, however, was found to ameliorate the toxicity of the dissolved zinc (ANZECC 2000). There were no exceedances of any water quality DGV at background site MC2 in 2023, and concentrations of all dissolved metals except iron were much lower at MC2 than SCdn in both sampling events.

Sediment quality indicated elevated concentrations of several metals at SCdn in autumn 2023 compared with the Marrangaroo Creek site, including nickel and zinc, which were observed in concentrations exceeding the GV-high, suggesting a high probability of biological effects (ANZG 2019). In spring 2023, however, concentrations of all sediment metals were much lower, and no exceedances of the sediment DGVs were observed. Concentrations of all sediment metals at background site MC2 were very low in both seasons, with all except zinc below the laboratory limit of reporting.

As mentioned in Section 6.1, conditions were generally dry in 2023. In addition to this, discharge volumes from LDP6 prior to sampling in spring 2023 were very low, averaging just 0.002 ML per day in the week prior to sampling at SCdn, and averaging 0.09 ML/day in the month prior to sampling. This contrasts with discharge volumes previously observed, with an average of 0.41 ML/day recorded in the week prior in sampling in autumn 2023, and an average of 2.09 ML/day prior to sampling in spring 2022. Given these reduced discharge volumes in spring 2023, the elevated concentrations of metals in sediment at SCdn are likely to be attributable to historical Springvale LDP6 discharges, rather than recent Springvale discharges.

The reduced rainfall and discharge volumes led to water levels at SCdn in spring 2023 being very low compared to historical conditions, and substantially reduced availability of aquatic habitat, as the water receded away from the channel's trailing vegetation, and the section of the channel containing macrophytes *Typha* sp. was completely dry and not able to be sampled. These drier conditions also likely contributed to the elevated aqueous metals observed at SCdn in spring 2023, through evapoconcentration. Despite this combination of reduced aquatic habitats and poorer water quality observed at SCdn in spring 2023 compared to autumn, the macroinvertebrate community was in a similar condition between the two sampling events in 2023.

The macroinvertebrate community health in the Coxs River downstream of the Springvale Creek confluence (at CR6) was in a poorer condition than the site immediately upstream of the Springvale Creek confluence (at CR5), with lower results of all metrics at CR6. This is consistent with historical results, which have demonstrated that the community condition at CR6 is often poor relative to most other Coxs River sites. Given the water quality at CR6 was similar or slightly improved compared to that at CR5 in both autumn and spring 2023, these differences in the macroinvertebrate community are likely to be due to the scouring influence at CR6 caused by the Lake Wallace spillway immediately upstream of CR6, and the reduced availability or accessibility of instream habitats at CR6. At recovery site CR7, located in Marrangaroo National Park, approximately five kilometres downstream of the Lake Wallace spillway, taxa richness, EPT richness and SIGNAL-2 in both autumn and spring 2023 were consistent with or higher than the 2023 results at upstream site CR5, impact site CR6, and the long-term CR5 median. Given the high sensitivity of the macroinvertebrate community (as indicated by the high EPT richness and SIGNAL-2 results) at CR7 relative to the background sites, there is no evidence of cumulative impacts from the Centennial operations on aquatic ecosystem health of the UCRC.

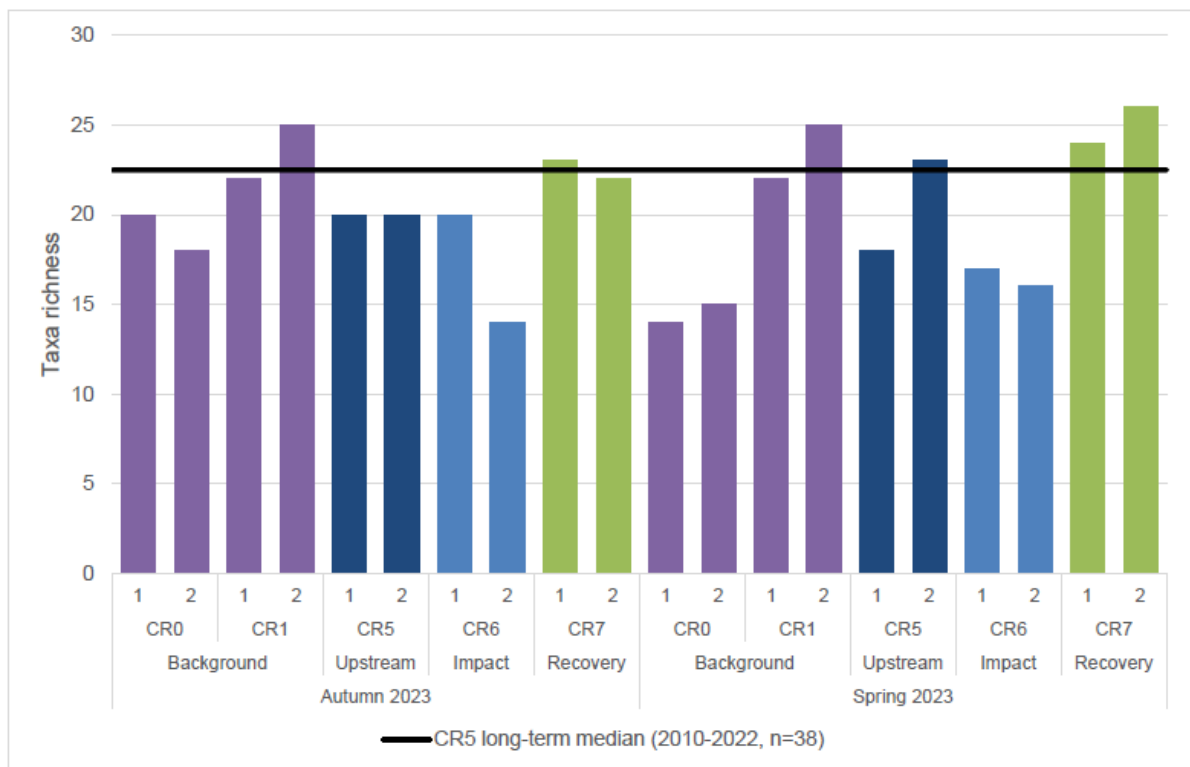


Figure 7-9. Taxa richness in Coxs River samples associated with Springvale Mine LDP6 in 2023

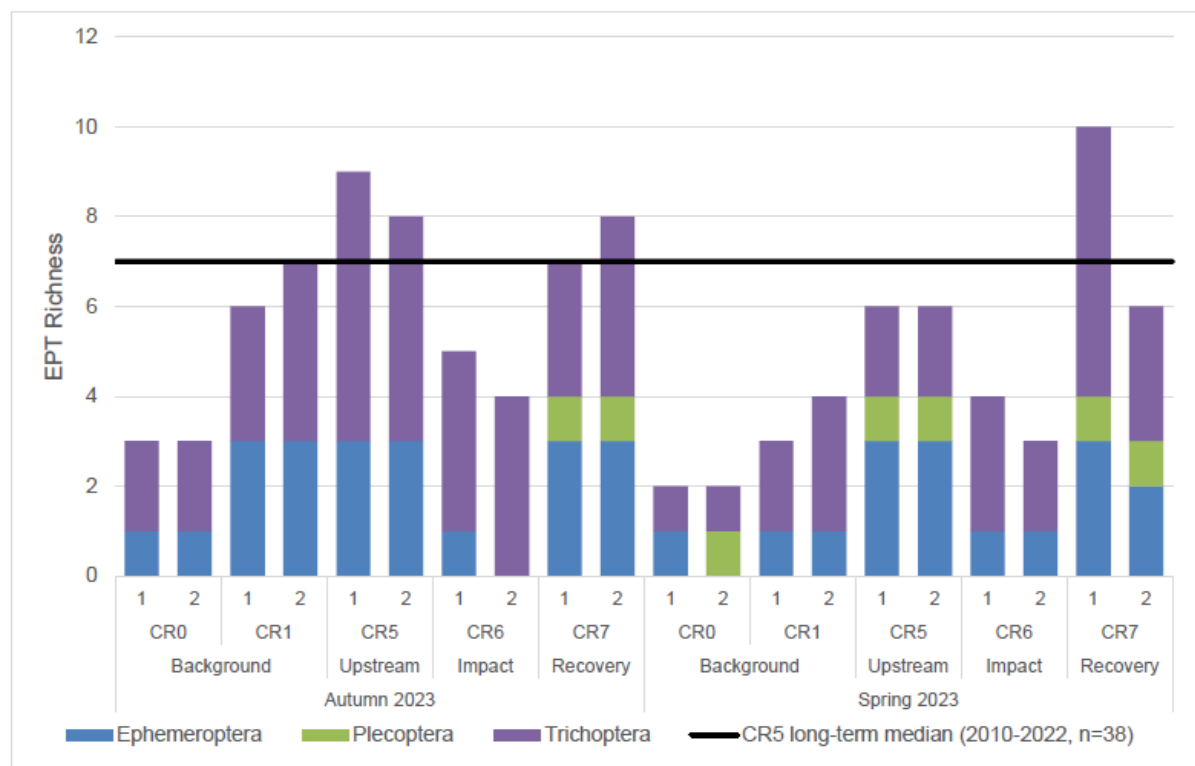


Figure 7-10. EPT richness in Coxs River samples associated with Springvale Mine LDP6

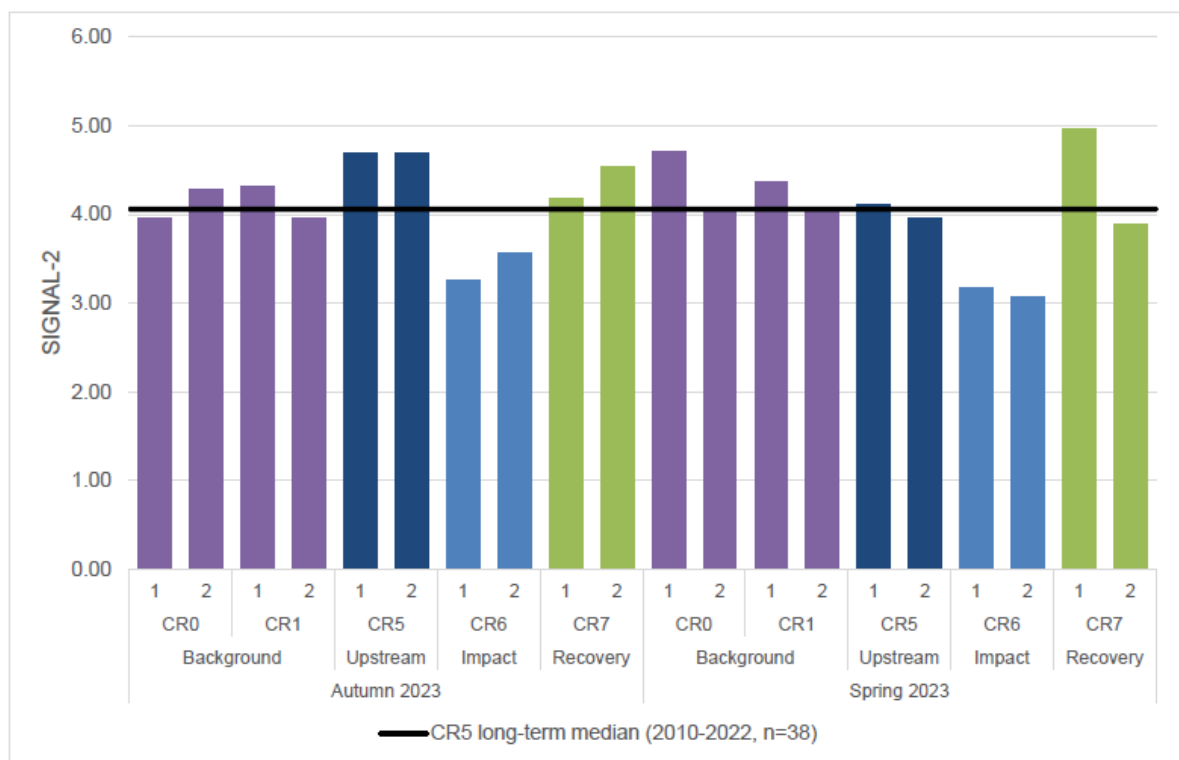


Figure 7-11. SIGNAL-2 in Cocks River samples associated with Springvale Mine LDP6

7.3.2.3 Stream Stability - Upper Coxs River Catchment

Stream stability and geomorphic condition is monitored in accordance with **Section 8.1** of the UCRAMP and also assessed against the objectives of the CILMP and the WMP. Monitoring was undertaken this reporting period in June 2023 which assessed existing erosion and vegetation conditions using multiple methodologies including Rapid Appraisal of Riparian Condition (RARC), visual assessment and CSIRO Ephemeral Stream Assessment. The results were presented in the 2023 Annual Stream Health and Stability Report (SLR, 2023), and are summarised in **Table 7-8**. Monitored streams included the following as shown on **Figure 7-12**. Assessed streams included:

- Marrangaroo Creek (MC)
- Carne Creek (CC)
- Springvale Creek (SC)
- Bungleboori Creek (BC)

Following the baseline assessment in early 2022, elevated rainfall conditions continued until the year end with an annual rainfall depth of 1,203.8 mm observed at the Springvale site AWS (exceeding the 90th percentile rainfall of the site water balance model). This matched closely with the 1,206.4 mm annual rainfall total recorded at the BoM gauge at Lidsdale (Lidsdale (Maddox Lane) AWS 63132). Due to heightened rainfall, a release volume of 496.8 ML was reported at LDP006 which was a substantial increase upon the 198 ML released during 2021. Throughout 2023, reduced rainfall conditions have prevailed in the region to the time of writing. It is also noted that impacts to vegetation in the Newnes Plateau due to the 2019-2020 Gospers Mountain fire remain apparent as widespread woodland regeneration is ongoing.

The results of this monitoring survey indicate that both stream health and channel stability fluctuate over different creeks in vicinity of the site. The survey identified that a number of the creeks, including the areas of Carne Creek, Marrangaroo Creek and Bungleboori Creek are currently in a stable to very stable condition, likely in their original form, with excellent vegetation. Upper reaches of Carne Creek have been vulnerable to erosion and movement of stream sediments due to impacts from the recent bushfires, however, most sites appear to be potentially stabilising as vegetation is re-established in these areas. Previously disturbed areas of Bungleboori Creek appear stable with good grassland growth. Springvale Creek downstream of LDP006 appears stable, however some bed sediment movement is apparent in the area.

The RARC stream health assessment identified the majority of monitoring points as 'Excellent' condition. This is due to lengths of Carnes Creek, Marrangaroo Creek and downstream sections of Bungleboori Creek being located within remnant bushland with very little to no human disturbance within its riparian corridor. The two upper stream points on Bungleboori Creek (BC01 and BC02) scored very poor due to absence of canopy by historical logging at the location, while SC01 on Springvale Creek also scored very poor as most the site is within open paddocks of exotic grass and limited canopy species with an absence of mid-storey cover and exotic ground cover throughout the location.

Downstream areas of Carne Creek are located within very steep, gorge topography and were not accessible for monitoring. However, the nature of streams in this area along with the

expected activities that are undertaken as part of the Springvale operations are not anticipated to have significant impacts on channel stability in these areas. Similar locations such as at monitoring sites CC01, CC02, CC03, CC08 and CC09 are not expected to experience significant deterioration of stream health and/or channel stability due to the location and nature of the channel and vegetation observed in these areas. Hence, these sites may inform the occurrence of any changes to the condition of downstream areas.

Table 7-8: Summary of Stream Stability Assessment (2023)

Site	RARC Stream Heath Assessment Classification	CSIRO Ephemeral Stream Assessment Classification	Primary Cause of Erosion
	2023	2023	
Marrangaroo Creek			
MC01	Good	Very Stable	NA
MC02	Excellent	Very Stable	NA
MC03	Excellent	Very Stable	NA
MC04	Excellent	Very Stable	NA
MC05	Excellent	Potentially Stabilising	Unstable Wall materials
Carne Creek			
CC01	Excellent	Stable	NA
CC02	Excellent	Stable	NA
CC03	Excellent	Stable	NA
CC04	Excellent	Active	Recent Bushfires, Unstable Wall and Bed Materials
CC05	Excellent	Potentially Stabilising	Recent Bushfires, Unstable Wall and Bed Materials
CC06	Excellent	Potentially Stabilising	Recent Bushfires, Unstable Wall and Bed Materials
CC07	Excellent	Stable	NA
CC08	Excellent	Stable	NA
CC09	Excellent	Very Stable	NA
Springvale Creek			
SC01	Very Poor	Stable	NA
BC01	Very Poor	Very Stable	NA
BC02	Very Poor	Stable	NA
BC03	Average	Very Stable	NA
BC04	Excellent	Very Stable	NA
BC05	Good	Very Stable	NA
BC06	Good	Very Stable	NA
BC01	Good	Stable	NA

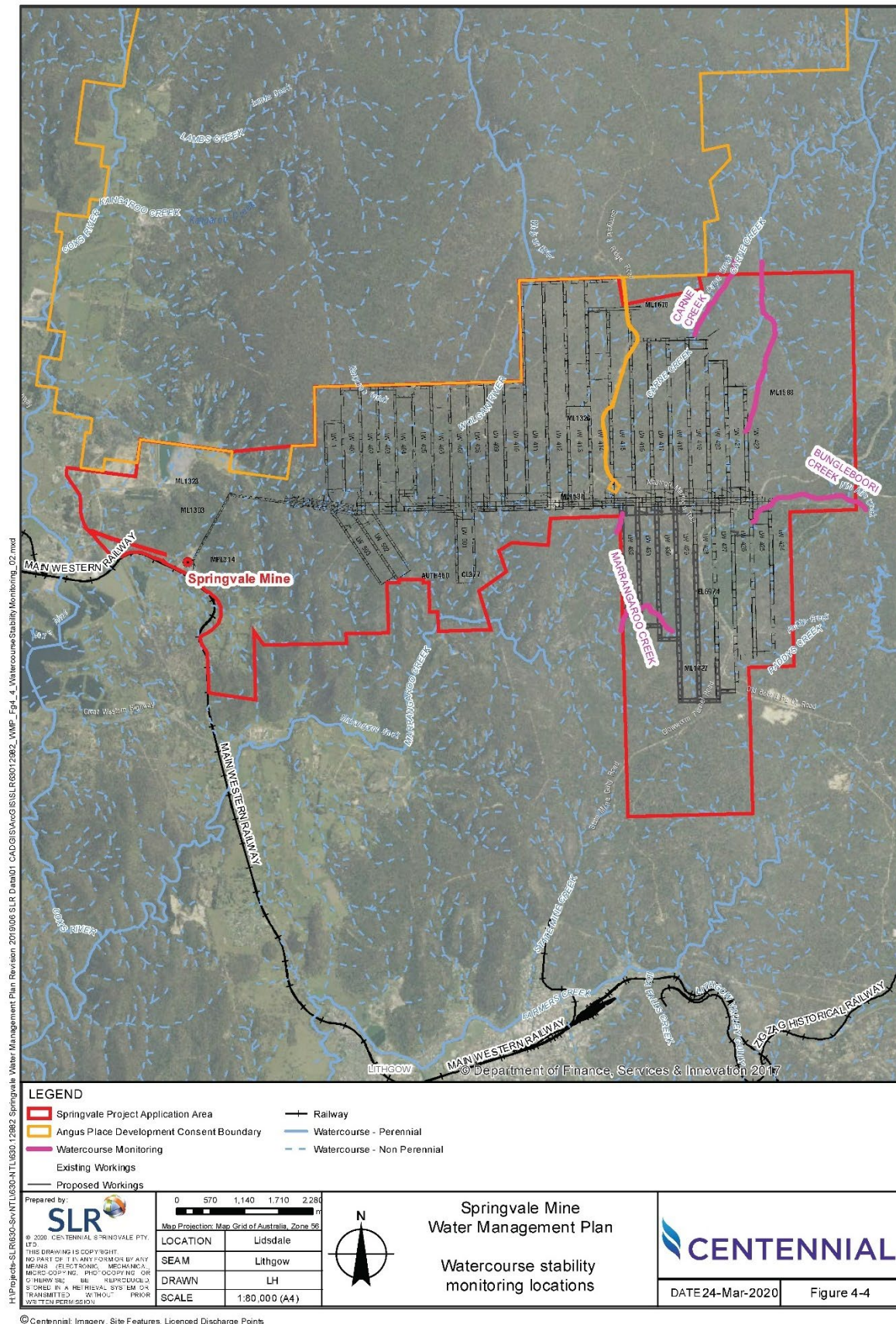


Figure 7-12. Watercourse Stability Monitoring Locations (WMP 2020)

7.3.3 Comparisons against Predictions

The following summarises predictions for riparian habitats for LW 424-427 as outlined in the subsidence assessment for the project and LW 424-427.

The predicted post mining grades along the drainage lines are similar to the natural grades. Therefore, it is not expected that there would be any significant adverse changes in ponding or scouring resulting from the proposed mining. There may be some very minor localised areas which could experience small increases in the levels of ponding, where the natural gradients are low immediately upstream of the longwall chain pillars.

It is expected that fracturing of the bedrock would occur beneath some sections of the drainage lines which are located directly above the proposed longwalls. There may be some diversion of surface water flows into the dilated strata beneath the beds of drainage lines that contain exposed bedrock. However, it is unlikely that there would be any net loss of water from the catchment, however, as any diverted surface water is likely to re-emerge into the catchment further downstream. Past mining has shown these impacts to be minor, localised and isolated, and consequently are unlikely to impact upon flora or fauna species that may occur therein.

Results obtained in the reporting period are consistent with these predictions.

In relation to mine discharges to receiving surface watercourses, successful commissioning of the Springvale Water Treatment Plant (SWTP) in recent years has resulted in the cessation of previous discharges from target LDPs as was predicted, with mine waters redirected to beneficial reuse by the Mount Piper Power Station (MPSS). This has been a significant achievement for Centennial to improve water management both at Springvale Mine and regionally.

7.3.4 Long Term Analysis

The results of this monitoring survey indicate that both stream health and channel stability fluctuate over different creeks in vicinity of the site. The survey identified that a number of the creeks, including the areas of Carne Creek, Marrangaroo Creek and Bungleboori Creek are currently in a stable to very stable condition, likely in their original form, with excellent vegetation. Upper reaches of Carne Creek have been vulnerable to erosion and movement of stream sediments due to impacts from the recent bushfires, however, most sites appear to be potentially stabilising as vegetation is re-established in these areas. Previously disturbed areas of Bungleboori Creek appear stable with good grassland growth. Springvale Creek downstream of LDP006 appears stable, however some bed sediment movement is apparent in the area.

7.3.5 Implemented / Proposed Improvements

The following improvements will be undertaken in accordance with the UCRAMP:

- In accordance with Section 8 of the UCRAMP, monitoring programs will be modified or rationalised as required with the actions proposed as part of the UCRAMP.
- Implementation of commitments for catchment improvement works in accordance with the CILMP (refer **Section 6.5.5.1**);

7.4 WATER MANAGEMENT IN EXTRACTION AREAS

This section presents water management and monitoring undertaken within mining extraction areas only, primarily associated with potential impacts related with mine subsidence in line with the Springvale Water Management Plan (WMP) and WMP's prepared for specific Extraction Plan (EP) areas as progressively approved in accordance with Schedule 3, Condition 10 of SSD5594, as outlined further in the following sections below.

Water management and monitoring beyond extraction areas, including surface water discharges and receiving water environments, is discussed separately in **Section 7.3**.

7.4.1 Environmental Management

Subsidence from longwall mining has potential to cause changes to hydrogeological regimes. Management and monitoring programs target swamps (NPSS and NPHS), perched aquifers, shallow aquifers and the deep aquifers using standpipe piezometers and vibrating wire piezometers (VWPs), as illustrated on **Figure 7-13** and **Figure 7-14**. Potential impacts are assessed against performance triggers established within related TARPs to identify when observed variances in groundwater levels, soil moisture and water quality exceed natural ranges. Groundwater models informing the WMP, SMPs and associated TARPs are regularly updated as detailed in **Section 7.2**.

Groundwater management and monitoring at Springvale is undertaken in accordance with the following guiding documents required by SSD5594:

- Springvale Water Management Plan (including Groundwater Management Plan and Groundwater Monitoring Program), prepared in accordance with Condition 14, Schedule 4, as detailed further in **Section 7.1**;
- Swamp Monitoring Programs (SMP) (shallow groundwater), developed and approved under SSD5594 and EPBC approvals as outlined further in **Section 6.5.1**;
- Western Region Stygofauna Monitoring and Assessment Plan (WR-SMAP), prepared in accordance with Schedule 4, Condition 17 (June 2018 approved by DPHI on 3 July 2018). The prescribed monitoring events required by the plan were completed in 2019.
- Subsidence Monitoring Programs developed and approved for each Extraction Plan in accordance with Condition of SSD5594, also inform water management within extraction areas.

It is important to note that an interrelationship exists between the Swamp, Biodiversity, Subsidence and Water Monitoring Programs and Management Plans. As discussed in **Section 6.5.1**, the recent LW 428-432 Extraction Plan consolidated monitoring sites and methodologies for past and present areas (LW 415-432) to address the approval requirements for SSD5594. Notwithstanding this, the consolidation process has not yet been approved at Commonwealth level and subsequently the previously Commonwealth-approved management and monitoring programs for individual EP areas remain applicable (refer **Section 6.5** for further details).

7.4.2 Environmental Performance

Water monitoring results in extraction areas is analysed in detail by an Annual Environmental Monitoring Review - Surface and Groundwater which is presented in **Appendix 4** (EMM, March 2024), including data and graphical trend analysis. A summary of the report's findings and conclusions is provided in the following sections. The full report should be referred to for further details.

7.4.2.1 Swamp Piezometers

Swamp standpipe piezometers are installed in the unconsolidated sediments of NPSS, typically to refusal on bedrock. Groundwater levels are monitored at 19 NPSS with a total of 51 standpipe piezometers. Groundwater level loggers record levels daily and are downloaded monthly with manual groundwater level measurements taken concurrently.

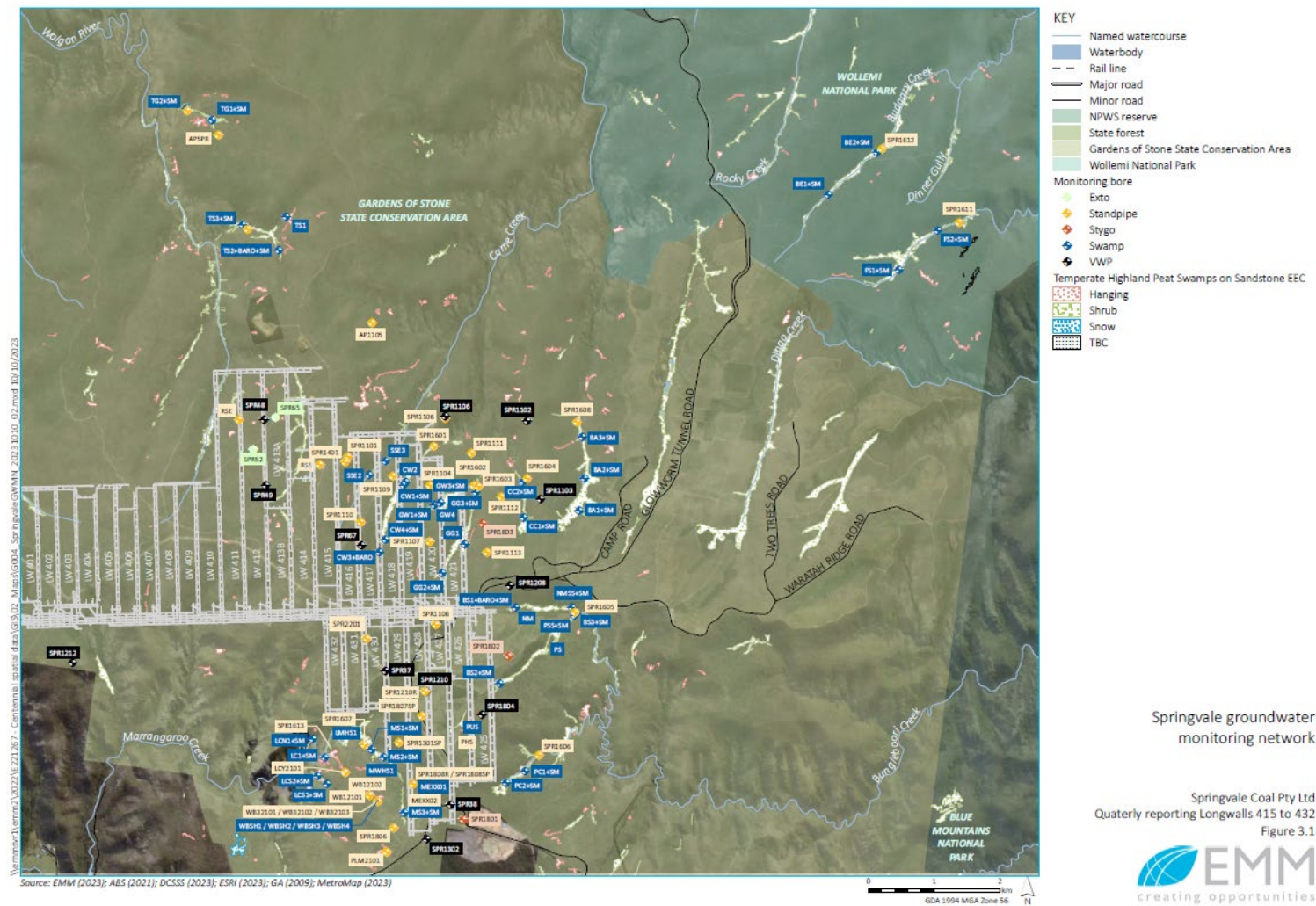


Figure 7-13: Springvale Ground Monitoring Network

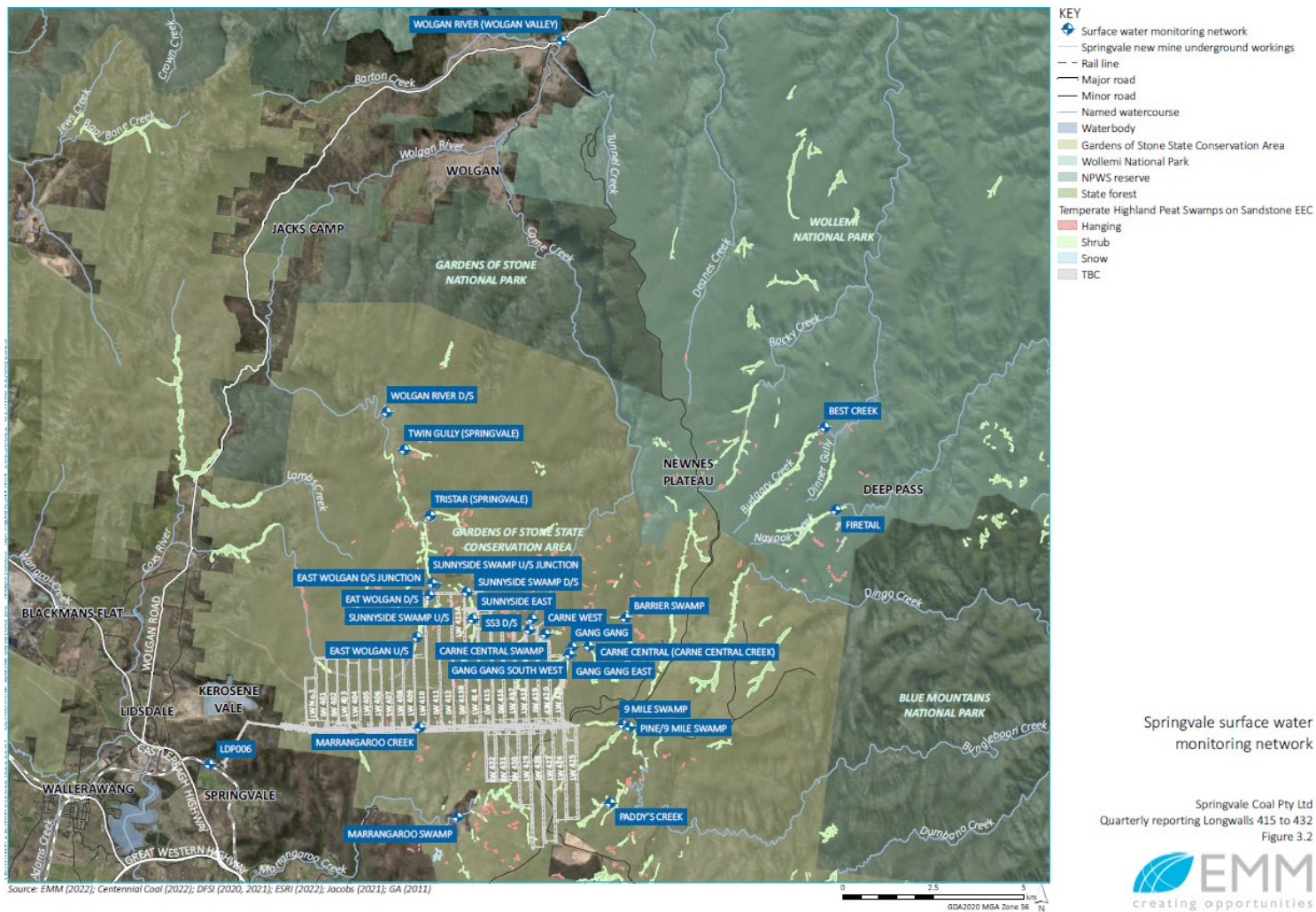


Figure 7-14. Springvale Surface Water Monitoring Network

Swamp Groundwater Levels

Groundwater levels are monitored at three NPHS, with a total of eight standpipe piezometers (hanging swamp piezometers). Piezometers are installed to refusal on bedrock. Groundwater level loggers record levels daily and are downloaded monthly with manual groundwater level measurements taken concurrently. **Table 7-9** summarises observed trends in swamp groundwater levels during the 2023 reporting period.

Table 7-9. Swamp Groundwater Level Trend Summary for 2023

Swamp	Monitoring ID	Site type as per SMP	Mined status	Comment
Barrier Swamp	BA1	Reference	NA	Decreasing – Decreasing from late July due to below average rainfall since November 2022, fluctuates with rainfall.
	BA2			Decreasing – Decreasing due to below average rainfall since November 2022, fluctuates with rainfall and follows the CRD.
	BA3			Decreasing – Decreasing due to below average rainfall since November 2022, fluctuates with rainfall and follows the CRD
Best Swamp	BE1	Reference	NA	Decreasing – Decreasing since early May due to below average rainfall, fluctuates with rainfall.
	BE2			Decreasing – Decreasing since late August due to below average rainfall, fluctuates with rainfall.
Carne Central	CC1	Reference	NA	Stable – Slight increasing trend until mid-October, declining from mid-October with fluctuations seen as spikes due to rainfall.
	CC2			Decreasing - Decreasing due to below average rainfall since November 2022, greater decline from early September with fluctuations seen as spikes due to rainfall
Fire Tail	FS1	Reference	NA	Decreasing – Decreasing due to below average rainfall since November 2022.
	FS2			Decreasing – Decreasing due to below average rainfall since November 2022.
Twin Gully	TG1	Reference	NA	Variable - Decreasing from November 2022 to early 2023, then slightly increasing trend until mid-August then decreasing from mid-August with fluctuations due to rainfall
	TG2			Stable – Slightly increasing trend until mid-August then decreasing from mid-August with fluctuations due to rainfall.
Tristar	TS1	Reference	NA	Decreasing – Fluctuating with the CRD. Highly responsive to individual rainfall events.
	TS2			Decreasing– Stable until mid-June, declining from mid-June and becoming responsive to individual rainfall events from mid-August.
	TS3			Stable – minor variations throughout the reporting period, responsive to large individual rainfall events.
East Wogan	WE1	Impact	Adjacent	Responded to rainfall events with short peaks in groundwater levels but was dry between rainfall events.
	WE2		LW411	Highly responsive to rainfall events. Groundwater level is generally close to bottom of the piezometer or dry.
Sunnyside West	SW1	Impact	LW413B/414	Fluctuates – Highly responsive to rainfall events.
Sunnyside	SS1	Impact	LW414	Decreasing – Fluctuating with the CRD.
	SS2			Decreasing – Fluctuating with the CRD.

Swamp	Monitoring ID	Site type as per SMP	Mined status	Comment
	SS3			Decreasing – Slight decrease until early July. Sudden decrease from early July going dry in early November. Responds to rainfall from early November however dry in between rainfall events.
	SS4			Decreasing – Fluctuating with daily CRD.
	SS5			Decreasing – Fluctuating with daily CRD.
Sunnyside East	SSE1	Impact	LW417	Damaged by bushfire – decommissioned.
	SSE2			Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
	SSE3			Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
Carne West	CW1	Impact	LW149	Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
	CW2			Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
	CW3		LW417	Dry – Historically responsive to rainfall events with a sustained groundwater level compared to the other CW piezometers.
	CW4			Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
Junction	JS1	Impact	LW408	Piezometer damaged by road grading in February 2021 – decommissioned.
	JS2			Decreasing – Declining trend until late November then stable, trending with the daily CRD.
	JS3			Decreasing – Declining trend until late November then stable, trending with the daily CRD.
Gang Gang West	GW1	Impact	LW420	Mostly dry, with some response to rainfall events.
	GW2			Damaged by bushfire – decommissioned.
	GW3			Dry – Historically responds to rainfall events with sharp increases in groundwater levels that slowly recline over days to weeks depending on the intensity of the rainfall event.
	GW4			Dry – Historically responds to rainfall events with sharp increases in groundwater levels that slowly recline over days to weeks depending on the intensity of the rainfall event.
Gang Gang	GG1	Impact	LW420	Decreasing – Going mostly dry from mid-October. Groundwater levels rise quickly following rainfall and slowly recede over several weeks.
	GG2			Dry.
	GG3			Decreasing – Going mostly dry from mid-May. Groundwater levels rise quickly following significant rainfall and slowly recede over several weeks.
Pine	BS2	Impact	LW425	Decreasing – Declining trend going dry from mid-July.
	BS3			Stable – Consistent with historical observations.
	BS4 (PSS)			Decreasing – Responsive to rainfall seen as peaks lasting several weeks, consistent with historical observations.
	PS			Decreasing – Trending with the daily CRD. Logger installed in October 2022.

Swamp	Monitoring ID	Site type as per SMP	Mined status	Comment
	PUS			Fluctuating – Declining trend up until July. Dry from July to mid-December. Responded to rainfall from mid-December. Logger installed in October 2022.
Nine Mile	BS1	Impact	NA	Decreasing – Stable with a slight decreasing trend until early August. Decreasing with responses to rainfall seen as fluctuations from August, corresponding to the daily CRD.
	BS5 (NMSS)			Stable – Minor fluctuation with rainfall.
	NM			Decreasing – Responses to rainfall seen as fluctuations from August, corresponding to the daily CRD.
Marrangaroo	MS1	Impact	LW428	Decreasing – Relatively stable until mid-July. Decreasing from July and fluctuating with rainfall corresponding to the daily CRD.
	MS2			Decreasing – Declining trend and fluctuating. A bailer was found blocking MS2 and was removed in October 2023. Since October sludge/sediment has been accumulating in the piezo and subsidence around the bore was observed, possibly affecting piezo integrity.
	MS3			Decreasing – Fluctuating with rainfall corresponding to the daily CRD.
Lost City	LCS1	Impact	NA	Stable – Slight decrease until early September.
	LCS2			Stable – Minor fluctuations in trend.
	LC1			Stable – Responsive to rainfall seen as fluctuations.
	LCN1			Stable – Responsive to rainfall seen as fluctuations.
Paddys Creek	PC1	Impact	NA	Stable – Minor fluctuations due to rainfall.
	PC2			Decreasing – Decreasing trend with minor fluctuations due to rainfall.
Wishbone Hanging Swamp	WBHS1	Impact	LW428	Mostly dry – Fluctuations follow the CRD and typically occur after periods of sustained rainfall.
	WBHS2			Mostly dry – Fluctuations follow the CRD and typically occur after periods of sustained rainfall.
	WBHS3			Mostly dry from late May. Fluctuations follow the CRD. A data gap is present from late September to early November due to logger error.
	WBH4			Fluctuates with rainfall and mostly dry in between rainfall events. A data gap is present from late September to early November due to logger error.
Marrangaroo Hanging Swamp	LHMS1	Impact	LW428	Stable – Slightly declining trend until mid-September, then increasing.
	MEXX01			Dry
	MWHS1			Fluctuates with rainfall and going dry in-between rainfall events.

¹ CRD = Cumulative Rainfall Departure

Swamp Groundwater Quality

Table 7-10 presents a summary of water quality trends at impact swamps during the reporting period. pH, salinity and filtered iron are key parameters of focus. Refer to the full detailed report in **Appendix 4** for further details.

Table 7-10. Summary of Impact swamp groundwater quality trends for 2023

Monitoring ID	Analyte	2023 Comment
Sunnyside Swamp		
SS1	pH	No baseline trigger value applicable as mining of LW413 commenced before monitoring. Trend is stable and within historical observations.
	EC	No baseline trigger value applicable as mining of LW413 commenced before monitoring. Trend is stable and within historical observations.
SS5	pH	No baseline trigger value applicable as mining of LW413 commenced before monitoring. No data available for 2023 due to a tree being reportedly down.
	EC	No baseline trigger value applicable as mining of LW413 commenced before monitoring. No data available for 2023 due to a tree being reportedly down.
Pine Swamp		
BS2	pH	Reported dry from May. Limited data available to determine trends. Single exceedance of upper trigger level in May.
	EC	Reported dry from May. Limited data available to determine trends.
BS3	pH	Upward trend within trigger levels.
	EC	Slight upward trend, within trigger levels.
PSS (BS4)	pH	Upward trend, within trigger levels. Single exceedance of the lower trigger limit in July.
	EC	Slight upward trend, within trigger levels.
Nine Mile Swamp		
NMSS (BS5)	pH	Generally stable trend. Upper pH trigger level was exceeded in May 2023 and lower pH trigger level was exceeded in July and August 2023.
	EC	Generally stable trend.
Marrangaroo Swamp		
MS1	pH	Generally stable trend, within trigger limits.
	EC	Generally stable trend, within trigger limits.
MS2	pH	Limited data available due to a reported blockage. Generally fluctuates within trigger limits
	EC	Limited data available due to a reported blockage. Generally fluctuates within trigger limits.
MS3	pH	Generally stable trend.
	EC	Generally stable trend.
Paddys Creek Swamp		

Monitoring ID	Analyte	2023 Comment
PC1	pH	No baseline data applicable to this site. Trends within historical limits apart for a single high value (7.6) recorded in May.
	EC	No baseline data applicable to this site. Trends within historical limits apart for a single low value (29) in May.
PC2	pH	No baseline data applicable to this site. Trends within historical limits apart for a single high value (7.8) in May.
	EC	No baseline data applicable to this site. Generally stable trend.
Lost City Swamp		
LC1	pH	No baseline applicable to this site. Stable trend, fluctuates during the reporting period within historical observations.
	EC	No baseline applicable to this site. Stable slight declining trend.
LCN1	pH	No baseline applicable to this site. Fluctuating trend with lowest historical observation (pH 4.4) recorded in June.
	EC	No baseline applicable to this site. Slight increasing trend.
LCS1	pH	No baseline applicable to this site. Fluctuates, largest recorded pH of 5.7 in April and lowest recorded pH of 4.2 in October.
	EC	No baseline applicable to this site. Stable trend. Highest recorded EC in October of 80 us/cm.
LCS2	pH	No baseline applicable to this site. Slightly upward trend. Fluctuates during the reporting period. Spike in April.
	EC	No baseline applicable to this site. Fluctuates, largest recorded pH of 6.0 in April and lowest recorded pH of 4.0 in October.

7.4.2.2 Shallow Groundwater System

The shallow groundwater system is monitored by twenty one standpipe piezometers (ridge piezometers) and targeted VWP sensors installed in the Burralow Formation and Banks Wall Sandstone. Groundwater level loggers record levels daily and are downloaded monthly with manual groundwater level measurements taken concurrently in accordance with the WMP. Groundwater quality is collected quarterly in accordance with the WMP at 12 of the 21 ridge piezometers.

A summary of results observed in 2023 for water quality is provided in **Table 7-11** below, and water level is presented in **Table 7-12**. Results for VWP's in shallow groundwater systems are presented in **Section 7.4.2.4**. Perched aquifers of the shallow groundwater system is monitored and reported separately as presented in **Section 7.4.2.3**.

Table 7-11. Shallow Aquifer Groundwater Quality Summary (2023)

Monitoring ID	Site type	Date range	Frequency	Analyte	2023 Water Quality Comment
AP9PR	Reference	17/03/2016 - present	Quarterly	pH	Upward trend.
			Quarterly	EC	Stable trend.
AP8PR	Reference	17/03/2016 - present	Quarterly	pH	Upward trend.
			Quarterly	EC	Upward trend. Single spike in early June, within trigger levels.
AP5PR	Reference	17/03/2016 - present	Quarterly	pH	Upward trend.
			Quarterly	EC	Stable trend. High EC in early June but below triggers level.
AP4PR	Reference	17/03/2016 - present	Quarterly	pH	Upward trend.
			Quarterly	EC	Downward trend.
AP1204	Reference	17/03/2016 - present	Quarterly	pH	Upward trend.
			Quarterly	EC	Slightly upward trend. Single upper trigger level exceedance in early June (104.6 µS/cm).
AP1105	Reference	4/12/2018 - present	Quarterly	pH	Upward trend.
			Quarterly	EC	Stable trend.
AP10PR	Reference	6/12/2022 - present	Quarterly	pH	Site added in December 2022. Upward trend.
			Quarterly	EC	Site added in December 2022. Stable trend.
SPR1401	Impact	17/03/2016 - present	Quarterly	pH	Upward trend.
			Quarterly	EC	Upward trend. Single spike in early June, within trigger levels.
SPR1109	Impact	18/03/2016 – 30/11/2016	Not sampled	pH	Damaged by subsidence.
			Not sampled	EC	Damaged by subsidence.
SPR1106	Impact	18/03/2016 – present	Quarterly	pH	Limited data available. Generally stable.
			Quarterly	EC	Limited data available. Generally stable
SPR1210	Impact	5/03/2019 – 28/05/2019	Quarterly	pH	No data available since June 2019. Too low and muddy to sample
			Quarterly	EC	No data available since June 2019. Too low and muddy to sample.
SPR1211	Impact	4/12/2018 – 12/09/2019	Not sampled	pH	Damaged by subsidence between October 2019 and March 2020.

Table 7-12.Shallow Groundwater Level Trend (2023)

Monitoring ID	Site type	Mined status	Comments
AP5PR	Reference	NA	Stable.
AP1105	Reference	NA	Stable – Slight increasing trend
RSE	Impact	LW411	Stable – slight decreasing trend.
RSS	Impact	LW415	Decreasing – Response to large rainfall events with short sharp rises in groundwater levels that likely indicates a compromised annulus or seepage from a nearby fire dam.
SPR1101	Impact	LW416	Damaged by subsidence – decommissioned.
SPR1104	Impact	LW420	Decreasing – Going dry from mid-April.
SPR1106	Impact	NA	Decreasing – Consistent with the CRD trend
SPR1107	Impact	LW420	Decreasing – Consistent with the CRD trend
SPR1108	Impact	LW427	Decreasing – Consistent with the CRD trend.
SPR1109	Impact	LW418	Decreasing – Consistent with the CRD trend.
SPR1110	Impact	LW417	Dry
SPR1111	Impact	NA	Decreasing – Consistent with the daily CRD trend.
SPR1112	Impact	NA	Decreasing – Consistent with the daily CRD trend.
SPR1113	Impact	NA	Decreasing – Consistent with the daily CRD trend.
SPR1210R	Impact	LW428	Stable – Slight increasing trend.
SPR1211	Impact	LW426	Damaged by subsidence – decommissioned.
SPR1301	Impact	NA	Decreasing –There is a gap in logger data during July because a hydrasleeve was stuck in the piezometer. The declining trend is not consistent with other impact (SPR1210 and SPR1806) or other reference piezometers and may have been impacted by LW428.
SPR1401	Impact	NA	Decreasing – Consistent with the daily CRD trend.
SPR1402	Impact	NA	Vandalised – decommissioned.
SPR1403	Impact	NA	Damaged by bushfire – decommissioned.
SPR1806	Impact	NA	Stable – Slight increasing trend until mid-September then a slight decreasing trend.
SPR1807	Impact	NA	Dry
SPR1808	Impact	NA	Dry since June 2022 - Impacted by LW426, LW427 and 428 with stepped water level declines. This piezo was replaced by SPR1808R.
SPR1808R	Impact	NA	Decreasing – Logger installed in December 2022, decreasing trend since installation.

7.4.2.3 Perched Aquifers Shallow Groundwater System

The shallow perched groundwater system is monitored by 21 standpipe piezometers (perched aquifer piezometers) targeting the Burralow Formation. Most standpipe piezometers are located downgradient of swamp piezometers. Groundwater level loggers are downloaded monthly with manual groundwater level measurements taken concurrently, as summarised in Table 7-13 below.

Table 7-13. Perched Groundwater Level Trend Summary

Monitoring ID	Associated swamp	Site type	Comment
SPR1601	Carne West	Impact	Declining – Trending with the CRD, spiked from mid-December due to a significant rainfall event.
SPR1602	Gang Gang West	Impact	Declining – Declining before stabilising from early December, consistent with the CRD trend.
SPR1603	Gang Gang	Impact	Declining – Declining before stabilising from mid-December, consistent with the CRD trend.
SPR1604	Carne Central	Impact	Declining.
SPR1605	Pine/Nine Mile	Impact	Declining – Declining before stabilising from mid-December, consistent with the CRD trend.
SPR1606	Paddys Creek	Impact	Declining
SPR1607	Marrangaroo	Impact	Declining – Trending with the CRD.
SPR1608	Barrier	Reference	Declining – Consistent with the CRD trend.
SPR1609	Tri Star	NA	Declining – Trending with the CRD.
SPR1610	Twin Gully	NA	No piezometer installed.
SPR1611	Fire Tail	Reference	Slight decline corresponding to below average rainfall since November 2022.
SPR1612	Best	Reference	Slight decline – Fluctuates with the daily CRD, increasing from mid-December due to rainfall.
SPR1613S	Lost City	NA	Stable – Slight increasing trend.
SPR1613D	Lost City	NA	Stable – Fluctuating with rainfall and with the daily CRD.
LCY2101	Lost City	NA	Declining – Fluctuates with the daily CRD, increasing from mid-December due to rainfall.
PHS	Pine	NA	Declining – Going dry from mid-November.
PLM2101	Plum	NA	Declining – Spike from late November due to rainfall, fluctuates with the daily CRD.
PLM2102	Plum	NA	Declining trend from July 2022.
WB12101	Wishbone	NA	Declining going dry, fluctuates with the CRD.
WB12102	Wishbone	NA	Dry.
WB32101	Wishbone	NA	Stable – Fluctuating with daily CRD.
WB32102	Wishbone	NA	Dry.
WB32103	Wishbone	NA	Increasing.

7.4.2.4 Vibrating Wire Piezometers (Shallow and Deep Groundwater Systems)

Multi-level vibrating wire piezometer (VWP) arrays are used to monitor piezometric pressures in the shallow and deep groundwater systems at ten locations. VWPs are used as a proxy for potential impacts to ridge and swamp piezometers and to monitor for potential connective cracking to swamps and perched and shallow groundwater sources (above the Mount York Claystone (MYC)). VWP loggers are managed and downloaded in accordance with the VWP (typically monthly).

The hydrographs for the VWP reference and impact monitoring sites, are shown Appendix 4. **Table 7-14** includes comments on the piezometric head trends.

Table 7-14. Vibrating wire piezometer piezometric head trend summary

Monitoring ID	Sensor depth (mbgl) ¹	Comment
SPR37	#1 405 (AQ1), #2 350 (AQ1), #3 320 (SP1), #4 260 (AQ3), #5 187 (AQ3), #6 165 (AQ4), #7 135 (AQ4), #8 110 (AQ4)	SPR37R was located within the Trigger Investigation Area (TIA) from early April to mid-November 2023. Piezometer sensor (piezo) #1 (405 m) has been unsaturated since late October 2022. Communication was lost with piezo #2 (350 m) in 2012. Piezo #3 (320 m) has been unsaturated since 2016. Piezo #6 (165 m) has been recording erroneous data since late 2020. A data gap from 2 August 2023 to 9 November 2023 is present due to a lightning strike damaging the logger. A new logger was installed early November 2023. A declining trend was observed in sensors #5 (187 m), #7 (137m) and #8 (110m) until August 2023 when the logger went offline. Following the installation of a new logger remaining piezos #4, #5, #7 and #8 (110m) showed stabilising water levels.
SPR38	#1 80 (AQ4), #2 100 (AQ4), #3 135 (AQ4), #4 190 (AQ3), #5 230 (AQ3), #6 300 (semi permeable layer), #7 355 (AQ1), #8 370 (AQ1)	SPR38 was previously undermined by LW 427 and was outside the TIA during the reporting period. Piezo #5 (230 m) has been unsaturated since 2016. Piezos #6 (300 m), #7 (355 m) and #8 (370 m) lost communication with the logger in 2020 due to LW427. Communication was lost with Piezo #1 (80 m) possibly due to subsidence caused by LW427 in 2020. During the reporting period, all remaining functional piezos showed stable slightly declining trends.
SPR1208	#8 90 m, #7 130 m, #6 226 m, #5 303 m, #4 330 m, #3 380 m, #2 411 m, #1 421 m.	Damaged by bushfire – decommissioned.
SPR1210	#1 388 (AQ1), #2 376 (AQ1), #3 326 (AQ2), #4 308 (semi permeable layer), #5 224 (AQ3), #6 160 (AQ4), #7 76 (AQ6)	SPR1210 was directly undermined by LW 428 in early May 2023 and remained within the TIA until late September 2023. Communication with piezo #1 (388 m), #2 (376 m) and #3 (326 m) (below the MYC) was lost due to the passing of LW 428 in May 2023. A stepped decline of piezometric head was observed at piezos #4 (308 m) and #5 (224 m) (below MYC) and #6 (160 m) and #7 (76 m) (above MYC) from early May 2023. The declines above the MYC were greater than 10 m and a trigger investigation report was issued to the regulator on 2 November 2023. The trigger investigation found the response observed at SPR1210 VWP was similar to other VWP sites impacted by earlier longwalls, however no impact was seen at nearby standpipe piezometer SPR1210R, indicating the aquifer could still be intact. As such the report concluded further observation was required to confirm the condition of the shallow aquifer and whether the observations were representative or a result of VWP grout failure or other geotechnical related issues. Piezo #4 showed a slight increasing trend until early April. From early April to late May a depressurisation was observed. From late May a relatively stable trend was observed with a slight decline and minor fluctuations. Piezo

Monitoring ID	Sensor depth (mbgl) ¹	Comment
		#5 remained relatively stable however showed a slight depressurisation and fluctuations between late March and late May. Piezo #6 showed a stable slightly declining trend until late April. From late April to mid-June a depressurisation was observed. From June a slightly declining trend has been observed. Piezo #7 remained relatively stable until early May. From early May to early July a depressurisation was observed. From early July a stable slightly increasing trend was observed.
SPR1212	182 (#6), 197 (#5), 208 (#4), 229 (#3), 264 (2), 280 (#1)	All piezos remain functional. In mid-July the logger failed to record data, when the logger resumed functioning on 20 July 2023 a slight pressure drop was observed across the shallowest piezos #6 (182m), #5 (197m) and #4 (208 m). The shallowest piezos had the greatest pressure decline with sensor #6 losing approximately 1.1m of head. Similar depressurisation of the shallowest sensors was observed from 9 November and 2 December 2023 which are also believed to be erroneous. Sensors #6 and #5 remained relatively stable showing a slight increasing trend except for the previously mentioned pressure declines. Sensor #4 remained stable. Piezo #3 (229 m) showed a slight increase in piezometric pressure from mid-September followed by a depressurisation from late September of approximately 2.6m of piezometric head. Piezo #2 (264 m) remains stable while Piezo #1 (280 m) shows a gradual decline in piezometric pressure.
SPR1302	#1 390 (AQ1), #2 370 (AQ1), #3 310 (AQ2), #4 270 (AQ3), #5 200 (AQ3)	SPR1302 was outside the TIA during the reporting period. Depressurisation responses were seen in September 2021 due to the commencement of first workings for LW428. A data gap is observed from early April 2022 to mid-July 2022 due to a logger failure. A new data logging system was installed mid-July 2022 and a drop in pressure was subsequently observed in the shallow piezos #4 (270 m) and #5 (200 m). This is believed to be due to the installation of a new logging system. Piezo #1 (390 m) remained stable throughout the reporting period. Piezo #2 (370 m) shows fluctuating piezometric pressures. Initially piezo #2 had an increasing trend until late April, it then showed a depressurisation from late April to early May of approximately 3.5 m of piezometric head. The piezo then recovered showing an increasing trend from early May. Piezo #3 (310m) remains dry. Piezo #4 remained relatively stable showing a slight increasing trend. Piezo #5 showed minor fluctuations and a decreasing trend.
SPR1804	345 (#1), 291 (#2), 217 (#3), 118 (#4), 69 (#5), 38 (#6)	Undermined by LW425 – decommissioned.
AP10PR	343 (#1), 327 (#2), 300 (#3), 270 (#4), 248(#5), 205 (#6), 150 (#7), 103 (#8), 60 (#9)	Piezos #1 (343 m), #2 (327 m), #3 (300 m) and #7 (150 m) showed stable, slightly increasing, trends. Piezos #5 (248 m), #8 (103 m) and #9 (60 m) showed stable, slightly decreasing, trends. Piezo #6 (205 m) showed a slight increasing trend plateauing from mid-September. Piezo #4 (270 m) malfunctioned from mid-May to mid-November which is seen as a data gap on the hydrograph. This piezo appears to show a slightly declining trend.
SPR64	390 (#1), 370 (#2), 310 (#3), 270 (#4), 200 (#5), 150 (#6), 100 (#7), 30 (#8)	SPR64 was previously damaged by bushfire and decommissioned. In mid-November a new data logger was installed and SPR64 was recommissioned. All piezos appear to be functioning however insufficient data is available to determine trends.
SPR67	35 (#8), 50 (#7), 70 (6), 90 (#5), 110 (#4), 160 (#3), 200 (#2), 260 (#1)	Piezos #1 (260 m), #2 (200m) and #3 (160 m) have been non-functional since 2015. Piezo #4 (110 m) has been non-functional since October 2022. Piezo #8 (35 m) showed a declining trend throughout the reporting period. A slight increase was seen from late August before a sudden decline from mid-September, losing approximately 9.5 m of piezometric head.

Monitoring ID	Sensor depth (mbgl) ¹	Comment
		Piezo #7 (50 m) had a reasonably stable slightly increasing trend until mid-August. From 10 August a sudden depressurisation of approximately 5.3 m of piezometric head was observed. From 20 August piezo #7 has been steadily increasing however remains below pre-August levels. Piezo #6 (70 m) showed stable slightly increasing trends until early December 2023. From 5 December a sudden depressurisation of approximately 6.1 m of piezometric head was observed. From 15 December there appears to be an increasing trend however piezo #6 remains below pre-December levels. Piezo #5 (90 m) showed a stable trend throughout the reporting period.
SPR1102	82 (#9), 125 (#8), 148 (#7), 160 (#6), 203 (#5), 292 (#4), 312 (#3), 380 (#2), 404 (#1)	A data gap exists between June 2021 and April 2023 because the logger was broken. A new logger was installed mid-April 2023. The logger was removed in early November 2023 to replace the broken logger at SPR37. Piezos #7 (148 m), #8 (125 m) and #9 (82 m) showed a stable trend, consistent with data prior to June 2021. Piezo #6 (160 m) showed a depressurisation in mid-August of approximately 2.9m of piezometric head however appeared to begin recovering from late August with an increasing trend. Piezo #5 (203 m) does not correlate with pre-June 2021 data however showed a stable slightly decreasing trend. Piezo #4 (292 m) showed a stable slightly increasing trend. Piezo #3 (312 m) showed a stable trend. Piezos #1 (404 m) and #2 (380 m) showed slightly increasing trends.
SPR1103	138 (#9), 151 (#8), 178 (#7), 236 (#6), 290 (#5), 313 (#4), 326 (#3), 381 (#2), 401 (#1)	A data gap exists between November 2020 and April 2023 because the data logger was broken. The data logger was struck by lightning in late August and subsequently failed. A new data logger was installed in December. All Piezos showed stable slightly decreasing trends for the period of logger functionality.
SPR1106	123 (#8), 163 (#7), 251 (#6), 261 (#5), 277 (#4), 323 (#3), 341 (#2), 362 (#1)	Logger issues since December 2021. Vandalised in August 2023.
SPR2303B	46 (#8), 146 (#7), 203 (#6), 247 (#5), 279 (#4), 316 (#3), 356 (#2), 387 (#1)	SPR2303B was installed in mid-December 2023, as such, insufficient data is available to determine trends. All sensors are functional and currently displaying stable data.

7.4.2.5 Swamp Surface Water Quality and Flow

A summary of results observed in the 2023 reporting period is provided in **Table 7-15** below. For further details refer to the detailed annual report (EMM, 2024) provided in **Appendix 4**.

Table 7-15. Swamp Surface Water Quality and Flow

Monitoring ID	Date Range	Frequency	Analyte	2023 Water Quality Comment
Reference Sites				
Barrier Swamp	27/09/2016 - present	Fortnightly/ monthly	pH	Slightly downward trend. One high pH values in June (8.3).
			EC	Slightly upward trend. One high EC values in May (103 $\mu\text{S/cm}$).
			Flow	Downward trend due to below average rainfall but higher flow and bigger fluctuations compared to historical pattern, due to higher than average rainfall during 2022.
Best Creek	24/11/2017 - present	Fortnightly/ Monthly	pH	No access due to Road closures
			EC	No access due to Road closures
			Flow	No access due to Road closures
Carne Central Swamp	27/09/2016 - present	Fortnightly/Monthly	pH	Downward trend. One high value recorded in February (8.2 pH).
			EC	Stable.
			Flow	Water level too low for flow monitoring or pooled water.
Firetail Swamp	24/11/2017 - present	Fortnightly/ monthly	pH	No access due to Road closures.
			EC	No access due to Road closures
			Flow	No access due to Road closures
Tristar (Springvale site)	2/11/2016	Fortnightly/monthly	pH	Fluctuating within historical limits. Downward trend. Lowest value recorded in July (3.1).
			EC	Generally stable trend. Highest value recorded in July (210 $\mu\text{S/cm}$).
			Flow	Downward trend due to below average rainfall.
Twin Gully (Springvale Site)	2/11/2016	Fortnightly/monthly	pH	Generally stable trend.
			EC	Stable.

Monitoring ID	Date Range	Frequency	Analyte	2023 Water Quality Comment
			Flow	Generally stable, slightly increasing flow due to above average rainfall during 2022.
Impact				
Carne Swamp	5/01/2005 – present	Fortnightly/monthly	pH	Single exceedance of the upper pH trigger level in March. Stable, remaining values within historical observations. Data available only for January and March 2023.
			EC	Limited data available. Stable trend between January and March 2023.
			Flow	No data available. Water level too low for flow monitoring or pooled water.
Gang Gang South West	27/09/2016 - present	Fortnightly/ monthly	pH	Slightly upward trend, fluctuating within historical range.
			EC	Stable trend. Slightly high EC recorded in late May and June (44.98 and 53 $\mu\text{S}/\text{cm}$, respectively).
			Flow	No data available. Water level too low for flow monitoring or pooled water.
Gang Gang East	27/09/2016 – present	Fortnightly / monthly	pH	Slightly downward trend, values within historical observations. Low values recorded in July (4.8) and August (5 and 4.8, respectively).
			EC	Slightly upward trend. Two consecutive exceedances of the 80th % trigger in mid-August (39 $\mu\text{S}/\text{cm}$) and late-August (42 $\mu\text{S}/\text{cm}$).
			Flow	No data available. Water level too low for flow monitoring or pooled water.
Marangaroo Swamp	24/11/2017 – present	Fortnightly / monthly	pH	Slightly downward trend, within trigger levels.
			EC	One single exceedances in January (774 $\mu\text{S}/\text{cm}$). Generally stable trend.
			Flow	Flows consistent with historical observations. High flow recorded in January.

Monitoring ID	Date Range	Frequency	Analyte	2023 Water Quality Comment
Nine Mile Swamp	27/11/2017 - present	Fortnightly/monthly	pH	Downward trend, values within trigger thresholds.
			EC	Upwards trend, two non-consecutive exceedances in June (72 $\mu\text{S/cm}$) and September (76 $\mu\text{S/cm}$).
			Flow	No data because water level too low for flow monitoring.
Sunnyside U/S Junction	31/03/2006 - present	Fortnightly/monthly	pH	Downward trend, within historical observations.
			EC	High value in April (95 $\mu\text{S/cm}$). Slightly upward trend.
			Flow	Declining flow due to below average rainfall.
Sunnyside Swamp Upstream	24/05/2005 - present	Fortnightly / monthly	pH	Slightly upward trend, fluctuations within historical observations.
			EC	Generally stable trend.
			Flow	Limited data available. Water level generally pooled or too low for flow monitoring.
Sunnyside Swamp Downstream	24/05/2005 - present	Fortnightly / monthly	pH	Generally stable, fluctuating within historical limits.
			EC	Generally stable trend.
			Flow	Fluctuating more than historical records. Declining trend.
Sunnyside East Swamp (SS3 D/S)	10/06/2010 - present	Fortnightly / monthly	pH	Dry since 2015.
			EC	Dry since 2015.
			Flow	Dry since 2015.
Sunnyside East	21/03/2016 - present	Fortnightly / monthly	pH	Slightly downward trend, values within historical observations.
			EC	Slightly downward trend, values within historical observations.
			Flow	Too low for flow monitoring.
Paddys Creek	24/11/2017 - present	Fortnightly / monthly	pH	Stable, values within trigger thresholds.
			EC	Generally stable trend with significant fluctuations. Five

Monitoring ID	Date Range	Frequency	Analyte	2023 Water Quality Comment
				non-consecutive exceedances of the upper trigger level in early and mid-May (297 and 52 $\mu\text{S/cm}$, respectively), July (76 $\mu\text{S/cm}$), August (55 $\mu\text{S/cm}$) and September (102 $\mu\text{S/cm}$).
			Flow	High flow from May.
Pine / Nine Mile Swamp	27/11/2017 - present	Fortnightly / monthly	pH	Trend consistent with Pine Swamp monitoring site. One single exceedance of the upper pH trigger level in April (8.1).
			EC	Upward trend but fluctuating within historical limits.
			Flow	Flow not sustained due to below average rainfall in 2023.

7.4.2.6 Tributary Surface Water Quality and Flow

Tributary surface water quality and flow is summarised in **Table 7-16** below. The timeseries for long term water quality trends are shown in Appendix G of the 2023 'AEMR Surface and Groundwater Report' (EMM, 2024), and tabulated statistics are shown in Appendix H. Tables 10.1 to Table 10.6 of the Report summarise the trends of key surface water quality parameters at reference and impact sites, and reviews the sites compliance status against respective site-specific trigger values outlined in Section 3.3 of the Report.

Table 7-16. Tributary Surface Water Quality and Flow

Monitoring ID	Date range	Frequency	Analyte	2023 Water Quality Comment
Carne Central				
Carne Central	21/03/2016 - present	Fortnightly/ monthly	pH	Stable trend with fluctuations within historical observations except for pH recorded in February (8.1 pH).
		Fortnightly/ monthly	EC	Slightly upward trend.
		Fortnightly/ monthly	Flow	Limited data available because after June the water level become too low to measure, differently from 2022 when the flow was high due to above average rainfall.
Wolgan River				
Wolgan River Downstream	4/01/2002 - present	Fortnightly/ monthly	pH	Fluctuating within historical values, low pH recorded in July (4.8 pH).
		Fortnightly/ monthly	EC	Generally stable trend. Fluctuations higher than historical records. Peak in September (454 µS/cm).
		Fortnightly/ monthly	Flow	Stable trend. Flow within historical limits.

Monitoring ID	Date range	Frequency	Analyte	2023 Water Quality Comment
Wolgan River (Wolgan Valley)	30/04/2018 - present	Fortnightly/ monthly	pH	Fluctuating within historical limits except for highest pH recorded in mid-August (8.3).
		Fortnightly/ monthly	EC	Stable trend with some fluctuations within historical limits.
		Fortnightly/ monthly	Flow	Limited data available. Flow within historical limits.
East Wolgan				
East Wolgan Upstream	8/04/2005 - present	Fortnightly/ monthly	pH	Limited data available. No data collected after February. Lowest historical pH recorded in January (4.9).
		Fortnightly/ monthly	EC	Limited data available. No data collected after February. Downward trend after being generally dry since 2009. Values similar to 2022.
		Fortnightly/ monthly	Flow	One data point collected in July. Generally dry or too low to measure.
East Wolgan Downstream	8/04/2005 - present	Fortnightly/ monthly	pH	Dry
		Fortnightly/ monthly	EC	Dry
		Fortnightly/ monthly	Flow	Dry
East Wolgan DS Junction	8/04/2005 - present	Fortnightly/ monthly	pH	Downward trend and minimum historical value recorded in late March (3.3).
		Fortnightly/ monthly	EC	Slightly upward trend. Some spikes recorded in late-March and late-April up to 127 µS/cm.
		Fortnightly/ monthly	Flow	Flow within latest historical values.
Carne Creek – Western (Carne West) Tributary				
Carne West	12/07/2016 - present	Fortnightly/ monthly	pH	No data available. Water level too low for flow monitoring or pooled water.
		Fortnightly/ monthly	EC	No data available. Water level too low for flow monitoring or pooled water.
		Fortnightly/ monthly	Flow	Water level too low for flow monitoring.

Monitoring ID	Date range	Frequency	Analyte	2023 Water Quality Comment
Gang Gang				
Gang Gang	21/3/2016 - present	Fortnightly/ monthly	pH	Slightly downward trend, within historical observations.
		Fortnightly/ monthly	EC	Slightly upward trend, within historical observations.
		Fortnightly/ monthly	Flow	No data available. Flow was too low to measure.
Marrangaroo Creek				
Marrangaroo Creek	30/01/2014 - present	Fortnightly/ monthly	pH	Generally stable trend but no data available since February 2023 due to below average rainfall.
		Fortnightly/ monthly	EC	Generally stable trend but no data available since February 2023 due to below average rainfall.
		Fortnightly/ monthly	Flow	Generally dry or too low for flow monitoring.

7.4.2.7 Soil Moisture

Soil moisture probes were installed within swamps, immediately adjacent to swamp piezometers, to provide data to support impact assessments and trigger investigations.

Soil moisture probes were installed between July and October 2018. The soil moisture systems were damaged in the 2019-2020 bushfires and were subsequently reinstated in September 2020. Four additional probes were installed in September 2021 at Lost City Swamp.

A summary of reported trends at each site is provided in **Table 7-17** and in Appendix 4.

Table 7-17 Summary of Longwall 424 – 427 Swamp Soil Moisture (2023)

Monitoring ID	Site type	Comment
BA1SM	Reference	The 10 cm sensor has shown a decreasing trend since February, consistent with below average rainfall. Remaining sensors are fully saturated and showed slight declining trends from April to September. From September increasing trends were observed.
BA2SM	Reference	The 10 and 30 cm sensors showed decreasing trends from March to August and an increasing trend from August. The 20 cm sensor showed an increasing trend from April. All other sensors were fully saturated and showed Increasing trends.
BA3SM	Reference	Increasing trends in all sensors. The 10 cm sensor showed decreased saturation between October and November due to below average rainfall. Remaining sensors were fully saturated.
BE1SM	Reference	The 10 cm sensor showed an increasing trend in June, then showed a decreasing trend. Remaining sensors were fully saturated and showed stable to slightly gradual increasing trends.
BE2SM	Reference	The 20 and 30 cm sensors showed decreasing trends and fluctuations consistent with rainfall. The 10 cm sensor showed a slightly increasing trend. Remaining sensors were fully saturated and show slight increasing trends.

Monitoring ID	Site type	Comment
BS1SM	Impact	The 10 cm sensor showed a decreasing trend consistent with below average rainfall. All other sensors were fully saturated and showed increasing trends, with a slight dip from May to August.
BS2SM	Impact	All sensors showed decreasing trends with fluctuations consistent with rainfall events.
BS3SM	Impact	The 10 and 20 cm sensors showed slightly increasing trend and fluctuations consistent with rainfall. Remaining sensors showed an increasing trend and were fully saturated.
BS4SM (PSS)	Impact	The 10, 20, 30 and 40 cm sensors showed decreasing trends which fluctuate with rainfall. Remaining sensors showed relatively stable trends and were fully saturated. A data gap exists between August and September, logger data may be obtained by re-downloading between the period of the data gap.
BS5SM (NMSS)	Impact	The 10 and 20 cm sensors are above ground. The 30 cm and 40 cm sensors fluctuated with rainfall. Remaining sensors show a gradual increasing trend and were fully saturated.
CC1SM	Reference	Increasing trends across all sensors. The 10, 20 and 30 cm sensors showed fluctuations consistent with rainfall. Sensors were fully saturated.
CC2SM	Reference	Sensors below 100 cm were relatively stable. Remaining sensors showed decreasing trends consistent with rainfall.
CW1SM	Impact	The 10 and 20 cm sensors are unsaturated. Remaining sensors fluctuated with rainfall and show a gradual increasing trend.
CW4SM	Impact	Sensors fluctuated with rainfall and showed slightly decreasing trends.
FS1SM	Reference	The 10, 20 and 30 cm sensors fluctuated with rainfall and showed a slight increasing trend. Remaining sensors showed slight increasing trends and were fully saturated.
FS2SM	Reference	All sensors fluctuated with rainfall and all but the 40cm sensor showed decreasing trends.
GG2SM	Impact	The 10 cm sensor fluctuated with rainfall and showed a slight decreasing trend. Remaining sensors were reasonably stable, all with moisture below 40%.
GG3SM	Impact	The 10, 20, 30 and 40 cm sensors were dry. Remaining sensors fluctuated with rainfall and showed a decreasing trend.
GW1SM	Impact	The 10 and 20 cm sensors were dry. Remaining sensors fluctuated with rainfall and showed a decreasing trend with moisture levels generally ranging between 15 to 30%.
GW3SM	Impact	The 10cm sensor was dry. Remaining sensors fluctuated with rainfall and showed decreasing trend with moisture levels ranging between 5 to 25%.
LC1SM	Impact	All sensors were saturated and showed increasing trends.
LCN1SM	Impact	The 10 and 20 cm sensors fluctuated with rainfall. Remaining sensors showed increasing trends and were fully saturated.
LCS1SM	Impact	All sensors showed increasing trends.
LC2SM	Impact	The 10 and 40 cm sensors remained stable. 30 and 50 cm sensors fluctuated with rainfall. All remaining sensors showed increasing trends.
MS1SM	Impact	The logger malfunctioned in June only showing spot data. Sensors 60 cm and deeper showed slightly increasing trends. Sensors above 60 cm showed declining trends.
MS2SM	Impact	All sensors showed decreasing trends.

Monitoring ID	Site type	Comment
MS3SM	Impact	All sensors showed decreasing trends.
PC1SM	Impact	The 10 and 20 cm sensors are unsaturated. Remaining sensors show increasing trends and were fully saturated.
PC2SM	Impact	The 10 cm sensor showed a declining trend. All other sensors showed increasing trends.
TG1SM	Impact	The 10, 20 and 30 cm sensors showed fluctuations with rainfall however remained relatively stable. The remaining sensors showed increasing trends.
TG2SM	Reference	The 10 to 40 cm sensors fluctuated with rainfall however remained relatively stable. Remaining sensors show slight increasing trends.
TS2SM	Reference	The 10, 20, 30 and 40 cm sensors showed decreasing trends and fluctuations consistent with rainfall. The 50, 60, 70 and 80 cm sensors showed fluctuations throughout the reporting period. Sensors from 90 cm show gradual increasing trends and were fully saturated.
TS3SM	Reference	All sensors showed gradual increasing trends. Sensor 10 cm fluctuated with rainfall. Remaining sensors were fully saturated.

7.4.2.8 Water Trigger Notifications and Review

During 2023 two (2) new trigger notifications were made under the WMP TARP for groundwater and surface water within extraction areas. A summary of the triggers, associated notifications and review findings is provided below.

MS2 and MS3

Notification of a groundwater a swamp groundwater trigger was provided on 15 June 2023 for Swamp piezometers. MS2 is an impact groundwater monitoring location in the Swamp Monitoring Program for Longwall 424-427. MS3 was included for completeness due to its location within Marrangaroo Swamp and being a monitoring site in subsequent Swamp Monitoring Programs approved under SSD 5594 by DPHI.

The trigger investigation report was provided on 2 August 2023. The trigger investigation concluded that the water level reduction could be mining induced, but it was too early to confirm given below average rainfall since November 2022.

Marrangaroo Swamp is a swamp listed within the Approved Swamp Offset Strategy.

SPR1210

Notification of a change in piezometric pressure at SPR1210 was provided on 26 October 2023. Vibrating Wire Piezometer SPR1210 is an impact groundwater monitoring location in the Water Management Plan for LW 415-432.

SPR1210 is also a monitoring location in the LW 424 to LW 427 Water Management Plan and Swamp Monitoring Program although extraction of the panels is complete.

The trigger investigation report was provided to DPHI on 3 November 2023. SPR1210 has shown a depressurisation response of greater than 5 meters (m) above the Mount York

Claystone (MYC) due to the progression of LW 428. Adjacent standpipe piezometer SPR1210 has shown no impact.

7.4.3 Comparison against Predictions

An interrelationship exists between the conditions of approval and impacts predicated in the subsidence and environmental assessments which form components of approved Extraction Plans. To ensure information is not misrepresented in the summary presented in the Annual Review, both the Approval and Extraction Plans available on the website shall be referred to for detail on the predications for the Project.

Approved performance measures of SSD5594 and EPBC approvals and related predictions are used to establish the staged triggers of TARPs in approved management and monitoring plans for the project, including the WMP and related SMPs among others.

7.4.4 Long Term Analysis

Long term groundwater and surface water monitoring data for quality and flow/level within extraction areas is presented in the 2023 Annual Environmental Monitoring Report (EMM, 2024) provided in **Appendix 4** to this Annual Review.

7.4.5 Implemented / Proposed Improvements

Centennial is continuing to implement an extensive groundwater and surface water monitoring program in accordance with the requirements of approved Extraction plans.

8 REHABILITATION

From 1 August 2022 Springvale commenced undertaking rehabilitation activities in accordance with the Rehabilitation Management Plan (RMP, 29 July 2022). A description of the proposed rehabilitation management and monitoring activities is provided in Part 6 and Part 8 of the RMP and is available on the Springvale website.⁴ The Final Landform and Rehabilitation Plan was Approved by the NSW Resource Regulator (NSWRR) on 8 November 2023.

For completeness, it is noted that the introduction of detailed annual rehabilitation reporting required under revised Mining Lease conditions (*'Annual Rehabilitation Report'*, in accordance with detailed 'Form and Way' reporting requirements set by NSWRR), is undertaken separately and in addition to the summary information provided in this Annual Review for SSD5594.

Additionally, in accordance with Condition 31A in Schedule 4 of SSD5594, Springvale is required to develop a Rehabilitation Strategy within six months of the determination of Modification 4. The Rehabilitation Strategy was submitted to DPHI on 25 May 2023 and is currently under assessment.

8.1 REHABILITATION PERFORMANCE MEASURES

8.1.1 Rehabilitation Objectives set by Development Consent SSD5594

Rehabilitation objectives are prescribed by Condition 30, Schedule 4 of SSD5594, under which Springvale must:

⁴ www.centennialcoal.com.au/operations/springvale/

- Rehabilitate the site in accordance with the conditions imposed on the mining lease(s) associated with the development under the *Mining Act 1992*.
- Rehabilitation must be generally consistent with the proposed rehabilitation strategy described in the EIS, and
- Comply with the objectives in Table 7, Condition 30, Schedule 4 of the consent.

To achieve the broad rehabilitation objectives presented in SSD5594, Springvale has developed specific domain rehabilitation objectives. The key rehabilitation objectives for each of the domains are defined in Part 4 of the RMP.

On 8 November 2023, the Springvale Rehabilitation Objectives Statement was approved by the NSWRR.

The approved final landform, land use and detailed performance criteria further established within the RMP toward these are discussed in the following sections below.

8.1.2 Approved Final Landform and Land Use Objectives

The approved final landform for Springvale 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 that is consistent with surrounding lands and pre-mining conditions.

Some water bodies and drainage structures will be maintained to manage surface water flows and provide water resources for native fauna. Some existing internal roads will be retained to allow for access to manage the final landform and to serve as fire breaks.

The long-term rehabilitation objective, as stated within the RMP, is:

“Springvale is required under the Development Consent and mining tenements to return any land disturbed by mining operations to its pre-mining capacity. The proposed post-mining land use at Springvale includes rehabilitating all major infrastructure/disturbance areas with woodland species commensurate with adjacent remnant vegetation. Additionally, a network of dams and associated water management structures will be retained in the final landform for future use”.

The post-mining land use has been determined through consultation and agreement with landowners and relevant stakeholders.

8.2 REHABILITATION PERFORMANCE DURING THE REPORTING PERIOD

8.2.1 Rehabilitation Performance Criteria (RMP)

Rehabilitation performance criteria is provided within the RMP. The current monitoring program has been designed to monitor the progress of rehabilitation against the rehabilitation objectives/criteria developed for the RMP in accordance with Form and Way RMP requirements set by the NSWRR.

Relevant objectives and completion criteria were further developed for all Centennial Coal operations in the NSW Rehabilitation Reform Support Rehabilitation Monitoring Review and Proposed Method (SLR 2022).

In accordance with relevant criteria, the rehabilitation monitoring focussed on the following key aspects:

- Vegetation composition - Characteristic native species of adjacent vegetation
- Vegetation structure - Establishment of tree, shrub, and groundcover species
- Ecosystem function
 - Natural regeneration of native tree species.

- Weed infestation, being the presence of 'priority' (formerly noxious) weeds, and High Threat Exotics (HTEs).
- Soil chemistry and microbiology.
- General stability of the rehabilitation areas.

8.2.2 Mining and Rehabilitation Status - Summary of Rehabilitation

Springvale adopts a progressive approach to rehabilitation which reduces and mitigates potential environmental impacts. Progressive rehabilitation at Springvale has mainly been associated with infrastructure corridors following the trenching of services. No major rehabilitation of the pit top and Newnes Plateau infrastructure is anticipated until site closure.

The status of disturbance and rehabilitation for Springvale (SSD5594) and the SWTP is presented in the following table.

In 2023 with the exception of exploration works, land disturbance and rehabilitation works were as associated with the Bore 8 to Booster station 1 and Booster Station 1 to Booster 2 maintenance works to the existing water transfer pipeline. These activities are described in **Section 4.4**. As the area was previously disturbed from the original pipeline installation, the areas associated with the projects are in the same phase of rehabilitation (ecosystem establishment). For this reason the changes in disturbance and rehabilitation between 2022 and 2023 are not shown in Table 8-1.

Table 8-1. Rehabilitation Status

Mine Area Type	Approval	Previous Reporting Period (Actual) 2022 (ha)	This Reporting Period (Actual) 2023 (ha)	Next Reporting Period (Forecast)
A1 Total Disturbance Footprint¹- Surface Disturbance (ha)	Springvale	42.97	42.97	42.97
A2. Total Underground Mining Area (ha)²	Springvale	3075.45	3075.45	3075.45
Total active disturbance	Springvale	31.79	31.79	31.79
Land being prepared for rehabilitation	Springvale	Nil	Nil	Nil
Rehabilitation – Ecosystem and land use establishment	Springvale	10.36	10.36	10.36
Rehabilitation - Ecosystem and land use development	Springvale	0.82	0.82	0.82
Completed rehabilitation	Springvale	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 (as defined in the DRE MOP/RMP Guidelines). 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 (as defined in DRE MOP/RMP Guidelines).

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' (as defined under the DRE MOP/RMP Guidelines).

⁵ **Completed rehabilitation:** requires formal sign off from DRE that the area has successfully met the rehabilitation land use objectives or completion criteria

NR = Not Required (prior to introduction of rehabilitation reforms. NS = not specified in Annual Rehabilitation Report and Forward Plan. NA = Not Applicable

8.2.3 Rehabilitation Schedule

As an underground coal mine, infrastructure at Springvale is required for the life of mine. Subsequently, land associated with key surface infrastructure will not become available for rehabilitation until the cessation of mining operations.

Mining is currently approved at Springvale up until 2028. There are no disturbance or rehabilitation activities associated with surface infrastructure planned over the next three years apart from minor exploration related rehabilitation as part of the exploration program/s. It is noted the land disturbance projects referred to in Section 4.4 is in the same phase of rehabilitation (ecosystem establishment) as the area was previously disturbed from initial pipeline installation.

Minor rehabilitation works associated with approved construction and/or exploration may be required and will be reported in the *Annual Rehabilitation Report* and *Forward Program*. Which is available on the Centennial website.

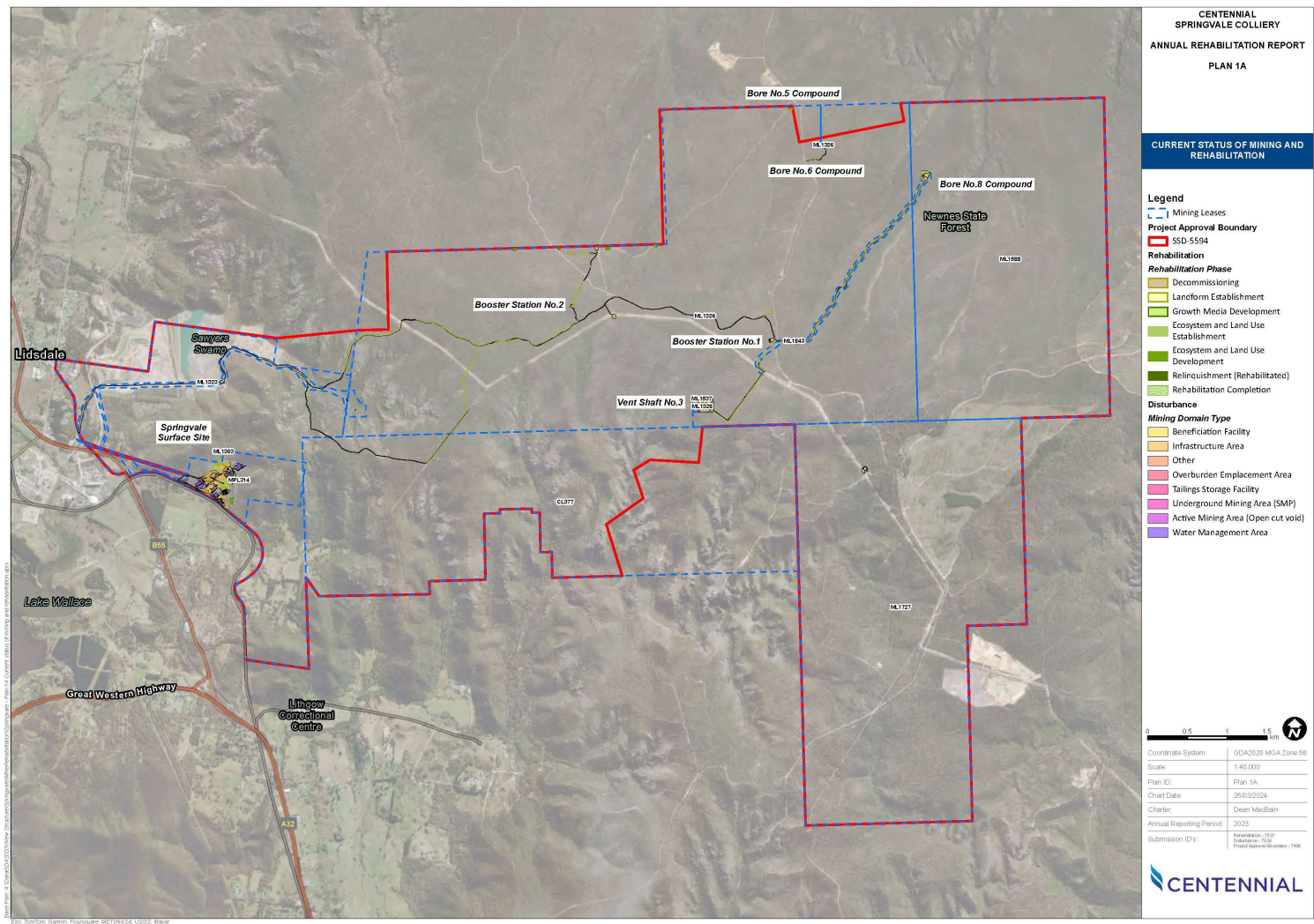


Figure 8-1 Disturbance and Rehabilitation as at December 2023

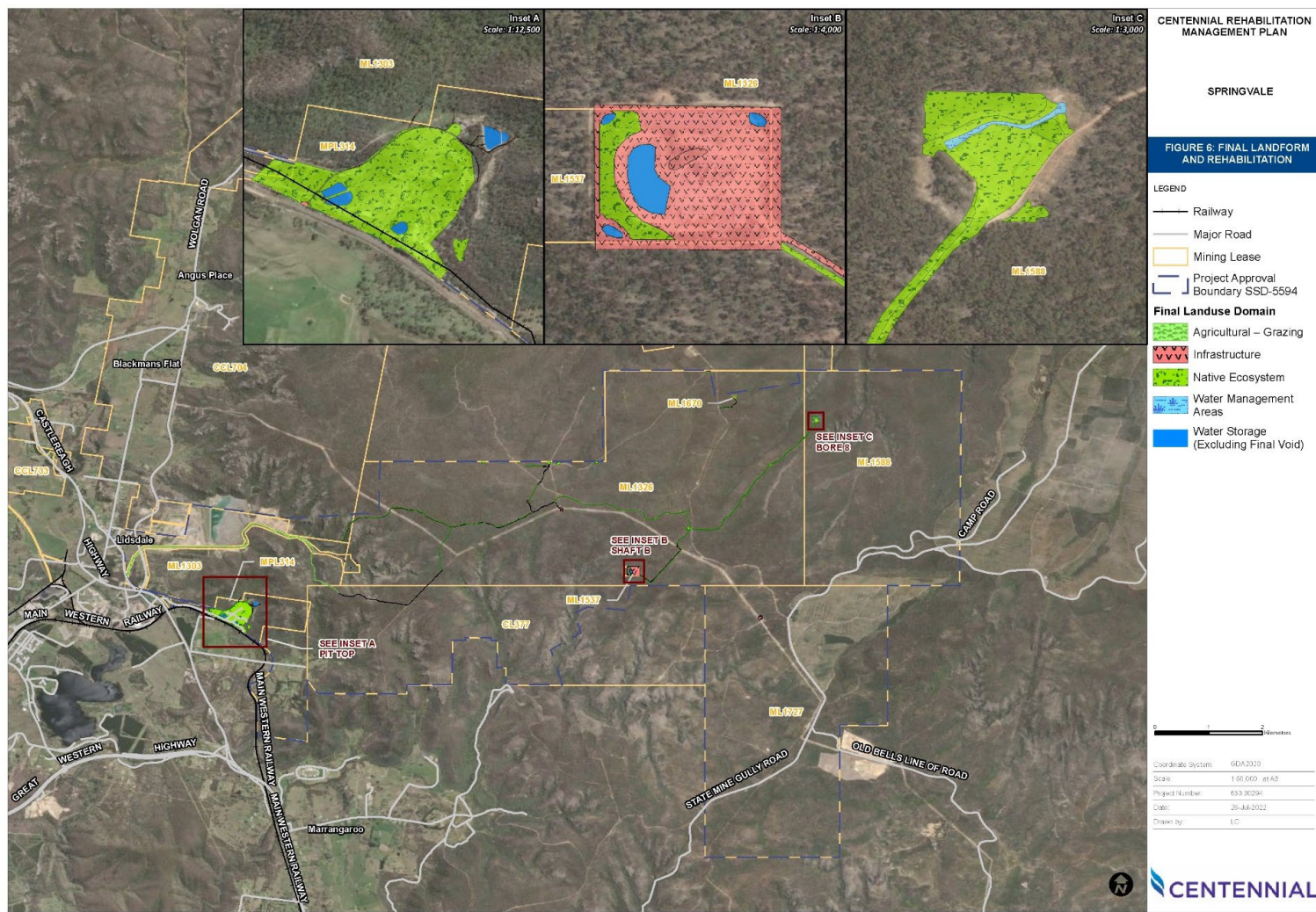


Figure 8-2 Final Landform and Rehabilitation (Source: RMP, July 2022)

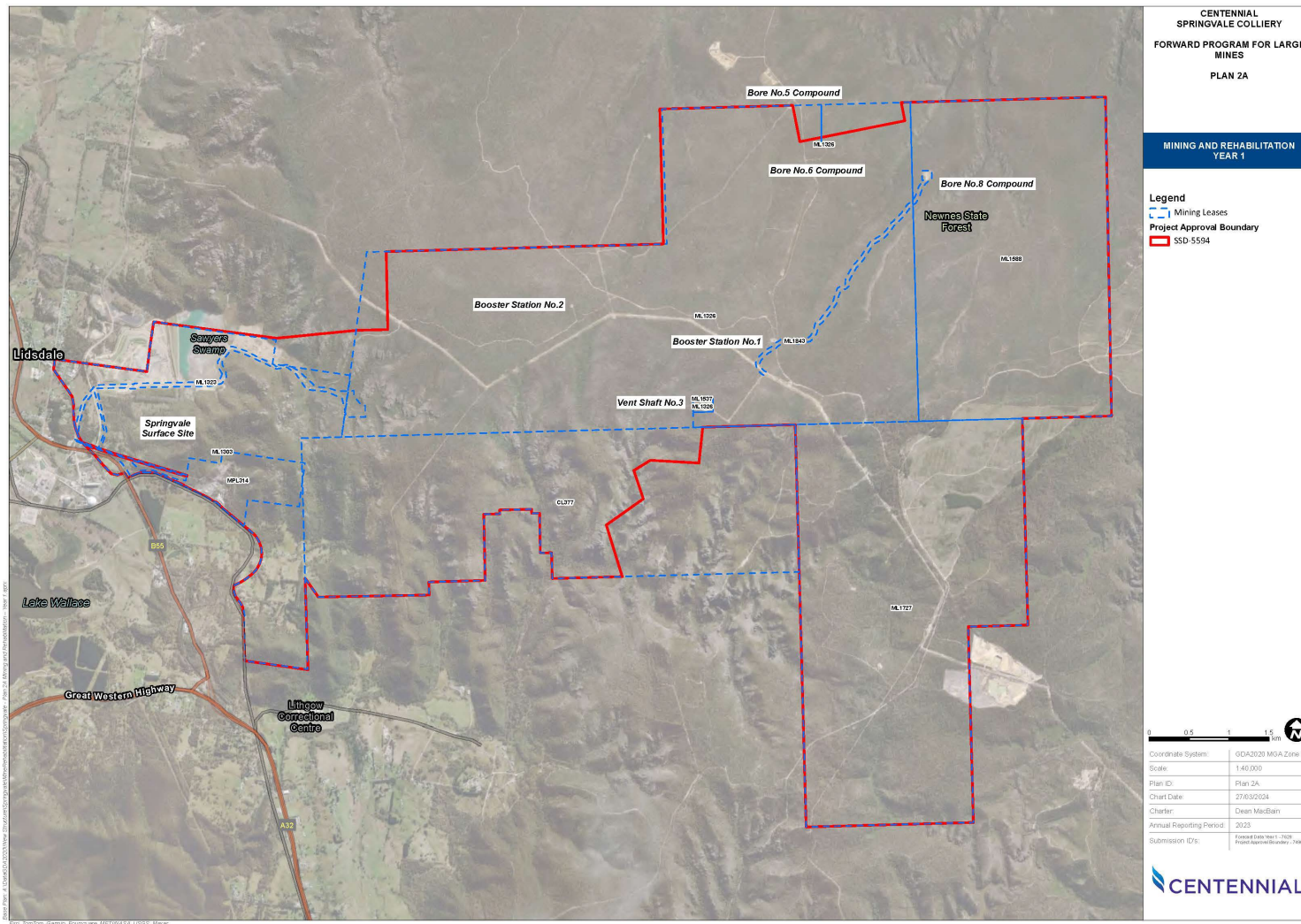


Figure 8-3 Rehabilitation 3 Year Forward Plan – Year 1 (2024)

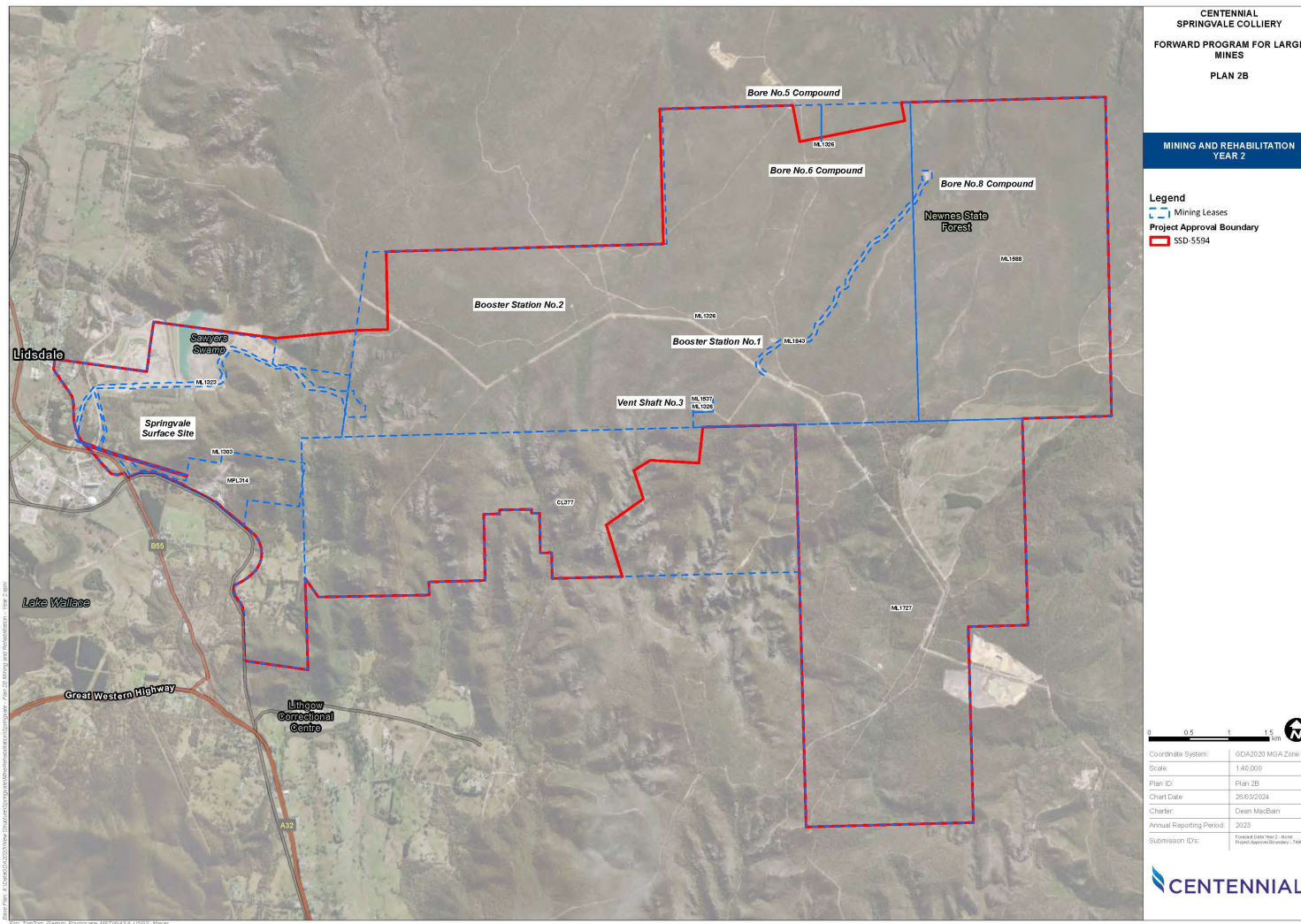


Figure 8-4 Rehabilitation 3 Year Forward Plan – Year 2 (2025)

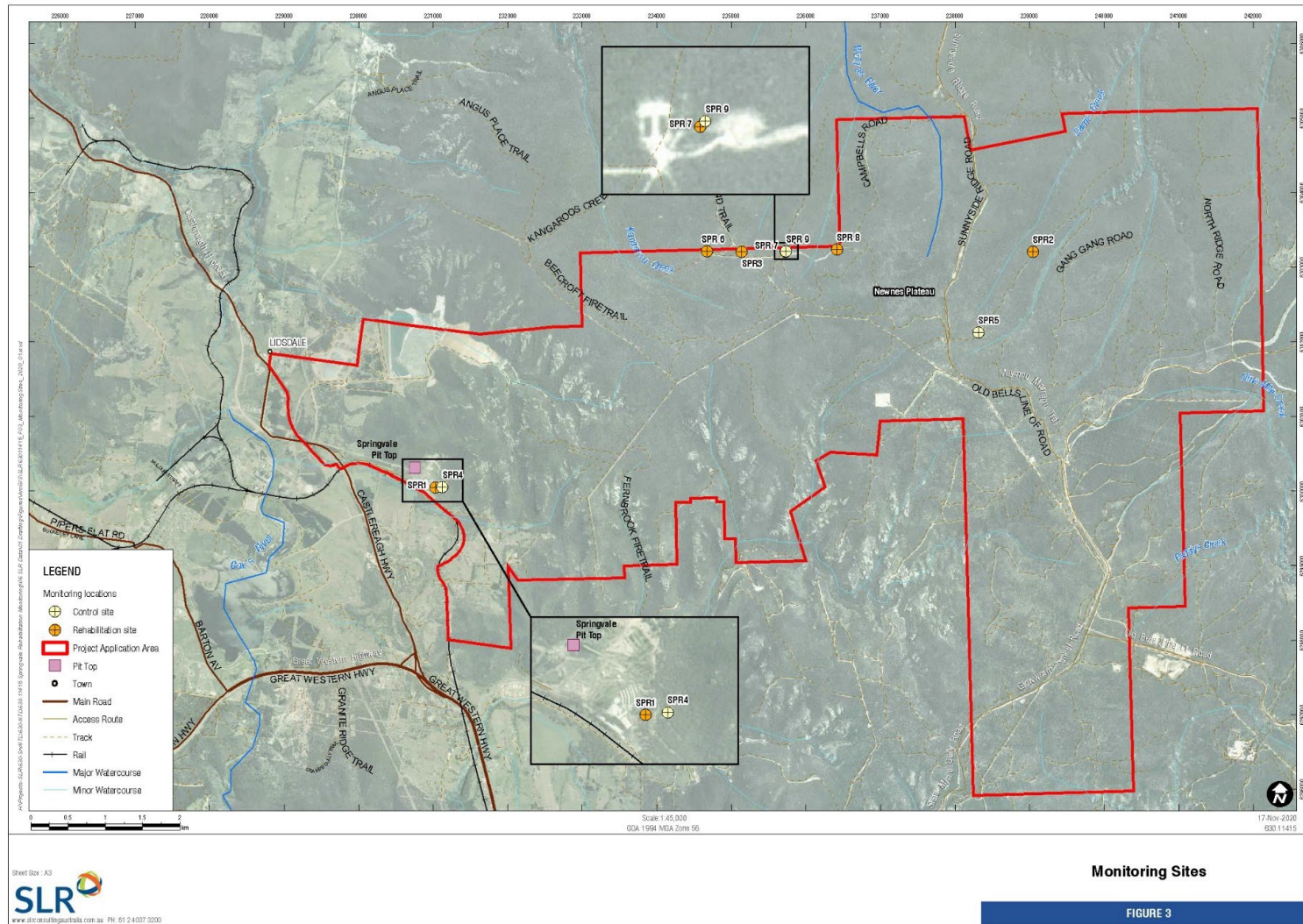


Figure 8-6 Rehabilitation and Analogue (Reference) Monitoring Sites

8.2.4 Rehabilitation Signoff

In 2023, Springvale did not seek formal signoff from the NSWRR that required land use objectives and completion criteria have been met for any rehabilitation areas.

