2021
Annual Review

BULGA
COAL

GLENCORE

PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Bulga Coal Management Pty Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.12954-R01-v0.2	18 March 2021	Sam McDonald	Adam Williams	Adam Williams
630.12954-R01-v0.2	29 March 2022	Sam McDonald	Adam Williams	Adam Williams

Cover photograph: Minimbah Teaching Place was built in the Wollombi Brook Conservation Area in 2021. The aim of the facility is to showcase and celebrate Wonnarua culture and provide storage for artefacts salvaged at our mine and other Glencore sites.

Name of Operation	Bulga Coal
Name of Operator	Bulga Coal Management Pty Ltd
Development consent / project approval #	Bulga Underground Operations DA 376-8-2003 Bulga Open Cut SSD 4960 Bulga Open Cut DA 41-03-99
Name of holder of development consent / project approval	Bulga Coal Management Pty Ltd
Mining lease #	ML 1494, ML 1547, ML 1674, ML 1717, ML 1788, CL 224, sublease within Mount Thorley Operations (CL 219, AUTH 447, AUTH 450, EL 5277, EL 5461, EL 8315
Name of holder of mining lease	Saxonvale Coal Pty Ltd; Saxonvale Coal Pty Ltd and Nippon Steel Australia Pty Ltd; and Bulga Coal Management Pty Ltd
Water licence #	WAL36221, WAL41543, WAL41544, WAL41545, WAL41546, WAL41687.
Name of holder of water licences	Bulga Coal Management Pty Ltd, Saxonvale Coal Pty Ltd, Beltana Highwall Mining Pty Ltd
MOP/RMP start date	1 July 2020 (Bulga Open Cut) 29 May 2018 (Bulga Underground Operations)
MOP/RMP end date	30 June 2023 (Bulga Open Cut) 31 December 2023 (Bulga Underground Operations)
Annual Review start date	1 January 2021
Annual Review end date	31 December 2021

I, Ralph Northey, certify that this audit report is a true and accurate record of the compliance status of Bulga Coal for the period 1 January 2020 to 31 December 2021 and that I am authorised to make this statement on behalf of Bulga Coal Management Pty Ltd.

Note.

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

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

Name of authorised reporting officer	Ralph Northey
Title of authorised reporting officer	Environment and Community Manager
Signature of authorised reporting officer	R Northey
Date	29-3-2022

DOCUMENT REFERENCES

TABLES

FIGURES

PHOTOGRAPHS

APPENDICES

1 Statement of Compliance

The Bulga Coal Complex (Bulga Coal) includes the Bulga Open Cut and the Bulga Underground Operations. During the reporting period Bulga Open Cut operated under development consents DA 41-03-99 and SSD-4960, while Bulga Underground Operations operated under DA 376-8-2003. Both sites operate under Environment Protection Licence (EPL) 563 and several mining and exploration leases.

Table 1 outlines compliance against major approvals. Where non-compliances have been identified, they are listed in **Table 2** and detailed in later sections of this report. **Table 3** describes the status of non-compliance.

Table 1 Summary Statement of Compliance for Major Approvals

Licence	Were all conditions of the Licence complied with?
DA 41-03-99	No
DA SSD-4960	No
DA 376-8-2003	No
EPBC 2002/773	Yes
EPBC 2012/6637	Yes
EPBC 2018/8300	Yes
ML 1494	Yes
ML 1547	No
ML 1674	Yes
ML 1717	Yes
ML 1788	Yes
EPL 563	No
EL 5277	Yes
EL 5461	Yes
EL 8315	Yes
AUTH 447	Yes
AUTH 450	Yes
CL 224	Yes

Table 2 Summary of Non-Compliances

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
SSD-4960	Schedule 3, Condition 26	Discharges must comply with EPL and Protection of the Environment Operations Act (POEO Act)	Non-Compliant	22/03/21 – 24/03/21	Discharge of sediment laden water from a dirty water dam into a clean water catchment. The discharge was caused by heavy rainfall over the 5 days prior to the event, exceeding the dam design criteria.	N/A	**Section 11.1**
EPL 563	O1.1, O2.1 and O6.1	O1.1 - Activities must be carried out in a competent manner O2.1a) - Plant and equipment must be maintained O6.1 - All above-ground tanks containing material likely to cause environmental harm must be bunded or have spill containment.	Non-Compliant	29/01/21	The Environment Protection Authority (EPA) undertook an inspection of the premises on 9 December 2020. Following the inspection on 29 January 2021 the EPA alleged that Bulga Coal had failed to: maintain bund taps in a closed position; contain dangerous goods within a bund; failed to adequately bund flocculant tanks; and failed to store hazardous waste under cover.	Actions taken: the taps draining the bunded pallets were closed; plugs for bunded pallets were installed; the discontinuous bund of the Coal Handling and Preparation Plant (CHPP) Flocculant Plant was repaired; and the waste batteries were removed to an undercover location.	**Section 11.2**
SSD4960	Schedule 3, Condition 16.	Air Quality Monitoring	Non-Compliant	Various	Failure to continuously monitor PM10 at air quality monitors D1, D3, D5 and D11.	Cause of the failures were investigated, and the monitors were fixed, or power restored.	**Section 11.3.1**

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
SSD4960	Schedule 3, Condition 16.	Air Quality Monitoring	Non-compliant	Various	Failure to continuously monitor PM2.5 at air quality monitors D2 and D10.	Cause of the failures were investigated, and the monitors were fixed, or power restored.	**Section 11.3.1**
EPL 563	Condition M2.2	Air Quality Monitoring	Non-Compliant	Various	Failure to continuously monitoring PM10 at air quality monitors EPA Point 9 and EPA Point 10.	Monitors were fixed. Details were reported to the EPA in the 2020-2021 Annual Return.	**Section 11.3.1**
EPL 563	Condition M4.1	Weather Monitoring	Non-Compliant	Various	Humidity data was not monitored continuously at EPA Point 23 – Southern Extension Meteorological Station due to equipment failure during the EPL Annual Return reporting period.	The humidity sensor was replaced on 10 February 2021. Details were reported to the EPA in the 2020-2021 Annual Return.	**Section 11.3.2**
EPL 563	Condition M8.1	Blast Monitoring	Non-Compliant	27/04/21 and 29/04/21	Overpressure and vibration data was not monitored at Dawtrey (EPA Point 5) blast monitor on 27 and 29 April 2021.	The missed results were caused by a corrupt memory card. The memory card was replaced by a blast monitoring technician on 29 April 2021. The monitor has recorded overpressure and vibration results since this date.	**Section 11.3.3**
SSD-4960	Schedule 3, Condition 15(g)						

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
ML1547	Condition 2(1)	Conduct operations in accordance with the Mining Operations Plan (MOP)	Non-Compliant	02/06/21	The Resources Regulator issued an Official Caution on 26 July 2021 for not conducting operations in accordance with the MOP. The Official Caution was regarding a cartographic error in the MOP plans where a 10 ha had inadvertently been assigned as rehabilitation. Bulga Coal self-reported the error to the Resources Regulator.	On 6 September 2021 Bulga Coal sought an amendment to the Mining Operations Plan 2020 – 2023 to address minor variations from the MOP plans provided in August 2020. The revised plans corrected the cartographic error.	**Section 11.3.4**

Table 3 Compliance Status Categories

Risk Level	Colour Code	Description
High	Non-Compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-Compliant	Non-compliance with potential for serious environmental consequences, but is unlikely to occur; or potential for moderate environmental consequences, but is likely to occur
Low	Non-Compliant	Non-compliance with potential for moderate environmental consequences, but is unlikely to occur; or potential for low environmental consequences, but is likely to occur
Administrative non-compliance	Non-Compliant	Non-compliance which does not result in any risk of environmental harm

Sections 6 and **7** of this report detail the environmental management and water management performance of Bulga Coal, respectively. Non-compliances are discussed in **Section 11**.

2 Introduction

2.1 Mine Operations

Bulga Coal is located approximately 12 kilometres (km) southwest of Singleton, and 2 km from the townships of Broke and Bulga in the Upper Hunter Valley of New South Wales (NSW) (refer **Figure 1**). Bulga Coal comprises two coal mining operations, being Bulga Open Cut and Bulga Underground Operations. The CHPP and rail loading facility are located in the eastern side of the site. In May 2018, Bulga Underground Operations ceased mining and the mine was sealed in July 2018.

Bulga Coal is managed by Bulga Coal Management Pty Ltd on behalf of the Bulga Joint Venture. Bulga Coal Management Pty Ltd is owned by Oakbridge Pty Ltd, which is the majority shareholder (87.5%) of the Bulga Joint Venture. Glencore is the majority shareholder of Oakbridge Pty Ltd.

This report details the environmental management performance of Bulga Coal over the period 1 January 2021 to 31 December 2021. It has been prepared in accordance with the *Annual Review Guideline* (DPIE, 2015), and satisfies:

- Schedule 6, Condition 4 of Bulga Underground Operations Development Consent DA 376-8-2003;
- Schedule 2, Condition 9.1 of Bulga Open Cut Development Consent DA 41-03-99;
- Schedule 5, Condition 4 of Bulga Optimisation Project Development Consent SSD-4960; and
- The requirement for Environmental Management Reports or Rehabilitation Reports required under various mining tenements.

2.2 Mine Contacts

The contact details for the personnel responsible for environmental management and community relations at Bulga Coal are provided in **Table 4**.

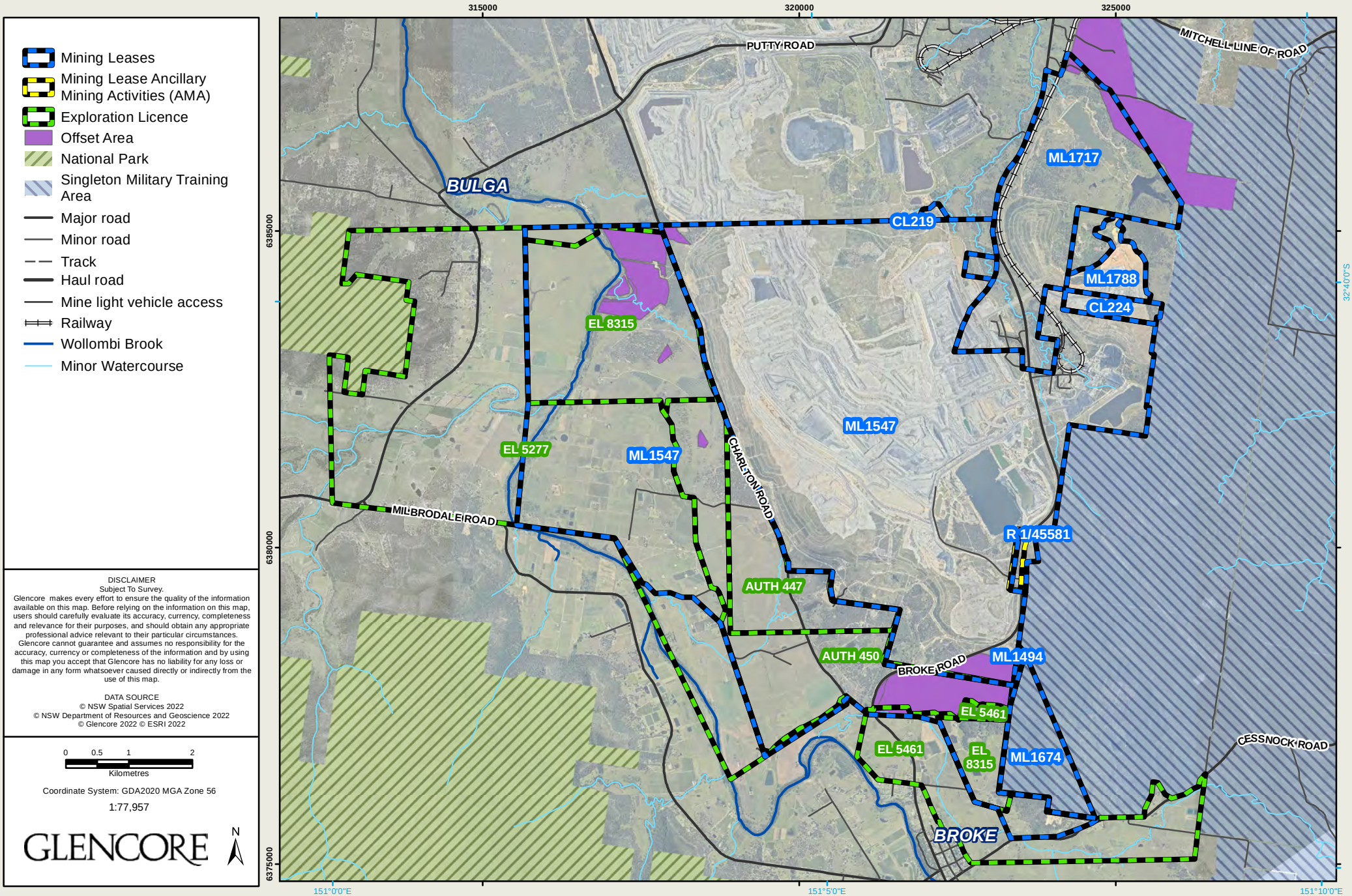
Table 4 Contacts for Bulga Coal

Contact	Position	Contact Details
Ralph Northey	Bulga Coal Environment and Community Manager	T: 02 6570 2539
		E: Ralph.Northey@glencore.com.au
Dave Foster	Bulga Coal Operations Manager	T: 02 6570 2400
		E: David.Foster@glencore.com.au

2.2.1 Mining Personnel

As at the end of the reporting period, Bulga Coal employed approximately 818 full time equivalent personnel.

FIGURE 1 - BULGA COAL LOCALITY & LICENCES 2021



3 Approvals

3.1 Development Consent/s and Commonwealth Approvals

Bulga Coal operates under three development consents; the Bulga Underground Operations DA 376-8-2003, Bulga Open Cut DA 41-03-99 and SSD-4960. SSD-4960 superseded DA 41-03-99 at the granting of the Bulga Optimisation Project approval. DA 41-03-99 is in the process of being relinquished.

In December 2021 Bulga Coal submitted administrative modifications for SSD-4960 (Mod 4) and DA 376-8-2003 (Mod 8). The modifications were approved 24 February 2022 and include amendments to the following conditions:

Schedule 5 Condition 4 of SSD-4960 and Schedule 6 Condition 4 of DA 376-8-2003 to change the Bulga Coal Annual Review reporting period to a calendar year; and

Schedule 3 Condition 23 and Appendix 7 Condition 1 of SSD-4960, and Schedule 4 Condition 33 and Appendix 4 Condition 1 of DA 376-8-2003 to include the use of the sigma theta method for determining the meteorological stability category as per the *Noise Policy for Industry (EPA, 2017)*.

Bulga Coal also operates in accordance with three Commonwealth approvals issued by the Department of Agriculture, Water and the Environment (DAWE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). For more information regarding compliance with Commonwealth approval conditions refer to **Appendix A**.

Details of the development consents and Commonwealth approvals are provided in **Table 5**.

Table 5 Development Consents and Commonwealth Approvals

Consent	Details	Expiry Date
DA 376-8-2003	Bulga Coal Continued Underground Operations	23 February 2031
	Mod 1 – Drift relocation (11 April 2006)	
	Mod 2 – Increase CHPP throughput (25 October 2006)	
	Mod 3 – Longwall realignment (1 October 2007)	
	Mod 4 – Methane Abatement and Gas-fired Power Plant (14 July 2010)	
	Mod 5 – Blakefield North Longwall Modification and Gas Fired Power Plant (18 October 2013)	
	Mod 6 – Modification to noise criteria, flora and fauna criteria, and independent auditing (8 December 2016)	
	Mod 7 – Relocation of the 9MW power station and associated flares (16 July 2020)	
	Mod 8 – Change to Annual Review reporting period and change to sigma theta method for meteorological monitoring (24 February 2022)	
DA 41-03-99	Bulga Coal Surface Operations	17 May 2025[1]
	Mod 1 – Time of commencement (approved 15 February 2001)	
	Mod 2 – Office extension (approved 11 January 2008)	

Consent	Details	Expiry Date
	Mod 3 – Surface facilities and CHPP dam (approved 5 November 2008)	
	Mod 4 – CHPP dam (approved 2 November 2009)	
	Mod 5 – Noise Conditions (approved 24 May 2010)	
	Mod 6 – Rail Refuelling Facility (approved 2 July 2011)	
	Mod 7 – Western limit extension (approved 15 March 2013)	
	Mod 8 – Sediment Dam (approved 14 March 2014)	
SSD-4960	Bulga Optimisation Project (1 December 2014)	31 December 2039
	Mod 1 – Eastern Emplacement Area and Tailings Storage (17 January 2017)	
	Mod 2 – Extend the period for construction of the outer face of the noise and visual bund (30 August 2018)	
	Mod 3 – Extend approval to extract additional 64mt from beneath tailings storage (16 July 2020)	
	Mod 4 – Change to Annual Review reporting period and change to sigma theta method for meteorological monitoring (24 February 2022)	
EPBC 2002/773	Commonwealth Land Consent (as varied 25 October 2015)	31 December 2034
	Mod 2002/773 – Commonwealth Land Subsidence Management Plan (SMP) Submission Schedule	
EPBC 2012/6637	Bulga Open Cut (as varied 5 January 2016)	31 December 2036
EPBC 2018/8300	Bulga Open Cut (as varied 9 September 2021)	31 December 2049

1 - DA 41-03-99 is in the process of being relinquished.

3.2 Mining Tenements

Mining operations at Bulga Coal are undertaken within Mining Lease (ML) 1494, ML 1547, ML 1674, ML 1717, ML 1788, Coal Lease (CL) 224 and a sublease within Mount Thorley Operations (CL 219). Bulga Coal has approval to undertake exploration activities in accordance with Exploration Lease (EL) 5277, EL 5461, EL 8315, Authorisation (AUTH) 447 and AUTH 450.

Mining tenements are summarised in **Table 6** and are shown on **Figure 1**.

Table 6 Mining Tenements

Tenement	Details	Expiry Date
ML 1494	Saxonvale Coal Pty Ltd and Nippon Steel and Sumitomo Metal Australia Pty Ltd	20 September 2027
ML 1547	Bulga Coal Management Pty Ltd	4 April 2025
ML 1674	Bulga Coal Management Pty Ltd	22 March 2033
ML 1717	Bulga Coal Management Pty Ltd	15 September 2036
ML 1788	Bulga Coal Management Pty Ltd	19 June 2040
Sublease within CL 219	Sublease to Bulga Coal within the Mount Thorley Operations CL 219	1 June 2025
CL 224	Saxonvale Coal Pty Ltd	23 December 2023

Tenement	Details	Expiry Date
EL 5277	Saxonvale Coal Pty Ltd	7 April 2021[1]
EL 5461	Saxonvale Coal Pty Ltd and Nippon Steel and Sumitomo Metal Australia Pty Ltd	2 April 2018[1]
EL 8315	Saxonvale Coal Pty Ltd	13 October 2027
AUTH 447	Saxonvale Coal Pty Ltd	2 September 2022
AUTH 450	Saxonvale Coal Pty Ltd	30 December 2022

1 – Renewal sought

Mining Operations Plan Status

From 1 January 2020 to 9 September 2020, Bulga Open Cut operated in accordance with *Bulga Open Cut Mining Operations Plan: 29 May 2018 – 31 December 2023*. In September 2021, Bulga Open Cut submitted a MOP amendment (Amendment A) to the Department of Regional NSW – Resources Regulator (RR) to incorporate the construction of a 13.6 hectare temporary pad for the potential storage of high ash ROM coal, and to address minor variations from the MOP Plans. The revised Plans corrected the cartographic error as discussed in **Section 11.3.4**. *The Bulga Open Cut Mining Operations Plan: 1 July 2020 – 30 June 2023 Amendment A* was approved by RR on 22 October 2021.

From January to December 2021 Bulga Underground Operations operated in accordance with the *Bulga Underground Operations Mining Operations Plan: 29 May 2018 – 31 December 2023*.

3.2.1 Subsidence Management Plan Status

The last underground coal was mined in May 2018 and the relevant Subsidence Management Plan expired in December 2019. Subsidence impact monitoring and mitigation works are now completed in accordance with the *Bulga Underground Operations Post Mining Subsidence Management Plan*.

3.3 Licences

The licences held by Bulga Coal are detailed in **Table 7**. Bulga Coal does not hold any surface water licences for mining purposes. The only surface water drawn for mining purposes is supplied from the Mount Thorley Water Supply Joint Venture. The scheme is operated by Singleton Council.

Environment Protection Licence (EPL) 563 was varied in August 2021.

The August variation included:

- Condition P1.1 – amendment of particulate monitoring station location (EPA identification 9);
- Note below Condition P1.4 – Updated "Figure 1" to represent the plan titled "Bulga Coal Figure 1 ELP 563 Premises Boundary" dated 21 June 2021; and
- Condition M4.1 – amendment of temperature, wind speed and wind direction from 10 metres to 30 meters for meteorological station EPA ID 23.

Table 7 Bulga Coal Licences

Licence	Details
Environmental Protection Licence (EPL)	
EPL 563	For scheduled activities: Coal works > 5,000,000t annual handling capacity; Crushing, grinding or separating >100,000-500,000t annual processing capacity; and Mining for coal >5,000,000t annual production capacity. Anniversary Date: 20 July.
Water Licences	
WAL41687	Mining: Volume licence limit 500ML. Sydney Basin-North Coast Groundwater Source.
WAL41546	Mining: Volume licence limit 365ML. Sydney Basin-North Coast Groundwater Source.
WAL41543	Mining: Volume licence limit 500ML. Sydney Basin-North Coast Groundwater Source.
WAL41544	Mining: Volume licence limit 500ML. Sydney Basin-North Coast Groundwater Source.
WAL41545	Mining: Volume licence limit 500ML. Sydney Basin-North Coast Groundwater Source.
WAL36221	Mining: Wollombi Brook Aquifer leakage to Permian coal measures 300 ML.
20BL166867	Monitoring (mining bore): GW1 – GW10. Total of 16 bores for monitoring purposes.
20BL167776	Monitoring: P1 – P3, P4A, P4B, P5 – P8 and V3. Licence for total of 9 bores for monitoring purposes.
20BL167777	Monitoring: V1, V2, F1 and F2.
20BL169204	Monitoring: Bore – ACARP Project.
20BL169246	Monitoring: Bore – ACARP Project.
20BL172659	Monitoring: WBR180 and WBR181.
20BL172660	Monitoring: WBR182 and WBR183.
20BL173014	Monitoring: SBD194, SBD196.
20BL173617	Monitoring: Lot 61/755264.
20BL173618	Monitoring: Lot 34/755264.
20BL173619	Monitoring: Lot 33/755264.
20BL173620	Monitoring: Lot 23/755264.
20BL173621	Monitoring: Lot 24/755264.
20BL173640	Monitoring Bore - 25//755264.
20BL173657	Monitoring Bore - 22//755264.
20BL173708	Monitoring Bore - 11//730762.
Radiation/Dangerous Goods Licences	

Licence	Details
Radiation Management Licence 5061333	Serial No: 6230GK – Fixed Radiation Gauge ID No 8929. Serial No: 4421GK – Fixed Radiation Gauge ID No 8934. Serial No: 4412GK – Fixed Radiation Gauge ID No 8935. Serial No: 4376GK – Fixed Radiation Gauge ID No 8938. Serial No: 6218GK – Fixed Radiation Gauge ID No 8939. Serial No: OC519 – Fixed Radiation Gauge ID No 9581. Serial No: 0532/06 – Fixed Radiation Gauge ID No 9582. Serial No: 0528/07 – Fixed Radiation Gauge ID No 9583. Serial No: 0538/07 – Fixed Radiation Gauge ID No 9584. Serial No: 0539/07 – Fixed Radiation Gauge ID No 9585.
NDG018992	Hazardous Chemicals Notification for the storage and handling of hazardous chemicals.
XSTR100095	Bulga Open Cut Licence to Store Explosives.

3.3.1 Other Approvals

In 2015, Bulga Underground Operations was granted a surface access agreement by the Commonwealth Department of Finance to allow the construction and operation of goaf gas drainage wells on the Singleton Military Training Area for Blakefield South Longwall 7. This agreement was modified in 2016 to include an additional four goaf wells to service Blakefield South Longwall 8. The access agreement was relinquished in 2021 following the decommissioning of redundant infrastructure rehabilitation of any disturbed areas and two weed control programs. The area has been remediated to the satisfaction of Department of Defence.

4 Operations Summary

Mining activities including exploration at Bulga Underground Operations and Bulga Open Cut during 2021 are detailed in the following sections. Mining activities at Bulga Underground Operations and Bulga Open Cut are displayed on **Figure 2** and **Figure 3** respectively.

4.1 Exploration

A total of five (5) exploration holes were drilled during 2021:

- WBD265, WBD265A, WBD266, WBD267 and WBD268 were drilled to investigate and monitor the gas reservoir at depth within the Piercefield, Broonies and Bayswater seams throughout the Main Pit mine plan.

The locations of the exploration holes are shown on **Figure 3**.

Under DA 376-8-2003 Schedule 4 Condition 7G following MOD 7 approval, a *Bulga Coal Exploration Activities and Surface Infrastructure Management Plan* was submitted to the Department of Planning Industry and Environment (DPIE) and this was approved on 14 October 2021. The plan was developed to manage Bulga Underground exploration activities that cause temporary surface disturbance or require the construction and/upgrade of minor surface infrastructure on site. No Bulga Underground prospecting exploration activities occurred in 2021, and no relevant infrastructure was constructed/upgraded in 2021.

4.2 Land Preparation

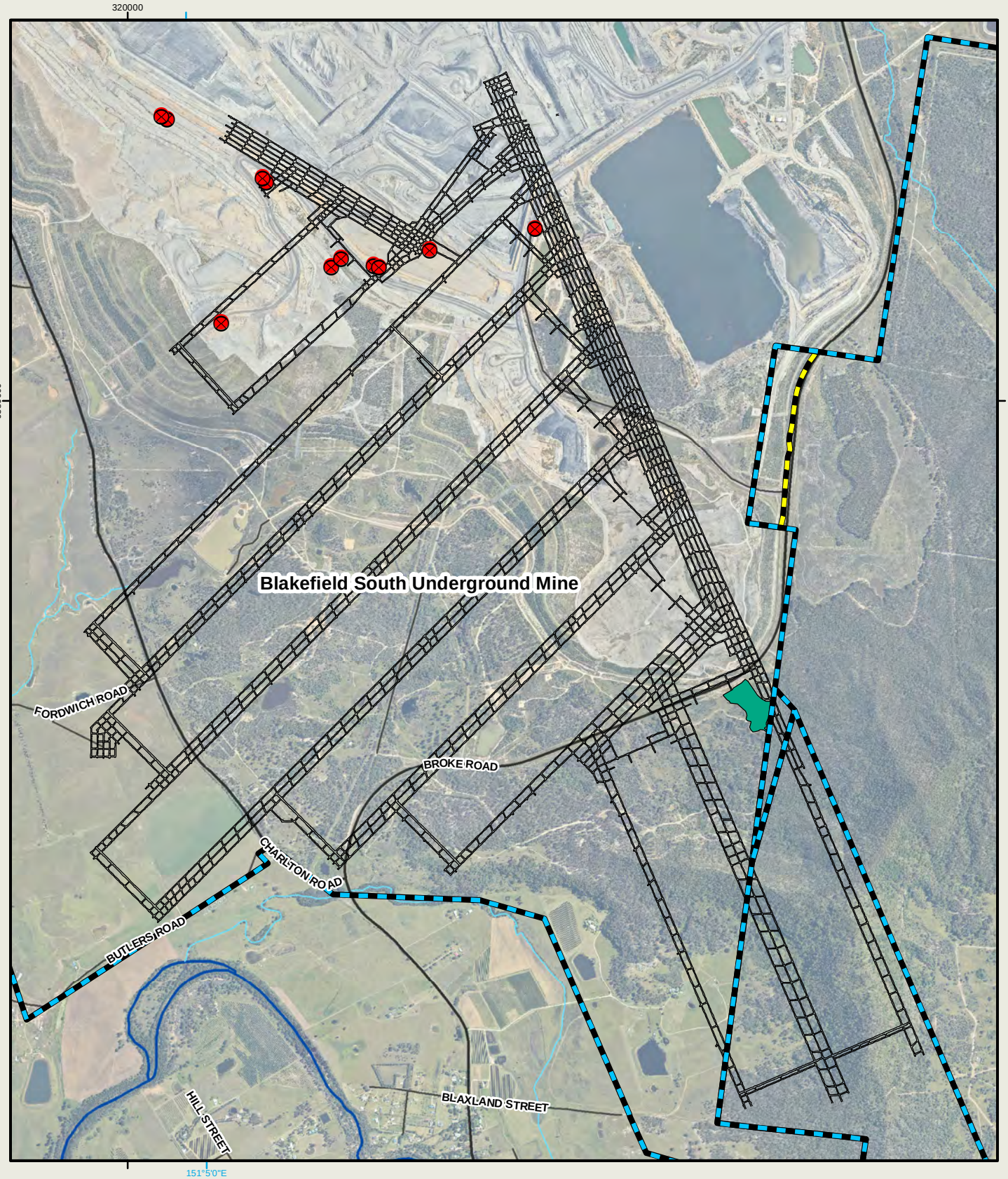
Land preparation ahead of open cut mining operations involves the construction of erosion and sediment control measures, clearing vegetation, soil stripping and stockpiling topsoil. These activities were undertaken in accordance with the *Bulga Coal Biodiversity Management Plan* (BMP) and the Bulga Open Cut and Bulga Underground Operations MOP's.

Grassland, fragmented woodland communities, and previously rehabilitated land is cleared and topsoil stripped ahead of mining. Vegetation and vegetative matter is either mulched and incorporated into topsoil or stockpiled for future use in rehabilitation. During 2021, approximately 53,900 m^3 of topsoil was stripped and 13 habitat trees were salvaged by Bulga Coal.

During 2021, 11.4 ha of disturbance was undertaken to allow mining, overburden dumping and construction activities (roads, drains, dams) to commence. There was also 42.5 ha of existing rehabilitation cleared to facilitate infrastructure construction and the southerly extension of mining operations. An additional 13.3 ha of vegetation was cleared to allow the construction of overhead powerlines, however this did not involve disturbance of groundcover or soil.

Clearing and disturbance areas are shown on **Figure 3**.

FIGURE 2 - BULGA UNDERGROUND SUMMARY OF OPERATIONS 2021



Mining Lease
Mining Lease AMA
Blakefield South Mine Workings
Wollombi Brook
Minor Watercourse
2021 Decomissioned Boreholes
2021 Bulga Underground Rehabilitation

0 0.2 0.4 0.8
Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:28,308 @ A4

N

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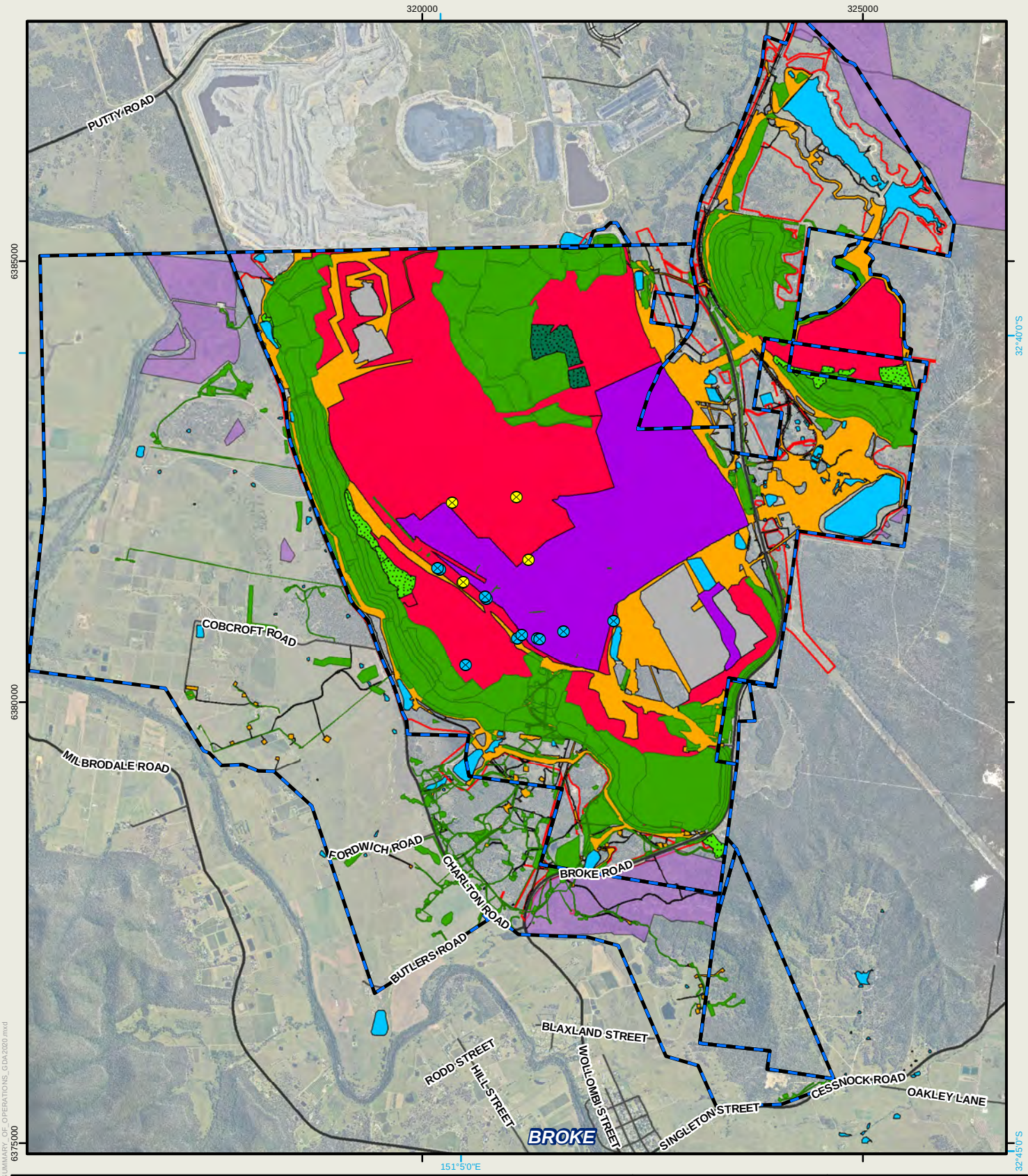
FIGURE 3 - BULGA OPEN CUT SUMMARY OF OPERATIONS 2021



- Railway
- Major road
- Minor road
- Current_Authorisations
- Approved Disturbance Boundary
- Offset & Management Areas
- 2021 Exploration
- 2021 Decomissioned Boreholes

2021 Rehabilitation & Disturbance

- Existing Rehabilitation
- 2021 Rehabilitation
- 2021 Temporary Rehabilitation
- 2021 Disturbance

2021 Primary Domains

- Active Mining Area (Open cut void)
- Infrastructure Area
- Overburden Emplacement Area
- Tailings Storage Facility
- Water Management Areas

0 0.5 1 2
Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:59,682 @ A4

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4.3 Mining Operations

Bulga Underground Operations

Bulga Underground Operations comprises the sealed Blakefield South Mine, along with the approved, but not commenced, Blakefield North Mine.

Mining of Blakefield South Longwall 1B was completed on 3 May 2018, following which underground mining at Bulga Underground Operations ceased and the Blakefield South mine was sealed. The Blakefield North Mine has been postponed; however, the associated pre-drainage wellfield continues to be operated to supply the gas fired power station. The Blakefield South Pit Top facilities have been demolished to allow the progression of open cut mining.

Bulga Underground Operations finished producing coal in May 2018. Therefore, no ROM coal, saleable coal or reject material was produced by Bulga Underground during the reporting period.

Bulga Open Cut

Bulga Open Cut continued mining coal reserves from the East Pit, Main Pit, Woodlands Hill Pit and Whybrow Wedge in 2021. In the Woodlands Hill Pit, mining progressed in a westerly direction. In the East Pit, Main Pit and Whybrow Wedge, mining progressed in a southerly direction.

Bulga Open Cut placed overburden on the inside of the Noise and Visual Bund, Eastern Emplacement Area, Southern Extension Dump and undertook in-pit dumping in the Main Pit and East Pit. Overburden was stripped and coal mined using a fleet of excavators and trucks.

ROM coal was transported by dump truck via an overpass on Broke Road to the ROM coal hopper or stockpile at the CHPP.

One hydraulic shovel (Cat 6040), three haulage trucks (Cat 793D XQ), five tracked dozers (Cat D10T2), one grader (Cat 18) and three fuel trucks (1 x Cat 775G and 2 x Cat 773E) were acquired in 2021. Four tracked dozers (Cat D11R) and one fuel truck (Cat 777E) were removed from the fleet. The total mining fleet as at 31 December 2021 is listed in **Table 8**.

Table 8 Equipment Fleet

Type	Model	Units
Shovels – Electric	P&H4100	1
Shovels – Hydraulic	Hitachi EX8000	1
	Hitachi EX5600	1
	Hitachi EX5500	2
	Hitachi EX3600	1
	Liebherr EX9400	1
	Liebherr EX9250	1
	Liebherr EX9100	2
	Cat 6040	1
Haulage Trucks	Cat 793C XQ	6
	Cat 793D XQ	33
	Cat 789C XQ	9
	Cat 797F XQ	7
	Cat 789C XQ Water Trucks	4
	Cat 777F Hire Water Cart	1 (Hire)
Front End Loaders	LeTourneau L1850	2
	Hitachi ZW370-5	1
	Cat 980M Wheel Loader (Hire)	1 (Hire)
Dozers (tracked)	Cat D11T	5
	Cat D11R	5
	Cat D10T	4
	Cat D10T2	5
	Cat 854K	2
Graders	Cat 24H	1
	Cat 24M	2
	Cat 16H	1
	Cat 16M	1
	Cat 18	1 (Hire)
Fuel Trucks	Cat 773E	2
	Cat 775G	1
Drills	Sandvik D75K	1
	Terex SKS-W	2
	Terex SKF	2

A summary of coal production and waste material (overburden and reject) production for the Bulga Open Cut is provided in **Table 9**.

Table 9 Production and Waste Summary for the Bulga Open Cut

Aspect	Approved Limit SSD - 4960	2020 Reporting Period (Actual)	2021 Reporting Period (Actual)	2021 MOP Predictions	2022 Reporting Period (Forecast)
Waste Rock/ Overburden (bcm)	N/A	59,043,661	62,363,867	63,497,000	58,164,000
ROM Coal (t)	12,200,000	10,064,175	10,986,664	11,388,000	10,349,000
Coarse reject (t)	N/A	2,943,359	3,250,276	4,465,000	3,464,000
Fine Reject (tailings) (t)	N/A	887,033	845,700		
Saleable Product (t)	N/A	6,850,008	7,064,198	7,241,000	7,115,000

1- Total waste volume. The Bulga Open Cut MOP does not split the volumes of fine and coarse reject produced per year.

4.4 Other Operations

4.4.1 Coal Handling and Preparation Plant

10.98 million tonnes (Mt) of Run of Mine (ROM) coal was washed, producing 7.06 Mt of saleable product coal. The CHPP has approval to wash up to 20 Mt of ROM coal per year. 6.87 Mt of coal was railed to the Port of Newcastle.

4.4.2 Tailings Management

Deposition of tailings to the Northern Tailings Storage Facility (NTSF) Cell B continued for the duration of 2021. A portion of tailings were pumped to assist with the sealing of the Beltana Mine underground workings during August to October 2021. This work is being undertaken in preparation for open cut mining through this area.

4.4.3 Construction

Bulga Coal construction works included:

- The Minimbah Teaching Place was built in the Wollombi Brook Conservation Agreement Area (**Section 6.9.2.4**);
- A new CHPP communications building was constructed;
- The maintenance workshop slab bays 2-6 were upgraded;
- The road intersection at the dam S2A entrance was widened and upgraded;
- The access road to the CHPP was upgraded;
- The ROM B dam embankment was raised;
- Dam S6A was enlarged;

- 66 kV powerlines and transformers were relocated;
- 11 kV powerlines were installed, along with new pump stations, a flocculant plant and water supply pipelines from the Deep Pit to the Northern Tailings Storage Facility (NTSF), for the tailings relocation;
- The South Bulga Underground portals were sealed;
- Seven Bulga Underground gas monitoring boreholes were commissioned; and
- An Inert Gas Generator (IGG) overland pipeline was constructed.

The CHPP was upgraded to improve coal throughput and recovery, and to reduce water usage. The upgrades included:

- Replacement of SN3023 desliming screen;
- Replacement of CV8027 conveyor gantry section part B;
- Replacement and commissioning of the common services board;
- Replacement of the dart valve box including the construction of an additional dart valve box to assist with fines loading and dewatering; and
- Commissioning of University of Newcastle reflux flotation classifier.

4.4.4 Demolition

Bulga Coal demolition works included:

- The Bulk Fuel Farm was demolished; and
- Demolition of the dragline commenced in November 2021.

Following the cessation of underground mining, Bulga Underground Operations infrastructure has continued to be demolished/decommissioned including:

- Clean-up of the equipment laydown areas adjacent to the workshop and flares;
- Sealing and decommissioning one gas well (BLK8E) located on Commonwealth Land;
- Decommissioning of 2 gas monitoring boreholes; and

Installation of grout plugs at the South Bulga Underground MG3A, MG3B and Stage 2. Grout plugs were also installed at Blakefield South.

Several unused temporary relocatable office buildings at the CHPP were also removed from site.

Demolition works were carried out by a licensed demolition contractor in accordance with *Australian Standard AS 2601-2001.*

4.4.5 Waste Management

Waste management is undertaken in accordance with the *Bulga Complex Waste Management Plan* and EPL 563. Waste is removed by a licenced contractor and, where possible, is recycled. Waste removed from site includes batteries, light vehicle tyres, scrap metal, domestic waste, fuel and oil filters, solvent, radiator coolant, wooden pallets, oily rags and hydrocarbon contaminated material from maintenance workshops.

Bulga Coal produced 4,298t of waste during 2021, 83 % of the waste produced by Bulga Coal (3,567 t) was recycled. 797 t of scrap steel was recycled at Bulga Coal during the reporting period. Bulga generated 58 t of Hazardous Waste which included oily rags/ absorbents, contaminated soil and medical/ sanitary waste. Bulga produced 676 t of Non-Hazardous Waste which included mixed solid waste and treated timber. Waste disposed to landfill was 735 t.

184T of recycled gypsum plasterboard was received at the premises for use in rehabilitation.

Waste oil and grease removed from equipment is stored in bunded tanks. Wastewater generated from the workshop areas is treated through hydrocyclone oily water separators. Waste oil, grease and oily water from oil water separators are then removed by an authorised waste contractor for recycling.

The treatment and disposal of sewage at Bulga Open Cut is through an extended aeration sewage treatment plant. Effluent from this plant goes to two maturation ponds before it is returned to the CHPP circuit water. Sewage from the East Pit Muster is treated by an extended aeration sewage treatment plant. Effluent is also treated with ultra-violet (UV) light. Treated water is transferred to a mine water dam for reuse. Deactivated sludge is transported to the Singleton Council Treatment Works Depot.

4.4.5.1 Comparison against Predictions

The *Bulga Optimisation Project – Environmental Impact Statement* (Umwelt, 2013) predicted waste to be generally consistent with the current operations at the time. Operations in 2012 disposed of 507 tonnes of waste to landfill, 1,978 tonnes of waste (or approximately 80 per cent of waste generated by the Bulga Surface Operations) was recycled or reused.

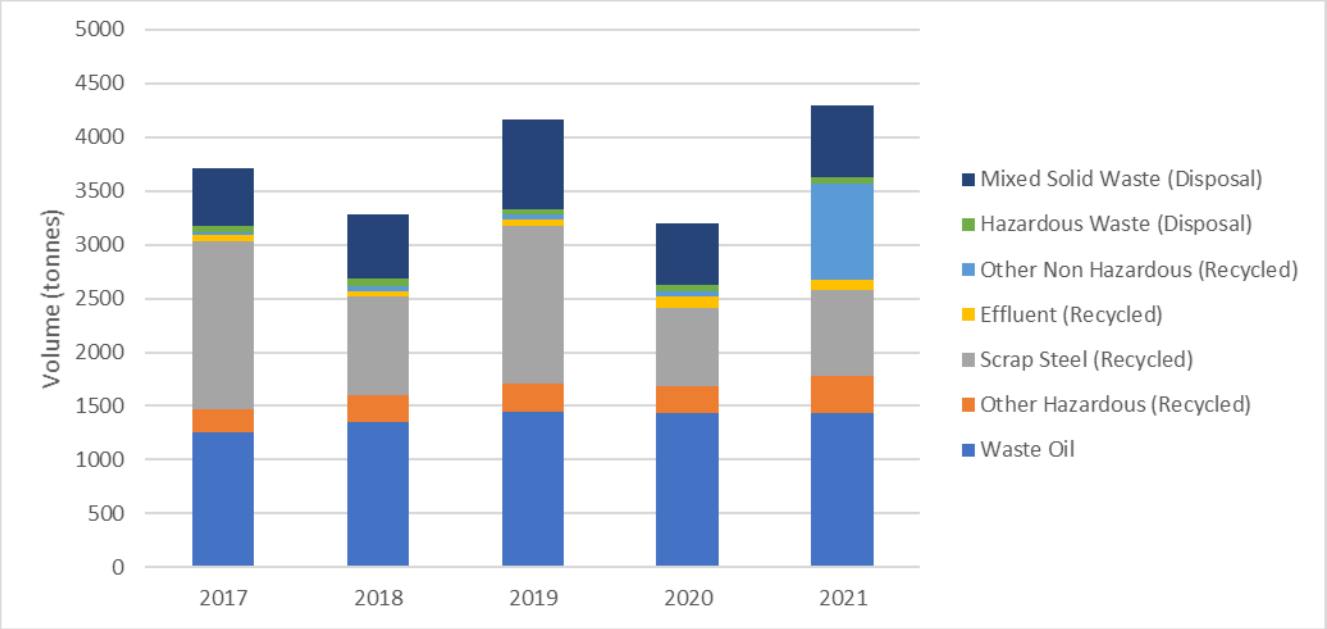
Waste disposed to landfill was 735 t during 2021 which was above the 507 tonnes outlined/predicted. Bulga Coal recycled 3,567 tonnes of waste (83 percent of all waste produced at Bulga Coal).

While the total volume of recycled waste was higher than the predictions, the percentage of waste recycled exceeded predictions. Increased waste volumes are associated with continued decommissioning activities including the Bulk Fuel Farm demolition (188 t of concrete disposal), removal of several unused temporary relocatable office buildings at the CHPP, dragline demolition and mining progression through a storage area (recycling of 642 t of timber power poles).

4.4.5.2 Long Term Analysis

A summary of waste disposal from 2017 to 2021 is presented in **Figure 4**. The figure shows waste volumes fluctuated, particularly the volumes of recycled waste. The changes in volumes and recycled material reflect the staged decommissioning of the Blakefield South Mine and the southerly progression of open cut mining.

Figure 4 2017-2021 Waste Streams Generated



4.4.6 Hazardous Materials Management

Hazardous and dangerous goods are stored and labelled according to the relevant Australian Standard.

Hazardous materials stored at Bulga Open Cut have been notified to WorkCover NSW. Notification of Hazardous Chemicals on Premises (Acknowledgement NDG018992) has been issued by WorkCover NSW.

Hazardous waste stored at Bulga Open Cut is tracked and transported by a licenced waste transporter and disposed of at a licenced facility.

Explosives are stored in a licenced explosive magazine according to WorkCover NSW requirements. Bulga Coal hold Licence No. XSTR100095 for the storage of explosives at Bulga Open Cut.

4.5 Next Reporting Period

4.5.1 Bulga Underground Operations

Activities proposed in 2022 are generally consistent with DA 376-8-2003 and the approved Bulga Underground Operations MOP. Underground mining, activities will include continued operation of the Blakefield South goaf drainage system, Blakefield North pre drainage system and 9 MW gas fired power station, decommissioning and demolition of Bulga Underground Operations surface infrastructure and rehabilitation of redundant gas drainage infrastructure, access tracks and pipelines.

4.5.2 Bulga Open Cut

Activities proposed in 2022 are generally consistent with SSD-4960 and the approved Bulga Open Cut MOP. **Figure 5** illustrates the proposed operations.

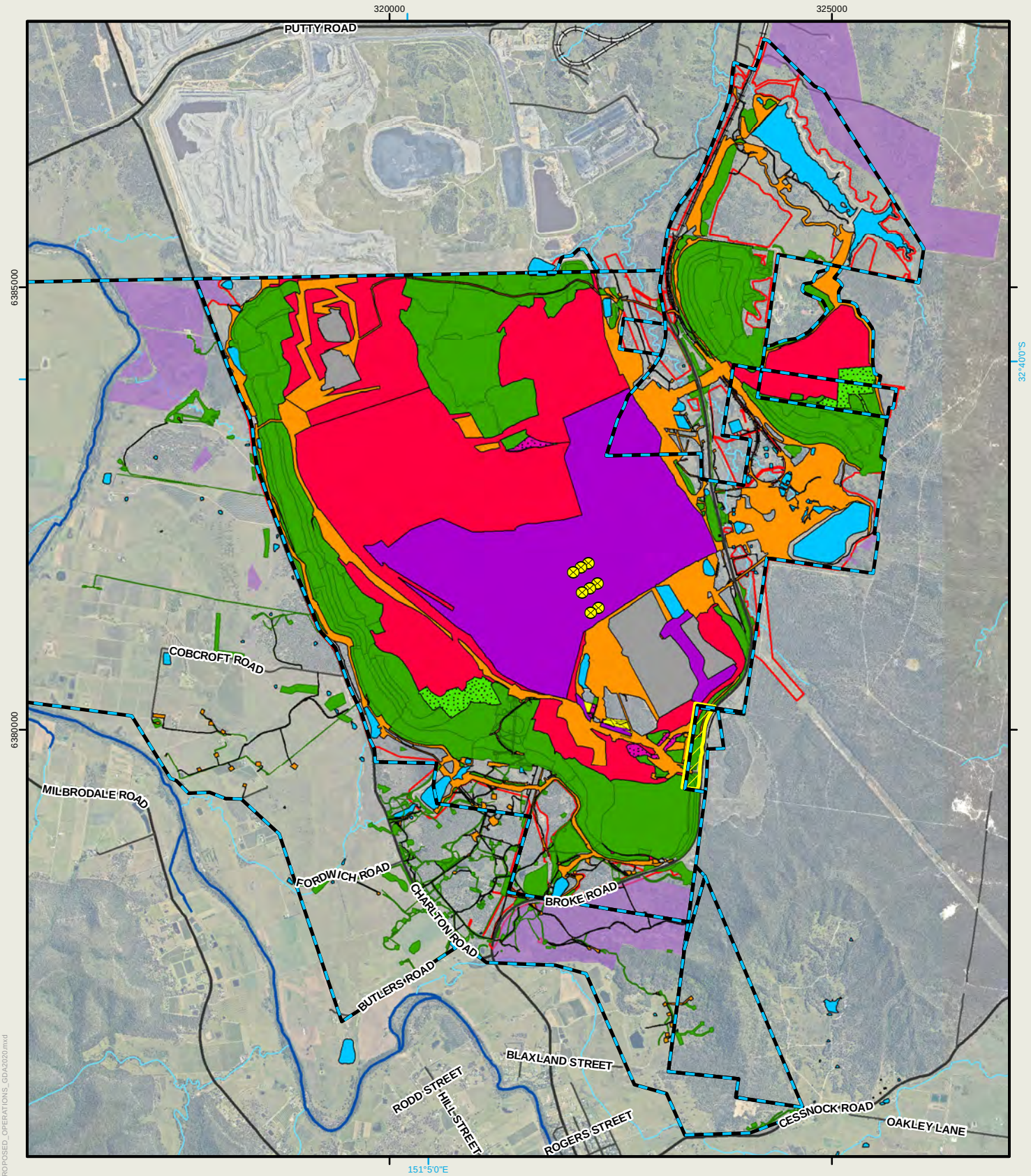
Mining operations will continue in the Main Pit, East Pit, Whybrow Wedge and Woodlands Hill Pit. Bulga Open Cut will continue to place overburden on the inside of the Noise and Visual Bund, Eastern Emplacement Area, Southern Extension Dump and in-pit dumping in the Main Pit and East Pit.

Construction activities will include:

- Finishing the demolition of the dragline;
- Drilling eight (8) boreholes. The exploration drilling will aim to further define the true seam dip at the inflection point of the Mt Thorley Monocline throughout the Main Pit mine plan; and
- Completion and commissioning of tailings relocation infrastructure, decant systems and the enlarged S6A Dam.

Dredging (relocation) of tailings from Deep Pit and Bayswater Pit to the in-pit NTSF will commence. This will enable mining of the underlying coal.

FIGURE 5 - BULGA OPEN CUT PROPOSED OPERATIONS 2022



- Mining Lease
- Mining Lease AMA
- Approved Disturbance Boundary
- Major road
- Minor road
- Track
- Haul road
- Mine light vehicle access
- Railway
- Wollombi Brook
- Minor Watercourse
- Offset & Management Areas
- Existing Rehabilitation

2022 Rehabilitation & Disturbance

- 2022 Disturbance
- 2022 Rehabilitation
- 2022 Rehabilitation Re-disturbance

2022 Primary Domains

- Infrastructure Area
- Overburden Emplacement Area
- Tailings Storage Facility
- Active Mining Area (Open cut void)
- Water Management Area
- 2022 Exploration

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Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:59,727 @ A4

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5 Actions Required from Previous Annual Review

The 2020 Annual Review was provided to DPIE and RR on 29 March 2021. DPIE considered the Annual Review to generally met the requirements of the approval in relation to reporting and the *Annual Review Guideline* (DPIE, 2015). No additional actions were required from the 2020 Annual Review, however the DPIE requested additional information be included in the 2021 Annual Review. Please refer to **Table 10** for the details.

Table10 DPIE 2020 Annual Review Information Requested

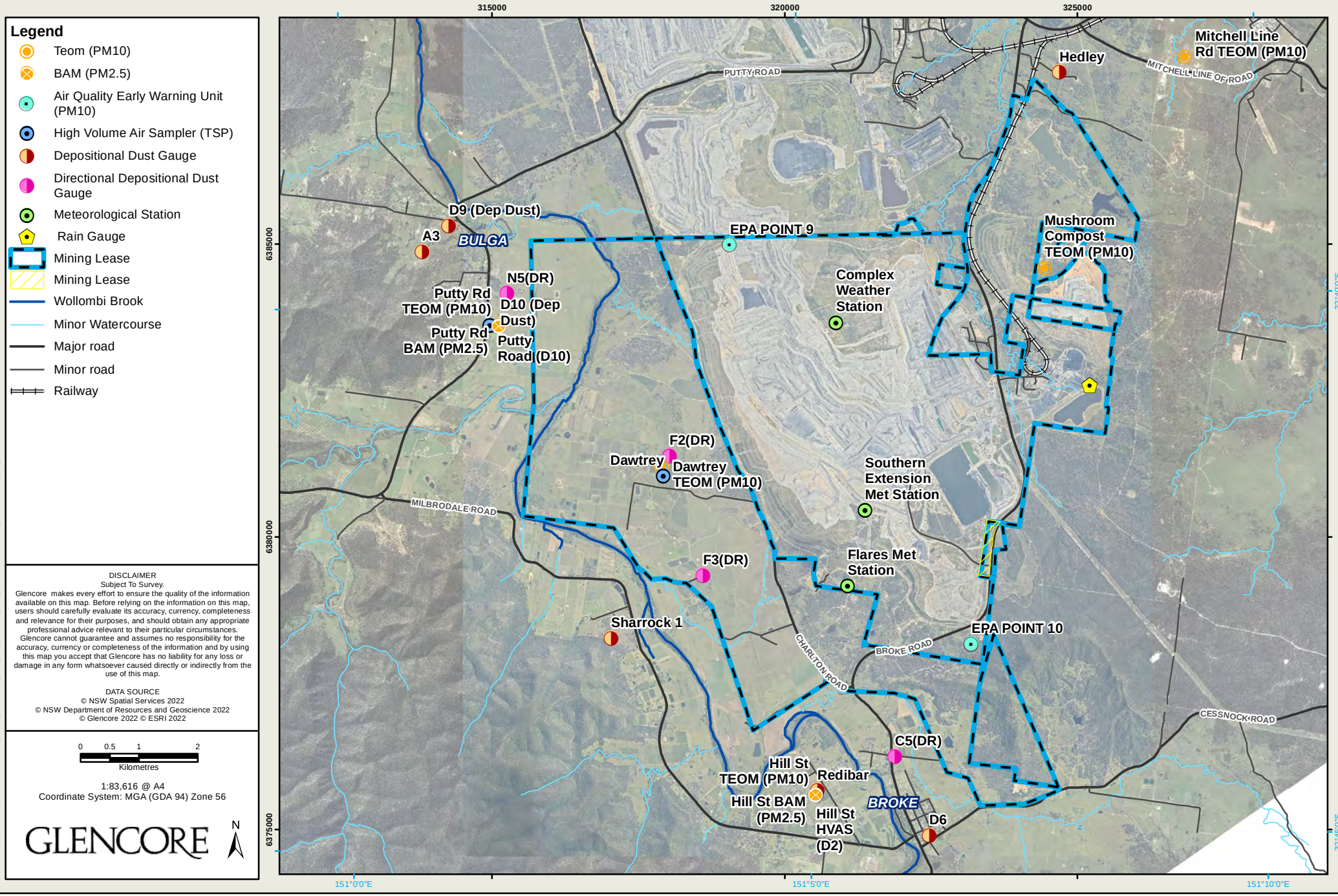
Information Requested from DPIE	Section Addressed
Schedule 5, Condition 4(b) of the Approval requires the Annual Review to include a comprehensive review of the monitoring results and complaint records. The Annual Review must include the following additional matters:	
a. a comprehensive review of surface water and groundwater monitoring including the following in accordance with the Water Management Plan (WMP):	**Section 7** and 2021 Annual Groundwater Monitoring Report (**Appendix D**)
i. Report water quality and groundwater monitoring against trigger levels from the WMP, including reporting for all groundwater stratigraphic units and not just the Alluvium.	**Sections 7.2** and **7.4**
ii. Report bi-annual groundwater water quality characterisation sampling as described in the WMP.	**Appendix B** of the 2021 Annual Groundwater Monitoring Report (**Appendix D**)
iii. Provide further detail as to why the monitoring at sites LC1 and LC2 has not been reported for the reporting period.	Refer to Section 7.4.1 Environmental Management in the 2020 Annual Review and Section 3.1.3 Loder Creek Alluvium in the 2020 Annual Groundwater Monitoring Report (Appendix C of 2020 Annual Review) for further details. LC1 was reported as being dry. LC2 data was reported in Table 35 of the 2020 Annual Review (refer to **Table 43** for 2021 results).
b. performance against the assessment criteria within the Conservation Management Plans and address all reporting requirements from the Annual Review sections of the Conservation Management Plans, including reporting results of Habitat Quality Assessments for offset areas.	**Section 6.7** and **Appendix C**
c. report on waste received at the premises in accordance with Condition L4 of the Environmental Protection Licence (EPL).	**Section 4.4.5**
d. a summary of the meteorological monitoring completed in accordance with Schedule 3, Condition 23 of SSD-4 and EPL Condition M4.	**Section 6.1**

Information Requested from DPIE	Section Addressed
2. Schedule 5, Condition 4(d) of the Approval requires the Annual Review to identify any trends in the monitoring data over the life of the project. The Annual Review must include monitoring trends for the following additional aspects:	
a. a summary of long-term groundwater monitoring for all stratigraphic units, not just alluvium (Section 7.4.4)	Appendix A and Section 6 of the 2021 Annual Groundwater Monitoring Report (**Appendix D**)
b. waste trends (Section 4.2.5)	**Section 4.4.5.2**
3. Schedule 5, Condition 4(e) of the Approval requires the Annual Review to identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies. The Annual Review must provide a comparison to predictions for the following additional aspects:	
a. Groundwater level and quality sampling (Section 7.4.3)	Appendix A and B and Section 6 of the 2021 Annual Groundwater Monitoring Report (**Appendix D**)
b. Waste (Section 4.2.5)	**Section 4.4.5.1**

6 Environmental Management Performance

Bulga Coal implements a comprehensive *Environmental Management Strategy* (EMS) (which was revised in 2020 and approved by DPIE in July 2021) that provides a framework for managing environmental and community aspects, and impacts of mining operations. It includes management plans, procedures and standards to minimise the risks of impact to the environment and continually improve the environmental management performance of operations. An extensive environmental monitoring network is in place to monitor the environmental management performance of the site. The environmental monitoring network is shown in **Figure 6**, **Figure 7** and **Figure 8**.

FIGURE 6 - BULGA COAL AIR AND METEOROLOGICAL MONITORING



Legend

- Teom (PM10)
- BAM (PM2.5)
- Air Quality Early Warning Unit (PM10)
- High Volume Air Sampler (TSP)
- Depositional Dust Gauge
- Directional Depositional Dust Gauge
- Meteorological Station
- Rain Gauge
- Mining Lease
- Mining Lease
- Wollombi Brook
- Minor Watercourse
- Major road
- Minor road
- Railway

DATA SOURCE

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Kilometres

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FIGURE 7 - BULGA COAL NOISE AND BLAST MONITORING

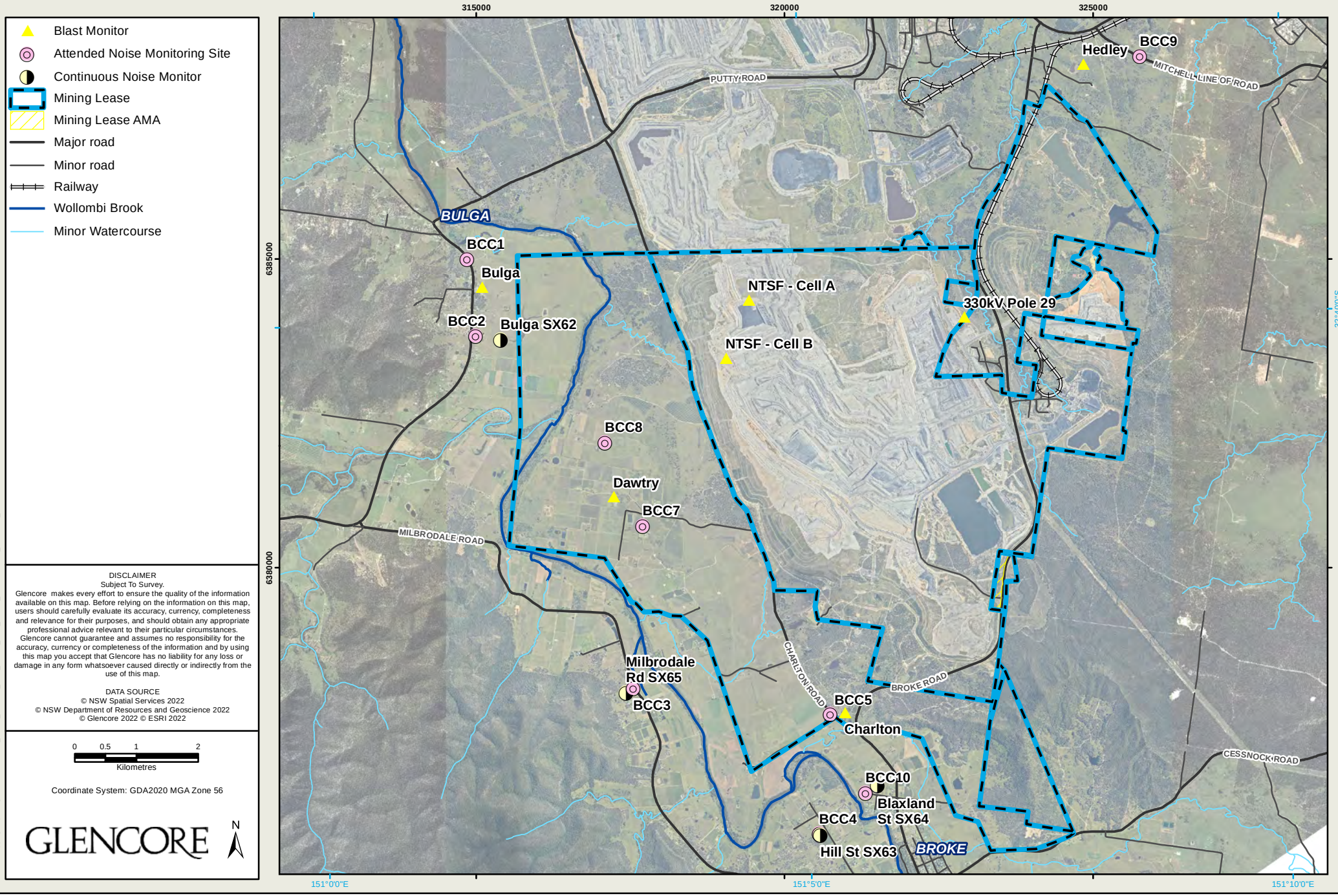
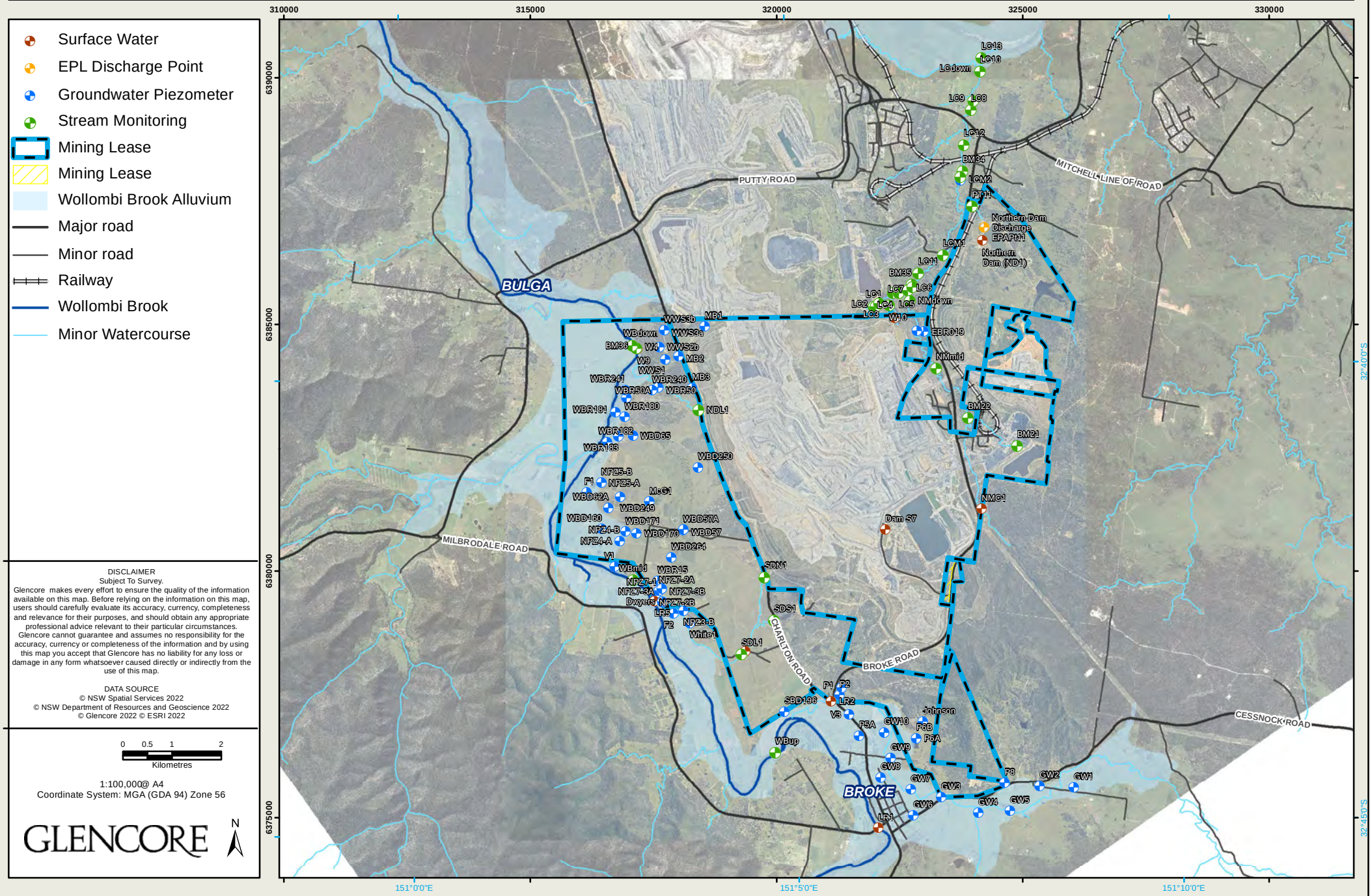


FIGURE 8 - BULGA COAL WATER MONITORING



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6.1 Meteorology

Bulga Coal has three meteorological monitoring sites as shown in **Figure 6**. Meteorological data from the Bulga Complex Meteorological Station is reported in the quarterly environmental monitoring reports available on the Bulga Coal website (https://www.glencore.com.au/operations-and-projects/coal/current-operations/bulga-coal).

In accordance with Schedule 3, Condition 23 of SSD 3960, and Condition M4 of EPL 563, Bulga continued to operate the Bulga Complex Weather Station, Southern Extension Weather Station and the Flares Weather Station.

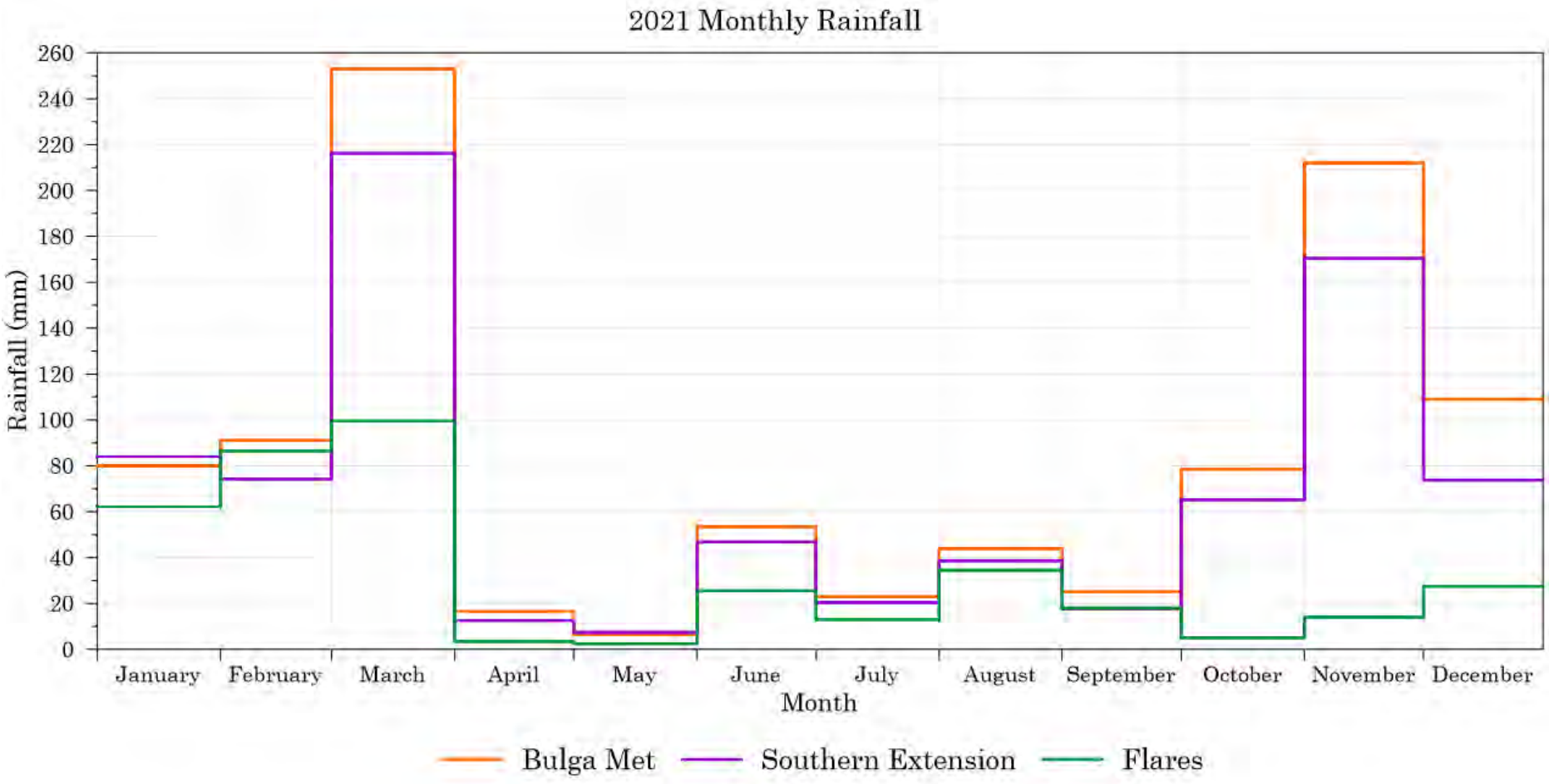
2021 was a wet year with total annual rainfall at Bulga Complex Weather Station being 994.5mm which was slightly higher than the 886.0 mm recorded in 2020.

A summary of the annual meteorological monitoring is shown in **Tables 11** to **17** and **Figures 9** to **13**.

Table 11 Distribution of Average Monthly Rainfall at Representative Monitoring Stations

Statistic	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total
Bulga Complex Weather Station													
Total	80.0	91.0	253.0	16.5	6.5	53.5	23.0	44.0	25.0	78.5	212.0	109.0	992
Southern Extension Weather Station													
Total	84	74.2	216.2	12.6	7.4	46.8	20.4	38.6	17.8	65.2	170.4	73.8	827.4
Flares Weather Station													
Total	62	86.5	99.5	3.5	2.5	25.5	13	34.5	18	5	14	27.5	391.5

Figure 9 Distribution of Average Monthly Rainfall at Representative Monitoring Stations



As shown in **Table 12** and **Table 13**, the daily minimum and maximum surface level temperatures ranged across Bulga's three monitoring stations at 2 metres and 10 metres above surface level from -12.2°C to 38.0°C respectively. Refer to **Table 14** for humidity recorded over the reporting period.

Table 12 2021 Temperature 2m (Degrees Celsius) at Representative Monitoring Stations

Temperature 2m (degrees celsius)	Bulga Complex			Southern Extension			Flares		
Month	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
January	23.3	13.5	38.7	22.9	12.9	38.2	22.2	6.5	37.9
February	22.3	14.6	34.6	21.7	14.8	33.6	21.5	8.0	33.6
March	20.7	13.1	33.9	20.3	12.6	33.4	20.0	11.1	33.5
April	17.2	6.2	29.6	16.8	5.2	27.7	15.5	2.4	27.9
May	14.7	4.1	27.2	14.4	2.3	24.9	12.9	-0.3	25.0
June	11.6	2.8	23.1	11.4	2.5	21.6	10.1	-0.9	22.0
July	11.4	0.4	23.8	11.2	0.7	23.7	9.8	-2.6	23.6
August	13.4	3.2	24.5	13.2	2.8	26.5	11.5	-0.9	26.7
September	16.7	6.1	30.7	15.7	4.7	30.1	14.5	0.7	30.2
October	18.0	6.8	34.0	18.1	7.4	33.1	17.4	3.7	33.1
November	19.2	8.3	32.2	18.8	10.2	29.4	18.7	6.8	29.1
December	22.2	13.0	37.4	21.9	13.4	38.6	21.5	11.5	37.2

Table 13 2021 Temperature 10m/30m (Degrees Celsius) at Representative Monitoring Stations

Temperature 10m/30m (degrees celsius)	Bulga Complex			Southern Extension			Flares		
Month	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
January	23.4	15.2	38.1	22.6	14.8	36.2	22.3	8.1	37.3
February	22.3	15.9	33.6	21.4	15.5	31.2	21.5	9.2	32.4
March	20.8	14.1	33.7	20.1	13.5	32.2	20.2	11.5	33.0
April	17.6	7.3	28.9	17.1	7.2	27.4	15.8	3.2	27.6
May	15.2	5.3	26.1	14.8	4.5	23.9	13.4	0.4	24.6
June	12.1	4.1	22.5	11.8	4.0	20.8	10.6	-0.4	21.6

Temperature 10m/30m (degrees celsius)	Bulga Complex			Southern Extension			Flares		
Month	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
July	11.9	1.8	23.3	11.7	2.3	22.4	10.3	-1.8	23.3
August	13.9	4.9	24.0	13.6	5.1	25.5	12.1	-0.6	26.3
September	17.1	6.9	30.4	15.8	6.0	28.9	14.8	1.6	29.9
October	18.2	7.8	33.9	18.0	9.1	31.8	17.6	4.4	32.5
November	19.2	8.7	30.4	18.4	10.6	28.5	18.7	7.7	28.9
December	22.2	13.9	36.8	21.3	13.8	36.5	21.5	12.6	36.9

Note: Temperature at Bulga Complex and Flares stations is at 10 m. Temperature at 30 m is recorded at Southern Extension.

Figure 10 2021 Monthly Temperature 2m (Degrees Celsius) at Representative Monitoring Stations

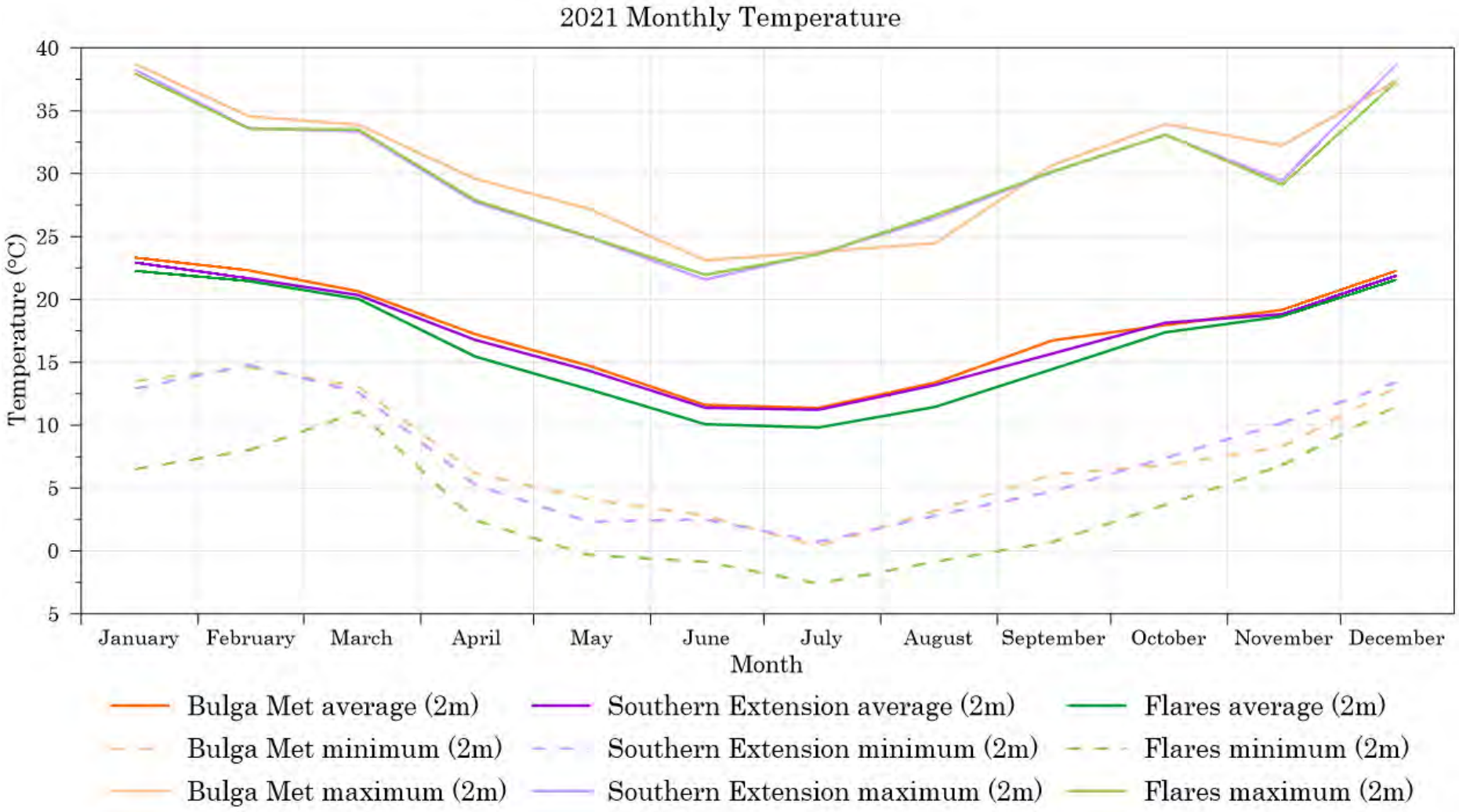


Figure 11 2021 Monthly Temperature 10m/30m (Degrees Celsius) at Representative Monitoring Stations

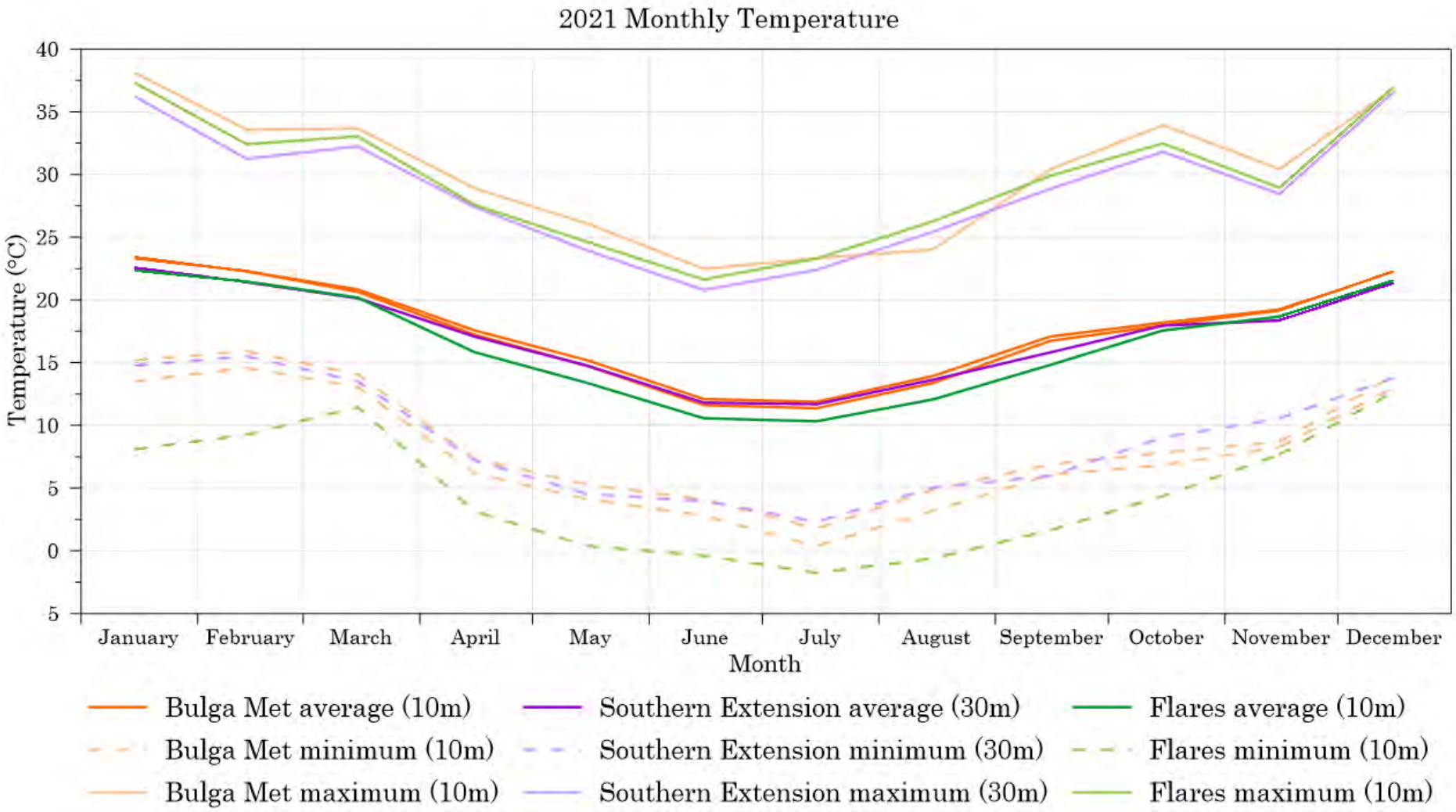


Table 14 2021 Relative Humidity (%) at Representative Monitoring Stations

Relative humidity (%)	Bulga Complex			Southern Extension			Flares		
Month	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
January	68.4	14.1	99.0	63.3	13.2	101.0	67.6	12.9	95.4
February	76.3	35.2	98.7	75.5	33.8	100.4	72.4	32.3	95.2
March	76.0	29.6	99.0	74.7	25.2	99.5	73.9	29.3	95.4
April	68.6	23.5	99.6	69.3	22.5	99.5	71.7	22.0	96.0
May	72.0	27.5	99.2	72.7	27.2	99.2	74.5	23.7	95.7
June	75.2	31.8	99.0	75.8	30.5	99.7	76.1	30.7	95.5
July	69.3	21.2	99.2	70.2	18.8	99.1	71.4	18.2	96.5
August	62.6	11.5	98.0	63.2	18.8	98.2	66.9	17.4	95.1
September	58.7	10.8	99.0	60.6	9.5	98.7	62.2	9.1	99.6
October	61.3	18.3	98.6	59.8	14.8	100.8	63.6	15.3	98.2
November	74.5	28.1	99.1	72.9	24.4	101.2	71.4	24.5	97.1
December	71.9	26.7	98.4	74.0	20.6	102.7	68.8	22.7	95.6

Figure 12 2021 Relative Humidity (%) at Representative Monitoring Stations

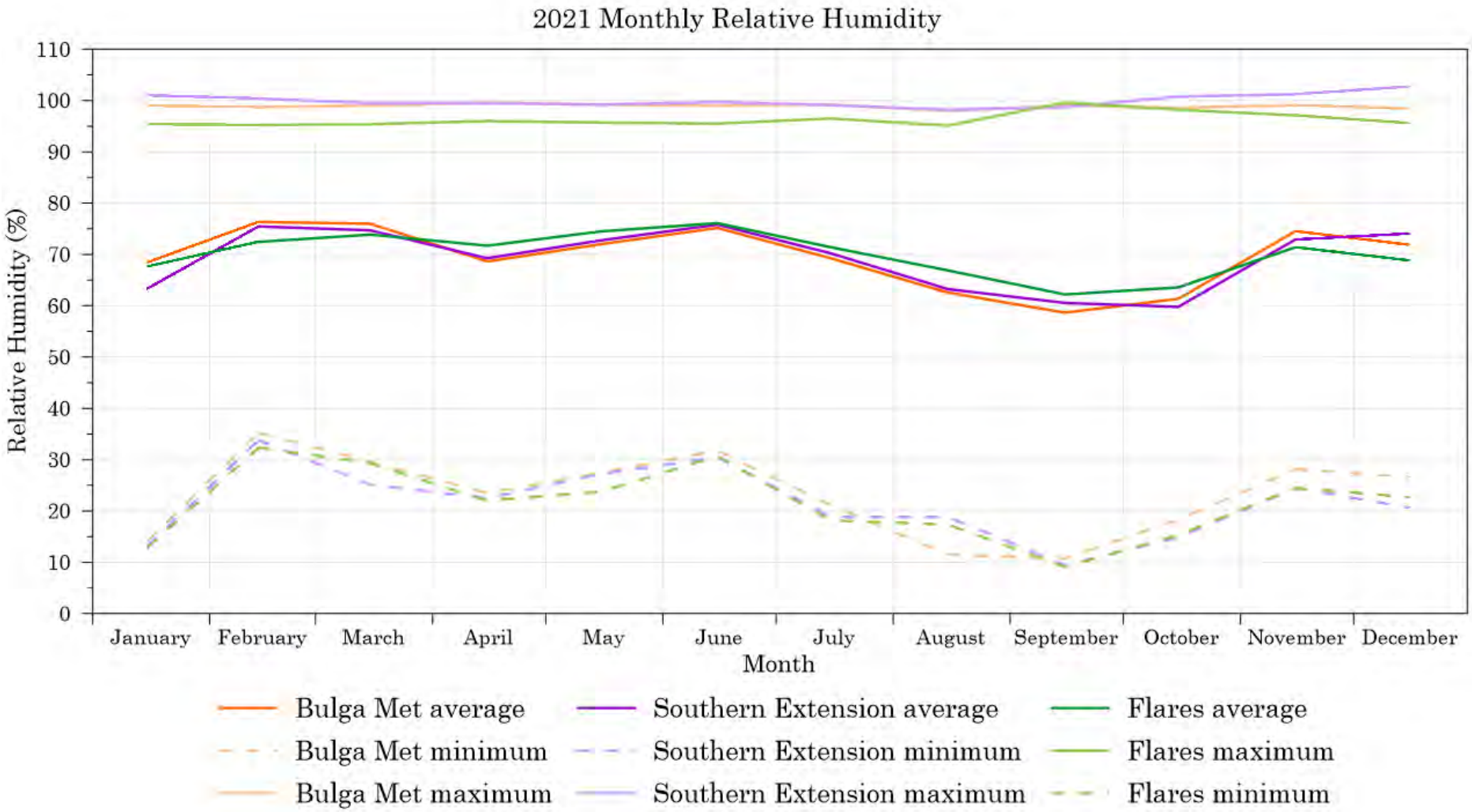


Table 15 2021 Wind speed at Representative Monitoring Stations

Wind speed (m/s)	Bulga Complex			Southern Extension			Flares		
Month	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
January	3.0	0.0	10.4	4.1	0.0	14.6	1.6	0.0	7.8
February	2.9	0.0	9.6	4.1	0.3	12.0	1.6	0.0	7.5
March	2.8	0.0	8.0	4.2	0.2	12.0	1.6	0.0	6.5
April	2.3	0.0	9.1	3.4	0.3	11.3	1.1	0.0	6.9
May	2.4	0.0	9.9	3.4	0.2	15.3	1.0	0.0	6.3
June	2.9	0.0	9.4	4.0	0.2	12.7	1.5	0.0	9.5
July	3.1	0.0	10.6	4.1	0.0	14.9	1.7	0.0	8.9
August	2.8	0.0	8.9	3.7	0.2	14.6	1.4	0.0	7.1
September	3.1	0.1	11.7	4.0	0.3	15.5	1.6	0.0	9.1
October	3.1	0.0	11.1	4.4	0.2	15.2	1.8	0.0	9.1
November	3.1	0.0	10.4	4.4	0.2	15.5	1.8	0.0	9.8
December	2.8	0.1	10.7	4.2	0.3	15.1	1.7	0.0	7.8

Figure 13 2021 Wind speed at Representative Monitoring Stations

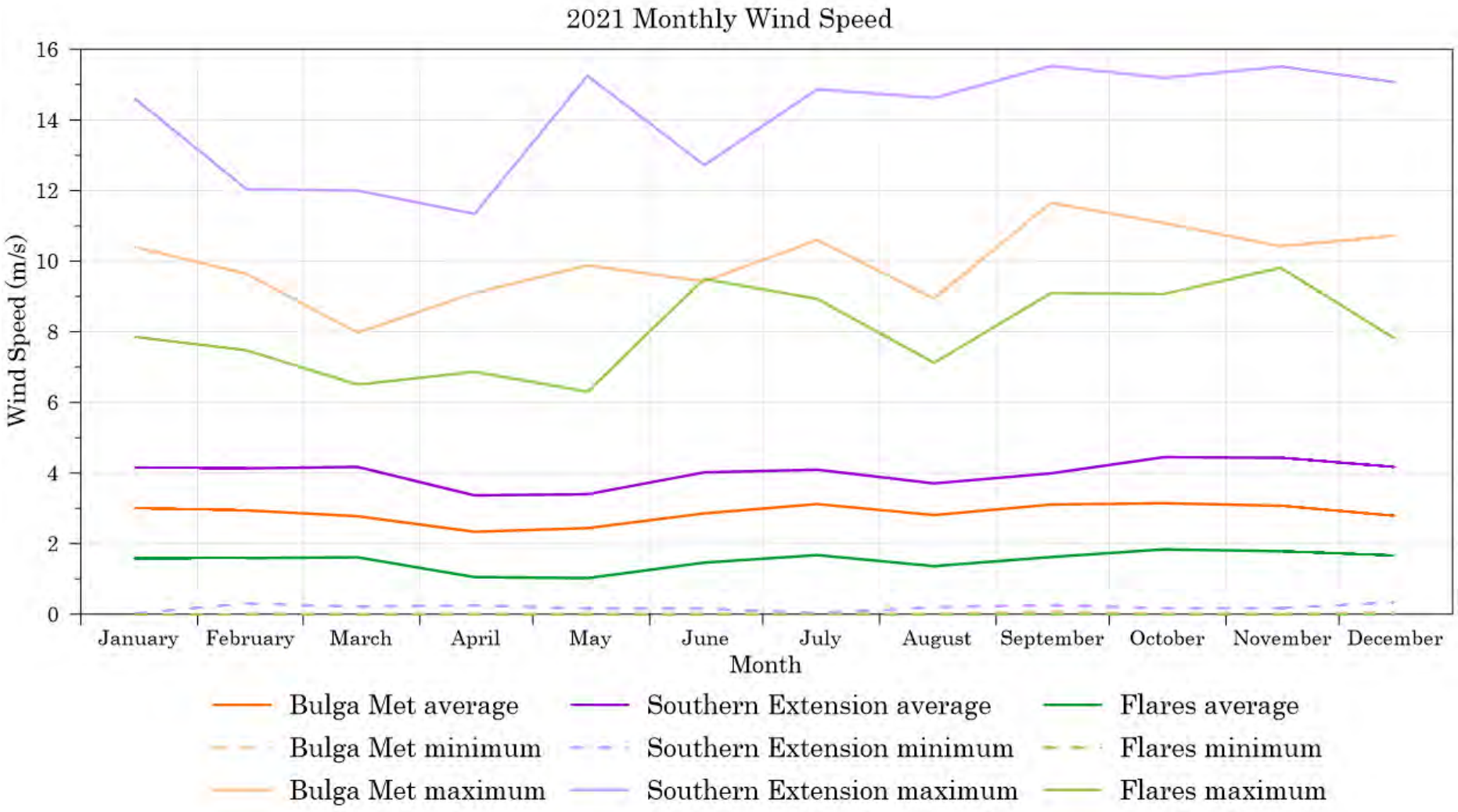


Table 16 2021 Wind direction at Representative Monitoring Stations

Wind direction (degrees)	Bulga Complex			Southern Extension			Flares		
Month	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
January	174.9	0.0	359.9	180.7	0.0	360.0	180.7	0.0	359.8
February	160.7	0.0	360.0	165.3	0.0	359.9	165.3	0.0	359.5
March	172.7	0.2	359.8	174.5	0.0	359.5	174.5	0.0	359.6
April	217.0	0.0	359.2	213.0	0.0	359.7	213.0	0.0	359.9
May	234.0	0.0	359.7	223.0	0.1	359.8	223.0	0.0	359.9
June	249.5	0.0	359.9	246.6	0.1	359.9	246.6	0.0	360.0
July	268.1	0.0	359.6	257.6	0.0	359.6	257.6	0.0	359.9
August	246.8	0.0	359.8	241.4	0.0	359.7	241.4	0.0	359.7
September	230.6	0.0	359.9	228.0	0.0	360.0	228.0	0.0	360.0
October	221.3	0.2	359.9	218.1	0.1	359.9	218.1	0.0	360.0
November	180.6	0.0	359.8	182.6	0.1	359.8	182.6	0.0	360.0
December	164.9	0.1	359.9	167.0	0.4	359.9	167.0	0.0	359.8

Table 17 2021 Sigma theta at Representative Monitoring Stations

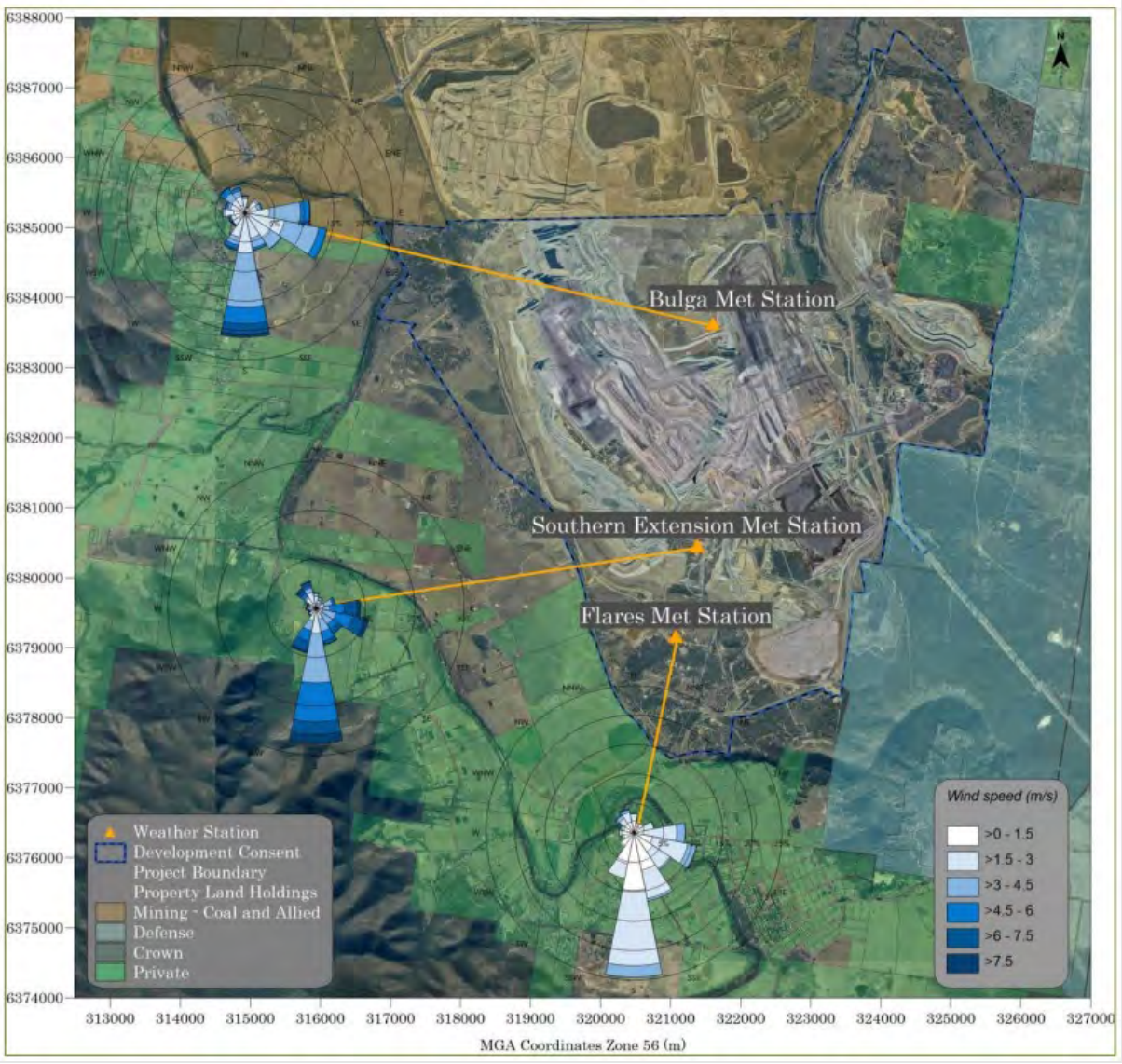
Sigma theta (degrees)	Bulga Complex			Southern Extension			Flares		
Month	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
January	15.5	0.0	97.8	14.7	0.0	99.7	26.1	0.0	98.6
February	16.2	0.0	96.1	13.5	0.0	100.8	27.0	0.0	98.9
March	16.6	0.0	90.1	13.0	0.0	98.3	26.4	0.0	95.3
April	15.3	0.0	86.6	13.0	0.0	96.8	25.6	0.0	99.7
May	14.1	0.0	86.5	12.4	1.0	96.0	24.9	0.0	95.7
June	13.6	0.0	100.7	11.1	1.1	98.8	23.0	0.0	92.5
July	14.5	0.8	85.3	12.4	0.0	93.0	22.6	0.0	90.3
August	14.7	0.0	92.4	13.1	0.0	93.9	24.3	0.0	97.3

Sigma theta (degrees)	Bulga Complex			Southern Extension			Flares		
Month	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
September	15.8	1.2	96.9	13.5	0.0	100.5	24.7	0.0	95.1
October	16.8	1.2	90.5	13.2	1.4	90.6	23.7	0.0	96.2
November	17.2	0.0	98.3	13.6	1.6	96.9	26.0	0.0	88.3
December	18.6	0.2	93.7	14.5	1.0	94.2	27.2	0.0	99.5

Wind Speed and Direction

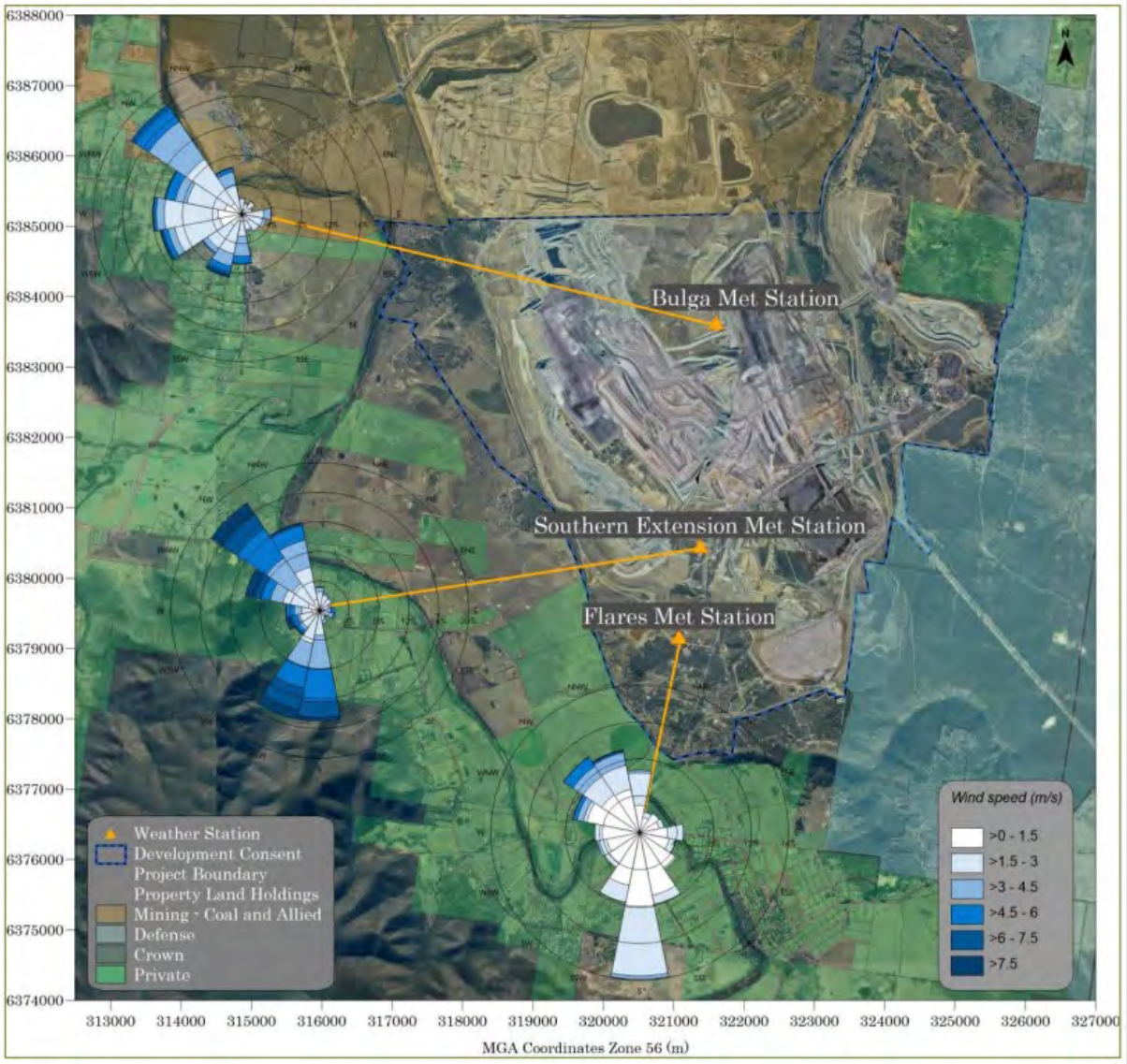
Wind speed and direction at Bulga during 2021 has been summarised in **Figure 14** to **Figure 17**.

