2020
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-v1.0	10 March 2021	Sam McDonald	Adam Williams	Adam Williams
630.12954-R01-v1.1	24 March 2021	Sam McDonald	Adam Williams	Adam Williams
630.12954-R01-v1.2	26 March 2021	Sam McDonald	Adam Williams	Adam Williams

Cover photograph: Eastern Emplacement Area rehabilitated with the Grey Box – Ironbark Woodland Endangered Ecological Community. Photograph shows four years of rehabilitation (2017-2020).

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, 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 licence	Bulga Coal Management, Saxonvale Coal Pty Ltd, Beltana Highwall Mining Pty Ltd
MOP/RMP start date	1 July 2020 (Bulga Open Cut) 29 May 2019 (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 2020
Annual Review end date	31 December 2020

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 2020 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	
Date	26-3-21

1 STATEMENT OF COMPLIANCE 1

2 INTRODUCTION 6

2.1 Mine Operations 6

2.2 Mine Contacts 6

3 APPROVALS 8

3.1 Development Consent/s and Commonwealth Approvals 8

3.2 Mining Tenements 10

3.3 Licences 11

4 OPERATIONS SUMMARY 13

4.1 Mining Operations 13

4.2 Other Operations 18

4.3 Next Reporting Period 20

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW 24

6 ENVIRONMENTAL MANAGEMENT PERFORMANCE 25

6.1 Meteorology 25

6.2 Noise 29

6.3 Blasting 32

6.4 Air Quality 34

6.5 Mine Subsidence 43

6.6 Flora and Fauna (Remnant Vegetation) 44

6.7 Biodiversity Offsets 48

6.8 Weeds and Pests 60

6.9 Archaeology and Heritage 61

6.10 Visual and Lighting 65

6.11 Spontaneous Combustion 66

6.12 Bushfire 66

6.13 Methane Drainage, Mine Ventilation and Greenhouse Gas Emissions 67

6.14 Hydrocarbon Management 69

6.15 Public Safety 72

7 WATER MANAGEMENT 73

7.1 Water Management 73

7.2 Surface Water 74
7.3 Erosion and Sedimentation 81
7.4 Groundwater 82

8 REHABILITATION 86
8.1 Post Mining Land Use 86
8.2 Rehabilitation Performance during the Reporting Period 86
8.3 Buildings 94
8.4 Department of Regional NSW-RR Sign-Off on Rehabilitation 94
8.5 Variations from Proposed MOP Activities 94
8.6 Rehabilitation Monitoring, Trials and Research 95
8.7 Key Issues that may Affect Rehabilitation 99
8.8 Actions for the Next Reporting Period 100

9 COMMUNITY 102
9.1 Community Engagement 102
9.2 Community Sponsorship and Donations 103
9.3 Community Complaints 106
9.4 Community Feedback 106

10 INDEPENDENT AUDIT 107

11 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD 108
11.1 Air Quality 108
11.2 Pollution of Waters 108
11.3 Administrative Non-compliances 108

12 ACTIVITIES TO BE COMPLETED IN THE NEXT REPORTING PERIOD 110
12.1 Bulga Underground Operations 110
12.2 Bulga Open Cut 110

13 REFERENCES 111

DOCUMENT REFERENCES

TABLES

Table 1 Summary Statement of Compliance for Major Approvals 1
Table 2 Summary of Non-Compliances 2
Table 3 Compliance Status Categories 5
Table 4 Contacts for Bulga Coal 6
Table 5 Development Consents and Commonwealth Approvals 9
Table 6 Mining Tenements 10
Table 7 Bulga Coal Licences 11
Table 8 Equipment Fleet 17
Table 9 Production and Waste Summary for the Bulga Open Cut 18
Table 10 Summary of Attended Noise Monitoring Data – 2020 30
Table 11 Summary of Exceedances by Noise Monitoring Location 2011 – 2020 31
Table 12 Private Property Amenity Impact Assessment Criteria 32
Table 13 Infrastructure Impact Assessment Criteria 32
Table 14 Heritage Impact Assessment Criteria 32
Table 15 2020 Private Property Overpressure and Vibration Monitoring Results 33
Table 16 2020 Infrastructure Vibration Monitoring Results 33
Table 17 2020 Declared Dam (Northern Tailings Storage Facility) Vibration Monitoring Results 33
Table 18 Air Quality Criteria SSD-4960 Mod 3 (approved 17 July 2020) 35
Table 19 DPIE Declared Extraordinary Event Days in 2020 35
Table 20 Summary of Dust Deposition Monitoring Results – 2020 Annual Average 36
Table 21 Summary of 2020 HVAS Annual Average Results 36
Table 22 Summary of TEOM 2020 Monitoring Results 37
Table 23 Summary of BAM 2020 Monitoring Results 38
Table 24 Summary of elevated particulate days 38
Table 25 Eastern Emplacement Area Exceedance Summary 42
Table 26 Observed Subsidence Impacts 44
Table 27 Bulga Coal Greenhouse Gas Emissions (Scope 1 and 2 Direct Emissions) 67
Table 28 Comparison of 2019/2020 Scope 1 and 2 Greenhouse Gas Emissions against Bulga Optimisation Project maximum Annual Predictions 68
Table 29 Hydrocarbon Monitoring Sites 71
Table 30 Ecological Investigation Levels (ANZECC) Adopted for Natural Waters (Surface and Groundwater) at Bulga Open Cut 71
Table 31 Bulga Coal 2020 Water Balance 73
Table 32 Water Take 2019-2020 74
Table 33 Summary of Surface Water Monitoring Results – 2020 Annual Averages 75
Table 34 Comparison of Surface Water Monitoring Results (2020) against Background (2013 Bulga Optimisation Project EIS) 78
Table 35 Summary of Groundwater Monitoring Results – 2020 Annual Averages 82
Table 36 Rehabilitation Status at Bulga Coal 87
Table 37 Maintenance Activities on Rehabilitated Land for Bulga Open Cut 90
Table 38 Maintenance Activities on Rehabilitated Land for Bulga Underground Operations 94
Table 39 Bulga Coal MOP Rehabilitation Predictions against 2020 Data 95
Table 40 Summary of Complaints by Issue 2015 – 2020 106

Table 41 Non-Compliance Findings and Action Status from 2019 IEA Report 107
Table 42 Bulga Underground Operations Proposed Activities in 2021 110
Table 43 Bulga Open Cut Proposed Activities in 2021 110

FIGURES

Figure 1 Bulga Coal Locality and Licences 2020 7
Figure 2 Bulga Underground Operations Summary of Operations 2020 14
Figure 3 Bulga Open Cut Summary of Operations 2020 15
Figure 4 Bulga Underground Proposed Operations 2021 22
Figure 5 Bulga Open Cut Proposed Operations 2021 23
Figure 6 Bulga Coal Air and Meteorological Monitoring Locations 2020 26
Figure 7 Bulga Coal Noise and Blast Monitoring Locations 27
Figure 8 Bulga Coal Water Monitoring Locations 2020 28
Figure 9 2020 Pollution Rose for EPA Point 10 PM_{10} Data (Todoroski Air Sciences (2021)) 40
Figure 10 2020 Pollution Rose for EPA Point 9 PM_{10} Data (Todoroski Air Sciences (2021)) 41
Figure 11 Mushroom Composting Facility (D4) Sampling Results 2020 – 13-hour PM_{10} Averages 42
Figure 12 Ecological and Rehabilitation Monitoring Locations 2020 46
Figure 13 Bulga Coal Hydrocarbon Monitoring Locations 70
Figure 14 Wollombi Brook Brickmans Bridge Gauging Station 210135 (Upstream) 76
Figure 15 Wollombi Brook – Bulga Gauging Station (210028) (Downstream) 76
Figure 16 Long Term Surface Water EC Results 79
Figure 17 Long Term Surface Water pH Results 80
Figure 18 Long Term Surface Water TSS Results 81
Figure 19 Bulga Open Cut Rehabilitation and Disturbance 2020 92

PHOTOGRAPHS

Photo 1 LCGG Photographic Monitoring – 2017 view from Photo Point 3 63
Photo 2 LCGG Photographic Monitoring – 2018 view from Photo Point 3 63
Photo 3 LCGG Photographic Monitoring – 2019 view from Photo Point 3 64
Photo 4 LCGG Photographic Monitoring – 2020 view from Photo Point 3 64
Photo 5 Example of traditional rehabilitation practices with contour banks (shaped in 2019 - right) next to natural landform design (shaped in 2020 - left). 88
Photo 6 Built natural landform design surface, Eastern Emplacement Area Southern Dump 88
Photo 7 Dump design surface, showing the shape of ridges and drainage lines dumped out for each bench. 89
Photo 8 Free skate workshops at the Broke Skate Park 103
Photo 9 New playground equipment installed as part of the Glencore P&C Grant Round 104
Photo 10 Morning Tea hosted by Bulga Coal 105

APPENDICES

Appendix A EPBC Approvals Compliance Reports
Appendix B Monitoring Data Review and Analysis at Bulga Complex 2020
Appendix C Annual Groundwater Monitoring Report
Appendix D Completion Criteria Checklist
Appendix E Annual Review Plan

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	No (Refer **Appendix A**)
EPBC 2018/8300	Yes
ML 1494	Yes
ML 1547	Yes
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
N/A	Section 120 of the POEO Act 1997	Prohibition of pollution of waters	Non-Compliant	03/04/20 to 06/04/20	Discharge of sediment laden water from a CHPP dirty water drain into a tributary of Nine Mile Creek. The discharge was caused by a piece of wood which blocked a culvert.	The crossing over the drain and culvert were removed from the drain to prevent the drain overtopping again. There was insufficient fine sediment to warrant removal from the streambed, however the gravel that eroded off the causeway was removed.	**Section 11.2**
SSD-4960	Schedule 3, Condition 26	Discharges must comply with EPL and POEO Act					
SSD-4960	Schedule 3, Condition 16	Air Quality Monitoring	Non-Compliant	19/04/20 20/04/20	Exceedance in PM_{10} concentration (24-hour average) at Mitchell Line Rd (D11) TEOM.	N/A	**Section 6.4.2 and 11.1**
DA 376-8-2003	Schedule 4, Condition 22						