8.2.5 Building Restoration or Removal

In 2023, no buildings were removed, demolished or restored.

8.2.6 Other Rehabilitation Works & Activities

During the reporting period there has been no subsidence repair activities and Exploration rehabilitation activities have been undertaken progressively during the reporting period.

The three-year rehabilitation schedule outlined in the 2023 Forward Program includes the following activities

- Completion of feasibility investigation for remediation of THPSS
- Understand arrangements for management and maintenance of water management (including trenched infrastructure) infrastructure post mining (contractual arrangements would be required)
- Investigate relationship between LDP006 and sealing of Renown Colliery.
- Understand if sites such as Bore 6 may be able to be decommissioned following extraction in a particular area.
- Investigate records for sealing of dewatering bores and adequacy.
- Stakeholder Engagement Strategy being developed and will consider approval from FCNSW/NPWS for retention of access tracks.
- Understanding access tracks that were on Plateau pre-mining using available records.
- Confirm if hydrogeological models consider potential for fill and spill.

8.3 REHABILITATION MONITORING

During 2023 rehabilitation monitoring was undertaken in accordance with the Rehabilitation Management Plan (RMP), prepared in accordance with Schedule 4, Condition 32, of SSD5594 and the conditions of relevant Mining Leases, in accordance with the regulatory reforms introduced by the NSW Government (see **Section 8.2**). Section 8 of the RMP details rehabilitation monitoring and reporting requirements.

Annual rehabilitation monitoring has been undertaken at Springvale since 2015, tracking rehabilitation success against previous completion criteria and informing any maintenance requirements. During 2022 a Rehabilitation Review was undertaken by Centennial to establish a site-specific monitoring program to support the ongoing refinement of rehabilitation objectives and completion criteria assessment, and alignment with the new associated guidelines and rehabilitation reforms under which the RMP was prepared. This included transitioning Centennial operations to the NSW Biodiversity Assessment Method ('BAM') (OEH 2020) to align with new rehabilitation objectives and completion criteria assessment as detailed in Section 4 of the RMP.

The RMP monitoring program assesses the condition, performance and progress of rehabilitated areas across the site. The monitoring results are also used to identify the need for corrective actions for rehabilitation performance. Monitoring results inform refinements to rehabilitation methodology as required and will be continued until rehabilitation has satisfied all rehabilitation and closure criteria.

Monitoring locations are used that are representative of the range of conditions for:

- **rehabilitation areas**; and
- at appropriate reference sites (**analogue sites**).

As part of the RMP transition, if/where required new reference control ('analogue') sites have been established in accordance with Section 8.1.1 of the RMP to increase statistical strength and allow comparison of rehabilitation scores to reference site scores (within percentile ranges) for certain variables. Accordingly, three (3) analogue sites were established in adjacent native bushland during 2022 to support ongoing monitoring. The location of analogue and rehabilitation monitoring sites is presented in **Figure 8.6**.

The RMP monitoring program is comprised of:

- **Analogue Site Baseline Monitoring**
- **Establishment Monitoring in Rehabilitation Areas**, comprised of detailed annual monitoring and regular monitoring inspections, with performance considered against the Rehabilitation TARP with adaptive management responses if/where required.

In accordance with Section 8.3 of the RMP, detailed annual monitoring in rehabilitation areas is typically undertaken in spring and is comprised of the following and reported in the Annual Rehabilitation Report and summarised in the Annual Review:

- Photographic monitoring of vegetation (BAM) plots
- BAM data collection (vegetation composition, function and structure)
- Soil chemistry Analysis
- Soil microbial analysis
- Monitoring inspections and general observations of erosion, presence of threatened or other significant species, weeds, evidence of native fauna using the site, and signs of pests or undesired disturbance.

8.3.1 Summary of Rehabilitation Monitoring

This section presents the results of rehabilitation monitoring undertaken during the 2023 reporting period as required under the Springvale Rehabilitation Management Plan (Part 8 – Rehabilitation Monitoring).

With respect to vegetation composition, the total number of species is considered consistent with the rehabilitation objectives in all rehabilitation plots. An examination of species showed similarities of species between rehabilitation plots and control plots.

Regarding vegetation structure, foliage cover by growth form at rehabilitation plots is generally comparable to that of control plots. SPR2 has a low species cover across most growth forms.

In relation to vegetation function, second-generation tree recruitment, resilience to bush fire and drought, exotic pests, domestic stock and native fauna activity were all similar to those observed at the control plots. Conversely, litter cover at SPR1 and SPR7 is outside of the percentile range and below benchmark. Additionally, organic carbon scores at SPR1 and SPR8 are outside those of the control plots.

A metric determining the status of the decomposer microbial communities of the rehabilitation plots soils showed not all of them to be similar to those of their respective control plots soils. The Newnes Plateau rehabilitation plot SPR6 is not similar to the control plot and other

Newnes Plateau plots (SPR7 and SPR8). The Pit Top rehabilitation plot SPR1 is not similar to its control SPR4.

In summary, the 2023 monitoring results are similar to those of 2022. The vegetation composition, structure and ecosystem function at the rehabilitation monitoring plots is progressing and showing early stages of native woodland regeneration. SPR3 has satisfied all completion criteria for two consecutive monitoring periods. By contrast performance criteria are still not met at the remaining monitoring plots.

As SPR3 has satisfied the completion criteria, the release of this rehabilitation area should be considered. The majority of rehabilitation areas are moving towards the completion criteria with only minor actions recommended. Weed control is recommended at SPR1 and SPR4 alongside the importation of logs into SPR1.

Table 8-2: BAM Rehabilitation objectives and completion criteria assessment (2023)

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	SPR1	SPR2	SPR3	SPR6	SPR7	SPR8
Vegetation composition recognisable as target vegetation community	Native plant species are characteristic of the target vegetation community(s)	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
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)	Achieved	Not Achieved	Achieved	Achieved		
Ecosystem function demonstrates rehabilitation is self- sustainable	Litter cover is within 10th-90th percentile variation range of reference sites/data	Not Achieved	Achieved	Achieved	Achieved	Not Achieved	Achieved
	Minimal erosion that would require moderate to significant ongoing management and maintenance. No visual signs of land instability such as mass movement	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
	Second generation individuals of trees are within the 10th-90th percentile variation range of reference sites	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
	Foliage cover of 'high threat exotic' (HTE) weeds is within 10th-90th percentile variation range of reference sites	Not Achieved	Achieved	Achieved	Not achieved	Achieved	Achieved

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	SPR1	SPR2	SPR3	SPR6	SPR7	SPR8
	Soil chemistry Total organic carbon is within 10th-90th percentile variation range of reference sites; Soil analytes ECe (salinity) and ESP (sodicity) at rehab sites are similar to reference sites	Not achieved for soil carbon. ECe and ESP comparable (non-saline and non-sodic)	Achieved for soil carbon. ECe and ESP comparable (non-saline and non-sodic)	Achieved for soil carbon. ECe and ESP comparable (non-saline and non-sodic)	Achieved for soil carbon. ECe and ESP comparable (non-saline and non-sodic)	Achieved for soil carbon. ECe and ESP comparable (non-saline and non-sodic)	Not achieved for soil carbon. ECe and ESP comparable (non-saline and non-sodic)
	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), and 3) the presence of the fungus <i>Trichoderma</i> (an indicator of significant amounts of plant cellulosic substrates in soils).	Not Achieved Actinomycete bacteria ratio similar to SPR4 Copiotrophic bacteria ratio is similar to SPR4 <i>Trichoderma</i> present	Achieved Represented by SPR6, SPR7 & SPR8 results Actinomycete bacteria ratio similar to SPR9 Copiotrophic bacteria ratio is similar to SPR9 <i>Trichoderma</i> present	Achieved Represented by SPR6, SPR7 & SPR8 results Actinomycete bacteria ratio similar to SPR9 Copiotrophic bacteria ratio is similar to SPR9 <i>Trichoderma</i> present	Not Achieved Actinomycete bacteria ratio similar to SPR9 Copiotrophic bacteria ratio is similar to SPR9 <i>Trichoderma</i> present	Achieved Actinomycete bacteria ratio similar to SPR9 Copiotrophic bacteria ratio is similar to SPR9 <i>Trichoderma</i> present	Achieved Actinomycete bacteria ratio similar to SPR9 Copiotrophic bacteria ratio is similar to SPR9 <i>Trichoderma</i> present

Ecological Rehabilitation Objective	Modified Rehabilitation Completion Criteria	SPR1	SPR2	SPR3	SPR6	SPR7	SPR8
	Resilience to drought and fire	Achieved Soil moisture and little scores comparable to control sites	Achieved Soil moisture and little scores comparable to control sites	Achieved Soil moisture and little scores comparable to control sites	Achieved Soil moisture and little scores comparable to control sites	Achieved Soil moisture and little scores comparable to control sites	Achieved Soil moisture and little scores comparable to control sites
	Vertebrate pest species – presence and damage is recorded and controlled.	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
	Domesticated stock - presence and damage is recorded and controlled.	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
	Native fauna activity – evidence of fauna habitation and/or utilisation of rehabilitation areas over time	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved

8.4 REHABILITATION TRIALS AND RESEARCH

Rehabilitation research, modelling and trials are undertaken in accordance with Section 9 of the RMP.

Rehabilitation research, modelling or trial projects are a component of the Western Region Biodiversity Offset Strategy summarized in **Section 6.5.6**.

There are no additional proposed rehabilitation research, modelling, or trials to be undertaken.

8.5 PROPOSED ACTIONS IN NEXT REPORTING PERIOD

Two high threat weeds, *Rosa rubiginosa* and *Rubus anglocandicans*, were recorded at SPR1. Weed control is recommended at SPR1 and SPR4 alongside the importation of logs into SPR1.

The regional recommendations for these species include mitigating any spread of the weed and reducing impact to conservation, economic and/or social lands (WeedWise, 2024). The recommended control measure for *Rosa rubiginosa* and *Rubus anglocandicans* in conservation areas is hand removal or mechanical removal. However, hand and mechanical removal isn't always effective on its own, with the addition of spot spraying with diluted herbicide for dense or widespread infestations would be required during suitable wind conditions.

This rehabilitation work will be undertaken in 2024.

9 COMMUNITY CONSULTATION

Centennial Site consults with the community through forums such as, the Western Region Community Consultative Committee and community organised events.

Meetings of the Centennial Western Region Community Consultative Committee (CCC) were held on:

- 28 March 2023
- 7 June 2023
- 12 September 2023
- 5 December 2023

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.

9.1 EXTRACTION PLAN CONSULTATION

Extensive community consultation with landowners in the Centennial Springvale mining area is undertaken for the purpose of monitoring and assessing subsidence effects on private properties. In general, the Centennial Springvale community consultation has included:

- DPHI
- Biodiversity Conservation Department (BCD)
- Independent Monitoring Panel (IMP)
- Water NSW
- Heritage NSW
- Resource Regulator (NSWRR)
- Forestry Corporation NSW
- Land Registry Services
- Lithgow City Council
- Endeavour Energy
- Owner(s) of potentially affected features
- Registered Aboriginal Parties (RAPs)

Full details of the consultation undertaken and associated outcomes are detailed within each Extraction Plan, which can be accessed on the company website.

Quarterly Extraction plan reports are provided to provide the DPHI Planning & Assessment Group and Biodiversity Conservation and Science Group, the Springvale Independent Monitoring Panel, National Parks & Wildlife Service and Commonwealth DCCEEW.

9.2 COMMUNITY SPONSORSHIPS AND DONATIONS

Springvale continues to support the local community through various sponsorship avenues and donations to community activities, groups and associations.

In accordance with Schedule 2, Condition 15 of SSD5594, during 2023 Springvale paid the Lithgow City Council (LCC) community contributions based on saleable tonnes for use in long-term community activities and agreed projects. This was calculated at a total of \$65,882 for the calendar year 2023.

It is also noted that at corporate level, Centennial Coal, of which Springvale Coal is a subsidiary, additionally donated to local sporting and community groups in the Lithgow area during 2023.

9.3 COMMUNITY COMPLAINTS

In accordance with Schedule 5, Condition 15 of SSD5594, Springvale is required to make a complaint register available monthly on the Centennial website. The register is available at <https://www.centennialcoal.com.au/operations/springvale/>.

Long term trends in complaints are presented in **Table 9.1** below.

During the 2023 calendar year reporting period, there has been two community complaints received relating to waste and noise, as summarised in **Table 9-2**

Table 9-1. Record of annual community complaints for 2019 to 2023

Community Complaints						
Year	Air	Water	Noise	Waste	Other	Total
2019	0	0	1	0	0	1
2020	0	0	0	0	0	0
2021	0	0	0	0	0	0
2022	0	0	2	0	0	2
2023	0	0	1	1	0	2

Table 9-2. Community Complaints during 2023

Date of Complaint	Complaint Method	Nature of Complaint	Springvale Response
4/4/2023	Phone	Waste – Complainant reported a large quantity of bagged polystyrene had been found on the Great Western Highway at Hartley to containing a business card. The person who was contacted advised the EC Department	Springvale Environmental Superintendent contacted complainant to advise the matter would be investigated. Springvale contacted the Licenced waste contractor who provided evidenced of handling procedures (load covering) and fault review. Hartley is not on disposal route for waste delivery for Springvale. The residential location of the business card owner is approximately 70km from the location waste was found and the quantity is considered to large to be associated with a personal household item. Outcomes of the investigation were discussed with complainant. No further action to be taken as waste had been disposed by complainant.
25/5/2023	Phone	Noise - Complainant reported dozer noise from the Springvale stockpile.	At the reported time of the complaint there was a temperature inversion.

10 INDEPENDENT ENVIRONMENTAL AUDIT

Centennial Springvale underwent an Independent Environmental Audit (IEA) in the 2022 reporting period to satisfy Schedule 6, Conditions 13 and 14 of SSD5594. The requirements of Condition 13 results in anniversary dates for commissioning of IEA's by 30 June each year. On 14 June 2022 DPHI granted an extension of time for commissioning (site inspection) of the audit to 31 August 2022 due to consultant availabilities, with submission due by 23 November 2022. The 2022 IEA was undertaken by IEMA (Integrated Environmental Management Australia) with the site inspection held on 15 August 2022 and submitted to DPHI on 1 November 2022.

Table 10-1 presents non-compliance finding and actions actus from the audit.

Table 10-1: Non-Compliance Findings and Action Status from 2022 IEA Report

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
SSD5594				
Schedule 4 Condition 12	NC Rec 1: For any future incidents, there should be improvements in relation to record keeping with the EPA when asking for advice regarding incidents (e.g. phone call, records, emails, etc) and written confirmation PIRMP management and reporting is not required.	SV REC 1: Incidents are to be reported in accordance with the PIRMP.	SV Rec 1: 1 November 2022	All incidents causing or threatening harm have been reported in accordance with the PIRMP.
	NC REC 2: Review hydrocarbon storage at site to ensure it meets relevant Australian Standards (AS/NZS 3833:2007). Review and update SV-STD-3797 (Springvale Pit Top Hazardous Substance Management and Storage) to ensure compliance with the standard.	SV REC 2: Review hydrocarbon storage at site to ensure it meets relevant Australian Standards (AS/NZS 3833:2007). Review and update SC-STD-3797 (Springvale Pit Top Hazardous Substance Management and Storage) to ensure compliance with the standard.	SV Rec 2: 31 March 2023	Hydrocarbon storage will continue to be reviewed to ensure it meets AS/NZS 3833:2007.
	NC REC 3: Ensure surface water monitoring is completed as per Section 4.2 of Water MP. Consultation should be undertaken with monitoring contractor to ensure it meets these requirements.	SV REC 3: Surface water monitoring is to be reviewed against Section 4.2 of the Water MP to identify any gaps in monitoring	SV REC 3: 28 November 2022	A review of surface water monitoring has been undertaken and changes have been discussed with the contractors. Sites listed in Section 4.2 of the WMP are associated with Angus Place.
		SV REC 4: Consultation will be undertaken with the monitoring contractors to review the current monitoring commitments.	SV REC 4: 28 January 2023	As per SV REC 3 Response

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
	NC REC 4: Notification should occur immediately if there is a potential for material harm or actual material harm, with this to be completed under the PIRMP process.	See SV REC 1 above.	See SV REC 1 above.	See SV REC 1 above.
Schedule 4 Condition 14	Recommendation as per Schedule 6 Condition 1	See SV REC 1 above.	See SV REC 1 above.	See SV REC 1 above.
Schedule 6 Condition 1	NC REC 4: Notification should occur immediately if there is a potential for material harm or actual material harm, with this to be completed under the PIRMP process.	See SV REC 1 above.	See SV REC 1 above.	See SV REC 1 above.
EPL 3607				
O1.1	Recommendation as per Schedule 4 Condition 12.	See SV REC 2 above.	See SV REC 2 above.	See SV REC 2 above.
R2.1	Covered by earlier recommendation.	See SV REC 1 above.	See SV REC 1 above.	See SV REC 1 above.
Additional Recommended Actions				
SSD5594 Schedule 3 Condition 1	IMP REC 1: Centennial to liaise with DPE regarding surrendering of DA11/92 now that it has been included in the 2022 Audit scope. There have been no compliance issues noted in reviewing DA11/92.	SV IMP REC 1: Centennial to liaise with DPE regarding the surrender of DA11/92.	SV IMP REC 1: 28 January 2023	On 25 October 2023 Springvale was notified that DA11/92 has been voluntarily surrendered pursuant to section 4.63 of the Environmental Planning and Assessment Act 1979 and section 68 of the Environmental Planning and Assessment Regulation 2021

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
	IMP REC 2: Section 6.5 (Subsidence Management) of the Annual Review should provide a summary outlining how the site has performed, against the performance measures in this condition (Schedule 3 Condition 1). This should be in a table format. Where there have been differences to performance measures (predictions) vs measured then further detail should be provided. It is recommended there are columns for: • Aspect. • Performance Measure. • Performance Indicator (e.g. from Extraction Plan). Actual Performance During the Year (including any proposed actions).	SV IMP REC 2: Section 6.5 (Subsidence Management) of the Annual Review to be updated to provide a summary of site performance against the performance measures in schedule 3 Condition 1. Further detail is to be provided when the monitoring indicates an exceedance of the performance measures	SV IMP REC 2: 31 March 2023	A complex relationship exists with other conditions of approval for SSD5594. Performance measures have been presented and compared to predictions in the annual review.
SSD5594 Schedule 3 Condition 1	IMP REC 3: Photo monitoring reports should provide analysis of whether changes are the result of Springvale mining activities. Currently these photo monitoring reports provide very little analysis.	SV IMP REC 3: Photo monitoring reports are to include additional information on any identified changes and if they are related to mining activities.	SV IMP REC 3: 28 January 2023	Springvale have an extensive amounts of photo monitoring sites Photo monitoring data is used in conjunction with other monitoring reports to assist with interpretation of impact.
	IMP REC 4: Clearly define benchmark values and limits for 'negligible change' in the Biodiversity Management Plans.	SV IMP REC 4: Update the Biodiversity Management Plan to define benchmark values and limits for 'negligible change'.	SV IMP REC 4: 28 February 2023	The LW 428-432 management plan has been prepared in consultation with relevant agencies.

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
SSD5594 Schedule 3 Condition 10	IMP REC 5: The height of depressurisation needs to be discussed in six monthly reports and Annual Review in accordance with the Extraction Plan WMP & Extraction Plan SMP. The vertical gradients between shallow and deep piezometers should also be validated.	SV IMP REC 5: Additional information is to be included in the Annual Review and Extraction Plan Reports to discuss the height of depressurisation in accordance with the Extraction Plan WMP & Extraction Plan SMP. The vertical gradients between shallow and deep piezometers should also be validated.	SV IMP REC 5: 31 March 2023	Springvale engage a specialist to complete monitoring review for data associated with the Extraction Plan. This report is appended to the annual review.
SSD5594 Schedule 3 Condition 10	IMP REC 6: The previous period should be discussed in the next monitoring period. Given that the groundwater inflows are monitored on a regular basis, they should be included in the 6 monthly report and Annual Reviews for consistency.	SV IMP REC 6: Follow up of any TARP investigation in the previous period is to be included in the Extraction Plan Reports and Annual Reviews.	SV IMP REC 6: 31 March 2023	Summaries are provided in the Annual Review of triggers and incorporated in the quarterly reports. Trigger notifications and investigations not completed during a reporting period will be incorporated into the next report
SSD5594 Schedule 4 Condition 7	IMP REC 7: Air Quality and Greenhouse Gas Management Plan should be updated to include the current monitoring status as per Table 3 of the current plan (i.e. short term monitoring should be removed).	SV IMP REC 7: The Air Quality and Greenhouse Gas Management Plan to be updated for the following: - The current monitoring status as per Table 3 of the current plan (i.e. short term monitoring should be removed). - Table 5.1 of TARP in the AQMP to include triggers and actions relating to real time dust levels. Current triggers need to be updated to address nuisance triggering (e.g. insects).	SV IMP REC 7: 28 February 2023	Revised AQMP submitted 30 June 2023 and under assessment.

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
SSD5594 Schedule 4 Condition 7	IMP REC 8: Update table 5.1 of TARP in the AQMP to include triggers and actions relating to real time dust levels. Current triggers need to be updated to address nuisance triggering (e.g. insects).	SV IMP REC 7 above.	SV IMP REC 7 above.	SV IMP REC 7 above.
SSD5594 Schedule 4 Condition 12	IMP REC 9: Review drainage area between pit top dam and support storage area to ensure it links up with water management system onsite. Currently small parts of this area water (within the dirty water catchment) can drain offsite into Biodiversity Conservation area.	SV IMP REC 8: Review drainage area between pit top dam and support storage area to ensure it links up with water management system onsite. Currently small parts of this area water (within the dirty water catchment) can drain offsite into Biodiversity Conservation area.	SV IMP REC 8: 28 April 2023	The biodiversity Conservation Area (BA425) is located above the dirty water catchment
SSD5594 Schedule 4 Condition 12	IMP REC 10: Obtain water results for water flanking LDP6 in particular Oil and Grease (other parameters if enough water available). Ensure there is a review of the source of this water and obtain additional testing after 24mm of rain.	SV IMP REC 9: An oil and grease sample is to be taken of the water flanking LDP6. An investigation is to be undertaken to determine the source of the water.	SV IMP REC 9: 28 January 2023	Oil and Grease sampling is routinely conducted at LDP006 and no results have indicated the presence of Oil and Grease in the sample. Sampling will continue to be undertaken in accordance with EPL requirements.

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
	IMP REC 11: Update to Figure 3.2 Site Catchment Plan to correspond with Dirty Water Clean Water Catchments to site.	SV IMP REC 10: The Water Management Plan is to be updated for the following: - Figure 3.2 Site Catchment Plan to correspond with Dirty Water and Clean Water Catchments onsite - Include the catchment which runs into the Oily Water Separator (i.e. from maintenance area and lower hardstand areas) - Figures 3.4 to be updated to include catchment and pipeline links from water separator	SV IMP REC 10: 28 February 2023	Revised WMP submitted 30 June 2023 and under assessment.
	IMP REC 12: Water Management Plan to be updated to include the catchment which runs into Oily Water Separator (i.e. from maintenance area and lower hardstand areas).	See SV IMP REC 10 above.	See SV IMP REC 10 above.	See SV IMP REC 10 above.
	IMP REC 13: Figure 3.4 in the Water Management Plan should be updated to include catchment and pipeline links from oily water separator to secondary pond.	See SV IMP REC 10 above.	See SV IMP REC 10 above.	See SV IMP REC 10 above.
SSD5594 Schedule 4 Condition 12	IMP REC 14: Water Management Plan should be updated to include details of channel stability.	See SV IMP REC 10 above.	See SV IMP REC 10 above.	See SV IMP REC 10 above.
	IMP REC 15: Create and clean drainage line path to collect sediment/coal run off from road exiting site. Note this is a collection drain and water will not necessarily flow to the dam. It will need to be regularly maintained.	SVP IMP REC 11: Review the drainage along the access road and identify where additional drainage can be installed Include any additional drains in the monthly inspection.	SV IMP REC 11: 28 January 2023	A clean water drain is installed.

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
	IMP REC 16: Review the site laydown area and develop an improvement plan to improve the laydown areas and trafficable roads at site to minimise tracking of material offsite. Noting currently there are large amounts of wet sediment/coal areas onsite that are used as laydown areas. This may include a review of drainage in these areas and purchasing of additional gravel.	SV IMP REC 12: Review the site laydown area and develop an improvement plan to improve the laydown areas and trafficable roads at site to minimise tracking of material offsite. Noting currently there are large amounts of wet sediment/coal areas onsite that are used as laydown areas. This may include a review of drainage in these areas and purchasing of additional gravel.	SV IMP REC 13: 28 April 2023	Washdown and road sweeping practices are implemented on site to prevent tracking material offsite
	IMP REC 17 Implement water management recommendations within the Springvale Surface Stability Review 2021	SV IMP REC 13: Implement water management recommendations within the Springvale Surface Stability Review 2021 and 2022.	SV IMP REC 13: 28 April 2023	To be considered 2024 monitoring
SSD5594 Schedule 4 Condition 14	IMP REC 18: Water monitoring going forward should be entered into a cumulative spreadsheet	SV IMP REC 14: Centennial to consult with the contractors to discuss the format of spreadsheets	SV IMP REC 14: 28 January 2023	Consultant will continue to use monthly sheets
	IMP REC 20: Include more detail in the 6 monthly reports and Annual Reviews regarding a response to groundwater triggers.	SV IMP REC 16: More detail is to be included in the Annual Reviews and Extraction Plan Reports regarding a response to groundwater triggers.	SV IMP REC 16: 31 March 2023	Summaries are provided in the Annual Review of triggers and incorporate in the quarterly reports.

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
	IMP REC 21: Evidence of groundwater model update needs to be provided in Water Management Plan and each Annual Review and comparison of monitoring results with modelled predictions needs to be documented.	SV IMP REC 17: Any groundwater model updates are to be discussed in the Annual Review.	SV IMP REC 17: 31 March 2023	Groundwater water model update presented in Section 7.1 of the Annual Reviews.
SSD5594 Schedule 4 Condition 18	IMP REC 22: Fencing was observed to be down around biodiversity conservation area near top dam and should be repaired.	SV IMP REC 18: Repair the fencing around the biodiversity conservation area near the top dam.	SV IMP REC 18: 28 August 2023	Temporary Repairs complete. Replacement Planned for 2024.
SSD5594 Schedule 4 Condition 20	IMP REC 23: The main road that leads out of the site should be Included in the weekly inspection (currently in monthly inspection), as well as post 20mm rain. The inspection should check if any mud is leaving site.	SV IMP REC 19: The weekly & post 20mm rain inspection is to be updated to include the main road that leads out of the site to determine if any mud is being tracked from the site.	SV IMP REC 19: 28 December 2022	The main road from the highway has been incorporated into the inspection process.
SSD5594 Schedule 4 Condition 27	IMP REC 25: Review materials onsite to ensure that all materials are required and improve general housekeeping i.e. older materials and wooden pallets that are not needed to be sorted onsite and general waste to be better managed to avoid litter flowing into offset areas.	SV IMP REC 21: Undertake a housekeeping audit to determine waste that can be sorted and / or removed from the site.	SV IMP REC 21: 28 April 2023	Ongoing-Springvale will continue review housekeeping practices.
SSD5594 Schedule 4 Condition 28	IMP REC 26: Update and include appendices into EAMSIMP on website.	SV IMP REC 22: Update and include appendices into EAMSIMP on website.	SV IMP REC 22: 28 November 2022	Complete.

Condition Reference	IEA Recommendation	Springvale Proposed Actions	Completion Date	Action Status
	IMP REC 27: Documentation should be improved relating to the implementation of the of EAMSIMP, with this including inspections, management of topsoil during clearing activities and final rehabilitation records.	SV IMP REC 23: Procedures to be updated to ensure alignment with the requirements of the EAMSIMP. This is to include improved record keeping for inspections, management of topsoil during clearing activities and final rehabilitation records.	SV IMP REC 23: 28 August 2023	Ongoing-Springvale will continue to utilise the Land disturbance permit process. Requirements vary between projects.
EPL M5.2	IMP REC 28: If a complaint is received but details are not provided a note should be included in the complaints log.	SV IMP REC 24: Update the Complaints procedure to include a note if the complainant does not want to provide personal details.	SV IMP REC 24: 28 December 2022	The complaint procedure has been updated.

11 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

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

During the 2023 calendar year reporting period there were a total of three reportable incidents or non-compliances (excluding community complaints).

Table 11-1 provides a summary of the incidents and non-compliances, including the actions taken by Centennial Springvale in response to the incident/non-compliance. A summary of incident and regulatory action is presented in **Table 11-2**. There were no incidents/regulatory action during the reporting period.

Table 11-1 Incidents and Non-Compliances during the Reporting Period

Compliance ⁵	Overview of incident/non-compliance	Description of incident/non-compliance	Actions
WAL36383	Over extraction of share component	Extraction of 9096.2 ML or water from Sydney Basin Richmond Groundwater Source	On 1 July 2023 the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023 commenced. As a result, the Sydney Basin Richmond Groundwater Source and Sydney Basin Cocks River Groundwater Source have been amalgamated to reflect their connectivity, now named the Sydney Basin West Groundwater Source. Centennial is currently undertaking the necessary reviews of water access works approvals (Works approvals) to WALs in this newly formed groundwater source
EPL367	Water Concentration limits	Water discharged at LDP006 was non-compliant with water concentration limits between 13:210 and 14:40 on 14 March 2023	The following actions have been completed. -Established portable pumping system at LDP006 prior to job commencement. -Reviewed of water isolation applicable to cease flow to discharge point LDP006 -Modified the bund established upstream of the discharge point to reduce permeability -Reviewed In-situ alert system with consideration to change in site personnel
CL377 ML1303 ML1323 ML1326 ML1424 ML 1537 ML 1588 ML 1670 ML 1727 MPL 314	Failure to submit Rehabilitation Cost Estimate and Annual Rehabilitation Report and Forward Program by the due date	A large mine must submit an Annual Report and Forward Program, and a Rehabilitation Cost Estimate	All required documents have now been submitted to the Resource Regulator. Both contraventions of s.378D of the <i>Mining Act 1992</i> were sustained and Springvale was issued an Official Caution on 22 December 2023. This has been documented in Table 11.2 with additional detail described below.

A summary of incident and regulatory action is presented in the following table.

⁵ See Compliance Status Key beneath Table 1-2 for risk level, colour code and description.

Table 11-2 Summary of Reportable Incidents and Regulatory Actions in 2023

Compliance Type	Regulator / Agency	Number
Incidents	EPA and DPHI	2
Caution Notices	Resource Regulator	1
Warning Letters	-	0
Penalty Notices	-	0
Prosecutions	-	0

On 10 October 2023, Centennial Springvale Pty Ltd was notified of the commencement of an investigation into the alleged contravention of 2 breaches of the Regulation against titles CL 377 (1973), ML 1303 (1992), ML 1323 (1992), ML 1326 (1992), ML 1424 (1992), ML 1537 (1992), ML 1588 (1992), ML 1670 (1992), ML 1727 (1992), MPL 314 (1973).

These contraventions were for the 2022 and 2023 Forward Program against Clause 13(1) of Schedule 8A of the Regulation requiring a forward program to be developed and Clause 15(2) requiring its submission to the Secretary before 60 days after the last day of each annual reporting period (or a later date as approved by the Secretary).

In relation to the 2022 contravention, Springvale Colliery failed to submit the 2022 forward program to the Regulator as required.

In relation to the 2023 contravention Springvale Colliery submitted the 2023 forward program on 4 May 2023 after the due date although Regulator Portal issues are acknowledged as a contributing factor to this late submission. The Rehabilitation Cost Estimate (RCE) required as a component of the forward program was submitted on 6 October 2023. The late submission of the RCE component means the forward program requirement was not satisfied until 6 October 2023, significantly later than the 31 March 2023 due date.

Both contraventions s.378D of the Mining Act 1992 were sustained and Springvale was issued an Official Caution as the enforcement action.

12 ACTIVITIES 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 2024

Improvement Actions
• Seek Approval for Amendment 2 of the Extraction Plan LW 428-432. • Development of monitoring programs for future extraction areas. • Exploration Drilling. • Continue to undertake land management works at Coxs River and Biodiversity Offset Sites.
Management Plan Revisions
• Extraction Plan Subcomponent Plans as triggered by IMP advice. • Water Management Plan.
Condition Triggers
• Undertake revisions to Management Plans within three months of Annual Review Submission.

13 REFERENCES

Centennial Coal, March 2022, Independent Monitoring Panel Report

EMM, March 2024, Annual Environmental Monitoring Review – Surface and Groundwater, January to December 2023

SLR, March 2023, Annual Rehabilitation Report & Forward Program

SLR, March 2023, Springvale Colliery Quarterly Noise Monitoring 1st Quarter 2023

SLR, July 2023, Springvale Colliery Quarterly Noise Monitoring 2nd Quarter, 2023

SLR, September 2023, Springvale Colliery Quarterly Noise Monitoring 3rd Quarter, 2023

SLR, December 2023, Springvale Colliery Quarterly Noise Monitoring 4th Quarter, 2023

SLR, September 2023, Springvale Mine Stream Health Monitoring 2023

SLR, March 2024, Springvale Coal Pty Ltd Annual Rehabilitation Report & Forward Program Springvale Coal

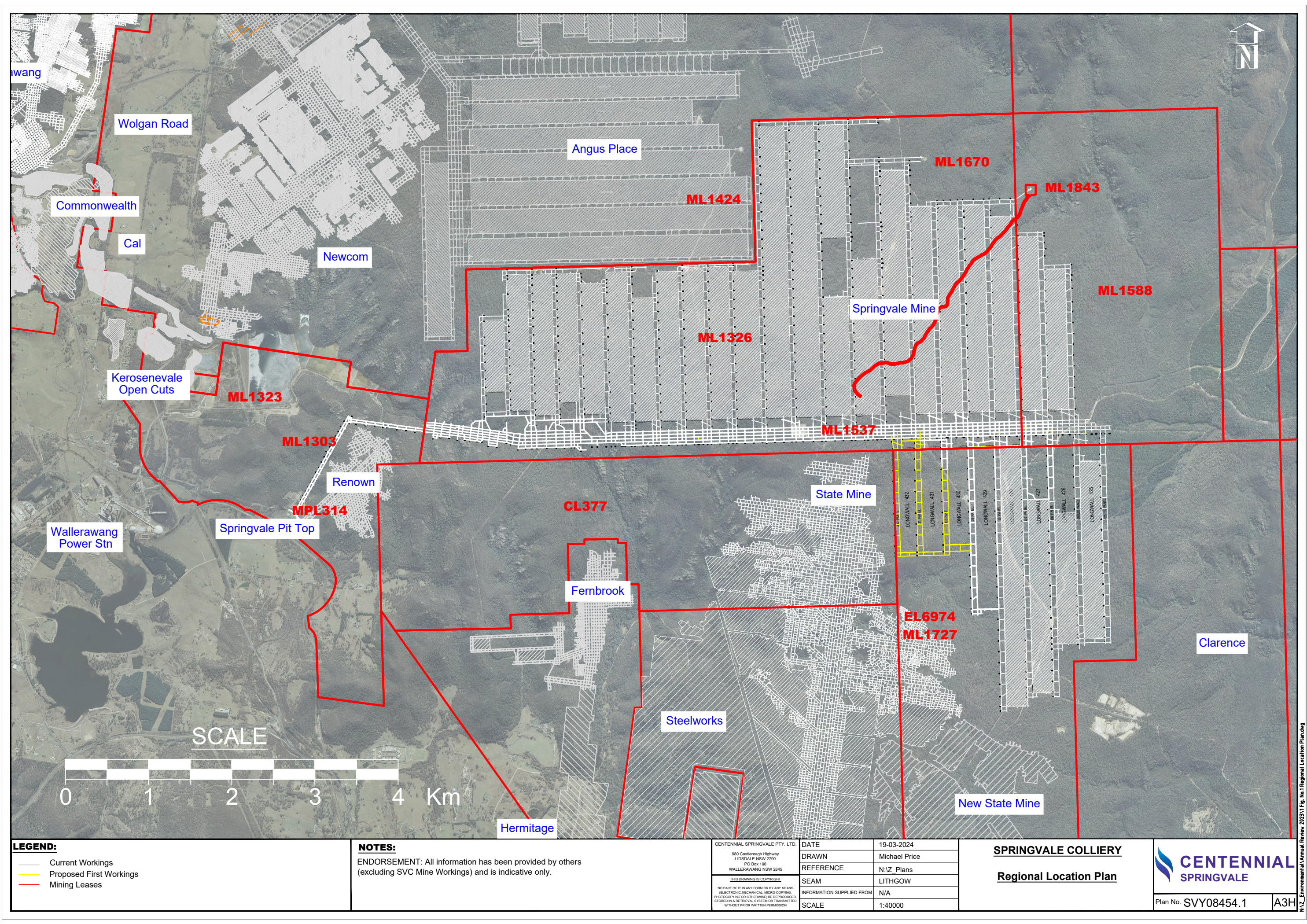
GHD, February 2024, UCRC Aquatic Ecology Springvale Mine site summaries from 2023 monitoring

GHD, March 2024, Newnes Plateau Swamps Aquatic Ecology Annual Report 2023

RPS, February 2024, Giant Dragonfly Research and Monitoring Program LW428-432

RPS, October 2023, Blue Mountains Water Skink Research and Management Program. Annual Report: 2022 – 23 Monitoring Period

PLANS



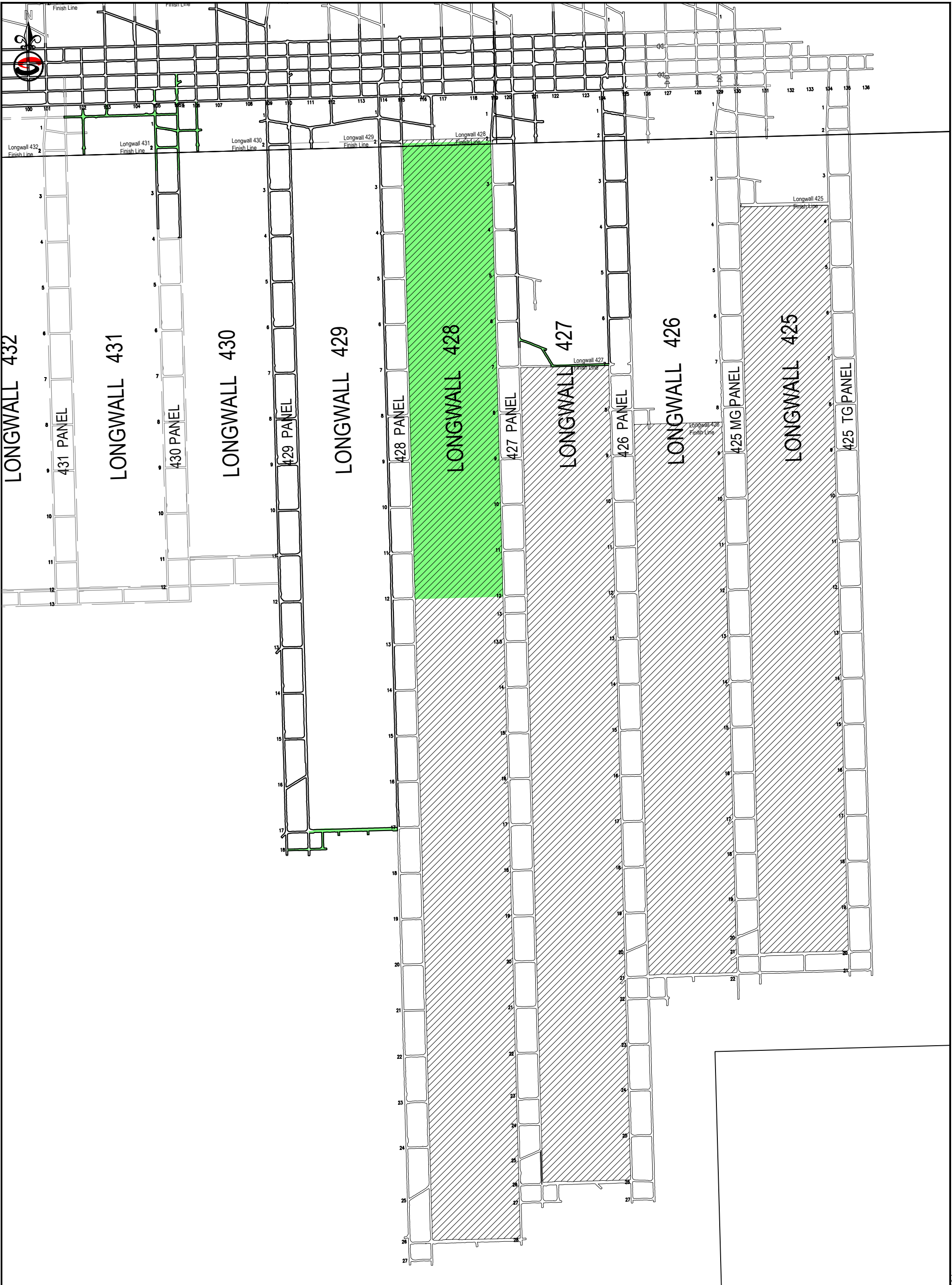
LEGEND:	
	Current Workings
	Proposed First Workings
	Mining Leases

NOTES:	
ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.	

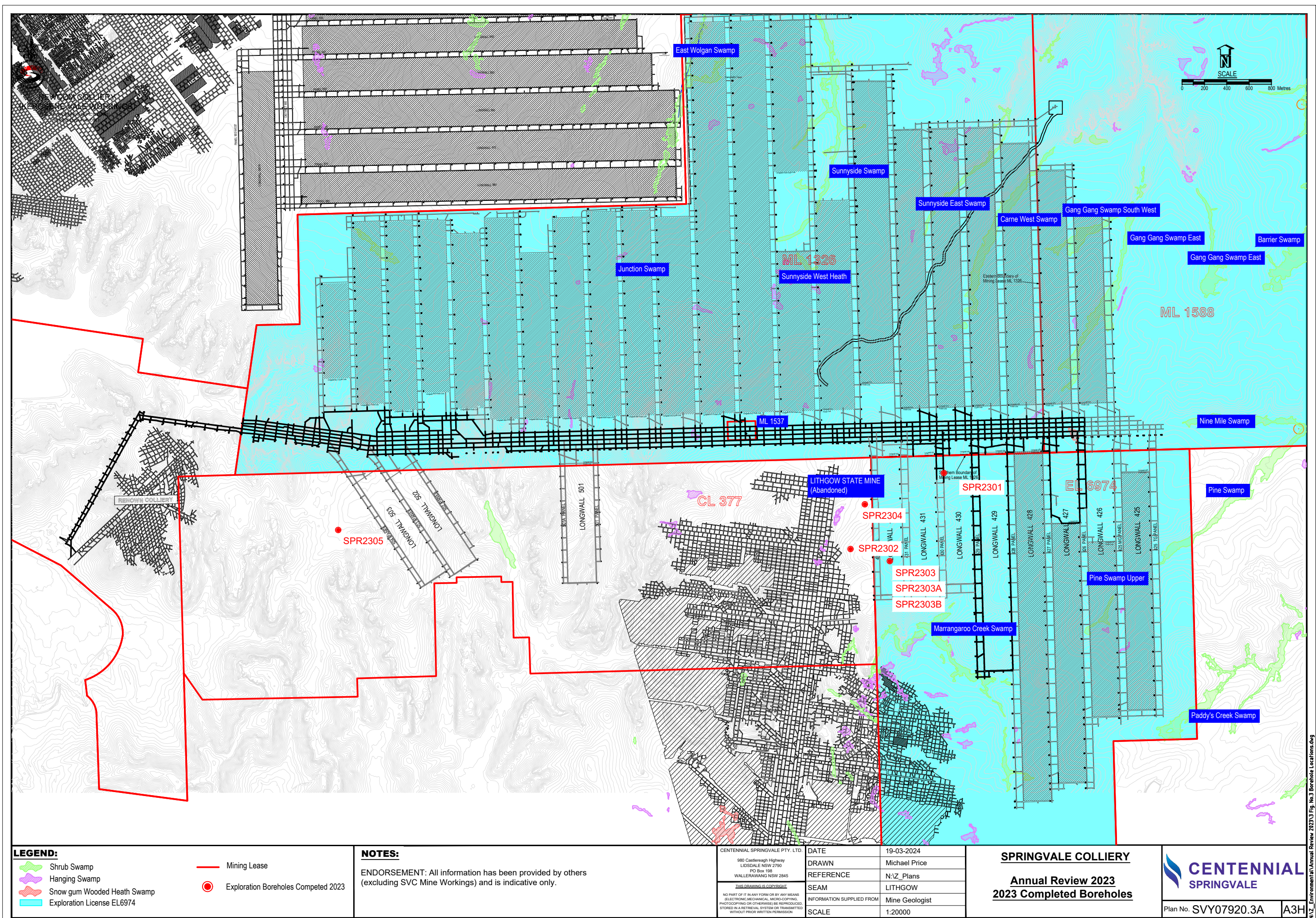
CENTENNIAL SPRINGVALE PTY. LTD. 980 Castlereagh Highway LIDSDALE NSW 2790 PO Box 198 WALLERAWANG NSW 2845 THIS DRAWING IS COPYRIGHT NO PART OF IT IN ANY FORM OR BY ANY MEANS (ELECTRONIC MECHANICAL MICRO-COPYING, PHOTOCOPYING OR OTHERWISE) BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED WITHOUT PRIOR WRITTEN PERMISSION	DATE	19-03-2024
	DRAWN	Michael Price
	REFERENCE	N\Z_Plans
	SEAM	LITHGOW
	INFORMATION SUPPLIED FROM	N/A
SCALE		1:40000

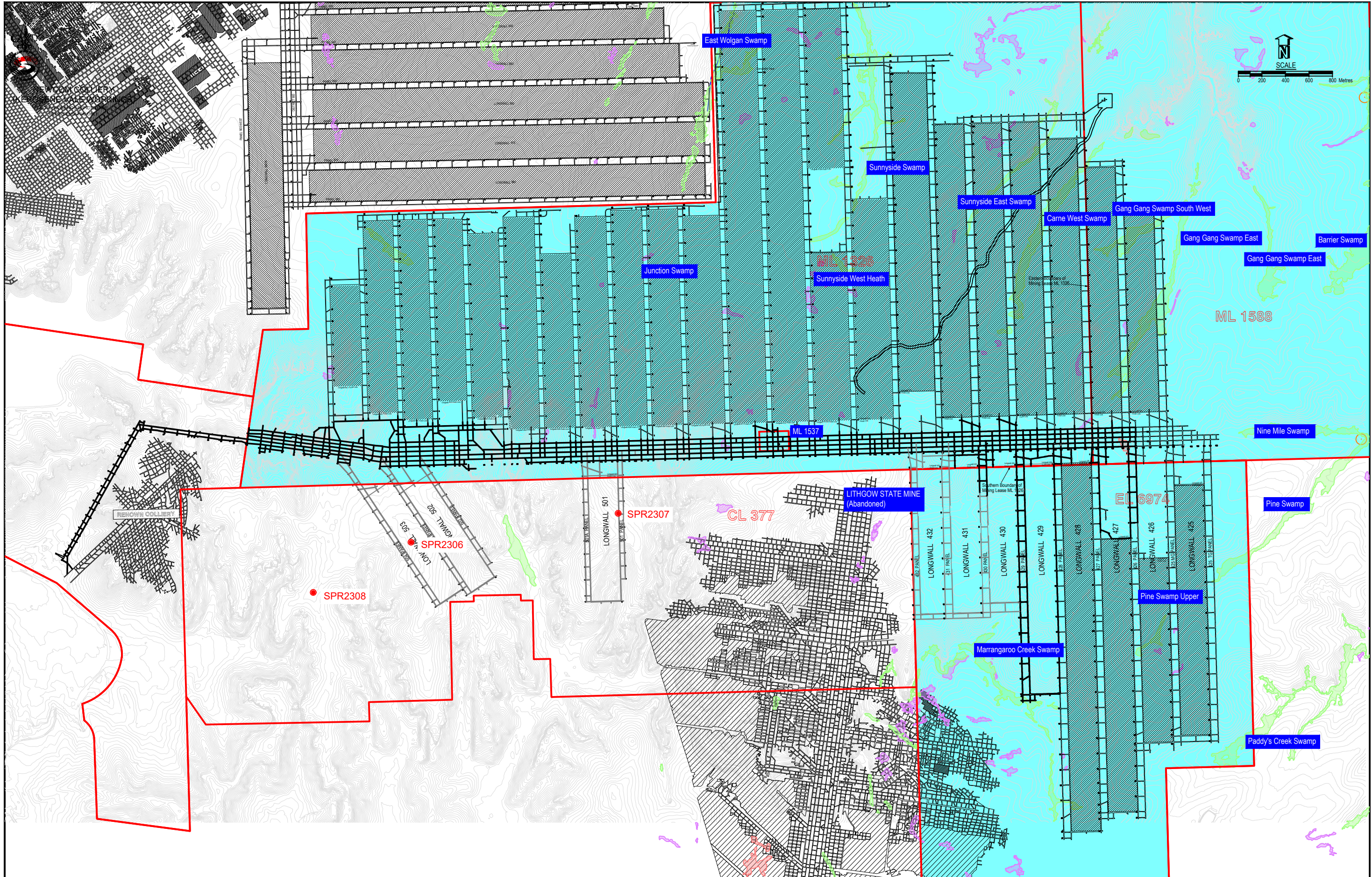
SPRINGVALE COLLIERY	
Regional Location Plan	

Plan No. SVY08454.1	A3H

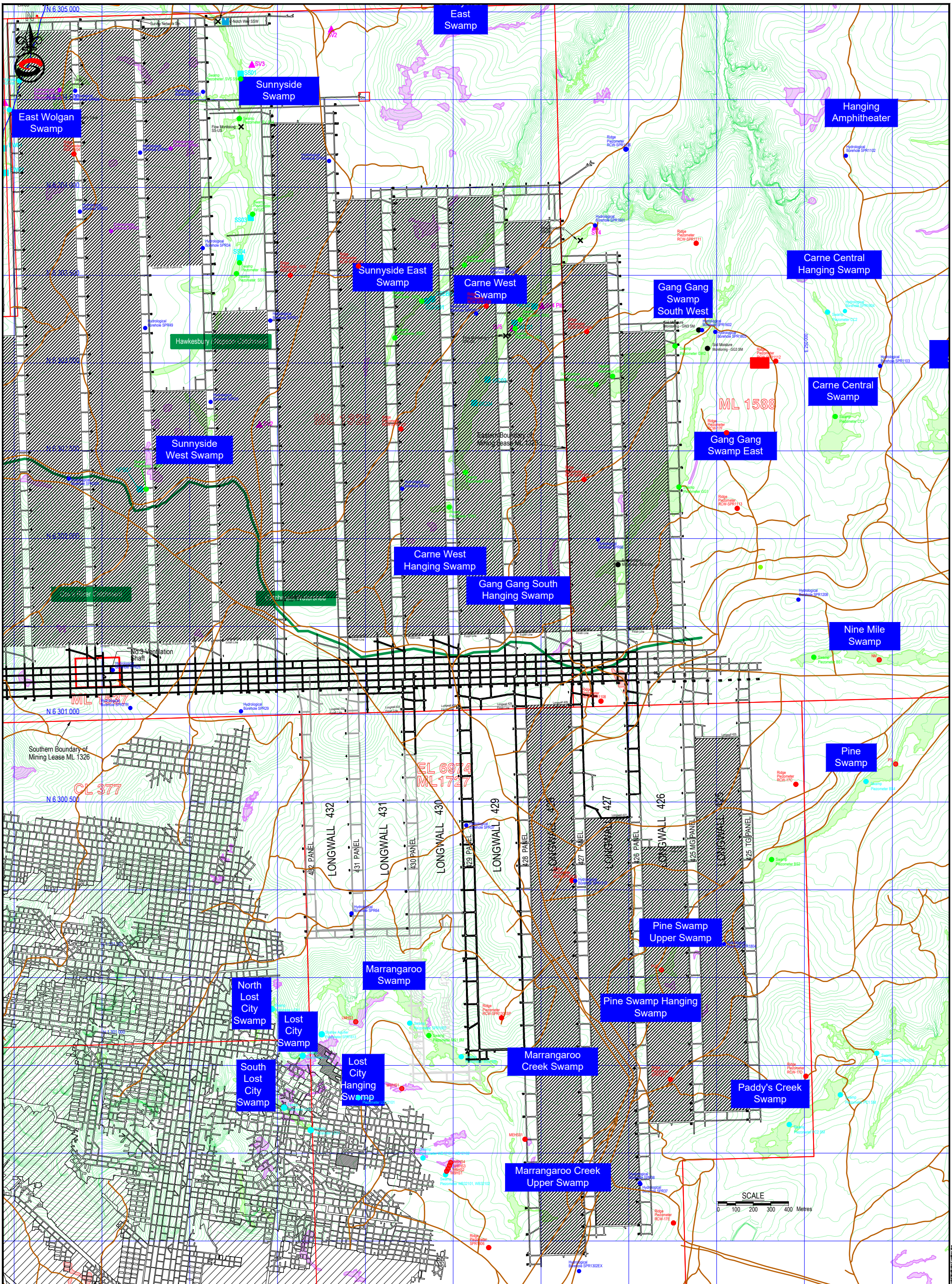


LEGEND: Mine Production 2023		NOTES:		CENTENNIAL SPRINGVALE PTY. LTD. 980 Castlereagh Highway LIDSDALE NSW 2790 PO Box 198 WALLERAWANG NSW 2845 THIS DRAWING IS COPYRIGHT NO PART OF IT IN ANY FORM OR BY ANY MEANS (ELECTRONIC MECHANICAL MICRO-COPYING, PHOTOCOPYING OR OTHERWISE) BE REPRODUCED STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED WITHOUT PRIOR WRITTEN PERMISSION DATE DRAWN REFERENCE SEAM INFORMATION SUPPLIED FROM SCALE 19-03-2024 Michael Price N:\Z_Plans LITHGOW - Not To Scale		SPRINGVALE COLLIERY Annual Review 2023 Mine Production 2023		CENTENNIAL SPRINGVALE Plan No:SVY08454.2 A3V
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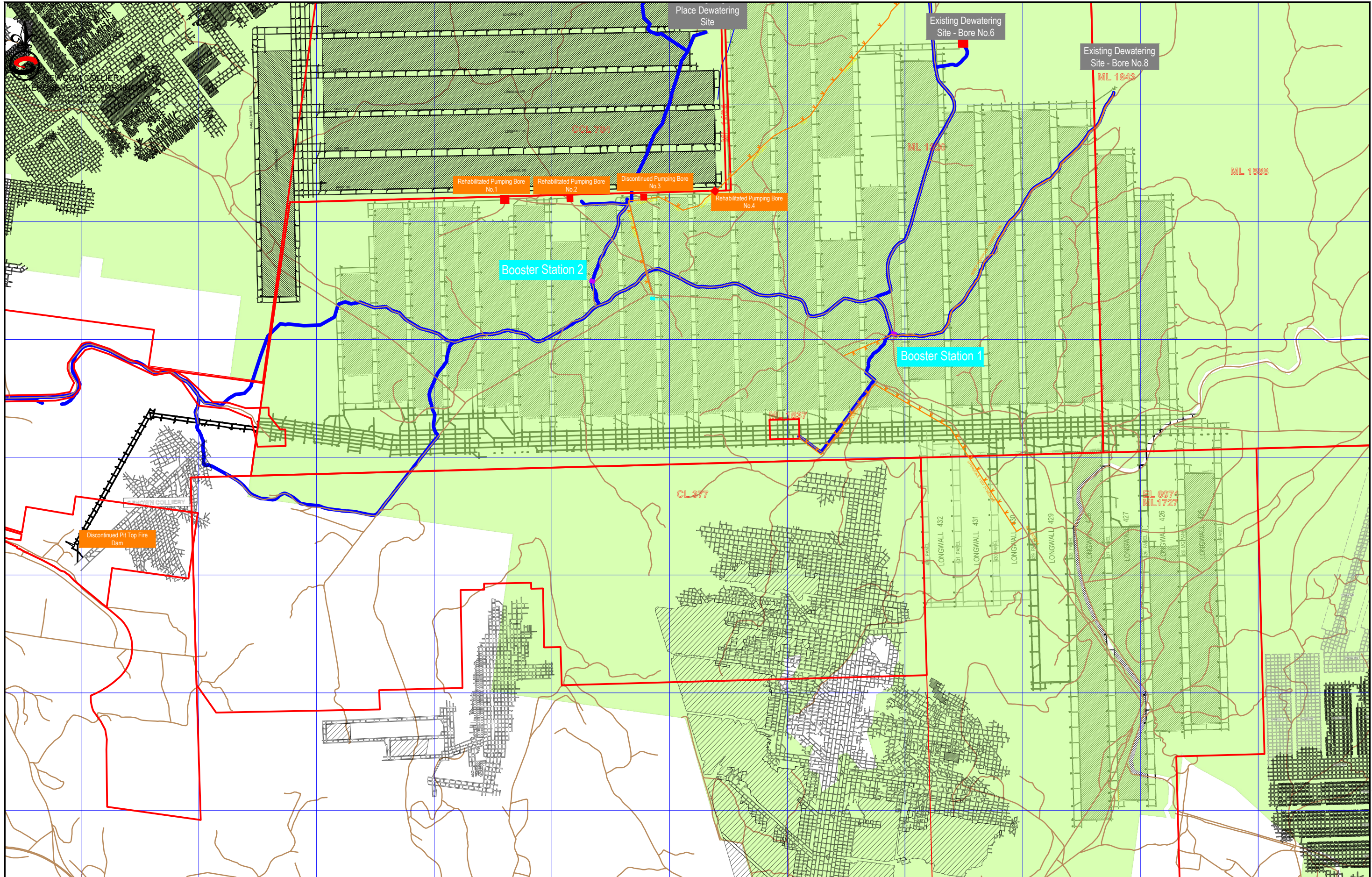




LEGEND:  Shrub Swamp  Hanging Swamp  Snow gum Wooded Heath Swamp  Exploration License EL6974 Mining Lease Access track  Exploration Boreholes Proposed 2024			NOTES: ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.			CENTENNIAL SPRINGVALE PTY. LTD. 980 Castlereagh Highway LIDSDALE NSW 2790 PO Box 198 WALLERAWANG NSW 2845 THIS DRAWING IS COPYRIGHT NO PART OF IT IN ANY FORM OR BY ANY MEANS (ELECTRONIC MECHANICAL MICRO-COPYING, PHOTOCOPYING OR OTHERWISE) BE REPRODUCED STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED WITHOUT PRIOR WRITTEN PERMISSION		<table><tr><td>DATE</td><td>19-03-2024</td></tr><tr><td>DRAWN</td><td>Michael Price</td></tr><tr><td>REFERENCE</td><td>N\Z_Plans</td></tr><tr><td>SEAM</td><td>LITHGOW</td></tr><tr><td>INFORMATION SUPPLIED FROM</td><td>Mine Geologist</td></tr><tr><td>SCALE</td><td>1:20000</td></tr></table>	DATE	19-03-2024	DRAWN	Michael Price	REFERENCE	N\Z_Plans	SEAM	LITHGOW	INFORMATION SUPPLIED FROM	Mine Geologist	SCALE	1:20000	SPRINGVALE COLLIERY Annual Review 2023 2024 Proposed Boreholes		 CENTENNIAL SPRINGVALE Plan No. SVY07920.3B A3H	
DATE	19-03-2024																							
DRAWN	Michael Price																							
REFERENCE	N\Z_Plans																							
SEAM	LITHGOW																							
INFORMATION SUPPLIED FROM	Mine Geologist																							
SCALE	1:20000																							



LEGEND:  Shrub Swamp  Hanging Swamp  Snow gum Wooded Heath Swamp Mining Lease Access track		NOTES: ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.		CENTENNIAL SPRINGVALE PTY. LTD. 980 Castlereagh Highway LIDSDALE NSW 2790 PO Box 198 WALLERAWANG NSW 2845 THIS DRAWING IS COPYRIGHT NO PART OF IT IN ANY FORM OR BY ANY MEANS (ELECTRONIC MECHANICAL MICRO-COPYING, PHOTOCOPYING OR OTHERWISE) BE REPRODUCED STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED WITHOUT PRIOR WRITTEN PERMISSION		<table><tr><td>DATE</td><td>19-03-2024</td></tr><tr><td>DRAWN</td><td>Michael Price</td></tr><tr><td>REFERENCE</td><td>N\Z_Plans</td></tr><tr><td>SEAM</td><td>LITHGOW</td></tr><tr><td>INFORMATION SUPPLIED FROM</td><td>-</td></tr><tr><td>SCALE</td><td>1:20000</td></tr></table>		DATE	19-03-2024	DRAWN	Michael Price	REFERENCE	N\Z_Plans	SEAM	LITHGOW	INFORMATION SUPPLIED FROM	-	SCALE	1:20000	SPRINGVALE COLLIERY Annual Review 2023 Environmental Monitoring Locations		 CENTENNIAL SPRINGVALE Plan No. SVY08454.4 A3V	
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DRAWN	Michael Price																						
REFERENCE	N\Z_Plans																						
SEAM	LITHGOW																						
INFORMATION SUPPLIED FROM	-																						
SCALE	1:20000																						



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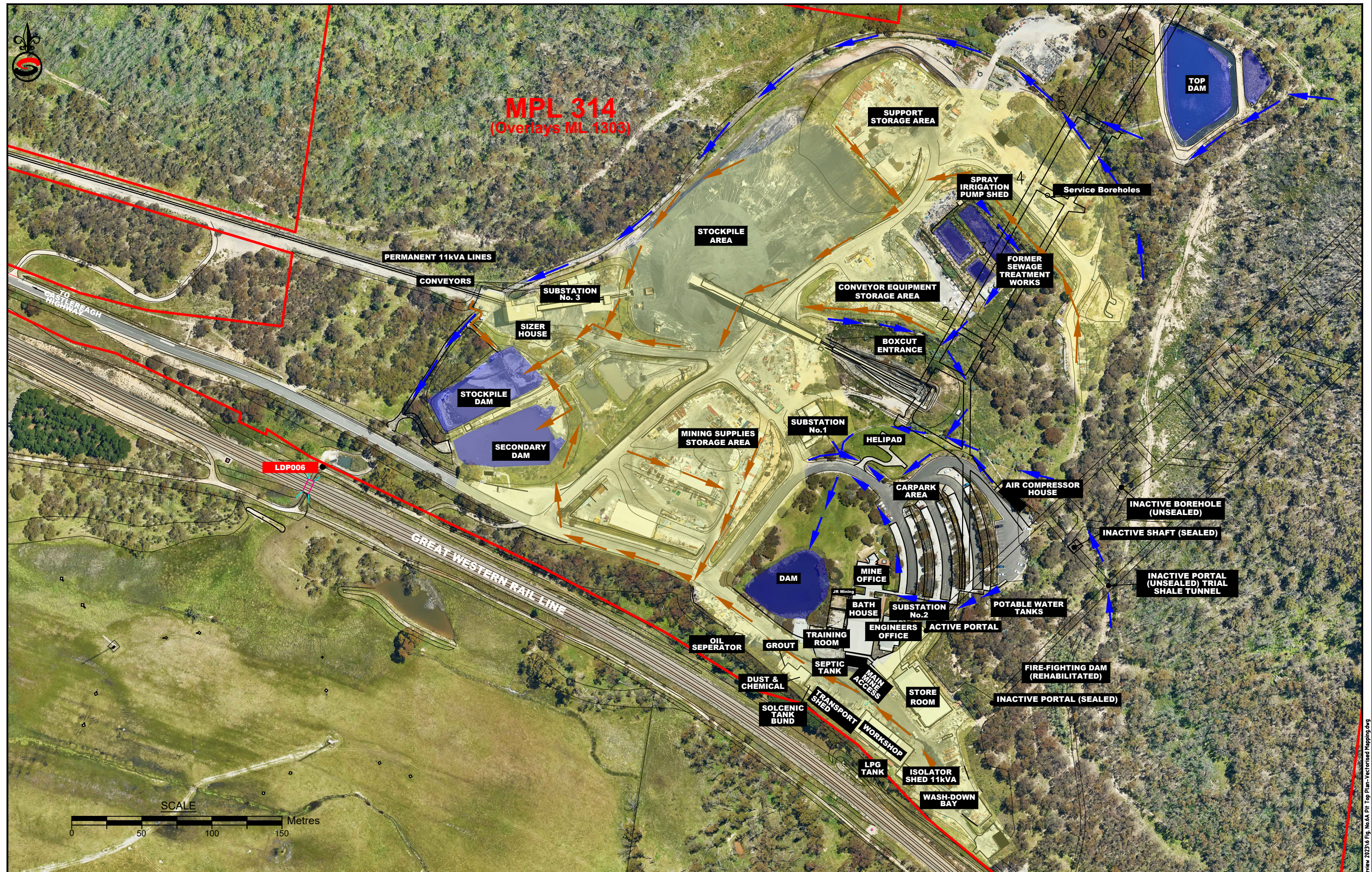
	State Conservation Area		Formed Track		Proposed Rehabilitation Areas 2023
	Longwall Extraction		Water Transfer Pipeline		Rehabilitated Areas prior to 2021
	11KV Powerline Path		Active Infrastructure Area		
	Mining Lease				

NOTES:	
No Proposed Rehabilitation for 2023	

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		SEAM	LITHGOW
		INFORMATION SUPPLIED FROM	-
		SCALE	1:30000

SPRINGVALE COLLIERY	
Annual Review 2023	
Proposed Rehabilitation 2024	
Newnes Plateau	

Plan No. SVY08454.5	A3H



LEGEND:	
	Clean Water
	Dirty Water
	Dirty Water Catchment
	Pollution Control Structures
	Mining Lease

NOTES:	
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SCALE		1:2500

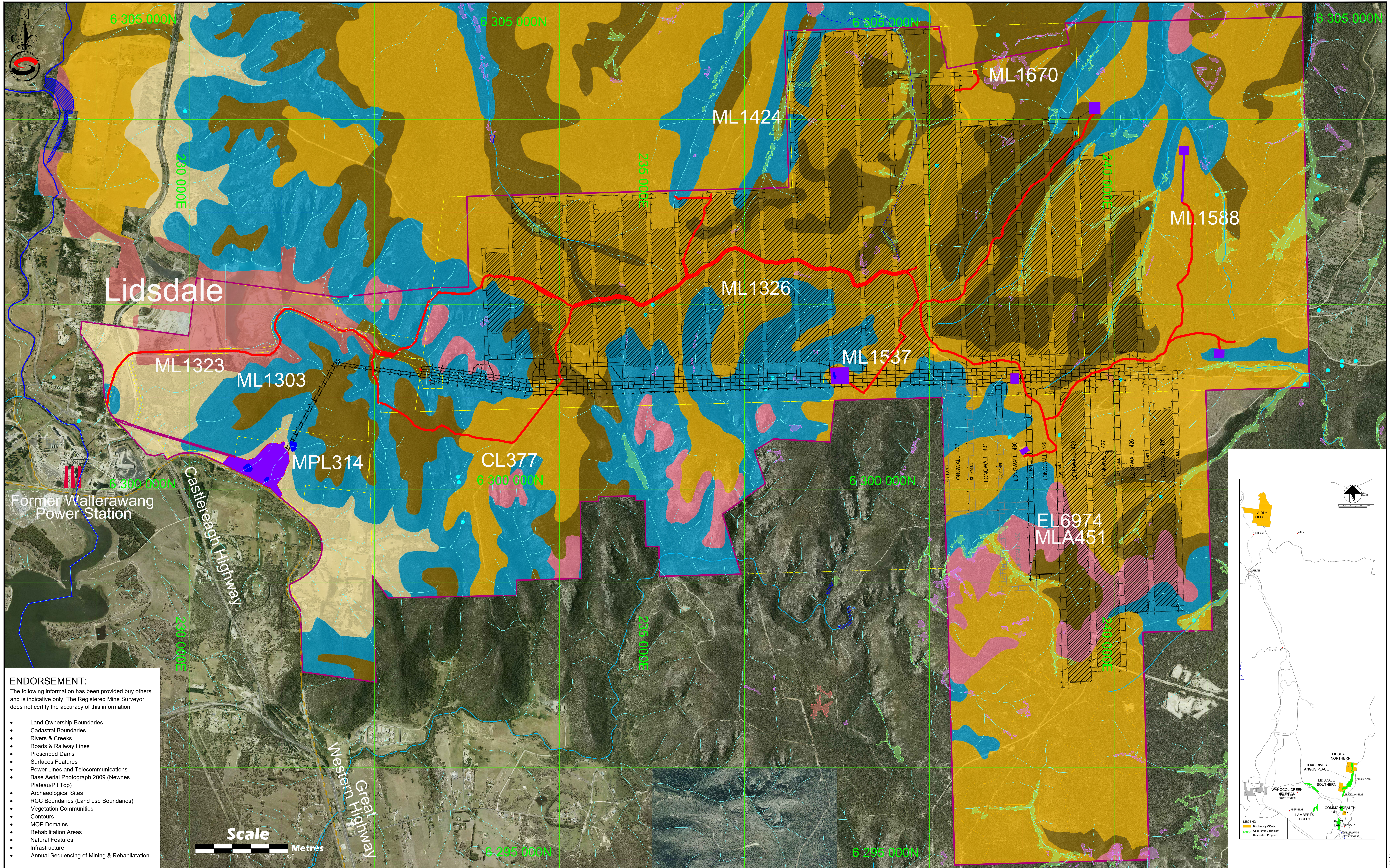
SPRINGVALE COLLIERY	
Annual Review 2023	
Pit Top Plan	
Surface Water Management	

Plan No. SVY08454.6	A3H

N:\2_Environmental\Annual Review 2023\6 Fig No.64 Pit Top Plan-Vectorised Mapping.dwg

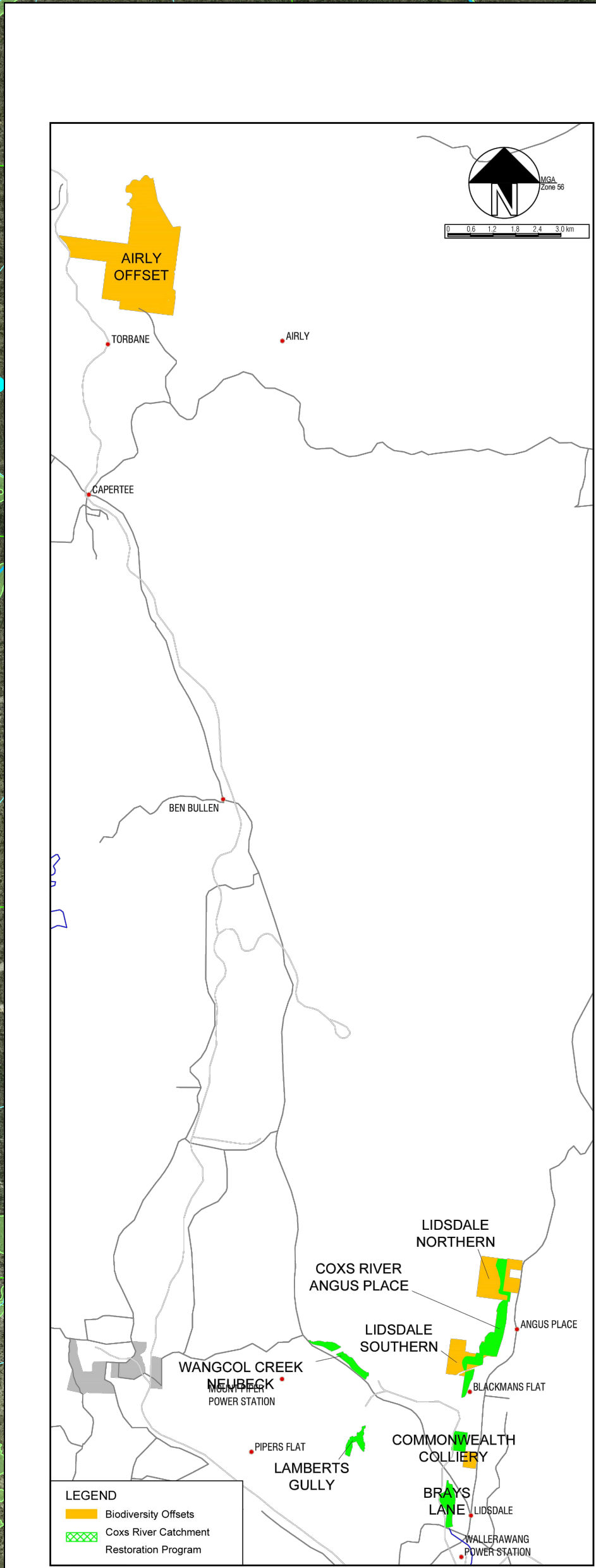


LEGEND: Mining Lease		NOTES: ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.		CENTENNIAL SPRINGVALE PTY. LTD. 980 Castlereagh Highway LIDSDALE NSW 2790 PO Box 198 WALLERAWANG NSW 2845 THIS DRAWING IS COPYRIGHT NO PART OF IT IN ANY FORM OR BY ANY MEANS (ELECTRONIC MECHANICAL MICRO-COPYING PHOTOCOPYING OR OTHERWISE) BE REPRODUCED STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED WITHOUT PRIOR WRITTEN PERMISSION DATE 19-03-2024 DRAWN Michael Price REFERENCE N.Z. Plans SEAM LITHGOW INFORMATION SUPPLIED FROM - SCALE 1:25000 SPRINGVALE COLLIERY Annual Report 2023 Pit Top Plan - Aerial Photograph CENTENNIAL SPRINGVALE Plan No:SVY08454.7 A3V
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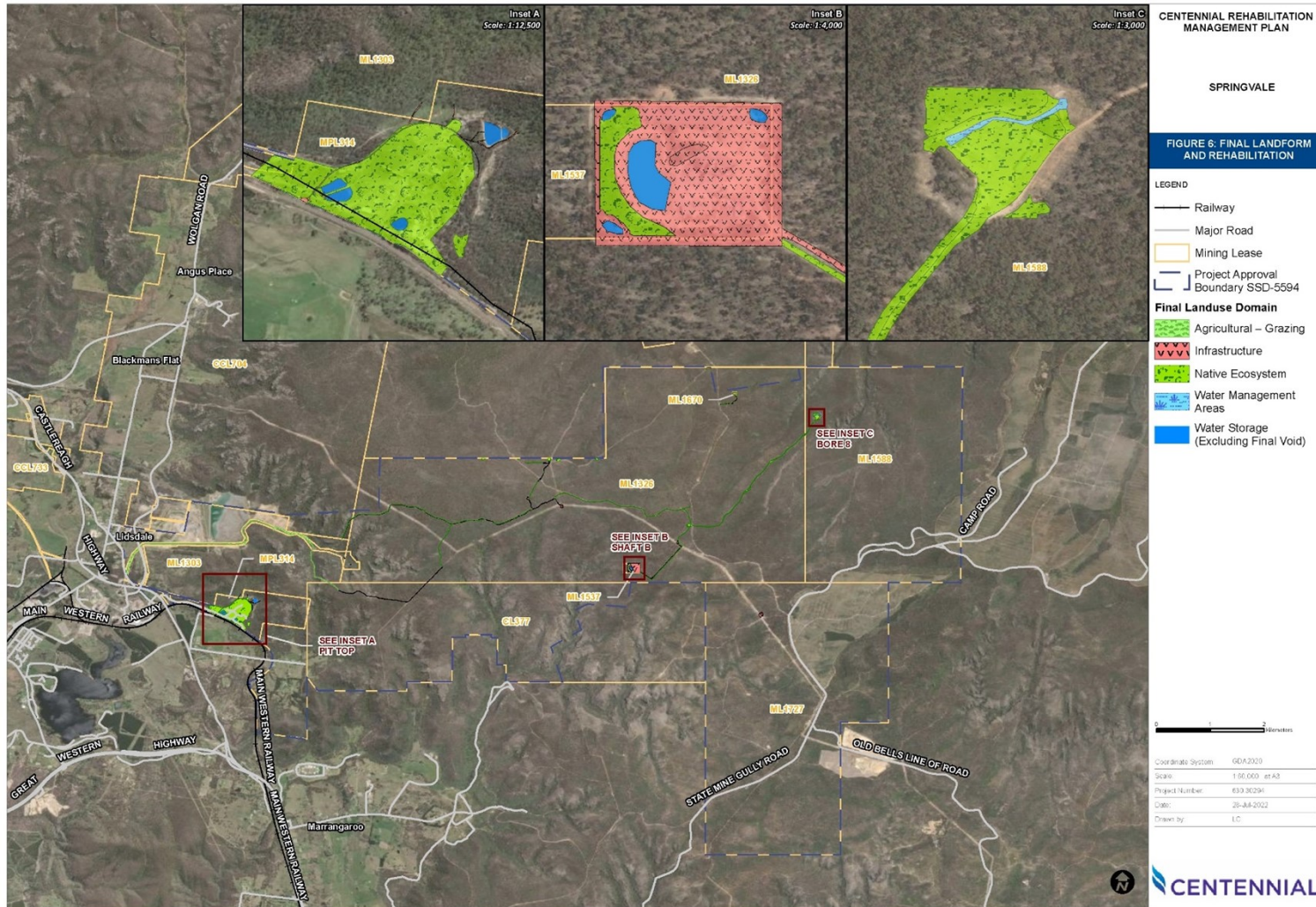
ENDORSEMENT:
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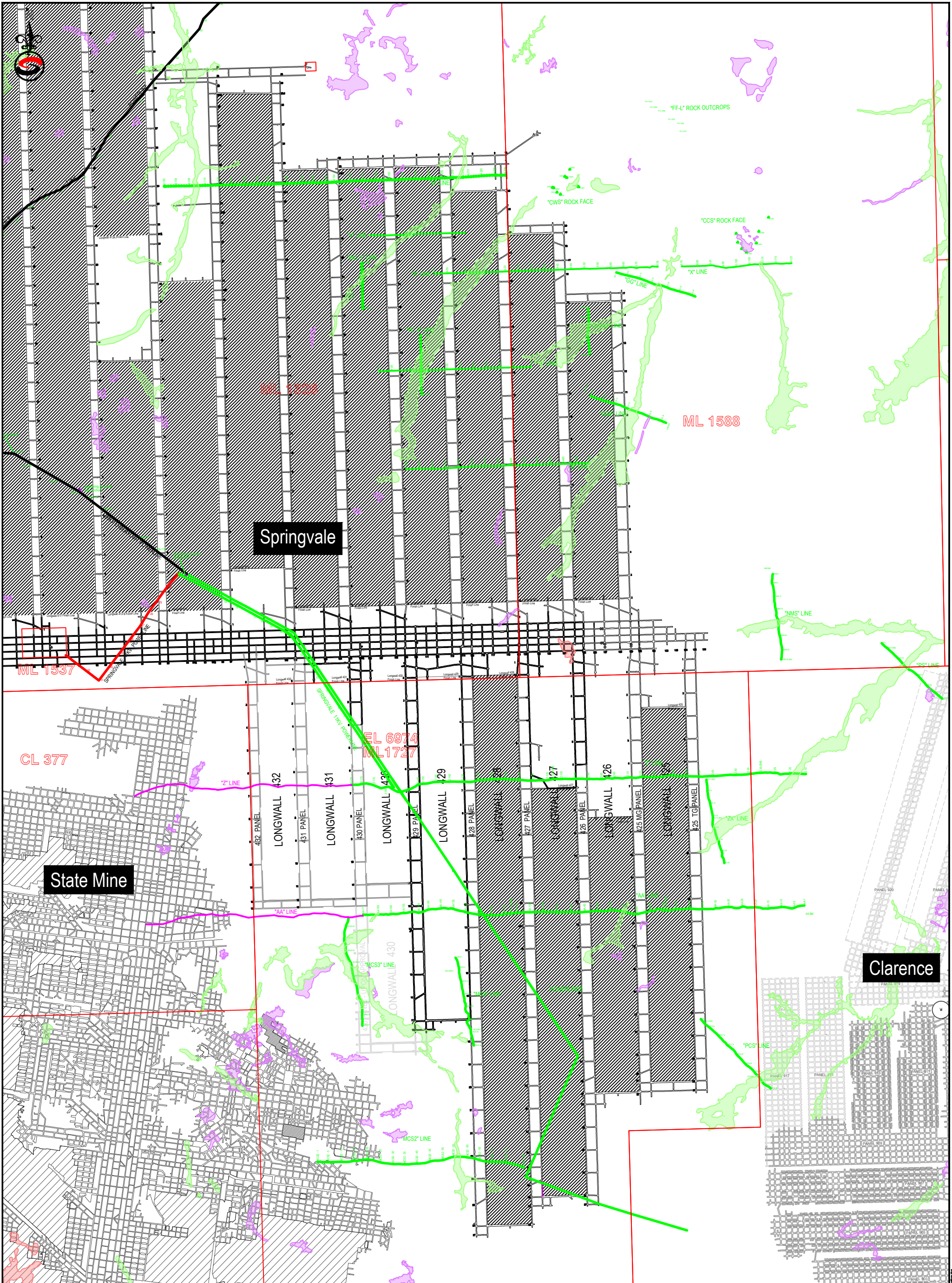
- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers & Creeks
- Roads & Railway Lines
- Prescribed Dams
- Surfaces Features
- Power Lines and Telecommunications
- Base Aerial Photograph 2009 (Newnes Plateau/Pit Top)
- Archaeological Sites
- RCC Boundaries (Land use Boundaries)
- Vegetation Communities
- Contours
- MOP Domains
- Rehabilitation Areas
- Natural Features
- Infrastructure
- Annual Sequencing of Mining & Rehabilitation



LEGEND: Project Approval Area Mining Tenement Surface Contour - 5m River Creek Drainage Line Aboriginal Cultural Heritage Sites MU50 Newnes Plateau Shrub Swamp MU51 Newnes Plateau Hanging Swamp MU52 Newnes Plateau Rush Sedge Snow Gum Hollow Wooded Heath Secondary Domain - Infrastructure (Existing Forestry Tracks) Secondary Domain - Water Management Secondary Domain - Rehabilitation - Woodland Land Capability - Class 4 Land Capability - Class 5 Land Capability - Class 6 Land Capability - Class 7 Land Capability - Class 8 Land Capability - Disturbed Land

FIGURE 6: FINAL LANDFORM AND REHABILITATION





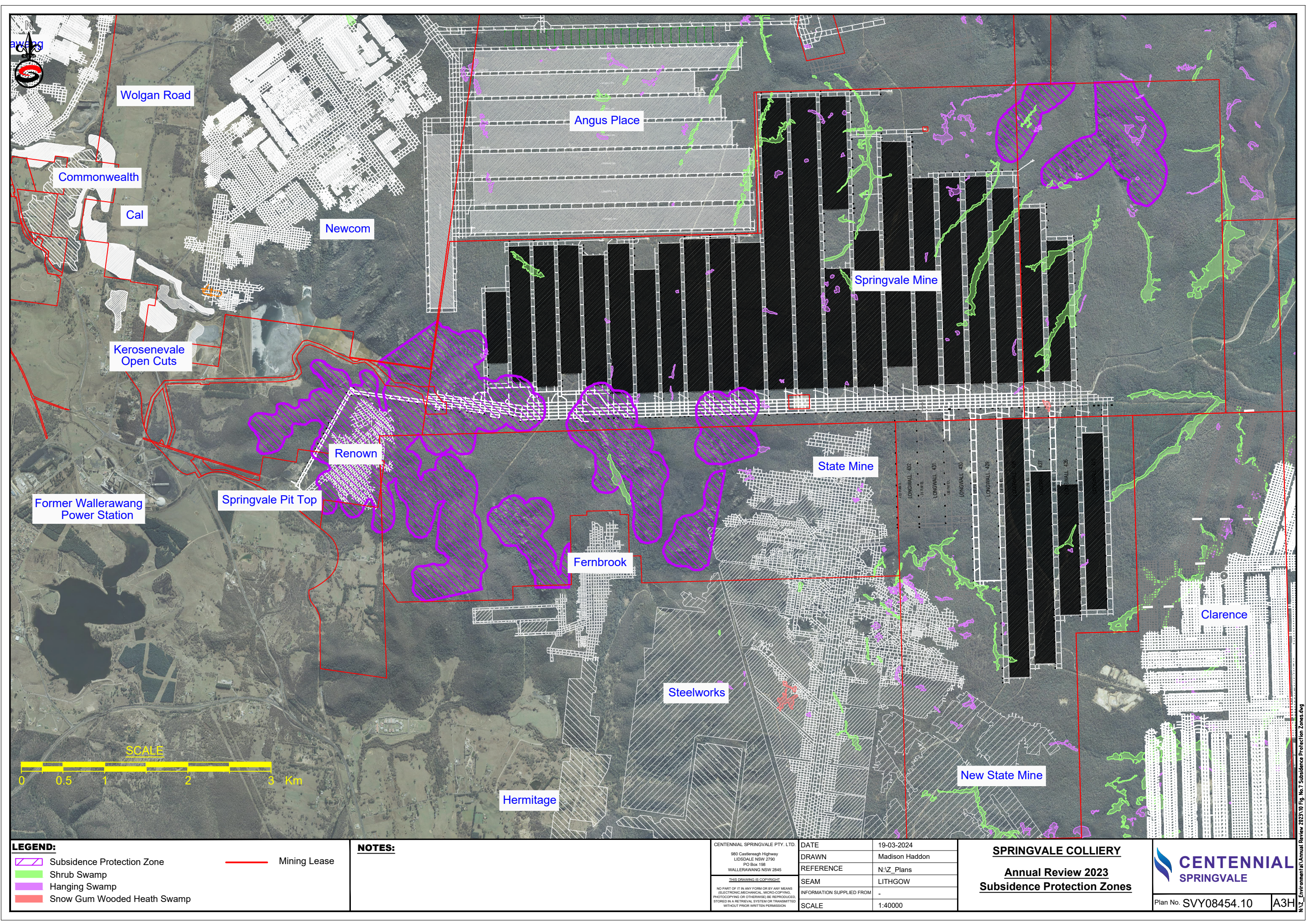
LEGEND:	
	SMP Monitored Subsidence Element
	SMP Proposed Subsidence Line
	Endeavor Powerlines
	Shrub Swamp
	Hanging Swamp
	Snow Gum Wooded Heath Swamp

NOTES:	
ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.	

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		INFORMATION SUPPLIED FROM	-
		SCALE	1:20000

SPRINGVALE COLLIERY	
Annual Review 2023	
Subsidence Monitoring	

Plan No:SVY08454.9	
A3V	



LEGEND:

	Subsidence Protection Zone		Mining Lease
	Shrub Swamp		
	Hanging Swamp		
	Snow Gum Wooded Heath Swamp		

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DRAWN Madison Haddon	REFERENCE N:Z_Plans
SEAM LITHGOW	INFORMATION SUPPLIED FROM -
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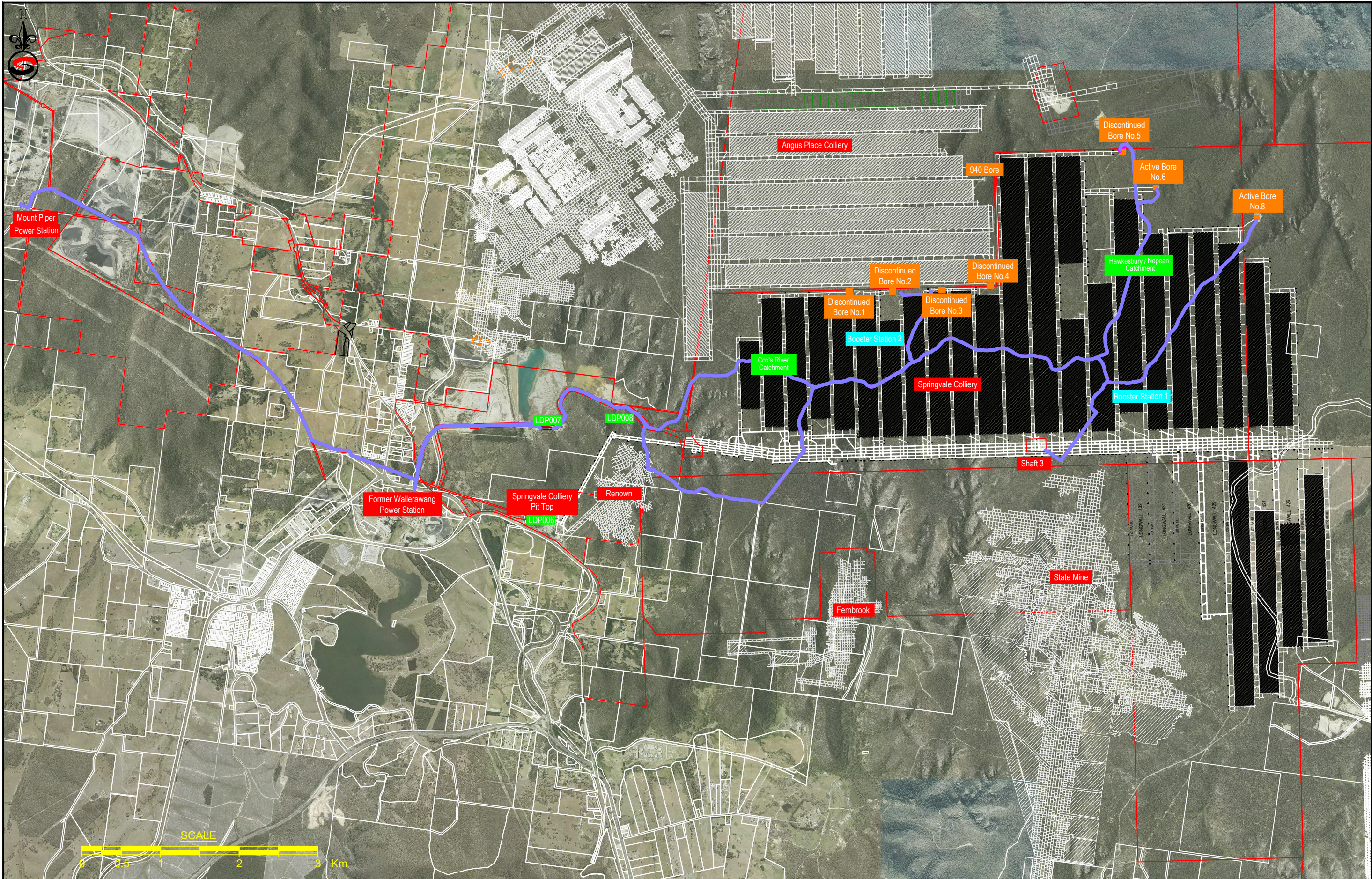
SPRINGVALE COLLIERY

Annual Review 2023

Subsidence Protection Zones

Plan No. SVY08454.10

A3H



LEGEND:

- Water Transfer Route
- Mining Lease
- Pumping Compound

NOTES:

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	REFERENCE	N:Z_Plans
	SEAM	LITHGOW
	INFORMATION SUPPLIED FROM	-
SCALE	1:45000	

SPRINGVALE COLLIERY

Annual Review 2023

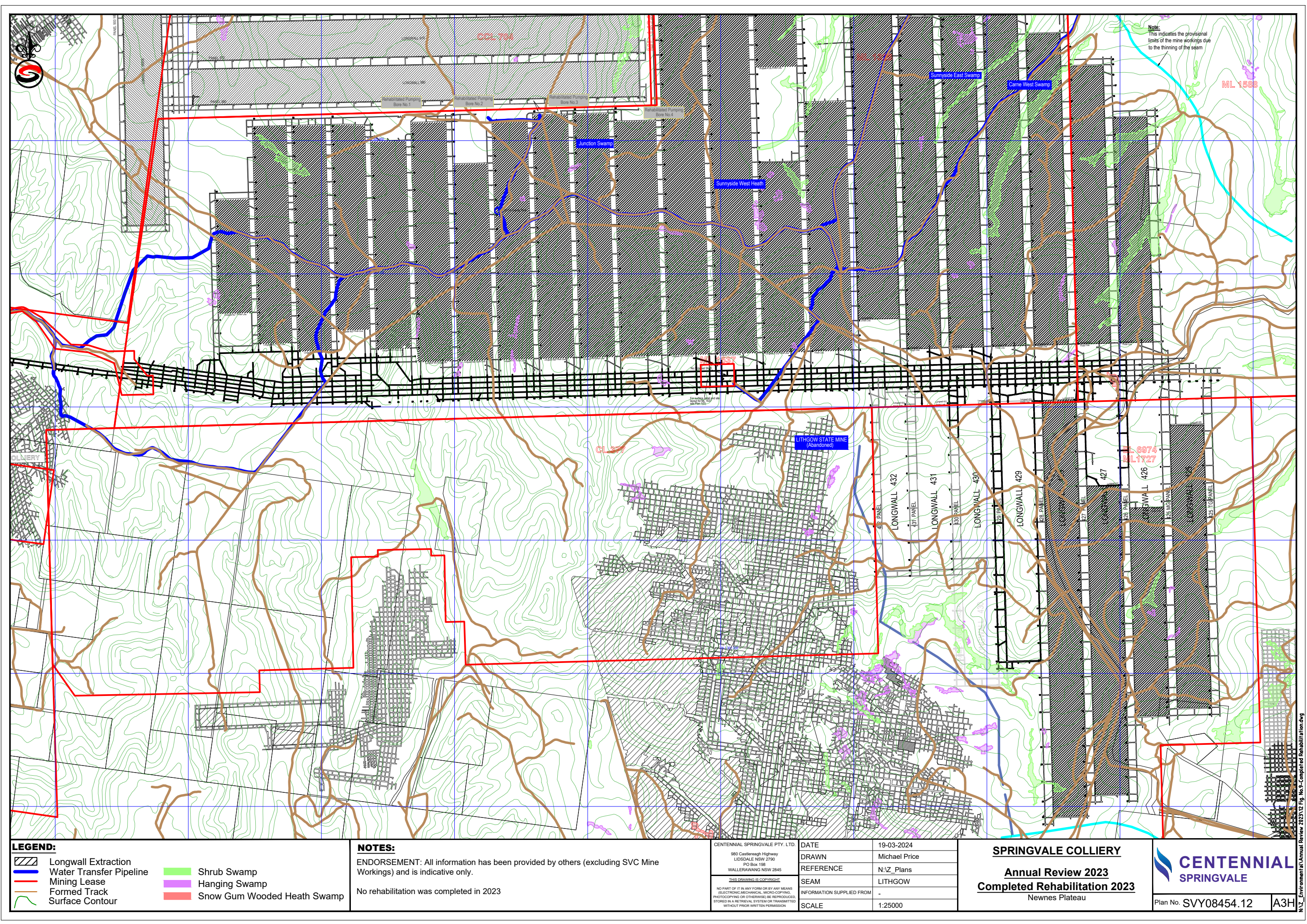
Water Transfer Route

To Mount Piper Power Station and LDPs.

CENTENNIAL SPRINGVALE

Plan No. SVY08454.11

A3H



Note:
This indicates the provisional
limits of the mine workings due
to the thinning of the seam

LEGEND:

	Longwall Extraction		Shrub Swamp
	Water Transfer Pipeline		Hanging Swamp
	Mining Lease		Snow Gum Wooded Heath Swamp
	Formed Track		
	Surface Contour		

NOTES:

ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.

No rehabilitation was completed in 2023

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	REFERENCE	N:Z_Plans
	SEAM	LITHGOW
	INFORMATION SUPPLIED FROM	-
SCALE	1:25000	

SPRINGVALE COLLIERY

Annual Review 2023

Completed Rehabilitation 2023

Newnes Plateau

**CENTENNIAL
SPRINGVALE**

Plan No. SVY08454.12

A3H

APPENDICES

Appendix 1: Checklist of Annual Review Reporting Requirements

This appendix provides a checklist of reporting requirements and performance conditions addressed within the Annual Review, including:

- **Table A1-1** provides a checklist of reporting requirements and performance conditions addressed within the Annual Review; and
- **Table A1-2** provides other Annual Review requirements outlined in the Project Approvals.

Table A1-1: Project Approval Annual Review Requirements

Approval	Requirement	Annual Review Section
Development Consent SSD5594, Schedule 6, Condition 12.	By the end of March each year, or as otherwise agreed by the Secretary, the Applicant shall review the environmental performance of the development to the satisfaction of the Secretary. This review must:	Noted
	(a) describe the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the current calendar year;	Section 8
	(b) include a comprehensive review of the monitoring results and complaints records of the development over the past calendar year, which includes a comparison of these results against the: i. relevant statutory requirements, limits or performance measures/criteria. ii. requirements of any plan or program required under this consent; iii. monitoring results of previous years; and relevant predictions in the EIS;	Sections 6 & 7
	(c) identify any non-compliance over the past calendar year, and describe what actions were (or are being) taken to ensure compliance;	Sections 1 & 11
	(d) identify any trends in the monitoring data over the life of the development;	Sections 6 & 7
	(e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and	Sections 6 & 7
	(f) describe what measures will be implemented over the current calendar year to improve the environmental performance of the development.	Section 12

Table A1-2: Other Annual Reporting Requirements

Approval	Requirement	Annual Review Section
LW 419 Extraction Plan	Annual Review The Annual Review is completed in accordance with the post-approval requirements for State significant mining developments Annual Review Guidelines (2015) as required by the Department of Planning and Environment, incorporating the reporting requirements of the Department of Resources and Energy. The Annual Review will include information on operational activities, environmental performance and non-conformances and complaints received. This report is made available on the Centennial Coal website.	Section 4, 6, 7, 8 and 11
LW420-422 Extraction Plan		
LW424 – 427 Extraction Plan		
LW 428 – 432 Extraction Plan		

Appendix 2: Water Monitoring Results and Trends

Appendix 1: Discharge Water Monitoring Results and Trends

This Appendix presents a summary of discharge water monitoring results for the 2023 Reporting Period, required by Water Management Plan approved under SSD5594

- **LDP006** (primary discharge point)
- LDP007 – *Nil discharges in 2023*
- LDP008 – *Nil discharges in 2023*
- Analytes with performance criteria prescribed within the WMP and EPL3607 are presented graphically in **Figures 2A.1 – 2A.4**.
- **Table 7.4 in Section 7** of the Annual Review main report provides a summary of water quality analytes required to be monitored by the WMP and EPL3607.