Figure 14 Wind Speed and Direction Quarter 1



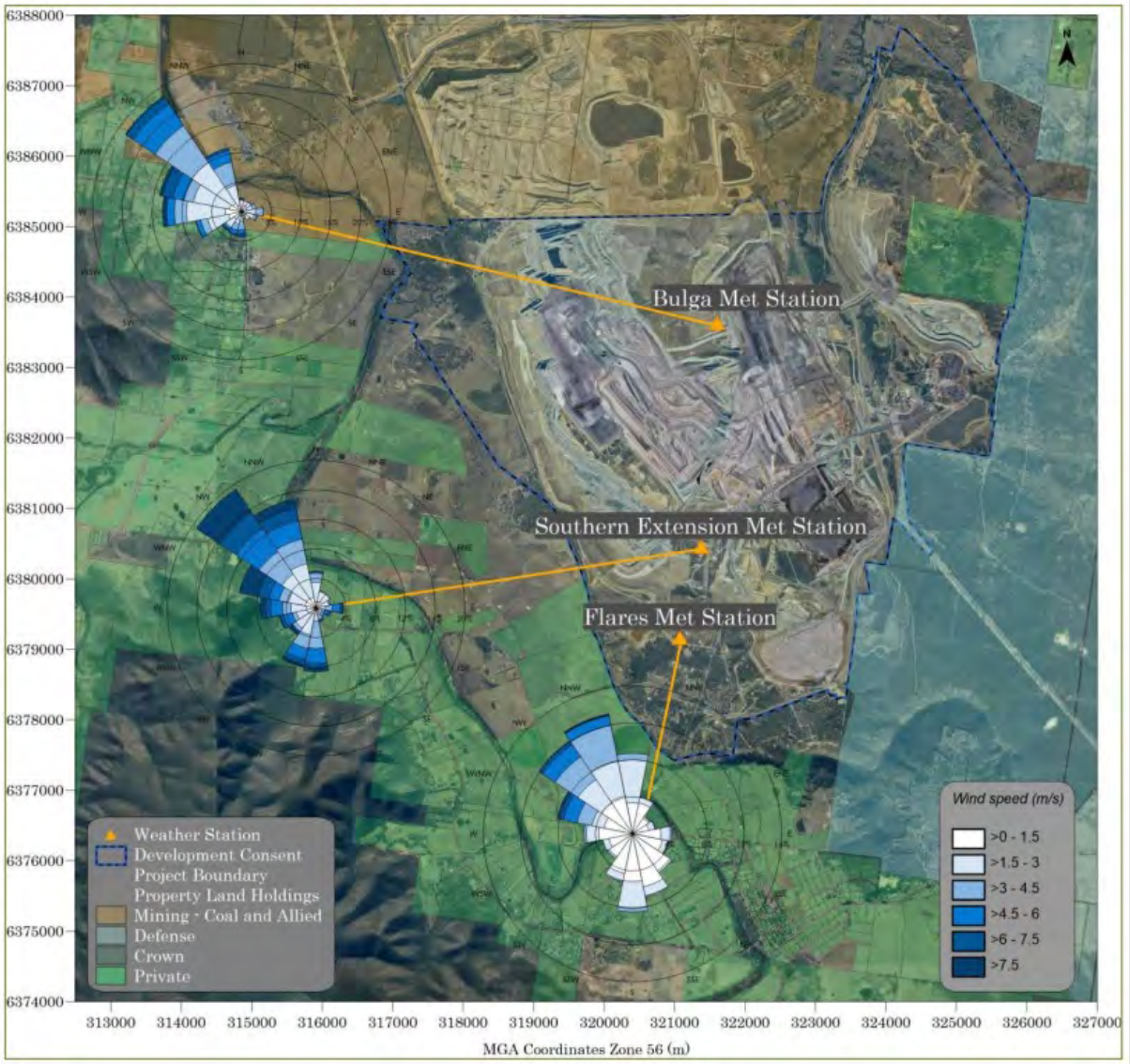
The Bulga Meteorological Station predominantly recorded winds originating from the south and east-southeast in Q1 2021. The Southern Extension and Flares stations predominantly recorded winds from the south. The calms recorded at the Flares Meteorological Station were most likely due to sheltering from vegetation.

Figure 15 Wind Speed and Direction Quarter 2



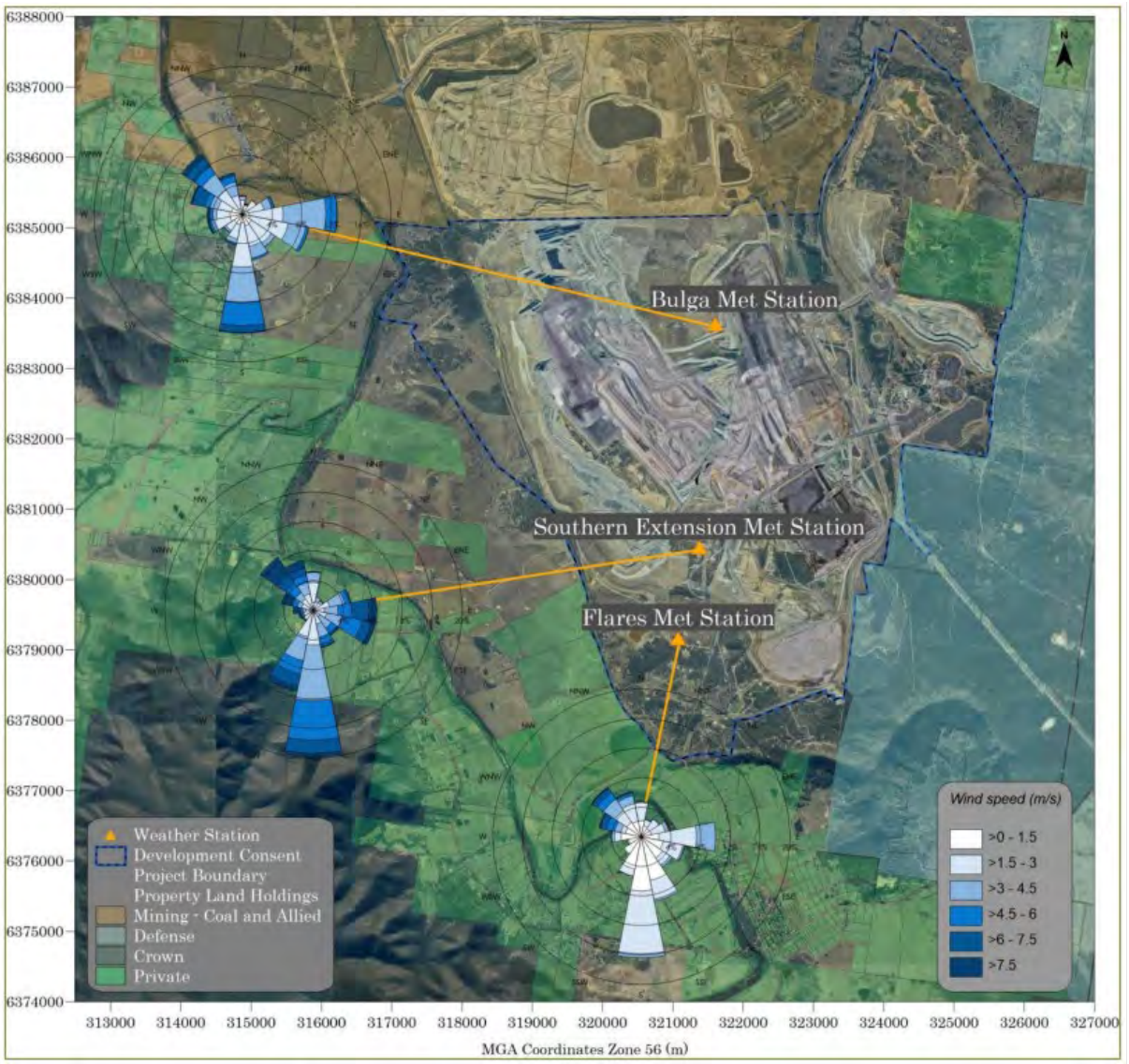
The Bulga Meteorological Station predominantly recorded winds originating from the northwest, the Southern Extension station predominantly recorded winds from the northwest, south and south-southwest and the Flares station predominantly recorded winds from the south in Q2 2021. The calms recorded at the Flares Meteorological Station were most likely due to sheltering from vegetation.

Figure 16 Wind Speed and Direction Quarter 3



The Bulga Meteorological Station and Southern Extension station predominantly recorded winds originating from the northwest. The Flares station predominantly recorded winds from the north-northwest in Q3 2021. The calms recorded at the Flares Meteorological Station were most likely due to sheltering from vegetation.

Figure 17 Wind Speed and Direction Quarter 4



The Bulga Meteorological Station, Southern Extension station and Flares station predominantly recorded winds originating from the south, with a significant percentage of winds also occurring from the easterly and north westerly directions in Q4 2021. The calms recorded at the Flares station were most likely due to sheltering from vegetation.

6.2 Noise

6.2.1 Environmental Management

Noise monitoring is undertaken in accordance with the *Bulga Coal Noise Management Plan*.

The location of noise monitoring sites is shown on **Figure 7**. The monitoring program includes:

- Monthly attended night-time monitoring at nine;
- Real-time monitoring at four locations;
- Sound power testing of a representative sample of the open cut fleet; and
- Additional monitoring as initiated by alarms or in response to community concerns.

The real-time monitoring network assists with the management of noise impacts from mining operations. Monitors are operated at locations representative of Broke, Fordwich, Milbrodale and Bulga. Fordwich real-time monitor was removed from the monitoring network on 17 December 2021 as it is no longer representative of privately owned properties. Data is recorded continuously and reported real-time to the Bulga Open Cut control room via an internal website. Dispatch is notified of noise levels that are approaching or exceeding the Development Consent noise criteria. Return to work alarms are implemented to alert Dispatch to a change to non-noise enhancing weather conditions. Dispatch and Open Cut Examiners investigate noise sources and make changes to reduce noise, where required. The noise criteria was changed to the criteria in Appendix 6 of SSD 4960 on 3 December 2021 as directed by DPIE. Compliance with the new criteria is assessed in attended monitoring from 3 December 2021. **Table 18** displays the old and new attended monitoring criteria.

Sound power testing involves testing a representative sample of the open cut fleet annually. Every item of mobile equipment is tested at least once every three years. Measured sound power levels are compared to levels included in the *Bulga Surface Operations Eastern Emplacement Area Modification Statement of Environmental Effects* (SEE) dated July 2016, including the *Bulga Surface Operations Eastern Emplacement Area Modification Response to Submissions* (RTS) dated December 2016. Individual items that exceed specified levels by 3 dB or more are investigated to assess the cause of the exceedance. Defects are rectified as soon as practicable.

The total measured fleet-wide (logarithmic) averages of mobile plant for the current sound power testing campaign are calculated annually. The total measured fleet averages should remain equal to or less than 2 dB of the relevant modelled fleet averages.

6.2.2 Environmental Performance

Attended Noise Monitoring

A summary of attended noise monitoring data for each monitoring location (**Figure 7**) is shown in **Table 18**. Results are presented as the maximum noise levels from Bulga Coal at each location during 2021. A detailed discussion of monitoring results is provided in monthly noise monitoring reports available on the Bulga Coal website.

Bulga Coal were compliant with the noise management plan. On two attended noise monitoring events (1 June 2021 and 8 June 2021) the criteria were exceeded by 1dB BCC5 (Broke Cemetery). This was likely a result of a mining continuum. Remeasures were taken within 75 minutes and follow up measurements were taken within one week in accordance with the process described in the Bulga Coal Noise Management Plan. The noise levels attributable to Bulga Coal during the follow-up measurements were below the relevant noise criteria.

Table 18 Summary of Attended Noise Monitoring Data – 2021

Location	Bulga Coal Noise Monitoring Results - dBA (Max)		Bulga Coal Project Specific Noise Criteria - dBA		
	LAeq(15minute)	LA1(1minute)	Criteria 1 January to 2 December 2021 LAeq(15minute)	Criteria 3 December to 31 December 2021 LAeq(15minute)	LA1(1minute)
BCC1	34	37	36	35	45
BCC2	32	36	36	35	
BCC3	33	36	35	35	
BCC4	34	43	35	35	
BCC5	**37**	44	36	35	
BCC7	35	43	36	36	
BCC8	33	41	36	36	
BCC9	30	31	37	35	
BCC10	35	44	35	35	

Mobile Plant Sound Power Testing

In 2019, 2020 and 2021 sound power testing was undertaken by Global Acoustics (Global Acoustics, 2022). During 2021 measurements were taken on 101 items of mobile plant giving a total of 166 items measured over the three year period which is 100% of the entire mobile plant fleet.

Mobile plant items tested in 2021 were within 2 dB of the noise targets, except for:

- The Caterpillar D10 dozers;
- Hitachi EX5500, EX5600, and EX8000 excavators;
- P&H 4100 XPC shovel; and
- SKS class drills.

Sound attenuation packages on trucks are inspected every three to four weeks and replaced every four years. Some variation across the feet is expected as individual units will be at different stages of their build cycle. Individual items of plant that did not meet the targets by more than 3dB will be inspected and defects fixed, where required.

The modelled total mobile plant (SSD-4960, Mod 3 2022 model) LW1 and A-weighted sound power level (LWA) were 1 dB lower than the 2019-2021 measured total mobile plant LW and LWA.

[1] Linear sound power level, expressed in decibels, is the logarithmic ratio of the sound power of a source in watts (W) relative to the sound power reference base of 10-12W.

6.2.3 Comparison against Predictions

The *Noise Impact Assessment for the Bulga Optimisation Project – Eastern Emplacement Area Development Consent Modification* (Global Acoustics, 2016) predicted Bulga Coal only noise levels from reasonable worst-case operating conditions throughout the life of the open cut mine. Modelling was done for Year 4 of the Bulga Optimisation Project. *The Bulga Extension Project Noise Impact Assessment* (Global Acoustics, 2019) and the *Bulga Extension Project Noise Impact Assessment* (Global Acoustics, 2019b) (for Modification 3) stated the modification would comply with approved noise limits at all receptor locations throughout the mining progression with an appropriate level of noise mitigation applied during periods of adverse meteorological conditions. Therefore, the existing predictions remain the same.

As noted in **Section 6.2.2**, attended monitoring results in 2021 were compliant with SSD-4960 noise criteria. Two exceedances did occur during 2021 which were deemed within criteria after follow-up measurements had been taken (refer **Section 6.2.2**) This shows that measured noise levels were generally managed below reasonable worst-case night-time predictions made for Year 4 of the Bulga Optimisation Project.

6.2.4 Long Term Analysis

Table 19 shows the number of noise criteria exceedances recorded by Bulga Coal during the period from 2011 to 2021.

Table 19 Summary of Exceedances by Noise Monitoring Location 2011 – 2021

Location	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
BCC1	0	1	0	0	0	0	0	0	0	0	0	1
BCC2	0	0	0	0	0	0	0	0	0	0	0	0
BCC3	0	0	0	0	0	0	0	1	0	0	0	1
BCC4	0	0	0	0	0	0	0	1	0	0	0	1
BCC5	0	0	0	0	1	0	1	2	0	0	1	5
BCC6	0	0	0	0	0	1	0	-[1]	-[1]	0	0	1
BCC7	0	1	0	0	0	4	0	1	0	0	0	6
BCC8	0	0	0	0	0	0	0	0	0	0	0	0
BCC9	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	0	0	0	0	0	0
BCC10	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	1	0	0	0	1
Total	**0**	**2**	**0**	**0**	**1**	**5**	**1**	**6**	**0**	**0**	**1**	**16**

1 – Noise levels not monitored at this location.

As indicated in **Table 19**, occasional exceedances of the Bulga Coal noise criteria have been recorded during the period from 2011 to 2021. The results show that very few noise exceedances attributable to Bulga Coal have occurred over the period 2011 to 2021, indicating that noise impacts from Bulga Coal are well managed. The results also show that the occurrence of noise exceedances attributable to Bulga Coal is not increasing over time.

6.2.5 Implemented/Proposed Improvements

The *Noise Management Plan* was revised in 2020 for SSD-4960 Modification 3 and DA 376-8-2003 Modification 7 and was approved on 9 March 2022 by DPIE. The revised *Noise Management Plan* did not include any material changes.

Changes to noise monitoring or management

Changes to noise management during 2021 included:

- SX64 (Fordwich) real-time monitor was removed from the monitoring network as it is no longer representative of privately owned properties;
- The Noise Management Procedure was changed to:
  - Minimise noise during noise enhancing conditions when the criteria do not apply (as consistent with SSD4960);
  - Manage noise in the morning (7am to 9am) through the real-time noise management system;
  - Include return to work alarms to alert Dispatch to a change to non-noise enhancing weather conditions; and
- Noise alarms were modified to be consistent with the new criteria in Appendix 6 of SSD-4960.

Continuous Improvement

Continuous improvement to noise management during 2021 included:

- A quieter dual skin exhaust was trialled on a 793D truck to see if it would achieve a noise reduction. The trial will continue in 2022; and
- A quieter dual skin exhaust was installed on a Komatsu L1850 Front end loader to reduce noise.

6.3 Blasting

6.3.1 Environmental Management

Blasting is undertaken in accordance with the *Blast Management Plan*. Monitoring is carried out to assess air blast overpressure and ground vibration impacts to the nearest privately owned residents.

Private property blast impact assessment criteria are provided in **Table 20**. The criteria apply at the compliance monitoring locations (Dawtrey, Bulga, Charlton and Hedley) shown on **Figure 7**.

Table 20 Private Property Amenity Impact Assessment Criteria

Airblast Overpressure Level (dB(Lin Peak))	Ground Vibration Peak Particle Velocity (ppv)	Allowable Exceedance
115	5 mm/s	5% of the total number of blasts over a period of 12 months
120	10 mm/s	0%

Blasting is managed to minimise ground vibration at public infrastructure. Infrastructure impact assessment criteria are provided in **Table 21**. Vibration monitoring is undertaken when the predictions from the scaled distance model are greater than or equal to 80% of the criteria. During the year, monitoring was undertaken at Pole 29 of the 330 kV powerline as shown on **Figure 7**.

Table 21 Infrastructure Impact Assessment Criteria

Infrastructure	Ground Vibration peak particle velocity (ppv)	Allowable Exceedance
330 kV Suspension Towers, Private Irrigation District (PID) Pipeline and public roads	100 mm/s	0%
Declared dams	50 mm/s	0%
All other public infrastructure	50 mm/s *(Unless the Planning Secretary has agreed to an alternative a specific limit determined in accordance with the structural design methodology in AS2187.2-2006, or its latest version)*	0%

Heritage blast vibration impact assessment criteria are listed in **Table 22**. The Bulga, Charlton and Dawtrey blast monitors shown in **Figure 7** are used to assess compliance.

Table 22 Heritage Impact Assessment Criteria

Heritage Site	Ground vibration ppv	Allowable Exceedance
'Mt Leonard Homestead', BH14 – 'Charlton', B13 – Stone Wall alongside Monkey Place Creek, St Andrews Anglican Church, BH6 – Broke Cemetery, Murinbin House Group.	5 mm/s	0%

6.3.2 Environmental Performance

196 blasts from Bulga Open Cut were recorded during 2021. Monitoring data is available on the Bulga Coal website, with a summary provided in **Table 23** to **Table 25**. There were two blast overpressure results above the 115 dBL criteria, however this was less than the 5% of total blasts allowable exceedance under consent.

Table 23 2021 Private Property Overpressure and Vibration Monitoring Results

Monitoring Location	Airblast Overpressure Level dBL (Lin Peak)				Ground Vibration ppv (mm/s)			
	Average	Max	Results >115 dBL	Results >120 dBL	Average	Max	Results >10 mm/s	Results >5 mm/s
Bulga	93.1	116.4	1 (0%)	0.5 (0%)	0.1	1.4	0 (0%)	0 (0%)
Charlton	91.5	107.1	0 (0%)	0 (0%)	0.2	1.3	0 (0%)	0 (0%)
Dawtrey	93.7	114.3	0 (0%)	0 (0%)	0.2	1.8	0 (0%)	0 (0%)
Hedley	93.0	116.1	1 (0%)	0.5 (0%)	<0.1	0.2	0 (0%)	0 (0%)

Table 24 2021 Infrastructure Vibration Monitoring Results

Monitoring Location	Ground Vibration ppv (mm/s)		
	Average	Max	Results > 100 mm/s
330 kV Pole 29	0.7	6.5	0 (0%)

Table 25 2021 Declared Dam (Northern Tailings Storage Facility) Vibration Monitoring Results

Monitoring Location	Ground Vibration ppv (mm/s)		
	Average	Max	Results > 50 mm/s
Northern Tailings Storage Facility	0.35	2.49	0 (0%)
Portable Blast NTSF - Cell B	0.14	0.58	0 (0%)

6.3.3 Comparison against Predictions

A *Blasting Noise and Vibration Impact Assessment* (Wilkinson Murray, 2012) was undertaken as part of the Bulga Optimisation Project EIS. The assessment noted that blasting would be managed to meet the amenity air blast and vibration criteria identified for inclusion in the Development Consent and EPL. The results are consistent with predictions.

6.3.4 Implemented/Proposed Improvements

A vibration monitor was installed on the Northern Tailings Storage Facility Cell-B. This was relocated to the RL120 western highwall crest on 30 November 2021 for better reception.

6.4 Air Quality

6.4.1 Environmental Management

Bulga Coal implements controls to mitigate air quality impacts in accordance with the *Air Quality Management Plan,* the *Eastern Emplacement Area Management Framework* (EEAMF) and the *Air Quality and Greenhouse Gas Management Plan.* The *Air Quality and Greenhouse Gas Management Plan* was revised in 2020 for SSD-4960 Modification 3 and DA 376-8-2003 Modification 7 and approved by DPIE on 8 October 2020.

Bulga Coal operates a monitoring network to assess air quality impacts on surrounding communities. The monitoring network (refer **Figure 6**) consists of:

Air quality monitors required by the relevant consents:

- Eleven Dust Deposition Gauges (DDGs) (four of which are directional) used for monitoring of larger dust particles (typically >50 micrometres [µm]). DDGs are sampled monthly (+/- 2 days) and results include the insoluble (mineralogical) matter (IM) and ash residue (organic);
- Three High Volume Air Samplers (HVAS) that monitor Total Suspended Particulates (TSP) over a 24-hour period every sixth day, known as D10, Dawtrey and Hill Street monitors;
- Five Tapered Element Oscillating Microbalance (TEOM) continuous air quality monitors that measure the concentration of PM_{10}, located at Putty Road (D3), Dawtrey (D5), Hill Street (D1), Mitchell Line Road (D11) and the Mushroom Composting Facility (D4);
- Two Beta Attenuation Monitors (BAM) located at Hill Street (D2) and Putty Road (D10) that measure the concentration of particulate matter less than 2.5µm in diameter ($PM_{2.5}$); and

Air quality monitors required by EPL 563:

- Two E-BAM monitors continuously measuring PM_{10}, at EPL Point 9 and EPL Point 10 at the north-west and south-east of the EPL premises, respectively.

6.4.2 Environmental Performance

The environmental performance presented below includes the data from the Bulga Complex monitors including DDGs, HVAS, TEOMs, BAMs and E-BAMs.

Table 26 presents the SSD-4960 Mod 3 air quality criteria.

Table 26 Air Quality Criteria SSD-4960 Mod 3

Pollutant	Averaging Period	Criterion	
Particulate Matter <10µm (PM_{10})	Annual	[a,c] 25µg/m^3	
	24-hour	[b] 50µg/m^3	
Particulate Matter <2.5µm ($PM_{2.5}$)	Annual	[a,c] 8µg/m^3	
	24-hour	[b] 25µg/m^3	
Total Suspended Particulates (TSP)	Annual	[a,c] 90µg/m^3	
[d]Deposited Dust	Annual	[b]2g/m^2/month	[a]4g/m^2/month

Notes:

- *Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).*
- *[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own).*
- *[c] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed to by the Planning Secretary.*
- *[d]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.*

In 2021, there were no days declared as "extraordinary air quality events" by DPIE.

Depositional Dust Monitoring

Depositional dust monitoring results are summarised in **Table 27**. Monitoring results are available on the Bulga Coal website.

Table 27 Summary of Dust Deposition Monitoring Results – 2021 Annual Average

Offsite Gauge		IM Deposited (g/m^2/mth)	Ash Residue (g/m^2/mth)	Adopted Consent Criteria (g/m^2/mth)
Code	General Location			
A3	Inlet Road	1.0	0.6	4.0
C5 (DR[1])	Mount Eyre Vineyard	0.7	0.6	
D6	Howe Street	1.5	1.0	
D9	Inlet Road	0.8	0.6	
D10	Putty Road	1.4	0.8	
F3 (DR[1])	Fordwich	1.7	1.0	
N5 (DR[1])	Putty Road	1.0	0.6	
Redibar	Redibar	1.8	0.9	

Offsite Gauge		IM Deposited (g/m²/mth)	Ash Residue (g/m²/mth)	Adopted Consent Criteria (g/m²/mth)
Code	General Location			
Sharrock 1	Sharrock	0.7	0.4	
Hedley[2]	Mitchell Line Road	1.7	1.3	
F2 (DR[1])	Cobcroft Rd	1.2	0.7	

[1]Indicates Directional Depositional Dust Monitor.
[2]Depositional dust was only collected from Hedley on one occasion in 2021 on the 23 December 2021.

There were no exceedances of the depositional dust criteria during 2021. There was a decrease in the monthly deposited dust levels across the majority of sites during 2021 compared with previous years, likely due to the wetter conditions experienced during 2021.

High Volume Air Sampling

Table 28 presents a summary of monitoring results and compares annual averages for TSP against consent criteria. Results include dust from mine (including neighbouring operations) and non-mine sources and are not attributable to Bulga Coal only.

Annual averages were below the relevant criteria at all locations in 2021.

Table 28 Summary of 2021 HVAS Annual Average Results

Gauge	Annual Average (µg/m3) (excluding extraordinary events)
	TSP (µg/m³)
Consent Criteria	**90**
Dawtrey	22.6
Putty Road (D10)	21.0
Hill Street (D2)	18.9

Continuous Monitoring

A summary of the recorded PM_{10} levels at the TEOM units is presented in **Table 29**. The number of days that exceeded the consent criterion is also shown.

The annual PM_{10} averages were below the criterion of 25µg/m³ at Hill St (D1), Putty Rd (D3), Dawtrey (D5) and Mitchell Line Rd (D11).

The maximum 24-hour PM^{10} were lower than 2020 at all sites which can likely be attributed to the wetter conditions in 2021.

There was one elevated level recorded at D11 on the 24 April 2021. Investigation indicates that Bulga contributed less than 50µg/m³ to the elevated 24-hour PM_{10} levels recorded and thus these are not considered to have been a non-compliance per SSD-4960 Schedule 2, Condition 16.

Table 29 Summary of TEOM 2021 Monitoring Results

Gauge	Annual average PM_{10} (µg/m³)		Maximum 24 hour average PM_{10} (µg/m³)	
	PM_{10} (µg/m³) [1]	Number of days exceeding criterion	PM_{10} (µg/m³) [1]	Number of days exceeding criterion
Consent Criteria	25	-	50	-
Hill Street (D1)	11.0	-	34.0	-
Putty Road (D3)	12.3	-	33.1	-
Dawtrey (D5)	13.1	-	33.6	-
Mitchell Line Road (D11)	15.2	-	64.1	1

[1] Excluding extraordinary events

Table 30 presents a summary of the recorded $PM_{2.5}$ levels at the BAM monitors. The annual $PM_{2.5}$ averages were below the relevant criterion of 8µg/m³ at D2 (Hill St) and D10 (Putty Rd).

The maximum 24-hour $PM_{2.5}$ averages were below the relevant criterion of 25µg/m³ during 2021.

Table 30 Summary of BAM 2020 Monitoring Results

Gauge	Annual average $PM_{2.5}$ (µg/m³)		Maximum 24 hour average $PM_{2.5}$ (µg/m³)	
	$PM_{2.5}$ (µg/m³)	Number of days exceeding criterion	$PM_{2.5}$ (µg/m³)	Number of days exceeding criterion
Consent Criteria	**8**	-	**25**	-
Putty Road (D10)	4.6	-	17.2	-
Hill Street (D2)	3.9	-	24.0	-

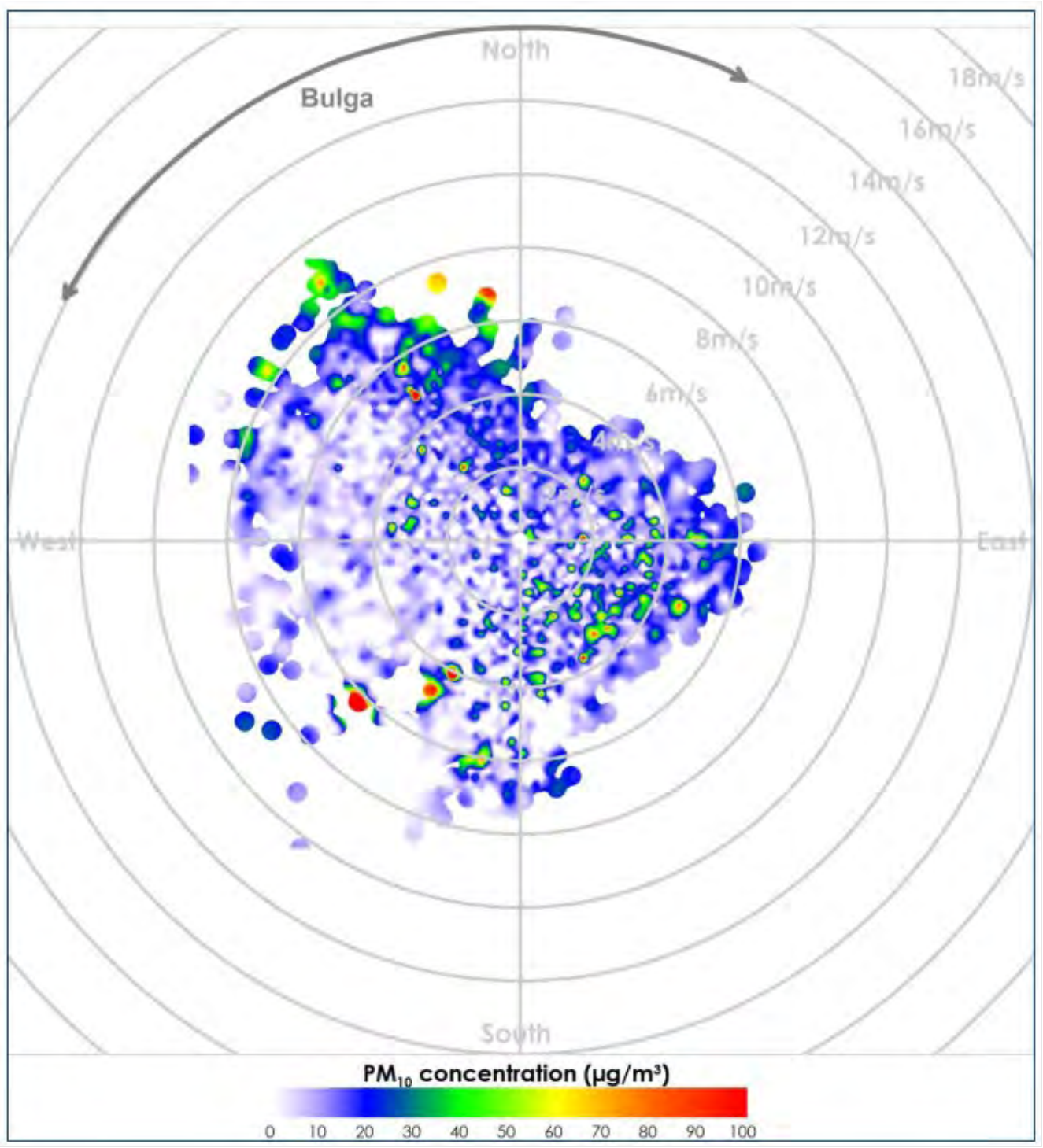
Onsite EPL Monitors

In accordance with the requirements of EPL 563, Bulga Coal operated two E-BAM type continuous air quality (PM_{10}) monitors close to the EPL premises boundary.

The data is analysed with wind speed and wind direction data to estimate the Bulga Coal PM_{10} contribution at each location. The monitors are not used to assess compliance with the air quality criteria in the Development Consent; they inform the Bulga Open Cut Air Quality TARP. Alarms are generated in the control room when elevated PM_{10} levels occur. Actions to minimise dust are taken in response to alarms, where required.

Figure 18 and **Figure 19** present the pollution roses for EPA Point 9 and EPA Point 10 monitors, respectively. The figures show that EPA Point 9 and EPA Point 10 there is a mild to moderate effect on dust levels from the direction of the Bulga mine. Some high levels occur in the direction of Bulga at the D9 monitor after the monitor was relocated, however the monitor recorded a greater proportion of high levels when winds were from the northwest quadrant during which the monitor would not have been downwind of Bulga.

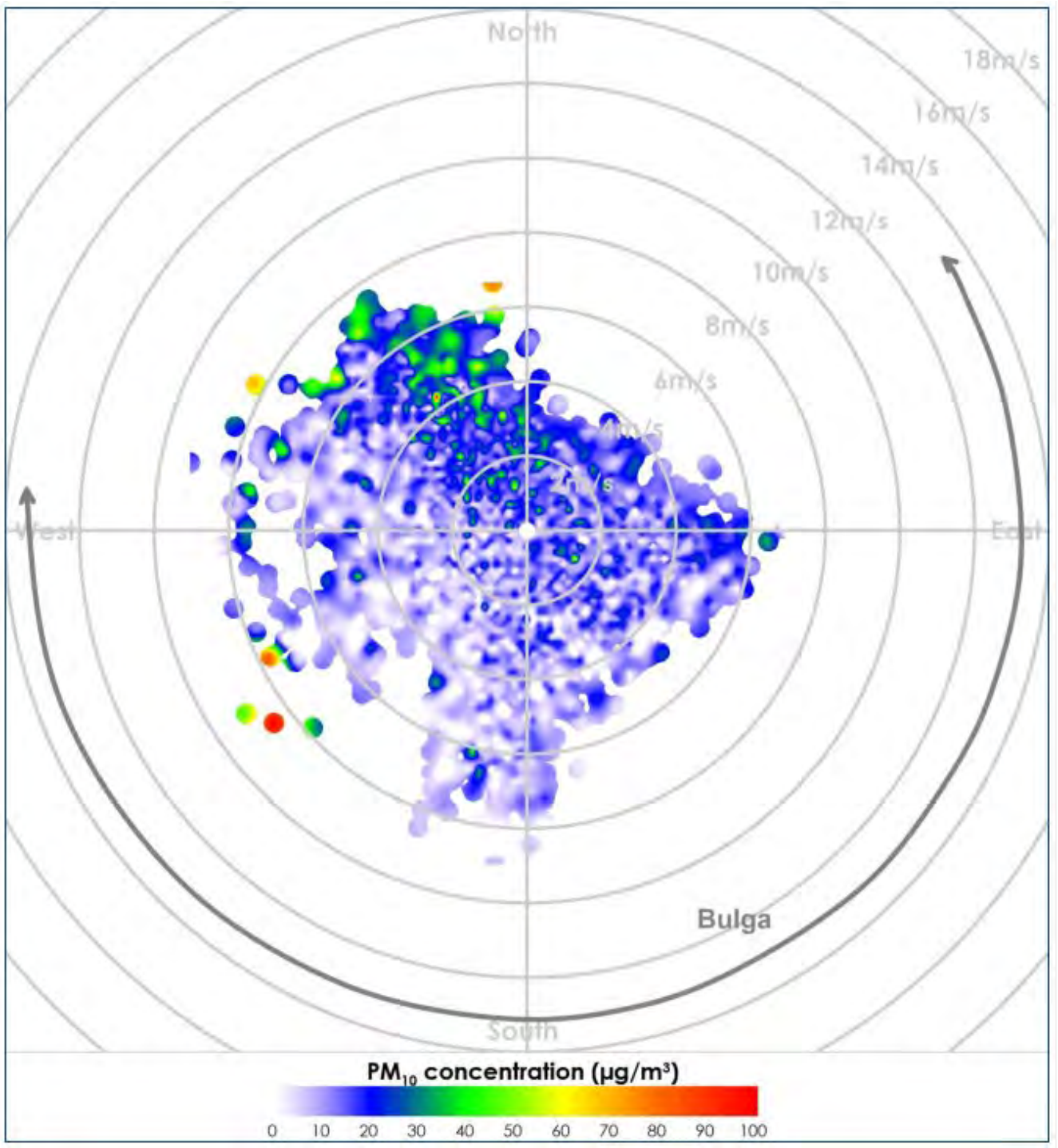
Figure 18 2021 Pollution Rose[2] for EPA Point 10 PM_{10} Data (Todoroski Air Sciences (2021))



[2] How to read a pollution rose:

- The colour indicates the pollutant concentration measured at the monitor.
- The position of pollutant concentration markings along the 360° axis indicates the corresponding direction from which pollutants arise from.
- The position of pollutant concentration markings relative to the banded rings indicates the wind speed for the corresponding hourly concentration.
- The arc labelled "Bulga" indicates the relative direction of Bulga Complex from the monitor.

Figure 19 2020 Pollution Rose[3] for EPA Point 9 PM_{10} Data (Todoroski Air Sciences (2021))



[3] How to read a pollution rose:

- The colour indicates the pollutant concentration measured at the monitor.
- The position of pollutant concentration markings along the 360° axis indicates the corresponding direction from which pollutants arise from.
- The position of pollutant concentration markings relative to the banded rings indicates the wind speed for the corresponding hourly concentration.
- The arc labelled "Bulga" indicates the relative direction of Bulga Complex from the monitor.

Mushroom Composting Facility

Figure 20 presents the PM_{10} 13-hour average measured at the Mushroom Composting Facility (D4 TEOM monitor) against the 13-hour average Assessment Level of 91 µg/m^3. The Assessment Level only applies during the approved operating hours of the Mushroom Composting Facility. These are between 6:00 am and 7:00 pm Monday to Friday, and any additional operating hours of the Mushroom Composting Facility, provided that:

Such operating hours do not exceed 6:00 am to 12:00 pm on weekends; and

The Mushroom Composting Facility has given Bulga Coal at least one month advance notice of the intention to operate during those additional operating hours.

As shown in **Figure 20**, there were 2 occasions where levels above the assessment level of 91 µg/m^3 were measured. These were investigated in accordance with the Eastern Emplacement Area Air Quality Management Framework (EEAAQMF). In accordance with the investigation and incident reporting process in the EEAAQMF, Bulga Coal and the Mushroom Composters agreed that Bulga Coal was not the main cause of these exceedances. These are not classified as incidents or non-compliances and no notification to DPIE was required.

Table 31 presents a summary of the identified exceedance days and the identified causes of each exceedance.

Figure 20 Mushroom Composting Facility (D4) Sampling Results 2021 – 13-hour PM_{10} Averages

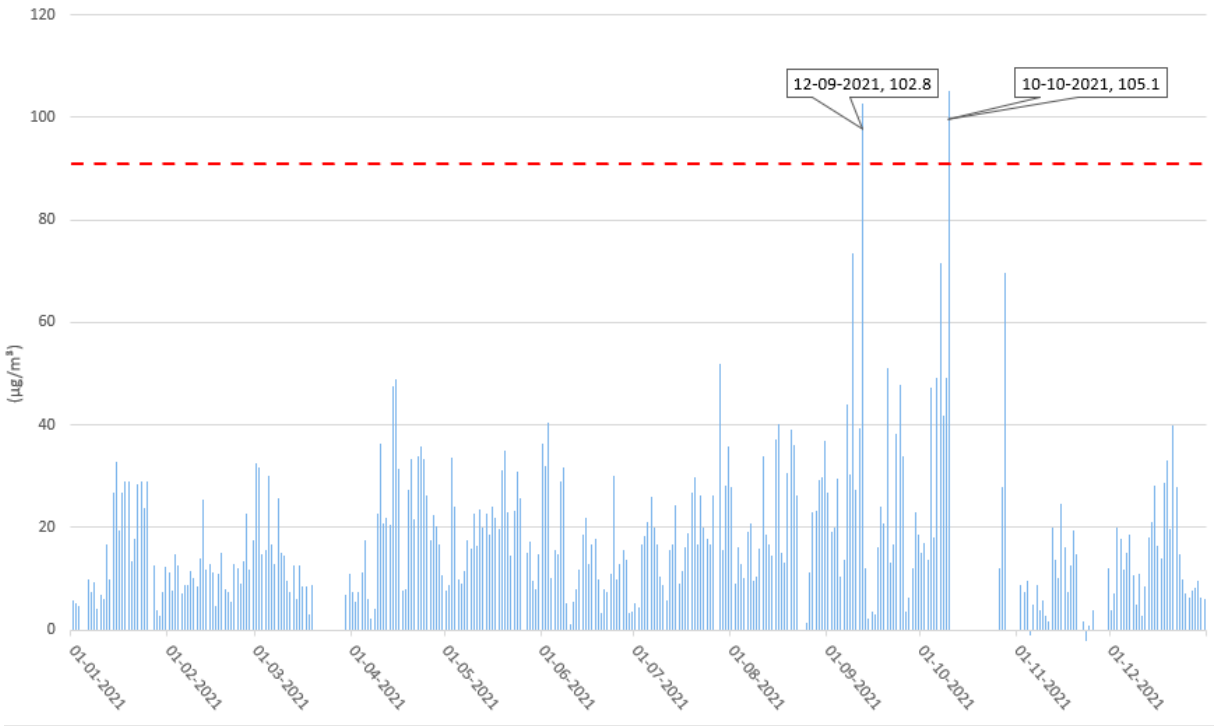


Table 31 Eastern Emplacement Area Exceedance Summary

Date	Primary Cause of Elevated Levels
12/092021	Strong NW winds
10/10/2021	Strong NW winds

6.4.3 Comparison against Predictions

A comparison of 2021 dust monitoring data with the modelled predictions made in the *Bulga Coal Complex Modification 3 Air Quality Impact Assessment* (Jacobs, 2019) (Year 22) was undertaken by Todoroski Air Sciences (2022) (attached as **Appendix B**). The analysis shows that the annual average measured levels in 2021 were lower than the predictions for the representative modelling scenario. In general, it is considered that 2021 was a relatively cool and wet year for NSW which may have contributed to lower dust levels measured in 2021.

6.4.4 Long Term Analysis

An assessment of long-term trends over the life of Bulga Coal operations was undertaken by Todoroski Air Sciences (2022) (**Appendix B**). Annual average levels were generally lower than previous years, likely due to more rainfall and a significant reduction in the frequency of extraordinary events (bushfires and dust storms). The trends in air quality reflect the prevailing meteorological conditions and not the mining activity.

6.4.5 Implemented/Proposed Improvements

Changes to air quality management and monitoring during 2021 are summarised below:

Continuous air quality monitor (EPA Point 9) moved from the north-east to the north-west boundary between Bulga Open Cut and Mt Thorley Operations. This was because the new location on the north-western boundary is more representative of dust emissions coming onto and leaving the premises boundary in prevailing weather conditions (north-west to south-east). This was requested by the Community Consultative Committee. The Air Quality Management Procedure was changed to show the new monitoring location.

The Air Quality Management Procedure was changed to remove the dragline visual dust trigger. This is because the dragline is no longer operational and is currently being decommissioned.

6.5 Mine Subsidence

6.5.1 Environmental Management

Since the cessation of mining in May 2018, surface safety monitoring has continued to be undertaken in accordance with approved methods.

6.5.2 Environmental Performance

6.5.2.1 Monitoring Results

Repairs to surface subsidence cracking identified during monitoring activities for previously mined areas continued to be undertaken during the reporting period. Repairs were undertaken in accordance with the *Bulga Underground Operations Subsidence Mapping and Repair Procedure* and the *Bulga Underground Operations Post Mining Subsidence Management Plan*. The observed impacts caused by subsidence are summarised in **Table 32**.

Table 32 Observed Subsidence Impacts

Feature	Impact Performance Measures	Observed Impacts
Surface Cracking	Always safe. Stable, non-polluting post mining Landform.	No adverse impacts reported. Continue to monitor and repair as required
Telecommunications & powerlines	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure
Pipelines and tanks	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure.
Roads and gates	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure.
Fences	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure.
Buildings	Always safe. Serviceability should be maintained wherever practicable.	No adverse impacts identified to public or internal infrastructure.
Archaeology sites and vegetation	Stable, non-polluting post mining Landform.	No adverse impacts reported.

6.5.3 Comparison against Predictions

A comparison against predictions was not applicable considering underground mining did not occur during 2021.

6.5.4 Proposed/Implemented Improvements

As noted above, Bulga Underground Operations have continued to progressively complete repairs to surface subsidence cracking identified from monitoring. Monitoring of previously mined areas will continue in 2022. Any required mitigation works will be completed in accordance with the Bulga Underground Operations *Subsidence Mapping and Repair Procedure* and the *Bulga Underground Operations Post Mining Subsidence Management Plan*.

6.6 Flora and Fauna (Remnant Vegetation)

Bulga Coal conducts ecological monitoring of the:

- Remnant vegetation around the mine site (**Section 6.6**);
- Offset areas (**Section 6.7**); and
- Mine rehabilitation (**Section 8.6**).

6.6.1 Environmental Management

Flora and fauna monitoring is conducted around the mining operations in accordance with the *Biodiversity Management Plan* (BMP). The locations of ecological monitoring sites are shown in **Figure 21**. The ecological monitoring of mine rehabilitation is covered in **Section 8.6**.

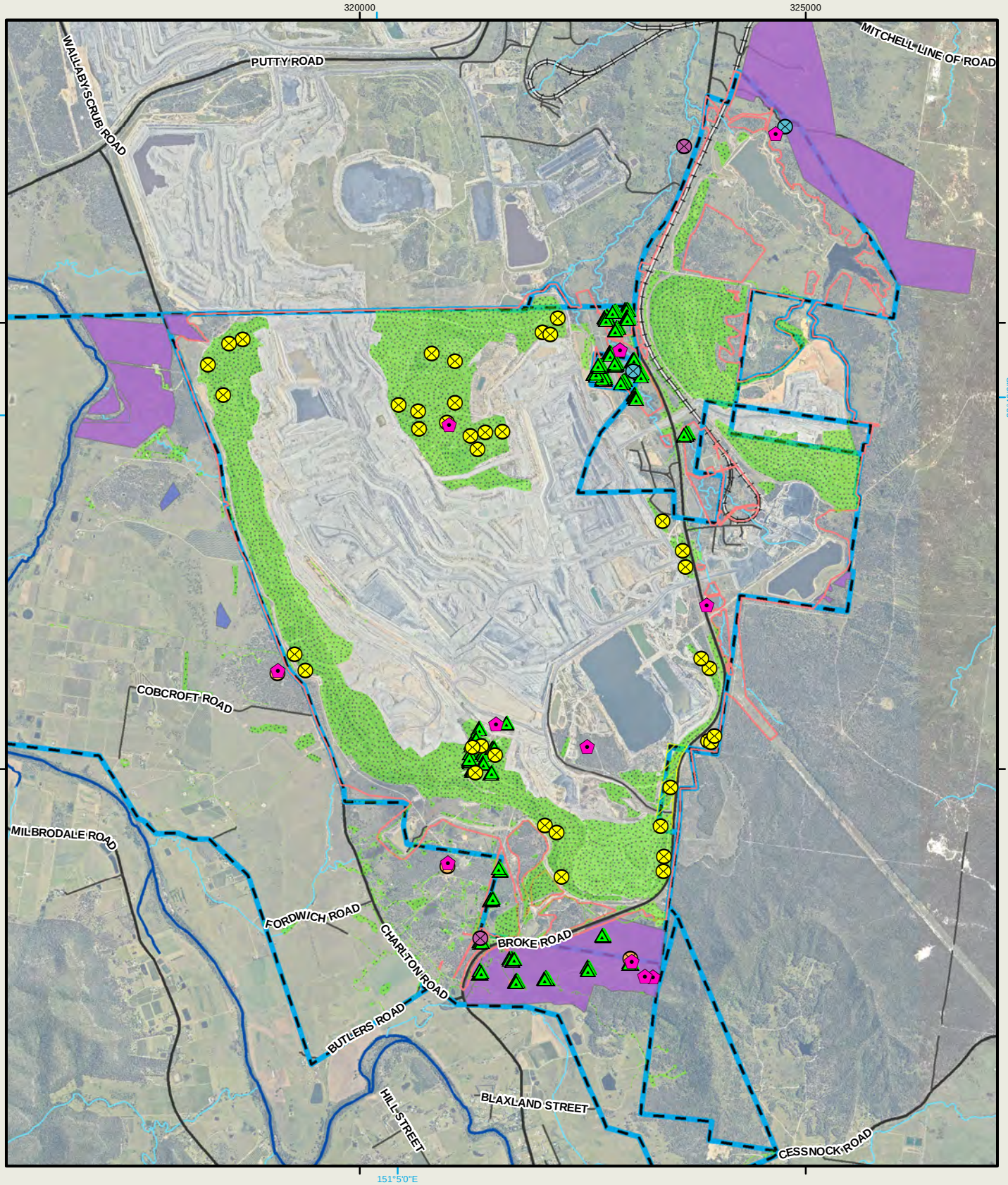
6.6.1.1 Annual Ecological Monitoring Program - Flora

The annual ecological monitoring program for remnant vegetation was undertaken by Umwelt (2021) with a summary of the results presented in **Section 6.6.2**. The full report is available on the Bulga Coal website.

The long-term remnant vegetation monitoring program utilises the Biodiversity Assessment Methodology (BAM) to compare rehabilitation areas with biometric scores from the targeted vegetation communities

The primary objective of the monitoring program is to assess the health and condition of remnant vegetation at Bulga Coal. The BAM was adopted during 2018 to be consistent with Biodiversity Conservation Division (BCD) (formerly the Office of Environment and Heritage (OEH)) requirements and to match the methodology used at rehabilitation sites. BAM involves assessing vegetation condition based on the compositional, structural and functional attributes of a site (OEH 2018).

FIGURE 21 - ECOLOGICAL AND REHABILITATION MONITORING 2021



Approved Disturbance Boundary
Mining Lease
Mining Lease AMA
Major road
Minor road
Railway
Wollombi Brook
Minor Watercourse
Management Area
Offset Area
Rehabilitation
Ecology Monitoring
Reference
Reference/Ecology Monitoring
Rehabilitation Monitoring
2021 Nest Box Monitoring
2021 Fauna Monitoring

0 0.5 1 2
Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:59,761 @ A4

N

GLENCORE

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Subject To Survey.
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Ref: L:\Mapping\Reporting\AEMR\2021\2021_AEMR_FIGURES_BCC_ECOLOGICAL_REHABILITATION_MONITORING_V1_GDA2020.mxd

6.6.1.2 Annual Ecological Monitoring Program – Fauna

Ecological monitoring for fauna was completed by Forest Fauna Surveys (2021) and results provided in the 2021 Annual Ecological Monitoring Report. A summary of results is provided in **Section 6.6.2**. The methodology includes targeted surveys for birds, bats, reptiles and amphibians, owl call-playback, fauna spotlighting and opportunistic fauna surveying.

The program is designed to check if there have been any impacts on the surrounding terrestrial and aquatic habitats (outside of approved disturbance areas) as a result of mining operations and to monitor the strength of rehabilitation areas.

6.6.2 Environmental Performance

6.6.2.1 Flora Monitoring

Ecological monitoring of flora was conducted at three reference sites in 2021 located within the following vegetation communities:

- PCT 1603 - Central Hunter Grey Box – Ironbark Woodland Endangered Ecological Community (EEC);
- PCT 1604 - Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC; and
- PCT 1731 - Swamp Oak Forest.

Remnant monitoring sites are considered generally stable. Signs of regeneration were seen at all sites and comprised species from all strata. Signs of native species regeneration were observed at all reference sites. There is consistency in native species richness and cover at these reference sites (when compared to 2020 monitoring results), however exotic species have increased including those in the High Threat category. BM10 demonstrated a high presence of exotic species (including four High Threat species accounting for 36.6% foliage cover) compared to other reference sites, however it has maintained good diversity and cover of native species. Attention will continue to be paid to managing exotic species in these communities.

6.6.2.2 Fauna Monitoring

Diurnal bird surveys were performed at selected sites during winter, spring / early summer of 2021. A cumulative total of 101 native and 2 introduced bird species were recorded in 2021, of which 77 bird species were recorded by diurnal census surveys. The additional 21 native bird species were observed opportunistically whilst undertaking other duties. The cumulative total of bird species was an increase from the previous two years. 2020 and 2021 have been the years since 2018 where species numbers have increased and is likely due to the above average annual rainfall since 2019 and the break from drought like conditions. Four threatened bird species were recorded, being the Little Lorikeet (*Glossopsitta pusilla)*, Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) and Speckled Warbler (*Chthonicola sagittata*). Surveys for nocturnal birds were conducted in Spring (October) and Summer (December) and comprised quiet listening for calls whilst undertaking spotlight searches, and broadcast of pre-recorded calls of threatened large forest owls (Sooty, Powerful, Masked, Barking) at each location at each site on 1 night. Calls were broadcast for 1 minute each and followed 5-minute quiet listening, prior to commencement of spotlight search. No threatened bird species were identified during nocturnal surveys.

A total of twelve microbat species were detected during the 2021 surveys, which is four more than the number of species recorded in 2020. Two of the species recorded in 2021 were listed as threatened under the *Biodiversity Conservation Act 2016* and the *EPBC Act*; the Eastern Coastal Freetailed-bat (*Micronomus norfolkensis*) and the Eastern Bentwing-bat (*Miniopterus fuliginosus*). Both species have previously been recorded at Bulga.

Nine reptile species were recorded in the 2021 fauna monitoring period including the Eastern Snake-necked Turtle (*Chelondina longicollis*), Bearded Dragon (*Pogona barbata*), Lace Monitor (*Varanus varius*), Striped Skink (*Ctenotus robustus*), Copper-tailed Skink (*Ctenotus taeniolatus*), Tree-crevice Skink (*Egernia striolata*), Dark-flecked Garden Sunskink (*Lampropholis delicata*), Eastern Blue-tongue (*Tiliqua scincoides*), Red-bellied Black Snake (*Pseudechis porphyriacus*).

Ten frog species were detected opportunistically whilst undertaking other survey duties, or heard calling during nocturnal spotlight searches. Small dams and minor creek lines occur in proximity to several monitoring sites, providing aquatic habitat for a range of frog species.

6.6.3 Implemented/Proposed Improvements

Recommendations from monitoring reports have been incorporated, where appropriate, into the Environment and Community operating budgets for 2022. These recommendations focus on land management practices to improve the health of vegetation and quality of habitat in surrounding vegetation. Land management activities to be implemented in 2022 to action issues across remnant vegetation areas include: ongoing weed management (particularly focussing on Lantana (*Lantana camara*), Opuntias (*Opuntia species*) and African boxthorn (*Lycium ferocissimum*). Pest animal management will include dog baiting and opportunistic kangaroo culling and pig trapping in response to sightings or evidence of presence. As Bulga continues to clear remnant vegetation to allow for the progression of mining activities, habitat resources (logs, rocks, and tree hollows) will be salvaged for re-use in rehabilitation and where feasible, remnant vegetation areas.

6.7 Biodiversity Offsets

Schedule 3, Condition 29 of SSD-4960 requires Bulga Coal to establish and maintain four Biodiversity Offset Areas (BOAs). Condition 9 of EPBC 2012/6637 and Condition 12 of EPBC 2018/8300 requires an annual report including implementation of the associated management plans (see **Sections 6.7.1** to **6.7.4**) and detailing compliance with the conditions of the approval (see **Appendix A**). The BOAs are:

- Broke Road BOA (241 ha);
- Condran BOA (50 ha);
- Reedy Valley BOA (1,486 ha);
- Wollombi Brook Conservation Area (WBCA) including 65 ha of BOA and 51 ha of Aboriginal heritage conservation area; and
- Vere Offset Area (153.7 ha).

The Broke Road and Wollombi Brook BOAs are shown in **Figure 16** and are located in the north-eastern and north-western corners of Bulga Coal, respectively. The Reedy Valley and Condran BOAs are located further from Bulga Coal and are approximately 30 km north-west and 10 km south-east of Muswellbrook, respectively. In addition, Bulga Coal committed to establishing two Weeping Myall Management Areas in the Bulga Optimisation Project EIS. These were established in 2015 and are shown on **Figure 21**.

In accordance with Schedule 3, Condition 33A of SSD-4960 Bulga Coal has committed to establishing and managing the Vere Offset Area (153.7 ha) located to the south of Bulga Coal (**Figure 16**) within two years of the commencement of development approved under SSD-4960 Mod 3. Development approved under Mod 3 commenced in September 2020.

6.7.1 Broke Road BOA

6.7.1.1 Environmental Management

Environmental management activities undertaken at the Broke Road BOA in 2021 included:

- Weed control works focussing in particular on Lantana (*Lantana camara*), African Boxthorn (*Lycium ferocissimum*), Galenia (*Galenia pubescens*), African Olive (*Olea europaea*) and Blue Heliotrope (*Heliotropium amplexicaule*);
- Bushfire firebreak slashing;
- Wild dog and fox baiting during autumn and spring months (10 wild dogs, 12 Fox (*Vulpes vulpes*) takes);
- 35 Pigs trapped;
- 75 Eastern Grey Kangaroos culled across the Broke Road BOA and adjacent Hedley East properties with carcases donated to Devil Ark;
- Revegetation planting of 24 Ha (24,000 stems) of Central Hunter Grey Box Ironbark Woodland EEC;
- Removal of 3.2 km of redundant internal fencing;
- Six monthly inspections; and
- Ongoing ecological monitoring program.

6.7.1.2 Monitoring Results

Flora

Monitoring in 2021 at the Broke Road BOA continued with the nine permanent monitoring transects established in 2015 and the three additional temporary revegetation plots established in 2018.

Compared to the long-term average (>60 years), 2021 was a relatively wet year, with seven months receiving at or above-average falls of rain spread throughout the year. Relative to 2020, there was a decreasing trend in native and weed species diversity in 2021, except for all revegetation plots (increasing natives but mostly decreasing weeds) and BRO03G (increasing weeds) in response to better growing conditions (Bell, Murray & Sims 2022a). The decrease in native and weed species diversity is likely due to growth of grasses impacting detection of smaller forbs and herbs during surveys, in addition to natural competition (access to light) between the grass species and these other growth forms. 93 plant species were recorded within the nine transects, a decrease to 2020 (110), 2019 (117), 2018 (118), 2017 (116), 2016 (144) and 2015 (142). There was an decrease in the number of weed species recorded in 2021 (61) compared with 2020 (68) but an increase compared with 32 detected in 2019, and 45 in 2018.

Biometric data from the twelve monitoring plots have been compared against benchmark values for the single Plant Community Types (PCTs) present at Broke Road VCA: PCT 1605 (Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter). For Forest transects, only Native Ground Cover (grass) (NGCG), Native Ground Cover (other) (NGCO) and Native Plant Species (NPS) meet or approach benchmark values, but all other attributes fall well below. The same trend is apparent for Grassland transects, and as expected Revegetation transects currently lie below benchmark values for most attributes, except for some transects which exceed benchmark for Native Ground Cover (grass) (NGCG) and Native Ground Cover (Other) NGCO).No new records of threatened plant species were recorded, and the existing individual of *Cymbidium canaliculatum* (endangered population in the Hunter catchment) persists adjacent to transect BRO04F and was in flower in November 2021. Both monitoring plots established within the vulnerable *Eucalyptus glaucina* population showed good evidence of new recruitment following a wet two years, a feature repeated throughout the whole population.

The exotic shrub Creeping Lantana (*Lantana montevidensis*) also remains across the property, despite the commencement of weed management strategies. During good growing conditions in 2020 and 2021 this species has become prominent in the grassy woodlands and continues to expand. Immediate control of this species is recommended through herbicide application or as best determined by appropriate land management contractors experienced in weed management within Threatened Ecological Communities.

Saffron Thistle (*Carthamnus lanatus*) and Cotton Bush (*Gomphocarpus fruticosus*) are locally abundant in some areas of the VCA. Control of these has commenced through mechanical slashing and ripping of ground for revegetation, however in some sections this ground disturbance has encouraged further weed growth. Continued intermittent control by mechanical means (slashing) may be the best alternative at Broke Road. Infestations of Cotton Bush should be treated in the same way where they occur prior to dispersal of seed.

Parts of the main creekline in the south of Broke Road supports a narrow band of Spiny Rush (*Juncus acutus*). If left unmanaged, this species may form impenetrable thickets around water bodies and should be removed to prevent further spread. Slashing of above-ground biomass in the first instance, followed by repeated application of herbicide has been shown to be effective in estuarine environments (Paul & Young 2006; Paul et al. 2007). For small occurrences (such as at Broke Road), manual removal of entire plants is preferable.

During dry conditions in recent years, high mortality of planted stock within revegetation areas has been noted (e.g. up to 86% on one transect in 2018), however over 2020 and 2021 survival has stabilised. For future management, it is suggested that revegetation areas be irrigated during drought periods using water carts and hoses, perhaps after 2 months of below average rainfall or similar. Alternatively, planting out during drought periods should be avoided as much as possible, irrespective of the need to meet planting quotas. Observations made from the VCA in recent years suggest that planting tubestock within rip lines often encourages dense colonisation by weed species such as *Galenia pubescens* in the freshly exposed soil, and this process impacts detrimentally on native ground cover grasses and herbs. It is suggested that this process be reduced or replaced with other planting techniques (e.g. use of hand or machine-mounted augers). Future revegetation procedures could also incorporate direct seeding to avoid this effect and increase the survival of planted species.

For Broke Road, it is recommended that an ecological and cultural fire management plan be prepared that will initially introduce fire into the landscapes with regular burns in grassy woodlands every 2-3 years, pending appropriate conditions (Bell, Murray & Sims 2022a).

Bulga Coal will address recommendations of specialist consultants according to priority in 2022, through the development of a weed management strategy.

Fauna

Bird census surveys were conducted at nine sites over three monitoring periods, two in winter and one in spring. The diurnal bird census recorded 52 bird species in 2021, compared to 49 in 2020, 42 in 2019, 43 in 2018, 26 in 2017, 37 in 2016 and 38 in 2015. As such, results were comparable to previous years' results. Note three new species were recorded in 2021; the Rainbow Lorikeet (*Trichoglossus haematodus*), Swift Parrot (*Lathamus discolor*) and Brush Cuckoo (*Cacomantis variolosus*). The critically endangered Swift Parrot (*Lathamus discolor*) (listed under the *Biodiversity Conservation Act 2016* and the *EPBC Act*) was recorded in 2021. Small to large flocks of 10 – 50 Swift Parrots were observed feeding both in flowering Narrow-leaved Ironbark (*Eucalyptus crebra*) and also taking lerps in Rough-barked Apple (*Angophora floribunda*) trees. This is the first occasion the Swift Parrot has been detected in the VCA, despite its close proximity to a known site where the species is detected annually (the Singleton Army Training Area, Department of Defence).

Camera monitoring detected four introduced species not recorded by other survey techniques. Note that the number of days an individual pest species was photographed over the monitoring period (n = 92 consecutive days) is low, suggesting either avoidance of camera traps by these species, or occurrence in low densities across the VCA. In 2021, larger mammals recorded included the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*), wild Dog (*Canis lupus familiaris*), red fox (Vulpes vulpes), feral cat (*Felis Catus*) and pigs (*Sus scrofa*). Smaller terrestrial mammals recorded by camera include Common Brushtail Possum (*Trichosurus vulpecula*), Brown Hare (*Lepus europaeus*) and European Rabbits. The vulnerable Squirrel Glider (*Petaurus norfolcensis)* (listed under the *Biodiversity Conservation Act 2016*) was also recorded in 2021.

Fourteen microchiropteran bat species were recorded in 2021 by echolocation call recordings. Of the fourteen species recorded, four species are vulnerable: the Eastern Coastal Freetailed-bat (*Micronomus norfolkensis*) and Little Bentwing-bat (*Miniopterus australis)* (listed under the *Biodiversity Conservation Act 2016);* the Large-eared Pied Bat (*Chalinolobus dwyeri)* and the Eastern Bent-wing Bat (*Miniopterus fuliginosus*) *(listed under the Biodiversity Conservation Act 2016* and the *EPBC Act)*, all of which had previously been recorded within the Broke Road BOA. Six reptile species were recorded in 2021, the Eastern Long-necked Tortoise (*Chelodina longicollis*) the Bearded Dragon (*Pogona barbata*), Lace Monitor (*Varanus varius*), Red-bellied Black Snake (*Pseudechis porphyriacus*), Striped Skink (*Ctenotus robustus*) and Tree Skink (*Egernia striolata*).

During the 2021 surveys five frog species were heard calling, but with low calling activity in the Spring 1 survey (September 2021). However, following above average rainfall over the period October to December 2021, all water bodies (i.e. farm dams) were full, and frog activity was high. Several species such as Green Tree Frog (*Litoria caerulea*) were heard calling in large choruses at one dam near BR06, a site which had not previously recorded this species at Broke Road VCA.

Performance against Criteria

During 2021, 14 of the 17 performance indicators were met. One was not applicable and two failed to achieve the specific criteria.

Progress against 2021 performance indicators, Broke Road VCA, as detailed in Biodiversity Offset Management Plan (BOMP) is shown in **Appendix C**.

6.7.1.3 Implemented/Proposed Improvements

Weed Control

The 2022 weed management strategy for Broke Road BOA will focus on the management of priority species identified in the 2021 monitoring and inspection programs including; Creeping Lantana (*Lantana montevidensis*), St Johns Wort (*Hypericum perforatum*), Galenia (*Galenia Pubescens*), Spiny Rush (*Juncus acutus*) and control of annual weeds including Saffron Thistle (*Carthamnus lanatus*) and Cotton Bush (*Gomphocarpus fruticosus*).

Pest Management

Surveys and control activities undertaken in 2021 indicate that feral pig numbers are continuing to decline. Wild Dog (*Canis lupus familiaris*) and Fox (*Vulpes vulpes*) take increased slightly during the 2021 baiting programs.

It must be recognised that pest fauna present are contiguous with the wider landscape, and effective management for control will require a coordinated approach with neighbouring landholders (particularly the neighbouring Department of Defence) to ensure the wider source populations are controlled to reasonable levels. The monitoring to date indicates pest species do not require any additional control efforts over those already prescribed in the BOMP and current management practices. In 2022 pest control activities will continue to be implemented with additional opportunistic management also undertaken in response to sightings or evidence of pest species presence. Planned pest management activities include wild dog and fox baiting in collaboration with LLS to maximise the effectiveness of the program, and kangaroo culling.

Habitat Augmentation & Revegetation

In 2022 revegetation works will continue at the Broke Road BOA with planting of 25 Ha (25,000 stems) of Central Hunter Grey Box Ironbark Woodland EEC.

General Management

Slashing of boundary fencing, tracks and annual weed infestations will be undertaken where feasible to minimise both bushfire risk and further spread of annual weeds.

Fence repairs will be undertaken on an as needs basis as identified through inspection programs.

6.7.2 Condran BOA

6.7.2.1 Environmental Management

Activities undertaken at the Condran BOA in 2021 included:

- Inspections of and repairs to boundary fences;
- Bushfire firebreak slashing;
- Weed controls works, focusing on St Johns Wort and Coolatai grass;
- Six monthly inspections; and
- Continuation of the ecological monitoring program established in 2013.

6.7.2.2 Monitoring Results

Flora

Monitoring in 2021 at the Condran BOA continued with the eight transects, consisting of six permanent monitoring transects established in 2013 and the two additional temporary revegetation plots established in 2018.

146 plant species (99 natives, 47 weeds) were recorded within the eight transects at the Condran BOA during 2021 surveys. Relative to 2020 data, there was a decreasing trend in species diversity of native species and weeds in 2021 except for the Grassland (Ironbark) MU (plots CON02G and CON03G) and Revegetation plot CON04R, This decrease is due to the growth of grasses impacting detection of smaller forbs and herbs during surveys, in addition to natural competition (access to light) between the grass species and these other growth forms. The revegetation transects survivorship increased at CON04R (>230%) and CON05R (220%) – the apparent increase was due to the adjustment of the transect position.

The existing population of *Diuris tricolor* (vulnerable, and an endangered population in the Muswellbrook Local Government Area (LGA)) persists within the BOA, with an increased detection rate evident in 2021 due to good rainfall. Collection of phenology data revealed that only 4% of *Diuris tricolor* individuals released seed from at least one mature capsule, and that grazing (invertebrate and vertebrate) and flower withering (from inclement weather or non-pollination) prevented capsule dehiscence in 47% of individuals. After two years of data collection, important insights are accruing in relation to successive flowering events of individuals from season to season, with 33 (41%) of *Diuris tricolor* individuals that flowered in 2020 not emerging or flowering in 2021. Conversely, of the 9 *Diuris* that did not progress past the leaf stage in 2020, 8 (89%) subsequently produced an inflorescence or flowered in 2021, two (22%) of which developed capsules. Comparative phenology monitoring of the co-occurring *Diuris sulphurea* displayed similar variability in emergence and fruiting, with a 700% increase in the number of individuals detected from 2020 (to 25 individuals). All of these progressed to flowering, yet only 4% successfully released seed (Bell, Murray & Sims 2022b).

Biometric data from the eight monitoring plots have been compared against benchmark values for the relevant PCTs present at Condran VCA: PCT 1605 (*Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter*) and PCT 1607 (*Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter*). For PCT 1605, NGCG, NGCO and Native Plant Species NPS for Ironbark exceed or approach benchmark values, but all other attributes are yet to be reached. Grassland data for PCT 1605 show NGCG and NGCO to be mostly exceeding benchmarks, while only NGCO reaches benchmark in the Revegetation MU within PCT 1605. For PCT 1607, NGCG, NGCO and NPS partly exceed benchmark for the Redgum MU (CON01F), but all other attributes are generally below.

Bulga Coal has targeted control and eradication of Coolatai Grass (*Hyparrhenia hirta*) from the Condran BOA, but given its presence in neighbouring lands, it will require follow-up control. Control strategies for these grass species are varied. CRC (2008) suggest that for small outbreaks of Coolatai Grass, manual removal of plants is most effective, preferably before seeding has occurred. For larger infestations, a combination of slashing or burning, followed by herbicide application is recommended. Crash grazing by domestic cattle is only effective when plants are young, as older plants are relatively unpalatable (Lodge et al. 2005).

Whisky Grass (*Andropogon Virginicus*) was observed to be dying back in some parts of the BOA as a result of targeted control and dry conditions during 2019. However, it does remain in the general locality ensuring ongoing recolonization, some minor spreading remains in the vicinity of transect CON03 in 2021, and all occurrences should continue to be monitored regularly. Spiny Rush (*Juncus acutus*) remains an issue along sections of the creek line although localized flood events in 2014 and 2016, drought from 2017 to 2019 and targeted removal has reduced its vigour and spread. Targeted treatment will continue to minimise the spread of these species.

A few clumps of African Love Grass (*Eragrostis curvula*) were present within the *Diuris tricolor* population on the western boundary of the Condran BOA. It is strongly recommended that these individuals be located and carefully extracted by hand (to avoid unnecessary disturbance to orchid tubers) before they spread further across this area.

Red Natal Grass (*Melinis repens*) is problematic mainly in and around the threatened *Diuris tricolor* population, which presents additional challenges for its control. Regular low intensity fire may be effective and should be trialled to reduce this threat.

Blady Grass (*Imperata cylindrica*) has become invasive in some of the cleared portions of Condran, particularly in the east. Although a native species, it is uncommon in the Upper Hunter and tends to occur only in disturbed landscapes. Early reporting for Condran made note of the possible expansion of the species and the suppression of other native grassland species, and it may be timely to commence trialing the treatment of this species in combination with before-and-after monitoring trials.

For Condran BOA, it is recommended that an ecological and cultural fire management plan be prepared that will initially introduce fire into the landscapes with regular burns in grassy woodlands every 2-3 years, pending appropriate conditions (Bell, Murray & Sims 2022b).

Bulga Coal will address recommendations of specialist consultants according to priority in 2022, through the development of a weed management strategy.

Fauna

30 bird species were recorded by diurnal census in 2021 which compares with 29 species in 2020, 49 species in 2019 and 27 species in 2018. This was a slight increase from 2020 and a significant decrease from 2019, despite the property recovering from severe drought in the previous 5 years. Very high honeyeater activity was observed in Forest Red Gum (*Eucalyptus tereticornis*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) (particularly at site ConFA2), with several species competing for the resource. The Wedge-tailed Eagle pair again raised a young chick in the nest at Condran VCA in 2021. This pair has raised a new chick each year for the past 5 years.

Two vulnerable bird species (listed under the *Biodiversity Conservation Act 2016*) were recorded in 2021, the Speckled Warbler (*Chthonicola sagittate*) and Grey-crowned Babbler (*Pomatostomus temporalis*). Both species have previously been recorded nesting at Condran BOA.

The Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*) and Common Wallaroo (*Macropus robustus*) were observed during 2021

Note that the absence of non-native mammals is due to theft of remote field cameras; cameras are effective in the detection of a range of native and introduced mammal species, as well as other fauna groups (Bell, Murray & Sims 2022b).

No Arboreal species were detected in Condran BOA in 2021.

Two microbat species Eastern Bent-wing Bat (*Miniopterus schreibersii)* and Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) were recorded at Condran VCA in 2021 by echolocation call recordings of which had previously been recorded within the Condran BOA. The low abundance and diversity of microbat species is likely associated with the very cold nocturnal temperatures experienced during the late September 2021 survey.

Since 2019, microbat activity as determined by echolocation call recordings has significantly reduced to previous monitoring periods. The consistent low recordings at Condran VCA across three monitoring years (2019 – 2021) is likely a combination of influences, including weather conditions such as those experienced in 2021. Survey design may also influence the ability to document higher microbat species diversity.

Performance against Criteria

During 2021, 14 of the 16 performance indicators were met. One was not applicable and one failed to achieve the specific criteria.

Progress against 2021 performance indicators, Condran VCA, as detailed in BOMP is shown in **Appendix C**.

6.7.2.3 Implemented/Proposed Improvements

Weeds

During 2022 weed control in Condran BOA will focus on targeting Coolatai grass (*Hyparrhenia hirta*), Sweet Briar, Red Natal Grass (*Melinis repens*), African Love Grass (*Eragrostis curvula*), Whisky Grass (*Andropogon Virginicus*) and Spiny Rush (*Juncus acutus*).

Pest Animals

Based on long term monitoring of the Condran BOA by field cameras, the presence of introduced pest animals is considered low. Pest species that do occur at the Condran BOA are part of the wider surrounding landscape and will require a co-operative approach with input from several stakeholders to manage effectively. It is not considered that the pest species present are adversely affecting the quality of the existing or regenerating vegetation, or native fauna populations at the Condran BOA.

During 2022 Bulga will aim to align timing of wild dog and fox baiting programs at Condran with the LLS aerial baiting program and neighbouring land holders to maximise the effectiveness of the program. In addition to this other pest species will be controlled on an as needs basis based on inspection and monitoring outcomes.

6.7.3 Reedy Valley BOA

6.7.3.1 Environmental Management

The activities undertaken at the Reedy Valley BOA in 2021 included:

- Feral animal control continued in conjunction with the wider program being completed by Local Land Services (LLS) and surrounding property owners. Wild Dog (*Canis lupus familiarise*) and feral animal baiting during autumn resulted in 10 wild dog, 10 pig and 28 fox takes;
- Revegetation planting of 18.6 Ha (18600 stems) of Central Hunter Grey Box Ironbark Woodland EEC, and 4.7 Ha (4,700 stems) of White Box – Yellow Box – Blakely's Red Gum Woodland CEEC;

- One six-monthly inspection was completed in 2021 with the second inspection unable to be undertaken due to high rainfall and flooding washing out access; and
- Ongoing ecological monitoring.

It is noted that the ongoing ecological monitoring program could not be completed in 2021 due to high rainfall and flooding.

6.7.3.2 Implemented/Proposed Improvements

Pest Management

Bulga will aim to align timing of wild dog and fox baiting programs at Reedy Valley with the LLS aerial baiting program in 2022 to maximise the effectiveness of the program. Ongoing inspections and monitoring will determine if cattle and other pest species persist, including feral pigs, deer, fox and goat which have been sighted at elevated and riparian parts of the offset.

Management of some of these pests, particularly in the rocky outcrop parts of the site will be difficult due to the terrain and abundance of source populations in adjoining properties.

Weed Management

During 2022 weed management will focus on priority weeds as identified during previous monitoring and inspection programs including; African Boxthorn, African Olive, St Johns Wort and Sweet Briar, with follow up treatment of Prickly Pear and Tiger Pear.

Due to the remote nature of the property and difficult terrain, Bulga is investigating the use of remote sensing technology to obtain a better understanding of weed presence and extents with the objective of improving the current weed management strategy.

Habitat Augmentation & Revegetation

In 2022 revegetation works will continue at the Reedy Valley BOA with planting of 5 Ha (5,000 stems) of White Box – Yellow Box – Blakely's Red Gum Woodland, and 18.6 Ha (18,600 stems) of Central Hunter Grey Box Ironbark Woodland EEC.

General Management

Due to significant rainfall and flooding access has been washed out tracks have become eroded and overgrown. During 2022 works will be undertaken to restore access across existing tracks throughout the offset.

Slashing of boundary fencing, tracks and annual weed infestations will be undertaken where feasible to minimise both bushfire risk and further spread of annual weeds.

Fence repairs will be undertaken on an as needs basis as identified through inspection programs.

6.7.4 Wollombi Brook Conservation Area

6.7.4.1 Environmental Management

The activities undertaken at the Wollombi Brook Conservation Area in 2021 included:

- Weed control works focussing on:
  - Prickly Pear (Cylindropuntia spp);
  - African Love Grass (Eragrostis curvula);
  - Guinea Grass (Megathyrsus maximus);
  - Galenia (Galenia pubescens);
  - Tiger Pear (Opuntia aurantiaca);
  - Balloon vine (Cardiospermum grandiflorum);
  - Moth Vine (Araujia sericifera);
  - Green cestrum (Cestrum parqui); and
  - Lantana (Lantana spp).
- Monitoring of trial plots to establish the effectiveness of thinning bulloak (*Allocasuaina luehmannii*) and tea-tree (*Leptospermum polyanthum*) species;
- Bushfire firebreak slashing;
- Installation of boundary gate;
- Construction of the Teaching Keeping Place facility;
- Wild dog and fox baiting autumn and spring months (5 wild dogs, 1 Fox (*Vulpes vulpes*) take);
- Noisy Miner culling;
- Revegetation planting of 4.9 Ha (4,900 stems) of Central Hunter Grey Box Ironbark Woodland EEC;
- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.4.2 Monitoring Results

Flora

Monitoring in 2021 at the Wollombi Brook Conservation Area continued within the eight transects, consisting of six permanent monitoring transects established in 2015 and two new temporary revegetation plots established in 2019.

Relative to 2020, there was an increasing trend in diversity of native species and weeds in 2021, in response to better growing conditions. In total, 109 plant species (79 native and 30 weeds) were recorded within the eight transects compared with 82 natives and 39 weed species in 2020, and 63 natives and 23 weeds in 2019. No new threatened plant species were recorded in 2021.

Biometric data from the six monitoring plots have been compared against benchmark values for the two PCTs present at Wollombi Brook Conservation Area: PCT 1605 (Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter) and PCT 1658 (Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area).

For PCT 1605, only NGCG and NGCO for transect WOL02F or WOL02G exceed benchmark values, but all other attributes are yet to meet them (although NPS is close). For PCT 1658, NGCS benchmark values are exceeded for WOL03G and NGCO for all transects, while benchmarks are approached for Native Over-storey Cover (NOS) for WOL03F and WOL01F. Number of Tree Hollows (NTH) and Fallen Logs (FL) for both PCTS are well below benchmark for all but WOL03F, but both will take considerable time to improve. For Revegetation transect WOL04R (also allocated to PCT 1658), only NGCO exceeds benchmark values, while NGCG and NPS approach benchmark. Progress on natural regeneration of Warkworth Sands Woodland within the experimental thinning plots has been slow due to drought occurring between 2017 and 2019, returning variable results within plots relative to Target and Unthinned controls. Better growing conditions from 2020 to 2021 have resulted in encouraging trends in the recovery of thinned areas of both Bulloak and Ti-tree. After 64 months, the mean floristic diversity of native species in Thinned plots of both Bulloak and Ti-Tree is now higher than Unthinned plots, and for Bulloak this number is close to the Target diversity. For both groups, remnant vegetation without dense stands of Bulloak or Ti-tree support the highest overall species diversity within their respective groups, and after 64 months Thinned plots are more diverse than Unthinned plots for both Bulloak and Ti-tree. One Thinned plot (TI_THIN02) is now approaching the floristic composition of its desired target community, forming a significant split away from previous samples. The absence of similar significant changes in the Target control samples (TI_TARG01 and TI_TARG02) over the same time period suggests that these changes may be the direct result of recovery following thinning.

Noticeable weeds dominating the grassland and regenerating areas of Warkworth Sands Woodland in 2020 including:

- Red Natal Grass (*Melinis repens*);
- Mexican Clover (*Richardia brasiliensis, R. stellaris*);
- African Love Grass (*Eragrostis curvula*);
- Prickly Pear (*Cylindropuntia spp*); and
- Blue heliotrope (*Heliotrope amplexicaule*).

No problematic exotic woody weeds species were noted within the Wollombi Brook Conservation Area.

Key diagnostic understorey species for Warkworth Sands Woodland continue to flourish within grassland and shrubland monitoring transects in the absence of stock grazing pressures. These include:

- Comet Grass (Perotis rara);
- Large copper-wire daisy (Podolepis canescens); and
- Mountain grevillea (Grevillea montana).

Survivorship of revegetation areas increased overall during 2021. WOL01R counts of live individuals in 2021 found a significant increase in stems, however on review this was due to copious natural recruitment of nearby mature Angophora floribunda and not planted stock. Eight out of the ten species planted were still present. WOL04R has increased slightly (possibly due to the same Angophora recruitment event) but is otherwise stable. Nine of the ten species planted were still present.

For Wollombi Brook Conservation Area, it is recommended that an ecological and cultural fire management plan be prepared that will initially introduce fire into the landscapes with regular burns in grassy woodlands every 2-3 years, pending appropriate conditions (Bell, Murray & Sims 2022d).

Fauna

A total of 57 bird species were recorded at the Wollombi Brook Conservation Area by census survey in 2021 This is a decrease compared to previous years.

Notable was the presence of Noisy Miner populations at most sites, despite an annual cull of this competitive species in 2019 and 2020. Many factors can contribute to a low bird diversity score, such as time of day the census survey is conducted, climatic conditions, abundance of foraging resources such as pollen, nectar, mistletoe and insects, and seasonal influences on species presence. The Spring 1 census survey failed to detect several summer migrant species that are typically present at Wollombi Brook Conservation Area. However, by the second Spring survey they were present in the study area.

One new species was detected in 2021, Yellow-tufted Honeyeater (*Lichenostomus melanops*). This species was observed feeding on flowering Broad-leaved Ironbark (*Eucalyptus fibrosa*) along Charlton Road adjacent to the access gate into Wollombi Brook VCA.

In 2021, two vulnerable bird species listed under the *Biodiversity Conservation Act 2016* were recorded:

- Grey-crowned Babbler (*Pomatostomus temporalis*); and
- Speckled Warbler (*Chthonicola sagittate*).

Wollombi Brook Conservation Area recorded the following larger mamals, the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*), Bare-nosed Wombat wild dog (*Canis lupus*), Fox (*Vulpes vulpes*), and Pig (*Sus scrofa*). The Common Brushtail Possum (*Trichosurus vulpecula*), Brown Hare (*Lepus capensis*) and European Rabbit (*Oryctolagus cuniculus*) were also identified.

Echolocation calls of microchiropteran bat species recorded the presence of eleven bat species in 2021. These included the vulnerable (under the *Biodiversity Conservation Act 2016*) Eastern Coastal Freetailed-Bat (*Micronomus norfolkensis*), Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis)* and Little Bent-wing Bat (*Miniopterus australis*).

Two reptiles, the Red-bellied Black-snake (*Pseudechis porphyriacus*) and Bearded Dragon (*Pogona barbata*) were recorded in 2021 (Bell, Murray & Sims 2022d). Frog activity was very limited in 2021, with a small dam near WB02 supporting a low abundance of calling frogs in September 2021. Reptile abundance and diversity is limited at Wollombi Brook due to a number of factors, including absence of structured ground litter such as logs, rock piles and fallen trees, high degree of past disturbance to the area, and general absence of mature habitat features such as large trees with hollows.

Feral animal presence was low in 2021. Through camera monitoring, opportunistic observations and nocturnal spotlight searches Pig (*Sus scrofa*), Fox (*Vulpes vulpes*), Wild Dog (*Canis lupus*), Brown Hare (*Lepus capensis*) and European Rabbit (*Oryctolagus cuniculus*) were recorded.

The presence of pests that may occur in the Wollombi Brook Conservation Area will be wide-ranging and present in the surrounding landscape. Therefore, permanent prevention will be difficult but intensive targeted management can be undertaken to minimise pests to the area. This would be especially beneficial to reduce the damage to replanting and regeneration.

Performance against Criteria

During 2021, 14 of the 17 performance indicators were met. One was not applicable and two failed to achieve the specific criteria.

Progress against 2021 performance indicators for Wollombi Brook Conservation Area, as detailed in BOMP is shown in **Appendix C**.

6.7.4.3 Implemented/Proposed Improvements

Weeds

The 2022 weed management program will focus on four key invasive species Weeping Lovegrass (*Eragrostis curvula*), Natal Grass (*Melinis repens*), Eastern prickly pear (*Opuntia humifusa*) and Blue Heliotrope (*Heliotropium amplexicaule),* Balloon Vine (*Cardiospermum grandiflorum*) as a priority. With additional management and monitoring of exotic herbs to ensure their persistence and spread is prevented.

The experimental thinning trial established in Warkworth Sands Woodland to combat the invasion of the native woody shrub *Leptospermum polyanthum* and the native small tree bulloak (*Allocasuarina luehmannii*) has shown only limited and variable results after 64 months. Although encouraging, recolonization by native shrubs, grasses and herbs has been delayed within monitoring plots, and likely exacerbated by the drought between 2017- 2019. Wetter conditions from 2020 to 2021 have allowed important developing trends to be realized, including the recording of higher overall species diversity in Thinned monitoring plots compared to Unthinned plots, and progression away from Unthinned plots and towards Target plots in floristic composition of some plots. Continued monitoring of these trends will occur, together with more widespread thinning of problem woody species in 2022 to benefit the endangered communities present.

An ecological and cultural cool burn will be trialled at WBCA in 2022, the program will incorporate pre and post ecological monitoring to document the effect the trial has on native vegetation and weed suppression. Following the trial Bulga plans to refine the methodology and broaden the scope to utilise cool burns at other offset properties.

Pest Management

Noisy miners have significant impact on the endangered Regent Honeyeater through competition for food and breeding habitat. Without control measures taking place within WBCA Noisy Miners could contribute to the reduction and possible extinction of the endangered Regent Honeyeater within the area. In 2021 the Noisy Miner cull trial continued achieving control of 11 Noisy miner birds. In 2022 monitoring of populations will be undertaken through the annual fauna monitoring program to assess whether the program was effective in reducing population numbers and determine whether future control programs are required.

In 2022 pest control activities will continue to be implemented with additional opportunistic management also undertaken in response to sightings or evidence of pest species presence. Planned pest management activies include wild dog and fox baiting in collaboration with LLS to maximise the effectiveness of the program and kangaroo culling.

Habitat Augmentation & Revegetation

In 2022 revegetation works will continue at the Wollombi Brook Conservation Area with planting of 5 Ha (5,000 stems) of Central Hunter Grey Box Ironbark Woodland EEC, and 3.5 Ha of Warkworth Sands Woodland EEC.

General Management

Slashing of boundary fencing, tracks and annual weed infestations will be undertaken where feasible to minimise both bushfire risk and further spread of annual weeds.

Fence repairs will be undertaken on an as needs basis as identified through inspection programs.

6.7.5 Weeping Myall Management Areas

6.7.5.1 Environmental Management

The activities that were undertaken within the two Weeping Myall Management Areas (WMMAs) during 2021 included:

- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.5.2 Monitoring Results

Monitoring of Weeping Myall within the two WMMAs during 2021 has revealed few changes to either *Acacia pendula* individuals or the landscapes in which they occur, and most plants are in good health. Extensive coppice growth from root suckers is continuing to occur in both Management Areas, but there remains no evidence of successful flowering, fruiting or new recruitment. Mistletoe continues to infest the larger individuals in WMMA # 2, but apart from the senescence of one individual during recent drought (which will likely resprout from root suckers), it does not appear to be having additional impact on the species.

Overall, floristic diversity and abundance within the two monitoring plots showed stability in both native and weed species in 2021 when compared to previous years. Changes in diversity and abundance are a normal feature of grassy woodland environments, as variability in the timing and amount of rainfall influences species presence and detection. Numerical analysis of floristic compositions within these two plots over seven seasons showed significant differences in the diversity and abundance of species relative to rainfall received, with observable differences in the dry years of 2017 to 2019 compared to the wetter years of 2015-2016 and 2020-2021. Thirty-six months after establishment, there has been an increase of up to 15% in the number of *Acacia pendula* stems evident within the growth monitoring plots established in 2018, but reductions of up to 20% across all 6 plots over this period. These reductions may be an artefact of sampling, as dense ground layer growth over the past two seasons prevented detection of some young *Acacia pendula* stems, particularly in Grassy Woodland where reductions of 20% were evident (cf. increases of up to 31% in 2020). The maximum height of Acacia within plots ranged from 1.9 to 2.5 m in 2021, showing a continuing increasing trend from baseline data in 2018 (1.0 – 1.6 m). Species diversity within all plots returned to 2018 baseline levels for native species and exceeds them for weeds. Four years into this experiment, there are no significant differences in floristic composition between areas supporting developing stands of *Acacia pendula* and those where this species is absent (in either Grassland, Bare Woodland or Grassy Woodland), however analysis is complicated by large seasonal changes in rainfall. Over time, as thickets increase in size and number of stems, decreases in diversity and abundance are expected to occur (Bell 2022).

Note the Weeping Myall Management Area Plan does not contain performance indicators.

6.7.5.3 Implemented/Proposed Improvements

Monitoring

Bulga Coal will continue to monitor the WMMAs to address the general health of Weeping Myall plants, together with annual re-surveying of the floristic composition within the two monitoring plots, and counts of *Acacia pendula* stems and floristic composition within the twelve growth monitoring plots. Additionally, the following recommendations will be implemented:

- Monitor prevalence of Saffron Thistle within WMMA # 2 and remove plants as necessary;
- Continue to informally monitor for flowering on individual *Acacia pendula* trees, in the event that a repeat flowering event occurs over the next twelve months;
- Continue to informally monitor the impact of mistletoes on older individuals of *Acacia pendula* within WMMA # 2; and
- Monitor activity by Feral pigs within WMMA # 2, and trap or bait where appropriate.

6.7.6 Vere Offset

During November 2021 a land management inspection was conducted at the proposed Vere Offset to establish future actions at the site including weed management, pest management and maintenance.

Key recommendations from *The Vere Offset Area Property Inspection Report* (Enright Land Management, 2021) are summarised below:

- Repair and install fences;
- Consider structural restoration maintenance of infrastructure (general condition of any sheds, stockyards);
- Treat weeds including *Acacia Saligna,* Lantana (*Lantana camara*), African Boxthorn (*Lycium ferocissimum*), Blackberry (*Rubus fruiticosus*), Pampas Grass (*Cortaderia selloana*) Green Cestrum (*Cestrum parqui)*, Senna (*Senna pendula)*, Stone Fruit (*Prunus species*), and Oleander (*Nerium oleander)*, Galenia (*Galenia pubescens*), Tree Tobacco (*Nicotiana glauca*), Cotton Bush (*Gomphocarpus fruiticosus)*, Prickly Pear (*Cylindropuntia species)* and general seasonal weeds;
- Complete bi-annual baiting and trapping programs to control wild dogs and foxes;
- Complete pig and feral cat trapping;
- Complete open range shooting to manage foxes, rabbits, pigs and other vertebrate pests observed;
- Maintain tracks;
- Remove rubbish; and
- Monitor erosion in gullies and dams on the property.

6.8 Weeds and Pests

6.8.1 Environmental Management

An ongoing weed control program was carried out by licenced contractors. Annual buffer land inspections monitor success of any previous weed control and identify areas which will require additional treatment.

A land management contractor was engaged by Bulga Coal to undertake vertebrate pest control programs in Autumn, Spring and Summer of 2021 in conjunction with the coordinated program being organised by LLS. As part of the program, 1080 baiting was conducted, targeting Wild dog (*Canis lupus familiaris*) and fox (*Vulpes vulpes*) populations within the landholdings. Additionally, soft jaw trapping was conducted in September 2021. Pig trapping was conducted in June, July, August, November and December targeting populations onsite travelling through buffer lands and Broke Road Biodiversity Offset Area. As part of feral pest management in 2021 75 kangaroos were shot and carcases supplied to Devils Ark.

6.8.2 Environmental Performance

Annual buffer land inspections generally indicate that weed management is successful, but ongoing monitoring and treatment is required to prevent further infestations.

The 1080 baiting program was successful as shown by the number of baits taken. The Autumn program included a total of 261 baits laid with a total of 106 baits taken, which represented 41% of the available baits and an increase on the 2020 results. The Spring baiting program had 46 baits taken by target species which represented 24% of the available baits. This was higher than the previous year's results which was 19%. In addition to 1080 baiting soft jaw trapping was undertaken to control bait shy wild dogs, an additional 2 wild dogs and 2 foxes were managed through this additional control method.

Open range shooting was undertaken in 2021 for the control of Eastern Grey Kangaroos across buffer land areas, with a total of 18 Eastern Greys dispatched.

6.8.3 Implemented/Proposed Improvements

Weed management will focus on the recommendations from the Annual Weed Action Plan. Monitoring inspections will continue, and further vertebrate pest control will be undertaken during 2022.

6.9 Archaeology and Heritage

6.9.1 Environmental Management

Bulga Coal continues to work with the Registered Aboriginal Parties (RAPs) regarding aspects of Aboriginal heritage and the implementation of the *Bulga Coal Aboriginal Cultural Heritage Management Plan* (ACHMP).

Bulga Coal manages European (historical) heritage through the implementation of the *Historic Heritage Management Plan* (HHMP).

6.9.2 Environmental Performance

6.9.2.1 2021 Quarterly Monitoring

A program for quarterly monitoring of Aboriginal heritage sites began in 2013 at Bulga Coal. Bulga Coal continued to monitor Aboriginal heritage sites in conjunction with (up to) four Registered Aboriginal Parties (RAP)s and an OzArk archaeologist in 2021. Quarterly monitoring reports are available on the Bulga Coal website and the results are summarised as:

- Quarter 1 monitoring was undertaken on 10 March 2021. The inspection included review of sites primarily within the Wollombi Brook Conservation Area and at the Loders Creek Grinding Grooves Conservation Area (refer to **Section 6.9.2.5**).
- Quarter 2 monitoring was undertaken on 25 May 2021, this included a review of sites to the west of Charlton Road;
- Quarter 4 monitoring was undertaken on 15 September 2021. This monitoring was focused on sites to the southwest of Bulga Coal (south of Broke Road); and
- Quarter 4 monitoring occurred on 11 November 2021. This monitoring was focused on sites to the northeast of Bulga Coal.

6.9.2.2 New Aboriginal Heritage Sites

There were no newly recorded Aboriginal heritage sites recorded in 2021.

6.9.2.3 Salvages During 2021

On 10 March 2021, an additional salvage of three sites at BOP SC-8 (37-6-2852) occurred. The three sites were within the site extent of BOP SC-8 (37-6-2852) and were recorded during the Quarter 4 2020 monitoring program. BOP SC-8 (37-6-2852) had previously been salvaged during the Bulga Optimisation Project (SSD-4960) salvage program in 2015. The three sites were within the approved disturbance area and were either in danger of being harmed by approved mining activity or by erosion. Therefore, they were salvaged in accordance with the ACHMP.

6.9.2.4 Wollombi Brook Conservation Agreement Area

The Wollombi Brook Conservation Area is both a biodiversity offset area and an Aboriginal and Cultural Heritage Offset Area. Heritage is managed in accordance with the *Wollombi Brook Plan of Management* (Appendix J of the ACHMP). Land management is undertaken in accordance with the BOMP.

The Minimbah Teaching Place was built in 2021 (**Photo 1**). The facility is located in the Conservation Area and will be available for the community and tourists to learn about local Aboriginal history. It will also store salvaged artefacts from Bulga Coal, as well as United Wambo and Mt Owen Glendell Operations. There is access to the waterhole at the Wollombi Brook and interpretive signage telling the Wonnarua story.

On 15 December 2021 the Annual Aboriginal Stakeholder meeting was held at the Minimbah Teaching Place (**Photo 2**), to celebrate the completion of the building. Bulga Coal will continue to work with the Aboriginal community on projects including bush tucker gardens, walking trails, signage and educational resources.

Photo 1 Minimbah Teaching Place

Photo 2 Annual Stakeholder Meeting at the Minimbah Teaching Place

6.9.2.5 Loders Creek Grinding Grooves Conservation Area

Photographic monitoring of the Loders Creek Grinding Grooves Conservation Area (LCGGCA) occurs annually, and the site is monitored once a year as part of the Quarterly Monitoring Program. In March 2021, the four fixed photo points were photographed to monitor the condition of the Loders Creek Grinding Grooves. There are 5 main groups of grooves within the site (Groups A to E). The site was originally photographed in September 2015 following the relocation, and annually between 2017 and 2021. **Photo 3**, **Photo 4**, **Photo 5**, **Photo 6** and **Photo 7** present the 2017 to 2021 condition from Photo Point 3 for comparison. Results are summarised below:

- **Group A**

  The slabs are stable apart from one area where a layer of sandstone is exfoliating. This portion of the slab appears not to be detaching further but is becoming more weathered. Generally, the grooves are slowly becoming less distinct although this remains a marginal change.

- **Group B**

  The slabs are stable apart from cracks within the slabs. There has been no discernible increase in the width of the cracks.

- **Group C**

  Slabs are stable apart from the pre-existing cracks between the slabs. There has been no discernible increase in the width of the cracks.

- **Group D**

  Slab is stable with no sign of exfoliation or cracking. There has been discernible weathering of the area surround the groove.

- **Group E**

  There has been no discernible weathering of the areas surrounding the grooves since the relocation occurred. In 2019 some exfoliation of small portions of the rock from the edge of the slab was noticed. These portions did not appear to have worsened in the intervening years.

Photo 3 LCGGCA Photographic Monitoring – 2017 view from Photo Point 3

Photo 4 LCGGCA Photographic Monitoring – 2018 view from Photo Point 3

Photo 5 LCGGCA Photographic Monitoring – 2019 view from Photo Point 3

Photo 6 LCGGCA Photographic Monitoring – 2020 view from Photo Point 3

Photo 7 LCGGCA Photographic Monitoring – 2021 view from Photo Point 3

6.9.3 Historic Heritage – Blasts Assessments

Structural assessments were undertaken at Monkey Place Creek Stone Wall, Broke Cemetery; 'Charlton' Homestead, St Andrews Anglican Church and Mt Leonard Homestead to determine any blasting impacts in accordance with the HHMP. The assessments are carried out annually by a structural engineer. The reports indicate there have been no noticeable changes from blast impacts.

6.9.3.1 Incidents

No heritage related incidents occurred during 2021.

6.9.4 Implemented/Proposed Improvements

The Minimbah Teaching Place was built in 2021 (refer to **Section 4.4.3** and **Section 6.9.2.4)**.

The ACHMP and HHMP were both revised and submitted to DPIE in November 2020 and are awaiting approval. Key changes in the ACHMP include the removal of the Steering Committee and salvaging artefacts within the Mod 3 disturbance area. Key changes to the HHMP include:

- Updates to reflect the current status of sites and work that is complete;
- Revision of the schedule for structural assessments; and
- Updates to reflect the cessation of Bulga Underground mining.

6.10 Visual and Lighting

6.10.1 Environmental Management

Control strategies are implemented to reduce potential visual and light related impacts associated with mining operations. Management is undertaken in accordance with the *Bulga Lighting Plant Procedure* and the *Visual Impact Management Plan* which was revised in 2020 and was approved by DPIE on 30 June 2021.

Visual and lighting impacts are assessed through monitoring and inspection regimes. Onsite monitoring includes assessments of lighting impacts, compliance with Development Consent conditions and the angle at which light is emitted from lamps and luminaries, glare, spill and sky glow.

An independent visual and lighting review of Bulga Coal was completed in 2021 to assess compliance against the lighting and visual amenity requirements. The assessment confirmed operations are generally being undertaken to minimise external visual and lighting impacts, in accordance with the relevant obligations of SSD-4960 and DA 376-8-2003.