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
DA 41-03-99	Schedule 2, Condition 6.1.2 (c)				Exceedances caused by a localised source upwind of Bulga Open Cut. Cause of the exceedance is unknown; however, investigations show it is unlikely that Bulga had a significant contribution to the elevated PM_{10} levels.		
SSD-4960	Schedule 3, Condition 16	Air Quality Monitoring	Non-Compliant	23/04/20	Exceedance in PM_{10} concentration (24-hour average) at Mitchell Line Rd (D11) TEOM. Cause of the exceedance is unknown; however, investigations show it is unlikely that Bulga had a significant contribution to the elevated PM_{10} levels.	N/A	**Section 6.4.2 and 11.1**
DA 376-8-2003	Schedule 4, Condition 22						
DA 41-03-99	Schedule 2, Condition 6.1.2 (c)						
SSD-4960	Schedule 3, Condition 16	Air Quality Monitoring	Non-Compliant	26/04/19	Exceedance in PM_{10} concentration (24-hour average) at Mitchell Line Rd (D11) TEOM.	N/A	**Section 6.4.2 and 11.1**
DA 376-8-2003	Schedule 4, Condition 22						

Approval/ Licence	Condition / Legislative Reference	Condition Summary	Compliance Status	Date	Details of the Non-compliance	Corrective Action/s	Section of this Annual Review
DA 41-03-99	Schedule 2, Condition 6.1.2 (c)				Cause of the exceedance is unknown; however, investigations show it is unlikely that Bulga had a significant contribution to the elevated PM_{10} levels.		
SSD-4960	Schedule 3, Condition 16	Air Quality Monitoring	Non-Compliant	October-December 2020	Depositional dust not monitored at F2(DR). F2 was included in Bulga Coal Air Quality Management Plan approved in October 2020. The dust gauge was not installed and operational at the time the management plan was approved.	A directional depositional dust gauge has been installed at this location and the site is being monitored.	**Section 6.4.2 and 11.3**
DA 376-8-2003	Schedule 4, Condition 22						
DA 41-03-99	Schedule 2, Condition 6.1.2 (c)						
EPL 563	Condition M4	Weather Monitoring	Non-Compliant	Various	Weather data was not monitored continuously at EPA Point 20, Point 21 and Point 23 due to the equipment failure during the EPL Annual Return reporting period.	The cause of the break downs were investigated promptly, and the monitors were fixed. Details were reported to the EPA in the 2019-2020 Annual Return.	**Section 11.3**

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

Section 6 of this report details the environmental management performance of Bulga Coal. 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 Coal Handling and Preparation Plant (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 2020 to 31 December 2020. 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.

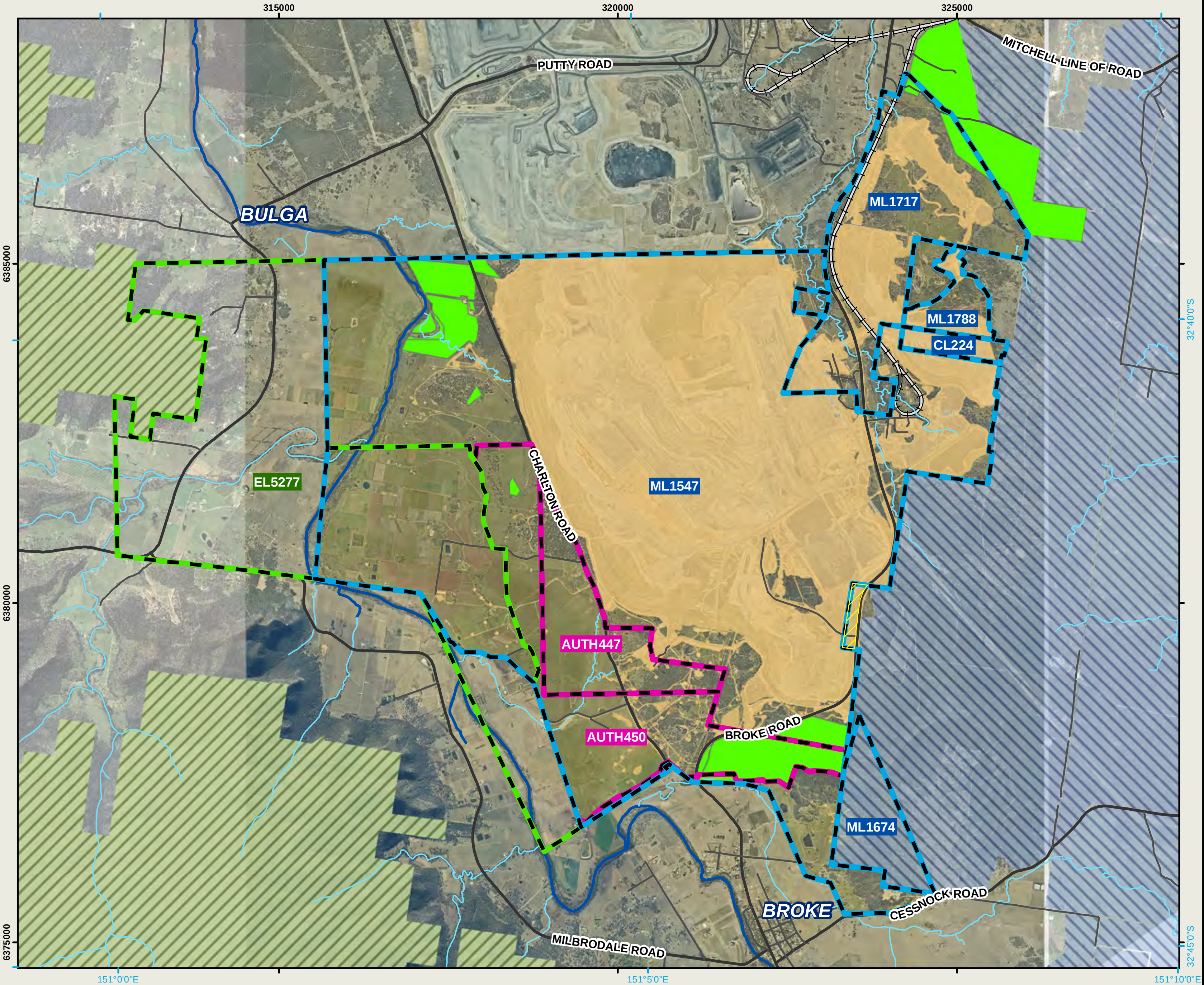
2.2 Mine Contacts

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

FIGURE 1 - BULGA COAL LOCALITY & LICENCES 2020



- Mining Lease
- Exploration License
- Exploration
- Mining Lease Ancillary Mining Activities (AMA)
- Bulga Complex Disturbance Footprint
- Offset Area
- National Park
- Singleton Military Training
- Major road
- Minor road
- Railway
- Wollombi Brook
- Minor Watercourse

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Kilometres

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Coordinate System: MGA (GDA 94) Zone 56

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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 2019, Bulga Coal applied to modify the Bulga Open Cut SSD-4960 (Mod 3) and Bulga Underground DA 376-8-2003 (Mod 7). Mod 3 and Mod 7 were approved on 16 July 2020. Key aspects of the modifications include:

SSD-4960 (Mod 3)

- Continuation of mining behind the noise and visual bund and within the existing approved project area;
- Relocation of tailings within the Deep Pit to an in-pit tailings facility in the north of the mine to enable mining of the underlying coal. Relocation of the tailings will be via a system of pumps and pipelines;
- Mining of an approximately 63 million additional tonnes of coal over the life of the mine;
- Disturbance of an additional 20.2 hectares (ha) of vegetation, which will be offset;
- Extension of the mine life of the open cut operation by four years to 2039; and
- Re-disturbance and rehabilitation of approximately 200 ha of existing immature rehabilitation.

DA 376-8-2003 (Mod 7)

- Demolition and relocation of the Bulga Underground Operations Mining Infrastructure Area (MIA);
- Allowance for the relocation of underground mine ventilation, as required;
- Relocation of the 9 megawatt (MW) power station and associated flares;
- Relocation of the Bulga Underground Operations electrical substation; and
- Upgrading, relocation, construction and decommissioning of mine owned power transmission lines and associated access tracks.

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). EPBC 2018/8300 was approved on 22 September 2020 and allows Bulga Coal to clear a specified area of listed threatened species and ecological community to extend the existing Bulga open-cut mine to access additional coal resources. EPBC 2018/8300 was corrected on 25 November 2020 to change the conditions numbers to the correct numbers. No change was made to the condition's contents during the correction. For more information on EPBC 2018/8300 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).	
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)	
	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)	
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 corrected 25 November 2020)	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. 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
CL 224	Saxonvale Coal Pty Ltd	23 December 2023
EL 5277	Saxonvale Coal Pty Ltd	7 April 2021
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 2019[1]
AUTH 447	Saxonvale Coal Pty Ltd	2 September 2022
AUTH 450	Saxonvale Coal Pty Ltd	30 December 2018[1]

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 August 2020, Bulga Open Cut submitted a new MOP to the Department of Regional NSW – Resources Regulator (RR) to incorporate the additional activities approved by SSD-4960 Mod 3. *The Bulga Open Cut Mining Operations Plan: 1 July 2020 – 30 June 2023* was approved by RR on 9 September 2020.

From January to December 2020 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 the Singleton Council.

Environment Protection Licence (EPL) 563 was varied in August 2020.

The August variation included:

- Removal of the Hunter River Salinity Trading Scheme (HRSTS) discharge point 4;
- Removal of saline mine water discharge points;
- Addition of ambient water quality monitoring and reporting;
- Addition of turbidity reporting from HRSTS discharge point 4 with the Annual Return;
- Addition of authorisation to receive saline mine water from Mt Thorley;
- Addition of authorisation to transfer saline mine water to Mt Thorley;
- Authorisation to dispose of heavy plant-tyre waste generated on the premises, in the pit. The authorisation included the requirement to generate a plant-tyre disposal report;
- Removal of meteorological point 19 (Bulga Highwall Weather Station) and addition of point 23 (Southern Extension Weather Station);
- Addition of blast exceedance reporting; and
- Removal of Special Condition E2 as the requirement to undertake ambient water quality monitoring has been completed.

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.