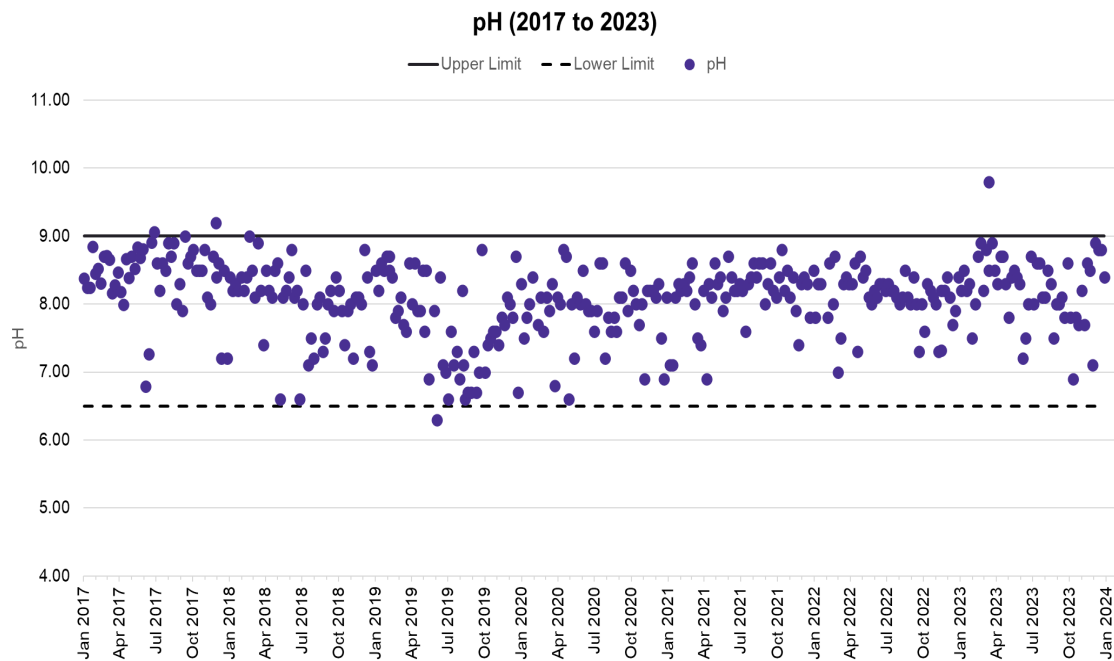


Figure 2A.1 LDP006 pH

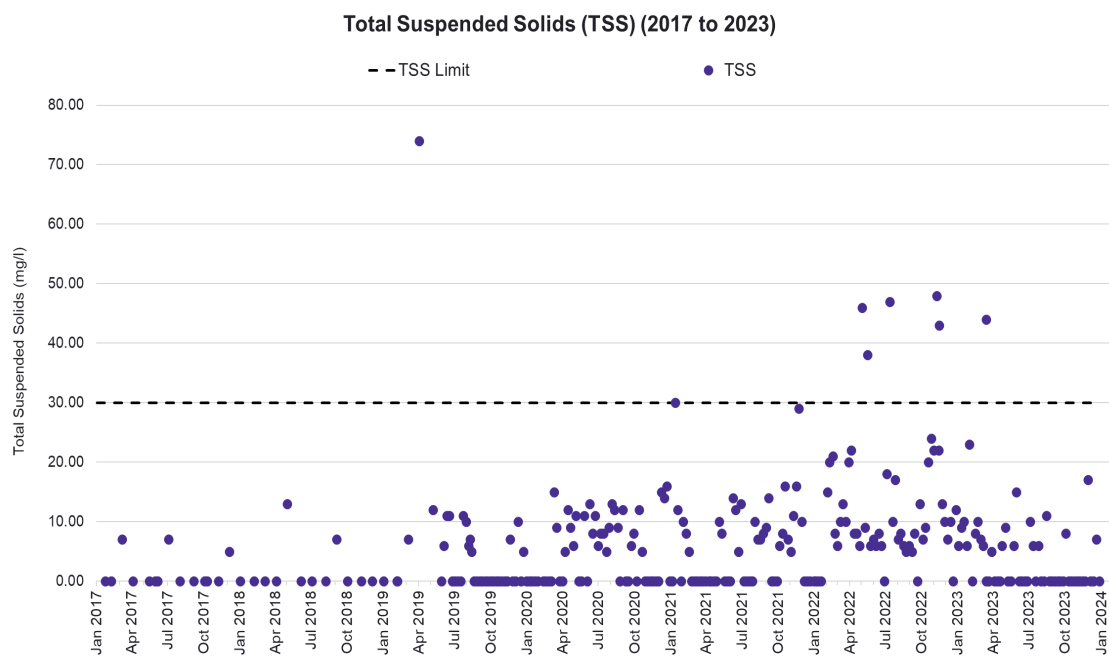


Figure 2A.2 LDP006 Total Suspended Solids

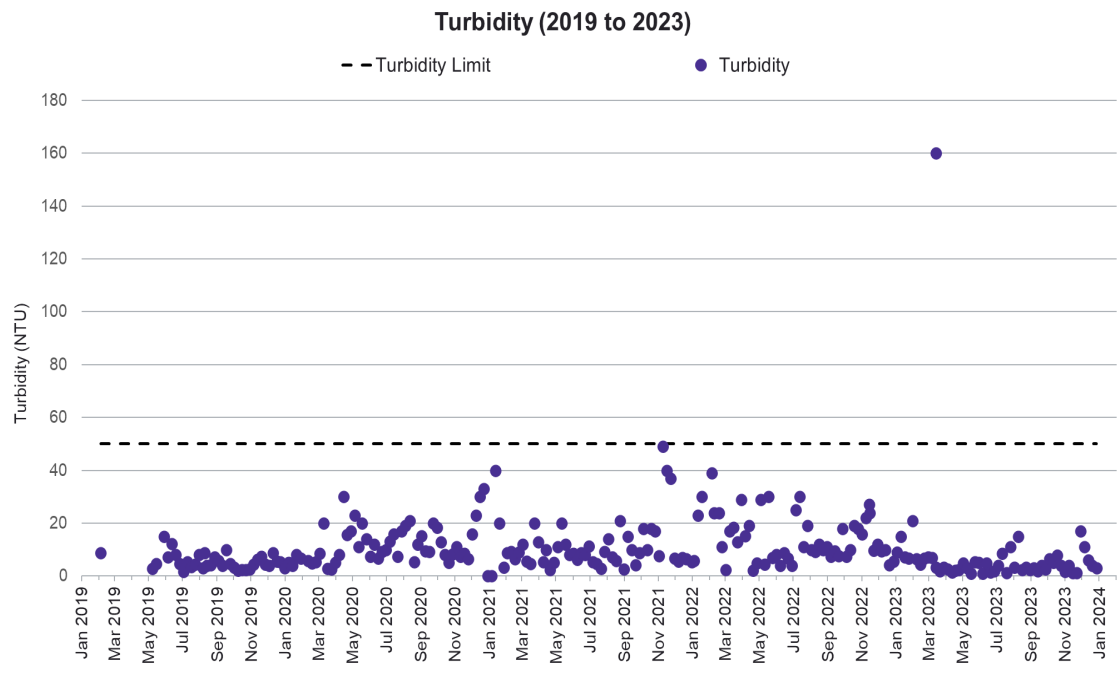


Figure 2A.3 LDP006 Turbidity

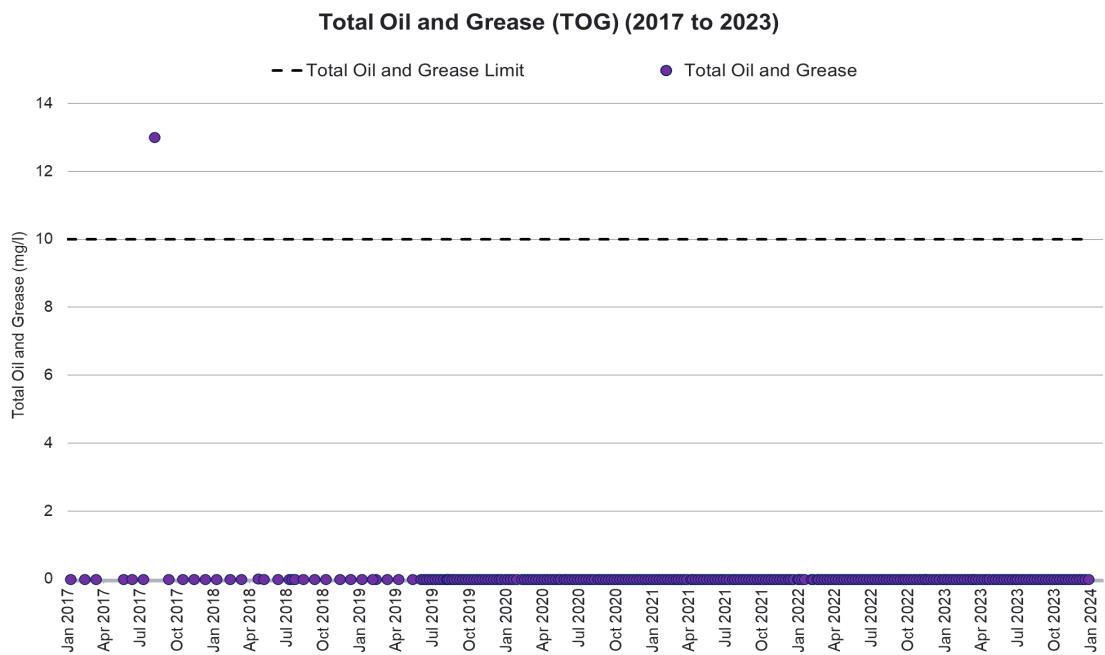


Figure 2A.4. LDP006 Total Oil and Grease

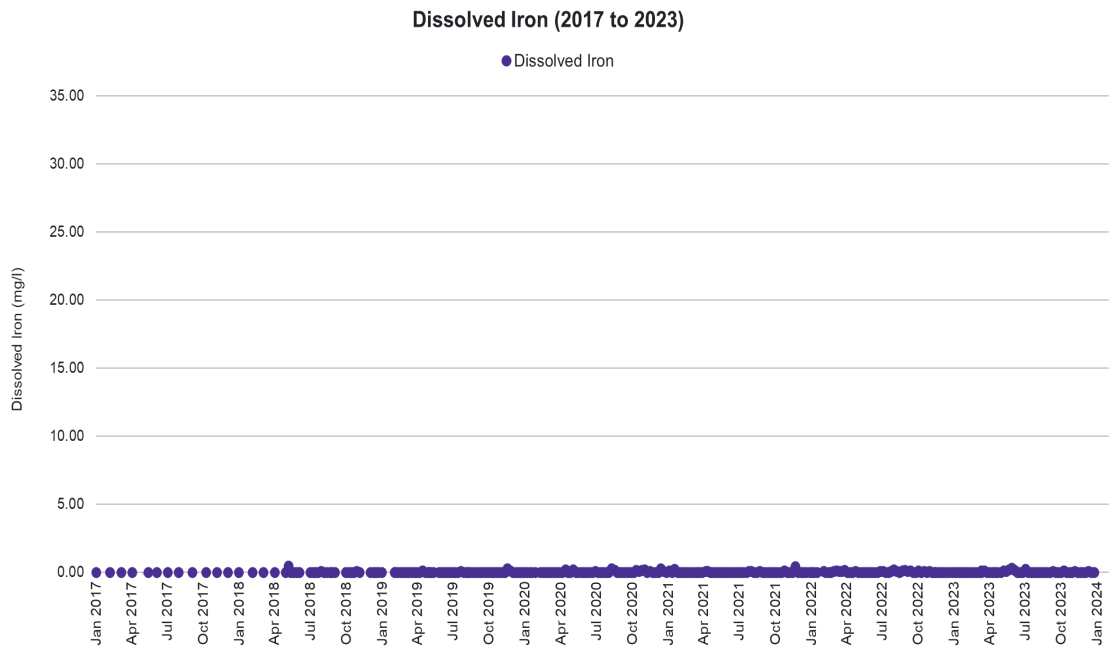


Figure 2A.5 LDP006 Dissolved Iron

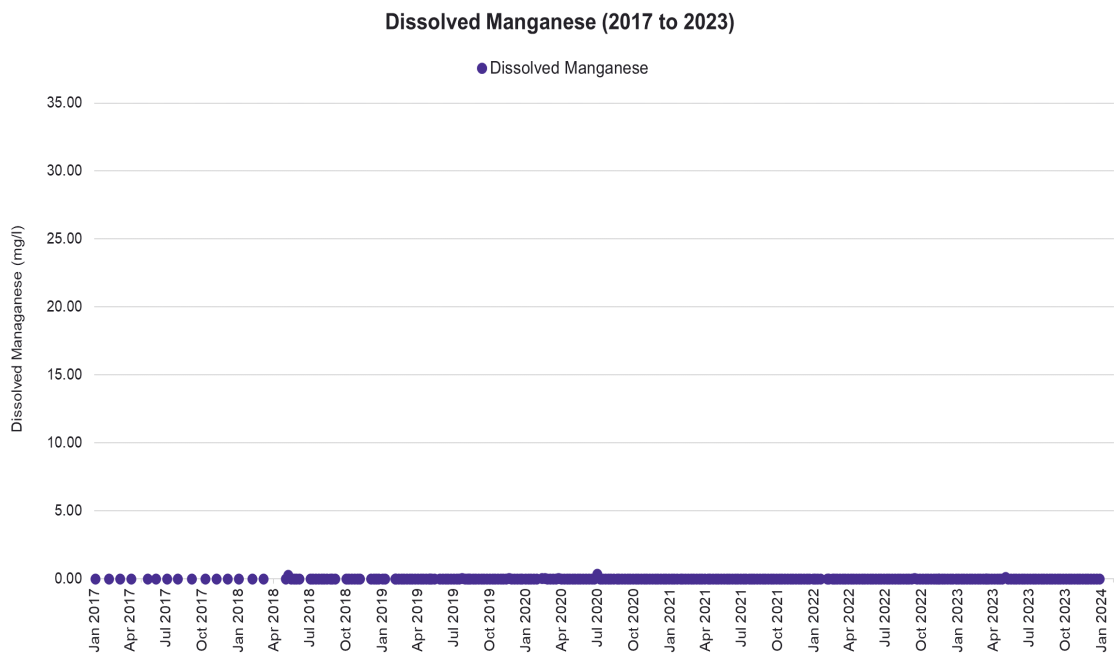


Figure 2A.6 LDP006 Dissolved Manganese

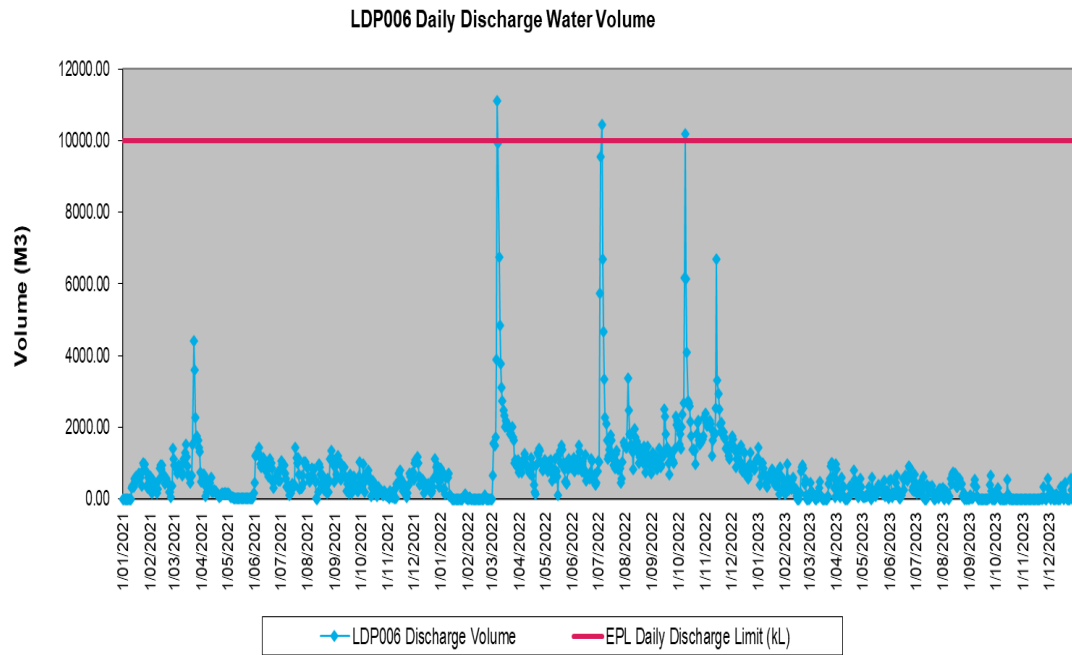


Figure 2A.7 LDP006 Daily Flow

Table 2A.1 RARC Stream Heath Assessment Classification Trends

Site	RARC Stream Heath Assessment Classification		Description of Trend
	2022	2023	
Marrangaroo Creek			
MC01	Good	Good	Static since 2022
MC02	Excellent	Excellent	Static since 2022
MC03	Excellent	Excellent	Static since 2022
MC04	Excellent	Excellent	Static since 2022
MC05	Excellent	Excellent	Static since 2022
Carne Creek			
CC01	Excellent	Excellent	Static since 2022
CC02	Excellent	Excellent	Static since 2022
CC03	Excellent	Excellent	Static since 2022
CC04	Excellent	Excellent	Static since 2022
CC05	Excellent	Excellent	Static since 2022
CC06	Excellent	Excellent	Static since 2022
CC07	Excellent	Excellent	Static since 2022
CC08	Excellent	Excellent	Static since 2022
CC09	Excellent	Excellent	Static since 2022
Springvale Creek			
SC01	Very Poor	Very Poor	Static since 2022
Bungleboori Creek			
BC01	Very Poor	Very Poor	Static since 2022
BC02	Very Poor	Very Poor	Static since 2022
BC03	Average	Average	Static since 2022
BC04	Excellent	Excellent	Static since 2022
BC05	Excellent	Good	Minor decline since 2022
BC06	Excellent	Good	Minor decline since 2022

Table 2A.2 CSIRO Ephemeral Stream Assessment Classification Trends

Site	CSIRO Ephemeral Stream Assessment Classification		Description of Trend
	2022	2022	
Marrangaroo Creek			
MC01	Very Stable	Very Stable	Steady since 2022
MC02	Very Stable	Very Stable	Steady since 2022
MC03	Very Stable	Very Stable	Steady since 2022
MC04	Stable	Stable	Steady since 2022
MC05	Potentially Stabilising	Potentially Stabilising	Steady since 2022
Carne Creek			
CC01	Very Stable	Stable	Could view the channel better in 2023 (less dense vegetation), revealing some incision in channel bed
CC02	Very Stable	Stable	Could view the channel better in 2023 (less dense vegetation), revealing some incision in channel bed
CC03	Very Stable	Stable	Could view the channel better in 2023 (less dense vegetation), revealing some incision in channel bed
CC04	Potentially Stabilising	Active	Channel visibly more eroded than in 2022
CC05	Potentially Stabilising	Potentially Stabilising	Generally steady since 2022
CC06	Potentially Stabilising	Potentially Stabilising	Generally steady since 2022
CC07	Potentially Stabilising	Stable	Reduced signs of frequent flow events (less loose material in bed than in 2022)
CC08	Stable	Stable	Generally steady since 2022
CC09	Very Stable	Very Stable	Generally steady since 2022
Springvale Creek			
SC01	Stable	Stable	Generally steady since 2022
Bungleboori Creek			
BC01	Very Stable	Very Stable	Generally steady since 2022
BC02	Stable	Stable	Generally steady since 2022
BC03	Stable	Very Stable	Less sediment exposed across channel than in 2022
BC04	Very Stable	Very Stable	Generally steady since 2022
BC05	Very Stable	Very Stable	Generally steady since 2022
BC06	Very Stable	Very Stable	Generally steady since 2022

Appendix 3: Air Quality Monitoring Results

Appendix 3: Air Quality Monitoring Results

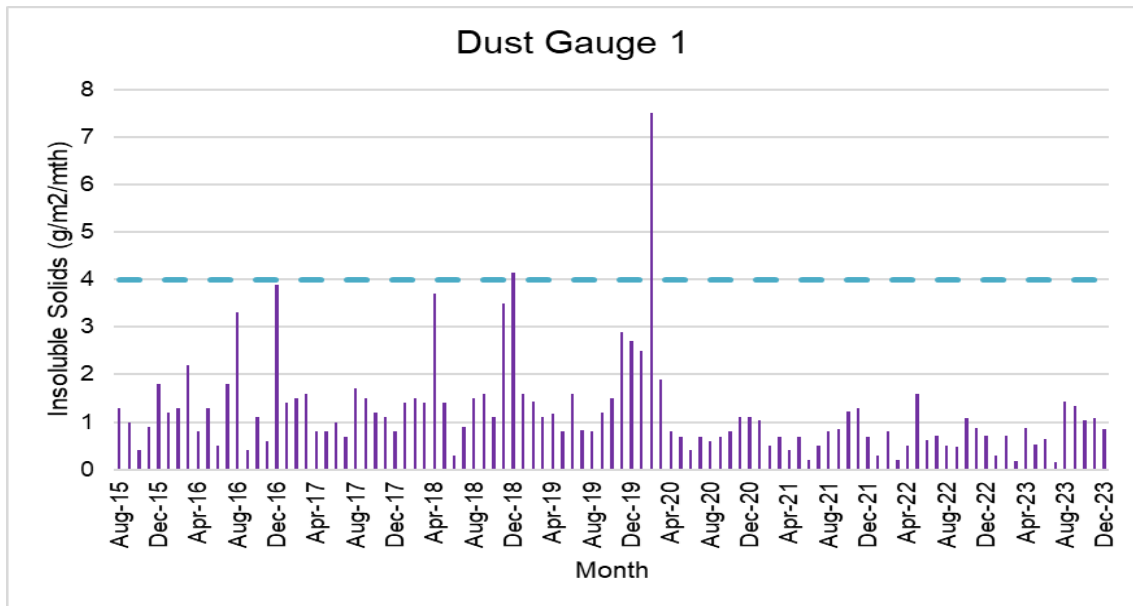


Figure 3A.1 Deposited Dust Gauge 1

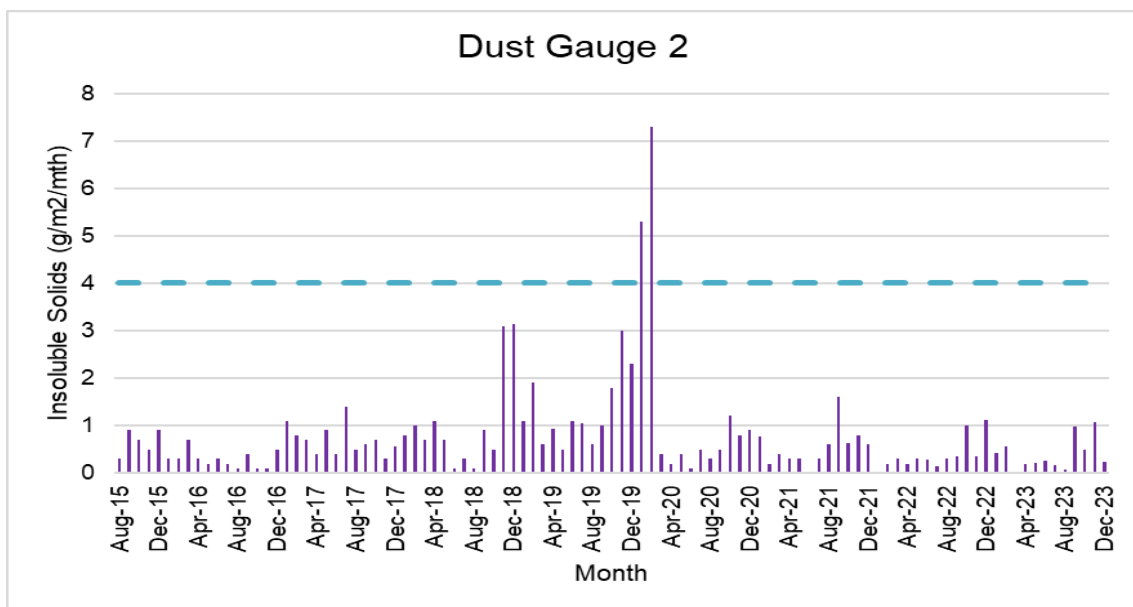


Figure 3A.2 Deposited Dust Gauge 2

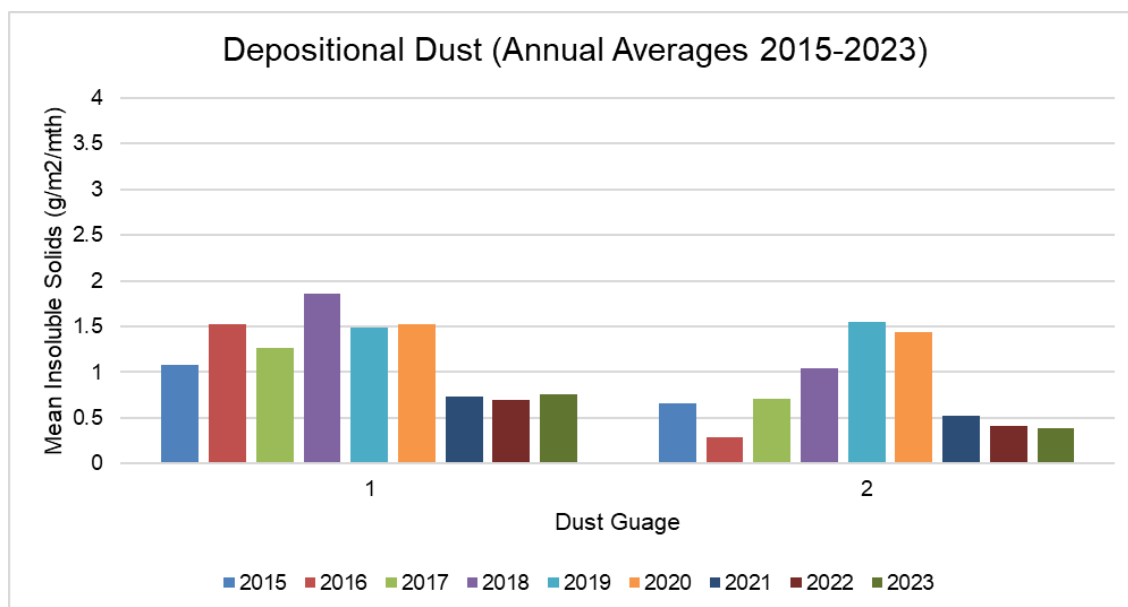


Figure 3A.3 Annual Averages

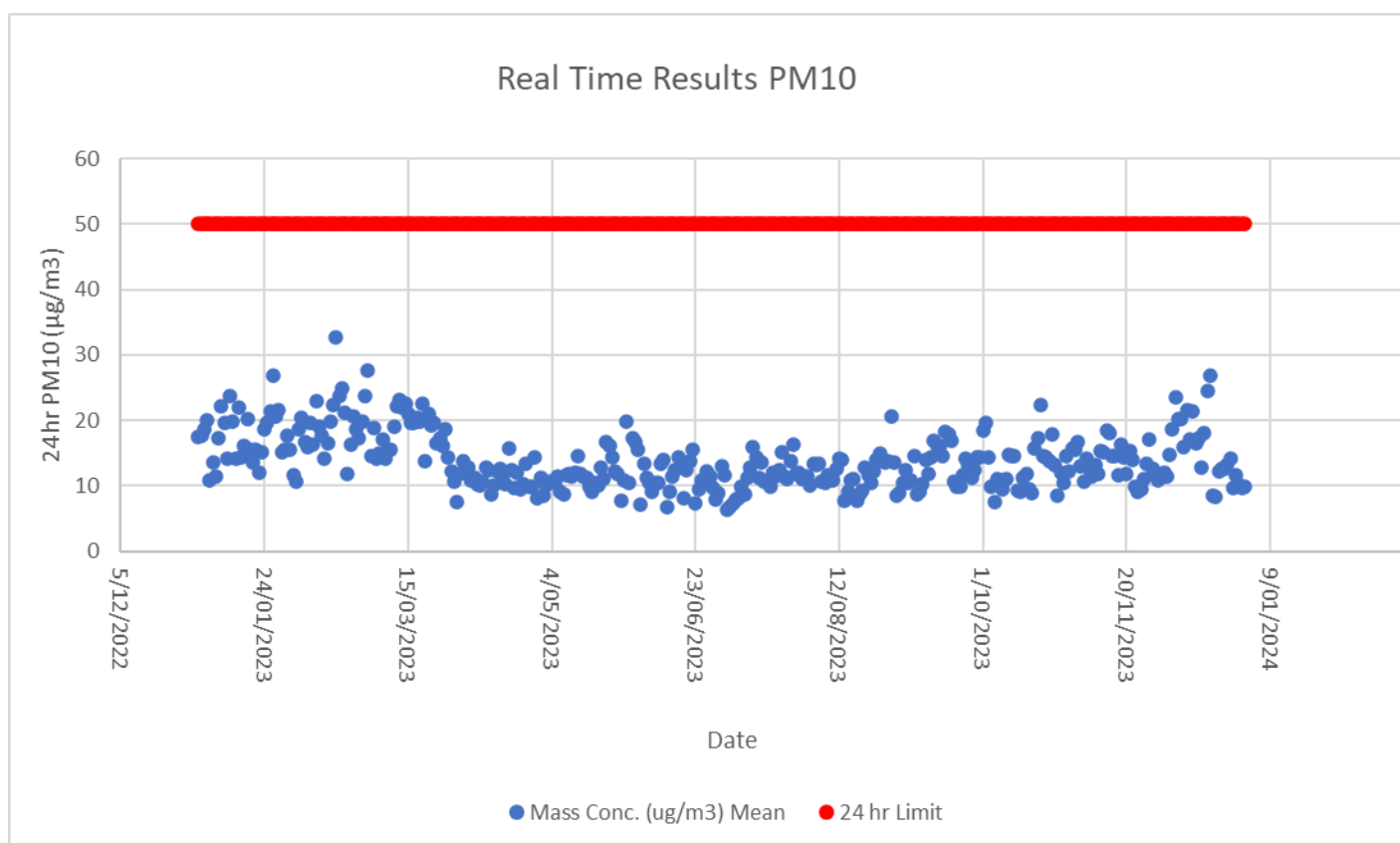


Figure 3A.4 Real Time Monitoring – 24hr Average PM10

Appendix 4: Annual Environmental Monitoring Review – Surface and Groundwater

Annual Environmental Monitoring Review - Surface and Groundwater

January to December 2023

Prepared for Springvale Coal Pty Ltd

March 2024

Annual Environmental Monitoring Review - Surface and Groundwater

January to December 2023

Springvale Coal Pty Ltd

E221267SV RP#7

March 2024

Version	Date	Prepared by	Approved by	Comments
V1	29 February 2024	Jordan de Boer	Jonathon Tait	Draft
V2	21 March 2024	Jordan de Boer	Jonathon Tait	Final

Approved by



Jonathon Tait

Associate Hydrogeologist

21 March 2024

Ground floor 20 Chandos Street

St Leonards NSW 2065

PO Box 21

St Leonards NSW 1590

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.

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1 Introduction

1.1 Background

Springvale Colliery (Springvale) is an existing underground coal mine located 15 kilometres (km) to the northwest of Lithgow. Underground coal mining commenced at Springvale in 1995 following the Development Consent (DA 11/92) being granted on 27 July 1992. Development Consent SSD-5594 was granted on 21 September 2015 allowing the ongoing operation of Springvale until 2028. Current mining operations are regulated and managed under the Extraction Plan for Longwalls 428 to 432 (Centennial, 2021).

This annual review spans the period 1 January to 31 December 2023 (the reporting period) and references the monitoring requirements detailed in the Longwall (LW) 415 to 432 Water Management Plan (WMP) (Centennial, 2022a) and LW415 to 432 Swamp Management Program (SMP) (Centennial, 2022b). The WMP outlines Springvale's management approach for monitoring shallow and deep groundwater systems, while the SMP addresses perched groundwater systems, swamp systems and surface water features in and around Springvale.

The SMP and WMP detail the monitoring programs that have been implemented to monitor potential impacts from underground mining on the groundwater regime, and in particular the Newnes Plateau Shrub Swamps (NPSS) and Newnes Plateau Hanging Swamps (NPHS). The NPSS and NPHS are listed as Endangered Ecological Community (EEC) under the *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999*. The monitoring program includes groundwater monitoring locations above both Springvale and Angus Place.

1.2 Purpose of this report

The annual review complies with requirements specified in the WMP and SMP and details important surface and groundwater observations or trends that occurred during the reporting period. The annual review is not designed to identify trigger exceedances. It does however summarise any trigger exceedances, as well as the outcomes of any trigger investigations, that arose during the reporting period.

2 Existing environment

2.1 Rainfall data

Daily rainfall is sourced from the ALS Global Newnes Plateau Prison Farm rain gauge and the Bureau of Meteorology (BoM) weather station at Maddox Lane, Lidsdale (Station No. 063132). Rainfall data for the reporting period is summarised in Table 2.1. Comparative analysis of the two weather stations have been presented below due to the disparate weather patterns occurring across the region, influenced by topography.

Below average rainfall was observed across all months in 2023 except January, April, November and December for both rain gauges, with above average rainfall also observed in March for the Lidsdale rain gauge. Cumulative total rainfall for the Newnes Plateau and Lidsdale rain gauges was below the average annual long-term rainfall at each rain gauge (Table 2.1 and Figure 2.1).

Table 2.1 January to December 2023 rainfall summary

Month	Long term average rainfall (mm)		2023 monthly total rainfall (mm)	
	Newnes Plateau ¹	Lidsdale ²	Newnes Plateau	Lidsdale
January	92.5	86.5	101.4	104.8
February	118.5	76.6	43.8	41.4
March	112.1	70.8	84.4	87.4
April	61.2	43.2	63.2	66.8
May	42.1	47.9	4.6	4.6
June	69.7	48.9	39.0	29.0
July	57.4	51.0	17.2	21.0
August	58.4	63.5	44.6	45.2
September	56.8	53.5	23.0	20.8
October	78.8	67.5	39.8	42.4
November	102.9	74.9	112.0	113.0
December	89.1	73.4	132.0	116.0
Total	939.5	757.7	694.8	692.4

Notes: 1. 20 August 1998 to 30 November 2023.
2. 1 August 1959 to 30 November 2023.

The daily cumulative rainfall deviation (CRD) from daily mean rainfall for the Newnes Plateau is shown on Figure 2.2. The CRD trend shows below average rainfall between February 2019 and February 2020, followed by neutral rainfall conditions between February 2020 to August 2021. Above average rainfall conditions have been observed from August 2021 to November 2022. The CRD shows a below average rainfall trend since November 2022, including during this reporting period, except for later months November and December 2023 showing above average rainfall.

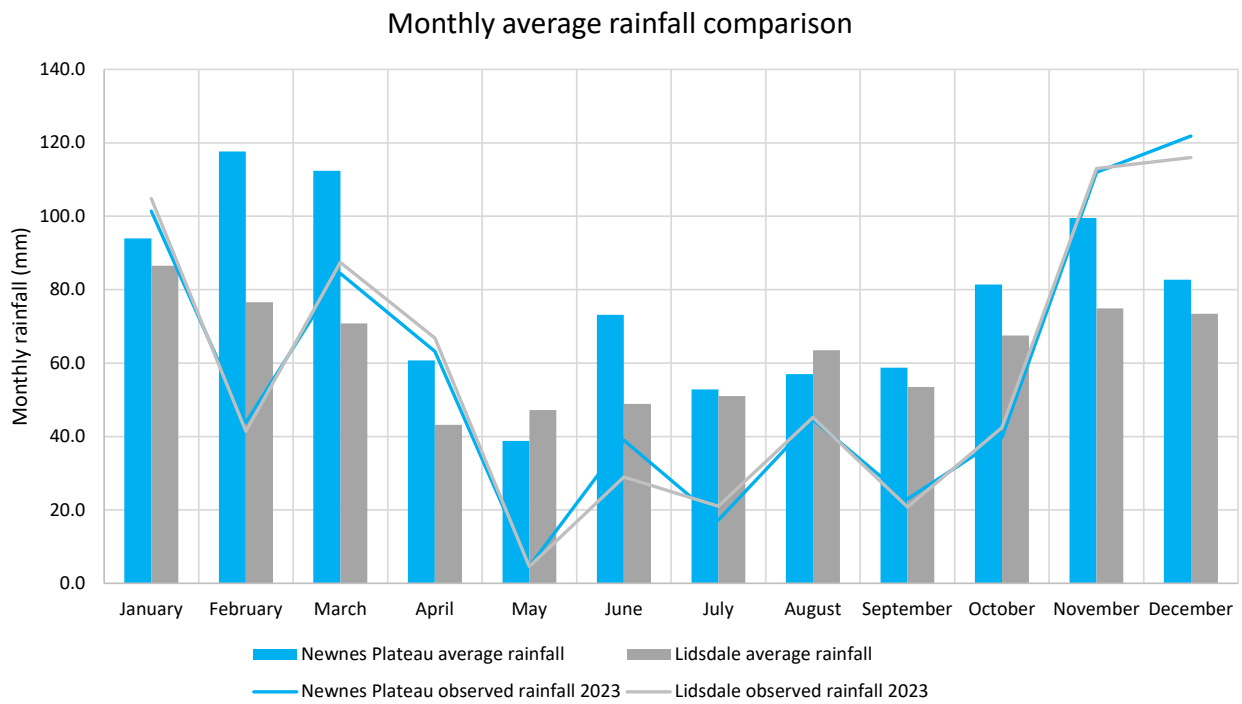


Figure 2.1 Monthly average rainfall comparison for Newnes Plateau and Lidsdale

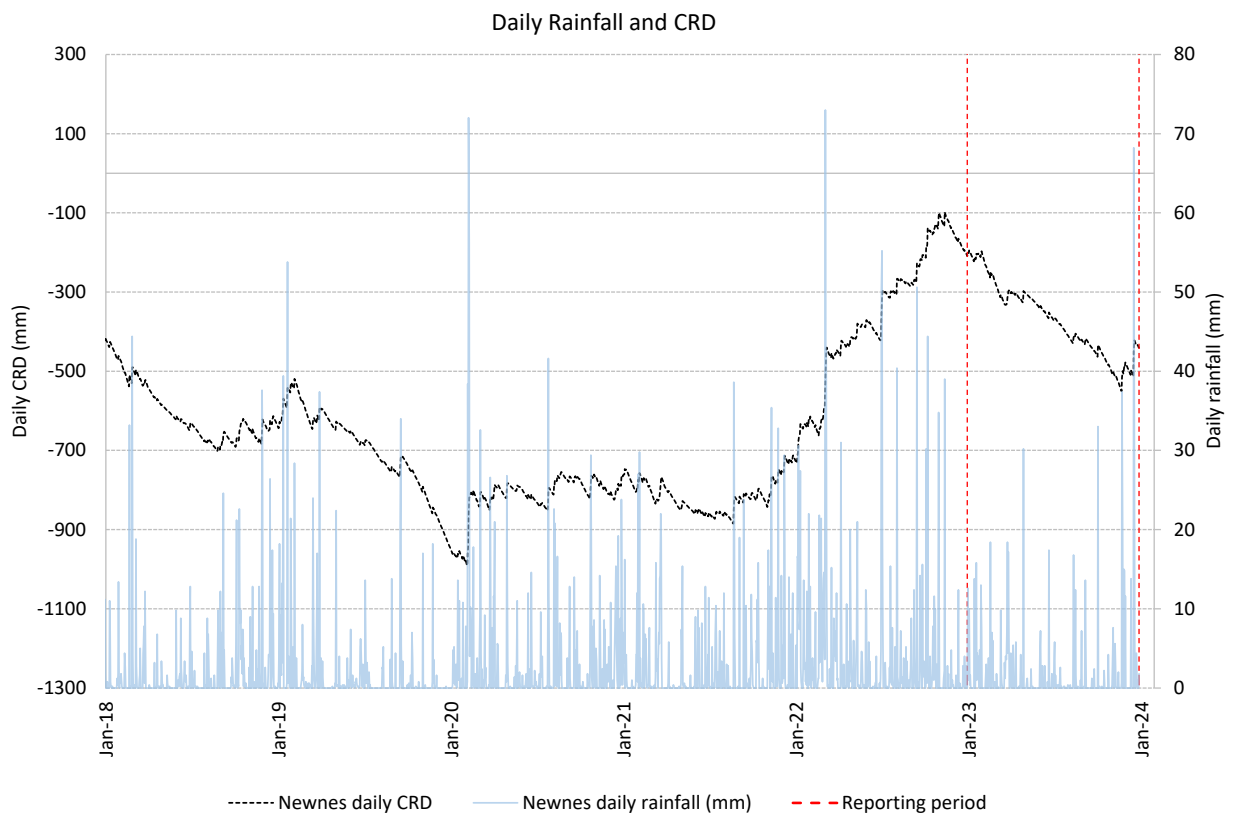


Figure 2.2 Daily CRD from the daily rainfall mean – August 1998 to December 2023

2.2 Hydrology

Springvale Mine is in the catchments of the Coxs River and Wolgan River, which are both part of the greater Hawkesbury-Nepean catchment. The Coxs River catchment is bounded to the west by the Great Dividing Range, to the north by the upper Colo River catchment and to the south by the Wollondilly River catchment. The Coxs River rises within the Gardens of Stone to the north of the project and flows generally in a south-east direction into Lake Burragorang (impounded by Warragamba Dam), which is the primary reservoir for drinking water supply to Sydney. The Wolgan River flows north off the Newnes Plateau into the Wolgan Valley to join the Capertee River in Wollemi National Park to the east of the project.

Watercourses from the Newnes Plateau are often deeply incised in their lower reaches, incorporating numerous cliff lines and pagodas bordering the valley flanks. In the upper catchment areas, drainage lines are typically poorly defined to non-existent with overland sheet flow being the typical mode of discharge during rainfall events. Watercourses in this area are typically ephemeral, noting there are periods of persistent flow.

2.3 Hydrogeology

The hydrogeological complexities of the Springvale local area have been well investigated over time. The groundwater systems interacting with the Springvale Mine have been conceptualised, and are divided into three distinct aquifers (McHugh, 2018):

- perched aquifers, predominantly sandstone aquifers between several claystone aquitard units
- shallow aquifers, predominantly regional sandstone aquifers, ranging from unconfined to semi-confined
- deep aquifers, which are confined in the project area and includes the Katoomba and Lithgow Coal Seams.

2.3.1 Perched groundwater system – Burralow Formation

The perched groundwater system is hosted within the Burralow Formation (Triassic Narrabeen Group) and is up to 110 m in thickness. The perched aquifer comprises multiple discontinuous perched localised flow bands and is recharged by excess rainfall. The presence of seven distinct fine-grained claystone and siltstone units (YS1 to YS6, including YS5a) act as aquitards, or semi permeable layers, which impede rainfall percolation to the shallow groundwater system associated with the underlying Banks Wall Sandstone (McHugh, 2018). These hydrogeological units are also known as AQ6 (aquifers between YS1 to YS4) and AQ5 (aquifers between YS4 to YS6).

The NPSS and NPHS coincide with the lithographic and topographic occurrence of the YS units in the Burralow Formation (McHugh, 2018).

2.3.2 Shallow groundwater system – Banks Wall Sandstone

The shallow groundwater system is a regional system in the Banks Wall Sandstone (Narrabeen Group) and is up to 100 m in thickness (McHugh, 2018). This hydrogeological unit is also known as AQ4.

The shallow groundwater system is recharged by rainfall, overlying watercourses where it outcrops in incised gullies, and by leakage from the perched groundwater system. Regional recharge potentially occurs in areas of outcrop and sub-crop to the west and south-west of the study area (Jacobs, 2019).

Local discharge is inferred to occur in incised gullies that intercept the water table with some swamps coinciding with this occurrence (McHugh, 2014). Regional discharge is inferred to occur to the north-east, where the unit outcrops in the scarp of the plateau.

Groundwater flow is mainly controlled by interconnective fracturing, bedding planes and structural features such as lineaments and faults, with some contribution from pore porosity (Jacobs, 2019). The low permeability of the rock matrix means that the fracture system is the primary control of groundwater flow. The direction of groundwater flow is toward the north-east, which is consistent with the dip of the strata.

At the base of the shallow groundwater system is the Mount York Claystone (MYC). This unit comprises a sequence of sandstone, shale and claystone that form an aquitard which limits connectivity between the shallow and deep groundwater systems. This hydrogeological unit is also known as SP3.

2.3.3 Deep groundwater system – Illawarra Coal measures

Underlying below the MYC, the deep aquifer, associated with the Triassic Burra-moko Head Sandstone, Caley Formation and Permian Illawarra Coal Measures (which includes the Katoomba Seam, Farmers Creek Formation, Gap Sandstone, Denman Formation, Long Swamp Formation, Blackmans Flat Conglomerate, Lithgow Seam and Marrangaroo Conglomerate), is up to 200 m in thickness.

The Burra-moko Head Sandstone, Caley Formation and Katoomba Seam hydrogeological units are also known as AQ3. The Farmers Creek Formation and Gap Sandstone hydrogeological units are also known as AQ2. The Long Swamp Formation, Blackmans Flat Conglomerate and Lithgow Seam hydrogeological units are known as AQ1. The Denman Formation hydrogeological unit is a semi-permeable layer known as SP1.

Groundwater flow occurs primarily via interconnective fracturing, bedding planes, cleated coal seams and structural features such as lineaments and faults. The fracture system is the primary control of groundwater flow as the rock matrix has low permeability.

The general groundwater flow direction in the deep aquifer is towards the north-east, which is consistent with the dip of the strata. Regional recharge potentially occurs in areas of outcrop/sub-crop to the west and south-west of the study area by rainfall, overlying watercourses, dams and minor leakage from the shallow aquifer. Groundwater discharge is inferred to occur to the north-east, where the units outcrop in the scarp of the plateau.

2.4 Surface water and groundwater interaction

The dominant surface water and groundwater interaction on the Newnes Plateau involves recharge to shallow groundwater and groundwater discharge to surface water (Jacobs, 2019).

Surface water leakage to shallow groundwater occurs from overlying watercourses. Groundwater discharge to surface water flow occurs as seepages and drips from exposed faces of cliff lines or exposed bedrock in drainage lines, or as seepage from sub-cropping bedrock to regolith or residual soil profiles on valley flanks and valley floors (Jacobs, 2019). Where sufficient seepage occurs, the development of NPHS or NPSS may be supported. Groundwater seepage may contribute to stream baseflow either directly as discharge to drainage lines in the valley floor, or indirectly as a contribution to catchment subsurface flow (Jacobs, 2019).

2.5 Mining progress

LW428 commenced mining on 26 March 2022 and extraction continued during the reporting period. Appendix A details the historical long wall mining progression at Springvale.

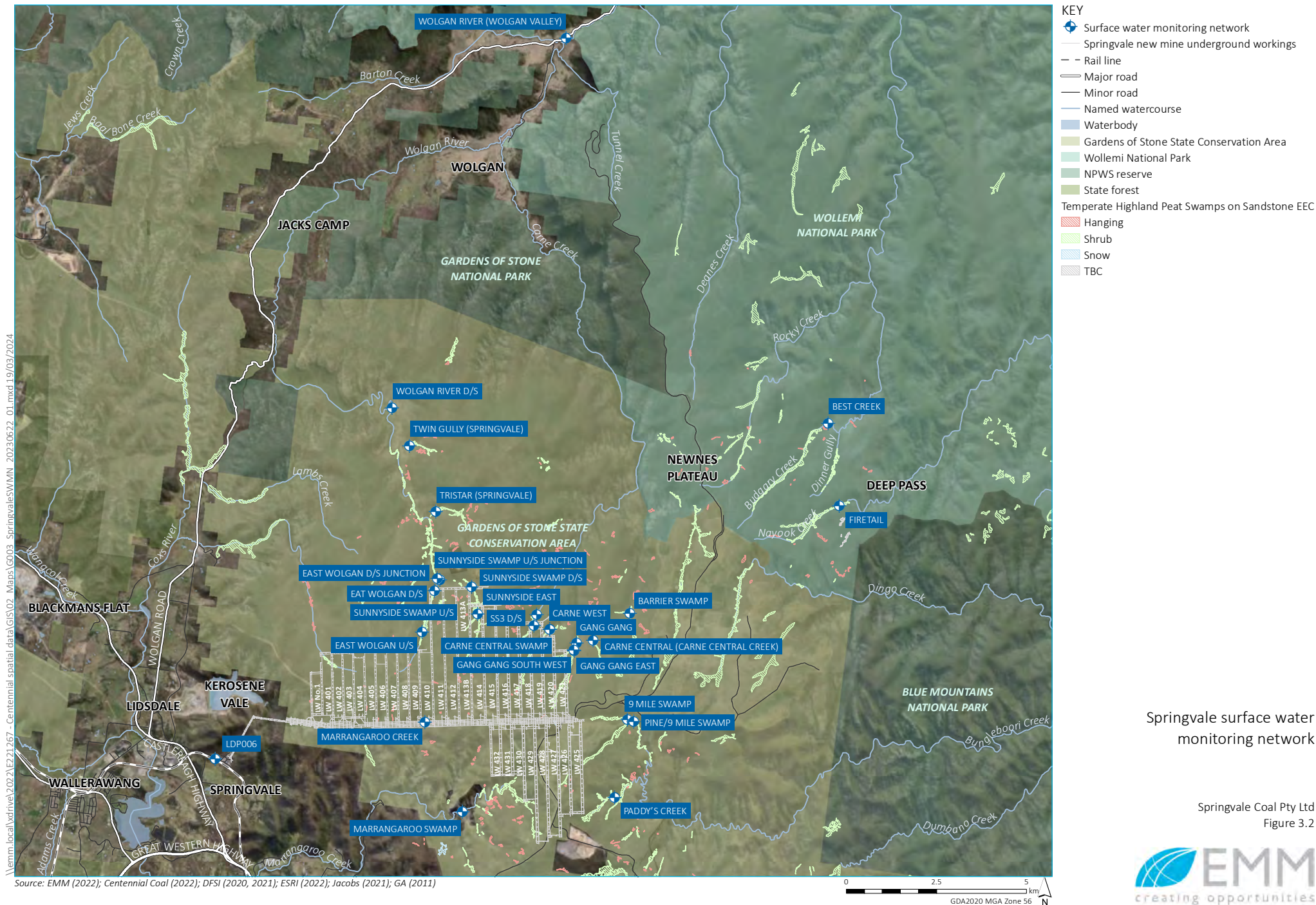
3 Monitoring program

3.1 Overview

The groundwater monitoring program detailed in the WMP (Centennial, 2022a) and SMP (Centennial, 2022b) targets the NPSS and NPHS, as well as the perched, shallow and deep aquifers using standpipe piezometers and vibrating wire piezometers (VWPs). Specifically, the monitoring network at Springvale comprises:

- Swamp standpipe piezometers (swamp piezometers) installed in the unconsolidated sediments of NPSS, typically to refusal on bedrock. Groundwater levels are monitored at 19 NPSS with a total of 51 standpipe piezometers. Groundwater level loggers record groundwater levels daily and are downloaded monthly with manual groundwater level measurements taken concurrently.
- Groundwater levels monitored at three NPHS, with a total of seven standpipe piezometers (hanging swamp piezometers). Piezometers are installed to refusal on bedrock. Groundwater level loggers record groundwater levels daily and are downloaded monthly with manual groundwater level measurements taken concurrently.
- Monitoring of the perched groundwater system by 35 standpipe piezometers (perched aquifer piezometers) targeting aquifers in the Buralow Formation. Most standpipe piezometers are located downgradient of swamp piezometers. Groundwater level loggers record groundwater levels daily and are downloaded monthly with manual groundwater level measurements taken concurrently.
- Monitoring of the shallow groundwater system by 13 standpipe piezometers (shallow aquifer piezometers). Groundwater level loggers record groundwater levels daily and are downloaded monthly with manual groundwater level measurements taken concurrently.
- Multi-level VWP arrays used to monitor piezometric pressures in the shallow and deep groundwater systems. VWP loggers are downloaded monthly at 12 locations. VWPs are used as a proxy for possible impacts to shallow aquifer and swamp piezometers and to monitor for potential connective cracking to swamps and perched and shallow groundwater sources (above the MYC).
- Daily measurement of soil moisture by 33 soil moisture loggers at 15 NPSS. Soil moisture loggers record daily and are downloaded monthly.
- Groundwater quality samples collected monthly at 22 swamp piezometers and quarterly at 16 shallow aquifer piezometers.
- Measurement of surface water for water quality and flow at 11 locations on a fortnightly basis and monthly at an additional 16 locations.

The locations of the groundwater and surface water monitoring sites are shown on Figure 3.1 and Figure 3.2. Further detail regarding monitoring frequencies for standpipe piezometers and VWP is summarised Appendix B.



Springvale surface water monitoring network

Springvale Coal Pty Ltd
Figure 3.2

3.2 Performance measurement

The WMP (Centennial, 2022a) and SMP (Centennial, 2022b) include details relating to surface water and groundwater trigger levels for swamp piezometers, standpipe piezometers, VWPs and surface water monitoring sites within the LW428 to 432 trigger investigation area (TIA).

There are two types of monitoring sites that form the basis of the SMP and WMP:

1. Impact sites located within the LW428 to 432 TIA.
2. Reference sites located outside the LW428 to 432 TIA and distant from active mining. Reference sites have similar climatic, geological, hydrogeological, hydrological and vegetative conditions to impact sites and are used to help discern natural and anthropogenic influences at impact sites.

The TIA is defined as a 600 m buffer zone around the active longwall mining face. When an impact site falls within the TIA, the pre-mining period of data collection ends, and the pre-mining trigger level is set. If an impact site is within 2 km of an undermined significant lineament, the pre-mining period of data collection ends and pre-mining trigger levels are set. Groundwater level data collected once an impact site is within the TIA or within 2 km of an intercepted significant lineament is referred to as post-mining data. Post mining data from impact monitoring sites are compared to trigger levels and reference sites to determine whether anomalous results have been observed at impact sites.

3.3 Trigger criteria

Performance triggers are used to identify exceedances in groundwater levels and quality that may be due to mining activity. The WMP (Centennial, 2022a) and SMP (Centennial, 2022b) includes surface and groundwater trigger levels for swamp piezometers, standpipe piezometers and surface water monitoring sites within the LW424 to 427 and LW428 to 432 TIA. Groundwater level triggers have not been developed for perched groundwater piezometers due to insufficient pre-mining baseline data.

The focus of this report is to assess annual changes against the performance criteria, with the intention of identifying any potential impacts or trends in groundwater levels and quality. Conclusions are drawn through detailed investigation as specified in the WMP (Centennial, 2022a) and SMP (Centennial, 2022b). The trigger criteria detailed in the WMP (Centennial, 2022a) and SMP (Centennial, 2022b) are shown in Table 3.1.

Table 3.1 Springvale management plan performance criteria

SMP short-term performance criteria		
Groundwater levels	Swamp piezometer	Trigger level is exceeded if the post-mining water level depth in any swamp piezometer is greater than the 95 th percentile pre-mining water level depth for more than seven consecutive days.
	Perched aquifer piezometer	Insufficient pre-mining baseline data to establish triggers for impact sites.
Groundwater quality	Swamp piezometer	Trigger level is exceeded if electrical conductivity (EC) and pH is greater than the pre-mining 80 th percentile by two standard deviations for more than two months. For the lower pH trigger, the same method is applied, but using the 20 th percentile.
	Perched aquifer piezometer	Insufficient pre-mining baseline data to establish triggers for impact sites.

Table 3.1 Springvale management plan performance criteria

SMP short-term performance criteria		
Surface water	Swamp flow	If noticeable deviation from historical hydrograph trends is observed for more than three consecutive monitoring events, which cannot be explained by climate trends and is not replicated at a reference site, then the surface water flow trigger is considered breached.
	Swamp quality	If post-mining pH and EC values are greater than the pre-mining 80 th percentile values (or 20 th percentile for lower pH values) by two standard deviations for more than two consecutive months, the short-term change trigger is breached.
WMP performance criteria		
Groundwater levels	Shallow aquifer piezometers	Trigger level is exceeded if the groundwater level in the impact shallow aquifer piezometer is less than the pre-mining 5 th percentile for more than one month.
	Vibrating wire piezometer	Trigger level is exceeded if the piezometric level in groundwater systems above the MYC shows a stepped decline in piezometric head of more than five metres.
Groundwater quality	Shallow aquifer piezometers	If pH and EC values are greater than 80th percentile (or less than the 20th percentile for lower pH values) at a reference site (greatest value of all reference sites) for three consecutive monitoring events, the trigger is exceeded; otherwise use the following default trigger values: • pH <2.73 or >7.87. • EC >100 micro siemens per centimetre (µS/cm).

4 Groundwater level monitoring

This section provides a summary of groundwater level trends during the reporting period. The following subsections have been divided into piezometers and performance criteria that are addressed under the SMP and WMP, with groundwater levels compared to the trigger criteria for the reporting period.

A summary of groundwater level trigger investigations for the reporting period are summarised in Table 4.1.

Table 4.1 Groundwater level trigger investigations during 2023

Monitoring ID	Type	Comment	Submitted to the Department?
MS2	Swamp piezometer	A trigger investigation for MS2 was issued to the regulator on 3 August 2023 following a trigger exceedance in late May 2023. The trigger investigation concluded that the water level decline at MS2 could be mining induced, but it was too early to confirm given below average observed during the exceedance.	Yes
SPR1210 VWP	Vibrating wire piezometer	A trigger investigation for SPR1210 VWP was issued to the regulators on 2 November 2023 following a trigger level exceedance. The trigger investigation found the response observed at SPR1210 VWP was similar to other VWP sites impacted by earlier longwalls, however no impact was seen at nearby standpipe SPR1210R indicating the perched aquifer could still be intact. The report concluded further observation was required to confirm the condition of the perched aquifer.	Yes

4.1 Swamp monitoring program

Hydrographs for impact swamp piezometers within the LW428 to 432 TIA and reference swamp piezometers are shown in Figure 4.1 to Figure 4.19. Table 4.2 includes comments on the groundwater level trends. A summary of historical observations prior to the reporting period is in Appendix C.

Table 4.2 Swamp groundwater level trend summary

Swamp	Monitoring ID	Site type as per SMP	Mined status	Comment
Barrier Swamp	BA1	Reference	NA	Decreasing – Decreasing from late July due to below average rainfall since November 2022, fluctuates with rainfall.
	BA2			Decreasing – Decreasing due to below average rainfall since November 2022, fluctuates with rainfall and follows the CRD.
	BA3			Decreasing – Decreasing due to below average rainfall since November 2022, fluctuates with rainfall and follows the CRD.
Best Swamp	BE1	Reference	NA	Decreasing – Decreasing since early May due to below average rainfall, fluctuates with rainfall.
	BE2			Decreasing – Decreasing since late August due to below average rainfall, fluctuates with rainfall.

Table 4.2 Swamp groundwater level trend summary

Swamp	Monitoring ID	Site type as per SMP	Mined status	Comment
Carne Central	CC1	Reference	NA	Stable – Slight increasing trend until mid-October, declining from mid-October with fluctuations seen as spikes due to rainfall.
	CC2			Decreasing – Decreasing due to below average rainfall since November 2022, greater decline from early September with fluctuations seen as spikes due to rainfall
Fire Tail	FS1	Reference	NA	Decreasing – Decreasing due to below average rainfall since November 2022.
	FS2			Decreasing – Decreasing due to below average rainfall since November 2022.
Twin Gully	TG1	Reference	NA	Variable – Decreasing from November 2022 to early 2023, then slightly increasing trend until mid-August then decreasing from mid-August with fluctuations due to rainfall?
	TG2			Stable – Slightly increasing trend until mid-August then decreasing from mid-August with fluctuations due to rainfall.
Tristar	TS1	Reference	NA	Decreasing – Fluctuating with the CRD. Highly responsive to individual rainfall events.
	TS2			Decreasing – Stable until mid-June, declining from mid-June and becoming responsive to individual rainfall events from mid-August.
	TS3			Stable – Minor variations throughout the reporting period, responsive to large individual rainfall events.
East Wolgan	WE1	Impact	Adjacent LW411	Responded to rainfall events with short peaks in groundwater levels but was dry between rainfall events.
	WE2			Highly responsive to rainfall events. Groundwater level is generally close to bottom of the piezometer or dry.
Sunnyside West	SW1	Impact	LW413B/414	Fluctuates – Highly responsive to rainfall events.
Sunnyside	SS1	Impact	LW414	Decreasing – Fluctuating with the CRD.
	SS2			Decreasing – Fluctuating with the CRD.
	SS3			Decreasing – Slight decrease until early July. Sudden decrease from early July going dry in early November. Responds to rainfall from early November however dry in between rainfall events.
	SS4			Decreasing – Fluctuating with daily CRD.
	SS5			Decreasing – Fluctuating with daily CRD.
Sunnyside East	SSE1	Impact	LW417	Damaged by bushfire – Decommissioned.
	SSE2			Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
	SSE3			Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.

Table 4.2 Swamp groundwater level trend summary

Swamp	Monitoring ID	Site type as per SMP	Mined status	Comment
Carne West	CW1	Impact	LW419	Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
	CW2			Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
	CW3		LW417	Dry – Historically responsive to rainfall events with a sustained groundwater level compared to the other CW piezometers.
	CW4			Dry – Historically responsive to large rainfall events with a short sharp rise in groundwater level.
Junction	JS1	Impact	LW408	Piezometer damaged by road grading in February 2021 – decommissioned.
	JS2			Decreasing – Declining trend until late November then stable, trending with the daily CRD.
	JS3			Decreasing – Declining trend until late November then stable, trending with the daily CRD.
Gang Gang West	GW1	Impact	LW420	Mostly dry, with some response to rainfall events.
	GW2			Damaged by bushfire – Decommissioned.
	GW3			Dry – Historically responds to rainfall events with sharp increases in groundwater levels that slowly recline over days to weeks depending on the intensity of the rainfall event.
	GW4			Dry – Historically responds to rainfall events with sharp increases in groundwater levels that slowly recline over days to weeks depending on the intensity of the rainfall event.
Gang Gang	GG1	Impact	LW420	Decreasing – Going mostly dry from mid-October. Groundwater levels rise quickly following rainfall and slowly recede over several weeks.
	GG2			Dry.
	GG3			Decreasing – Going mostly dry from mid-May. Groundwater levels rise quickly following significant rainfall and slowly recede over several weeks.
Pine	BS2	Impact	LW425	Decreasing – Declining trend going dry from mid-July.
	BS3			Stable – Consistent with historical observations.
	BS4 (PSS)			Decreasing – Responsive to rainfall seen as peaks lasting several weeks, consistent with historical observations.
	PS			Decreasing – Trending with the daily CRD. Logger installed in October 2022.
	PUS			Fluctuating – Declining trend up until July. Dry from July to mid-December. Responded to rainfall from mid-December. Logger installed in October 2022.

Table 4.2 Swamp groundwater level trend summary

Swamp	Monitoring ID	Site type as per SMP	Mined status	Comment
Nine Mile	BS1	Impact	NA	Decreasing – Stable with a slight decreasing trend until early August. Decreasing with responses to rainfall seen as fluctuations from August, corresponding to the daily CRD.
	BS5 (NMSS)			Stable – Minor fluctuation with rainfall.
	NM			Decreasing – Responses to rainfall seen as fluctuations from August, corresponding to the daily CRD.
Marrangaroo	MS1	Impact	LW428	Decreasing – Relatively stable until mid-July. Decreasing from July and fluctuating with rainfall corresponding to the daily CRD.
	MS2			Decreasing – Declining trend and fluctuating. A bailer was found blocking MS2 and was removed in October 2023. Since October sludge/sediment has been accumulating in the piezo and subsidence around the bore was observed, possibly affecting piezo integrity.
	MS3			Decreasing – Fluctuating with rainfall corresponding to the daily CRD.
Lost City	LCS1	Impact	NA	Stable – Slight decrease until early September.
	LCS2			Stable – Minor fluctuations in trend.
	LC1			Stable – Responsive to rainfall seen as fluctuations.
	LCN1			Stable – Responsive to rainfall seen as fluctuations.
Paddys Creek	PC1	Impact	NA	Stable – Minor fluctuations due to rainfall.
	PC2			Decreasing – Decreasing trend with minor fluctuations due to rainfall.
Wishbone Hanging swamp	WBHS1	Impact	LW428	Mostly dry – Fluctuations follow the CRD and typically occur after periods of sustained rainfall.
	WBHS2			Mostly dry – Fluctuations follow the CRD and typically occur after periods of sustained rainfall.
	WBHS3			Mostly dry from late May. Fluctuations follow the CRD. A data gap is present from late September to early November due to logger error.
	WBHS4			Fluctuates with rainfall and mostly dry in between rainfall events. A data gap is present from late September to early November due to logger error.
Marangaroo hanging swamp	LMHS1	Impact	LW428	Stable – Slightly declining trend until mid-September, then increasing.
	MEXX01			Dry.
	MWHS1			Fluctuates with rainfall and going dry in-between rainfall events.