6.10.2 Environmental Performance

Potential lighting impacts are assessed as part of the overburden dump design process. Dumps are orientated, where practicable, and windrows or bunds are designed and constructed to mitigate lighting impacts.

A sensitive lighting receiver map is updated and communicated to mining personnel prior to commencing exposed dumps that have the potential to cause lighting impacts offsite.

6.11 Spontaneous Combustion

6.11.1 Environmental Management

Spontaneous combustion is managed in accordance with the *Spontaneous Combustion Management Plan*. Inspections of potentially affected areas are conducted during each shift. Spontaneous combustion incidents at Bulga Coal are predominantly associated with coal stockpiles.

Portable gas monitoring units are used by units working in areas of spontaneous combustion or where toxic gases are suspected of being present. This is for the purpose of identifying the presence of spontaneous combustion and any potential increase in risk.

6.11.2 Environmental Performance

Two incidences of spontaneous combustion occurred in 2021; one in the old Vaux Pit in February and one in the Main Pit (Ramp 22) in November. In both incidences the hot material was treated as per the *Spontaneous Combustion Management Plan*.

6.12 Bushfire

6.12.1 Environmental Management

Bushfire management strategies and monitoring are undertaken at Bulga Coal in accordance with the *Bushfire Management Plan* which was updated in October 2021. The contact details of key personnel were updated and the revised documents were provided to the Rural Fire Service (RFS).

The following activities were undertaken during the reporting period:

- Consultation with RFS to provide the latest version of the Bushfire Management Plan;
- Annual fire season review completed including currency of contacts and refuge points, GIS database and works required prior to Bushfire Season;
- Monitoring of fuel loads in areas that adjoin Charlton Road and the former Broke Road, private property boundaries, tenanted properties and mine owned assets;
- Monitoring of tracks and trails within the Bulga Coal colliery holding to ensure these remain accessible by checking for fallen logs, erosion or other signs of trail degradation;
- Monitoring of weather conditions; and
- Hazard reduction measures were implemented including slashing powerline easements, access tracks and boundaries of adjoining land holdings.

6.12.2 Environmental Performance

No bushfires were recorded on the site.

6.12.3 Implemented/Proposed Improvements

Bulga Coal continued to maintain existing fire breaks and monitor fuel loads.

6.13 Methane Drainage, Mine Ventilation and Greenhouse Gas Emissions

6.13.1 Environmental Management

Bulga Coal use both pre-mining and post-mining gas drainage to provide a safer, more productive mining environment. Pre-mining drainage wells extract methane and carbon dioxide from the coal seams which is piped to the 9 Megawatt (MW) gas fired power station and Pre-drainage Flaring Facility where it is burned and converted to carbon dioxide. A small amount of coal seam water is also extracted from the pre-drainage wells as a by-product of gas production. All coal seam water is contained within the Bulga Coal water management system.

Post-mining drainage methane and carbon dioxide is extracted from the mined out goaf and is sent to the Post-drainage Flaring Facility for combustion of the methane. This conversion of coal seam methane gas to carbon dioxide gas and water substantially reduces greenhouse gas emissions from the Bulga Underground Operations.

Methane and carbon dioxide levels are measured in the gas drainage operations. The gas drainage operations have monitoring at the gas wells, flaring facilities and the 9 MW power station. The gas composition and flow rate are trended in the site's continuous monitoring system, and long-term data stored offsite in a database.

Bulga Coal calculates greenhouse gas emissions by utilising industry standard factors for diesel usage and explosives, and site-specific factors for fugitive emissions from mining coal, and operates in accordance with the *Air Quality and Greenhouse Gas Management Plan*.

Greenhouse gas emissions are shown in **Table 33**. The emissions have been estimated using the methods specified in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* and reported in accordance with the *National Greenhouse and Energy Reporting Act 2007*.

Table 33 Bulga Coal Greenhouse Gas Emissions (Scope 1 and 2 Direct Emissions)

Emissions Source Electricity consumption (grid)	Bulga Open Cut ($t CO_2$-e)			Bulga Underground Operations ($t CO_2$-e)		
	2018/2019	2019/2020	2020/2021	2018/2019	2019/2020	2020/2021
Fossil Fuel	210,690	219,659	204,334	6	6	6
Fugitive Emission - Post Mining	440,123	315,048	165,008	-	-	-
Fugitive Emission - Extraction of Coal/Flaring/Electricity Generation	-	-	-	211,722	142,027	93,528
Decommissioned Mine	-	-	-	123,766	70,765	53,738
Total Scope 1 Emissions	***650,813***	***534,707***	***369,342***	***335,494***	***212,798***	***147,272***
Electricity from Grid	64,321	51,323	42,369	382	350	51
Total Scope 2 Emissions	***64,321***	***51,323***	***42,369***	***382***	***350***	***51***
Total Emissions (Scope 1 and 2)	**715,134**	**586,030**	**411,711**	**335,876**	**213,148**	**147,323**

Note - 'Post Mining' refers to emissions released from the extraction of ROM and associated gas bearing strata, applicable to the open cut. 'Extraction of Coal' refers to the unabated emissions from the extraction of coal in the underground.

Overall, there was a decrease in Bulga Open Cut emissions of approximately 30% when compared to the 2019/2020 reporting period. The majority of the decrease is attributable to fugitive emissions from ROM coal. Over the 2020/2021 period Bulga mined coal in areas of the mine which have lower gas zones compared to the 2019/2020 period.

Emissions from Bulga Underground Operations were approximately 31% lower during 2020/2021 when compared to the previous reporting period. This is due to the cessation of Bulga Underground mining in 2018 which has resulted in a continued reduction in flaring and dissipation of gases.

6.13.2 Comparison against Predictions

6.13.2.1 Bulga Underground Operations

The annual average emissions from gas drainage and ventilation sources at the Bulga Underground Operations, based on the 2007 Blakefield South Statement of Environmental Effects (SEE) were predicted to be 1,415,362 CO_2-e. The considerable difference between the 2007 SEE prediction and the 2020/2021 result is due to the cessation of underground mining at Blakefield South Mine in May 2018.

6.13.2.2 Bulga Open Cut

A Greenhouse Gas and Energy Assessment was prepared by Umwelt (2012) as a component of the Bulga Optimisation Project EIS. A comparison against the predictions of the Greenhouse Gas and Energy Assessment is included in **Table 34.**

Table 34 Comparison of 2020/2021 Scope 1 and 2 Greenhouse Gas Emissions against Bulga Optimisation Project maximum Annual Predictions

Scope	Source	Predicted Source Totals (t CO_2-e)	Predicted Scope Totals (t CO_2-e)	20/21 Data (t CO_2-e)	20/21 Totals (t CO_2-e)
Scope 1 (Direct)	Diesel use	240,885	1,011,888	204,334	369,342

Scope	Source	Predicted Source Totals (t CO_2-e)	Predicted Scope Totals (t CO_2-e)	20/21 Data (t CO_2-e)	20/21 Totals (t CO_2-e)
	Fugitive emissions	771,003		165,008	
Scope 2 (Indirect)	Electricity	55,042	55,042	42,369	42,369
Total Annual Operation			**1,066,930**		**411,711**

Predictions represent the maximum annual greenhouse gas emissions for Bulga Coal during operations, hence both Scope 1 and Scope 2 emissions were lower than predicted. Overall, greenhouse emissions were approximately 61% lower than predicted in the Bulga Optimisation Project EIS. This is due to the predictions in the EIS being based upon Method 1 which specifies the use of designated emission factors in the estimation of emissions. Bulga Coal has since adopted Method 2 which is an industry-specific method using site sampling in order to gain more accurate estimates for emissions. Therefore, the emissions are being calculated more accurately, which is resulting in lower than predicted fugitive emissions.

6.13.3 Implemented/Proposed Improvements

Under DA 376-8-2003 Schedule 4 Condition 7D and 7E following MOD 7 approval, the *Bulga Coal Gas Drainage Management Plan* was submitted to the DPIE and this was approved on 8 July 2021. The plan applies to the ongoing operation of Bulga Underground and associated gas drainage infrastructure.

6.14 Hydrocarbon Management

6.14.1 Environmental Management

Controls implemented to manage the risk of hydrocarbon related impacts are conducted under:

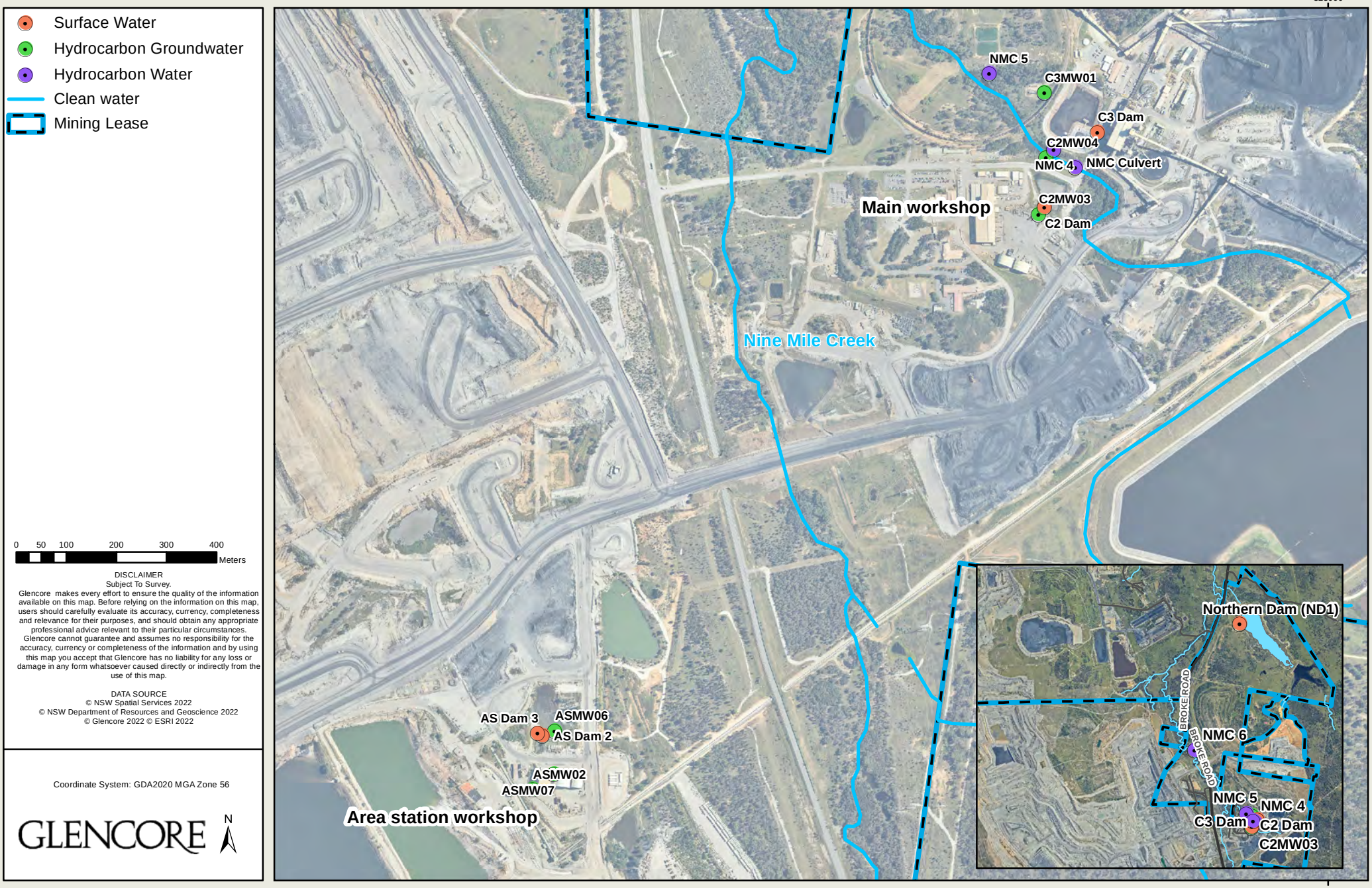
- *Bulga Coal Hydrocarbon Management Plan*, incorporating spill response procedure and Bulga Open Cut Hydrocarbon TARP;
- *Bioremediation Area Management Plan*; and
- *Bulga Coal Pollution Incident Response Management Plan*.

Hydrocarbon storage facilities have been designed generally in accordance with AS 1940-2004 – '*The Storage and Handling of Flammable and Combustible Liquids'*. The storage system includes computerised controls for the purpose of monitoring and identification of faults.

Bulga Coal monitor for petroleum hydrocarbons at dirty water dams, EPL discharge points and groundwater bores surrounding hydrocarbon storage and natural watercourses, in accordance with the *Bulga Open Cut Remediation Action Plan* and the *Bulga Coal Hydrocarbon Management Plan*. The monitoring program involves:

- Regular inspections of hydrocarbon infrastructure to identify losses or leakages;
- Monthly oil and grease analysis at the surface water monitoring sites shown on **Figure 22**; and
- Hydrocarbon monitoring at the locations listed in **Table 35**. Surface water sites are monitored quarterly, following rain. Groundwater sites are monitored six-monthly.

FIGURE 22 - BULGA COAL HYDROCARBON SURFACE AND GROUNDWATER MONITORING



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DATA SOURCE

Coordinate System: GDA2020 MGA Zone 56

GLENCORE

6.14.2 Environmental Performance

Surface water and groundwater monitoring was conducted at the locations listed in **Table 35** and shown on **Figure 22**. Results were assessed against the Hydrocarbon Trigger Action Response Plan (TARP) triggers in **Table 36**.

Table 35 Hydrocarbon Monitoring Sites

Type	Monitoring Location
Groundwater	ASMW02
	ASMW06
	ASMW07
	BFMW01
	BFMW02
	BFMW03
	C2MW03
	C2MW04
	C3MW01
Surface Water	NMC4
	NMC5
	NMC6
	NMC Culvert
Licenced Discharge Point (LDP)	Northern Dam (ND1)
Onsite Dirty Water Dam	AS Dam 1
	AS Dam 2
	AS Dam 3
	C2 Dam
	C3 Dam

Table 36 Ecological Investigation Levels (ANZECC) Adopted for Natural Waters (Surface and Groundwater) at Bulga Open Cut

Sampling Location	Contaminant	Trigger (µg/L)
Surface Water NMC4, NMC5, NMC6, Nine Mile Creek Culvert, ND1. **Groundwater** ASMW02, ASMW06, BFMW01, BFMW02, BFMW03, C2MW03, C2MW04, C3MW01.	TRH C6-C10	20 (LOR)
	TRH >C10-C16	100 (LOR)
	TRH >C16-C34	100 (LOR)
	TRH >C34-C40	100 (LOR)
	TRH >C10-C40	300 (LOR)
	Naphthalene	16
	Phenanthrene	0.6
	Anthracene	0.01
	Fluoranthene	1
	Benzo(a) pyrene	0.1

Groundwater monitoring results in 2021 were below the Ecological Investigation Levels.

Surface water monitoring results from the Nine Mile Creek monitoring sites and the Northern Dam were also below the Ecological Investigation Levels.

Hydrocarbon spills were contained, cleaned-up and bioremediated or transported offsite as hazardous waste by a licensed waste contractor.

6.14.3 Implemented/Proposed Improvements

A new bulk diesel storage facility was constructed across from the Area Station workshop during the reporting period. The facility provides diesel to mobile fuel trucks and light vehicles. This will replace the existing bulk diesel tanks.

6.15 Public Safety

6.15.1 Environmental Management

Controls implemented to minimise the potential for public safety incidents include:

- Implementation of a security system. These systems and procedures have been established in accordance with the relevant requirements under the *Work Health and Safety Act 2011*, *Mining Act 1992* and conditions stipulated in the relevant mining tenements;
- Using sentries to prevent unauthorised entry into the blast exclusion zone; and
- Maintaining a fence around the perimeter of mining operations.

6.15.2 Environmental Performance

There were no public safety incidents recorded at Bulga Coal during the reporting period. Management measures and control strategies implemented at Bulga Coal have been effective in the prevention of incidents regarding public safety during the reporting period.

There were no changes to public safety management in 2021.

7 Water Management

7.1 Water Management

7.1.1 Water Balance

Bulga Coal uses a water balance model to assist in the management of water onsite. The model is used to review performance and undertake short term projections (12 months) of water requirements. The model is also used to predict water needs for the life of the mine. Major water transfers are monitored via flow meters. Water storage volumes are measured fortnightly.

The water balance for Bulga Coal has been presented in **Table 37**. The discrepancy between inflows, outflows and change in storage is due to the limitations of the accuracy of the surface and groundwater storage measurements and water balance model predictions.

Table 37 Bulga Coal 2021 Water Balance

Bulga Coal 2021 Water Balance	Volume (ML)
Water Inventory and Capacity	
Total estimated water stored on site 1 January 2021 (4,124 ML predicted to be in the underground goaf)	9,898
Total estimated water stored on site 31 December 2021 (8,804 ML predicted to be in the underground goafs (Beltana and Blakefield South)	15,857
Change in water inventory	5,959
Inflows	
Water extracted from Hunter River (monitored)	672
Rainfall and runoff intercepted from mine areas	10,910
Groundwater inflow (Groundwater model prediction)	880
Pumped from dewatering bores	30
Water entrained in CHPP feed material	656
Potable supply	9
Total Inflows	**13,157**
Outflows	
Evaporation	2,431
Discharge to Hunter River under Hunter River Salinity Trading Scheme (HRTS)	952
Water entrained in product coal, coarse rejects and tailings	1,482
Open Cut Dust suppression	1,574
Bulga Underground Operations Water Consumption	0
Potable water consumption	9
Other losses	5
Total outflows	**6,453**

7.1.2 Water Take

Water taken by Bulga Coal during the previous water year (1 July 2020 to 30 June 2021) is summarised in **Table 38**.

Table 38 Water Take 2020-2021

Water Licence #	Water Sharing Plan, Source and Management Zone	Entitlement (ML)	Total entitlement under Source	Passive take/inflows	Active Pumping	Total
Groundwater						
WAL41687	Mining: Sydney Basin-North Coast Groundwater Source	500	2365	0	880	880
WAL41546	Mining: Sydney Basin-North Coast Groundwater Source	365				
WAL41543	Mining: Sydney Basin-North Coast Groundwater Source	500				
WAL41544	Mining: Sydney Basin-North Coast Groundwater Source	500				
WAL41545	Mining: Sydney Basin-North Coast Groundwater Source	500				
WAL36221	Mining: Wollombi Brook Aquifer leakage to Permian coal measures	300	300	0	0	0
Surface Water						
Singleton Council Agreement	Hunter River	867		0	178	178

*This is the annual Singleton Council agreement allocation. There were no additional temporary transfers from other mines in 2020/2021. Bulga did not transfer water to or from other mines in 2020/2021.

7.2 Surface Water

7.2.1 Environmental Management

Bulga Coal implements surface water management measures in accordance with the *Water Management Plan*. This Plan outlines procedures for the detection of significant offsite impacts. The *Plan* also outlines trigger levels to identify and manage potentially adverse impacts. Trigger levels are included in the site Environmental Monitoring Database (EMD), which generates an alarm if a trigger level is reached.

The site also operates a Surface Water TARP to assist with managing the site's surface water during storm events. The Plan further outlines the methods for monitoring the quantities of water extracted, imported or discharged under groundwater extraction licences, surface water extraction licences and the EPL.

Monthly surface water quality monitoring is undertaken at dams, streams and creeks in and around Bulga Coal mining operations. Monitoring locations were selected to obtain representative samples. Water quality parameters including temperature and depth are tested onsite, whilst pH, electrical conductivity (EC), and total suspended solids (TSS) are undertaken by a National Association of Testing Authorities (NATA) accredited laboratory.

Surface water quality monitoring is conducted in accordance with:

- *AS 5667.4 – 1998 Water Quality Sampling – Guidance on Sampling from Lakes, Natural and Man-made*;
- *AS 5667.6 – 1998 Water Quality Sampling-Guidance on Sampling of Rivers and Streams*; and
- The *Bulga Coal Water Management Plan*.

The Water Management Plan was approved by DPIE in 2021.

7.2.2 Environmental Performance

A summary of surface water monitoring results against relevant criteria from the Water Management Plan is provided in **Table 39**. The location of surface water monitoring sites is shown on **Figure 8**. Monitoring data is available on the Bulga Coal website.

Table 39 Summary of Surface Water Monitoring Results – 2021 Annual Averages

Sample Point	pH (range)	pH Criteria		EC (µS/cm)	EC Criteria (µS/cm)	TSS (mg/L)	TSS Criteria (mg/L)	Temperature (°C)
		Lower 20th percentile	Upper 80th percentile		80th percentile		80th percentile	
LR1[1]	7.1 – 7.4	7.12	7.81	394	944	7	12	18
LR2	6.8 – 7.7	7.39	7.91	2,205	4,924	31	40	17
LR5	7.0 – 7.5	7.41	7.98	519	1,350	10	12	19
W2	7.0 – 7.3	7.13	7.67	539	836	7	12	19
W4	7.0 – 7.4	7.33	7.87	534	947	8	10	20
SDL1	7.0 – 9.2	6.70	7.24	215	285	29	39	19
NDL1	7.1 – 7.7	7.14	7.26	913	399	31	70	20
W9[3]	7.6 – 8.1	7.36	7.92	4,740	1,970	12	157	18
W10	7.2 – 8.5	7.00	7.64	16,724	691	49	102	19
NMC1[2]	7.6 – 8.7	-	-	845	-	39	-	20

1 – Site is upstream of the operations and is used as a reference site.
2 – Insufficient data to establish criteria
3 – W9 replaced W8 as it was mined through.

7.2.2.1 Surface water pH

Surface water pH levels ranged from 6.8 to 9.2. pH results which fell outside the pH level criteria included:

- LR1 during September 2021 (7.1), noting this is a reference site;
- LR2 during January to June and during December 2021 pH results were below the lower threshold;
- LR5 during every month with the exception of October 2021 pH results were below the lower threshold;
- W2 during January to April and during December 2021 pH results were below the lower threshold;
- W4 during every month with the exception of October and November 2021 pH results were below the lower threshold;
- SDL1 during February to June and during October 2021 pH results were above the upper threshold;

- NDL1 during June 2021 (7.1); and
- W10 during March, May and between July to November 2021 pH results were above the upper threshold.

Most pH levels recorded outside the trigger levels were within historical data range from the Water Management Plan. W10 elevated pH results are likely because the site is located within a refugial pool on Nine Mile Creek which typically has poor quality water, being alkaline and highly saline except during high rainfall events.

7.2.2.2 Surface water EC

EC results across the site ranged from 161 µS/cm to 25,400 µS/cm, with an average of 2,690 µS/cm.
EC results which fell outside the EC level criteria included:

- W2 during November 2021 (928 µS/cm);
- NDL1 during January, May, June, July, September, October and December 2021 EC results were above the threshold;
- W9 during January to October as well as December 2021 EC results were above the threshold; and
- W10 during every month in 2021 EC results were above the threshold.

Most EC levels recorded outside the trigger levels were within historical data range from the Water Management Plan. NDL1 and W10 elevated pH results are currently being investigated. Both are located within refugial pools which typically have poor quality water, being alkaline and highly saline except during high rainfall events.

7.2.2.3 Surface water TSS

TSS levels during the reporting period ranged from 5 mg/L to 294 mg/L, with an average of 22mg/L.

TSS results which fell outside the TSS level criteria included:

- LR1 during March 2021 (14 mg/L), noting this is a reference site;
- LR2 during February and March 2021 TSS results were above the threshold;
- LR5 during March and December 2021 TSS results were above the threshold;
- SDL1 during March, July and October 2021 TSS results were above the threshold; and
- W10 during February 2021 (294 mg/L).

All TSS levels above the trigger levels were investigated and are within historical data range from the Water Management Plan. There did not appear to be any elevated results at locations without trigger values.

7.2.2.4 Stream flow impacts in Wollombi Brook

Stream flow impacts in Wollombi Brook from Bulga Coal are determined by comparing the Water NSW gauging station records, upstream and downstream of the site. The upstream site is the Wollombi Brook – Brickmans Bridge (Paynes Crossing) gauging station (210135), which is located approximately 20 km upstream of Bulga Coal. The downstream site is the Wollombi Brook – Bulga gauging station (210028), located approximately 5 km downstream of Bulga Coal. **Figure 23** and **Figure 24** show the gauging station records for 2020 to 2021 for the upstream and downstream sites, respectively.

Figure 23 Wollombi Brook Brickmans Bridge Gauging Station 210135 (Upstream)

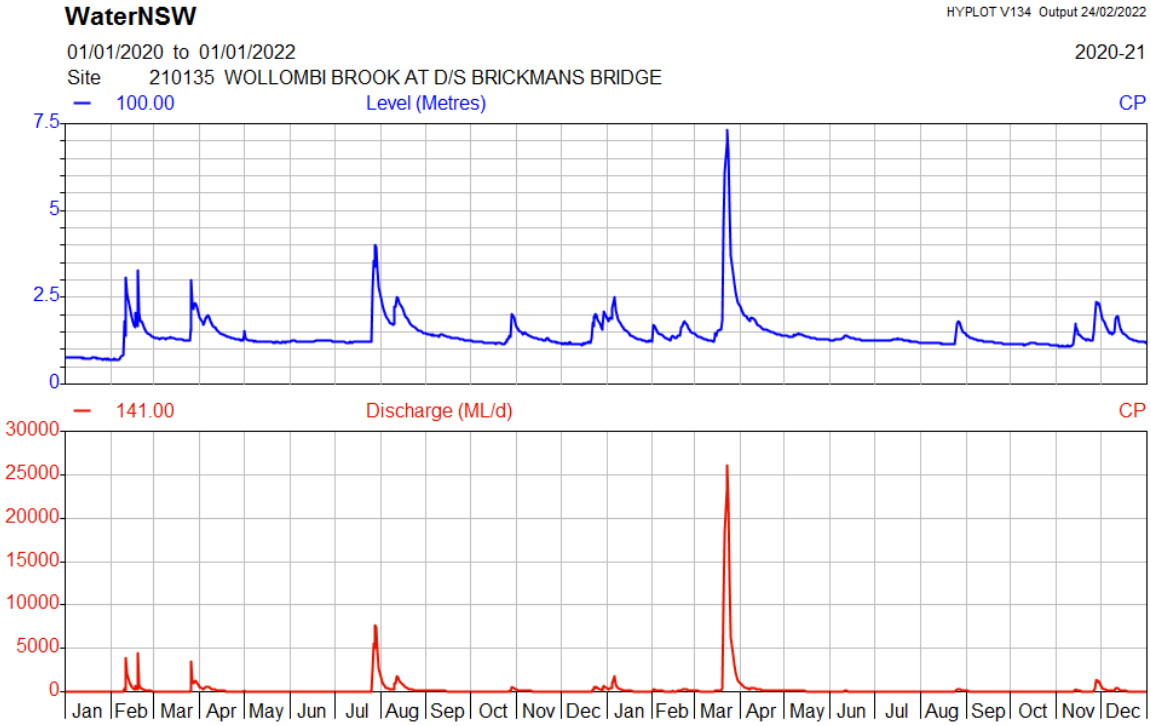
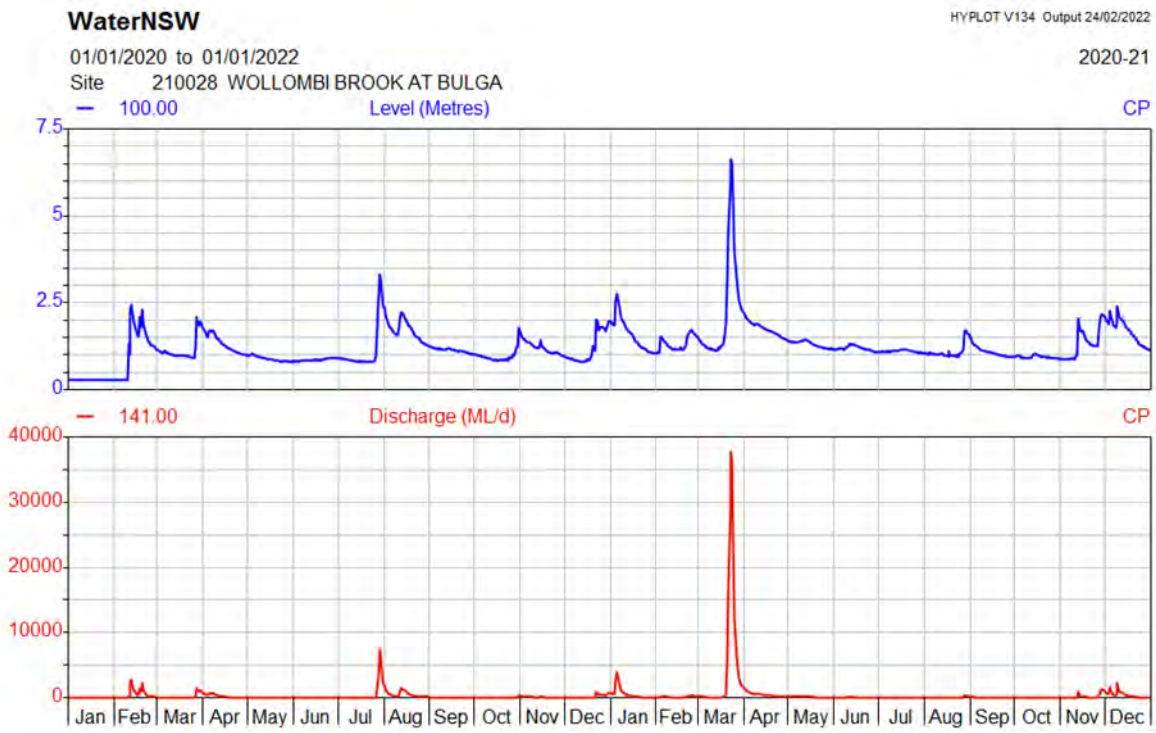


Figure 24 Wollombi Brook – Bulga Gauging Station (210028) (Downstream)



The data presented in **Figure 23** and **Figure 24** indicates that the water level in Wollombi Brook increased over the 2020-2021 period due to consistent rain. Some fluctuations occurred in response to large rainfall events particularly in March 2021.

7.2.2.5 Hunter River Salinity Trading Scheme

The site has one Hunter River Salinity Trading Scheme (HRSTS) LDP:

EPL ID 11 – Northern Dam.

EPL 563 requires the discharge volume, pH, TSS and turbidity to be monitored during discharge events.

EPL 563 requires the discharge volume, pH, TSS and turbidity to be monitored during discharge events.
A total of 952ML was discharged from the Northern Dam (EPL ID 11) in March 2021 during 4 HRSTS discharge blocks. The daily volume discharged was compliant with the maximum daily discharge limit of 500ML. Total Suspended Solids and pH levels measured during discharge were compliant with the limits of 120mg/L and 6.5-9.5, respectively. Details are provided in **Table 40** and **Table 41.**

Table 40 Discharge Records

River Register Information		Discharge Record						
Block ID	Total allowable discharge	Start		Finish		Volume discharged	Mean EC	Salt load
(1 block / line)	Tonnes	Time	Date	Time	Date	ML	ms/cm	Tonnes
2021-80(3)	6,008	15:20	20/03/21	13:00	21/03/21	411.8	1,680	435.7
2021-81(2)	3,335	13:40	21/03/21	14:00	22/03/21	3.4	1,540	2.8
2021-82(4)	6,859	14:00	22/03/21	14:00	23/03/21	373.3	1,620	377.4
2021-89(1)	2,470	14:40	29/03/21	14:00	30/03/21	163.6	1,770	192.8

Table 41 Discharge Water Quality Results

Block ID	pH grab sample during discharge	pH Limit	TSS grab sample during discharge (mg/L)	TSS Limit (mg/L)
2021-80(3)	8.4	6.5-9.5	35	120
2021-81(2)	8.3		62	
2021-82(4)	8.6		66	

7.2.2.6 Channel Stability Monitoring Results

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) Ephemeral Stream Assessment Methodology was used to assess the channel stability of Nine Mile Creek, Loders Creek and Wollombi Brook. The assessment uses indicators (vegetation presence, shape and profile, type of materials, nature of walls etc.) to produce a rating which ranges from Very Stable to Very Active.

The CSIRO channel stability assessment for Nine Mile Creek sites BM21 and BM22 and Wollombi Brook site BM36 recorded Stable Activity ratings, and varied between Very Active and Stable over the length of the Loder Creek study area in 2021. Whereas sites that recorded Very Active and Active classifications generally supported localised areas of exposed soils or active erosion scars contained mostly along the upper channel banks, sites with Stable classifications contained continuous riparian corridors with minimal evidence of erosion processes throughout the channel environments. There were some minor variations to overall category scores at four sites due to inter-seasonal fluctuations in the levels of mobile sediment accumulations or vegetation, however the variations were insufficient to change the overall site Activity ratings which were maintained at all sites from 2020 to 2021.

Despite the study area being subjected to at least two flow events over the year to date (in March and November), there were minimal indications of increased erosive events or other scouring impacts associated with flood activity.

7.2.2.7 Stream Health

The Rapid Appraisal of Riparian Condition (RARC) is an assessment method incorporating indicators of geophysical, and biological properties and processes which are likely to provide reliable estimate of ecological condition in riverine ecosystems (Jansen et al, 2005). Each indicator is given a score which combine to provide an overall creek health score, ranging from Very Poor (<25) to Excellent (40 - 50).

As for the CSIRO channel stability assessment indices, the 2021 Stream Health Monitoring RARC results showed consistency in results over the consecutive post-drought surveys in 2020 and 2021, with no changes to the RARC classification ratings. Overall, the individual site RARC results varied between Very poor (BM21) to Average (BM35 and BM36) and Good (BM22 and BM34). Nine Mile Creek site BM21 continues to record the lowest RARC rating (Very poor), in part due to the inhibition of native vegetation regeneration by dense swamp-oak detritus throughout the riparian corridor floor, whereas BM22 recorded a higher rating (Stable) due to the continuous riparian corridor and dense understorey vegetation community comprised of mixed grasses, shrubs and weeds.

Despite some inter-survey proliferation of groundcover species, the RARC rating at Loder Creek site BM35 (Average) was influenced by relatively poor scores for native understorey and groundcover species, however the downstream site rating at BM34 (Good) reflects the dense and continuous coverage of groundcover and canopy forming species.

Wollombi Brook site BM36 maintained the RARC rating of Average in 2021, which follows on from an improvement from Poor to Average between the 2019 and 2020 surveys. Since 2020, the channel banks and broader riparian zone have shown continued growth of understorey species and groundcovers (mostly terrestrial grasses and weeds), however for the most part, the condition of the riparian corridor canopy forming species has remained consistent between surveys.

7.2.2.8 Aquatic Ecology

The 2021 Annual Stream Health Aquatic Ecology monitoring survey included sampling of the aquatic macroinvertebrate fauna using the AusRivAS sampling, sorting and identification protocols. A total of 10 sites were sampled in drainages downstream of mining operations and the LDP (Northern Dam). Drainages include Nine Mile and Loder Creek to the east and the Southern and Northern Drainage Lines plus Wollombi Brook to the west. The period leading into the 2021 survey in mid-November was very wet and with the exception of upstream Nine Mile Creek site BM21, all monitoring sites contained continuous surface water and stream flows for the 2021 survey.

Aquatic Habitat Condition

Most sites contained indications that recent high flow water levels had reached around 1m above the background water levels in the upper catchment channels in Nine Mile and Loder Creek plus the Northern and Southern Drainage lines, reaching 2 to 3m higher in downstream areas. The channel banks and pool basins had been scoured free of detrital accumulations and the overall complexity of aquatic habitats for aquatic biota was generally low, consisting mostly of macrophytes, sparse detritus, trailing bank vegetation and undercut banks.

Aquatic Ecology Site Water Quality

Surface waters were generally well mixed and there were no indications of layering between surface and bottom water quality readings. Salinity readings were variable in Nine Mile and Loder Creek, generally decreasing with distance downstream in each system, and the Northern and Southern Drainage lines contained the overall lowest conductivity readings. Dissolved oxygen values were lowest in isolated areas (low flow sections) of the upper Southern Drainage line, and moderate to high for the other aquatic habitats throughout the Northern and Southern Drainage lines, Wollombi Brook and the Loder Creek catchment. Water turbidity was moderate to high for most sites reflecting fine sediments mobilised by recent rainfall runoff.

Aquatic Macroinvertebrate Results

A total of 54 macroinvertebrate taxa were recorded from the 10 sample sites in spring 2021, with the individual site macroinvertebrate diversity (richness) ranging between 13 taxa at Loder Creek site LCM1 and 26 taxa at Wollombi Brook site WBDn. Overall, the Wollombi Brook sites supported the highest diversity of macroinvertebrates (with 36 taxa from three sites compared to Loder Creek inline sites with 30 taxa from three sites), and higher diversity of sensitive EPT macroinvertebrate taxa - which ranged between 3 and 7 EPT taxa in Wollombi Brook and 1 to 2 EPT taxa for Loder Creek. The site SIGNAL scores indicate that the Nine Mile and Loder Creek sites contained a higher proportion of pollution tolerant macroinvertebrates compared to Wollombi Brook and the Northern and Southern Drainage lines.

Fish Sample Results

Each of the study area drainages provided fish habitat during the spring 2021 survey for two native gudgeon species (flathead and firetail gudgeons), and the introduced invasive pest fish species plague minnow (*Gambusia holbrooki*) was recorded at all sites. The overall fish occurrences encountered during spring 2021 is indicative of the prevailing weather conditions experienced over the year to date as the ability for aquatic macroinvertebrates and fish species to occupy the study area aquatic habitats is limited by surface water availability on a year-to-year basis (with most sites usually being dry).

7.2.3 Comparison against Predictions

A Surface Water Assessment was undertaken by Umwelt (2013) as part of the Bulga Optimisation Project EIS. The assessment concluded that with the implementation of the water management system and the proposed controls there was only a low risk of impacting on the water quality of the downstream watercourses, and that results would be comparable to background levels. A comparison of the background water quality against the 2021 data has been made in **Table 42** The *Annual Groundwater Assessment* (Jacobs, 2022) (refer to **Appendix D**) reviews groundwater performance against criteria.

Table 42 Comparison of Surface Water Monitoring Results (2021) against Background (2013 Bulga Optimisation Project EIS)

Sample Point	pH		EC (µS/cm)		TSS (mg/L)	
	2021 Range	EIS Range	2021 Average	EIS Range	2021 Average	EIS Range
LR1	7.1 – 7.4	6.6 - 8.8	394	4 - 9,470	7	1 - 72
LR2	6.8 – 7.7	6.3 - 8.8	2,205	130 - 6,230	31	3 - 440
LR5	7.0 – 7.5	6.7 - 8.4	519	196 - 3,470	10	2 - 144
W2	7.0 – 7.3	6.6 - 8.2	539	195 - 1,470	7	1 - 114
W4	7.0 – 7.4	6.5 - 8.2	534	200 - 1,760	8	2 - 42

The results presented in **Table 42**, show that the 2021 data is within the EIS ranges at all sites.

7.2.4 Long Term Trend Analysis

Figure 25, Figure 26 and **Figure 27** show surface water monitoring results recorded by Bulga Coal during the period 2005 to 2021 for EC, pH and TSS, respectively.

Figure 25 Long Term Surface Water EC Results

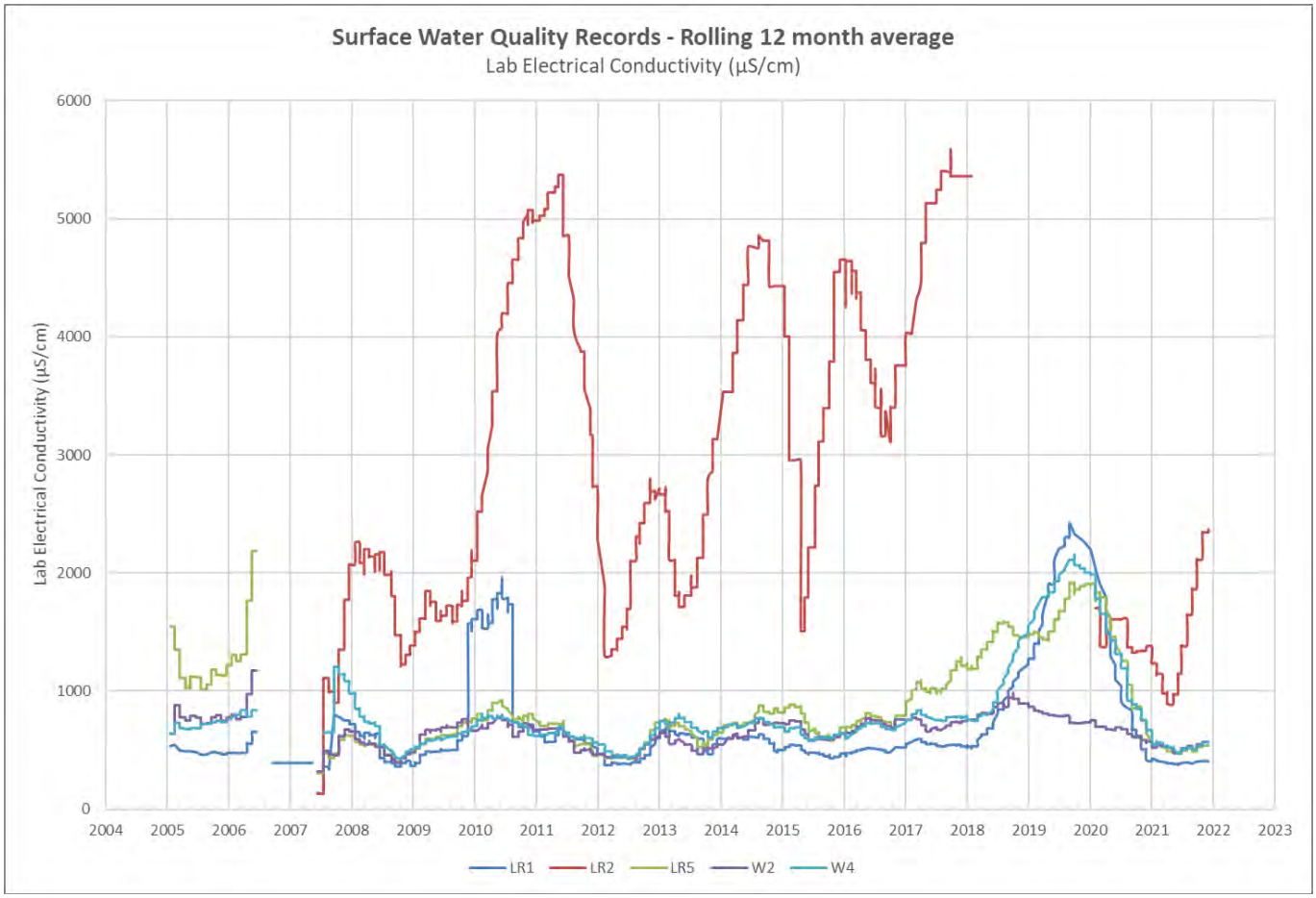


Figure 26 Long Term Surface Water pH Results

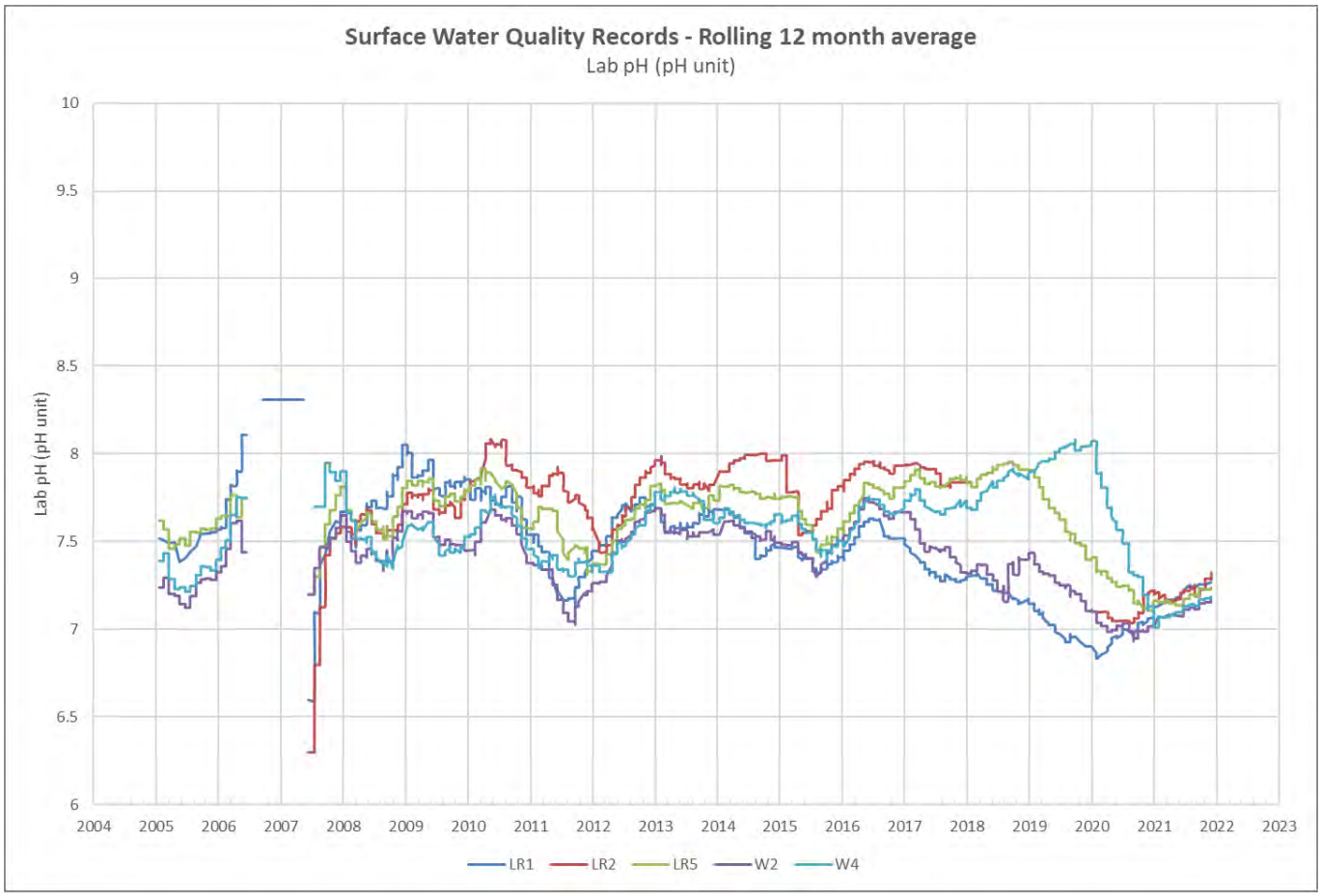
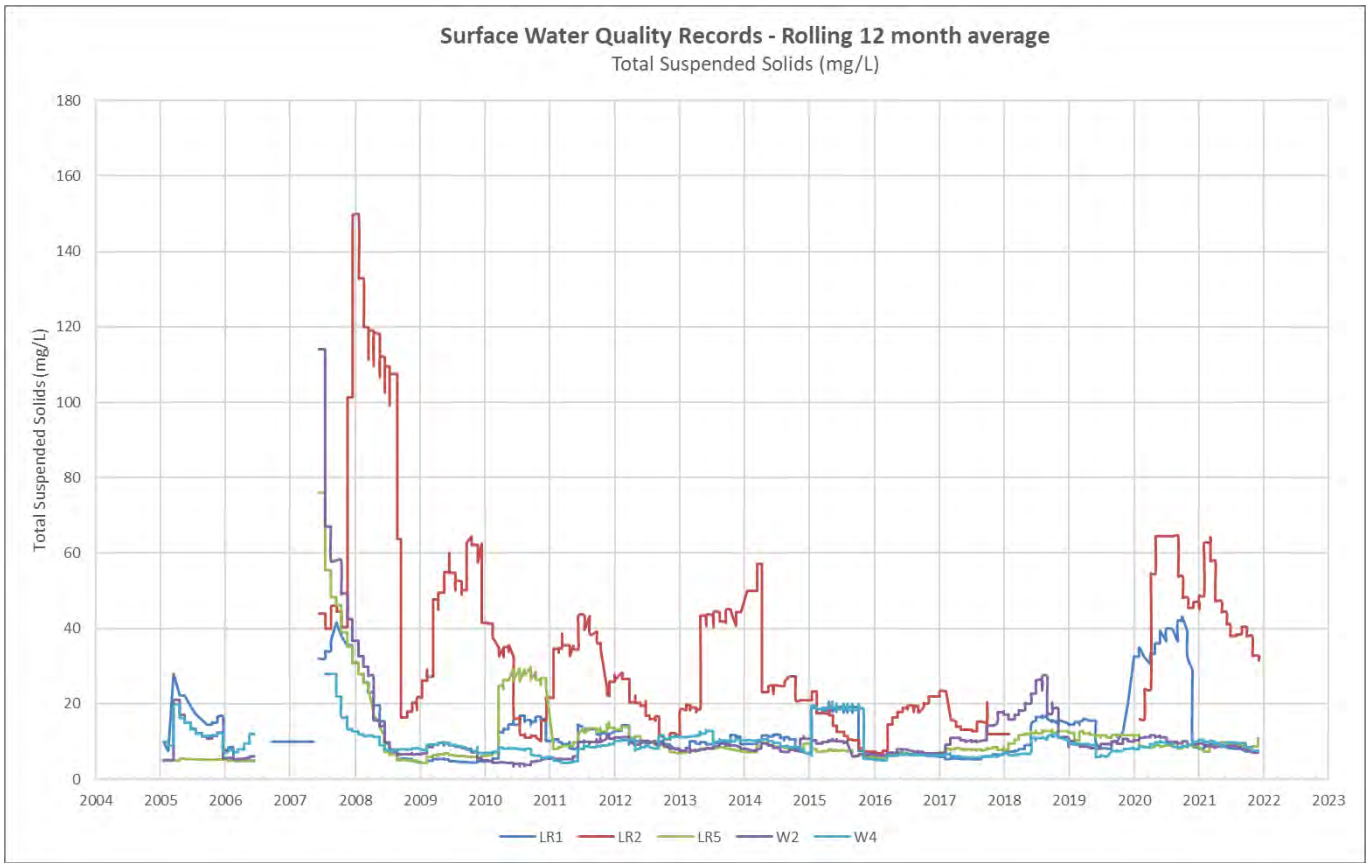


Figure 27 Long Term Surface Water TSS Results



Seasonal variations in pH, EC and TSS are evident at the sites along Wollombi Brook (LR1, LR5, W2 and W4) with values generally remaining within the predicted ranges shown in **Table 42**.

7.3 Erosion and Sedimentation

7.3.1 Environmental Management

A variety of controls are implemented at Bulga Coal to mitigate operational risks associated with erosion and sedimentation. During and following ground disturbance, structures such as sediment ponds, sediment fences, spoon drains, sediment catches and site catch sumps are used where appropriate to manage runoff and minimise erosion and sedimentation. Inspections are undertaken following more than 20 mm of rain in 24-hours to evaluate the effectiveness of erosion and sediment control structures. Additional stabilisation works for these areas may include reshaping, amelioration of dispersive soil, revegetation, fencing and weed control.

High risk sediment dams have been incorporated into an automatic management system which continuously monitors dam water levels and commences dewatering when the water level reaches set trigger levels. Other sediment dams are monitored weekly and following rainfall events to determine pumping requirements.

Monitoring and inspections at Bulga Coal are completed in accordance with the *Bulga Coal Erosion and Sediment Control Plan* approved in 2021. This monitoring system is designed to comply with EPL 563 and the erosion and sediment control conditions stipulated within the Bulga Underground Operations and Bulga Open Cut Development Consents.

7.3.2 Environmental Performance

There were no erosion related incidents recorded at Bulga Coal during the reporting period.

7.4 Groundwater

7.4.1 Environmental Management

Groundwater is managed in accordance with the approved *Water Management Plan*.

Mapping of the deep and shallow depressurisation of the hard rock (coal measures) strata is undertaken. This identifies the potential for any adverse impacts on the shallow alluvial aquifer systems associated with Wollombi Brook and Monkey Place Creek. Depressurisation is predicted within the coal measures on a regional scale; however, it is not expected to produce any measurable impact in the overlying alluvial aquifer.

The monitoring program provides early warning for potential changes in groundwater levels and quality.

Bulga has a comprehensive groundwater monitoring network within and outside of the mine footprint area with 59 groundwater monitoring points shown in **Figure 8**. The monitoring network comprises both standpipe piezometers and multilevel vibrating wire piezometers installed in all hydrostratigraphic units.

As part of the EPBC Act approval EPBC 2018/8300 (as varied on the 9 September 2021), an ecohydrological conceptual model was submitted to DAWE 21 December 2021, currently pending approval. As part of the assessment additional monitors were installed including:

Five sealed vibrating wire piezometers (VWPs), MB1A, MB1B, MB2, MB3A and MB3B were installed in June 2020 to monitor the potentiometric responses to the Main Pit Tailings Storage Facility.

Groundwater monitoring bores were installed in the Warkworth Sands at WWS1, WWS2a/b, WWS3a/b in June 2021, and soil moisture loggers at WWS1 and WWS2. These are shallow bores that were installed in the Warkworth Sands which are located to the north-west of the Open Cut. None of these monitoring bore had any free water in them when constructed or when an attempt to sample them two weeks after construction.

The groundwater monitoring system is designed to effectively monitor the two general types of groundwater located within the vicinity of Bulga Coal. These groundwater resources are the alluvial aquifers of Wollombi Brook and Monkey Place Creek, and the typically more saline and low yielding hard rock aquifers associated with the Whittingham and Wollombi Coal Measures (various coal seams within these).

7.4.2 Environmental Performance

A summary of groundwater monitoring results and relevant criteria from the *Water Management Plan* is provided in **Table 43**, with detailed groundwater monitoring results available on the Bulga Coal website

Table 43 Summary of Groundwater Monitoring Results – 2021 Annual Averages

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Water Level (mAHD)	Lab pH	Lab pH		Lab EC (µS/cm)	Lab EC (µS/cm)
			Lowest Depth Trigger Value		20th Percentile Trigger Value	80th Percentile Trigger Value		80th Percentile Trigger Value
Broke Area Alluvials[#]								
GW1	2.9	89.4	NA[2]	6.9	6.7	7.3	3,270	3,634
GW2	1.0	85.4	-	7.3	-	-	5,340	-
GW3	1.1	76.9	73.99	7.5	6.7	7.2	1,559	6,010
GW4	1.1	79.5	-	7.4	-		1,968	-
GW5	0.7	81.3	-	7.2	-	-	2,625	-
GW6	1.8	75.2	72.19	7.6	7.3	7.8	7,597	7,900
GW7	0.5	74.6	63.29	6.9	6.7	7.4	1,843	3,946
GW8	2.6	72.5	70.00	6.9	6.6	7.0	5,383	5,936
GW9	1.0	72.8	70.34	6.9	6.7	7.2	832	4,458
GW10	0.7	72.6	69.14	7.7	7.1	7.6	5,550	10,252
V3	6.6	68.8	64.99	7.1	7.1	7.6	1,895	1,744
Broke Area Wollombi Seam								
P2	5.6	69.0	NA[1]	7.4	7.4	8.0	11,557	12,834
P5A	6.9	69.2	NA[1]	7.8	7.5	8.2	3,942	6,242
P6A	18.2	66.9	NA[1]	7.8	7.0	8.1	2,265	2,740
Northern Area Shallow Alluvials								
F1	6.6	63.6	60.83	7.5	7.2	7.6	1,265	1,025
F2	4.9	65.2	62.93	7.3	7.1	7.4	736	1,720
WBR50A	5.2	59.9	NA[1]	7.5	7.1	7.7	3,657	14,000

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Water Level (mAHD)	Lab pH	Lab pH		Lab EC (µS/cm)	Lab EC (µS/cm)
			Lowest Depth Trigger Value		20th Percentile Trigger Value	80th Percentile Trigger Value		80th Percentile Trigger Value
V1	6.4	64.7	62.53	7.7	7.3	7.7	1,365	1,570
V2	5.9	61.4	58.7	6.4	6.4	7.1	123	922
SBC/Broke Area Lower Whybrow Seam								
P6B	105.4	-20.3	NA[1]	8.2	6.7	7.3	5,767	1,353
P8	13.0	75.2	NA[1]	6.7	7.3	9.3	257	5,076
Northern Area Lower Whybrow Seam								
WBR50	36.4	28.1	NA[1]	6.8	6.7	8.0	1,566	8,382
Northern Alcheringa Seam								
WBD62A	15.9	64.3	-	7.1	-	-	568	-
Beltana Area Miscellaneous Bores and Wells								
Dwyers	6.7	63.4	60.54	7.8	7.3	7.6	901	1,476
Fernance	6.7	64.9	59.27	7.8	7.3	8.0	1,010	1,473
McG1	18.6	93.8	NA[2]	7.7	7.5	8.0	275	918
White1	5.5	65.1	62.22	7.5	7.0	7.4	2,065	2,444
WBR15	14.6	63.5	62.16	7.1	6.8	7.3	1,202	924
Beltana Area NPZ								
NPZ3-A	-	NA	-	-	7.3	7.7	-	1,362
NPZ3-B	9.8	63.0		7.5	NA[1]	7.5	753	921
NPZ4-A	20.4	62.3		7.0	NA[1]	7.3	684	729
NPZ4-B	30.9	51.2	NA[1]	7.7	7.3	7.8	1,307	1,342
NPZ5-A	11.0	63.4	NA[1]	7.1	6.9	7.3	894	886
NPZ5-B	23.6	50.3	NA[1]	7.5	7.1	7.6	2,690	2,760

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Water Level (mAHD)	Lab pH	Lab pH		Lab EC (µS/cm)	Lab EC (µS/cm)
			Lowest Depth Trigger Value		20th Percentile Trigger Value	80th Percentile Trigger Value		80th Percentile Trigger Value
NPZ7-1	8.6	60.4	NA[1]	7.6	6.7	7.7	1,175	1,240
NPZ7-2A	5.9	64.6	NA[1]	7.3	7.1	7.6	1,453	2,250
NPZ7-2B	12.7	57.6	NA[1]	7.9	6.8	7.8	1,315	1,307
NPZ7-3A	9.3	64.6	NA[1]	7.2	7.0	7.5	2,055	2,540
NPZ7-3B	12.5	61.1	NA[1]	7.6	7.4	7.8	1,273	1,316
Wollombi Alluvials and Shallow Coal Measures[#]								
WBD160	9.4	64.4	NA[2]	7.1	6.9	7.3	1,039	1,310
WBR180	34.3	35.6	NA[1]	7.3	7.1	7.5	19,950	20,850
WBR181	7.2	61.3	59.65	7.3	7.2	7.5	1,952	2,670
WBR182	7.0	62.7	62.16	7.2	7.3	8.3	1,552	1,512
WBR183	13.1	61.6	NA[1]	7.1	7.0	7.4	3,702	3,484
SBD196	4.3	68.7	-	7.2	-	-	4,248	-
WBR240	5.1	60.3	NA[1]	7.3	7.0	7.5	20,633	26,800
WBR241	6.8	61.4	60.20	6.6	6.4	6.9	501	435
Loders Creek Alluvials								
LC1	5.5[2]	53.0[2]		-[1]			-	
LC2	2.3	42.6		7.5			4,873	
Northern Tailings emplacement facility piezometers[3]								
MB1a	16.3	62.4		-	-	-	-	-
MB1b	93.7	-15.0		-	-	-	-	-
MB2	28.3	61.4		-	-	-	-	-
MB3a	24.3	53.8		-	-	-	-	-

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Water Level (mAHD)	Lab pH	Lab pH		Lab EC (µS/cm)	Lab EC (µS/cm)
			Lowest Depth Trigger Value		20th Percentile Trigger Value	80th Percentile Trigger Value		80th Percentile Trigger Value
MB3b	85.4	-7.2		-	-	-	-	-
Warkworth Sands monitoring bores[4]								
WWS1	-[1]	-	-	-	-	-	-	-
WWS2a	1.9	94.7	-	-[1]	-	-	-	-
WWS2b	2.1	94.3	-	6.1	-	-	147	-
WWS3a	1.9	83.7	-	-[1]	-	-	-	-
WWS3b	2.2	83.2	-	6.3	-	-	414	-

– No trigger values have been established.

1 – No results available for 2021.

2 – The annual averages were calculated from 2 results.

3 – The Northern Tailings emplacement facility piezometers sites are grouted live wire piezometers and do not have access to water quality.

4 – The annual averages were calculated based on results from June 2021 (following installation) to December 2021.

Notes: Where the groundwater monitoring reveals a result outside the impact assessment criteria the Response Plan will be activated as detailed in Section 10 of the Water Management Plan. P1 and P7B are located on AGL land and no longer accessible.

2021 Bulga Coal Complex Annual Groundwater Monitoring Report

Jacobs have produced the *2021 Bulga Coal Complex Annual Groundwater Monitoring Report* (Jacob, 2022) which is attached as **Appendix D**. The report includes a review of standpipe and vibrating wire piezometer data. Overburden pressures in the top 50 m to 100 m from surface have recorded generally increasing groundwater levels in 2021 . Recovery observed in various bores is likely related to the increasing rainfall between 2020 through 2021.

Groundwater levels in SBD196 (Blakefield Seam) have recovered over the monitoring period, returning to near-2015 pressures. Re-pressurisation in the Alcheringa Seam is observed through hydrographs for numerous bores monitoring the seam. Groundwater levels in most monitoring bores targeting the Alcheringa Seam increased significantly over the period. The majority of recovery in the seam has occurred since the start of 2020 and is related to the cessation of extraction in 2018 and prevailing climatic conditions since 2020.

Shallow groundwater levels in the alluvium (Wollombi Creek and Monkey Place Creek) increased over the period, generally recovering to pre-2016 to 2019 drought conditions. However, rainfall is the major influence on alluvium groundwater levels with no apparent influence from mining operations.

Groundwater quality (EC and pH) trigger values were exceeded for several monitoring bores over the monitoring period. While the trigger values are not assessment criteria, exceedances are used to initiate investigations into groundwater quality. Groundwater pH exceedances were within ranges of natural variation, and do not show impacts attributable to Bulga Coal over the period.

A review of groundwater quality exceedances in nine bores was undertaken in Q3 2021 (Jacobs, 2022), concluding that “long-term trends for Bulga groundwater monitoring bores reflect the drought conditions from 2017 to 2019; bores recorded increasing EC over the period of drought, and EC has remained generally stable since the end of drought conditions in early-2020. This trend is similarly reflected in groundwater level and recharge trends over the period, with groundwater levels increasing throughout 2020 and 2021. Long-term groundwater EC exceedances are likely linked to regional climatic conditions and do not show distinct impacts attributable to mining activities at Bulga Coal” (Jacobs, 2022).

The major ion chemistry for groundwater samples collected in June and December 2021 are similar to the December 2020 data. The alluvium and sandstone water samples typically plot as different water types, with some minor over-lap, indicating different recharge mechanisms and residence times. The water type interpretation indicates that the alluvium and coal seam water samples may predominantly receive recharge directly or indirectly from rainfall and/or have shorter transmission times from the recharge point.

7.4.3 Comparison against Predictions

With the cessation of underground mining the combined Blakefield and Whybrow Seam workings are now filling with groundwater. 30 ML was drawn from the Beltana goaf (Whybow Seam) in 2021 with a net increase in storage of approximately 2,700 ML as a result if pumping approximately 1,800 ML of mine water into the Underground operations. *Bulga Optimisation Project Modification 3 and Bulga Underground Modification 7 Statement of Environmental Effects – Appendix 11* (Umwelt 2019) groundwater model inflow prediction of approximately 880 ML per year is consistent with the change in underground and open cut pit storage as shown in **Table 37**.

7.4.4 Long Term Trend Analysis

Bulga Coal has an extensive groundwater monitoring network which covers Wollombi Brook and Monkey Place Creek alluvium, overburden, sandstone, and deep coal seam hydrostratigraphic units. A long-term monitoring record (over 20 years) now exists and it enables interpretation of groundwater trends.

The groundwater levels in the Wollombi Brook and Monkey Place Creek alluvium continue to fluctuate in response to rainfall events clearly evident in 2021. Overall, there does not appear to be any measurable impact from mining operations on the alluvial aquifers (Jacobs, 2022). Detailed groundwater monitoring trend graphs are presented in the *Annual Groundwater Monitoring Report* (Jacobs, 2022) which is attached as **Appendix D**.

8 Rehabilitation

Progressive rehabilitation of disturbed areas is an important aspect of the mining operations at Bulga Coal. The objective of rehabilitation is to restore the land to a condition that is equal or greater than that prior to disturbance. Ongoing rehabilitation of areas disturbed by operations has continued throughout the reporting period. Annual rehabilitation inspections and scientific plot-based monitoring is undertaken by experienced rehabilitation consultants to monitor the success of rehabilitation works.

As requested, the Rehabilitation Reports that monitor the trajectory of the rehabilitation performance have been provided to the RR with this Annual Review. The table outlining the progression towards the completion criteria attached as **Appendix E.**

8.1 Post Mining Land Use

In accordance with SSD-4960 and the *Biodiversity Management Plan*, rehabilitation has continued to focus on the goal of establishing EECs.

The post-mining land use goal is the combination of objectives contained in the Bulga Optimisation Project approval (for the Bulga Open Cut), the Bulga Underground Operations 2003 EIS and *Bulga Optimisation Project Modification 3 and Bulga Underground Modification 7 – Statement of Environmental Effects* (Umwelt, 2019). It is anticipated that following the expected closure of Bulga Coal and the subsequent rehabilitation activities, that the areas disturbed by mining activities will be predominantly native vegetation (woodlands on spoil dumps and riparian communities along established drainage lines) with a minimum of 260 ha being returned to land suitable for agricultural uses. In summary, the land associated with BUO to the east of Charlton Road is either contained within the footprint of the BOC final land use or is regenerating woodland above underground workings; whilst the land to the west of Charlton Road is principally agricultural land used for grazing, viticulture or olive groves. Apart from an ecological and archaeological conservation area in the north-west of the colliery holding, the goal is to retain the agricultural productivity of the land to the west of Charlton Road and above the underground mine (SLR, 2020).

It is expected that the areas disturbed by mining will be predominantly returned to land and soil capability Classes 6 and 7. Existing areas currently mapped as being land and soil capability Class 3 and Class 4 will remain generally consistent post closure, with a small reduction in Class 5 areas expected. Based upon current approvals mining operations at Bulga Coal will cease mining in 2039.

8.2 Rehabilitation Performance during the Reporting Period

8.2.1 Rehabilitation Summary

Rehabilitation activities have been completed in accordance with the approved Bulga Open Cut and Bulga Underground Operations MOPs. Rehabilitation activities undertaken in 2021 were:

- Shaping of overburden dumps;
- Removal of decommissioned infrastructure (where required);
- Installation of contour drains and geomorphic drainage structures;
- Deep ripping;
- Rock raking;

- Installation of habitat features (e.g. stag trees, woody debris, rock piles);
- Spreading of topsoil;
- Application of ameliorants;
- Re-ripping of prepared surface; and
- Seeding with target ecological communities.

Further details on these steps are provided in the Bulga Open Cut and Bulga Underground Operations MOPs which are available on the Bulga Coal website. A summary of rehabilitation at Bulga Coal as at the end of 2021 is presented in **Table 44** and is shown in the plan included as **Appendix E**.

Table 44 Rehabilitation Status at Bulga Coal

Mine Area Type	Previous Reporting Period (Actual) 2020	This Reporting Period (Actual) 2021	Next Reporting Period (Forecast) 2022
Total mine footprint	3,440.80	3,489.13	3,492.94
Total active disturbance	2,325.42	2,400.29	2,378.95
Land being prepared for rehabilitation	38.39	35.28	34.58
Land under active rehabilitation	1,115.34	1,088.83	1,113.98
Completed rehabilitation*	0	0	0

* Denotes land that has been signed off by DPE-RR as completed rehabilitation.

8.2.2 2021 Rehabilitation – Bulga Open Cut

During 2021, Bulga Coal completed 35.28 Ha of rehabilitation. Bulga Open Cut rehabilitated 32.48 ha across the Eastern Emplacement Area and the Noise and Visual Bund. 2.8 ha of land was rehabilitated at the Bulga Underground. With maintenance of BOC and BUO rehabilitation occurring throughout the year.

8.2.2.1 Landform Details

During 2021, Bulga Open Cut continued to implement a Geomorphic natural landform design, shaping of overburden dumps occurred on both the Eastern Emplacement Area (EEA) and the Noise and Visual Bund (NVB). Bulga Open Cut continued to progressively rehabilitate all available overburden emplacement areas which have reached final landform extents, as shown in Photo 9.

Photo 8 The natural landform design was integrated with the existing landform and drainage on the NVB, photo showing topsoil application in progress following shaping of the final landform.

Natural drainage patterns are included at the conceptual design phase and refined for final construction. An example of a constructed geomorphic drain is shown in **Photo 9**.

Photo 9 Natural drainage constructed within a geomorphic natural landform.

Photo 10 Vegetation establishment on the Noise and Visual Bund (foreground), and completed 2021 rehabilitation (background).

8.2.2.2 Cover Materials

Direct emplacement of topsoil from Eastern Emplacement Area Extension 3 clearing area occurred throughout 2021 on Eastern Emplacement Area rehabilitation areas, whilst stockpiled material was used for rehabilitation on the Noise and Visual Bund. Topsoil was spread at 100mm and gypsum was applied at a rate of 8t/ha. Gypsum was applied immediately after spreading of topsoil and the area was ripped to a depth of 450mm to incorporate the topsoil into overburden material to create a suitable seed bed.

8.2.2.3 Physical and Chemical Characteristics

Bulga Open Cut has identified some coal seams and interburdens which are potentially acid forming and contain elevated sulfur levels. These seams and interburdens have been analysed and are separated and handled/dumped to reduce the long-term potential to form acids. Further detail on this material and its management is provided in the Bulga Open Cut MOP.

8.2.2.4 Vegetation Species

Revegetation activities in 2021 focused on the establishment of the Central Hunter Grey Box – Ironbark Woodland community on both the Eastern Emplacement Area and Noise and Visual Bund. The seed mix for these areas focused on establishing the key overstorey, shrub and ground cover species for the community (as outlined in the Bulga Open Cut MOP and *Biodiversity Management Plan*). Outcomes from the Hunter Ironbark Research Program were used to guide the species selected for the seed mix.

8.2.2.5 Habitat Resources and Potential

The *Biodiversity Management Plan* outlines the requirement for incorporating habitat features into rehabilitated landscapes. In 2021, a number of methods were used to increase the habitat potential of the rehabilitated areas:

- Woody debris;
- Incorporation of drains and water sources;
- Rock piles; and
- Stag trees.

As rehabilitation matures, other habitat enhancement methods such as nest boxes will be utilised.

8.2.2.6 Temporary Rehabilitation and Visual Mitigation

Approximately 23 hectares of temporary rehabilitation was undertaken over the North Blakefield Dump in 2021. A pasture seed mix was developed for these areas to stabilise slopes and reduce the potential for dust generation.

8.2.2.7 Rehabilitation Maintenance

Rehabilitated areas at Bulga Open Cut are subject to an ongoing monitoring and maintenance program to ensure that the completion criteria are achieved. Inspections are conducted annually by an external rehabilitation consultant. A summary of these care and maintenance activities undertaken during 2021 are outlined in the following sections and in **Table 45.**

Table 45 Maintenance Activities on Rehabilitated Land for Bulga Open Cut

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
	2021 (actual)	2022 (planned)	
Additional erosion control works (drains, recontouring, rock protection, erosion repairs)	<1	10	A landform stability inspection was conducted by a consultant in 2021 to identify all erosion features across the Eastern Emplacement Area and Noise and Visual Bund rehabilitation areas. During 2021 repairs were undertaken on erosion identified across the entire Noise and Visual Bund and the northern section of the Eastern Emplacement Area. A follow up landform stability inspection will be undertaken with continued erosion remediation works undertaken on drop structures, contour banks and slopes across all rehabilitation areas, as required.
Re-seeding/replanting (species density, season etc.)	0	2	Remediation of bare contour banks in a section of the Noise and Visual Bund will occur in 2022.

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
	2021 (actual)	2022 (planned)	
Adversely affected by weeds (type and treatment)	240	300	Weed control works in 2021 focused across the entire Noise and Visual Bund and Eastern Emplacement Area. This will continue in 2022 with new rehabilitation areas being added to the program as required. The main weeds being controlled are Galenia, Blue Heliotrope, Acacia Saligna and Lantana.
Feral animal control (additional fencing, trapping, baiting etc.)	As required	As required	Feral animal control will concentrate on wild dog control using baiting and kangaroo culls within rehabilitation areas.

8.2.3 2021 Rehabilitation – Bulga Underground Operations

Rehabilitation during the reporting period focused on rehabilitation of decommissioned gas drainage infrastructure. Bulga Underground Operations maintenance and rehabilitation has been shown in **Figure 2**. Additional detail regarding the rehabilitation of these areas during the reporting period has been provided in the following sections.

8.2.3.1 Landform Details

Rehabilitation of decommissioned gas drainage infrastructure is undertaken to match the previous and surrounding landform, reinstating cut fill, levelling windrows and respreading stockpiles.

Rehabilitation of disturbance associated with gas drainage infrastructure is undertaken considering existing landform, drainage, stability and mitigation of visual impacts.

8.2.3.2 Cover Materials

Topsoil is spread over the prepared final landform for drill pads and pipeline corridors; generally, to a depth of 100 mm. Seeding of the area is undertaken as soon as practicable following the surface preparation using a site and season specific grass or tree mix, however this is subject to weather conditions (seeding will be delayed during windy conditions). The seed mix is applied to ensure consistent ground cover.

All 2021 rehabilitation areas were covered with topsoil sourced from onsite. Topsoil was generally sourced from stockpiles directly associated with the rehabilitation activity.

8.2.3.3 Physical and Chemical Characteristics

Topsoil is generally stockpiled for less than two years and at a scale not warranting material characterisation prior to use in rehabilitation.

8.2.3.4 Vegetation Species

Specific tree seed mix (based on local vegetation communities) and pasture seed mix have been developed for the rehabilitation of disturbed land at Bulga Underground Operations. The mix is consistent with the native environmental setting of Bulga Underground Operations and includes seed that has been harvested from within the mining lease boundaries and properties managed by Bulga Underground Operations.

Additionally, an agricultural seed mix is applied to subsidence repairs and disturbance associated with gas drainage infrastructure on grazing land.

8.2.3.5 Rehabilitation Maintenance

Rehabilitated areas at Bulga Underground Operations are subject to an ongoing monitoring and maintenance program to ensure that the completion criteria are achieved. A summary of rehabilitation maintenance activities undertaken during 2021 are outlined in **Table 46**.

Table 46 Maintenance Activities on Rehabilitated Land for Bulga Underground Operations

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
	2021(actual)	2022(planned)	
Additional erosion control works (drains re-contouring, rock protection)	As required	As required	Maintaining temporary controls around active rehabilitation areas as identified in routine and scheduled inspections.
Soil treatment (fertiliser, lime, gypsum etc.)	4.6	0	Fertiliser used in seed mix for rehabilitation.
Re-seeding/replanting (species density, season etc.)	4.6	0	Supplementary seeding of rehabilitation maintenance and repairs identified in annual rehabilitation inspection.
Adversely affected by weeds (type and treatment)	As required	As required	Weed management activities were ongoing for 2021 and focused mainly on the Vere, Underground and Commonwealth rehabilitation areas. Target areas identified during monthly inspections, annual rehabilitation inspection and buffer land inspections.
Feral animal control (additional fencing, trapping, baiting etc.)	As required	As required	Feral animal control concentrating on wild dog and pig control.

8.3 Buildings

As outlined in **Section 4.2.4**, in 2021 Bulga Underground Operations infrastructure continued to be demolished and/or dismantled including:

- Equipment laydown areas;
- Gas drainage pipelines and tracks;
- Gas drainage well; and
- In-seam wells.

In 2021 Bulga Open Cut infrastructure continued to be demolished and/or dismantled including:

- Temporary relocatable office buildings
- Bulk fuel farm; and
- Dragline (partially demolished during 2021).

8.4 Department of Regional NSW-RR Sign-Off on Rehabilitation

In 2021, no areas of rehabilitation received formal sign-off from RR that land use objectives and completion criteria had been met.

8.5 Variations from Proposed MOP Activities

Table 47 summarises the rehabilitation progress at Bulga Coal (including Bulga Open Cut and Bulga Underground Operations) during 2021 against the MOP predictions.

Table 47 Bulga Coal MOP Rehabilitation Predictions against 2021 Data

Mine Area Type	2021 Actual Data (Bulga Coal)	MOP Prediction 2021
Rehabilitation (ha)	35.28	34.1
Disturbance (ha)	11.41	11.4

Rehabilitation in 2021 exceeded the MOP prediction, whilst disturbance was consistent.

8.6 Rehabilitation Monitoring, Trials and Research

Bulga Coal has an extensive rehabilitation monitoring program to track the establishment and progress of rehabilitated areas towards the completion criteria. The objectives of the rehabilitation monitoring program are to:

- Assess the long-term stability and functioning of re-established ecosystems on mine affected land;
- Assess rehabilitation performance against the completion criteria; and
- Facilitate continuous improvement in rehabilitation practices.

The monitoring program will continue within rehabilitated and non-mined areas (reference sites) until it can be demonstrated that rehabilitation has satisfied the closure criteria. The rehabilitation monitoring criteria for each domain have been developed to demonstrate that selected indicators (or criteria) have reached their established completion criteria or that a satisfactory successional trajectory has been established that will result in a self-sustainable ecosystem.

Based on the outcomes of the rehabilitation monitoring program, a care and maintenance program is implemented. The scope of the care and maintenance program may include weed and feral animal control, fertilising, re-seeding or planting (where required), and erosion and sediment control works.

8.6.1 Annual Rehabilitation Monitoring Program

2020 saw the implementation of Glencore's new rehabilitation monitoring procedure for all existing and new rehabilitation sites. Due to the large size of the rehabilitation monitoring program at Bulga Coal, the sites required have been split into biennial groups – Year A being monitored for its baseline in 2020 and Year B being monitored for the first time in 2021. The new monitoring includes Initial Establishment Monitoring and Long-Term Monitoring. In summary, the Initial Establishment Monitoring is a rapid style assessment of young (≤3 years old) rehabilitated areas, principally to determine germination success, landform stability and other management issues such as establishment of weeds. The Long-Term Monitoring procedure is applied to rehabilitation that is a minimum of four years since establishment. The objective of the long-term monitoring program (areas ≥4 years old) is to evaluate progress of rehabilitation towards fulfilling completion criteria, additional statutory requirements that may apply to the operation and ultimately the targeted post-mining land use. The methods described for long term rehabilitation monitoring apply to both rehabilitation and reference monitoring sites. For further details on methodology and timing refer to the *GCAA Rehabilitation Monitoring Procedure*.

8.6.1.1 General Observations

Between 2017 and 2019, rainfall has been lower than average and temperature was hotter than average across the Hunter Valley. These intense drought conditions continued until early 2019, eased across later 2019 with some moderate rainfall and then eased to recovery in winter of 2020 following increased and sustained rainfall. The majority of the Hunter Valley was declared as non-drought affected in September of 2020. Rainfall during 2021 was higher than average for most months (except for June 2020, April 2021 and May 2021 which were lower), while the total annual rainfall was substantially higher than the long-term average.

A key recent change has been observable improvement in vegetation condition driven by the breaking of the drought in 2020. Data shows drought impact in remnant vegetation (canopy and shrub defoliation and reduction of groundcover vegetation) throughout the Hunter Valley. It appears that rehabilitation sites have suffered less than remnant vegetation during the drought and these sites are responding more rapidly to improved conditions. There were no clear signs of dieback in tree and shrub vegetation of Rehabilitation Areas, and where *Acacia spp*. were experiencing dieback it was considered more likely to be attributable to age-appropriate senescence.

Most rehabilitation sites (LTMs only in 2021) comprised generally healthy vegetation with new growth, indicating resilience to stochastic events. This is a positive sign given that the aim is to return self-sustaining vegetation communities.

It was noted that prior weed management for galenia (*Galenia pubescens*) had been undertaken across large extents of the rehabilitation. Many of these prior infestations were now either dead or dying, but some minor extents of regrowth were identified requiring ongoing attention. Signs of native species regeneration was observed at all sites.

Evidence of feral animals in the remnant and rehabilitation sites was generally low and broadly spread, with minor grazing recorded at a small number of rehabilitation sites, likely from macropods or small numbers of other herbivores such as rabbits or hares. Presence of these species is expected at least to some degree given the previous drought, however increased rainfall is likely to encourage at least some dispersal. As requested, a copy of the rehabilitation monitoring report has been provided to the RR with the Annual Review. A copy of the report is also available on the Bulga Coal website.

A summary of the results has been provided in the following sections with the table outlining the progression towards the completion criteria attached as **Appendix D.**

8.6.1.2 Reference Site Monitoring

Monitoring was conducted at four reference sites in 2021 located within the following vegetation communities:

- Central Hunter Grey Box – Ironbark Woodland Endangered Ecological Community (EEC);
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC; and
- Swamp Oak Forest (two sites).

Reference monitoring sites are considered generally stable. Signs of regeneration were seen at all sites and comprised species from all strata. There is consistency in native species richness and cover at these reference sites (when compared to 2020 ecological monitoring results), however exotic species have increased including those in the High Threat category. BM10 demonstrated a high presence of exotic species (including four High Threat species accounting for 36.6% foliage cover) compared to other reference sites, however it has maintained good diversity and cover of native species. Attention should continue to be paid to managing exotic species in these communities.

8.6.1.3 Woodland Rehabilitation Site Monitoring

The Rehabilitation Monitoring Program for 2021 included a total of 52 floristic sites consisting of 45 rehabilitation LTM sites, two reference LTM sites, three ecological monitoring sites and two sites corresponding to both reference and ecological monitoring requirements. Some sites were not monitored in 2021 on advice from Bulga.

Overall, the 2021 rehabilitation monitoring identified that sites are generally on appropriate trajectories towards their target communities in many aspects, however active management and further monitoring to ensure this should continue.

The Ironbark-Spotted Gum-Grey Box Woodland sites (proposed for PCT 1604) returned similar results to each other in terms of native species richness, total exotics and High Threat weed species. These sites contained scattered occurrences of *Acacia saligna* (true of most rehabilitation sites), however this species was not recruiting and was less common in younger rehabilitation. This species should continue to be excluded from planting or seeding mixes, however is not present in sufficient numbers or thickets to warrant specific management.

Of the rehabilitation LTM sites, six are considered to be on a neutral trajectory against their performance criteria, being GBIW04B, GBIW06B, GBIW07B, GBIW09B, GBIW11B and GBIW15B. The remaining sites indicated as being on a negative trajectory were identified with less than 50% of the metrics satisfied, where 15 sites were considered to be on a marginal negative trajectory (GBIW01B, GBIW02B, GBIW03B, GBIW10B, NB6, NVB1N, NVB3, SE1, ISGGB01B, ISGGB02B, ISGGB03B, ISGGB04B, ISGGB12B, ISGGB13B and OTD1). The main factors influencing these were the ground cover species richness and their percent foliage cover, as well as the presence of logs and large trees that are expected to improve naturally over time. Four sites demonstrated less than 25% of metrics satisfied, these included GBIW14B, GBIW17B, GBIW19B and GBIW20B.

The presence of high threat weeds following rainfall and the long term survival of midstory and canopy species during and following drought, continue to be of highest management concern. Both management aspects assist greatly to maintain a trajectory towards the establishment of self-sustaining native woodland communities. Recommendations have been made to improve rehabilitation practices/management to assist in meeting the criteria and broadly include:

- Continue existing weed management programs targeting significant weed infestations or high threat exotic species;
- Monitor the establishment of vegetation in eroded gullies recorded in the vicinity of ISGGB10B monitoring site; and
- In areas with more established treed vegetation consider the establishment of nest boxes, stags or rock piles throughout older rehabilitation areas located in northern and western rehabilitation corridors.

8.6.2 Rehabilitation Trials and Research

Tree Thinning Trial

A tree thinning trial commenced across areas of rehabilitation on the Noise and Visual bund in response to monitoring results demonstrating higher than desired densities of Eucalypt species leading to suppression of understory CHGBIB EEC species. A team of experienced land management and environmental restoration contractors conducted the tree thinning using the cut and paint method. Areas subject to thinning works will be monitored in subsequent years to assess EEC development.

Tree thinning works will continue in 2022 across rehabilitation areas identified as having a higher than desired density of Eucalypt species.

8.7 Key Issues that may Affect Rehabilitation

A risk assessment was conducted during preparation of the Bulga Open Cut MOP which identified the key risks to rehabilitation. The key risks to rehabilitation at Bulga Coal are:

- Drought (or extended dry conditions);
- Exposure to fire prior to rehabilitation reaching an age at which it will demonstrate tolerance;
- Erosion and sedimentation;
- Exotic weeds; and
- Unapproved access and/or disturbance.

Key risks to rehabilitation are included in a rehabilitation TARP within the Bulga Open Cut and Underground MOPs to identify required management actions in the event of impacts to rehabilitation, or where rehabilitation outcomes are not achieved in an acceptable timeframe.

Ongoing works will be undertaken throughout the life of the operation to ensure rehabilitation areas meet the requirements of the completion criteria. These works will mostly include weed control, erosion repairs and planting/seeding to meet the requirements of target vegetation communities. Identification of these works will be through the long term rehabilitation monitoring program and annual walkover inspections.

A review to the risk assessment will be undertaken in 2022 in accordance with RR Guideline: Rehabilitation Risk Assessment. This risk assessment will be incorporated in the Bulga Coal Rehabilitation Management Plan and associated works under the NSW Rehabilitation Reforms.

8.7.1 Bulga Open Cut

8.7.1.1 Weeds and Pest Species

Weed management in rehabilitation areas is an ongoing challenge for all mining operations. Considerable planning is undertaken at Bulga Open Cut to prevent weeds entering rehabilitation areas in the first instance, primarily through topsoil management. Despite this, several weed species are present throughout most historical rehabilitation areas and significant resources are dedicated to their removal. The methods employed at Bulga Open Cut include:

- Appropriate topsoil management, including scraping of topsoil stockpiles prior to spreading and weed control in areas prior to stripping;

- Seeding with quick establishing cover crops and acacia species to out-compete weed species;
- Ongoing weed spraying and removal; and
- Seeding with a eucalypt and acacia heavy forest seed mix to shade-out introduced weed species such as Rhodes grass (*Chloris gayana*) and Galenia (*Galenia pubescens*).

The key weed species targeted in 2021 were Lantana (*Lantana camara*), Galenia (*Galenia pubescens*), Inkweed *(Phytolacca octandra)*, African Boxthorn (*Lycium ferocissimum*), Spear Thistle (*Carthamus lanatus*), Narrow-leaved Cotton Bush (*Gomphocarpus fruticosus*), African Olive (*Olea europaea Africana*), Bitou Bush (*Chrysanthemoides monilifera*), Acacia Saligna (*Acacia Saligna*), Castor Oil (*Ricinus Communis*), Verbena (*Verbena bonariensis*) and Blue Heliotrope (*Heliotropium arboescens/amplexicaule*).

The 2022 Rehabilitation weed management program will continue to implement controls for the above mentioned weed species plus any additional weeds identified during 2022 inspections and monitoring, control of weeds will be undertaken in order of priority according to biosecurity duties and actions required to achieve target vegetation communities in rehabilitation.

As part of the dog baiting program, 1080 baits were placed in rehabilitation areas where wild dogs had previously been identified.

8.7.1.2 Erosion and Water Quality

Drainage structures such as contour banks and drop structures at Bulga Open Cut are largely functioning as designed and require little to no maintenance.

During 2021 Bulga continued to implement the Annual walkover inspection of rehabilitation and drainage structures. The inspection was undertaken by a consulting engineer to identify erosion features such as rills, tunnelling, silt accumulation, and overtopping drains. Spatial data was collected for all erosion and drainage maintenance features identified across the Noise and Visual bund and Eastern Emplacement rehabilitation areas. This data was then used to develop a maintenance program which was carried out throughout 2021. Maintenance works undertaken included repairing rock drainage lines, desilting contour banks, repairing rill and gully erosion and tunnelling. Coir logs were also successfully used to prevent and stabilise minor rill erosion across natural landform areas.

In 2022 another drainage and erosion inspection will be conducted to identify any new erosion features and assess the success of the 2021 maintenance program. Significant budget has been allocated to rehabilitation maintenance to allow for works to be conducted throughout the year and in response to new erosion identified following high rainfall events.

Monthly water quality sampling is undertaken on all sediment dams downstream of rehabilitated areas. Bi-annual full chemical analysis is also undertaken on the sediment dams. This monitoring will be used to assess when surface water runoff can be diverted back into clean water catchments.

Ongoing rehabilitation inspections will identify any additional maintenance required throughout 2022.

8.7.1.3 Safety Risks

Currently there are no rehabilitation areas that present safety risks to the public or employees. At the time of mine closure (in year 2039 based upon current approvals), the proposed final void and highwall will be rehabilitated in accordance with the approved Bulga Open Cut MOP and appropriate safety controls will be implemented.

8.7.2 Bulga Underground Operations

8.7.2.1 Weed and Pest Species

Due to the small and isolated nature of rehabilitation and the maintenance of buffer land at Bulga Underground Operations, weed and pest management activities are not isolated to rehabilitation areas. Weed and pest management, inclusive of rehabilitation was undertaken throughout 2021 as outlined in **Section 6.7.**

8.7.2.2 Erosion and Water Quality

Maintenance of erosion controls identified during scheduled and routine inspections was undertaken during 2021.

8.7.2.3 Safety Risks

Currently there are no rehabilitation areas that present safety risks to the public or employees.

8.8 Actions for the Next Reporting Period

8.8.1 Rehabilitation Outcomes

The rehabilitation outcomes have been agreed with stakeholders and documented in the approved MOPs, which are available on the Bulga Coal website.

8.8.2 Proposed Rehabilitation Trials, Projects and Initiatives

No rehabilitation trials are currently proposed at Bulga Coal.

8.8.3 Rehabilitation Activities Proposed for 2022

Bulga Coal plans to undertake the following rehabilitation and disturbance works during 2022:

- 3.8 ha of disturbance;
- 34.58 ha of rehabilitation (levelled/re-contoured, topsoiled and seeded);
- 9.40 ha of disturbance of rehabilitation;
- Maintenance tasks as required on existing rehabilitation areas; and
- Subsidence repairs as required.

The proposed 2022 operations for Bulga Underground Operations and Bulga Open Cut have been presented in **Figure 4** and **Figure 5**, respectively.

9 Community

9.1 Community Engagement

Bulga Coal kept the community informed about our activities through one on one meetings, community barbeques and newsletters. A number of planned local events were cancelled due to COVID-19.

9.1.1 Community Barbeque Program

We held 2 community barbeques in April with 69 community attendees at Broke and 66 in Bulga. There were no barbeques held in the second half of the year due to COVID-19 restrictions.

9.1.2 Newsletters

Community newsletters were distributed to letterboxes in Broke, Milbrodale and Bulga in June and November 2021.

9.1.3 Community Consultative Committee

Bulga Coal enjoys an open and honest dialogue with community representatives and Singleton Council through our Community Consultative Committee. Bulga Coal hosted meetings in May and November 2021. Minutes from the CCC meetings are available on the Bulga Coal website.

9.1.4 Voluntary Planning Agreement

The Deed of Variation to the Voluntary Planning Agreement associated with the Bulga Open Cut MOD 3 approval was signed in April 2021. An additional $1M was paid to the Singleton Community Economic Development Fund.

9.1.5 Annual Stakeholder Meeting

Updates on the building of Minimbah Teaching Place were provided to the Aboriginal community in January, April and June. In December, RAPs were invited for the Annual Stakeholder Meeting and to celebrate the completion of the building at a barbeque. Aboriginal heritage is discussed further in **Section 6.8**. Minutes of the meeting in December are available on the Bulga Coal website.

9.2 Community Sponsorship and Donations

Bulga Coal contributed approximately $31,000 in sponsorships and donations in 2021 to the projects and organisations listed below.

9.2.1 Broke School

The school purchased 14 laptops with the annual contribution in Bulga Coal's Voluntary Planning Agreement. Kids were treated to an online magic show as an end of lockdown lift and a planned 150th celebration event did not go ahead due to COVID-19.

Photo 11 Kids at Broke School enjoying new laptops as well as an online magic show

9.2.2 Broke Bulga Landcare

Bulga Coal is a partner of the Wollombi Brook Riparian Rehabilitation Project with Hunter Local Land Services, Broke Bulga Landcare and Singleton Council. The project aims to reduce weed infestations and rehabilitate areas owned by private landholders along the Wollombi Brook. In 2021, Bulga Coal attended committee meetings, site visits and participated in the schools event in March at McNamara Park, where the kids planted lomandras to stabilize the river bank.

Photo 12 Planting lomandras at the Wollombi Brook at the Schools Environment Day event

9.2.3 Community Yoga classes

Bulga Coal supported weekly yoga classes in Bulga during 2021. The classes were well attended and appreciated by the community.

9.2.4 Sponsorships

Organisations and events that were sponsored by Bulga Coal during 2021 included:

- Singleton Library – Summer Reading Program;
- Broke Public School – laptops;
- Singleton Tidy Towns Adopt a Spot Broke Road Clean-up; and
- Smoke in Broke barbeque festival.

A Little Bit of Italy, Broke Fair, Milbrodale Mountain Classic and Broke School 150th Celebration events were cancelled due to COVID-19.

9.2.5 Donations

Donations were made to these recipients in 2021:

- Singleton Track and Field
- Cedar Creek Wombat Hospital;
- Gresford P&C;
- Rotary Club of Singleton;
- Singleton Men's Shed;
- Luskintyre Landcare Group; and

- Special Children's Christmas Party.

9.3 Community Complaints

During the reporting period, 14 community complaints were recorded from 6 stakeholders and 2 anonymous stakeholders. 10 of the 14 complaints related to noise, received from 4 stakeholders. The other complaints related to dust (2), blast vibration (1) and blast road closure signage (1).

Table 48 shows a comparison of the environmental complaints received by Bulga Coal during the reporting period against the previous five years.

Table 48 Summary of Complaints by Issue 2016 – 2021

Complaint Type	2016	2017	2018	2019	2020	2021
Blast vibration/ overpressure	3	0	0	1	2	1
Lighting	5	3	3	5	2	0
Dust	0	3	3	4	1	2
Noise	10	9	14	11	12	10
Traffic	0	1	0	0	0	0
Visual Amenity	0	0	2	2	0	0
Odour	0	0	0	0	0	0
Fume	0	0	0	0	0	0
Other	0	1	0	1	0	1
Total	**18**	**17**	**22**	**24**	**17**	**14**

Each of these complaints followed the *Bulga Coal Community Complaint Procedure* and the response is available in the complaints register on the Bulga Coal website.

Noise

Each noise complaint was investigated. Where the noise levels were found to be above the relevant criteria at the nearest real-time monitor or by the handheld monitor, operational changes were made to reduce the noise. Where the noise was below the criteria, the complainant was notified of this and the levels were monitored.

9.4 Community Feedback

Bulga Coal receives formal and informal feedback about the consultation program and environmental performance.

During 2021, 63 stakeholders were surveyed as part of the Glencore Community Perception Survey. The survey included a range of questions including trust in and acceptance of the company, social investment and environmental impacts. Where relevant, feedback has been incorporated into engagement plans in 2022.

Concerns were raised by the CCC and the Bulga community about the distribution of Voluntary Planning Agreement funds into the Singleton Community and Economic Development Fund. An application for the feasibility and design of a Broke to Bulga Discovery Trail (shared trail) was submitted to the Singleton Economic and Community Development funding round. The shared trail concept was developed by Bulga Coal with the support of 4 local community groups.

Bulga Coal received positive feedback from the community regarding the Mininbah Teaching Place and we will continue to work with the Aboriginal community on projects in 2022.

10 Independent Audit

10.1 2021 Independent Environmental Audit

In accordance with the requirements Schedule 5 Conditions 9 and 10 of SSD-4960, Condition 8.4 of DA 41-03-99, and Schedule 6 Conditions 6 and 7 of DA 376-8-2003, an Independent Environmental Audit (IEA) was undertaken for Bulga Coal in 2021. The audit was conducted in November 2021 and was submitted to DPIE on 10 February 2022. It should be noted that the findings of the audit presented below are still pending DPIE approval.

The audit found that approximately 41% of all conditions and commitments were found to be compliant, 55% not triggered and 4% were non-compliant. A summary of non-compliances and the status of the proposed actions is presented in **Table 49**. Actions that are ongoing, required no action or were completed prior to this Annual Review have been excluded.

Table 49 Non-Compliance Findings and Action Status from 2021 IEA

Non-Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Action Status
SSD 4960 Schedule 3 Condition 17	Several exceedances of 24-hour PM_{10} assessment criteria were recorded by the BCC air quality monitoring network during the audit period. While standard Glencore tenancy agreements are issued that include advice on health risks associated with exceedances. Currently tenants of these properties are not notified of exceedances when they occur. Recommendation: Where exceedances of particulate emission limits occur, ensure that notification is provided for tenants on mine owned land.	Bulga will notify tenants of mine owned properties if the air quality criteria is exceeded in the region of the properties as a result of Bulga Coal emissions.	Triggered by exceedance	Not triggered within the reporting period.

Non-Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Action Status
SSD 4960 Schedule 3, Condition 27	Multiple discharge events of sediment laden water and chemical and hydrocarbon storage at workshop. Recommendation: Ensure Chemical and hydrocarbon storage is periodically reviewed for compliance against the relevant Australian standards.	Undertake a compliance review against the relevant Australian Standards for chemical and hydrocarbon storage across site.	30/06/2023	Outstanding. Will be completed in 2023.
SSD 4960 Schedule 3, Condition 27	Multiple discharge events of sediment laden water and Chemical and hydrocarbon storage at workshop. Recommendation: Ensure Chemical and hydrocarbon storage is periodically reviewed for compliance against the relevant Australian standards.	Investigate the potential and feasibility of divert the water off the workshop roof to capture it onsite for use.	30/06/2022	Outstanding.
SSD 4960 Schedule 3, Condition 51A	Bushfire Management Plan. Recommendation: Section 9.1 of GCAA-625378177-10531 GCAA Work Authorisation and Permit System – Protocol should be referenced in Section 6 of the Bushfire Management Plan to meet item d.	Review the Bushfire Management Plan to ensure that Section 9.1 of GCAA-625378177-10531 GCAA Work Authorisation and Permit System – Protocol is referenced in Section 6 to meet item (d) of SSD 4960 S3 C51A.	30/06/2022	Outstanding.
SSD 4960 Schedule 3, Condition 52	Waste management. Recommendation: It is recommended that the bioremediation area be sign posted to better track contaminated material deposited.	Install sign posts at the bioremediation area to better track contaminated material deposited.	30/06/22	Outstanding

Non-Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Action Status
SSD 4960 Schedule 3, Condition 53	Rehabilitation Objectives. Recommendation: Undertake a whole of site soil balance to quantify shortfall and plan for contingency. There is 260ha of 'Agricultural land' to be established at the end of mine life. This is currently a risk to lease relinquishment down the track if there is inadequate soil to verify the land is resilient to stock grazing, drought, erosion etc in comparison to analogue sites. Some soil material was lost to Rhodes Grass contamination in the rehabilitation that is to be re-disturbed.	Undertake a whole of site soil balance to quantify shortfall and plan for contingency.	31/12/2022	Outstanding
SSD 4960 Schedule 3, Condition 53	Rehabilitation Objectives. Recommendation: Plan and install additional access tracks throughout rehab to provide easy access for rehab inspections and maintenance, especially as the geomorphic landform is being used from this point forward. The site is already planning this but worth mentioning as a support for the idea.	Undertake a review of whether additional access tracks can be installed throughout rehab to provide easier access for rehabilitation inspections and maintenance.	31/12/2022	Outstanding
Schedule 3, Condition 53	Rehabilitation Objectives. Recommendation: Ensure Topsoil stockpiles are signposted to reduce chance of disturbance or dumping.	Install sign posts for topsoil stockpiles to reduce the chance of disturbance or dumping.	31/12/2022	Outstanding
SSD 4960 Schedule 5, Condition 5			30/06/2022	Outstanding

Non-Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Action Status
DA-41-03-99 Schedule 2, Condition 10.1	In September 2019, Bulga Coal received a Show Cause Notice from DPIE for failing to operate the CCC in accordance with the CCC Guidelines. Recommendation: Ensure CCC operation is periodically reviewed for compliance against the Department's Community Consultative Committee Guidelines for State Significant Projects (2016, or its latest version).	Undertake a compliance review of the CCC operation against the Department's Community Consultative Committee Guidelines for State Significant Projects (2016, or its latest version).		
DA-41-03-99 Schedule 2, Condition 10.1	No overpressure or vibrations results were recorded at the Dawtrey monitor for blasts fired at Bulga Open Cut on 27/04/21 at 14:18 and 29/04/21 at 12:24. Recommendation: Relinquish DA-41-03-99	Relinquish DA-41-03-99	30/06/2022	Outstanding
DA-41-03-99 Schedule 2, Condition 6.3.5	Cumulative Land Acquisition Criteria. Recommendation: Relinquish DA-41-03-99			
DA-41-03-99 Schedule 2, Condition 6.3.6	Cumulative land acquisition criteria are not provided in the noise management plan. Cumulative mine noise is not measured during regular noise compliance monitoring. It is not possible, based on the information provide, to determine if the cumulative noise impact assessment criteria are being achieved. Recommendation: Relinquish DA-41-03-99			

Non-Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Action Status
DA-41-03-99 Schedule 2, Condition 8.2	The AQMP and WMP have not been updated to include quality assurance/quality control plan and shall require approval from the relevant regulatory agencies. Recommendation: Relinquish DA-41-03-99			
DA 376-8-2003 Schedule 4 Condition 24A	Air Quality & Greenhouse Gas Management Plan. Recommendation: AQGGMP should include evidence of approval of the suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary along with evidence of consultation with the EPA in Appendix C.	The Air Quality Management Plan will be revised to include evidence of approval that the suitably qualified and experienced person has been endorsed by the Planning Secretary along with evidence of consultation with the EPA.	30/06/2022	Completed. The revised AQGGMP was submitted for approval on 14 February 2021.
ML1547 Schedule 00, Condition 2.1	Failure to comply with Condition 2(1) of ML1547 – Conduct operations in accordance with MOP due to spatial data review. Recommendation: Review quality assurance process and ensure data management systems are up to date.	Undertake a review of the quality assurance process for MOP GIS data management and ensure the GIS system is up to date.	30/09/2022	Oustanding

11 Incidents and Non-Compliances during the Reporting Period

Incidents and non-compliances which are considered as low risk of environmental harm are detailed in this section.