Licence	Details
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	
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 extended in 2020 to allow decommissioning of redundant infrastructure, rehabilitation of any disturbed areas and an opportunity to continue monitoring potential subsidence impacts after substantial rain events.

4 Operations Summary

4.1 Mining Operations

Mining activities including exploration at Bulga Underground Operations and Bulga Open Cut during 2020 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.

A total of Sixteen (16) exploration holes were drilled:

- EBR099, EBR100, EBR101, EBR102, EBR103, EBR104 and EBR105 were drilled to define a large normal fault in the East Pit as well as increase structural continuity throughout the Life of Mine (LOM) Model;
- MB1, MB2 and MB3 were drilled for the installation of piezometers to monitor the effect of tailings emplacement in the northers tailing dams;
- EBR096 and EBR098 were drilled to define the change of grade at depth along the LOM pit shell;
- EBR097 was drilled for the installation of a piezometer to monitor depressurisation of the footwall;
- SBD221 and SBD222 were drilled to validate gas desorption results and integrate the results into the National Greenhouse and Energy Reporting Scheme (NGERS) Model; and
- SBR215 was drilled to define a reverse fault in the Southern Extension pit.

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 Infrastructure Management Plan* was submitted to the planning portal and awaiting feedback from stakeholders.

4.1.1 Land Preparation

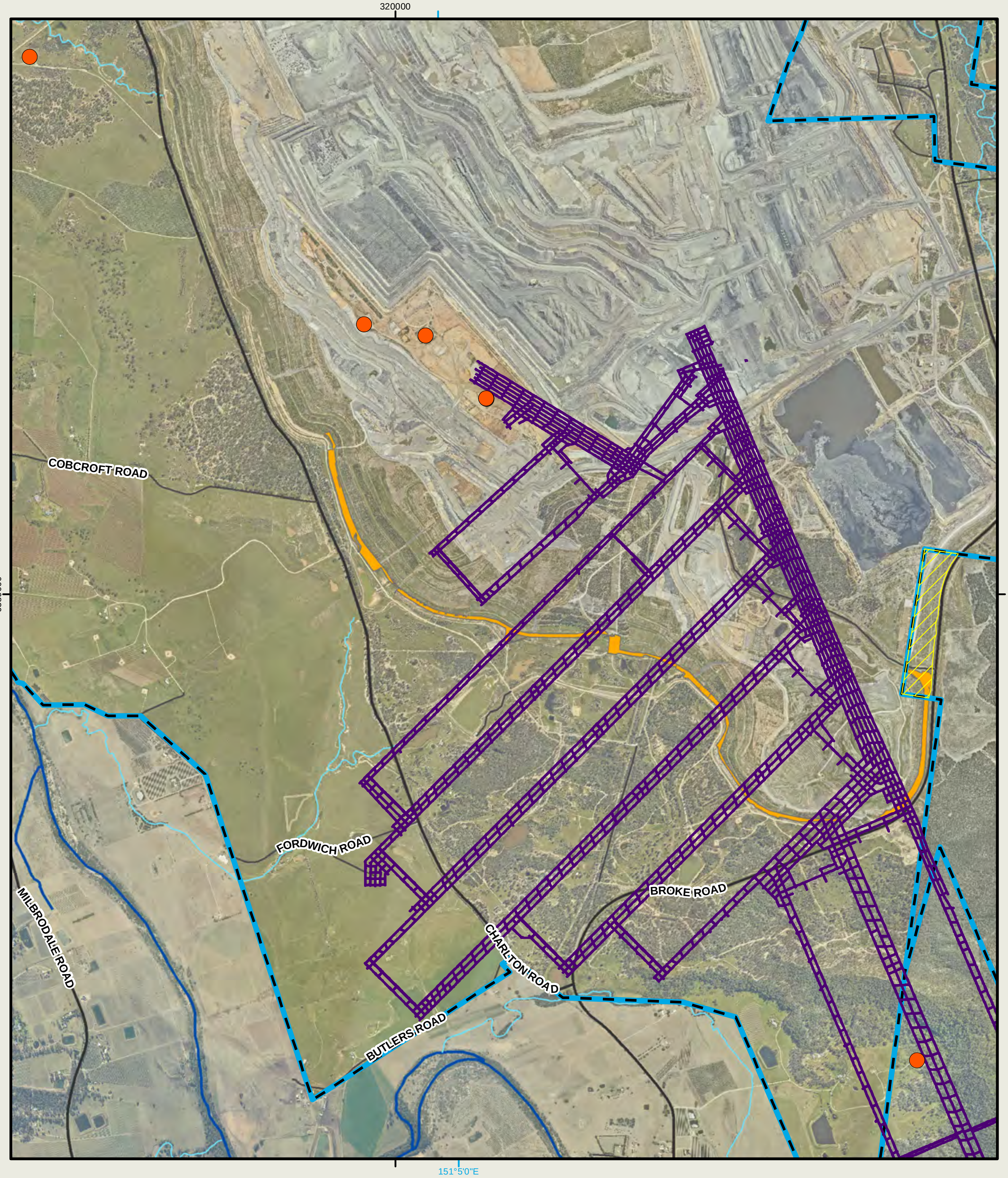
Land preparation ahead of open cut mining operations involves the construction of erosion and sediment control measures, clearing vegetation, soil stripping and stockpiling topsoil. These activities were undertaken in accordance with the *Bulga Coal Biodiversity Management Plan* (BMP) (which is currently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

Grassland, fragmented woodland communities, previously rehabilitated land is cleared and topsoil stripped ahead of mining. Vegetation and vegetative matter are either mulched and incorporated into topsoil or stockpiled for future use in rehabilitation. During 2020, approximately 95,300 m^3 of topsoil was stripped and 70 habitat trees were salvaged by Bulga Coal.

During 2020, 95.3 ha of disturbance was undertaken to allow mining, overburden dumping and construction activities (roads, drains, dams and powerlines) to commence.

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

FIGURE 2 - BULGA UNDERGROUND SUMMARY OF OPERATIONS 2020



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- Mining Lease
- Mining Lease AMA
- Blakefield South Mine Workings
- 2020 Disturbance (BEP Power Line)
- Decomossioned boreholes
- Major road
- Minor road
- Railway
- Wollombi Brook
- Minor Watercourse

0 0.25 0.5 1
Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:34,647 @ A4

N

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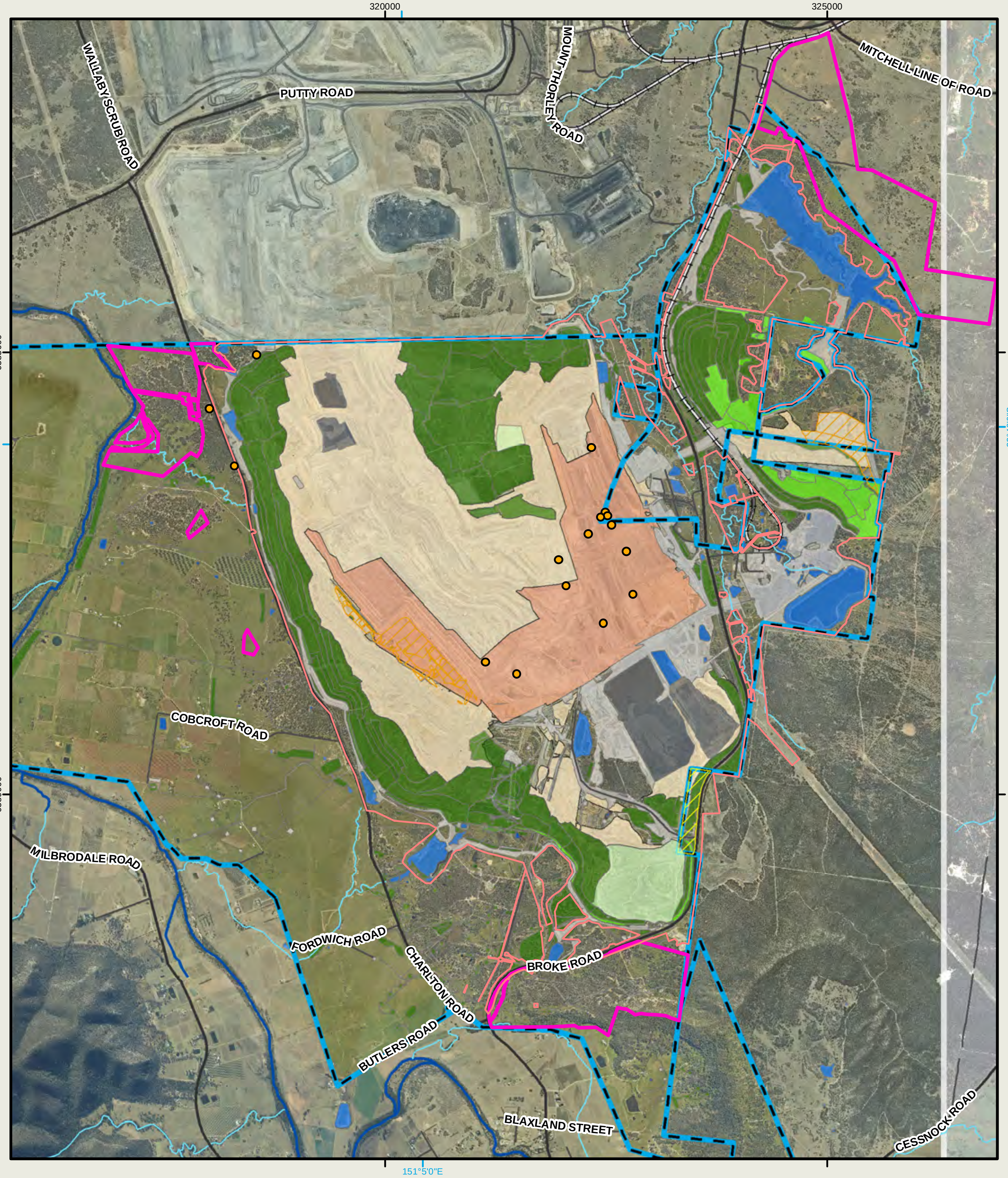
FIGURE 3 - BULGA OPEN CUT SUMMARY OF OPERATIONS 2020