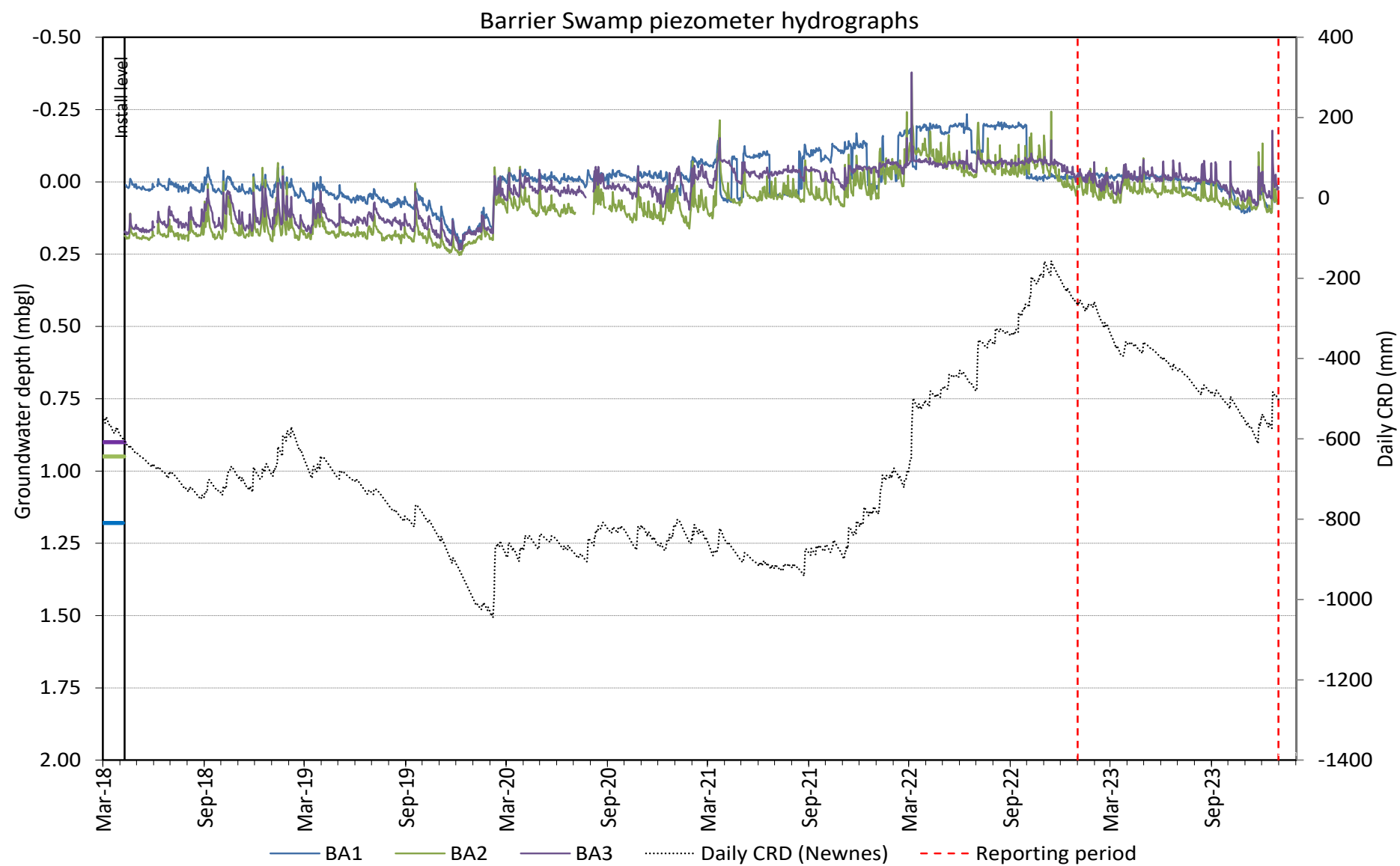


Figure 4.1 Barrier Swamp hydrograph

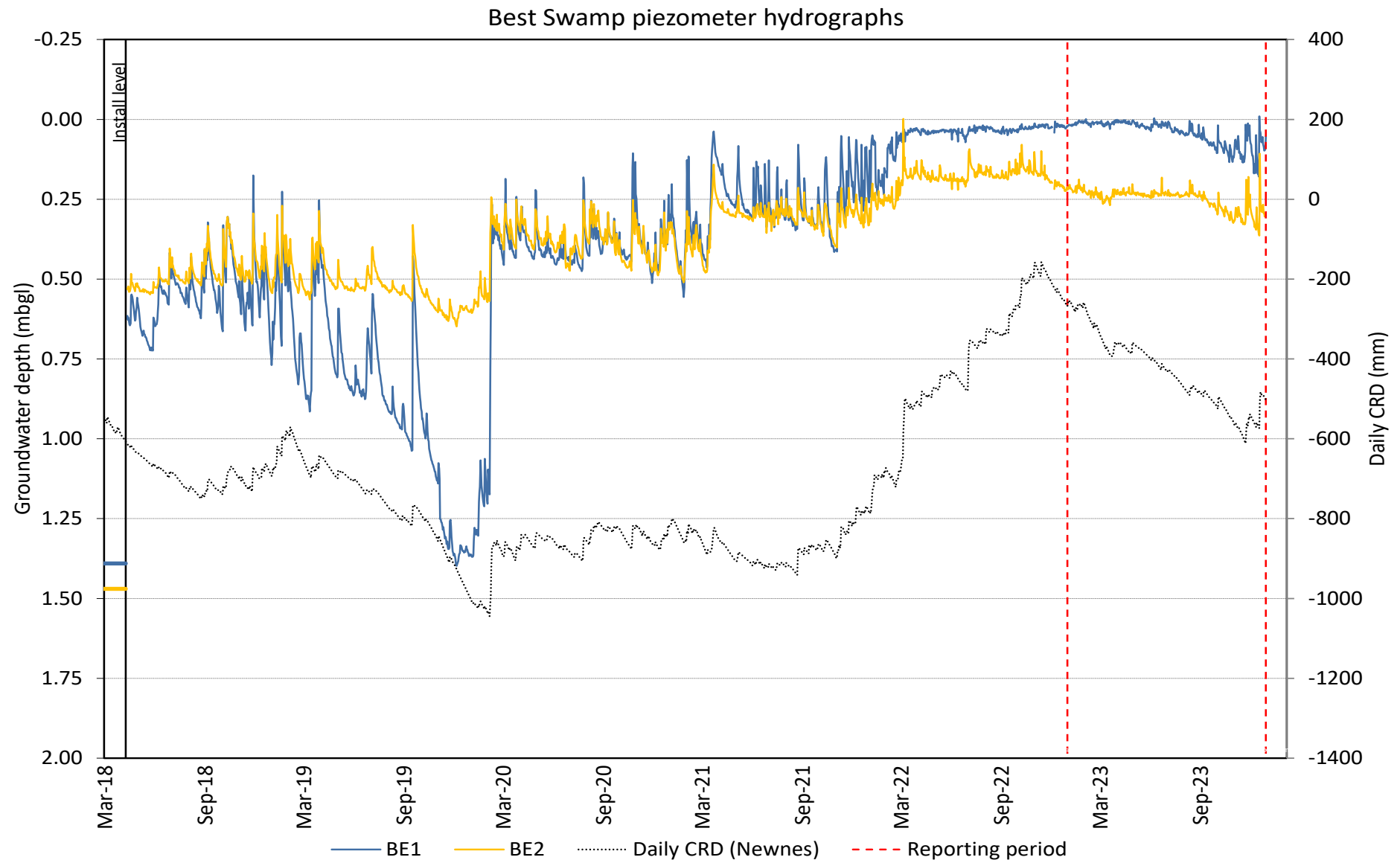


Figure 4.2 Best Swamp hydrograph

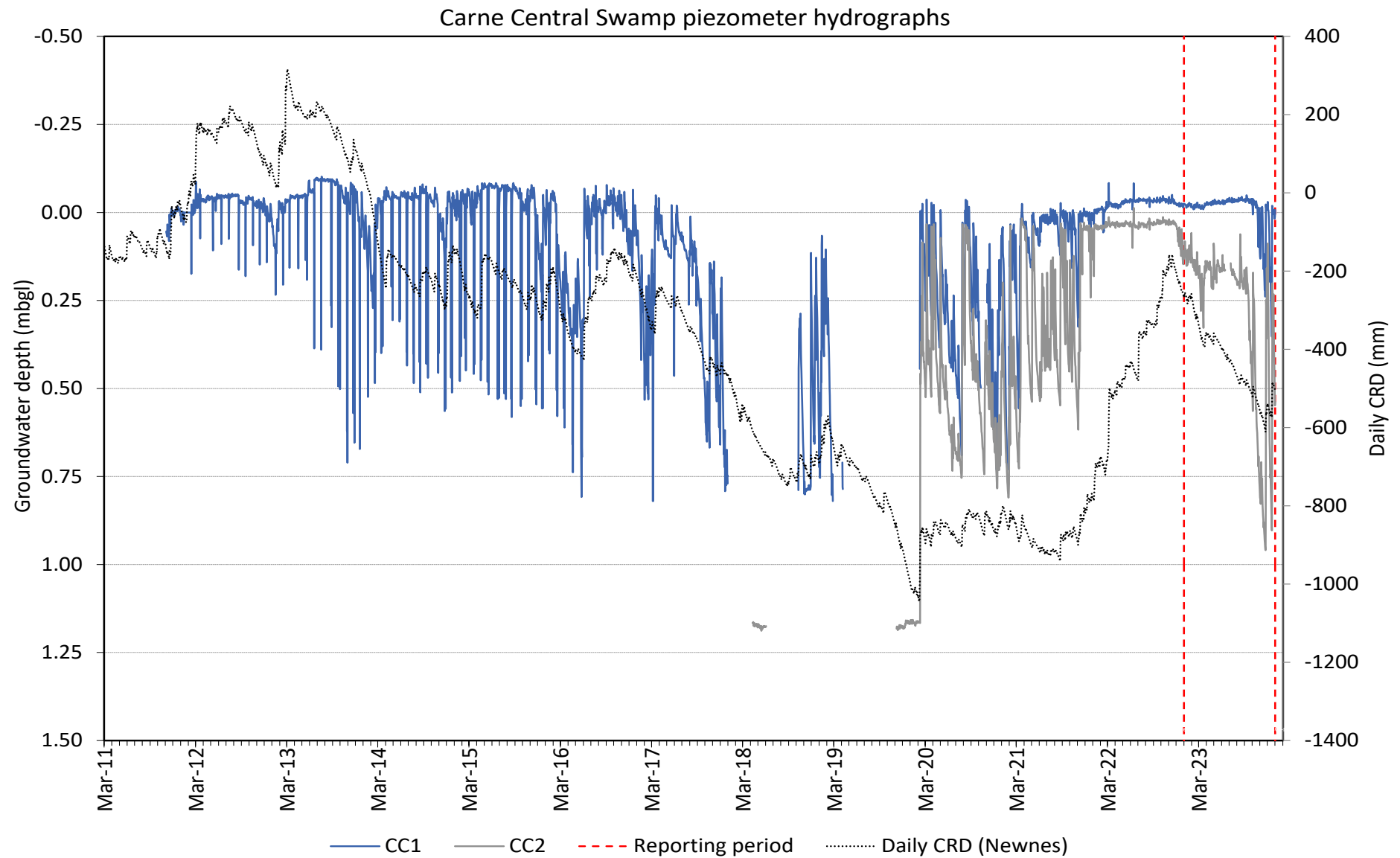


Figure 4.3 Carne Central Swamp hydrograph

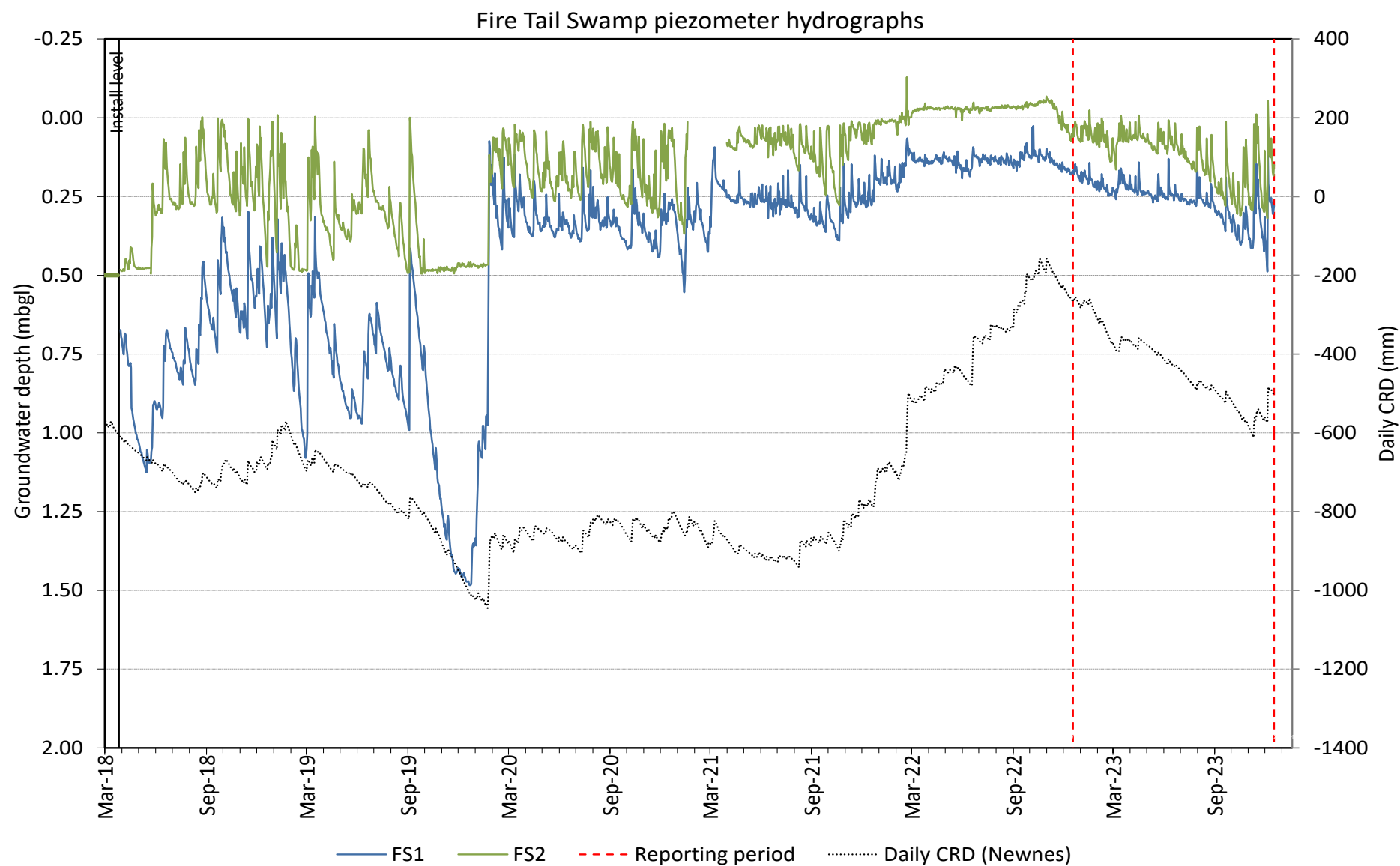


Figure 4.4 Fire Tail Swamp hydrograph

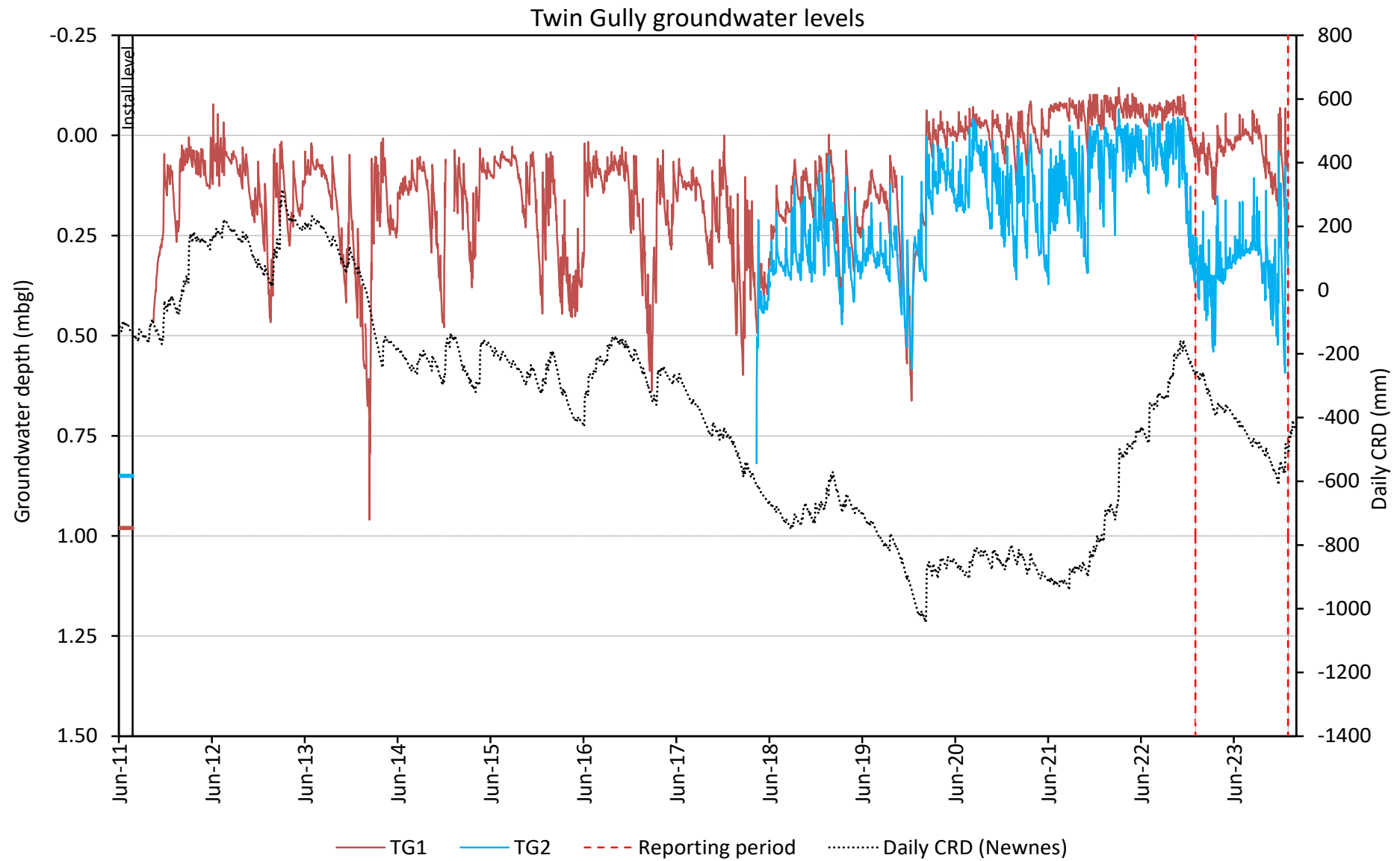


Figure 4.5 Twin Gully Swamp hydrograph

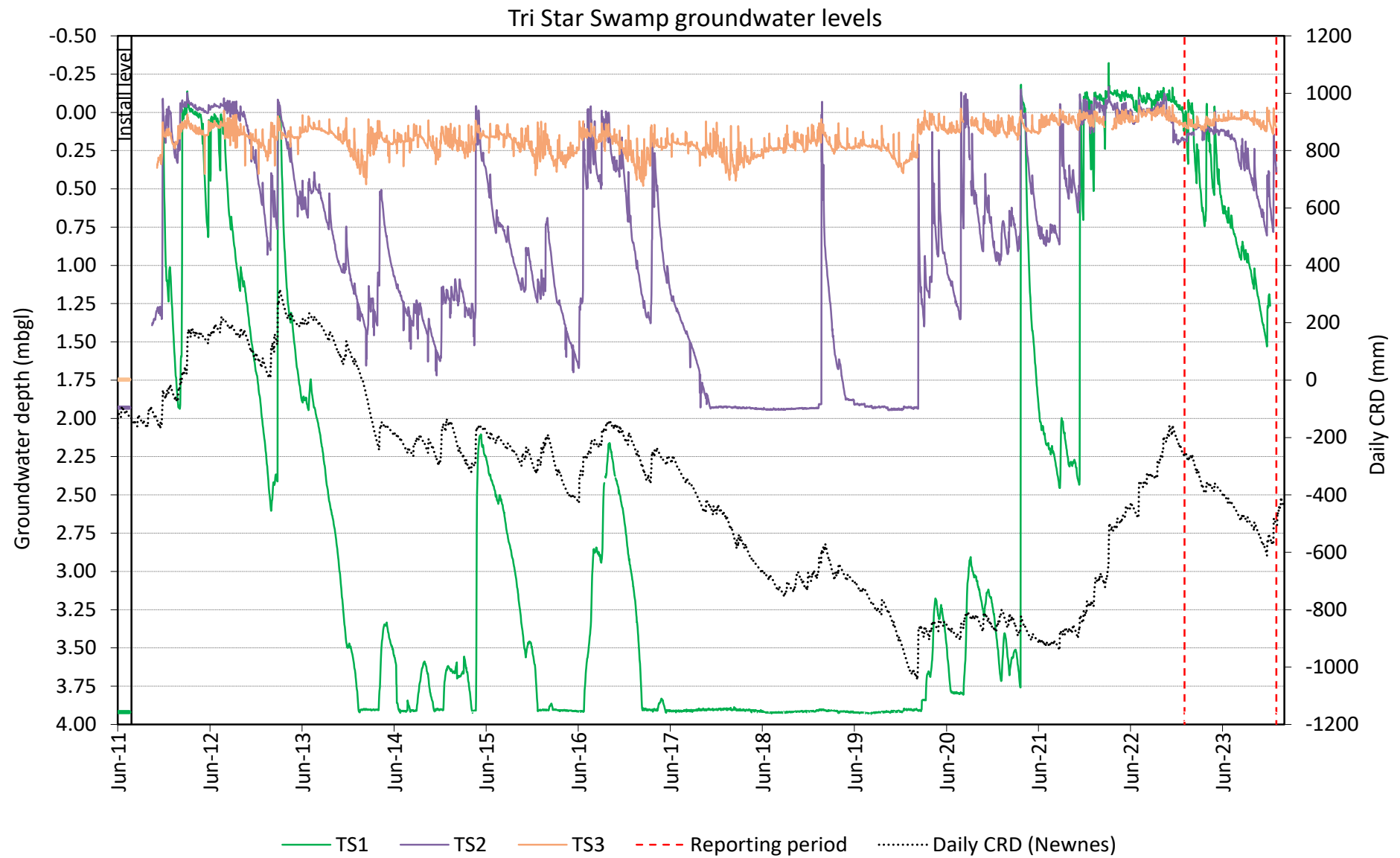


Figure 4.6 Tristar Swamp hydrograph

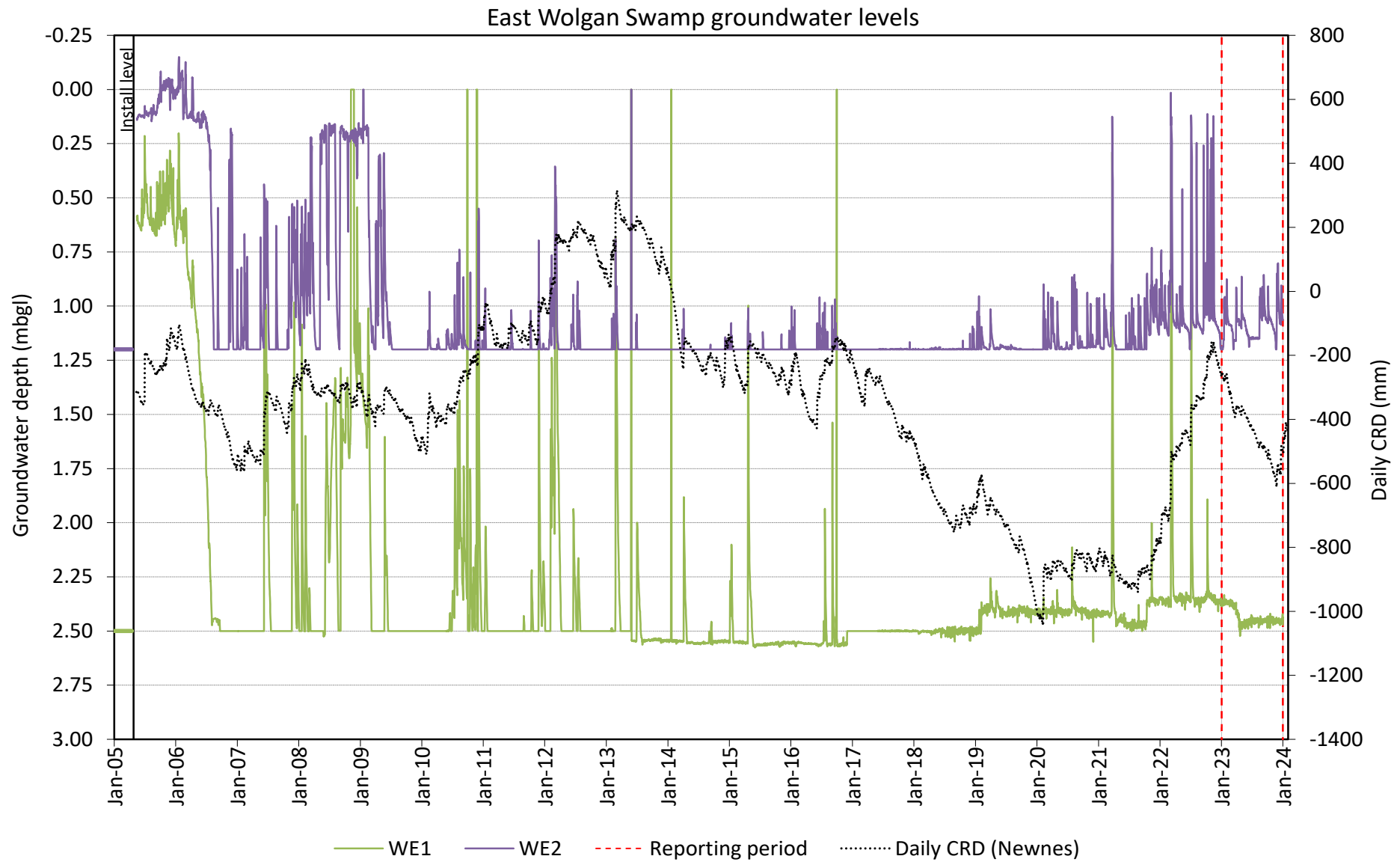


Figure 4.7 East Wolgan hydrograph

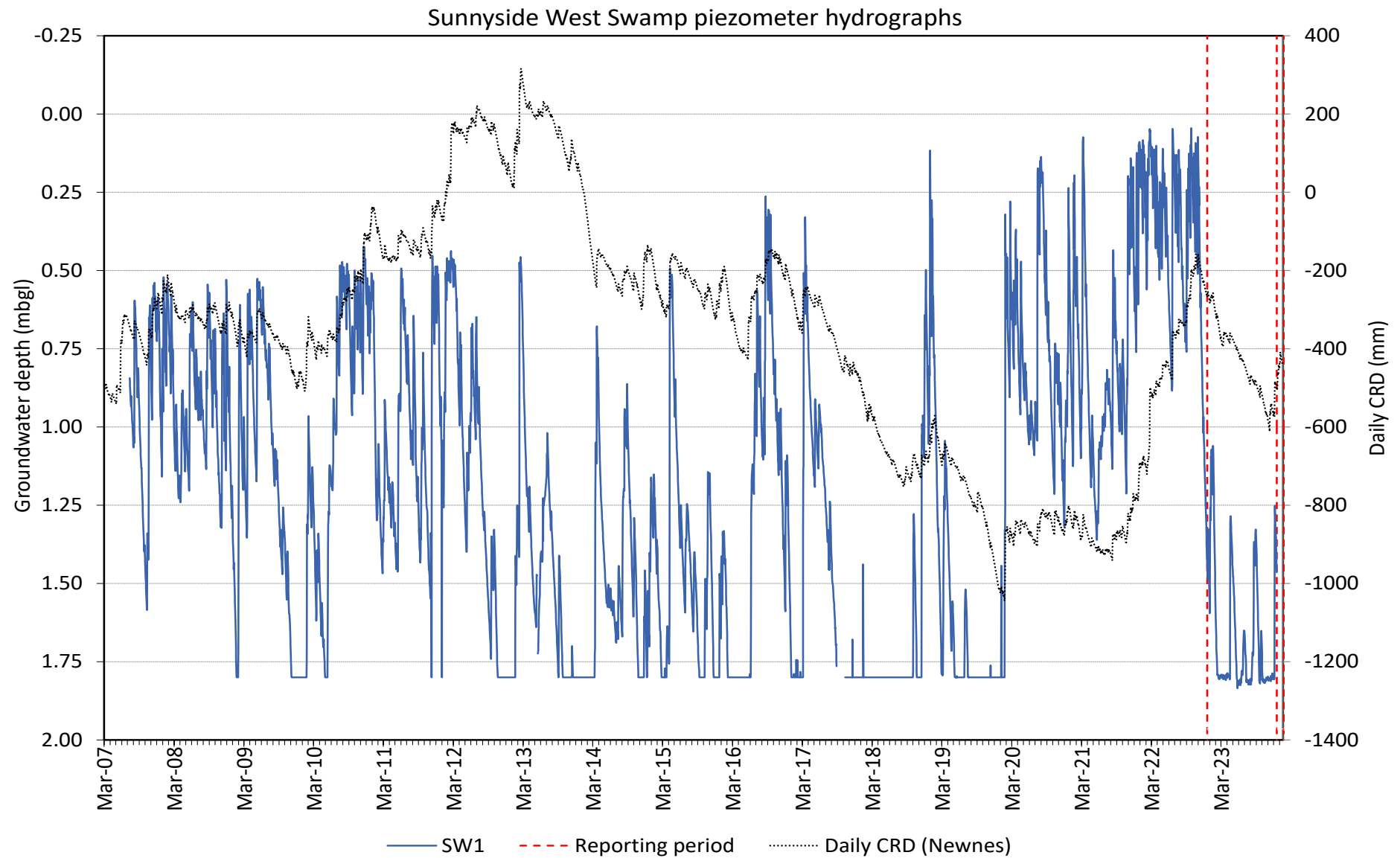


Figure 4.8 Sunnyside West Swamp hydrograph

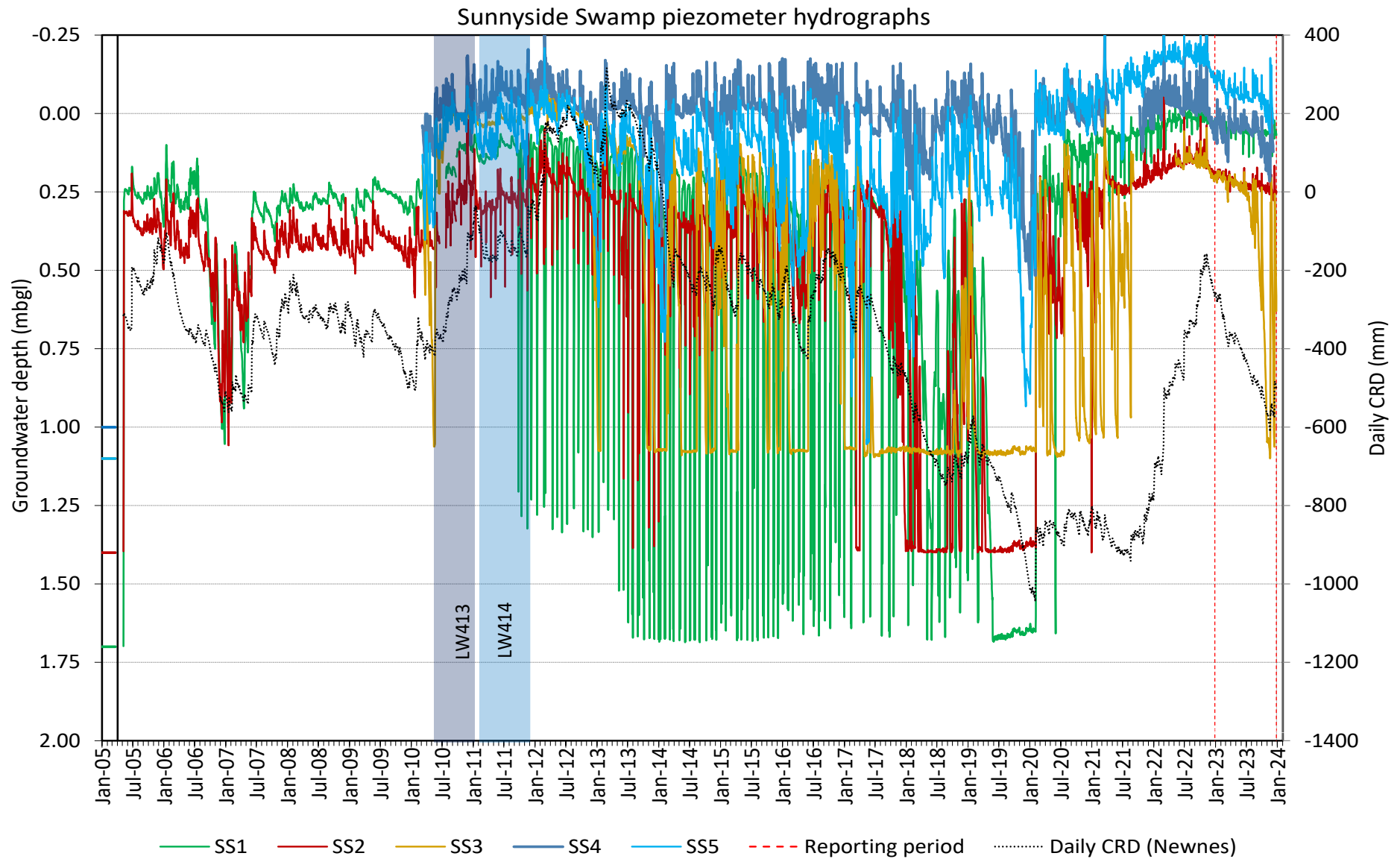


Figure 4.9 Sunnyside Swamp hydrograph

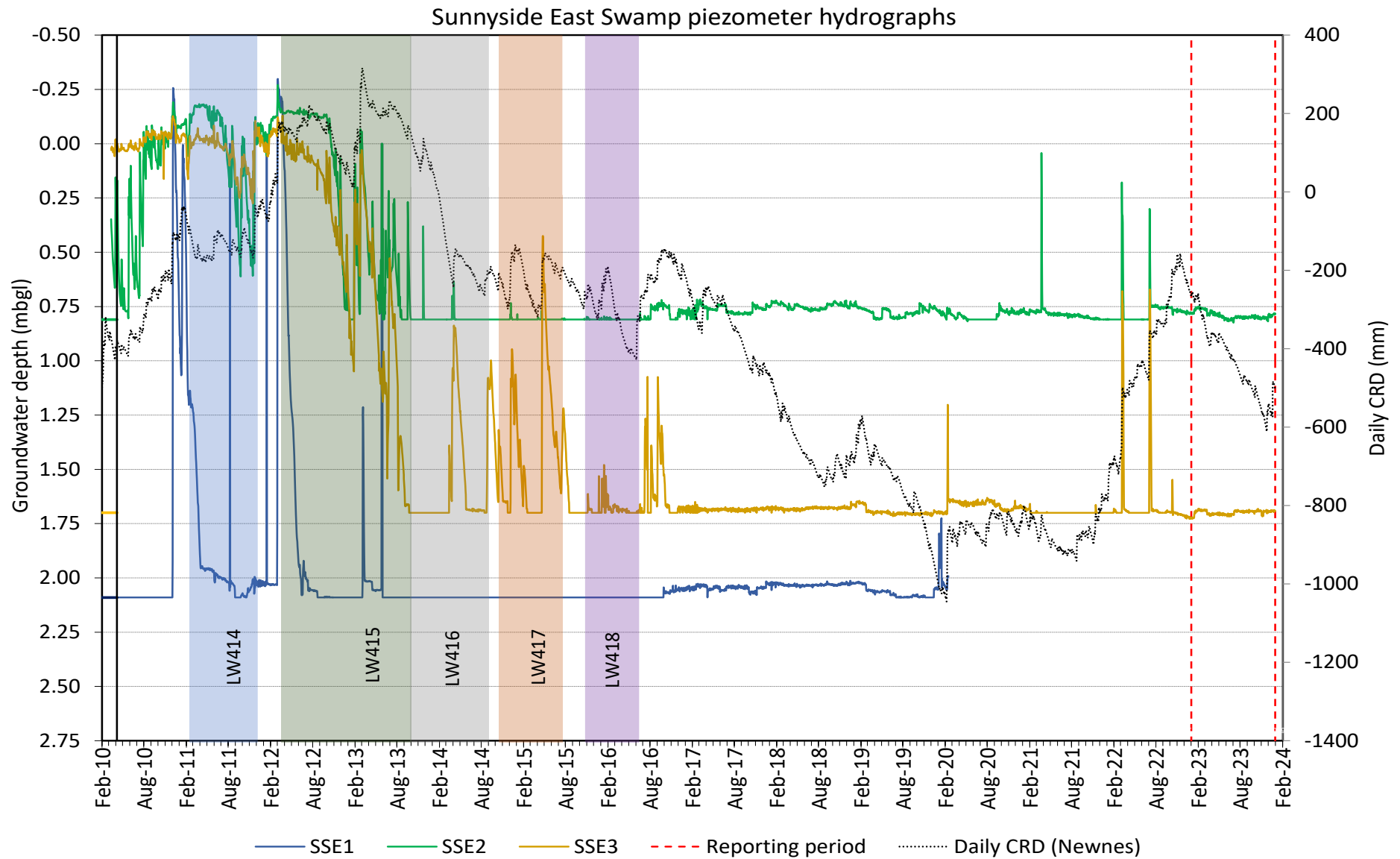


Figure 4.10 Sunnyside East Swamp hydrograph

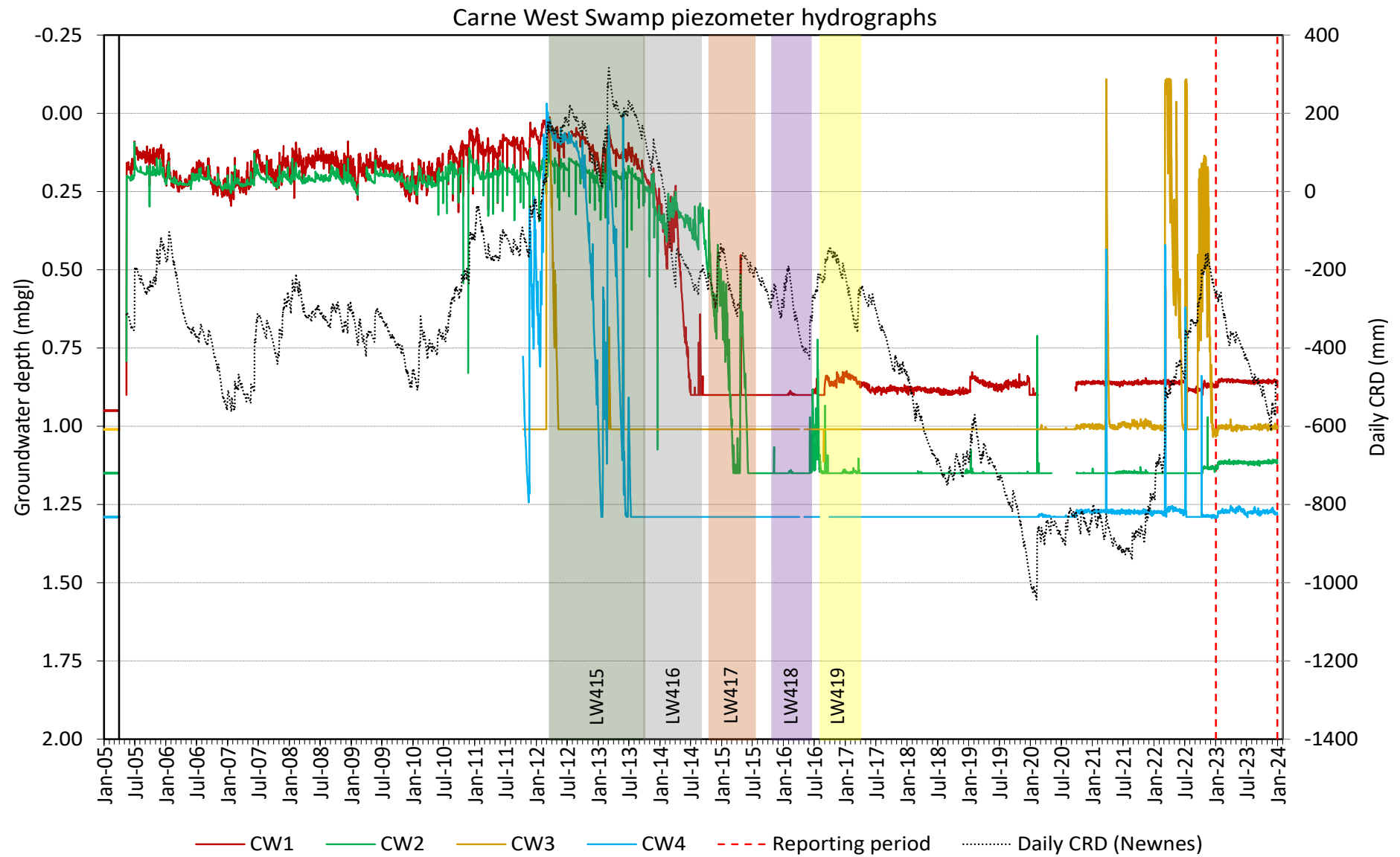


Figure 4.11 Carne West Swamp hydrograph

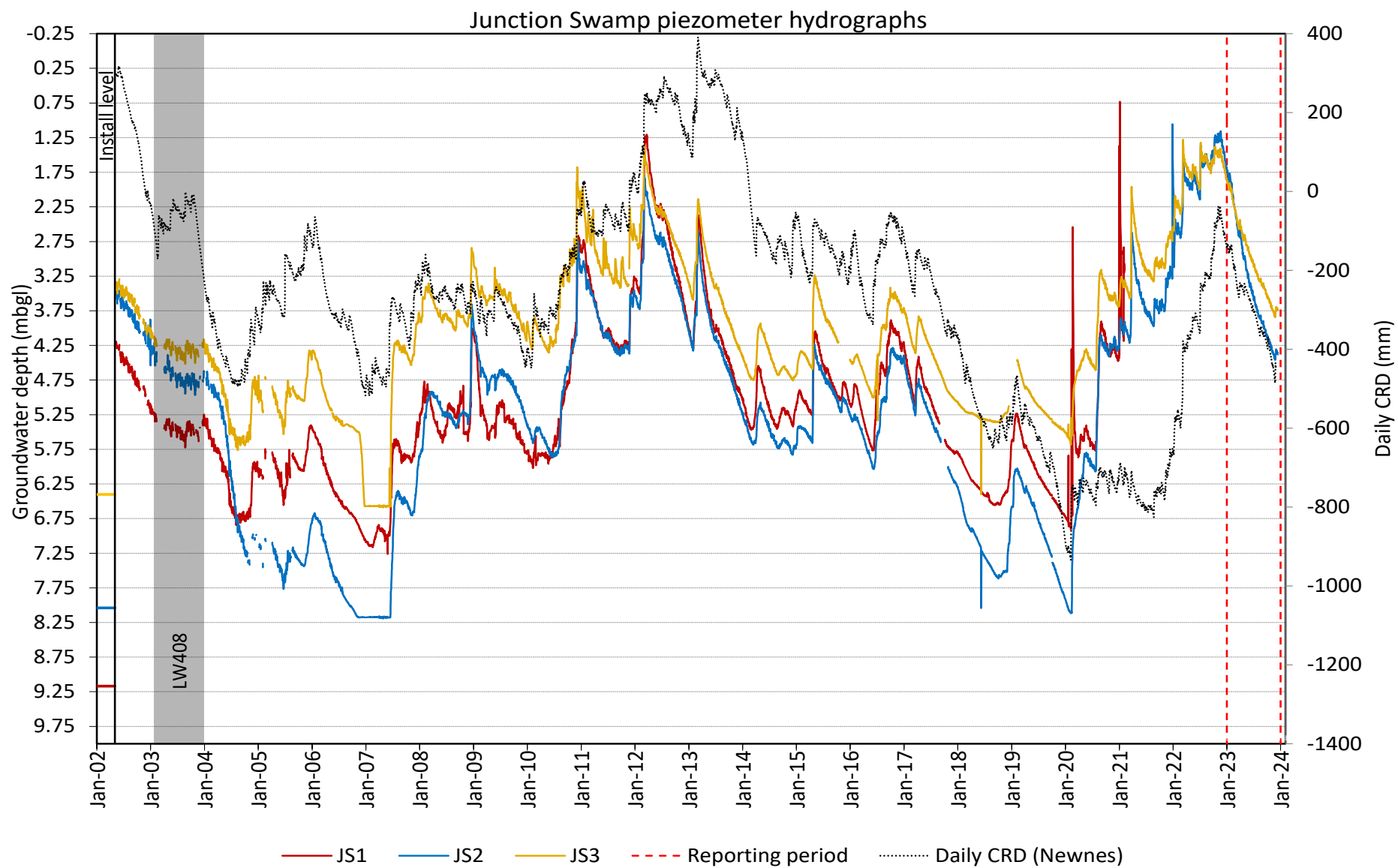


Figure 4.12 Junction Swamp hydrograph

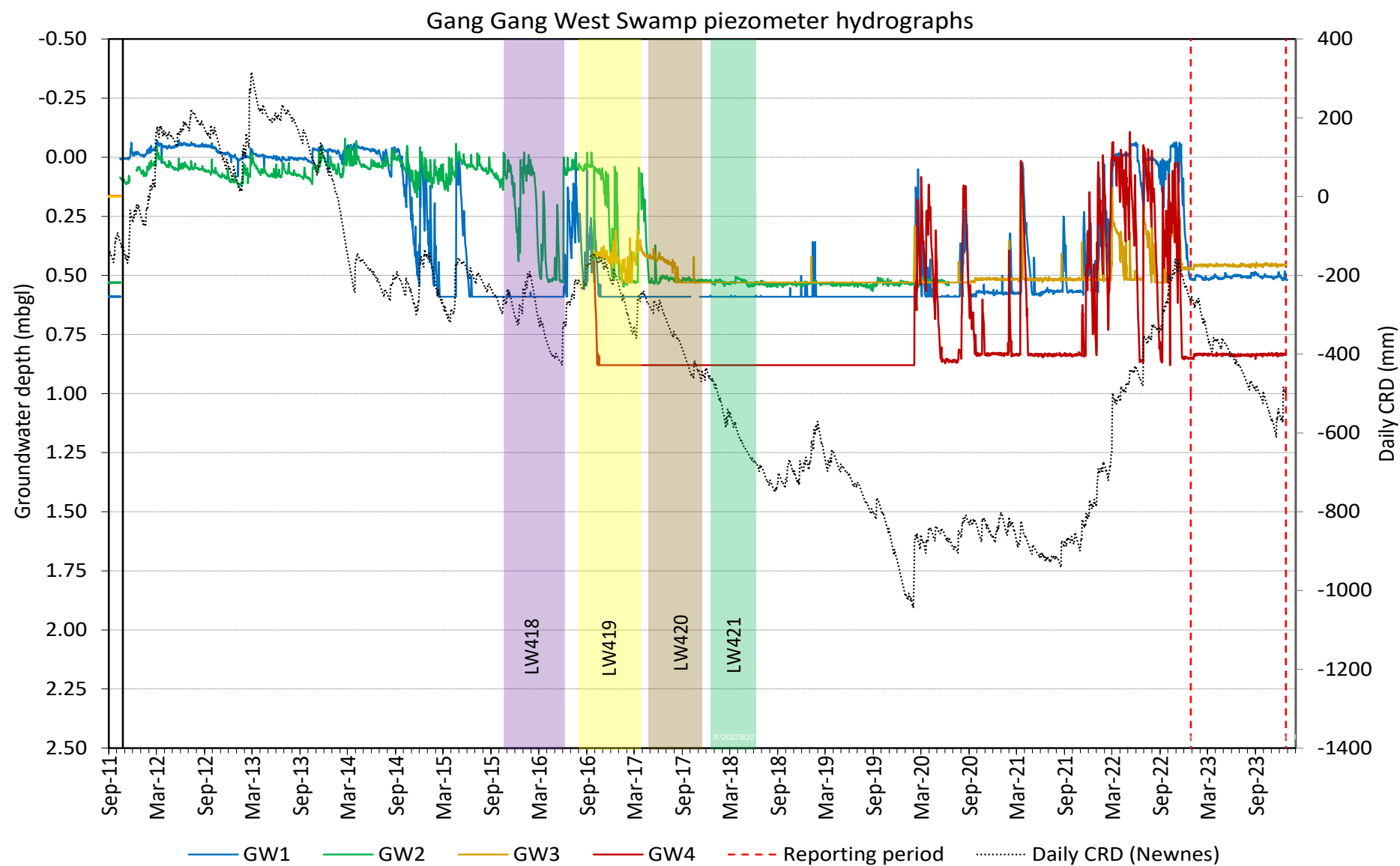


Figure 4.13 Gang Gang West Swamp hydrograph

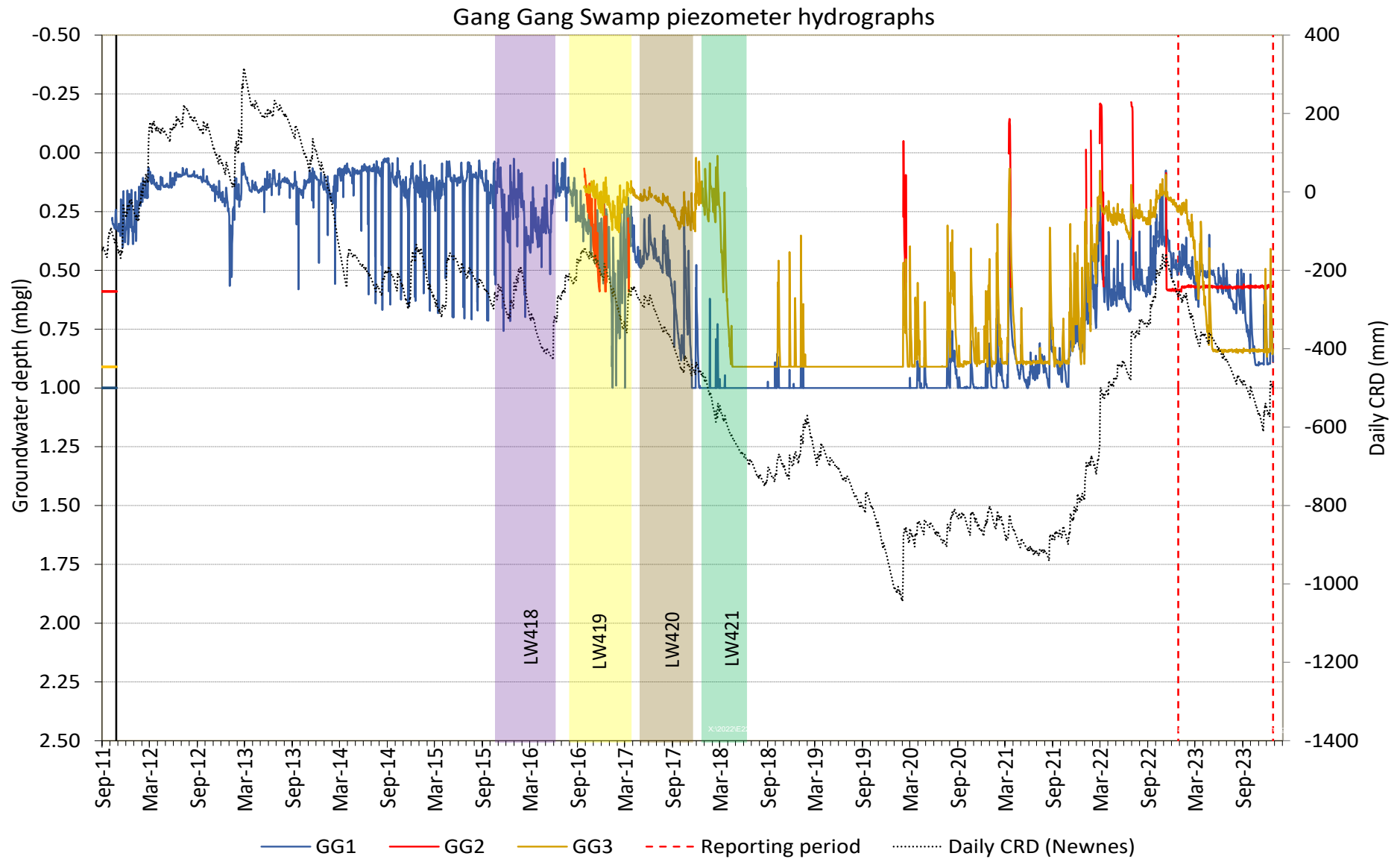


Figure 4.14 Gang Gang Swamp hydrograph

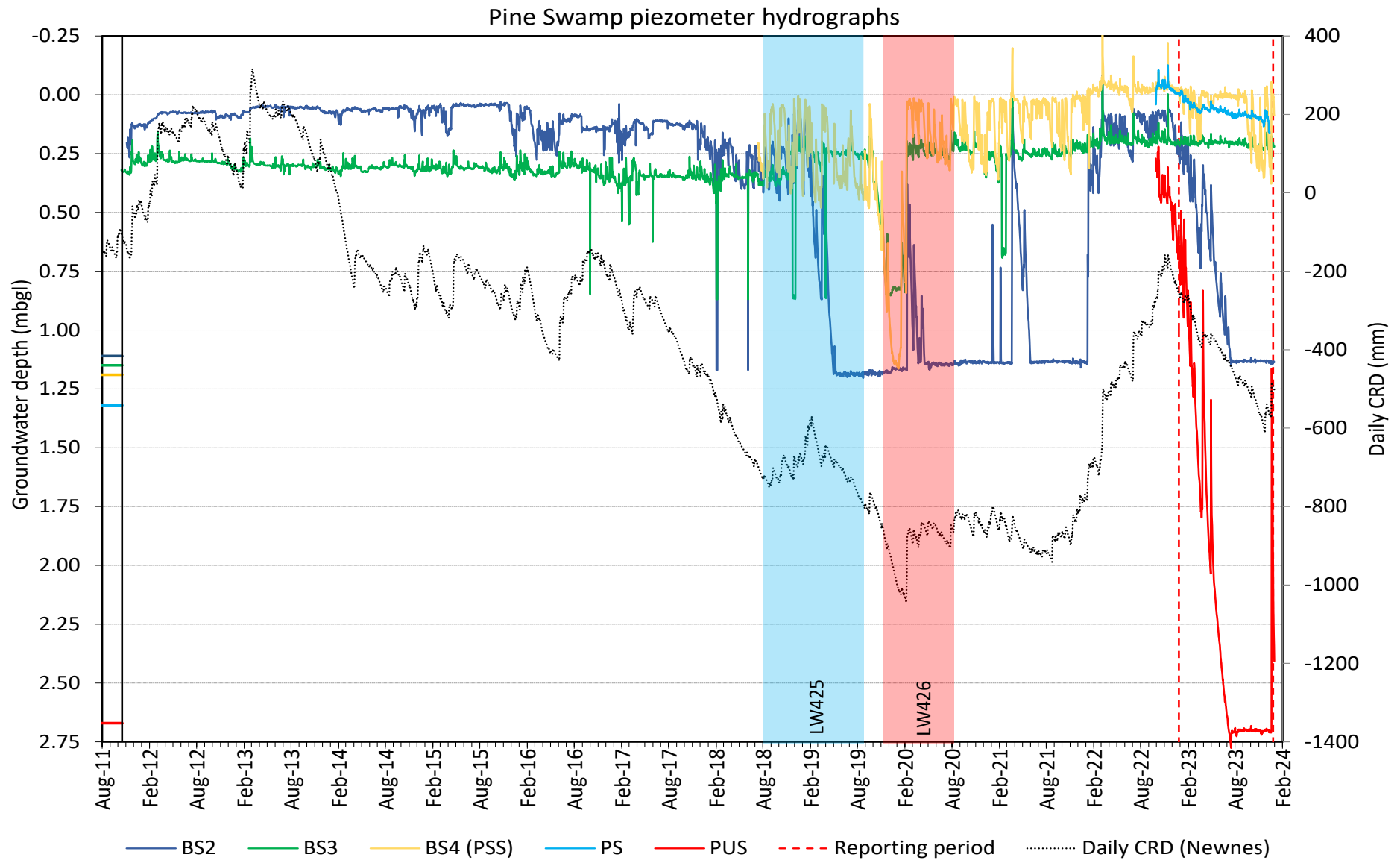


Figure 4.15 Pine Swamp hydrograph

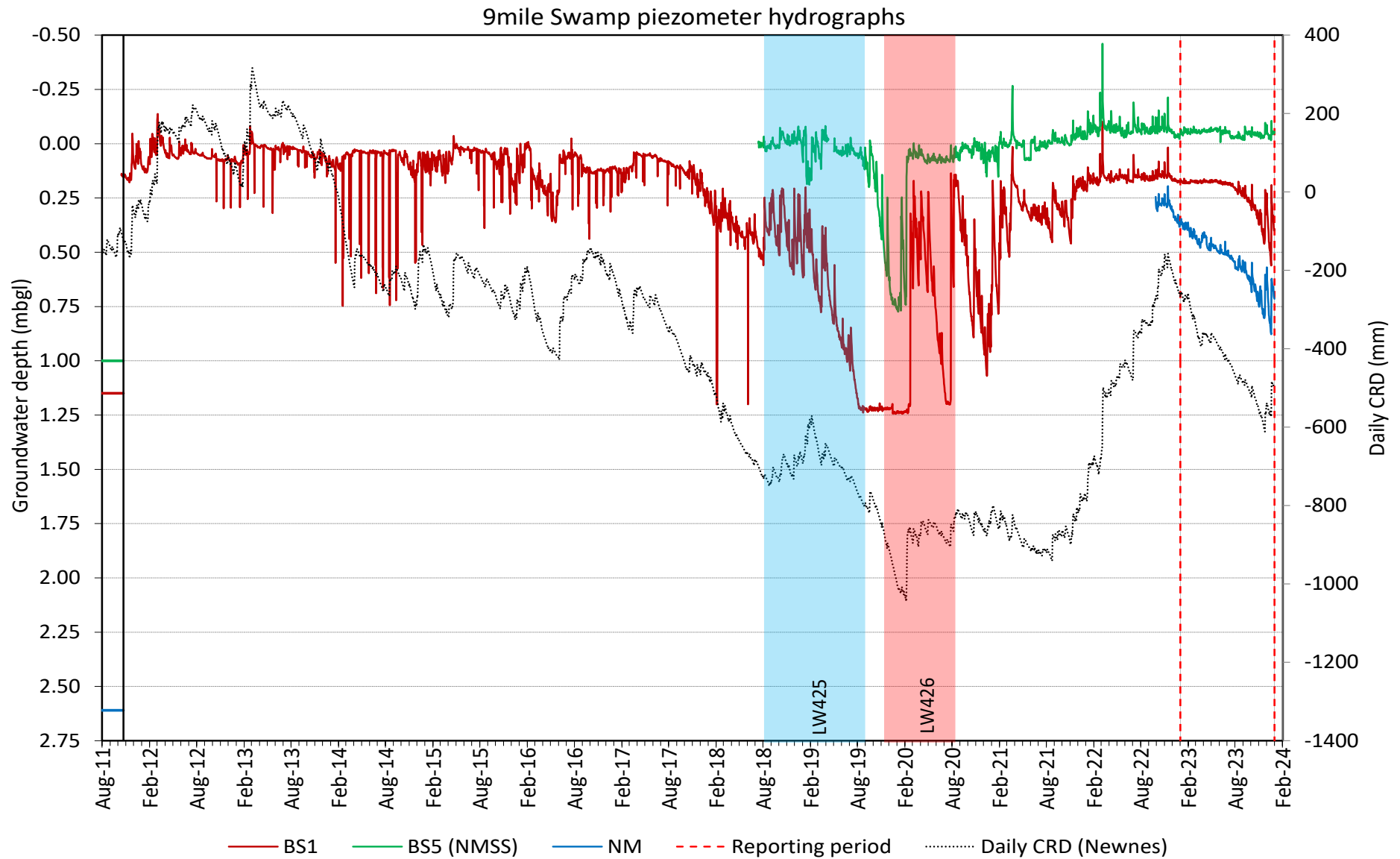


Figure 4.16 Nine Mile Swamp hydrographs

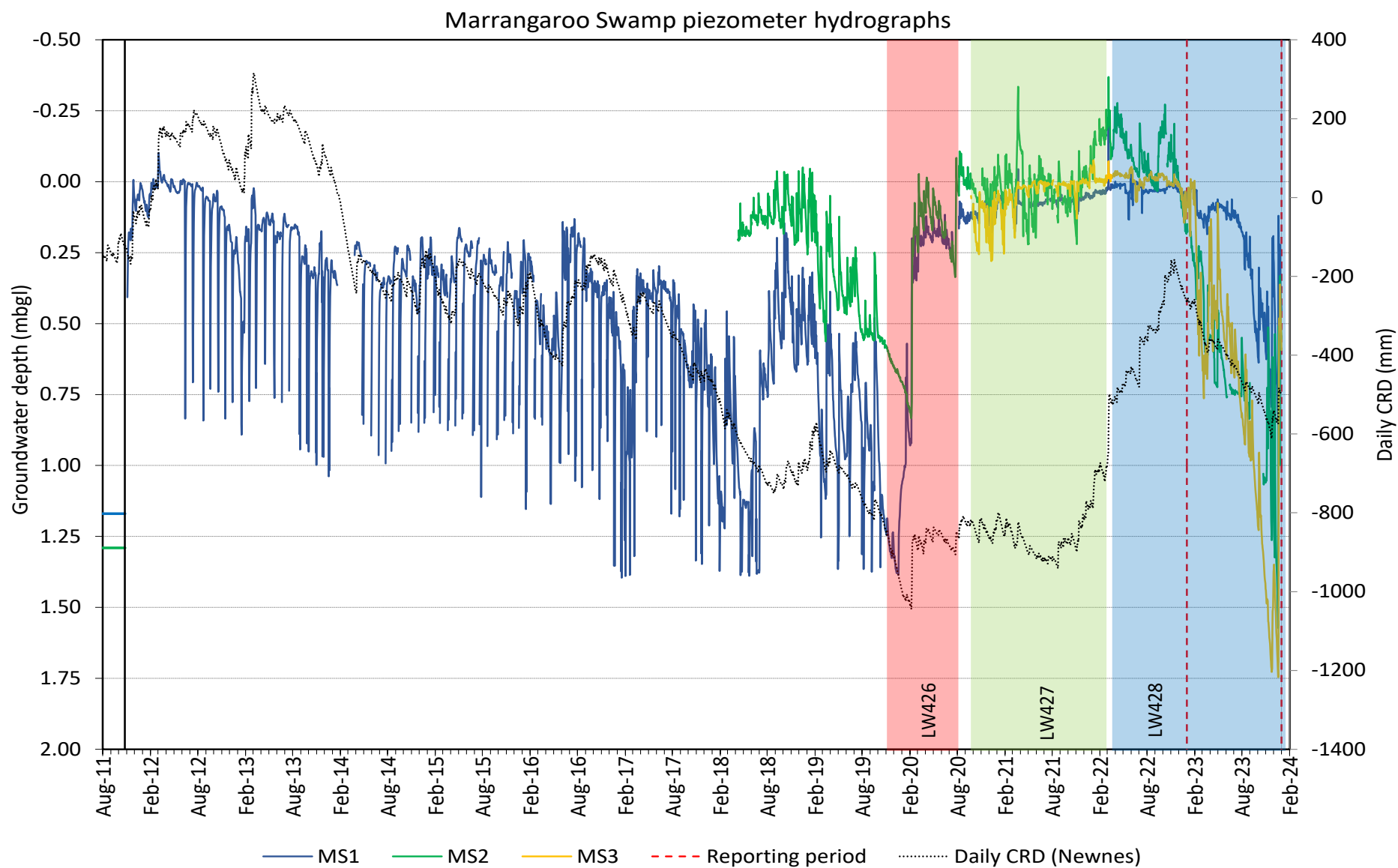


Figure 4.17 Marrangaroo Swamp hydrograph

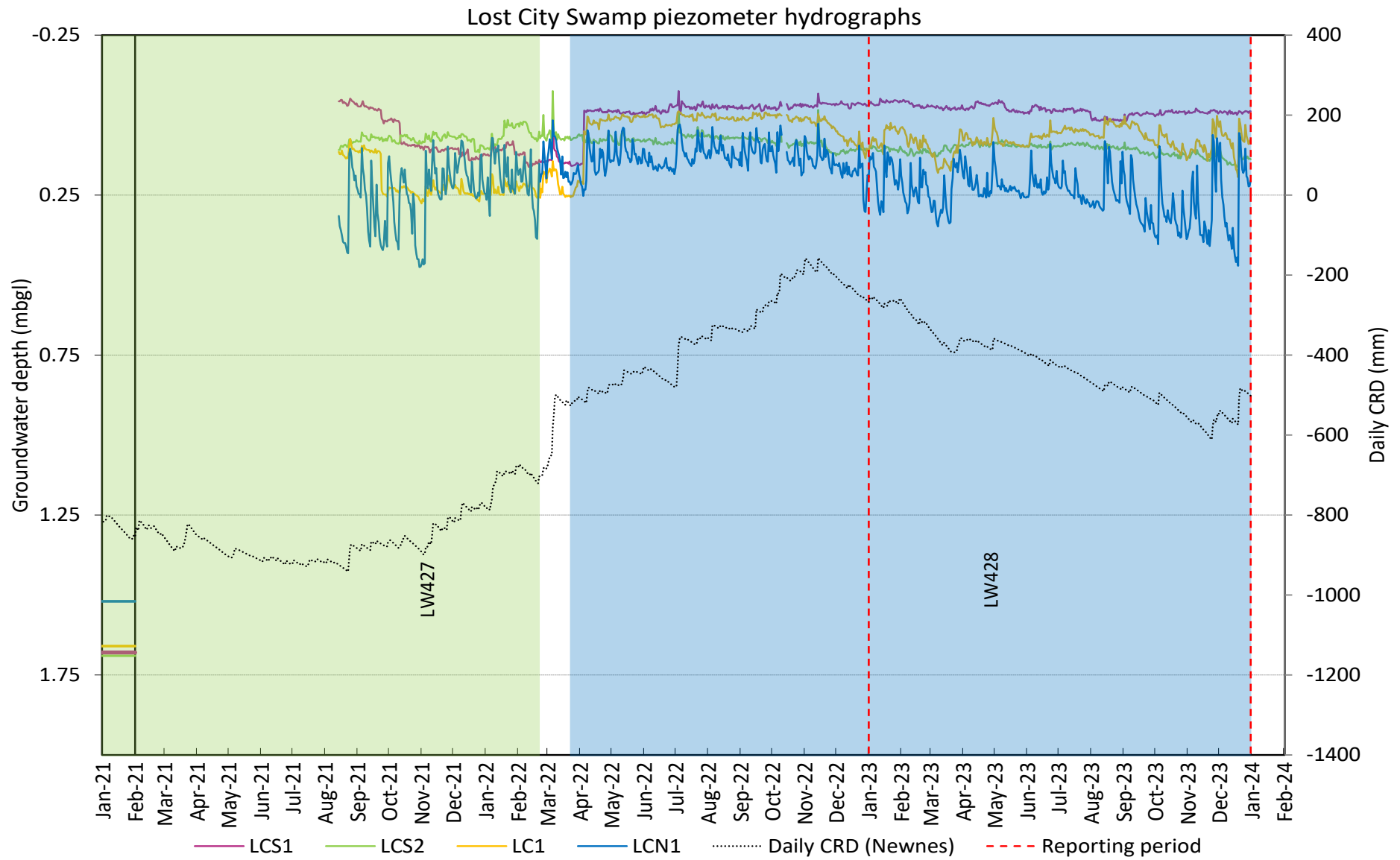


Figure 4.18 Lost City Swamp hydrograph

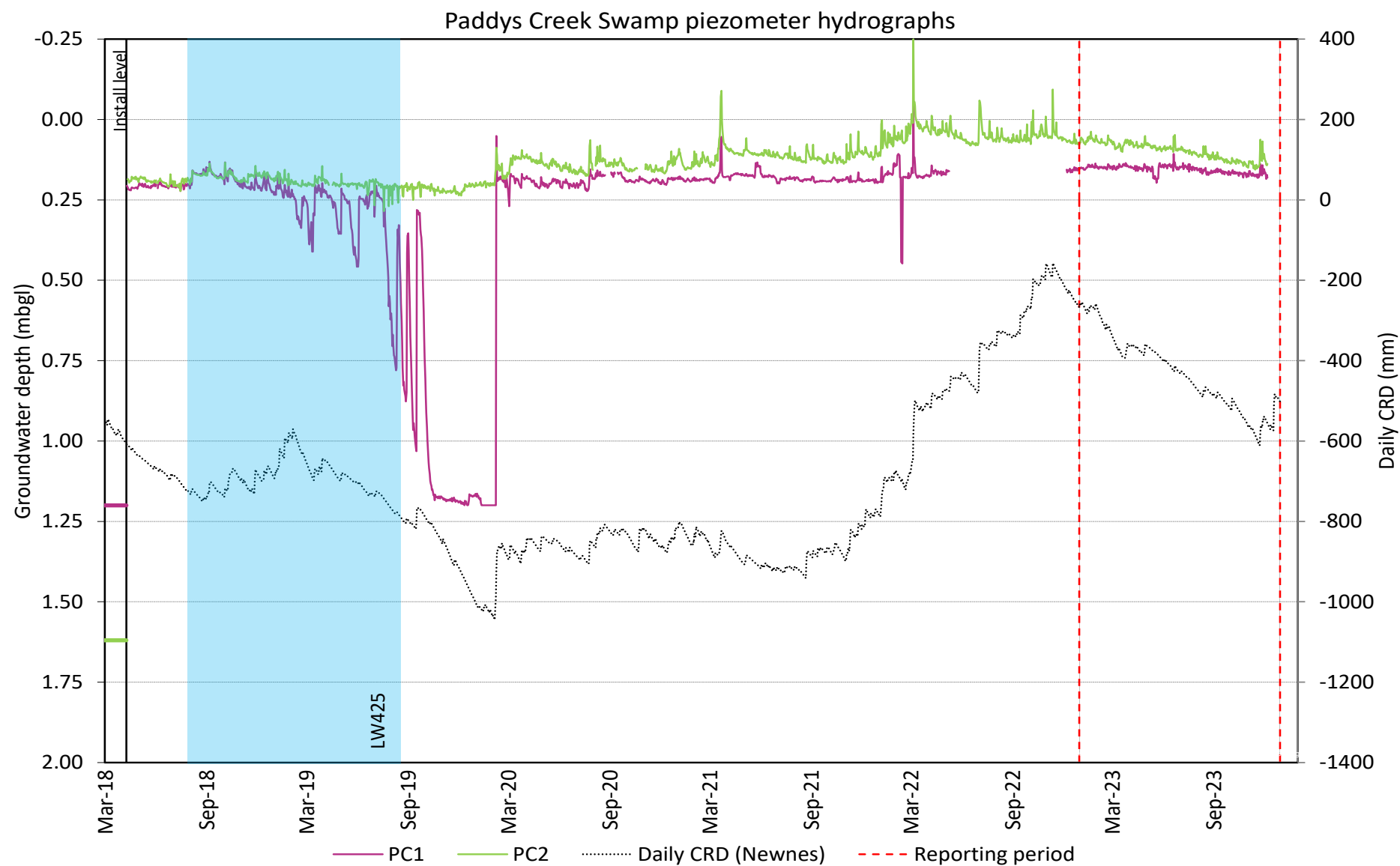


Figure 4.19 Paddys Creek hydrograph

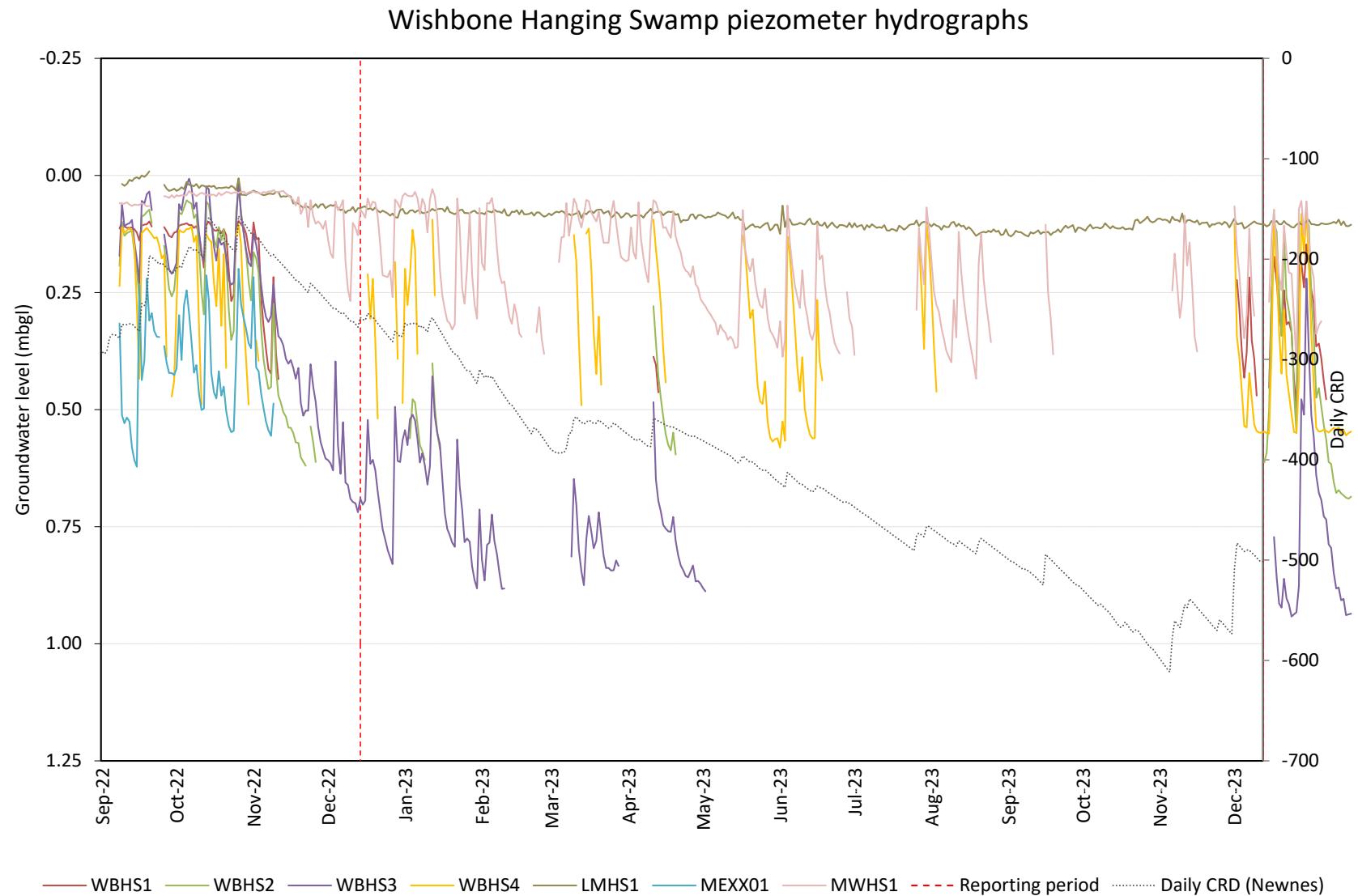


Figure 4.20 Hanging Swamps (Marangaroo and Wishbone swamps) hydrograph

4.2 Perched aquifer piezometers

Hydrographs for reference and impact Perched aquifer piezometers is shown in Figure 4.21 and Figure 4.22. Comments on groundwater level trends during the reporting period are summarised in Table 4.3.

Table 4.3 Perched groundwater level trend summary

Monitoring ID	Associated swamp	Site type	Comment
SPR1601	Carne West	Impact	Declining – Trending with the CRD, spiked from mid-December due to a significant rainfall event.
SPR1602	Gang Gang West	Impact	Declining – Declining before stabilising from early December, consistent with the CRD trend.
SPR1603	Gang Gang	Impact	Declining – Declining before stabilising from mid-December, consistent with the CRD trend.
SPR1604	Carne Central	Impact	Declining.
SPR1605	Pine/Nine Mile	Impact	Declining – Declining before stabilising from mid-December, consistent with the CRD trend.
SPR1606	Paddys Creek	Impact	Declining
SPR1607	Marrangaroo	Impact	Declining – Trending with the CRD.
SPR1608	Barrier	Reference	Declining – Consistent with the CRD trend.
SPR1609	Tri Star	NA	Declining – Trending with the CRD.
SPR1610	Twin Gully	NA	No piezometer installed.
SPR1611	Fire Tail	Reference	Slight decline corresponding to below average rainfall since November 2022.
SPR1612	Best	Reference	Slight decline – Fluctuates with the daily CRD, increasing from mid-December due to rainfall.
SPR1613S	Lost City	NA	Stable – Slight increasing trend.
SPR1613D	Lost City	NA	Stable – Fluctuating with rainfall and with the daily CRD.
LCY2101	Lost City	NA	Declining – Fluctuates with the daily CRD, increasing from mid-December due to rainfall.
PHS	Pine	NA	Declining – Going dry from mid-November.
PLM2101	Plum	NA	Declining – Spike from late November due to rainfall, fluctuates with the daily CRD.
PLM2102	Plum	NA	Declining trend from July 2022.
WB12101	Wishbone	NA	Declining going dry, fluctuates with the CRD.
WB12102	Wishbone	NA	Dry.
WB32101	Wishbone	NA	Stable – Fluctuating with daily CRD.
WB32102	Wishbone	NA	Dry.
WB32103	Wishbone	NA	Increasing.

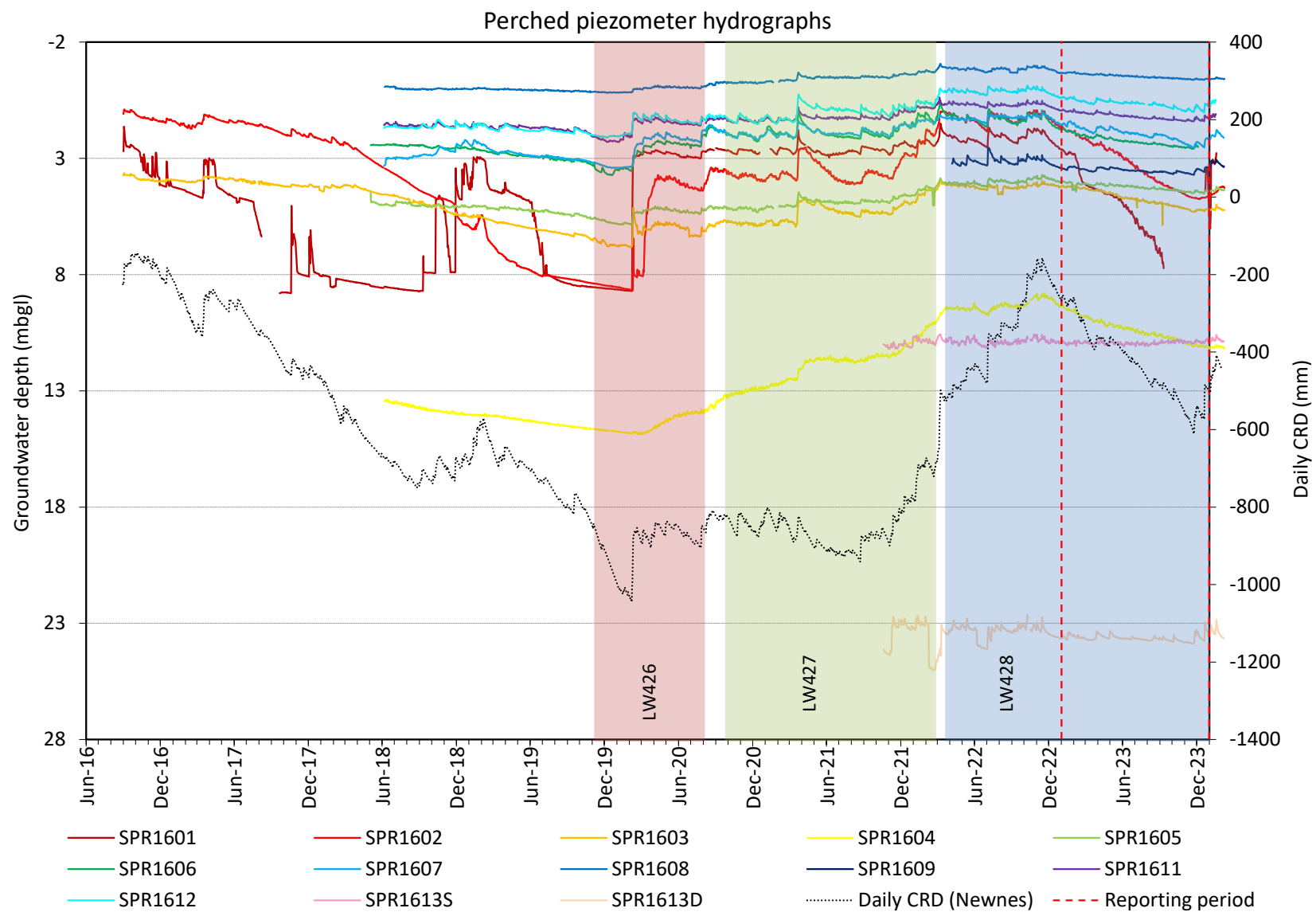


Figure 4.21 Perched aquifer hydrograph

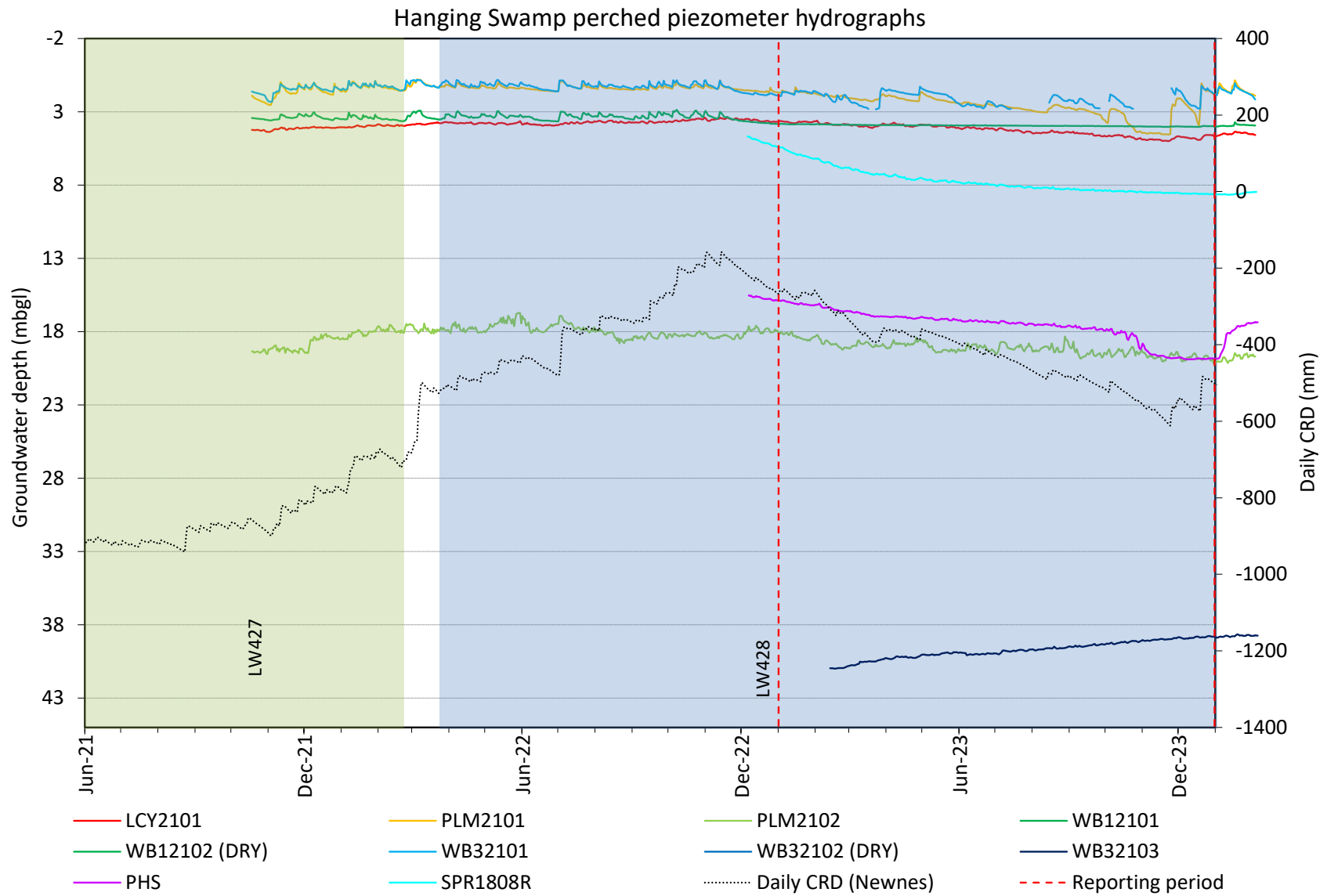


Figure 4.22 Perched aquifer hydrograph

4.3 Standpipe piezometers

Hydrographs for reference and impact standpipe piezometers are shown in Figure 4.23 and Figure 4.24. Comments on groundwater level trends during the reporting period are shown on Table 4.4.

Table 4.4 Shallow groundwater level trend summary

Monitoring ID	Site type	Mined status	Comments
AP5PR	Reference	NA	Stable.
AP1105	Reference	NA	Stable – Slight increasing trend.
RSE	Impact	LW411	Stable – Slight decreasing trend.
RSS	Impact	LW415	Decreasing – Response to large rainfall events with short sharp rises in groundwater levels that likely indicates a compromised annulus or seepage from a nearby fire dam.
SPR1101	Impact	LW416	Damaged by subsidence – Decommissioned.
SPR1104	Impact	LW420	Decreasing – Going dry from mid-April.
SPR1106	Impact	NA	Decreasing – Consistent with the CRD trend.
SPR1107	Impact	LW420	Decreasing – Consistent with the CRD trend.
SPR1108	Impact	LW427	Decreasing – Consistent with the CRD trend.
SPR1109	Impact	LW418	Decreasing – Consistent with the CRD trend.
SPR1110	Impact	LW417	Dry.
SPR1111	Impact	NA	Decreasing – Consistent with the daily CRD trend.
SPR1112	Impact	NA	Decreasing – Consistent with the daily CRD trend.
SPR1113	Impact	NA	Decreasing – Consistent with the daily CRD trend.
SPR1210R	Impact	LW428	Stable – Slight increasing trend.
SPR1211	Impact	LW426	Damaged by subsidence – Decommissioned.
SPR1301	Impact	NA	Decreasing – There is a gap in logger data during July because a hydrasleeve was stuck in the piezometer. The declining trend is not consistent with other impact (SPR1210 and SPR1806) or other reference piezometers and may have been impacted by LW428.
SPR1401	Impact	NA	Decreasing – Consistent with the daily CRD trend.
SPR1402	Impact	NA	Vandalised – Decommissioned.
SPR1403	Impact	NA	Damaged by bushfire – Decommissioned.
SPR1806	Impact	NA	Stable – Slight increasing trend until mid-September then a slight decreasing trend.
SPR1807	Impact	NA	Dry.
SPR1808	Impact	NA	Dry since June 2022 - Impacted by LW426, LW427 and 428 with stepped water level declines. This piezo was replaced by SPR1808R.
SPR1808R	Impact	NA	Decreasing – Logger installed in December 2022, decreasing trend since installation.
SPR2301	Impact	NA	Decreasing – logger installed August 2023.

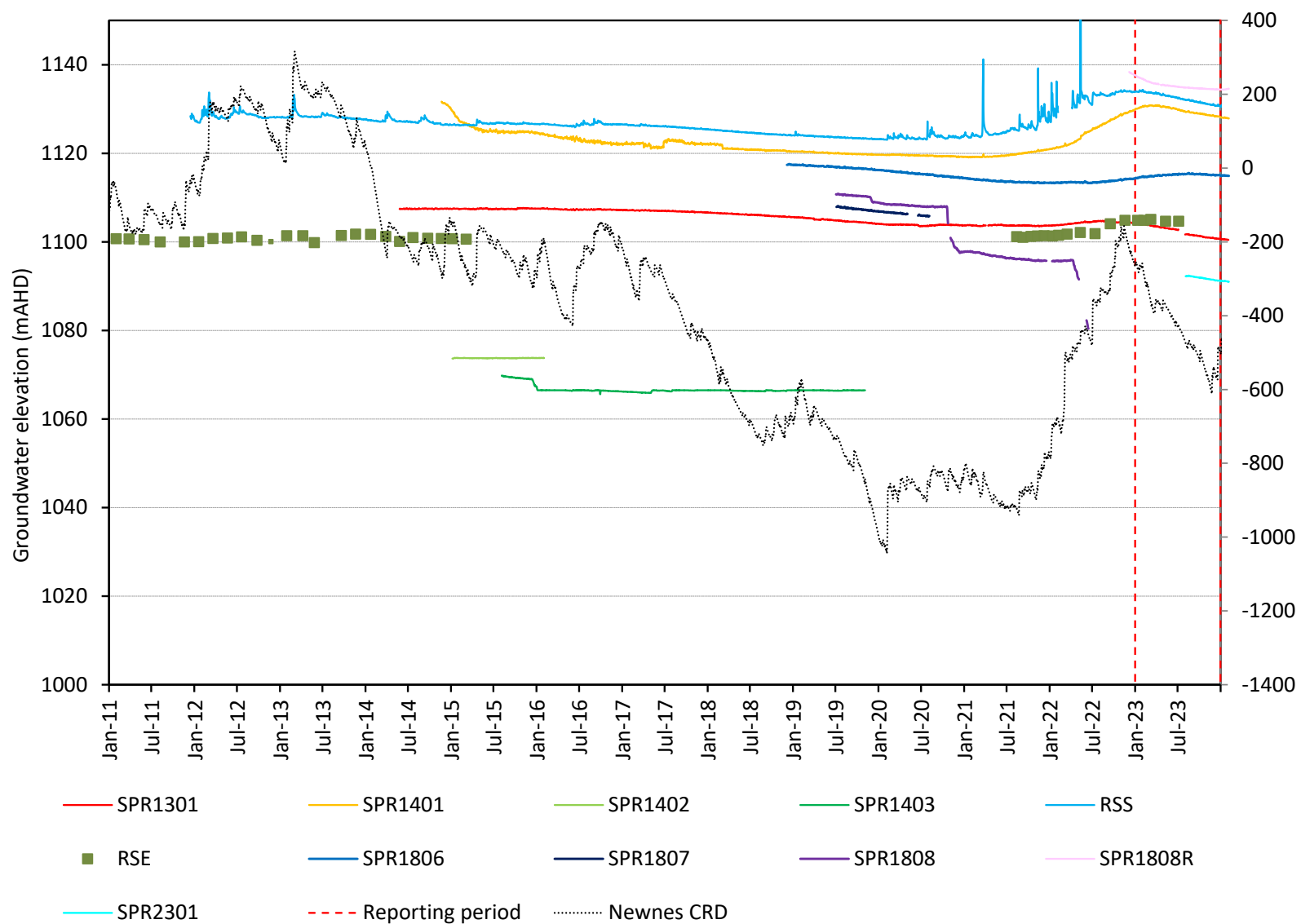


Figure 4.23 Shallow aquifer hydrographs

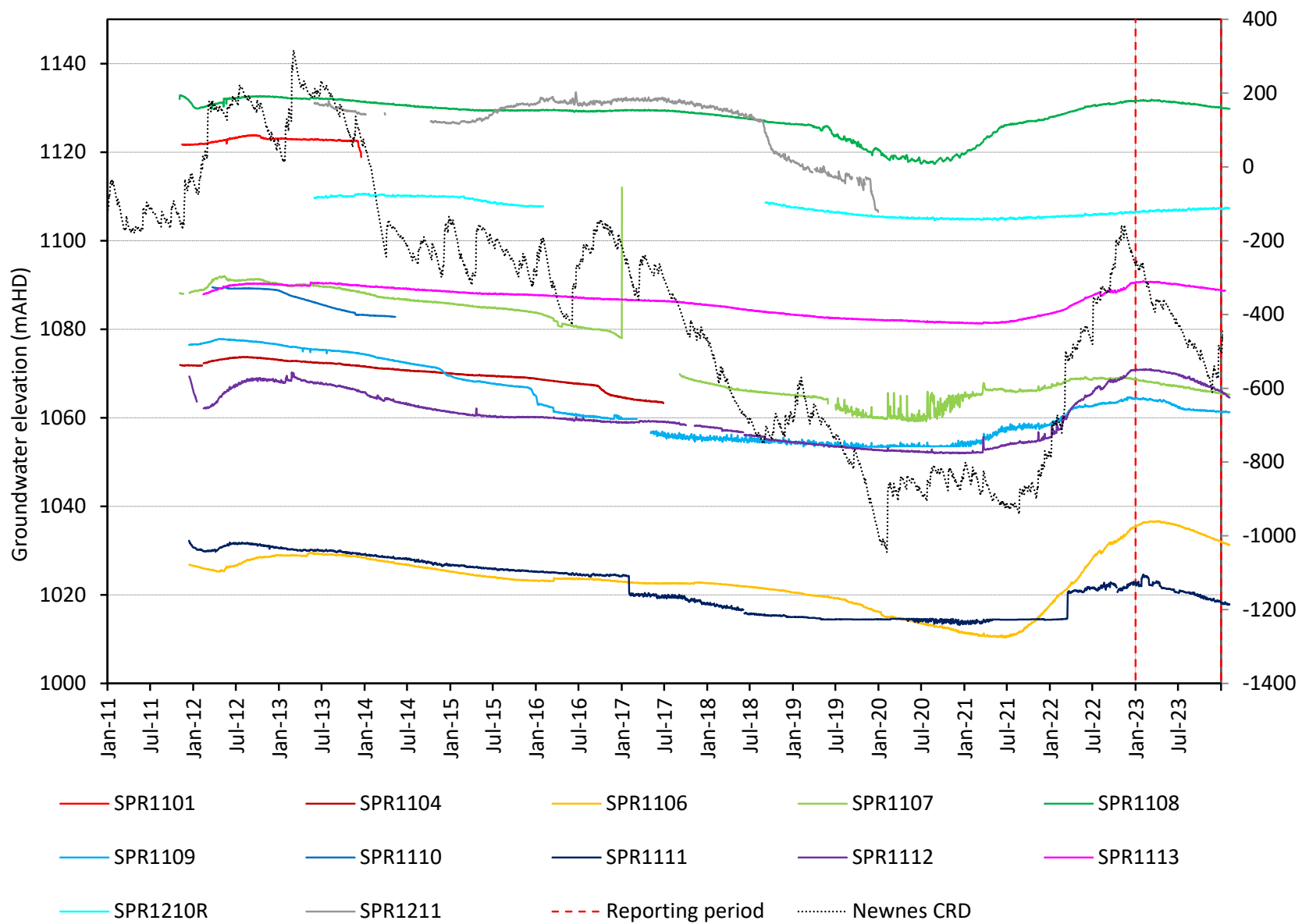


Figure 4.24 Shallow aquifer hydrographs

4.4 Vibrating wire piezometers

Hydrographs for the reference and impact VWP's are shown in Figure 4.25 to Figure 4.36. Table 4.5 summarises key groundwater level observations for VWPs during the reporting period. Sensors that are **bold** have been either damaged by subsidence, are no longer functional or unsaturated.

Table 4.5 Vibrating wire piezometer piezometric head trend summary

Monitoring ID	Sensor depth (mbgl) ¹	Comment
SPR37	#1 405 (AQ1), #2 350 (AQ1), #3 320 (SP1), #4 260 (AQ3), #5 187 (AQ3), #6 165 (AQ4), #7 135 (AQ4), #8 110 (AQ4)	SPR37R was located within the TIA from early April to mid-November 2023. Piezometer sensor (piezo) #1 (405 m) has been unsaturated since late October 2022. Communication was lost with piezo #2 (350 m) in 2012. Piezo #3 (320 m) has been unsaturated since 2016. Piezo #6 (165 m) has been recording erroneous data since late 2020. A data gap from 2 August 2023 to 9 November 2023 is present due to a lightning strike damaging the logger. A new logger was installed early November 2023. A declining trend was observed in sensors #5 (187 m), #7 (137 m) and #8 (110 m) until August 2023 when the logger went offline. Following the installation of a new logger remaining piezos #4, #5, #7 and #8 (110 m) showed stabilising water levels.
SPR38	#1 80 (AQ4), #2 100 (AQ4), #3 135 (AQ4), #4 190 (AQ3), #5 230 (AQ3), #6 300 (semi-permeable layer), #7 355 (AQ1), #8 370 (AQ1)	SPR38 was previously undermined by LW427 and was outside the TIA during the reporting period. Piezo #5 (230 m) has been unsaturated since 2016. Piezos #6 (300 m), #7 (355 m) and #8 (370 m) lost communication with the logger in 2020 due to LW427. Communication was lost with Piezo #1 (80 m) possibly due to subsidence caused by LW427 in 2020. During the reporting period, all remaining functional piezos showed stable slightly declining trends.
SPR48	#1 200 m, #2 170 m, #3 140 m, #4 110 m, #5 90 m, #6 70 m, #7 50 m.	SPR48 was undermined by LW412 and 413. All functional piezos show stable trends besides #5 which shows a gradual declining trend.
SPR49	#1 295 m, #2 250 m, #3 200 m, #4 150 m, #5 110 m, #6 80 m, #7 50 m, #8 30 m	SPR48 was undermined by LW412 and 413. Piezo #7 shows an increasing trend due to delayed recharge. Piezo #8 shows a stable trend.
SPR1208	#8 90 m, #7 130 m, #6 226 m, #5 303 m, #4 330 m, #3 380 m, #2 411 m, #1 421 m.	Damaged by bushfire – decommissioned.

Table 4.5 **Vibrating wire piezometer piezometric head trend summary**

Monitoring ID	Sensor depth (mbgl) ¹	Comment
SPR1210	#1 388 (AQ1), #2 376 (AQ1), #3 326 (AQ2), #4 308 (semi-permeable layer), #5 224 (AQ3), #6 160 (AQ4), #7 76 (AQ6)	SPR1210 was directly undermined by LW428 in early May 2023 and remained within the TIA until late September 2023. Communication with piezo #1 (388 m), #2 (376 m) and #3 (326 m) (below the MYC) was lost due to the passing of LW428 in May 2023. A stepped decline of piezometric head was observed at piezos #4 (308 m) and #5 (224 m) (below MYC) and #6 (160 m) and #7 (76 m) (above MYC) from early May 2023. The declines above the MYC were greater than 10 m and a trigger investigation report was issued to the regulator on 2 November 2023. The trigger investigation found the response observed at SPR1210 VWP was similar to other VWP sites impacted by earlier longwalls, however no impact was seen at nearby standpipe piezometer SPR1210R, indicating the aquifer could still be intact. As such the report concluded further observation was required to confirm the condition of the shallow aquifer and whether the observations were representative or a result of VWP grout failure or other geotechnical related issues. Piezo #4 showed a slight increasing trend until early April. From early April to late May a depressurisation was observed. From late May a relatively stable trend was observed with a slight decline and minor fluctuations. Piezo #5 remained relatively stable however showed a slight depressurisation and fluctuations between late March and late May. Piezo #6 showed a stable slightly declining trend until late April. From late April to mid-June a depressurisation was observed. From June a slightly declining trend has been observed. Piezo #7 remained relatively stable until early May. From early May to early July a depressurisation was observed. From early July a stable slightly increasing trend was observed.
SPR1212	182 (#6), 197 (#5), 208 (#4), 229 (#3), 264 (2), 280 (#1)	All piezos remain functional. In mid-July the logger failed to record data, when the logger resumed functioning on 20 July 2023 a slight pressure drop was observed across the shallowest piezos #6 (182 m), #5 (197 m) and #4 (208 m). The shallowest piezos had the greatest pressure decline with sensor #6 losing approx 1.1 m of head. Similar depressurisation of the shallowest sensors was observed from 9 November and 2 December 2023 which are also believed to be erroneous. Sensors #6 and #5 remained relatively stable showing a slight increasing trend except for the previously mentioned pressure declines. Sensor #4 remained stable. Piezo #3 (229 m) showed a slight increase in piezometric pressure from mid-September followed by a depressurisation from late September of approximately 2.6 m of piezometric head. Piezo #2 (264 m) remains stable while Piezo #1 (280 m) shows a gradual decline in piezometric pressure.

Table 4.5 **Vibrating wire piezometer piezometric head trend summary**

Monitoring ID	Sensor depth (mbgl) ¹	Comment
SPR1302	#1 390 (AQ1), #2 370 (AQ1), #3 310 (AQ2) , #4 270 (AQ3), #5 200 (AQ3)	SPR1302 was outside the TIA during the reporting period. Depressurisation responses were seen in September 2021 due to the commencement of first workings for LW428. A data gap is observed from early April 2022 to mid-July 2022 due to a logger failure. A new data logging system was installed mid-July 2022 and a drop in pressure was subsequently observed in the shallow piezos #4 (270 m) and #5 (200 m). This is believed to be due to the installation of a new logging system. Piezo #1 (390 m) remained stable throughout the reporting period. Piezo #2 (370 m) shows fluctuating piezometric pressures. Initially piezo #2 had an increasing trend until late April, it then showed a depressurisation from late April to early May of approximately 3.5 m of piezometric head. The piezo then recovered showing an increasing trend from early May. Piezo #3 (310m) remains dry. Piezo #4 remained relatively stable showing a slight increasing trend. Piezo #5 showed minor fluctuations and a decreasing trend.
SPR1804	345 (#1), 291 (#2), 217 (#3), 118 (#4), 69 (#5), 38 (#6)	Undermined by LW425 – decommissioned.
AP10PR	343 (#1), 327 (#2), 300 (#3), 270 (#4), 248(#5), 205 (#6), 150 (#7), 103 (#8), 60 (#9)	Piezos #1 (343 m), #2 (327 m), #3 (300 m) and #7 (150 m) showed stable, slightly increasing, trends. Piezos #5 (248 m), #8 (103 m) and #9 (60 m) showed stable, slightly decreasing, trends. Piezo #6 (205 m) showed a slight increasing trend plateauing from mid-September. Piezo #4 (270 m) malfunctioned from mid-May to mid-November which is seen as a data gap on the hydrograph. This piezo appears to show a slightly declining trend.
SPR64	390 (#1), 370 (#2), 310 (#3), 270 (#4), 200 (#5), 150 (#6), 100 (#7), 30 (#8)	SPR64 was previously damaged by bushfire and decommissioned. In mid-November a new data logger was installed and SPR64 was recommissioned. All piezos appear to be functioning however insufficient data is available to determine trends.
SPR67	35 (#8), 50 (#7), 70 (#6), 90 (#5), 110 (#4), 160 (#3), 200 (#2), 260 (#1)	Piezos #1 (260 m), #2 (200 m) and #3 (160 m) have been non-functional since 2015. Piezo #4 (110 m) has been non-functional since October 2022. Piezo #8 (35 m) showed a declining trend throughout the reporting period. A slight increase was seen from late August before a sudden decline from mid-September, losing approximately 9.5 m of piezometric head. Piezo #7 (50 m) had a reasonably stable slightly increasing trend until mid-August. From 10 August a sudden depressurisation of approximately 5.3 m of piezometric head was observed. From 20 August piezo #7 has been steadily increasing however remains below pre-August levels. Piezo #6 (70 m) showed stable slightly increasing trends until early December 2023. From 5 December a sudden depressurisation of approximately 6.1 m of piezometric head was observed. From 15 December there appears to be an increasing trend however piezo #6 remains below pre-December levels. Piezo #5 (90 m) showed a stable trend throughout the reporting period.

Table 4.5 Vibrating wire piezometer piezometric head trend summary

Monitoring ID	Sensor depth (mbgl) ¹	Comment
SPR1102	82 (#9), 125 (#8), 148 (#7), 160 (#6), 203 (#5), 292 (#4), 312 (#3), 380 (#2), 404 (#1)	A data gap exists between June 2021 and April 2023 because the logger was broken. A new logger was installed mid-April 2023. The logger was removed in early November 2023 to replace the broken logger at SPR37. Piezos #7 (148 m), #8 (125 m) and #9 (82 m) showed a stable trend, consistent with data prior to June 2021. Piezo #6 (160 m) showed a depressurisation in mid-August of approximately 2.9m of piezometric head however appeared to begin recovering from late August with an increasing trend. Piezo #5 (203 m) does not correlate with pre-June 2021 data however showed a stable slightly decreasing trend. Piezo #4 (292 m) showed a stable slightly increasing trend. Piezo #3 (312 m) showed a stable trend. Piezos #1 (404 m) and #2 (380 m) showed slightly increasing trends.
SPR1103	138 (#9), 151 (#8), 178 (#7), 236 (#6), 290 (#5) , 313 (#4), 326 (#3), 381 (#2), 401 (#1)	A data gap exists between November 2020 and April 2023 because the data logger was broken. The data logger was struck by lightning in late August and subsequently failed. A new data logger was installed in December. All Piezos showed stable slightly decreasing trends for the period of logger functionality.
SPR1106	123 (#8), 163 (#7), 251 (#6), 261 (#5), 277 (#4), 323 (#3), 341 (#2), 362 (#1)	Logger issues since December 2021. Vandalised in August 2023.
SPR2303B	46 (#8), 146 (#7), 203 (#6), 247 (#5), 279 (#4), 316 (#3), 356 (#2), 387 (#1)	SPR2303B was installed in mid-December 2023, as such, insufficient data is available to determine trends. All sensors are functional and currently displaying stable data.

Notes: Bold numbers indicate sensors that are faulty or disconnected.