11.1 Discharge of Sediment Laden Water into Clean Water Catchment

On 22 March 2021 during a workplace inspection following heavy rainfall, it was observed that Sediment Dam S2A was spilling into a clean water catchment. Sediment Dam S2A spills into clean water drainage that runs adjacent to Broke Road and then into what Bulga Coal refers to as the Southern Drainage Line, which flows into Wollombi Brook approximately 4.2km from the Sediment Dam S2A spillway. The rainfall totals for the 5 days prior to Sediment Dam S2A spilling as measured by the Bulga Complex and Southern Extension weather stations was 143.5mm and 122.8 mm respectively. This rainfall is in the order of twice the dam design rainfall depth value of 64.7mm. During the period the Sediment Dam S2A spilled (22 March 2021 to 24 March 2021) a further 44 mm of rainfall was recorded at the Southern Extension Weather Station.

Given the observed Sediment Dam S2A spill flow rate and duration it is calculated that between 2 and 3 ML flowed into the clean water drainage system. The water quality results indicated that the water spilled from Sediment Dam S2A had:

- A pH slightly above the receiving clean water but well within range observed in the surrounding surface and groundwater systems;
- Total Suspended Solids levels slightly higher than the receiving clean water; and
- Electrical Conductivity similar to the receiving clean water.

The DPIE recorded the incident and required no further information. The DPIE noted the following findings:

- Sediment Dam S2A was designed, constructed and maintained to suitable capacity as required by Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008).
- The Sediment Dam S2A settling zone was completely dewatered prior to the rainfall commencing on the 17 March 2021 and that pump continued to operate at above the required flow rate for the duration of the event.
- The rainfall during the 5 days prior to the 22 March was approximately twice the design rainfall depth value of 64.7mm.

11.2 Alleged contraventions of EPL 563 following inspection

The EPA undertook an inspection of the premises on 9 December 2020. On 29 January 2021 the EPA provided a Show Cause Notice alleging that Bulga Coal had failed to:

- Maintain bund taps in a closed position – water was observed draining from an opened chemical bund tap;
- Contain dangerous goods within a bund – two chemical IBC bunds had no bund plugs;
- Adequately bund flocculant tanks and other tanks containing materials that could cause environmental harm – a flocculant bund had a hole and a spill was observed from a chemical storage cabinet; and
- Store hazardous waste under cover – waste batteries were not stored undercover.

Immediate corrective actions taken included:

- The chemical bund taps observed open were closed;
- Bund plugs were installed on the two chemical bunds;
- The discontinuous bund of the CHPP Flocculant Plant was repaired; and
- The waste batteries were removed to an undercover location.

Further Improvement Actions included:

- Increased inspections to ensure that the bund plugs installed remained in place;
- Bulga Coal revised the procedure for the management of water and or spills captured by bunded pallets;
- The requirement to clean all chemical spills was reinforced to the Bulga workforce;
- Earthworks were completed around the flocullant plant to prevent sediment laden runoff from entering the concrete bund; and
- Options for providing permanent undercover storage for waste batteries were reviewed.

Bulga Coal provided a response to the Show Cause Notice on 26 February 2021. On 6 July 2021 an Official Caution was received from the EPA regarding Bulga Coal's failure to adequately bund the flocculant tank. An Advisory letter was also received regarding the chemical storage allegations.

11.3 Administrative Non-compliances

11.3.1 Failure to Continuously Monitor Air Quality

PM_{10} air quality data was not monitored continuously at EPA Point 9 and Point 10 due to the equipment failure at various times during the EPL Annual Return reporting period. Valid data was captured for 98.6% of the reporting period, at EPA Point 9, and 95.3% of the reporting period, at EPA Point 10.

The cause of the break downs were investigated promptly, and the monitors were fixed. Details were reported to the EPA in the 2020-2021 Annual Return.

PM_{10} air quality data was not monitored continuously at air quality monitors D1, D3, D5 and D11 due to equipment failure, power outages and planned maintenance at various times during the reporting period. Valid data was recorded for 99%, 96%, 99% and 98% of 24-hour events during the reporting period respectively.

$PM_{2.5}$ air quality data was not monitored continuously at air quality monitors D2 and D10 due to equipment failure, power outages and planned maintenance at various times during the reporting period. Valid data was recorded for 92% and 88% of 24-hour events during the reporting period respectively. D2 and D10 monitors will be replaced in 2022.

The cause/s of the break downs were investigated promptly, and the monitors were fixed. Further details are included in the Annual Air Quality Report in Appendix B.

11.3.2 Failure to Monitor Humidity Data

Humidity data was not monitored continuously at EPA Point 23 – Southern Extension Meteorological Station at various times between January 2021 and February 2021.

The cause of the break down was an intermittent fault with output from the humidity sensor resulting in invalid data being recorded at the logger. The humidity sensor was replaced on 10 February 2021. Details were reported to the EPA in the 2020-2021 Annual Return.

11.3.3 Failure to Monitor Blast

Overpressure and vibration data was not monitored at Dawtrey (EPA Point 5) blast monitor on 27 and 29 April 2021.

The missed results were caused by a corrupt memory card. This was determined after the blast monitoring technician retrieved the memory card in the field and attempted to download the data. The memory card was replaced by a blast monitoring technician on 29 April 2021. The monitor has recorded overpressure and vibration results since this date.

11.3.4 Cartographic Error in Bulga Open Cut Mining Operations Plan 2020-2023

On 2 June 2021 Bulga coal advised the RR of the intention to construct a 13.6 hectare temporary pad for the potential storage of high ash ROM coal, and self-reported that 10 hectares of the proposed pad location had incorrectly been labelled as rehabilitation in the 2020 MOP series 3 Plans and Appendix E in the 2020 Annual Review.

On 16 July the RR commenced an investigation and issued an Official Caution on 26 July 2021 for not conducting operations in accordance with the MOP. On 6 September 2021 sought an amendment to the Mining Operation Plan 2020 – 2023 to address minor variations from the MOP Plans provided in August 2020. The revised Plans corrected the cartographic error. *The Bulga Open Cut Mining Operations Plan: 1 July 2020 – 30 June 2023 Amendment A* was approved by RR on 22 October 2021.

12 Activities to Be Completed in the Next Reporting Period

12.1 Bulga Underground Operations

The works listed in **Table 50** have been/will be completed in 2022 at Bulga Underground Operations.

Table 50 Bulga Underground Operations Proposed Activities in 2022

Topic	Proposed Activity	By When
Decommissioning	Decommission and demolish redundant Bulga Underground Operations surface infrastructure.	Ongoing
Rehabilitation	Progressive rehabilitation of redundant gas drainage infrastructure, access tracks, pipelines and boreholes on Bulga Coal land.	Ongoing
Rehabilitation	Continue weed control, erosion repairs and planting/seeding to meet the requirements of target vegetation communities at Bulga Underground Operations.	Ongoing

12.2 Bulga Open Cut

The works listed in **Table 51** have been/will be completed in 2022 at Bulga Open Cut.

Table 51 Bulga Open Cut Proposed Activities in 2022

Topic	Proposed Activity	By When
Construction & Demolition	Commission tailings infrastructure systems, decant systems, and the enlarged S6A Dam.	Q1 2022
	Finish demolishing the dragline.	Q1 2022
Approvals	Relinquish DA 41-03-99.	Q2 2022
Archaeology & Heritage	Salvage the four Aboriginal heritage sites that will be harmed by MOD 3 and MOD 7. Sites include 37-6-1659 (BPL5), 37-6-1660 (BPL6), 37-6-2844 (BOP-OS10) and 37-6-3763 (Bulga IF-2).	Q2 2022
Rehabilitation	Continue weed control works on the Noise and Visual Bund, Eastern Emplacement Area, Old Tailings Dam and Mount Thorley Warkworth Common Boundary Area.	Ongoing
Mining Operations	Commence dredging of tailings in Deep Pit and Bayswater Pit.	Q2 2022

APPENDIX A

EPBC Approvals Compliance Reports

EPBC Approval 2012/6637 Compliance Report

Condition	Actions During the Reporting Period	Status
1. The approval holder must not clear more than 611 ha of native woodland vegetation.	495 ha of native woodland vegetation has been cleared to date as part of the Project.	Compliant
2. To compensate for the loss of approximately 557 ha of Regent Honeyeater, Swift Parrot and Grey Headed Flying Fox habitat, 611 ha of Large-eared Pied Bat habitat and approximately 65 Slatey Red Gum trees, the approval holder must provide for the protection of offset lands identified in the maps at Schedule 1 of this notice as: • Reedy Valley Offset Site; • Wollombi Brook Conservation Area; • Broke Road Offset Site. These offset lands must meet the requirements of the EPBC Offsets Policy and provide for the protection of threatened species habitat on these sites for the duration of the action's impact through a legally binding conservation covenant which must be in force within 3 years of the commencement of the action. Written evidence of compliance against this condition must be provided to the Department prior to the commencement of the action including evidence that action is being taken to put in place a suitable legally binding conservation covenant.	Not applicable, this occurred outside the reporting period. Bulga Coal has formerly established these offset sites as Conservation Agreements under the National Parks and Wildlife Act 1974. The Conservation Agreements were signed by the NSW Minister for the Environment on the 7th of May 2019.	Not Applicable
3. The approval holder must submit for the Minister's approval a Biodiversity Management Plan (BMP) which provides for the offsetting of residual impacts to matters of national environmental significance including but not limited to: • Regent Honeyeater; • Swift Parrot; • Large-eared Pied Bat; • Slatey Red Gum. The BMP must include: a). management actions designed to improve the ecological quality of habitat for the above species on offset lands identified in Condition 2 and protect these sites from ecological degradation for the duration of the action's impact on matters of national environmental significance;	The Biodiversity Management Plan was submitted to the former Department of Environment (now DAWE) on 23 February 2015. The DEE provided comments on the draft plan in April 2016, December 2016 and April 2017 and subsequently approved the document in April 2017. A revised version of the Biodiversity Management Plan (following SSD-4960 Mod 3 approval) was submitted to DPIE in November 2020 and approved by DPIE on 14 October 2021. The revised BMP was then submitted to DAWE on 18 November 2021 and is pending approval.	Compliant
b). an ecological monitoring program to monitor the success of the management actions in the BMP and define measurable targets of management actions, performance indicators, and an adaptive management framework for the duration of the action's impact on habitat for matters of national environmental significance. Management actions prescribed by the BMP must be clear, measurable, auditable and time bound;	The Biodiversity Management Plan contains an ecological monitoring program. Program commenced in 2015. Results are summarised in this Annual Review.	Compliant
c). clear objectives and performance indicators as well as corrective actions for circumstances where a management action fails to meet its prescribed objective or performance indicator. The BMP must be approved in writing by the Minister within 3 months of approval of the action. The approved BMP must be implemented and must be published on the approval holder's website within one month of approval of the BMP and remain published on this website for the duration of the action.	The Biodiversity Management Plan meets the requirements of this condition. The Biodiversity Management Plan was approved by the former DEE in April 2017. The Biodiversity Management Plan is available on the Bulga Coal website.	Compliant
4. The approval holder must submit for the Minister's approval a Water Management Plan (WMP) which provides for the avoidance, mitigation and offsetting of residual impacts to water resources. The WMP must include: a). management actions, mitigation measures and practices designed to limit impacts of the proposal on surface and groundwater resources;	The Water Management Plan was approved by the former DEE in February 2017.	Compliant

Condition	Actions During the Reporting Period	Status
	A revised version of the Water Management Plan (following SSD-4960 Mod 3 approval) was submitted to DPIE in November 2020 and approved by DPIE on 14 October 2021. A copy of the revised WMP was then submitted to DAWE on 18 November 2021.	
b). surface and groundwater monitoring programs to monitor the success of the management actions in the WMP and define measurable targets of management actions, performance indicators, and an adaptive management framework for the duration of the action's impact on water resources. Management actions, mitigation measures and practices prescribed by the plan must be clear, measurable, auditable and time bound;	The Water Management Plan meets the requirements of this condition.	Compliant
c). clear objectives and performance indicators, as well as corrective actions for circumstances where a management action, mitigation measure or practice fails to meet its prescribed objective or performance indicator. The WMP must be approved in writing by the Minister within 3 months of commencement of the action. The approved WMP or plan revised under condition 12 must be implemented.	The Water Management Plan meets the requirements of this Condition.	Compliant
5. The approval holder must provide written evidence and detailed documentation relating to the conservation covenant specified in Condition 2 to the Department within one month of the conservation covenant coming into force. This must include offset attributes, shapefiles and textual descriptions and maps to clearly define the location and boundaries of the offset sites.	Not applicable, this occurred prior to the reporting period. Evidence and documentation was provided to the DAWE on 20 January 2020.	Not applicable
6. Unless otherwise agreed to in writing by the Minister, the approval holder must provide the approved plans referred to in these conditions of approval to members of the public upon request. Copies must be provided within 14 days of the request.	There have been no requests from members of the public to provide approved plans referred to in the conditions of approval. Notwithstanding, the approved plans are available to the public on the Bulga Coal website.	Compliant
7. Within 30 days after the commencement of the action, the approval holder must advise the Department in writing of the actual date of commencement of the action.	Not triggered within the audit period. Action under this approval commenced 3 December 2014. Notification of the commencement of the action was provided by Bulga Coal to the former DEE on 2 December 2014.	Not applicable
8. The approval holder must maintain accurate records substantiating all activities associated with or relevant to these conditions of approval, including measures taken to implement the management plans, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be published on the Department's website. The results of audits may also be publicised through the general media.	Accurate records substantiating all activities associated with conditions of approval are maintained in accordance with the Bulga Coal Environmental Management System. Results are also summarised in the Bulga Coal Annual Review. There have been no audits to date.	Compliant
9. By 31 March each year, the approval holder must publish a report on their website addressing compliance with each of the conditions of this approval including implementation of the management plans for the previous calendar year (i.e. 01 January to 31 December). Documentary evidence providing proof of the date of publication must be provided to the Department at the same time as the compliance report is published.	The 2020 Bulga Coal Annual Review was published on the website and provided to the DAWE on 29 March 2021.	Compliant
9A. Potential or actual contraventions of conditions of approval must be reported to the Department in writing within 2 business days of the approval holder becoming aware of the actual or potential contravention. All contraventions must also be included in the annual compliance report outlined in condition 9.	There have been no potential or actual contraventions of conditions of this approval within the reporting period.	Compliant

Condition	Actions During the Reporting Period	Status
10. Upon the direction of the Minister, the approval holder must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.	No directions for an independent audit of compliance with EPBC Ref: 2012/6637 have been received by Bulga Coal.	Not Applicable
11. If, at any time after five (5) years from the date of this approval, the approval holder has not commenced the action, then the approval holder must not commence the action without the written agreement of the Minister.	Action under EPBC Ref: 2012/6637 was commenced 3 December 2014.	Compliant
12. The approval holder may choose to revise a plan approved by the Minister under condition 4 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised plan would not be likely to have a new or increased impact. If the approval holder makes this choice they must: i. notify the Department in writing that the approved plan has been revised and provide the Department with an electronic copy of the revised plan. ii. implement the revised plan from the date that the plan is submitted to the Department; and iii. for the life of this approval, maintain a record of the reasons the approval holder considers that taking the action in accordance with the revised plan would not be likely to have a new or increased impact.	A revised version of the Water Management Plan (following SSD-4960 Mod 3 approval) was submitted to DPIE in November 2020 and approved by DPIE on 14 October 2021. A copy of the revised WMP was then provided to DAWE on 18 November 2021 for their records.	Compliant
12A. The approval holder may revoke their choice under condition 12 at any time by notice to the Department. If the approval holder revokes the choice to implement a revised plan, without approval under section 143A of the Act, the plan approved by the Minister must be implemented.	This condition was not triggered during the reporting period.	Not Applicable
12B. Condition 12 does not apply if the revisions to the approved plan include changes to environmental offsets provided under the plan in relation to a matter protected by the controlling provision for the action, unless otherwise agreed by the Minister. This does not otherwise limit the circumstances in which the taking of the action in accordance with a revised plan would, or would not, be likely to have new or increased impacts.	This condition was not triggered during the reporting period.	Not Applicable
12c. If the Minister gives a notice to the approval holder that the Minister is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new or increased impact, then: i. Condition 12 does not apply, or ceases to apply, in relation to the revised plan; and ii. The approval holder must implement the plan approved by the Minister. To avoid any doubt, this condition does not affect any operation of conditions 12, 12A and 12B in the period before the day the notice is given. At the time of giving the notice the Minister may also notify that for a specified period of time that condition 12 does not apply for one or more of the specified plans required under the approval.	This condition was not triggered during the reporting period.	Not Applicable
12D. Conditions 12, 12A, 12B and 12C are not intended to limit the operation of section 143A of the EPBC Act which allows the approval holder to submit a revised plan, to the Minister for approval.	This condition was not triggered during the reporting period.	Not Applicable
13. Condition 13 has been revoked.	Noted.	Not Applicable
14. Unless otherwise agreed to in writing by the Minister, the Approval holder must publish all management plans referred to in these conditions of approval on their website. Each Management plan must be published on the website within 1 month of being approved by the minister or being submitted under condition 12i, and remain published for the duration of the action.	The Biodiversity Management Plan was approved by the former DEE in April 2017. A revised version of the Biodiversity Management Plan (following SSD-4960 Mod 3 approval) was submitted to DPIE in November 2020 and approved by DPIE on 14 October 2021. The revised BMP was then submitted to DAWE on 18 November 2021 and is pending approval. Both versions are available on the Bulga Coal website.	Compliant

Condition	Actions During the Reporting Period	Status
	A copy of the revised Water Management (previously approved by DEE in February 2017) was provided to DAWE on 18 November 2021 for their records, in accordance with Condition 12. The revised WMP plan is available on the Bulga Coal website.	

EPBC Approval 2018/8300 Compliance Report

Condition	Actions During the Reporting Period	Status
1. The approval holder must comply with State development consent conditions 24, 24A, 25, 26, 27 and 28 of Schedule 3.	Noted. Bulga Coal has been compliant with the relevant SSD 4960 State development consent conditions since EPBC Approval 2018/8300 was granted.	Compliant
2. The approval holder must determine the extent and distribution of riparian vegetation (including EPBC Act listed ecological communities identified as being partially or wholly groundwater dependent, including the EPBC Act listed Warkworth Sands Woodland of the Hunter Valley) and potential for stygofauna within the alluvium that are likely to be affected by the action, through ground-truthing surveys. The approval holder must submit the findings of these surveys to the Department within 15 months of the date of this approval or prior to open cut mining below the Woodlands Hill Seam in the Modification Additional Coal Extraction Area (delineated by a blue boundary at Annexure 1).	Bulga Coal was granted a 3 month extension to the required timeframe to satisfy this condition, and the condition was varied on 9 September 2021. Bulga Coal submitted a Ecohydrological Assessment satisfying conditions 2 and 3 to the DAWE on 20 December 2021.	Compliant
3. To investigate how changes in the rate of water movement through the environment may impact water-dependent ecosystems, the approval holder must develop ecohydrological conceptual models flora. the potential impacts to ephemeral streams and the Wollombi Brook. the EPBC Act listed Warkworth Sands Woodland of the Hunter Valley ecological community to show how the perched aquifer and associated groundwater dependent ecosystems may be affected by the action. The ecohydrological conceptual models must include potential changes to flow regimes (frequency, duration and timing of low- and zero-flow periods) and how this could impact biota, including through changes in refugial pool persistence. The approval holder must submit the ecohydrological models to the Minister for approval within 15 months of the date of this approval. The approval holder must not commence mining below the Woodlands Hill Seam unless the Minister has approved the ecohydrological models in writing.	Bulga Coal was granted a 3 month extension to the required timeframe to satisfy this condition, and the condition was varied on 9 September 2021. Bulga Coal submitted a Ecohydrological Assessment satisfying conditions 2 and 3 to the DAWE on 20 December 2021.	Compliant
4. Within the Modification Additional Disturbance Areas (delineated by a red boundary at Annexure 1), the approval holder must not clear more than: a. 16.4 hectares of Regent Honeyeater (Anthochaera phrygia) habitat, b. 16.4 hectares of Swift Parrot (Lathamus discolor) habitat, c. 16.4 hectares of the Central Hunter Valley Eucalypt Forest and Woodland EPBC Act listed ecological community.	No clearing has occurred within the Modification Additional Disturbance Areas to date.	Compliant
5. The approval holder must comply with the State development consent conditions 29, 30, 33, 33A, 33B, 34 and 34A of Schedule 3.a. To compensate for the loss of the listed threatened species and ecological community habitat identified at condition 4, the approval holder must submit the Biodiversity Offset Strategy (specified at condition 29 of the State development consent) to the Minister for approval. i. The approval holder must not commence vegetation clearing within the modification additional disturbance area (delineated by a red boundary at Annexure 1) until the Biodiversity Offset Strategy has been approved by the Minister .ii. The approval holder must implement the Biodiversity Offset Strategy as approved by the Minister.	Noted. Bulga has been compliant with the relevant SSD 4960 State development consent conditions since EPBC Approval 2018/8300 was granted. The Biodiversity Offset Strategy is within the approved Biodiversity Management Plan. A revised version of the Biodiversity Management Plan (following SSD-4960 Mod 3 approval) was submitted to DPIE in November 2020 and approved by DPIE on 14 October 201. The revised BMP was then submitted to DAWE on 18 November 2021 and is pending approval.	Compliant

Condition	Actions During the Reporting Period	Status
6. The approval holder must comply with the State development consent conditions 53, 54, 55 and 56.	Noted. Bulga Coal has been compliant with the relevant SSD 4960 State development consent conditions since EPBC Approval 2018/8300 was granted. The Mining Operations Plan was approved by the DPIE on 9 September 2020, the Mining Operations Plan was revised and approved by the RR on 22 October 2021, a copy of the Mining Operations Plan Amendment A is available on the Bulga Coal Website.	Compliant
7. The approval holder must notify the Department in writing of the date of commencement of the action within 10 business days after the date of commencement of the action.	Not applicable, occurred before the reporting period. Bulga Coal commenced the action on 22 September 2020 and notified the DAWE on 24 September 2020.	Not Applicable
8. If the commencement of the action does not occur within 5 years from the date of this approval, then the approval holder must not commence the action without the prior written agreement of the Minister.	Not applicable, occurred before the reporting period. Bulga Coal commenced the action on 22 September 2020 and notified the DAWE on 24 September 2020.	Not Applicable
9. The approval holder must maintain accurate and complete compliance records.	Compliant. Accurate records substantiating all activities associated with conditions of approval are maintained in accordance with the Bulga Coal Environmental Management System. Results are also summarised in the Bulga Coal Annual Review.	Compliant
10. If the Department makes a request in writing, the approval holder must provide electronic copies of compliance records to the Department within the timeframe specified in the request. Note: Compliance records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, and or used to verify compliance with the conditions. Summaries of the result of an audit may be published on the Department's website or through the general media.	Noted. This has not been triggered to date. No requests have been received from the Department.	Not Applicable
11. The approval holder must: a. Submit the ecohydrological models required under condition 3 and the Biodiversity Offset Strategy required under condition 5. an electronically to the Department for approval by the Minister, b. publish the ecohydrological models on the website within 20 business days of the date the ecohydrological models are approved by the Minister, unless otherwise agreed to in writing by the Minister, c. publish the Biodiversity Offset Strategy on the website within 20 business days of the date the Biodiversity Offset Strategy is approved by the Minister, unless otherwise agreed to in writing by the Minister, d. exclude or redact sensitive ecological data from the Biodiversity Offset Strategy published on the website or provided to a member of the public, and e. keep the ecohydrological models and Biodiversity Offset Strategy published on the website until the end date of this approval.	On 20 December 2021 the ecohydrological models report was submitted to the DAWE for approval. The revised BMP (inclusive of the Biodiversity Offset Strategy) was then submitted to DAWE on 18 November 2021 and is pending approval.	Compliant

Condition	Actions During the Reporting Period	Status
12. The approval holder must prepare a compliance report addressing compliance with each of the conditions of this approval, including implementation of any management plans and strategies from the State development consent that are referred to in this approval, for each 12 month period following the date of commencement of the action, or otherwise in accordance with an annual date that has been agreed to in writing by the Minister. The approval holder must: a. publish each compliance report on a website within 60 business days following the relevant 12 month period, b. notify the Department by email that a compliance report has been published on the website and provide the website's link for the compliance report within five business days of the date of publication, c. keep all compliance reports publicly available on the website until this approval expires, d. exclude or redact sensitive ecological data from compliance reports published on the website, and e. where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication. Note: Compliance reports may be published on the Department's website.	Compliant. This is the compliance report. The 2020 compliance report was submitted to DAWE on 29 March 2021.	Compliant
13. The approval holder must notify the Department in writing of any: incident, or non-compliance with the conditions, or non-compliance with the commitments made in plans. The notification must be given as soon as practicable, and no later than two business days after becoming aware of the incident or non-compliance. The notification must specify: a. any condition which is in breach, b. a short description of the incident and/or non-compliance, and c. the location (including co-ordinates), date, and time of the incident and/or non-compliance. In the event the exact information cannot be provided, provide the best information available.	There have not been any incidents or non-compliances with the conditions which have required notification.	Compliant
14. The approval holder must provide to the Department the details of any incident or noncompliance with the conditions or commitments made in plans as soon as practicable and no later than 10 business days after becoming aware of the incident or non-compliance, specifying: a. any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future, b. the potential impacts of the incident or non-compliance, and c. the method and timing of any remedial action that will be undertaken by the approval holder.	There have not been any incidents or non-compliances with the conditions which have required notification.	Compliant
15. The approval holder must ensure that independent audits of compliance with the conditions are conducted as requested in writing by the Minister.	This condition has not been triggered. No requests for an audit have been received by the Minister to date.	Not Applicable
16. For each independent audit, the approval holder must: a. provide the name and qualifications of the independent auditor and the draft audit criteria to the Department, b. only commence the independent audit once the audit criteria have been approved in writing by the Department, and c. submit an audit report to the Department within the timeframe specified in the approved audit criteria.	This condition has not been triggered. No requests for an audit have been received by the Minister to date.	Not Applicable
17. The approval holder must publish the audit report on the website within 10 business days of receiving the Department's approval of the audit report and keep the audit report published on the website until the end date of this approval.	This condition has not been triggered. No requests for an audit have been received by the Minister to date.	Not Applicable
18. The approval holder must comply with the State development consent condition 5 in Schedule 2.	Noted. Condition 5 in Schedule 2 states that the Applicant may carry out mining operations on site until 31st December 2039.	Compliant
19. Within 30 days after the completion of the action, the approval holder must notify the Department in writing and provide completion data.	This has not been triggered. The action has not been completed.	Not Applicable
20. The approval holder must notify the Department in writing of any proposed change to the State development consent conditions referred to in these conditions within 10 business days of formally proposing a change or becoming aware of any proposed change.	This condition has not been triggered. There has been no proposed changes to the relevant SSD 4960 consent conditions since EPBC Approval 2018/8300 was granted.	Not Applicable

Condition	Actions During the Reporting Period	Status
21. The approval holder must notify the Department in writing of any change to the conditions of the State development consent referred to in these conditions, within 10 business days of a change to conditions being finalised.	This condition has not been triggered. There has been no changes to the relevant SSD 4960 consent conditions since EPBC Approval 2018/8300 was granted.	Not Applicable
22. The approval holder may, at any time, apply to the Minister for a variation to an action management plan approved by the Minister under conditions 3 and 5.a, or as subsequently revised in accordance with these conditions, by submitting an application in accordance with the requirements of section 143A of the EPBC Act. If the Minister approves a revised action management plan (RAMP) then, from the date specified, the approval holder must implement the RAMP in place of the previous action management plan.	This condition has not been triggered during the reporting period.	Not Applicable
23. The approval holder may choose to revise an action management plan approved by the Minister under conditions 3 and 5.a, or as subsequently revised in accordance with these conditions, without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the RAMP would not be likely to have a new or increased impact.	This condition has not been triggered during the reporting period.	Not Applicable
24. If the approval holder makes the choice under condition 21 to revise an action management plan without submitting it for approval, the approval holder must: a. notify the Department in writing that the approved action management plan has been revised and provide the Department with: i. an electronic copy of the RAMP, ii. an electronic copy of the RAMP marked up with track changes to show the differences between the approved action management plan and the RAMP ,iii. an explanation of the differences between the approved action management plan and the RAMP,1 Condition 5 in Schedule 2 states that the Applicant may carry out mining operations on the site until 31 December 2039.iv. the reasons the approval holder considers that taking the action in accordance with the RAMP would not be likely to have a new or increased impact, and written notice of the date on which the approval holder will implement the RAMP(RAMP implementation date), being at least 20 business days after the date of providing notice of the revision of the action management plan, or a date agreed to in writing with the Department. b. subject to condition 24, implement the RAMP from the RAMP implementation date.	This condition has not been triggered during the reporting period.	Not Applicable
25. The approval holder may revoke their choice to implement a RAMP under condition 21 at anytime by giving written notice to the Department. If the approval holder revokes the choice under condition 21, the approval holder must implement the action management plan in force immediately prior to the revision undertaken under condition 21.	This condition has not been triggered during the reporting period.	Not Applicable
26. If the Minister gives a notice to the approval holder that the Minister is satisfied that the taking of the action in accordance with the RAMP would be likely to have a new or increased impact, then: a. condition 21 does not apply, or ceases to apply, in relation to the RAMP; and b. the approval holder must implement the action management plan specified by the Minister in the notice.	This condition has not been triggered during the reporting period.	Not Applicable
27. At the time of giving the notice under condition 24, the Minister may also notify that for a specified period of time, condition 21 does not apply for one or more specified action management plans. Note: conditions 21, 22, 23 and 24 are not intended to limit the operation of section 143A of the EPBC Act which allows the approval holder to submit a revised action management plan, at any time, to the Minister for approval.	This condition has not been triggered during the reporting period.	Not Applicable

EPBC Approval 2002/773 Compliance Report

Condition	Actions During the Reporting Period	Status
1. Prior to the commencement of the mine expansion, the person taking the action must submit for the Minister's approval a plan for managing the impacts of subsidence on the environment on Commonwealth land. The plan must include: a) a full description, including maps, of the area that may be impacted by ruining activity, including areas of environmental and heritage sensitivity; b) predictions of the expected extent of subsidence; c) a detailed outline of the potential environmental, heritage, land use and other impacts of subsidence; d) proposals to minimise the impacts of surface subsidence, particularly in areas of environmental and heritage sensitivity; e) measures for ground and surface water monitoring and management; f) proposals for any necessary rehabilitation and repair of subsidence impacts; g) a process of stakeholder consultation, and; h) a detailed and ongoing Subsidence Monitoring and Reporting Program. The plan must he submitted for the approval of the Minister within three years of the date of this approval. The approved plan must be implemented	Not Applicable in reporting period. Longwall operations commenced in Commonwealth Land in November 2015. Following completion of mining in Blakefield South Longwall 8 on 28 July 2017, all mining within the Commonwealth Land is now complete.	Not Applicable
2. Within one year of the Commencement of mining activities on Commonwealth land and at the completion of mining activities, the person taking the action must ensure that an independent audit of compliance with the plan referred to in paragraph 1 is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.	Not Applicable in reporting period. The initial audit was submitted on 9 March 2016 and was approved on 21 April 2017. The audit done upon completion of mining activities was submitted on the 15 March 2019 and was approved on 18 July 2019.	Not Applicable
3 The person taking the action may choose to revise a management plan approved by the Minister under Condition 1 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action is accordance with the revised plan would not be likely to have a new of increased impact, If the person taking the action makes this choice they must: i. notify the Department in writing that the approved plan has been revised and provide the Department with an electronic copy of the revised plan; ii. implement the revised plan from the date that the plan is submitted to the Department; and iii. for the life of this approval, maintain a record of the reasons the person taking the action considers that taking the action in accordance with the revised plan would not be likely to have a new or increased impact.	This condition was not triggered during the reporting period.	Not Applicable
3A. The person taking the action may revoke their choice under condition 3 or any time by notice to the Department. If the person taking the action revokes the choice to implement a revised plan, without approval under section 143A of the Act, the plan approved by the Minister must be implemented.	This condition was not triggered during the reporting period.	Not Applicable

Condition	Actions During the Reporting Period	Status
3B. If the Minister gives a notice to the person taking the action that the Minister is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new of increased impact, then: i. Condition 3 does not apply, or ceases to apply, in relation to the revised plan; and ii. The person taking the action must implement the plan approved by the Minister. To avoid any doubt, the condition does not affect any operation of conditions 3I, 3A in the period before the date the notice is given. At the time of giving the notice the Minister may also notify that for a specified period of time that Condition 3 does not apply for one or more specified plans required under the approval.	This condition was not triggered during the reporting period.	Not Applicable
3C. Conditions 3, 3A and 3B are not intended to limit the operation of Section 143A of the EPBC Act which allows the person taking the action to submit a revised plan to the Minister for approval.	Noted. Conditions 3, 3A and 3B were not triggered during the reporting period.	Not Applicable
4. The Condition was revoked the day the Variation Notice was signed.	Noted.	Not Applicable
5. On 1 July of each year after the commencement of raining operations on Commonwealth land, the General Manager of Bulge Coal Management Pty Ltd must provide a certificate stating that the Bulga Coal Management Pty Ltd has complied with the conditions of this Approval.	This report and the Bulga Coal Annual Review details how Bulga Coal has complied with the conditions of the Approval. Approval from DAWE was granted on 17 March 2021 to align EPBC approval reporting dates to NSW state government compliance reporting obligations. An annual compliance report for the 1 January 2021 to 31 December 2021 reporting period was submitted on 29March 2021. No non-compliances were identified.	Compliant

APPENDIX B

Air Quality Monitoring Data Review and Analysis at Bulga Complex 2021
(Todoroski, 2022)

AIR QUALITY MONITORING DATA REVIEW AND ANALYSIS AT BULGA COMPLEX 2021

Bulga Coal

18 February 2022

Job Number 14070348S

Prepared by
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Air Quality Monitoring Data Review and Analysis at Bulga Complex 2021

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	01/02/2022	K Trahair	D Kjellberg
FINAL - 001	17/02/2022	K Trahair	
FINAL - 002	17/02/2022	K Trahair	

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APPENDIX

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LIST OF FIGURES

1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of Bulga Coal. The report presents a review and analysis of the dust monitoring data recorded at the Bulga Complex and includes a comparison between the dust levels measured in 2021 with the modelled predictions for the approximate year (Year 2022) per the *Bulga Coal Complex Modification 3 Air Quality Impact Assessment* (**Jacobs, 2019**) and a long-term trend analysis of air quality data from the beginning of monitoring to the end of 2021.

The review involved analysis of the monitoring data retrieved from:

- the Bulga Complex monitors including High Volume Air Samplers (HVAS), Tapered Element Oscillating Microbalances (TEOMs), Beta Attenuation Monitors (BAMs), E-BAMs and Dust Deposition Gauges; and,
- concurrent meteorological data from the Bulga Complex, Bulga High Wall, Southern Extension and Flares weather stations collected over the same period.

2 PROJECT SETTING AND METEOROLOGY

Figure 2-1 presents the location of the Bulga Complex in the context of the Hunter Valley and the Upper Hunter Air Quality Monitoring Network (UHAQMN) monitoring locations.

Figure 2-2 shows the locations of the weather stations at the Bulga Complex, together with the 2021 annual wind distributions at the weather stations (refer to **Appendix A** for how to read a windrose plot).

The weather stations experienced generally similar wind patterns with winds from the south and northwest dominating the annual distribution. All stations recorded very few winds from the northeast. The Flares weather station experienced lower wind speeds compared to the other stations.

Figure 2-3 shows the seasonal windroses at the weather stations for 2021. The weather stations generally experienced similar seasonal wind patterns. The Bulga Complex weather station recorded fewer winds from the south in autumn compared with the Southern Extension and Flares weather stations. The Flares Met Station recorded a higher percentage of light and calm winds compared to the other weather stations most likely due to sheltering from vegetation.

Appendix B provides a summary of the percentage data capture for each weather station during 2021.

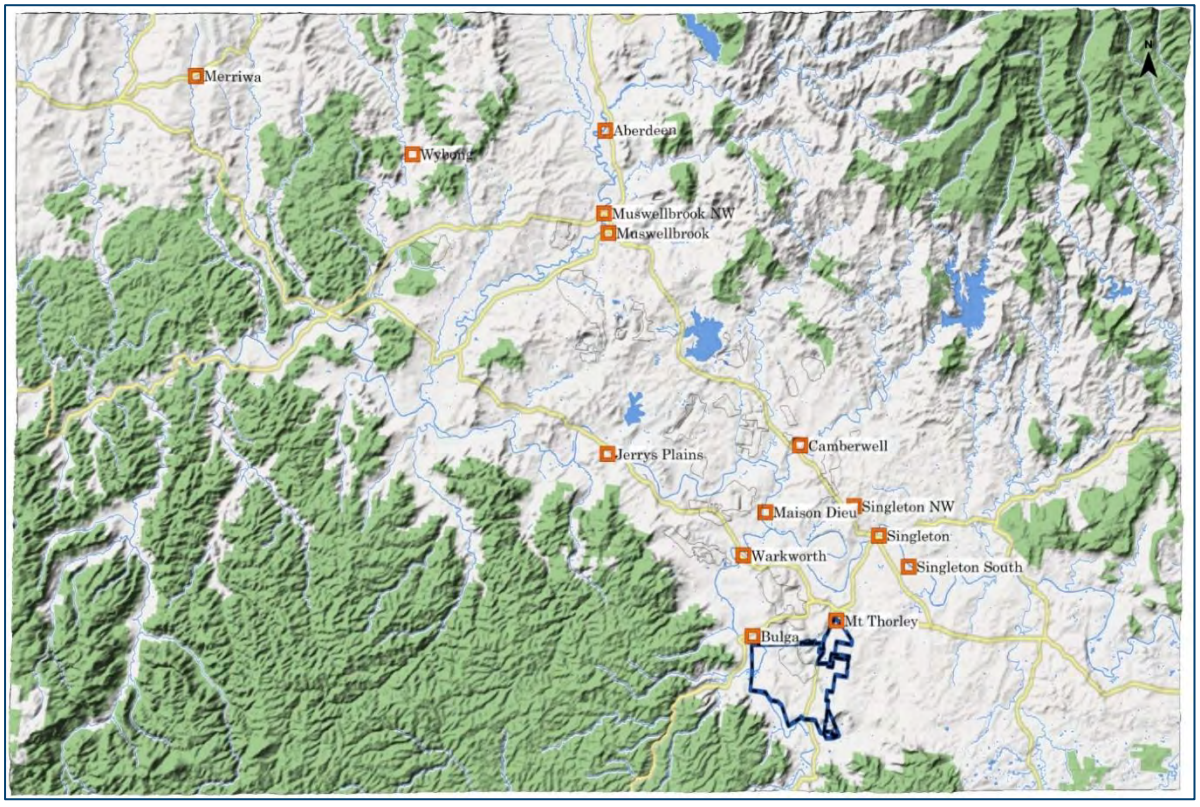


Figure 2-1: Site Location

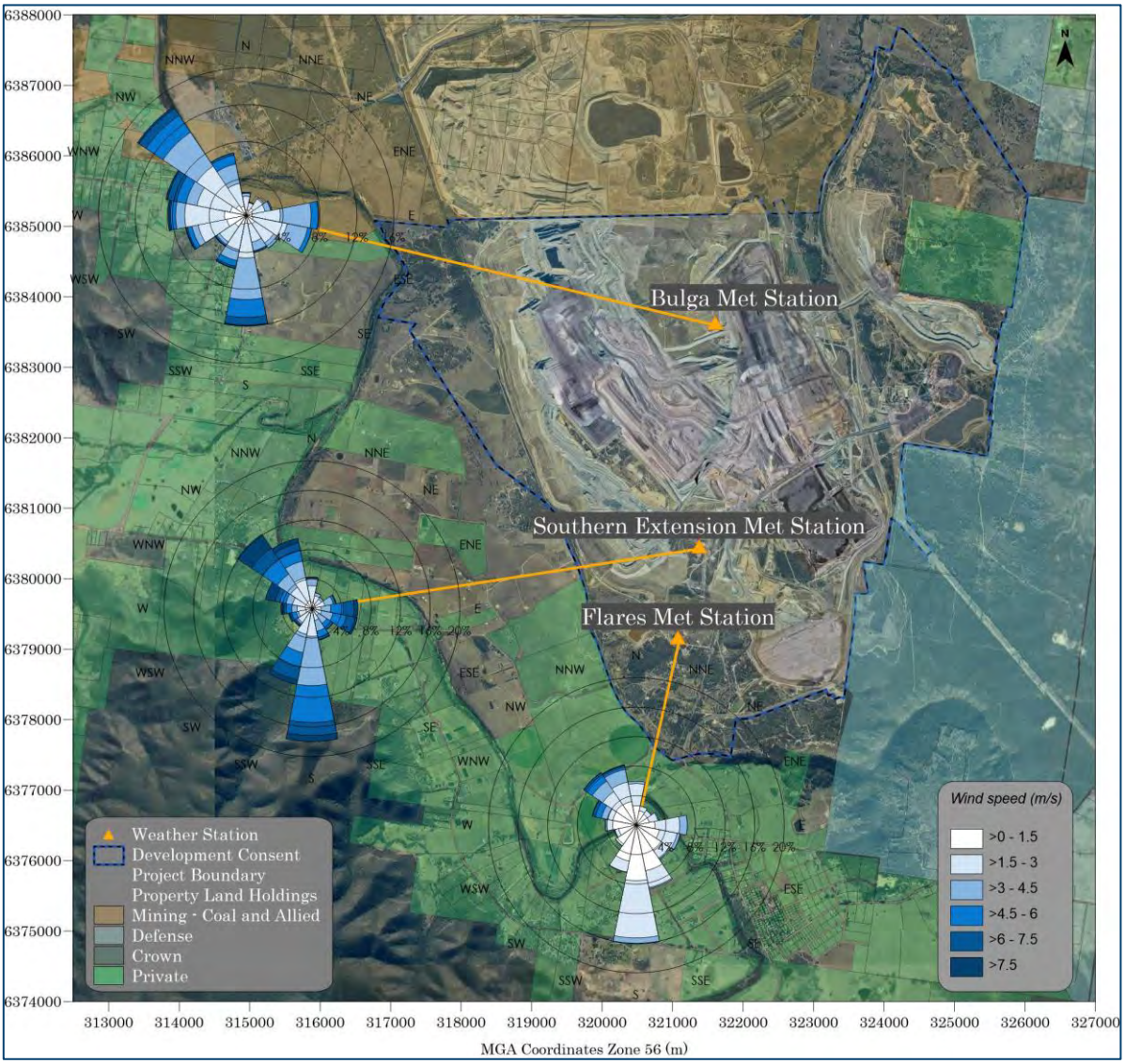


Figure 2-2: Annual windroses (2021)

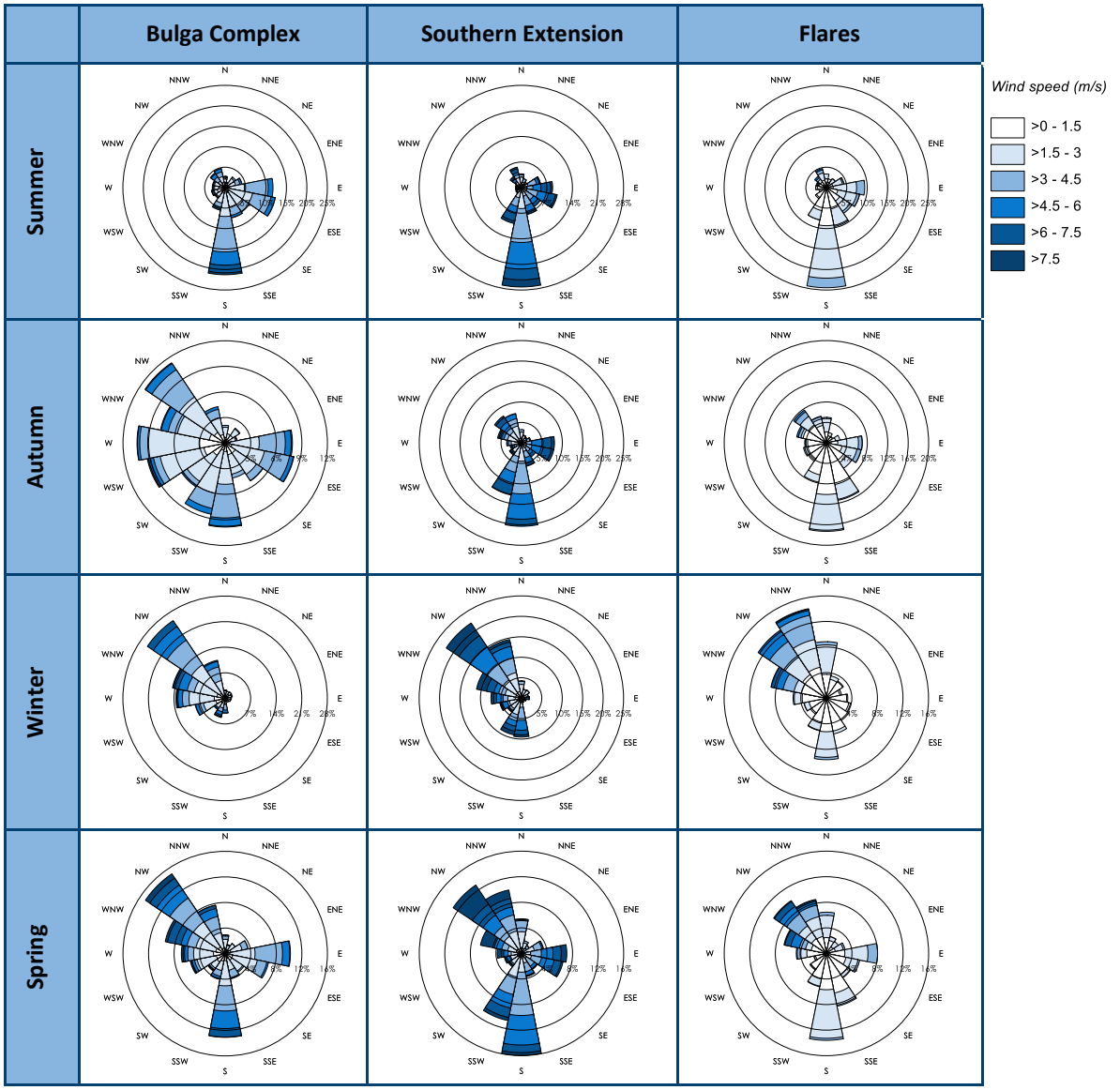


Figure 2-3: Windroses for each season of 2021 for the Bulga Complex, Southern Extension and Flares weather stations

3 COMPARISON OF MEASURED 2021 DATA AND MODEL PREDICTIONS

The locations of the HVAS, TEOM, BAM, E-BAM and deposited dust gauge monitors surrounding the Bulga Complex are shown in **Figure 3-1**. It is noted that the D9 E-BAM monitor was relocated approximately 1.7km to the west on 23 August 2021. **Figure 3-1** presents the updated D9 location.

Monitoring data collected at these locations during 2021 were compared with modelling predictions for the approximate year (Year 2022) per the *Bulga Coal Complex Modification 3 Air Quality Impact Assessment* (**Jacobs, 2019**).

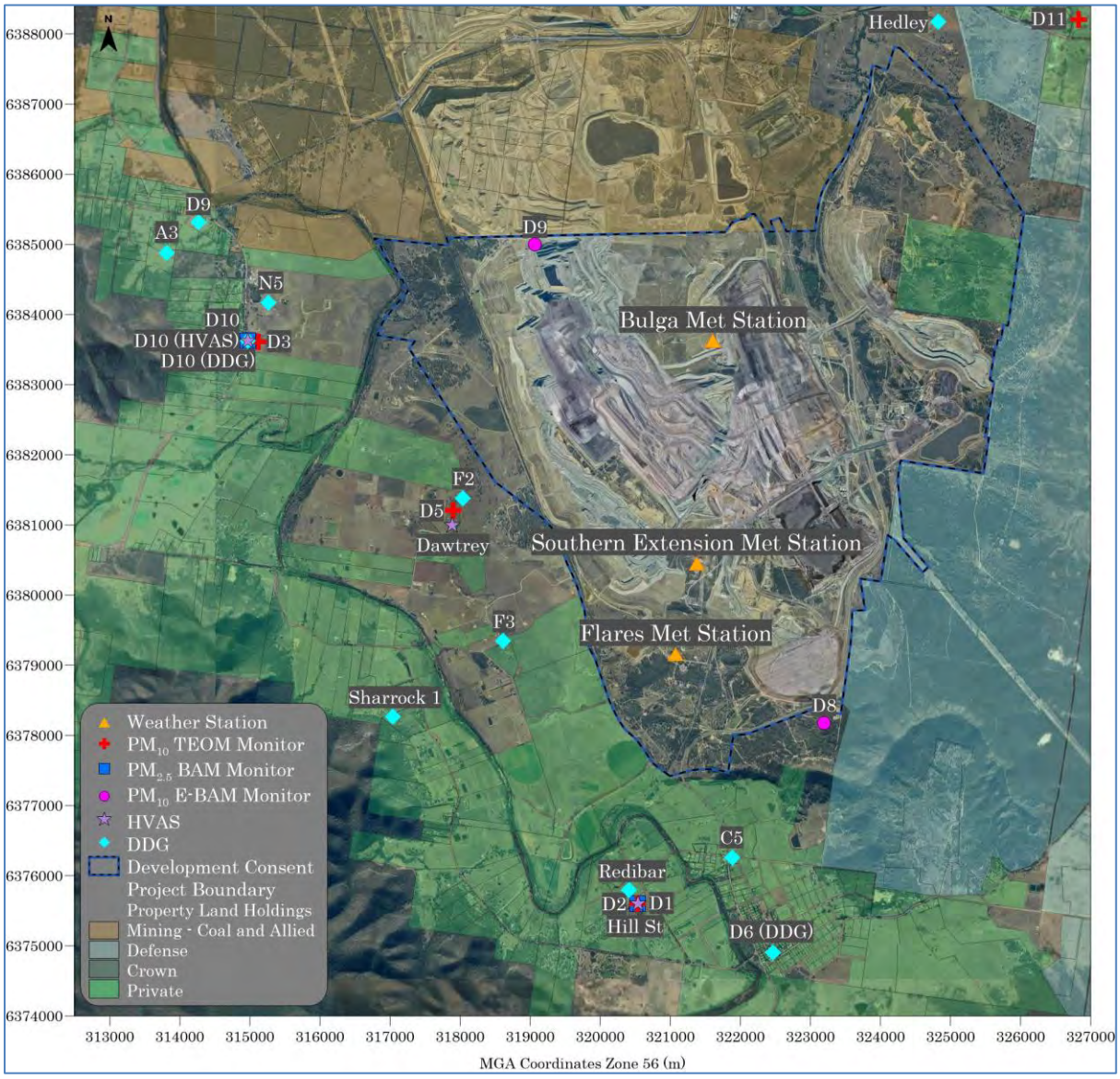


Figure 3-1: Air quality monitoring locations

3.1 Annual average $PM_{2.5}$

Figure 3-2 presents the measured 2021 annual average $PM_{2.5}$ data superimposed over the dispersion modelling contours reproduced from the *Bulga Coal Complex Modification 3 Air Quality Impact Assessment* (Year 2022) (**Jacobs, 2019**). The measured and predicted data in the figures include dust levels from Bulga and other sources.

Figure 3-2 indicates that the measured annual average $PM_{2.5}$ levels in 2021 are approximately 1µg/m^3 lower than the predicted levels for the Year 2022 modelling scenario.

Source: **Jacobs, 2019**

Figure 3-2: 2021 $PM_{2.5}$ annual average monitoring data superimposed over the predicted $PM_{2.5}$ annual average modelling contour (Year 2022 cumulative)

3.2 Annual average PM_{10}

Figure 3-3 presents the measured 2021 annual average PM_{10} data superimposed over the dispersion modelling contours reproduced from the *Bulga Coal Complex Modification 3 Air Quality Impact Assessment* (Year 2022) (**Jacobs, 2019**). The measured and predicted data in the figures include dust levels from Bulga and other sources.

Figure 3-3 indicates that the measured annual average PM_{10} levels in 2021 are approximately 3µg/m^3 to 5µg/m^3 lower than the predicted levels for the Year 2022 modelling scenario.

Source: **Jacobs, 2019**

Figure 3-3: 2021 PM_{10} annual average monitoring data superimposed over the predicted PM_{10} annual average modelling contour (Year 2022 cumulative)

3.3 Annual average TSP

Figure 3-4 presents the locations of the TSP HVAS monitors where the measured TSP data were used to calculate the 2021 annual average TSP concentrations.

The figures present an overlay of the 2021 TSP annual averages over the dispersion modelling predictions. The measured and predicted data in the figures include dust levels from Bulga and other sources.

Figure 3-4 indicates that the measured annual average PM_{10} levels in 2021 are approximately 20µg/m^3 lower than the predicted levels for the Year 2022 modelling scenario.

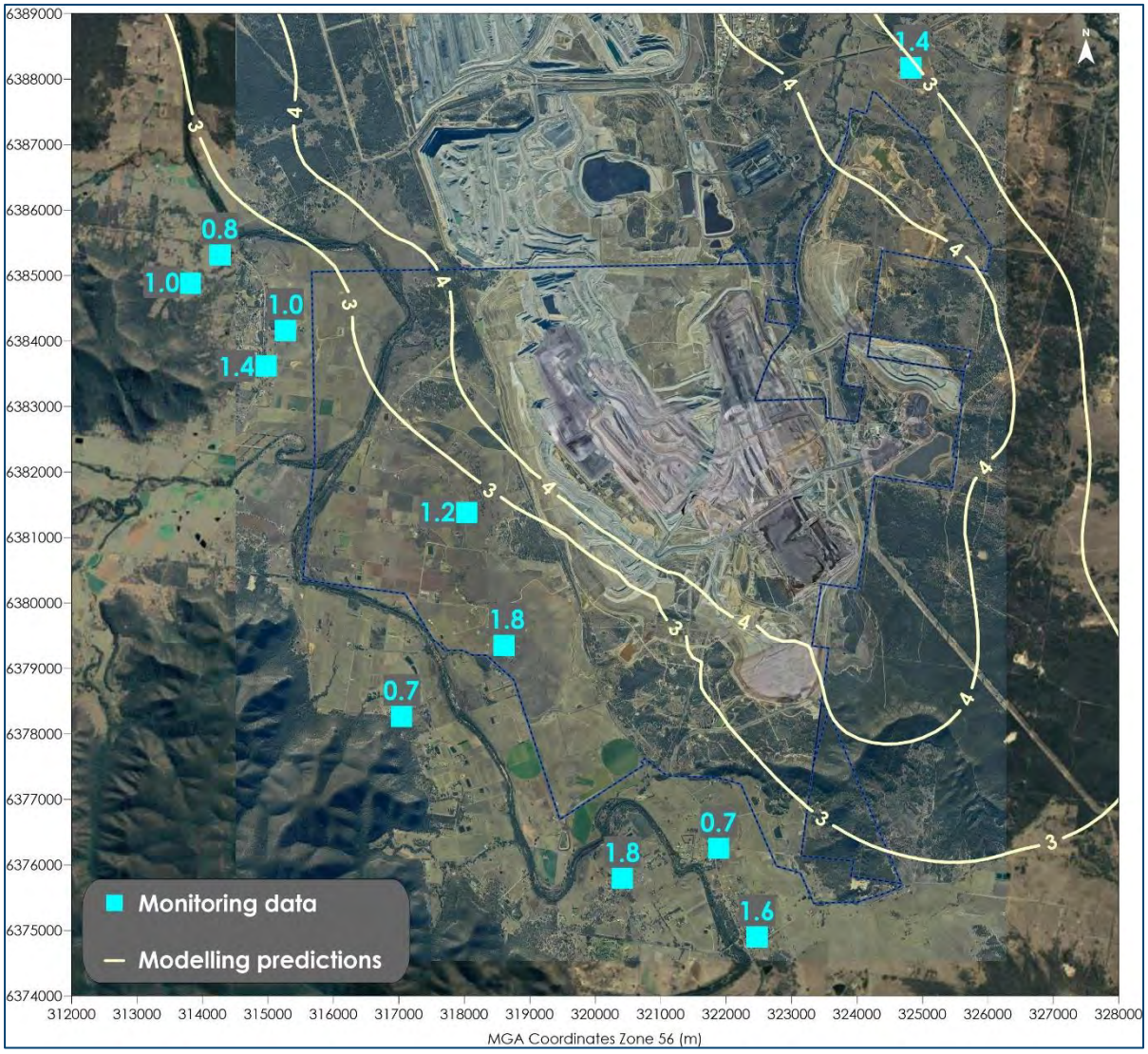
Source: **Jacobs, 2019**

Figure 3-4: 2021 TSP annual average monitoring data superimposed over the predicted TSP annual average modelling contour (Year 2022 cumulative)

3.4 Annual average deposited dust

Figure 3-5 presents an overlay of the measured 2021 annual average deposited dust levels over the dispersion modelling contours reproduced from the *Bulga Coal Complex Modification 3 Air Quality Impact Assessment* (Year 2022) (**Jacobs, 2019**).

The measured levels in 2021 are all well below the 4g/m^2/month contour as predicted for Year 2022.



Source: **Jacobs, 2019**

Figure 3-5: 2021 deposited dust annual average monitoring data superimposed over the predicted deposited dust annual average modelling contour (Year 2022 cumulative)

4 AIR QUALITY CRITERIA

The sections below identify the key pollutants currently being monitored at the Bulga Coal air quality monitoring sites and the applicable air quality criteria.

4.1 Particulate Matter

Particulate matter consists of particles of varying size and composition. The total mass of all particles suspended in air is defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

The TSP is defined further into two sub-components. They are PM_{10} particles, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

4.1.1 DPIE air quality criteria

Table 4-1 to **Table 4-3** summarises the air quality goals that are relevant to particulate pollutants as outlined in the Bulga Coal Development Consent (SSD-4960).

The development consent outlines that the applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the particulate emissions generated by the Bulga mine complex do not exceed the criteria listed in **Table 4-1** to **Table 4-3** at any residence on privately-owned land. As the E-BAM monitors are located within the mine site, the DPIE criteria are not directly applicable to these monitors.

Table 4-1: Long term criteria for particulate matter

Pollutant	Averaging Period	[a,c]Criterion
Total suspended particulates (TSP)	Annual	90µg/m^3
Particulate Matter < 10µm (PM_{10})	Annual	25µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual	8µg/m^3

Table 4-2: Short term criteria for particulate matter

Pollutant	Averaging Period	[b]Criterion as per MOD 3
Particulate Matter < 10µm (PM_{10})	24-hour	50µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m^3

Table 4-3: Long term criteria for deposited dust

Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
[d]Deposited dust	Annual	[b]2g/m^2/month	[a]4g/m^2/month

Notes for **Table 4-1** to **Table 4-3**:

- [a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to other sources);
- [b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own);

- [c] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed to by the Secretary; and
- [d] 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.

5 LONG TERM REVIEW

Figure 5-1 to **Figure 5-9** show the long-term trends for $PM_{2.5}$, PM_{10}, TSP and deposited dust from the start of commissioning of the monitors up until the end of the 2021 calendar year. The data in the figures include extraordinary event days. These plots are discussed in more detail in the following sections.

There were no days specifically considered to be extraordinary events at the Bulga Complex in 2021, however it has been identified by DPIE that a dust storm impacted some monitors in the Upper Hunter region on 29/10/2021. It is noted that the D11 monitor recorded a 24-hour average reading of 49.9µg/m^3 on this day and thus was below the relevant criterion. For the purpose of this assessment no extraordinary event days have been considered for Bulga Complex in 2021, and thus a single annual average for all days has been calculated for each monitor in 2021.

Appendix C presents a summary of the 24-hour average periods where there was less than 75% valid data for the TEOM and BAM monitors during the 2021 calendar year.

5.1 $PM_{2.5}$ monitoring data

Table 5-1 presents a summary of the recorded $PM_{2.5}$ levels at the BAM monitors. The annual average $PM_{2.5}$ concentrations at D2 and D10 were below the relevant criteria of 8µg/m^3 in 2021.

The maximum 24-hour average $PM_{2.5}$ concentrations were below the relevant criterion of 25µg/m^3 in 2021.

Table 5-1: Summary of recorded BAM $PM_{2.5}$ levels

Year	Annual average $PM_{2.5}$ (µg/m^3)				
	D2		D10		Criterion
2012	5.9 (4%)		-		8
2013	6.1 (72%)		-		8
2014	5.5		5.4 (46%)		8
2015	5.0		5.1		8
2016	6.1 (52%)		5.7		8
2017	5.2		5.0		8
2018	5.5		5.5		8
2019	**11.2**	*5.1	**15.4 (73%)**	*6.7	8
2020	5.1	*4.1	**9.5**	*6.1	8
2021	3.7		4.5		8
Year	**Maximum 24-hour average $PM_{2.5}$ (µg/m^3) (No. of days > criterion)**				
	D2		**D10**		**Criterion**
2012	10.2 (0)		-		25
2013	**60.8 (6)**		-		25
2014	**25.3 (1)**		21.3 (0)		25
2015	**32.9 (2)**		**31.2 (1)**		25
2016	22.5 (0)		19.4 (0)		25
2017	24.7 (0)		**30.2 (1)**		25
2018	**46.5 (1)**		23.9 (0)		25
2019	**188.7 (32)**	***25.3 (1)**	**212.2 (33)**	***25.9 (1)**	25
2020	**37.4 (8)**	*17.3 (0)	**226.8 (11)**	***29.0 (1)**	25
2021	14.0 (0)		16.5 (0)		25

(#%) The recorded data are less than 75% complete for the year, (data availability %)

*Excluding extraordinary events

The numbers in **red** are concentrations that are above the relevant criterion.

Figure 5-1 presents the 24-hour average $PM_{2.5}$ concentrations at the D2 and D10 BAM monitors. The data shows that elevated 24-hour average $PM_{2.5}$ levels were recorded during the 2019/2020 bushfire season. The 24-hour average $PM_{2.5}$ levels recorded in 2021 were broadly consistent with the levels recorded prior to 2019.

Figure 5-2 presents the annual average $PM_{2.5}$ concentrations recorded at the BAM monitors including extraordinary events. The D2 and D10 monitors show generally similar annual average $PM_{2.5}$ levels throughout the monitoring period until 2019 when the annual average at the D2 monitor is approximately double that of previous years. Note that there are insufficient data (less than 75%) for an annual average for the D10 monitor in 2019 however it would also have been elevated. The annual average $PM_{2.5}$ level at the D2 and D10 monitors in 2021 are lower than the levels in previous years. This decrease is likely due to the ending of drought conditions and significant reduction in the frequency of extraordinary events.

Figure 5-3 presents the 31-day running averages for the 24-hour average $PM_{2.5}$ concentrations, daily rainfall and mean daily temperature recorded by the Bulga Complex weather station (where Bulga Complex temperature and rainfall data are unavailable, data from the Bulga DPIE monitor has been used). In general, the figure indicates a trend in dust levels being lower during significant rainfall and/or colder temperatures, or dust levels being higher in dry and hot conditions. There was a decrease in average temperature during 2021 from the previous years.

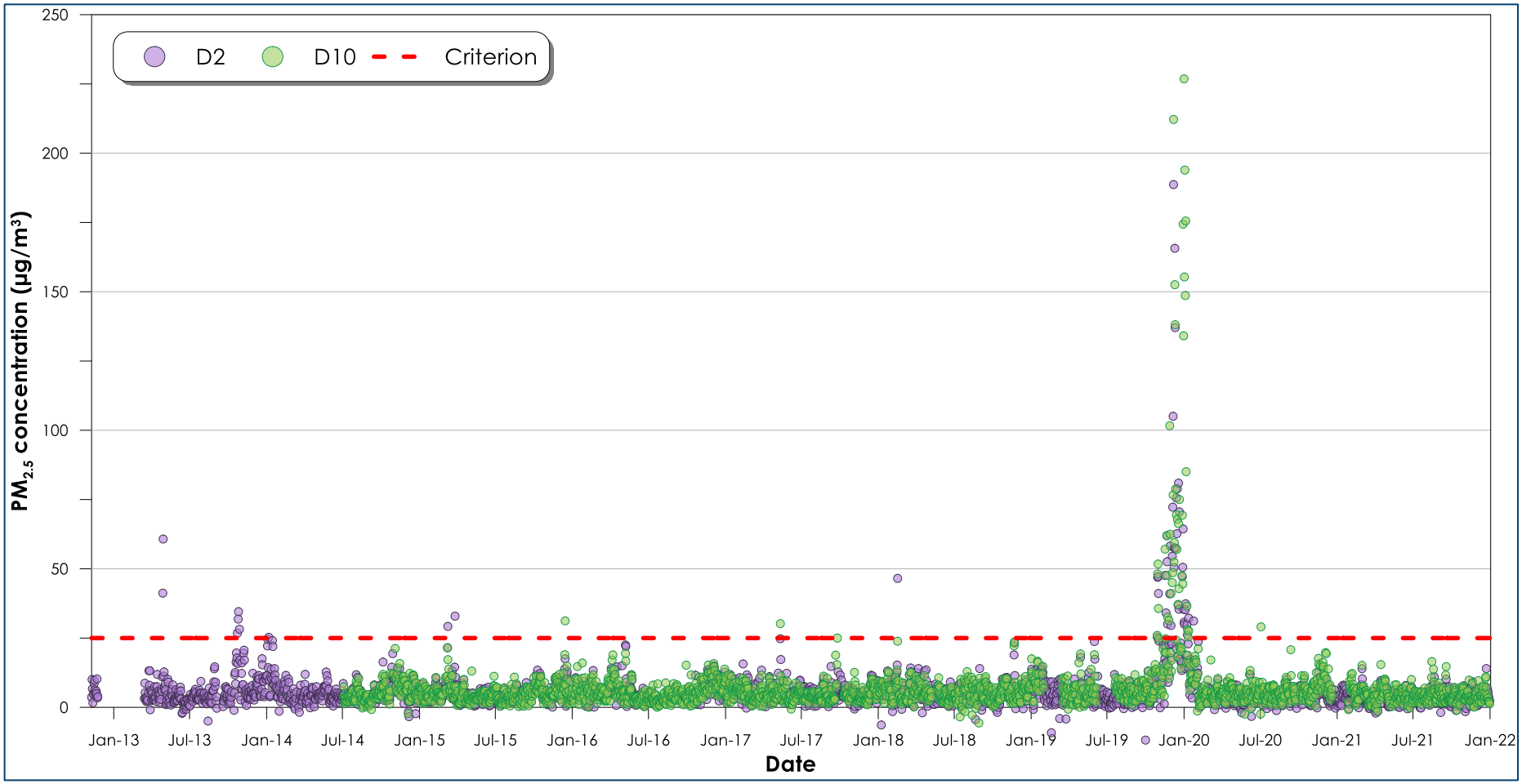


Figure 5-1: 24-hour average $PM_{2.5}$ concentrations

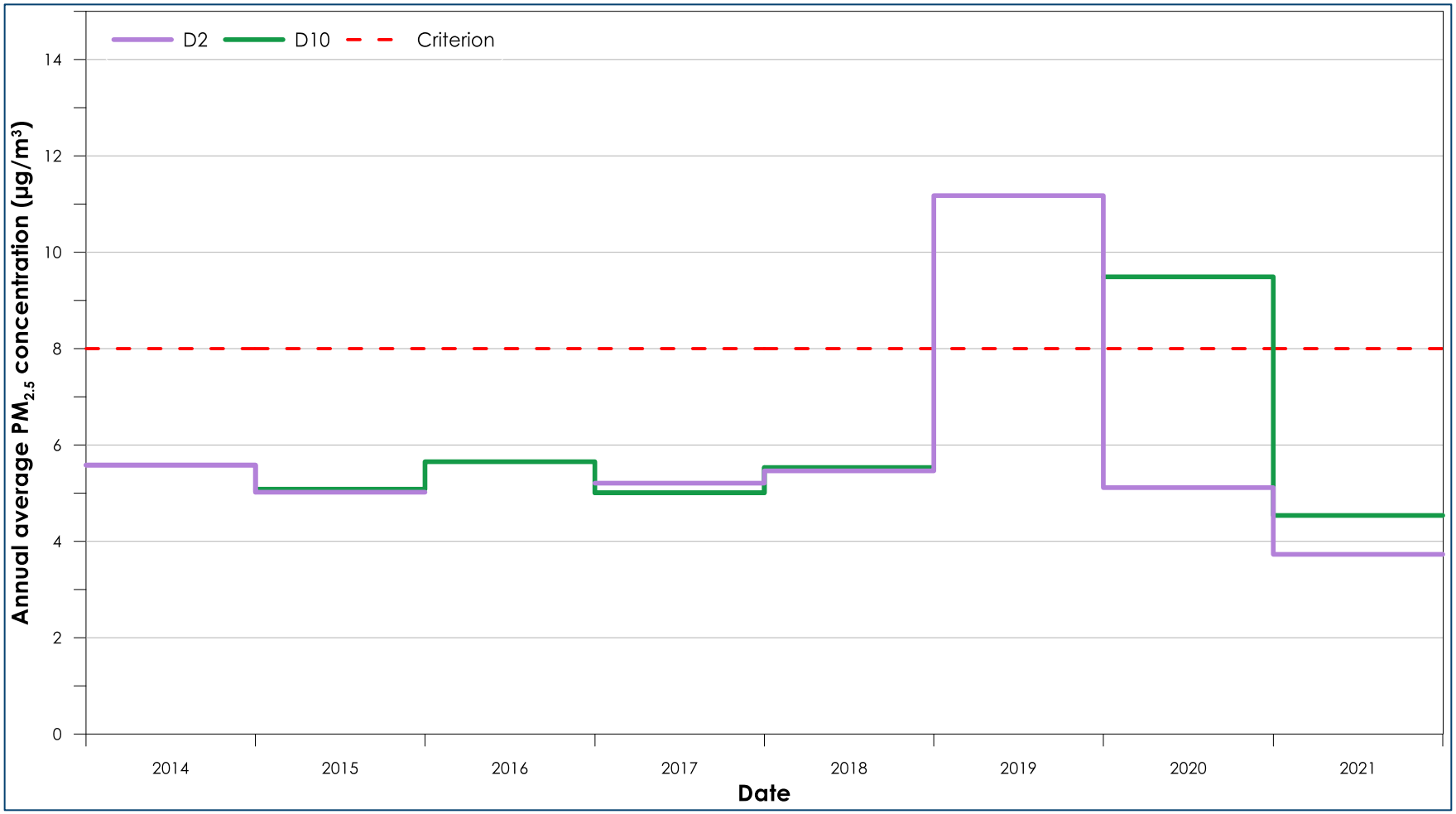


Figure 5-2: Annual average $PM_{2.5}$ concentrations

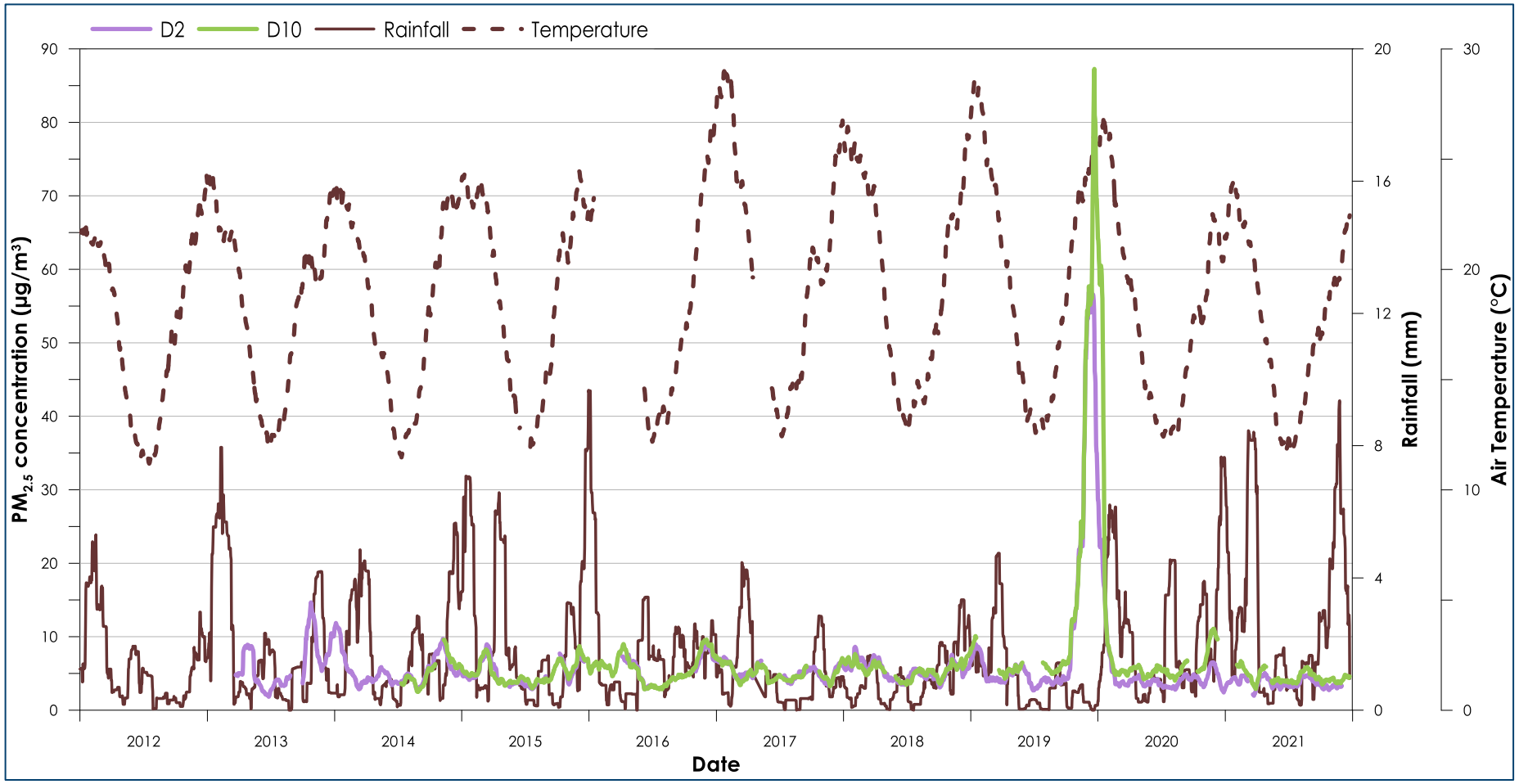


Figure 5-3: 31-day running average of the 24-hour average $PM_{2.5}$ concentrations with the 31-day running average of daily rainfall and mean daily temperature

5.2 PM_{10} monitoring data

Table 5-2 presents a summary of the recorded PM_{10} levels at the TEOM monitors. Annual average PM_{10} concentrations in 2021 were below the relevant criteria of 25µg/m³.

A maximum 24-hour average PM_{10} concentration above 50µg/m³ was recorded on one occasion at the D11 monitor in 2021. An investigation indicates that Bulga contributed less than 50µg/m³ to the elevated 24-hour PM_{10} levels recorded, and thus is not considered to have been a non-compliance per SSD-4960 Schedule 2 Condition 16.

The maximum 24-hour average PM_{10} concentrations were below 50µg/m³ during 2021 at all other TEOM monitors.

Table 5-2: Summary of the recorded TEOM PM_{10} levels

Year	Annual average PM_{10} (µg/m³)								
	D1		D3		D5		D11		Criteria
2011	-		12.1 (7%)		-		-		25 / 30
2012	21.8 (9%)		14.8		14.3 (73%)		-		25 / 30
2013	16.1		15.8		15.7		-		25 / 30
2014	15.9		15.3		13.1		-		25 / 30
2015	10.7		11.2		10.7		-		25 / 30
2016	11.5		10.8		11.7		18.8 (44%)		25 / 30
2017	12.7		12.2		11.5		20.0		25 / 30
2018	15.4		19.9		18.9		22.3		25 / 30
2019	22.1	*14.7	**28.0**	*19.0	**25.3**	*17.1	**27.8**	*22.2	25 / 30
2020	14.0	*12.4	16.5	*14.6	16.6	*15.2	19.3	*17.5	25
2021	11.2		12.4		13.2		15.5		25
Year	**Maximum 24-hour average PM_{10} (µg/m³) (No. of days > criterion)**								
	D1		**D3**		**D5**		**D11**		**Criterion**
2011	-		17.7 (0)		-		-		50
2012	48.2 (0)		46.1 (0)		45.3 (0)		-		50
2013	**70.0 (5)**		**75.3 (3)**		**65.0 (2)**		-		50
2014	43.8 (0)		41.8 (0)		46.2 (0)		-		50
2015	**61.2 (1)**		**59.3 (1)**		**61.6 (1)**		-		50
2016	33.0 (0)		33.2 (0)		**53.5 (2)**		**60.7 (1)**		50
2017	36.4 (0)		37.1 (0)		37.7 (0)		**67.5 (6)**		50
2018	**138.6 (5)**		**166.4 (7)**		**160.3 (7)**		**159.6 (15)**		50
2019	**172.1 (31)**	*37.9 (0)	**170.5 (44)**	***60.4 (3)**	**177.4 (36)**	*47.2 (0)	**180.7 (33)**	***53.8 (4)**	50
2020	**68.9 (4)**	*37.2 (0)	**94.9 (5)**	*39.9 (0)	**75.8 (4)**	*41.0 (0)	**105.9 (12)**	***68.6 (4)**	50
2021	34.3 (0)		33.6 (0)		34.1 (0)		65.4 (1)		50

(#%) The recorded data are less than 75% complete for the year, (data availability %)

*Excluding extraordinary events

The numbers in **red** are concentrations that are above the relevant criterion.

Figure 5-4 presents the 24-hour average PM_{10} concentrations at the TEOM monitors. The data shows that elevated 24-hour average PM_{10} levels were recorded during the 2019/2020 bushfire season. There were generally less elevated 24-hour average PM_{10} levels recorded in 2021 compared with recent years and also significantly fewer extraordinary event days.

Figure 5-5 presents the annual average PM_{10} concentrations recorded at the TEOM monitors including extraordinary events. The annual average PM_{10} level at the TEOM monitors in 2021 are lower than the levels in 2018 to 2020. This decrease is likely due to the ending of drought conditions and significant reduction in the frequency of extraordinary events.

Figure 5-6 shows the 31-day running averages of the 24-hour average PM_{10} concentrations at the TEOM monitors including extraordinary events, together with the 31-day running averages of daily rainfall and mean daily temperature recorded by the Bulga Complex weather station (where Bulga Complex temperature and rainfall data are unavailable, data from the Bulga DPIE monitor has been used). The figure indicates a general trend in dust levels being lower during significant rainfall and/or colder temperatures, or dust levels being higher in dry and hot conditions. There was a decrease in average temperature during 2021 from the previous years.

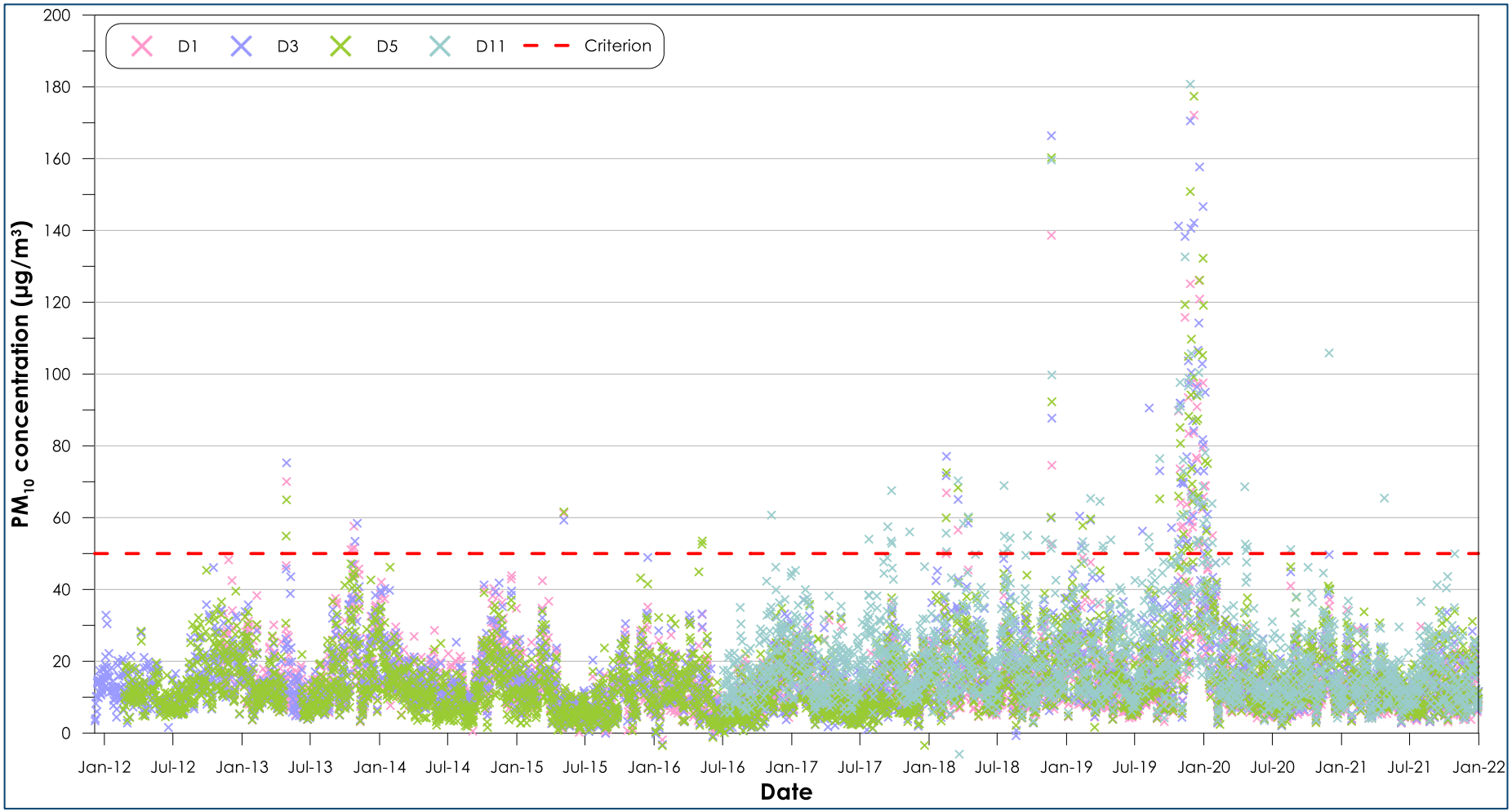


Figure 5-4: 24-hour average PM_{10} concentrations at TEOM monitors

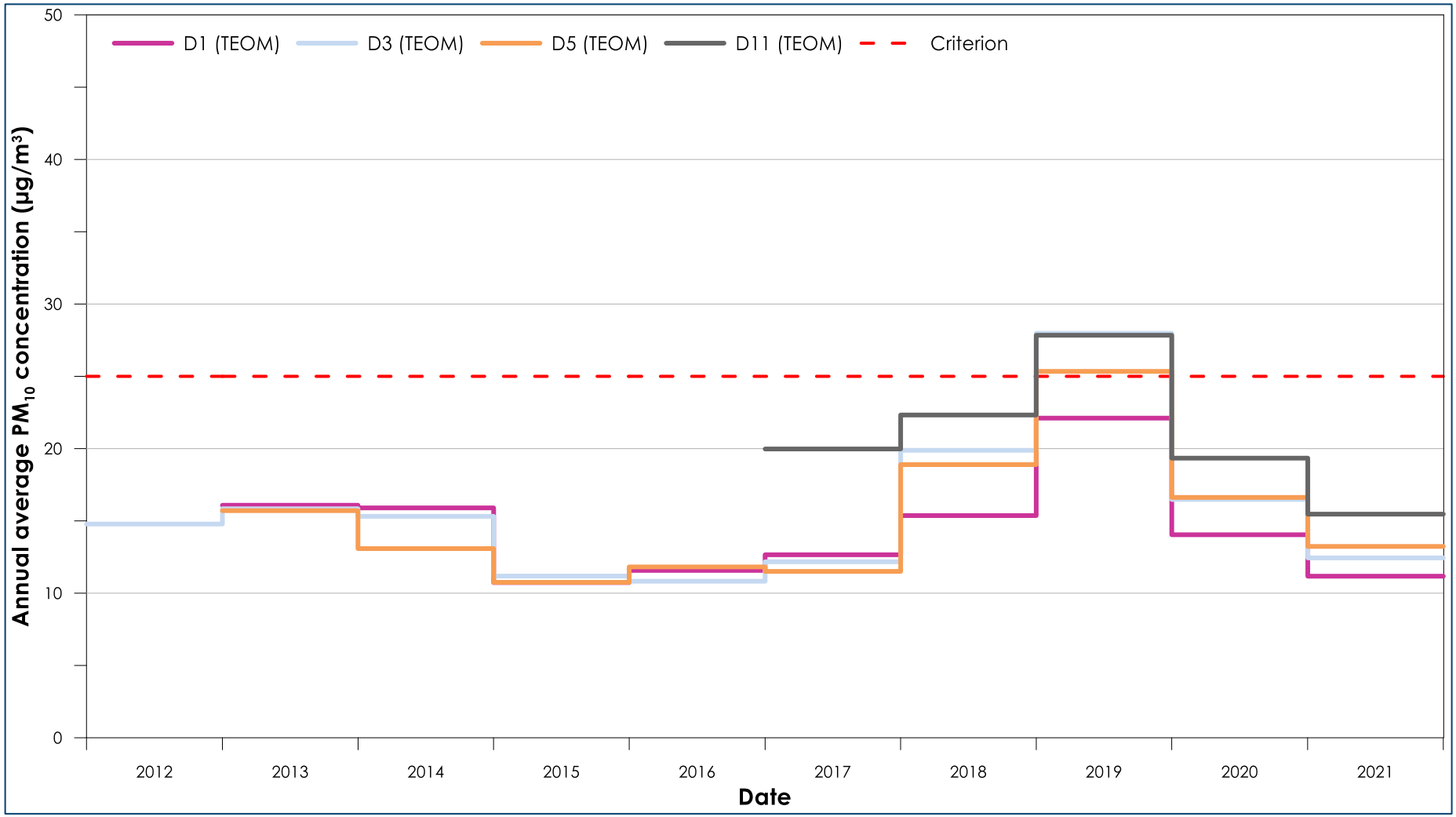


Figure 5-5: Annual average PM_{10} concentrations at TEOM monitors

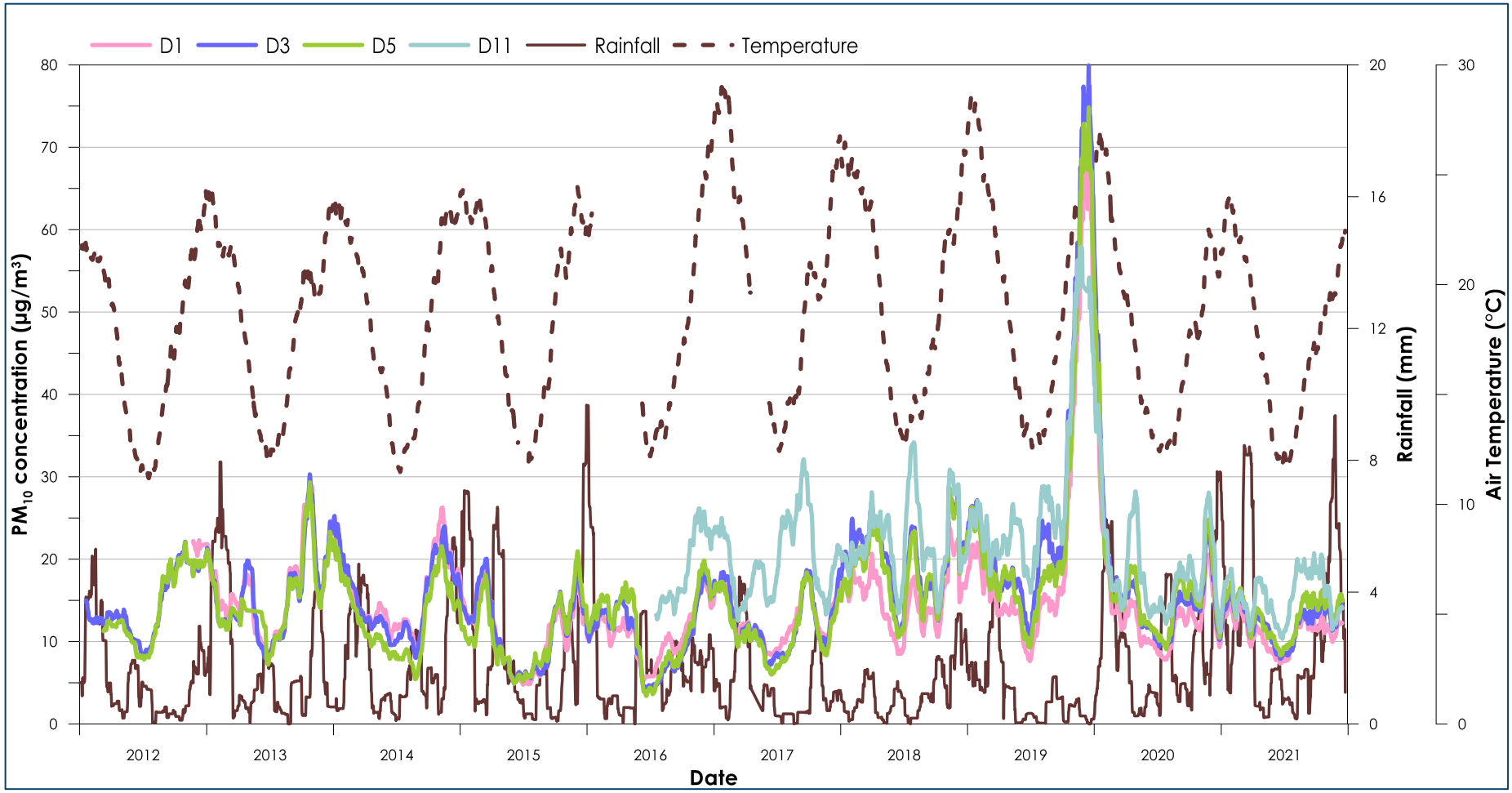


Figure 5-6: 31-day running average of the 24-hour average PM_{10} concentrations at the TEOM monitors with the 31-day running average of daily rainfall and mean daily temperature

5.3 TSP monitoring data

Table 5-3 presents a summary of the recorded TSP levels at the HVAS monitors. Annual average TSP concentrations were below the relevant criterion of 90µg/m^3 in 2021.

Table 5-3: Summary of the recorded HVAS TSP levels

Year	Annual average TSP (µg/m^3)						
	Dawtrey		D10		Hill St		Criterion
2005	28.2 (74%)		32.3 (67%)		-		90
2006	35.0		36.2		-		90
2007	33.2		36.7		-		90
2008	33.3		34.8		-		90
2009	39.3		41.4		-		90
2010	26.9		29.2		-		90
2011	27.1		33.8		-		90
2012	26.2		34.5		-		90
2013	30.4		32.5		-		90
2014	34.5		40.0		-		90
2015	27.9		30.6		-		90
2016	31.7		36.9		23.3 (67%)		90
2017	29.8		36.5		26.0		90
2018	42.9		48.6		32.1		90
2019	56.0	*37.5	67.3	*46.3	50.7	*30.7	90
2020	38.5	*35.7	40.9	*36.3	31.8	*29.2	90
2021	22.6		21.0		18.9		90

(#%) The recorded data are less than 75% complete for the year, (data availability %)

*Annual average excluding extraordinary events

Figure 5-7 shows the 24-hour and annual average TSP concentrations including extraordinary events at the HVAS monitors. The data shows that elevated 24-hour average TSP levels were recorded during the 2019/2020 bushfire season. The annual average data from the TSP HVAS monitors show that the levels remained below the criterion of 90µg/m^3 throughout the period. There was a decrease in the annual average TSP levels during 2021 compared with the previous year. This decrease is likely due to the ending of drought conditions and significant reduction in the frequency of extraordinary events.

Figure 5-8 shows the 31-day running average of the TSP concentrations including extraordinary events, rainfall readings and mean daily temperatures. The levels show a general trend of lower TSP concentrations during periods of higher rainfall and lower temperatures.

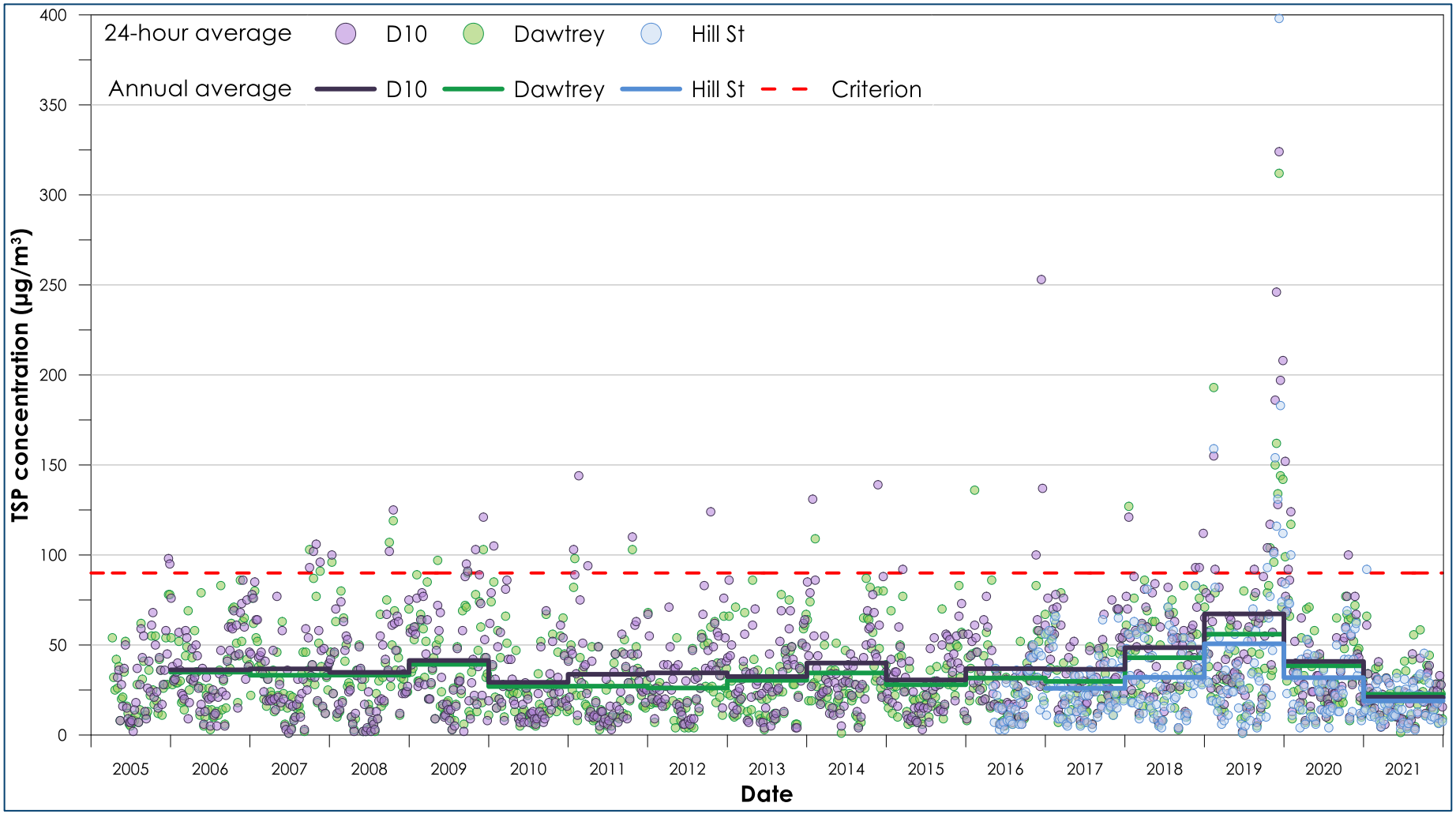


Figure 5-7: 24-hour and annual average TSP concentrations

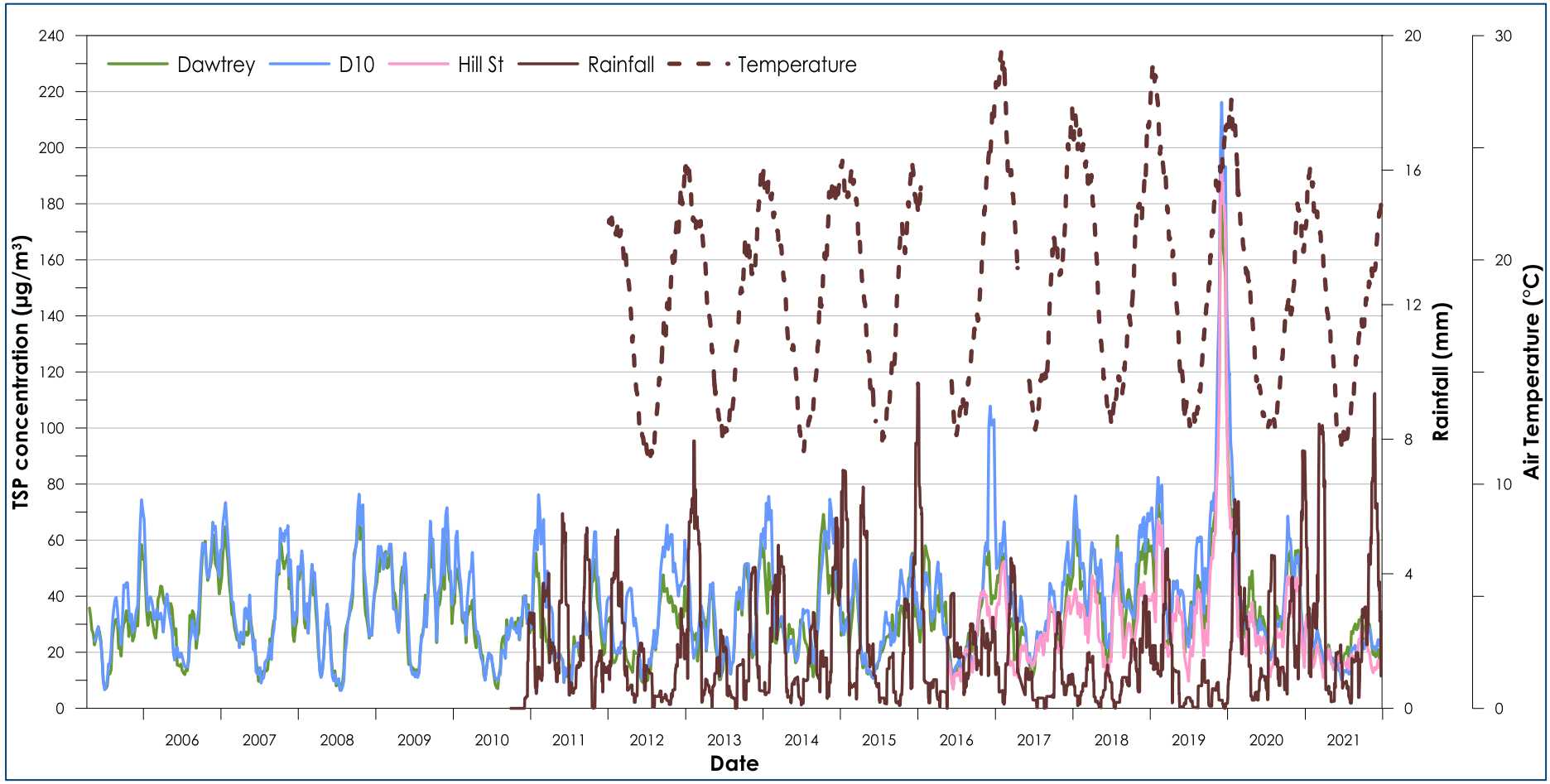


Figure 5-8: 30-day running average of the 24-hour average TSP concentrations with the 31-day running average of daily rainfall and mean daily temperature

5.4 Deposited dust data

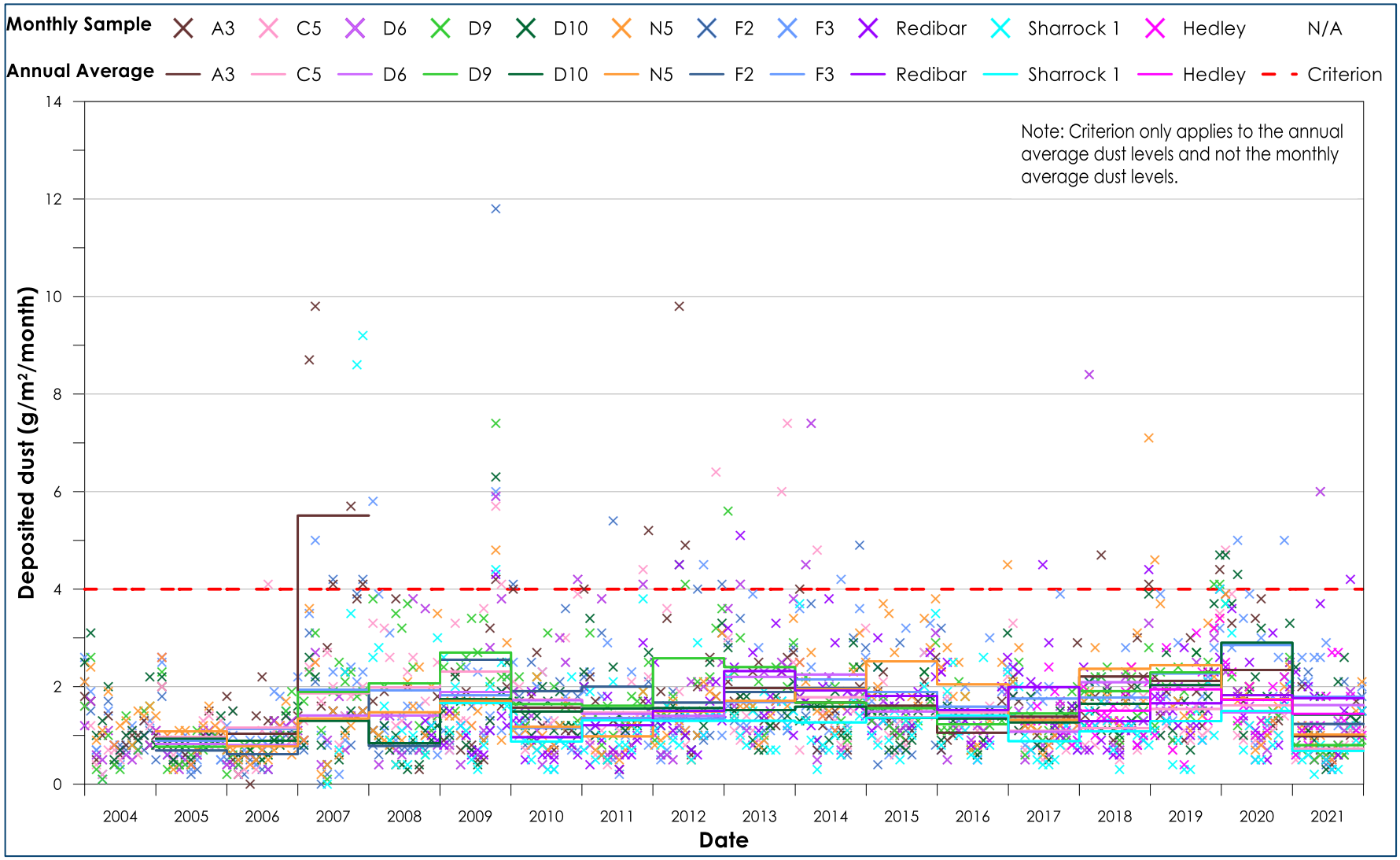
Table 5-4 presents a summary of the annual average deposited dust levels at the statutory compliance dust gauges. The results show that in 2021 the deposited dust levels were below the annual average limit of 4g/m^2/month at the compliance monitoring locations.