Approved Disturbance Boundary
Mining Lease
Mining Lease AMA
Major road
Minor road
Railway
Wollombi Brook
Minor Watercourse
Offset Area
Domain 1 - Infrastructure
Domain 2 - Emplacement Areas
Domain 3 - Active Mining
Domain 4 - Tailings Emplacement
Domain 7 - Surface Water/Dams
Existing Rehabilitation
2020 Rehabilitation
2020 Temporary Rehabilitation (Pasture)
2020 Disturbed
2020 Exploration Hole

0 0.5 1 2
Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:60,000 @ A4

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4.1.2 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 and Woodlands Hill Pit in 2020. Mining also commenced in the Whybrow Wedge in November. 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 using a dragline and a truck/shovel fleet. The dragline ceased operations in the second half of 2020. Coal was mined by 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 Front End Loader (Cat 980H) and Tyred Dozer (Cat 834H) were not used in 2020. One new Loader (Hitachi ZW370-5) and one wheeled Dozer (Cat 854K) were acquired in 2020. The total mining fleet as at 31 December 2020 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
Haulage Trucks	Cat 793C XQ	6
	Cat 793D XQ	30
	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	9
	Cat D10T	4
	Cat D10R	1
	Liebherr PR776	1 (Hired)
	Cat 854K	2 (0 Hire)
Graders	Cat 24H	1
	Cat 24M	2
	Cat 16H	1
	Cat 16M	1
Fuel Trucks	Cat 777E	1
	Cat 775E (Hire)	1 (Hire)
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	2019 Reporting Period (Actual)	2020 Reporting Period (Actual)	2020 MOP Predictions	2021 Reporting Period (Forecast)
Waste Rock/ Overburden (bcm)	N/A	64,357,000	59,043,661	59,295,000	63,497,000
ROM Coal (t)	12,200,000	12,200,000	10,064,175	10,593,000	11,388,000
Coarse reject (t)	N/A	3,391,551	2,943,359	3,350,000	4,465,000
Fine Reject (tailings) (t)	N/A	1,065,844	887,033		
Saleable Product (t)	N/A	8,461,000	6,850,008	6,778,000	7,241,000

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

Limited wet weather impact throughout the year enabled Bulga Coal to produce more than was forecast.

4.2 Other Operations

4.2.1 Coal Handling and Preparation Plant

10.10 million tonnes (Mt) of Run of Mine (ROM) coal was washed, producing 6.85 Mt of saleable product coal. The CHPP has approval to wash up to 20 Mt of ROM coal per year. 6.94 Mt of coal was railed to the Port of Newcastle.

4.2.2 Tailings Management

Deposition of tailings to the North Pit Tailings Storage Facility (NPTSF) Cell A ceased in April 2020. Consolidation of the tailings at the Deep Pit allowed for Tailings to be pumped to the Deep Pit between April and December 2020. Deposition of tailings to the NPTSF Cell B commenced in December 2020.

Tailings were pumped to assist with the sealing of the Beltana Mine underground workings during October, November, and December 2020. This work is being undertaken in preparation for open cut mining through this area.

4.2.3 Construction

Bulga Coal construction works included:

- Construction of a new fuel farm east of the Area Station. The new facility has light vehicle refuelling bowsers that replaced the refuelling facility at the former bulk fuel farm;
- Refurbishment of existing light vehicle workshop bathhouse and crib room;
- Reject bin approach apron repairs;

- Dewatering bore and pipeline construction to make more effective use of the water stored in the Bulga Underground Operations workings;
- Blakefield South Longwall 9E gas drainage borehole and pipeline to the Goaf Plant were installed; and
- Civil work adjacent to the Old Tailings Dam in preparation for the construction of a powerline.

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

- Construction of NPTSF Cell B and associated pumping infrastructure;
- Replacement of CV8027 conveyor gantry section;
- Commencement of construction for the Power Factor Correction units;
- Construction of concrete Intermediate Bulk Container (IBC) storage area;
- Construction of University of Newcastle Reflux Flotation Classifier.

4.2.4 Demolition

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;
- Decommissioning of a gas well;
- Sealing of 5 surface to in-seam wells located within the Blakefied North gas reservoir; and
- Installation of grout plugs at the South Bulga Underground Stage 1, Beltana, and Blakefield South conveyor and materials drift.

In 2020 a new CHPP Bathhouse was constructed and the old Bathhouse was demolished. Several unused temporary relocatable office buildings at the Bulga Open Cut were also removed from site.

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

4.2.5 Waste Management

Waste management is undertaken in accordance with the *Bulga Complex Waste Management Plan*. 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.

80 % of the waste produced by Bulga Coal (4,473 t) was recycled. 723 t of scrap steel was recycled at Bulga Coal during the reporting period.

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.

4.2.6 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. The Notification of Hazardous Chemicals on Premises was revised with WorkCover NSW on 8 November 2020 to include compressed nitrogen, updated storage locations and storage quantities.

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.

4.3 Next Reporting Period

4.3.1 Bulga Underground Operations

Activities proposed in 2021 are generally consistent with DA 376-8-2003 and the approved Bulga Underground Operations MOP. Due to the cessation of underground mining, activities will include the decommissioning and demolition of Bulga Underground Operations surface infrastructure, rehabilitation of redundant gas drainage infrastructure, access tracks and pipelines. **Figure 4** illustrates the proposed rehabilitation activities.

4.3.2 Bulga Open Cut

Activities proposed in 2021 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, Southern Extension, 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:

- Construction of an Aboriginal Teaching and Keeping Place at the Wollombi Brook Conservation Area.
- Demolition of the old bulk fuel facility.

- One borehole is planned to be drilled in 2021. The borehole will be used to install a piezometer to monitor the depressurisation of the footwall.
- Construction of the tailings relocation infrastructure including access tracks, pipelines, pump station and powerlines.