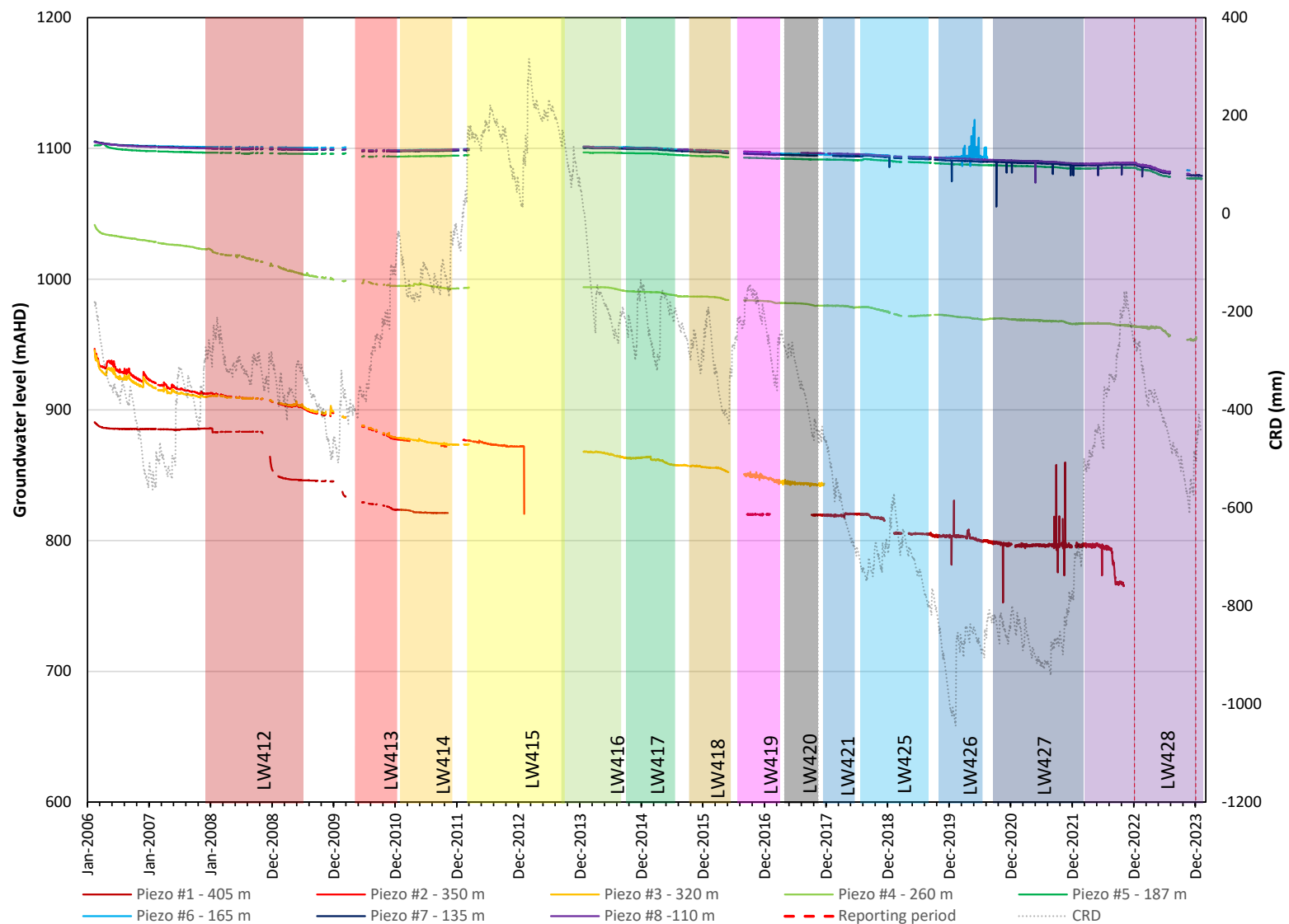


Figure 4.25 SPR37R hydrograph

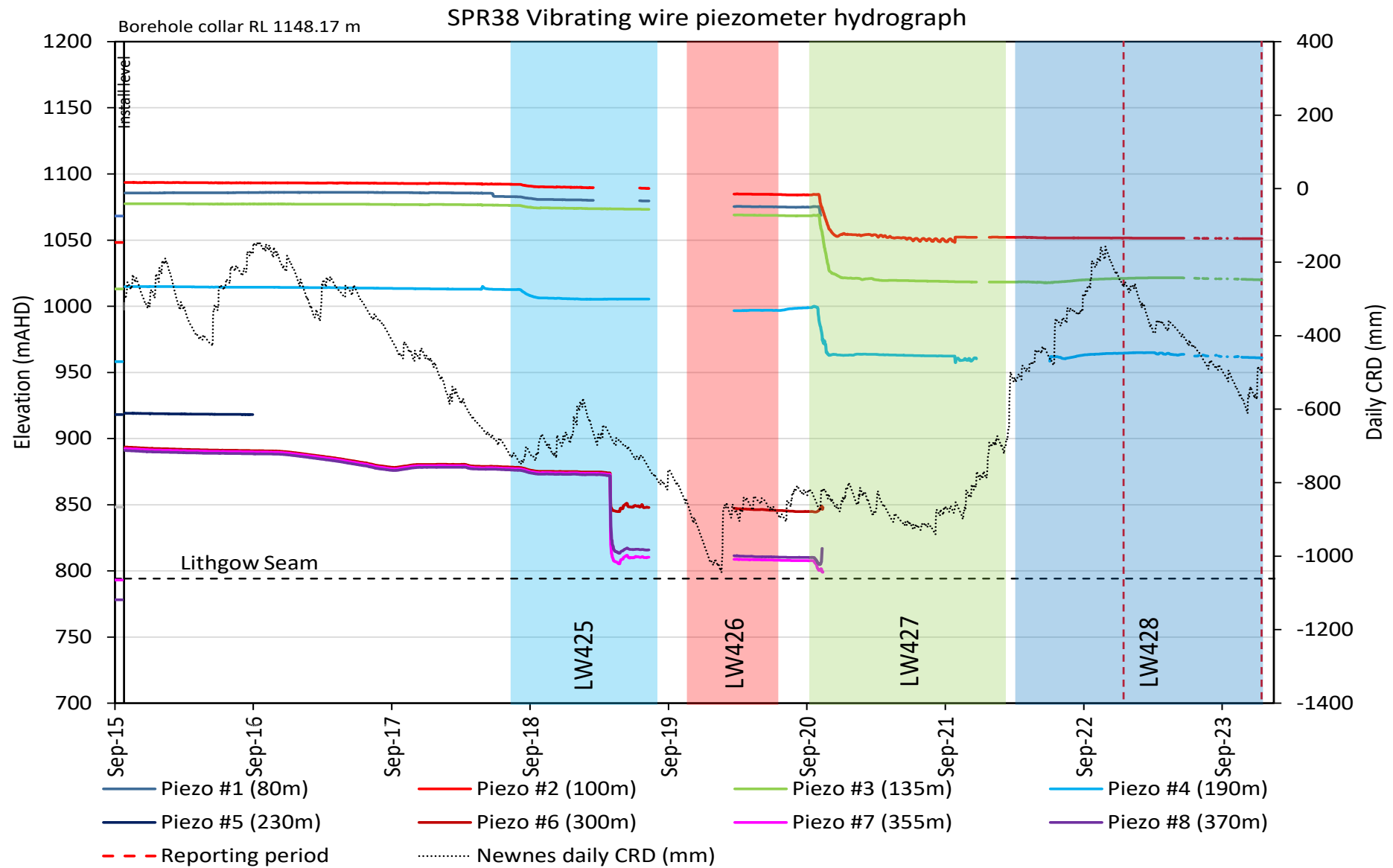


Figure 4.26 SPR38 hydrograph

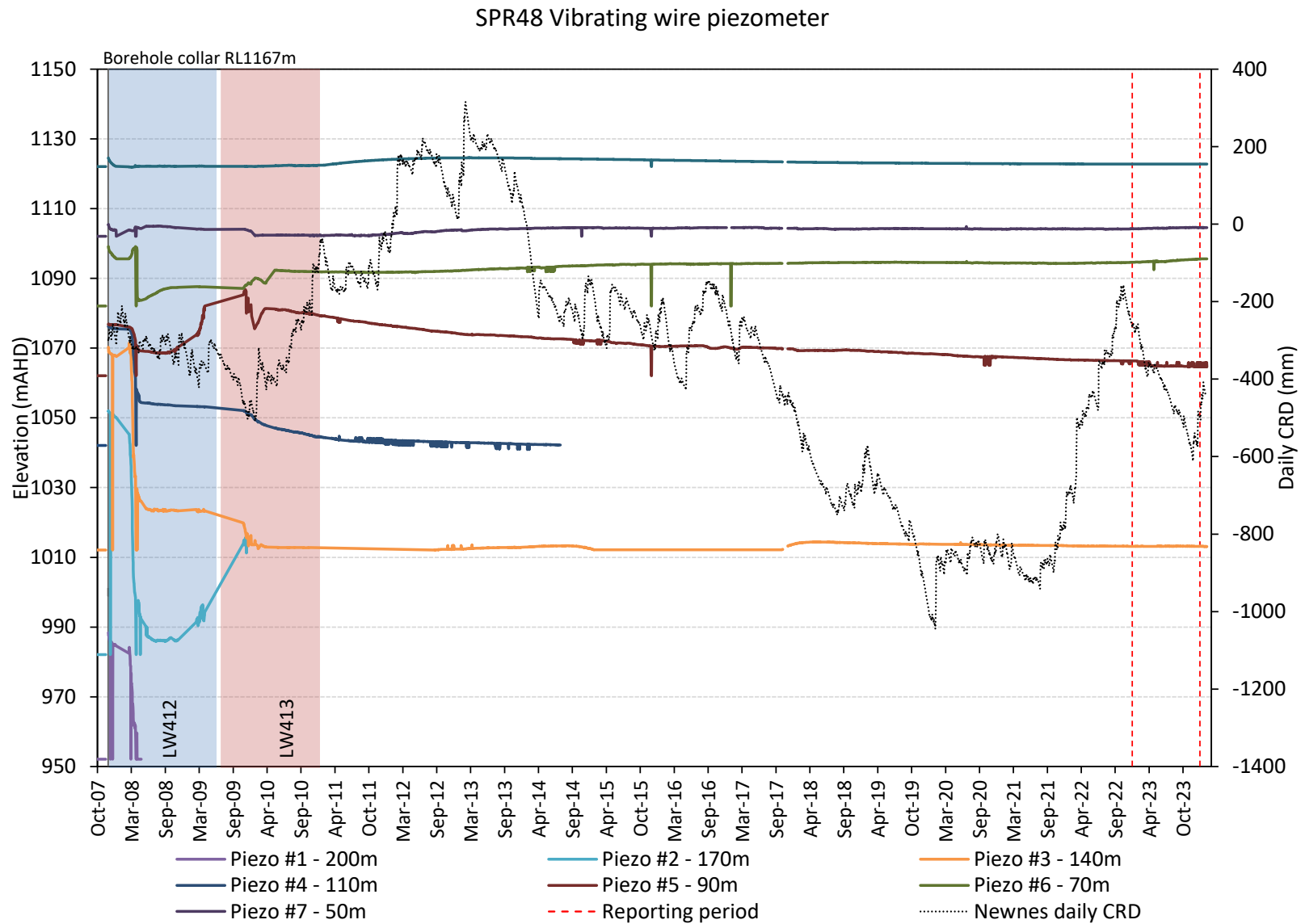


Figure 4.27 SPR48 hydrograph

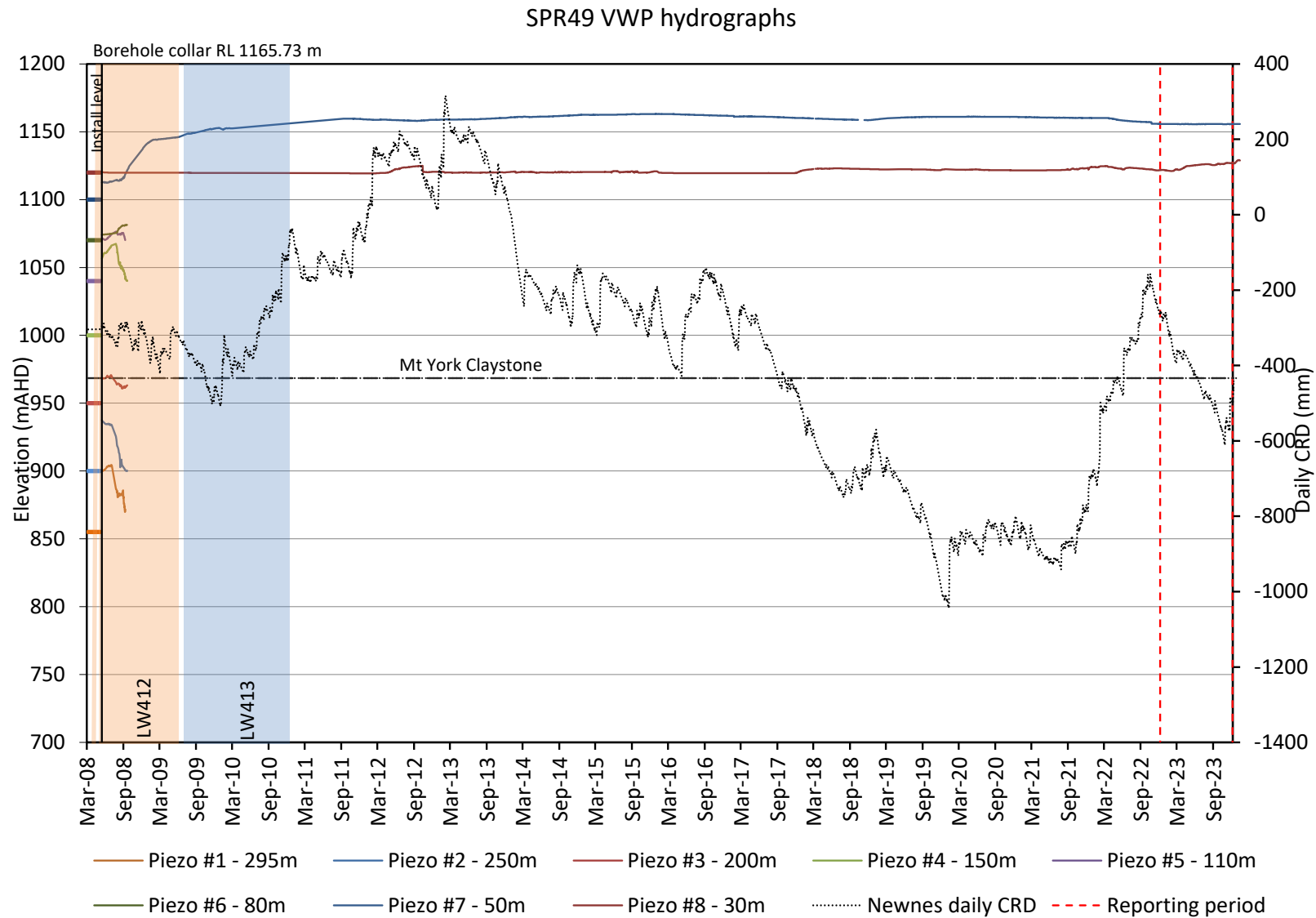


Figure 4.28 SPR49 hydrograph

SPR1210 Vibrating Wire Piezometer Hydrograph

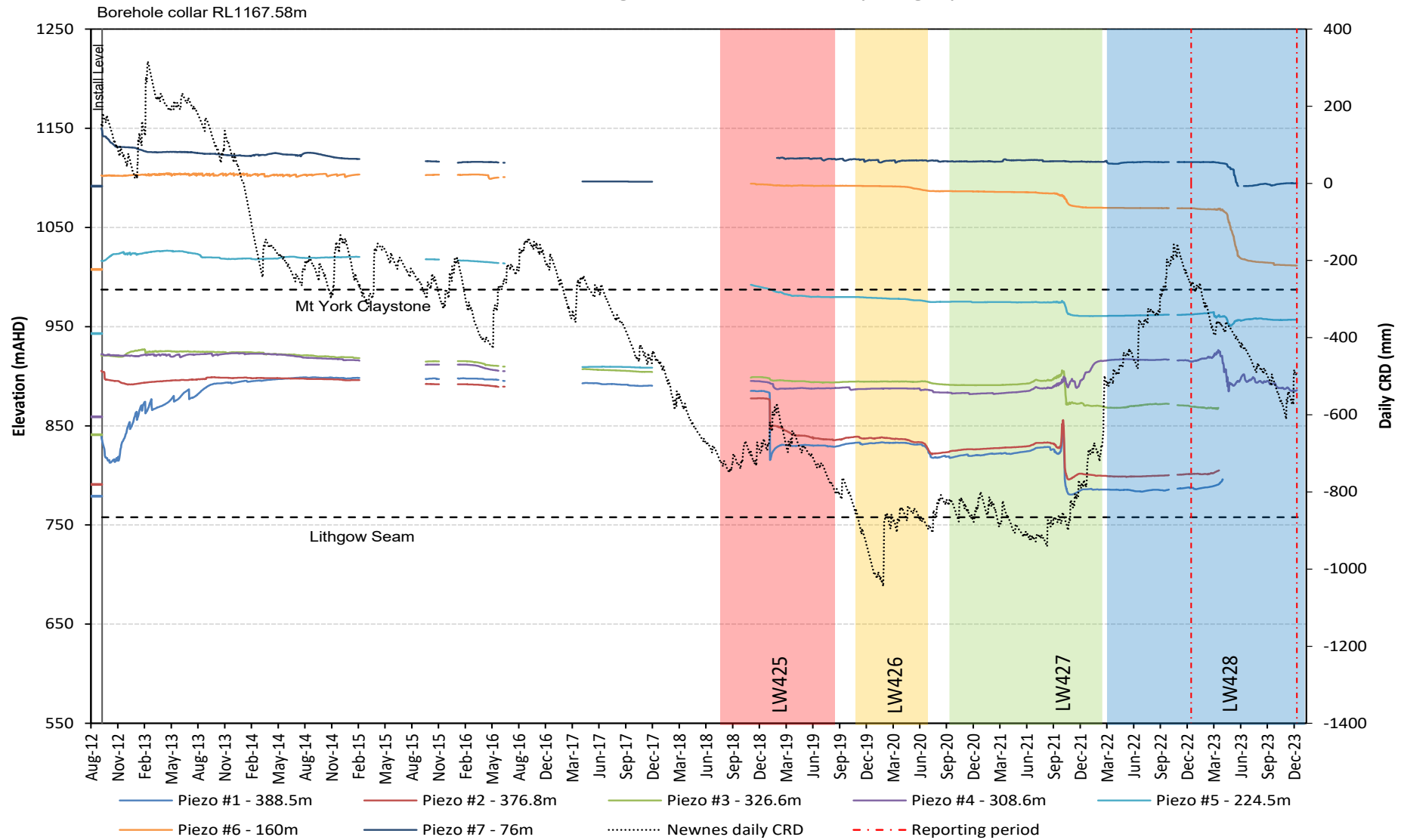


Figure 4.29 SPR1210 hydrograph

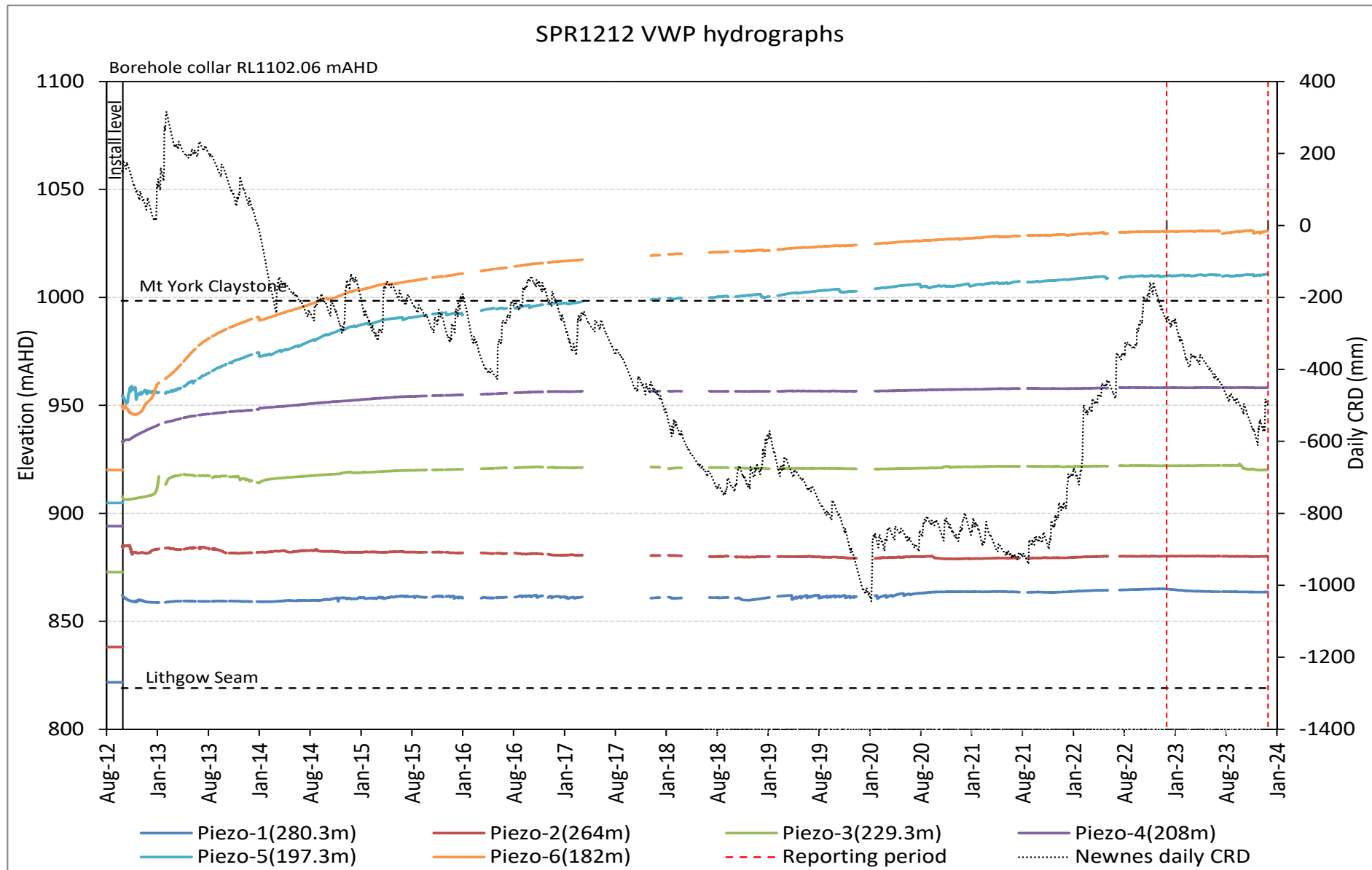


Figure 4.30 SPR1212 hydrograph

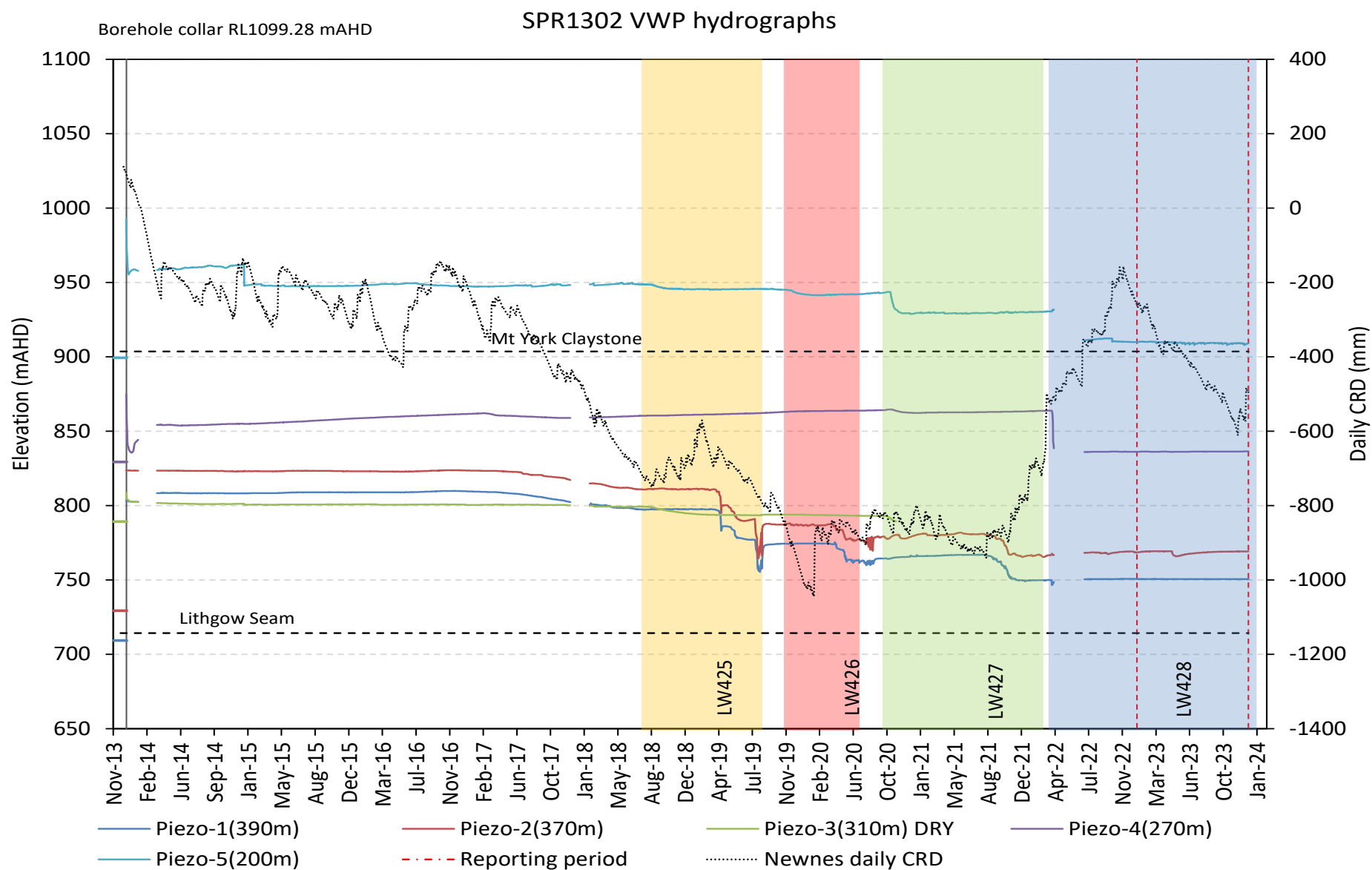


Figure 4.31 SPR1302 hydrograph

AP10PR VWP hydrographs

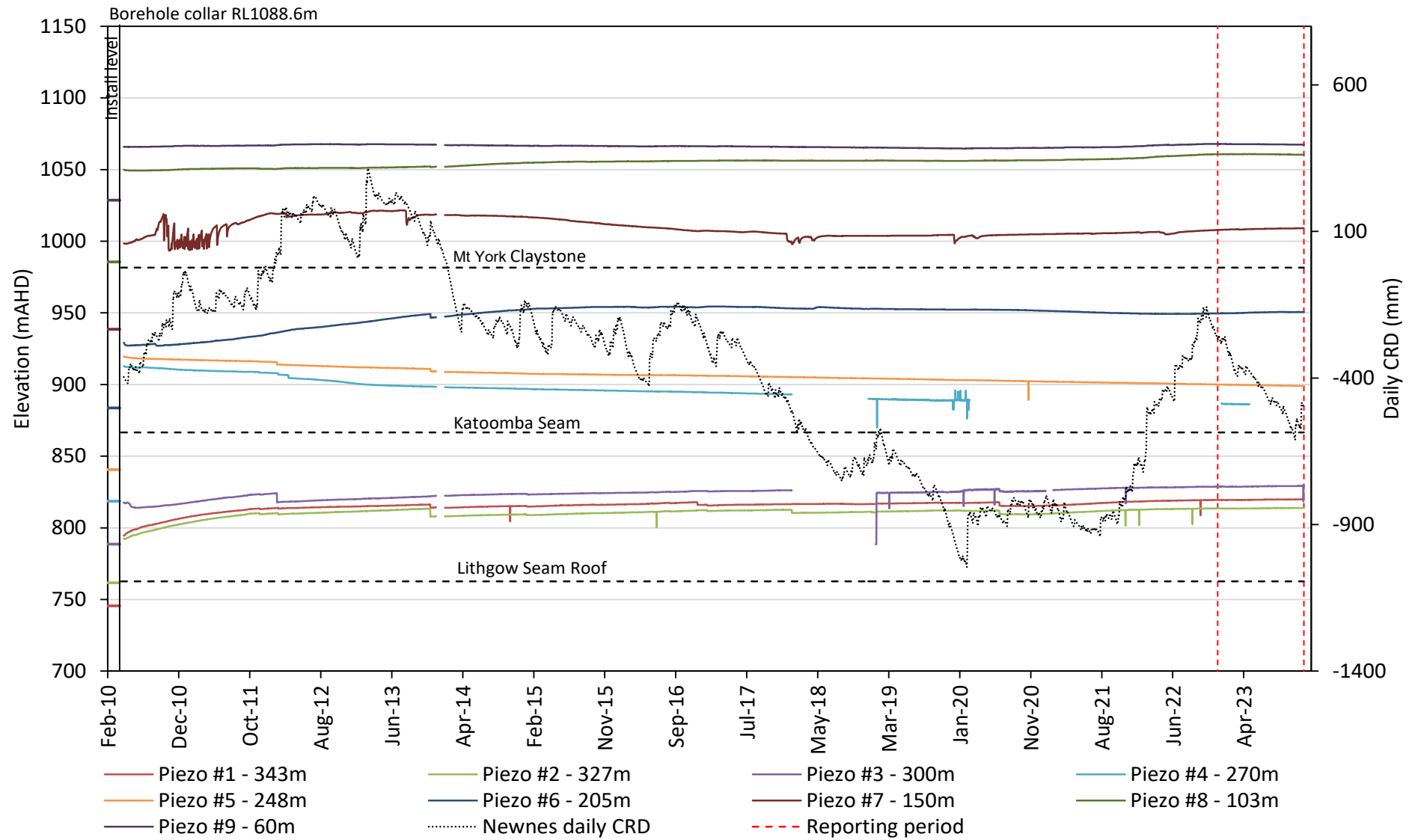


Figure 4.32 AP10PR hydrograph

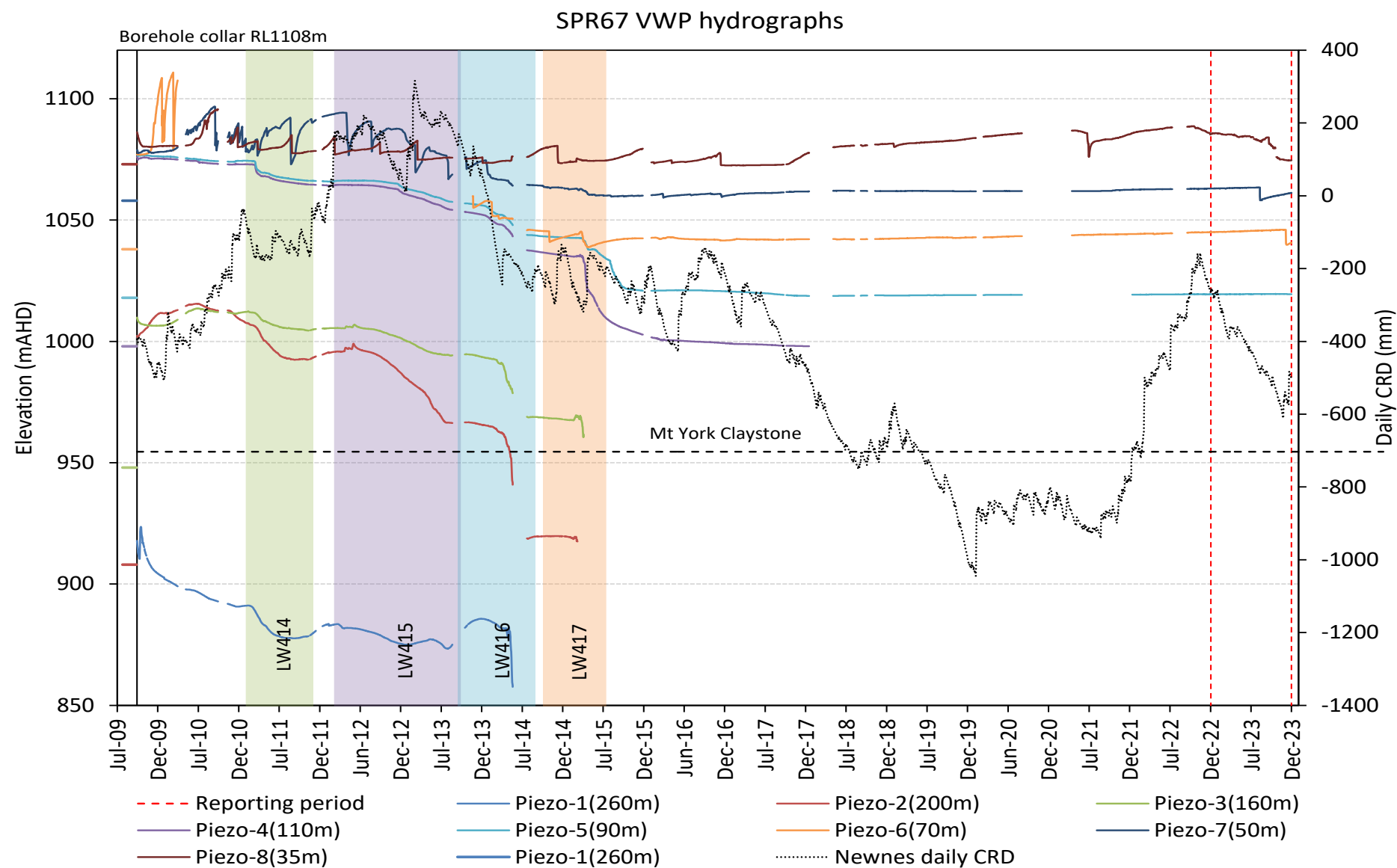


Figure 4.33 SPR67 hydrograph

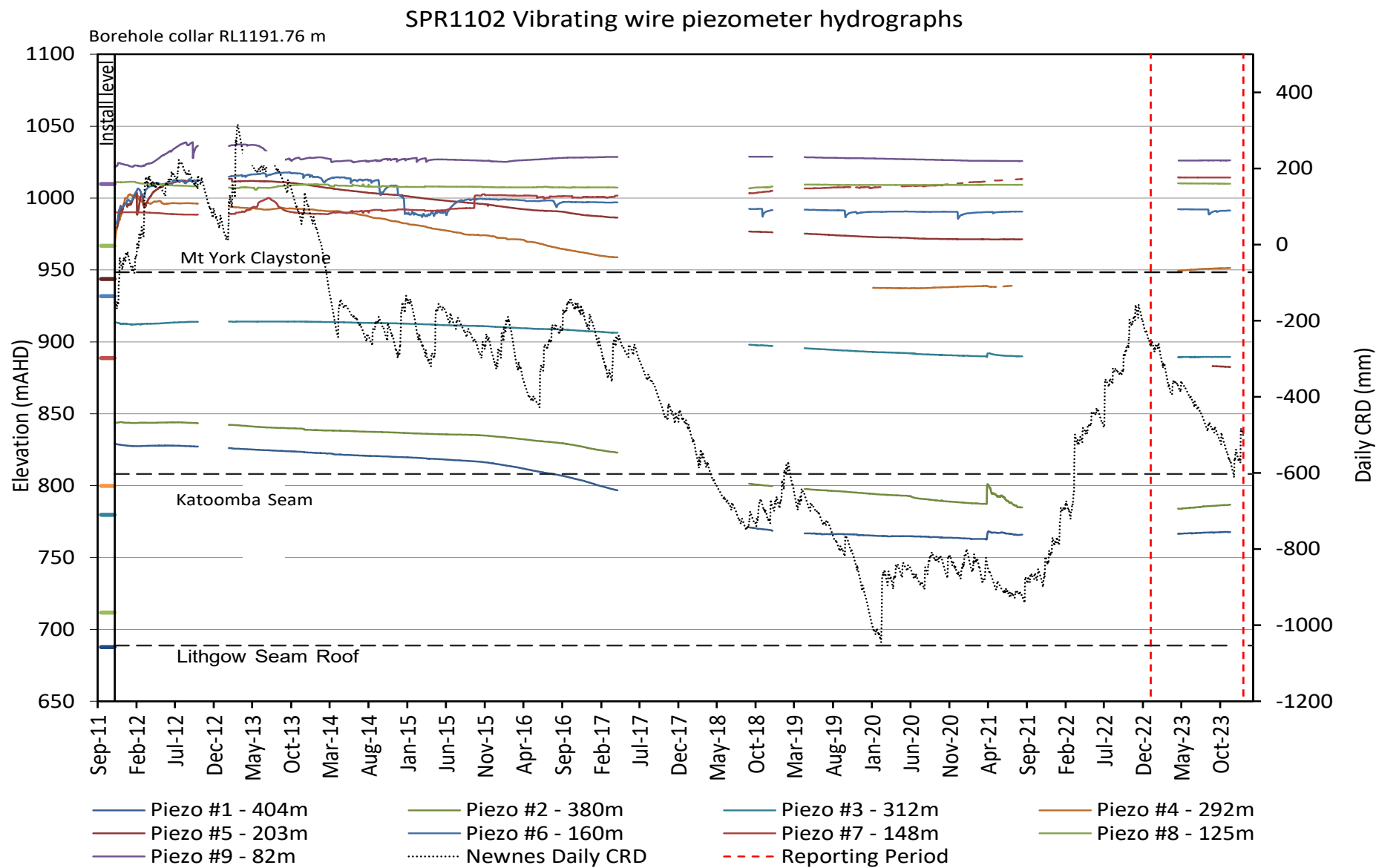


Figure 4.34 SPR1102 hydrograph

SPR1103 VWP hydrographs

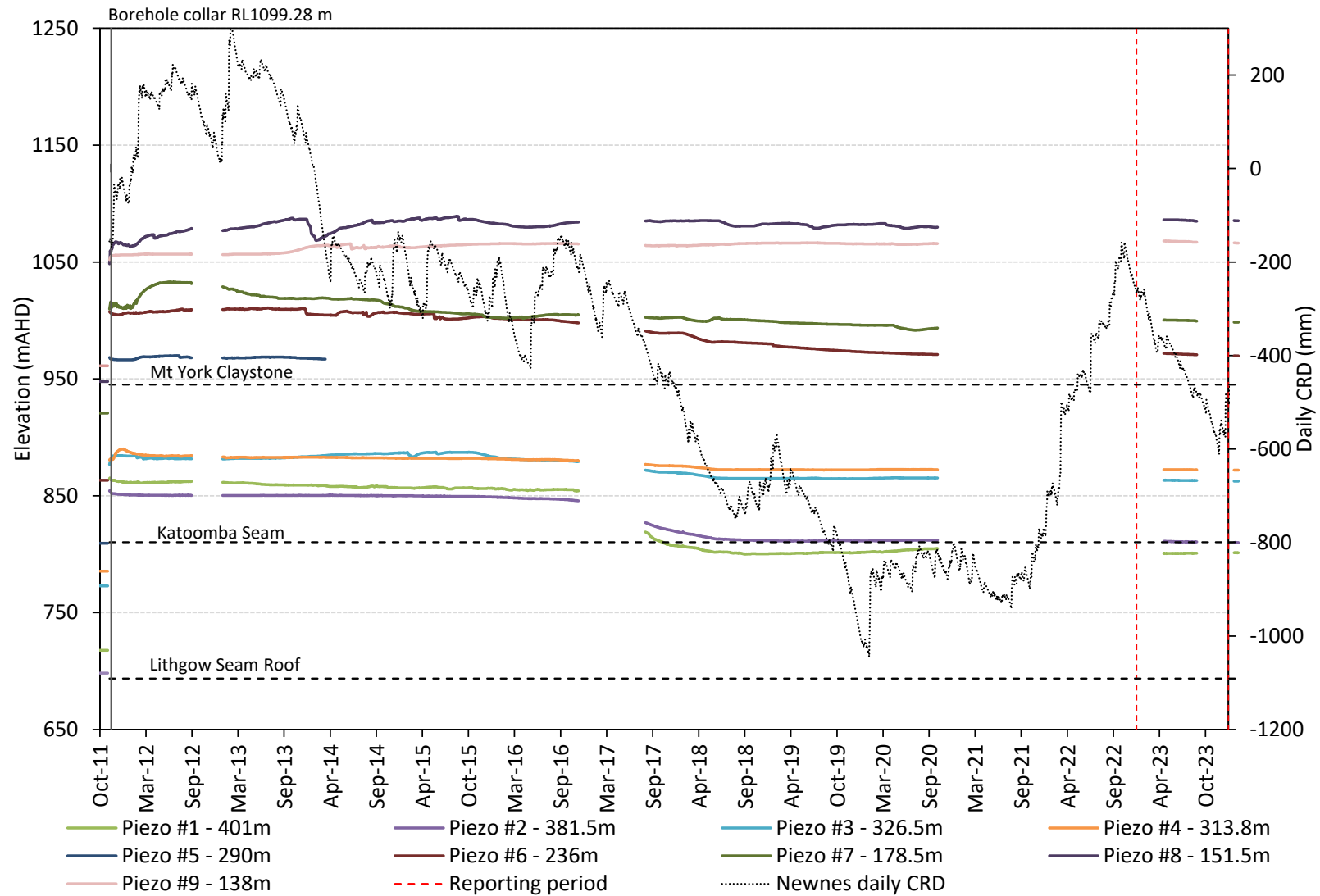


Figure 4.35 SPR1103 hydrograph

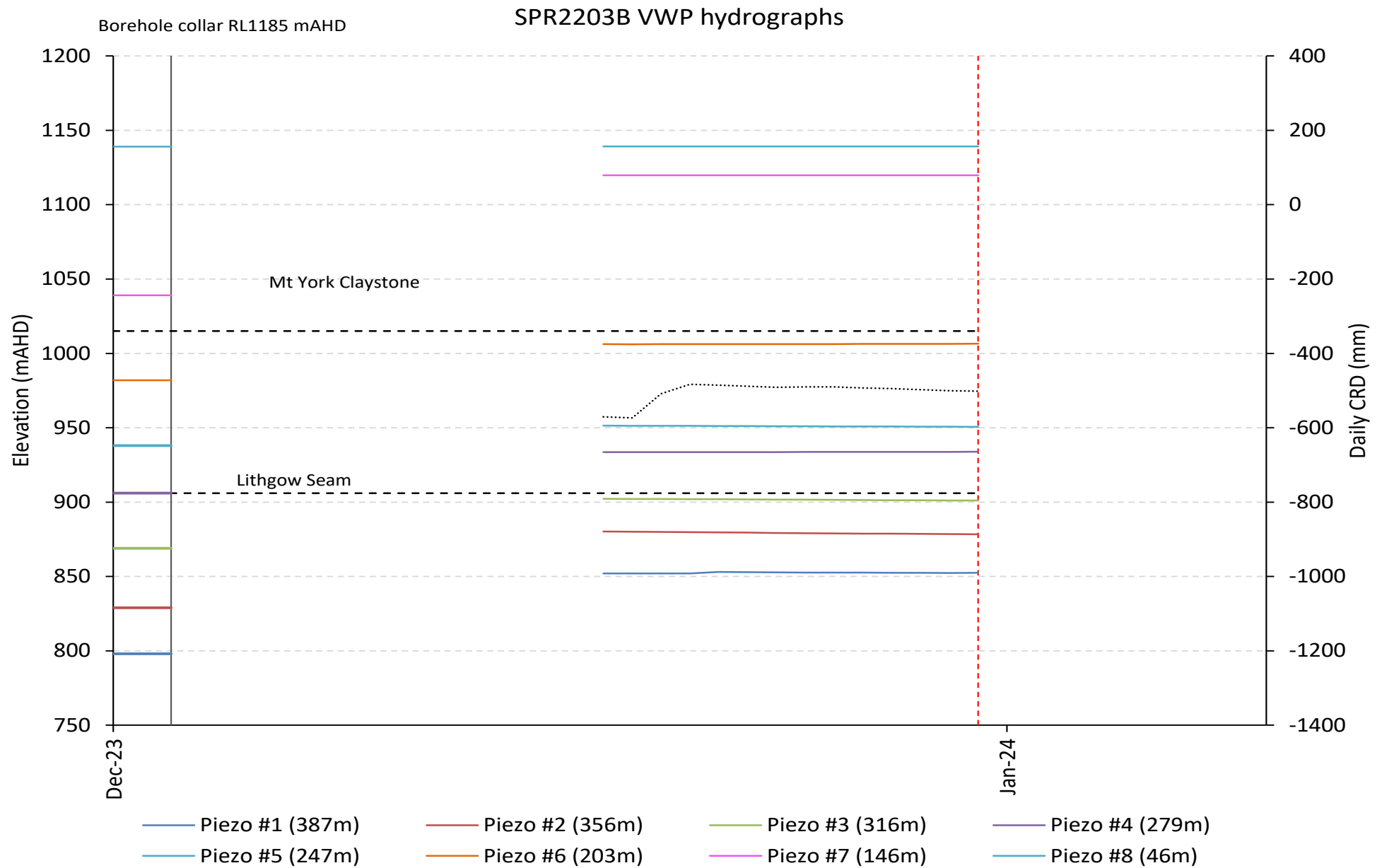


Figure 4.36 SPR2303B Hydrograph

5 Soil moisture monitoring

Soil moisture probes were installed within swamps, immediately adjacent to swamp piezometers, to provide data to support impact assessments and trigger investigations (Centennial, 2022a).

Soil moisture probes were installed between July and October 2018. The soil moisture systems were damaged in the 2019/2020 bushfires and were subsequently reinstated in September 2020. Four additional probes were installed in September 2021 at Lost City Swamp.

Table 5.1 provides commentary on the soil moisture trends. Time series for soil moisture sites are shown in Appendix D.

Table 5.1 Soil moisture monitoring trend summary

Monitoring ID	Site type	Comment
BA1SM	Reference	The 10 cm sensor has shown a decreasing trend since February, consistent with below average rainfall. Remaining sensors are fully saturated and showed slight declining trends from April to September. From September increasing trends were observed.
BA2SM	Reference	The 10 and 30 cm sensors showed decreasing trends from March to August and an increasing trend from August. The 20 cm sensor showed an increasing trend from April. All other sensors were fully saturated and showed increasing trends.
BA3SM	Reference	Increasing trends in all sensors. The 10 cm sensor showed decreased saturation between October and November due to below average rainfall. Remaining sensors were fully saturated.
BE1SM	Reference	The 10 cm sensor showed an increasing trend in June, then showed a decreasing trend. Remaining sensors were fully saturated and showed stable to slightly gradual increasing trends.
BE2SM	Reference	The 20 and 30 cm sensors showed decreasing trends and fluctuations consistent with rainfall. The 10 cm sensor showed a slightly increasing trend. Remaining sensors were fully saturated and show slight increasing trends.
BS1SM	Impact	The 10 cm sensor showed a decreasing trend consistent with below average rainfall. All other sensors were fully saturated and showed increasing trends, with a slight dip from May to August.
BS2SM	Impact	All sensors showed decreasing trends with fluctuations consistent with rainfall events.
BS3SM	Impact	The 10 and 20 cm sensors showed slightly increasing trend and fluctuations consistent with rainfall. Remaining sensors showed an increasing trend and were fully saturated.
BS4SM (PSS)	Impact	The 10, 20, 30 and 40 cm sensors showed decreasing trends which fluctuate with rainfall. Remaining sensors showed relatively stable trends and were fully saturated. A data gap exists between August and September, logger data may be obtained by re-downloading between the period of the data gap.
BS5SM (NMSS)	Impact	The 10 and 20 cm sensors are above ground. The 30 cm and 40 cm sensors fluctuated with rainfall. Remaining sensors show a gradual increasing trend and were fully saturated.
CC1SM	Reference	Increasing trends across all sensors. The 10, 20 and 30 cm sensors showed fluctuations consistent with rainfall. Sensors were fully saturated.
CC2SM	Reference	Sensors below 100 cm were relatively stable. Remaining sensors showed decreasing trends consistent with rainfall.
CW1SM	Impact	The 10 and 20 cm sensors are unsaturated. Remaining sensors fluctuated with rainfall and show a gradual increasing trend.
CW4SM	Impact	Sensors fluctuated with rainfall and showed slightly decreasing trends.

Table 5.1 **Soil moisture monitoring trend summary**

Monitoring ID	Site type	Comment
FS1SM	Reference	The 10, 20 and 30 cm sensors fluctuated with rainfall and showed a slight increasing trend. Remaining sensors showed slight increasing trends and were fully saturated.
FS2SM	Reference	All sensors fluctuated with rainfall and all but the 40 cm sensor showed decreasing trends.
GG2SM	Impact	The 10 cm sensor fluctuated with rainfall and showed a slight decreasing trend. Remaining sensors were reasonably stable, all with moisture below 40%.
GG3SM	Impact	The 10, 20, 30 and 40 cm sensors were dry. Remaining sensors fluctuated with rainfall and showed a decreasing trend.
GW1SM	Impact	The 10 and 20 cm sensors were dry. Remaining sensors fluctuated with rainfall and showed a decreasing trend with moisture levels generally ranging between 15 to 30%.
GW3SM	Impact	The 10cm sensor was dry. Remaining sensors fluctuated with rainfall and showed decreasing trend with moisture levels ranging between 5 to 25%.
LC1SM	Impact	All sensors were saturated and showed increasing trends.
LCN1SM	Impact	The 10 and 20 cm sensors fluctuated with rainfall. Remaining sensors showed increasing trends and were fully saturated.
LCS1SM	Impact	All sensors showed increasing trends.
LCS2SM	Impact	The 10 and 40 cm sensors remained stable. 30 and 50 cm sensors fluctuated with rainfall. All remaining sensors showed increasing trends.
MS1SM	Impact	The logger malfunctioned in June only showing spot data. Sensors 60 cm and deeper showed slightly increasing trends. Sensors above 60 cm showed declining trends.
MS2SM	Impact	All sensors showed decreasing trends.
MS3SM	Impact	All sensors showed decreasing trends.
PC1SM	Impact	The 10 and 20 cm sensors are unsaturated. Remaining sensors show increasing trends and were fully saturated.
PC2SM	Impact	The 10 cm sensor showed a declining trend. All other sensors showed increasing trends.
TG1SM	Impact	The 10, 20 and 30 cm sensors showed fluctuations with rainfall however remained relatively stable. The remaining sensors showed increasing trends.
TG2SM	Reference	The 10 to 40 cm sensors fluctuated with rainfall however remained relatively stable. Remaining sensors show slight increasing trends.
TS2SM	Reference	The 10, 20, 30 and 40 cm sensors showed decreasing trends and fluctuations consistent with rainfall. The 50, 60, 70 and 80 cm sensors showed fluctuations throughout the reporting period. Sensors from 90 cm show gradual increasing trends and were fully saturated.
TS3SM	Reference	All sensors showed gradual increasing trends. Sensor 10 cm fluctuated with rainfall. Remaining sensors were fully saturated.

6 Swamp groundwater quality

Section 6.1 and Section 6.2 summarise trends of key groundwater quality parameters at reference and impact sites, respectively. The sections include a review of the swamp piezometers compliance status against respective site-specific trigger values.

The timeseries charts for swamp water quality are provided in Appendix G. Tabulated statistics are provided in Appendix F.

6.1 Reference sites

6.1.1 Barrier Swamp

Table 6.1 Barrier Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
BA1	18/03/2018 – present	Monthly	pH	Declining trend, fluctuations within historical observations.
	18/03/2018 – present	Monthly	EC	Stable – fluctuating within historical observations.
BA2	18/03/2018 – present	Monthly	pH	Declining trend, fluctuations within historical observations.
	18/03/2018 – present	Monthly	EC	Trend within historical observations including peaks recorded in January, February and March.
BA3	18/03/2018 – present	Monthly	pH	Declining trend, fluctuations within historical observations.
	18/03/2018 – present	Monthly	EC	Stable – fluctuating within historical observations.

6.1.2 Best Swamp

Access to Best Swamp was reported as limited due to degraded road conditions and road closures. Limited sampling occurred during the reporting period.

Table 6.2 Best Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
BE1	18/03/2018 – present	Monthly	pH	Insufficient data to determine trends.
	18/03/2018 – present	Monthly	EC	Insufficient data to determine trends.
BE2	18/03/2018 – present	Monthly	pH	Insufficient data to determine trends.
	18/03/2018 – present	Monthly	EC	Insufficient data to determine trends.

6.1.3 Carne Central Swamp

Table 6.3 Carne Central Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
CC1	12/06/2012 – present	Monthly	pH	Declining trend with fluctuations similar to 2022.
	12/06/2012 – present	Monthly	EC	Generally stable. Average conductivity comparable to previous year but lower than other historical observations.
CC2	8/07/2019 – present	Monthly	pH	Declining trend with fluctuations similar to 2022.
	8/07/2019 – present	Monthly	EC	Fluctuations within historical observations.

6.1.4 Firetail Swamp

Access to Firetail Swamp was reported as limited due to degraded road conditions and road closures. Limited sampling occurred during the reporting period.

Table 6.4 Firetail Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
FS1	18/03/2018 – present	Monthly	pH	No data available during the reporting period.
	18/03/2018 – present	Monthly	EC	No data available during the reporting period.
FS2	29/05/2019 – present	Monthly	pH	No data available during the reporting period.
	29/05/2019 – present	Monthly	EC	No data available during the reporting period.

6.1.5 Twin Gully Swamp

Access to Twin Gully Swamp was limited due to degraded access tracks.

Table 6.5 Twin Gully Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
TG1	15/10/2012 – present	Monthly	pH	No data available during the reporting period.
	15/10/2012 – present	Monthly	EC	No data available during the reporting period.
TG2	19/11/2018 – present	Monthly	pH	No data available during the reporting period.
	19/11/2018 – present	Monthly	EC	No data available during the reporting period.

6.1.6 Tristar Swamp

Table 6.6 Tristar Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
TS1	12/06/2014 – present	Monthly	pH	Slight declining trend consistent with historical observations.
	12/06/2014 – present	Monthly	EC	Stable trend, within historical observations.
TS2	16/10/2012 – present	Monthly	pH	Stable slight declining trend consistent with historical observations.
	16/10/2012 – present	Monthly	EC	Stable trend, within historical observations.
TS3	17/10/2012 – present	Monthly	pH	Stable trend, within historical observations.
	17/10/2012 – present	Monthly	EC	Declining trend, within historical observations.

6.2 Impact sites

6.2.1 Sunnyside Swamp

Sunnyside Swamp is an impact swamp overlying LW413–LW414. Water quality sampling commenced after mining began in LW413-LW414 and subsequently there is no baseline pre-mining data and no triggers defined.

Table 6.7 Sunnyside Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
SS1	22/02/2011 – present	Monthly	pH	No baseline trigger value applicable as mining of LW413 commenced before monitoring. Trend is stable and within historical observations.
		Monthly	EC	No baseline trigger value applicable as mining of LW413 commenced before monitoring. Trend is stable and within historical observations.
SS5	22/02/2011 – present	Monthly	pH	No baseline trigger value applicable as mining of LW413 commenced before monitoring. No data available for 2023 due to a tree being reportedly down.
		Monthly	EC	No baseline trigger value applicable as mining of LW413 commenced before monitoring. No data available for 2023 due to a tree being reportedly down.

6.2.2 Sunnyside East Swamp

Sunnyside East Swamp is an impact swamp that overlies LW416–LW418. It has been predominately dry since mid-2013 and limited samples have been collected since 2017 due to dry conditions.

Table 6.8 Sunnyside East Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
SSE2	12/06/2012 – present	Monthly	pH	Dry. No data available over the reporting period.
		Monthly	EC	Dry. No data available over the reporting period.
SSE3	22/02/2011 – present	Monthly	pH	Dry. No data available over the reporting period.
		Monthly	EC	Dry. No data available over the reporting period.

6.2.3 Carne West Swamp

Carne West is an impact swamp that overlies LW417–LW419. It has been predominately dry since 2016.

Table 6.9 Carne West Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
CW1	22/02/2011 – present	Monthly	pH	Dry.
		Monthly	EC	Dry.
CW2	22/02/2011 – present	Monthly	pH	Dry.
		Monthly	EC	Dry.
CW4	22/02/2011 – present	Monthly	pH	Dry.
		Monthly	EC	Dry.

6.2.4 Gang Gang West Swamp

Gang Gang West is an impact swamp that overlies LW419. It has been predominately dry since 2016, including over 2023.

Table 6.10 Gang Gang West Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
GW1	13/12/2012 – present	Monthly	pH	Dry.
		Monthly	EC	Dry.

6.2.5 Gang Gang East Swamp

Gang Gang East is an impact swamp that overlies LW419. It has been predominately dry since 2018. More regular samples were collected from February following above average rainfall during since February 2020.

Table 6.11 Gang Gang Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
GG1	16/10/2012 – present	Monthly	pH	Slight downward trend observed and fluctuation within trigger limits.
		Monthly	EC	Slight upward trend with fluctuations within the trigger limits.

6.2.6 Pine Swamp

Pine is an impact swamp within the TIA for LW424–LW427. BS2 has been predominately dry since 2019. Recent data is from February onwards due to above average rainfall since February 2020.

Table 6.12 Pine Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
BS2	15/10/2012 – present	Monthly	pH	Reported dry from May. Limited data available to determine trends. Single exceedance of upper trigger level in May.
		Monthly	EC	Reported dry from May. Limited data available to determine trends
BS3	15/10/2012 – present	Monthly	pH	Upward trend, within trigger levels.
		Monthly	EC	Slight upward trend, within trigger levels.
PSS (BS4)	18/02/2018 – present	Monthly	pH	Upward trend, within trigger levels. Single exceedance of the lower trigger limit in July.
		Monthly	EC	Slight upward trend, within trigger levels.

6.2.7 Nine Mile Swamp

Nine Mile is an impact swamp within the TIA for LW420–LW427.

Table 6.13 Nine Mile Swamp groundwater quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
BS1	16/10/2012 – present	Monthly	pH	Generally stable trend. Upper pH trigger level was exceeded in May 2023 and lower pH trigger level was exceeded in July and August 2023.
		Monthly	EC	Generally stable trend.

Table 6.13 **Nine Mile Swamp groundwater quality summary**

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
NMSS (BS5)	18/02/2018 – present	Monthly	pH	Generally stable trend. Upper pH trigger level was exceeded in June 2023 and lower pH trigger level was exceeded in February and July 2023.
		Monthly	EC	Generally stable trend.

6.2.8 Marrangaroo Swamp

Marrangaroo is an impact swamp in proximity of LW428. MS3 was within the TIA when works for LW427 commenced in 2020 however sampling commenced in 2022.

Table 6.14 **Marrangaroo Swamp groundwater quality summary**

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
MS1	12/06/2012 – present	Monthly	pH	Generally stable trend, within trigger limits.
		Monthly	EC	Generally stable trend, within trigger limits.
MS2	19/11/2018 – present	Monthly	pH	Limited data available due to a reported blockage. Generally fluctuates within trigger limits.
		Monthly	EC	Limited data available due to a reported blockage. Generally fluctuates within trigger limits.
MS3	27/06/2022 – present	Monthly	pH	Generally stable trend.
		Monthly	EC	Generally stable trend.

6.2.9 Paddys Creek Swamp

Paddys Creek is an impact swamp within the TIA for LW424–LW427. Water quality sampling commenced after mining began in LW415 and subsequently there is no baseline pre-mining data and no triggers defined.

Table 6.15 **Paddys Creek Swamp groundwater quality summary**

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
PC1	18/02/2018 – present	Monthly	pH	No baseline data applicable to this site. Trends within historical limits apart for a single high value (7.6) recorded in May.
		Monthly	EC	No baseline data applicable to this site. Trends within historical limits apart for a single low value (29) in May.
PC2	18/02/2018 – present	Monthly	pH	No baseline data applicable to this site. Trends within historical limits apart for a single high value (7.8) in May.
		Monthly	EC	No baseline data applicable to this site. Generally stable trend.

6.2.10 Lost City Swamp

Lost City is an impact swamp within the TIA for LW428–LW432. Water quality sampling commenced in 2022 and no baseline is applicable because the site was established after the LW424-427 SMP.

Table 6.16 **Lost City Swamp groundwater quality summary**

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
LC1	27/06/2022 – present	Monthly	pH	No baseline applicable to this site. Stable trend, fluctuates during the reporting period within historical observations.
		Monthly	EC	No baseline applicable to this site. Stable slight declining trend.
LCN1	27/06/2022 – present	Monthly	pH	No baseline applicable to this site. Fluctuating trend with lowest historical observation (pH 4.4) recorded in June.
		Monthly	EC	No baseline applicable to this site. Slight increasing trend.
LCS1	27/06/2022 – present	Monthly	pH	No baseline applicable to this site. Fluctuates, largest recorded pH of 5.7 in April and lowest recorded pH of 4.2 in October.
		Monthly	EC	No baseline applicable to this site. Stable trend. Highest recorded EC in October of 80 us/cm.
LCS2	27/06/2022 – present	Monthly	pH	No baseline applicable to this site. Slightly upward trend. Fluctuates during the reporting period. Spike in April.
		Monthly	EC	No baseline applicable to this site. Fluctuates, largest recorded pH of 6.0 in April and lowest recorded pH of 4.0 in October.

7 Shallow aquifer groundwater quality

The timeseries for long term shallow groundwater quality trends are shown in Appendix G and tabulated statistics are shown in Appendix F. Table 7.1 summarises the trends of key groundwater quality parameters at reference and impact sites, and reviews the standpipes piezometers compliance status against respective site-specific trigger values outlined in Section 3.3.

Table 7.1 Shallow aquifer groundwater quality summary

Monitoring ID	Site type	Date range	Frequency	Analyte	2023 water quality comment
AP9PR	Reference	17/03/2016 – present	Quarterly	pH	Upward trend.
			Quarterly	EC	Stable trend.
AP8PR	Reference	17/03/2016 – present	Quarterly	pH	Upward trend.
			Quarterly	EC	Upward trend. Single spike in early June, within trigger levels.
AP5PR	Reference	17/03/2016 – present	Quarterly	pH	Upward trend.
			Quarterly	EC	Stable trend. High EC in early June but below triggers level.
AP4PR	Reference	17/03/2016 – present	Quarterly	pH	Upward trend.
			Quarterly	EC	Downward trend.
AP1204	Reference	17/03/2016 – present	Quarterly	pH	Upward trend.
			Quarterly	EC	Slightly upward trend. Single upper trigger level exceedance in early June (104.6 $\mu\text{S}/\text{cm}$).
AP1105	Reference	4/12/2018 – present	Quarterly	pH	Upward trend.
			Quarterly	EC	Stable trend.
AP10PR	Reference	6/12/2022 – present	Quarterly	pH	Site added in December 2022. Upward trend.
			Quarterly	EC	Site added in December 2022. Stable trend.
SPR1401	Impact	17/03/2016 – present	Quarterly	pH	Upward trend.
			Quarterly	EC	Upward trend. Single spike in early June, within trigger levels.
SPR1109	Impact	18/03/2016 –	Not sampled	pH	Damaged by subsidence.
		30/11/2016	Not sampled	EC	Damaged by subsidence.
SPR1106	Impact	18/03/2016 – present	Quarterly	pH	Limited data available. Generally stable.
			Quarterly	EC	Limited data available. Generally stable.
SPR1210	Impact	5/03/2019 – 28/05/2019	Not sampled	pH	No data available since June 2019. Too low and muddy to sample.
			Not sampled	EC	No data available since June 2019. Too low and muddy to sample.

Table 7.1 **Shallow aquifer groundwater quality summary**

Monitoring ID	Site type	Date range	Frequency	Analyte	2023 water quality comment
SPR1211	Impact	4/12/2018 – 12/09/2019	Not sampled	pH	Damaged by subsidence between October 2019 and March 2020.
			Not sampled	EC	Damaged by subsidence between October 2019 and March 2020.
SPR1301	Impact	4/12/2018 – present	Quarterly	pH	Historical trend of continual exceedances. Elevated pH attributed to grout contamination and not representative of natural conditions. pH trending downwards and value within the trigger limits.
			Quarterly	EC	EC constantly exceeding the trigger level. Elevated concentration attributed to grout contamination and is not representative of natural conditions. EC trending downwards and value within the trigger limits in September.
RSS	Impact	17/03/2016 – present	Quarterly	pH	Upward trend.
			Quarterly	EC	Upward trend, within historical observations after 2020.
SPR1806	Impact	3/12/2020 – present	Quarterly	pH	Downward trend, within trigger limits.
			Quarterly	EC	Stable trend.
SPR1807	Impact	5/07/2019 – 14/02/2020	Quarterly	pH	Dry since shortly after installation. No data available.
			Quarterly	EC	
SPR1808	Impact	2/12/2020 – present	Quarterly	pH	Dry – No data available since June 2022.
			Quarterly	EC	Dry – No data available since June 2022.

8 Bore 6 and 8

Bore 6 and 8 are dewatering bores that provide indicative water quality of mine inflows. They can also be influenced by underground mining activities. The timeseries charts for water quality are provided in Appendix E. Tabulated statistics are provided in Appendix F. In general, both sites show variability that is consistent with previous observations.

Table 8.1 Bore 6 and Bore 8 groundwater quality summary for 2023

Bore ID	Date Range	Frequency	Analyte	Units	Minimum	Median	Maximum
Bore 6	4/09/2009 – present	Weekly	pH	Units	6.11	7.43	11.82
			EC	µS/cm	115	1,138.0	2,881
			Iron	mg/L	0.05	0.33	3.47
Bore 8	15/01/2012 – present	Weekly	pH	Units	5.5	7.64	8.59
			EC	µS/cm	228	1,201.5	2,532
			Iron	mg/L	0.05	0.14	3.24

9 Swamp surface water quality and flow (SMP)

Section 9.1 and Section 9.2 summarise the trends of key surface water quality parameters at reference and impact swamp sites, respectively. The sections also provide comparison of the sites compliance status against respective site-specific trigger values outlined in Section 3.3.

The timeseries for long term water quality trends are shown in Appendix G and tabulated statistics are shown Appendix H.

9.1 Reference sites

9.1.1 Barrier Swamp

Table 9.1 Barrier Swamp surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Barrier Swamp	27/09/2016 – present	Fortnightly/monthly	pH	Slightly downward trend. One high pH values in June (8.3).
		Fortnightly/monthly	EC	Slightly upward trend. One high EC values in May (103 µS/cm).
		Fortnightly/monthly	Flow	Downward trend due to below average rainfall but higher flow and bigger fluctuations compared to historical pattern, due to higher than average rainfall during 2022.

9.1.2 Best Creek

There is limited data for the reporting period due to access constraints.

Table 9.2 Best Creek surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Best Creek	24/11/2017 – present	Fortnightly/monthly	pH	No data from March 2022.
		Fortnightly/monthly	EC	No data from March 2022.
		Fortnightly/monthly	Flow	No data from March 2022.

9.1.3 Carne Central Swamp

Table 9.3 Carne Central Swamp surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Carne Central Swamp	27/09/2016 – present	Fortnightly/monthly	pH	Downward trend. One high value recorded in February (8.2 pH).
		Fortnightly/monthly	EC	Stable.
		Fortnightly/monthly	Flow	No flow data.

9.1.4 Firetail Swamp

There was limited access to the site due to road closures.

Table 9.4 Firetail surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Firetail	24/11/2017 – present	Fortnightly/monthly	pH	No data from September 2022.
		Fortnightly/monthly	EC	No data from September 2022.
		Fortnightly/monthly	Flow	No data from September 2022.

9.1.5 Tristar Swamp

Table 9.5 Tristar surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Tristar (Springvale site)	2/11/2016 – present	Fortnightly/monthly	pH	Fluctuating within historical limits. Downward trend. Lowest value recorded in July (3.1).
		Fortnightly/monthly	EC	Generally stable trend. Highest value recorded in July (210 µS/cm).
		Fortnightly/monthly	Flow	Downward trend due to below average rainfall.

9.1.6 Twin Gully Swamp

Access was limited during the reporting period due to degraded track conditions. Only one data point was available in 2023 (March 2023).

Table 9.6 Twin Gully surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Twin Gully (Springvale site)	2/11/2016 – present	Fortnightly/monthly	pH	Generally stable trend.
		Fortnightly/monthly	EC	Stable.
		Fortnightly/monthly	Flow	Generally stable, slightly increasing flow due to above average rainfall during 2022.

9.2 Impact Site

9.2.1 Carne West Swamp

Table 9.7 Carne Swamp surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Carne Swamp	5/01/2005 – present	Fortnightly/monthly	pH	Single exceedance of the upper pH trigger level in March. Stable, remaining values within historical observations. Data available only for January and March 2023.
		Fortnightly/monthly	EC	Limited data available. Stable trend between January and March 2023.
		Fortnightly/monthly	Flow	No data available. Water level too low for flow monitoring or pooled water.

9.2.2 Gang Gang West Swamp

Surface water monitoring commenced after impact therefore no trigger levels were developed.

Table 9.8 Gang Gang West Swamp surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Gang Gang South West	27/09/2016 – present	Fortnightly/monthly	pH	Slightly upward trend, fluctuating within historical range.
		Fortnightly/monthly	EC	Stable trend. Slightly high EC recorded in late May and June (44.98 and 53 µS/cm, respectively).
		Fortnightly/monthly	Flow	No data available.

9.2.3 Gang Gang East

Table 9.9 Gang Gang East surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Gang Gang East	27/09/2016 – present	Fortnightly/monthly	pH	Slightly downward trend, values within historical observations. Low values recorded in July (4.8) and August (5 and 4.8, respectively).
		Fortnightly/monthly	EC	Slightly upward trend. Two consecutive exceedances of the 80 th % trigger in mid- August (39 µS/cm) and late-August (42 µS/cm).
		Fortnightly/monthly	Flow	Too low to sample.

9.2.4 Marrangaroo Swamp

Table 9.10 Marrangaroo Swamp surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Marrangaroo Swamp	24/11/2017 – present	Fortnightly/monthly	pH	Slightly downward trend, within trigger levels.
		Fortnightly/monthly	EC	One single exceedances in January (774 $\mu\text{S}/\text{cm}$). Generally stable trend.
		Fortnightly/monthly	Flow	Flows consistent with historical observations. High flow recorded in January.

9.2.5 Nine Mile Swamp

Table 9.11 Nine Mile Swamp surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
9 Mile Swamp	27/11/2017 – present	Fortnightly/monthly	pH	Downward trend, values within trigger thresholds.
		Fortnightly/monthly	EC	Upwards trend, two non-consecutive exceedances in June (72 $\mu\text{S}/\text{cm}$) and September (76 $\mu\text{S}/\text{cm}$).
		Fortnightly/monthly	Flow	No data because water level too low for flow monitoring.

9.2.6 Sunnyside Swamp

Table 9.12 Sunnyside Swamp surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Sunnyside U/S Junction	31/03/2006 – present	Fortnightly/monthly	pH	Downward trend, within historical observations.
		Fortnightly/monthly	EC	High value in April (95 $\mu\text{S}/\text{cm}$). Slightly upward trend.
		Fortnightly/monthly	Flow	Declining flow due to below average rainfall.
Sunnyside Swamp Upstream	24/05/2005 – present	Fortnightly/monthly	pH	Slightly upward trend, fluctuations within historical observations.
		Fortnightly/monthly	EC	Generally stable trend.
		Fortnightly/monthly	Flow	Limited data available. Water level generally pooled or too low for flow monitoring.
Sunnyside Swamp Downstream	24/05/2005 – present	Fortnightly/monthly	pH	Generally stable, fluctuating within historical limits.
		Fortnightly/monthly	EC	Generally stable trend.
		Fortnightly/monthly	Flow	Fluctuating more than historical records. Declining trend.

9.2.7 Sunnyside East Swamp - Downstream

Surface water monitoring commenced after impact therefore no trigger levels were developed.

Table 9.13 Sunnyside East downstream surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
SS3 D/S	10/06/2010 – present	Fortnightly/monthly	pH	Dry since 2015.
		Fortnightly/monthly	EC	Dry since 2015.
		Fortnightly/monthly	Flow	Dry since 2015.

9.2.8 Sunnyside East Swamp - Upstream

Surface water monitoring commenced after impact therefore no trigger levels were developed.

Table 9.14 Sunnyside East upstream surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Sunnyside East	21/03/2016 – present	Fortnightly/monthly	pH	Slightly downward trend, values within historical observations.
		Fortnightly/monthly	EC	Slightly downward trend, values within historical observations.
		Fortnightly/monthly	Flow	Too low for flow monitoring.

9.2.9 Paddys Creek

Table 9.15 Paddys Creek surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Paddys Creek	24/11/2017 – present	Fortnightly/monthly	pH	Stable, values within trigger thresholds.
		Fortnightly/monthly	EC	Generally stable trend with significant fluctuations. Five non-consecutive exceedances of the upper trigger level in early and mid-May (297 and 52 µS/cm, respectively), July (76 µS/cm), August (55 µS/cm) and September (102 µS/cm).
		Fortnightly/monthly	Flow	High flow from May.

9.2.10 Pine/Nine Mile Swamp

Table 9.16 Pine/Nine Mile Swamp surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Pine/9 Mile Swamp	27/11/2017 – present	Fortnightly/monthly	pH	Trend consistent with Pine Swamp monitoring site. One single exceedance of the upper pH trigger level in April (8.1).
		Fortnightly/monthly	EC	Upward trend but fluctuating within historical limits.
		Fortnightly/monthly	Flow	Flow not sustained due to below average rainfall in 2023.

10 Tributary surface water quality and flow

Table 10.1 to Table 10.6 summarises the trends of key surface water quality parameters at reference and impact tributary sites and reviews the sites compliance status against respective site-specific trigger values outlined in Section 3.3.

The timeseries for long term water quality trends are shown in Appendix G and tabulated statistics are shown in Appendix H.

10.1.1 Carne Central Tributary

Table 10.1 Carne Central surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Carne Central	21/03/2016 – present	Fortnightly/monthly	pH	Stable trend with fluctuations within historical observations except for pH recorded in February (8.1 pH).
		Fortnightly/monthly	EC	Slightly upward trend.
		Fortnightly/monthly	Flow	Limited data available because after June the water level become too low to measure, differently from 2022 when the flow was high due to above average rainfall.

10.1.2 Wolgan River

Table 10.2 Wolgan River surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Wolgan River Downstream	4/01/2002 – present	Fortnightly/monthly	pH	Fluctuating within historical values, low pH recorded in July (4.8 pH).
		Fortnightly/monthly	EC	Generally stable trend. Fluctuations higher than historical records. Peak in September (454 µS/cm).
		Fortnightly/monthly	Flow	Stable trend. Flow within historical limits.
Wolgan River (Wolgan Valley)	30/04/2018 – present	Fortnightly/monthly	pH	Fluctuating within historical limits except for highest pH recorded in mid-August (8.3).
		Fortnightly/monthly	EC	Stable trend with some fluctuations within historical limits.
		Fortnightly/monthly	Flow	Limited data available. Flow within historical limits.

10.1.3 East Wolgan Tributary

Surface water monitoring commenced after impact therefore no trigger levels were developed.

Table 10.3 East Wolgan surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
East Wolgan Upstream	8/04/2005 – present	Fortnightly/monthly	pH	Limited data available. No data collected after February. Lowest historical pH recorded in January (4.9).
		Fortnightly/monthly	EC	Limited data available. No data collected after February. Downward trend after being generally dry since 2009. Values similar to 2022.
		Fortnightly/monthly	Flow	One data point collected in July. Generally dry or too low to measure.
East Wolgan Downstream	8/04/2005 – present	Fortnightly/monthly	pH	No data available.
		Fortnightly/monthly	EC	No data available.
		Fortnightly/monthly	Flow	No data available.
East Wolgan DS Junction	8/04/2005 – present	Fortnightly/monthly	pH	Downward trend and minimum historical value recorded in late March (3.3).
		Fortnightly/monthly	EC	Slightly upward trend. Some spikes recorded in late-March and late-April up to 127 µS/cm.
		Fortnightly/monthly	Flow	Flow within latest historical values.

10.1.4 Carne Creek – Western (Carne West) Tributary

Surface water monitoring commenced after impact therefore no trigger levels were developed.

Table 10.4 Carne West surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Carne West	12/07/2016 – present	Fortnightly/monthly	pH	No data available.
		Fortnightly/monthly	EC	No data available.
		Fortnightly/monthly	Flow	Water level too low for flow monitoring.

10.1.5 Gang Gang Tributary

Surface water monitoring commenced after impact therefore no trigger levels were developed.

Table 10.5 Gang Gang surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Gang Gang	21/3/2016 – present	Fortnightly/monthly	pH	Slightly downward trend, within historical observations.
		Fortnightly/monthly	EC	Slightly upward trend, within historical observations.
		Fortnightly/monthly	Flow	No data available. Flow was too low to measure.

10.1.6 Marrangaroo Creek

Table 10.6 Marrangaroo Creek surface water quality summary

Monitoring ID	Date range	Frequency	Analyte	2023 water quality comment
Marrangaroo Creek	30/01/2014 – present	Fortnightly/monthly	pH	Generally stable trend but no data available since February 2023 due to below average rainfall.
		Fortnightly/monthly	EC	Generally stable trend but no data available since February 2023 due to below average rainfall.
		Fortnightly/monthly	Flow	Generally dry or too low for flow monitoring.

11 Conclusions

This report has reviewed groundwater level and quality as well as surface water quality and flow data for the reporting period 1 January to 31 December 2023. The key outcomes of this review, in accordance with the WMP (Centennial, 2022a) and SMP (Centennial, 2022b) are:

- Swamp piezometers:
 - Shrub swamps: Groundwater levels show slight declines at NPSS due to below average rainfall throughout the reporting period. There is no obvious indication of mining impacts due to the mining of LW 428.
 - Hanging swamps: Groundwater levels have declined throughout the reporting period and most hanging swamp piezometers are dry, only responding to periods of sustained rainfall. This is consistent with a declining CRD and is not a result of mining.
- Perched groundwater system: Groundwater levels in perched piezometers that are reference sites or have not been impacted by mining, show a slightly declining trend consistent with below average rainfall conditions. Perched piezometers that are classified as impact piezometers, discussed in Section 4.2, or that were installed post mining, show natural groundwater trends similar to reference sites or historical observations.
- Shallow groundwater system: Groundwater levels in shallow aquifer piezometers that have not been directly impacted by mining show a stable or slightly decreasing trends, consistent with below average rainfall conditions.
- Deep/shallow groundwater systems: VWPs located adjacent to longwalls and targeting the shallow and deep groundwater systems show typical depressurisation responses due to subsidence from nearby longwall mining. Depressurisation of VWPs above the MYC have been recorded during the reporting period at SPR1210. A trigger investigation report was issued to the regulator on 2 November 2023.

The trigger investigation found the response observed at SPR1210 VWP was similar to other VWP sites impacted by earlier longwalls, however no impact was seen at nearby standpipe piezometer SPR1210R, indicating the aquifer could still be intact. As such the report concluded further observation was required to confirm the condition of the shallow aquifer and whether the observations were representative or a result of VWP grout failure or other geotechnical related issues.

- Swamp groundwater water quality: No trigger exceedances have been identified during the reporting period.
- Shallow groundwater system water quality: EC at SPR1301 exceeded the upper trigger threshold for more than two consecutive monitoring events. No trigger investigation is required since this is a historical trend associated with grout contamination.
- Surface water quality and flow: Flows are consistent with rainfall observations. Consecutive exceedances of EC were observed Paddys Creek Swamp and a single exceedance of pH was observed at 9 Mile Swamp. These sites did not exceed the performance criteria detailed in Table 3.1. Similar trends observed at impact sites were also observed at reference sites Barrier Swamp and Carne Central Swamp. Most trends are decreasing, becoming more acidic due to below average rainfall.

References

Centennial (2017) Swamp Monitoring Program for LW420 to 422, Springvale Mine, April 2017.

Centennial (2018a) Swamp Monitoring Program for LW424 to LW427, Springvale Mine, May 2018.

Centennial (2018b) Water Management Plan of Extraction plan for LW424-427, Springvale Mine, May 2018.

Centennial (2021) Extraction Plan Main Report, Longwalls 428-432, Springvale Mine, March 2021.

Centennial (2022a) Water Management Plan for Longwalls 415 to 432, Springvale Mine, June 2022.

Centennial (2022b) Swamp Monitoring Program for Longwalls 415 to 432, Springvale Mine, June 2022.

EMM (2022) Trigger investigation – Standpipe ridge piezometers SPR1806, SPR1807 and SPR1808, letter prepared by EMM for Centennial Springvale Pty Ltd, 18 August 2022

Jacobs (2019) Groundwater Impact Assessment, Angus place Amended Project, prepared by Jacobs Group (Australia) Pty Ltd for Centennial Angus Place Pty Ltd, October 2019.

Jacobs (2020) SPR38 and SPR1302 trigger investigation, prepared by Jacobs (Australia) Pty Ltd for Springvale Coal Pty Ltd, 16 December 2020.

McHugh (2014) The geology of the shrub swamps within Angus place, Springvale and the Springvale Mine extension project areas, prepared by E.A. McHugh Geological and Petrographic Services for Centennial Coal Pty Ltd, September 2014.

McHugh (2018) The geology of the shrub swamps within Angus place, Springvale and the Springvale Mine extension project areas, prepared by E.A. McHugh Geological and Petrographic Services for Centennial Coal Pty Ltd, September 2018.

Appendix A

Historical longwall progression

A.1 Longwall dates

Table A.1 Springvale mining progress

Longwall	Start	Finish
No 1	March 1995	January 1996
401	March/April 1996	January/February 1997
402	February/March 1997	November/December 1997
403	January/February 1998	November/December 1998
404	January/February 1999	February/March 2000
405	10 April 2000	26 March 2001
406	27 May 2001	23 January 2002
407	28 March 2002	9 January 2003
408	20 February 2003	18 December 2003
409	18 February 2004	10 December 2004
410	9 February 2005	19 January 2006
411	10 March 2006	26 October 2007
412	14 December 2007	22 June 2009
413A	7 August 2009	1 April 2010
413B	20 May 2010	29 December 2010
414	11 February 2011	21 November 2011
415	15 March 2012	17 September 2013
416	24 September 2013	19 August 2014
417	11 October 2014	4 July 2015
418	22 October 2015	30 May 2016
419	2 August 2016	18 March 2017
420	29 April 2017	9 November 2017
421	23 December 2017	15 June 2018
425	2 August 2018	16 August 2019
426	22 November 2019	31 July 2020
427	28 September 2020	21 February 2022
428	26 March 2022	January 2024

Appendix B

Springvale monitoring network

B.1 Monitoring locations

Table B.1 Springvale swamp monitoring network

Site	Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target	Comments
Barrier Swamp	BA1	242024	6302814	Swamp water level + Soil moisture + Quality	• Surface water quality monthly. • Flows fortnightly. • Swamp groundwater quality monthly. • Perched groundwater quality monthly.
	BA2	242099	6303297	Swamp water level + Soil moisture + Quality	
	BA3	242070	6303923	Swamp water level + Soil moisture + Quality	
	SPR1608	241991	6304157	Burralow Formation	
	Barrier Swamp	242026	6304243	Surface water quality	
Best Swamp	BE1	245818	6307614	Swamp water level + Soil moisture + Quality	• Surface water quality monthly. • Flows fortnightly. • Swamp groundwater quality monthly. • Perched groundwater quality monthly.
	BE2	246565	6308274	Swamp water level + Soil moisture + Quality	
	SPR1612	246637	6308319	Burralow Formation	
	Best Creek	247523	6309517	Surface water quality	
Carne Central Swamp	CC1	241175	6302695	Swamp water level + Soil moisture + Quality	• Surface water quality monthly. • Flows fortnightly. • Swamp groundwater quality monthly. • Perched groundwater quality monthly.
	CC2	241131	6303290	Swamp water level + Soil moisture + Quality	
	SPR1604	241231	6303296	Burralow Formation	
	Carne Central Swamp	239810	6303794	Surface water quality	
	Carne Central (Carne Central Creek)	241008	6303476	Surface water quality	

Table B.1 **Springvale swamp monitoring network**

Site	Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target	Comments
Carne West Swamp	CW1	239350	6303195	Swamp water level + Soil moisture + Quality	• Surface water quality monthly. • Flows fortnightly. • Swamp groundwater quality monthly. • Perched groundwater quality monthly.
	CW2	239379	6303249	Swamp water level + Quality	
	CW3	238982	6302173	Swamp water level	
	CW4	239075	6302375	Swamp water level + Soil moisture	
	SPR1601	239808	6303789	Burralow Formation	
	Carne West	239809	6303794	Swamp water level	
Firetail Swamp	FS1	246893	6306485	Swamp water level + Soil moisture + Quality	• Surface water quality monthly. • Flows fortnightly. • Swamp groundwater quality monthly. • Perched groundwater quality monthly.
	FS2	247489	6307074	Swamp water level + Soil moisture + Quality	
	SPR1611	247843	6307206	Burralow Formation	
	Firetail	247829	6307217	Surface water quality	
Gang Gang Swamp	GG1	240283	6302299	Swamp water level + Quality	• Surface water quality monthly. • Flows fortnightly. • Swamp groundwater quality monthly. • Perched groundwater quality monthly.
	GG2	239937	6301850	Swamp water level + Soil moisture	
	GG3	240449	6303084	Swamp water level + Soil moisture	
	SPR1603	240491	6303177	Burralow Formation	
	Gang Gang East	240486	6303211	Surface water quality	
	Gang Gang	240553	6303429	Surface water quality	

Table B.1 **Springvale swamp monitoring network**

Site	Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target	Comments
Gang Gang West Swamp	GW1	239820	6302891	Swamp water level + Soil moisture + Quality	• Surface water quality monthly. • Flows fortnightly. • Swamp groundwater quality monthly. • Perched groundwater quality monthly.
	GW2	240258	6303093	Swamp water level + Quality	
	GW3	240397	6303190	Swamp water level + Soil moisture	
	GW4	239906	6302926	Swamp water level	
	SPR1602	240414	6303186	Burralow Formation	
	Gang Gang South West	240467	6303220	Surface water quality	
Junction Swamp	JS1	235774	6302686	Burralow Formation	
	JS2	235800	6302753	Burralow Formation	
	JS3	235857	6302737	Burralow Formation	
Lost City Swamp	LCN1	237966	6299321	Swamp water level + Soil moisture	• Baseline data collection.
	LC1	238146	6299054	Swamp water level + Soil moisture	
	LCS1	238188	6298631	Swamp water level + Soil moisture	
	LCS2	238037	6298759	Swamp water level + Soil moisture	
	LCY2101	238460	6298816	Burralow Formation	
	SPR1613S	238246	6299175	Banks Wall Sandstone	
	SPR1613D	238246	6299175	Banks Wall Sandstone	

Table B.1 **Springvale swamp monitoring network**

Site	Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target	Comments
Marrangaroo Swamp	MS1	238861	6299170	Swamp water level + Soil moisture + Quality	• Surface water quality monthly.
	MS2	239046	6299049	Swamp water level + Soil moisture + Quality	• Flows fortnightly.
	MS3	239359	6298208	Swamp water level + Soil moisture + Quality	• Swamp groundwater quality monthly.
	LMHS1	238445	6299248	Hanging wamp water level	• Perched groundwater quality monthly
	MWHS1	238707	6298868	Hanging wamp water level	
	SPR1607	238751	6299241	Perched groundwater system	
	MExx01	239409	6298579	Hanging wamp water level	
	Marrangaroo Swamp	237378	6298734	Surface water quality	
	Marrangaroo Creek	236347	6301221	Surface water quality	
Paddys Creek Swamp	PC1	241204	6298832	Swamp water level + Soil moisture + Quality	• Surface water quality monthly.
	PC2	240913	6298663	Swamp water level + Soil moisture + Quality	• Flows fortnightly.
	SPR1606	241416	6299066	Banks Wall Sandstone	• Swamp groundwater quality monthly.
	Paddy's Creek	241601	6299127	Surface water quality	• Perched groundwater quality monthly.
Pine/9 Mile Swamp	BS1 (Nine Mile)	241053	6301325	Swamp water level + Soil moisture + Quality	• Surface water quality monthly.
	BS2 (Pine)	240813	6300172	Swamp water level + Soil moisture + Quality	• Flows fortnightly.
	BS3 (Pine)	241980	6301243	Swamp water level + Soil moisture + Quality	• Swamp groundwater quality monthly.
	PSS (BS4) (Pine confluence)	241959	6301202	Swamp water level + Soil moisture + Quality	• Perched groundwater quality monthly.
	NMSS (BS5) (Nine Mile confluence)	241913	6301328	Swamp water level + Soil moisture + Quality	
	NM (Nine Mile)	241425	6301309	Swamp water level	

Table B.1 **Springvale swamp monitoring network**

Site	Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target	Comments
	PS (Pine Swamp)	241516	6300728	Swamp water level	
	PUS (Pine Swamp)	240199	6299453	Swamp water level	
	PHS	240199	6299435	Perched groundwater system	
	SPR1605	241965	6301250	Burralow Formation	
	9 Mile Swamp	241955	6301301	Surface water quality	
	Pine/9 Mile swamp	242130	6301240	Surface water quality	
Plum Swamp	PLM2101	239095	6297595	Burralow Formation	Baseline data collection.
	PLM2102	239095	6297595	Burralow Formation	
Sunnyside Swamp	SS1	237770	6303520	Swamp water level + Quality	- Surface water quality monthly. - Flows fortnightly. - Swamp groundwater quality monthly.
	SS2	237780	6303573	Swamp water level	
	SS3	237844	6303844	Swamp water level + Quality	
	SS4	237791	6304398	Swamp water level + Quality	
	SS5	237787	6304631	Swamp water level + Quality	
	Sunnyside Swamp Upstream	237809	6304220	Surface water quality	
	Sunnyside Swamp Downstream	237637	6304967	Surface water quality	
	Sunnyside Swamp Upstream Junction	236752	6305174	Surface water quality	

Table B.1 **Springvale swamp monitoring network**

Site	Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target	Comments
Sunnyside East Swamp	SSE2	238825	6303351	Swamp water level + Quality	• Surface water quality monthly.
	SSE3	239075	6303566	Swamp water level + Quality	• Flows fortnightly.
	SS3 D/S (Sunnyside East Downstream)	239363	6303908	Surface water quality	• Swamp groundwater quality monthly.
	Sunnyside East	239442	6304205	Surface water quality	
Sunnyside West Swamp	SW1	237230	6302421	Swamp water level	
Tristar Swamp	TS1	237555	6307286	Swamp water level + Quality	• Surface water quality monthly.
	TS2	237446	6306779	Swamp water level + Soil moisture + Quality	• Flows fortnightly.
	TS3	236897	6307163	Swamp water level + Soil moisture + Quality	• Swamp groundwater quality monthly.
	Tristar (Springvale)	236644	6307057	Surface water quality	
	SPR1609	236975	6307097	Banks Wall Sandstone	
Twin Gully Swamp	TG1	236436	6308767	Swamp water level + Soil moisture + Quality	• Surface water quality monthly.
	TG2	236043	6308932	Swamp water level + Soil moisture + Quality	• Flows fortnightly.
	Twin Gully (Springvale)	235912	6308894	Surface water quality	• Swamp groundwater quality monthly.
Wishbone Swamp	WB12101	238830	6298471	Burralow Formation	• Baseline data collection.
	WB12102	238830	6298471	Burralow Formation	
	WB32101	238957	6298378	Burralow Formation	
	WB32102	238957	6298378	Burralow Formation	
	WB32103	238957	6298378	Burralow Formation	

Table B.1 **Springvale swamp monitoring network**

Site	Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target	Comments
	WBSH1	238962	6298397	Hanging swamp water level	
	WBSH2	238970	6298411	Hanging swamp water level	
	WBSH3	238979	6298430	Hanging swamp water level	
	WBSH4	238985	6298446	Hanging swamp water level	
Wolgan East Swamp	WE1	236387	6304057	Swamp water level	• Surface water quality monthly. • Flows fortnightly. • Swamp groundwater quality monthly.
	WE2	236419	6304178	Swamp water level	
	East Wolgan Upstream	236262	6303726	Surface water quality	
	Eat Wolgan Downstream	236606	6304856	Surface water quality	
	East Wolgan Downstream Junction	236684	6305200	Surface water quality	
Wolgan River	Wolgan River (Wolgan Valley)	240256	6320189	Springvale water quality site	• Surface water quality monthly. • Flows monthly.
	Wolgan river Downstream	235432	6309941	Springvale water quality site	
Springvale discharge points	Bore 6	238507	6304494	Springvale water quality site	
	Bore 8	239763	6304072	Springvale water quality site	
	LDP006	230519	6300198	Springvale water quality site	

Table B.2 **Springvale shallow aquifer monitoring network**

Monitoring ID	Easting (GDA94)	Northing (GDA94)	Depth (mbgl)	Target	Comments
AP5PR	236529	6308528	94.0	Banks Wall sandstone	Groundwater quality sampled quarterly.
AP1105	238865	6305671	75.7	Banks Wall sandstone	
RSE	236840	6304191	49.8	Burralow Formation	Manually measured.
RSS	238072	6303500	43.9	Burralow Formation	Groundwater quality sampled quarterly.
SPR1101	238498	6303632	47.4	Burralow Formation	Damaged by subsidence.
SPR1104	239747	6303190	47.0	Banks Wall sandstone	Groundwater quality sampled quarterly.
SPR1106	239983	6304218	86.2	Banks Wall sandstone	
SPR1107	239745	6302337	55.6	Burralow Formation	Damaged by subsidence.
SPR1108	239841	6301074	76.1	Burralow Formation	Damaged by subsidence.
SPR1109	239188	6303324	60.1	Burralow Formation	Groundwater quality sampled quarterly.
SPR1110	238702	6302625	65.8	Banks Wall sandstone	
SPR1111	240383	6303682	60.9	Banks Wall sandstone	
SPR1112	240836	6303010	50.0	Burralow Formation	
SPR1113	240617	6302172	60.6	Burralow Formation	
SPR1210R	239694	6300050	70.0	Burralow Formation	
SPR1211	240237	6298920	133.8	Banks Wall sandstone	Damaged by subsidence.
SPR1301	239275	6299271	86.7	Banks Wall sandstone	Groundwater quality sampled quarterly.
SPR1401	239716	6297828	46.6	Burralow Formation	
SPR1402	238453	6303547	92.9	Burralow Formation	Vandalised.

Table B.2 Springvale shallow aquifer monitoring network

Monitoring ID	Easting (GDA94)	Northing (GDA94)	Depth (mbgl)	Target	Comments
SPR1403	238163	6303489	51.1	Burralow Formation	Damaged by bushfire.
SPR1806	239202	6297962	57.2	Burralow Formation	Groundwater quality sampled quarterly.
SPR1807	239628	6299681	73.5	Burralow Formation	
SPR1808	239495	6298643	62.6	Burralow Formation	Damaged by subsidence.
SPR1808R	239495	6298643	10.66	Burralow Formation	Redrill SPR1808R target aquifer above YS4.
SPR2301	238786	6300858	108.1	Banks Wall sandstone	

Table B.3 Springvale vibrating wire monitoring network

Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target depth (m)	Comments
SPR37	239078	6300367	110, 135, 165, 187, 260, 320, 350, 405	
SPR38	240061	6298330	370, 355, 300, 230, 190, 135, 100, 80	Deeper sensors damaged by subsidence.
SPR48	237225	630419	200, 170, 140, 110, 90, 70, 50	
SPR49	237255	6303196	295, 250, 200, 150, 110, 80, 50, 30	Deeper sensors damaged by subsidence.
SPR64	238420	6299866	390, 370, 310, 270, 200, 150, 100, 30	
SPR67	238712	6302278	260, 200, 160, 110, 90, 70, 50, 35	Deeper sensors damaged by subsidence.
SPR1102	241235	6304180	407, 380, 312, 300, 292, 160, 151, 125, 82	
SPR1103	241430	6302983	407, 381, 326, 313, 290, 258, 178, 151, 138	
SPR1208	240965	6301652	421, 411, 380, 330, 303, 226, 130, 90	Damaged by bushfire.

Table B.3 **Springvale vibrating wire monitoring network**

Monitoring ID	Easting (GDA94)	Northing (GDA94)	Target depth (m)	Comments
SPR1210	239694	6300050	388, 376, 326, 308, 224, 160, 76	
SPR1212	234308	6300483	280, 264, 229, 208, 197, 182	
SPR1302	239716	6297828	390, 370, 310, 271, 200	
SPR1804	240542	6299690	345, 291, 217, 118, 69, 38	Damaged by subsidence.
SPR2303B	234308	6300483	387, 356, 316, 279, 247, 203, 146, 46	
AP10PR	237246	6306781	343, 327, 300, 270, 248, 205, 150, 103, 60	

Appendix C

Historical piezometer observations

C.1 Historical observations

Table C.1 Swamp groundwater level history

Swamp name	Piezometers	Swamp characteristics and mining history
Barrier Swamp	BA1 BA2 BA3 SPR1608	There are three piezometers installed in Barrier Swamp and the perched groundwater system is monitored by SPR1608. Groundwater at Barrier swamp is primarily fed by the outcropping of the YS4 ply which runs parallel to the length of the swamp. The swamp terminates downstream intersecting with the YS5, YS5a and YS6 plies. From bore logs, the surface peat layer is typically 0.3 m to 0.6 m thick, under which lies a clayey sand or sand that transitions into a weathered sandstone. Barrier Swamp is a waterlogged swamp that exhibits stable water levels with consistent groundwater base flow contribution. Water levels at the three piezometers reflect the general trends of the CRD curve and respond to rainfall events in relative agreement.
Best Swamp	BE1 BE2 SPR1612	There are two piezometers installed in Best Swamp and the perched groundwater system is monitored by SPR1612. The profile is varied with the peat layer in the upstream section at BE1 approximately 0.7 m thick and at BE2 it is 0.3 m thick. At BE1 beneath the peat is a thin 0.2 m layer of clayey sand that transitions in to a 0.5 m thick weathered sandstone soil that terminates on bedrock. At BE2 beneath the peat is a 0.2 m layer of sand, then a 0.4 m layer of clayey sand with bands of clay, then a 0.6 m thick weathered sandstone soil that terminates on bedrock. Best Swamp is a waterlogged swamp with water levels strongly correlated to the daily CRD trend particularly upstream at BE1. The declining water levels since installation to January 2020 reflect the below average rainfall conditions since 2016.
Carne Central Swamp	CC1 CC2 SPR1604	There are two piezometers installed in Carne Central Swamp and the perched groundwater system is monitored by SPR1604. The swamp is fed by outcropping of the YS4 ply in the upstream section near CC1 and YS5 ply near CC2. Further downstream Carne Central hanging swamp is supported by outcropping of the YS5, YS5a and YS6 plies near the cliff edge. The upstream section at CC1 has 0.2 m of root mat followed by 0.2 m of sandy clay, then a 0.5 m layer of clayey sands which terminates on weathered sandstone bedrock at 0.95 m. The downstream section at CC2 is characterised by a 0.3 m surface peat layer followed by a 0.3 m clayey sand layer followed by a 0.2 m sandy clay layer that transitions into a weathered sandstone profile (0.4 m thick). The clay layers within the swamp profile are likely related to the outcropping plies. Carne Central swamp is a reference swamp with water levels strongly correlating to the daily CRD trend. The sharp drawdowns observed in the hydrograph are sampling spikes caused by bore purging. The declining water levels from 2016 to early 2020 at CC1 reflect the drought conditions experienced on the plateau. During this time, Carne Central Swamp has transitioned from a permanently waterlogged swamp into a periodically waterlogged swamp. Following the above average rainfall conditions since February 2020 to November 2022 waterlogged conditions were once again observed at the swamp.

Table C.1 **Swamp groundwater level history**

Swamp name	Piezometers	Swamp characteristics and mining history
Firetail Swamp	FS1 FS2 SPR1611	There are two piezometers installed in Fire Tail Swamp and the perched groundwater system is monitored by SPR1611. The profile at FS1 is relatively deep at 2.9 m with a 0.4 m surface peat layer, followed by a 2.5 m layer of clayey sands with two 0.2 m bands of clay between 1 m and 1.5 m depth, and terminating on bedrock. The profile at FS2 is relatively shallow at 0.5 m deep with a 0.3 m surface peat layer followed by a thin 0.1m sandy layer that transitions into the weathered sandstone bedrock. Fire Tail Swamp is a reference swamp located out of the extraction area. Water levels at FS1 located upgradient, fluctuate readily and appear to be influenced by rainfall variation. FS2 is observed to have a baseflow contribution that keeps the swamp waterlogged.
Twin Gully	TG1 TG2	There are two piezometers installed in Twin Gully Swamp. Twin Gully lies predominantly over the Banks Wall sandstone and commences between the YS5 and YS6 plies where hanging swamps are observed. On the southern side of the swamp, a hanging swamp outcrops from the YS6 ply where there is a permanent pool of water. Twin Gully Swamp is highly channelized with free-flowing surface water. The swamp is characterised by a surface peat layer above a sandy/weathered sandstone profile. TG1 is located on the edge of the swamp and there is only a thin root mat layer, whereas TG2, which is located within the swamp has a 0.3m peat layer. The depth of the swamp varies from 0.9 m to greater than 1.1 m. It is noted the total depth from the bore log of TG1 is not representative as drilling was terminated prior to refusal on bedrock due to collapse of the borehole. Water levels are correlated to the daily CRD trend and the trends between TG1 and TG2 are very similar. Long term water level trends at Twin Gully are relatively stable. This suggests there is a large groundwater baseflow contribution to the swamp that maintains waterlogged conditions.
Tristar Swamp	TS1 TS2 TS3 SPR1609	There are three piezometers installed in TriStar Swamp and the perched groundwater system is monitored by SPR1609. The swamp consists of two arms that converge in the main swamp valley. The swamp commences below YS5. Two substantial hanging swamps coincide with the location of YS5 above the upper reaches of the two arms of the swamp. A large proportion of the swamp is situated within the Banks Wall Sandstone. The swamp is characterised by a peaty/highly organic surface soil layer that ranges from 0.3 m to 1.1 m, and a sandy profile that extends to the weathered sandstone bedrock. The valley walls are steep, and the swamp is highly channelised with free-flowing surface water observed down gradient at TS3. The swamp profile is very deep compared to other swamp on the plateau with the bedrock encountered 3.95 m below ground level at TS1 and hole termination beyond 2 m due to collapse at TS2. The swamp at TS1 is rainfall dependent with water levels only observed during periods of prolonged above average rainfalls. The swamp at TS2 is strongly influenced by the prevailing rainfall conditions closely following the CRD curve. The swamp at TS3 is permanently waterlogged with evidence of a strong groundwater contribution. Water levels remained stable at TS3 through the drought from 2016 and rainfall events do not significantly influence water levels compared to TS1 and TS2.

Table C.1 **Swamp groundwater level history**

Swamp name	Piezometers	Swamp characteristics and mining history
East Wolgan Swamp	WE1 WE2	The swamp intercepts the YS4 ply that runs along the length of the swamp. The bore logs show the depth of the swamp at WE1 is 2.8 m with a 0.5 m surface peat layer, followed by a 0.8 m sand layer, followed by a 1.5 m clayey sand layer and terminating on sandstone bedrock. At WE2, a 1.0 m thick peat layer is present, followed by a 0.3 m clayey sand layer and terminates on sandstone bedrock. Wolgan East Swamp was within the Angle of Draw of Springvale Longwall 411 in July 2006 and undermined by Angus Place Longwall 960 in August and September 2011. It was also used as an emergency licenced discharge point (LDP004) for Springvale from 2005 to 2009. Water levels in East Wolgan are believed to be rainfall dependent with little groundwater contribution, likely due to mining impact. The elevated water levels on the hydrograph apparent during 2005, 2006, 2008 and early 2009 are due to the upstream discharge from LDP004. It is difficult to characterise the swamp's natural water level behaviour prior to 2005 because the swamp was subject to mine water discharge at the time of installation and was soon passed by LW411.
Sunnyside West Swamp	SW1	The swamp is located south west, upgradient of Sunnyside Swamp. Sunnyside West swamp is a shrub swamp lying on a local high point with no visible surface water. The bore log shows there is a 0.4 m peat layer above a 1.1 m clayey sand layer, and below that a 0.5 m silty clay and terminates at 2 m on siltstone. The groundwater is likely from the perched aquifer/sub surface flow from above the YS1 ply. Sunnyside West Swamp was undermined by LW412 which commenced in December 2007. It is difficult to assess the pre-mining hydrogeological conditions of the swamp as the baseline period is short. Water levels are highly variable and correlate to periods of above average rainfall.
Sunnyside Swamp	SS1 SS2 SS3 SS4 SS5	Sunnyside Swamp generally commences below YS2, however the western branch (containing SS3) commences between YS1 and YS2. The swamp likely receives seepage contribution from above the YS2 to YS4 plies. Sunnyside swamp has not been undermined but was within 600 m of LW413 and LW414. No mining impacts have been observed. Drawdown from groundwater sampling is evident in some piezometers. Sunnyside Swamp has been a permanently waterlogged swamp until the drought between 2016 to 2020, where the upper reaches of the swamp at SS1, SS2 and SS3 were observed to become dry. Waterlogging resumed following above average rainfall from February 2020.

Table C.1 **Swamp groundwater level history**

Swamp name	Piezometers	Swamp characteristics and mining history
Sunnyside East Swamp	SSE1	Groundwater seepage is likely from the YS4 ply where it outcrops above the edges of the swamp. The swamp alignment coincides with a significant lineament that trends parallel with the Deanes Creek Lineament Zone. Sunnyside East Swamp profile is relatively deep compared to other swamps on the plateau with logs suggesting depths of approximately 1.8 m to 2.3 m. The swamp profile is characterised by a surface layer of peat with depths of 0.2 m to 0.4 m, below that a clayey sand layer with thicknesses of 1.0 m to 1.5 m, below that a thin interface approximately 0.2 m to 0.4 m between the swamp and the underlying bedrock. This interface is a sandy gravel in the upgradient section and a silty clay in the downgradient section. It is noted that SSE2, which monitors the middle section, may not provide a full representation of the swamp as the installation reached refusal on tree roots and did not go all the way to the bedrock. Sunnyside swamp water level impacts were first observed towards the end of LW414 when it intersected with the lineament underlying the swamp. Water levels made a subsequent recovery but when the Deanes Creek lineament was undermined by LW415, changes to the groundwater regime were observed. The swamp was dry by the time LW417 and LW418 directly undermined the swamp.
	SSE2	
	SSE3	
Carne West Swamp	CW1	The hanging swamp upstream of Carne West coincides with the outcropping of the YS2 ply and the swamp terminates downstream of YS5. Carne West likely receives groundwater input from above the YS3 and YS4 plies, and to a lesser extent YS5 plies. CW1 and CW2 are installed below the YS4 ply. CW3 is installed above the YS3 ply and CW4 is installed above the YS4 ply. SPR1601 is installed above YS6. The swamp alignment also coincides with the regional Deanes Creek lineament structural zone. Data from the four swamp bore logs were used to characterise the swamp. There is a 0.4 to 0.8 m peat layer, and below that a layer of sand/gravelly sand that transitions into the weathered bedrock. At CW3 there is a clay presence that is likely related to the YS3 ply. The depth of the swamp varies from 1 to 1.5 m. The first indications of impact at Carne West swamp were observed in September 2013 towards the completion of LW415 when it approached the Deanes Creek lineament. The significant water level decline was more apparent by September 2014 when the lineament was once again approached by LW416. By the time Carne West was directly undermined by LW418 and LW419, the swamp had become dry.
	CW2	
	CW3	
	CW4	
	SPR1601	
Junction Swamp	JS1	Three piezometers were installed in the Burralow Formation using a drill rig. The profile consists of a thin topsoil with a clayey sand layer than transitions into the sandstone bedrock. At JS1, YS1 ply is present at the base of the borehole. Since installation in May 2002, water levels at JS1, JS2 and JS3 show a strong correlation with rainfall and CRD except for the period when LW408 was extracted from February 2003 to December 2003. During this period water levels were out of sync with the CRD and remained stable to slightly declining despite increasing CRD.
	JS2	
	JS3	

Table C.1 Swamp groundwater level history

Swamp name	Piezometers	Swamp characteristics and mining history
Gang Gang West Swamp	GW1	The upper reach of the swamp starts just above the YS4 ply and the swamp terminates on the YS5 ply. A lineament is mapped along the length of the swamp and is correlated to the Deanes Creek lineament. Data from GW1 and GW2 bore logs and the GW3 soil analysis were used to characterise the swamp profile. The top layer comprises of a highly organic sandy clay/peat about 0.3 m thick. Below this is a layer of sand that transitions into the weathered sandstone bedrock. Mining impacts were observed in the upper reaches at GW1 in August 2014 toward the completion of LW416 as it intersected the Deanes Creek lineament. The subsequent longwalls saw increasing changes due to decreasing groundwater baseflow contribution. By the time the swamp was directly undermined by LW420, the swamp had become dry.
	GW2	
	GW3	
	GW4	
	SPR1602	
Gang Gang Swamp	GG1	Gang swamp intercepts YS2 to YS5 plies. A lineament is mapped along the length of the swamp and is correlated to the Deanes Creek lineament. Data from the GG1 bore log and the soil analysis from GG2 and GG3 were used to characterise the swamp profile. The swamp is characterised by a thin shallow organic peat/clay layer less than 0.3 m; overlying a sandy gravel and weathered sandstone bedrock. In some areas, e.g. at GG2, a very fine sand/clay layer approximately 20cm thick is observed at the interface between the bedrock. Gang Water level declines were first observed at GG1 in August 2016 during the extraction of LW419. GG2 and GG3 were installed October 2016 and only capture the respective declines. In August 2017, GG1 displayed a rapid decline in water levels as LW420 advanced. Downgradient at GG3, water levels remained elevated until February 2018 until LW421 undermined the swamp. Gang Gang Swamp remained predominately dry after April 2018 with brief responses to prolonged periods of above average rainfall.
	GG2	
	GG3	
Pine Swamp	BS2	There are three piezometers installed in Pine Swamp and the perched groundwater system is monitored by SPR1605. Pine Swamp intercepts the YS2 and YS3 plie in the upper reaches, with the confluence with Nine Mile Swamp occurring below the YS4 ply. A mapped lineament coincides with the strike of the swamp. The top layer consists of a clayey sand/sand with high organics approximately 0.8 m to 1 m in thickness. At BS4, a thin 0. 2 m peat layer is present above this layer. There is a thin sand interface approximately 0.2 m thick above the weathered sandstone bedrock but at BS4 this interface is slightly thicker at 0.4 m. At BS4 where the YS4 ply runs parallel to the swamp and a clay band is observed beneath the peat layer. Pine Swamp has been a historically waterlogged swamp with stable water level trends that suggest a significant component of groundwater contribution. In February 2019, when the upper reaches of the swamp were undermined LW425, water levels in the upper reaches rapidly declined and BS2 became dry three months later in May 2019. Downgradient at BS3 and BS4, water levels began to show indications of decline in mid-2019 and commencing rapid decline in October 2019. Since February 2020, the above average rainfalls have caused water levels return to pre-mining conditions in the lower reaches of the swamp at BS3 and BS4. However, in the upper reaches at BS2 the brief water level increases suggest an altered groundwater regime with the primary contribution now from precipitation.
	BS3	
	BS4	
	SPR1605	

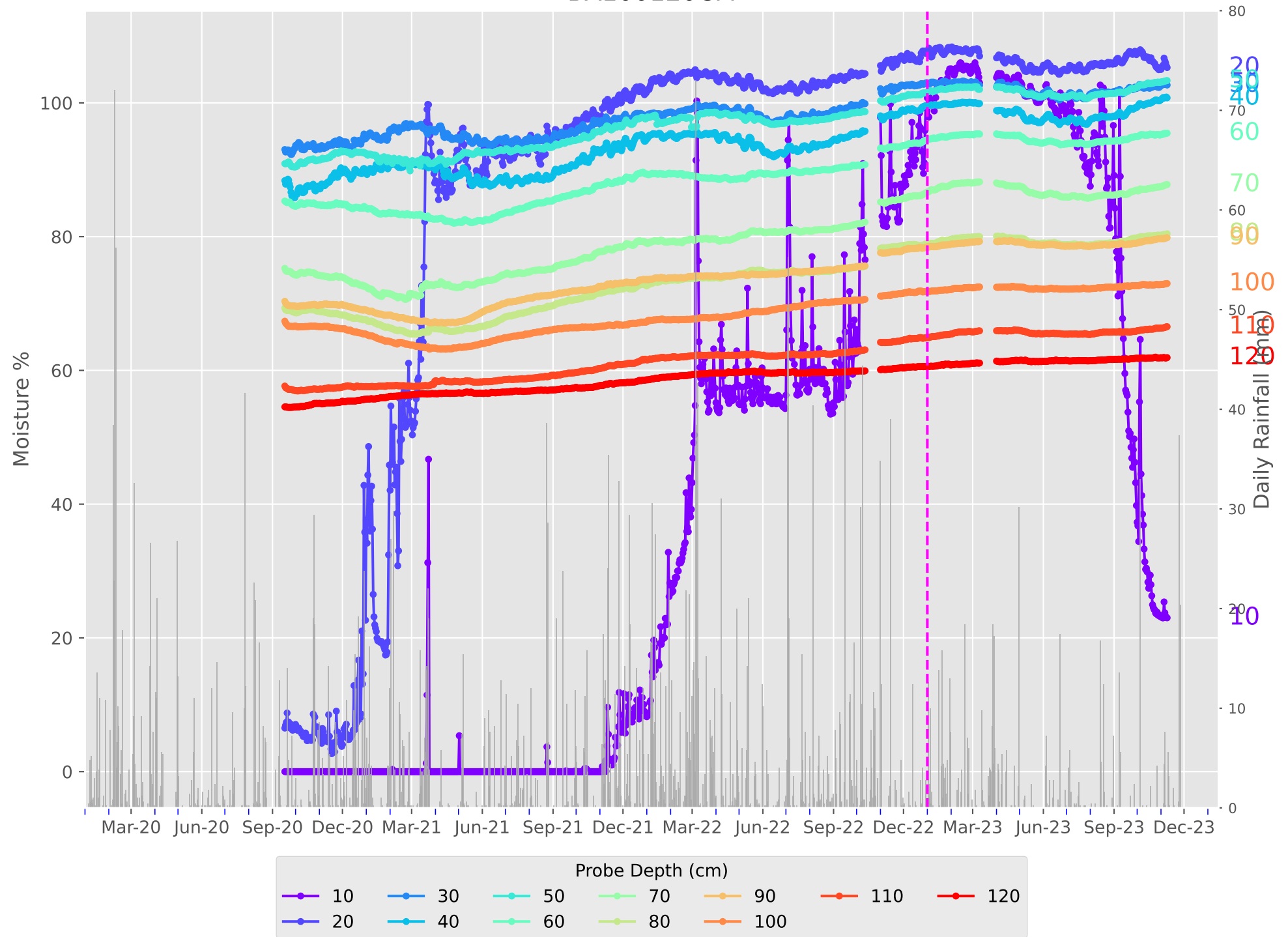
Table C.1 **Swamp groundwater level history**

Swamp name	Piezometers	Swamp characteristics and mining history
Nine Mile Swamp	BS1	The YS3 ply runs parallel to the length of the swamp and the confluence with Pine Swamp occurs around the YS4 outcrop. Pine Swamp receives groundwater seepages from YS2 to YS4 plies. There is a major NNE-SSW fault zone in this area that intersects with both LW425, LW426 and Pine and Nine Mile Swamps. The swamp profile is varied. In the upstream section, the bore log at BS1 does not penetrate the full depth of the swamp due to refusal on caving at 1.1 m. This top layer consists of a highly organic clay. In the downstream section at BS5 there is a 0.4 m peat top layer that transitions into a peaty clay layer (0.3 m thick) and below that is a 0.3 m thick layer of gravelly sand that terminates on weathered sandstone bedrock at 1 m. Nine Mile swamp is a historically waterlogged swamp with relatively stable water levels. Drawdown from groundwater sampling is evident. From mid-2017 water levels at BS1 began declined in response to drought in 2016. The water level decline at BS1 was accelerated during the extraction of LW425 (800 m from BS1) and in February 2019 when the longwall passed through the Pine Swamp lineament. Towards the end of extraction of LW425, when the mining face was approximately 600 m away from Nine Mile Swamp, BS1 went dry and BS5 was observed to decline rapidly. The rains in February 2020 recharged water levels at Nine Mile Swamp. BS5 water levels returned to historic levels and have remained stable. Water levels at BS1 have also recovered but appear to respond to rainfall more readily than previously observed.
	BS5	
	SPR1605	
Marrangaroo Swamp	MS1	The Marrangaroo Swamp overlies YS3 to YS6 plies along its length. The bore logs indicate the swamp depth is approximately 1.3 m to 1.5 m. A 0.3 m peat layer is only present in the upper segment (MS2 and MS3) of the swamp. The swamp has a sandy profile above a weathered sandstone bedrock. Bore logs indicate the presence of a clayey layer in the order of 0.5 m to 0.6 m thickness at swamp piezometers. Marrangaroo Swamp is a waterlogged swamp and historical records show a strong correlation between water levels and CRD. The three swamp piezometers display similar water level fluctuations. The continued below average rainfall since mid-2016 resulted in declining swamp water levels. Marrangaroo Swamp hydrograph displayed less stability as the groundwater contribution decreased from YS plies. In February 2020, the above average rainfalls recharged the swamps to pre-drought water levels where they have since remained stable. Marrangaroo swamp is now within proximity to LW428.
	MS2	
	SPR1607	
Paddys Creek Swamp	PC1	There are two piezometers installed in Paddy's Creek Swamp and the perched groundwater system is monitored by SPR1606. The swamp overlies YS4 to YS6 plies along its length. The bore logs indicate the swamp depth is approximately 1.2 m to 1.6 m. The swamp is characterised by a 0.3 m peat layer followed by a clayey sand before refusing on weathered bedrock. Paddys Creek Swamp is located to the south east of LW425. Although the longwall did not directly undermine the swamp, it was within 600 m. Water levels downstream at PC1 began to decline in late 2018 despite an increasing rainfall. Water level declines at PC1 were likely influenced by below average rainfall as groundwater levels have recovered following above rainfall from February 2020. Water levels at PC2 (upstream) remained stable throughout this time.
	PC2	
	SPR1606	