Table 5-4: Summary of the annual average deposited dust levels (g/m²/month) at compliance dust gauges

Year	A3	C5	D6	D9	D10	N5	F2	F3	Redibar	Sharrock 1	Hedley	Criterion
2004	1.0	0.9	0.8	1.0	1.3	1.4	0.8	1.0	-	-	-	4
2005	1.0	1.0	0.8	0.8	0.9	1.1	0.7	0.9	-	-	-	4
2006	1.0	1.2	0.8	0.9	0.9	0.8	0.6	1.1	-	-	-	4
2007	**5.5**	1.9	1.4	1.9	1.3	1.3	1.9	1.9	-	4.1 (50%)	-	4
2008	1.7 (67%)	2.0	1.4	2.1	0.8	1.5	0.8	1.9	1.1 (25%)	1.4	-	4
2009	1.9	2.3	1.9	2.7	1.7	1.7	2.6	1.8	1.3	1.7	-	4
2010	1.6	1.7	1.7	1.6	1.5	1.2	1.9	1.2	1.0	0.9	-	4
2011	1.8 (67%)	1.5	1.4	1.6	1.6	1.0	2.0	1.4	1.2	1.3	-	4
2012	3.3	2.3 (58%)	1.4	2.6	1.6	1.5	1.7	1.3	1.5	1.3	-	4
2013	2.0	2.7	2.2	2.4	1.5	1.7	1.9	1.7	2.3	1.3	-	4
2014	1.7	1.8	2.3	1.7	1.6	2.0	2.0	2.2	1.9	1.3	-	4
2015	1.6	1.4	1.5	1.6	1.4	2.5	-	1.9	1.8	1.4	-	4
2016	1.1	1.5	1.4	1.2	1.3	2.0	-	1.6	1.5	1.4	-	4
2017	1.4	1.1	1.1	1.5	1.3	1.3	-	1.8	2.0	0.9	1.4	4
2018	2.2	1.2	2.1	1.9	1.7	2.4	-	1.8	1.3	1.1	1.5	4
2019	2.1	1.5	2.0	2.3	2.0	2.4	-	2.3	1.7	1.3	1.9	4
2020	2.3	1.6	1.5	1.8	2.9	1.7	-	2.9	1.8	1.5	1.7	4
2021	1.0	0.7	1.6	0.8	1.4	1.0	1.2	1.8	1.8	0.7	1.4	4

Contaminated samples were not included in the computation of the average.
(#%) The recorded data are less than 75% complete for the year, (data availability %)

Figure 5-9 shows the monthly and annual average deposited dust levels at the Bulga Complex dust gauges. The deposited dust levels at the A3 monitor exceeded the cumulative annual average deposited dust criteria of 4g/m^2/month in 2007. No other exceedance was recorded from the onset of monitoring until the end of the 2021 calendar year. The levels at the monitors generally show relatively similar trends over time. In general, there was a decrease in the deposited dust levels during 2021 compared with the previous year.



Note: Data are clipped at a maximum of 14g/m^2/month. Only the A3 dust gauge measured a level above 14g/m^2/month (at 16.8g/m^2/month).

Figure 5-9: Annual and monthly averages deposited dust at the statutory compliance dust gauges

6 POLLUTION ROSES

The following section presents an analysis of a hybrid of a pollution rose and back trajectory data for all $PM_{2.5}$ and PM_{10} data measured at the BAM and TEOM monitors for 2021. The meteorological data used in generating the figures are taken from the Bulga Complex weather station. Refer to **Appendix A** for guidance on how to interpret a pollution rose plot.

6.1 $PM_{2.5}$ data

Figure 6-1 and **Figure 6-2** present the pollution roses for the D2 and D10 $PM_{2.5}$ monitors respectively for 2021. The data do not indicate any significant impact on $PM_{2.5}$ dust levels from the direction of the Bulga Complex.

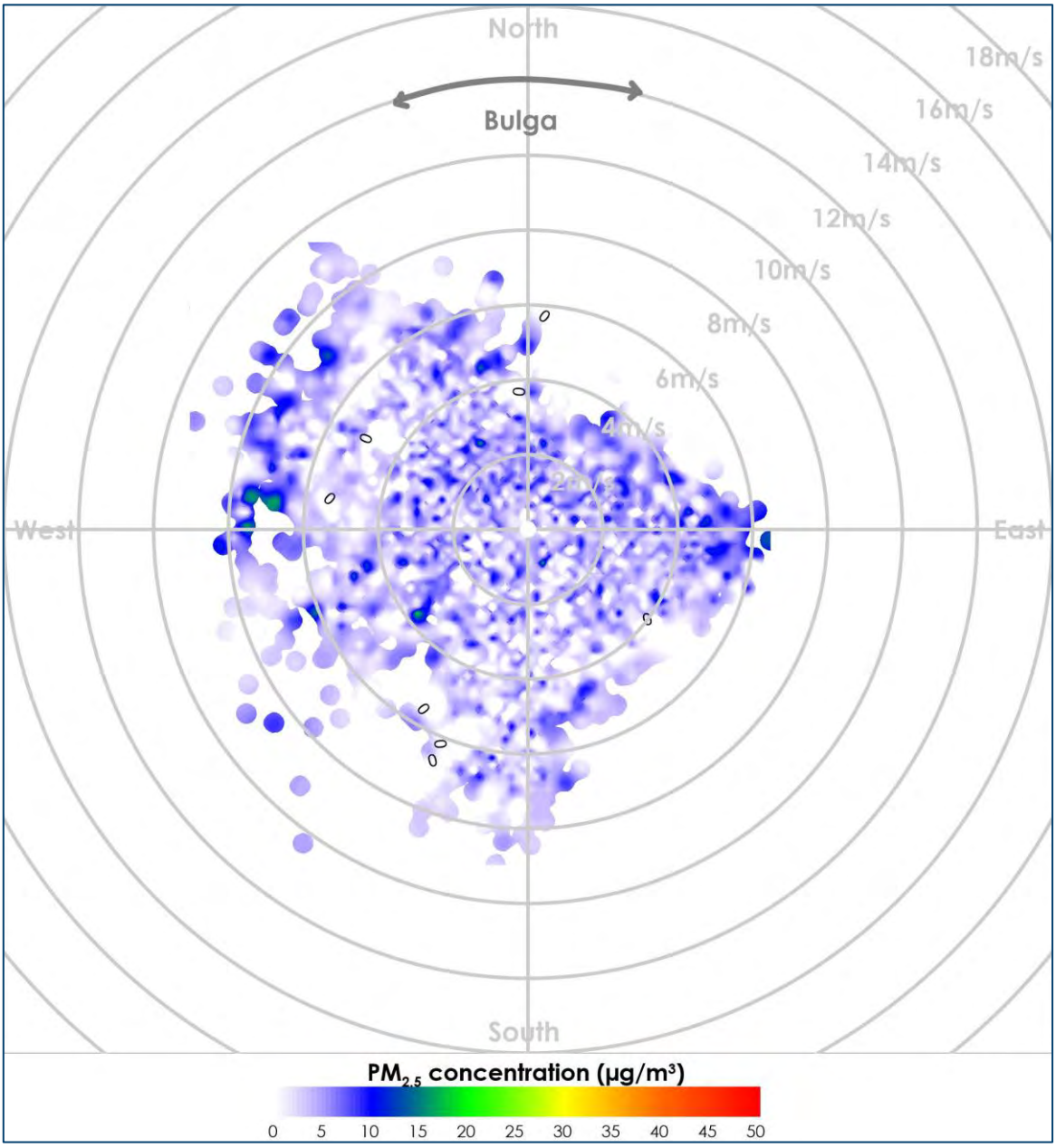


Figure 6-1: Pollution rose for D2 BAM $PM_{2.5}$ data (2021)

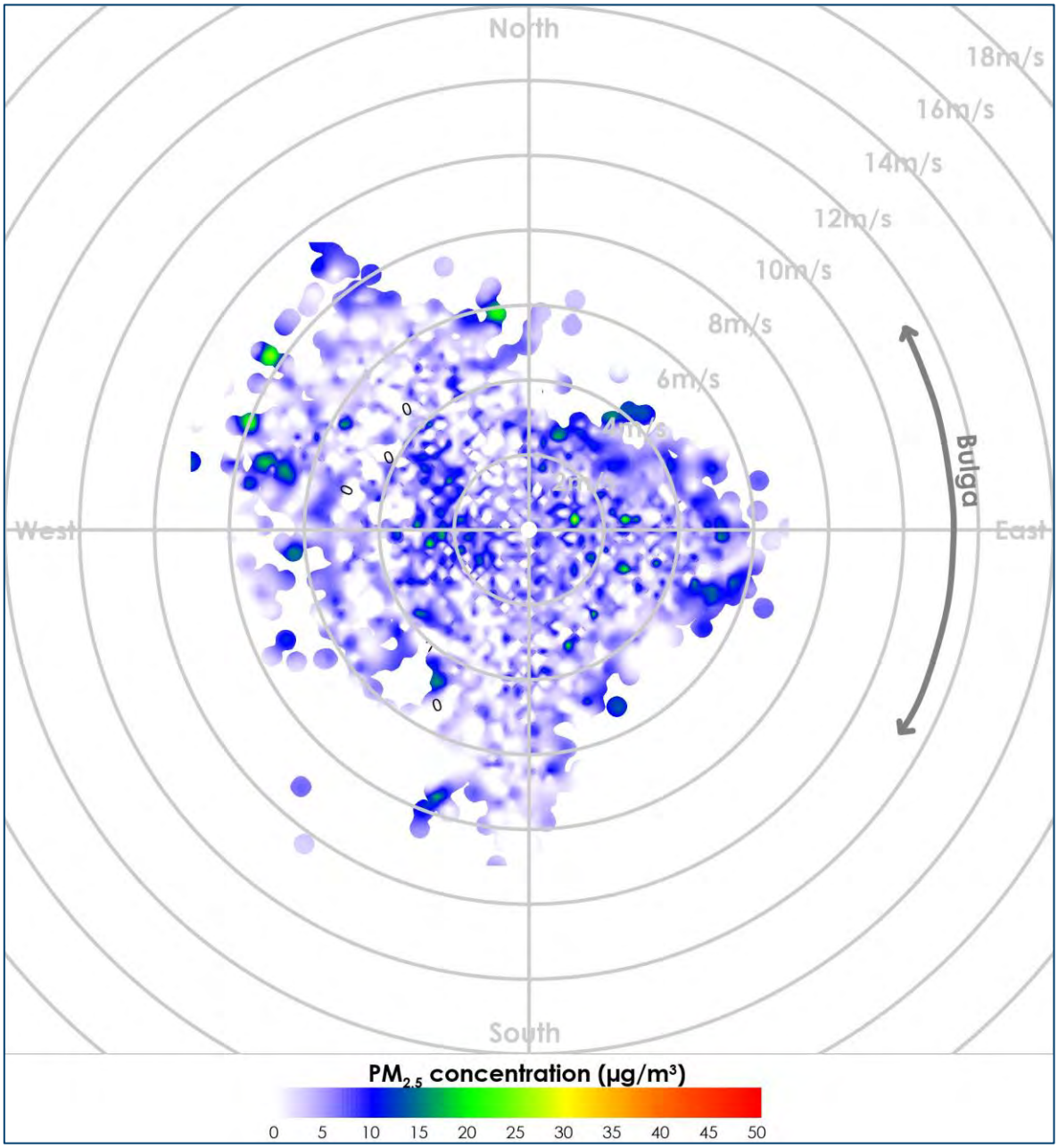


Figure 6-2: Pollution rose for D10 BAM $PM_{2.5}$ data (2021)

6.2 PM_{10} data

Figure 6-3 to **Figure 6-6** present the pollution roses for the D1, D3, D5 and D11 PM_{10} TEOM monitors respectively for 2021. **Figure 6-7** presents the pollution rose for the D8 PM_{10} E-BAM monitor for 2021. **Figure 6-8** and **Figure 6-9** present pollution roses for the D9 PM_{10} E-BAM monitor for the periods before and after the monitor relocation in 2021.

Generally, the figures show a mild to moderate effect on dust levels from the direction of the Bulga mine.

The E-BAM monitors are not compliance or reference standard monitors such as the TEOM and HVAS monitors. They are located close to mining activities and are used to assist with mine operational

management. As such the data may not be directly equivalent to the TEOM data. Some high levels occur in the direction of Bulga at the D9 monitor after the monitor was relocated, however the monitor recorded a greater proportion of high levels when winds were from the northwest quadrant during which the monitor would not have been downwind of Bulga.

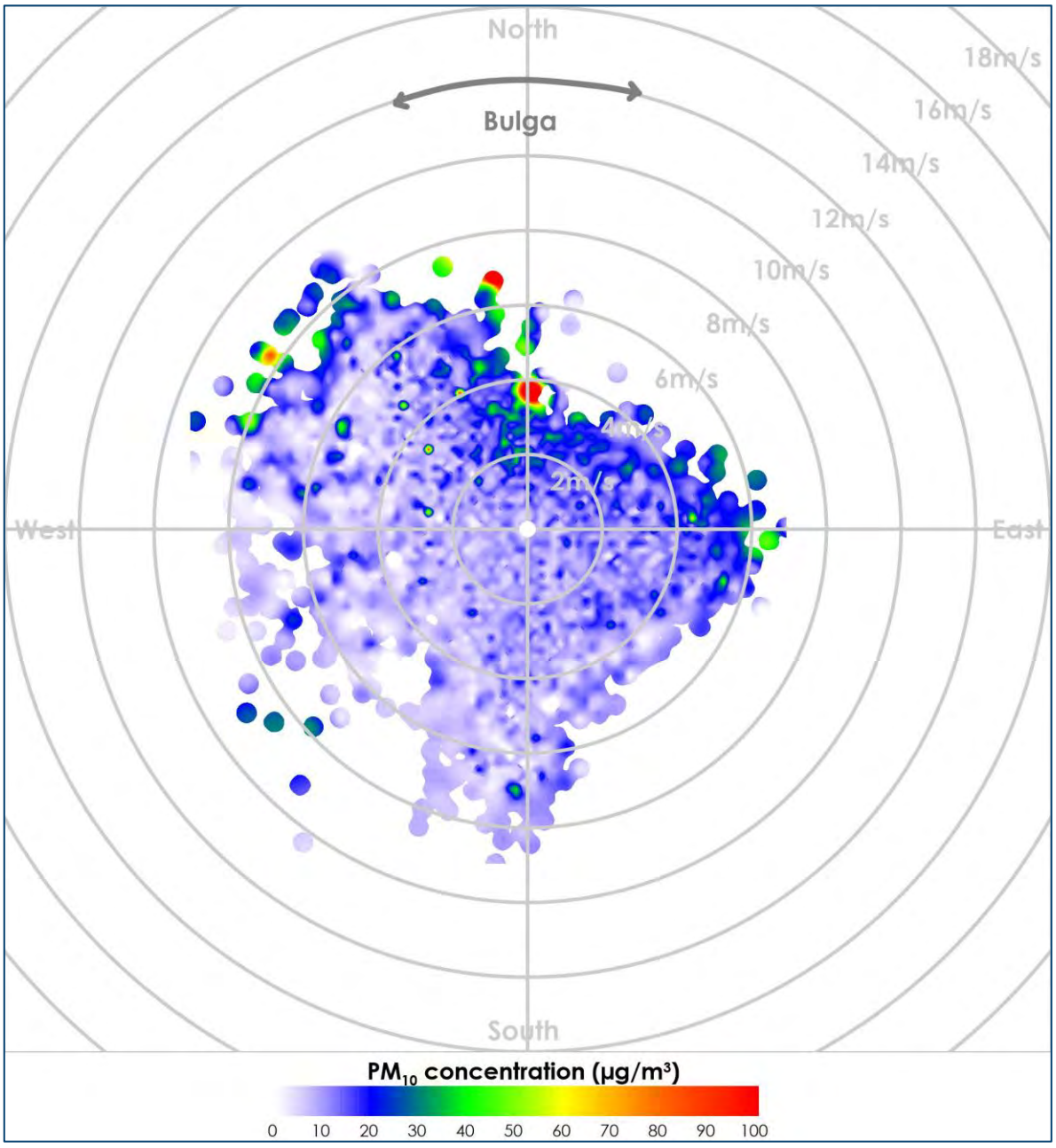


Figure 6-3: Pollution rose for D1 TEOM PM_{10} data (2021)

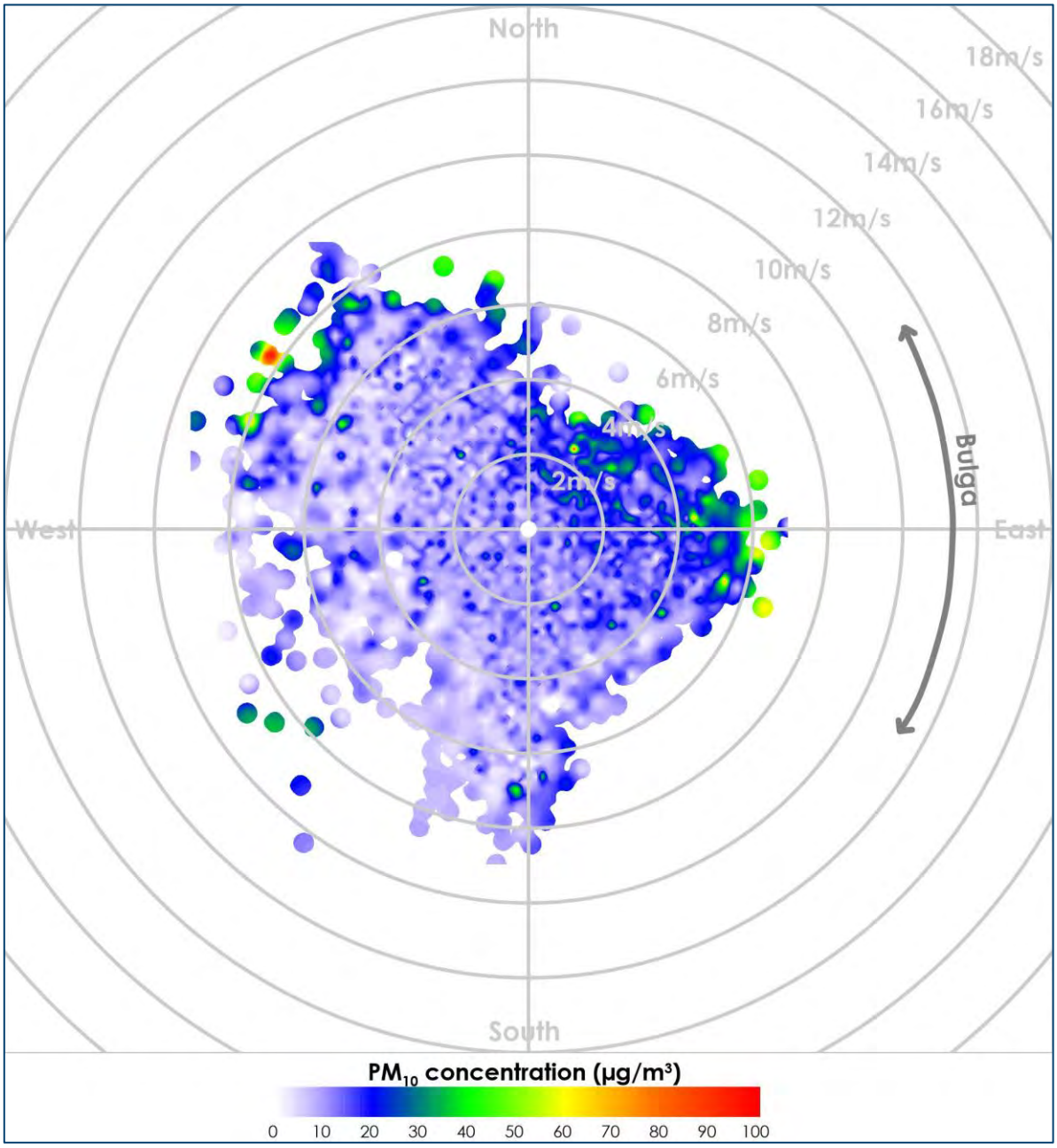


Figure 6-4: Pollution rose for D3 TEOM PM_{10} data (2021)

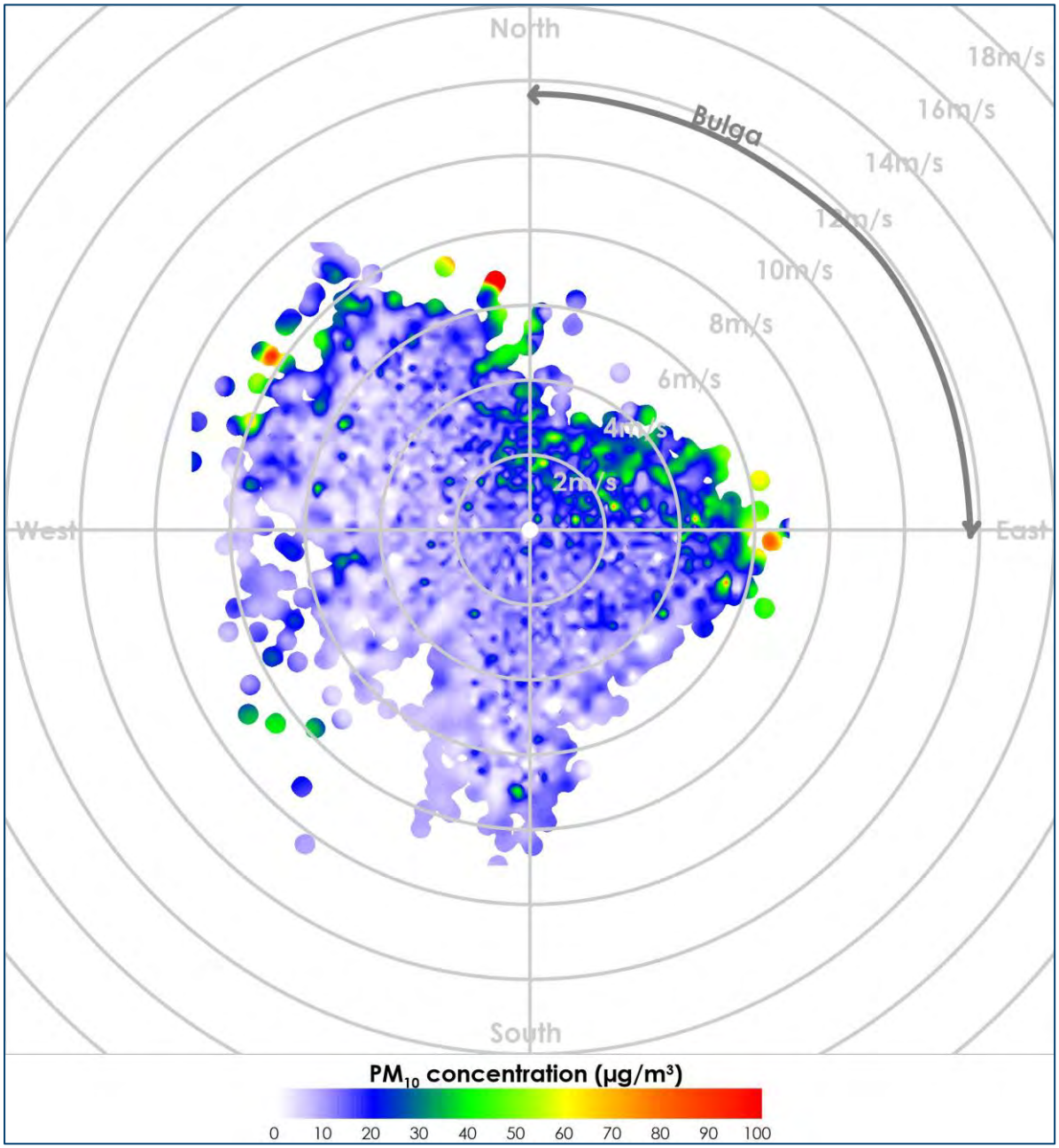


Figure 6-5: Pollution rose for D5 TEOM PM_{10} data (2021)

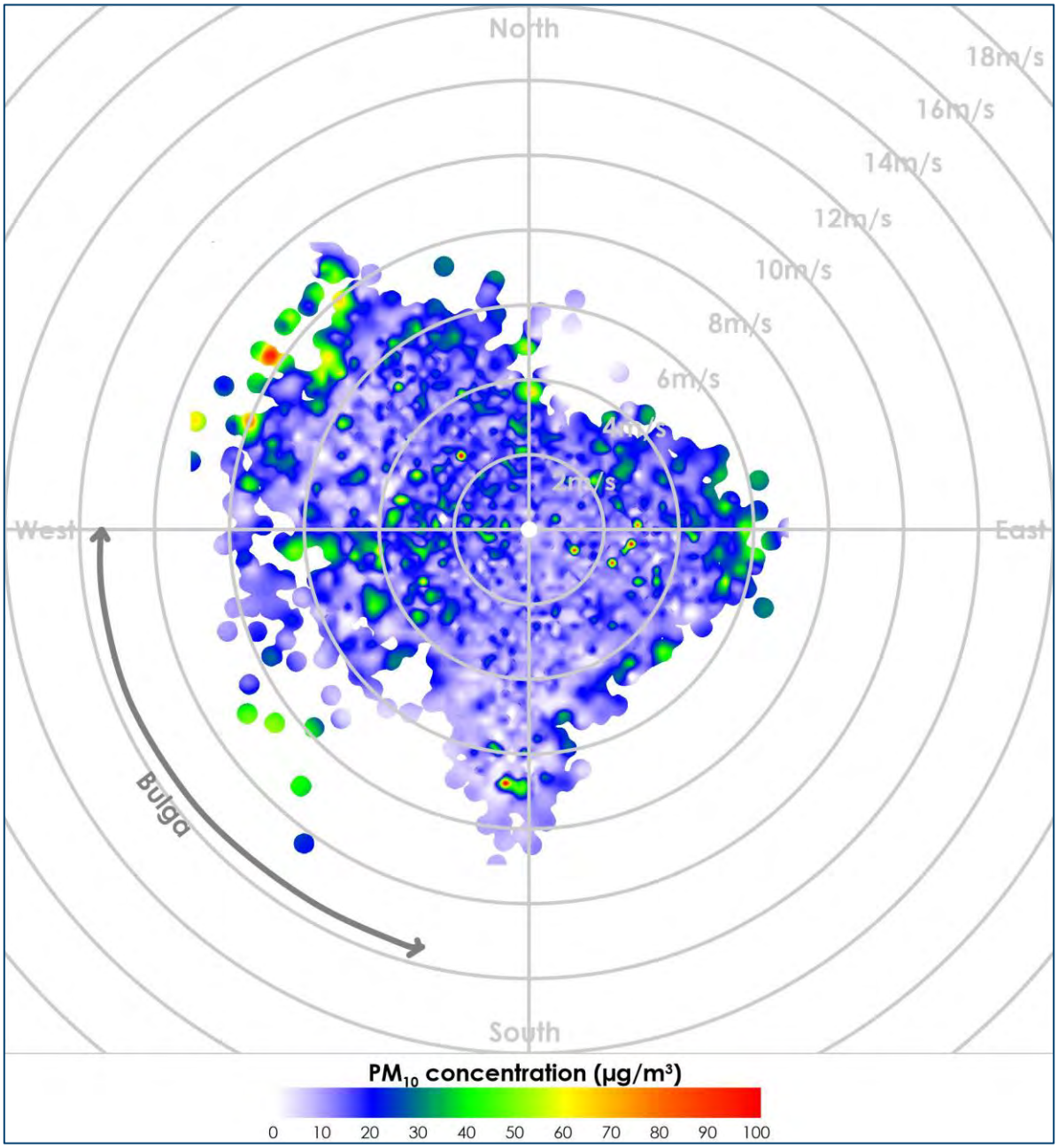


Figure 6-6: Pollution rose for D11 TEOM PM_{10} data (2021)

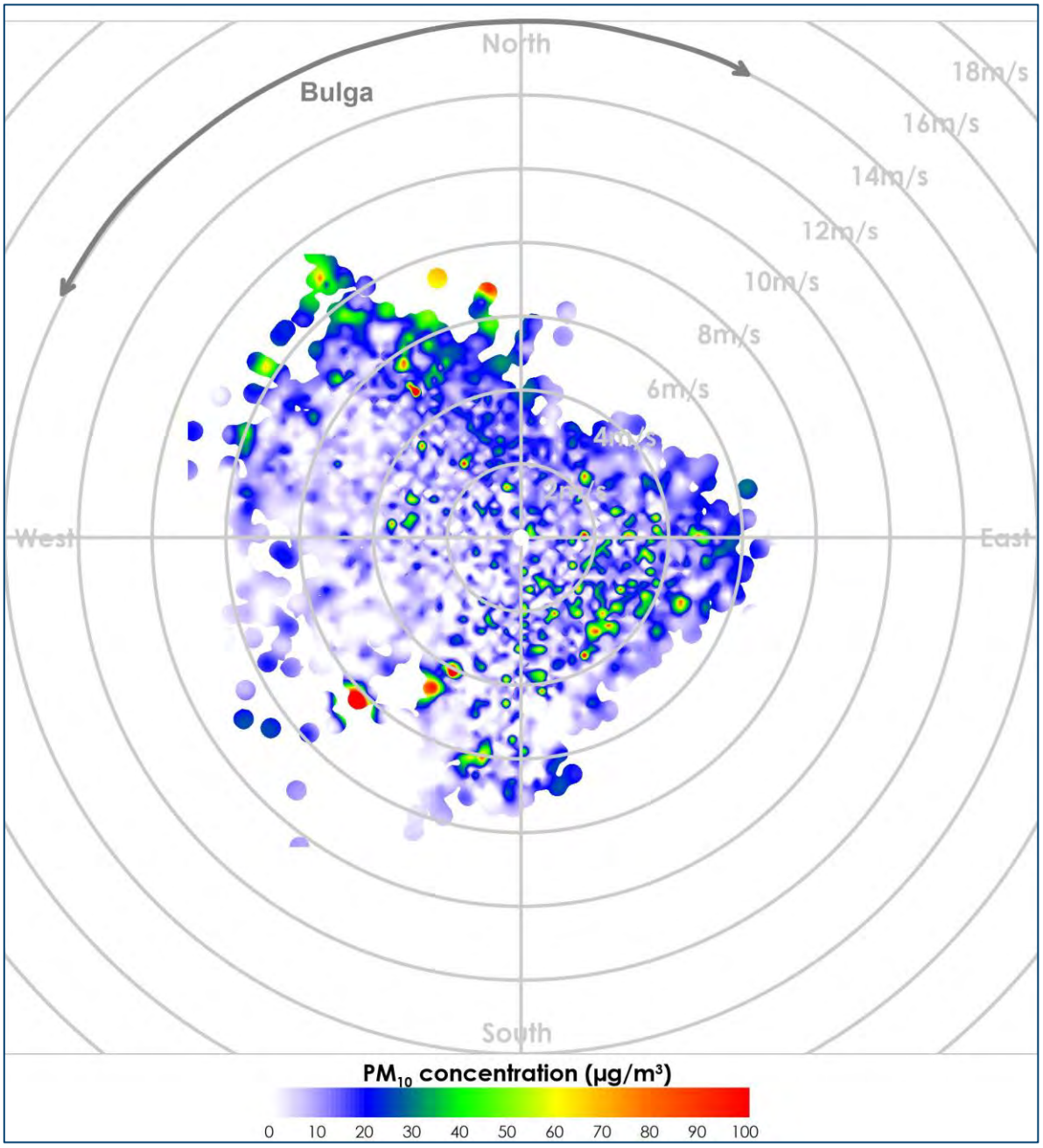


Figure 6-7: Pollution rose for D8 E-BAM PM_{10} data (2021)

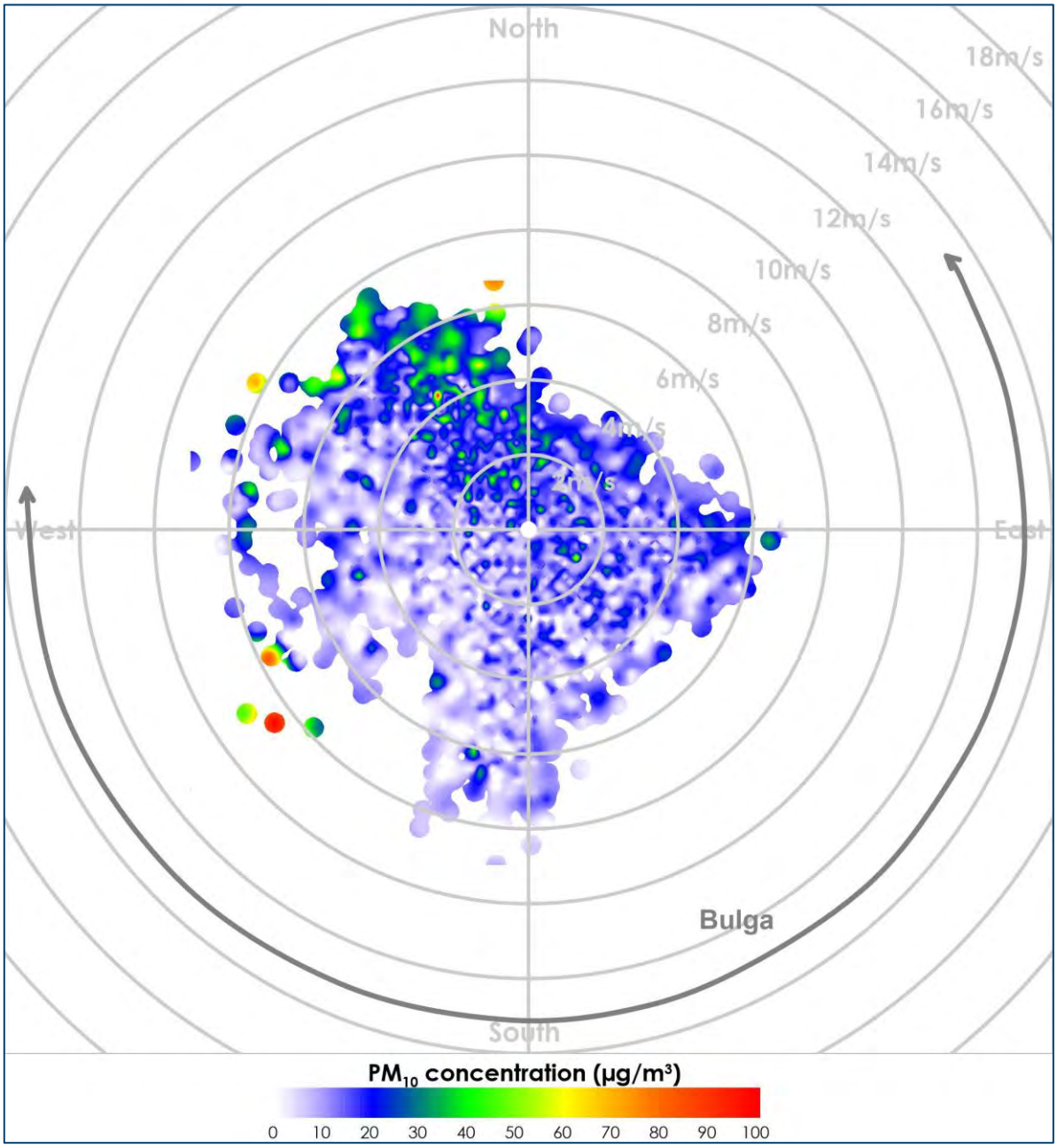


Figure 6-8: Pollution rose for D9 E-BAM PM_{10} data (1/1/2021 to 23/08/2021)

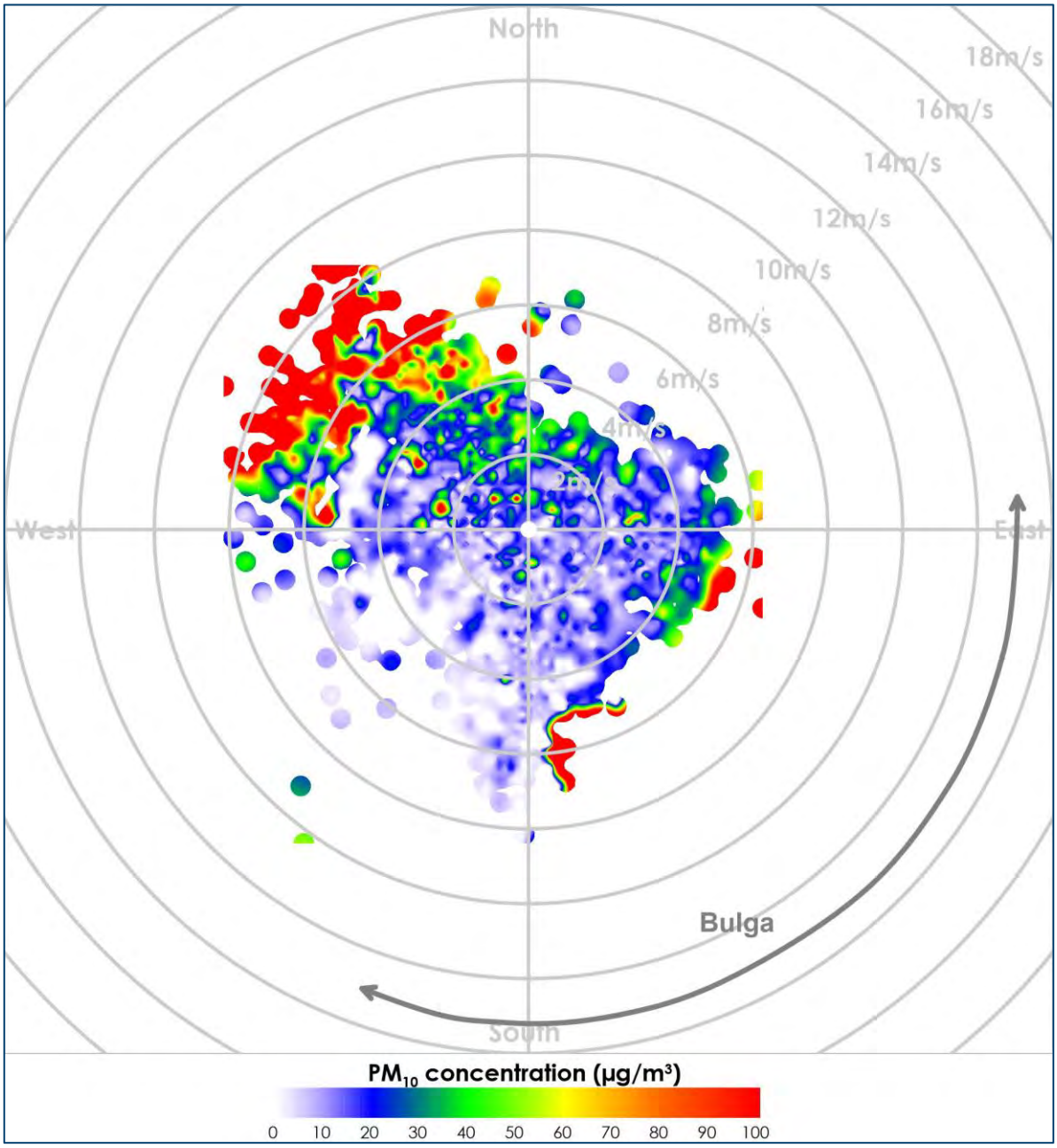


Figure 6-9: Pollution rose for D9 E-BAM PM_{10} data (23/08/2021 to 31/12/2021)

7 CONCLUSIONS

This report has analysed the dust monitoring data recorded at the Bulga Complex and provides a comparison between the dust levels measured in 2021 with the modelled predictions for that approximate year (Year 2022) per the *Bulga Coal Complex Modification 3 Air Quality Impact Assessment* (**Jacobs, 2019**).

The analysis shows that the annual average measured levels in 2021 were lower than the predictions for the representative modelling scenario. In general, it is considered that 2021 was a relatively cool and wet year for NSW which may have contributed to lower dust levels measured in 2021.

This report has also presented a review and long-term trend analysis of air quality data from the beginning of monitoring to the end of 2021. The analysis shows that the annual average levels were below the relevant criteria and were generally lower than previous years, likely due to the ending of drought conditions and significant reduction in the frequency of extraordinary events.

There was one elevated 24-hour PM_{10} level recorded during 2021, however an investigation indicated that Bulga contributed less than 50µg/m^3. There were considered to have been no instances of non-compliance with the applicable 24-hour average criteria in 2021.

An analysis of the pollution roses for 2021 generally shows minor effects from the direction of Bulga Complex on dust levels.

8 REFERENCES

Jacobs (2019)

"Bulga Coal Complex Modification 3 Air Quality Impact Assessment", prepared by Jacobs Group (Australia) Pty Ltd for Bulga Coal Management Pty Ltd, 10 June 2016.

Appendix A *How to read a windrose and pollution rose*

Windrose

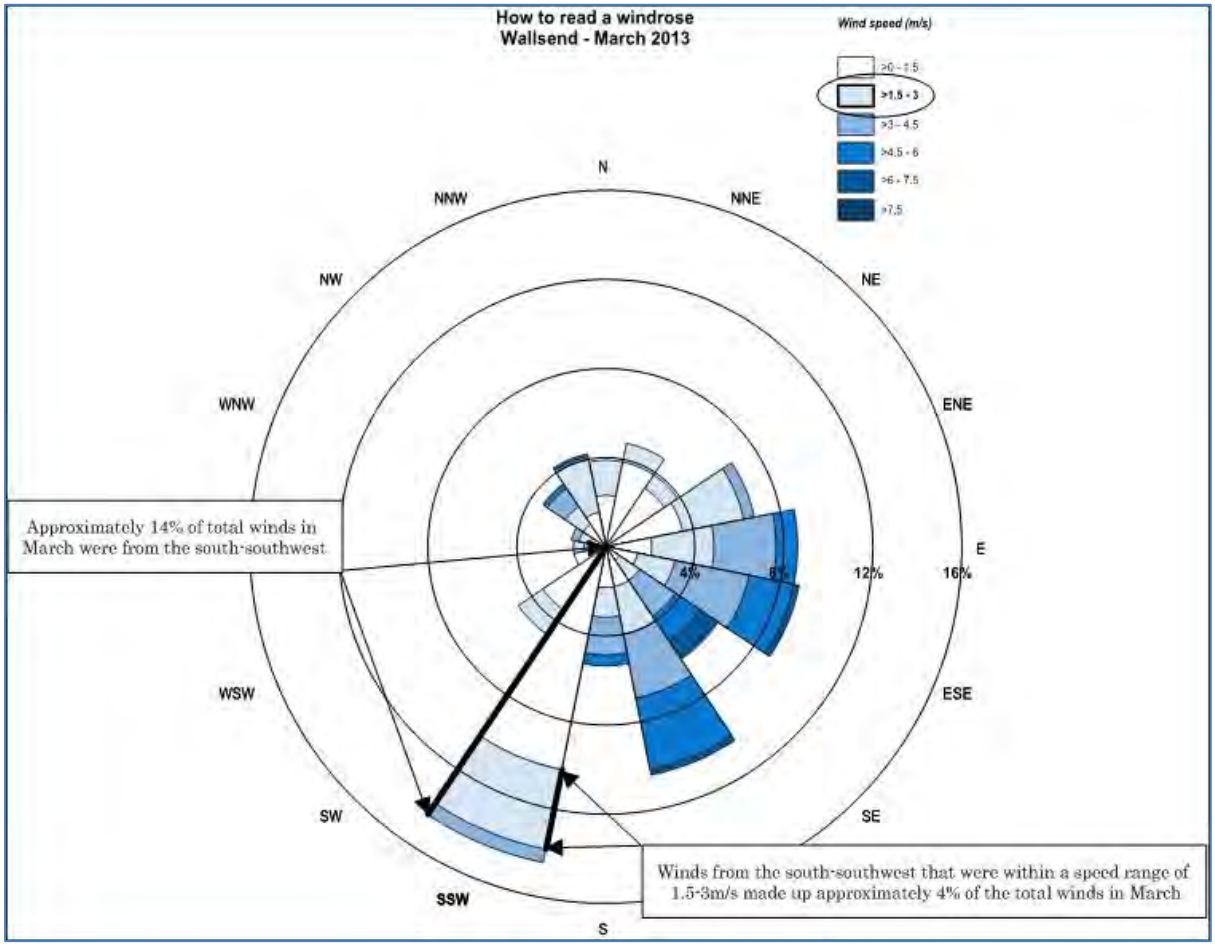


Figure A-1: How to read a windrose

Pollution rose

How to read a pollution rose:

- The colour indicates the pollutant concentration measured at the monitor.
- The position of pollutant concentration markings along the 360° axis indicate the corresponding direction from which pollutants arise from.
- The position of pollutant concentration markings relative to the banded rings indicate the wind speed for the corresponding hourly concentration.
- The arc labelled "Bulga" indicates the relative direction of Bulga Complex from the monitor.

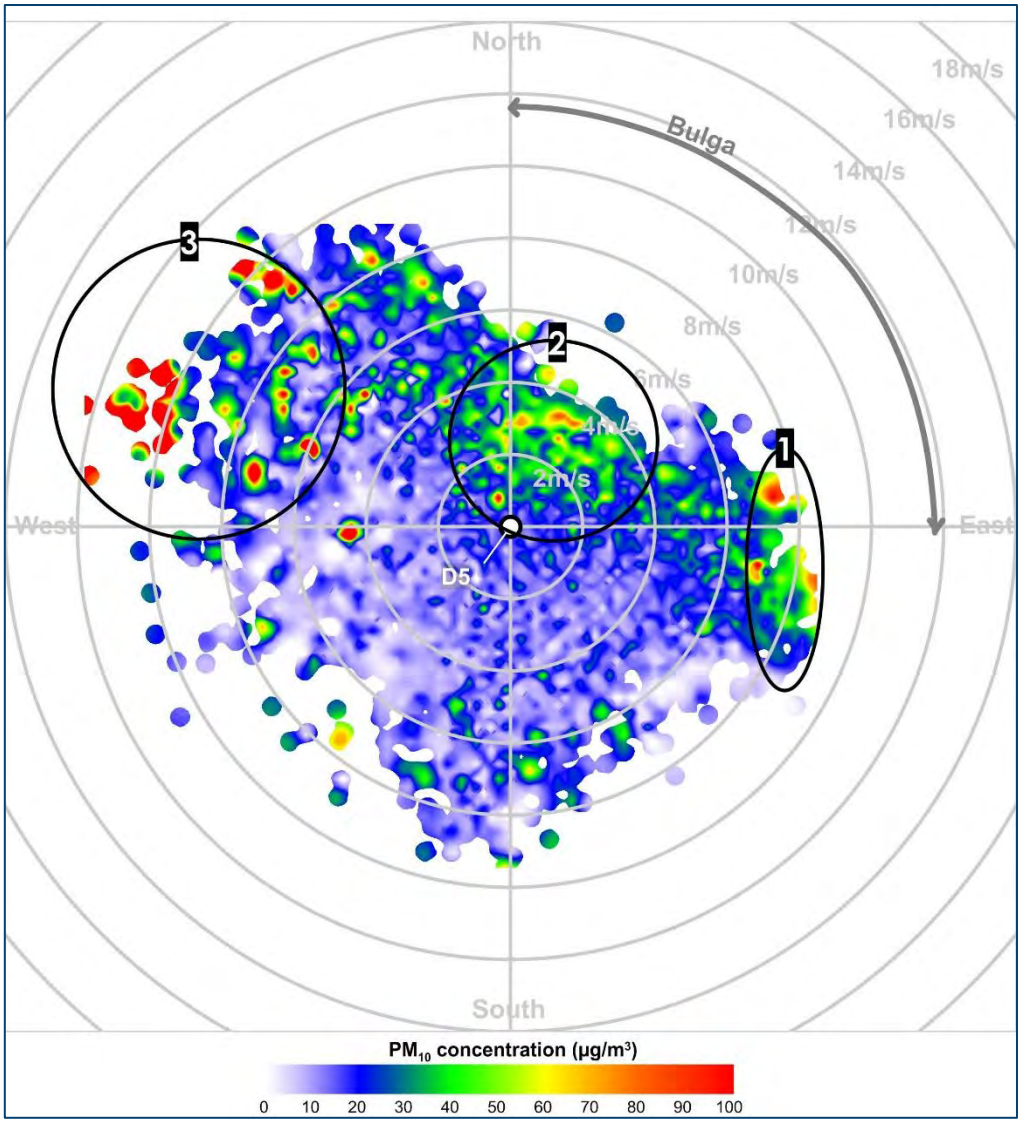


Figure A-2: Example Pollution Rose

1 - Moderate PM_{10} levels tended to originate from the east under wind speeds around 8m/s.

2 - Moderate PM_{10} levels were also recorded from the north and north-northeast direction under wind speeds generally between 2 m/s and 4 m/s.

3 - Some high levels were also recorded from the northwest under moderate wind speeds

Appendix B *Meteorological data capture summary*

This section presents a summary of the percentage data capture of the available 10-minute data from the Bulga Complex, Southern Extension and Flares meteorological stations for the 2021 calendar year.

Table B-1: Bulga Complex Weather Station summary of 10-minute data

Parameter	Temperature at 2m	Temperature at 10m	Wind speed at 10m	Wind direction at 10m	Relative humidity	Sigma Theta	Rainfall
Total data capture	98.03%	98.03%	98.03%	98.03%	98.03%	98.03%	98.02%
Missing data	1.97%	1.97%	1.97%	1.97%	1.97%	1.97%	1.98%
Erroneous data	0.05%	0.05%	0.00%	0.00%	4.44%	0.00%	0.00%
Valid data	97.97%	97.97%	98.03%	98.03%	93.59%	98.03%	98.02%

Table B-2: Southern Extension Weather Station summary of 10-minute data

Parameter	Temperature at 2m	Temperature at 30m	Wind speed at 30m	Wind direction at 30m	Relative humidity	Sigma Theta	Rainfall
Total data capture	97.23%	96.73%	97.23%	97.23%	97.23%	97.23%	97.21%
Missing data	2.77%	3.27%	2.77%	2.77%	2.77%	2.77%	2.79%
Erroneous data	0.00%	0.00%	0.26%	0.26%	9.23%	0.26%	0.00%
Valid data	97.23%	96.73%	96.96%	96.96%	88.00%	96.96%	97.21%

Table B-3: Flares Weather Station summary of 10-minute data

Parameter	Temperature at 2m	Temperature at 10m	Wind speed at 10m	Wind direction at 10m	Relative humidity	Sigma Theta	Rainfall
Total data capture	98.54%	98.54%	99.09%	99.09%	98.54%	98.54%	97.21%
Missing data	1.46%	1.46%	0.91%	0.91%	1.46%	1.46%	2.79%
Erroneous data	0.00%	0.00%	0.00%	0.00%	2.15%	0.00%	0.00%
Valid data	98.54%	98.54%	99.09%	99.09%	96.39%	98.54%	97.21%

Appendix C *TEOM and BAM 24-hour data capture summary*

This section presents a summary of the 24-hour average periods where there was less than 75% valid data for the TEOM and BAM monitors during the 2021 calendar year.

Table C-1: Days with insufficient data (i.e. <75%) for a 24-hour average calculation - D1

Date	Cause/s	Action
26/01/2021	Investigated and cause unable to be determined.	-
26/03/2021	Unexplained power outage.	Power restored.
9/12/2021	Power tripping.	
10/12/2021	Power tripping.	
21/12/2021	Unexplained power outage.	Power restored.

Table C-2: Days with insufficient data (i.e. <75%) for a 24-hour average calculation – D3

Date	Cause/s	Action
26/01/2021	Investigated and cause unable to be determined.	
22/02/2021	Unexplained power outage.	
23/02/2021	Unexplained power outage.	
9/04/2021	Power breakers tripped.	Remade breakers.
10/04/2021	Power breakers tripped.	Remade breakers.
11/04/2021	Power breakers tripped.	Remade breakers.
12/04/2021	Power breakers tripped.	Remade breakers.
7/05/2021	Power outage due to overheating circuit breakers.	-
8/05/2021	Power outage due to overheating circuit breakers.	-
9/05/2021	Power outage due to overheating circuit breakers.	-
10/05/2021	Power outage due to overheating circuit breakers.	-
12/05/2021	Power outage due to overheating circuit breakers.	-
13/05/2021	Power outage due to overheating circuit breakers.	-
14/05/2021	Power outage due to overheating circuit breakers.	Overheating circuit breakers replaced.

Table C-3: Days with insufficient data (i.e. <75%) for a 24-hour average calculation – D5

Date	Cause/s	Action
26/01/2021	Investigated and cause unknown.	-
28/07/2021	6 month planned maintenance.	-
3/10/2021	Unexplained power interruptions.	-

Table C-4: Days with insufficient data (i.e. <75%) for a 24-hour average calculation - D11

Date	Cause/s	Action
26/01/2021	Investigated and cause unknown.	-
19/06/2021	Investigated and cause unknown.	-
20/06/2021	Investigated and cause unknown.	-
1/11/2021	12 month planned maintenance and high filter load.	Changed TEOM filter. Zero filter installed.
2/11/2021	Reported result invalid due to zero filter being installed	-

Table C-5: Days with insufficient data (i.e. <75%) for a 24-hour average calculation – D2

Date	Cause/s	Action
9/01/2021	Power interruption.	-
26/01/2021	Investigated and cause unable to be determined.	-
4/03/2021	Low flow.	-
5/03/2021	Low flow.	Replaced vacuum pump.
6/03/2021	Low flow and periodic flow failures.	-
7/03/2021	Low flow and periodic flow failures.	-
8/03/2021	Low flow and periodic flow failures.	-
9/03/2021	Low flow and periodic flow failures.	-
10/03/2021	Low flow and periodic flow failures.	Calibrated flow. Reset filter counter to zero.
21/03/2021	Large negative values during heavy rain.	-
22/03/2021	Large negative values during heavy rain.	-
26/03/2021	Unexplained power interruptions.	-
23/04/2021	Unexplained power interruptions.	-
30/07/2021	Power interruption.	-
9/12/2021	Monitor damaged in a storm.	Monitor being repaired.
10/12/2021	Monitor offline for repairs.	Monitor being repaired.
11/12/2021	Monitor offline for repairs.	Monitor being repaired.
12/12/2021	Monitor offline for repairs.	Monitor being repaired.
13/12/2021	Monitor offline for repairs.	Monitor being repaired.
14/12/2021	Monitor offline for repairs.	Monitor being repaired.
15/12/2021	Monitor offline for repairs.	Monitor being repaired.
16/12/2021	Monitor offline for repairs.	Monitor being repaired.
17/12/2021	Monitor offline for repairs.	Monitor being repaired.
18/12/2021	Monitor offline for repairs.	Monitor being repaired.
19/12/2021	Monitor offline for repairs.	Monitor being repaired.
20/12/2021	Monitor offline for repairs.	Monitor being repaired.
21/12/2021	Monitor offline for repairs.	Monitor being repaired.
22/12/2021	Monitor offline for repairs.	Monitor being repaired.

Table C-6: Days with insufficient data (i.e. <75%) for a 24-hour average calculation - D10

Date	Cause/s	Action
1/01/2021	Unit exhibiting abnormal operation. Massive leak found (bench not closing properly).	Removed unit from field and returned to workshop for repairs.
2/01/2021	Monitor away for repair.	-
3/01/2021	Monitor away for repair.	-
4/01/2021	Monitor away for repair.	-
5/01/2021	Monitor away for repair.	-
6/01/2021	Monitor away for repair.	-
7/01/2021	Monitor away for repair.	-
8/01/2021	Monitor away for repair.	-
9/01/2021	Monitor away for repair.	-
10/01/2021	Monitor away for repair.	-
11/01/2021	Monitor away for repair.	-
12/01/2021	Monitor away for repair.	-
13/01/2021	Monitor away for repair.	-
14/01/2021	Monitor away for repair.	-
15/01/2021	Monitor away for repair.	-
16/01/2021	Monitor away for repair.	-
17/01/2021	Monitor away for repair.	-
18/01/2021	Monitor away for repair.	-
19/01/2021	Monitor away for repair.	-
20/01/2021	Monitor away for repair.	-
21/01/2021	Monitor away for repair.	-
22/01/2021	Reinstalled dust monitor.	-
23/01/2021	Inlet heater tripping circuit breakers.	-
24/01/2021	Inlet heater tripping circuit breakers.	-
25/01/2021	Inlet heater tripping circuit breakers.	Replaced heater.
26/01/2021	Unexplained outage.	-
19/02/2021	Large negative values during rain event.	-
22/02/2021	Unexplained power outage.	-
23/02/2021	Unexplained power outage.	-
24/02/2021	Large negative values during extended stabilisation after restart.	-
9/04/2021	Protected breakers tripped.	-
10/04/2021	Protected breakers tripped.	-
11/04/2021	Protected breakers tripped.	-
12/04/2021	Protected breakers tripped.	Remade breakers and started TEOM and BAM.
27/04/2021	Planned maintenance with zero noise filter installed overnight.	-
28/04/2021	Removed zero noise filter resulting in < 75% valid data so no 24 hr result possible.	-
7/05/2021	Unexplained outage or no data.	-
8/05/2021	Unexplained outage.	-
9/05/2021	Unexplained outage.	-
10/05/2021	Unexplained outage.	-
12/05/2021	Circuit breaker overheating.	

Date	Cause/s	Action
13/05/2021	Circuit breaker overheating.	
14/05/2021	Circuit breaker overheating.	Overheating circuit breaker restored.
13/07/2021	Large negative values during stabilisation after planned maintenance.	-
2/11/2021	Large negative values during stabilisation after planned maintenance.	-

APPENDIX C

Progress against 2021 Performance Indicators - Offset Areas

Table C1 Broke Road VCA

Number	Performance Indicator	Progress	Comments
1	Control of weeds in revegetation/regeneration areas – Weed control works are completed in accordance with this BOMP and actions recommended from monitoring recommendations	No	Spot control of problem weeds is undertaken as required, focusing on high priority species (Table 3.2 in BOMP). However, Lantana is expanding and requires control
2	Control of feral animals in revegetation/regeneration areas – Feral animal control works are completed, in accordance with this BOMP and actions recommended from monitoring recommendations	Yes	Feral animal activity is low across Broke Road.
3	Confirmation of mapping of areas for regeneration, including appropriateness of target community – Completed prior to commencing 2020-2023 revegetation works	Yes	Completed prior to revegetation.
4	Management of regeneration progress is responsive to monitoring outcomes – Monitoring of regeneration areas occurs. Management actions are implemented in response to monitoring	Yes	Monitoring is completed annually and identifies required management actions.
5	Review need for assisted generation where outcomes of natural regeneration is deemed lacking - 20 hectares of revegetation as per GSS (2017). Continue to monitor progress of natural regeneration and need for management intervention.	Yes	All assessed areas are regenerating naturally, as shown in annual monitoring.
6	Slaty Red Gum (*Eucalyptus glaucina*) – Stands of slaty red gum (*Eucalyptus glaucina*) are in good condition and natural recruitment of seedlings is evident.	Yes	Slaty Red Gum distribution has been mapped, and monitoring shows increasing new recruitment.
7	Develop detailed performance criteria for all management zone types - Detailed criteria developed based on annual monitoring of analogue sites (including target species diversities, coverage and abundance for different strata)	No	Yet to be developed, however, 7 years of baseline data available for this.
8	Native flora species diversity - key indicator species present for target vegetation community	Yes	All assessed areas support key indicator species of target communities
9	Native flora species coverage – Native flora coverage is higher than introduced coverage in all strata	Yes	Coverage of exotic species is <20% for all assessed regeneration areas, and <25% for revegetation areas.
10	Native canopy species abundance – Native canopy species present	Yes	All assessed areas support native canopy species
11	Formation of distinct vegetation strata – Native species are present that are capable of forming the strata of the target vegetation community	Yes	All assessed areas support native species from canopy, shrub and ground, but this is limited in Grassland Mus
12	Log coverage – Treed vegetation is increasing in DBH from previous monitoring year	-	DBH measured triennially, next due in 2022
13	Implement revegetation program – Implementation of plan	Yes	Revegetation commenced in 2018, monitored annually since 2018
14	Positive feedback loop from monitoring results – Feedback from monitoring is incorporated into ongoing review and improvement of plan	Yes	Recommendations from monitoring are adopted in ongoing management
15	Native fauna presence in rehabilitation/regeneration areas – Fauna monitoring completed. Native fauna utilising habitats present	Yes	Monitoring in 2021 shows 52 birds, 18 mammals, 6 reptiles and 5 amphibians present.

Number	Performance Indicator	Progress	Comments
16	Collate data on actions implemented and results of inspections and monitoring into the AR – AR completed annually	Yes	Monitoring results reported annually
17	Weed inspections of remnant areas – Annual inspections are undertaken of vegetation to identify areas of weed infestation. Subsequent weed management actions of infestations are undertaken in accordance with current or other best practice approaches	Yes	Weed inspections completed annually and detailed in this report. Control actions undertaken by Enright Land Management and reported separately.

Table C2 Condran VCA

Number	Performance Indicator	Progress	Comments
1	Control of weeds in revegetation / regeneration areas - Weed control works are completed in accordance with this BOMP and actions recommended from monitoring recommendations	Yes	Spot control of problem weeds is undertaken as required, focusing on high priority species Coolatai Grass and Whisky Grass.
2	Control of feral animals in revegetation/regeneration areas – Feral animal control works are completed, in accordance with this BOMP and actions recommended from monitoring recommendations	Yes	Feral animal activity is low across Condran.
3	Confirmation of mapping of areas for regeneration, including appropriateness of target community – Completed prior to commencing 2020-2023 revegetation works	Yes	Completed prior to revegetation
4	Management of regeneration progress is responsive to monitoring outcomes – Monitoring of regeneration areas occurs. Management actions are implemented in response to monitoring.	Yes	Monitoring is completed annually and identifies required management actions.
5	Review need for assisted regeneration where outcomes of natural regeneration is deemed lacking – Natural regeneration	Yes	All assessed areas are regenerating naturally, as shown in annual monitoring
6	Develop detailed performance criteria for all management zone types – Detailed criteria developed based on annual monitoring of analogue sites (including target species diversities, coverage and abundance for different strata)	No	Yet to be developed, however, 9 years of baseline data available for this.
7	Native flora species diversity – Key indicator species present for target vegetation community	Yes	All assessed areas support key indicator species of target communities
8	Native flora species coverage – Native flora coverage is higher than introduced coverage in all strata	Yes	Coverage of exotic species is <20% for all assessed regeneration areas, and <30% for revegetation areas.
9	Native canopy species abundance – Native canopy species present	Yes	All assessed areas support native canopy species
10	Formation of distinct vegetation strata – Native species are present that are capable of forming the strata of the target vegetation community	Yes	All assessed areas support native species from canopy, shrub and ground, but this is limited in Grassland Mus
11	Log coverage – Treed vegetation is increasing in DBH from previous monitoring year	-	DBH measured triennially, next due in 2022
12	Implement revegetation program – Implementation of plan	Yes	Revegetation commenced in 2016, monitored annually since 2018
13	Positive feedback loop from monitoring results – Feedback from monitoring is incorporated into ongoing review and improvement of plan	Yes	Recommendations from monitoring are adopted in ongoing management

Number	Performance Indicator	Progress	Comments
14	Native fauna presence in rehabilitation/regeneration areas – Fauna monitoring completed. Native fauna utilising habitats present	Yes	Monitoring shows 79 birds, 31 mammals, 11 reptiles and 10 amphibians present
15	Collate data on actions implemented and results of inspections and montoring into the AR – AR completed annually	Yes	Monitoring results reported annually
16	Weed inspections of remnant areas – Annual inspections are undertaken of vegetation to identify areas of weed infestation. Subsequent weed management actions of infestations are undertaken in accordance with current or other best practice approaches	Yes	Weed inspections completed annually and detailed in this report. Control actions undertaken by Enright Land Management and reported separately.

Table C3 Wollombi Brook VCA

Number	Performance Indicator	Progress	Comments
1	Control of weeds in revegetation/regeneration areas – Weed control works are completed in accordance with this BOMP and actions recommended from monitoring recommendations	Yes/No	Sport control of problem weeds is undertaken as required, focusing on high/medium priority species (Table 3.2 in BOMP). However, *Eragrostis curvula* and *Heliotrope amplexicaule* require increased control
2	Control of feral animals in revegetation / regeneration areas – Feral animal control works are completed in accordance with this BOMP and actions recommended from monitoring recommendations	Yes	Feral animal activity is low across Wollombi Brook
3	Management of Bulloak regeneration – Bulloak regeneration is actively managed to improve condition of existing Warkworth Sands Woodland EEC variants and ensure it does not inhibit successful regeneration of this community	Yes	Thinning trials have been underway since 2016 to monitor and assess impacts.
4	Confirmation of mapping of areas for regeneration, including appropriateness of target community – Completed prior to commencing 2020-2023 revegetation works	Yes	Completed prior to revegetation
5	Management of regeneration progress is responsive to monitoring outcomes – Monitoring of regeneration areas occurs. Management actions are implemented in response to monitoring	Yes	Monitoring is completed annually and identifies required management actions.
6	Review need for assisted regeneration where outcomes of natural regeneration is deemed lacking – Continue to monitor progress of natural regeneration and need for management intervention	Yes	All assessed areas are regenerating naturally, as shown in annual monitoring.
7	Develop detailed performance criteria for all management zone types – Detailed criteria developed based on annual monitoring of analogue sites (including target species diversities, coverage and abundance for different strata)	No	Yet to be developed, however, 7 years of baseline data available for this.
8	Native flora species diversity – key indicator species present for target vegetation community	Yes	All assessed areas support key indicator species of target communities.
9	Native flora species coverage – Native flora coverage is higher than introduced coverage in all strata	Yes	Coverage of exotic species is <20% for all assessed areas.
10	Native canopy species abundance – Native canopy species present	Yes	All assessed areas support native canopy species
11	Formation of distinct vegetation strata – Native species are present that are capable of forming the strata of the target vegetation community	Yes	All assessed areas support native species from canopy, shrub and ground, but this is limited in Grassland Mus

Number	Performance Indicator	Progress	Comments
12	Log coverage – Treed vegetation is increasing in DBH from previous monitoring year.	-	DBH measured triennially, next due in 2022
13	Implement revegetation program – Implementation of plan	Yes	Revegetation commenced in 2019, monitored annually since then.
14	Positive feedback loop from monitoring results – Feedback from monitoring is incorporated into ongoing review and improvement of plan	Yes	Recommendations from monitoring are adopted in ongoing management
15	Native fauna presence in rehabilitation/regeneration areas – Fauna monitoring completed. Native fauna utilising habitats present.	Yes	Monitoring in 2021 shows 57 birds, 15 mammals, 2 reptiles but no amphibians present.
16	Collate data on actions implemented and results of inspections and montoring into the AR – AR completed annually	Yes	Monitoring results reported annually
17	Weed inspections of remnant areas – Annual inspections are undertaken of vegetation to identify areas of weed infestation. Subsequent weed management actions of infestations are undertaken in accordance with current or other best practice approaches	Yes	Weed inspections completed annually and detailed in this report. Control actions undertaken by Enright Land Management and reported separately.

APPENDIX D

Annual Groundwater Monitoring Report (Jacobs, 2022)

Bulga Coal Complex

Annual Groundwater Monitoring Report - 2021 Monitoring Period

v01.02 | FINAL Rev1

Bulga Coal Complex

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Revision	Date	Description	Author	Checked	Reviewed	Approved
V01.01	15 March 2022	Draft for client review	GBrumm	GBrumm	CConte	CConte
V01.02	16 March 2022	Draft for client review following comments from SM	GBrumm	GBrumm	CConte	CConte
v1.03	25 March 2022	Final	CConte	CConte	CConte	CConte

Contents

Important note about your report

The sole purpose of this report is to present a review of the groundwater data collected during 2021 for the Bulga Coal Complex, for Bulga Coal Management Pty Ltd (BCM).

In preparing this report, Jacobs has relied upon, and presumed accurate, any information provided by BCM and other publicly available sources.

Unless otherwise stated, Jacobs has not verified the accuracy or completeness of any information provided by BCM or in publicly available reports and databases. If the information is subsequently determined to be false, inaccurate or incomplete, then it may be possible that observations and conclusions expressed in this report may be impacted. Data sources are referenced throughout the text and listed in the reference section at the end of this report.

Jacobs derived the conclusions in this report from information and data obtained from BCM and other available sources at the time this report was prepared. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report.

Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above. No other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed. This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

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1. Introduction

This report was prepared to support the Annual Review Report for Bulga Coal Complex (BCC). It documents groundwater conditions during the 2021 reporting period, between 01 January 2021 and 31 December 2021.

1.1 Background

The BCC is located in the NSW Hunter Coalfield, approximately 12 km southwest of Singleton and 1 km north of Broke, NSW. BCC includes the Bulga Open Cut (BOC)and Bulga Underground Operations (BUO).

BUO previously comprised three operations, Blakefield South (BFS) which ceased operation in 2018, Beltana mine which ceased operation in 2011 and South Bulga Underground which ceased operations in 2006. In 2010, BFS operations commenced extraction of the Blakefield Seam that underlies the previously extracted Whybrow Seam (Beltana and South Bulga). Mining operations at BUO were undertaken using the longwall retreat mining method. The BFS LW1A to BFS LW5 longwalls were extracted in the southwest to northeast direction, while longwalls BFS LW7 and BFS LW8 were extracted in the southeast-northwest direction (Figure 2.1).

1.2 Study Area

BFS is situated at the southern end of the BCC and just north of the Broke township. Wollombi Brook, flowing to the north-west, comes within 500 m south of BFS LW3. Monkey Place Creek, a tributary of Wollombi Brook, flows west and is located immediately to the south (100 m to 200 m) past BFS LW3 to BFS LW5.

1.3 Geology

Geologically, the BCC is located in the northern part of the Sydney Basin. A major structural feature is the Mt Thorley monocline, which is located to the east of the BCC. The BUO area is underlain by Late Permian age strata – the Wittingham Coal Measures, which are directly overlain by the Wollombi Coal Measures Group. The late Permian sequence is characterised by a series of sandstone, siltstone, conglomerate and coal formations.

The strata dip at approximately 2° to 5° to the south-west. Strata of Late Permian age outcrop across the site but are overlain in localised areas by alluvial deposits along Wollombi Brook and Monkey Place Creek. Table 1.1 shows the detailed stratigraphy of this part of the Sydney Basin and Table 1.2 presents the coals seams of the Jerrys Plains subgroup of the Wittingham Coal Measures.

Table 1.1: General stratigraphy of the Hunter Coalfields

Period	Stratigraphy		
Quaternary	Wollombi Brook alluvium, Monkey Place Creek alluvium		
Triassic	Hawkesbury Sandstone		
	Narrabeen Group	Terrigal Formation	
		Clifton Subgroup	Patonga Claystone
			Tuggerah Formation
			Widden Brook
Permian	Singleton Supergroup	Wollombi Coal Measures	Glen Gallic Subgroup
			Doyles Creek Subgroup
			Horseshow Creek Subgroup (**Alcheringa Seam** is the basal member)
			Apple Tree Flat Subgroup
			Watts Sandstone
		Wittingham Coal Measures	Denman Formation
			Jerrys Plains Subgroup (includes the Whybrow and Blakefield Seams)
			Archerfield Sandstone
			Vane Subgroup
			Saltwater Creek Formation

Table 1.2: Coal seams nomenclature of Jerrys Plains Subgroup (Beckett, 1988)

Subgroup	Coal Seams
Jerrys Plains	**Whybrow**
	Redbank Creek
	Wambo
	Whynot
	Blakefield
	Glen Munro
	Woodlands Hill
	Mount Arthur
	Piercefield
	Vaux
	Bayswater

1.4 Hydrogeology

1.4.1 Hydrostratigraphy

There are three broad groups of hydrostratigraphic units (HSUs):

- **Shallow groundwater system**: Alluvium (and underlying regolith) associated with Wollombi Brook and Monkey Place Creek and regolith
- **Interburden and shallow coal measures**: Weathered and fractured shallow sandstone and coal measures
- **Coal seams**: Wollombi Coal Measures and the Wittingham Coal Measures, which may be regarded as a fractured rock aquifer

The alluvium and regolith have low to moderate hydraulic conductivity and supports local water supplies with around 20 private bores within a 3 km radius of BFS. This aquifer is used for a variety of purposes including stock and domestic, water supply and irrigation. Water quality is generally fresh.

The intermediate depth shallow coal measures exhibit relatively low hydraulic conductivity.

The coal measures fractured rock aquifer comprises sandstone, siltstone and coal seams with varying degree of fracturing and hydraulic conductivity. This hydrostratigraphic unit is characterised by generally poor-quality groundwater and low hydraulic conductivity. There are no private bores extracting from the shallow coal measures within the vicinity of BFS.

1.4.2 Recharge and Discharge

Recharge to the alluvium and shallow weathered coal measures is mainly via ephemeral streamflow and rainfall infiltration with topography driving the shallow groundwater flow direction. As evidenced from water pressure monitoring and water quality data, the deeper hydrostratigraphic units are confined and are recharged from vertical leakage where depressurisation induces sufficient hydraulic gradient, and also from recharge zones some distance away from the BUO.

Discharge from the shallow groundwater system occurs via abstraction, evapotranspiration, leakage to deeper strata, and as baseflow to local watercourses. Discharge from deeper units occurs via mine dewatering and local horizontal and vertical flow driven by migration towards depressurised zones. Regional outflow may occur via horizontal migration and outflow at some distance away from the mining operation.

2. Groundwater Monitoring Network

The groundwater monitoring network for the BUO comprises a number of dedicated monitoring bores, nested monitoring bores and multi-level vibrating wire piezometers (VWP) (Figure 2.1). These are distributed throughout the three broad hydrostratigraphic groups (Section 1.4.1).

Groundwater monitoring is undertaken in accordance with the Bulga Water Management Plan. Over the past 15 years a number of monitoring points have been abandoned or destroyed and new ones installed as the underground workings progressed. A summary of currently operational monitoring bores is provided in Table 2.1 for standpipes and Table 2.2 for VWP, respectively. The locations of all currently monitored monitoring bores are shown on Figure 2.1.

The following provides a summary of the formations monitored, grouped under the three broad hydrostratigraphic groups outlined in Section 1.4.1:

Shallow Groundwater System:

- **Wollombi Alluvium** – twelve standpipe monitoring bores are located to the south and west of BFS. Three of the twelve monitoring bores are equipped with dataloggers
- **Monkey Place Creek Alluvium** - ten monitoring bores are installed to a maximum depth of 16 m to the south BFS. Nine are equipped with dataloggers
- **Loders Creek Alluvium** – two monitoring bores installed in November 2019, located to the northeast of the BOC.
- **Regolith/alluvium** - two standpipe monitoring bores are installed in regolith/volcanic sill/alluvium of which one was equipped with a datalogger in late 2017

Interburden and shallow coal measures:

- **Interburden sandstone** - six standpipe monitoring bores are installed in shallow interburden sandstone to a depth of up to 52 m to the west and northwest of BFS
- **Shallow Permian and Coal Measures (undifferentiated)** - eight standpipe monitoring bores are installed to the northwest and the southwest of BFS. Two monitoring bores were equipped with dataloggers from 2017 and 2018

Coal Seams*:*

- **Alcheringa Seam (Wollombi Coal Measures)** – five standpipe monitoring bores are currently monitored to the northwest of BFS at depths ranging from 10-42 m. Monitoring of a sixth bore ceased in 2018. Four of the five currently monitored standpipes have dataloggers installed
- **Lower Whybrow Seam (Wittingham Coal Measures)** - three standpipe monitoring bores, one of which has a datalogger installed

In addition, four VWP arrays are installed west, northwest and east of the BFS to a depth of 220 m to 367.7 m (up to 176 m below the mined Blakefield Seam). The VWP installation, including depth setting of sensors, are summarised in Table 2.2.

Table 2.1: Summary of standpipe monitoring bores

Site Name	Easting (MGA56)	Northing (MGA56)	Formation monitored	Depth of installation (m bgl)	Continuous loggers
Dwyers	317704.52	6379357.94	Wollombi Alluvium	<30	
F1	316152	6381601	Wollombi Alluvium	17.4	Y
F2	317916	6379142	Wollombi Alluvium	14	Y
Fernance	317697.38	6379366.74	Wollombi Alluvium	Unknown	
V1	316720.3	6380086.18	Wollombi Alluvium	<30	
V2	316959.49	6383505.26	Wollombi Alluvium	<30	
V3	321479.59	6377087.42	Wollombi Alluvium	<30	
WBD160	316435	6380857	Wollombi Alluvium	18	
WBR181	316735.26	6383229.55	Wollombi Alluvium	9	
WBR182	316570.5	6382623.04	Wollombi Alluvium	11.5	
White1	318248.9	6378942.98	Wollombi Alluvium	Unknown	
WBR241	316931.63	6383671.92	Wollombi Alluvium	13.5	Y
GW1	326035.56	6375616.55	Monkey Place Creek alluvium	Unknown	Y
GW10	322177.66	6376728.28	Monkey Place Creek alluvium	16	Y
GW2	325328.77	6375636.4	Monkey Place Creek alluvium	Unknown	Y
GW3	323342.37	6375423.79	Monkey Place Creek alluvium	13.2	Y
GW4	324107.37	6375104.12	Monkey Place Creek alluvium	Unknown	Y
GW5	324731.96	6375152.53	Monkey Place Creek alluvium	Unknown	Y
GW6	322800.98	6375050.58	Monkey Place Creek alluvium	13.3	
GW7	322738.39	6375581.53	Monkey Place Creek alluvium	10	Y
GW8	322120.98	6375817.87	Monkey Place Creek alluvium	16	Y
GW9	322319.08	6376212.93	Monkey Place Creek alluvium	13	Y
LC1	322,855	6,384,876	Loders Creek Alluvium	5	
LC2	323727	6387928	Loders Creek Alluvium	7.6	
McG1	317425.87	6381405.39	Regolith /sill/ alluvium	Unknown	
WBR15	317578.48	6379805.69	Regolith /sill/ alluvium	24	Y
WBR240	317495	6383685	Shallow Permian	9	Y
WBR50A	317619.47	6383700.52	Shallow Permian	18	Y
P2	321283.35	6377492.59	Shallow coal measures	52	
P5A	321682.07	6376660.68	Shallow coal measures	<100	
P6A	322839.83	6376615.27	Shallow coal measures	<100	
SBD196	320164.75	6377155.89	Shallow coal measures	Unknown	
WBR180	316926.13	6383123.84	Shallow coal measures	46	
WBR183	316802.5	6382733.61	Shallow coal measures	30.6	
NPZ3-B	318116.79	6379199.73	Interburden Sandstone	51.4	
NPZ4-B	316824.26	6380615.32	Interburden Sandstone	63.3	
NPZ5-B	316448.35	6381790.37	Interburden Sandstone	51.3	
NPZ7-1	317566.2	6379556.28	Interburden Sandstone	50	
NPZ7-2B	317623.98	6379598.15	Interburden Sandstone	57.5	
NPZ7-3B	317680.71	6379639.51	Interburden Sandstone	54	
NPZ3-A	318117.71	6379200.51	Alcheringa Seam	17	
NPZ4-A	316820.6	6380615.83	Alcheringa Seam	42.4	Y
NPZ5-A	316448.35	6381790.37	Alcheringa Seam	15.7	Y
NPZ7-2A	317623.98	6379598.15	Alcheringa Seam	10	Y

Site Name	Easting (MGA56)	Northing (MGA56)	Formation monitored	Depth of installation (m bgl)	Continuous loggers
NPZ7-3A	317680.71	6379639.51	Alcheringa Seam	17	Y
WBD62A	316593.58	6381282.77	Alcheringa Seam	27	Y
P6B	322839.83	6376615.27	Lower Whybrow Seam	390	
P7B*	-	-	Lower Whybrow Seam	-	
P8	324628.23	6375708.24	Lower Whybrow Seam	392.4	
WBR50	317604.5	6383719.6	Lower Whybrow Seam	125	Y
WWS1	317737.27	6384291.33	Warkworth Sands	2.15	
WWS2a	637639.41	6384540.53	Warkworth Sands	1.5	
WWS2b	637639.41	6384540.53	Warkworth Sands	2.6	
WWS3a	317728.96	6384886.79	Warkworth Sands	1.4	
WWS3b	317728.96	6384886.79	Warkworth Sands	2.0	
MB1A shallow	318544.83	6384967.25	Shallow Permian**	25.5	Y
MB1B deep	318544.83	6384967.25	Deep Permian**	136	Y
MB2	318017.67	6384363.33	Whybrow Seam**	43	Y
MB3 shallow	318297.2	6383709.03	Shallow Permian**	23.5	Y
MB3 deep	318297.2	6383709.03	Deep Permian**	192	Y

Note: ***Bore P7B has not been monitored since 2012 (not accessible)**

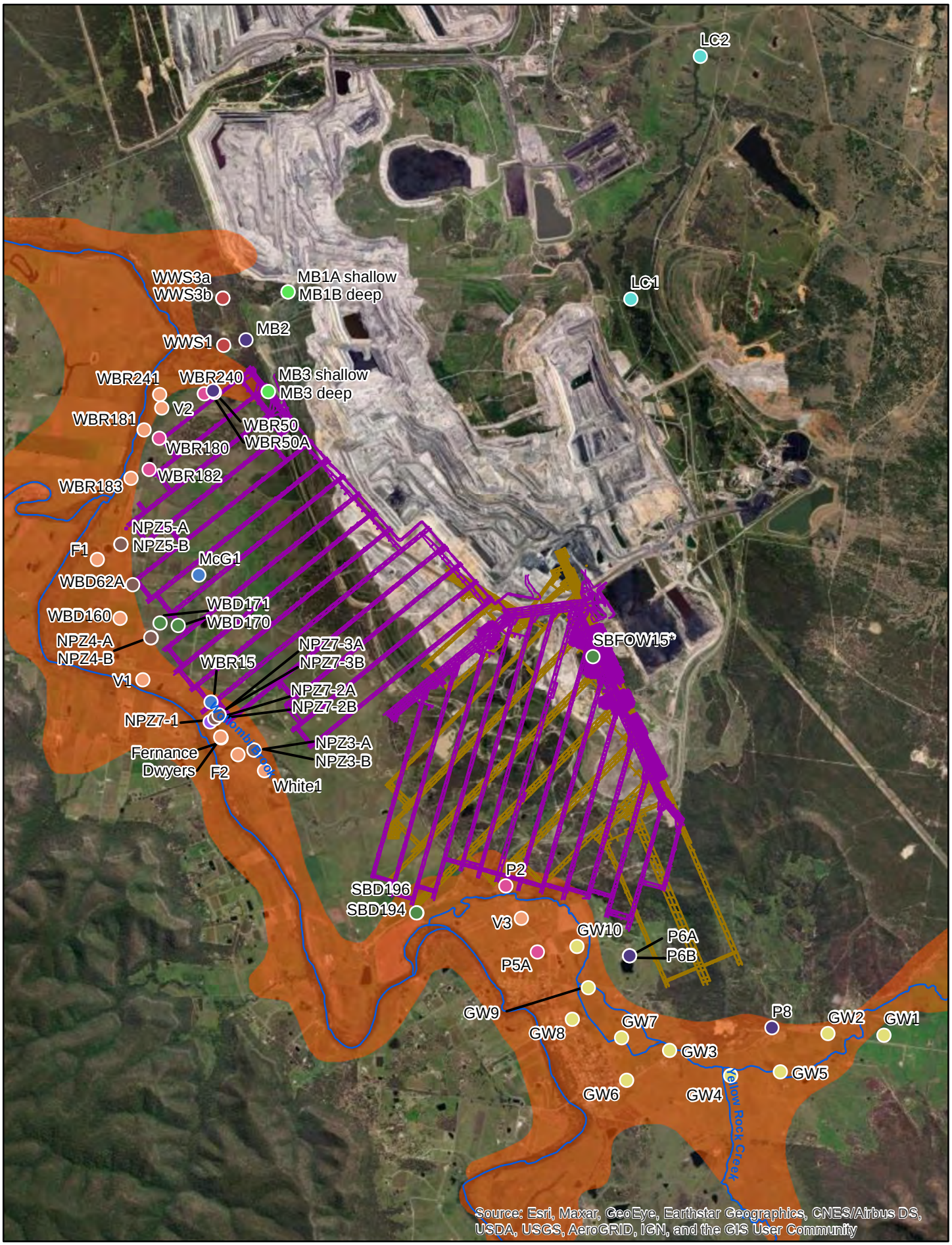
****Northern Tailings emplacement facility piezometers**

Table 2.2: Details of vibrating wire monitoring bores

VWP ID	Easting (MGA94z56)	Northing (MGA94z56)	Ground Level (m AHD)	Depth Drilled (m)	VWP Depth (m bgl)	Formation	Stratigraphy
WBD170	317164.3	6380768.3	93.9	220	60	Undifferentiated coal measures	-
					110		
					160		
					220	Whybrow Seam	Jerry's Plains Subgroup (Wittingham Coal Measures)
WBD171	316939.8	6380797.6	85.3	223	60	Undifferentiated coal measures	-
					110		
					160		
					223	Whybrow Seam	Jerry's Plains Subgroup (Wittingham Coal Measures)
SBD194	320162.1	6377154.6	73.0	367.6	35.3	Shallow Coal	-
					90.8	Watts Sandstone	
					171.4	Whybrow Seam	Jerry's Plains Subgroup (Wittingham Coal Measures)
					197.3	Redbank Creek Seam	
					227.0	Wambo Seam	
					265.9	300/301 (Blakefield) Seam	
					278.8	Glen Munro Seam	
					321.3	Woodlands Hill Seam	
					367.7	Piercefield A and B Seam	
SBFOW15*	322380.2	6380379.1	89.1	383	96	Redbank Creek Seam	Jerry's Plains Subgroup (Wittingham Coal Measures)
					122	Wambo Seam	
					158	Blakefield Seam	
					184	Glen Munro Seam	
					224	Woodlands Hill Seam	
					334	Piercefield C Seam	

*data not available for 2019-2021

Figure 2.1: Groundwater monitoring locations



LEGEND

monitoring locations

Formation

- Alcheringa Seam
- Deep coal measures
- Interburden Sandstone
- Loders Creek Alluvium
- Monkey Place Creek alluvium
- Regolith /sill/ alluvium
- Shallow coal measures
- VWP
- Warkworth Sands
- Whybrow Seam
- Wollombi Alluvium
- label lines
- Beltana_Underground_Workings
- Blakefield_South_Underground_Workings

Hydrology

- Watercourse

Geology

- Alluvium

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3. Groundwater level responses during 2021

Groundwater level and quality data collected during the reporting period have been reviewed to assess the groundwater response to underground mining and to natural effects. The reporting period data is viewed in the context of the historic dataset extending back as far as 2003 where data is available. Hydrographs to the end of the reporting period are attached in Appendix A.

3.1 Shallow Groundwater System

Groundwater levels for the alluvium are shown in Appendix A and compared to the rainfall excess / deficit (also known as cumulative rainfall departure, CRD), which is calculated as the cumulative difference between actual rainfall over the monitoring period and long term mean average rainfall. A rising trend on the rainfall excess / deficit plot represents periods of above average rainfall and falling trends represent periods of below average rainfall. Comparison of hydrographs to the rainfall excess / deficit trend helps interpretation of groundwater level fluctuations in the context of seasonal rainfall variations vs other potential influences.

Rainfall data for the calculation of the excess / deficit trend was sourced from Bureau of Meteorology (BOM) station 061100 (Broke), located approximately 3.5 km south of the BFS workings. Rainfall data for the last 129 years from station 061100 were used to calculate the long-term monthly average rainfall. Recent data (2013-2021) from the BCC weather station was used to fill gaps in the BOM record for the Broke gauge.

In the 2018, annual groundwater monitoring report the HARTT method (hydrograph analysis using rainfall and time trend (Ferdowsian, 2001) was used to assess groundwater level changes at selected alluvium monitoring bores. The HARTT methodology was developed to statistically analyse and estimate trends in groundwater levels. The method aims to separate the effect of rainfall events and the lag between rainfall and groundwater response from other underlying trends. The method is essentially a simple analytical modelling technique and produces a fitted curve through the observed groundwater level data using two variables, rainfall: Accumulative Monthly (or annual) Residual Rainfall (AMRR), and time. These variables can differentiate between the effect of rainfall fluctuations and other groundwater level trends.

The HARTT analysis aims to assess the influence of rainfall on groundwater level fluctuations relative to other (unspecified) influences, and is a somewhat subjective analytical tool, it was not adopted for the 2021 groundwater level analysis. Trends in most alluvial bores show a clear reflection of the increasing rainfall excess during the reporting period and to historical fluctuations in rainfall excess / deficit.

3.1.1 Wollombi Brook Alluvium

Between January and December 2021, groundwater levels in the Wollombi Brook alluvial monitoring bores increased. Bore groundwater levels within the Wollombi alluvium generally decreased from 2016 to January 2020, coincident with drought conditions experienced in the region over the period. Rainfall trends are reflected in the rainfall excess/deficit plot, shown through hydrographs in Appendix A.

All Wollombi Brook alluvial bore groundwater levels increased over the period, and bores water levels have returned to or exceeded pre-2016 to 2019 drought water levels, with the exception of WBD160. Bore WBD160 remains slightly below pre-drought water levels despite an increasing trend from 2020.

Most monitoring bores show a steady increase in groundwater level over the course of the reporting period. Several bores show short term responses to individual rainfall events.

HARTT analysis undertaken for the 2018 groundwater monitoring report for three Wollombi alluvium monitoring bores (Fernance, White and WBD160) located to the west of the BFS suggests there are other influences on alluvium groundwater levels. The HARTT analysis appeared to indicate a weaker statistical correlation to rainfall that the visual match would suggest. This is interpreted to indicate that other influences on alluvium groundwater levels such as alluvium supply bores and groundwater-surface water interaction. BCC staff have indicated there is significant localised pumping of groundwater from the alluvium (for irrigation of pasture and for vineyards).

3.1.2 Monkey Place Creek Alluvium

There is a network of ten monitoring bores that were installed to monitor groundwater levels in the Monkey Place Creek alluvium, located to the south and south-east of the BFS (Figure 2.1). All but one of these bores are equipped with dataloggers, although several of the dataloggers show departures from the more consistent manual readings and some show anomalous levels, which are likely to be error/electronic drift as the manual readings continue along the expected trend.

Groundwater levels increased in the Monkey Place Creek alluvial bores over the year, with the most significant increase in water levels occurring in Q1 2021. The rainfall excess/deficit shows an increasing trend over the year, with above-average rainfall in March and November 2021. Groundwater level trends generally follow rainfall excess / deficit trends, increasing at the start of 2021 and showed varying trends between months, with most bore groundwater levels increasing at the end of 2021 following rainfall in November.

The majority of groundwater levels in the Monkey Place Creek alluvium have returned to pre-2016 to 2019 drought groundwater levels.

The HARTT analysis completed for the 2018 groundwater monitoring report included two Monkey Place Creek alluvium monitoring bores: GW9 and GW10. As for the Wollombi Alluvium, the analysis concluded that parameters other than just rainfall appear to have some influence on groundwater levels in the Monkey Place Creek alluvium. These influences are likely to include groundwater-surface water interaction (Monkey Place Creek) and local irrigation across the Monkey Place Creek alluvium.

3.1.3 Loders Creek Alluvium

Loders Creek alluvial bores LC1 (5 mBGL) and LC2 (7.6 mBGL) were installed in November 2019. Groundwater levels in the Loders Creek alluvial bore LC2 ranged between 41.2 mAHD and 42.7 mAHD since monitoring began in 2020. Groundwater levels in LC2 increased between March and April 2021 and remained stable for the remainder of 2021.

LC1 has recorded groundwater elevations between 53.0 mAHD and 53.1 mAHD and has been measured as dry for four out of six monitoring events in 2021.

3.1.4 Warkworth Sands

In June 2021, five shallow monitoring bores were installed to monitor the Warkworth Sands (WWS1, WWS2A, WWS2B, WWS3A and WWS3B). Bore depths range from 1.4 m to 2.6 m. The bores are located within the northwest section of the Bulga mining lease, to the north of Beltana underground workings.

All bores were recorded as dry following drilling, and only two bores (WWS2B and WWS3B) have recorded consistent groundwater levels since installation, both show water level increases between October and November/December 2021 (reefer Appendix A). WWS2A and WWS2B both recorded a single groundwater level measurement since installation in June 2021, and WWS1 has remained dry.

3.1.5 Regolith/volcanic sill/alluvium

McG1 and WBR15 monitoring bores are installed in regolith/volcanic sill/alluvium and are located west of BFS.

Monitoring bore McG1 recorded increased groundwater levels as response to rainfall events in 2021, showing groundwater level increases following rainfall events in March and November (both events recorded rainfall greater than 200 mm monthly total). Groundwater levels in the bore show high responsiveness to rainfall and have typically shown a similar order of seasonal variation to rainfall since the end of the Millennium Drought in 2007, before which levels were very steady.

Groundwater levels in WBR15 increased steadily over the year, returning to pre-2016 to 2019 drought levels by the end of 2021. Groundwater levels in the bore increased by approximately 4.5 m over the monitoring period. The bore is equipped with a datalogger, and shows little immediate response to rainfall, but follows the rainfall excess/deficit trend with more gradual changes in groundwater levels.

3.2 Interburden and shallow coal measures

3.2.1 Interburden Sandstone

The shallow Permian interburden sandstone monitoring bores are installed to depths of <20 m and the sandstone bores at a range of depths between 50 m to 65 m (refer Table 2.1 for details).

Sandstone monitoring bores NPZ7-1, NPZ7-2B, NPZ7-3B, NPZ3-B all showed similar groundwater level trends over the monitoring period. All bore increased significantly over 2021, increasing between 4-7m between Q1 2021 and Q4 2021 following heavy rainfall in March 2021. Groundwater level trends in these bores follow CRD trends long-term. Groundwater levels recovered to pre-2016 to 2019 drought levels by the end of 2021.

The two sandstone monitoring bores located further north (NPZ4-B and NPZ5-B), to the north-west of BFS, show a sharp decline following installation in 2005 followed by a general increase since 2010. These bores are directly west of the Beltana underground workings where extraction of coal from the Whybrow Seam ceased in 2011 and appear to show a clear recovery response. In 2021, NPZ4-B showed significant (~2.5 m) increase in groundwater levels following a long-term decline that corresponds to the 2016-2019 drought. Levels in NPZ5-B also show an increase that is likely related to the increasing excess / deficit curve. The impact of the 2016-2019 drought on NPZ5-B water levels is visible but is only a minor impact, acting to attenuate water level recovery rather than resulting in a decline.

3.2.2 Undifferentiated Coal Measures

Shallow coal measure monitoring bores are located to the south of BFS (P2, P5A, P6A and SBD196) with two (WBR180 and WBR183) located to the north-east of the northern end of the Beltana underground workings.

Three of the four monitoring bores to the south of BFS (P2, P5A and SBD196) show varying groundwater level trends during the reporting period. P2 and SBD196 increased in Q1 2021 and subsequently declined through October, increasing again in December 2021. P5A groundwater levels increased throughout the year.

P6A is located south of BFS and groundwater levels in the bore increased between the end of 2020 and the start of 2021, remaining generally stable throughout the year. Groundwater levels in the bore previously showed a declining trend since 2016. The increase in water levels in 2021 was the first observed response in the bore to recovering groundwater levels in the region.

The two monitoring bores to the north-west of BFS (WBR180 and WBR183) both show a more subdued response to rainfall and climatic trends. The groundwater level in WBR180 remained relatively unchanged over the 2021 reporting period. Groundwater levels in WBR183 increased over the reporting period (most significant increase in Q1 2021), which is likely in response to the rainfall excess.

3.3 Coal Seams

3.3.1 Alcheringa Seam (Wollombi coal measures)

Monitoring bores targeting the Alcheringa Seam are installed to the west of BFS and at the eastern edge of the Wollombi Brook alluvium. Groundwater levels in the Alcheringa Seam increased over the period, with varying level increases between bores. Groundwater levels in WBD62A, NPZ4-A, NPZ7-2A and NPZ7-3A showed similar trends and increased between approximately 1 m to 4 m over the period. This trend follows rainfall excess/deficit trends for the year.

Bore NPZ5-A shows a subdued response to rainfall trends. Water levels in the bore increased over the year but showed significantly less response to rainfall than other bores within the Alcheringa Seam.

The trend in WBD62A for the most part reflects the rainfall excess / deficit plot with the exception of a steep decline through 2008 and 2009 against the trend of rainfall excess. In 2021, this monitoring bore showed a delayed response to the rainfall excess and increasing groundwater levels in the latter half of 2020.

Following a significant decline in 2008-2011, NPZ3-A began to recover slowly, although no data is available for 2019-2021.

3.3.2 Lower Whybrow (Wittingham Coal Measures)

As a result of either Beltana and/or South Bulga operations in the Whybrow Seam, a portion of the coal measures have been depressurised to various degrees in the past. This is observed in three monitoring bores (P6B and P8 to the south of BFS, and WBR50 4 km north-west of BFS and just north of the Beltana workings).

In 2021, groundwater levels in P6B declined gradually to October and declined suddenly from -15 mAHD to -62 mAHD in December. The bore recorded depressurisation from 60 mAHD to -20 mAHD between 2013 and the end of 2018, remaining generally stable from 2019 through Q3 2021. Groundwater trends in the bore may be a reflection the cessation of mining activity at BFS combined with the increase rainfall since early-2020. The most recent record (December 2021) may reflect an error and will require review following the 2022 monitoring rounds.

In P8, levels have been somewhat erratic over the course of the record with large step increases in 2005 and 2008 with water levels following the CRD. Since 2016, approximately 15 m of depressurisation had been recorded coinciding with the rainfall deficit over the period, water levels have recovered somewhat in line with increasing CRD. Groundwater levels in the bore increased from 2020 monitoring and remained stable over the year with the exception of the December 2021 record, which showed a sharp decline in groundwater pressure.

Groundwater levels at WBR50 increased over 2021, commensurate with the rainfall trends in the area. Depressurisation of the Whybrow Seam at this location occurred between 2008 and 2011 and the monitoring bore has not yet shown any significant recovery to pre-mining levels.

3.4 Clustered Standpipe Monitoring bores

The change in vertical hydraulic gradients and connectivity between different formations is monitored by seven clustered standpipe monitoring bores. The charts showing the hydrographs for each pair of monitoring bores are attached in Appendix A and the detailed of targets are summarised below:

- One pair (P6A and P6B) installed in the shallow coal measures and Lower Whybrow Seam, respectively, southwest of BFS.
- Five pairs (NPZ3-A/ NPZ3-B, NPZ4-A/ NPZ4-B, NPZ5-A/ NPZ5-B, NPZ7-2A/ NPZ7-2B and NPZ7-3A/ NPZ7-3B) installed in the Alcheringa Seam (monitoring bore -A), and the underlying interburden sandstone (monitoring bore -B) to the west of the BFS. Note that data collection at NPZ3-A ceased in 2016, whereas NPZ3-B continues to be monitored.
- One pair (WBR50A and WBR50), installed 5 km northwest of BFS and just northwest of the Beltana workings, target the shallow coal measures and Lower Whybrow Seam, respectively.

3.4.1 Alcheringa Seam and Interburden Sandstone Connectivity

During 2021, the vertical hydraulic gradients at these nested monitoring bores were as follows:

NPZ3 – the upward vertical hydraulic gradient was steadily returned to an **increasing** trend with recovery in pressure in the sandstone and a slowly increasing pressure trend in the Alcheringa Seam up to 2016 when monitoring stopped. It is likely that the rainfall in 2020 recharged both units; however, the Alcheringa Seam was depressurised in 2006-2009 and has been recovering slowly since then. Groundwater levels in NPZ3-B (sandstone) have recovered to pre-2016 to 2019 drought conditions.

NPZ4 – the downward vertical hydraulic gradient remained relatively **constant** with the pressure reduction in both units recovering significantly due to the elevated rainfall since 2020.

NPZ5 – the downward vertical hydraulic gradient **decreased** slightly with a continued gradual pressure recovery in the Alcheringa Seam and pressure increase in the sandstone. Water levels in both units have increased slightly as a result of elevated rainfall in the reporting period.

NPZ7-2 – the downward vertical hydraulic gradient which started increasing in 2016 ceased in 2020 with the recharge to both units due to elevated rainfall in 2020. The hydraulic gradient has since been decreasing between the units as both experience groundwater recharge.

NPZ7-3 – the downward vertical hydraulic gradient which started increasing in 2016 ceased in 2020 with the recharge to both units due to elevated rainfall in 2020 and 2021. The gradient has decreased significantly since the start of 2021.

The vertical hydraulic gradients between the Alcheringa Seam and the underlying interburden sandstone are generally downward with the vertical head difference between these units ranging between 5 m and15 m. At NPZ3, there appears to be an upward vertical gradient, from the sandstone to the Alcheringa Seam, at with a head difference of approximately 2 m.

3.4.2 Shallow and Deep Coal Measures Connectivity

There has been little change in the downward vertical hydraulic gradient (~34m pressure difference) between the shallow coal measures at WBR50A and the Lower Whybrow Seam (WBR50), since depressurisation of the Whybrow Seam between 2008 and 2011. The hydraulic gradient decreased slightly (to 30 m pressure difference) over 2021.