FIGURE 4 - BULGA UNDERGROUND PROPOSED OPERATIONS 2021

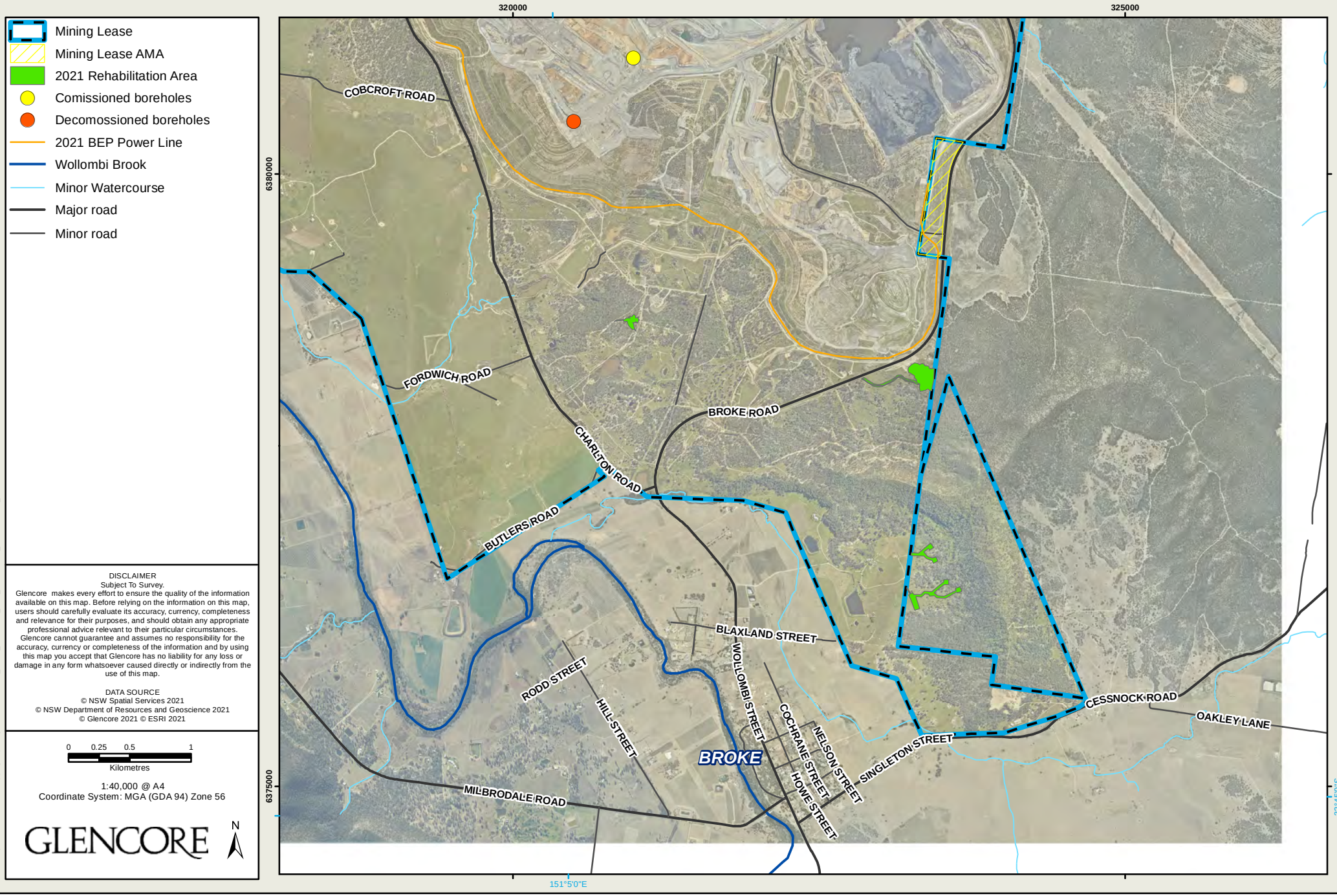

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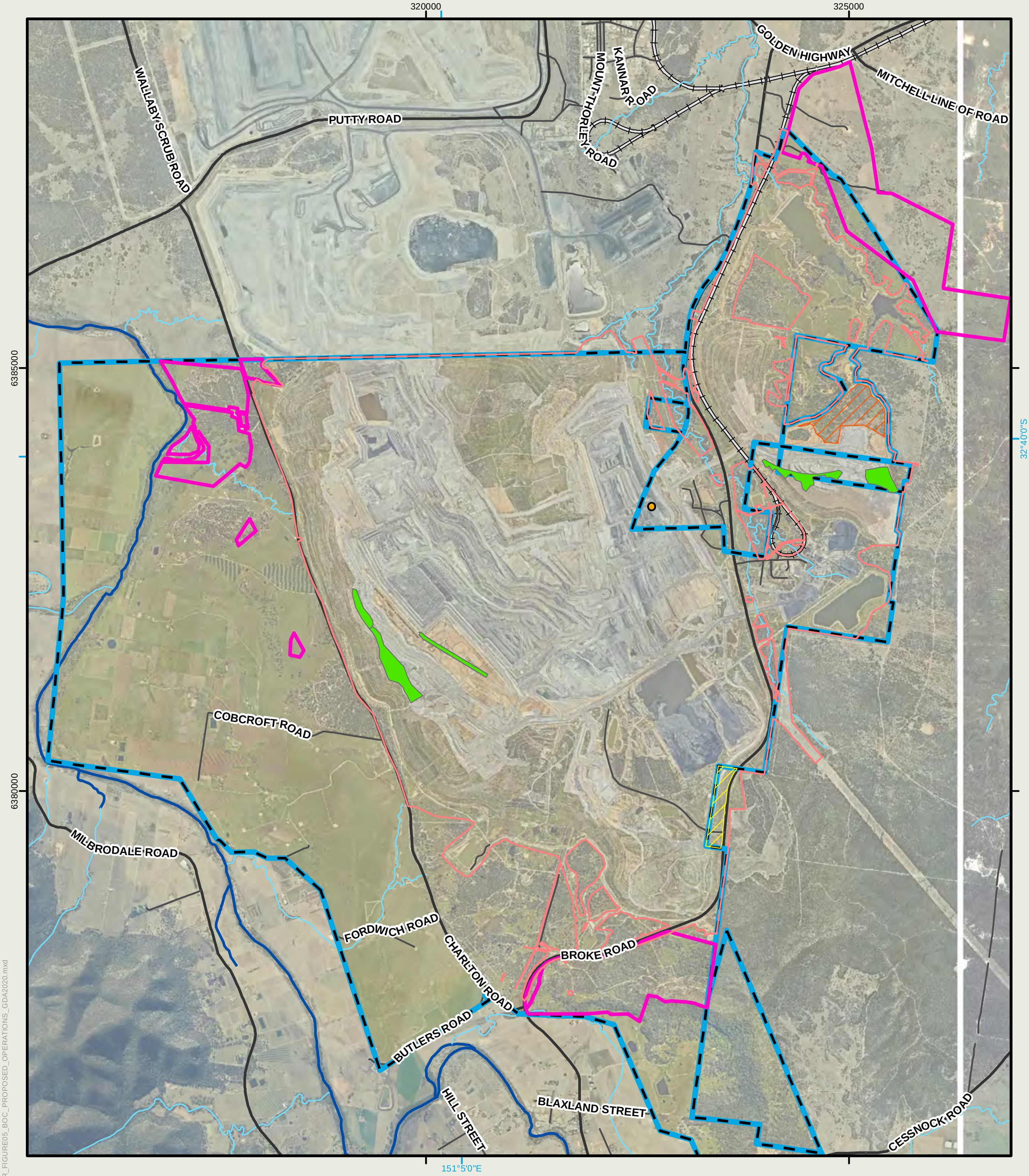
FIGURE 5 - BULGA OPEN CUT PROPOSED OPERATIONS 2021



Mining Lease

Mining Lease AMA

Major road

Minor road

Railway

Wollombi Brook

Minor Watercourse

Offset Area

2021 Rehabilitation Area

2021 Disturbed

Proposed Exploration Hole

0 0.5 1 2

Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:62,500 @ A4

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5 Actions Required from Previous Annual Review

The 2019 Annual Review was provided to DPIE and RR on 31 March 2020. DPIE and RR considered the Annual Review to generally meet the requirements of the approval in relation to reporting and the *Annual Review Guideline* (DPIE, 2015). No additional actions were required from the 2019 Annual Review, however the DPIE requested the following additional information in regards to the Noise and Visual Bund:

- A registered survey to demonstrate compliance with the full design height (in metres AHD) as required by Schedule 3, Condition 47 of SSD-4960;
- A description, photographs, aerial imagery and maps etc. to demonstrate compliance with Schedule 3, Conditions 47 and 50 of SSD-4960 (the *Visual Impact Management Plan*) (as it relates to the Noise and Visual Bund); and
- The date that the Noise and Visual Bund was completed, and any works that have occurred on or near the Noise and Visual Bund since 1 September 2019.

Bulga provided the information to DPIE on 5 June 2020, who confirmed on 28 August 2020 that Bulga Coal had complied with Schedule 3, Conditions 47(b) and 47(c) of SSD-4960.

6 Environmental Management Performance

Bulga Coal implements a comprehensive *Environmental Management Strategy* (EMS) (which was revised in 2020 and is awaiting approval by DPIE) 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**, **Figure 8** and **Figure 13.**

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).