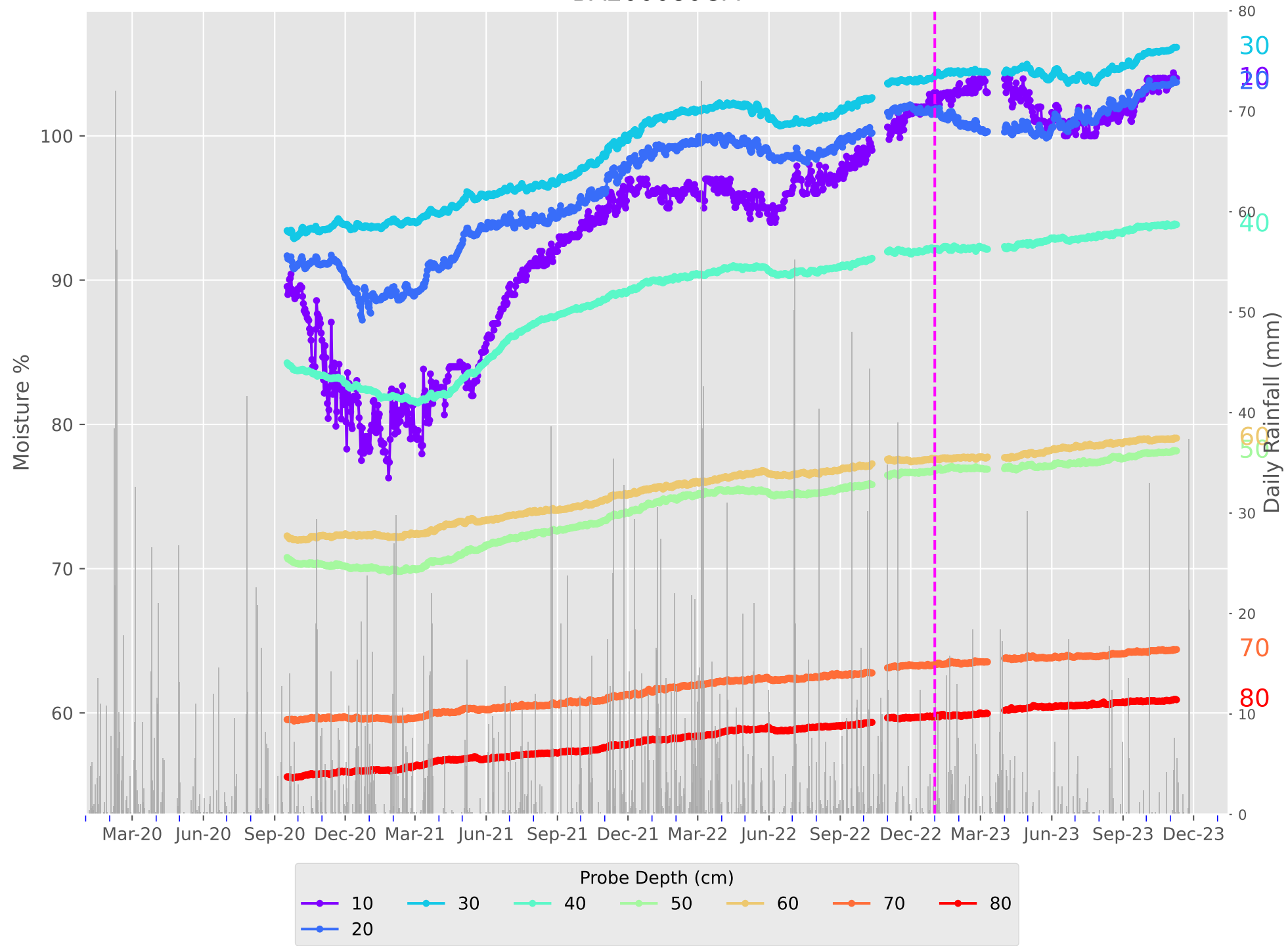
Appendix D

Soil moisture probe time series

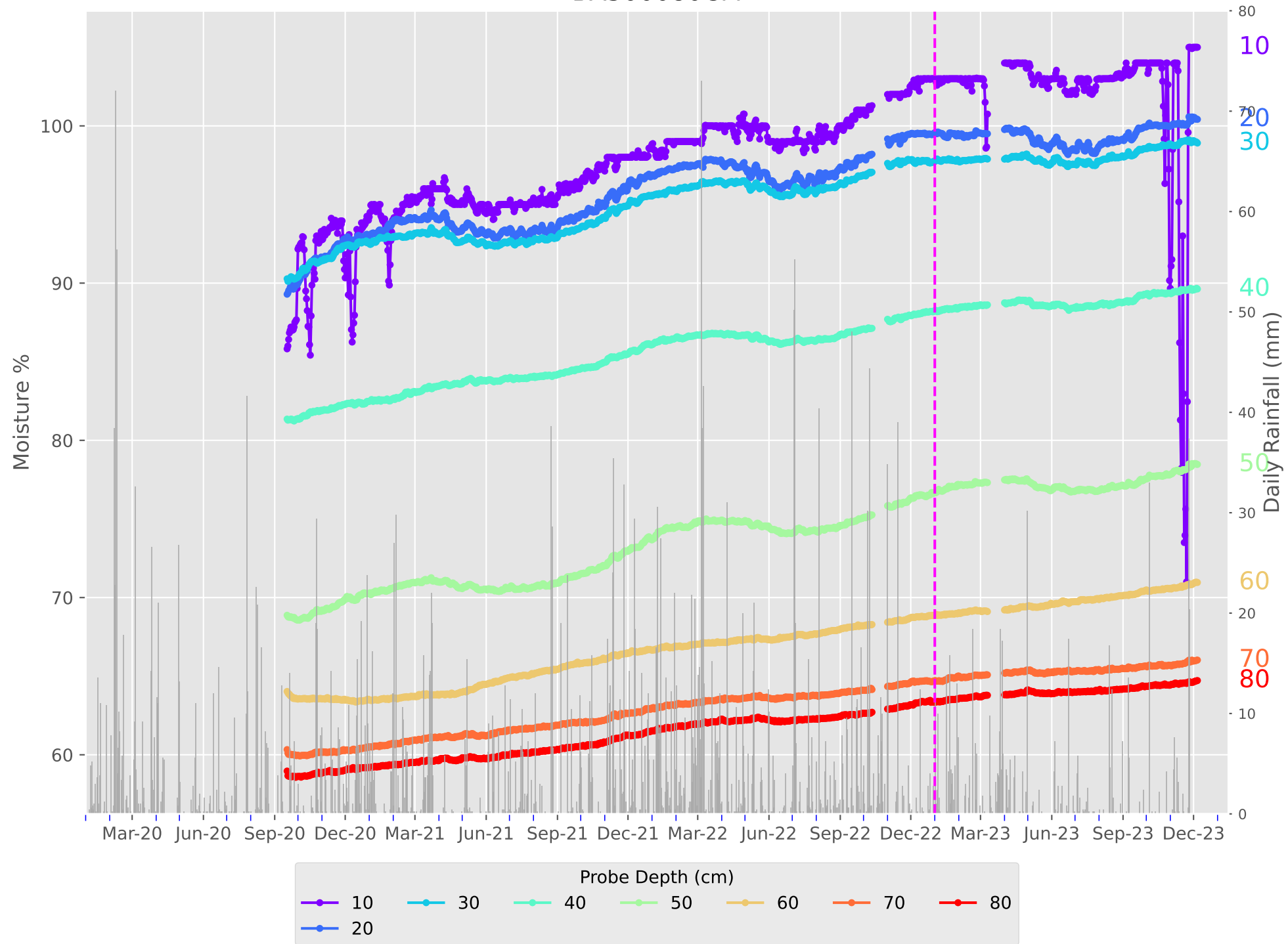
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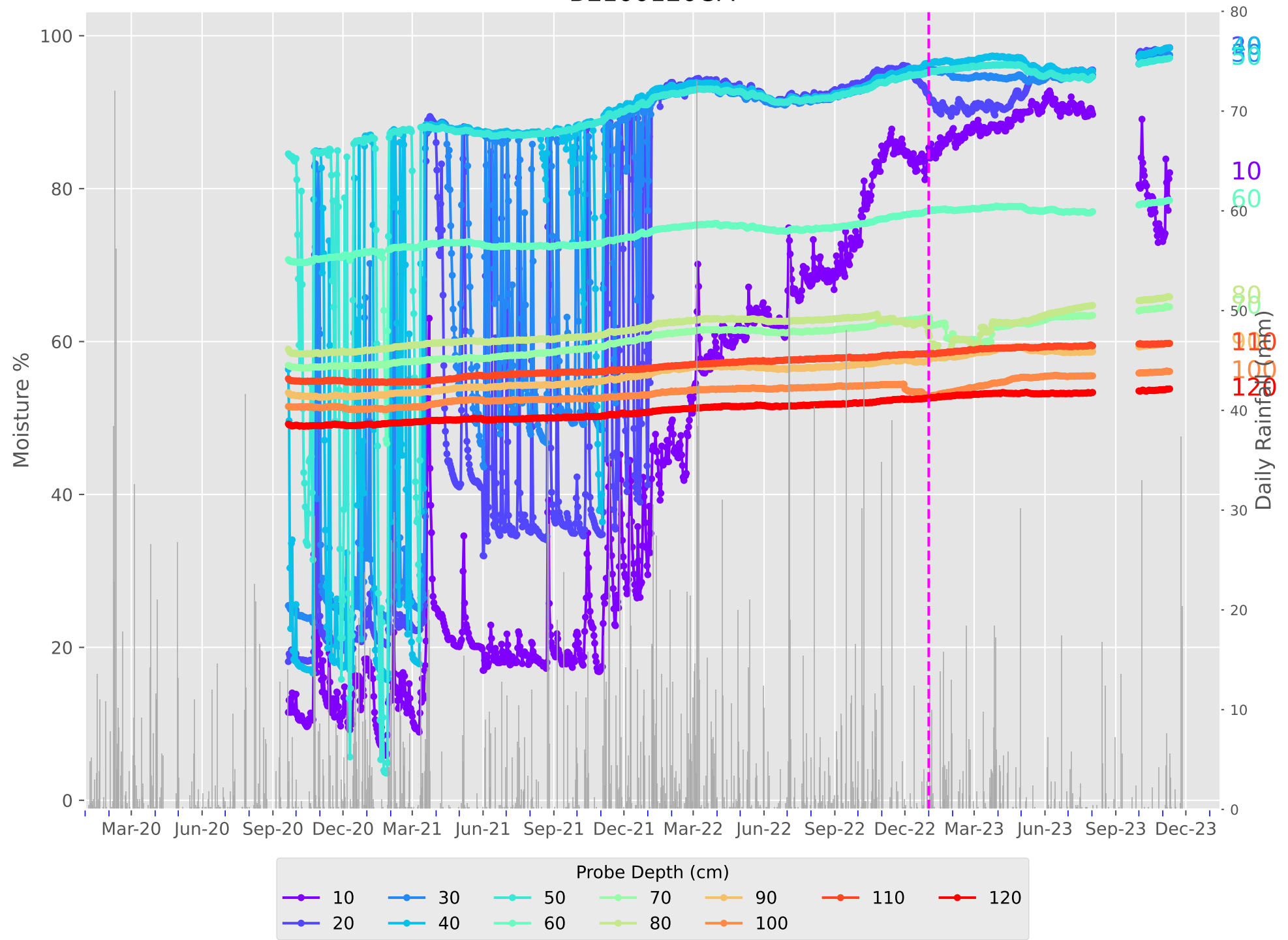
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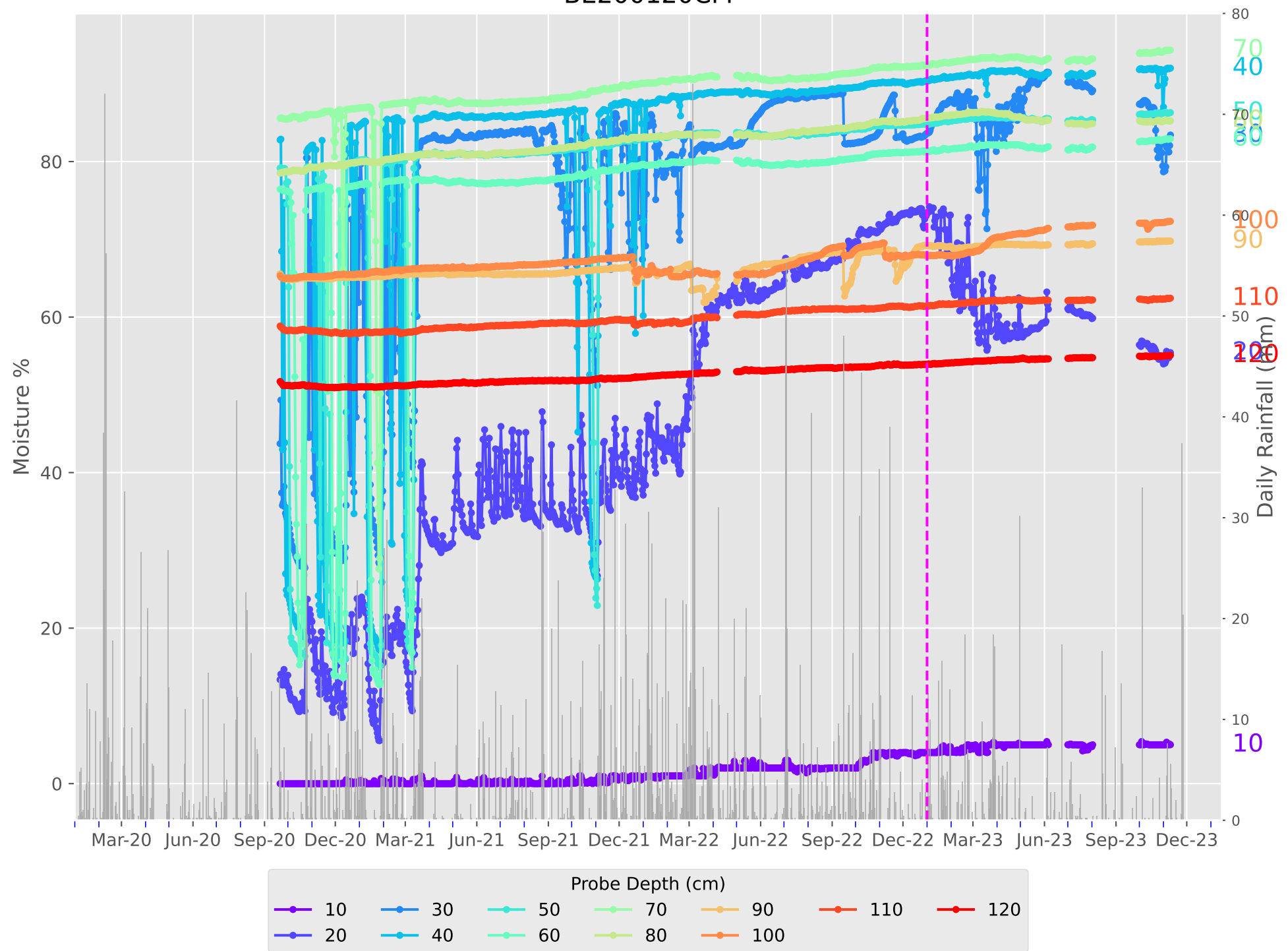
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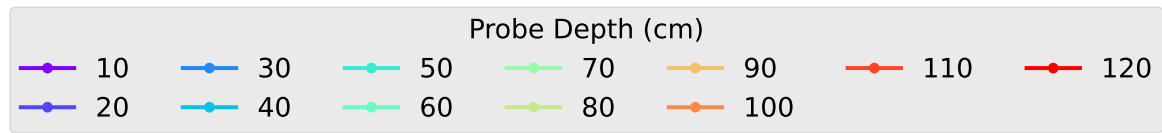
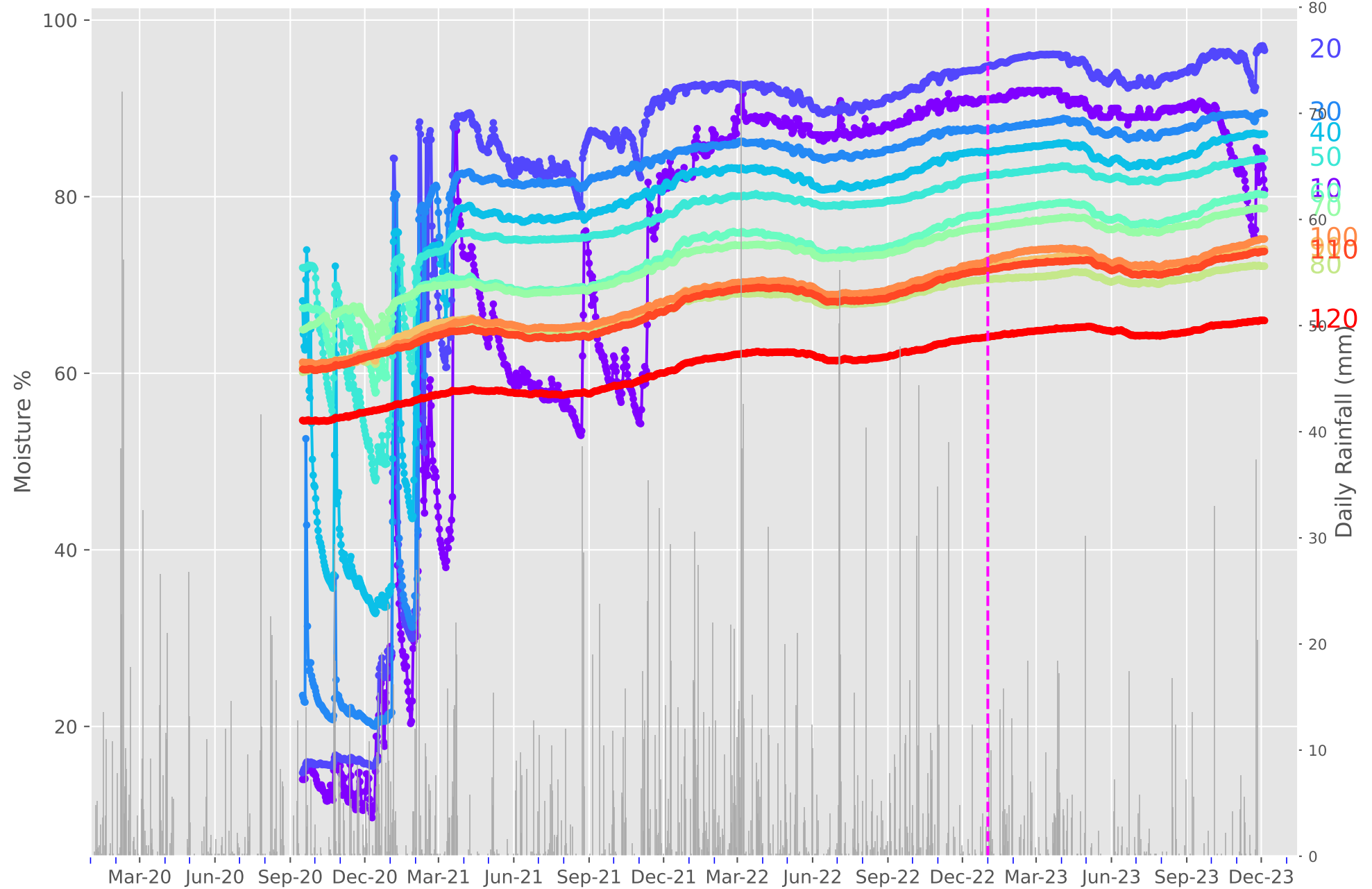
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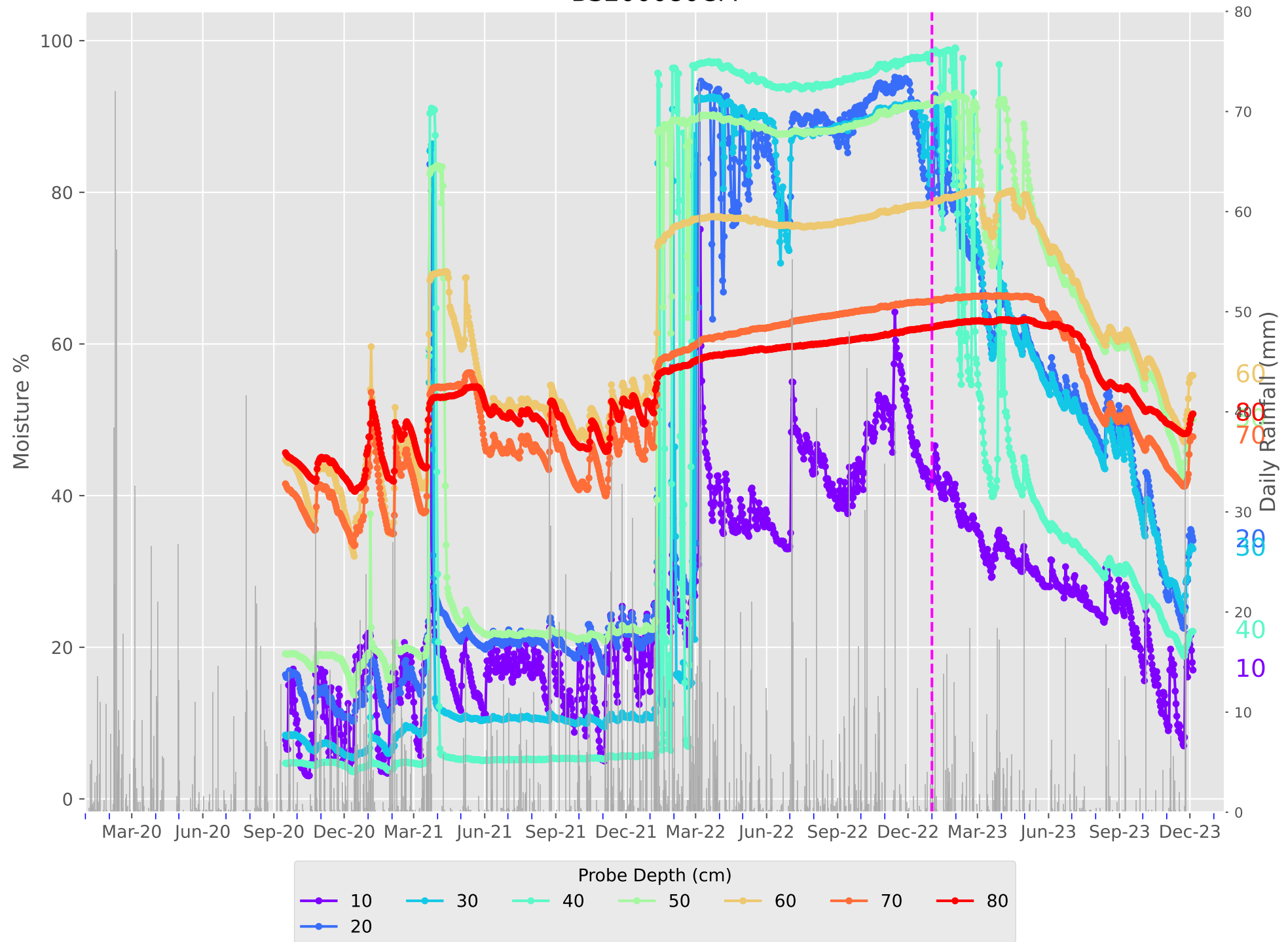
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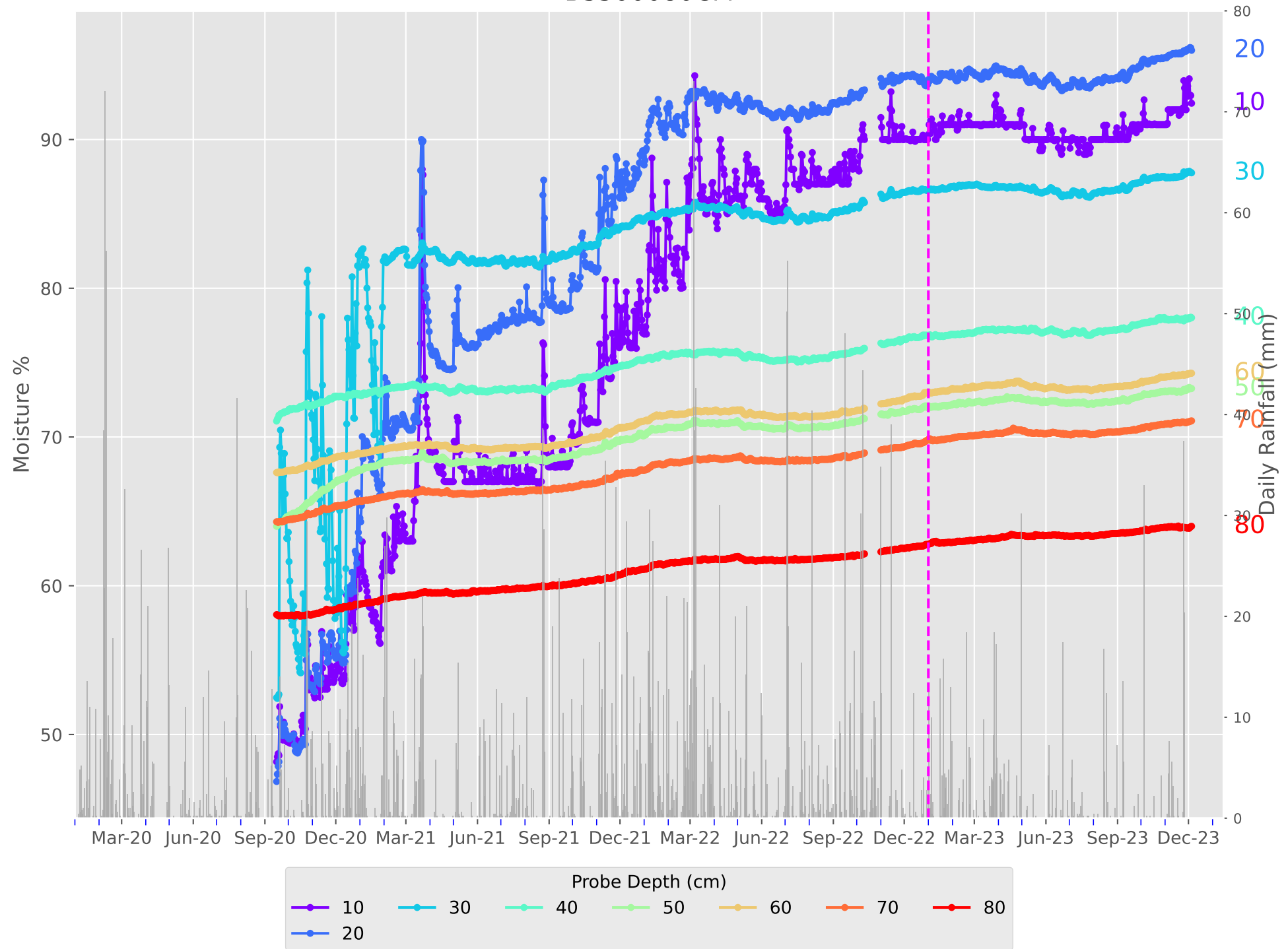
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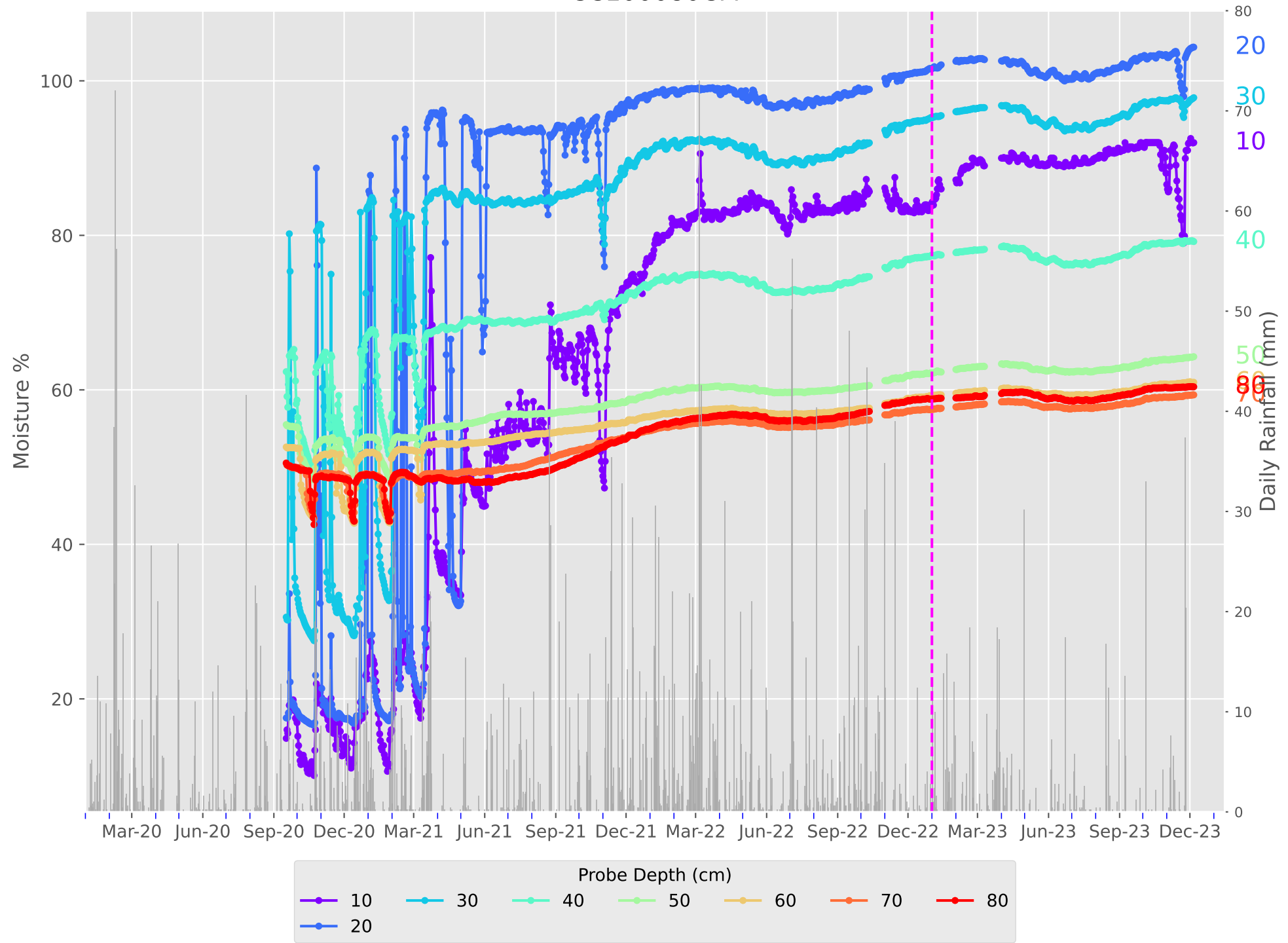
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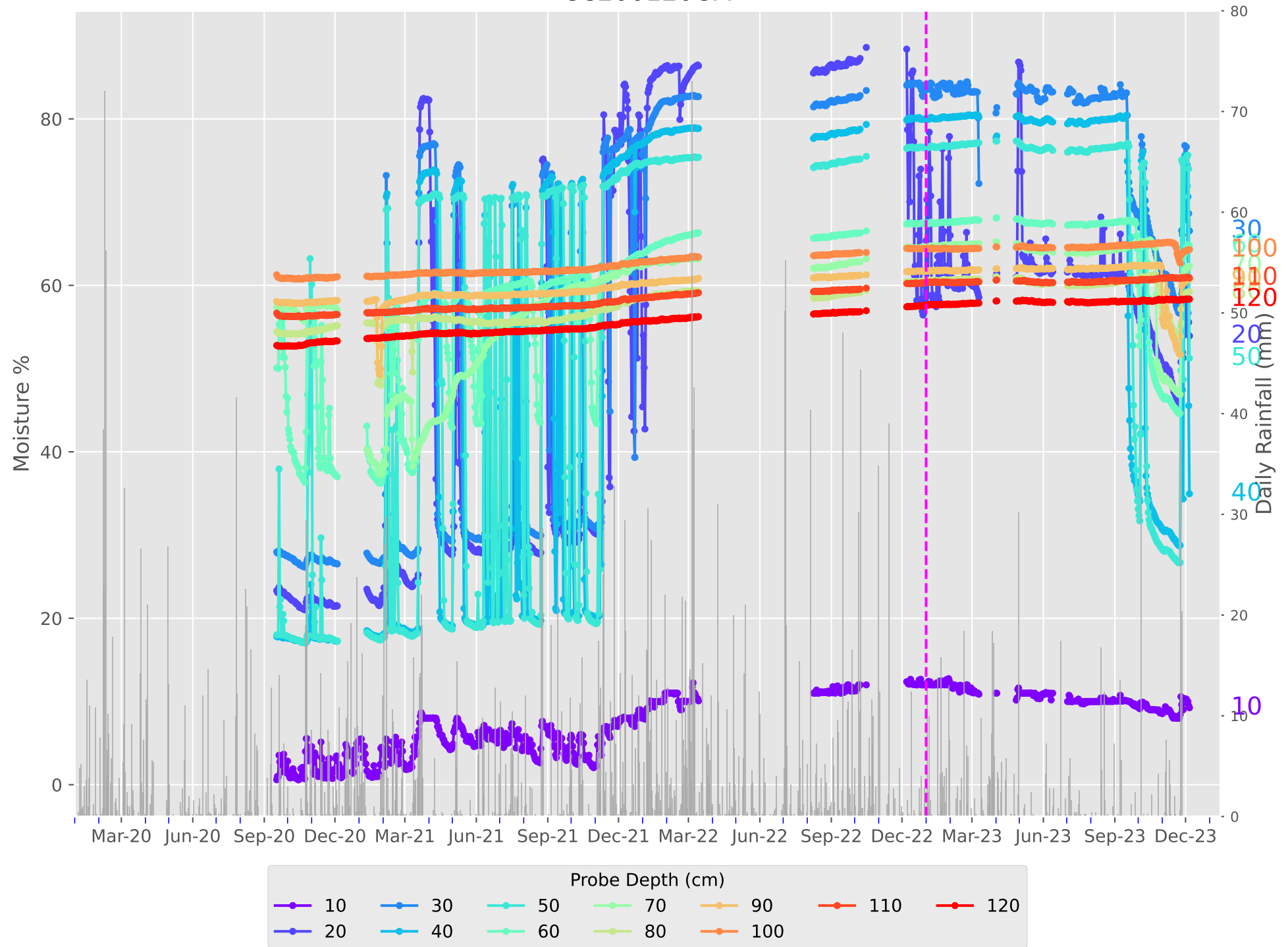
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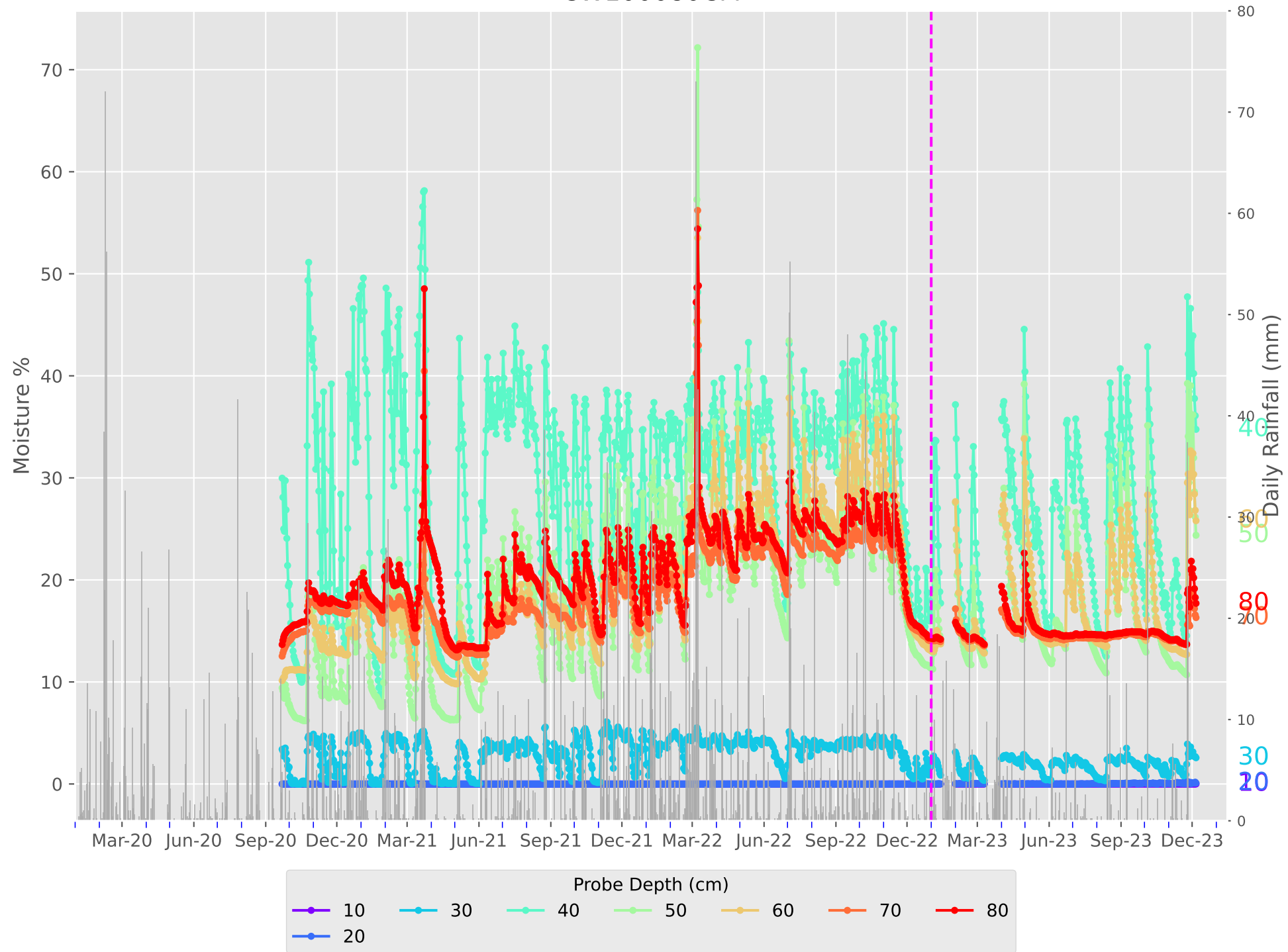
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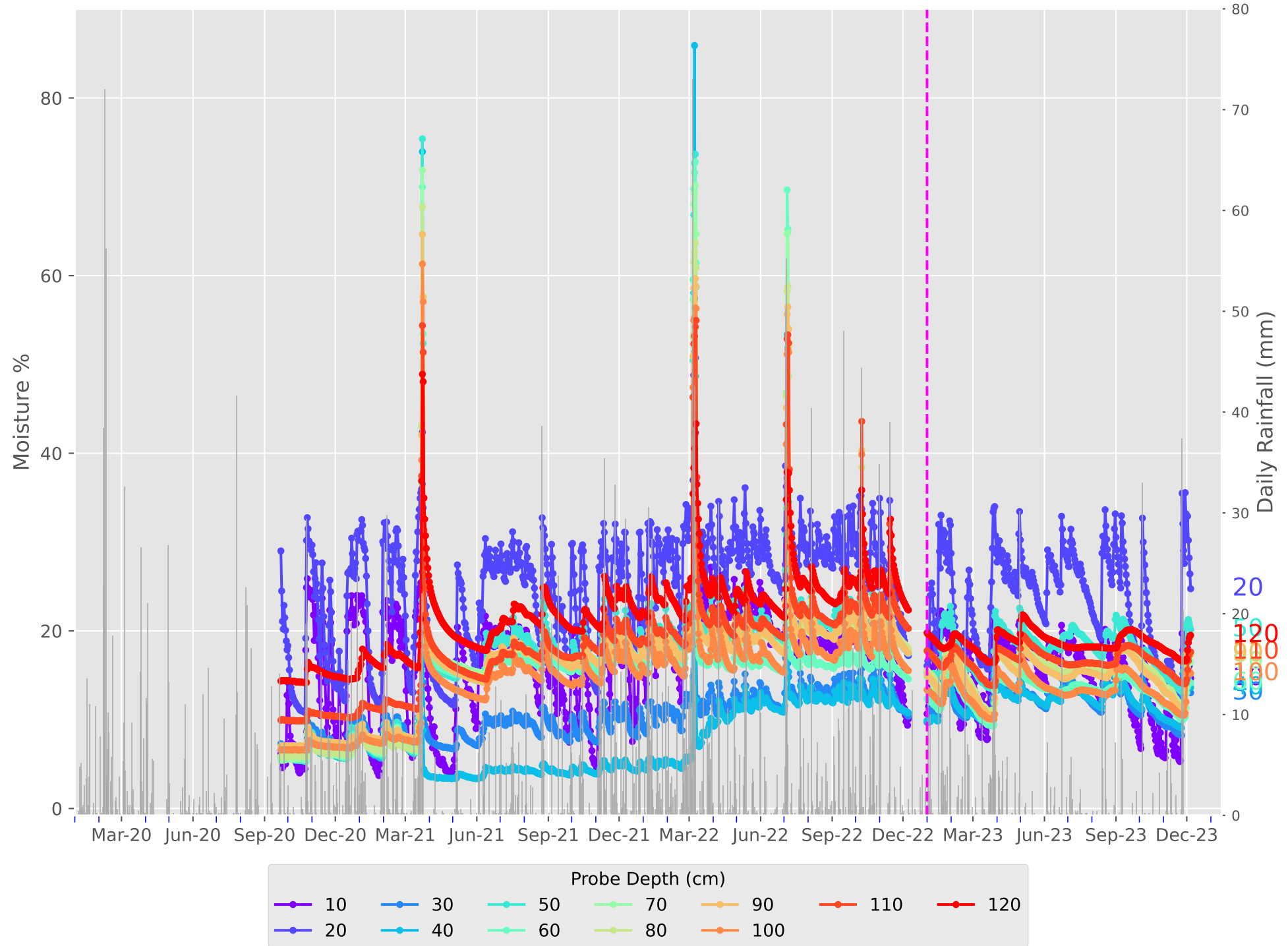
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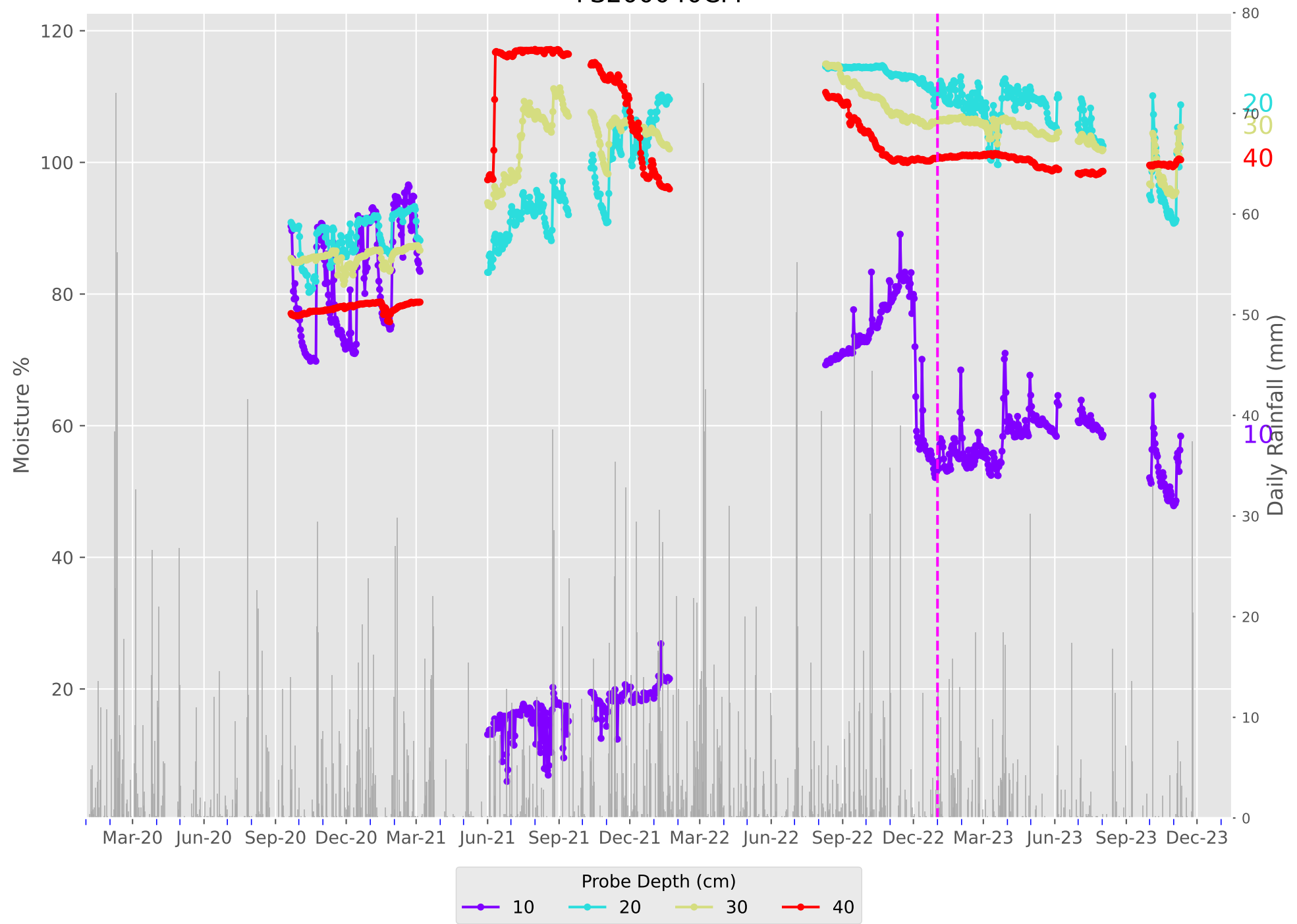
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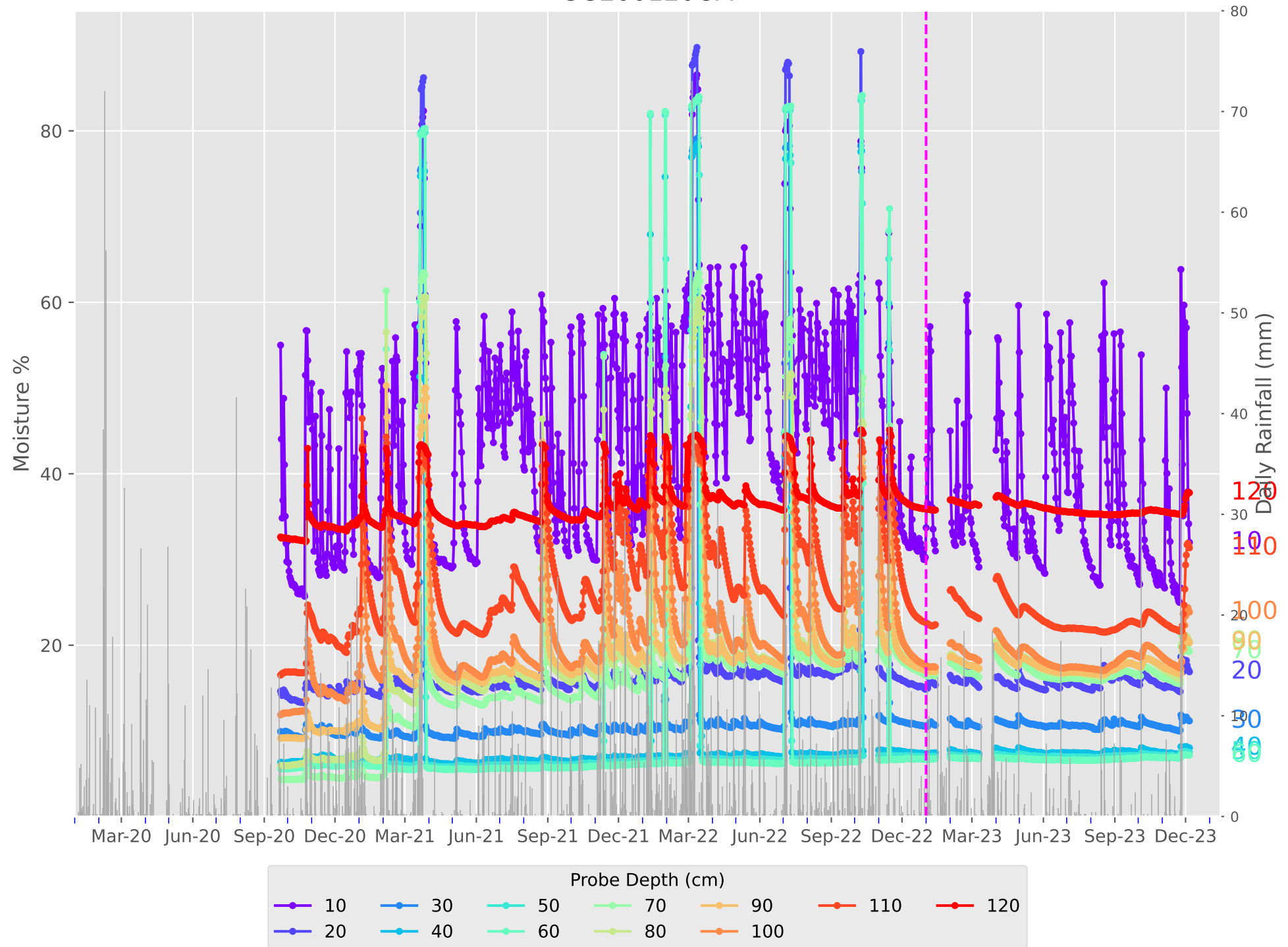
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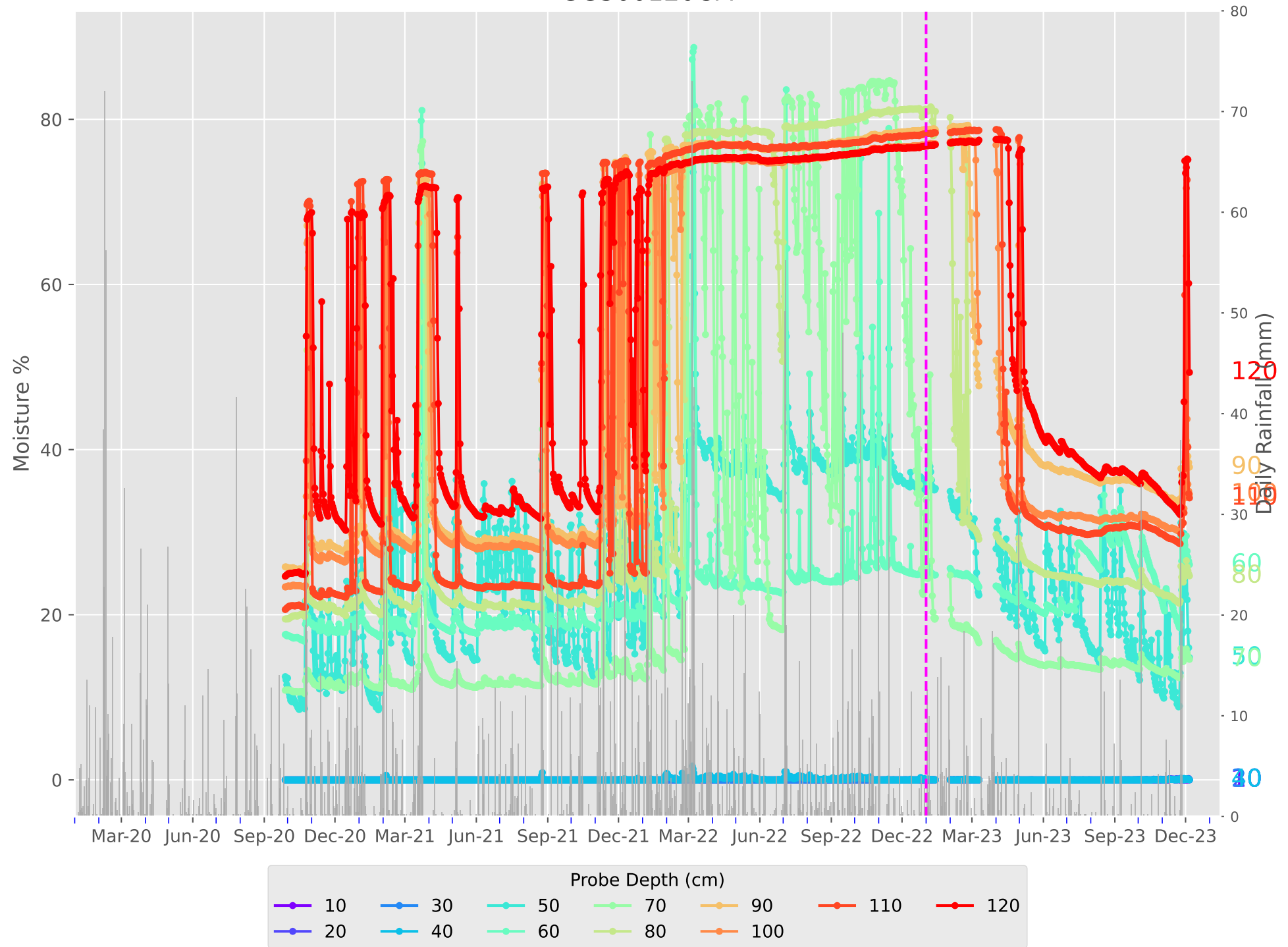
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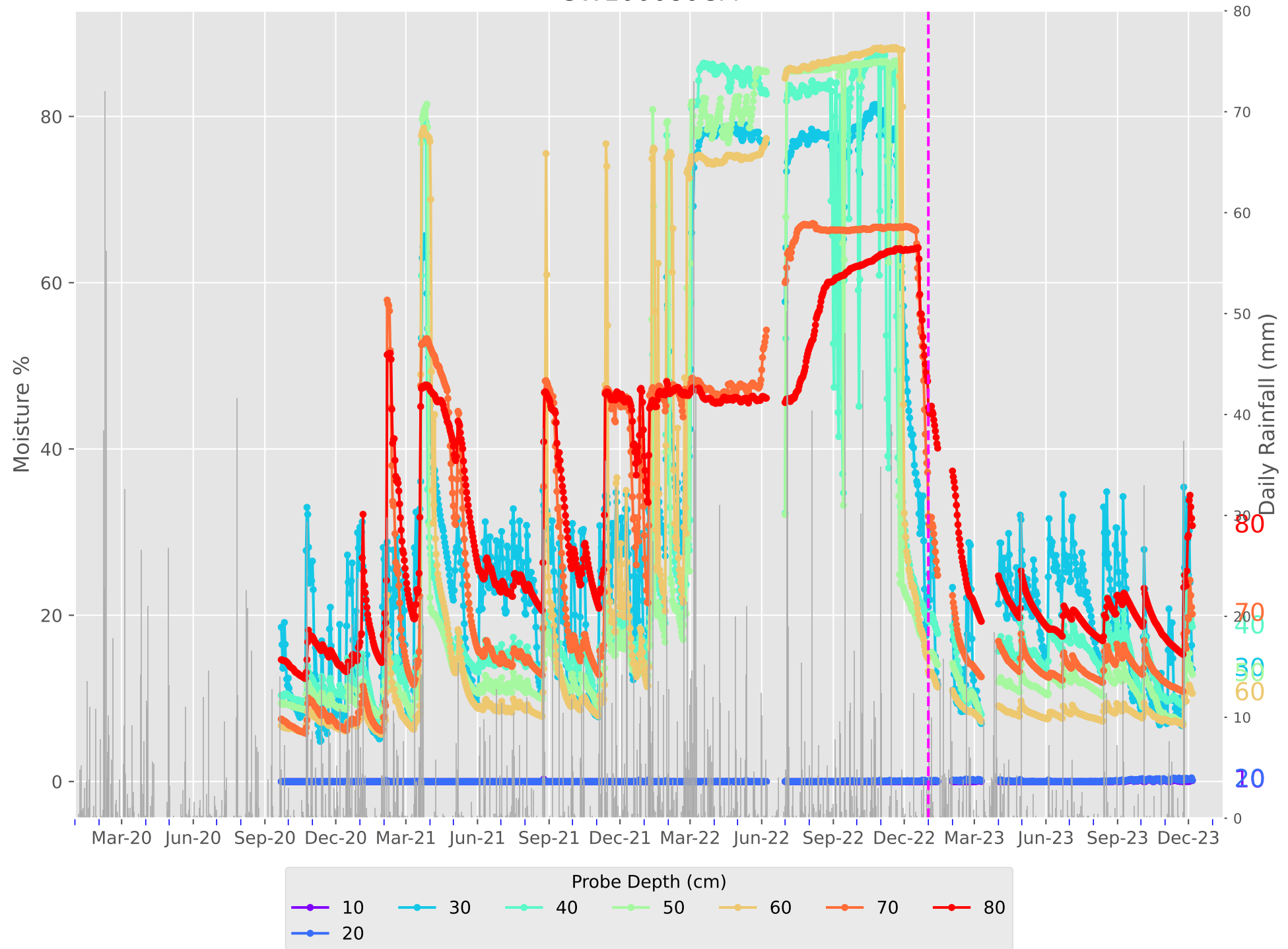
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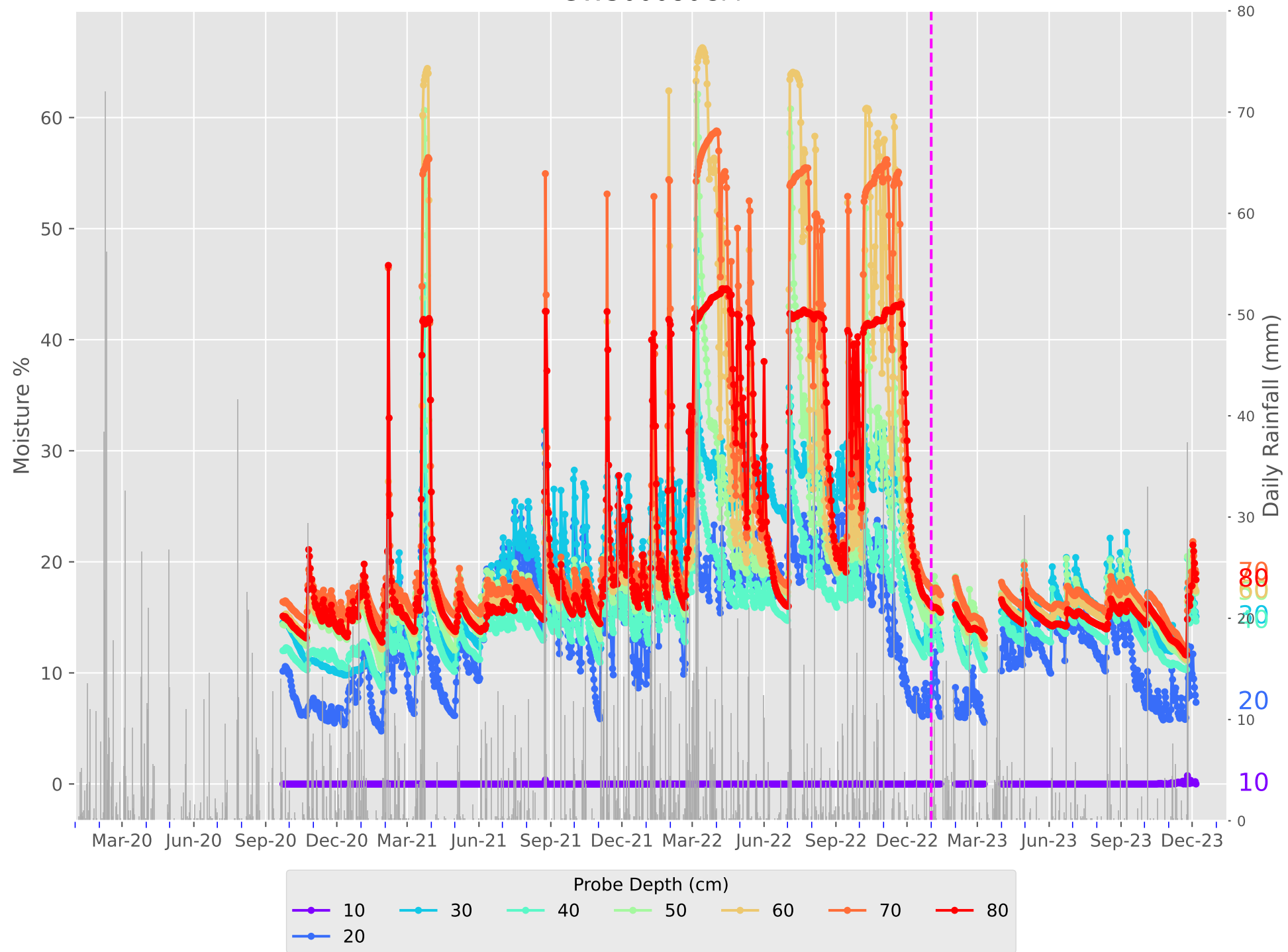
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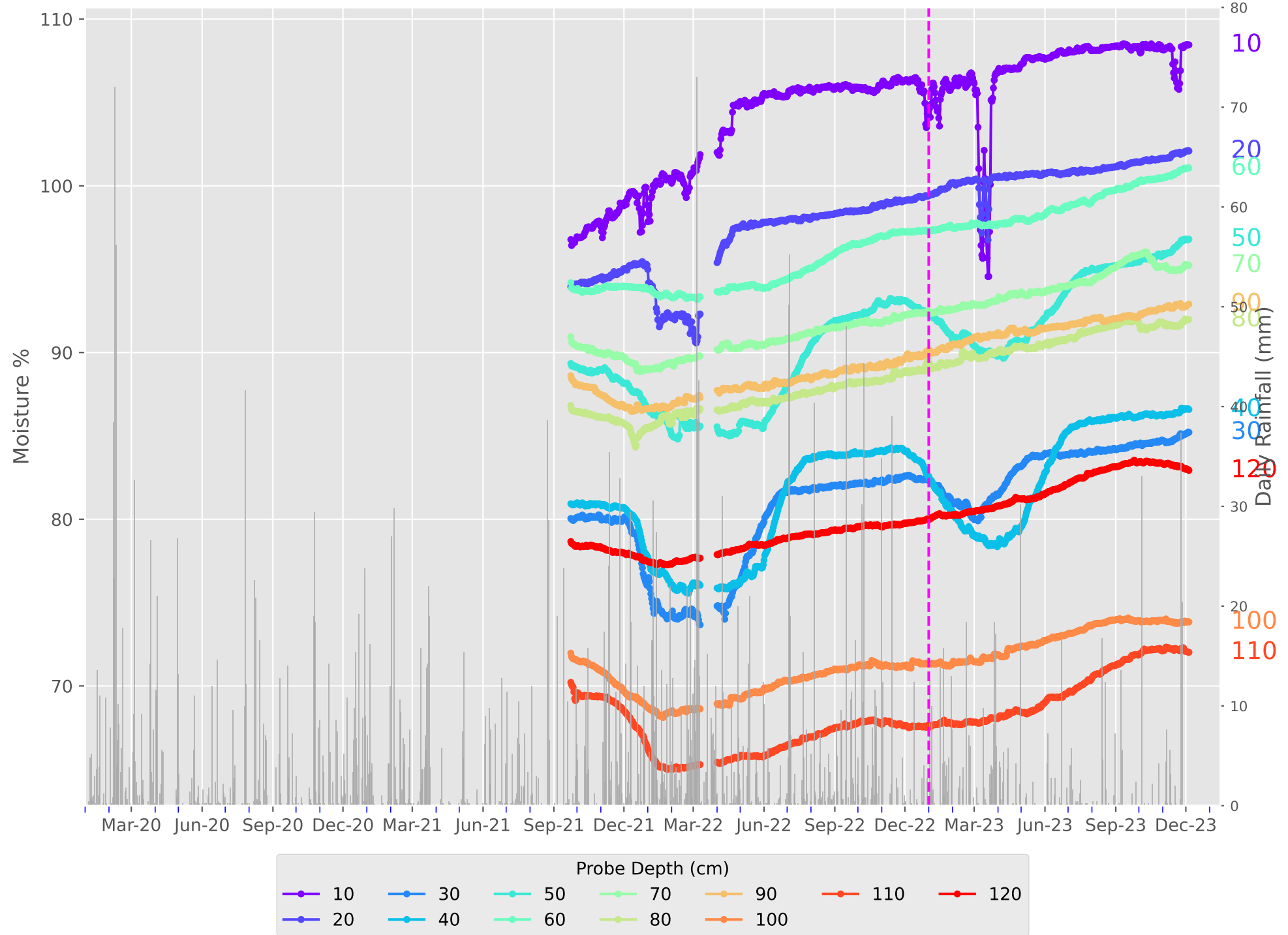
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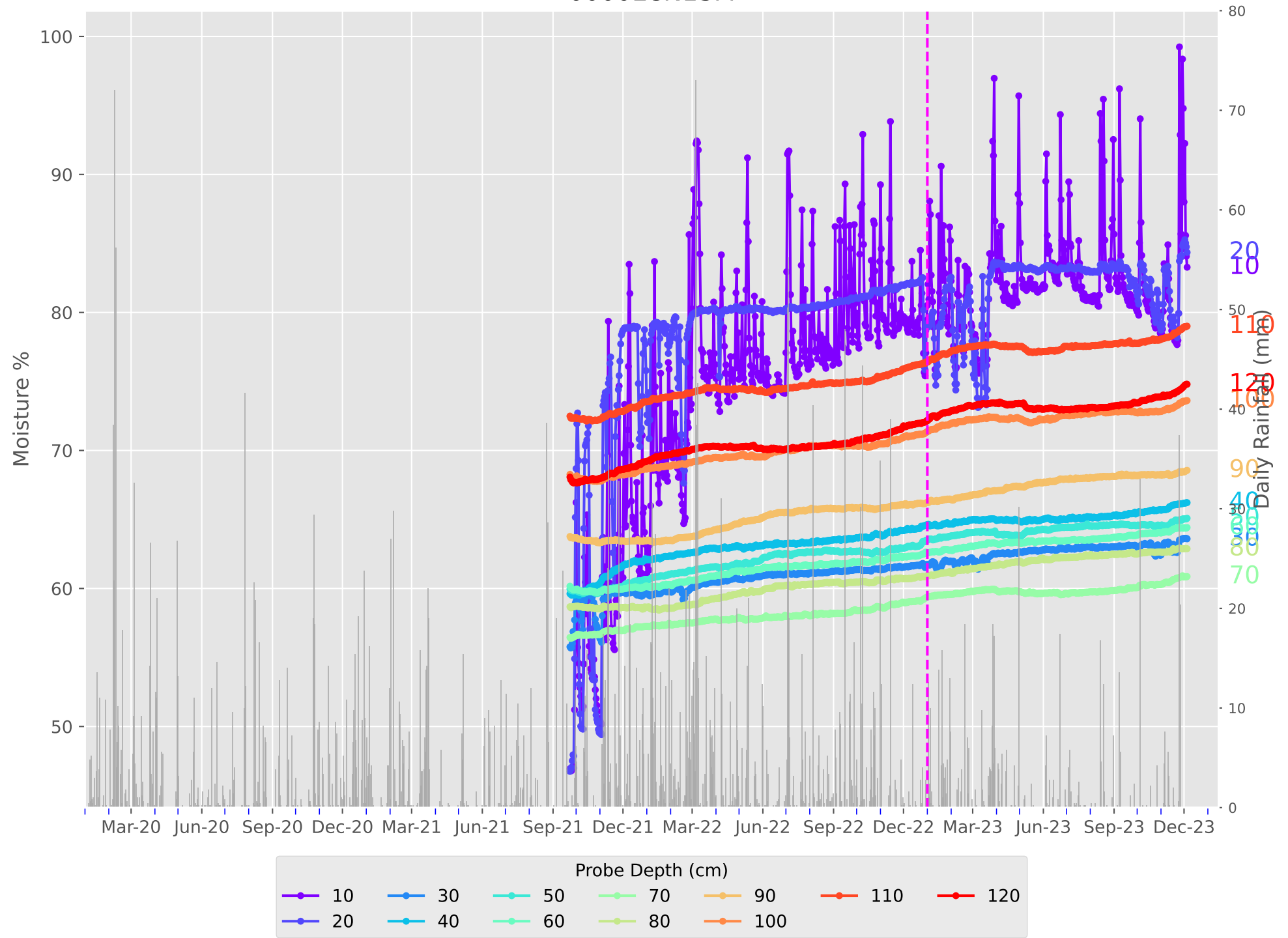
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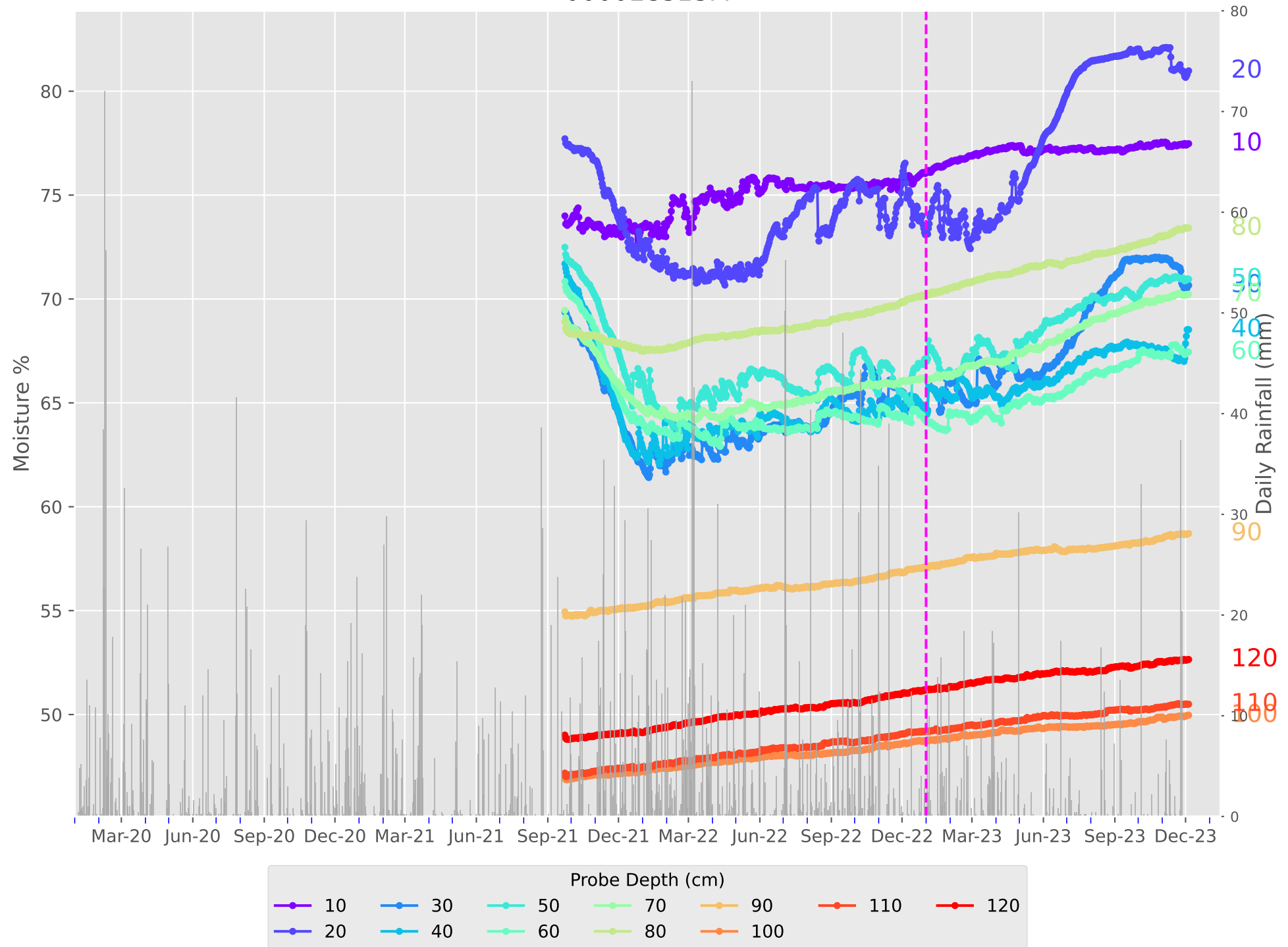
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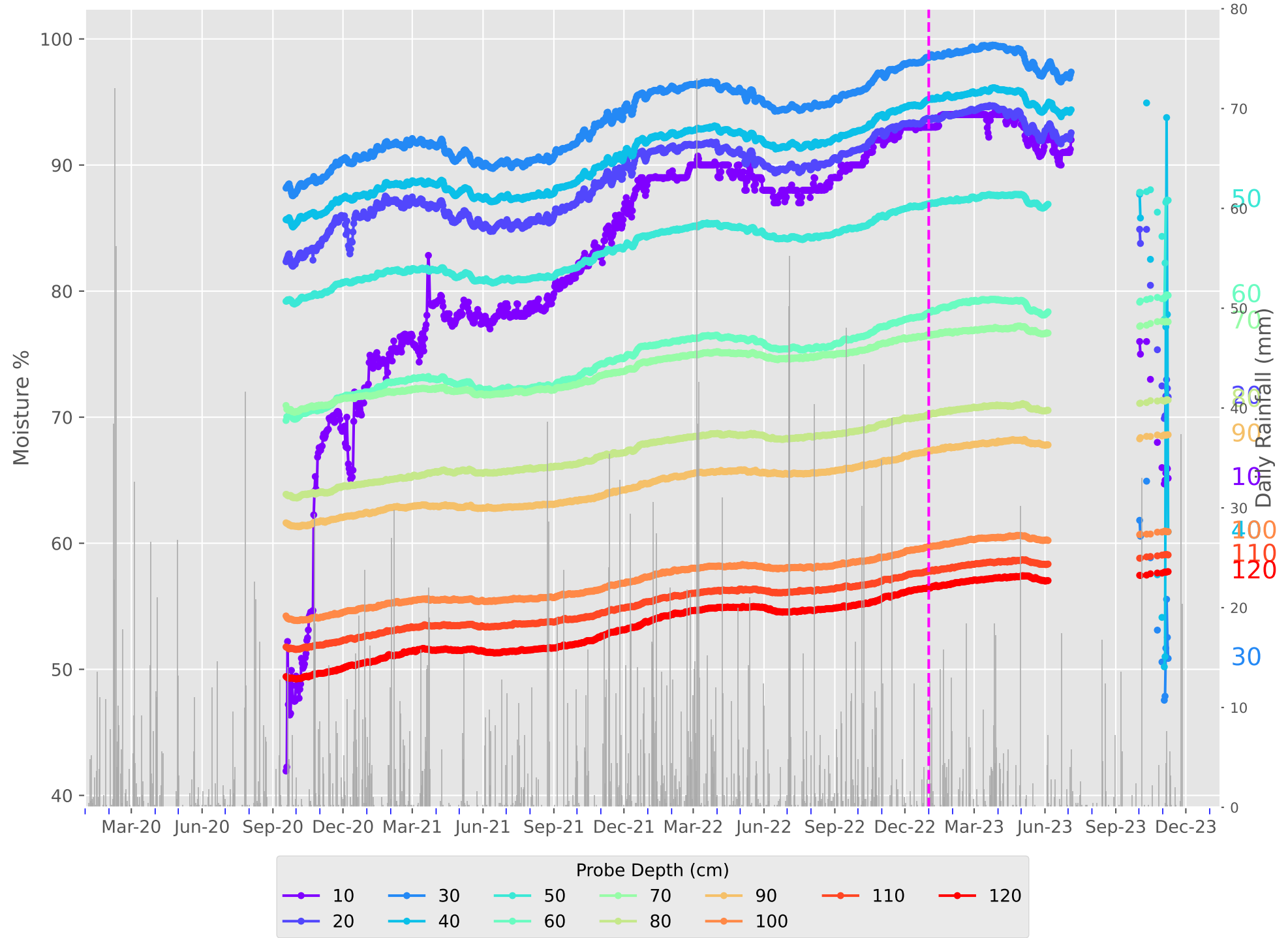
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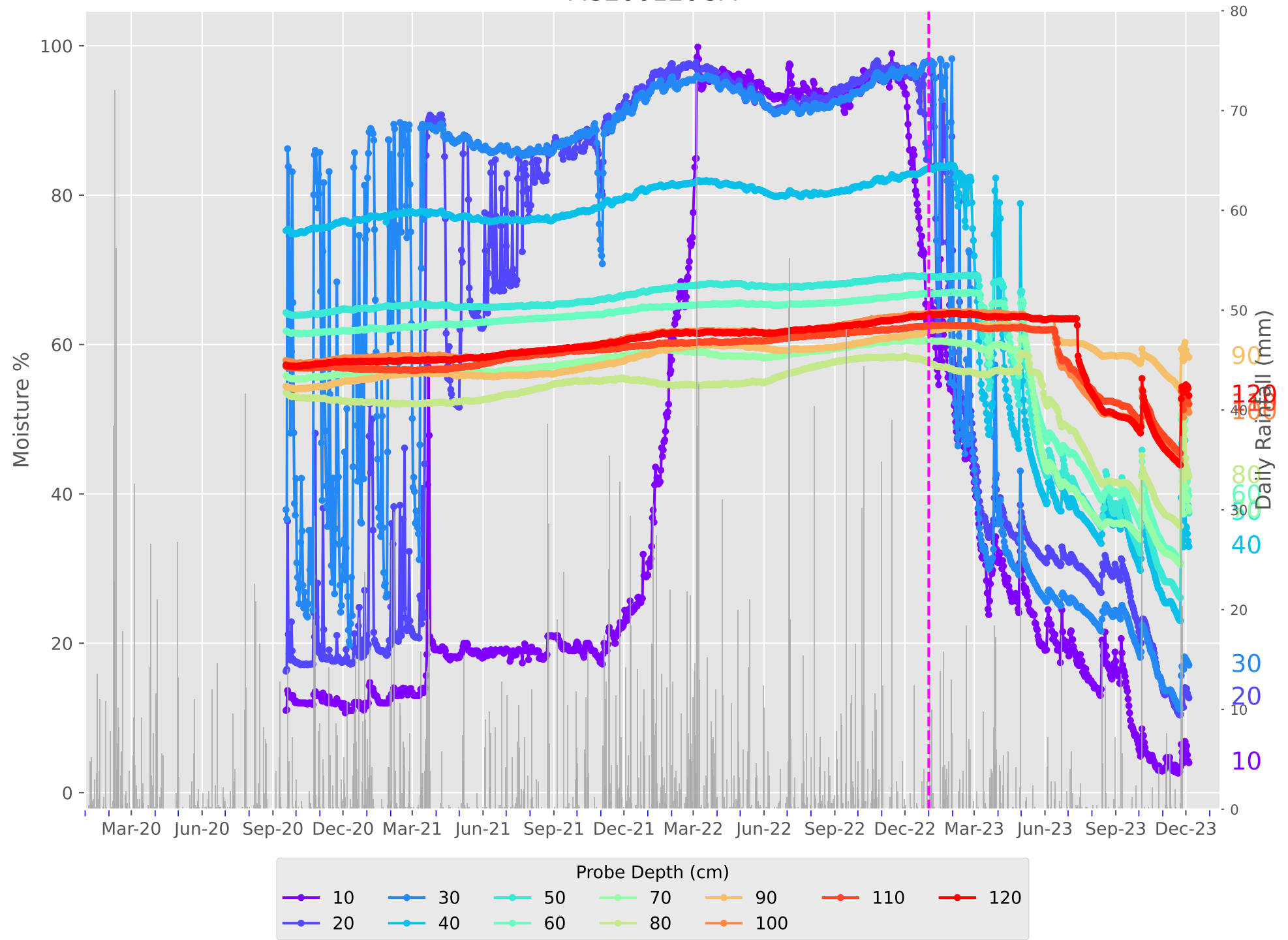
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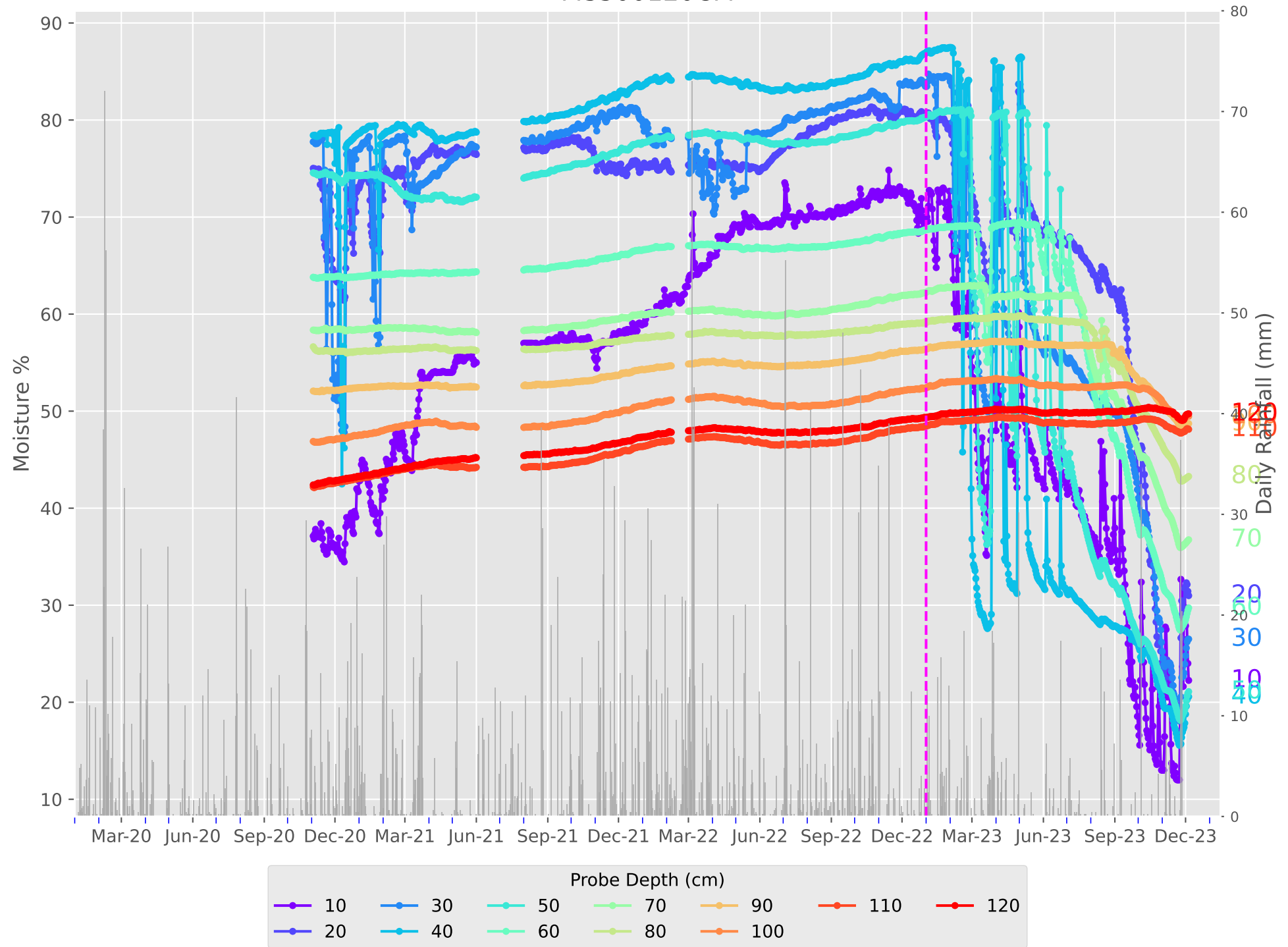
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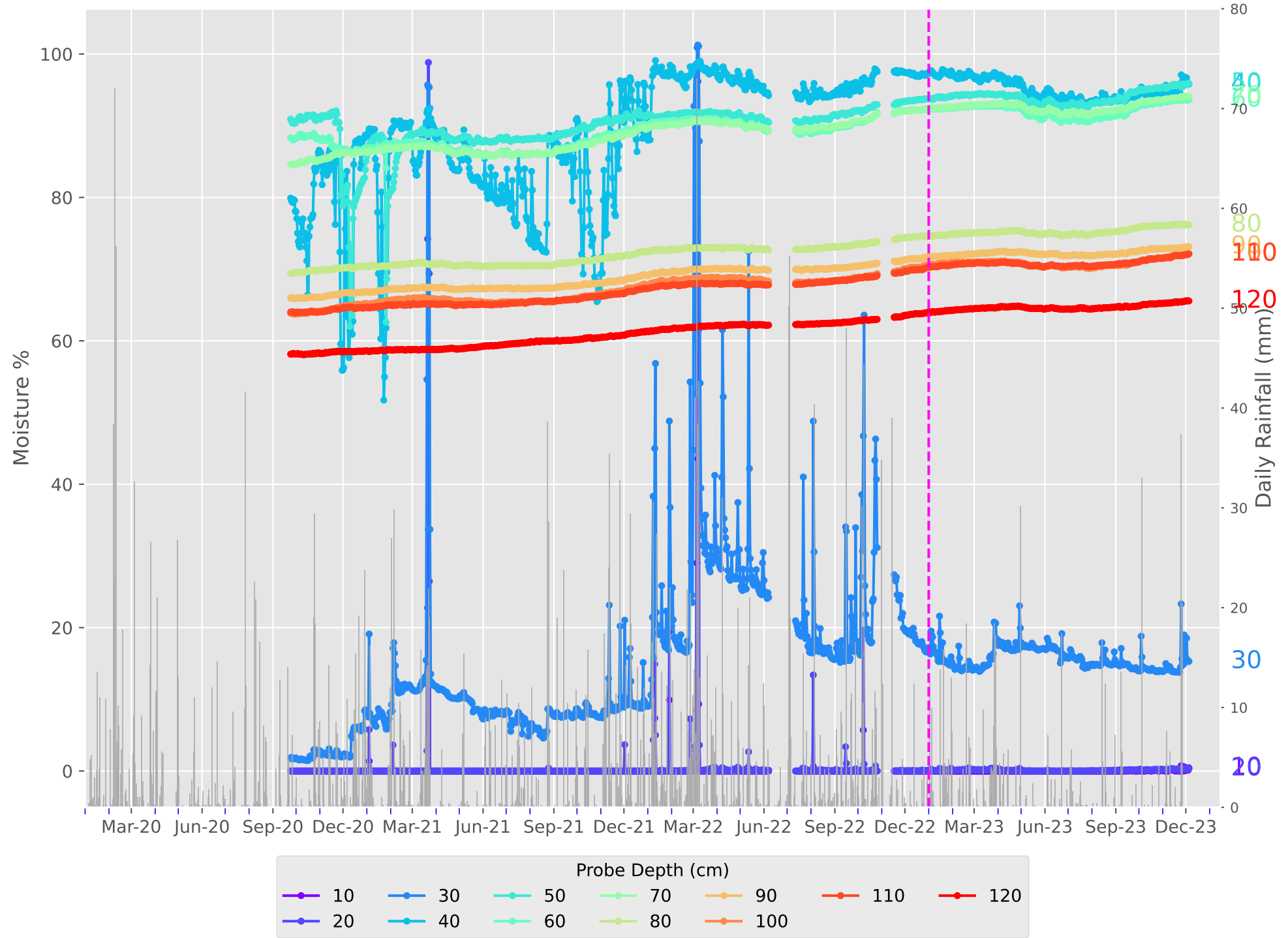
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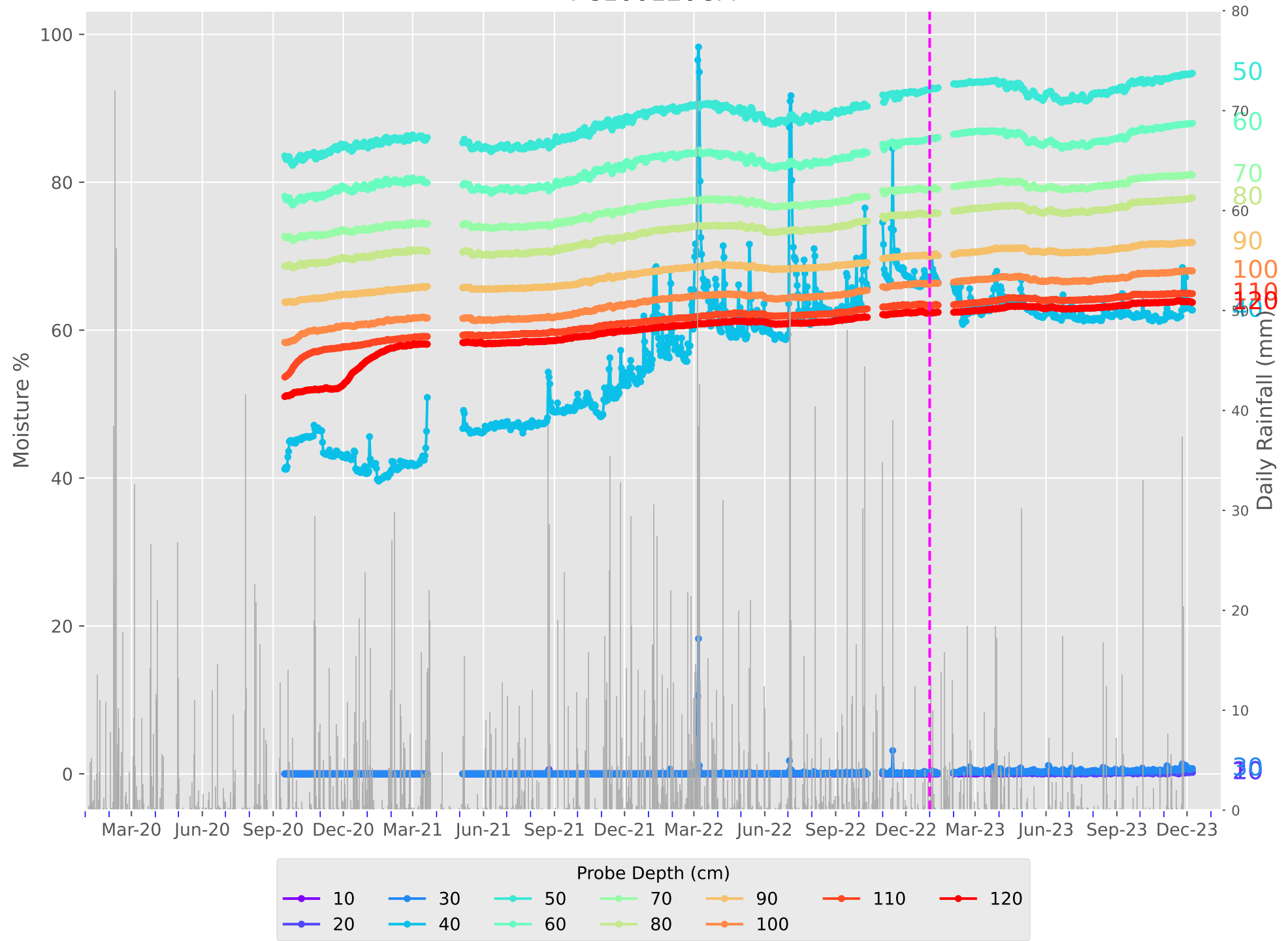
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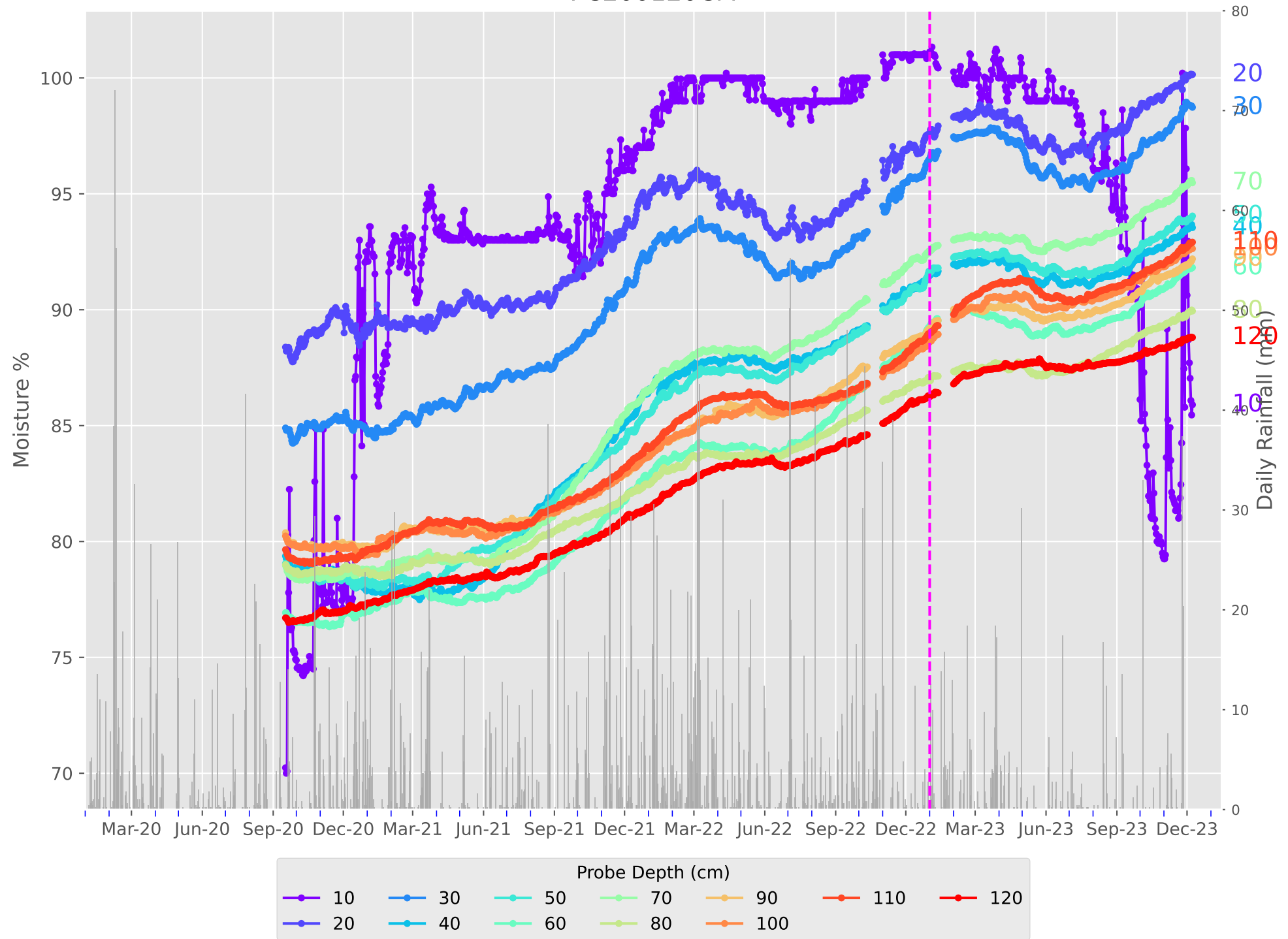
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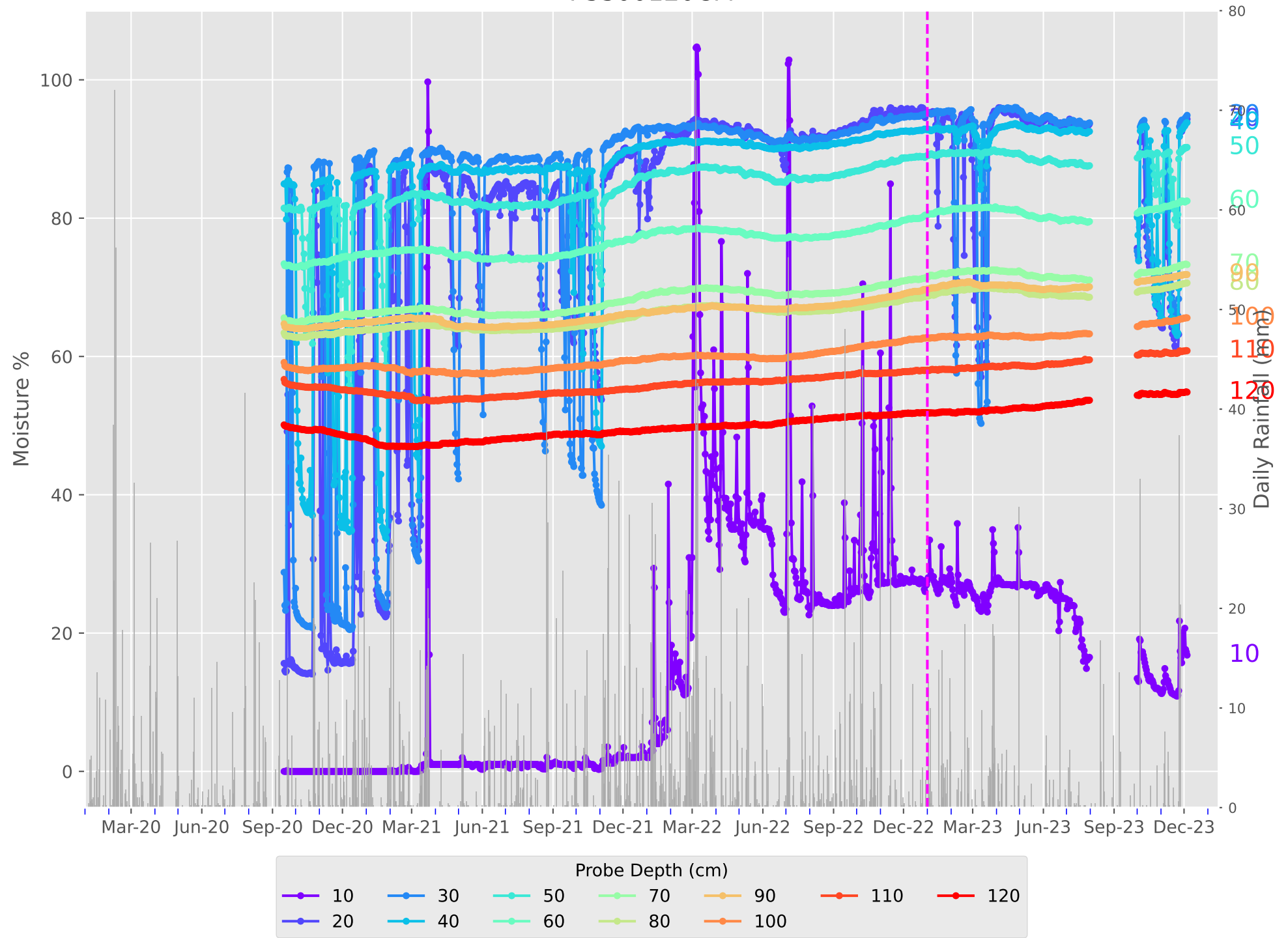
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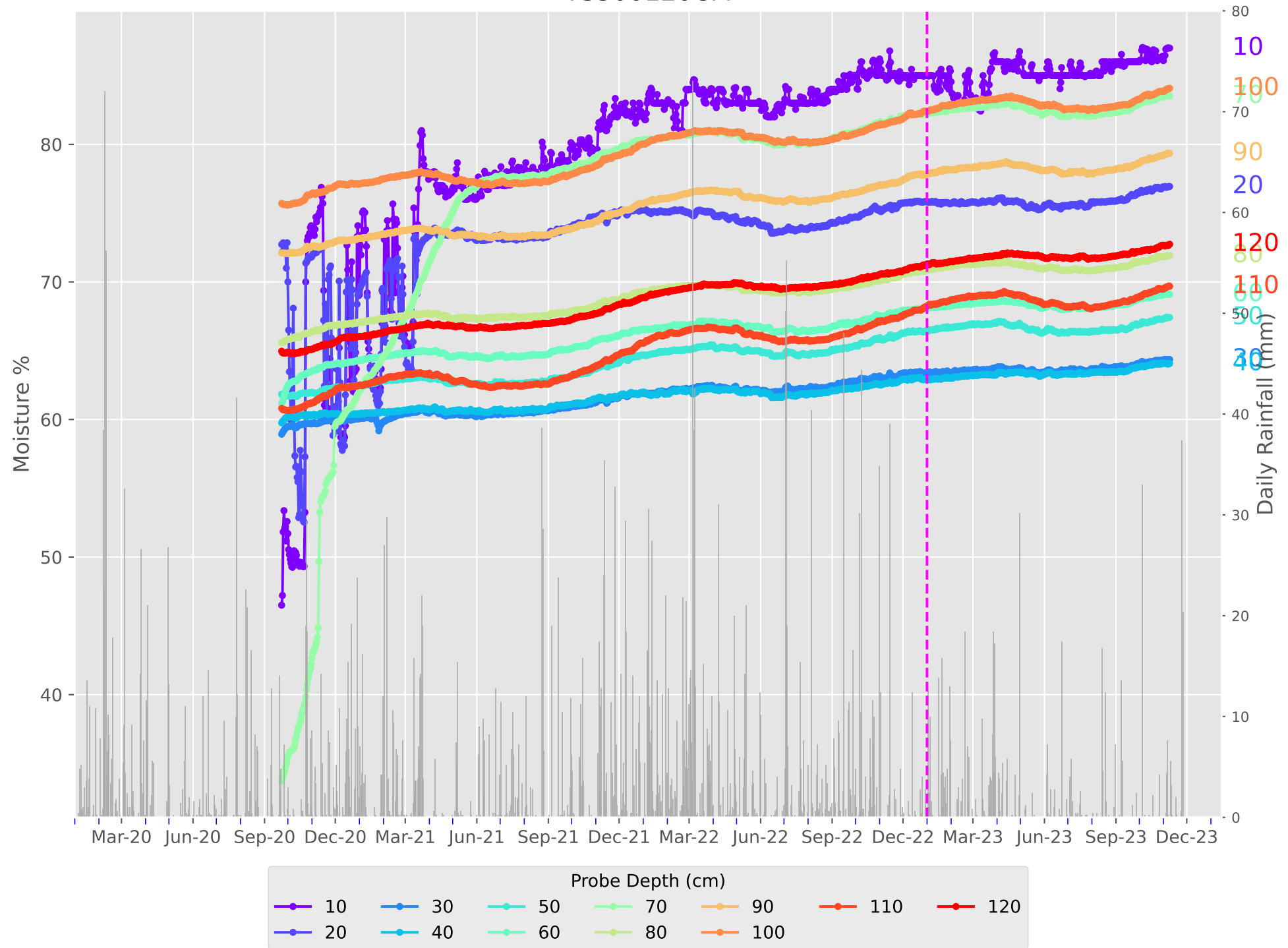
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Appendix E