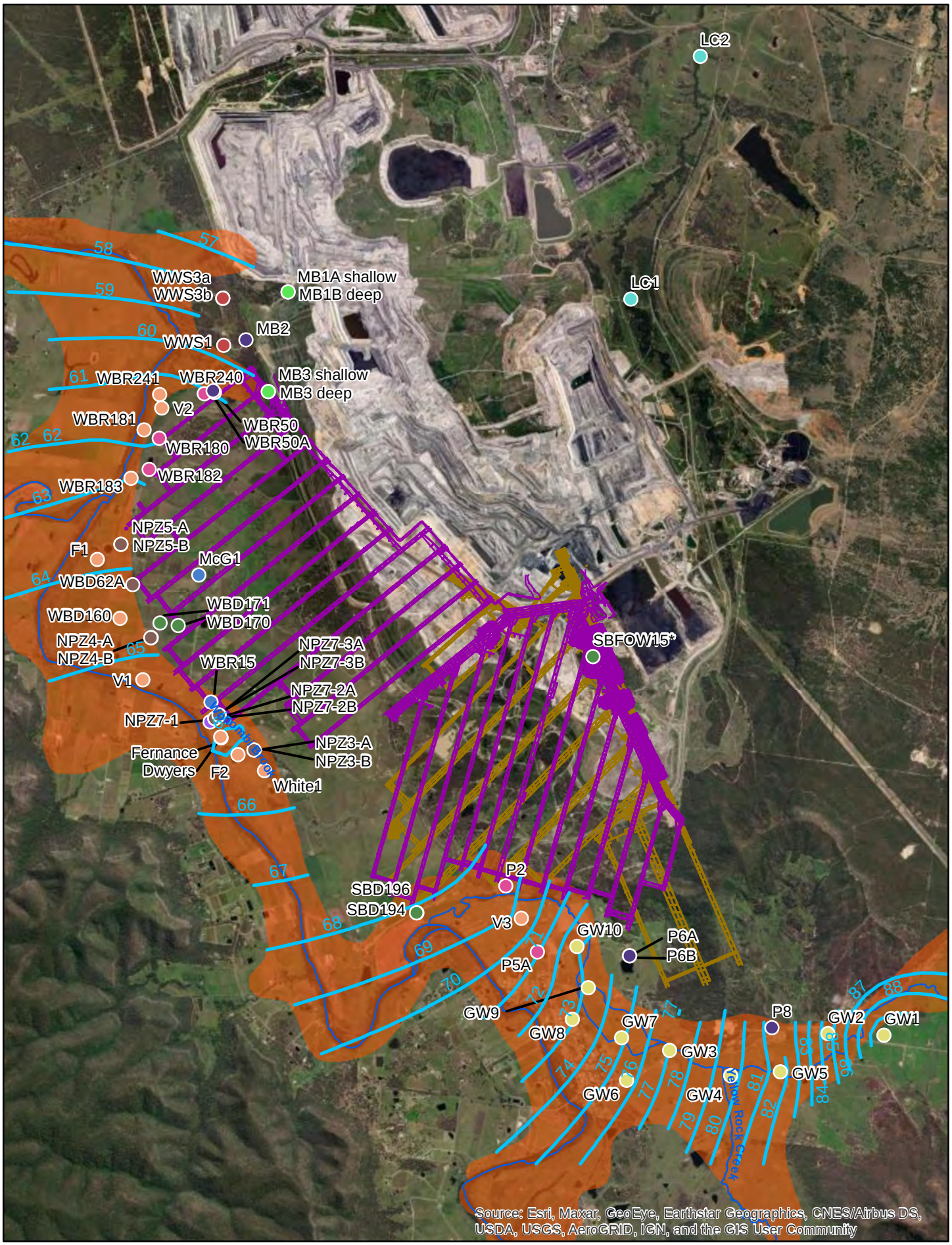
There is a downward vertical gradient (~74 m pressure difference) between the shallow coal measures (P6A) and the Lower Whybrow Seam (P6B), which started to develop in 2016 presumably due to the depressurisation of the Blakefield Seam at BFS to the north. The depressurisation appears to have stopped with little net change in the levels in P6B during 2021, aside from the recovery observed in 2020 that is likely due to the rainfall trends. Levels in P6A increased between December 2020 and February 2021, and have remained stable over 2021.

Based on the data collected, including the lack of significant response in the shallow coal measures during the initial depressurisation of the Whybrow Seam, there appears to be little evidence of significant hydraulic connection between these units at these two monitoring locations.

3.5 Groundwater Flow in Alluvium

Groundwater contours for the Wollombi Alluvium and Monkey Place Creek Alluvium, based on data for December 2021, are presented in Figure 3.1. Groundwater flow in alluvium is essentially parallel to the flow of the creek lines and generally in the direction to the west and then north-west along the body of alluvium. Groundwater levels have generally recovered compared to previous drought years. A groundwater depression is interpreted from the data in the vicinity of Dwyers monitoring bore west of Beltana, which is considered most likely due to local groundwater extraction from the alluvium for stock and domestic or irrigation purposes. The hydraulic gradient along the Monkey Place Creek alluvium is a steeper than that along the Wollombi Brook alluvium suggesting lower hydraulic conductivity or steeper topography.

Figure 3.1: Groundwater contours - Alluvium - December 2021



LEGEND

monitoring locations

Formation

- Alcheringa Seam
- Deep coal measures
- Interburden Sandstone
- Loders Creek Alluvium
- Monkey Place Creek alluvium
- Regolith /sill/ alluvium
- Shallow coal measures
- VWP
- Warkworth Sands
- Whybrow Seam
- Wollombi Alluvium
- Alluvium Groundwater contours Dec 21
- label lines
- Beltana_Underground_Workings
- Blakefield_South_Underground_Workings

Hydrology

- Watercourse

Geology

- Alluvium

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Kilometres

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4. Groundwater exceedances

Groundwater impact assessment criteria are outline in the Bulga Coal Water Management Plan [WMP] (Bulga, 2017 and Bulga 2021). Site-specific trigger values have been derived using water level and water quality data, including EC and pH in accordance with ANZECC (2000) guidelines. The trigger values are not assessment criteria but are used to initiate investigations into groundwater quality as reported by the monitoring program (Bulga, 2017).

The Bulga Coal WMP was revised, with the updated WMP coming into effect 15/10/2021. Groundwater assessment criteria are, therefore, compared against two sets of trigger values, described below.

Monitoring data exists for BCC since 1998 providing a dataset that is sufficiently long and of good quality to define site specific trigger levels. Trigger values for pH have been determined by using 80th and 20th percentile, while the trigger levels for EC are provided by calculating the 80th percentile, i.e. upper trigger level in accordance with the ANZECC (2000) guidelines and statistical analysis.

The baseline water level data was also analysed to derive trigger levels for the bores installed in the strata other than Permian coal measures such that they represent 5% reduction of saturated thickness, based on the minimum of the historical baseline monitoring. The confined Permian strata will be depressurised as a result of mining and therefore the trigger levels for those bores are not considered relevant.

4.1 Groundwater levels

Groundwater levels have been compared against impact assessment trigger values for piezometers in 2021. One piezometer groundwater level fell below established trigger values in 2021; WBR15 recorded a level of 61.07 mAHD, 1.09 m below the trigger value of 62.16 mAHD. Groundwater levels in the bore have been increasing since 2020, and continued to increase over the 2021 monitoring period. Groundwater levels in the bore closely reflect CRD trends since 2016, declining during the drought period and responding to rainfall since 2020. By the end of 2021, groundwater levels in the bore have recovered to pre-2016 to 2020 drought levels.

4.2 Groundwater electrical conductivity trigger exceedances

Groundwater electrical conductivity (EC) has been compared to two sets of trigger values, from the revised values effective from 15/10/2021 and the previous values effective up to that date (Bulga 2017, Bulga 2021).

Various EC exceedances of the assigned trigger values occurred between Jan 2021 and Dec 2021, with 18 bores recording EC higher than respective trigger values. Groundwater EC exceedances are summarised in

Table 4.1, and graphs for all bores and respective trigger levels are provided in Appendix B. the exceedances for Q3 were investigated and the results are summarised in Jacobs (2022) – refer Appendix C.

Broke Area alluvial bores generally remained within historical ranges for EC, and most bores recorded values below trigger criteria over the year, with the exception of V3 that remained above trigger values throughout the period. Bore V3 has remained consistent over the monitoring period, recorded the lowest EC values since 2017. Bore GW7 EC declined from 4480 µS/cm to 250 µS/cm in April, and subsequently increasing to above the trigger value at the end of 2021.

Northern Area Shallow alluvial bores showed varying EC trends over the year. Bore F1 EC fluctuated over the monitoring period, remaining above the trigger value and within historic ranges for the bore. Bore F2 EC dropped to below 200 µS/cm in April, far below the Q1 record of 1880 µS/cm. EC increased over the year, remaining below trigger values. Bore V1 recorded above the trigger value in February 2021, with subsequent samples falling below the trigger value for the rest of 2021, commensurate with CRD trends.

South Bulga/Broke Area Lower Whybrow Seam monitoring bore P6B exceeded the trigger values in all sampling events of 2021. The bore has remained stable since 2018, ranging between 6000 and 7000 µS/cm. EC in the bore dropped significantly in December 2021, recording a value of 1390 µS/cm.

Beltana Area Miscellaneous bore WBR15 recorded EC exceedances in all sampling events over the year. The bore has recorded values above the trigger since July 2018, and EC generally shows a delayed response to CRD; EC increased over the drought period ending in 2020, and has declined since mid-2020.

Beltana Area NPZ bores generally recorded declining or stable EC over the year. The bores are within historic ranges for EC.

Wollombi Alluvial and Shallow Coal Measure bores WBR182 and WBR183 recorded exceedances over the year. Wollombi alluvial bore WBR182 EC increased with a similar trend to groundwater levels in the bore and CRD, which both increased throughout the year. WBR183, while above assigned trigger values, remained within historic values for EC in 2021.

Table 4.1 Groundwater electrical conductivity exceedances (compared to Bulga 2017, Bulga 2020)

Bore ID	EC trigger values		Lab EC (µs/cm)					
Broke Area Alluvium	**EC trigger to 15/10/2021**	**EC trigger from 15/10/2021**	**Feb/Mar**	**Apr**	**Jun**	**Aug**	**Oct**	**Dec**
GW1	3244	3634	3740	-	-	3420	-	-
GW6	7830	7900	-	-	-	7900		
GW7	3786	3946	4480	-	-	-	-	4230
V3	1566	1744	1890	1920	1800	1920	1920	1920
Northern Area Shallow Alluvium								
F1	833	1025	1510	1050	1100	1460	1080	1390
F2	1676	1720	1880	-	-	-	-	-
V1	1560	1570	1620	-	-	-	-	-
South Bulga/Broke Area Lower Whybrow Seam								
P6B	1350	1353	6590	6700	6510	6510	6830	1460
Beltana Area Miscellaneous Bores and Wells								
WBR15	991	924	1500	1130	1040	1330	1150	1060
Beltana Area NPZ								
NPZ4-B	1248	1342	1310	-	1330	1350	-	-
NPZ5-A	894	886	900	-	913	924	910	-
NPZ5-B	2646	2760	2690	-	2730	2800	-	-
NPZ7-1	1240	1240	-	-	-	1300	1250	-
NPZ7-2B	1290	1307	1330	-	1340	1350	1330	1320
NPZ7-3A	2060	2540	2240	-	-	-	-	-
NPZ7-3B	1292	1316	-	-	-	1300	-	-
Wollombi Alluvium and Shallow Coal Measures								
WBR182	1473	1512	-	-	1570	1610	1540	1600
WBR183	3270	3484	3850	3510	3710	3890	3590	3660

4.3 Groundwater pH exceedances

Groundwater pH has been compared to two sets of trigger values, from the revised WMP values effective from 15/10/2021 and the previous trigger values effective until that date (Bulga 2017, Bulga 2021).

Trigger values for pH have been determined by using 80th and 20th percentile of previously recorded values and are summarised in the Bulga Coal WMP (Bulga 2017, Bulga 2021).

A total of 28 bores recorded values outside of respective groundwater pH trigger levels throughout the year. The exceedances are outlined in Table 4.2, and graphs showing pH trends are provided in Appendix B. Groundwater pH values generally remained stable over the year, showing no distinct trends between differing strata. Groundwater pH in all bores was recorded within acceptable ranges and close to trigger levels. Deviance from trigger range is attributed to natural variation in the bores.

Table 4.2 Groundwater pH exceedances (compared to WMP 2017, 2020)

Bore ID	pH Trigger Criteria				pH value					
	pH to Oct 2021, lower	pH to Oct 2021, higher	pH from Oct 2021, lower	pH from Oct 2021, higher	Feb/March	Apr	Jun	Aug	Oct	Dec
Broke Area Alluvium										
GW3	6.7	7.2	6.7	7.2	7.35	6.5	-	7.73	7.83	8.56
GW6	7.3	7.8	7.3	7.8	-	-	7.9	-	-	-
GW10	7.1	7.6	7.1	7.6	-	-	7.64	7.86	-	-
V3	7.1	7.7	7.1	7.6	6.82	7	6.9	-	-	-
Broke Area Wollombi Seam										
P2	7.6	8	7.4	8	7.37	7.3	7.27	7.51	-	-
P6A	6.9	8	7	8.1	-	-	-	8.08	-	-
Northern Area Shallow Alluvium										
F1	7.1	7.5	7.2	7.6	-		-	-	8.01	-
F2	7.1	7.4	7.1	7.4	-	6.75	-	7.56	-	-
WBR50A	7.2	7.7	7.1	7.7	7.75	6.45	-	-	7.76	7.89
V1	7.3	7.6	7.3	7.7	7.84	-	-	7.8	-	-
V2	6.5	7.1	6.4	7.1	6.34	6.12	-	-	6.18	-
South Bulga/Broke Area Lower Whybrow Seam										
P6B	6.6	7	6.7	7.3	8.18	8.16	8.21	8.29	8.33	7.85
P8	7.5	9.5	7.3	9.3	6.74	6.24	6.54	6.74	7.08	7.02
Northern Area Lower Whybrow Seam										
WBR50	6.7	8.2	6.7	8	-	6.19	-	-	6.52	-
Beltana Area Miscellaneous Bores and Wells										
Dwyers	7.2	7.7	7.3	7.6	7.77	7.76	7.88	-	7.78	7.71
Fernance	7.2	7.9	7.3	8	8.01	-	8.03	8.11	-	-
McG1	7.5	8	7.5	8	-	7.21	-	-	-	-
White1	7	7.4	7	7.4	-	-	7.51	7.68	7.52	7.64
Beltana Area NPZ										
NPZ3-B	7.3	7.5	7.3	7.5	7.82		7.03	-	7.58	-
NPZ4-A	7	7.3	6.9	7.3	-	6.85	6.88	-	-	-
NPZ4-B	7	7.7	7.3	7.8	7.84	-	-	7.76	-	-
NPZ7-1	6.84	7.7	6.7	7.7	7.72	-	-		-	-
NPZ7-2B	7.1	8	6.8	7.8	-	-	-		7.88	7.93
NPZ7-3A	7.2	7.6	7	7.5	7	7.01	-	-	-	-

Bore ID	pH Trigger Criteria				pH value					
NPZ7-3B	7.4	7.8	7.4	7.8	-	7.02	-	-	-	-
Wollombi Alluvium and Shallow Coal Measures										
WBR181	7.3	7.6	7.2	7.5	-	7.27	7.24	-	-	7.11
WBR182	7.9	8.51	7.3	8.3	-	7.13	7.12	7.3	7.2	7.25
WBR241	6.5	8	6.4	6.9	-	6.15	-	-	-	-

Notes: Refers to pH values below assigned trigger
Refers to pH values above assigned trigger

5. Groundwater Chemistry

Groundwater quality sampling and analysis is undertaken on a six-monthly basis, while field water quality data (electrical conductivity (EC) and pH) is collected every 2 months from all monitoring bores. EC data has been used as an early indicator of water chemistry change in selected Wollombi Creek and Monkey Place Creek alluvial bores and to assist interpretation of the groundwater system changes, plotted EC data is presented in Appendix A and Appendix B.

Major ion chemistry data for groundwater samples from bores screened in alluvium, coal seams and sandstone/regolith, collected in June 2021 and December 2021, shown in Figure 5.1 and Figure 5.2. Piper plots present the relative concentrations (as milliequivalents per litre) of common ions in water samples and group samples by their major ion chemistry into facies. The results of the Piper plot analysis are summarised as follows:

- The alluvium water samples plot as having predominantly sodium-chloride water types. Several alluvial water samples plot as mixed type, and some plotted as magnesium bicarbonate type. This indicates that the groundwater is close to the recharge source and the water is most likely recharge from rainfall.
- The water samples from bores targeting the coal seam units plot as a wide range of water types, from sodium-chloride water type to sodium-bicarbonate, mixed type and magnesium bicarbonate water type. This indicates that recharge sources are varied and likely dependent on the depth of the bore and the geology.
- The water samples from bores targeting the sandstone units plot as having predominantly sodium-bicarbonate water type, with one bore classified as sodium-chloride water type and two classified as mixed type in December 2021. The sodium-bicarbonate water type indicated that the sandstone units are not recharged directly from rainfall, and potentially the alluvium. The recharge likely is stored in another HSU prior to transmission to the sandstone units.
- Water chemistry types remain similar between June and December 2021 sampling results, and likewise correspond to results from groundwater bores in 2020.

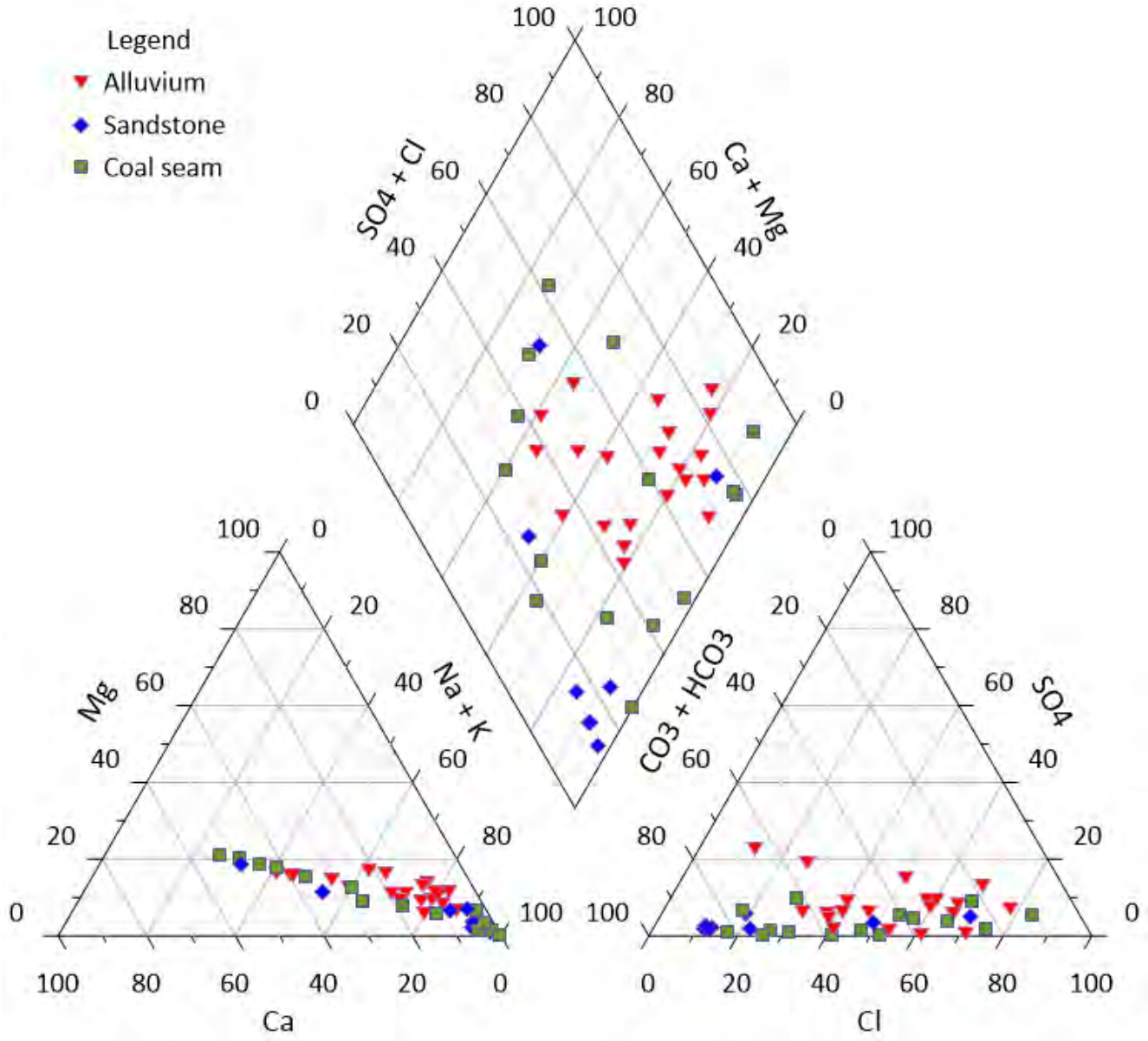


Figure 5.1 Piper plot comparison of major ion groundwater chemistry for the alluvium, coal seams and sandstone interburden (samples collected June 2021)

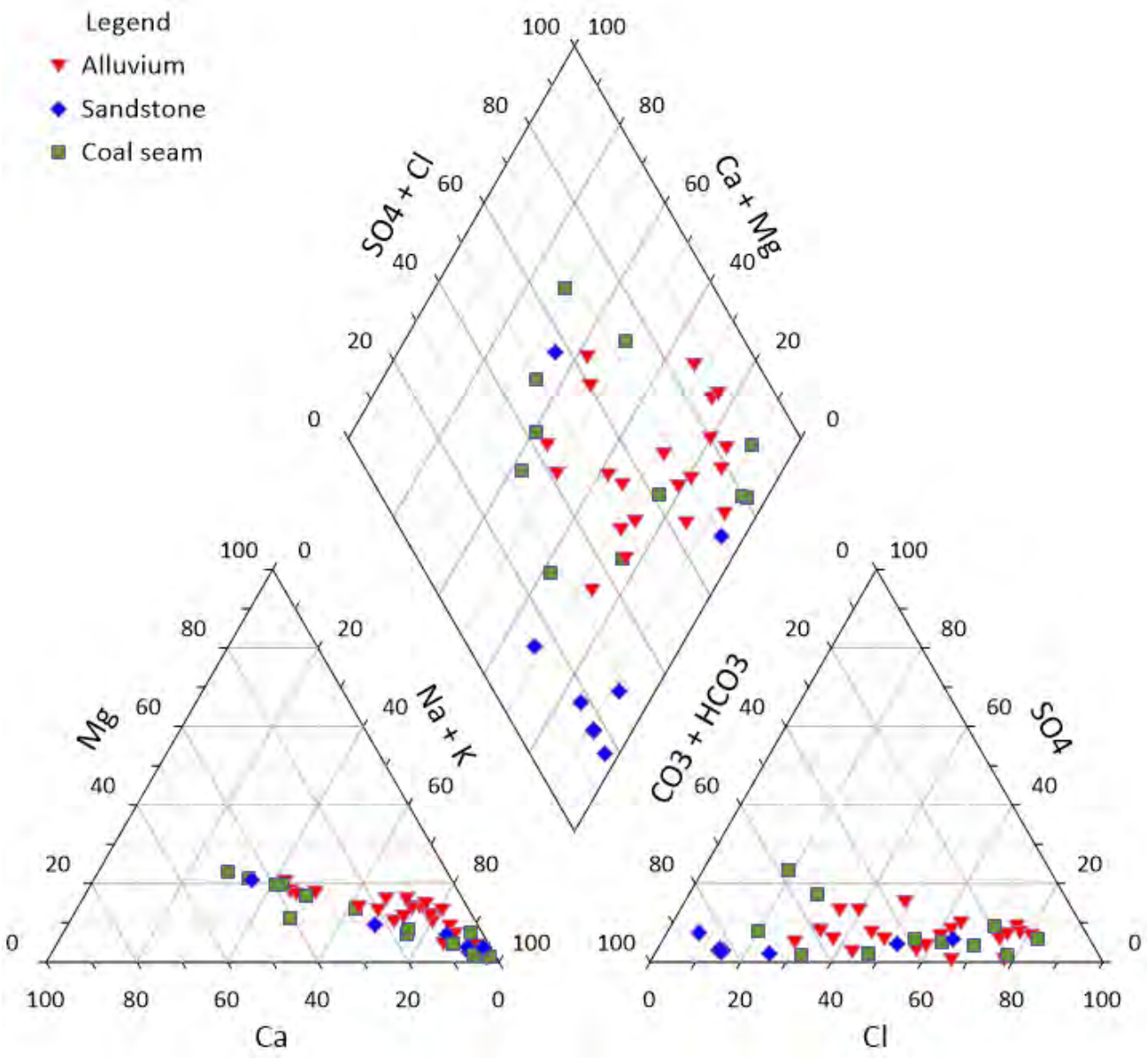


Figure 5.2 Piper plot comparison of major ion groundwater chemistry for the alluvium, coal seams and sandstone interburden (samples collected December 2021)

6. Summary and Conclusions

This groundwater report documents groundwater conditions during 2021. The potential impact on groundwater levels and quality has been assessed. The study found the following:

- The groundwater monitoring network covers the area along the Wollombi Brook and Monkey Place Creek to the west, south and north. The current groundwater monitoring network is comprehensive and includes 50 monitoring locations in the alluvium, overburden strata (sandstone and coal seams), Whybrow Seam, Blakefield Seam and underlying and overlying strata;
- In June 2021, five shallow monitoring bores were installed to monitor the Warkworth Sands. Bore depths range from 1.4 m to 2.6 m, and all bores were dry when constructed. Groundwater levels and quality have been recorded in several bores since installation.
- Overburden pressures in the top 50 m to 100 m from surface have recorded generally increasing groundwater levels in 2021. Recovery observed in various bores is likely related to the increasing rainfall between 2020 through 2021.
- Groundwater levels in SBD196 (Blakefield Seam) have recovered over the monitoring period, returning to near-2015 pressures. Re-pressurisation in the Alcheringa Seam is observed through hydrographs for numerous bores monitoring the seam. Groundwater levels in most monitoring bores targeting the Alcheringa Seam increased significantly over the period. The majority of recovery in the seam has occurred since the start of 2020 and is related to the cessation of extraction in 2018 and prevailing climatic conditions since 2020.
- Shallow groundwater levels in the alluvium (Wollombi Creek and Monkey Place Creek) increased over the period, generally recovering to pre-2016 to 2019 drought conditions. Rainfall is the major influence on alluvium groundwater levels with no apparent influence from mining operations.
- Groundwater quality (EC and pH) trigger values were exceeded for several monitoring bores over the monitoring period. While the trigger values are not assessment criteria, exceedances are used to initiate investigations into groundwater quality. Groundwater pH exceedances were within ranges of natural variation, and do not show impacts attributable to Bulga Coal over the period.
- A review of groundwater quality exceedances in nine bores was undertaken in Q3 2021 (Jacobs, 2022), concluding that "long-term trends for Bulga groundwater monitoring bores reflect the drought conditions from 2017 to 2019; bores recorded increasing EC over the period of drought, and EC has remained generally stable since the end of drought conditions in early-2020. This trend is similarly reflected in groundwater level and recharge trends over the period, with groundwater levels increasing throughout 2020 and 2021. Long-term groundwater EC exceedances are likely linked to regional climatic conditions and do not show distinct impacts attributable to mining activities at Bulga Coal" (Jacobs, 2022).
- The major ion chemistry for groundwater samples collected in June and December 2021 are similar to the December 2020 data. The alluvium and sandstone water samples typically plot as different water types, with some minor over-lap, indicating different recharge mechanisms and residence times. The water type interpretation indicates that the alluvium and coal seam water samples may predominantly receive recharge directly or indirectly from rainfall and/or have shorter transmission times from the recharge point.

7. Recommendations

The following recommendations are based on the outcomes of this report:

- Groundwater levels in P6B should be compared to Q1 2022 readings to determine if the December 2021 water levels recorded an erroneous reading.
- The automated water level datalogger in bore NPZ7-3A showed errors in the data in 2021, and calibration of the logger may be required.

8. References

(Bulga, 2017). Bulga Mine Water Management Plan (Effective: 22/02/2017).

(Bulga 2021). Bulga Mine Water Management Plan (Effective: 15/10/2021).

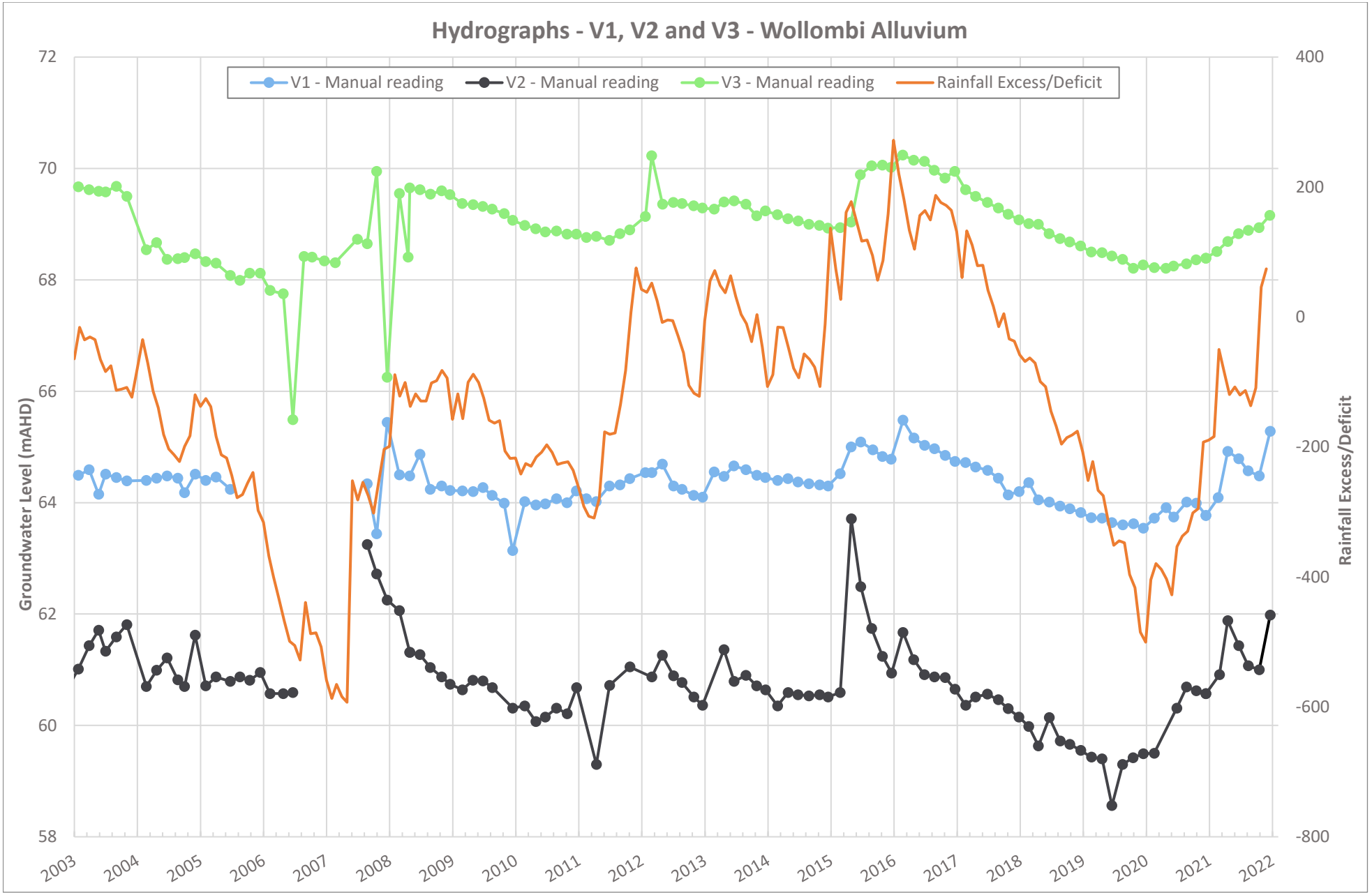
David, K. March 2019. Annual Groundwater Report for Blakefield South [2018], for Bulga Underground Operation Pty Ltd. Report KD2018/11 March 2019.

Ferdowsian, R., Pannell, D.J., McCarron, C., Ryder, A.T., Crossing, L. 2001. Explaining Groundwater Hydrographs: Separating Atypical Rainfall Events from Time Trends. AJSR vol. 39, 4.

Jacobs, 2022. Review of Q3 2021 Groundwater EC Trigger Exceedances. Memo report dated 31 January 2022.

Mackie Environmental Research 2013. Assessment of groundwater related impacts arising from the proposed Bulga optimisation project, Appendix 11 of the EIS, report prepared for Bulga Coal Management.

Appendix A. Groundwater hydrographs


Hydrographs - V1, V2 and V3 - Wollombi Alluvium
V1 - Manual reading
V2 - Manual reading
V3 - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit
72
70
68
66
64
62
60
58
400
200
0
-200
-400
-600
-800
2003
2004
2005
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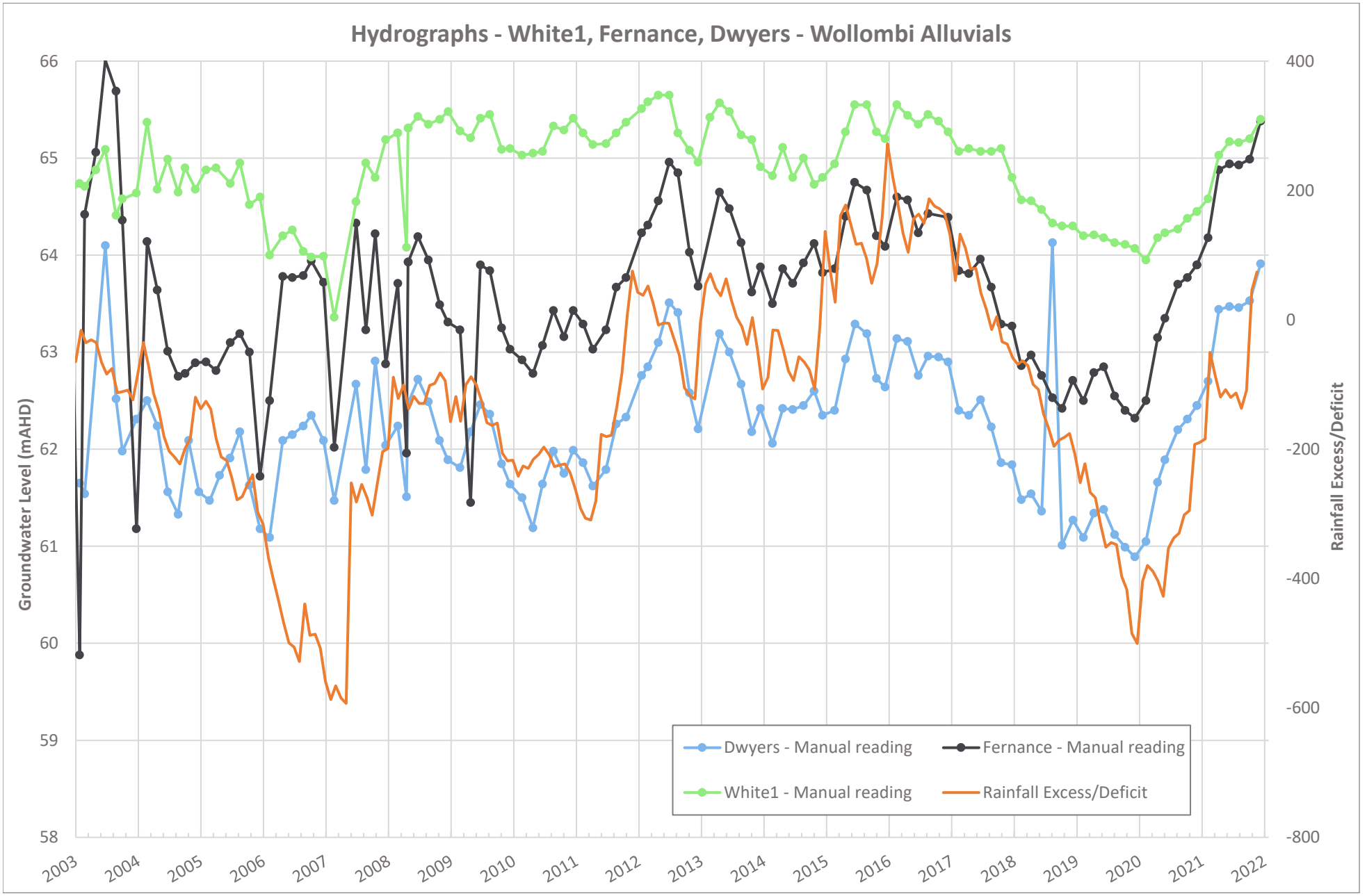
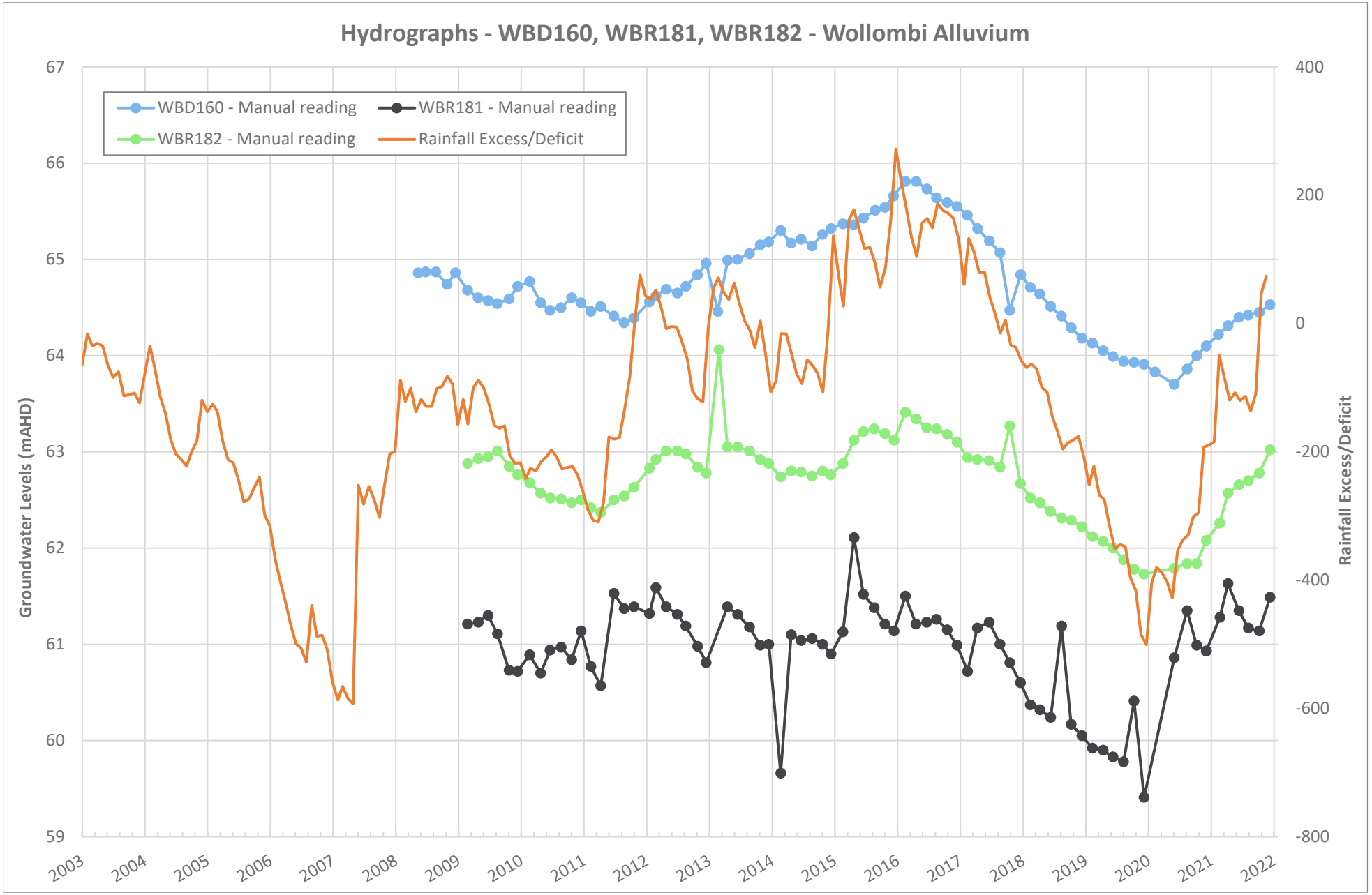
2019
2020
2021
2022


Hydrographs - White1, Fernance, Dwyers - Wollombi Alluvials
Groundwater Level (mAHD)
Rainfall Excess/Deficit
66
65
64
63
62
61
60
59
58
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Dwyers - Manual reading
Fernance - Manual reading
White1 - Manual reading
Rainfall Excess/Deficit


Hydrographs - WBD160, WBR181, WBR182 - Wollombi Alluvium
WBD160 - Manual reading
WBR181 - Manual reading
WBR182 - Manual reading
Rainfall Excess/Deficit
Groundwater Levels (mAHD)
Rainfall Excess/Deficit
67
66
65
64
63
62
61
60
59
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
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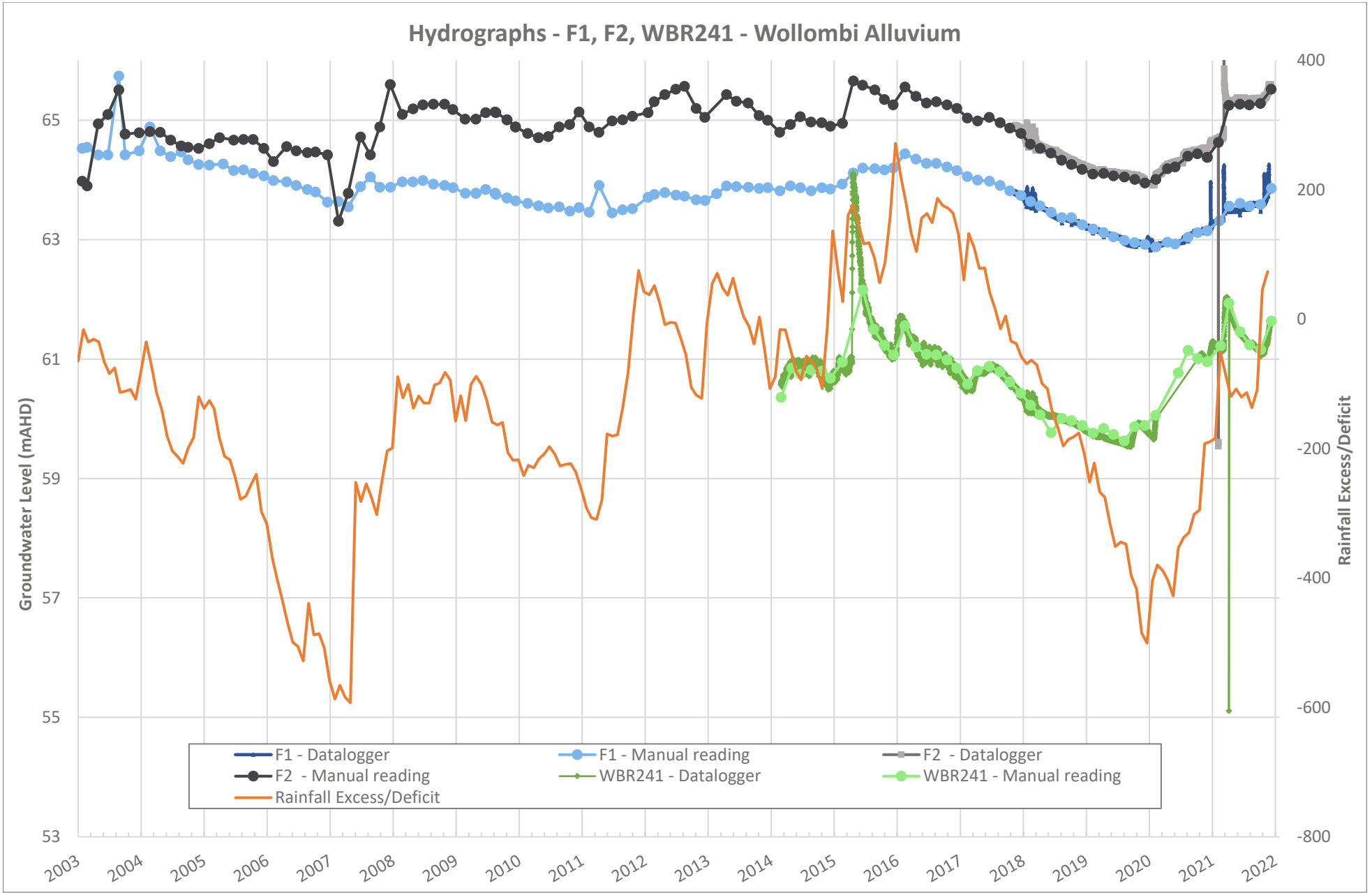
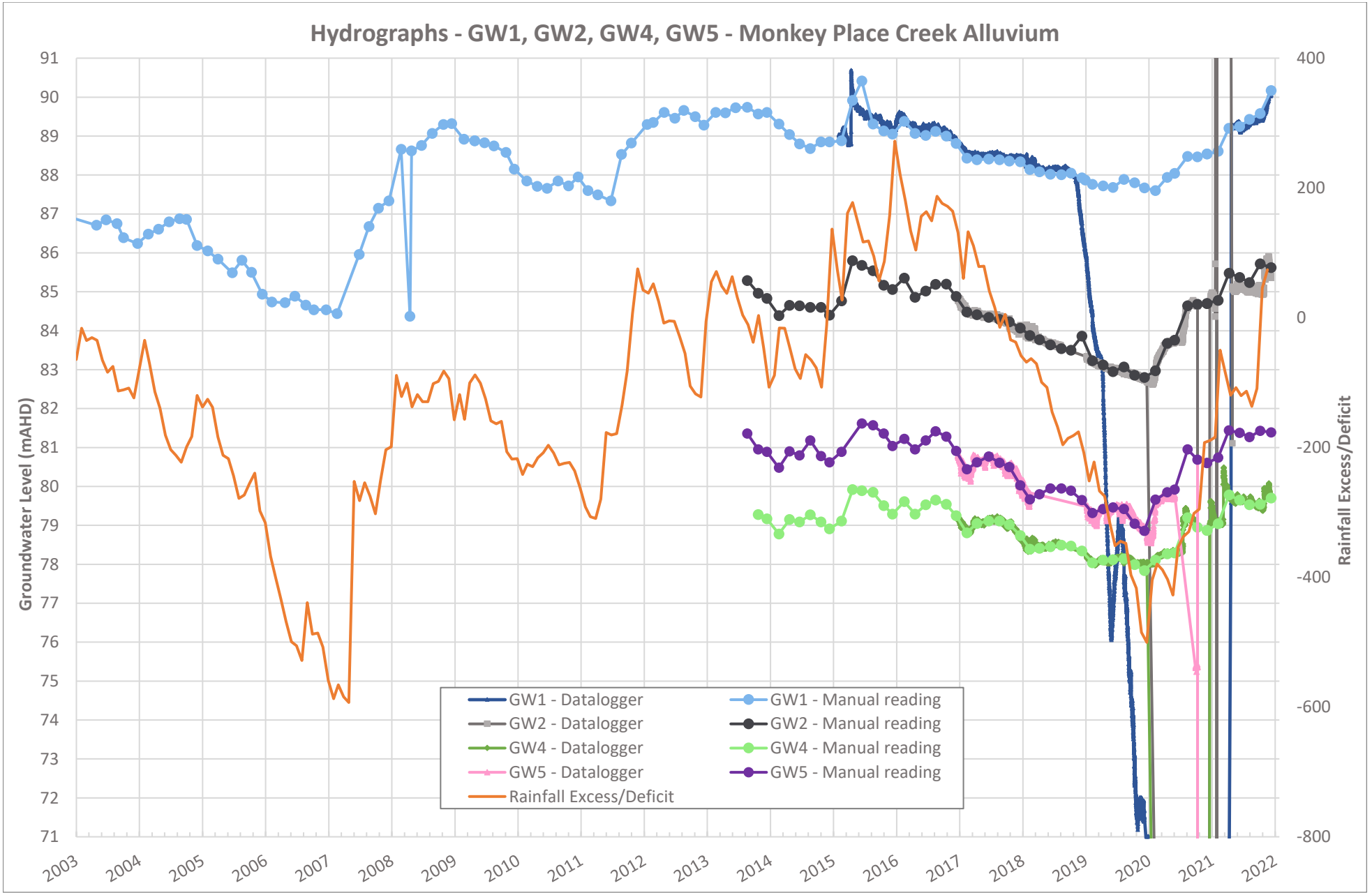
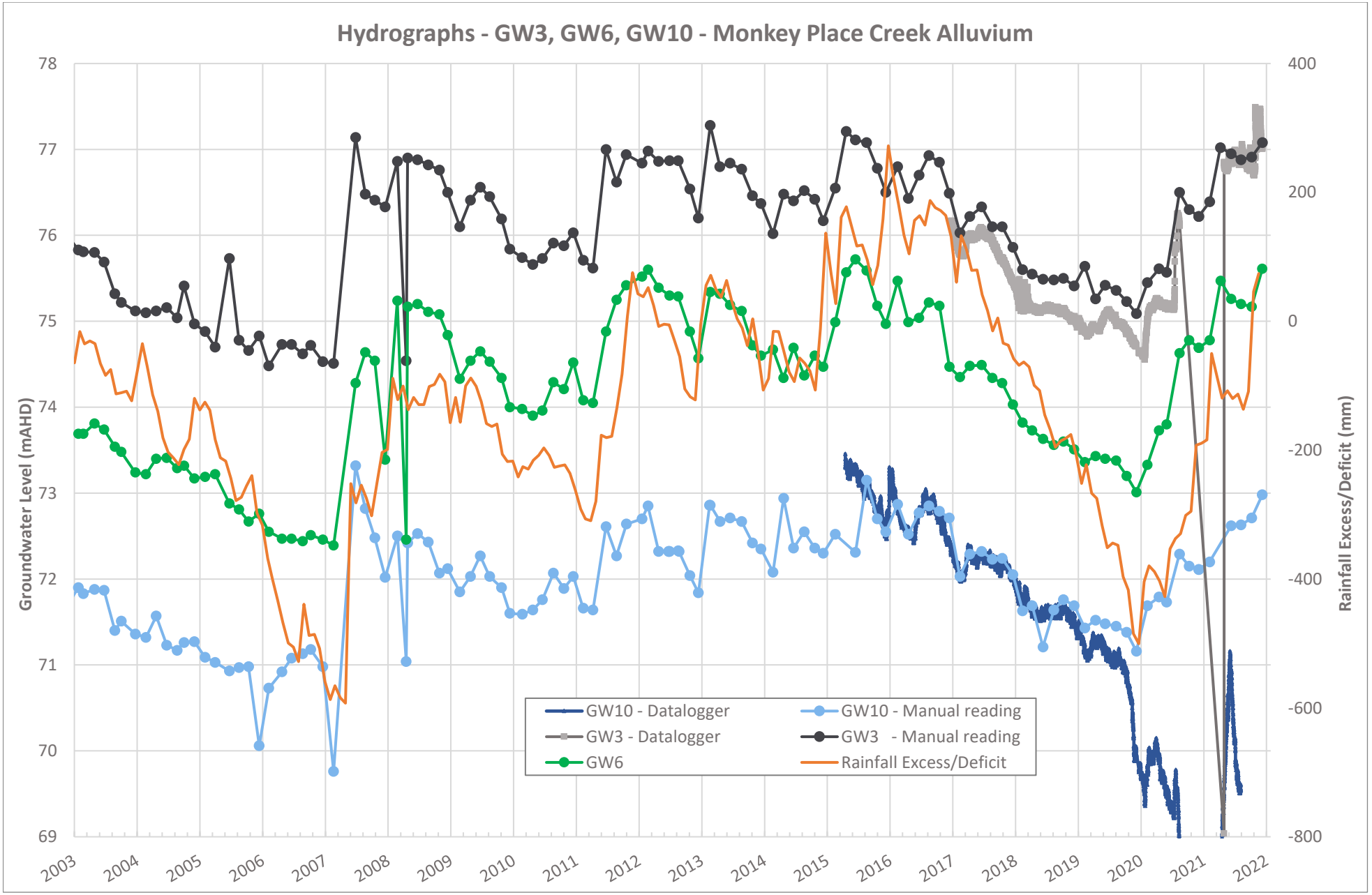
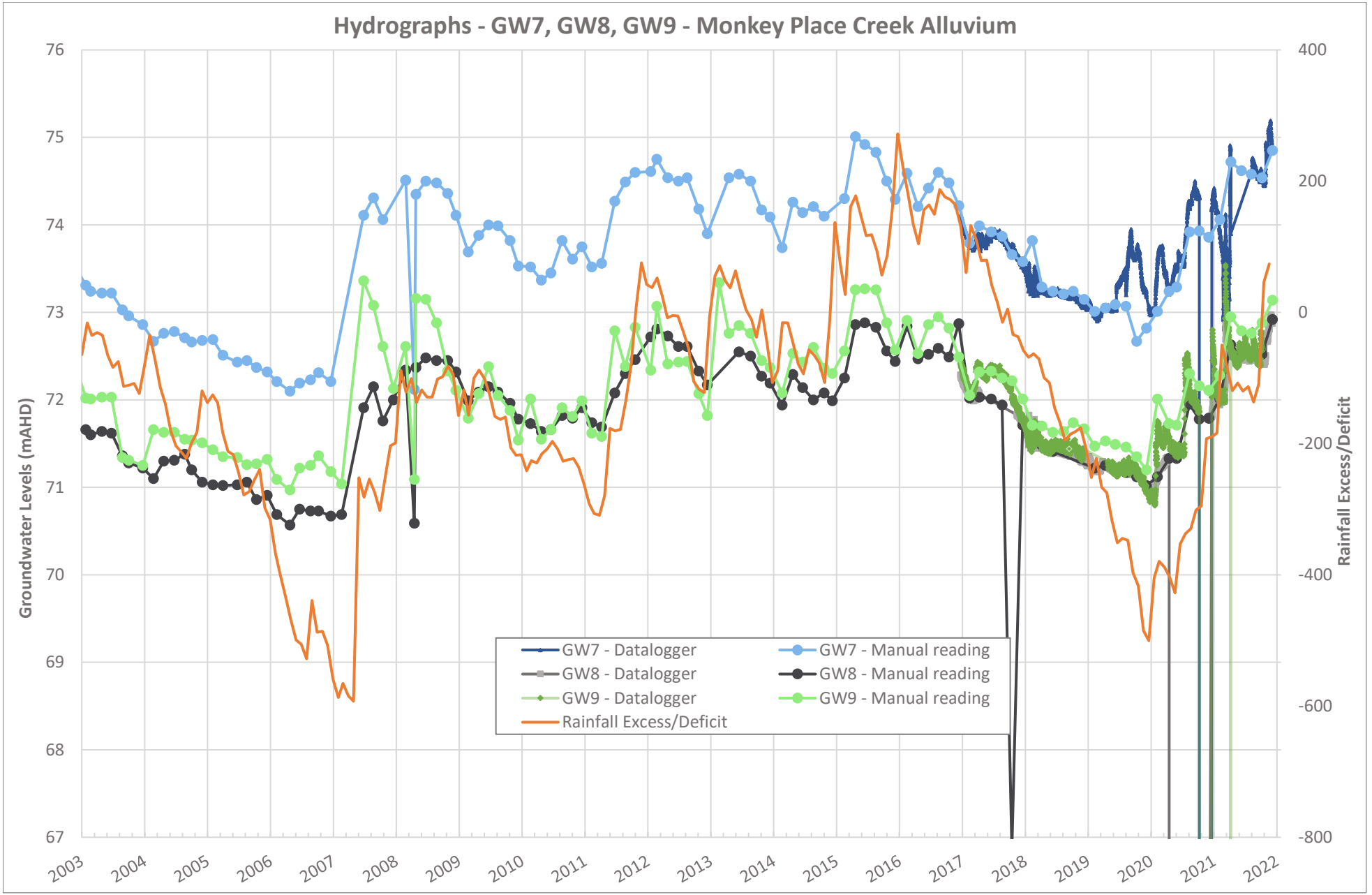
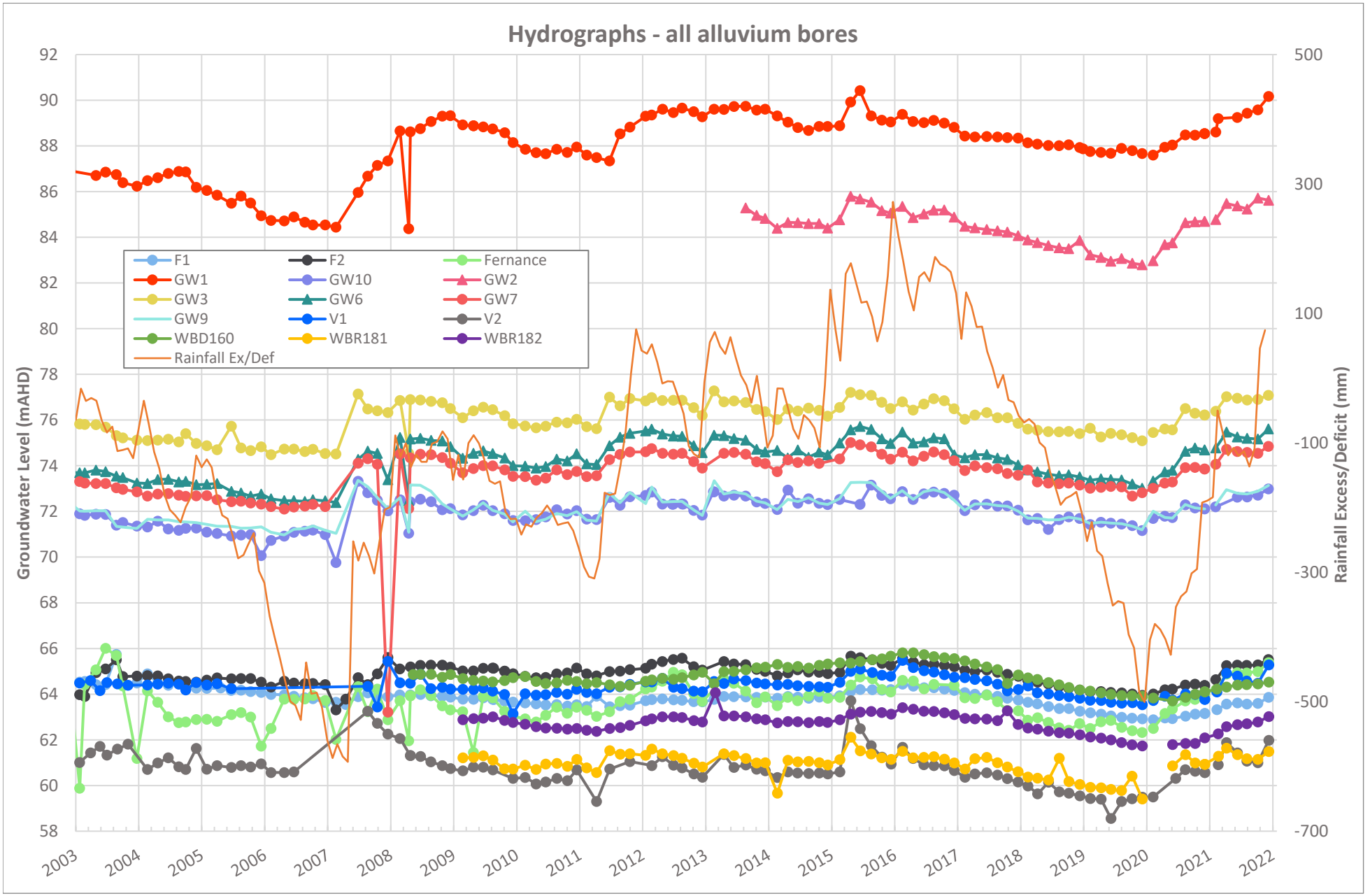
2016
2017
2018
2019
2020
2021
2022

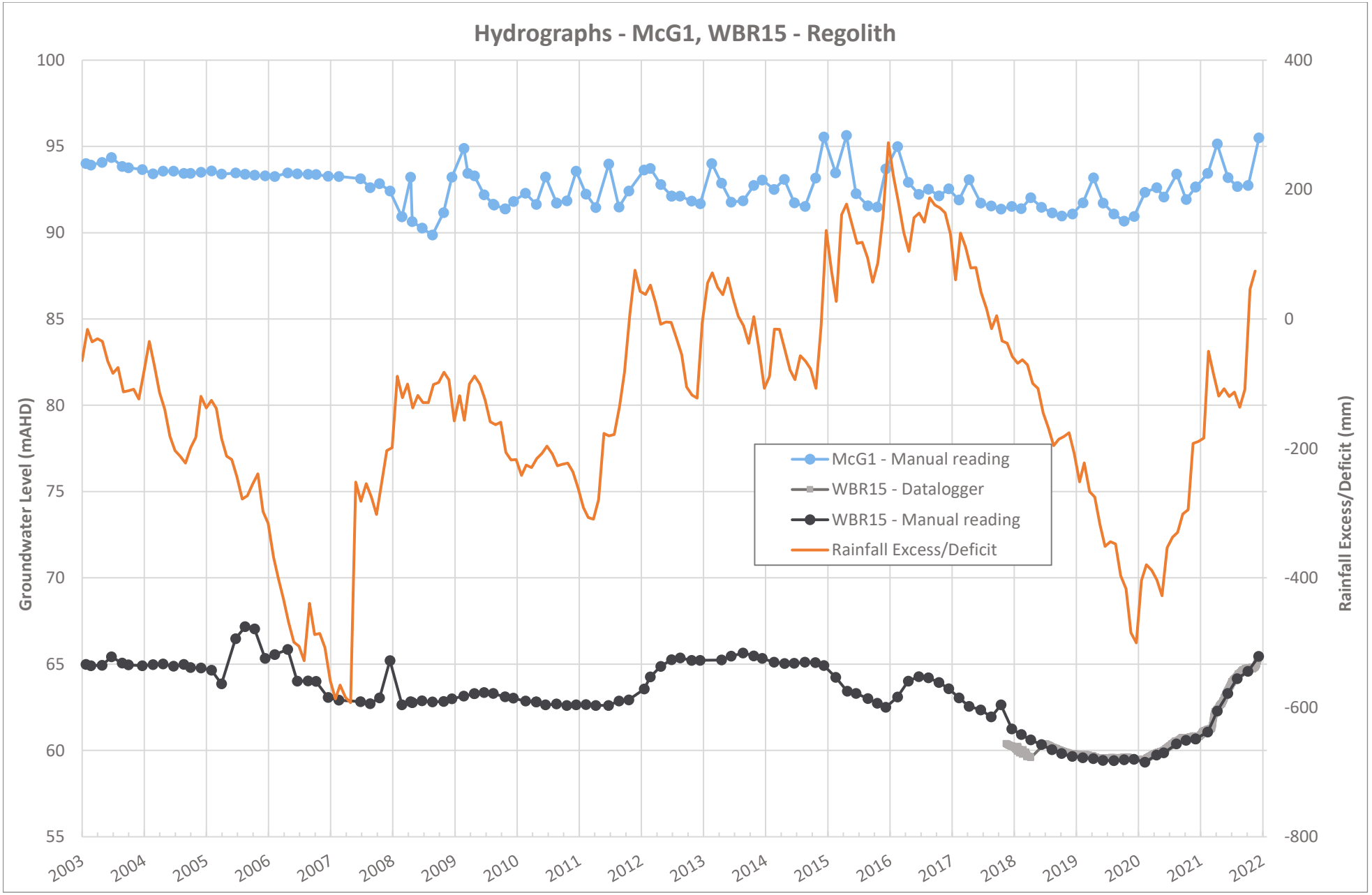

Hydrographs - F1, F2, WBR241 - Wollombi Alluvium
Groundwater Level (mAHD)
Rainfall Excess/Deficit
65
63
61
59
57
55
53
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
F1 - Datalogger
F1 - Manual reading
F2 - Datalogger
F2 - Manual reading
WBR241 - Datalogger
WBR241 - Manual reading
Rainfall Excess/Deficit

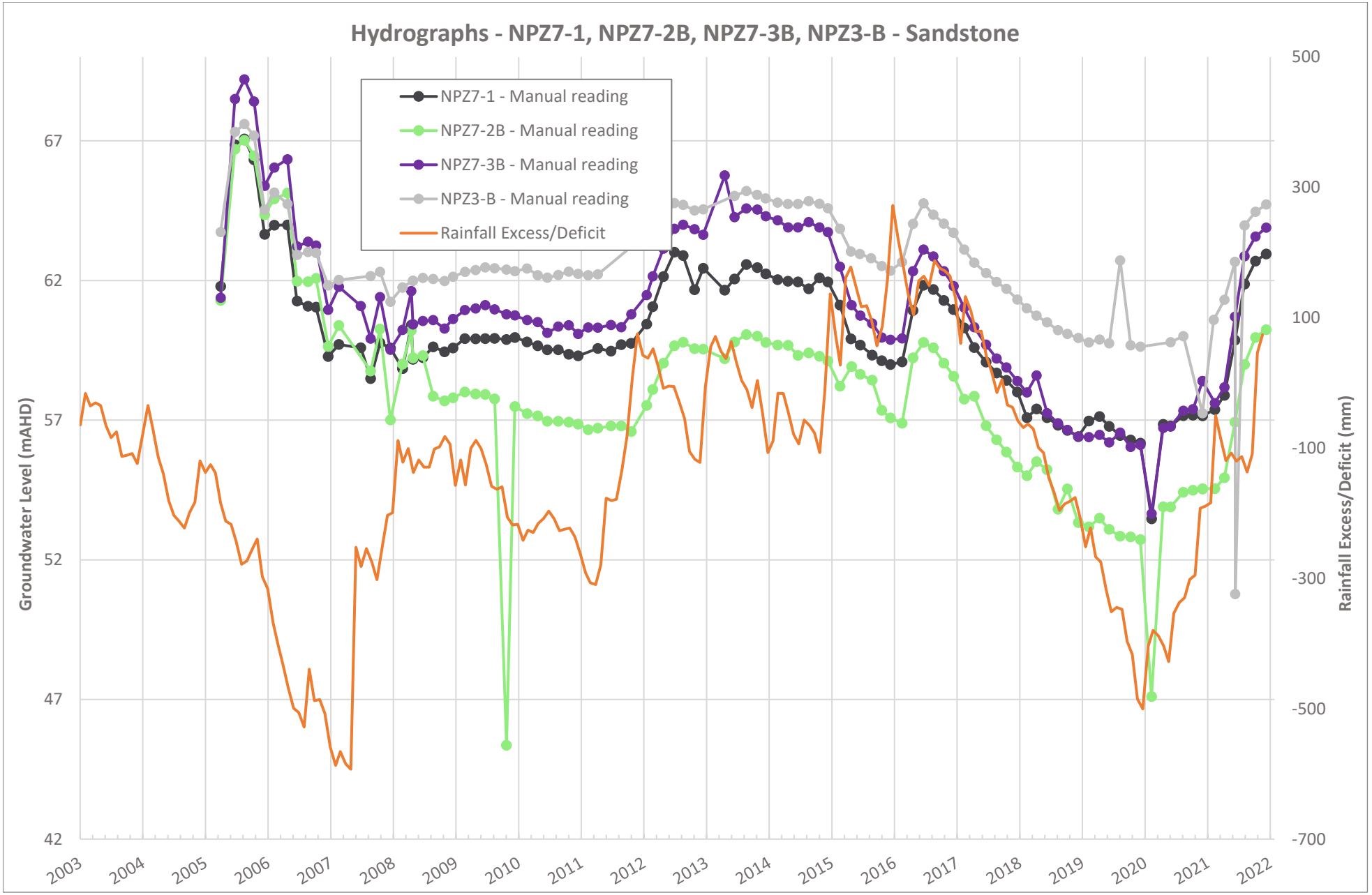

Hydrographs - GW1, GW2, GW4, GW5 - Monkey Place Creek Alluvium
Groundwater Level (mAHD)
Rainfall Excess/Deficit
91
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
GW1 - Datalogger
GW2 - Datalogger
GW4 - Datalogger
GW5 - Datalogger
Rainfall Excess/Deficit
GW1 - Manual reading
GW2 - Manual reading
GW4 - Manual reading
GW5 - Manual reading


Hydrographs - GW3, GW6, GW10 - Monkey Place Creek Alluvium
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
78
77
76
75
74
73
72
71
70
69
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
GW10 - Datalogger
GW10 - Manual reading
GW3 - Datalogger
GW3 - Manual reading
GW6
Rainfall Excess/Deficit


Hydrographs - GW7, GW8, GW9 - Monkey Place Creek Alluvium
Groundwater Levels (mAHD)
Rainfall Excess/Deficit
76
75
74
73
72
71
70
69
68
67
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
GW7 - Datalogger
GW7 - Manual reading
GW8 - Datalogger
GW8 - Manual reading
GW9 - Datalogger
GW9 - Manual reading
Rainfall Excess/Deficit


Hydrographs - all alluvium bores
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
500
300
100
-100
-300
-500
-700
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
F1
F2
Fernance
GW1
GW10
GW2
GW3
GW6
GW7
GW9
V1
V2
WBD160
WBR181
WBR182
Rainfall Ex/Def


Hydrographs - McG1, WBR15 - Regolith
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
100
95
90
85
80
75
70
65
60
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
McG1 - Manual reading
WBR15 - Datalogger
WBR15 - Manual reading
Rainfall Excess/Deficit


Hydrographs - NPZ7-1, NPZ7-2B, NPZ7-3B, NPZ3-B - Sandstone
NPZ7-1 - Manual reading
NPZ7-2B - Manual reading
NPZ7-3B - Manual reading
NPZ3-B - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
67
62
57
52
47
42
500
300
100
-100
-300
-500
-700
2003
2004
2005
2006
2007
2008
2009
2010
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2012
2013
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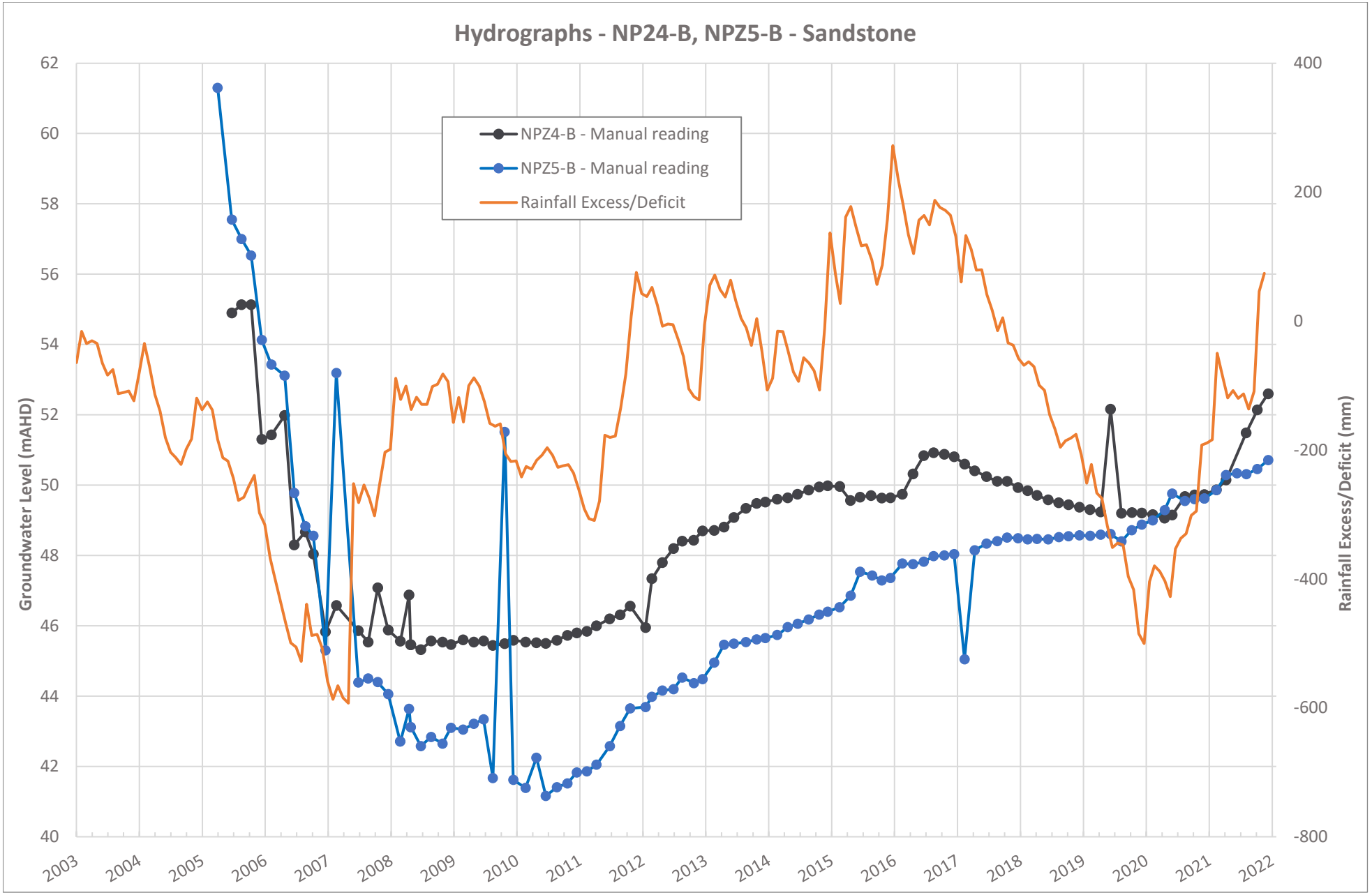
2015
2016
2017
2018
2019
2020
2021
2022


Hydrographs - NP24-B, NPZ5-B - Sandstone
NPZ4-B - Manual reading
NPZ5-B - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
62
60
58
56
54
52
50
48
46
44
42
40
400
200
0
-200
-400
-600
-800
2003
2004
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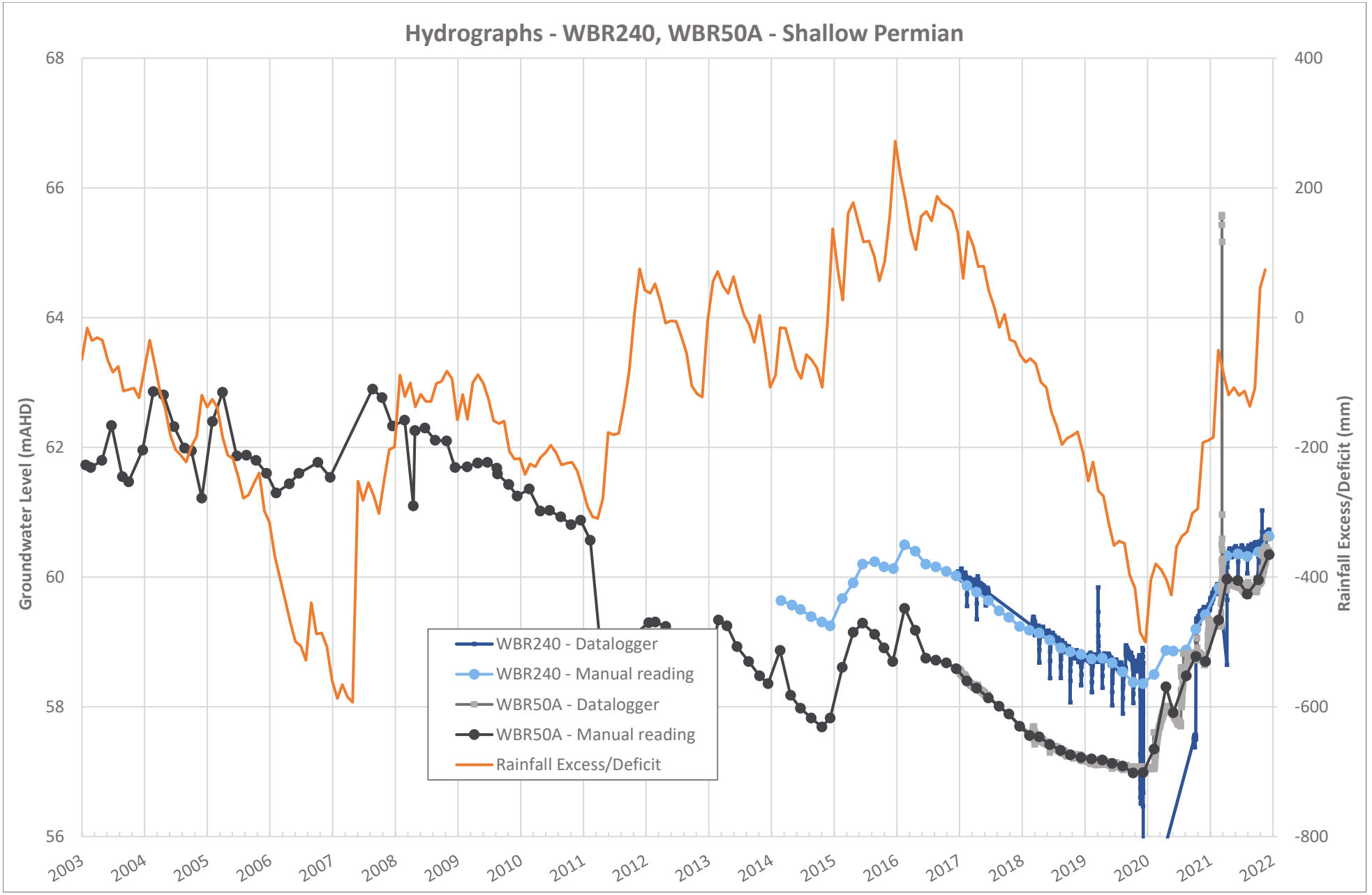
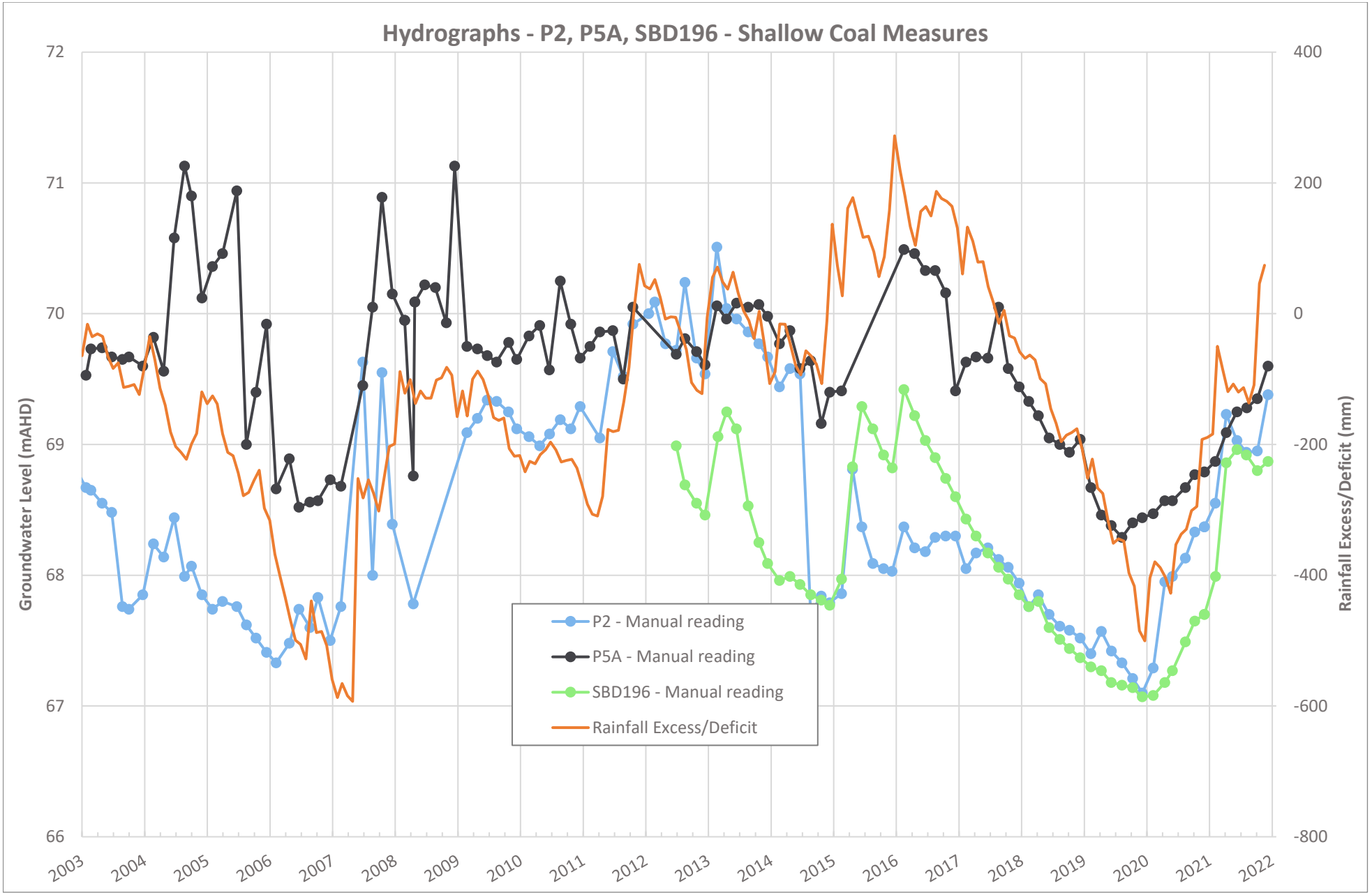
2020
2021
2022


Hydrographs - WBR240, WBR50A - Shallow Permian
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
68
66
64
62
60
58
56
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
WBR240 - Datalogger
WBR240 - Manual reading
WBR50A - Datalogger
WBR50A - Manual reading
Rainfall Excess/Deficit


Hydrographs - P2, P5A, SBD196 - Shallow Coal Measures
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
72
71
70
69
68
67
66
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
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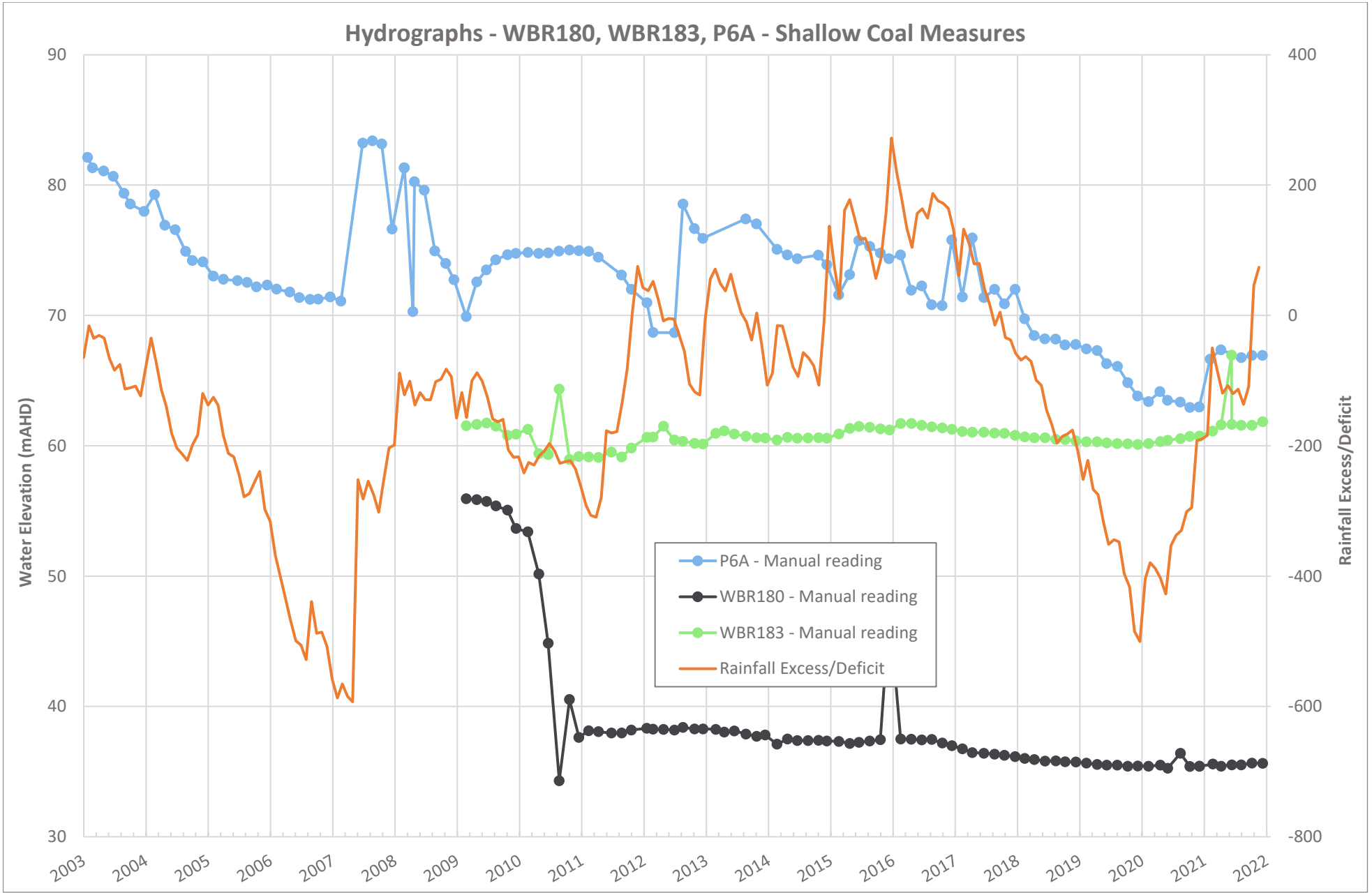
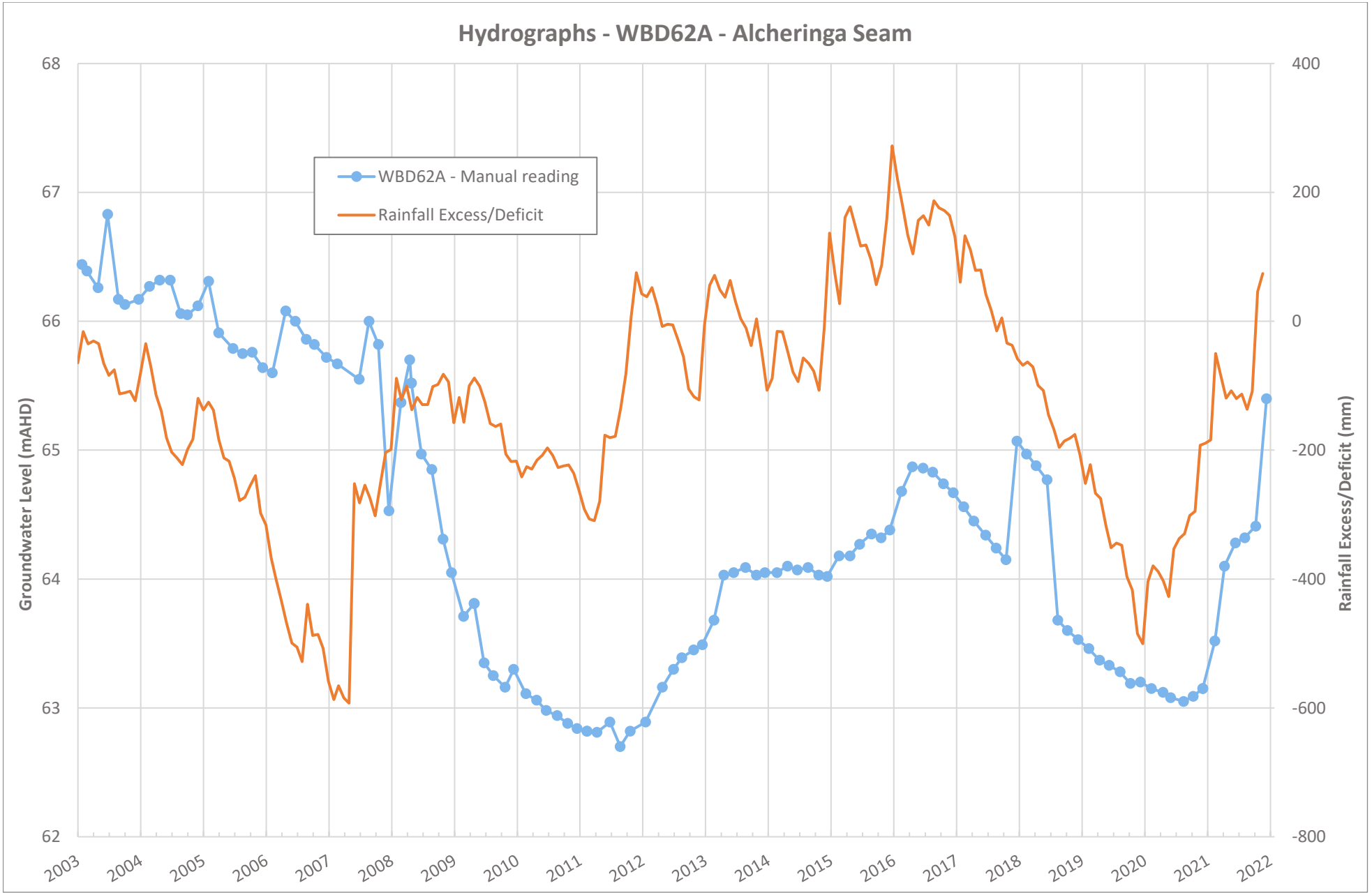
2016
2017
2018
2019
2020
2021
2022
P2 - Manual reading
P5A - Manual reading
SBD196 - Manual reading
Rainfall Excess/Deficit


Hydrographs - WBR180, WBR183, P6A - Shallow Coal Measures
Water Elevation (mAHD)
Rainfall Excess/Deficit
90
80
70
60
50
40
30
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
P6A - Manual reading
WBR180 - Manual reading
WBR183 - Manual reading
Rainfall Excess/Deficit


Hydrographs - WBD62A - Alcheringa Seam
WBD62A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
68
67
66
65
64
63
62
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
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2011
2012
2013
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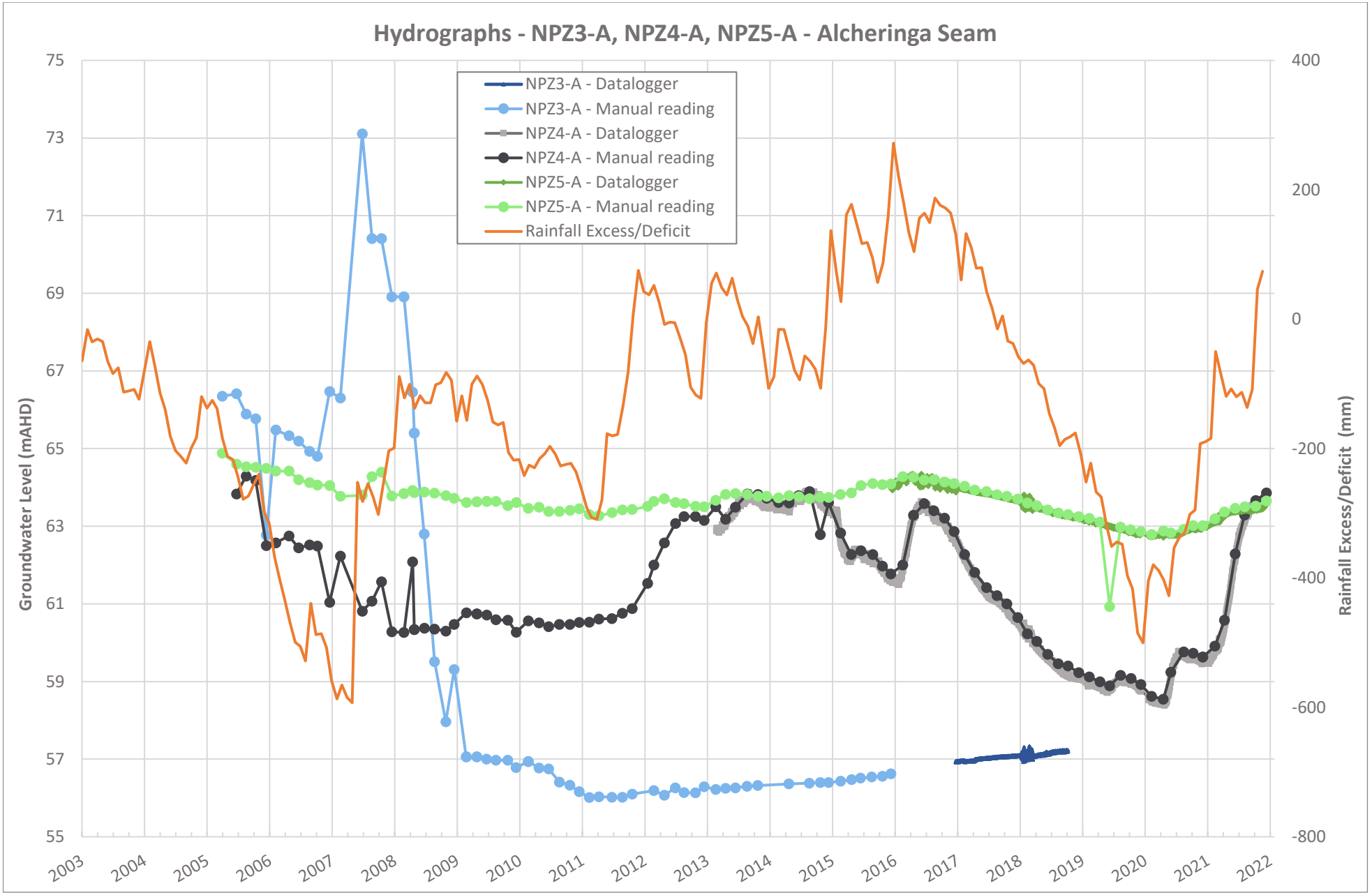
2015
2016
2017
2018
2019
2020
2021
2022


Hydrographs - NPZ3-A, NPZ4-A, NPZ5-A - Alcheringa Seam
NPZ3-A - Datalogger
NPZ3-A - Manual reading
NPZ4-A - Datalogger
NPZ4-A - Manual reading
NPZ5-A - Datalogger
NPZ5-A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
75
73
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
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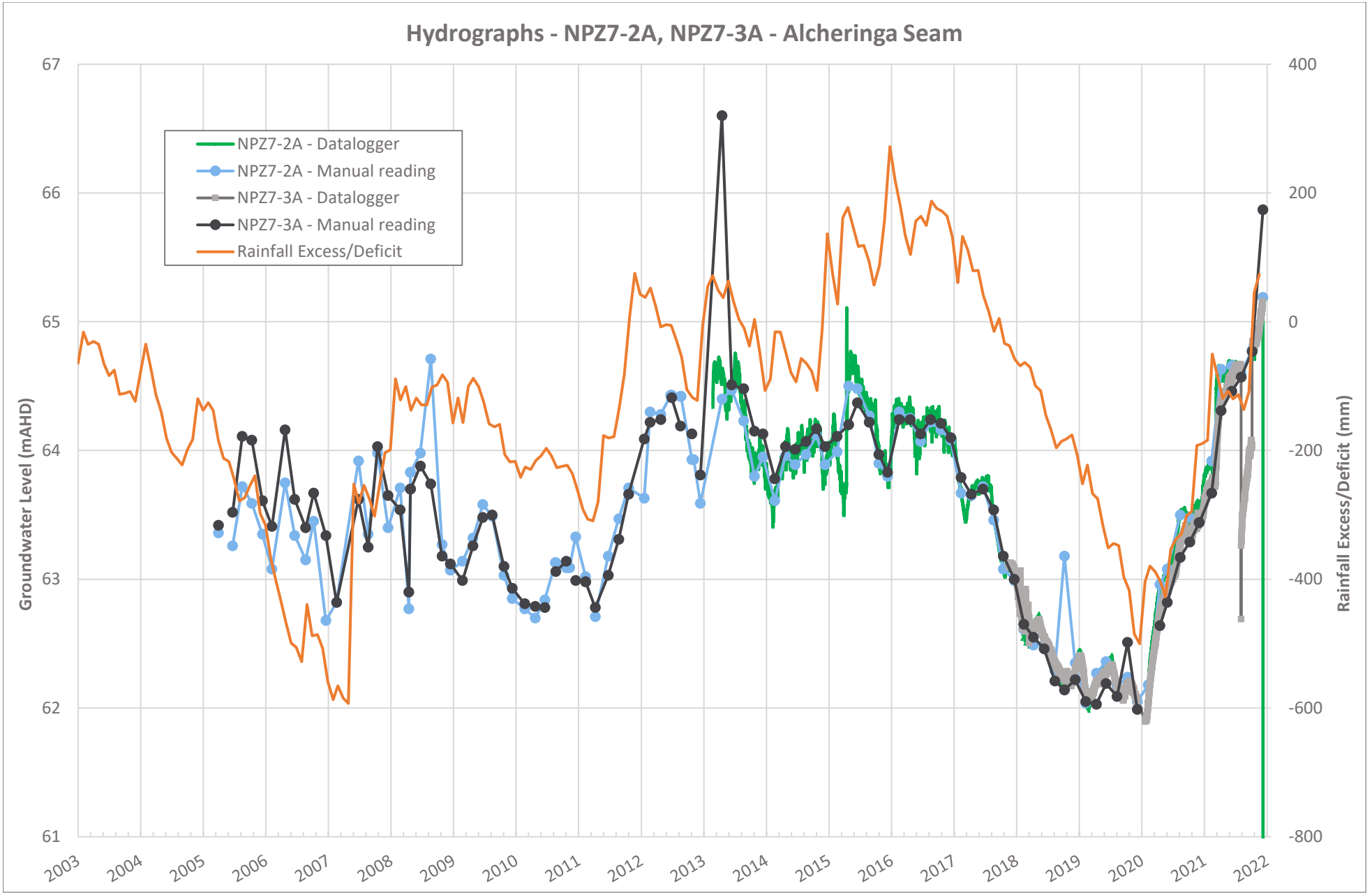
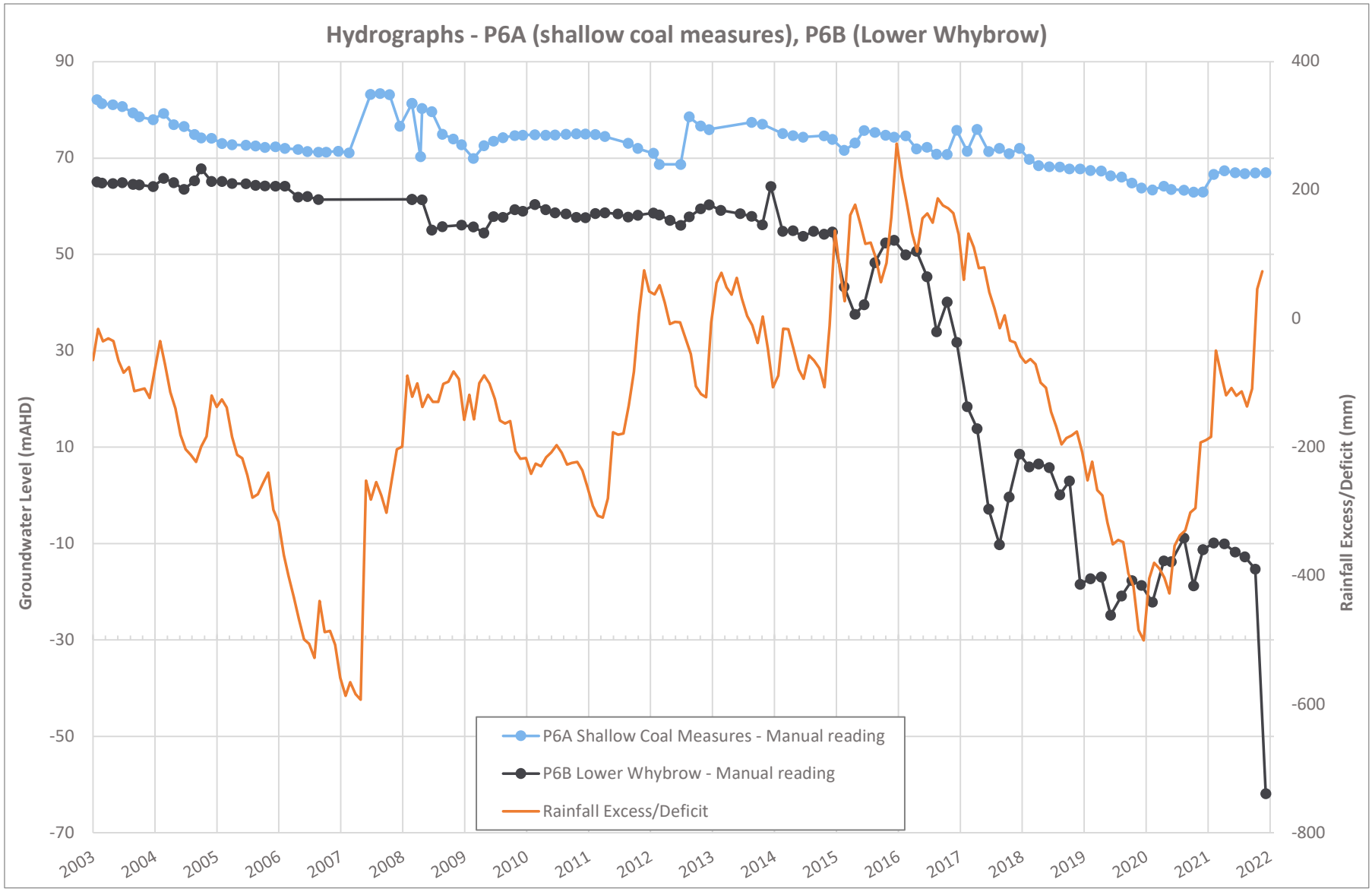
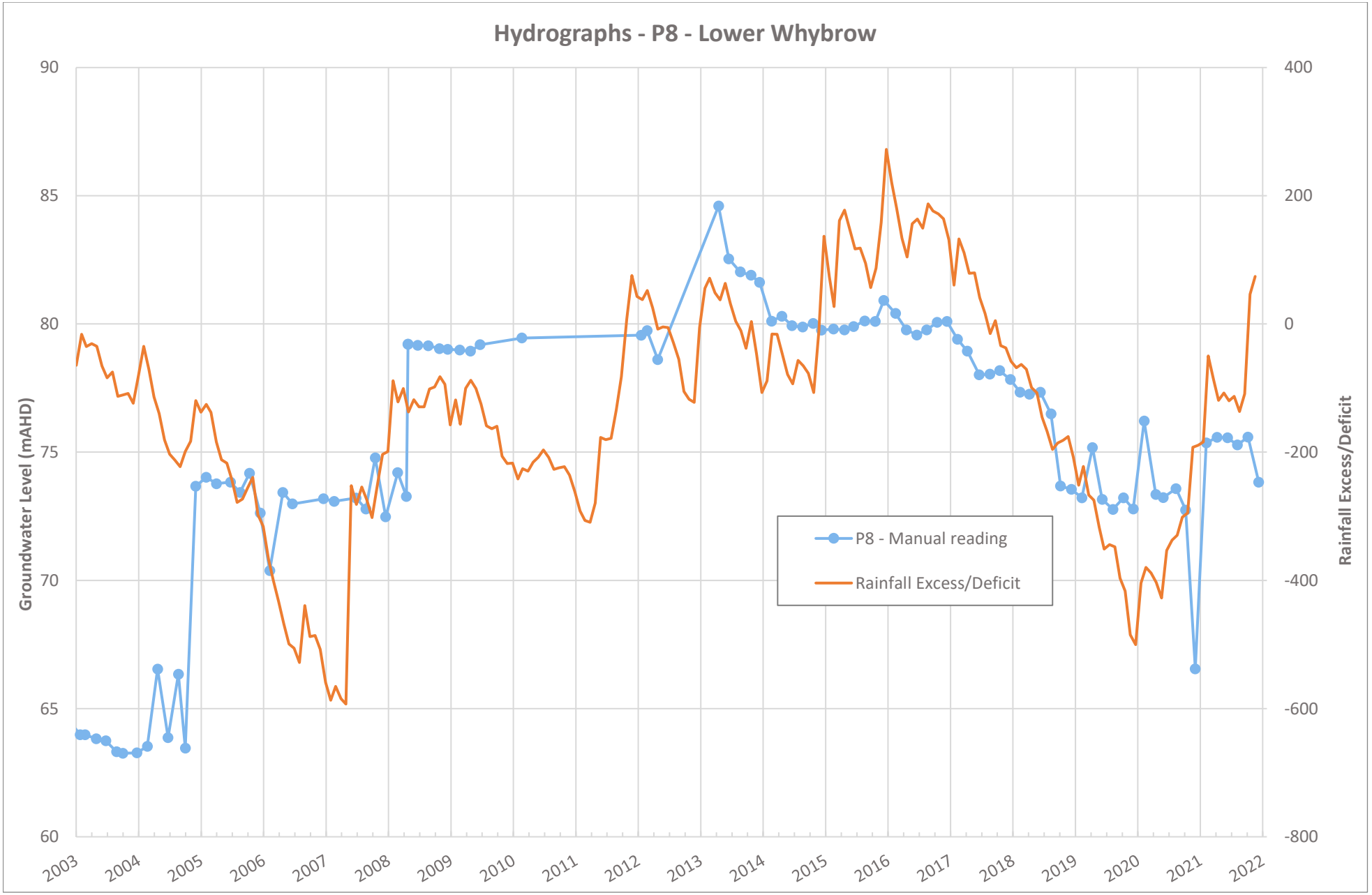
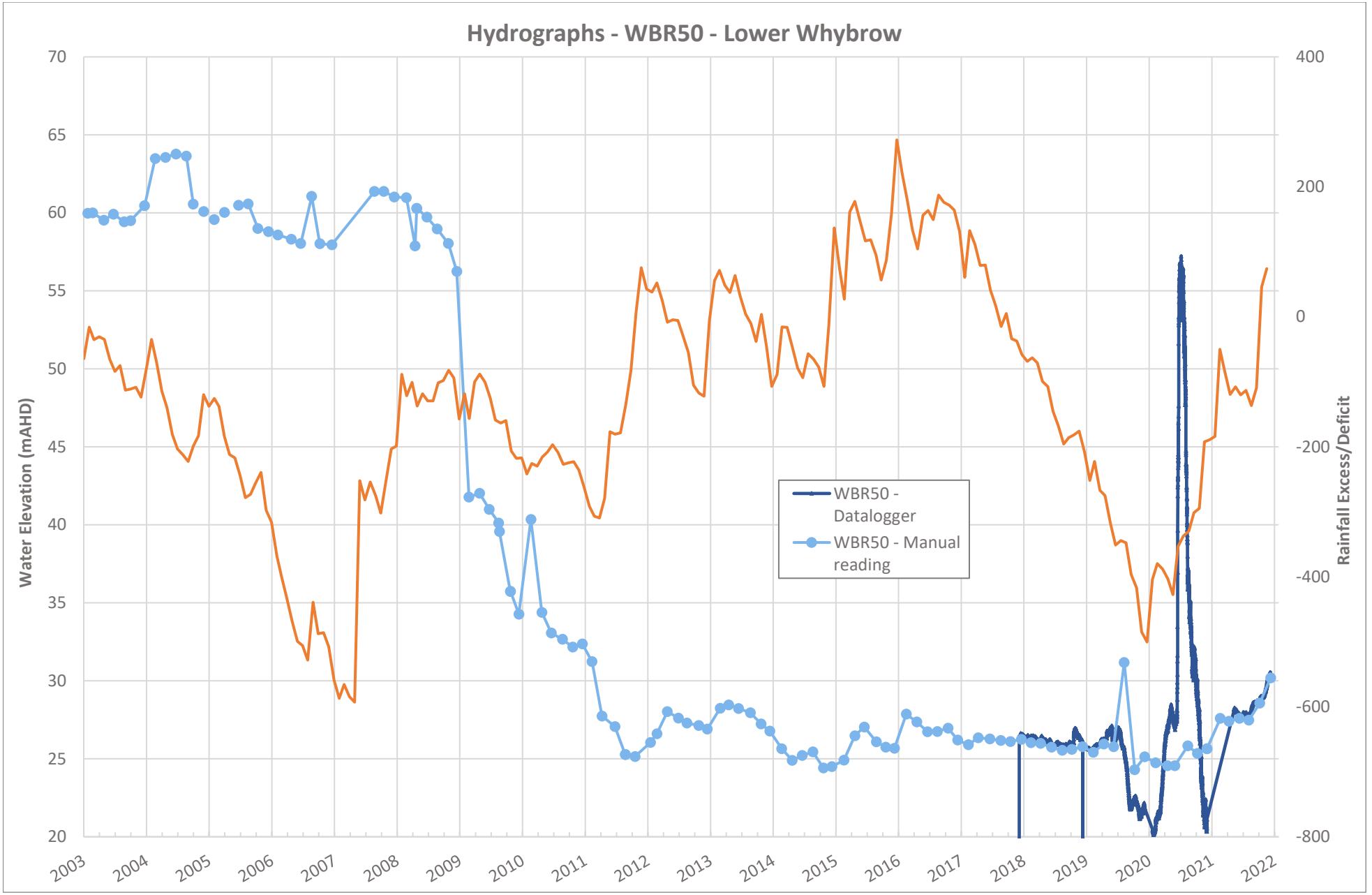
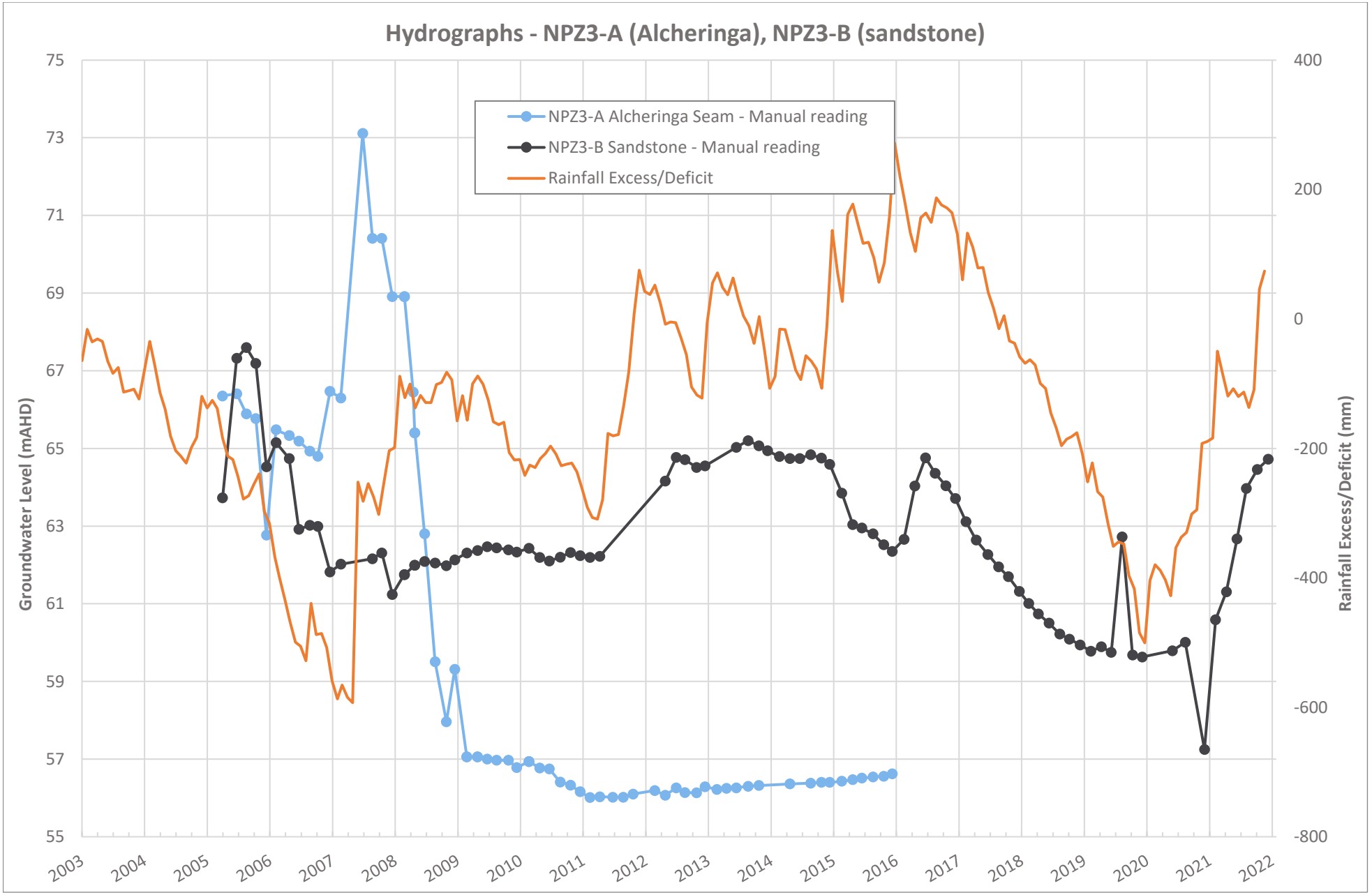
2017
2018
2019
2020
2021
2022