FIGURE 6 - BULGA COAL AIR AND METEOROLOGICAL MONITORING

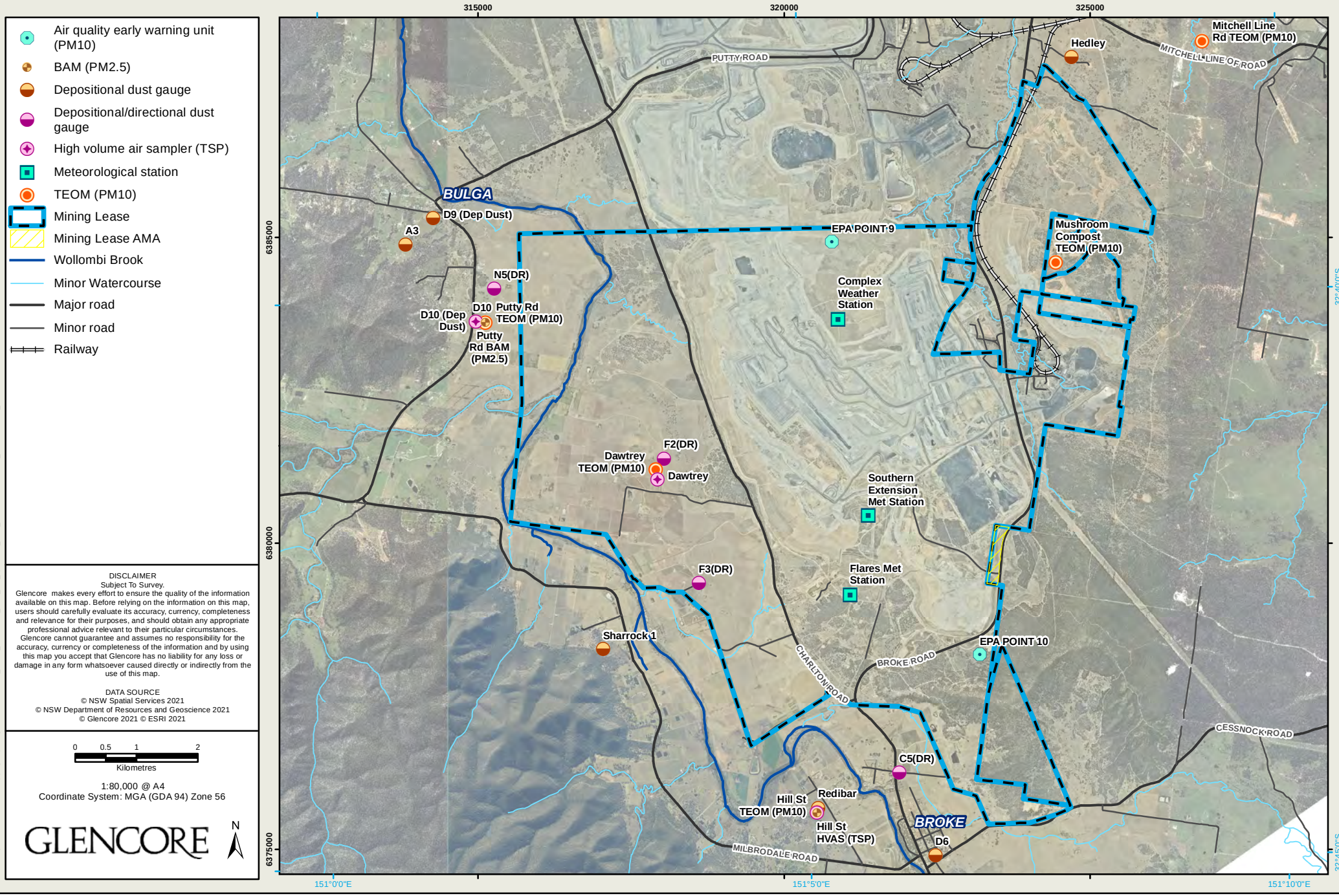


FIGURE 7 - BULGA COAL NOISE AND BLAST MONITORING

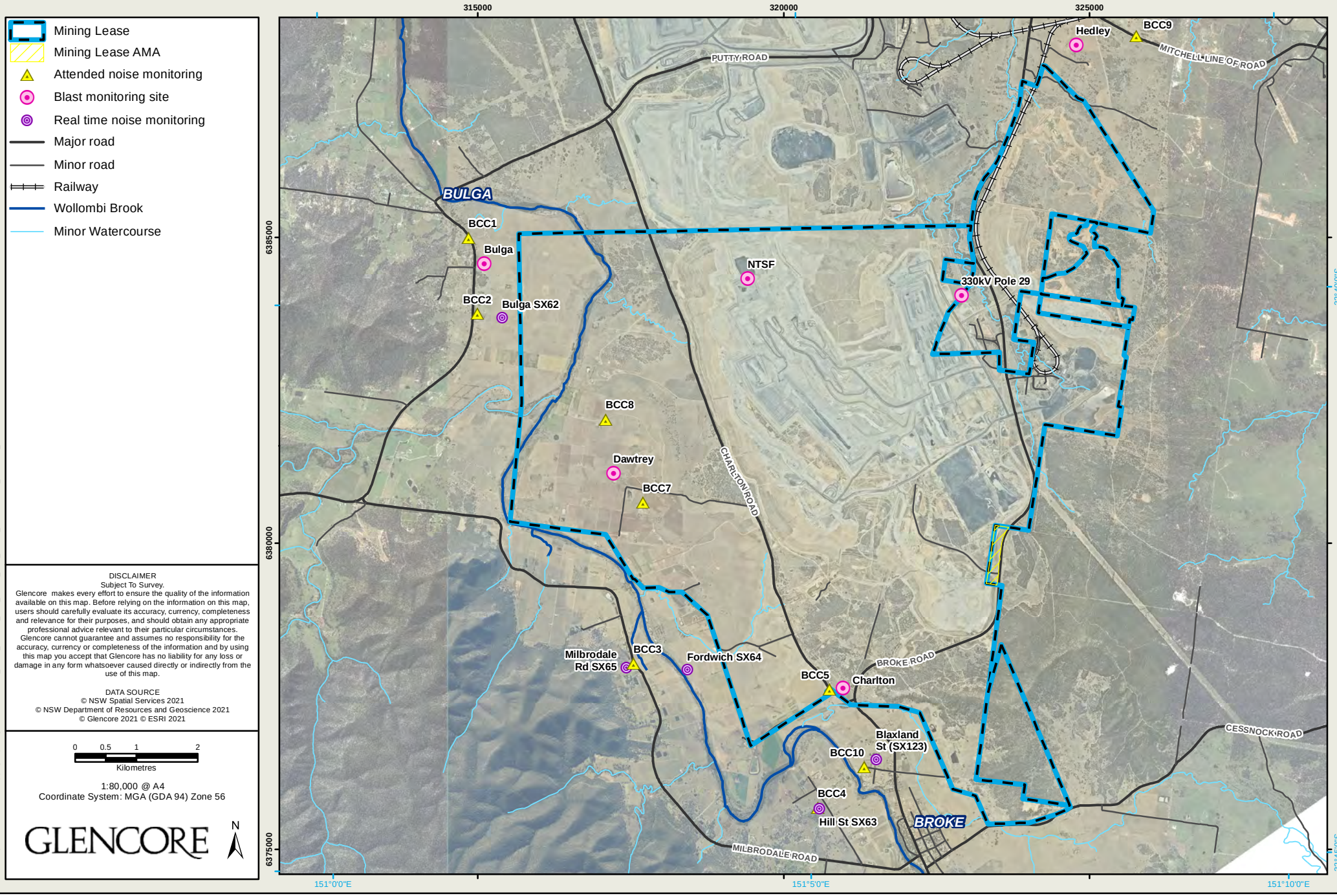
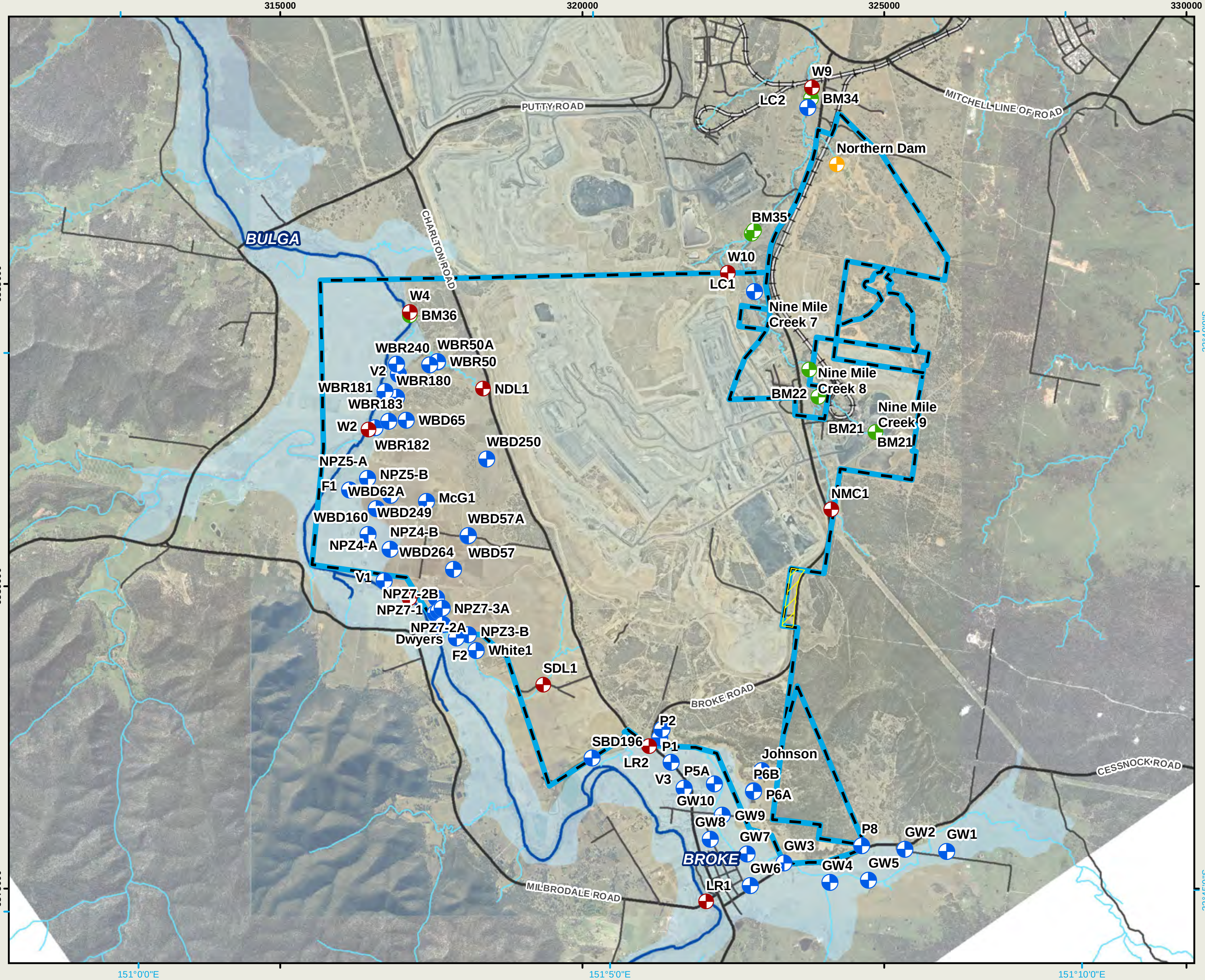


FIGURE 8 - BULGA COAL WATER MONITORING



Mining Lease

Mining Lease AMA

Groundwater Piezometer

Surface Water

EPL Discharge Points

Stream Health and Channel Stability

Wollombi Brook Alluvium

Major road

Minor road

Railway

Wollombi Brook

Minor Watercourse

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Kilometres

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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 sites;
- Real-time monitoring at five 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. 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. Dispatch and Open Cut Examiners investigate noise sources and make changes to reduce noise, where required.

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 10**. Results are presented as the maximum noise levels from Bulga Coal at each location during 2020. A detailed discussion of monitoring results is provided in monthly noise monitoring reports available on the Bulga Coal website.

As presented in **Table 10**, Bulga Coal were compliant with noise criteria. One exceedance was recorded on 13 May 2020, likely a result of a mining continuum and engine surges. A remeasure was taken within 75 minutes and a follow up measurement was 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 remeasure and follow-up measurement were below the relevant noise criteria.

Table 10 Summary of Attended Noise Monitoring Data – 2020

Location	Bulga Coal Noise Monitoring Results - dBA (Max)		Bulga Coal Project Specific Noise Criteria - dBA	
	LAeq(15minute)	LA1(1minute)	LAeq(15minute)	LA1(1minute)
BCC1	33	37	36	45
BCC2	31	39	36	
BCC3	28	38	35	
BCC4	33	39	35	
BCC5	33	45	36	
BCC7	33	37	36	
BCC8	31	45	36	
BCC9	<30	<30	37	
BCC10	**37**	44	35	

Mobile Plant Sound Power Testing

In 2019 and 2020, sound power testing was undertaken by Global Acoustics (Global Acoustics, 2021). Measurements were taken on 23 items of mobile plant during the year. At the end of 2020, measurements have been taken on 65 items of mobile plant, or 62% of the entire mobile plant fleet.

Mobile plant items tested in 2020 were within 2 dB of the noise targets, except for:

- One Caterpillar D10R Dozer;
- One Caterpillar D10T Dozer;
- One Caterpillar D11R Dozer;
- One Caterpillar 789C Rear Dump Truck; and
- One Caterpillar 793D Rear Dump Truck.

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.

Corrective actions for plant that exceeded the sound power targets by 3dB or more are listed below:

- the D10R dozer will be replaced;
- the D10T dozer will be inspected, defects fixed if required, and retested;
- the D11R dozer will be replaced;
- a number of components on the 789C haul truck will be replaced. The machine will be retested after the components are replaced; and
- a number of components on the 793D haul truck have been replaced. The machine will be retested.

The total measured a-weighted fleet average for the 2019-2020 sound power testing campaign was equal to the relevant modelled a-weighted fleet average. The total measured linear fleet average for the 2019-2020 sound power testing campaign was 2 dB to the relevant modelled a-weighted fleet average.

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) 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 2020 were compliant with SSD-4960 noise criteria. 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 11 shows the number of noise criteria exceedances recorded by Bulga Coal during the period from 2011 to 2020.

Table 11 Summary of Exceedances by Noise Monitoring Location 2011 – 2020

Location	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
BCC1	0	1	0	0	0	0	0	0	0	0	1
BCC2	0	0	0	0	0	0	0	0	0	0	0
BCC3	0	0	0	0	0	0	0	1	0	0	1
BCC4	0	0	0	0	0	0	0	1	0	0	1
BCC5	0	0	0	0	1	0	1	2	0	0	4
BCC6	0	0	0	0	0	1	0	-[1]	-[1]	0	1
BCC7	0	1	0	0	0	4	0	1	0	0	6
BCC8	0	0	0	0	0	0	0	0	0	0	0
BCC9	-1	-1	-1	-1	-1	-1	0	0	0	0	0
BCC10	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	1	0	0	1
Total	**0**	**2**	**0**	**0**	**1**	**5**	**1**	**6**	**0**	**0**	**15**

1 – Noise levels not monitored at this location.

As indicated in **Table 11**, occasional exceedances of the Bulga Coal noise criteria have been recorded during the period from 2011 to 2020. The results show that very few noise exceedances attributable to Bulga Coal have occurred over the period 2011 to 2020, 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 is awaiting approval by DPIE. The revised *Noise Management Plan* did not include any material changes.