Groundwater quality time series

E.1 Groundwater quality time series

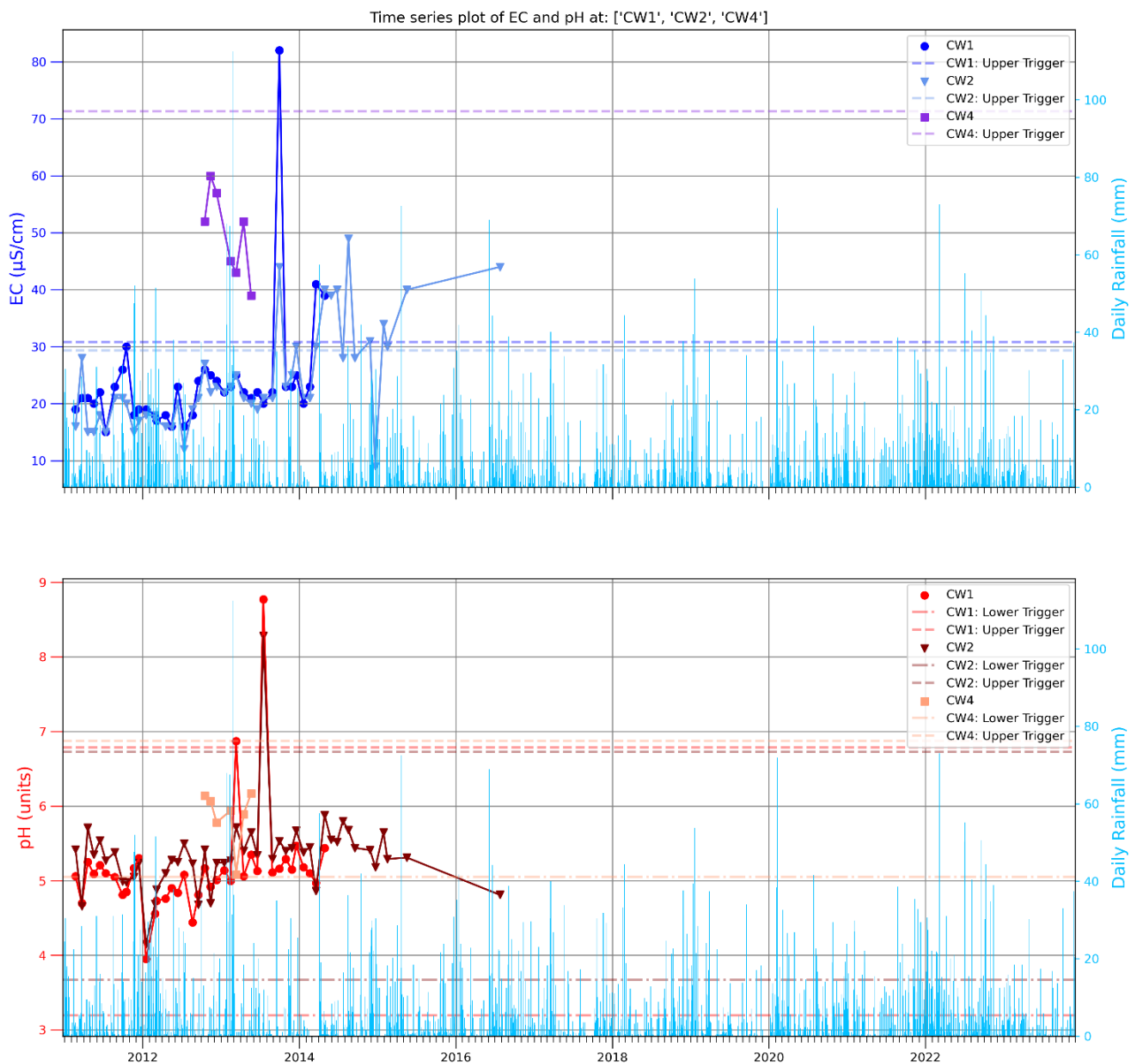


Figure E.E.1 Carne West Swamp piezometer water quality

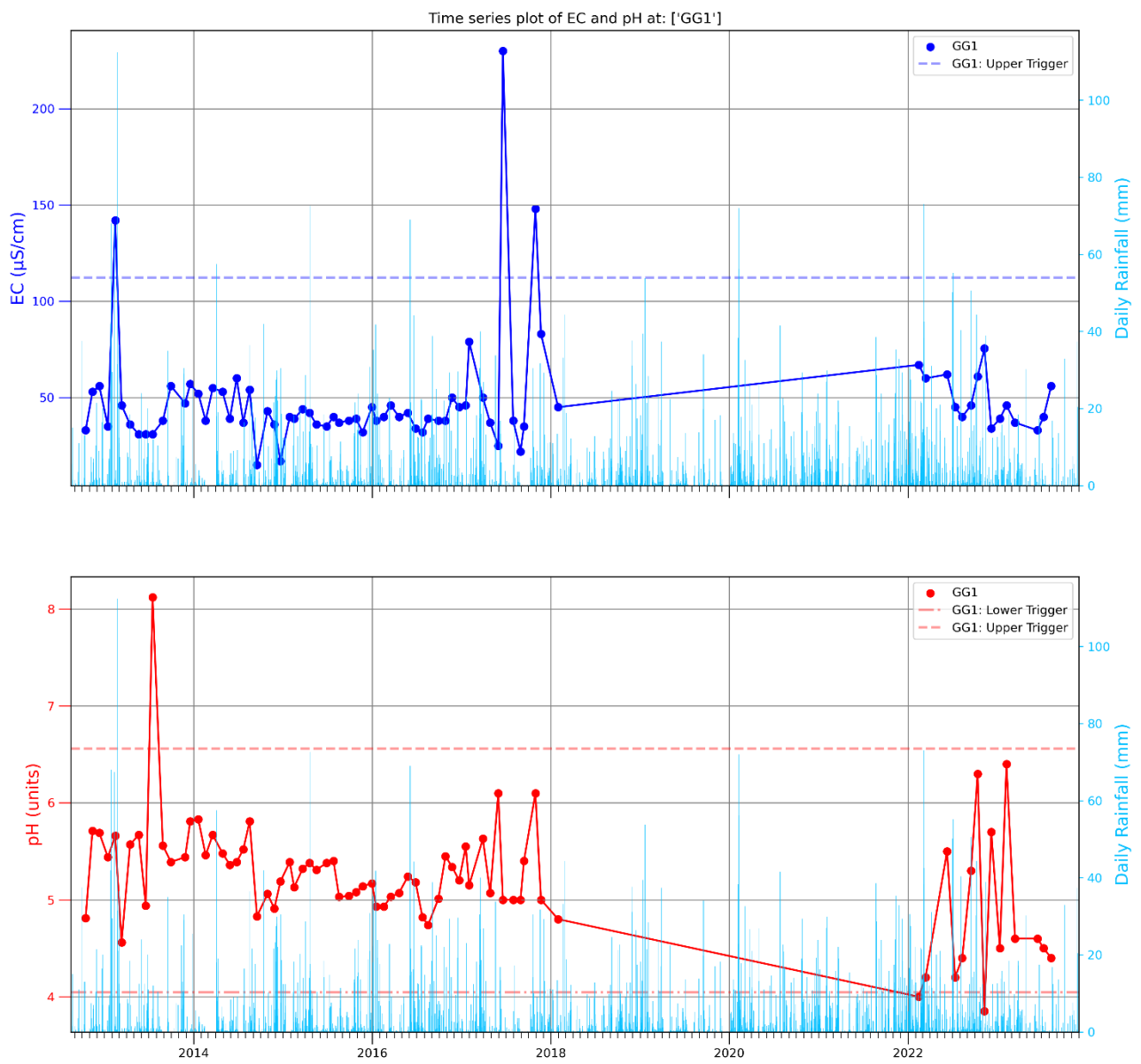


Figure E.2 Gang Gang Swamp piezometer water quality

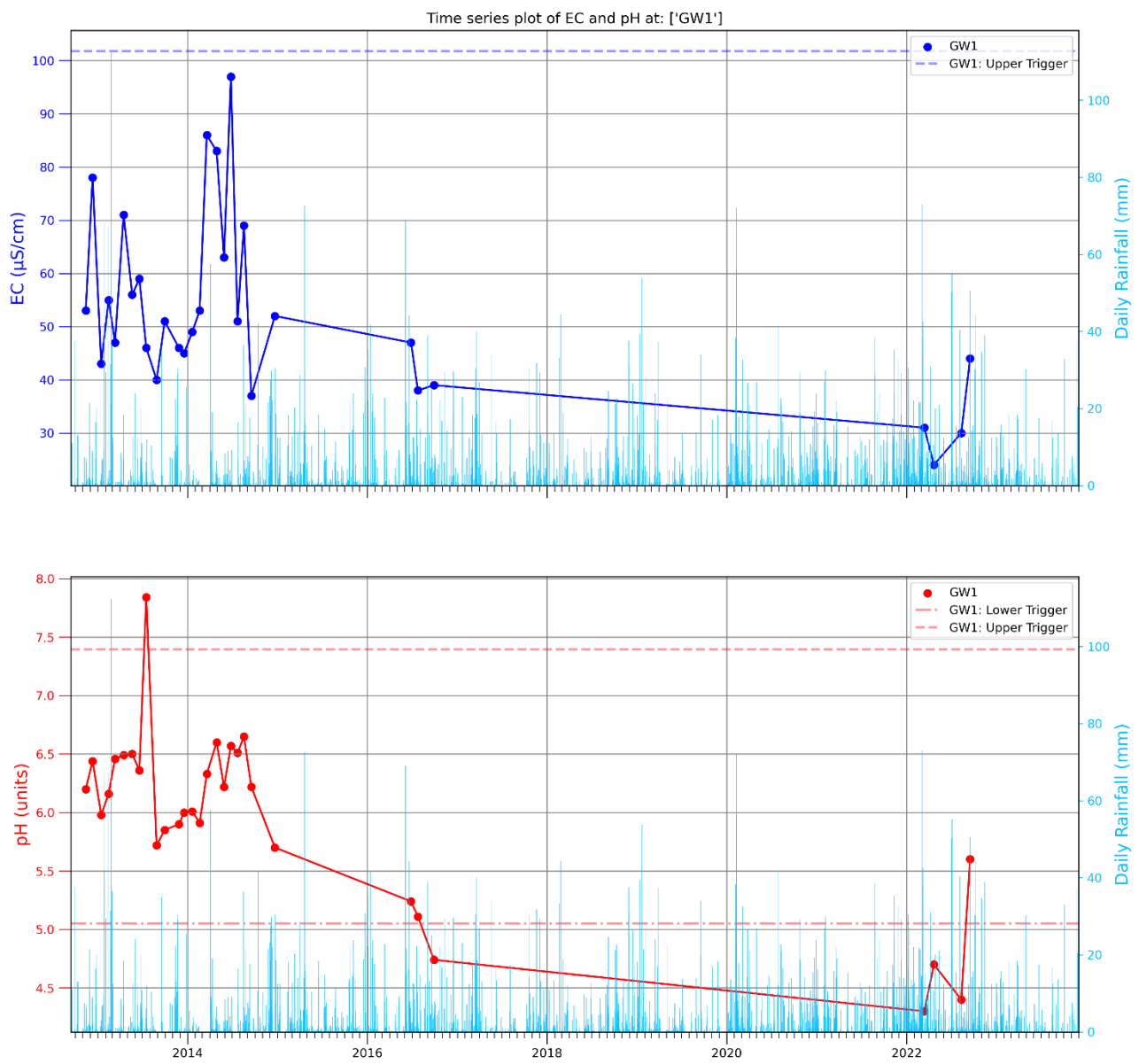


Figure E.3 Gang Gang West Swamp piezometer water quality

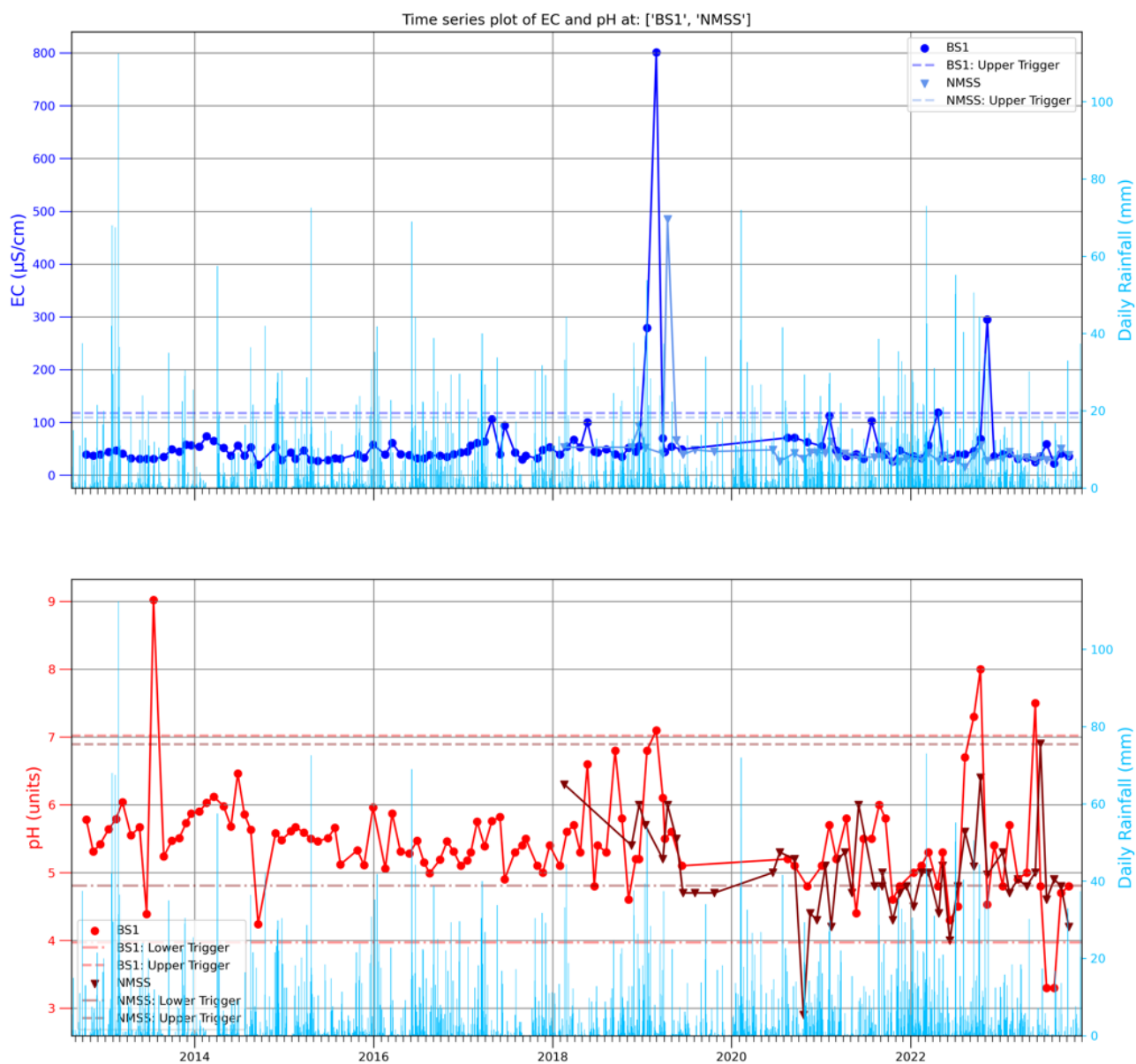


Figure E.4 9 Mile Swamp piezometer water quality

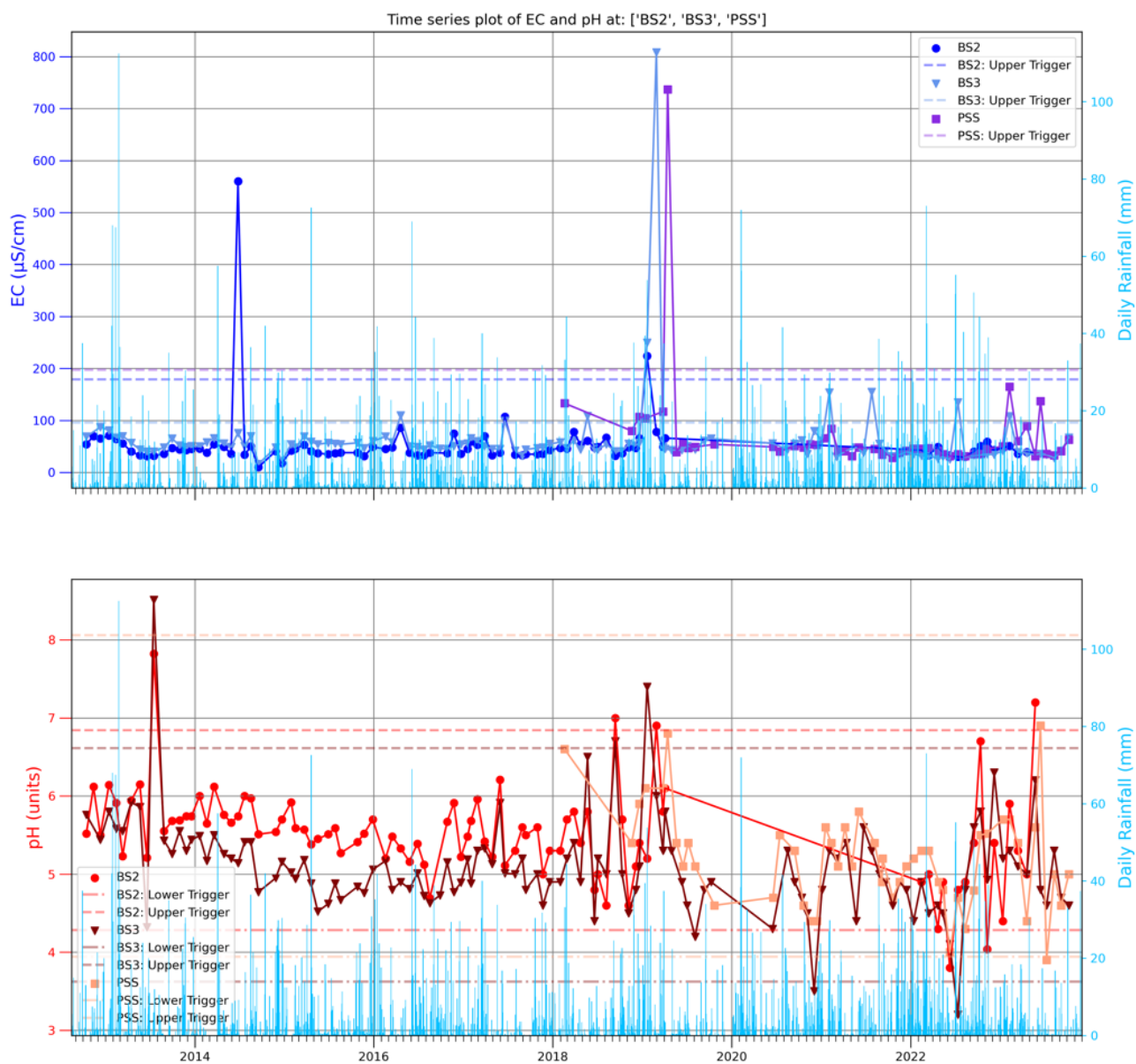


Figure E.5 Pine Swamp piezometer water quality

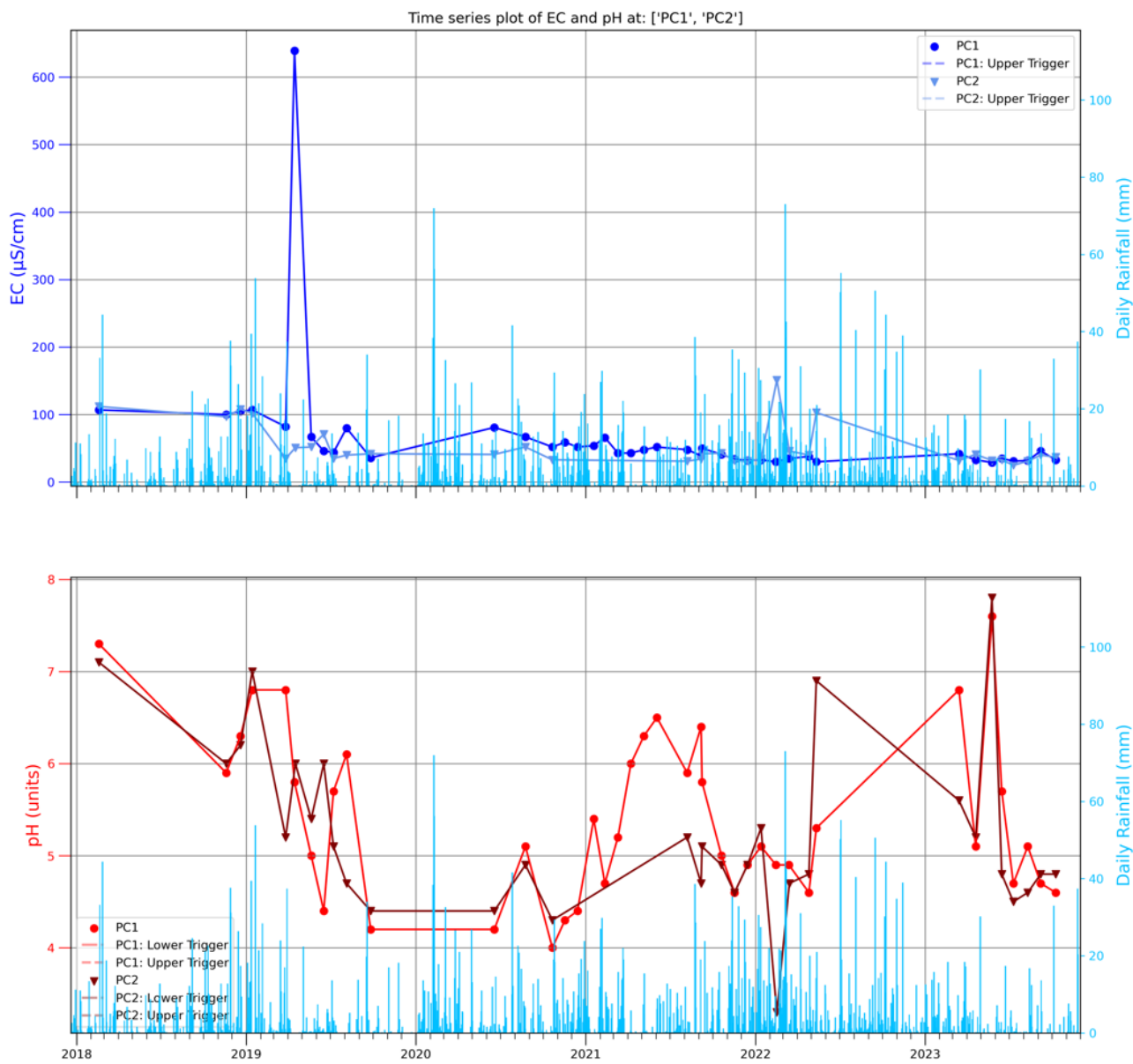


Figure E.6 Paddys Creek swamp piezometer water quality

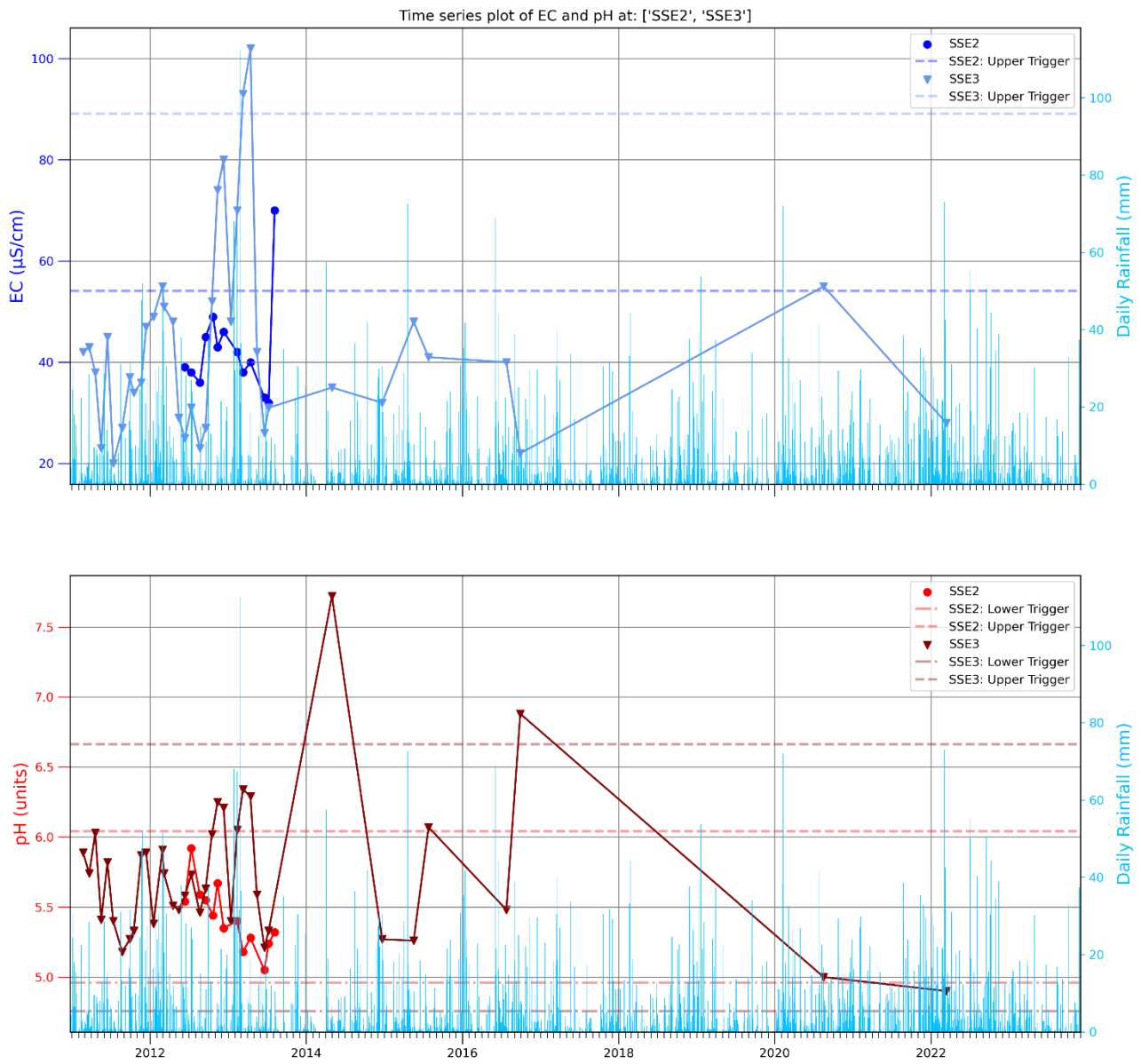


Figure E.7 Sunnyside East Swamp piezometer water quality

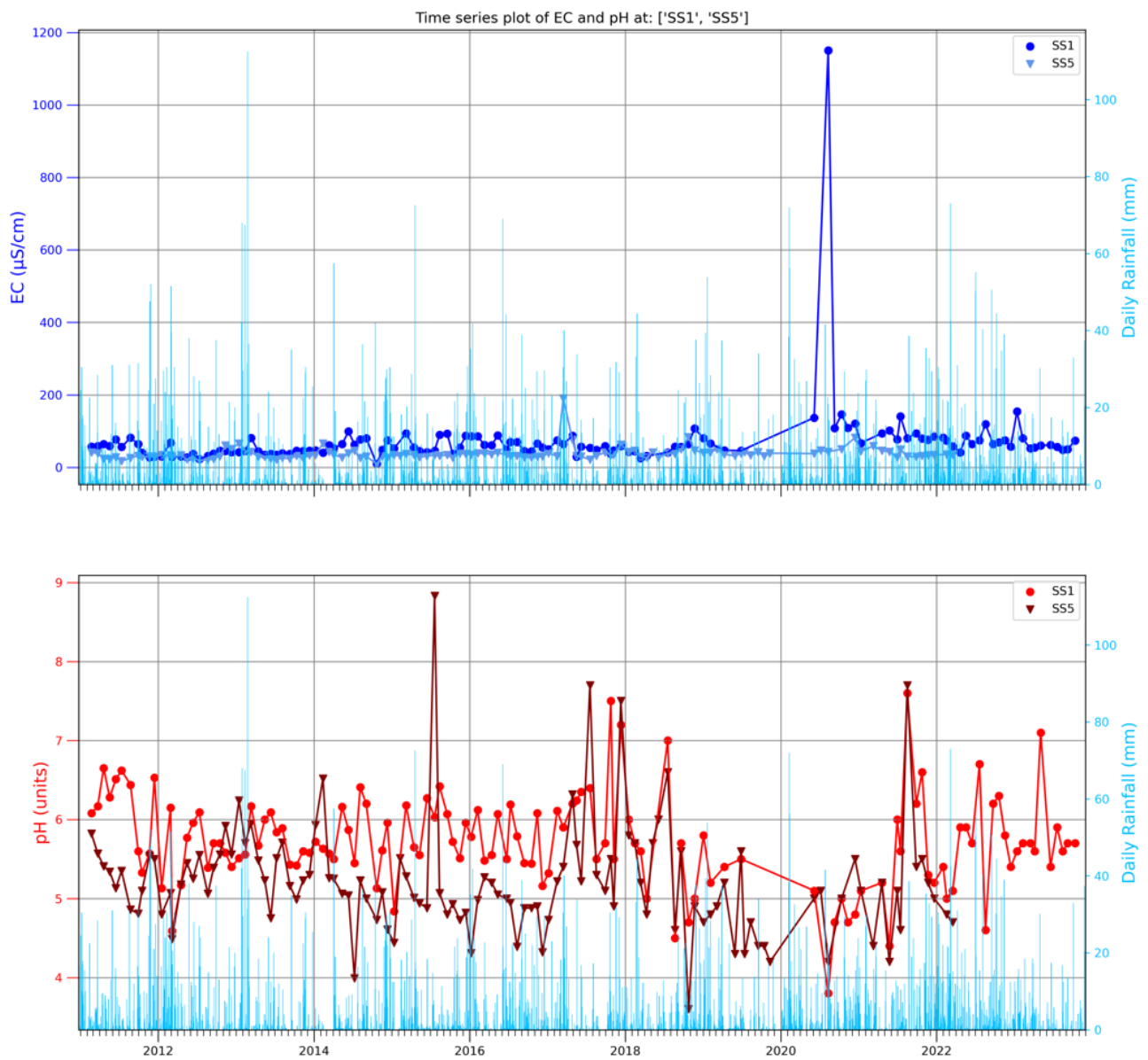


Figure E.8 Sunnyside Swamp piezometer water quality

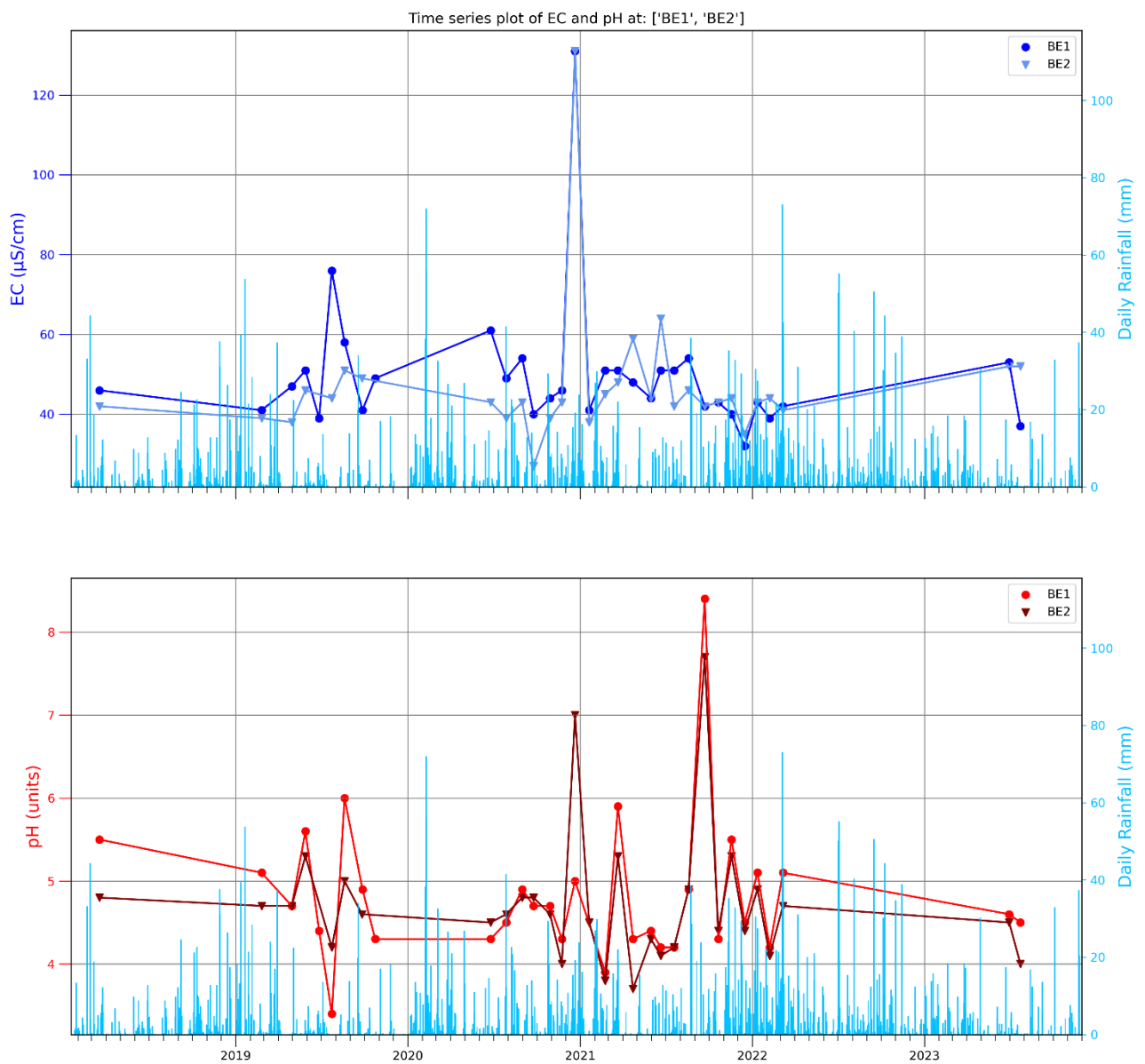


Figure E.9 Sunnyside Swamp piezometer water quality

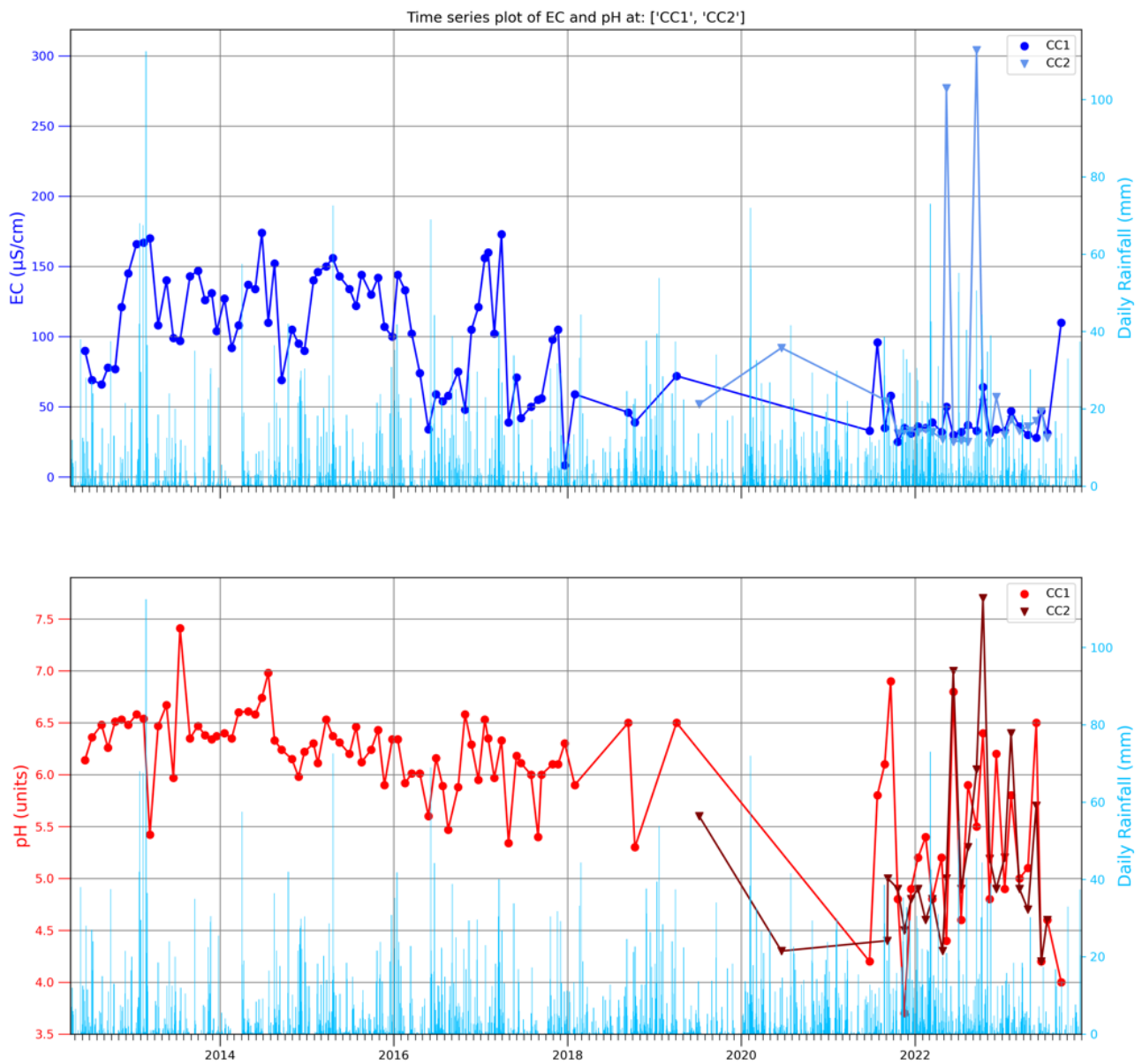


Figure E.10 Carne Central Swamp piezometer water quality

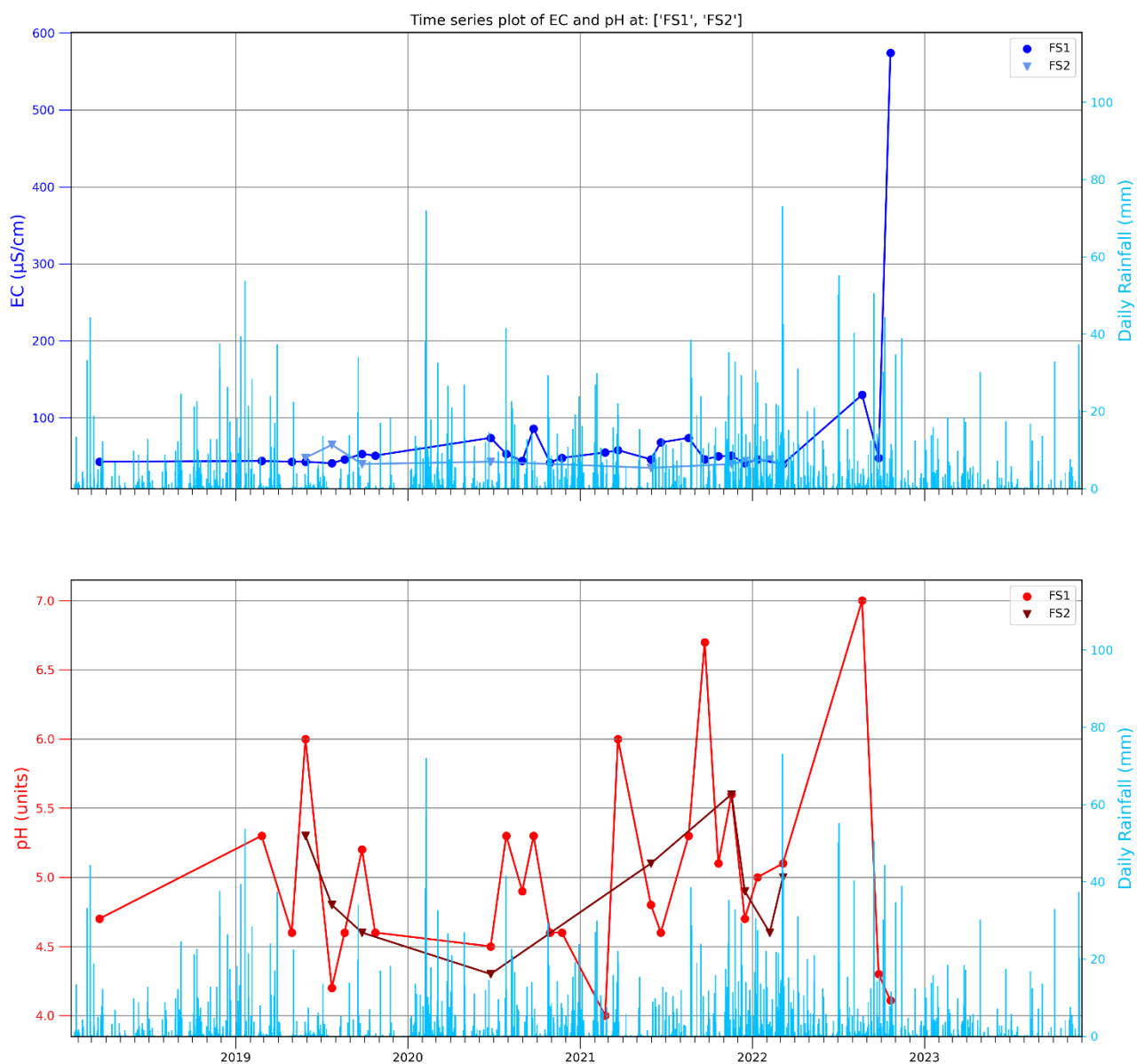


Figure E.11 Firetail Swamp piezometer water quality

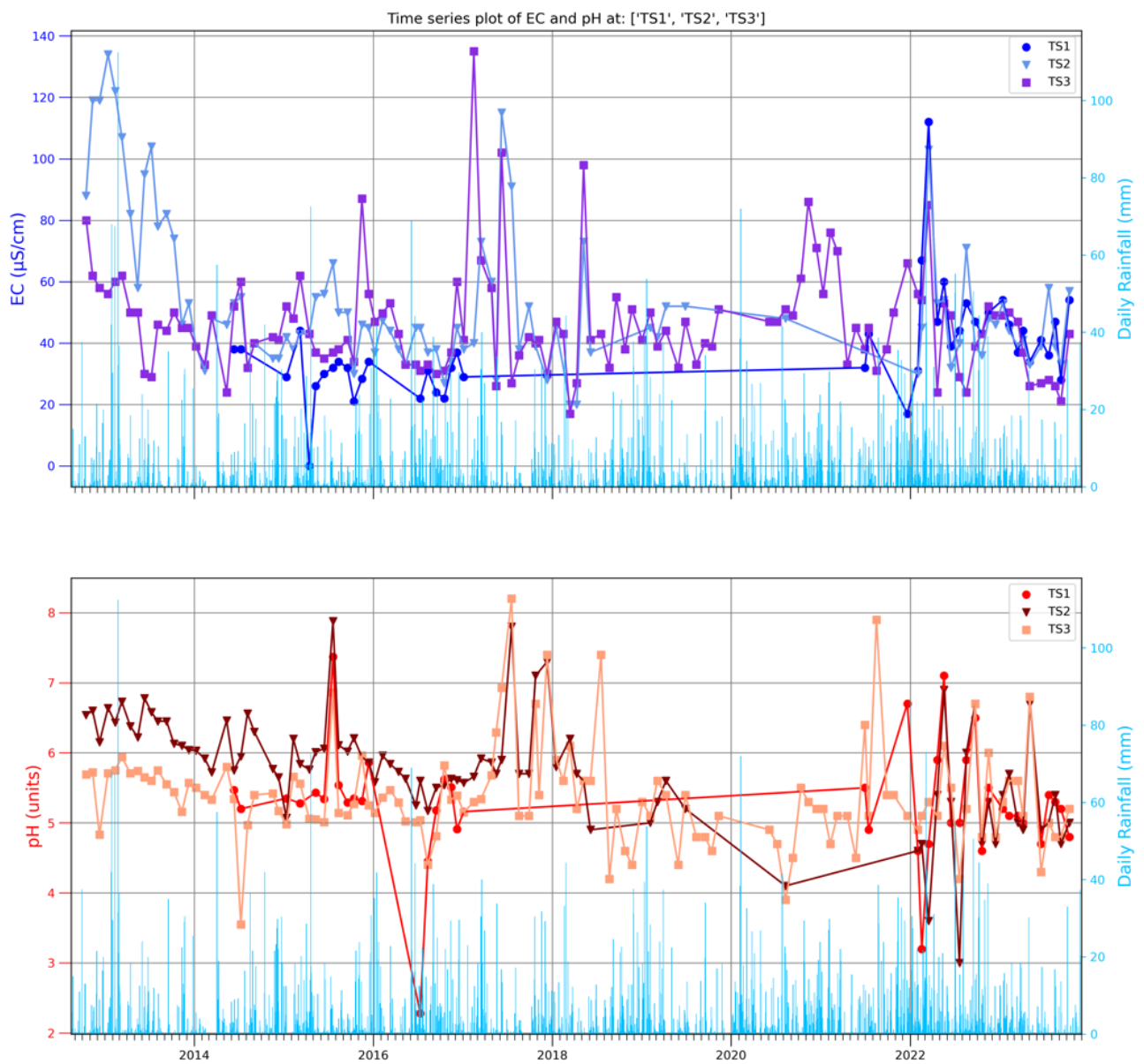


Figure E.12 Tristar Swamp piezometer water quality

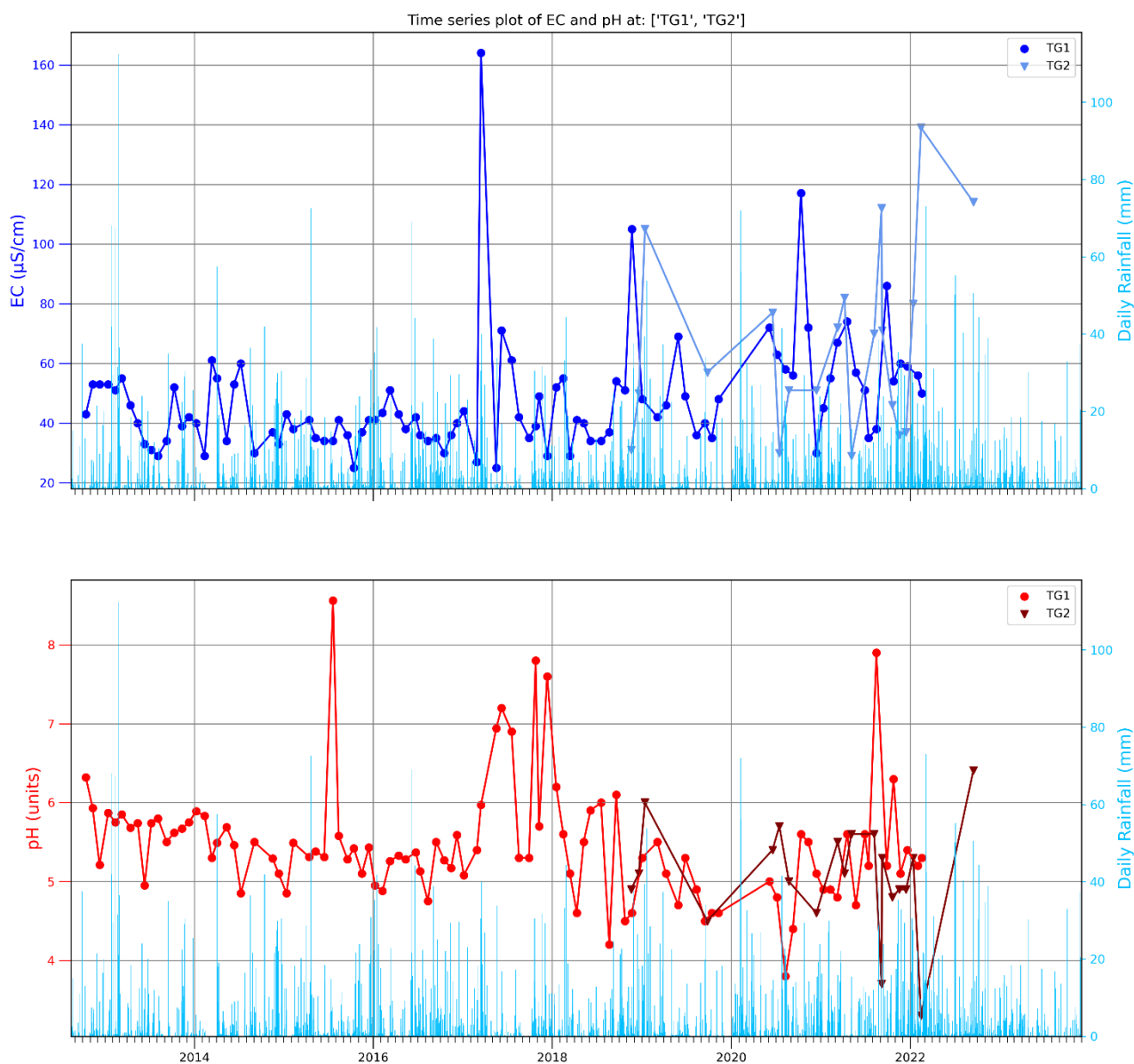


Figure E.13 Twin Gully Swamp piezometer water quality

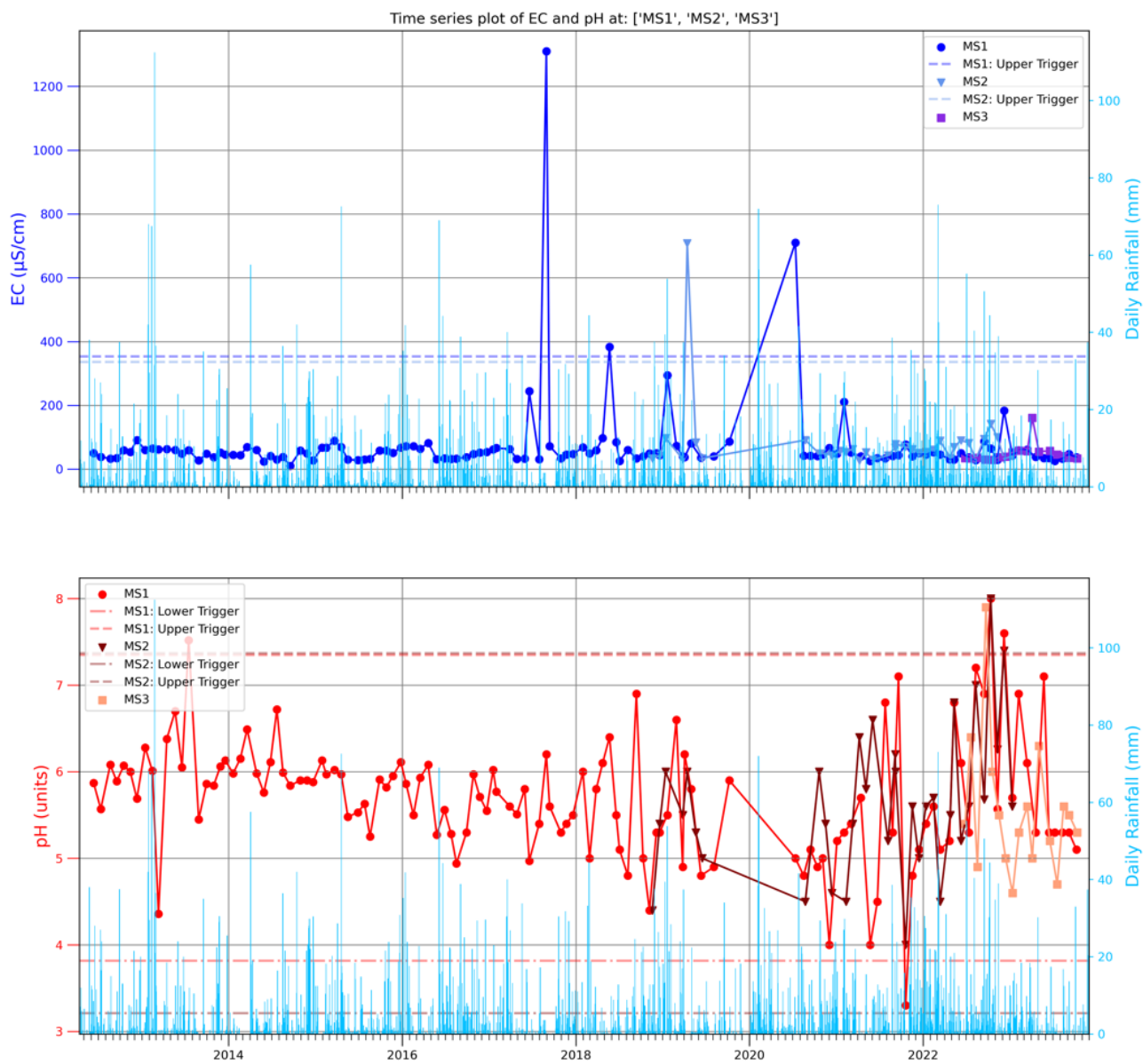


Figure E.14 Marangaroo Swamp piezometer water quality

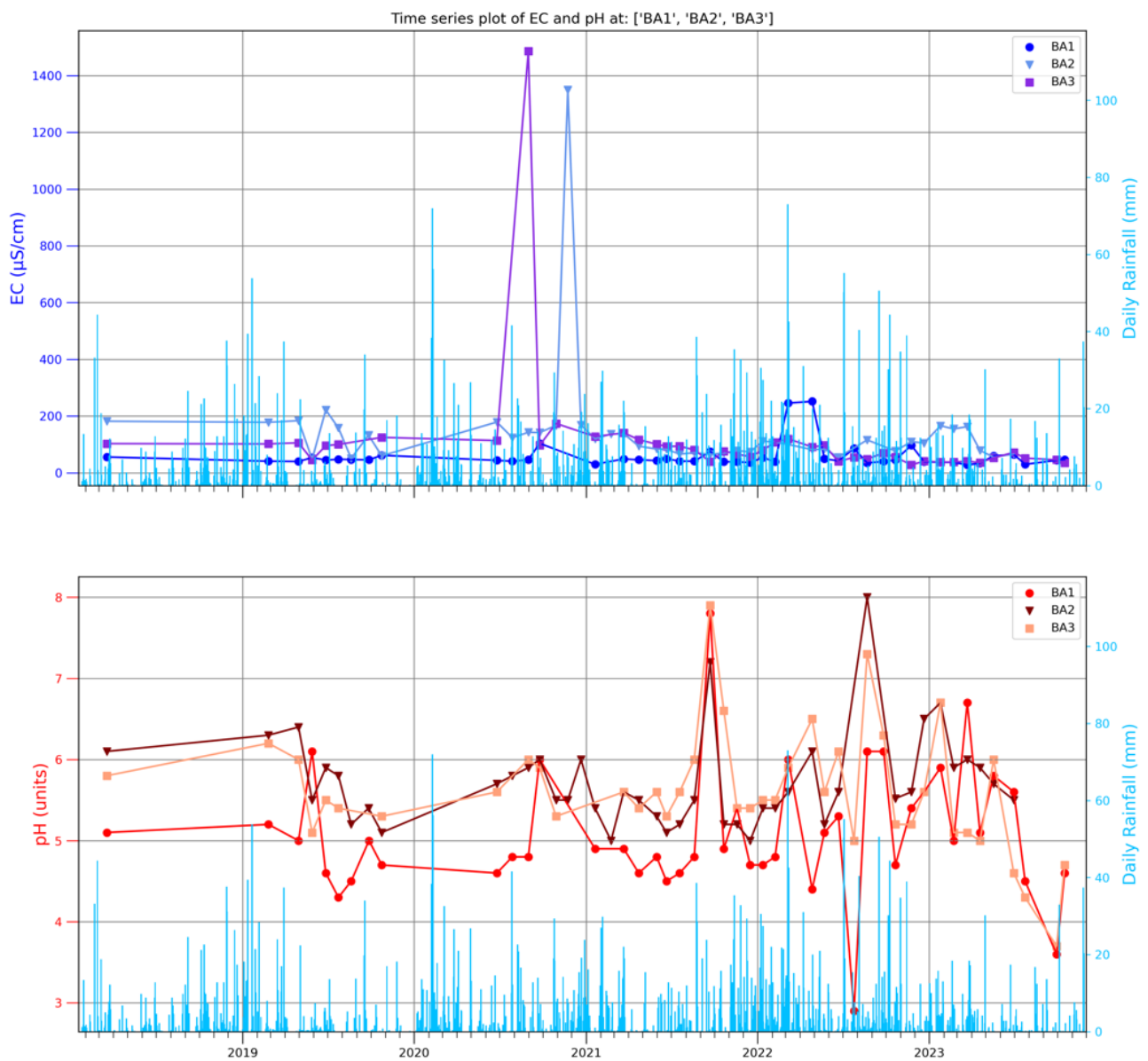


Figure E.15 Barrier Swamp piezometer water quality

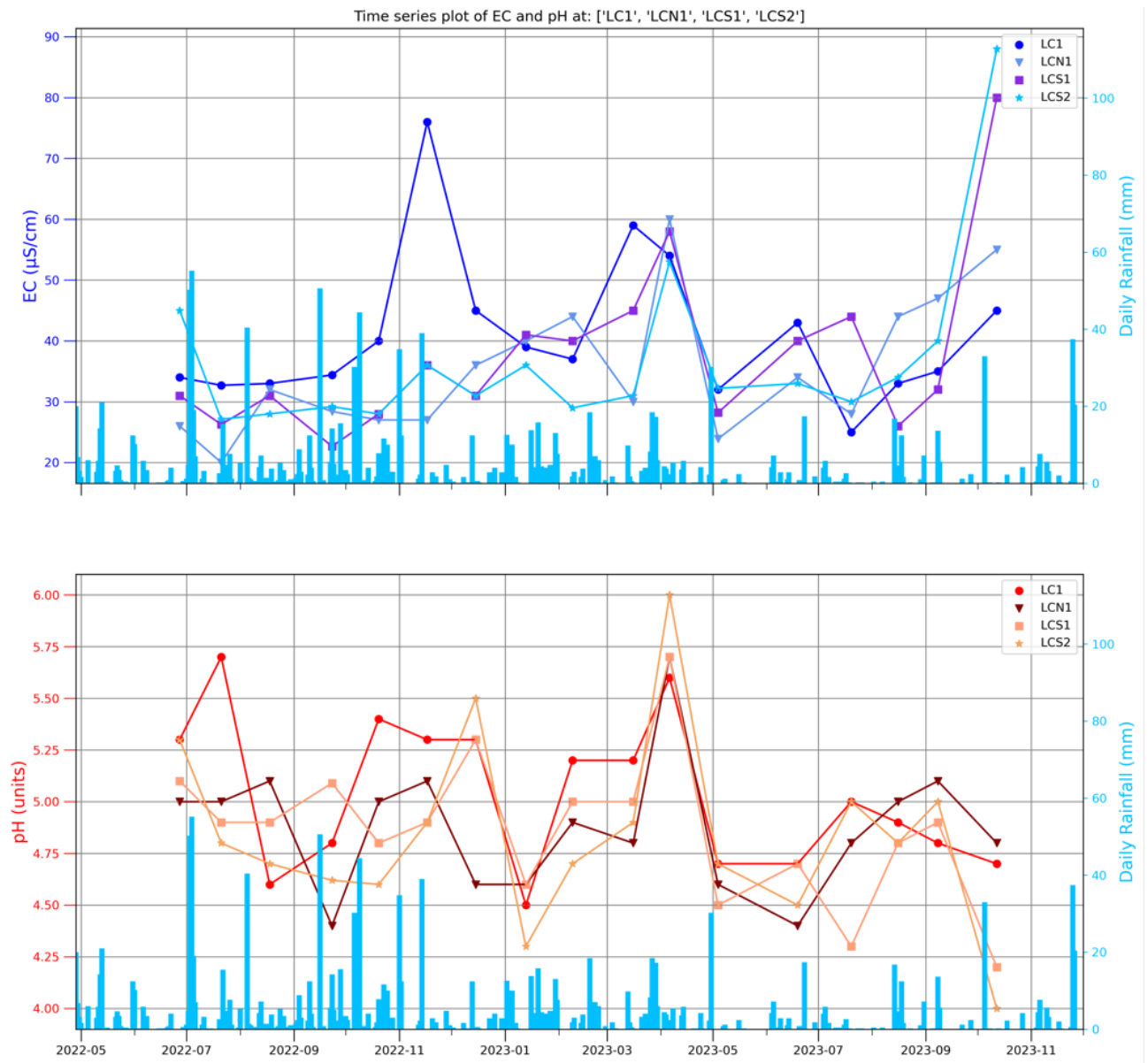


Figure E.16 Lost City Swamp piezometer water quality

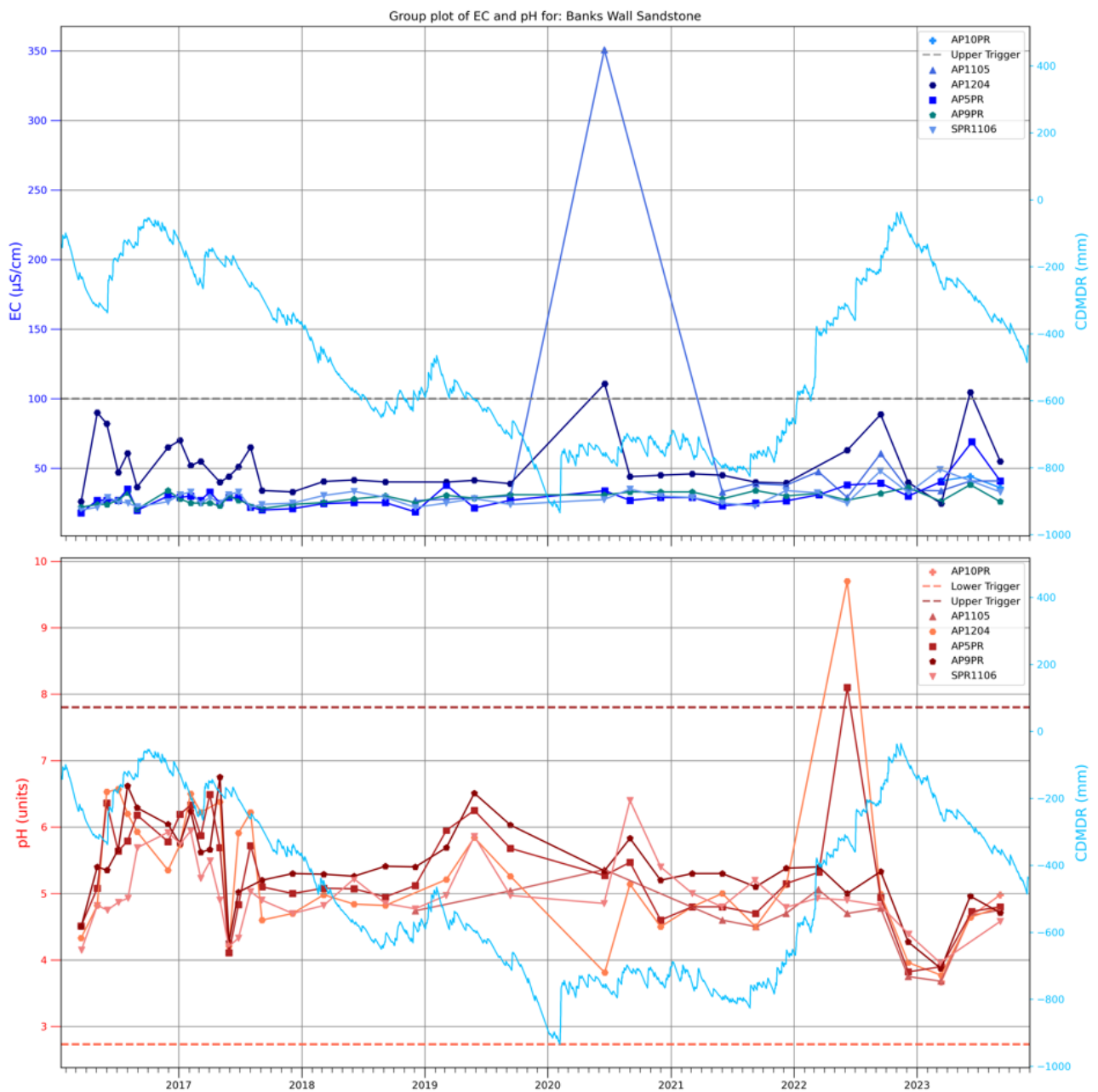


Figure E.17 Shallow aquifer piezometer (Banks Wall Sandstone) water quality

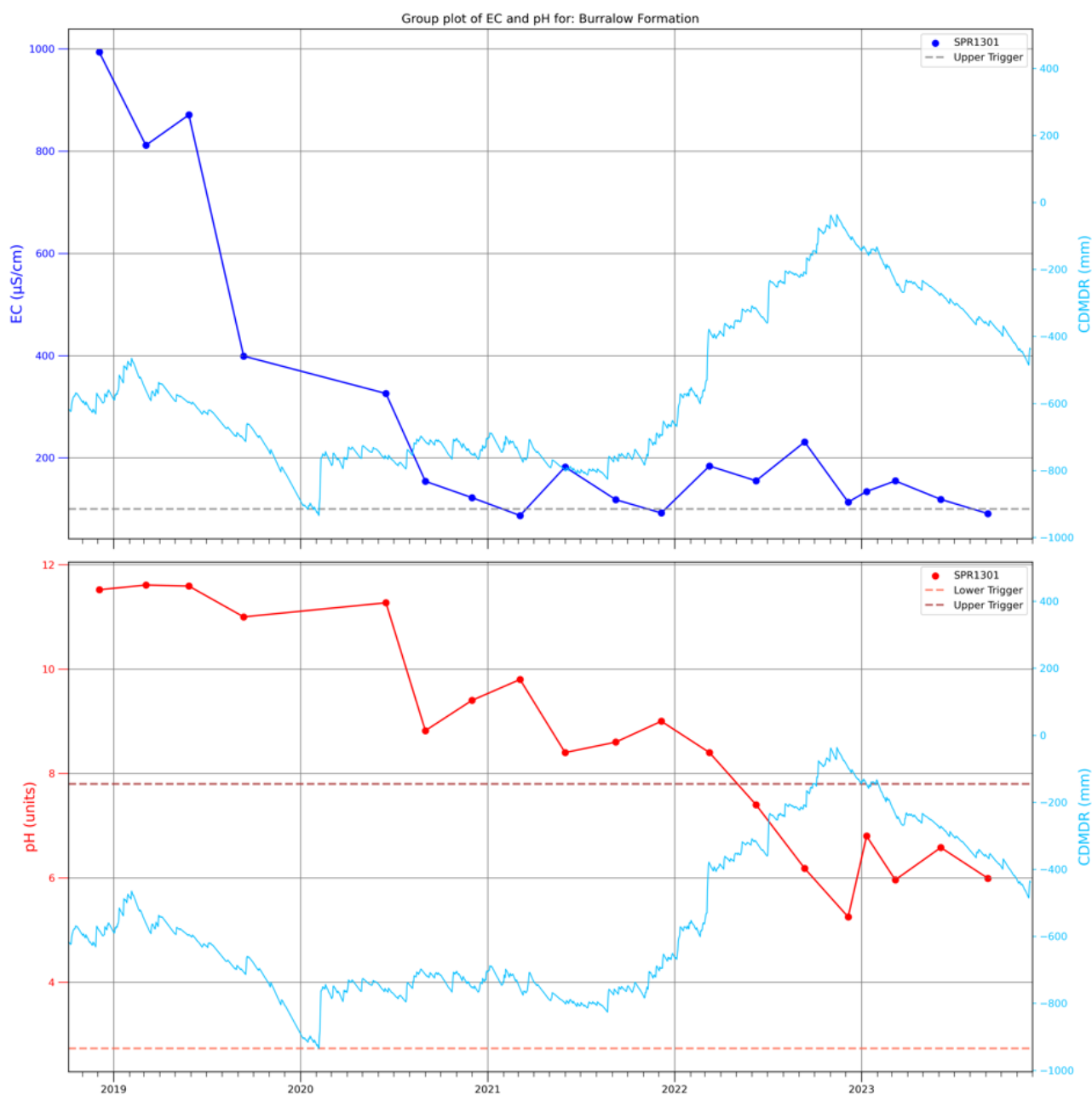


Figure E.18 Shallow aquifer piezometer (SPR1301) water quality

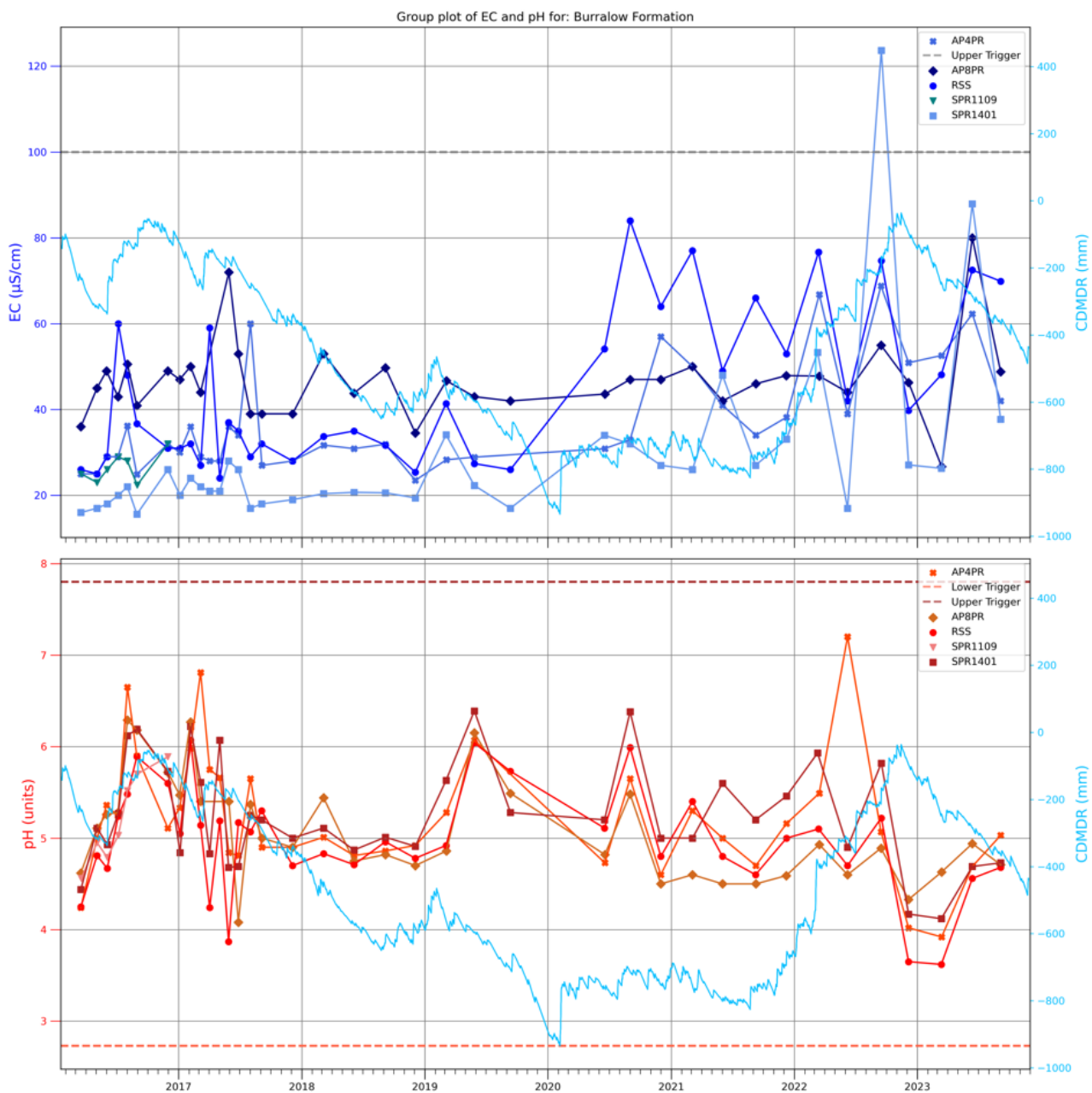


Figure E.19 Shallow aquifer piezometer (Burralow Formation) water quality

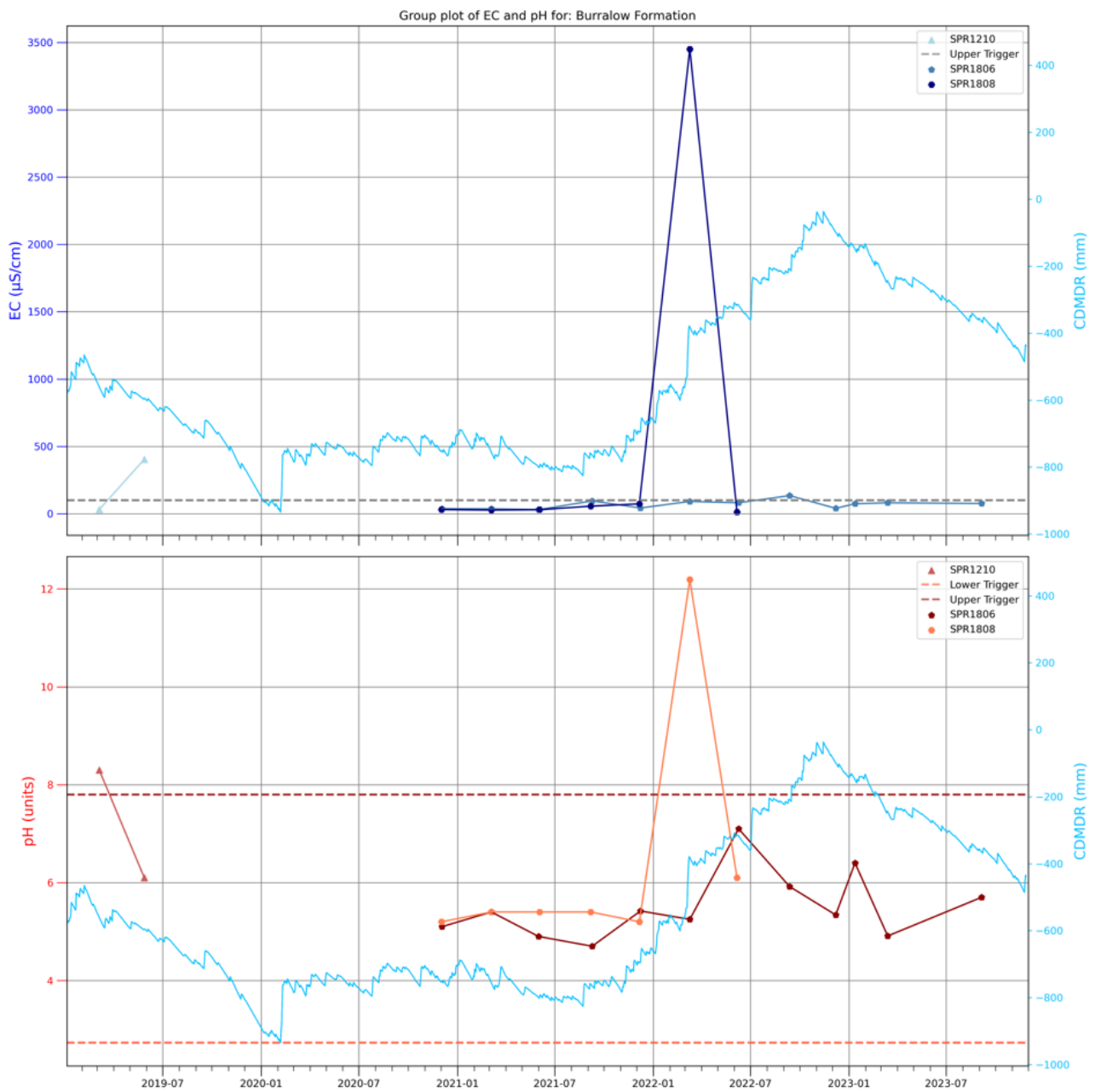


Figure E.20 Shallow aquifer piezometer (SPR1806 and SPR 1808) water quality

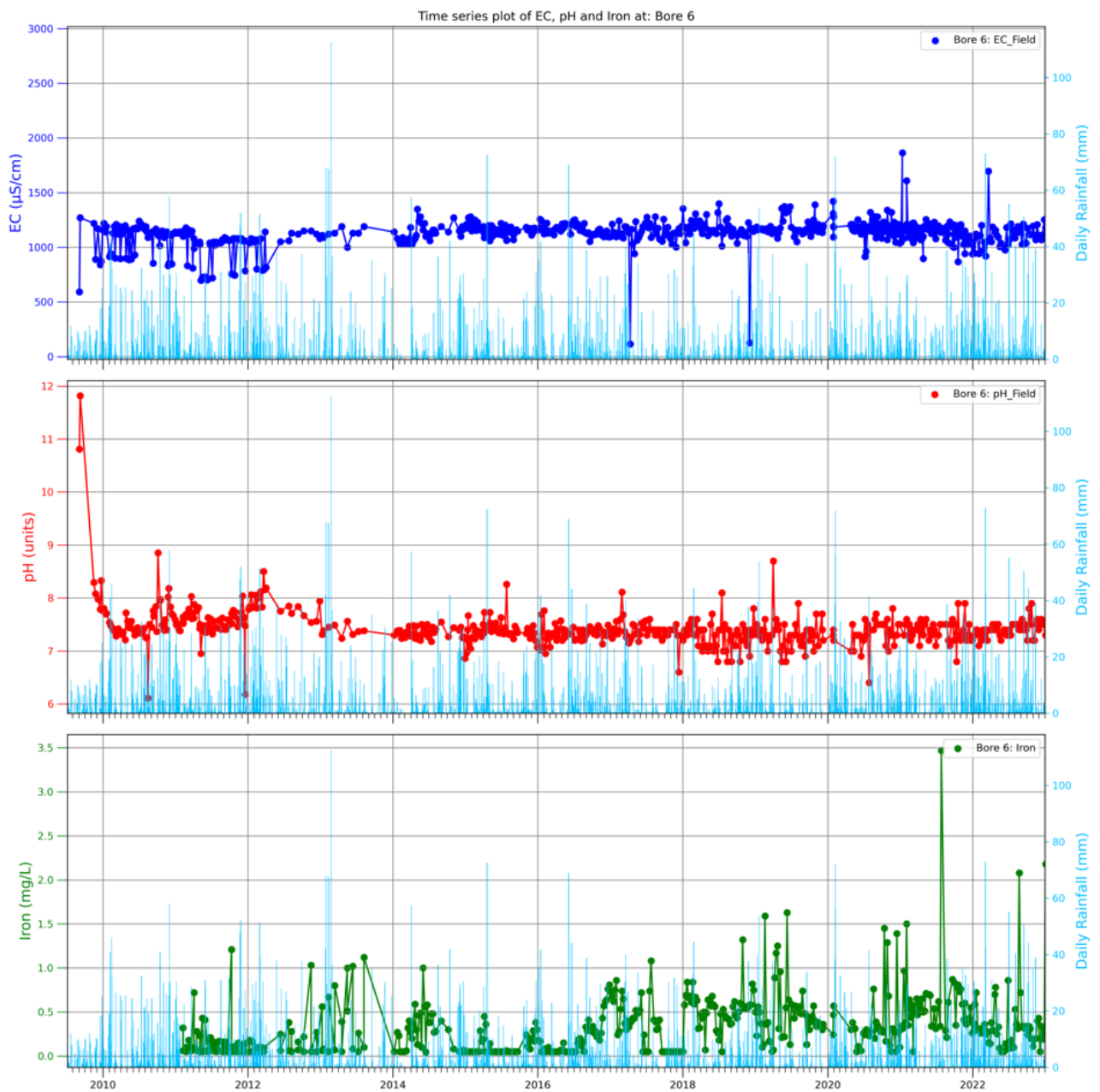


Figure E.21 Bore 6 water quality

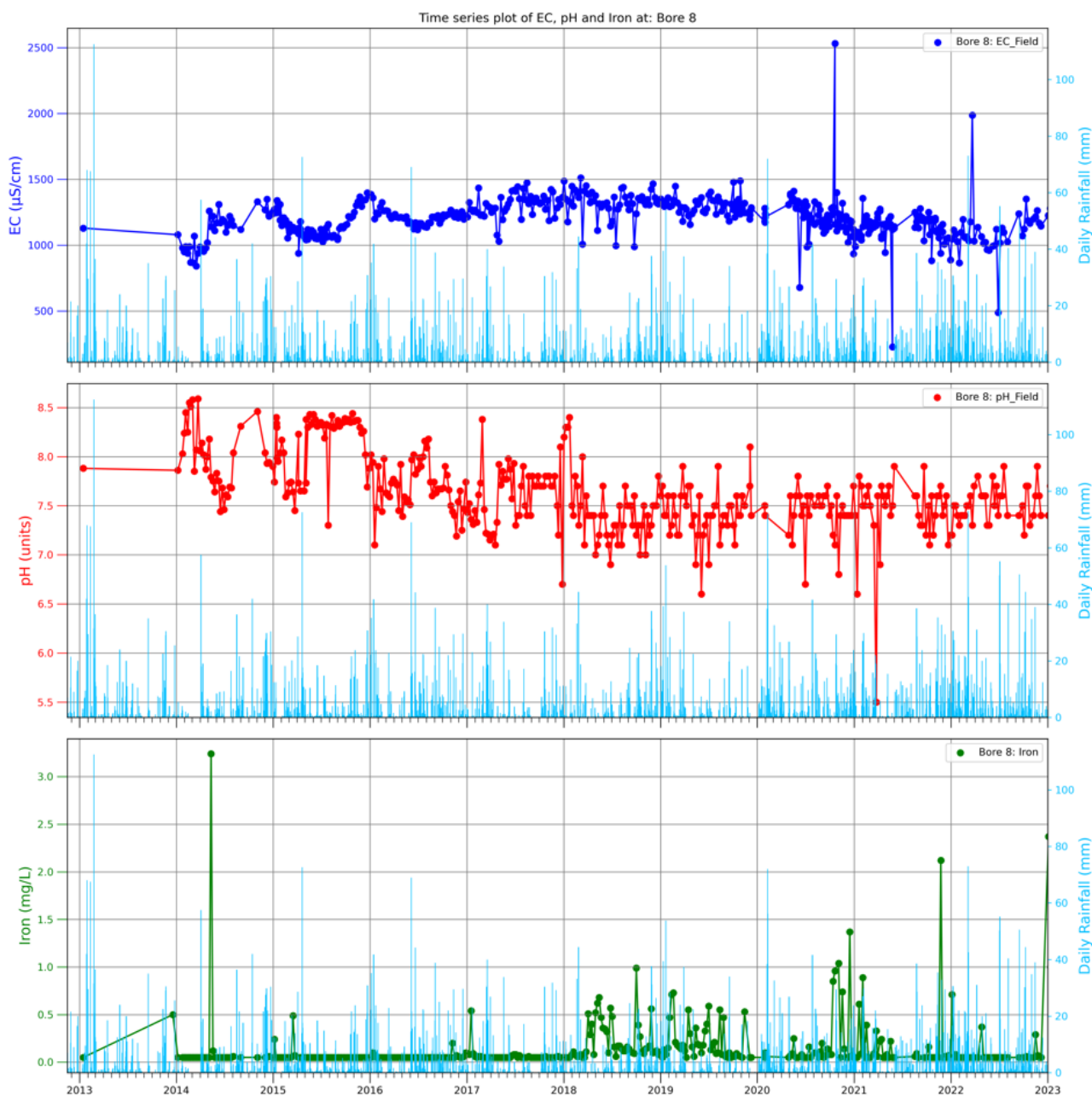


Figure E.22 Bore 8 water quality

Appendix F

Groundwater quality statistics

F.1 Groundwater quality statistics

Table F.1 Swamp piezometer groundwater quality statistics (SMP)

Monitoring ID	Pre-mining statistics							Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	Analyte	Unit	Count	20th %ile - 2×StDev	80th %ile + 2×StDev	Exceedance	Min	Median	Max
CW1	22/02/11	30/09/13	pH	Units	32	3.22	6.76	FALSE	Dry	Dry	Dry
CW1	22/02/11	30/09/13	EC (field)	µS/cm	32	NA	46.54	FALSE	Dry	Dry	Dry
CW1	22/02/11	30/09/13	Iron	mg/L	33	NA	0.48	FALSE	Dry	Dry	Dry
CW2	22/02/11	30/09/13	pH	Units	32	3.69	6.77	FALSE	Dry	Dry	Dry
CW2	22/02/11	30/09/13	EC (field)	µS/cm	32	NA	33.30	FALSE	Dry	Dry	Dry
CW2	22/02/11	30/09/13	Iron	mg/L	33	NA	0.36	FALSE	Dry	Dry	Dry
GG1	16/10/12	28/04/17	pH	Units	54	4.05	6.54	FALSE	4.4	4.55	6.4
GG1	16/10/12	28/04/17	EC (field)	µS/cm	54	NA	85.06	FALSE	33	39.5	56
GG1	16/10/12	28/04/17	Iron	mg/L	53	NA	5.38	FALSE	0.05	0.05	0.07
GW1	13/11/12	28/09/16	pH	Units	26	4.67	7.68	FALSE	Dry	Dry	Dry
GW1	13/11/12	28/09/16	EC (field)	µS/cm	26	NA	100.65	FALSE	Dry	Dry	Dry
GW1	13/11/12	25/07/16	Iron	mg/L	24	NA	1.26	FALSE	Dry	Dry	Dry
GW2	16/10/12	29/03/17	pH	Units	45	4.13	7.43	FALSE	Dry	Dry	Dry
GW2	16/10/12	29/03/17	EC (field)	µS/cm	45	NA	77.14	FALSE	Dry	Dry	Dry
GW2	16/10/12	29/03/17	Iron	mg/L	43	NA	10.00	FALSE	Dry	Dry	Dry
MS1	12/06/12	14/03/22	pH	Units	109	3.81	7.35	FALSE	4.8	5.3	7.1
MS1	12/06/12	14/03/22	EC (field)	µS/cm	109	NA	353.22	FALSE	26	37.5	61

Table F.1 Swamp piezometer groundwater quality statistics (SMP)

Monitoring ID	Pre-mining statistics							Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	Analyte	Unit	Count	20th %ile - 2×StDev	80th %ile + 2×StDev	Exceedance	Min	Median	Max
MS1	12/06/12	14/03/22	Iron	mg/L	109	NA	13.06	FALSE	0.05	0.60	3.53
MS2	19/11/18	14/03/22	pH	Units	25	3.21	7.37	FALSE	5.3	5.5	5.6
MS2	19/11/18	14/03/22	EC (field)	µS/cm	26	NA	336.47	FALSE	41	107.5	174
MS2	19/11/18	14/03/22	Iron	mg/L	23	NA	3.21	FALSE	0.26	0.81	1.36
MS3	27/06/2022	14/03/22	pH	Units	5	NA	NA	FALSE	4.6	5.25	6.3
MS3	27/06/2022	14/03/22	EC (field)	µS/cm	5	NA	NA	FALSE	23.0	49.5	161
MS3	27/06/2022	13/01/22	Iron	mg/L	5	NA	NA	FALSE	-	-	-
BS1	16/10/12	21/01/19	pH	Units	75	3.97	7.02	TRUE	3.3	4.85	7.5
BS1	16/10/12	21/01/19	EC (field)	µS/cm	75	NA	117.52	FALSE	22	36	59
NMSS	18/02/18	14/01/19	pH	Units	4	4.81	6.89	TRUE	4.6	4.9	6.9
NMSS	18/02/18	14/01/19	EC (field)	µS/cm	4	NA	109.34	FALSE	28	33.5	50
PC1	18/02/18	18/02/18	pH	Units	1	NA	NA	FALSE	4.7	5.4	7.6
PC1	18/02/18	18/02/18	EC (field)	µS/cm	1	NA	NA	FALSE	29	33	46
PC2	18/02/18	18/02/18	pH	Units	1	NA	NA	FALSE	4.5	5	7.8
PC2	18/02/18	18/02/18	EC (field)	µS/cm	1	NA	NA	FALSE	25	32.5	41
BS2	15/10/12	4/04/19	pH	Units	77	4.25	6.89	TRUE	4.4	5.3	7.2
BS2	15/10/12	4/04/19	EC (field)	µS/cm	77	NA	187.68	FALSE	36	39	51
BS3	15/10/12	9/10/19	pH	Units	83	3.55	6.69	FALSE	4.6	5.15	6.2

Table F.1 Swamp piezometer groundwater quality statistics (SMP)

Monitoring ID	Pre-mining statistics							Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	Analyte	Unit	Count	20th %ile - 2×StDev	80th %ile + 2×StDev	Exceedance	Min	Median	Max
BS3	15/10/12	9/10/19	EC (field)	µS/cm	83	NA	237.95	FALSE	28	38	108
PSS	18/02/18	23/10/19	pH	Units	11	3.75	7.45	FALSE	3.9	5.5	6.9
PSS	18/02/18	23/10/19	EC (field)	µS/cm	11	NA	519.10	FALSE	31	55	165
BA1	18/03/18	-	pH	Units	43	3.04	7.28	FALSE	4.5	5.6	6.7
BA1	18/03/18	-	EC (field)	µS/cm	45	NA	146.31	FALSE	28	37	65
BA2	18/03/18	-	pH	Units	44	4.10	7.16	FALSE	5.5	5.9	6.7
BA2	18/03/18	-	EC (field)	µS/cm	44	NA	547.80	FALSE	55	117	166
BA3	18/03/18	-	pH	Units	40	3.85	7.37	FALSE	4.3	5.1	6.7
BA3	18/03/18	-	EC (field)	µS/cm	43	NA	541.87	FALSE	35	41	72
BE1	18/03/18	-	pH	Units	32	2.57	6.83	FALSE	4.5	4.55	4.6
BE1	18/03/18	-	EC (field)	µS/cm	33	NA	85.71	FALSE	37	45	53
BE2	18/03/18	-	pH	Units	31	2.56	6.54	FALSE	4	4.25	4.5
BE2	18/03/18	-	EC (field)	µS/cm	31	NA	83.04	FALSE	52	52	52
CC1	12/06/12	-	pH	Units	98	4.09	7.83	FALSE	4.2	5	6.5
CC1	12/06/12	-	EC (field)	µS/cm	99	NA	229.94	FALSE	28	34.5	110
CC2	8/07/19	-	pH	Units	26	2.92	7.28	FALSE	4.2	4.9	6.4
CC2	8/07/19	-	EC (field)	µS/cm	26	NA	193.97	FALSE	28	36	47
FS1	18/03/18	-	pH	Units	28	3.16	6.74	FALSE	-	-	-

Table F.1 Swamp piezometer groundwater quality statistics (SMP)

Monitoring ID	Pre-mining statistics							Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	Analyte	Unit	Count	20th %ile - 2×StDev	80th %ile + 2×StDev	Exceedance	Min	Median	Max
FS1	18/03/18	-	EC (field)	µS/cm	28	NA	263.98	FALSE	-	-	-
FS2	29/05/19	-	pH	Units	9	3.81	5.97	FALSE	-	-	-
FS2	29/05/19	-	EC (field)	µS/cm	9	NA	64.45	FALSE	-	-	-
TS1	12/06/14	-	pH	Units	41	3.14	7.39	FALSE	4.7	5.15	6.8
TS1	12/06/14	-	EC (field)	µS/cm	44	NA	80.26	FALSE	28	42.5	54
TS2	16/10/12	-	pH	Units	90	3.77	7.92	FALSE	4.9	5.2	6.7
TS2	16/10/12	-	EC (field)	µS/cm	92	NA	113.80	FALSE	33	40	58
TS3	17/10/12	-	pH	Units	120	3.56	7.13	FALSE	4.3	5.20	6.8
TS3	17/10/12	-	EC (field)	µS/cm	122	NA	90.37	FALSE	21	32.5	50
TG1	15/10/12	-	pH	Units	100	3.44	7.25	FALSE	-	-	-
TG1	15/10/12	-	EC (field)	µS/cm	100	NA	93.79	FALSE	-	-	-
TG2	19/11/18	-	pH	Units	20	3.32	7.03	FALSE	-	-	-
TG2	19/11/18	-	EC (field)	µS/cm	20	NA	149.37	FALSE	-	-	-
SSE1	11/03/13	11/03/13	pH	Units	1	No pre-mining data		FALSE	Decommissioned		
SSE1	11/03/13	11/03/13	EC (field)	µS/cm	1			FALSE			
SSE2	12/06/12	6/08/13	pH	Units	13	4.80	6.03	FALSE	Dry	Dry	Dry
SSE2	12/06/12	6/08/13	EC (field)	µS/cm	13	NA	64.91	FALSE	Dry	Dry	Dry
SSE3	22/02/11	9/07/13	pH	Units	30	4.72	6.70	FALSE	Dry	Dry	Dry

Table F.1 Swamp piezometer groundwater quality statistics (SMP)

Monitoring ID	Pre-mining statistics							Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	Analyte	Unit	Count	20th %ile - 2×StDev	80th %ile + 2×StDev	Exceedance	Min	Median	Max
SSE3	22/02/11	9/07/13	EC (field)	µS/cm	30	NA	94.05	FALSE	Dry	Dry	Dry
SS1	22/02/11	-	pH	Units	131	4.14	7.36	FALSE	5.4	5.65	7.1
SS1	22/02/11	-	EC (field)	µS/cm	133	NA	276.13	FALSE	48	58	154
SS3	22/02/11	-	pH	Units	124	4.13	7.81	FALSE	3.4	5.65	6.7
SS3	22/02/11	-	EC (field)	µS/cm	126	NA	134.87	TRUE	53	71.5	260
SS4	22/02/11	-	pH	Units	114	3.76	7.14	FALSE	-	-	-
SS4	22/02/11	-	EC (field)	µS/cm	114	NA	123.02	FALSE	-	-	-
SS5	22/02/11	-	pH	Units	123	3.34	6.98	FALSE	-	-	-
SS5	22/02/11	-	EC (field)	µS/cm	123	NA	79.40	FALSE	-	-	-

Table F.2 Standpipe piezometer groundwater quality statistics (WMP)

Monitoring ID	Pre-mining statistics						Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	Analyte	Units	Count	SMP Trigger	Exceedance	Min	Median	Max
AP9PR	17/03/16	-	pH	units	36	2.73–7.87	FALSE	3.87	4.415	4.96
AP9PR	17/03/16	-	EC (field)	µS/cm	37	100	FALSE	26	26.2	38.2
AP8PR	17/03/16	-	pH	units	35	2.73–7.87	FALSE	4.63	4.785	4.94
AP8PR	17/03/16	-	EC (field)	µS/cm	36	100	FALSE	26.7	48.8	80

Table F.2 Standpipe piezometer groundwater quality statistics (WMP)

Monitoring ID	Pre-mining statistics					Reporting period statistics (31 Jan to 31 Dec 2023)				
	Start	Finish	Analyte	Units	Count	SMP Trigger	Exceedance	Min	Median	Max
AP5PR	17/03/16	-	pH	units	37	2.73–7.87	FALSE	3.9	4.315	4.73
AP5PR	17/03/16	-	EC (field)	µS/cm	38	100	FALSE	40.4	40.9	69
AP4PR	17/03/16	-	pH	units	36	2.73–7.87	FALSE	3.92	4.305	4.69
AP4PR	17/03/16	-	EC (field)	µS/cm	37	100	FALSE	42	52.6	62.3
AP1204	17/03/16	-	pH	units	34	2.73–7.87	FALSE	3.77	4.205	4.64
AP1204	17/03/16	-	EC (field)	µS/cm	35	100	FALSE	24.6	55	104.6
AP1105	4/12/18	-	pH	units	12	2.73–7.87	FALSE	3.68	4.175	4.67
AP1105	4/12/18	-	EC (field)	µS/cm	13	100	FALSE	33.8	40.8	40.9
RSS	17/03/16	N/A	pH	units	37	2.73–7.87	FALSE	3.62	4.09	4.56
RSS	17/03/16	N/A	EC (field)	µS/cm	38	100	FALSE	48.1	69.9	72.5
SPR1104	17/03/16	2/06/16	pH	units	3	2.73–7.87	FALSE	Dry	Dry	Dry
SPR1104	17/03/16	2/06/16	EC (field)	µS/cm	3	100	FALSE	Dry	Dry	Dry
SPR1106	18/03/16	-	pH	units	36	2.73–7.87	FALSE	3.96	3.96	3.96
SPR1106	18/03/16	-	EC (field)	µS/cm	37	100	TRUE	33	41.1	49.2
SPR1108	17/03/16	-	pH	units	36	2.73–7.87	FALSE	5.35	5.76	6.17
SPR1108	17/03/16	-	EC (field)	µS/cm	37	100	TRUE	38	44.3	365.8
SPR1112	17/03/16	-	pH	units	35	2.73–7.87	FALSE	3.88	4.22	4.56
SPR1112	17/03/16	-	EC (field)	µS/cm	36	100	FALSE	28	41.6	89.8

Table F.2 Standpipe piezometer groundwater quality statistics (WMP)

Monitoring ID	Pre-mining statistics					Reporting period statistics (31 Jan to 31 Dec 2023)				
	Start	Finish	Analyte	Units	Count	SMP Trigger	Exceedance	Min	Median	Max
SPR1210	5/03/19	28/05/19	pH	units	2	2.73–7.87	FALSE	Water level too low to sample		
SPR1210	5/03/19	28/05/19	EC (field)	µS/cm	2	100	FALSE	Water level too low to sample		
SPR1301	4/12/18	-	pH	units	18	2.73–7.87	FALSE	5.96	6.58	6.8
SPR1301	4/12/18	-	EC (field)	µS/cm	19	100	FALSE	90.8	126.3	154.8
SPR1107	17/03/16	30/08/16	pH	units	6	2.73–7.87	FALSE	Damaged by subsidence		
SPR1107	17/03/16	30/08/16	EC (field)	µS/cm	6	100	FALSE	Damaged by subsidence		
SPR1109	18/03/16	30/11/16	pH	units	7	2.73–7.87	FALSE	Damaged by subsidence		
SPR1109	18/03/16	30/11/16	EC (field)	µS/cm	7	100	FALSE	Damaged by subsidence		
SPR1111	17/03/16	7/03/17	pH	units	10	2.73–7.87	FALSE	3.77	4.26	4.75
SPR1111	17/03/16	7/03/17	EC (field)	µS/cm	10	100	TRUE	31	41	59
SPR1113	17/03/16	29/05/17	pH	units	13	2.73–7.87	FALSE	3.81	4.195	4.58
SPR1113	17/03/16	29/05/17	EC (field)	µS/cm	13	100	TRUE	26	44.2	89.2
SPR1211	4/12/18	12/09/19	pH	units	4	2.73–7.87	FALSE	Decommissioned		
SPR1211	4/12/18	12/09/19	EC (field)	µS/cm	4	100	FALSE	Decommissioned		
SPR1401	17/03/16	-	pH	units	37	2.73–7.87	FALSE	4.12	4.405	4.69
SPR1401	17/03/16	-	EC (field)	µS/cm	38	100	TRUE	26.3	37.7	87.9

Table F.3 **Bore 6 and 8 groundwater quality statistics**

Monitoring ID	Pre-mining statistics					Reporting period statistics (31 Jan to 31 Dec 2023)				
	Start	Finish	Analyte	Units	Count	SMP Trigger	Exceedance	Min	Median	Max
Bore 6	4/09/2009	-	pH	units	639	NA	FALSE	7	7.4	7.6
Bore 6	4/09/2009	-	EC (field)	µS/cm	783	NA	FALSE	92	1298	2881
Bore 6	8/02/2011	-	Iron	mg/L	483	NA	NA	0.05	0.32	5.89
Bore 8	15/01/2013	-	pH	units	445	NA	FALSE	7.3	7.5	7.8
Bore 8	15/01/2013	-	EC (field)	µS/cm	574	NA	FALSE	973	1194	1378
Bore 8	15/01/2013	-	Iron	mg/L	420	NA	NA	0.05	0.05	2.37