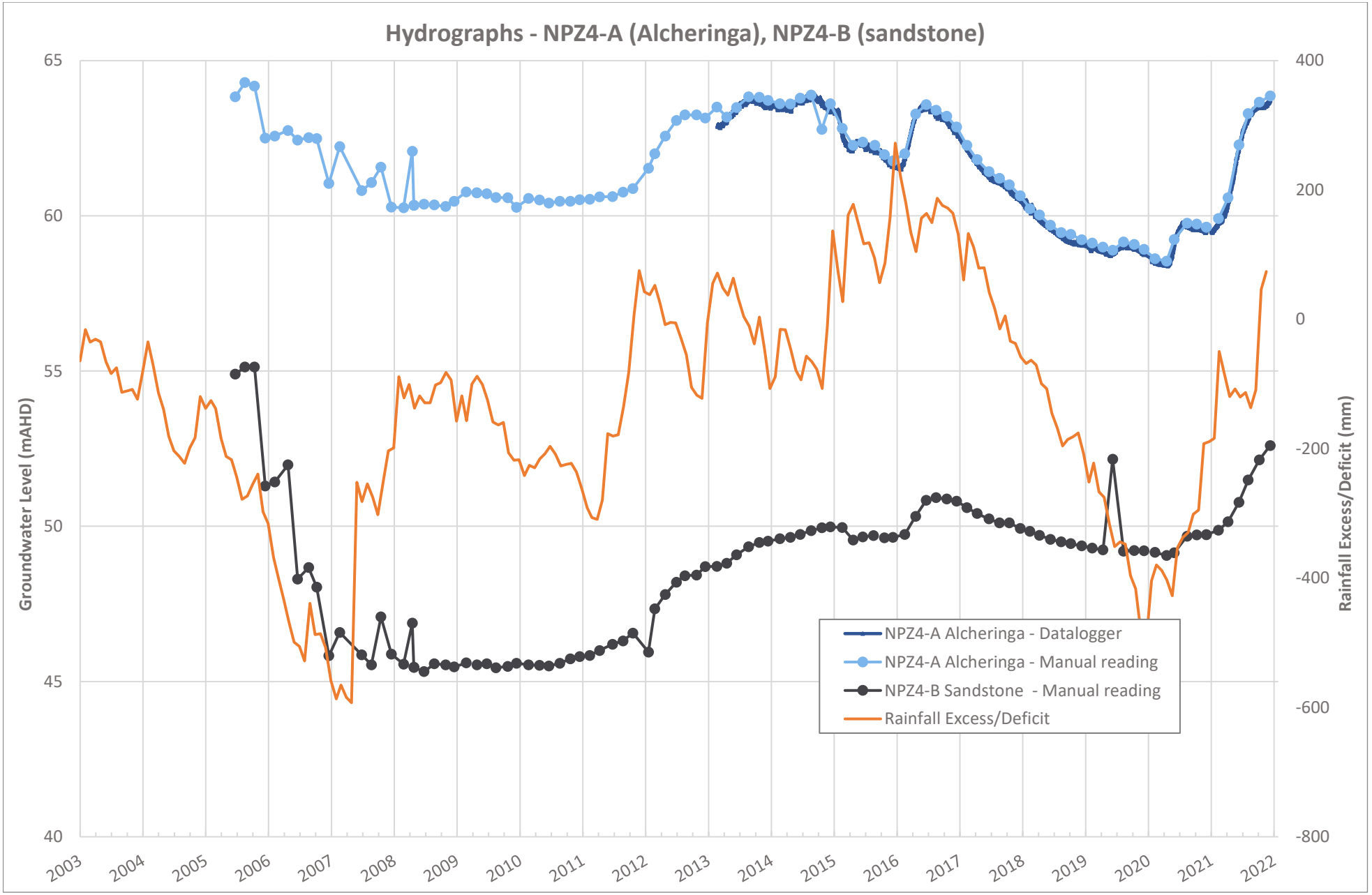

Hydrographs - NPZ7-2A, NPZ7-3A - Alcheringa Seam
NPZ7-2A - Datalogger
NPZ7-2A - Manual reading
NPZ7-3A - Datalogger
NPZ7-3A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
67
66
65
64
63
62
61
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

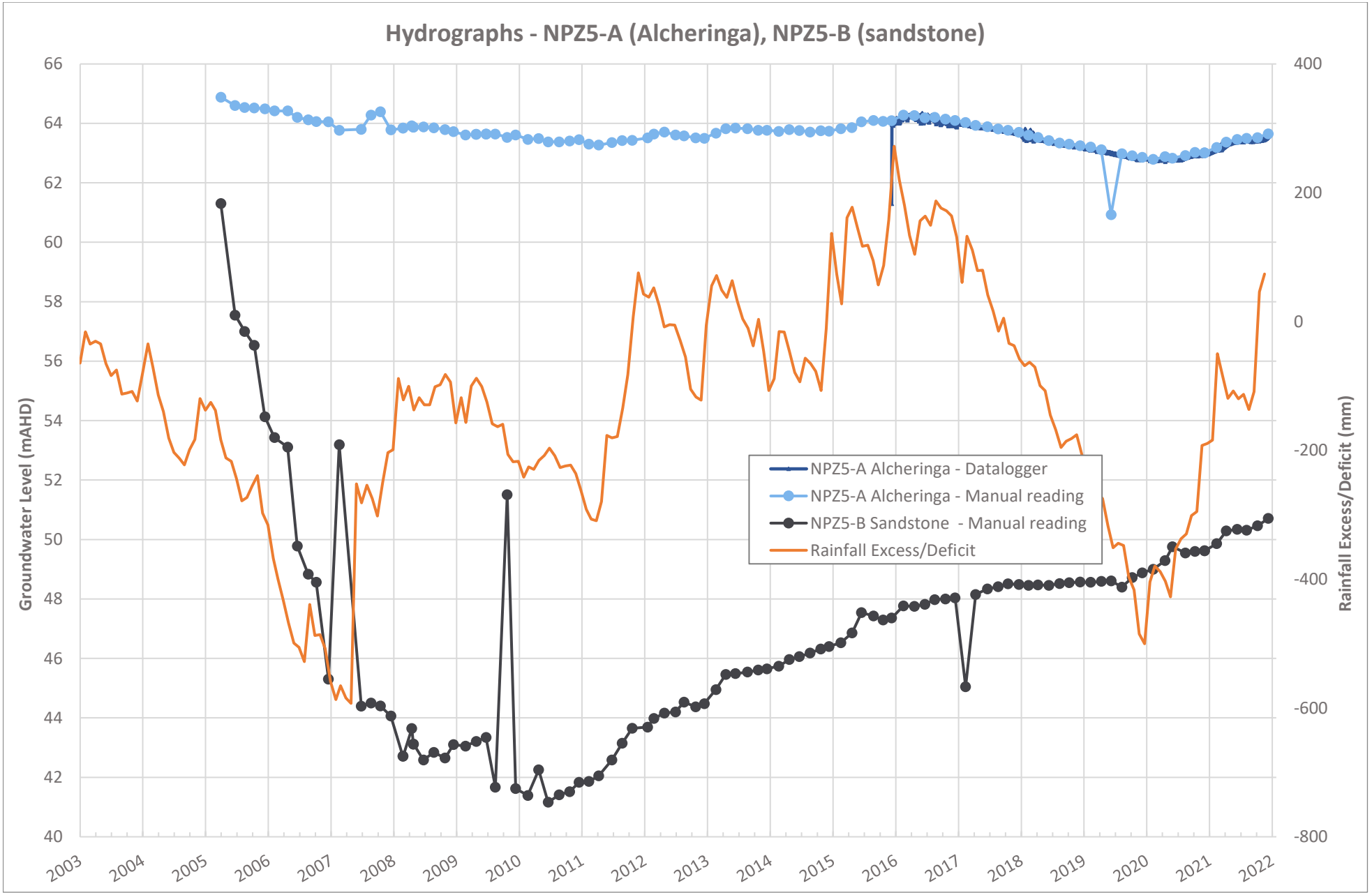

Hydrographs - P6A (shallow coal measures), P6B (Lower Whybrow)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
90
70
50
30
10
-10
-30
-50
-70
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
P6A Shallow Coal Measures - Manual reading
P6B Lower Whybrow - Manual reading
Rainfall Excess/Deficit

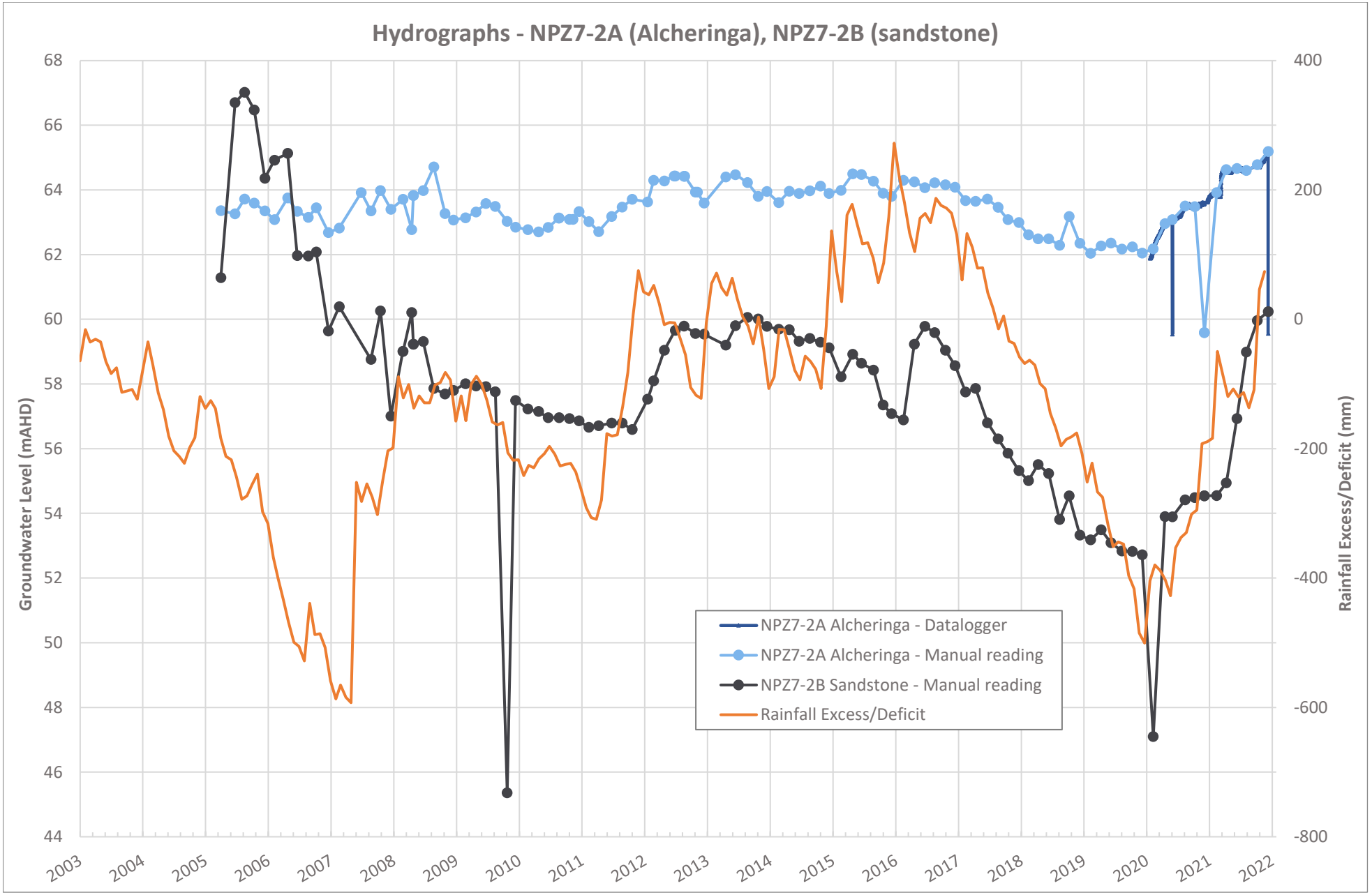

Hydrographs - P8 - Lower Whybrow
Groundwater Level (mAHD)
Rainfall Excess/Deficit
90
85
80
75
70
65
60
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
P8 - Manual reading
Rainfall Excess/Deficit

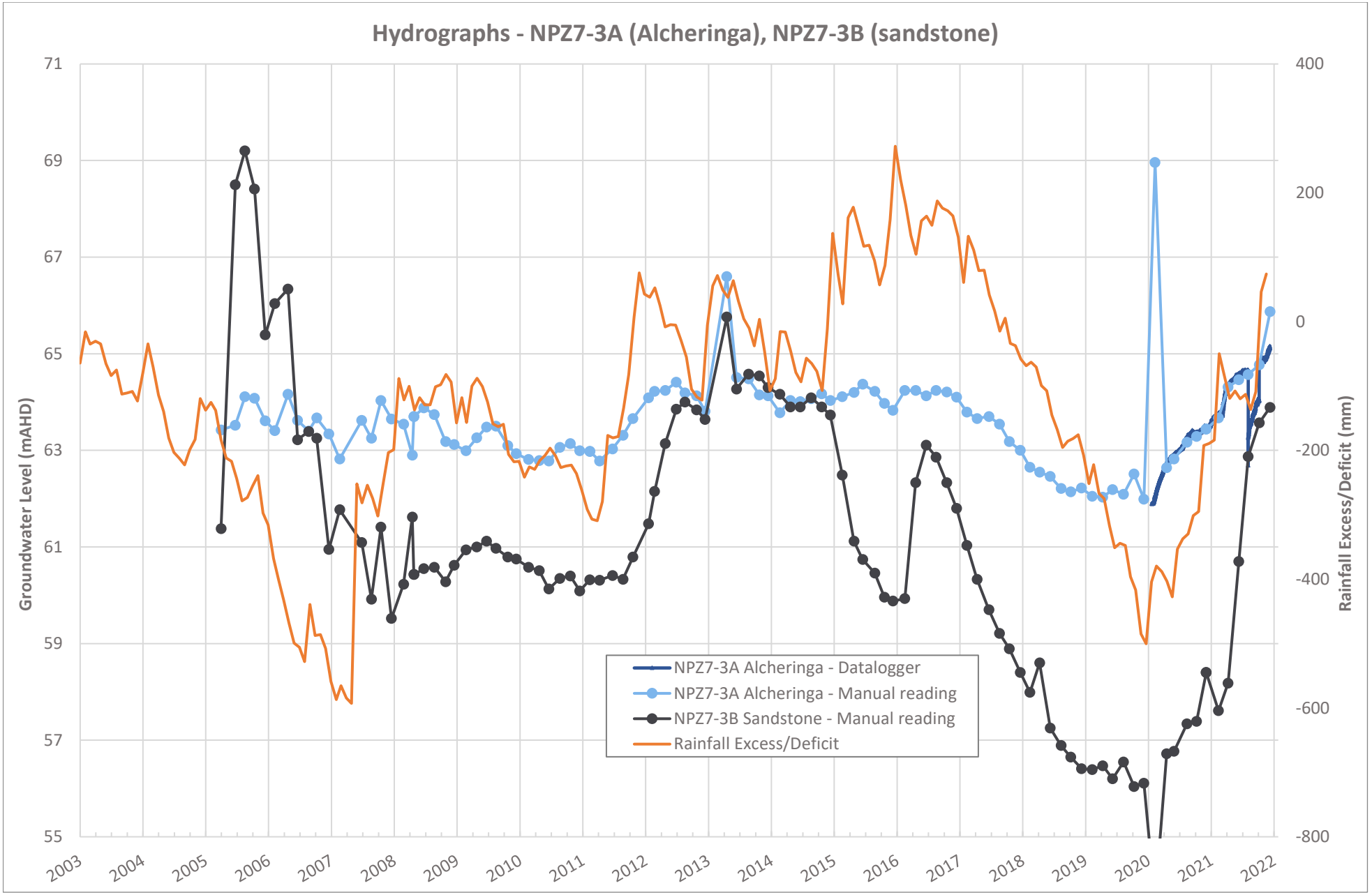

Hydrographs - WBR50 - Lower Whybrow
Water Elevation (mAHD)
Rainfall Excess/Deficit
70
65
60
55
50
45
40
35
30
25
20
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
WBR50 - Datalogger
WBR50 - Manual reading

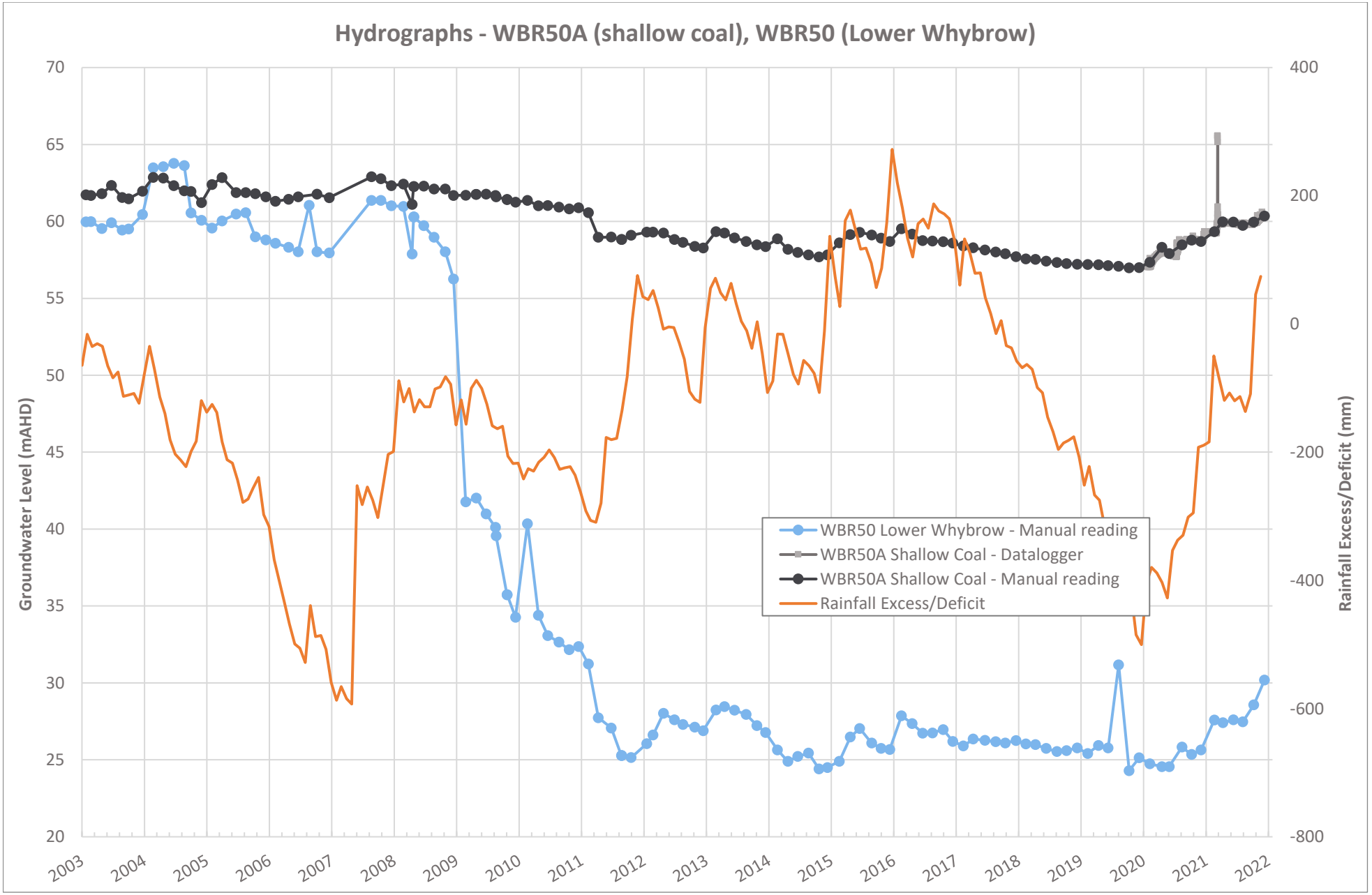

Hydrographs - NPZ3-A (Alcheringa), NPZ3-B (sandstone)
NPZ3-A Alcheringa Seam - Manual reading
NPZ3-B Sandstone - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
75
73
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

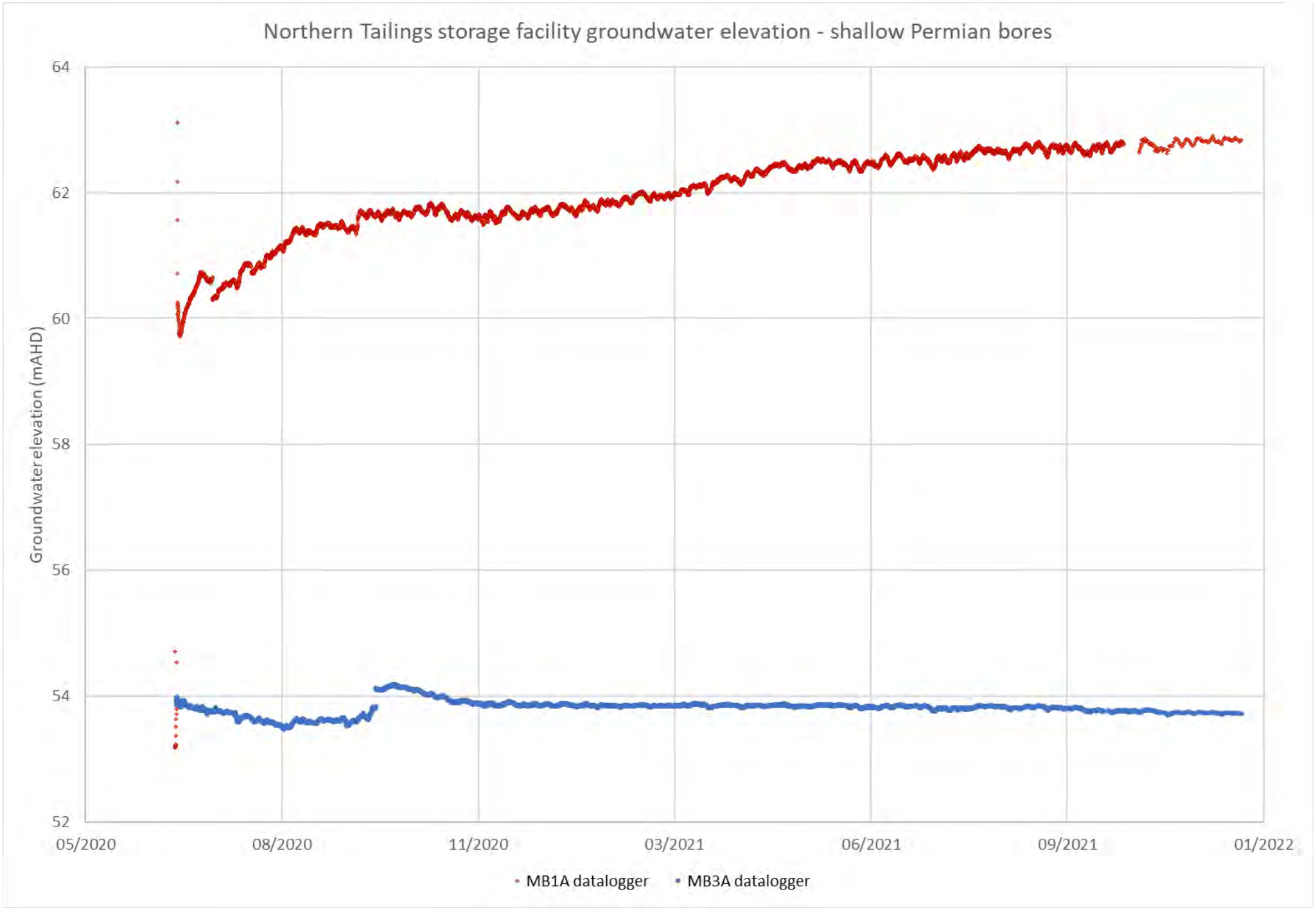

Hydrographs - NPZ4-A (Alcheringa), NPZ4-B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
65
60
55
50
45
40
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
NPZ4-A Alcheringa - Datalogger
NPZ4-A Alcheringa - Manual reading
NPZ4-B Sandstone - Manual reading
Rainfall Excess/Deficit

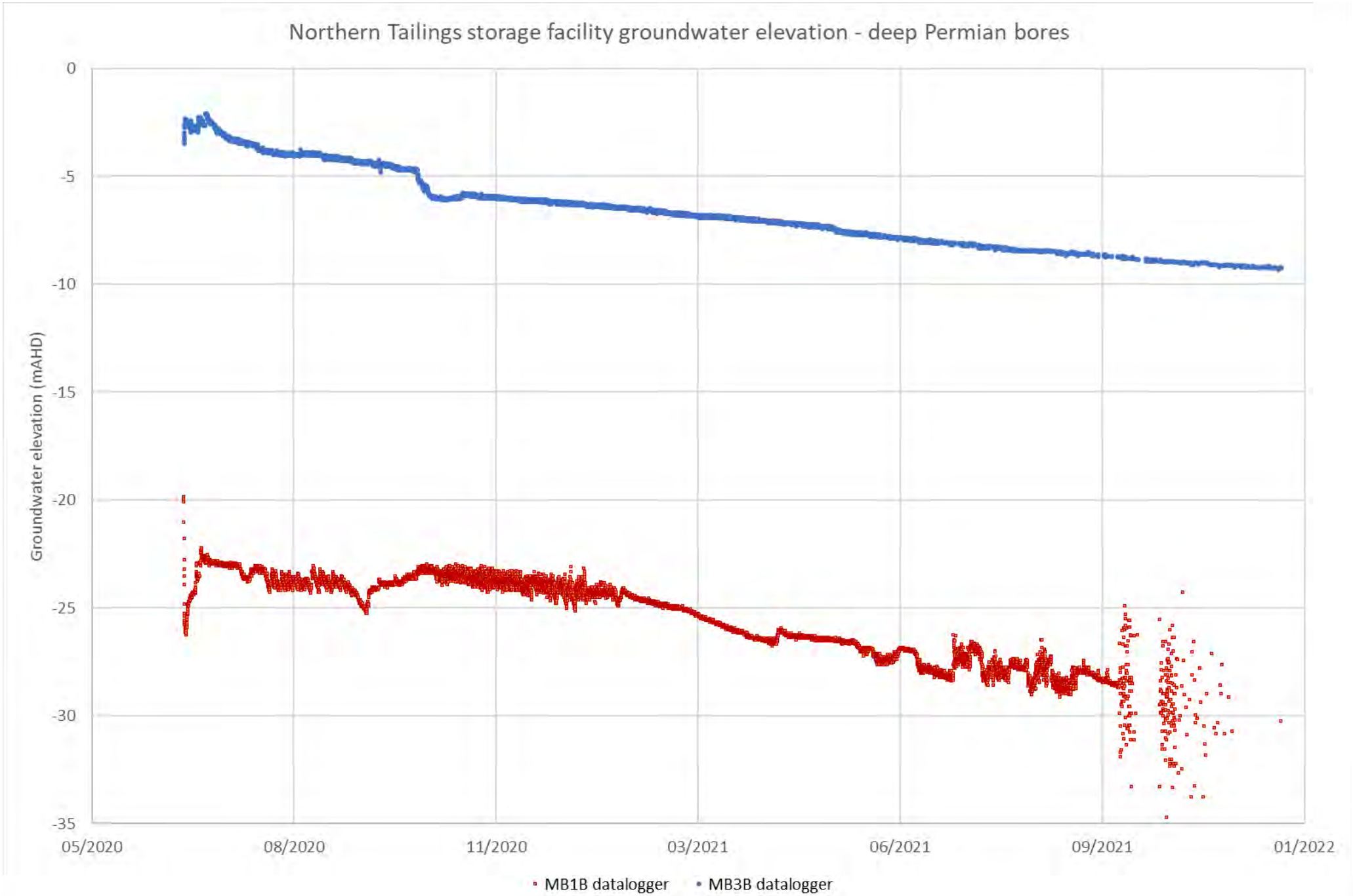

Hydrographs - NPZ5-A (Alcheringa), NPZ5-B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
66
64
62
60
58
56
54
52
50
48
46
44
42
40
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
NPZ5-A Alcheringa - Datalogger
NPZ5-A Alcheringa - Manual reading
NPZ5-B Sandstone - Manual reading
Rainfall Excess/Deficit

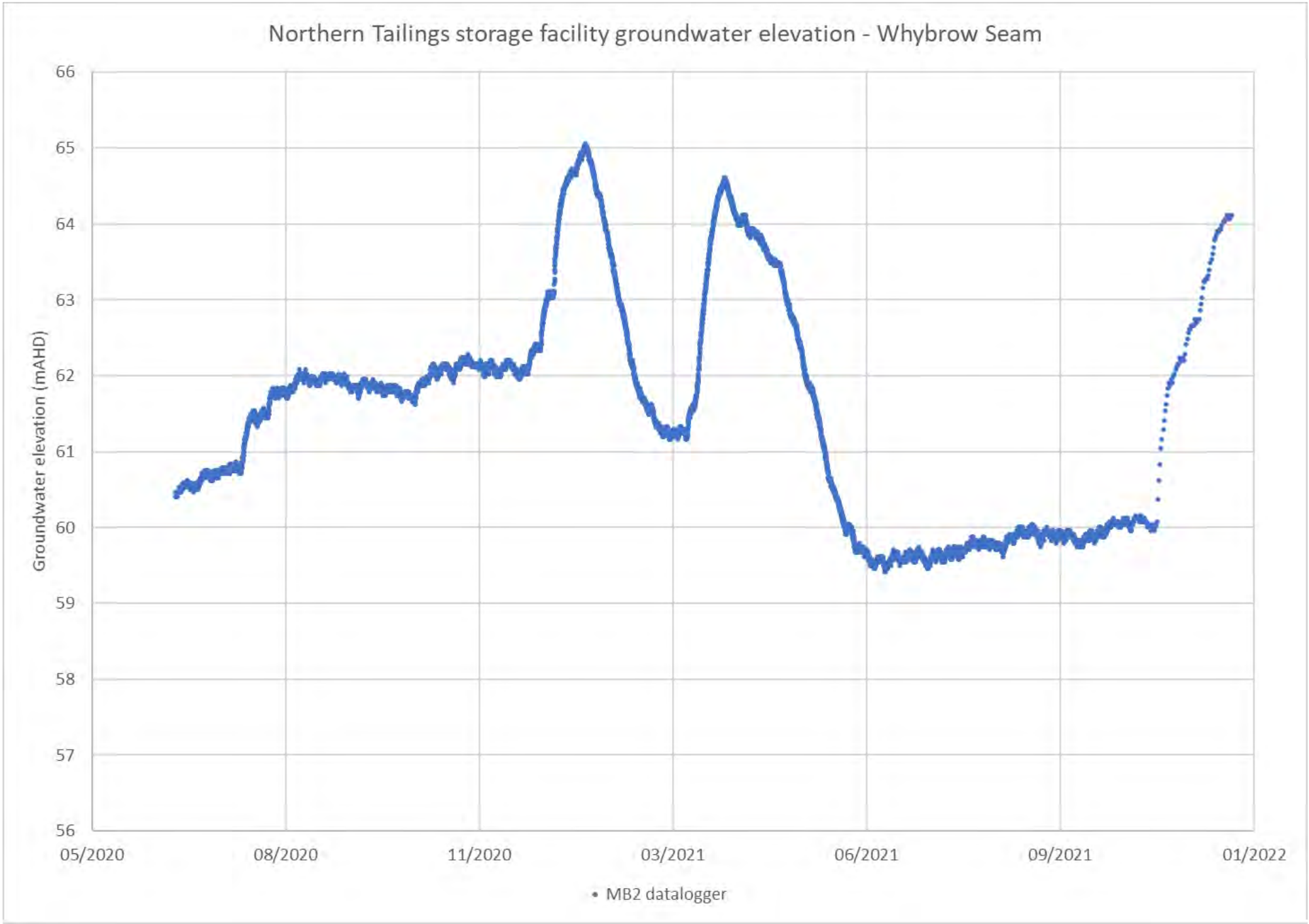

Hydrographs - NPZ7-2A (Alcheringa), NPZ7-2B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
68
66
64
62
60
58
56
54
52
50
48
46
44
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
NPZ7-2A Alcheringa - Datalogger
NPZ7-2A Alcheringa - Manual reading
NPZ7-2B Sandstone - Manual reading
Rainfall Excess/Deficit


Hydrographs - NPZ7-3A (Alcheringa), NPZ7-3B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
NPZ7-3A Alcheringa - Datalogger
NPZ7-3A Alcheringa - Manual reading
NPZ7-3B Sandstone - Manual reading
Rainfall Excess/Deficit


Hydrographs - WBR50A (shallow coal), WBR50 (Lower Whybrow)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
70
65
60
55
50
45
40
35
30
25
20
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
WBR50 Lower Whybrow - Manual reading
WBR50A Shallow Coal - Datalogger
WBR50A Shallow Coal - Manual reading
Rainfall Excess/Deficit

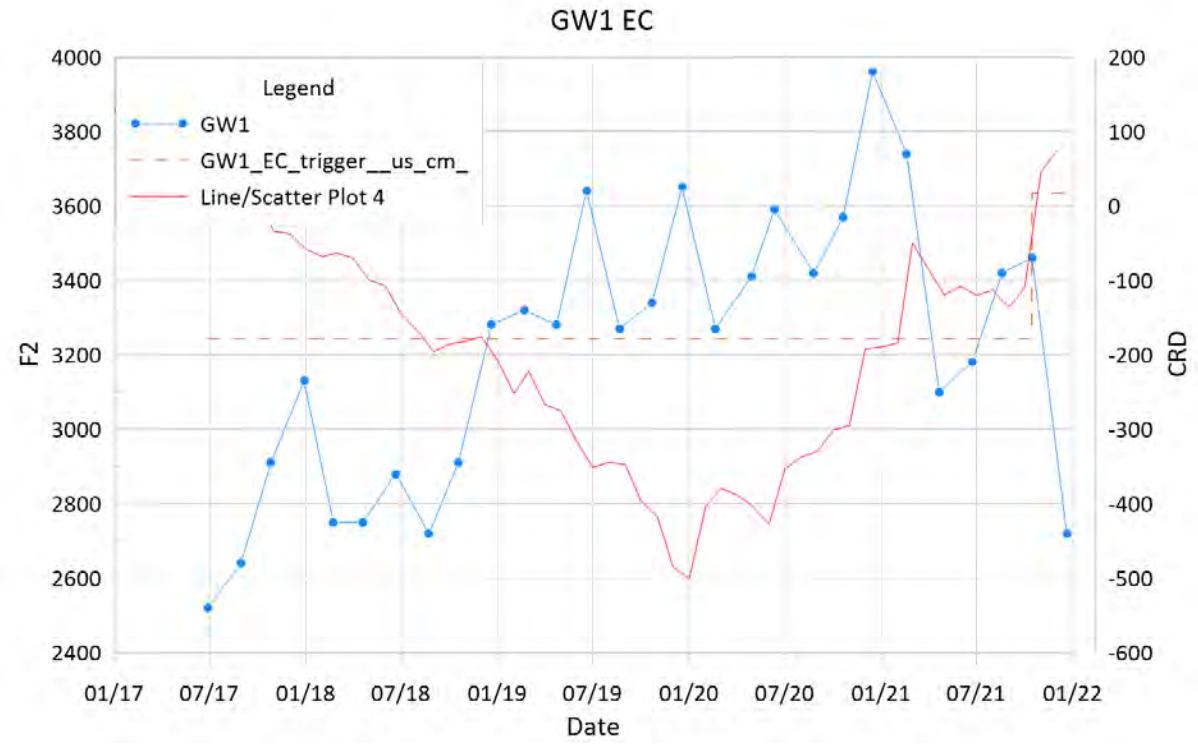

Northern Tailings storage facility groundwater elevation - shallow Permian bores
Groundwater elevation (mAHD)
64
62
60
58
56
54
52
05/2020
08/2020
11/2020
03/2021
06/2021
09/2021
01/2022
MB1A datalogger
MB3A datalogger

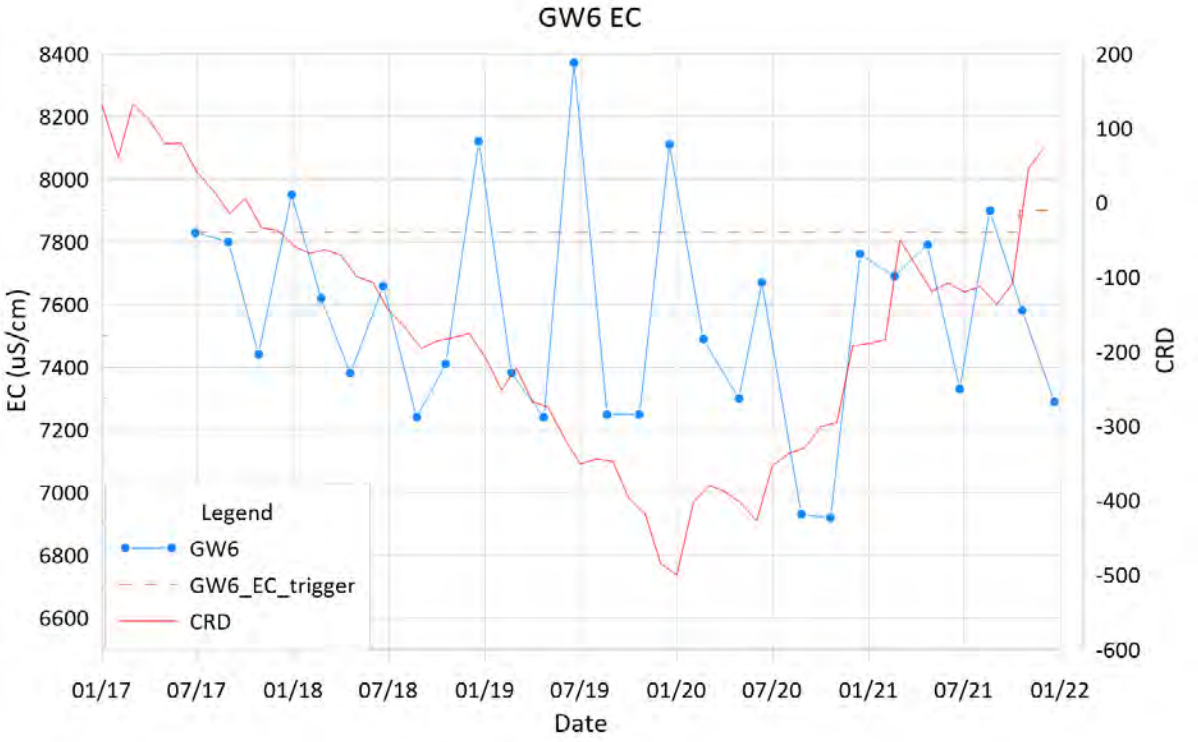

Northern Tailings storage facility groundwater elevation - deep Permian bores
Groundwater elevation (mAHD)
0
-5
-10
-15
-20
-25
-30
-35
05/2020
08/2020
11/2020
03/2021
06/2021
09/2021
01/2022
MB1B datalogger
MB3B datalogger


Northern Tailings storage facility groundwater elevation - Whybrow Seam
Groundwater elevation (mAHD)
66
65
64
63
62
61
60
59
58
57
56
05/2020
08/2020
11/2020
03/2021
06/2021
09/2021
01/2022
MB2 datalogger

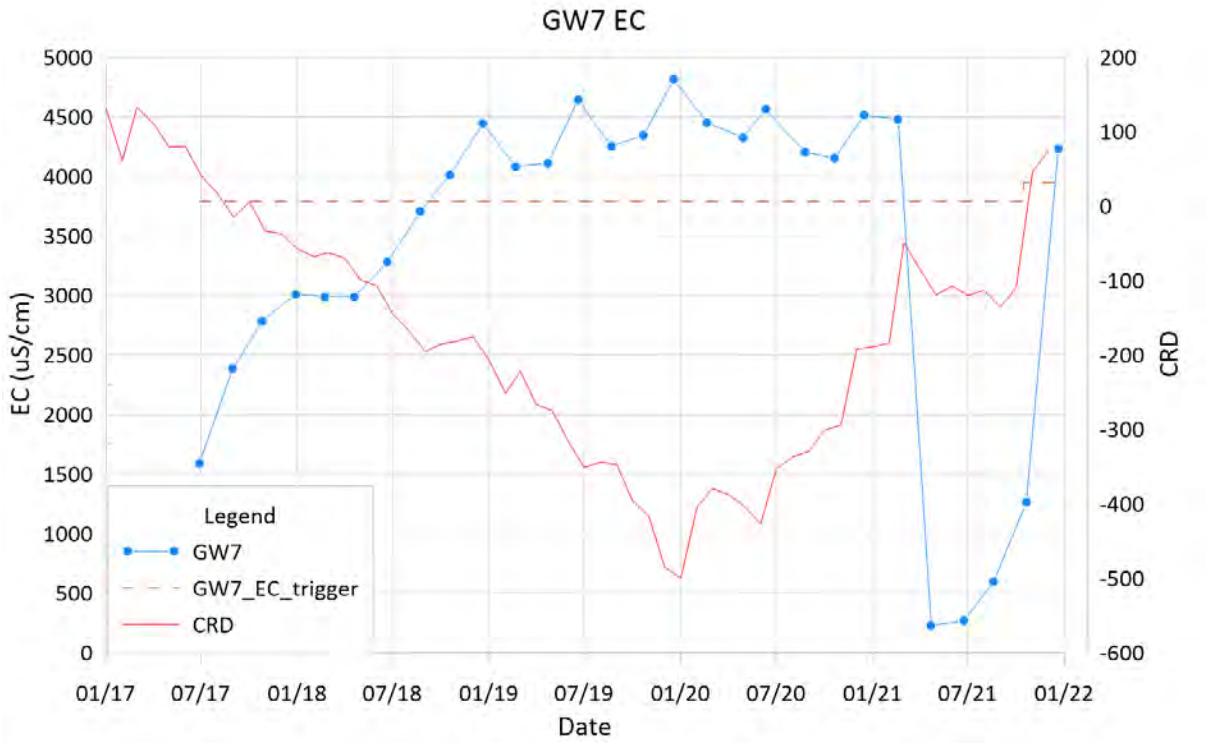
Appendix B. Groundwater quality plots

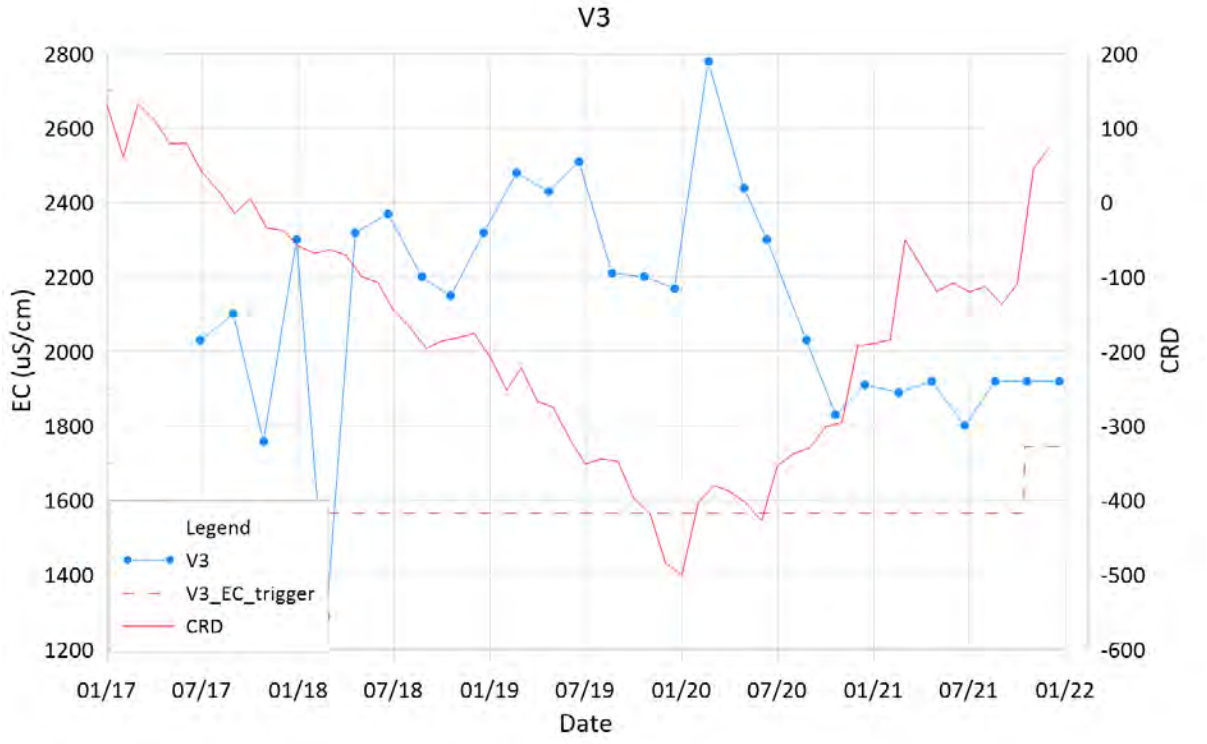
Appendix B
Groundwater EC and pH exceedance figures



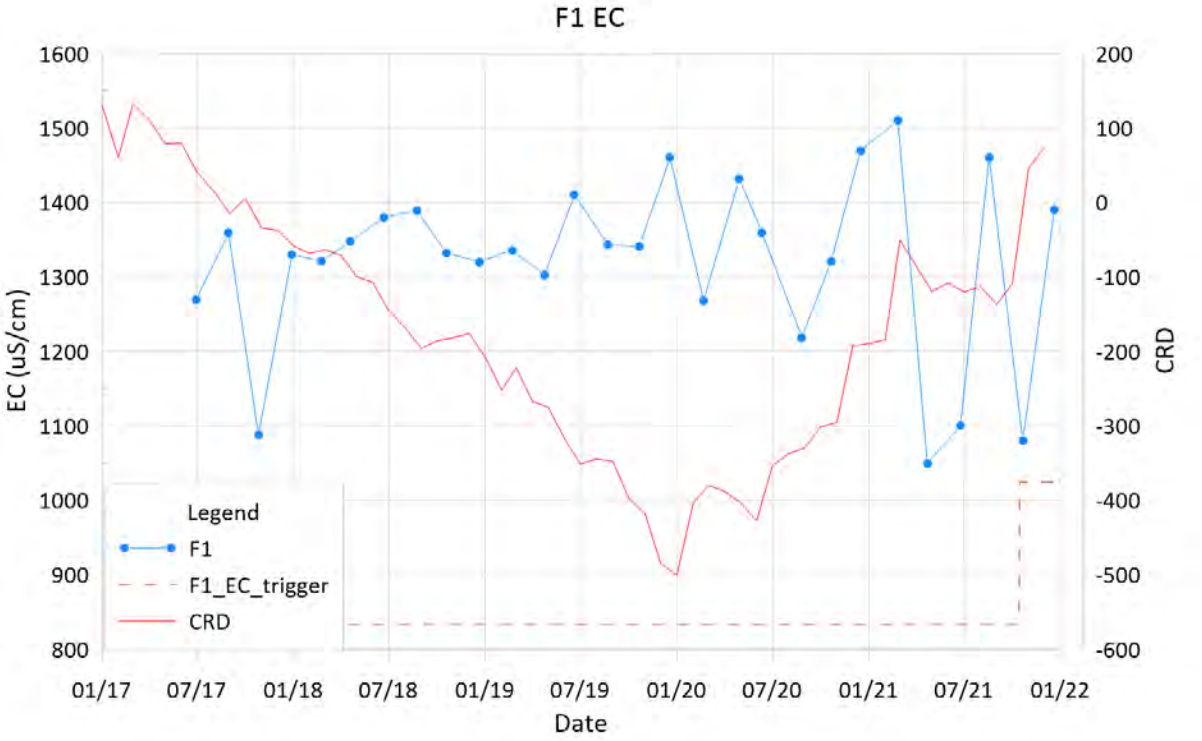


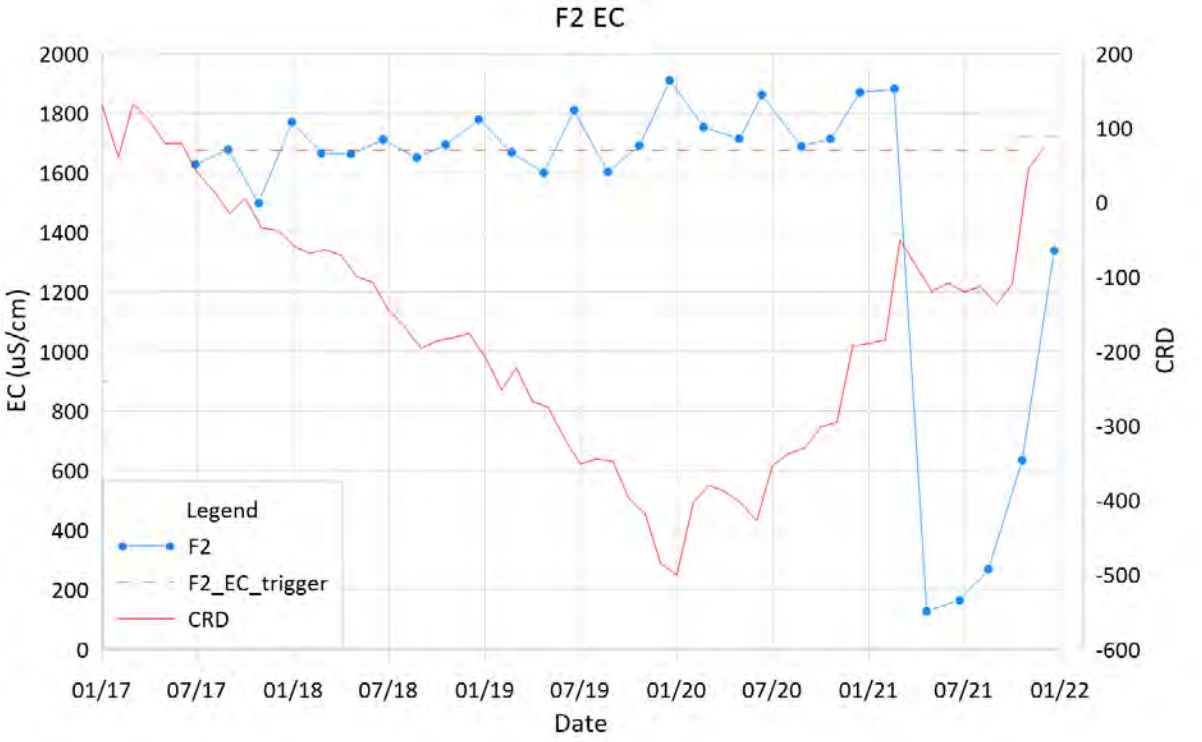
Appendix B
Groundwater EC and pH exceedance figures



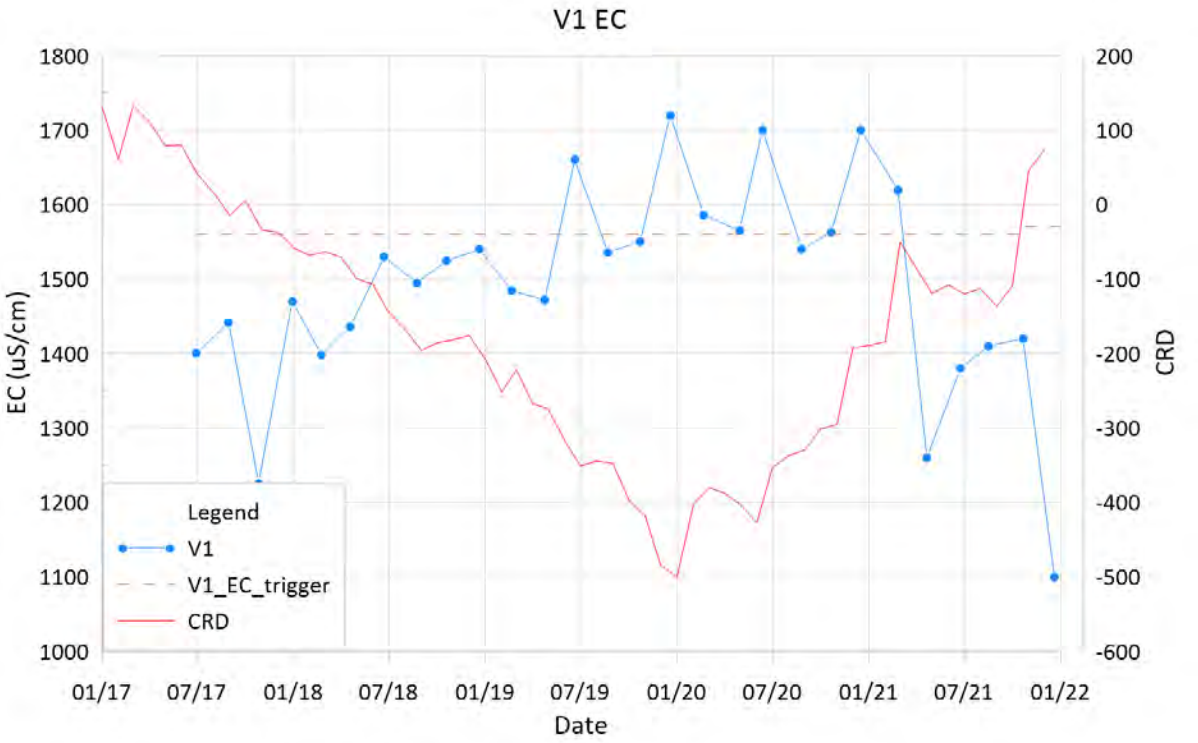


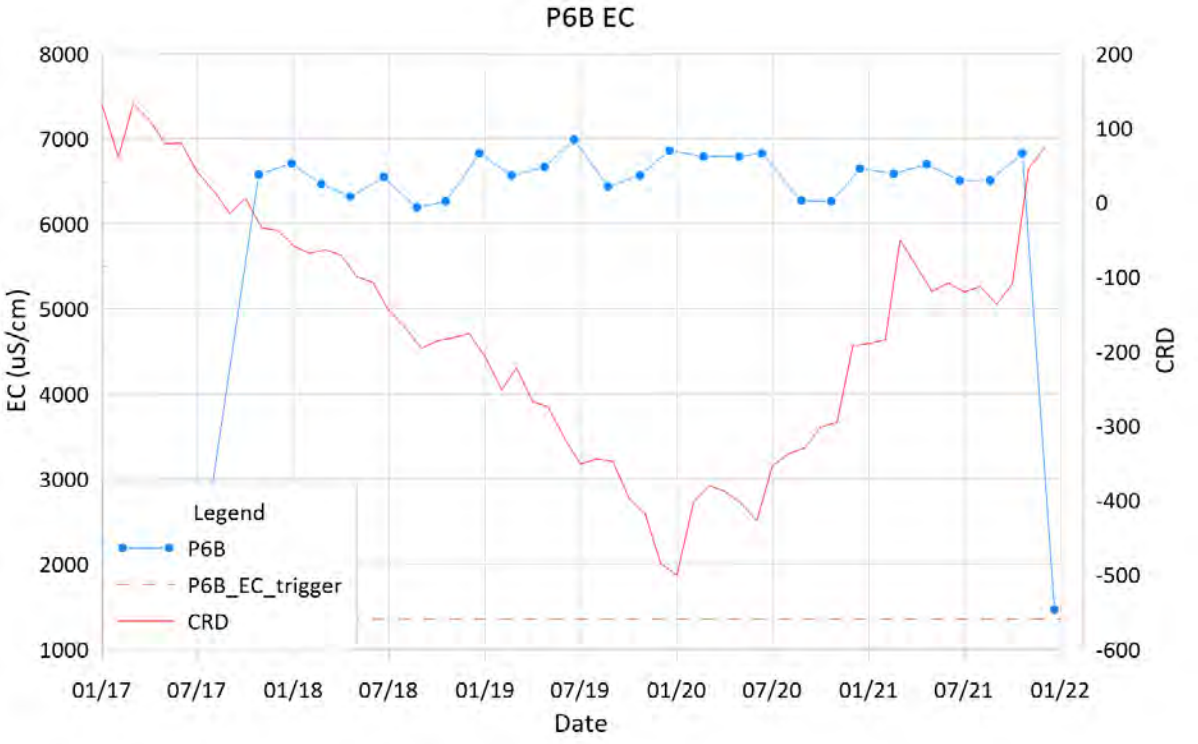
Appendix B
Groundwater EC and pH exceedance figures



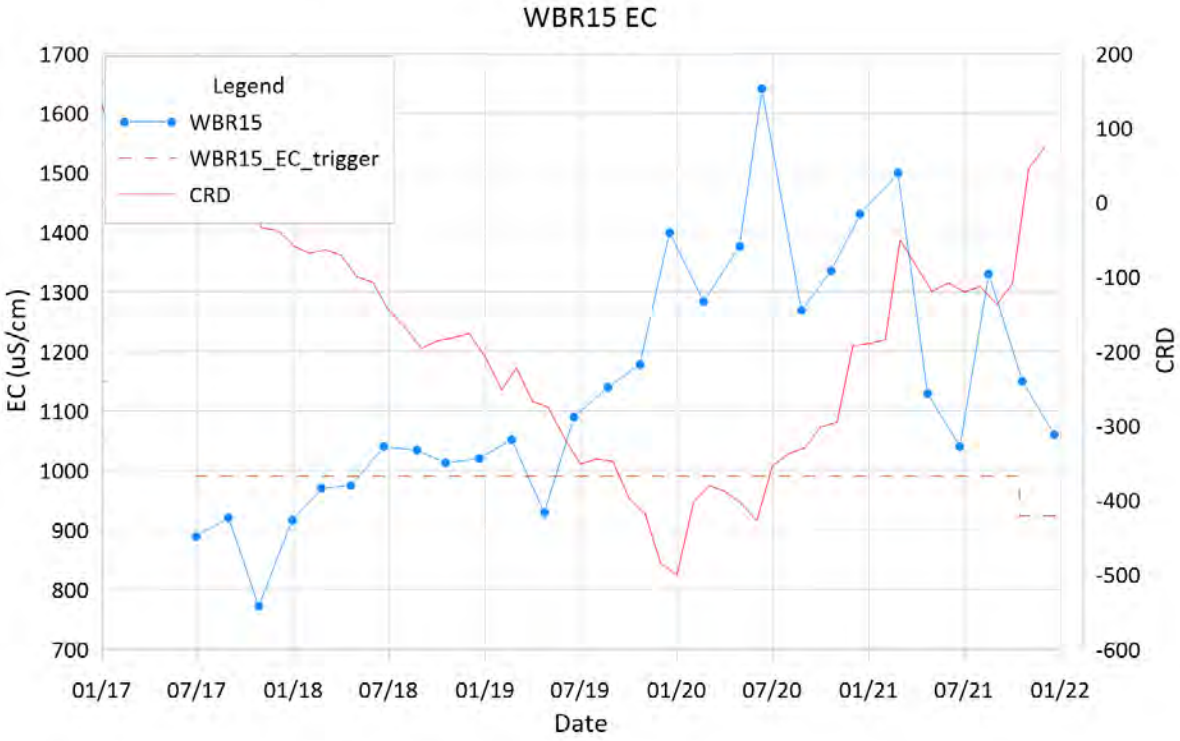


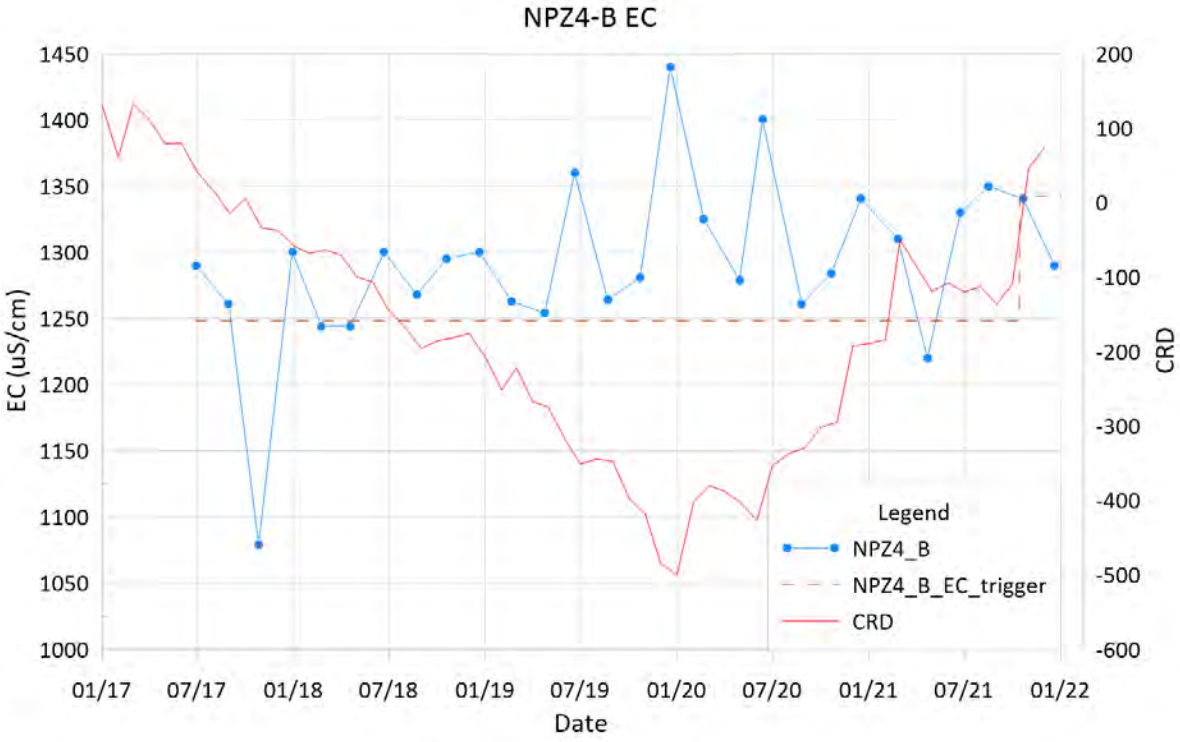
Appendix B
Groundwater EC and pH exceedance figures



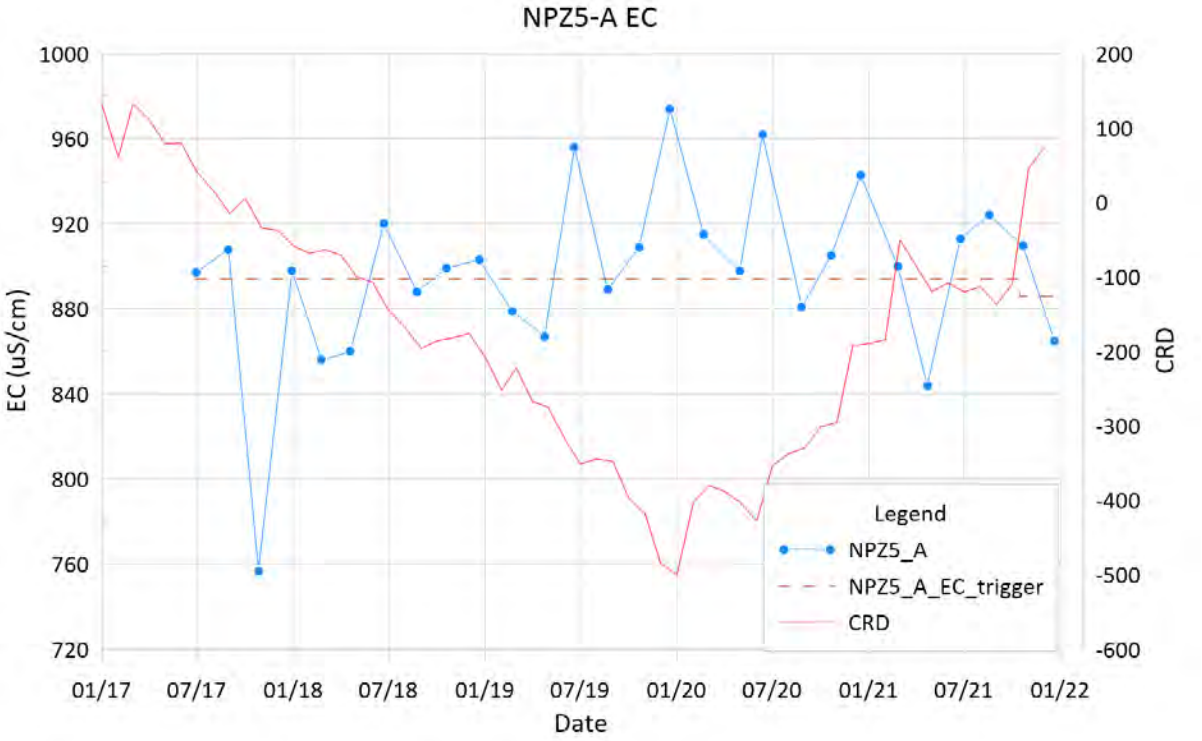


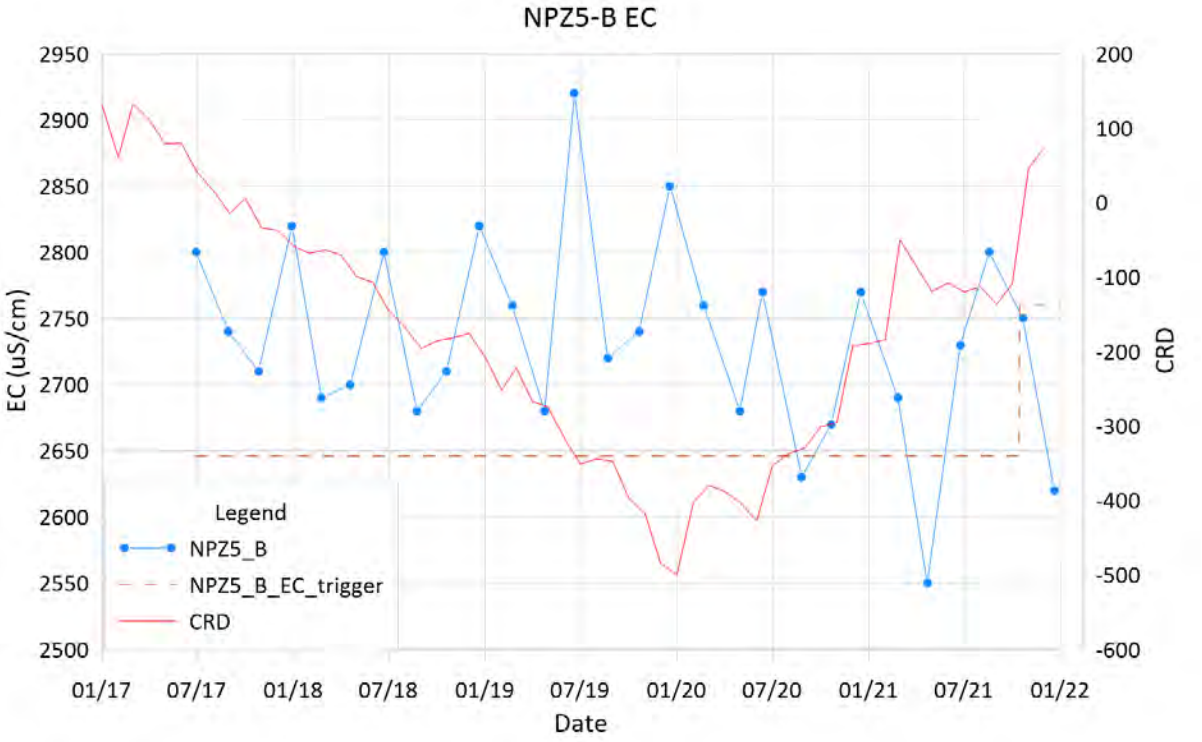
Appendix B
Groundwater EC and pH exceedance figures



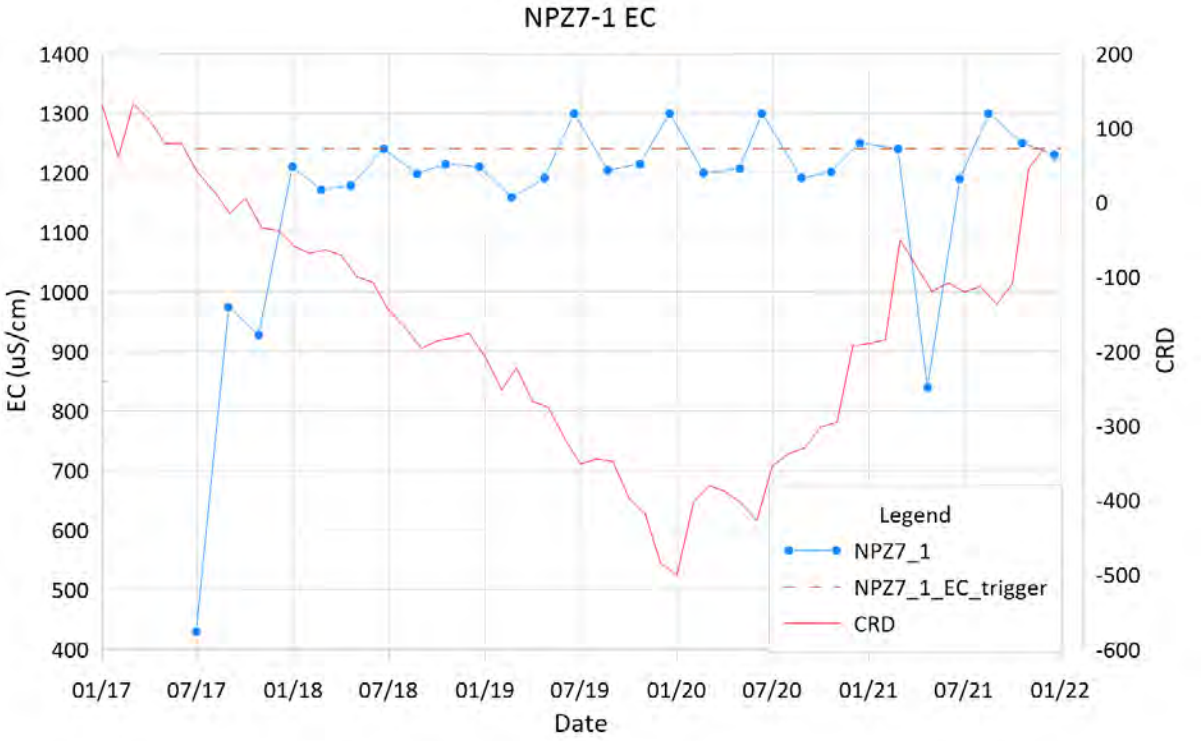


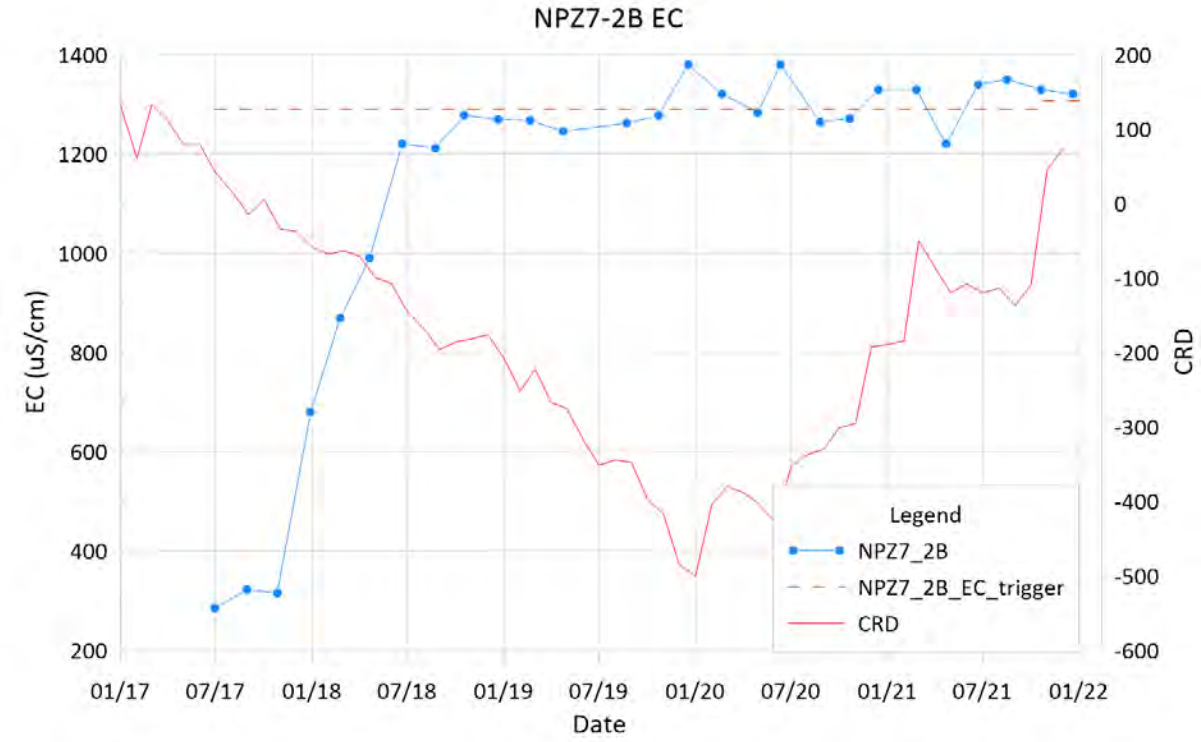
Appendix B
Groundwater EC and pH exceedance figures



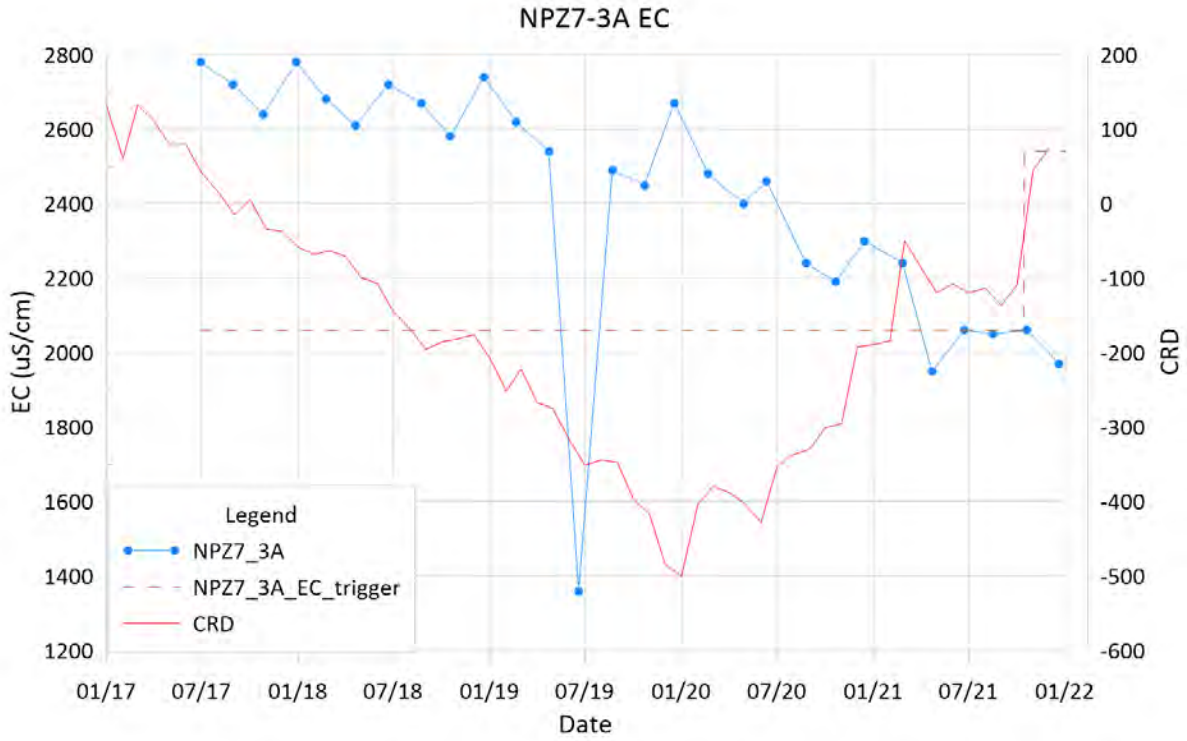


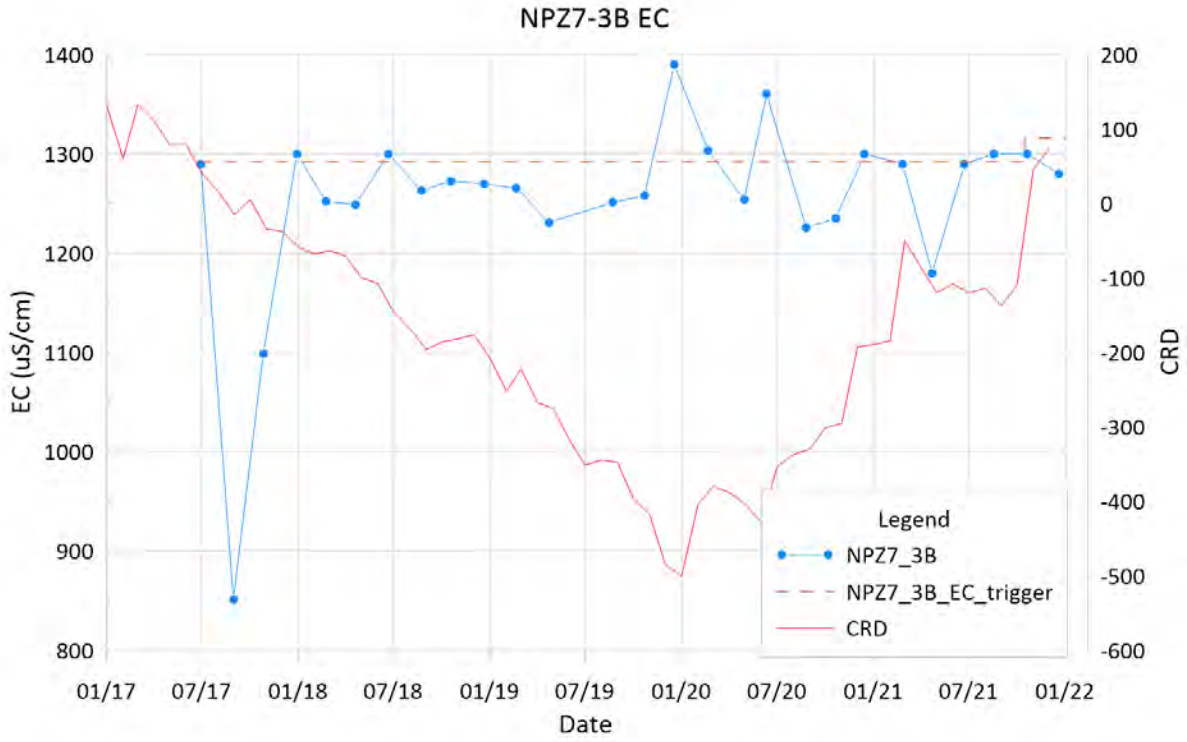
Appendix B
Groundwater EC and pH exceedance figures



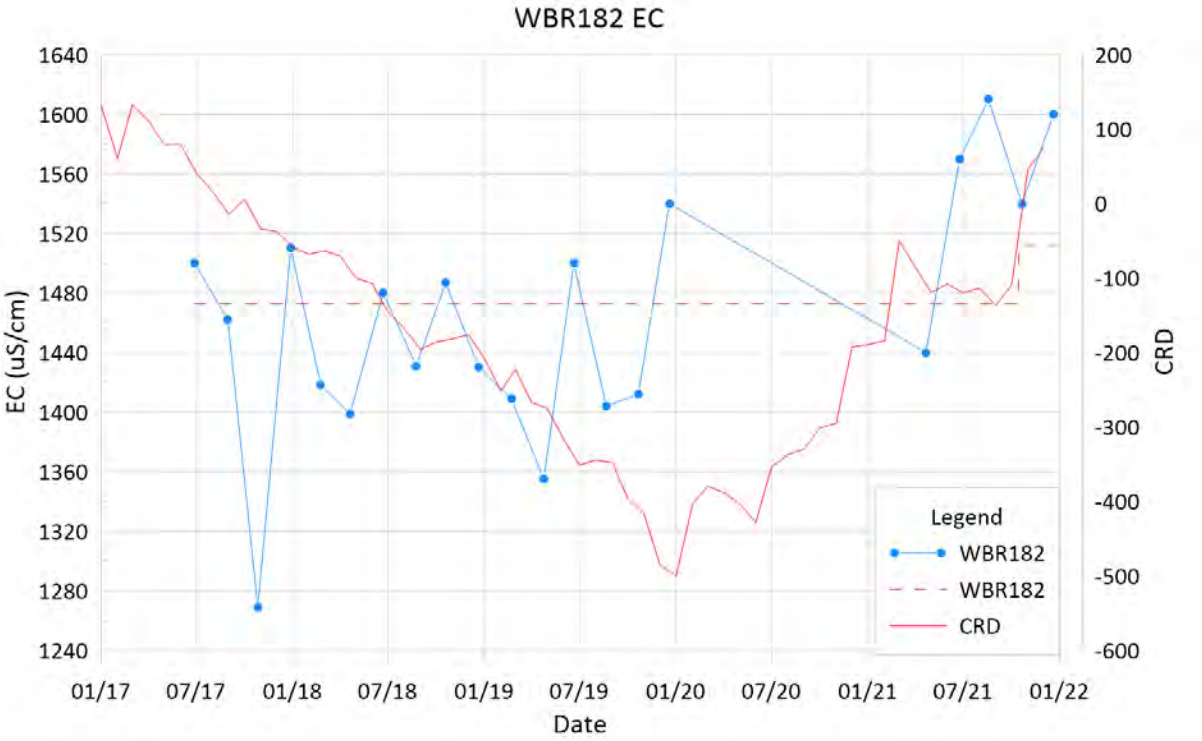


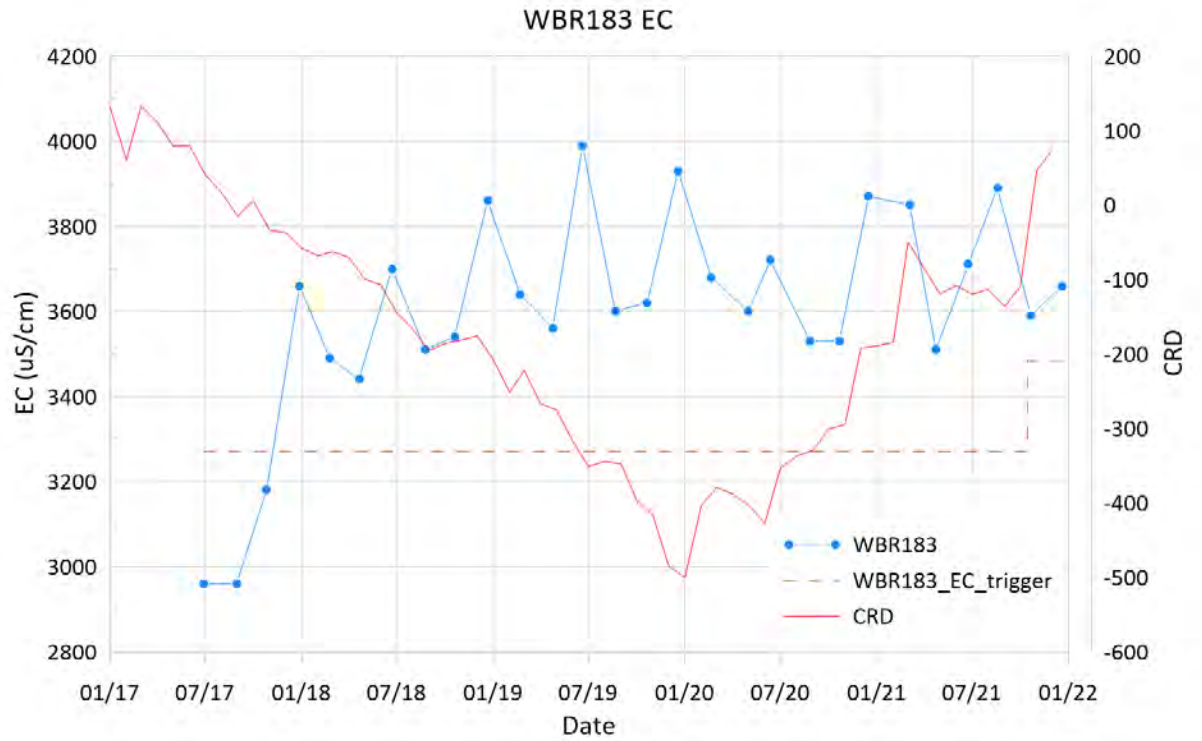
Appendix B
Groundwater EC and pH exceedance figures



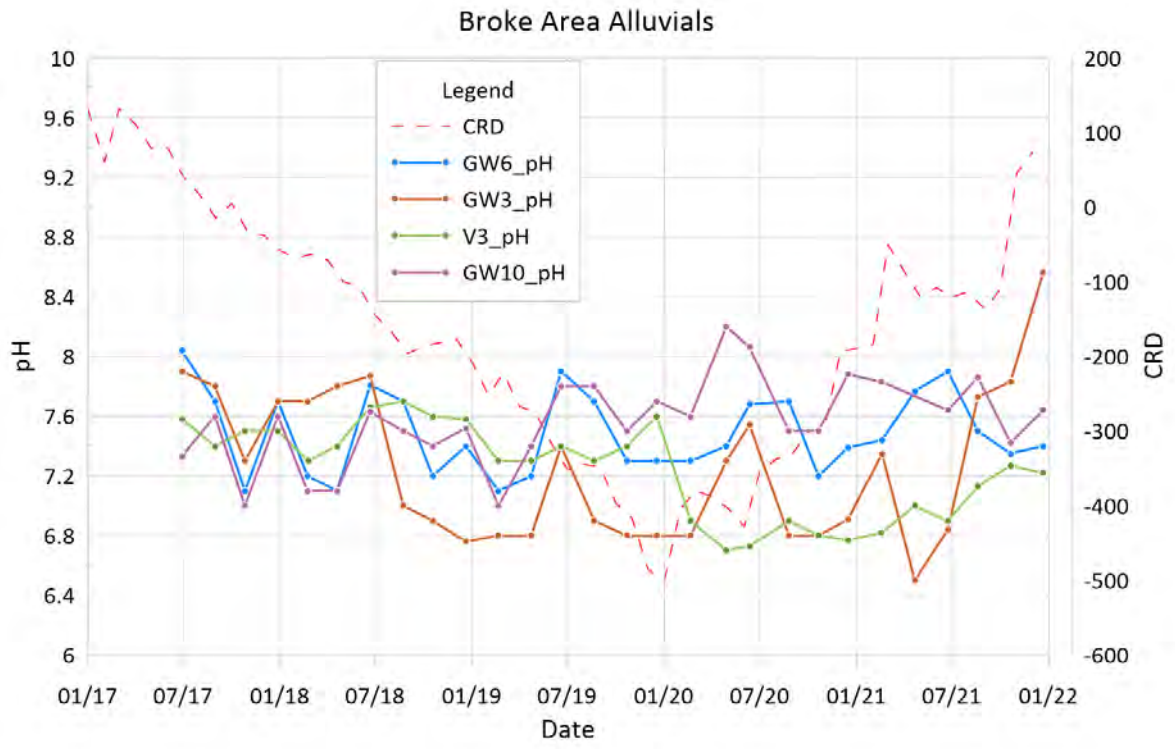


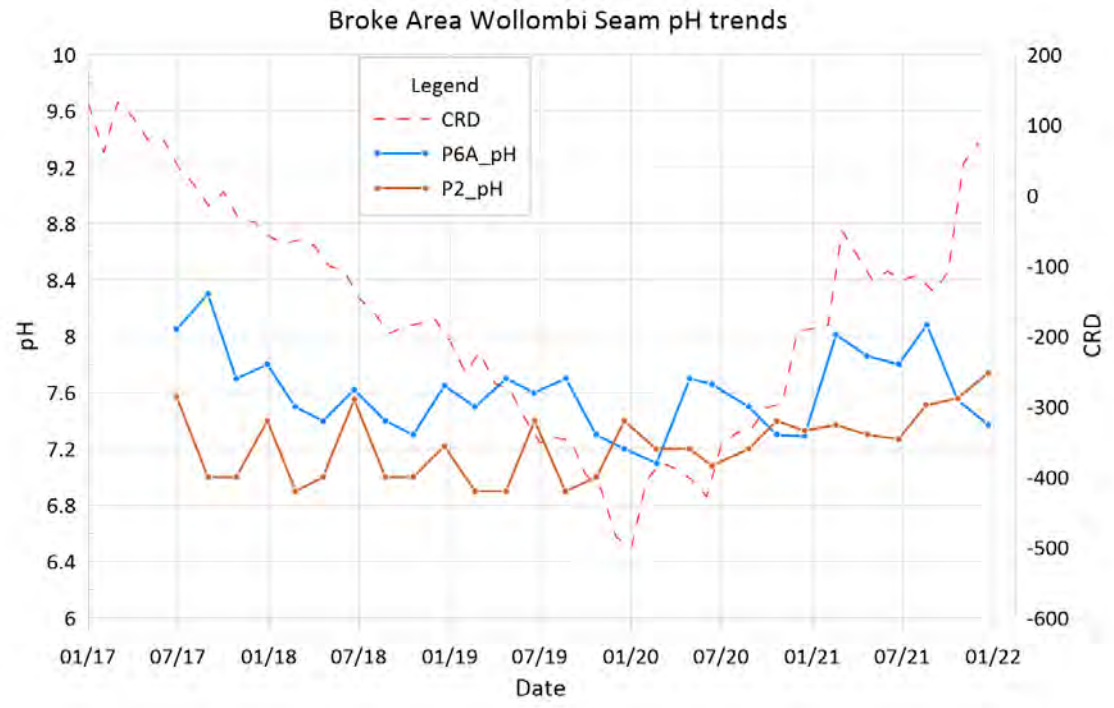
Appendix B
Groundwater EC and pH exceedance figures



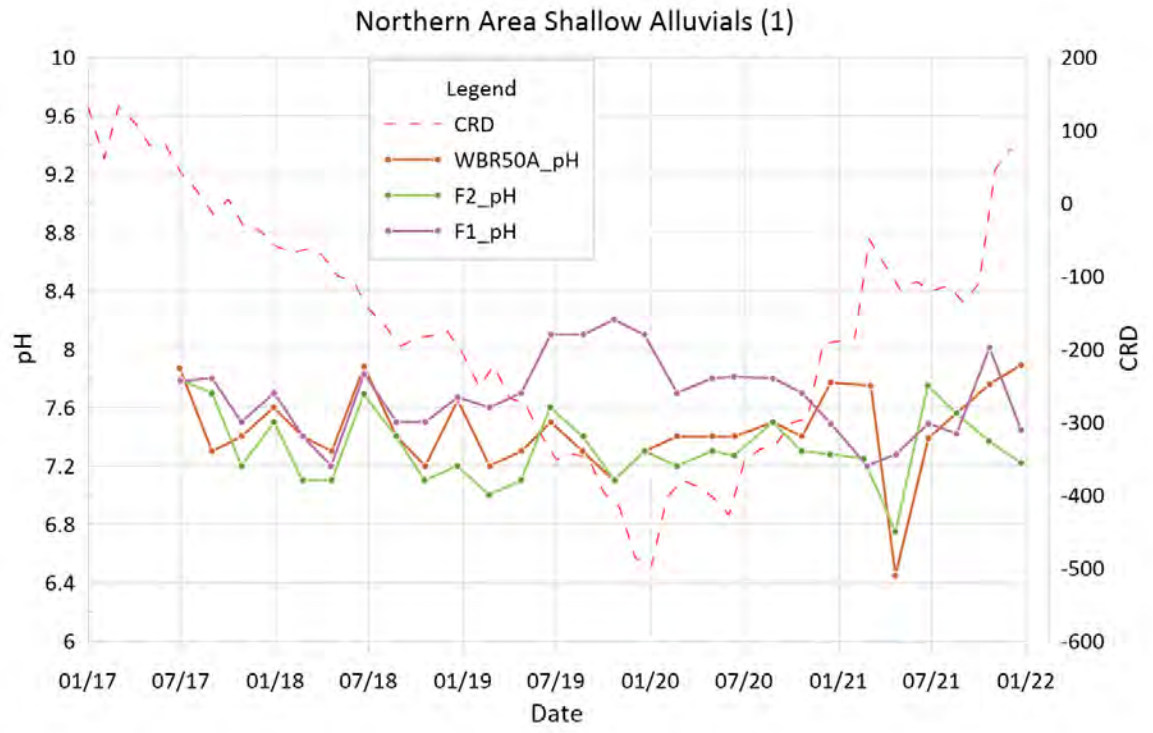


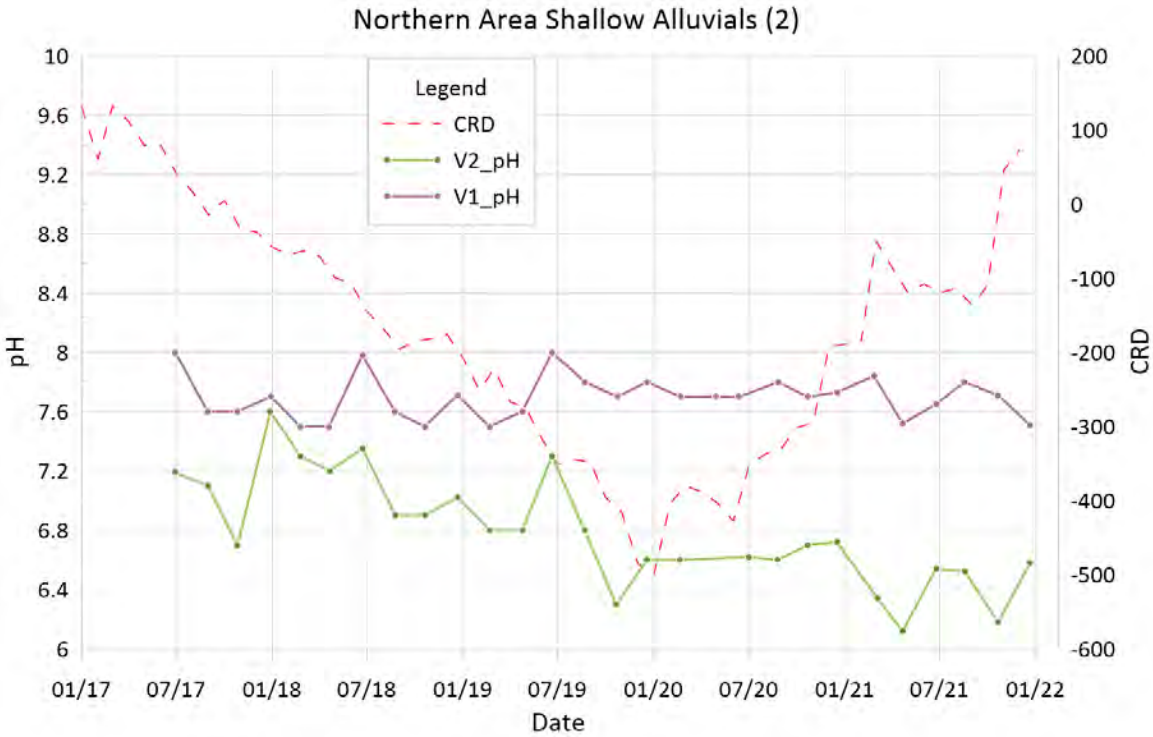
Appendix B
Groundwater EC and pH exceedance figures