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 12**. The criteria apply at the compliance monitoring locations (Dawtrey, Bulga, Charlton and Hedley) shown on **Figure 7**.

Table 12 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 13**. 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 13 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%
Prescribed 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 14.** The Bulga, Charlton and Dawtrey blast monitors shown in **Figure 7** are used to assess compliance.

Table 14 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

146 blasts from Bulga Open Cut were recorded during 2020. Monitoring data is available on the Bulga Coal website, with a summary provided in **Table 15** to **Table 17.** No exceedances were recorded.

Table 15 2020 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	92.4	113.6	0 (0%)	0 (0%)	0.2	0.7	0 (0%)	0 (0%)
Charlton	90.6	108.1	0 (0%)	0 (0%)	0.3	1.8	0 (0%)	0 (0%)
Dawtrey	92.7	108.6	0 (0%)	0 (0%)	0.3	1.8	0 (0%)	0 (0%)
Hedley	92.0	111.3	0 (0%)	0 (0%)	<0.1	0.2	0 (0%)	0 (0%)

Table 16 2020 Infrastructure Vibration Monitoring Results

Monitoring Location	Ground Vibration ppv (mm/s)		
	Average	Max	Results > 100 mm/s
330 kV Pole 29	1.2	8.9	0 (0%)

Table 17 2020 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	0.49	2.0	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

The *Blast Management Plan* was revised in 2020 for SSD-4960 Modification 3 and DA 376-8-2003 Modification 7 and is awaiting approval by DPIE. The main revisions in the *Blast Management Plan* include:

- new impact assessment criteria for declared dams and historic heritage sites; and
- revised schedule for structural assessments on historic heritage sites.

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. The main revisions in the *Air Quality and Greenhouse Gas Management Plan* included:

- inclusion of measures to reduce greenhouse gas emissions;
- revised impact assessment criteria;
- management of diesel exhaust emissions;
- energy efficiency measures; and
- spontaneous combustion management.

Bulga Coal operates a monitoring system to assess air quality impacts on surrounding communities. The monitoring system (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 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.

It is noted that the consent was revised on 17 July 2020 for the Modification 3 of SSD-4960 and included updates to the PM_{10}, $PM_{2.5}$ and TSP criteria. Changes to air quality criteria and how it will be applied to this Annual Review has been included below:

- the PM_{10} annual criterion reduced from 30 µg/m^3 to 25 µg/m^3 and has been adopted for the purpose of this Annual Review;
- PM_{10} and TSP annual criteria now exclude extraordinary events;

- the PM_{10} 24-hr average criterion changed from total impact to incremental impact and no longer excludes extraordinary events; and
- $PM_{2.5}$ annual and 24-hour average criteria were included in SSD-4960 Mod 3 (see **Table 18**).

Table 18 presents the SSD-4960 Mod 3 air quality criteria.

Table 18 Air Quality Criteria SSD-4960 Mod 3 (approved 17 July 2020)

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

Notes:
- *[a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).*
- *[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own).*
- *[c] 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 2020, there were 24 days declared as "extraordinary air quality events" by DPIE. The predominant cause of these extraordinary events was smoke associated with the 2019/2020 bushfires. In addition, drought conditions early in 2020 contributed to the high dust levels in the vicinity of Bulga Open Cut. 24-hour PM_{10} and TSP results on these days have been excluded from the PM_{10} and TSP annual averages.

Table 19 presents a list of the extraordinary event days in 2020 as declared by DPIE.

Table 19 DPIE Declared Extraordinary Event Days in 2020

Month	Extraordinary Days
January	1, 2, 3, 4, 5, 6, 7, 8 ,9, 10, 11, 12, 15, 20, 21, 23, 24, 25
February	1, 2, 4, 19
March	-
April	-
May	-
June	-
July	-
August	19
September	-

Month	Extraordinary Days
October	-
November	29
December	-

Depositional Dust Monitoring

Depositional dust monitoring results are summarised in **Table 20**. Monitoring results are available on the Bulga Coal website.

Table 20 Summary of Dust Deposition Monitoring Results – 2020 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	2.3	1.6	4.0
C5 (DR[1])	Mount Eyre Vineyard	1.6	1.1	
D6	Howe Street	1.5	1.0	
D9	Inlet Road	1.8	1.4	
D10	Putty Road	2.9	1.5	
F3 (DR[1])	Fordwich	2.9	1.8	
N5 (DR[1])	Putty Road	1.7	1.4	
Redibar	Redibar	1.8	1.0	
Sharrock 1	Sharrock	1.5	0.9	
Hedley	Mitchell Line Road	1.7	1.3	
F2 (DR[1])	Cobcroft Rd	-	-	

[1]Indicates Directional Depositional Dust Monitor.
[2]No samples collected from F2(DR) during the reporting period.

There were no exceedances of the depositional dust criteria during 2020. There was an increase in the monthly deposited dust levels at D10 and F3 during 2020 compared with previous years, likely due to the impact of bushfires.

High Volume Air Sampling

Table 21 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 2020.

Table 21 Summary of 2020 HVAS Annual Average Results

Gauge	Annual Average (µg/m3) (excluding extraordinary events)
	TSP ($\mu g/m^3$)
Consent Criteria	**90**
Dawtrey	35.7

Gauge	Annual Average (µg/m3) (excluding extraordinary events)
	TSP (µg/m³)
Putty Road (D10)	36.3
Hill Street (D2)	29.2

Continuous Monitoring

A summary of the recorded PM_{10} levels at the TEOM units is presented in **Table 22**. 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} averages were above the relevant criterion of 50µg/m³. Most of these elevated levels occurred on days determined by DPIE to be extraordinary events (e.g. bushfires, dust storms, etc). From July 2020, the 24-hour average PM_{10} criterion applies to the incremental impact (i.e. incremental increase in concentrations due to the development on its own) and no longer excludes extraordinary events.

There were two elevated levels recorded at D11 after July 2020. Investigations indicate that Bulga contributed less than 50 µg/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 22 Summary of TEOM 2020 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)	12.4	-	37.2	-
Putty Road (D3)	14.6	-	39.9	-
Dawtrey (D5)	15.2	-	41.0	-
Mitchell Line Road (D11)	17.5	-	68.6	4

[1] Excluding extraordinary events

Table 23 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) when extraordinary events were excluded.

The maximum 24-hour $PM_{2.5}$ averages were above the relevant criterion of 25µg/m³ for a number of days in 2020. These occurred on days determined by DPIE to be extraordinary events, with the exception of an exceedance at D10 on 3 July 2020. From July 2020, the 24-hour average $PM_{2.5}$ criterion applies to the incremental impact (i.e. incremental increase in concentrations due to the development on its own) and no longer excludes extraordinary events. An investigation into the exceedance at D10 on 3 July 2020 indicated that Bulga contributed less than 25µg/m³ to the elevated 24-hour $PM_{2.5}$ level recorded and thus it is not considered to have been a non-compliance per SSD-4960 Schedule 2, Condition 16. The maximum 24-hour average level recorded at D10 was significantly higher than that recorded at D2. **Table 24** presents a summary of the likely primary causes of elevated days and notes whether the day was determined to be an extraordinary event by DPIE.

Table 23 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) [1]	Number of days exceeding criterion[1]	$PM_{2.5}$ (µg/m³) [1#]	Number of days exceeding criterion[1]
Consent Criteria	**8**	**-**	**25**	**-**
Putty Road (D10)	6.1	-	29.0	1
Hill Street (D2)	4.1	-	17.3	-

[1] Excluding extraordinary events

[#]Applicability of criterion was updated in mid-2020.

Table 24 Summary of elevated particulate days

Date	Monitors above 24-hour Criteria	Determined as an extraordinary event by DPIE (Y/N)	Primary Cause of Elevated Levels
1/01/2020	D1, D3, D5, D11, D2, D10	Y	Bushfire smoke
2/01/2020	D10	Y	Bushfire smoke
3/01/2020	D10	Y	Bushfire smoke
4/01/2020	D1, D11, D2, D10	Y	Bushfire smoke
5/01/2020	D1, D3, D5, D11, D2, D10	Y	Bushfire smoke
6/01/2020	D10	Y	Bushfire smoke
7/01/2020	D10 HVAS	Y	Bushfire smoke
8/01/2020	D3, D11, D2, D10	Y	Bushfire smoke
9/01/2020	D2, D10	Y	Bushfire smoke
11/01/2020	D3, D5, D10	Y	Bushfire smoke
12/01/2020	D3, D2, D10	Y	Bushfire smoke
23/01/2020	D11	Y	Bushfire smoke and strong winds
24/01/2020	D1, D11, D2	Y	Bushfire smoke and strong winds
2/02/2020	D10 HVAS, Dawtrey HVAS	Y	Bushfire smoke
19/04/2020	D11	N	Localised source
20/04/2020	D11	N	Non-Bulga source
23/04/2020	D11	N	Non-Bulga source
26/04/2020	D11	N	Non-Bulga source
3/07/2020	D10	N	Very localised source or invalid data
19/08/2020	D11	Y	Dust storm
29/11/2020	D11	Y	Strong winds and regional wind erosion/ dust storm