Appendix G

Surface water quality time series

G.1 Surface water quality time series

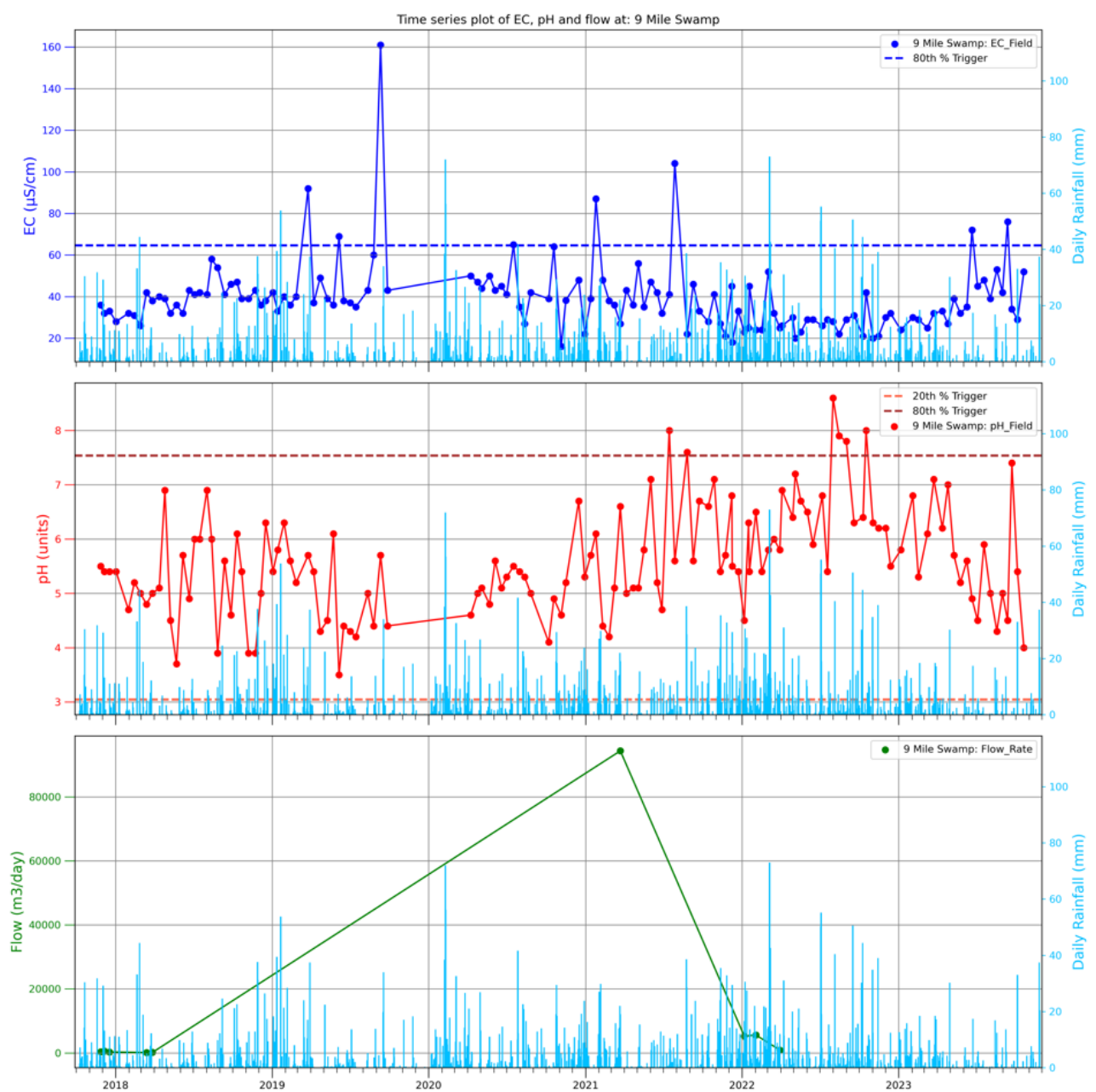


Figure G.1 9 Mile Swamp water quality and flow

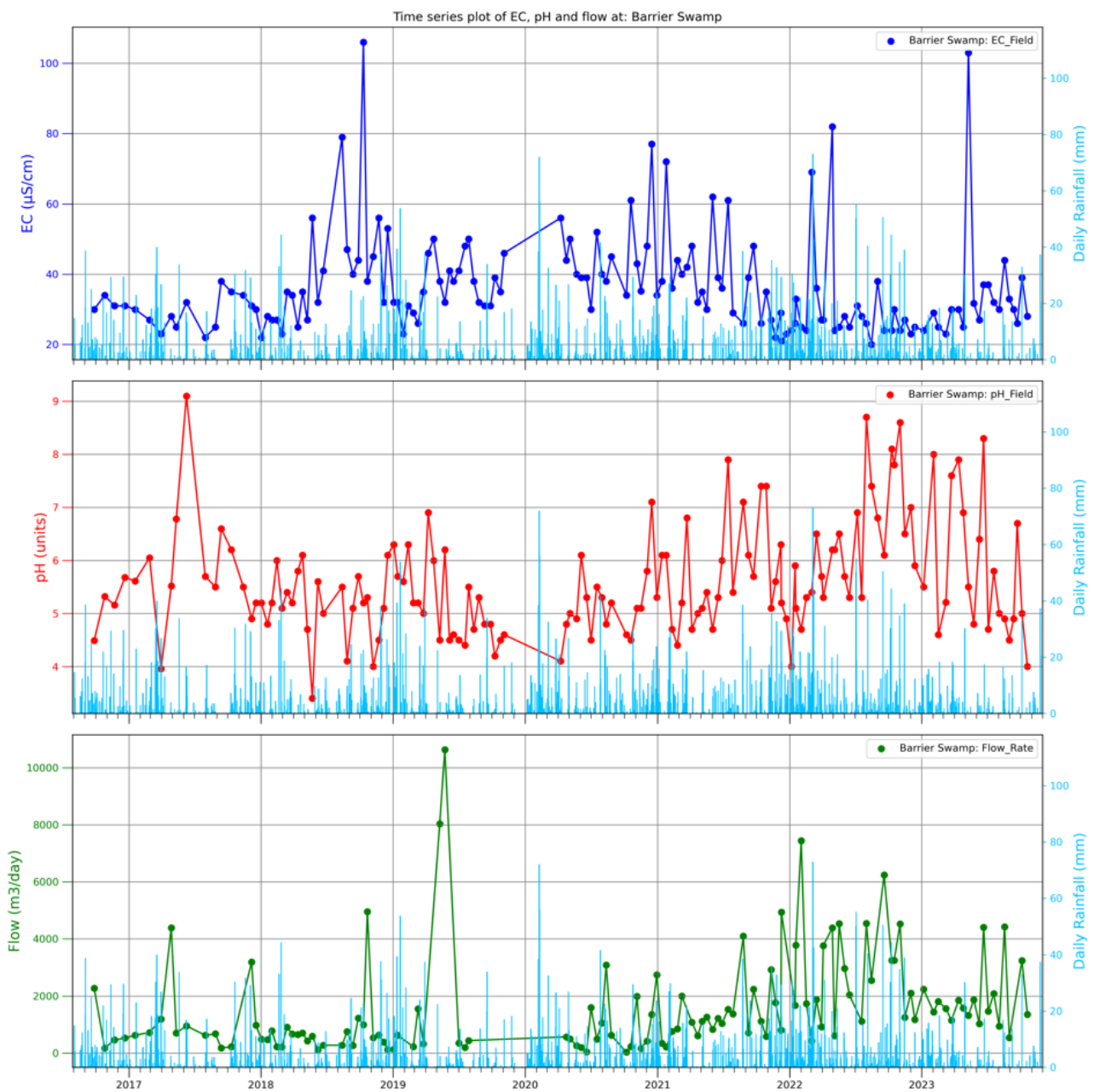


Figure G.2 Barrier Swamp water quality and flow

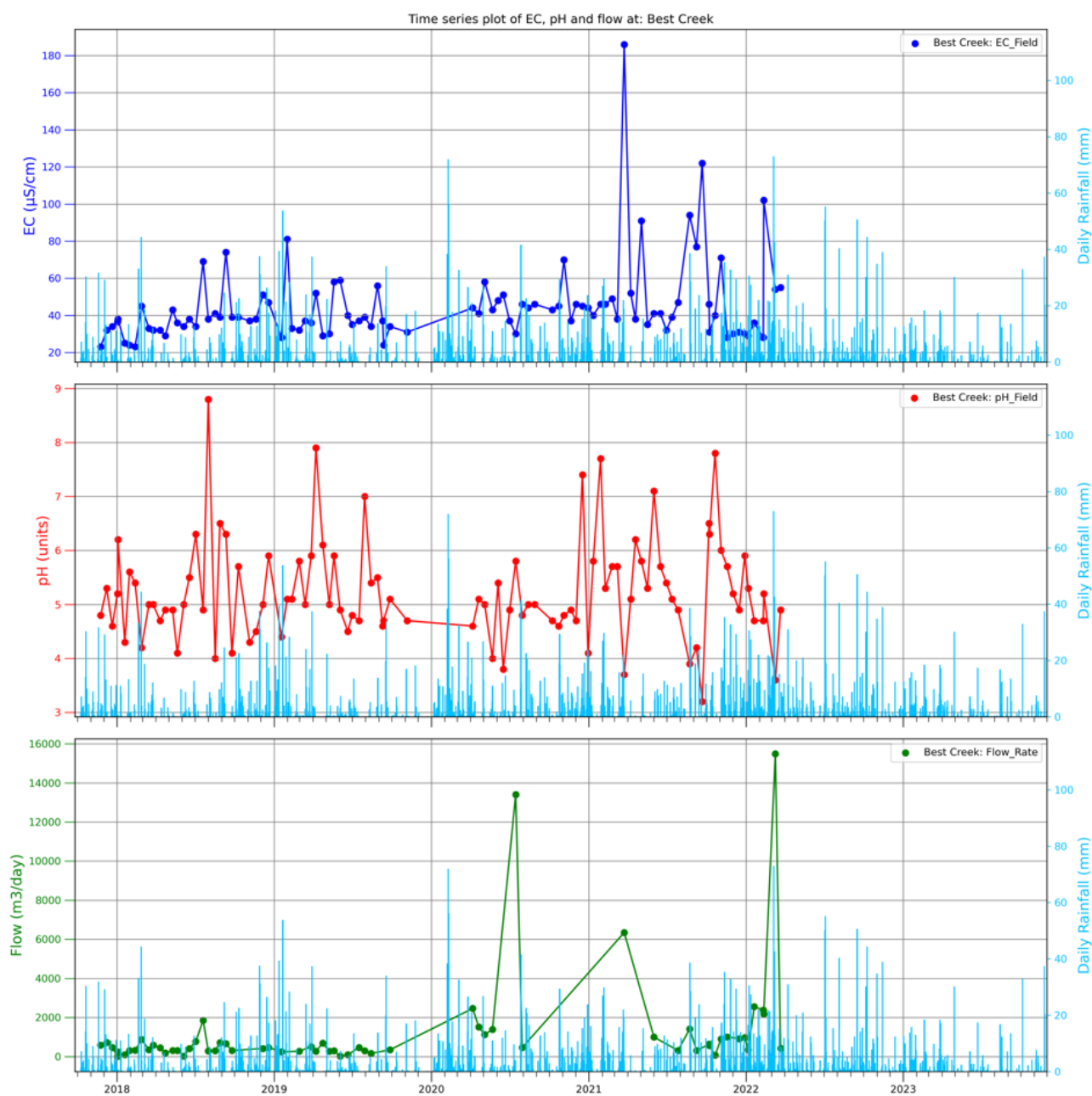


Figure G.3 Best Creek water quality and flow

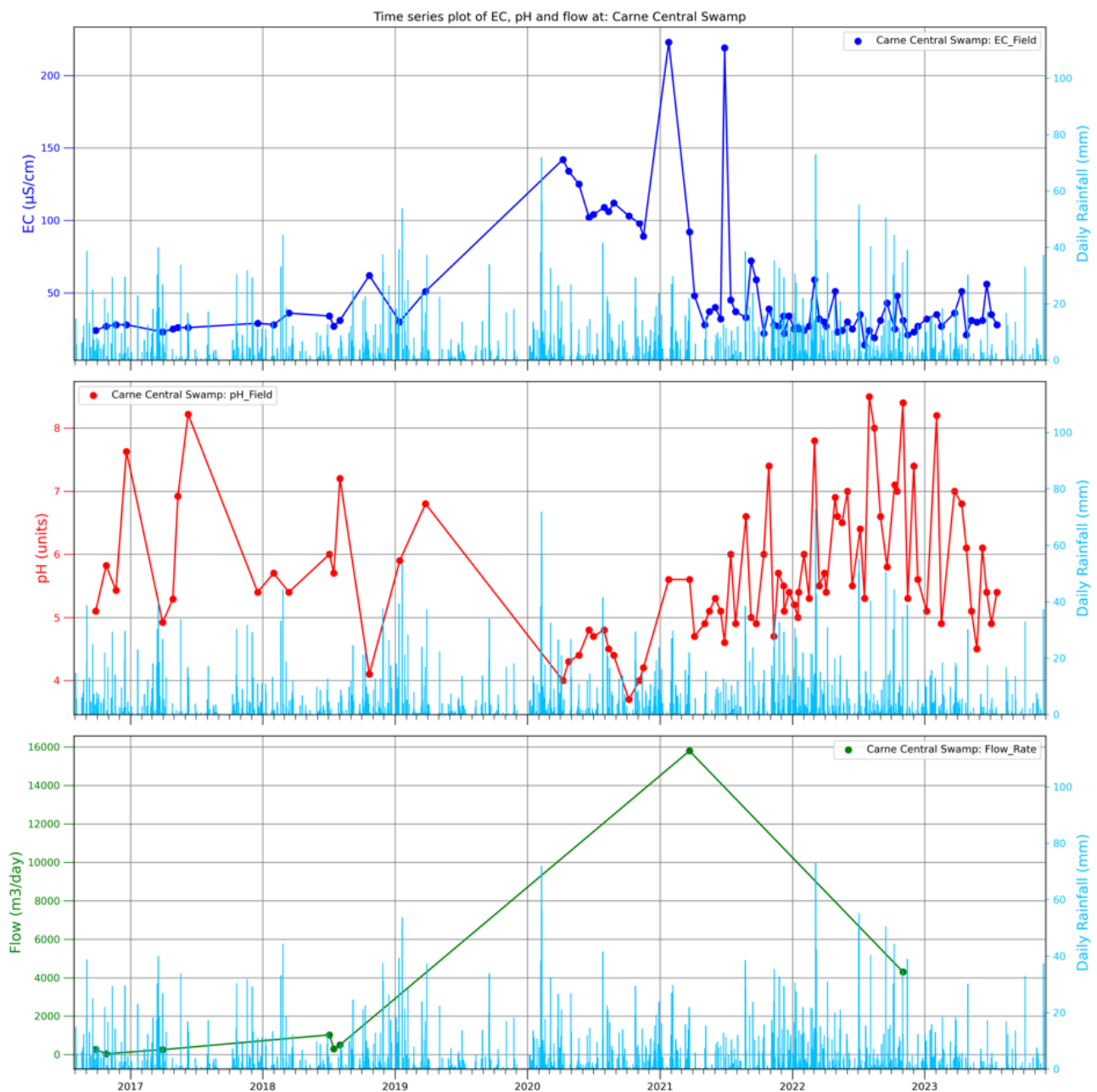


Figure G.4 Carne Central Swamp water quality and flow

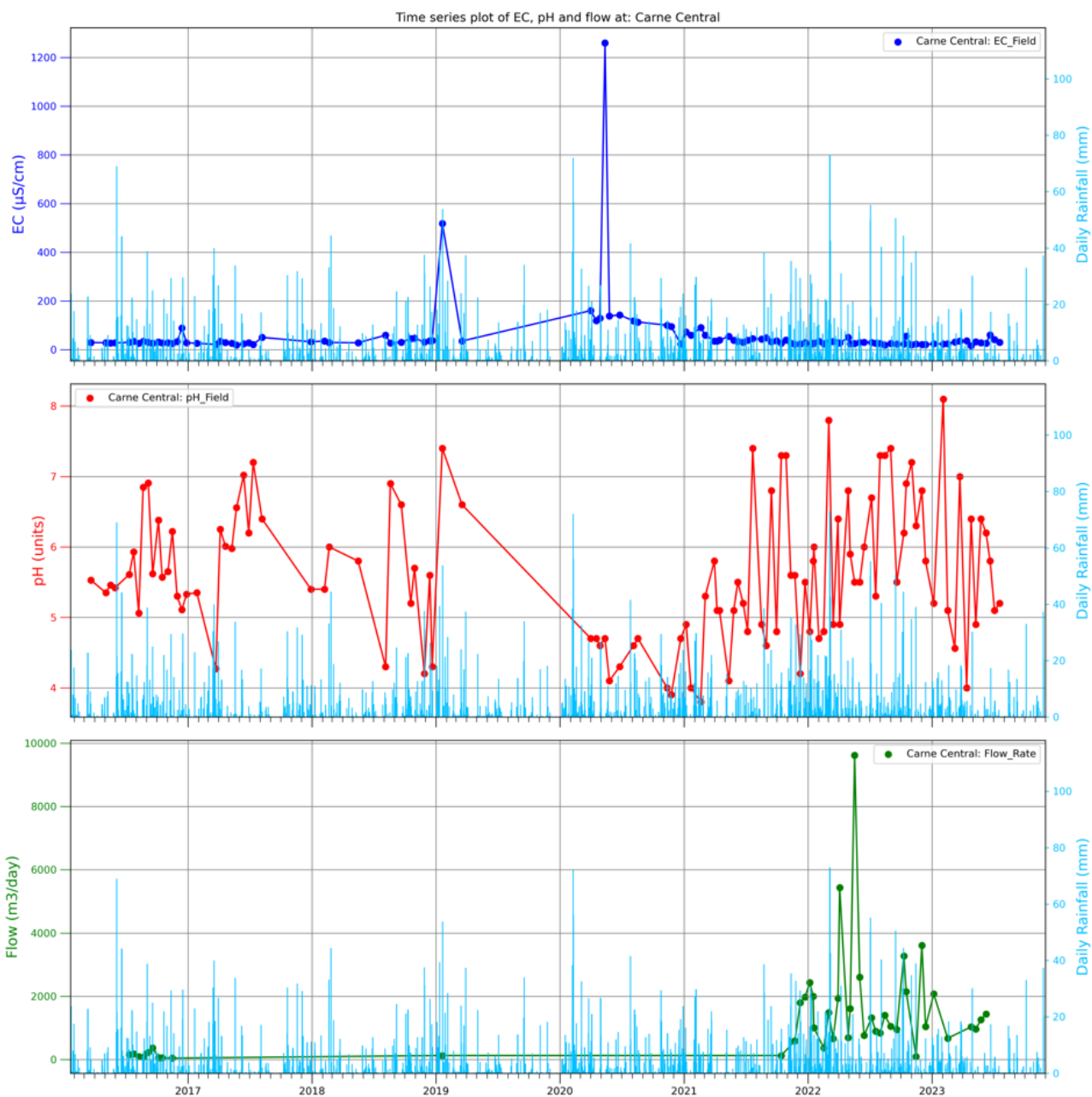


Figure G.5 Carne Central water quality and flow

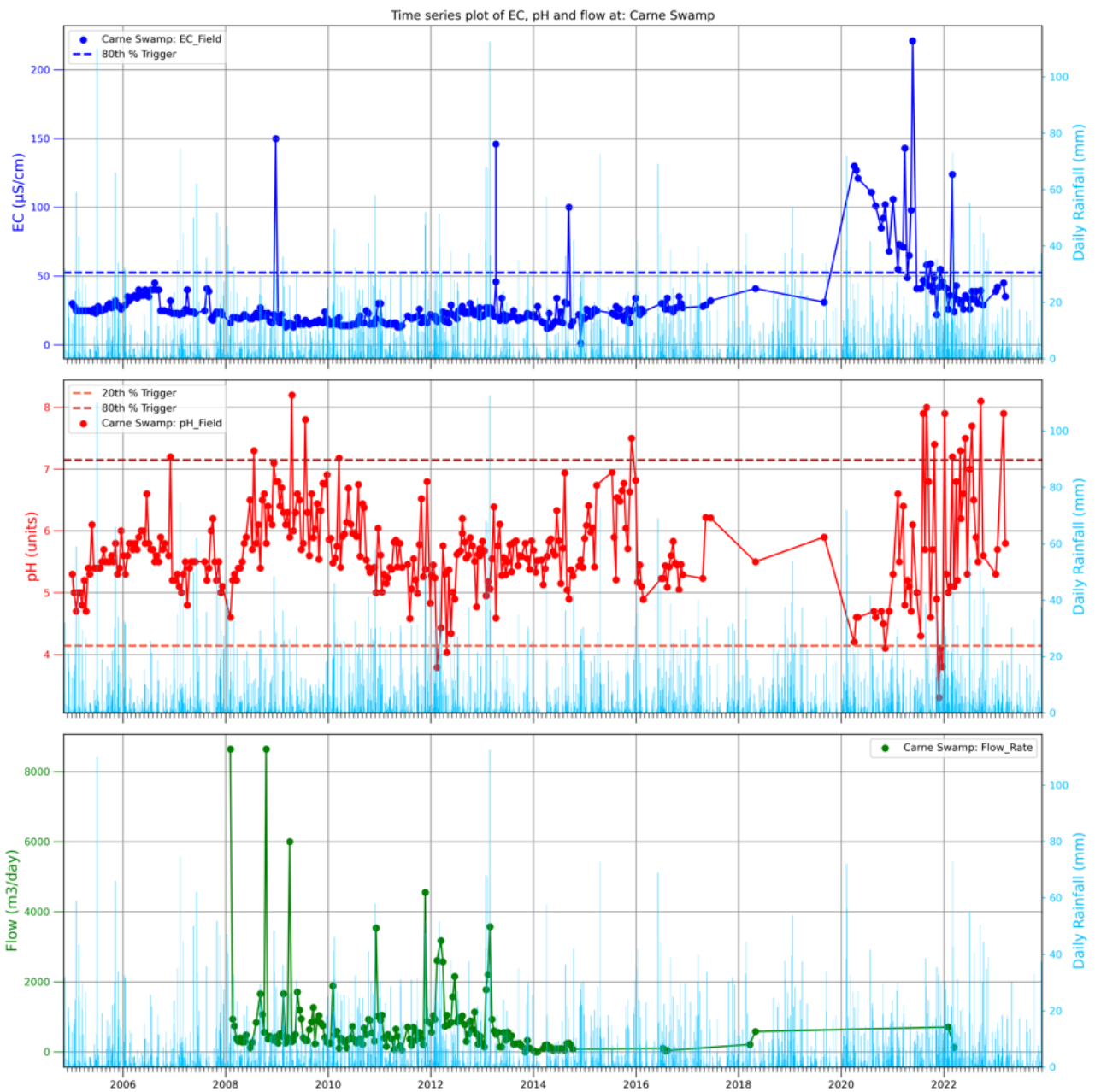


Figure G.6 Carne Swamp water quality and flow

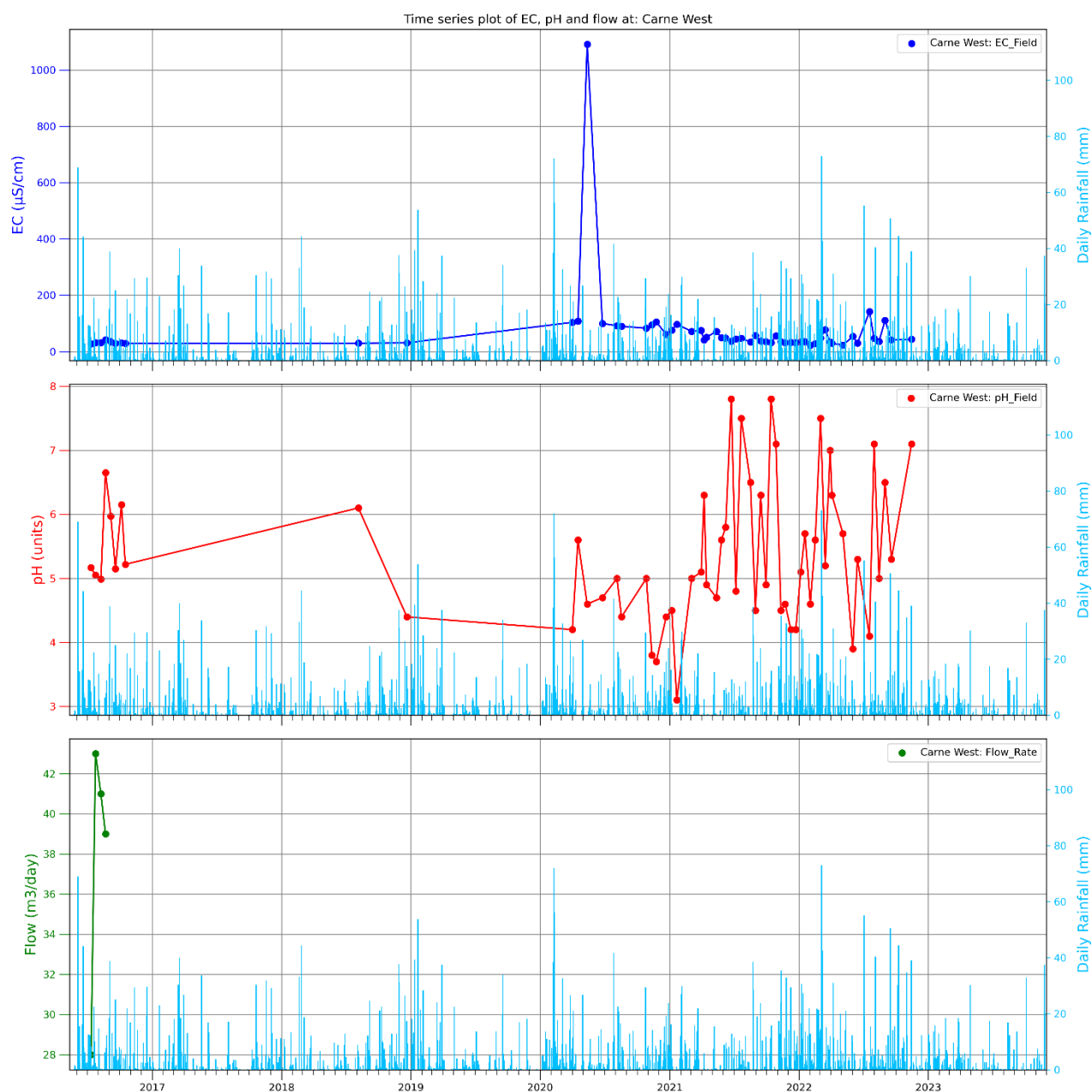


Figure G.7 Carne West water quality and flow

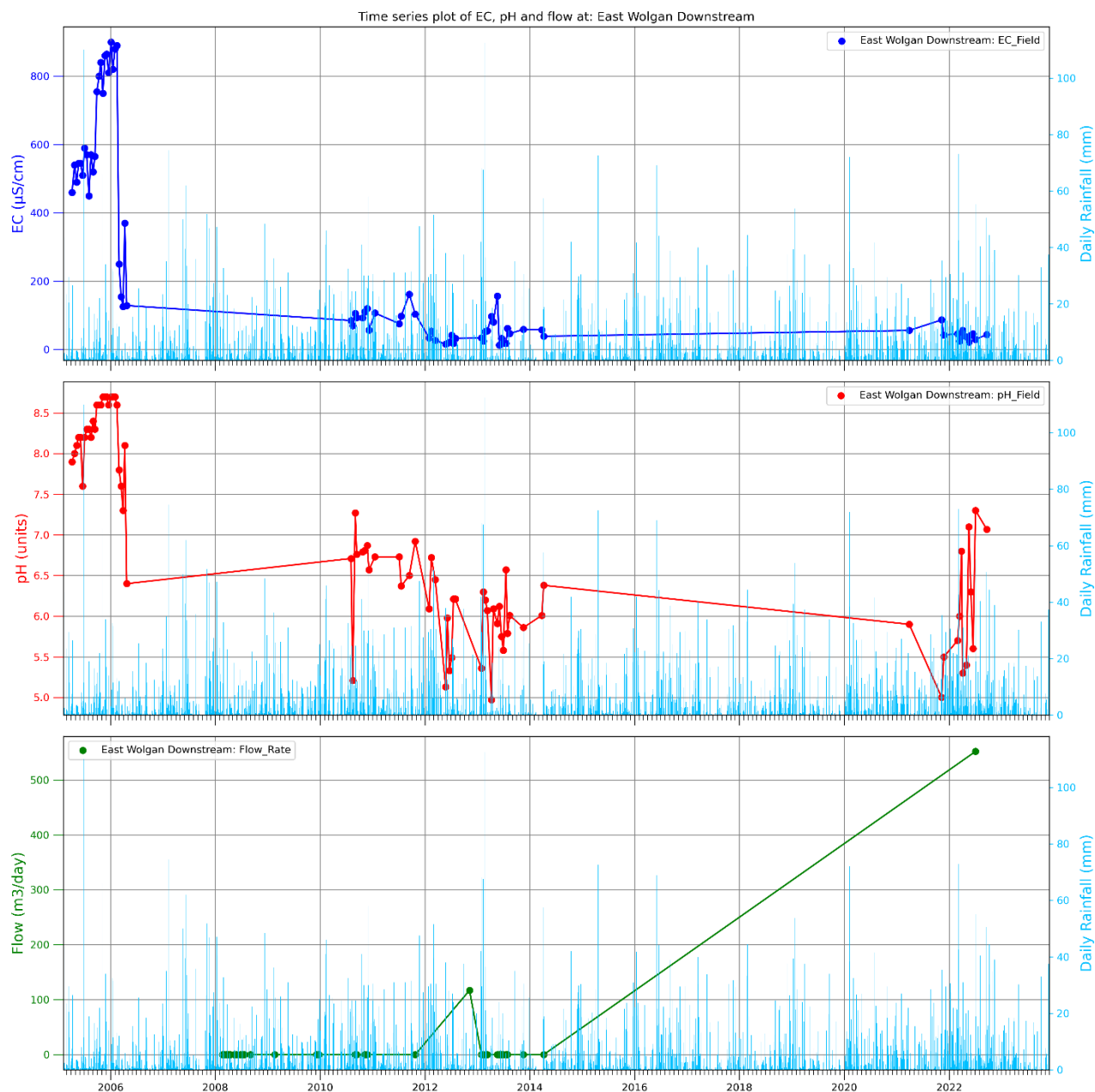


Figure G.8 East Wolgan Downstream water quality and flow

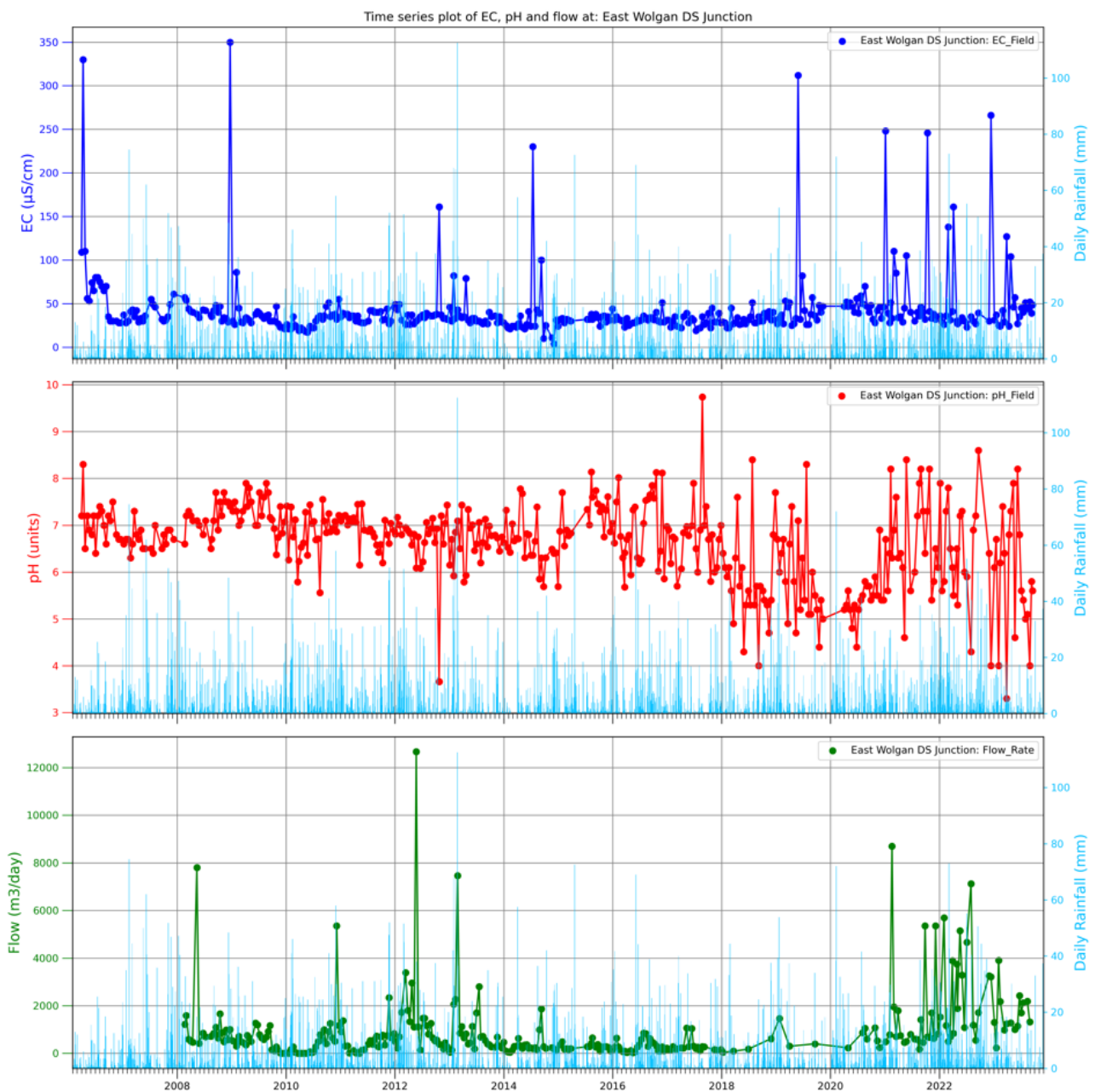


Figure G.9 East Wolgan Downstream Junction water quality and flow

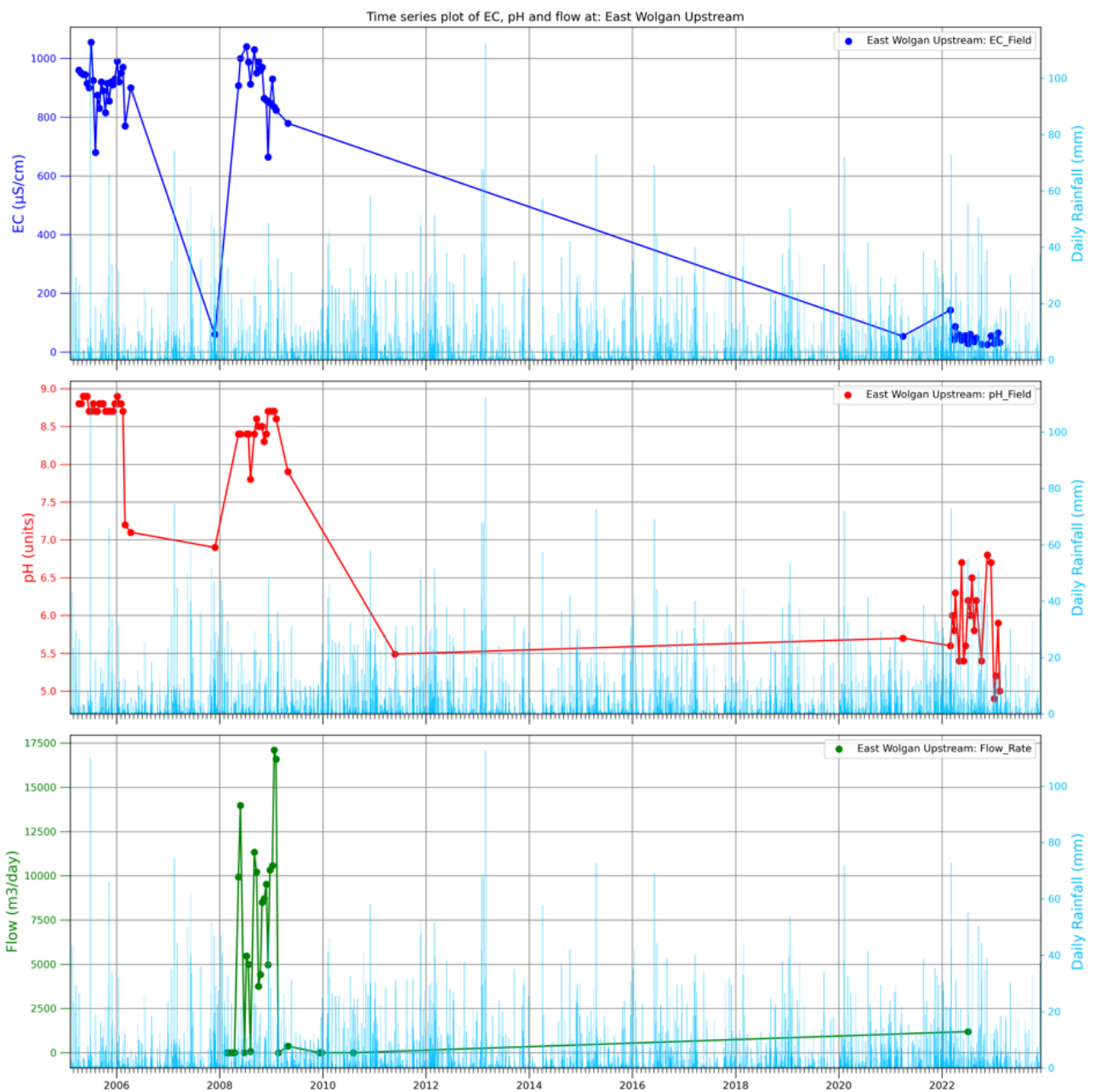


Figure G.10 East Wolgan Upstream water quality and flow

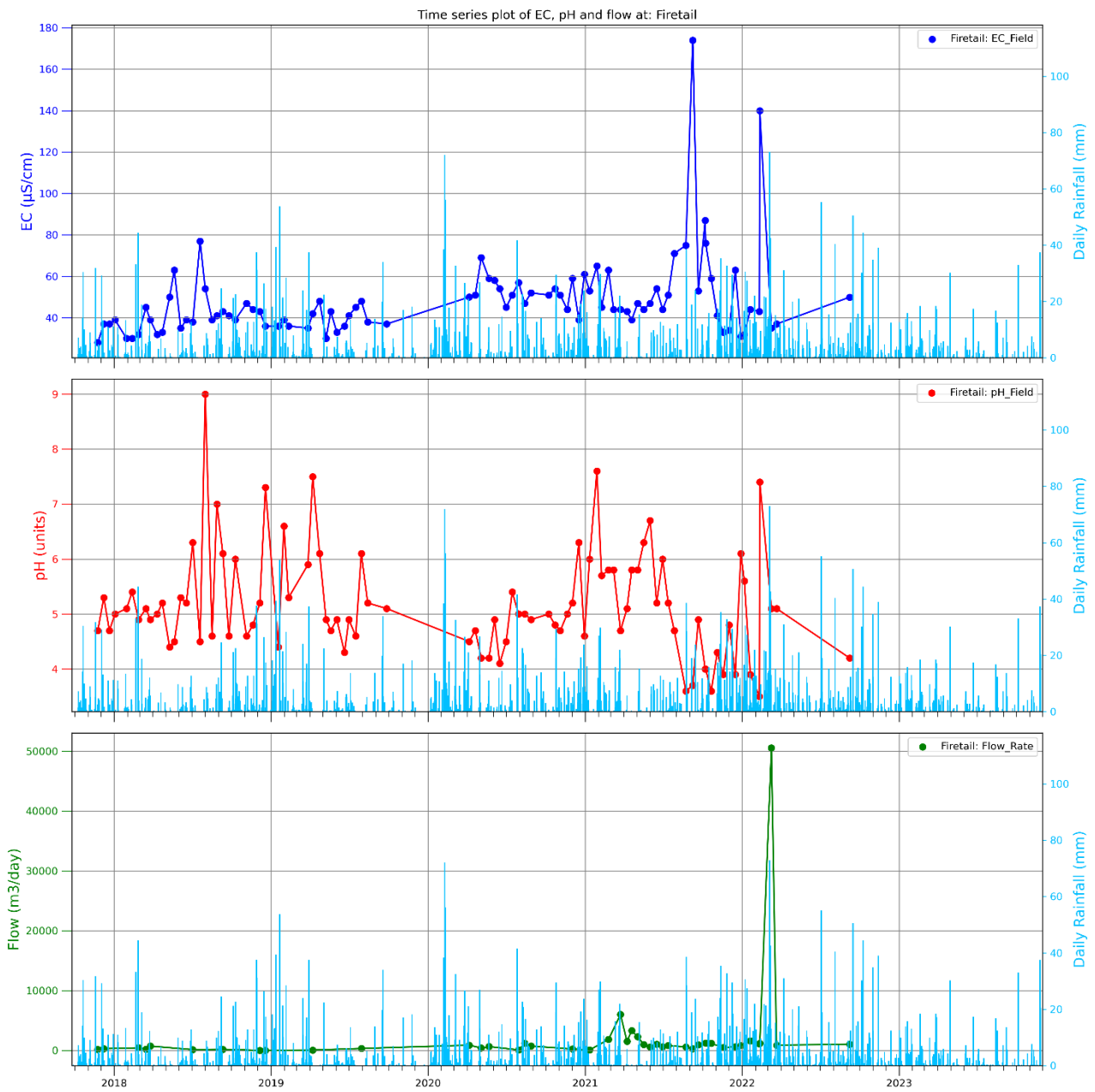


Figure G.11 Firetail water quality and flow

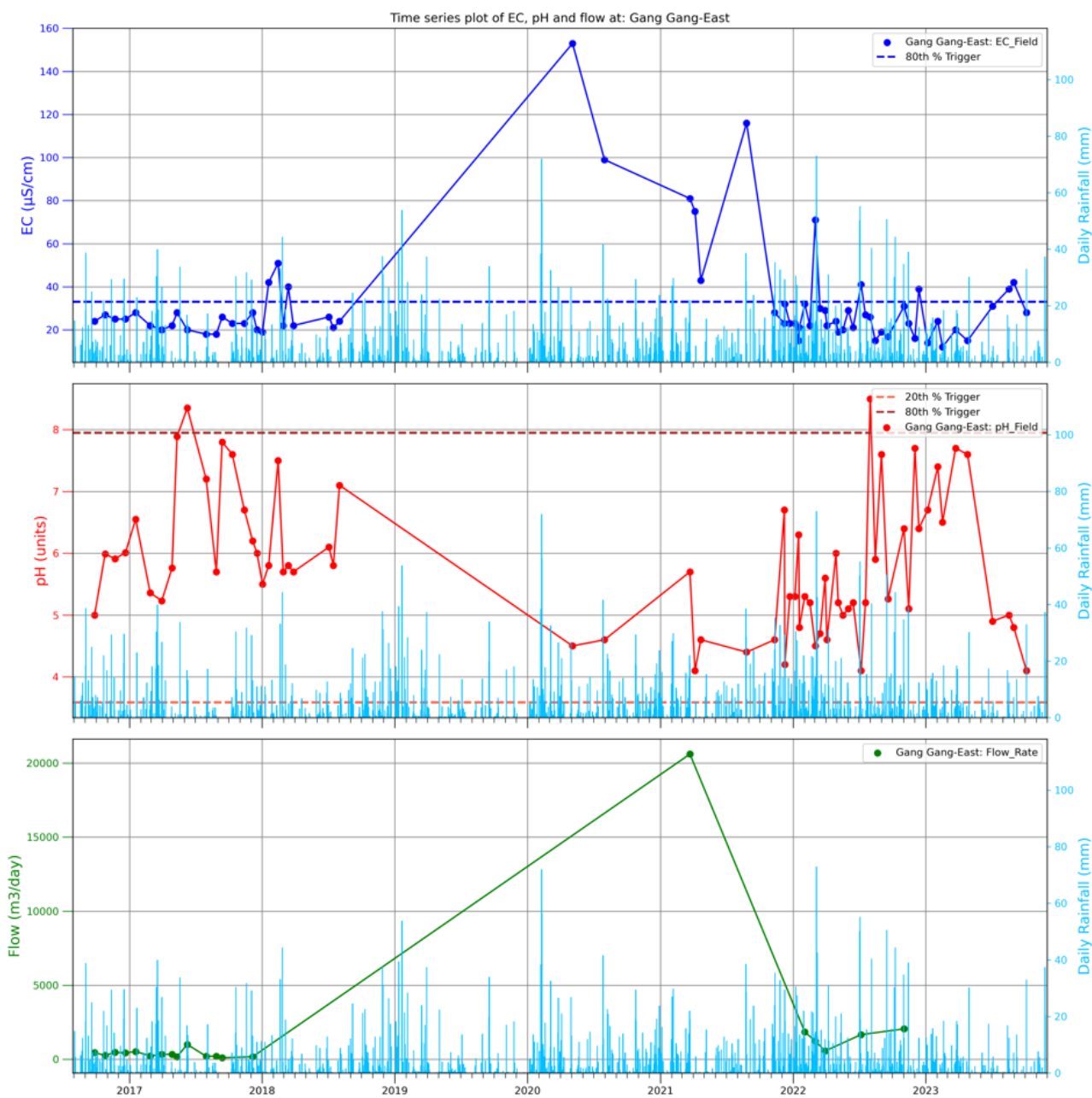


Figure G.12 Gang Gang East water quality and flow

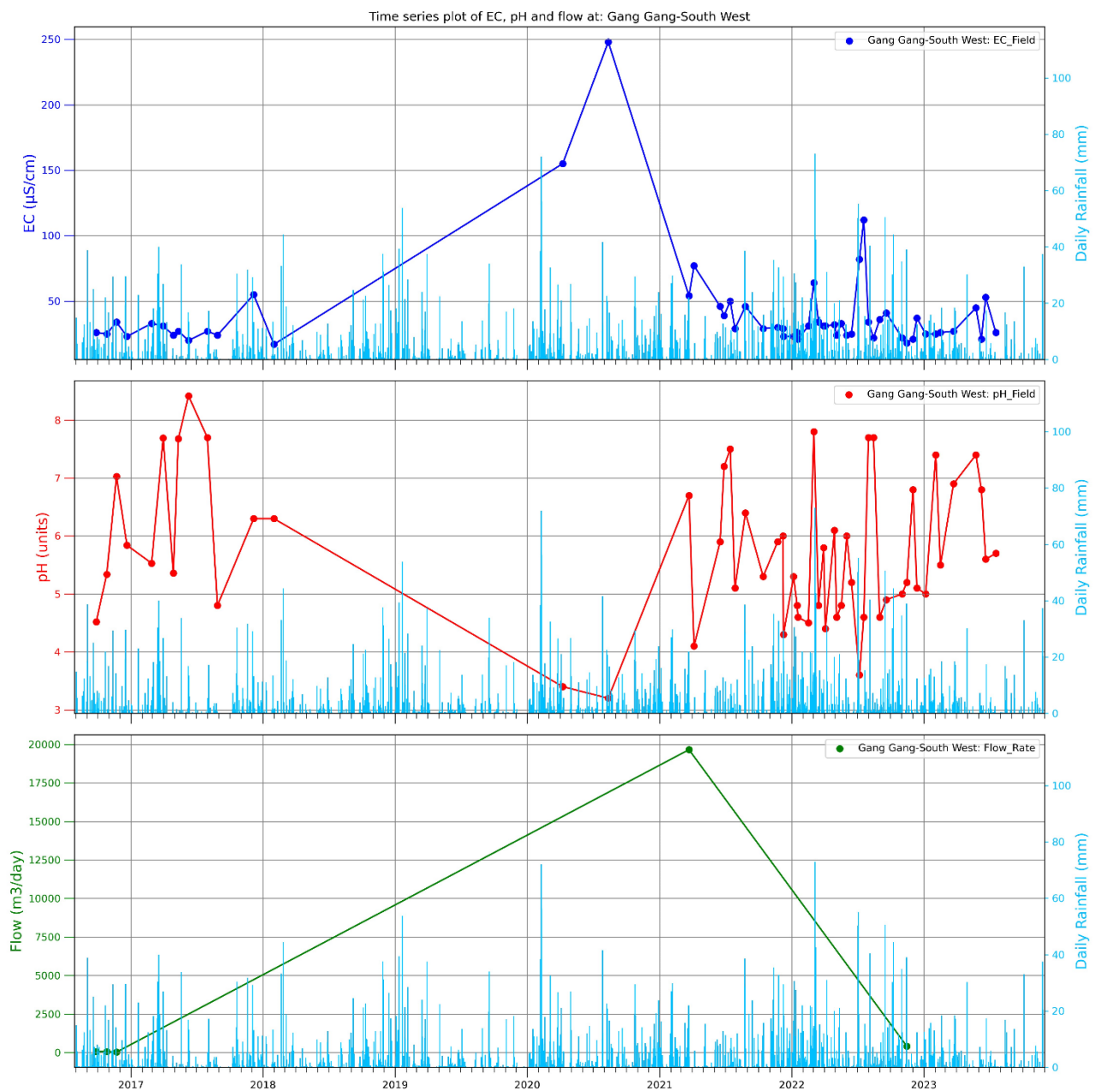


Figure G.13 Gang Gang Southwest water quality and flow



Figure G.14 Gang Gang water quality and flow

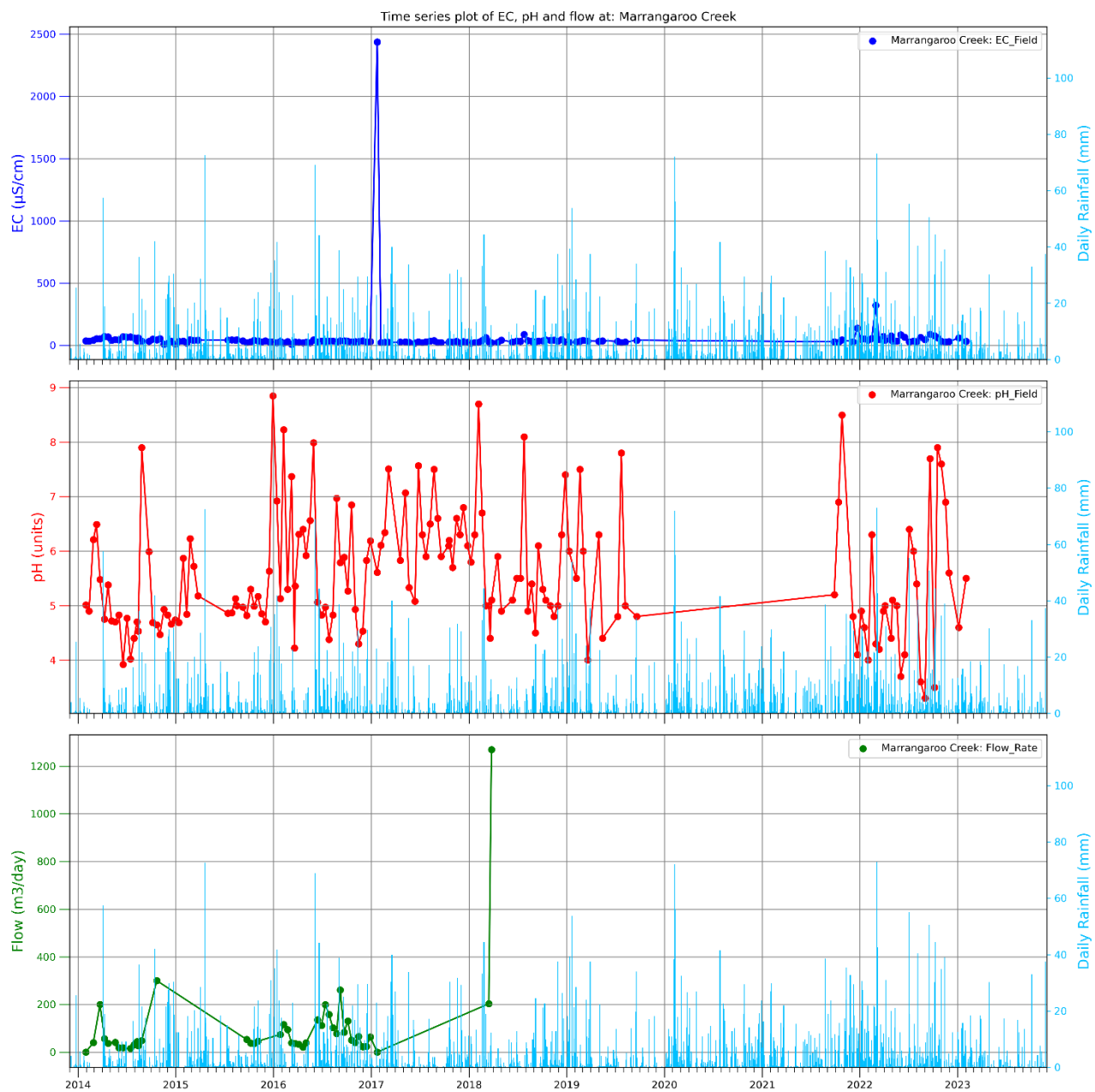


Figure G.15 Marangaroo Creek water quality and flow

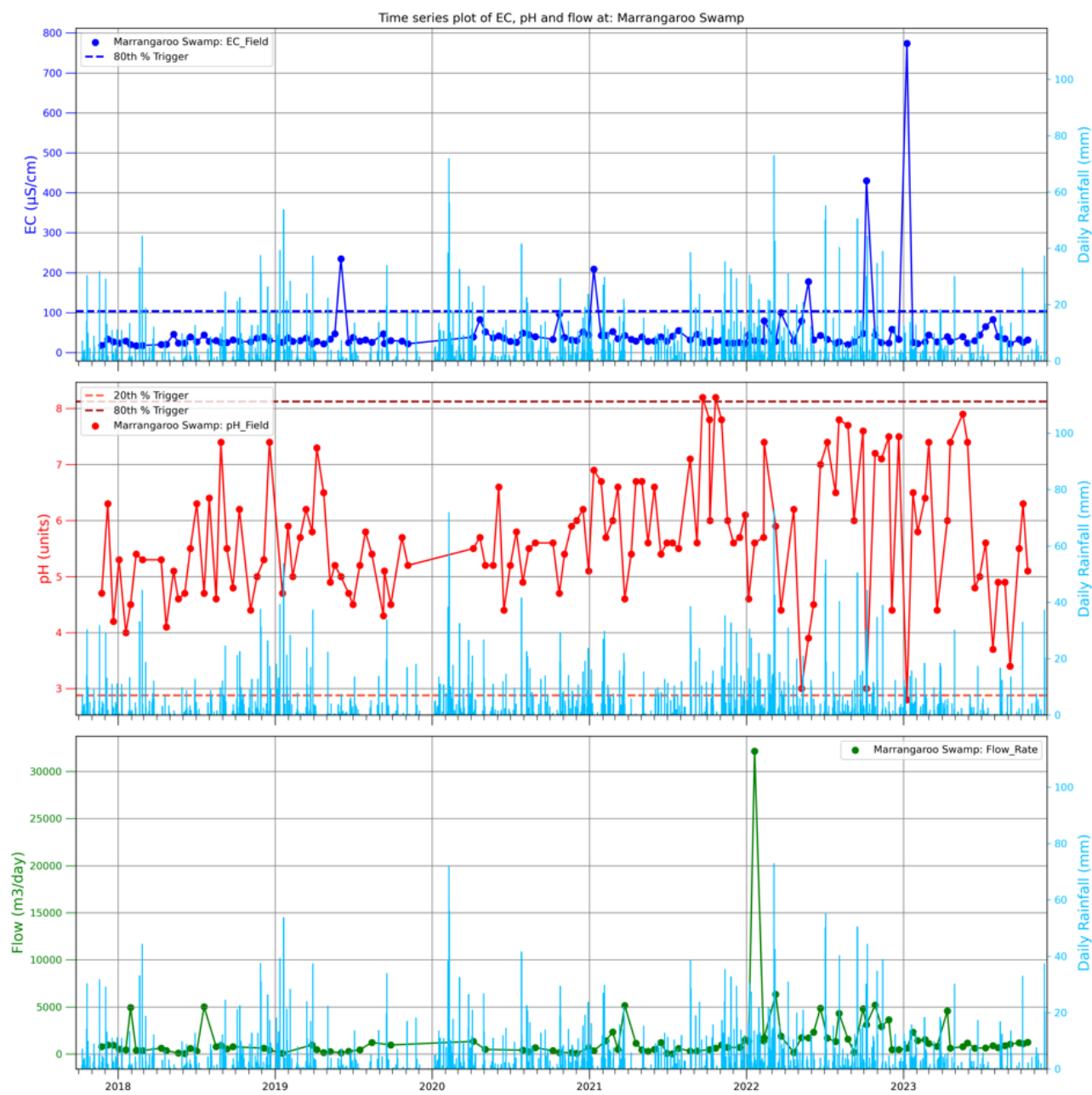


Figure G.16 Marangaroo Swamps water quality and flow

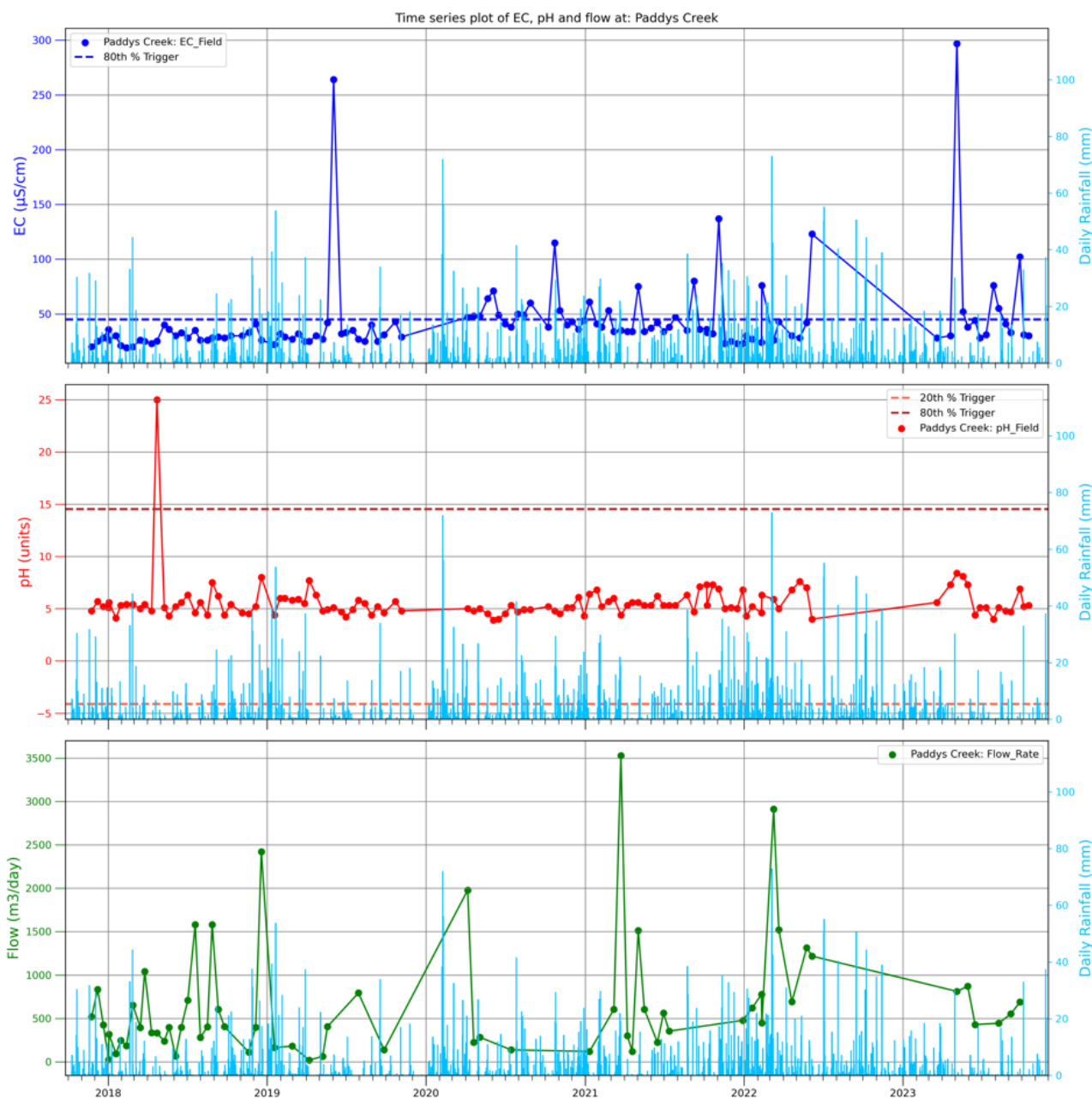


Figure G.17 Paddys Creek water quality and flow

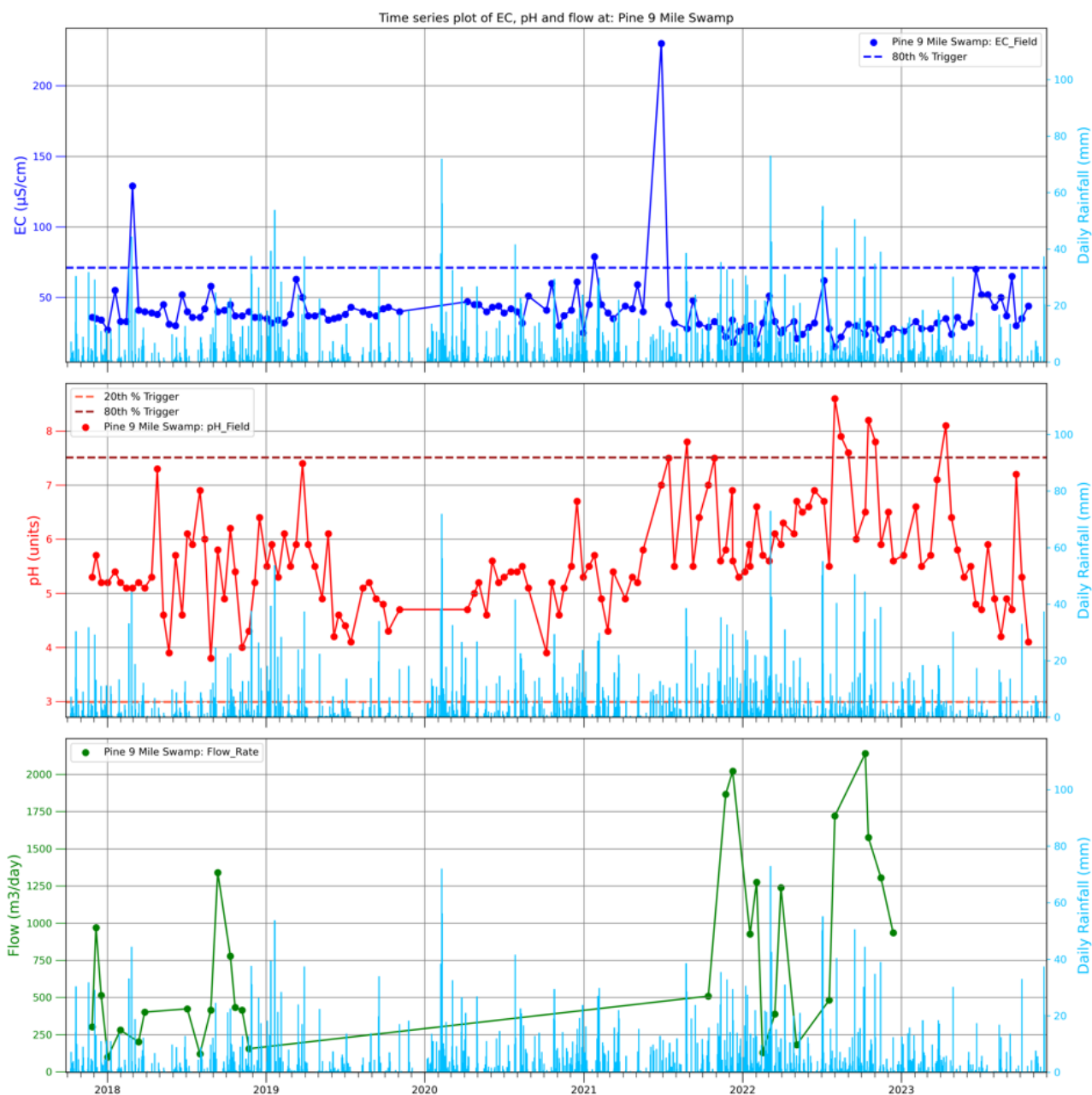


Figure G.18 Pine/9Mile Confluence Swamp water quality and flow

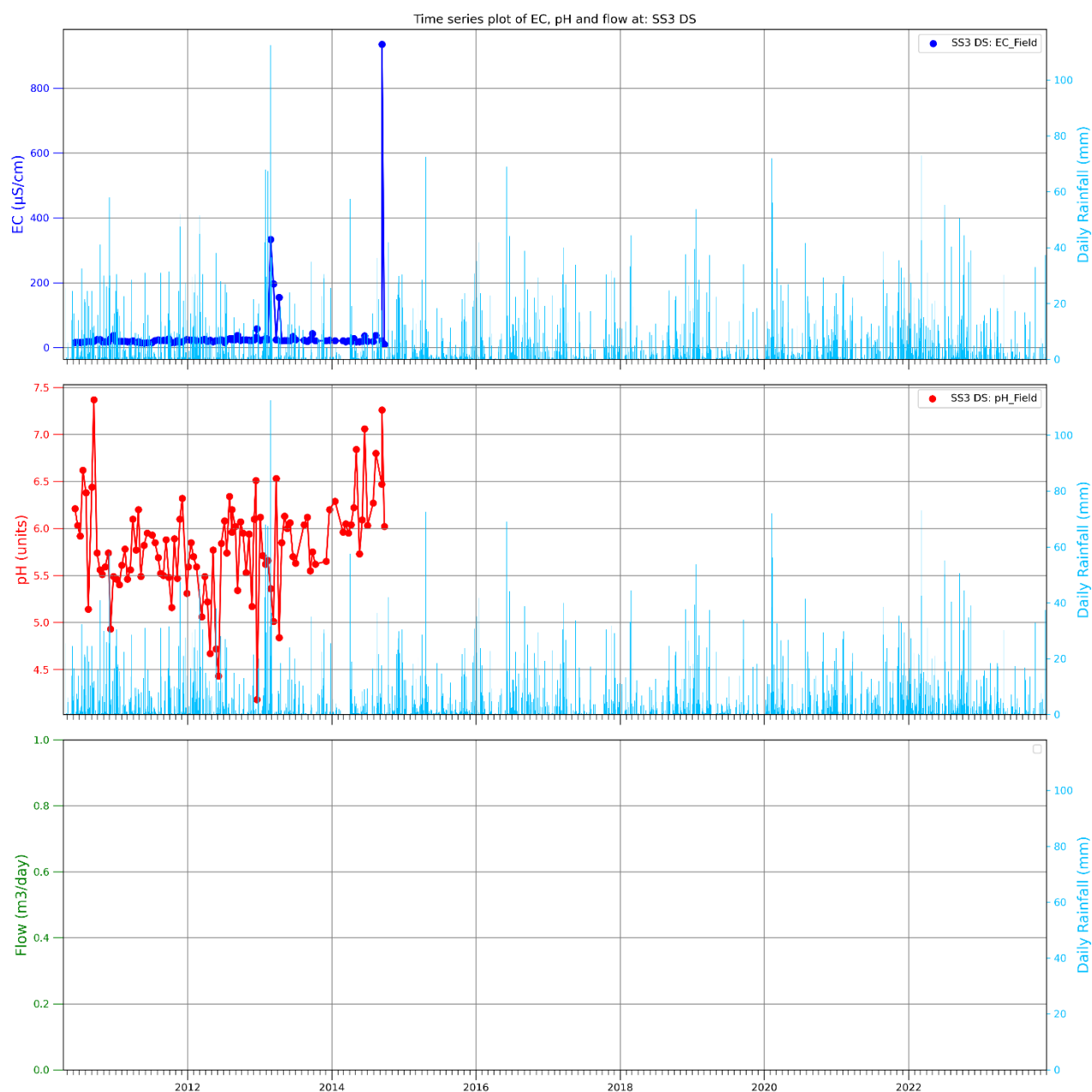


Figure G.19 SS3 Downstream water quality and flow

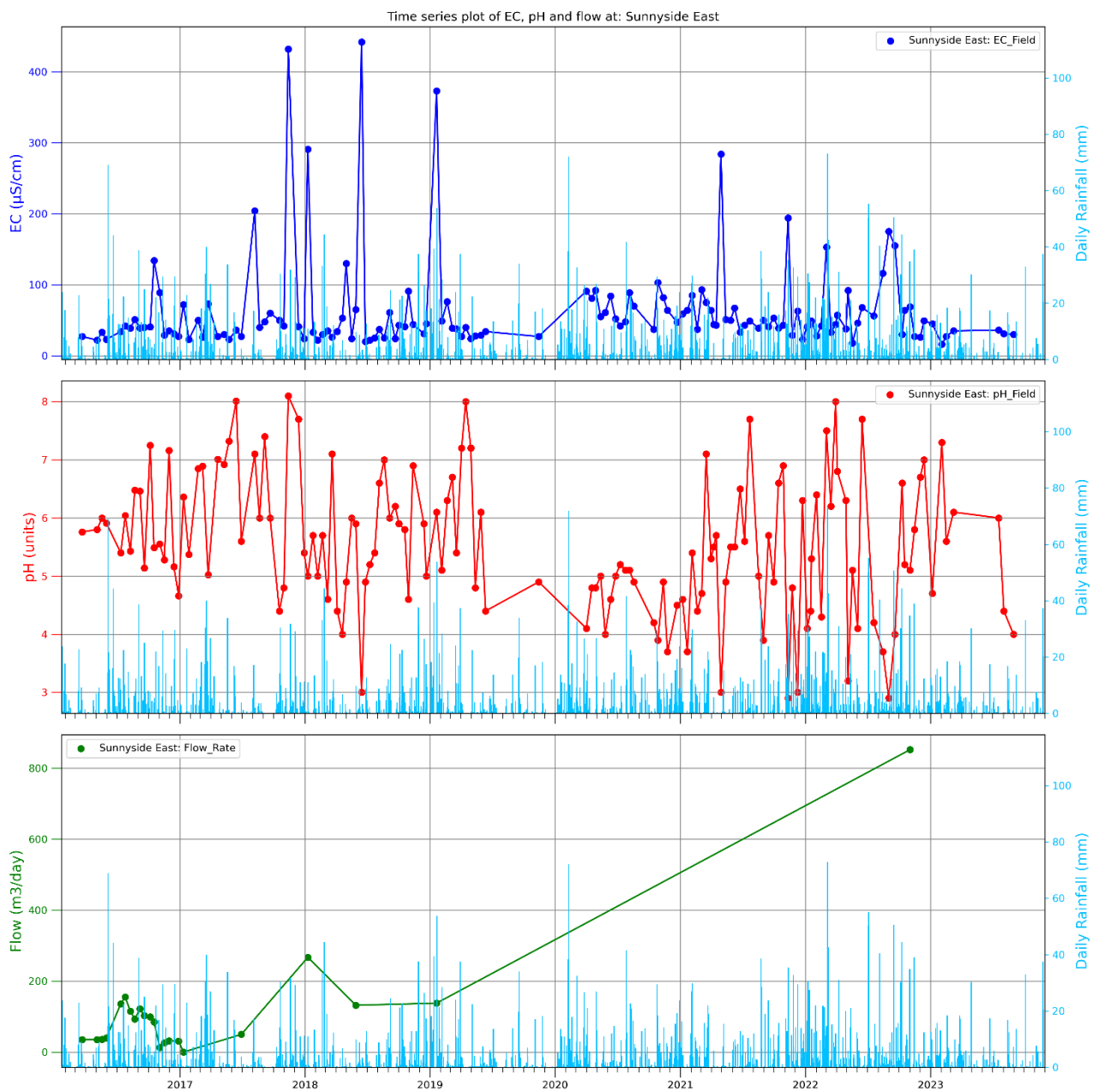


Figure G.20 Sunnyside East water quality and flow

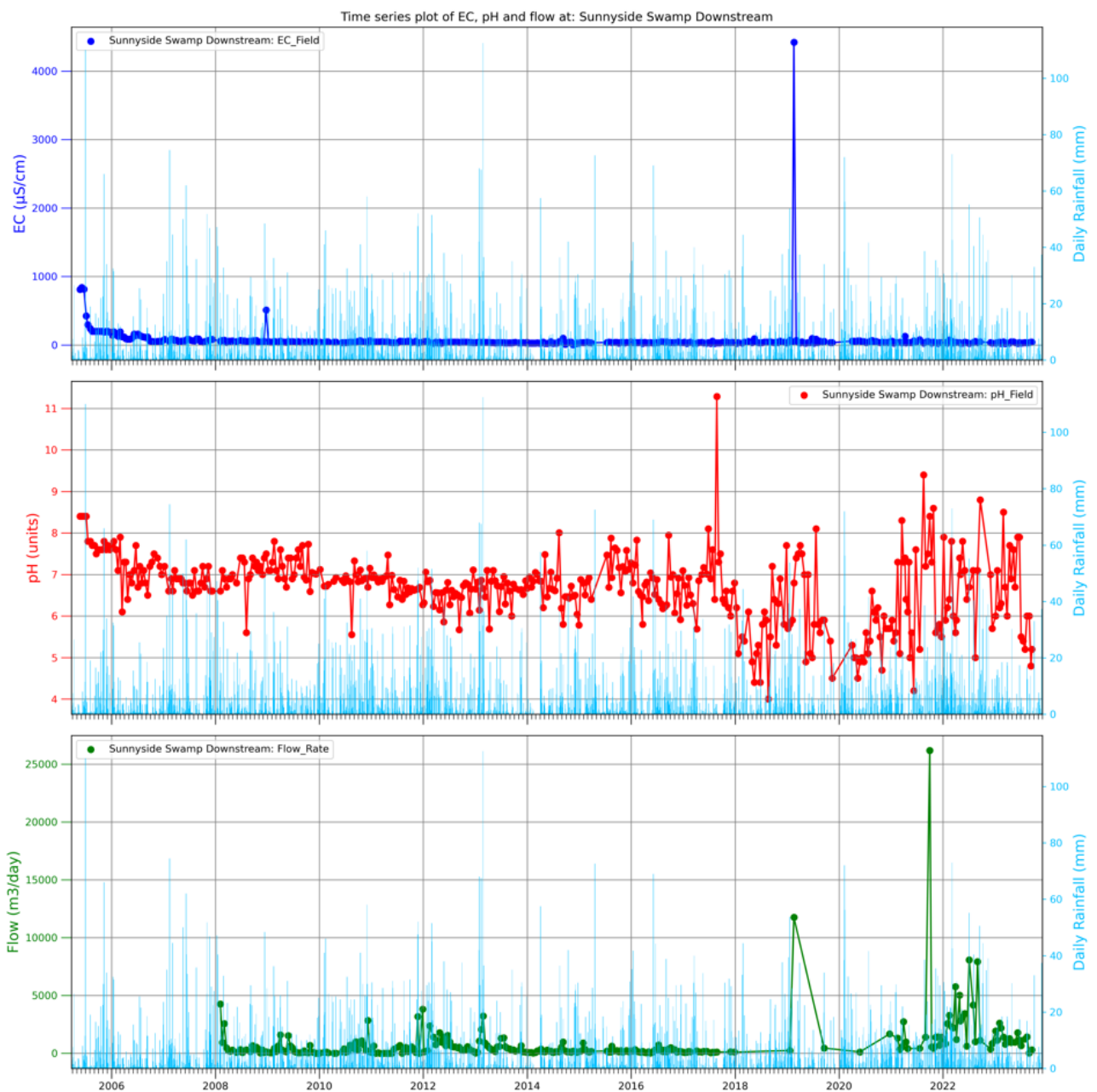


Figure G.21 Sunnyside Swamp Downstream water quality and flow

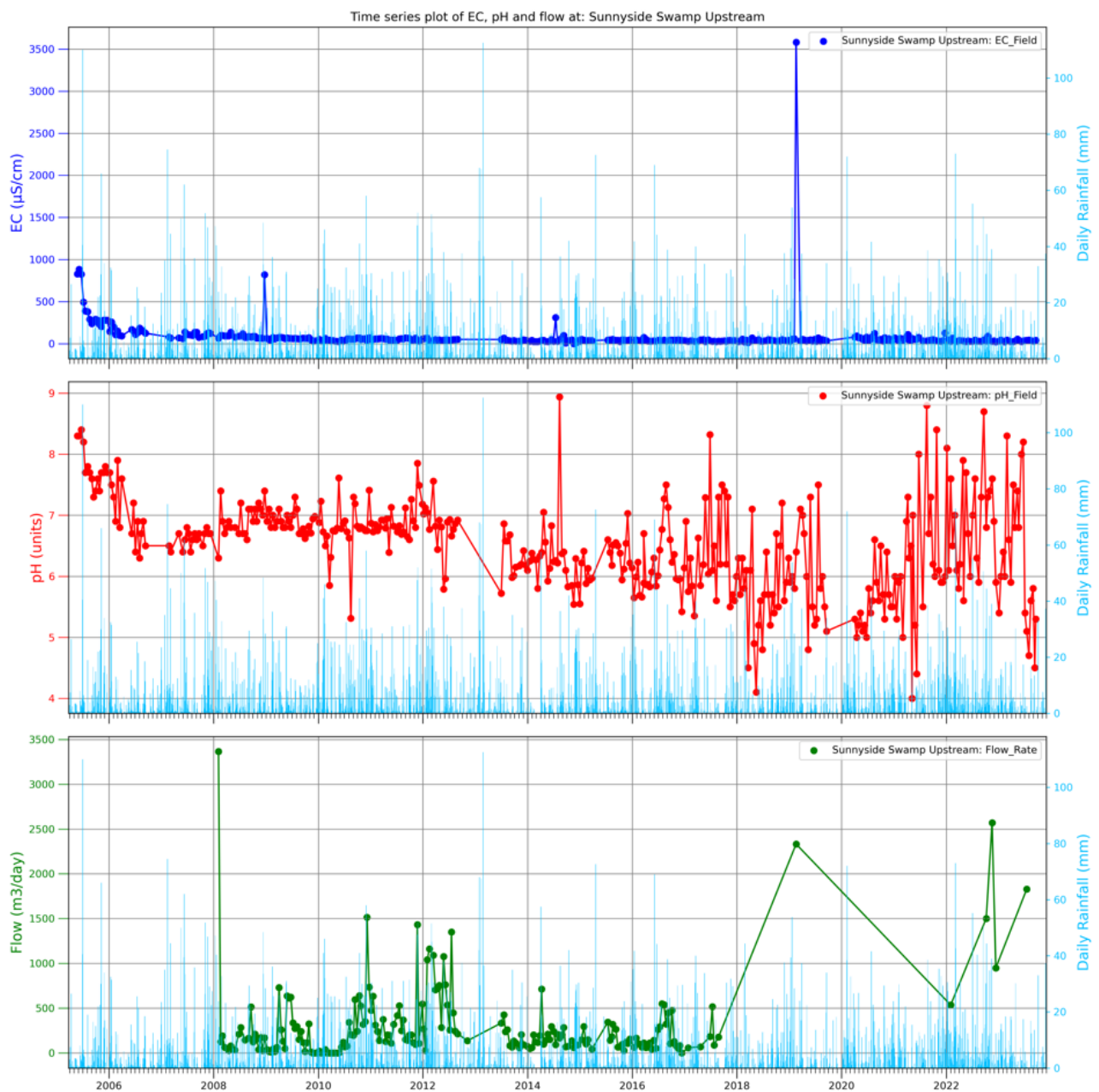


Figure G.22 Sunnyside Swamp Upstream water quality and flow

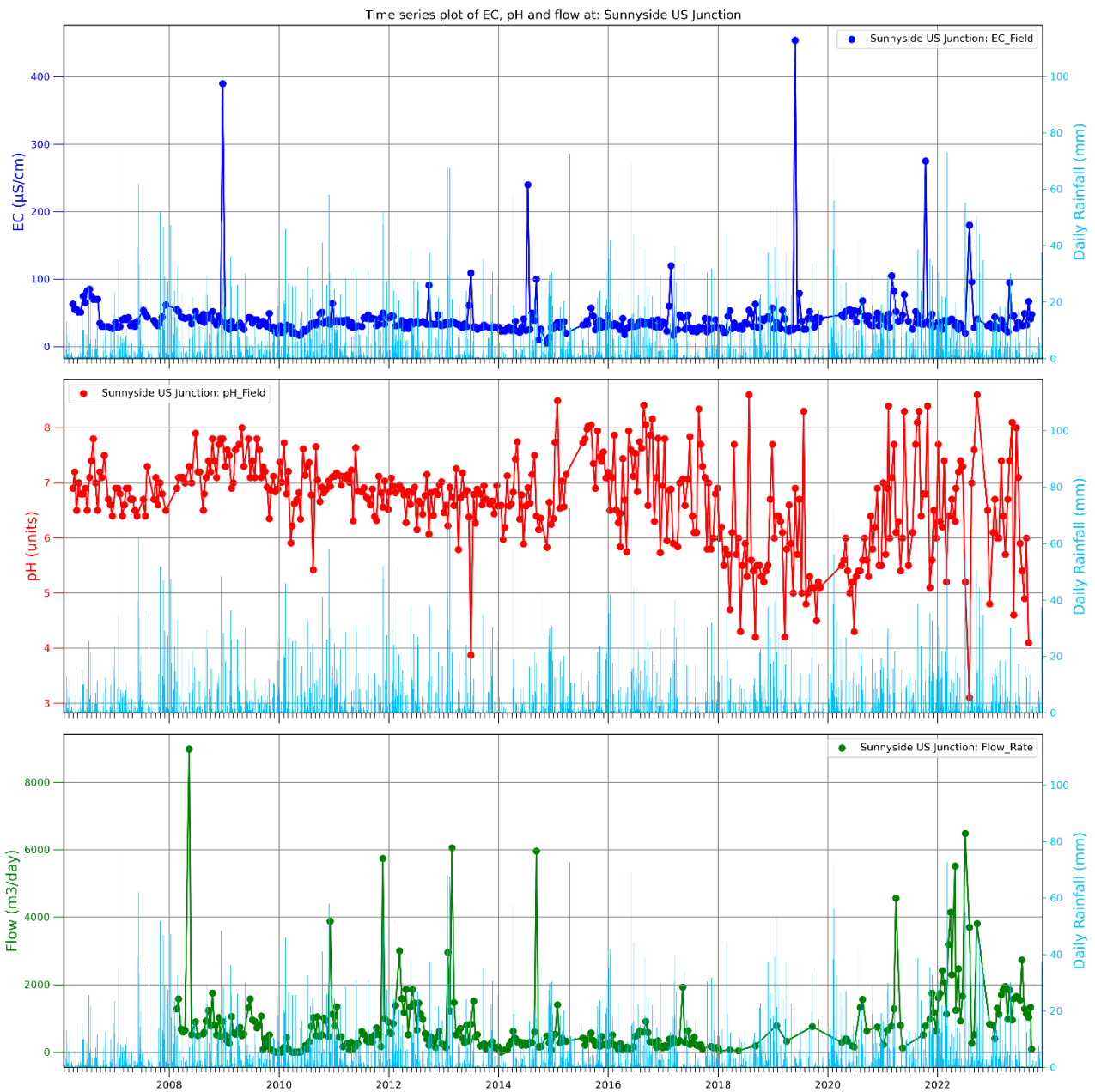


Figure G.23 Sunnyside Upstream Junction water quality and flow

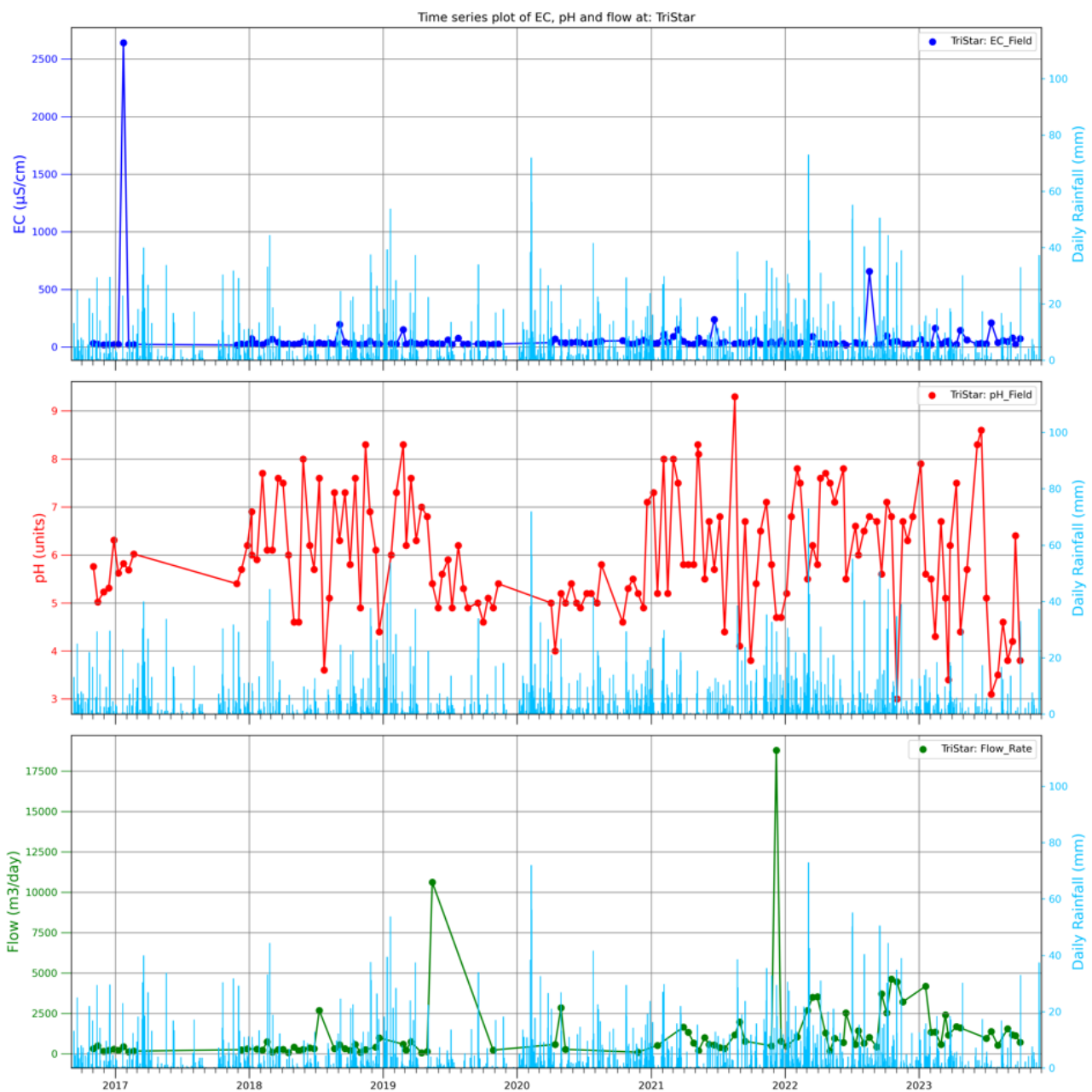


Figure G.24 Tristar water quality and flow

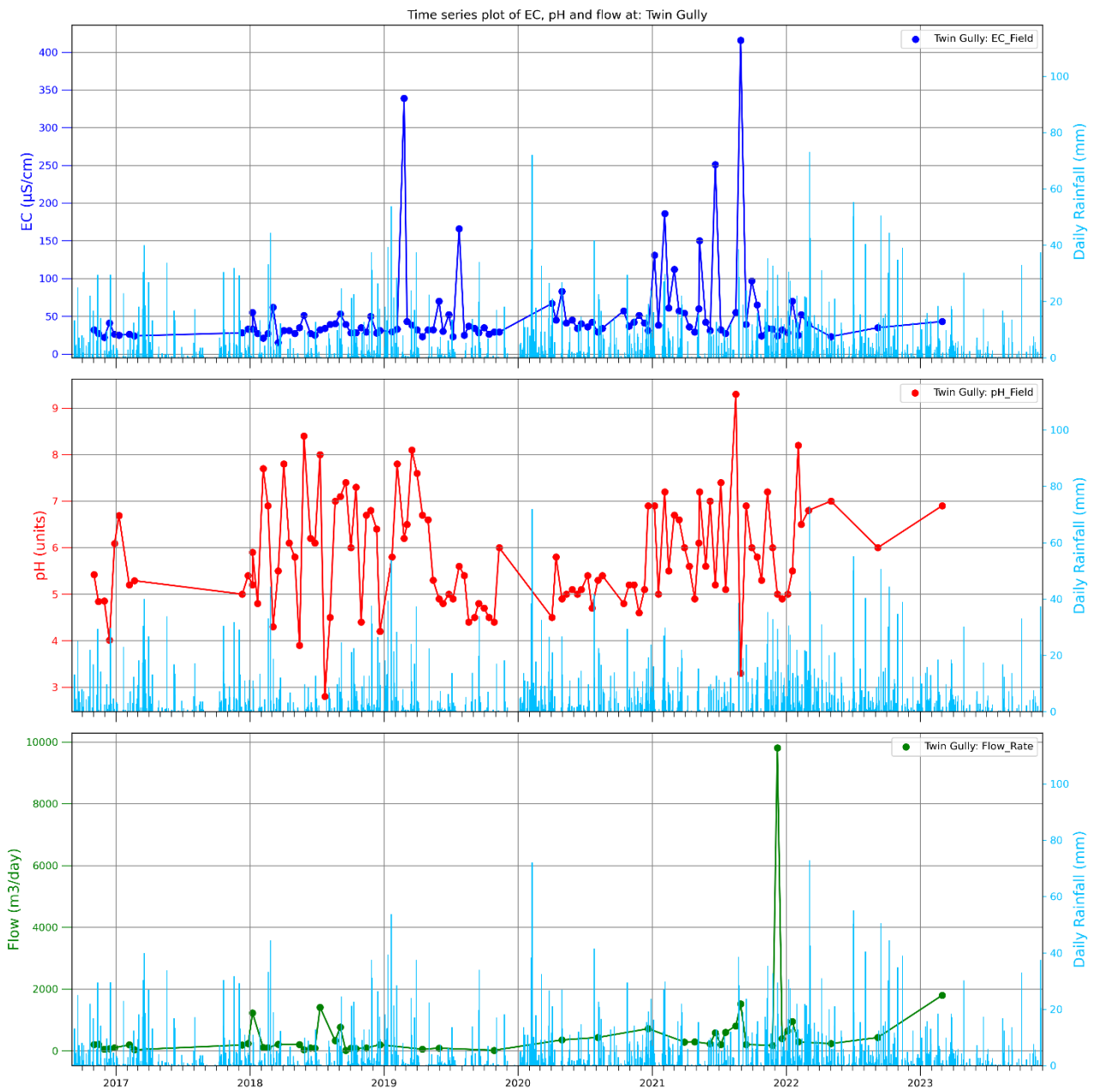


Figure G.25 Twin Gully water quality and flow

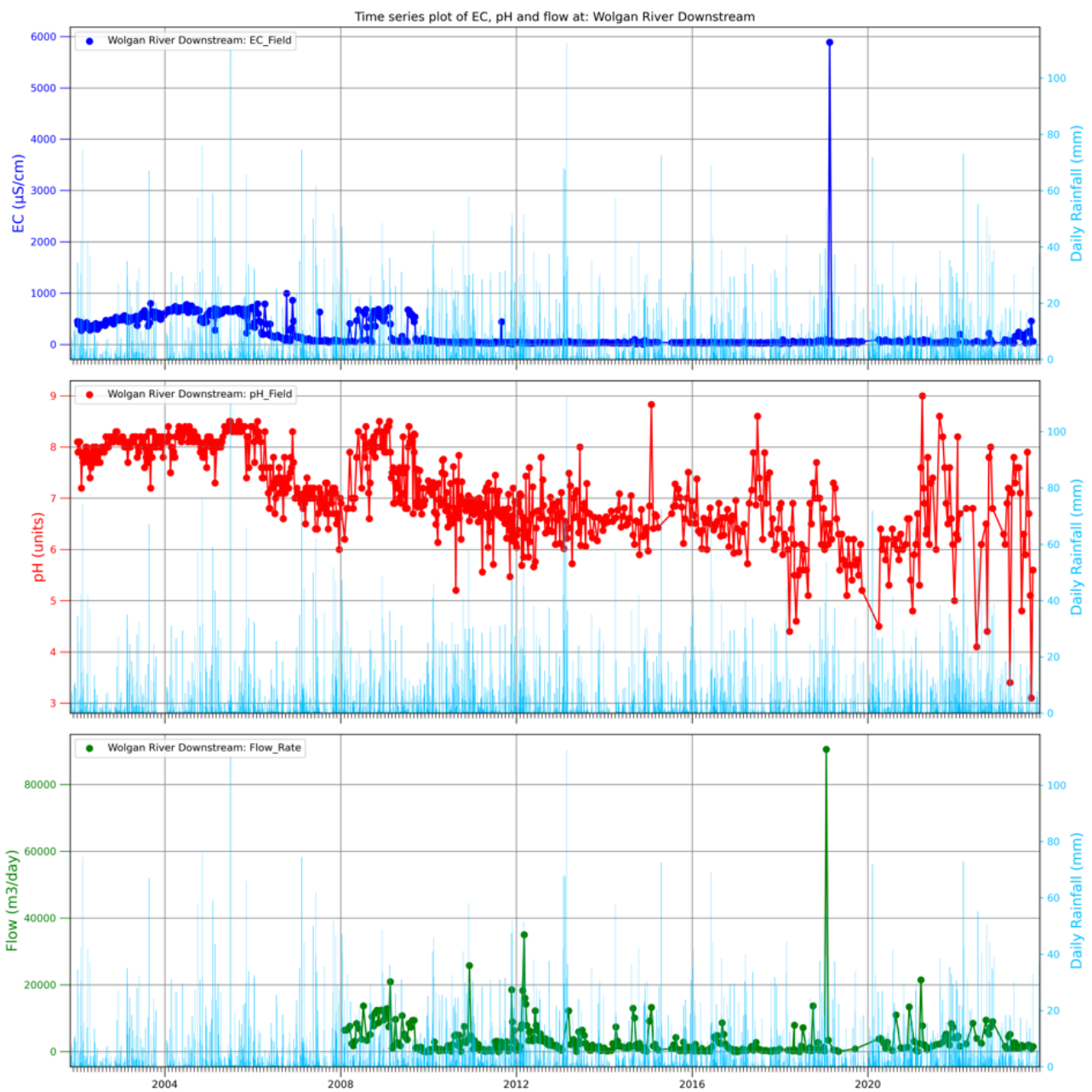


Figure G.26 Wolgan River Downstream water quality and flow

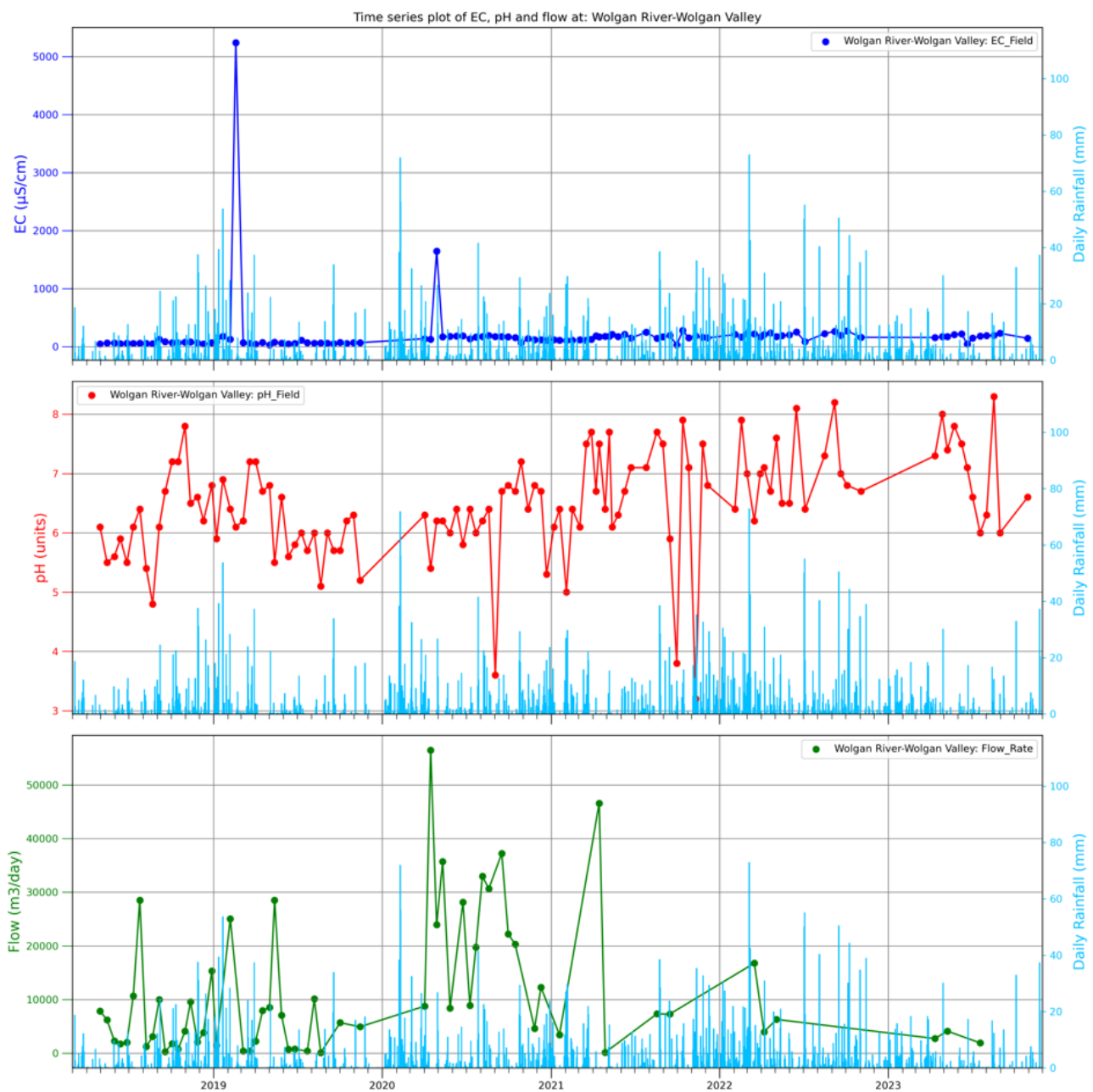


Figure G.27 Wolgan River/Wolgan Valley water quality and flow

Appendix H

Surface water quality statistics

H.1 Surface water quality statistics

Trigger levels for sites detailed in Table H.2 are consistent with Table 14 of the Water Management Plan for Longwalls 424 to 427 (Centennial 2018b).

Table H.1 Swamp surface water quality statistics

Monitoring ID	Pre-mining statistics							Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	analyte	Unit	count	20th %ile–2×StDev	80th %ile + 2×StDev	Exceedance	Min	Median	Max
Carne Swamp	5/01/05	25/09/13	pH	units	263	4.15	7.14	TRUE	5.3	5.75	7.9
Carne Swamp	5/01/05	25/09/13	EC (field)	µS/cm	263	NA	51.99	FALSE	35	40.5	45
Carne Swamp	4/02/08	25/09/13	Flow Rate	kL/day	142	NA	NA	FALSE	-	-	-
East Wolgan Upstream	8/04/05	11/04/06	pH	units	25	7.79	9.71	FALSE	4.9	5.1	5.9
East Wolgan Upstream	8/04/05	11/04/06	EC (field)	µS/cm	25	NA	1098.55	FALSE	29	37	65
East Wolgan Upstream	8/04/05	11/04/06	Flow Rate	kL/day	0	No pre-mining data		FALSE	-	-	-
East Wolgan Downstream	8/04/05	24/04/06	pH	units	28	6.89	9.71	FALSE	-	-	-
East Wolgan Downstream	8/04/05	24/04/06	EC (field)	µS/cm	28	NA	1307.51	FALSE	-	-	-
East Wolgan Downstream	8/04/05	24/04/06	Flow Rate	kL/day	0	NA	NA	FALSE	-	-	-
East Wolgan D_S Junction	22/04/78	21/06/06	pH	units	8	5.77	8.39	FALSE	3.3	6.15	8.2
East Wolgan D_S Junction	22/04/78	21/06/06	EC (field)	µS/cm	8	NA	298.67	FALSE	24	41	127
East Wolgan D_S Junction	22/04/78	21/06/06	Flow Rate	kL/day	0	No pre-mining data		FALSE	233	1312	3902
Gang Gang-East	27/09/16	12/05/17	pH	units	9	3.59	7.95	FALSE	4.8	6.6	7.7
Gang Gang-East	27/09/16	12/05/17	EC (field)	µS/cm	9	NA	33.07	TRUE	12	24	42
Gang Gang-East	27/09/16	12/05/17	Flow Rate	kL/day	9	NA	NA	FALSE	-	-	-
Gang Gang-South West	27/09/16	12/05/17	pH	units	8	2.97	9.80	FALSE	5	6.25	7.4

Table H.1 Swamp surface water quality statistics

Monitoring ID	Pre-mining statistics							Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	analyte	Unit	count	20th %ile–2×StDev	80th %ile + 2×StDev	Exceedance	Min	Median	Max
Gang Gang-South West	27/09/16	12/05/17	EC (field)	µS/cm	8	NA	40.65	TRUE	21	26	53
Gang Gang-South West	27/09/16	22/11/16	Flow Rate	kL/day	3	NA	NA	FALSE	Too low to measure		
Marrangaroo Swamp	24/11/17	22/03/22	pH	units	97	2.87	8.12	FALSE	2.8	5.5	7.9
Marrangaroo Swamp	24/11/17	22/03/22	EC (field)	µS/cm	97	NA	103.88	FALSE	22	32.5	774
Marrangaroo Swamp	24/11/17	22/03/22	Flow Rate	kL/day	69	NA	NA	TRUE	22	977	4586
9 Mile Swamp	27/11/17	14/01/19	pH	units	30	3.04	7.64	FALSE	4.3	5.65	7.1
9 Mile Swamp	27/11/17	14/01/19	EC (field)	µS/cm	30	NA	56.19	TRUE	24	34.5	76
9 Mile Swamp	27/11/17	28/03/18	Flow Rate	kL/day	5	NA	NA	FALSE	-	-	-
Barrier Swamp	27/09/16	-	pH	units	148	2.71	8.35	FALSE	4.5	5.5	8.3
Barrier Swamp	27/09/16	-	EC (field)	µS/cm	152	NA	71.02	TRUE	23	30	103
Barrier Swamp	27/09/16	-	Flow Rate	kL/day	130	NA	NA	FALSE	544	1570.5	4420
Best Creek	24/11/17	-	pH	units	100	2.69	7.72	FALSE	-	-	-
Best Creek	24/11/17	-	EC (field)	µS/cm	100	NA	95.17	FALSE	-	-	-
Best Creek	24/11/17	-	Flow Rate	kL/day	63	NA	NA	FALSE	-	-	-
Carne Central Swamp	27/09/16	13/12/22	pH	units	86	2.69	9.01	FALSE	4.5	5.4	8.2
Carne Central Swamp	27/09/16	13/12/22	EC (field)	µS/cm	86	NA	138.40	FALSE	21	31.5	56
Carne Central Swamp	27/09/16	13/12/22	Flow Rate	kL/day	8	NA	NA	FALSE	Too low to measure		
Firetail	24/11/17	-	pH	units	93	2.57	7.79	FALSE	-	-	-

Table H.1 Swamp surface water quality statistics

Monitoring ID	Pre-mining statistics							Reporting period statistics (31 Jan to 31 Dec 2023)			
	Start	Finish	analyte	Unit	count	20th %ile-2×StDev	80th %ile + 2×StDev	Exceedance	Min	Median	Max
Firetail	24/11/17	-	EC (field)	µS/cm	93	NA	94.28	FALSE	-	-	-
Firetail	24/11/17	-	Flow Rate	kL/day	43	NA	NA	FALSE	-	-	-
SS3 D_S	10/06/10	25/09/13	pH	units	128	4.50	7.03	FALSE	Dry	Dry	Dry
SS3 D_S	10/06/10	25/09/13	EC (field)	µS/cm	128	NA	127.19	FALSE	Dry	Dry	Dry
Sunnyside U_S Junction	31/03/06	22/08/09	pH	units	76	5.85	8.35	FALSE	4.1	6.05	8.1
Sunnyside U_S Junction	31/03/06	22/08/09	EC (field)	µS/cm	76	NA	136.21	FALSE	22	35	95
Sunnyside U_S Junction	21/02/08	22/08/09	Flow Rate	kL/day	36	NA	NA	FALSE	86	1301	2728
Sunnyside Swamp Upstream	24/05/05	19/08/09	pH	units	87	5.74	8.36	FALSE	4.7	6.2	8.3
Sunnyside Swamp Upstream	24/05/05	19/08/09	EC (field)	µS/cm	87	NA	548.61	FALSE	24	35	54
Sunnyside Swamp Upstream	4/02/08	19/08/09	Flow Rate	kL/day	37	NA	NA	FALSE	1830	1830	1830
Sunnyside Swamp Downstream	24/05/05	19/08/09	pH	units	104	5.85	8.55	FALSE	5.2	6.5	8.5
Sunnyside Swamp Downstream	24/05/05	19/08/09	EC (field)	µS/cm	104	NA	447.61	FALSE	21	33.5	47
Sunnyside Swamp Downstream	4/02/08	19/08/09	Flow Rate	kL/day	37	NA	NA	TRUE	17	1141	2614

Table H.2 **Surface water quality statistics**

Monitoring ID	Pre-mining statistics				Reporting period statistics (31 Jan to 31 Dec 2023)				
	Start	Finish	analyte	count	Reference trigger	Exceedance	Min	Median	Max
Carne West	No pre-mining data		pH	0	4.7–8.0	FALSE	-	-	-
Carne West			EC (field)	0	174	FALSE	-	-	-
Carne West			TSS	0	97	FALSE	-	-	-
Carne West			Flow Rate	0	NA	FALSE	Too low to measure		
Gang Gang	21/03/16	24/05/17	pH	27	4.7–8.0	FALSE	4.6	5.5	7.7
Gang Gang	21/03/16	24/05/17	EC (field)	27	174	TRUE	15	31.48	57
Gang Gang	4/05/16	10/05/17	TSS	11	97	FALSE	-	-	-
Gang Gang	21/03/16	24/05/17	Flow Rate	26	NA	FALSE	-	-	-
Marrangaroo Creek	30/01/14	14/03/22	pH	140	4.7–8.0	FALSE	4.6	5.05	5.5
Marrangaroo Creek	30/01/14	14/03/22	EC (field)	140	174	FALSE	32	45	58
Marrangaroo Creek	30/01/14	14/03/22	TSS	140	97	FALSE	-	-	-
Marrangaroo Creek	30/01/14	14/03/22	Flow Rate	44	NA	FALSE	Too low to measure		
Paddys Creek	24/11/17	1/08/18	pH	19	4.7–8.0	FALSE	4	5.1	8.4
Paddys Creek	24/11/17	1/08/18	EC (field)	20	174	TRUE	28	38	297
Paddys Creek	24/11/17	1/08/18	TSS	10	97	FALSE	-	-	-
Paddys Creek	24/11/17	1/08/18	Flow Rate	20	NA	FALSE	429	620.5	870
Pine_ 9 Mile Swamp	27/11/17	14/01/19	pH	31	4.7–8.0	TRUE	4.2	5.6	8.1
Pine_ 9 Mile Swamp	27/11/17	14/01/19	EC (field)	31	174	FALSE	24	35	70

Table H.2 **Surface water quality statistics**

Monitoring ID	Pre-mining statistics				Reporting period statistics (31 Jan to 31 Dec 2023)				
	Start	Finish	analyte	count	Reference trigger	Exceedance	Min	Median	Max
Pine_9 Mile Swamp	27/11/17	3/01/19	TSS	15	97	FALSE	-	-	-
Pine_9 Mile Swamp	27/11/17	23/11/18	Flow Rate	15	NA	FALSE	-	-	-
Carne Central	21/03/16	19/07/2023	pH	114	4.7–8.0	FALSE	4	5.2	8.1
Carne Central	21/03/16	19/07/2023	EC (field)	114	174	FALSE	16	30	60
Carne Central	4/05/16	13/12/22	TSS	31	97	FALSE	-	-	-
Carne Central	12/07/16	9/06/2023	Flow Rate	44	NA	FALSE	674	1147	2074
Tri Star (Springvale site)	2/11/16	-	pH	146	4.7–8.0	FALSE	3.1	5.3	8.6
Tri Star (Springvale site)	2/11/16	-	EC (field)	149	174	FALSE	21	47	210
Tri Star (Springvale site)	2/11/16	-	TSS	49	97	FALSE	-	-	-
Tri Star (Springvale site)	2/11/16	-	Flow Rate	95	NA	FALSE	532	1336	4181
Twin Gully (Springvale site)	2/11/16	-	pH	110	4.7–8.0	FALSE	6.9	6.9	6.9
Twin Gully (Springvale site)	2/11/16	-	EC (field)	110	174	FALSE	43	43	43
Twin Gully (Springvale site)	2/11/16	-	TSS	48	97	FALSE	-	-	-
Twin Gully (Springvale site)	2/11/16	-	Flow Rate	49	NA	FALSE	1797	1797	1797
Wolgan River Downstream	4/01/02	-	pH	354	4.7–8.0	FALSE	3.4	7	7.9
Wolgan River Downstream	4/01/02	-	EC (field)	354	174	FALSE	31	95	454
Wolgan River Downstream	4/01/02	-	TSS	333	97	FALSE	-	-	-
Wolgan River Downstream	4/02/08	-	Flow Rate	354	NA	FALSE	834	1573	5171

Table H.2 Surface water quality statistics

Monitoring ID	Pre-mining statistics				Reporting period statistics (31 Jan to 31 Dec 2023)				
	Start	Finish	analyte	count	Reference trigger	Exceedance	Min	Median	Max
Wolgan River (Wolgan Valley)	30/04/18	-	pH	114	4.7–8.0	FALSE	6	7.3	8.3
Wolgan River (Wolgan Valley)	30/04/18	-	EC (field)	115	174	FALSE	47	178.5	232
Wolgan River (Wolgan Valley)	30/04/18	-	TSS	86	97	FALSE	-	-	-
Wolgan River (Wolgan Valley)	30/04/18	-	Flow Rate	60	NA	FALSE	1924	2738	4131
Sunnyside East	No pre-mining data		pH	0	4.7–8.0	FALSE	4	5.6	7.3
Sunnyside East			EC (field)	0	174	FALSE	16	31	45
Sunnyside East			TSS	0	97	FALSE	-	-	-
Sunnyside East			Flow Rate	0	NA	FALSE	Too low to measure		

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