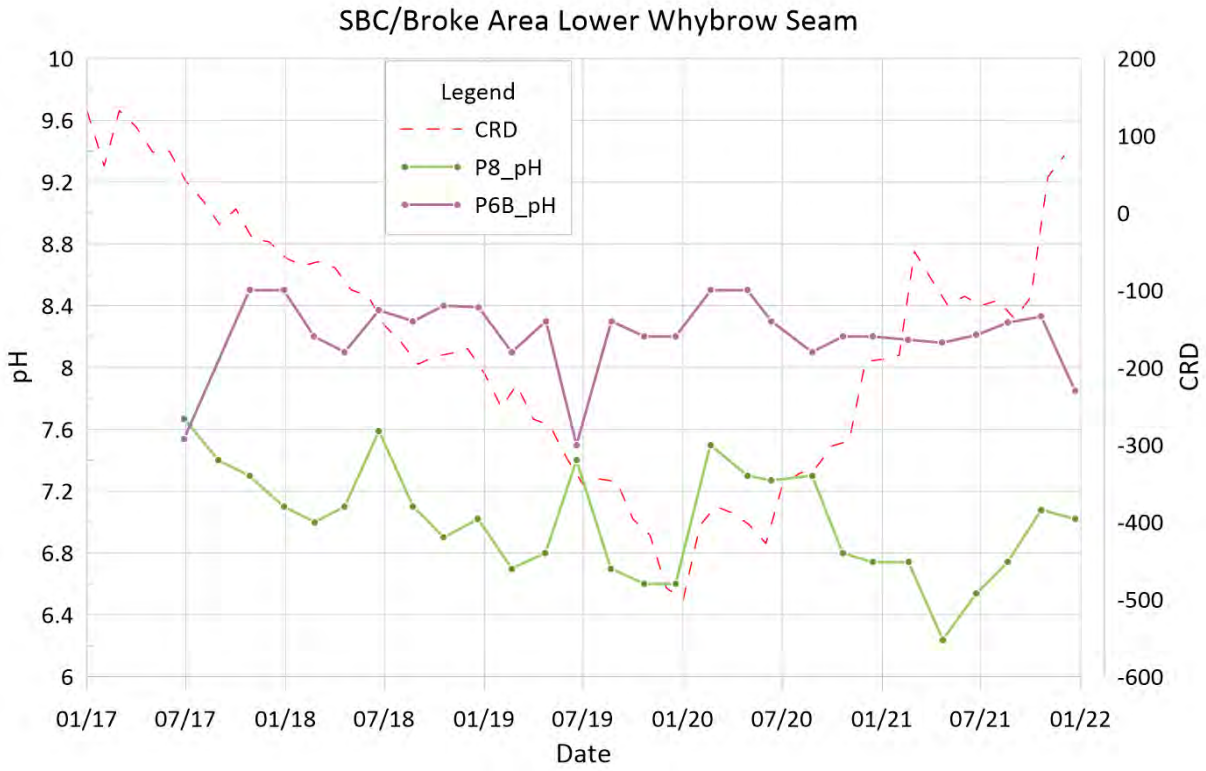


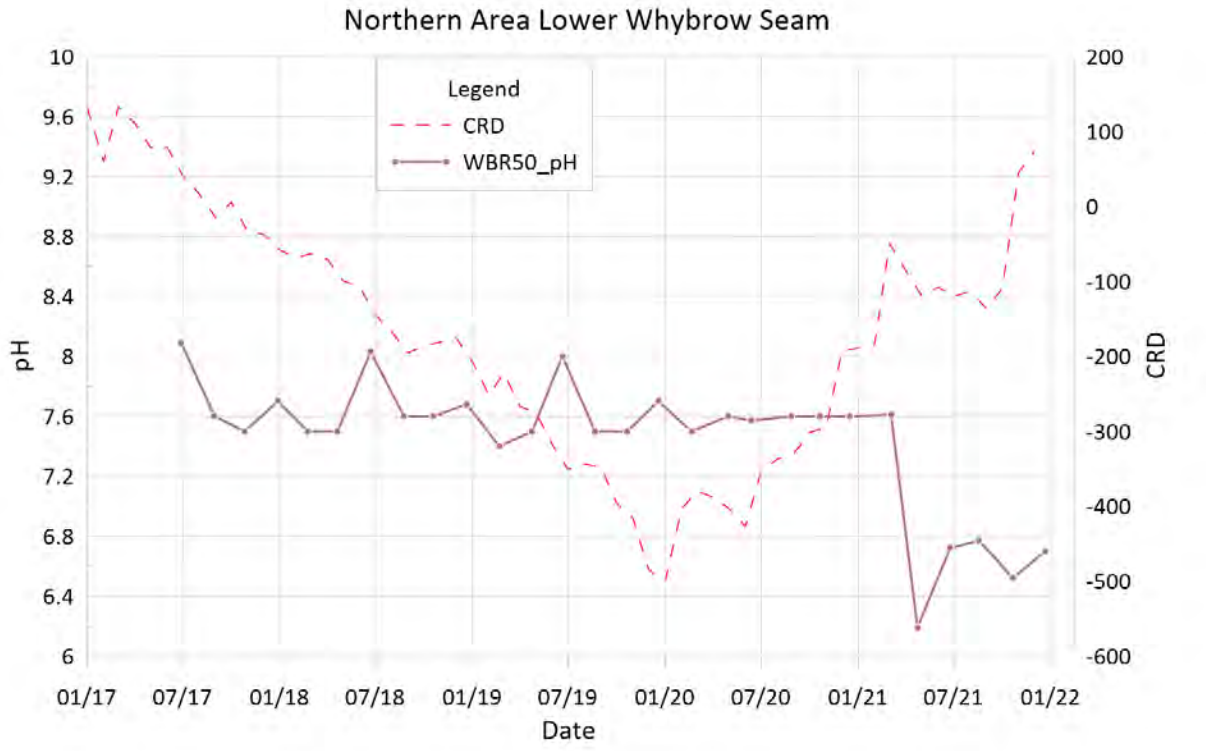
Appendix B
Groundwater EC and pH exceedance figures



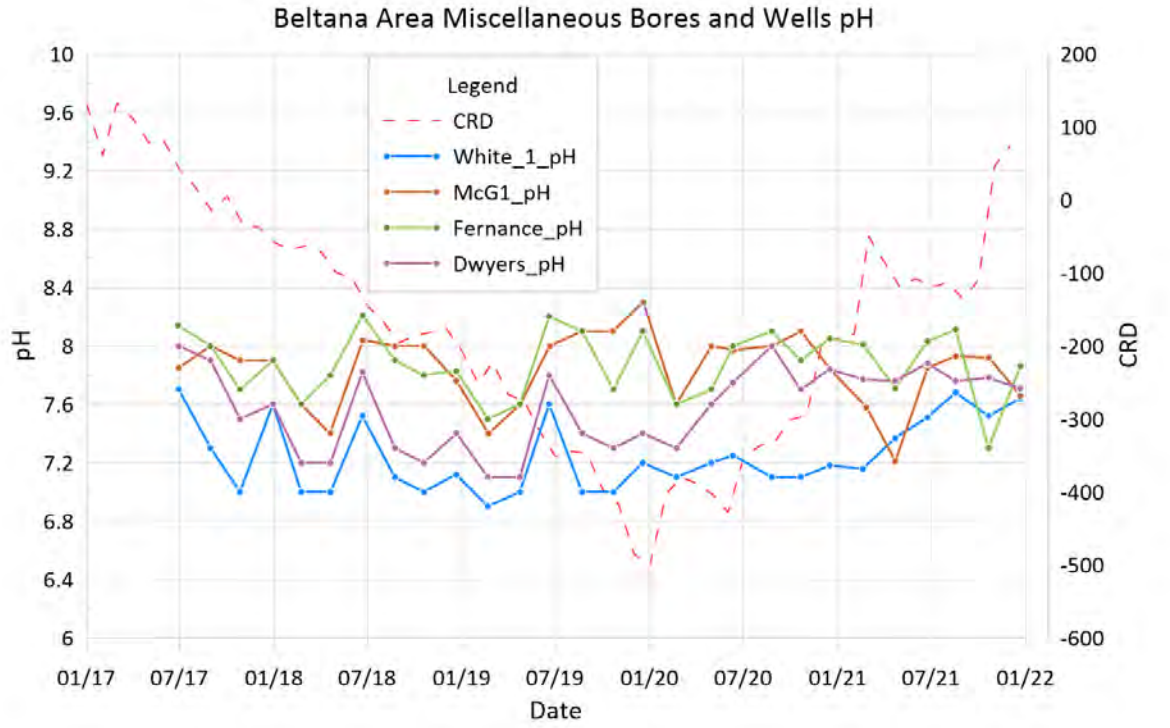


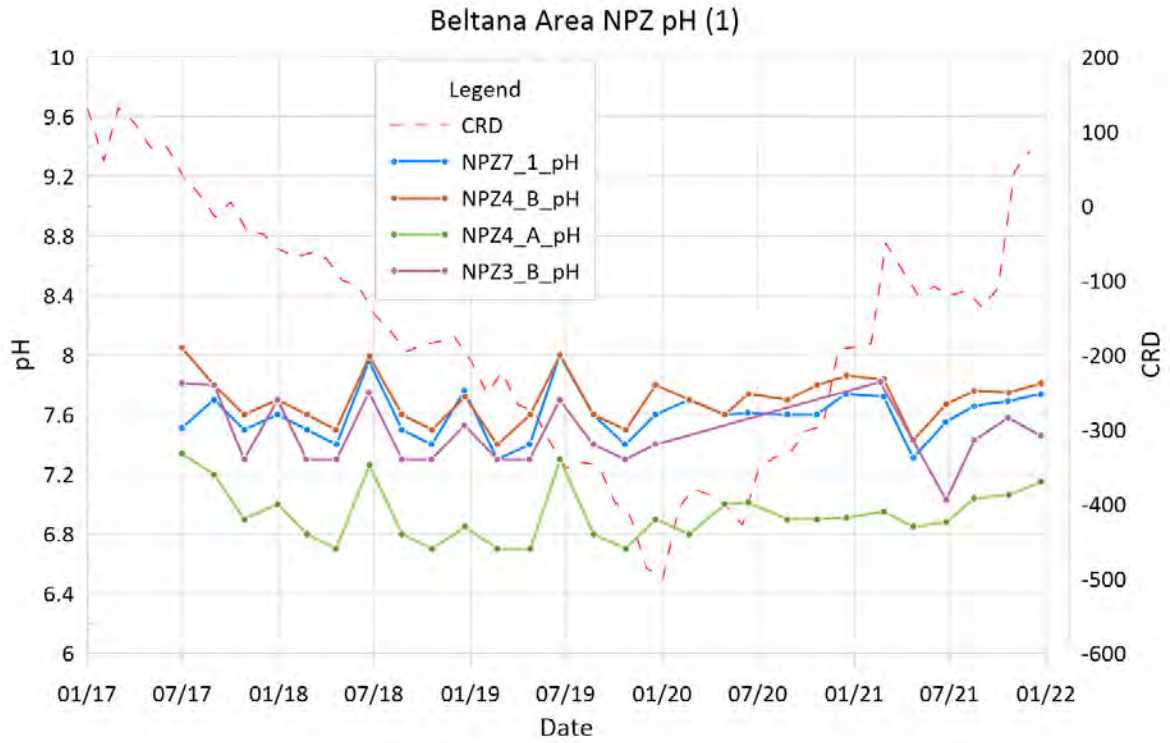
Appendix B
Groundwater EC and pH exceedance figures



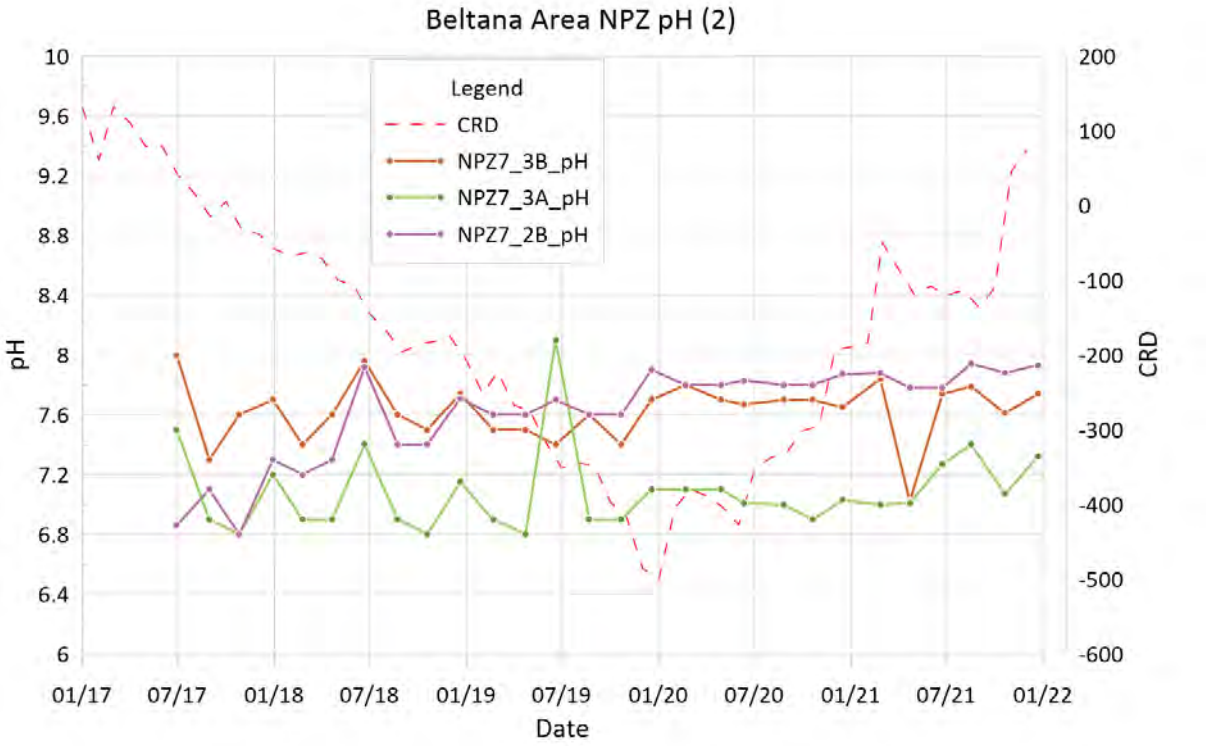


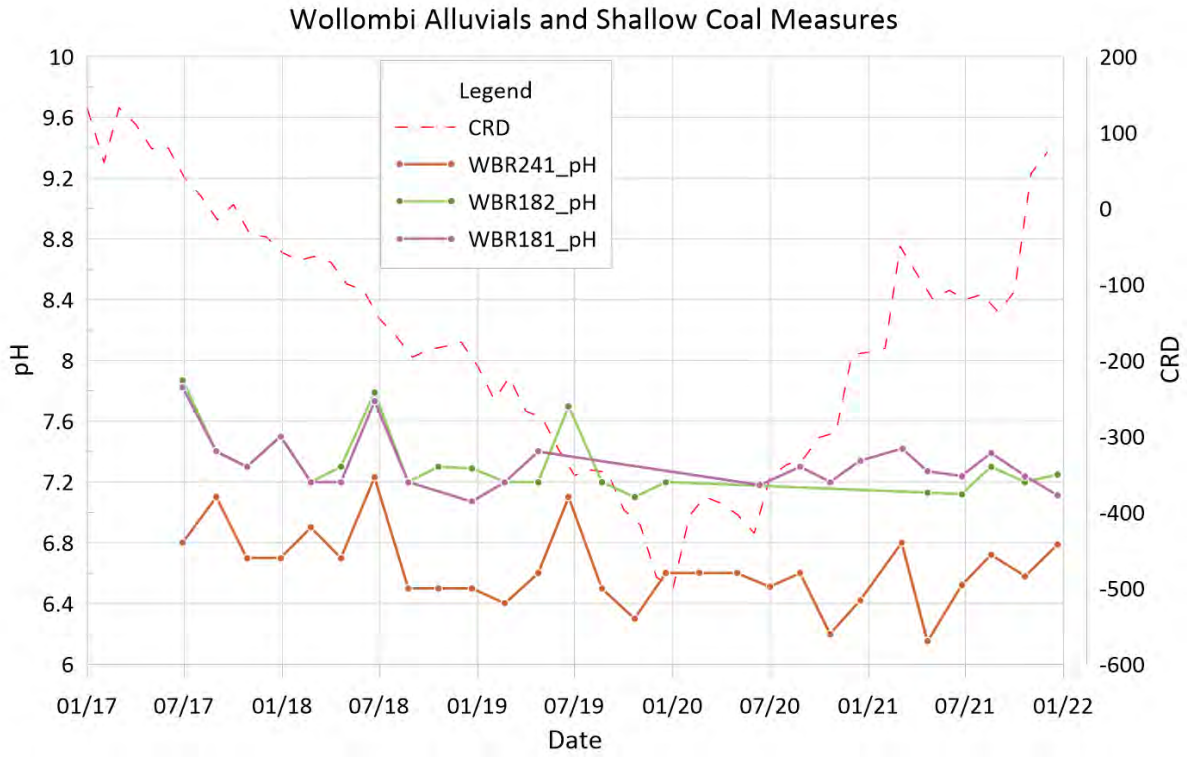
Appendix B
Groundwater EC and pH exceedance figures





Appendix B
Groundwater EC and pH exceedance figures





Appendix C. Groundwater EC trigger exceedance report – Jacobs (2022)

Level 4, 12 Stewart Ave
Newcastle West
NSW, 2302
0474 77 3919

www.jacobs.com

31 January 2022

Attention: Webster
Glencore Coal Australia
Bulga Coal Mine NSW

Project Name: Bulga Operations

Subject: Review of Q3 Groundwater EC Trigger Exceedances

Dear Lily,

1. Introduction

Bulga Coal Mine is located 15 kilometres south-west of Singleton in the Hunter Valley, NSW. Bulga Coal operate under two Development Consents, DA 376-8-2003 for the Bulga Underground Operations and SSD-4960 for Bulga Open Cut. Both operations fall under Environmental Protection Licence EPL 563. The site groundwater monitoring and exceedance response protocol are outlined by the Bulga Coal Water Management Plan (WMP).

The purpose of this memorandum is to undertake an investigation of groundwater quality trigger electrical conductivity (EC) exceedances at monitoring bores WBR240, P6B, WBR183, V3, WBR15, NPZ5-A, WBR182 and F1 at Bulga Mine for Quarter 3, 2021. Furthermore, two additional bores with elevated EC values were included in the review, including GW2 and SBD196. The aim of the review is to ascertain if increasing electrical conductivity trends are likely caused by prevailing climatic conditions or if other external factors have contributed. This memorandum provides a review of groundwater level and EC trends in relevant bores and climatic conditions and provides a summary of findings from the exceedance review.

2. Hydrogeology

Relevant hydrogeological units to the groundwater trigger exceedance review include the following:

- alluvial aquifers associated with Wollombi Brook, Monkey Creek Place and Loders Creek;
- weathered and fractured shallow sandstone and coal stratigraphy, regolith and colluvium; and
- underlying fractured rock aquifers associated with the Whittingham and Wollombi Coal measures.

3. Climate

Rainfall in the Hunter region is seasonal with rainfall occurring predominantly in the warmer months (refer Table 1). **Figure 1** shows rainfall trend compared to the average, where a declining slope indicates below average rainfall, an increasing slope indicates above average rainfall and a relatively flat trend indicates average rainfall. **Figure 1** shows that 2016 to early 2020 was a period of below average rainfall and is considered a drought period. Subsequent to rain in February and March 2020, the drought period ended and rainfalls since have been average or above average. Monthly rainfall trends for the region between 2018 and 2021 are shown in **Figure 1Error! Reference source not found.**. Monthly rainfall data is from Bureau of Meteorology (BOM) Station 61191 – Bulga (South Wambo).

Surface water flow data for Wollombi Brook (measured at Bulga measurement station 210028) was reviewed; water level and EC data from 2021 is shown in **Figure 2**. Rainfall also caused intermittent changes to the stream stage height in Wollombi Brook, which flows adjacent Bulga Mine Complex. **Figure 2** shows Wollombi Brook electrical conductivity vs water level (BOM measurement station 210028 – Wollombi Brook at Bulga). Peaks in stream height match low values of EC in the stream water. Considering the stream contributes to the recharge of the alluvial aquifer, rainfall and recharge of low EC water from the stream is likely to cause the EC of the alluvial groundwater to decline.

Table 1: rainfall statistics - 1959 to 2021 (Bulga Mine site - BOM station 61191)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	87.0	86.3	70.8	45.4	39.4	44.3	30.6	34.5	38.4	55.4	64.2	73.9	669.6

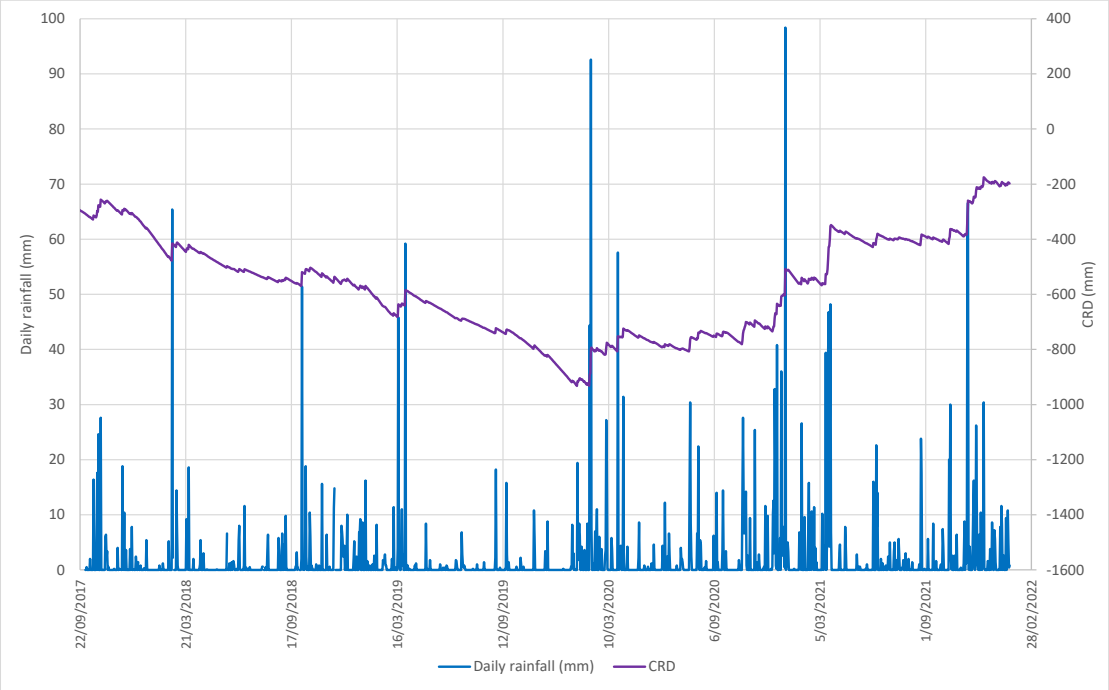


Figure 1 Cumulative Rainfall Departure (CRD) graph

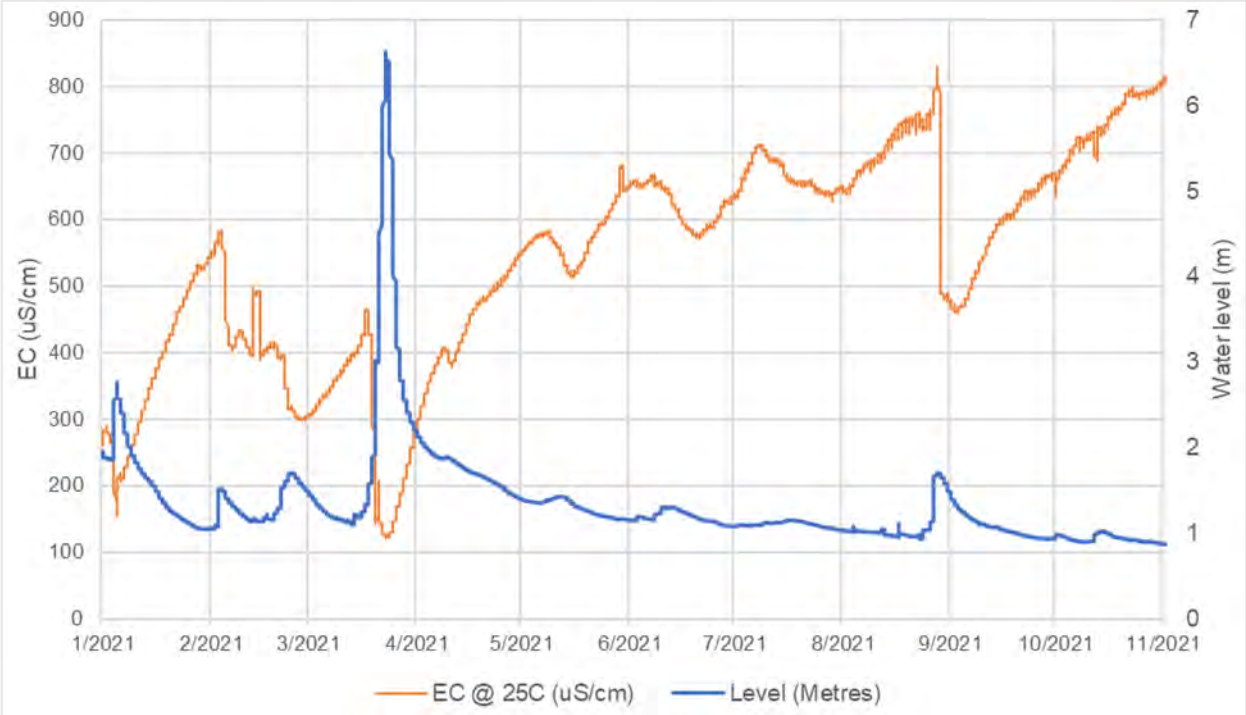


Figure 2 Wollombi Brook EC and water level data (BOM measurement station 210028 – Wollombi Brook at Bulga)

4. Groundwater trigger exceedances

4.1 Criteria

Groundwater exceedances over Q3 2021 occurred in site alluvial aquifers (Wollombi Creek and Monkey Place Creek alluvium), shallow Permian strata and shallow coal measures, and a single deep coal measure bore in the Lower Whybrow seam. This exceedance review will thus be divided into relevant hydrostratigraphic units to evaluate relevant factors.

The Q3 2021 groundwater EC exceedances are compared against values listed in the Bulga site Water Management Plan (Glencore 2021). The WMP groundwater trigger values were recently reviewed and updated in the latest version of the WMP (effective 15/10/2021). This review considers both the old and updated trigger values to compare results to long-term trends and updated data. Both sets of trigger values are listed in Table 2.

Table 2: Groundwater bore EC values and triggers (Glencore 2021)

Bore monitoring strata	Bore ID		EC trigger WMP effective 22/02/2017	EC trigger WMP effective 15/10/2021	Lab EC value October 2021 (µS/cm)
Alluvial	Monkey Place Creek	GW2	-*	-*	6,300
	Wollombi Creek	V3	1,566	1,744	1,920
		WBR15	911	924	1,330
		WBR182	1,473	1,512	1,610
		F1	833	1,025	1,460
Shallow Permian strata / shallow coal measure	WBR240		ND	26,800	21,100
	SBD196		-*	-*	4,420
	WBR183		3,270	3,484	3,890
	NPZ5-A		894	886	924
Deep coal measure	P6B		1,350	1,353	6,510

Notes: *No trigger values established for GW2 or SBD196

4.2 Alluvial groundwater exceedances

Groundwater elevations trends and EC exceedances for bores GW2, V3, WBR15, WBR182 and F1 are shown in Figure 3 to Figure 12, respectively.

Groundwater elevations show a buffered response to climate conditions with alluvium bore water levels generally recovering from early 2020 onward (i.e., the end of the 2016-2019 drought). EC has generally remained as stable in the alluvium over 2020 and 2021 despite being above the trigger criteria. The exception is monitoring bore V3, which has declined over the two years and displays fluctuations in EC over the period. Additionally, Bore WBR182 increased from previous measurements in 2019, and EC was not recorded in 2020.

GW2 does not have a trigger value but was included in this review due to its elevated EC value and increase value trend.

Long-term trends for the bores show that EC has increased in the majority of bores from 2016 to 2020, subsequently remaining stable from early 2020 through Q3 2021.

4.3 Shallow Permian / shallow coal measure groundwater exceedances

Groundwater elevations trends and EC trends for the shallow Permian / shallow coal measure monitoring bores NPZ5-A, WBR183, WBR240, P6B, SBD196 and V3 are shown in Figure 13 to Figure 20. SBD196 does not have a trigger in the Bulga WMP.

As per the alluvium monitoring bores, the shallow Permian groundwater elevations show a buffered response to climate conditions with monitoring bore water levels generally recovering from early 2020 onward (i.e., the end of the 2016-2019 drought). Groundwater EC values for the shallow Permian monitoring bores generally remained stable between 2020 and Q3 2021, with the exception of WBR183 which increased slightly (refer Figure 18).

Long-term EC trends show increasing trend in EC recorded between 2017 and 2019, with EC values stabilising or decreasing in 2020 through Q3 2021. This is attributable to climate conditions (ie. drought) causing reduced recharge of fresh water from the surface.

4.4 Deep coal measure exceedances

Groundwater field EC in deep coal measure bore P6B ranged from ~8,500 µS/cm to 7,300 µS/cm between 2020 and Q3 2021, with a lab EC value of 6,510 µS/cm recorded in October 2021. Groundwater level and EC trends for bore P6B is shown in Figure 21 and Figure 22, respectively. The trigger value for the bore is 1,350 µS/cm per the Bulga WMP (effective 2017) and has increased to 1,353 µS/cm in the 2021 WMP revision.

Long-term EC records for the bore show a sharp spike in EC in Q3 2017, with values increasing from 1,555 µS/cm to 6,890 µS/cm between June and October 2017. This sudden change could be attributable to a change in sampling methodology or contractor. Groundwater EC has

increased in the bore to values mentioned above. Through 2020 and 2021, groundwater EC has remained relatively stable.

5. Conclusion and recommendations

Eastern Australia experienced drought conditions between 2017 through to early 2020, with record low rainfall and widespread dry conditions observed. In 2017, 2018 and 2019, rainfall was measured below average over the cool months of April through September. The Hunter region received around 170 mm less rainfall than the next driest period (BOM, 2021). Rainfall over 2020 and 2021 has since alleviated the region from drought conditions.

Groundwater level trends and groundwater EC trends are generally aligned with the rainfall deficit trends and recover post-drought in the region. Long-term trends for Bulga groundwater monitoring bores reflect the drought conditions from 2017 to 2019; bores recorded increasing EC over the period of drought, and EC has remained generally stable since the end of drought conditions in early-2020. This trend is similarly reflected in groundwater level and recharge trends over the period, with groundwater levels increasing throughout 2020 and 2021.

Long-term groundwater EC exceedances are likely linked to regional climatic conditions and do not show distinct impacts attributable to mining activities at Bulga Coal.

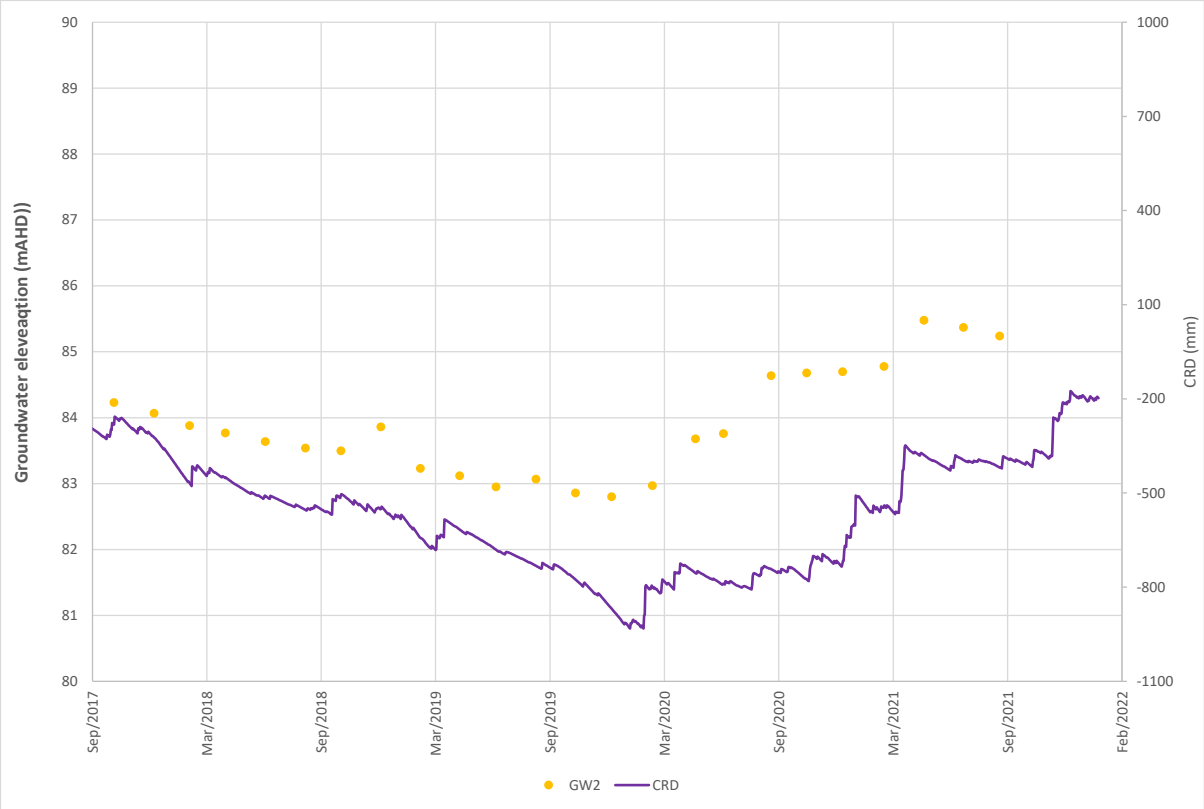


Figure 3 Groundwater elevation vs CRD – GW2 (alluvium)

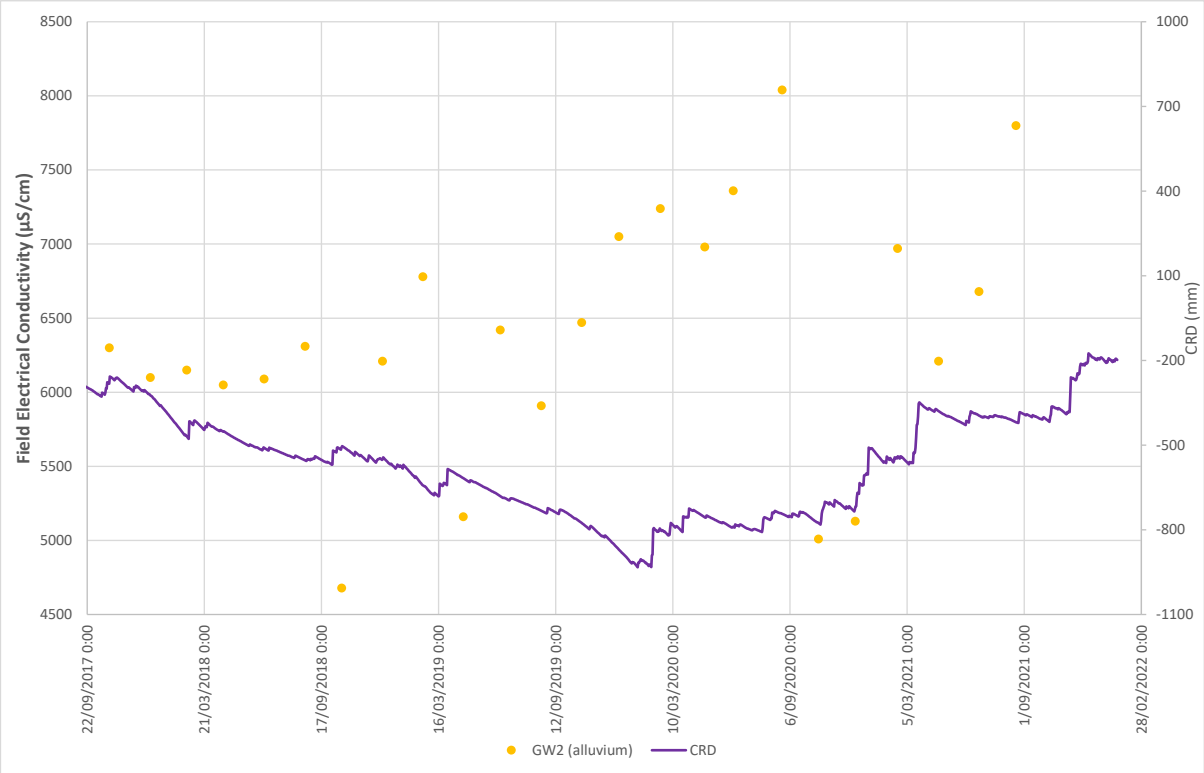


Figure 4 Groundwater EC vs CRD – GW2 (alluvium)

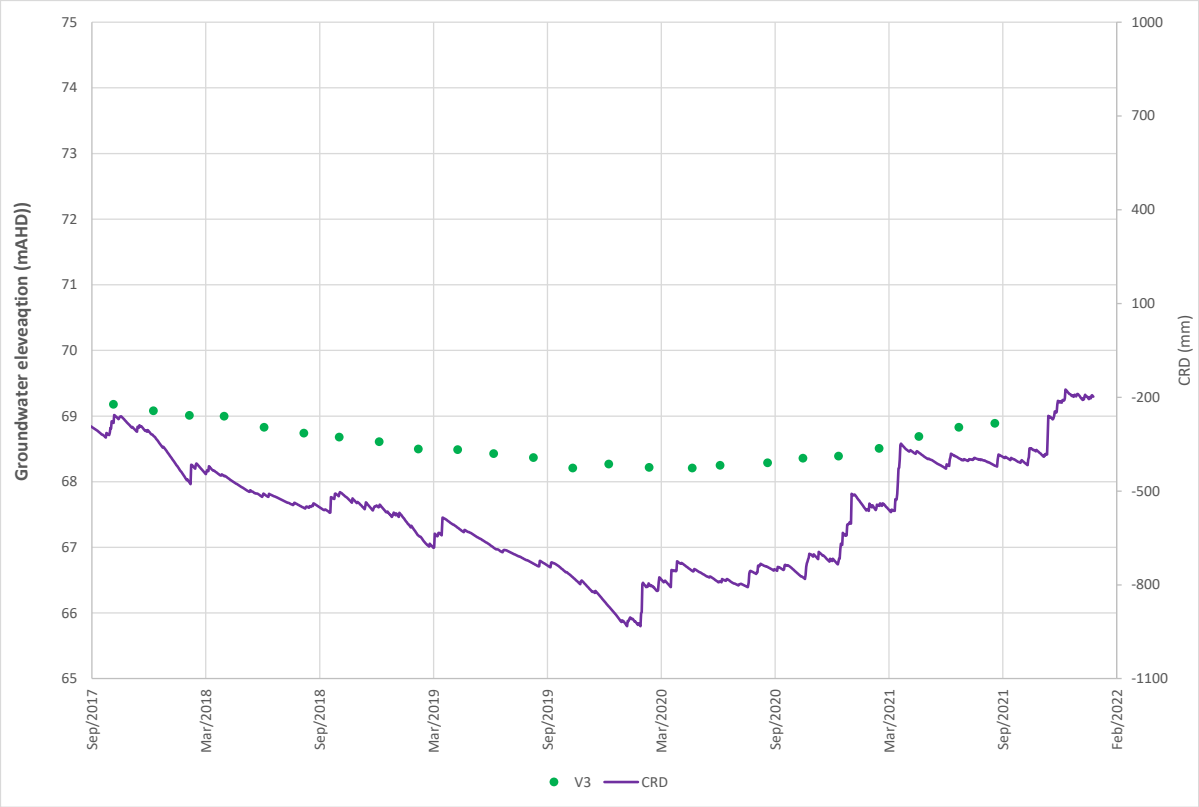


Figure 5 Groundwater elevation vs CRD – V3 (alluvium)

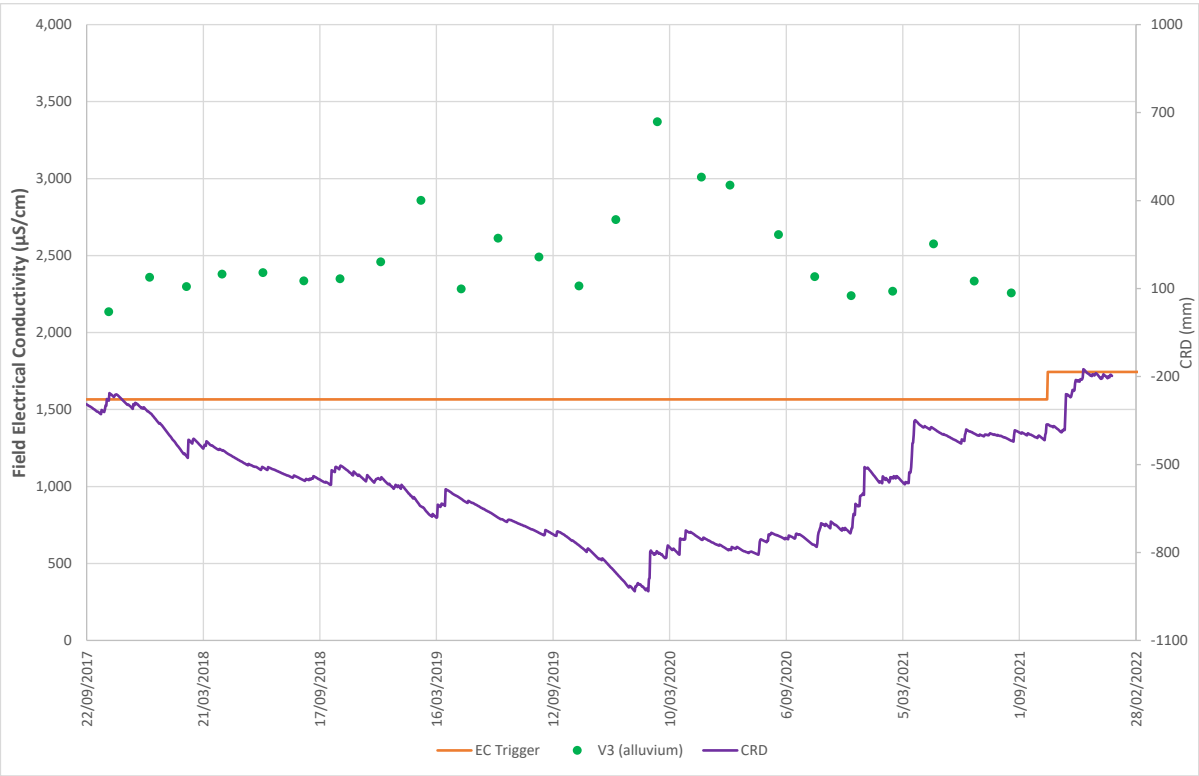


Figure 6 Groundwater EC vs CRD – V3 (alluvium)

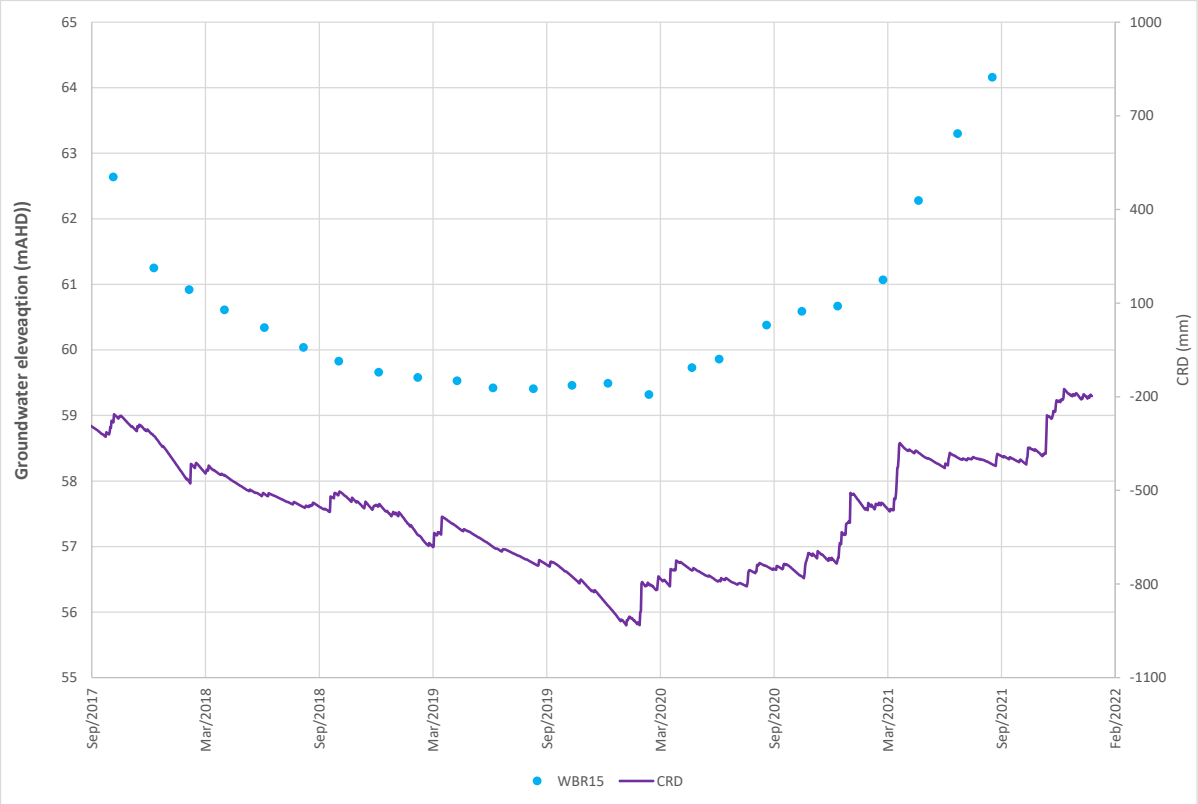


Figure 7 Groundwater elevation vs CRD – WBR15 (alluvium)

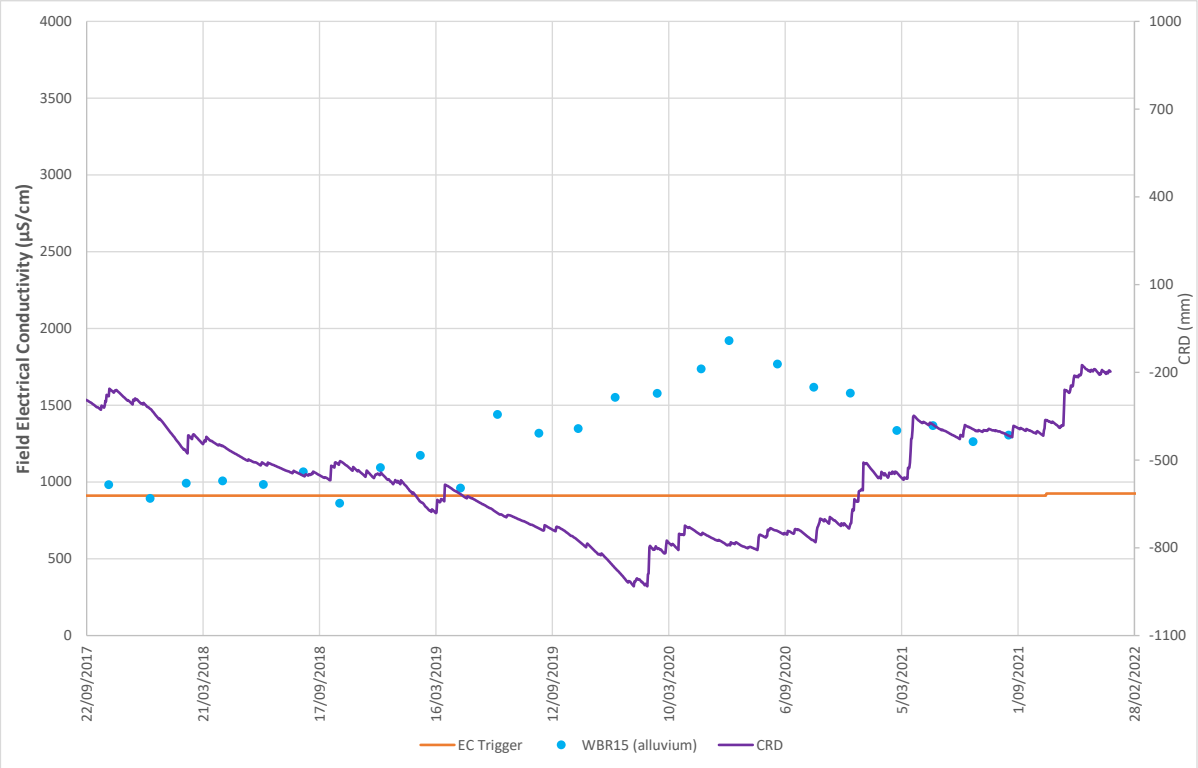


Figure 8 Groundwater EC vs CRD – WBR15 (alluvium)

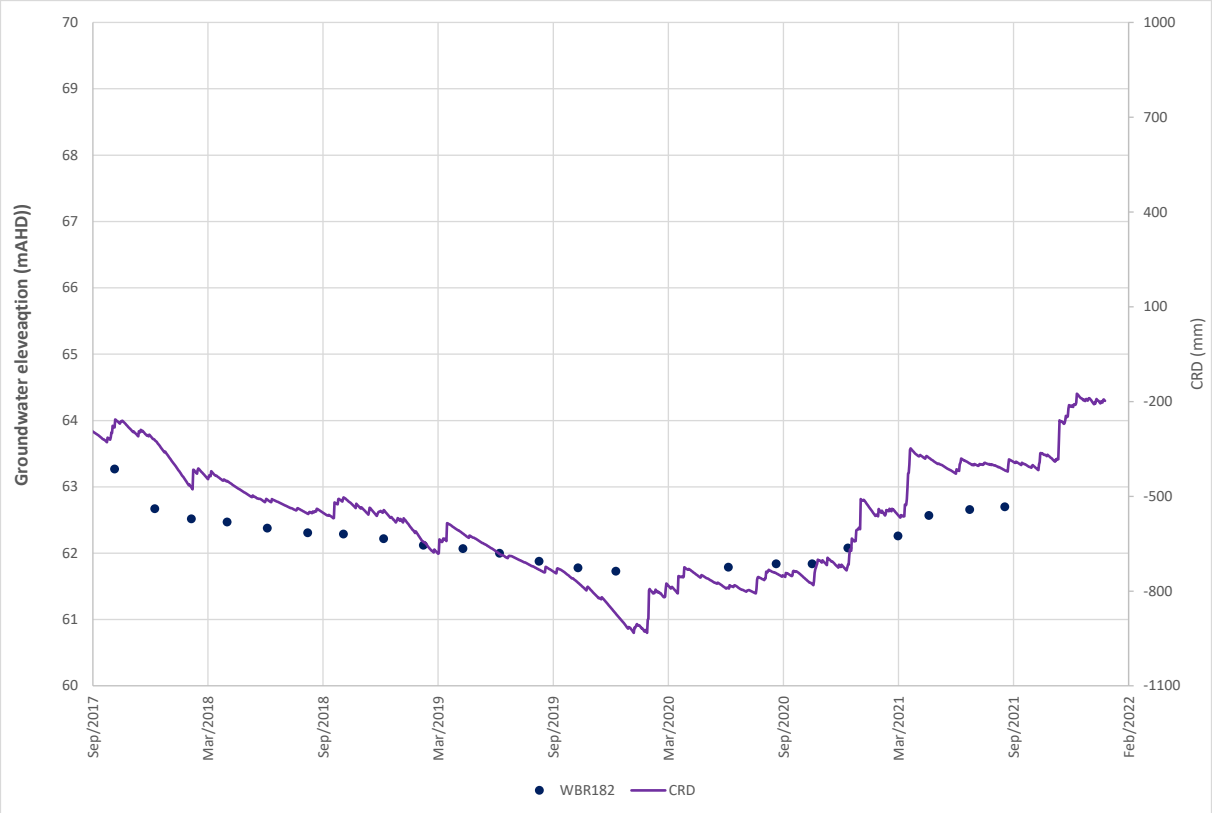


Figure 9 Groundwater elevation vs CRD – WBR182 (alluvium)

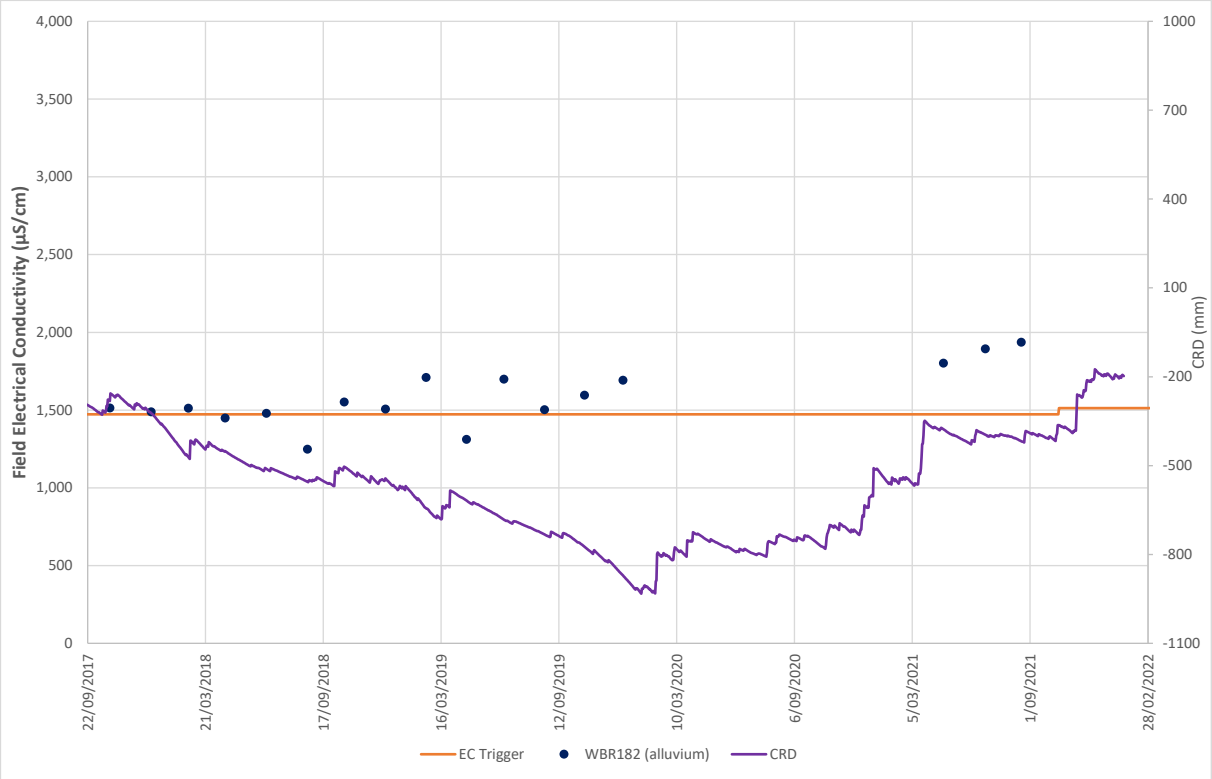


Figure 10 Groundwater EC vs CRD – WBR182 (alluvium)

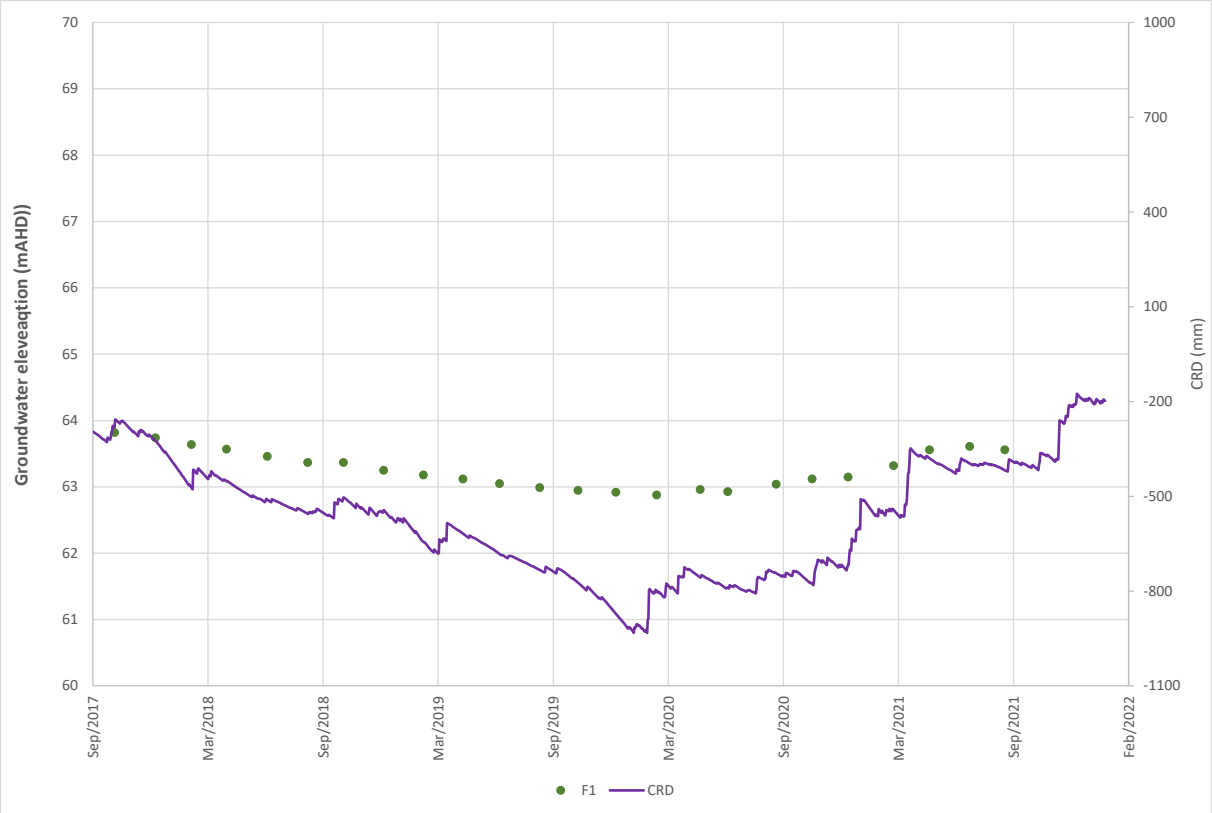


Figure 11 Groundwater elevation vs CRD – F1 (alluvium)

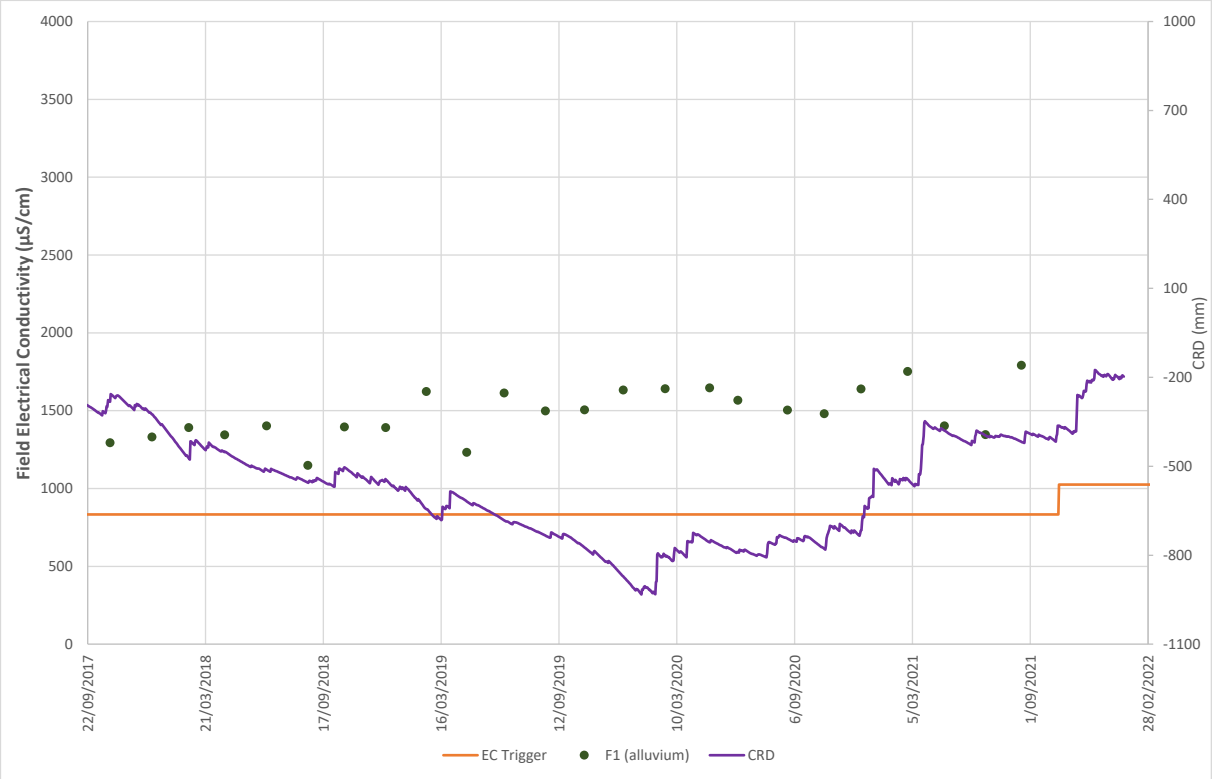


Figure 12 Groundwater EC vs CRD – F1 (alluvium)

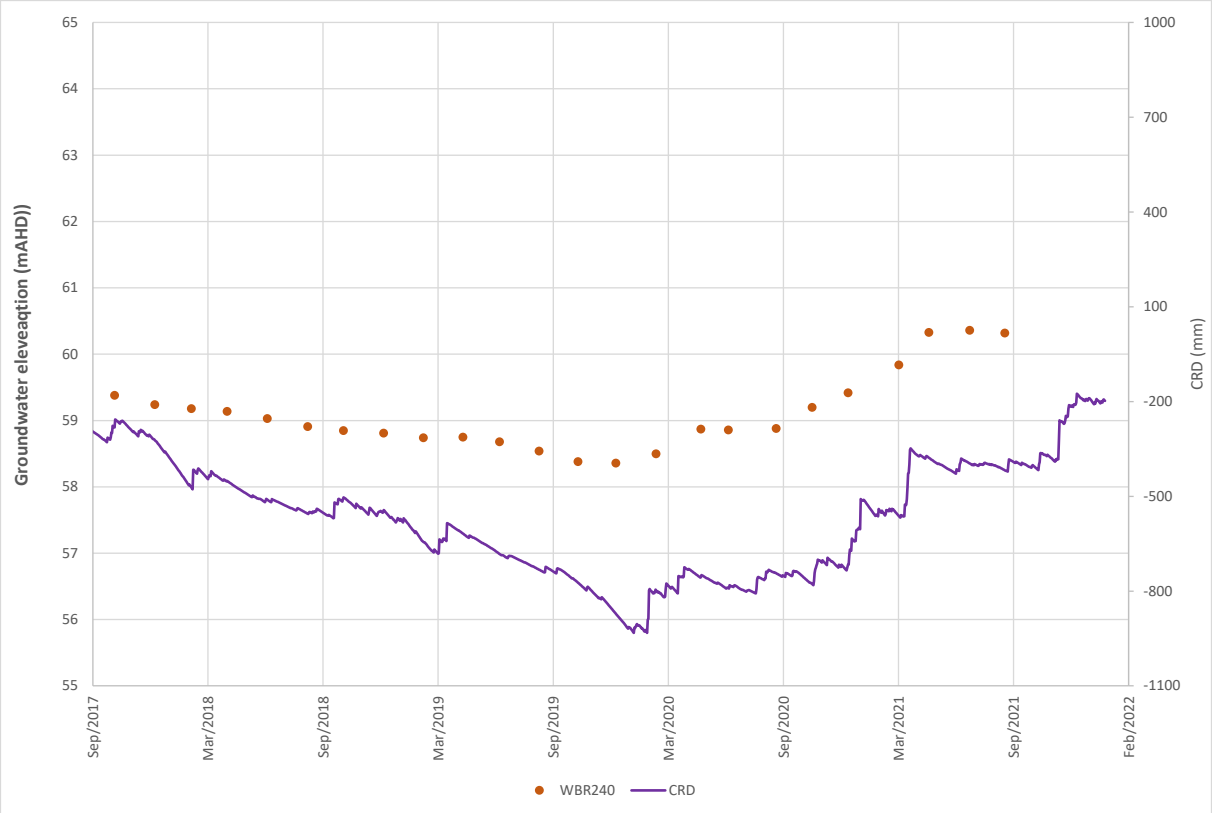


Figure 13 Groundwater elevation vs CRD – WBR240 (shallow Permian strata)

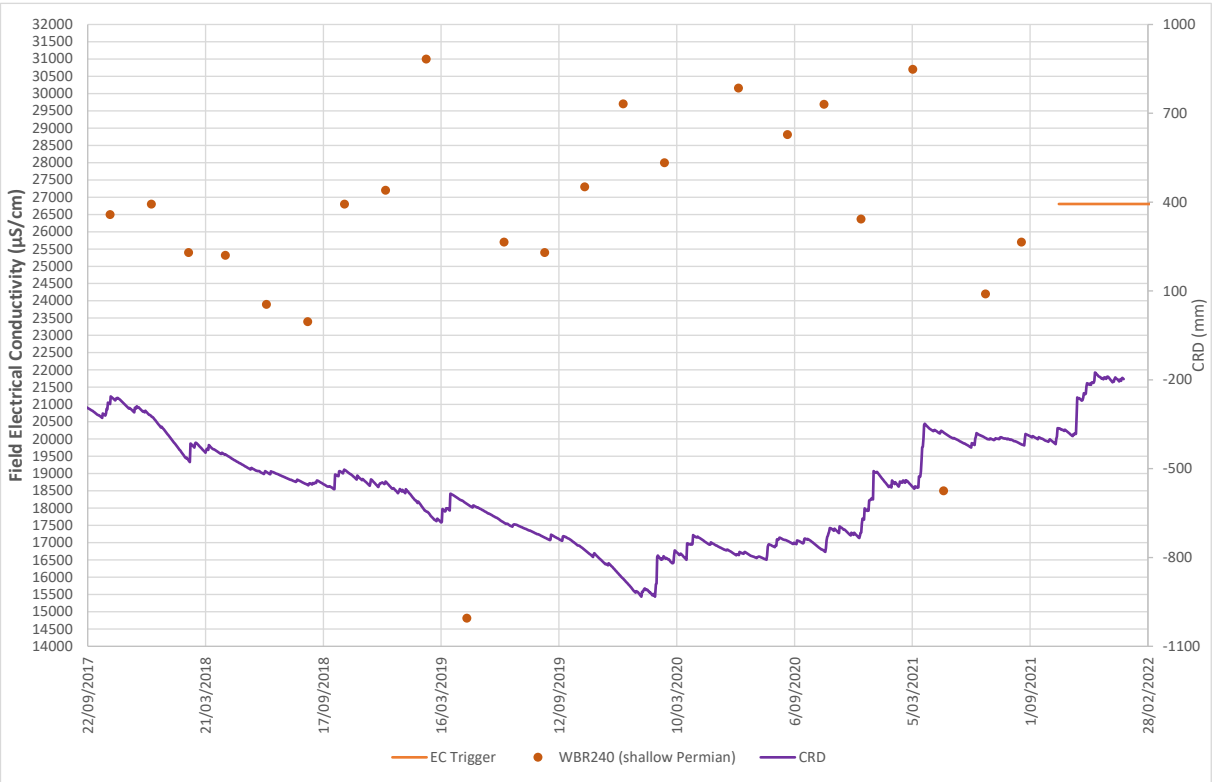


Figure 14 Groundwater EC vs CRD – WBR240 (shallow Permian strata)

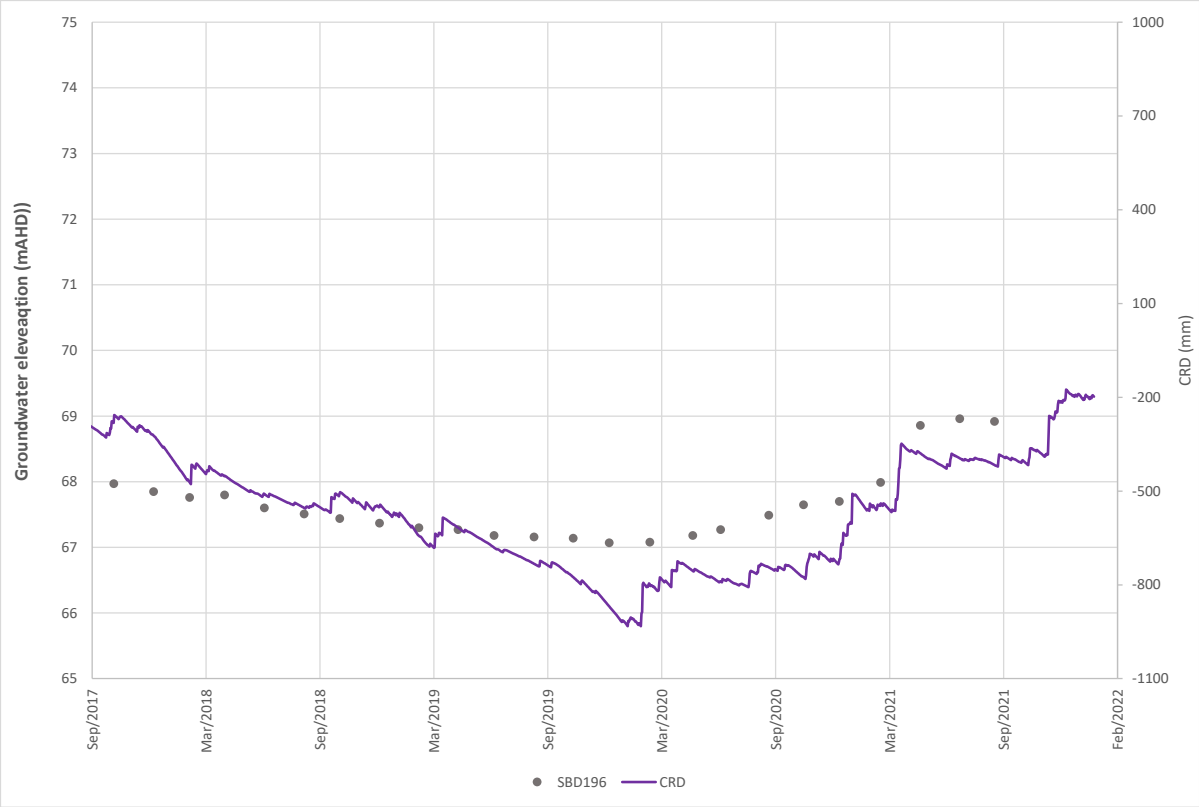


Figure 15 Groundwater elevation vs CRD – SBD196 (shallow Permian strata)

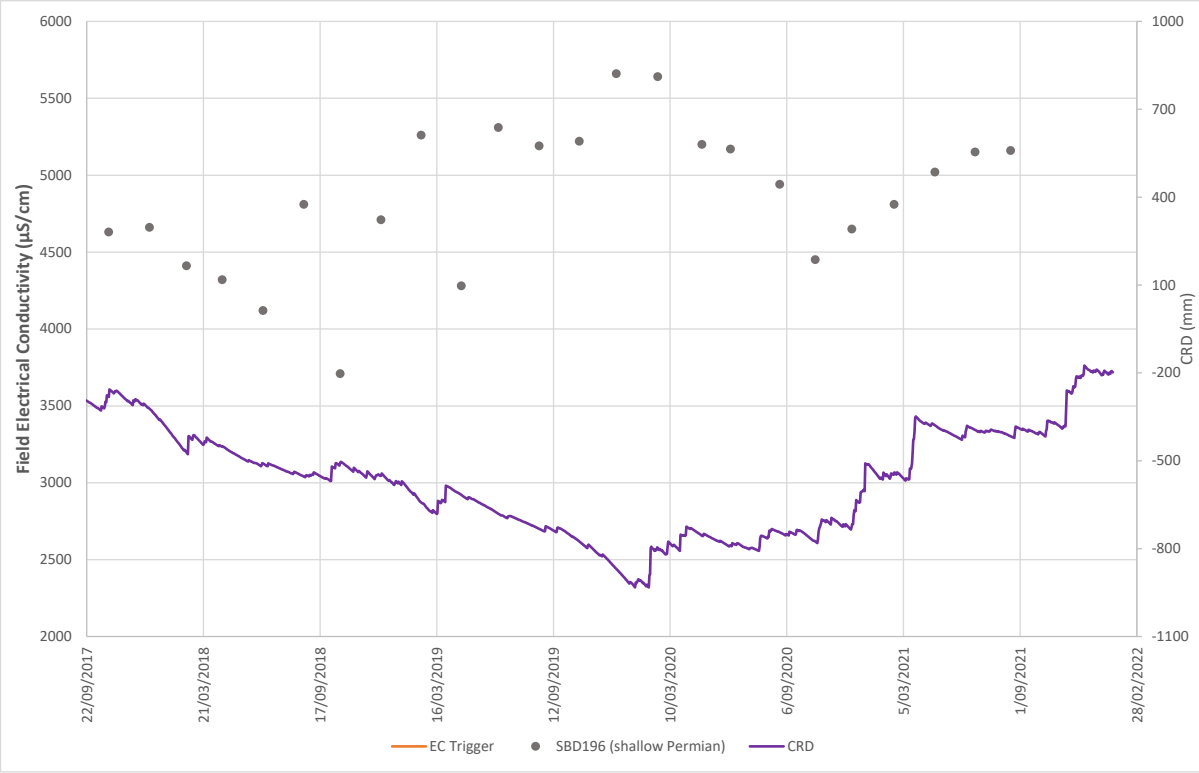


Figure 16 Groundwater EC vs CRD – SBD196 (shallow Permian strata)

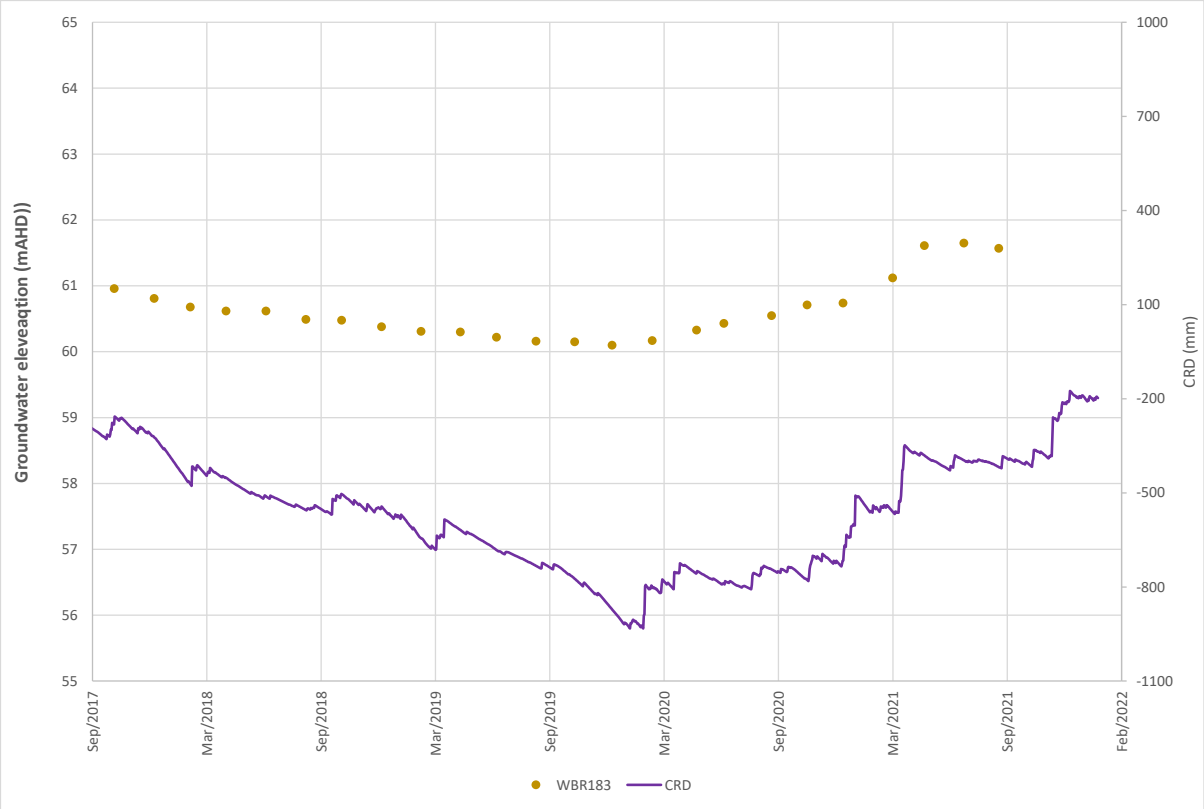


Figure 17 Groundwater elevation vs CRD – WBR183 (shallow Permian strata)

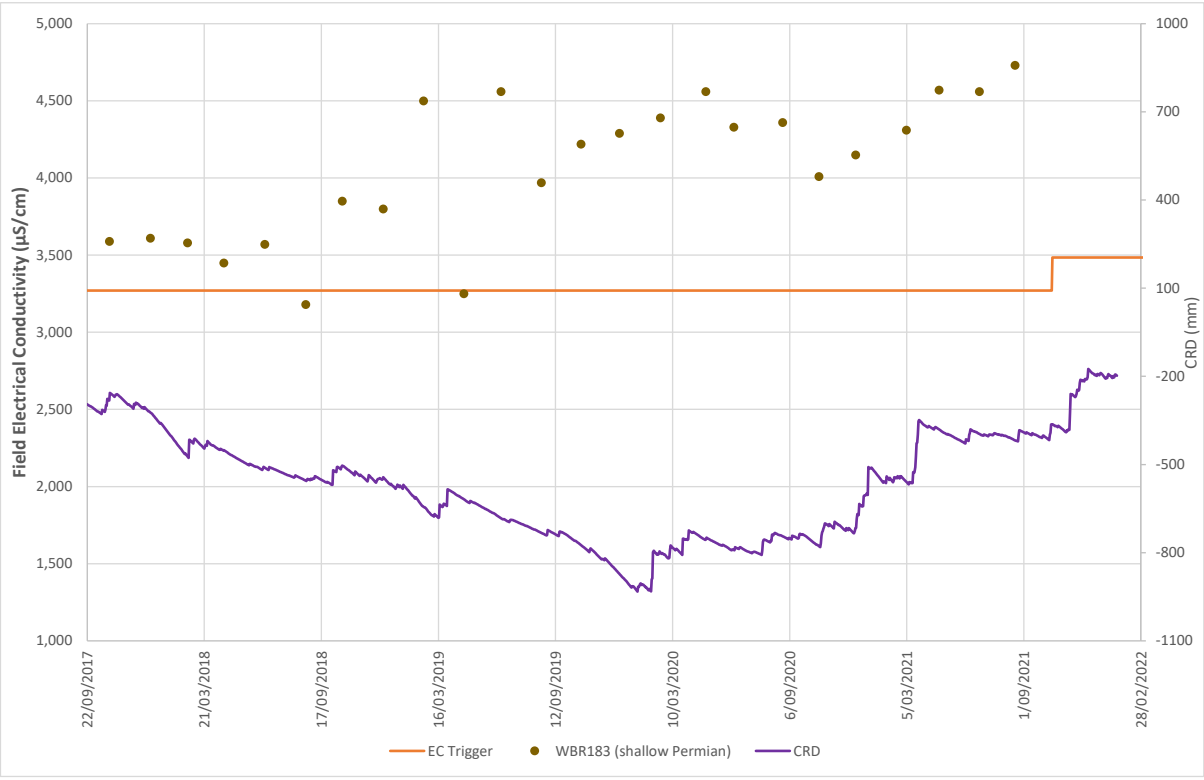


Figure 18 Groundwater EC vs CRD – WBR183 (shallow Permian strata)

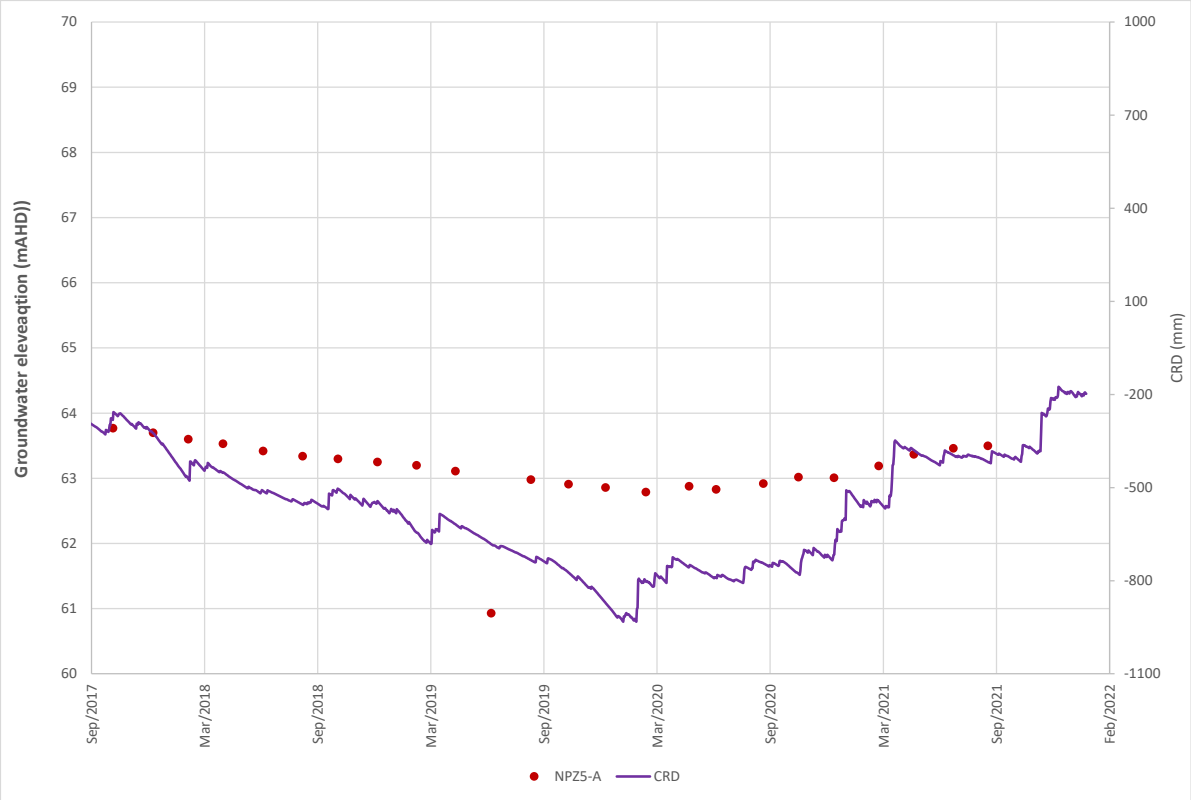


Figure 19 Groundwater elevation vs CRD – NPZ5-A (shallow Permian strata)

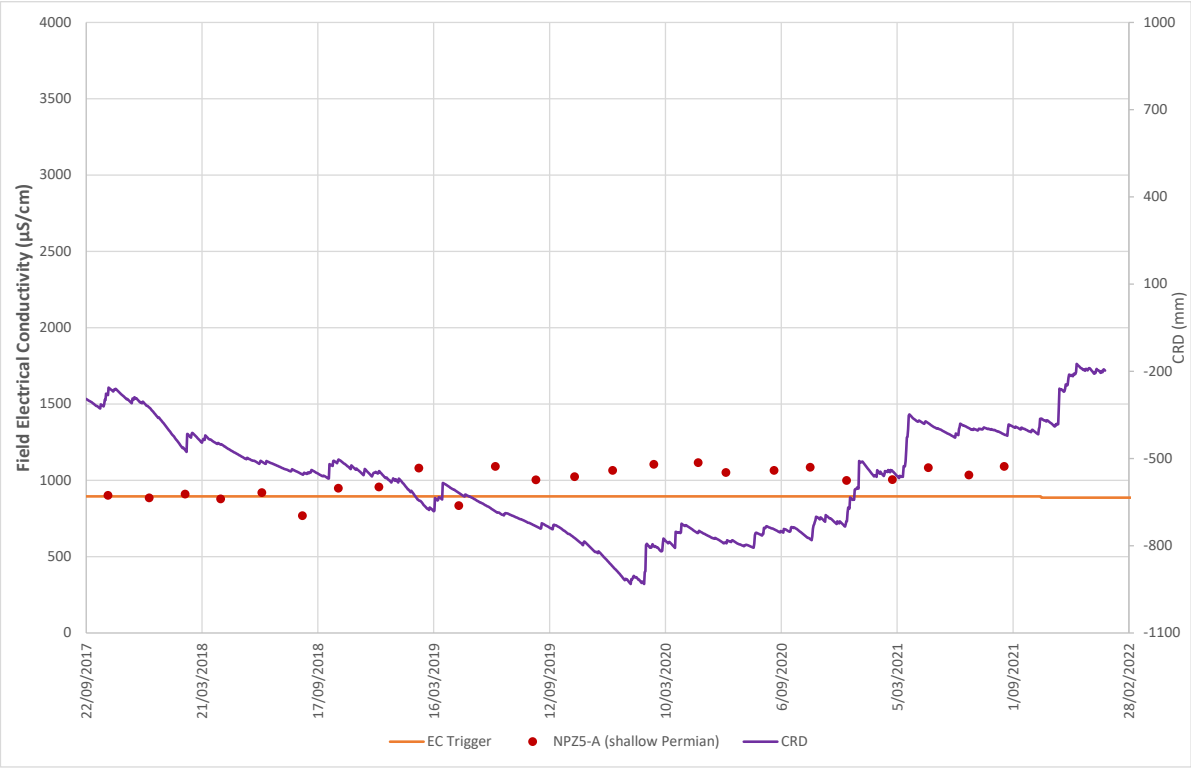


Figure 20 Groundwater EC vs CRD – NPZ5-A (shallow Permian strata)

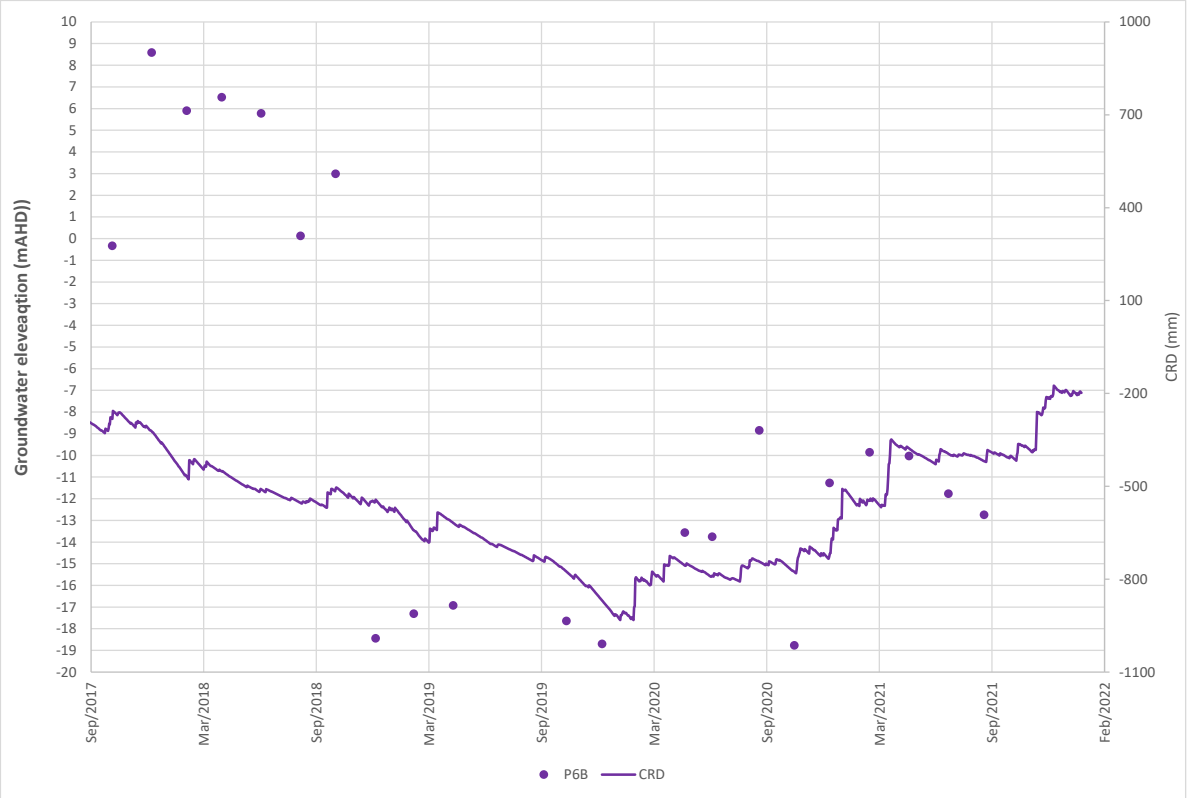


Figure 21 Groundwater elevation vs CRD – P6b (deep Permian strata)

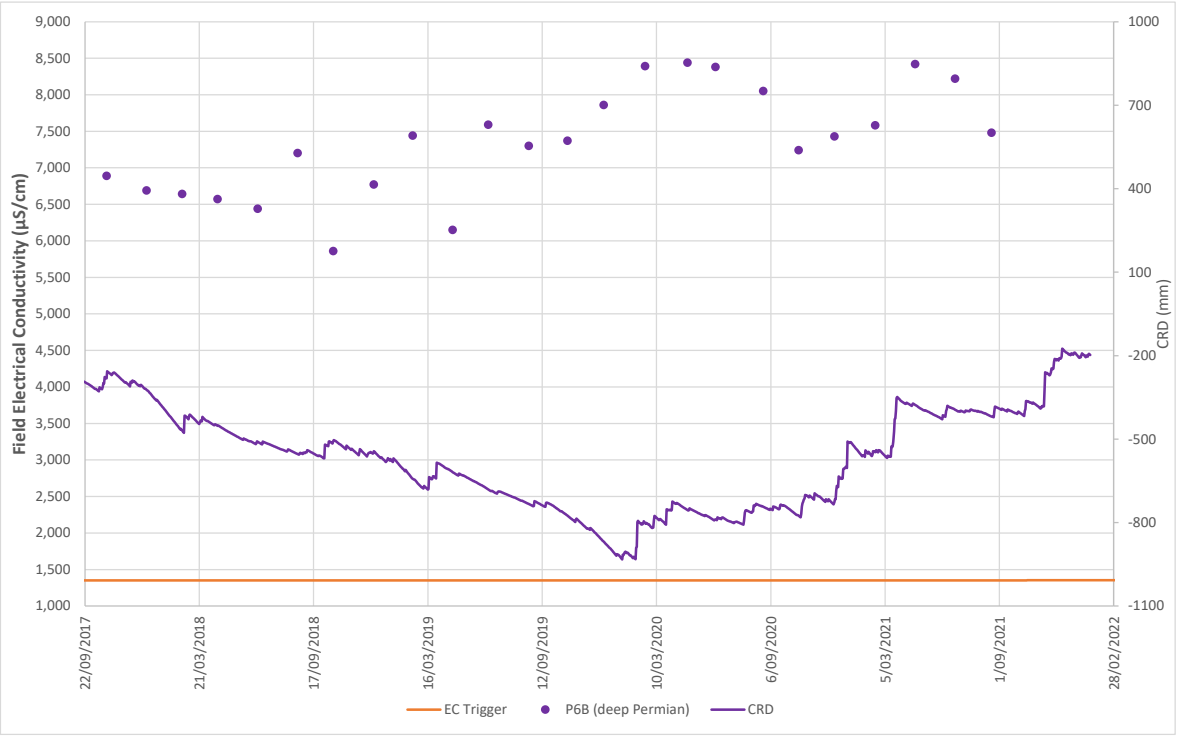


Figure 22 Groundwater EC vs CRD – P6b (deep Permian strata)

APPENDIX E

Completion Criteria Checklist

The following table provides a colour-coded guide to how the rehabilitation is progressing towards the closure criteria. The colour-coding relates to green achieving the benchmark value, blue within 20% of the benchmark value, orange between 21% and 50% of the benchmark value and red below 50% of the benchmark value.

5.2 Comparison of Results Against Performance Indicators

To track changes to values at the monitoring sites, the 2021 LTM results have been compared to their relevant performance indicators and triggers (as defined in the MOP). This will assist in identifying where management actions have been successful and where they may require review. **Table 5.3** summarises how the LTM monitoring sites are performing against relevant actions, targets and biodiversity triggers of the MOP using the following colour codes to identify:

Green	Criteria satisfied
Orange	Criteria partially satisfied
Red	Criteria not satisfied

Several factors have been identified in the completion criteria outlined in the MOP needing to be addressed before they will meet relevant criteria.

Table 5.3 Comparison of Monitoring Outcomes Against Completion Criteria – Ecological Rehabilitation (EEC) – PCT 1603 Grey box Ironbark Woodland

Rehabilitation Objective	Completion Criteria	Performance Indices	GBIW01B	GBIW02B	GBIW03B	GBIW04B	GBIW06B	GBIW07B	GBIW08B	GBIW09B	GBIW10B	GBIW11B	GBIW12B	GBIW13B	GBIW14B	GBIW15B	GBIW16B	GBIW17B	GBIW18B	GBIW19B	GBIW20B	GBIW21B	GBIW22B	GBIW23B	GBIW24B	NB6	NVB1	NVB3	SE1
Ecological Rehabilitation	**Objective 1**																												
The vegetation composition of the rehabilitation is recognisable as the target vegetation community (e.g., plant community type (PCT) contained within the NSW Vegetation Information System) **Note:** Recognisable is defined as' Diagnostic species present for each Growth form for PCT/TEC using the scientific description of the PCT available on Bionet	Native plant species are characteristic of the target plant community(s) **Note:** 'Characteristic of target plant community' is defined as '50% of all species in each Growth Form (i.e., trees, shrubs, grasses, forbs and ferns and other) that are known and accepted to form part of the PCT/TEC against benchmark value'	The compositional attribute score is a minimum of 50% for each rehabilitation monitoring site. **Note:** The compositional attribute score is based on the native species richness compared to benchmarks																												
Ecological Rehabilitation	**Objective 2**																												
The vegetation structure of the rehabilitation is recognisable as, or is trending towards the target plant community (e.g., plant community type (PCT) contained within the NSW Vegetation Information System) **Note:** 'Trending Towards the target plant community' requires use of time series data to show canopy height and cover for each Growth Form against benchmark value range (or successional benchmark)s	Cover and height range of all Growth Forms are characteristic of, or trending towards the target plant community(s)	The structural attribute score is a minimum of 50% for each rehabilitation monitoring site. **Note:** The structural attribute score is based on the foliage cover for each growth form group and is compared to benchmarks																												

Rehabilitation Objective	Completion Criteria	Performance Indices	GBIW01B	GBIW02B	GBIW03B	GBIW04B	GBIW06B	GBIW07B	GBIW08B	GBIW09B	GBIW10B	GBIW11B	GBIW12B	GBIW13B	GBIW14B	GBIW15B	GBIW16B	GBIW17B	GBIW18B	GBIW19B	GBIW20B	GBIW21B	GBIW22B	GBIW23B	GBIW24B	NB6	NVB1	NVB3	SE1
Ecological Rehabilitation	**Objective 3**																												
Levels of ecosystem function have been established that demonstrate the rehabilitation is self-sustainable OR Is trending towards the target plant community (e.g., plant community type (PCT) contained within the NSW Vegetation Information System)	Ecosystem function Is characteristic of. or trending towards the target plant community(s), and Is suitable for sustaining the target plant community	The functional attribute score is a minimum of 50 for each rehabilitation monitoring site. **Note:** The functional attribute score is based on the following attributes and is compared to benchmarks · number of large trees tree stem size class tree regeneration length of fallen logs, litter cover, number of trees with hollows																											
	Plant is "suitable"[1] for sustaining the target plant community(s). Suitable means: [1] Weeds - demonstrated decline in cover of high threat weeds measured as a moving average over time. Cover of high threat weeds within range measured at reference sites	The total cover of exotic plant species Is recorded at fixed monitoring plots or transects as per BAM and is within the range measured at reference sites																											
	Animal habitat is characteristic of the target plant community(s) (as measured by the above composition, structural and functional component)s																												

Table 5.4 Comparison of Monitoring Outcomes Against Completion Criteria – Ecological Rehabilitation (EEC) – PCT 1604 (Ironbark – Spotted Gum – Grey Box Woodland)

Rehabilitation Objective	Completion Criteria	Performance Indices	ISGGB01B	ISGGB02B	ISGGB03B	ISGGB04B	ISGGB05B	ISGGB08B	ISGGB09B	ISGGB10B	ISGGB11B	ISGGB12B	ISGGB13B	OTD1
Ecological Rehabilitation	**Objective 1**													
The vegetation composition of the rehabilitation is recognisable as the target vegetation community (e.g., plant community type (PCT) contained within the NSW Vegetation Information System) **Note:** Recognisable is defined as' Diagnostic species present for each Growth form for PCT/TEC using the scientific description of the PCT available on Bionet	Native plant species are characteristic of the target plant community(s) **Note:** 'Characteristic of target plant community' is defined as '50% of all species in each Growth Form (i.e., trees, shrubs, grasses, forbs and ferns and other) that are known and accepted to form part of the PCT/TEC against benchmark value'	The compositional attribute score is a minimum of 50% for each rehabilitation monitoring site. **Note:** The compositional attribute score is based on the native species richness compared to benchmarks											
Ecological Rehabilitation	**Objective 2**													
The vegetation structure of the rehabilitation is recognisable as, or is trending towards the target plant community (e.g., plant community type (PCT) contained within the NSW Vegetation Information System) **Note:** 'Trending Towards the target plant community' requires use of time series data to show canopy height and cover for each Growth Form against benchmark value range (or successional benchmark)s	Cover and height range of all Growth Forms are characteristic of, or trending towards the target plant community(s)	The structural attribute score is a minimum of 50% for each rehabilitation monitoring site. **Note:** The structural attribute score is based on the foliage cover for each growth form group and is compared to benchmarks												

Rehabilitation Objective	Completion Criteria	Performance Indices	ISGGB01B	ISGGB02B	ISGGB03B	ISGGB04B	ISGGB05B	ISGGB08B	ISGGB09B	ISGGB10B	ISGGB11B	ISGGB12B	ISGGB13B	OTD1
Ecological Rehabilitation	**Objective 3**													
Levels of ecosystem function have been established that demonstrate the rehabilitation is self-sustainable OR is trending towards the target plant community (e.g., plant community type (PCT) contained within the NSW Vegetation Information System)	Ecosystem function is characteristic of. or trending towards the target plant community(s), and is suitable for sustaining the target plant community	The functional attribute score is a minimum of 50 for each rehabilitation monitoring site. **Note:** The functional attribute score is based on the following attributes and is compared to benchmarks · number of large trees tree stem size class tree regeneration length of fallen logs, litter cover, number of trees with hollows												
	Plant is “suitable”[1] for sustaining the target plant community(s). Suitable means [1] Weeds - demonstrated decline in cover of high threat weeds measured as a moving average over time. Cover of high threat weeds within range measured at reference sites	The total cover of exotic plant species Is recorded at fixed monitoring plots or transects as per BAM and is within the range measured at reference sites												
	Animal habitat is characteristic of the target plant community(s) (as measured by the above composition, structural and functional component)s													

APPENDIX F

Annual Review Plan

BULGA COAL
ANNUAL REVIEW 2021
DOMAIN PLAN

December 2021 Domain Update

FIGURE A

- South Pit Extension
- Coal Stockpile
- Mining Lease
- Coal Lease
- Commonwealth Licence Agreement
- Sublease
- Colliery Holding
- Approved Mine Workings Outline – Open Cut
- Road
- Watercourse
- Minor Watercourse

Domains

- Domain 1 - Infrastructure
- Domain 2 - Emplacement
- Domain 3 - Active
- Domain 4 - Tailings Emplacement
- Domain 5 - Rehabilitation Woodland
- Domain 6 - Rehabilitation Pasture
- Domain 7 - Surface Water / Dams
- Domain 8 - Conservation Area & Offsite Offsets
- Domain 9 - Vegetation Re-establishment Area
- Domain 10 - Subsidence Management
- Public Infrastructure

2021

- 2021 - Rehabilitation
- 2021 - Disturbance
- 2021 - Disturbance of Rehabilitation
- 2021 - Clearing

2022

- 2022 - Rehabilitation
- 2022 - Disturbance
- 2022 - Disturbance of Rehabilitation

0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 56
Scale:	1:47,500 at A3
Project Number:	630.30233
Date:	30-Mar-2022
Drawn by:	PM

SLR

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