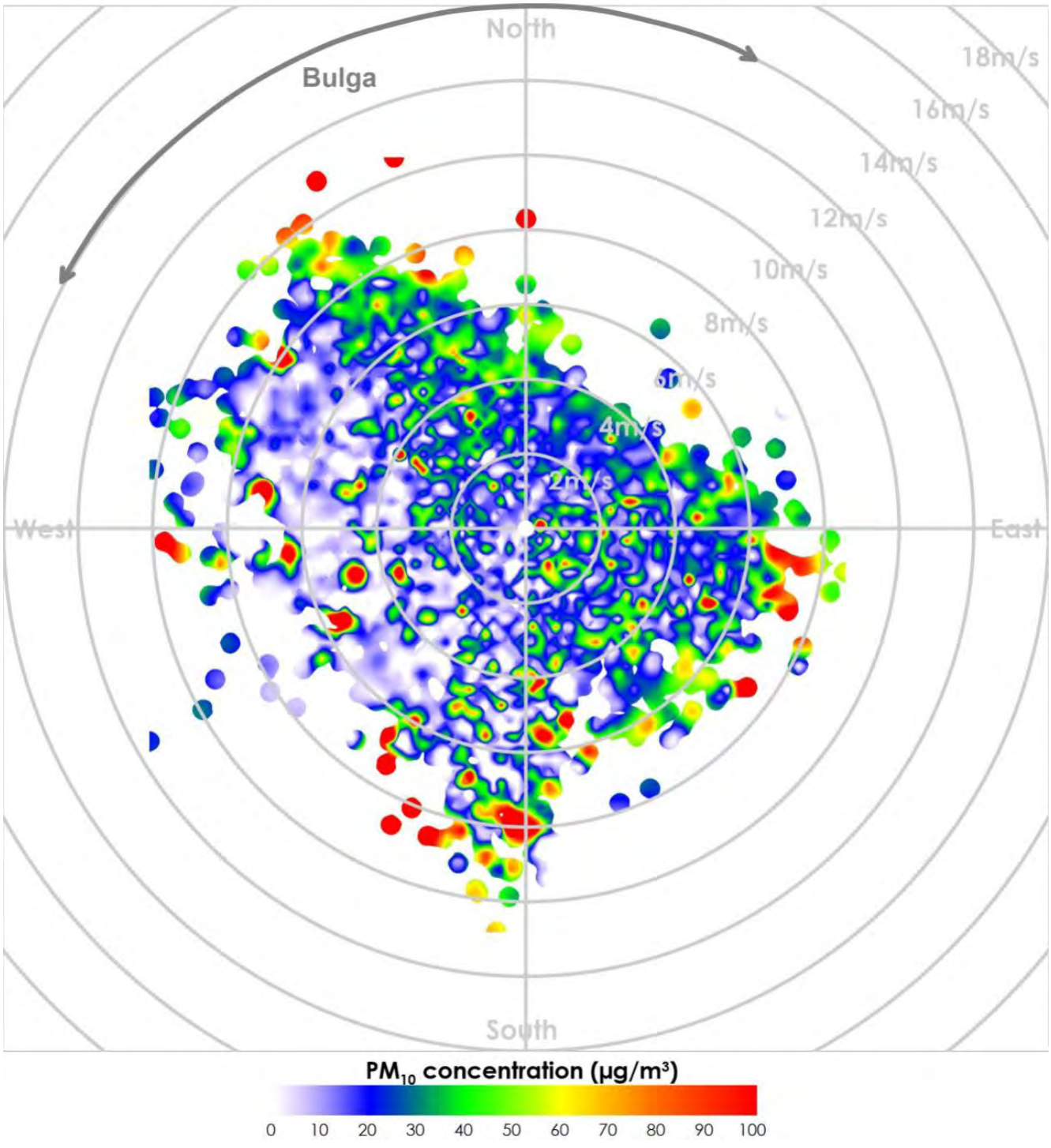
Onsite EPL Monitors

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 9 and **Figure 10** 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 measured low PM_{10} levels most of the time. High levels occur in all directions at the monitors, however the EPA Point 9 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.

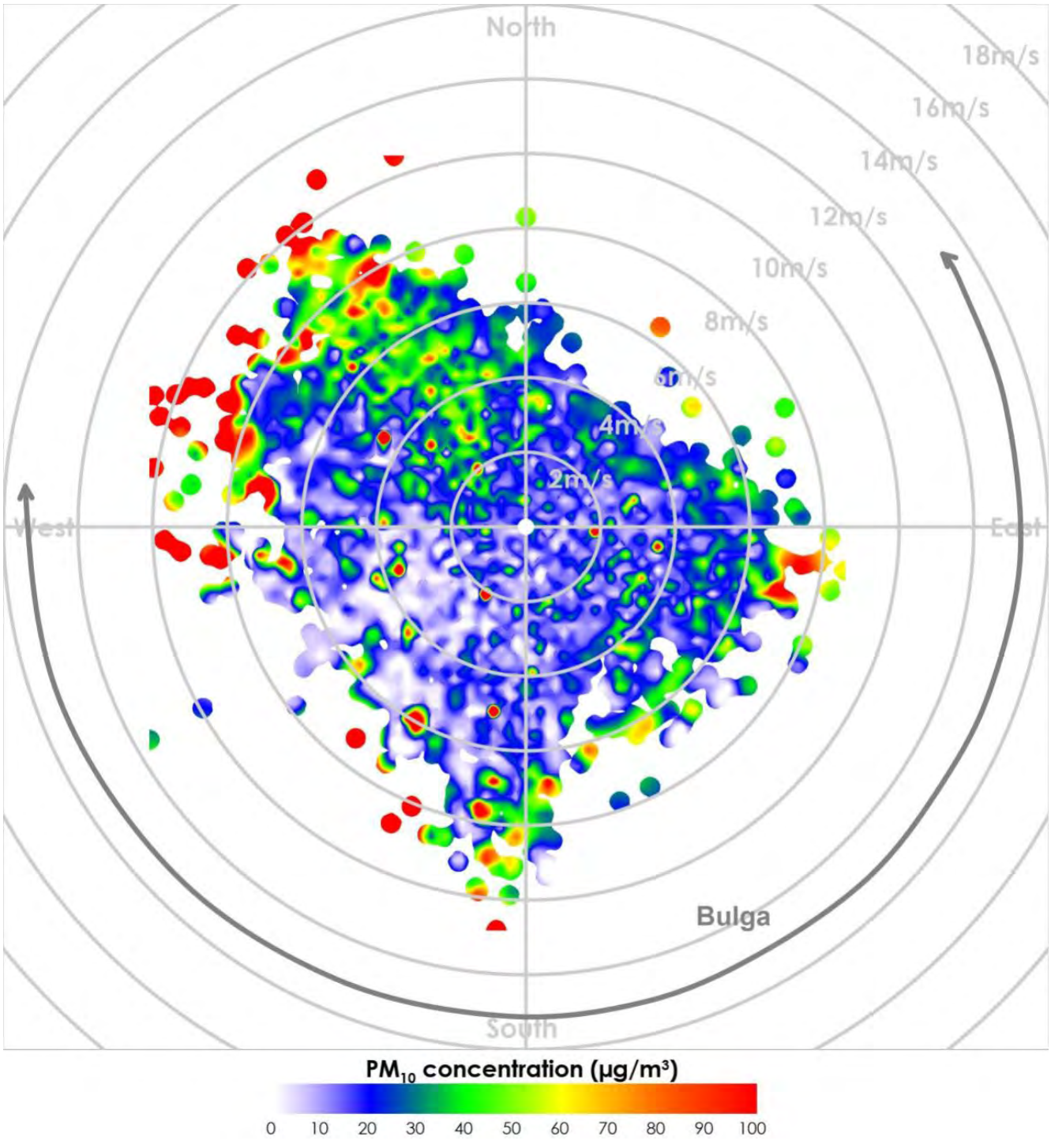
Figure 9 2020 Pollution Rose[1] for EPA Point 10 PM_{10} Data (Todoroski Air Sciences (2021))



[1] 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 10 2020 Pollution Rose[2] for EPA Point 9 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.

Mushroom Composting Facility

Figure 11 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 11**, there were 9 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 25 presents a summary of the identified exceedance days and the identified causes of each exceedance. Only the exceedances on 19 July, 27 August and 31 August occurred on days which were not declared as an extraordinary event days by DPIE (refer **Table 19**).

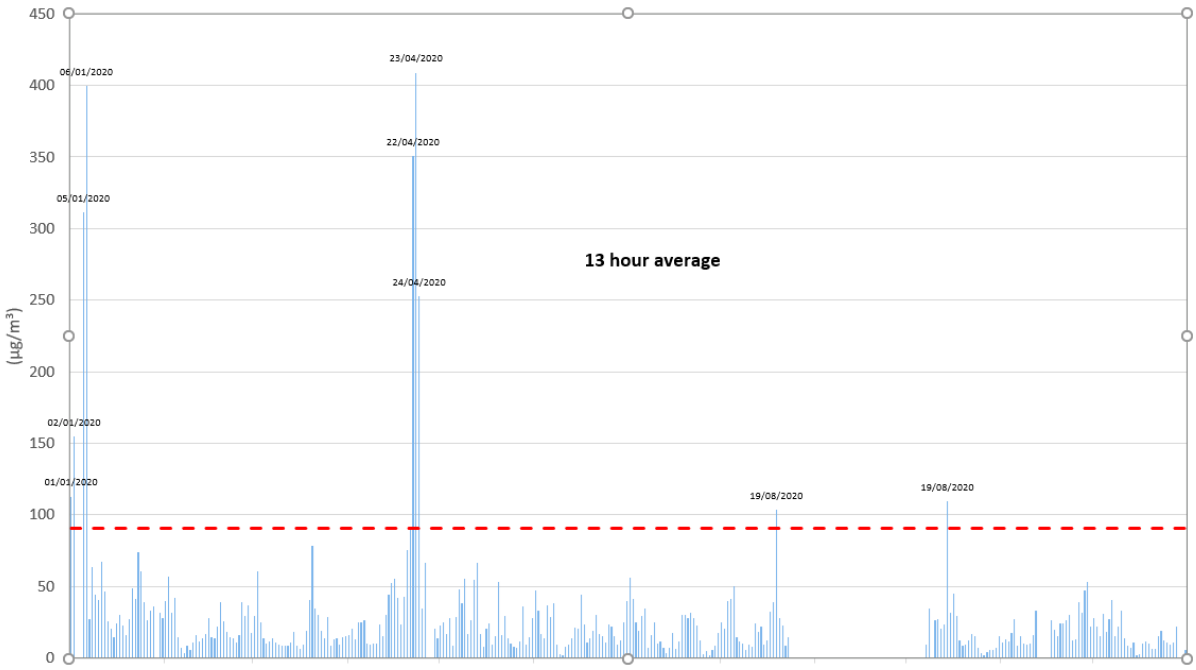


Figure 11 Mushroom Composting Facility (D4) Sampling Results 2020 – 13-hour PM_{10} Averages

Table 25 Eastern Emplacement Area Exceedance Summary

Date	Primary Cause of Elevated Levels
1/01/2020	Bushfire smoke
2/01/2020	Bushfire smoke
3/01/2020	Bushfire smoke
1/01/2020	Bushfire smoke

Date	Primary Cause of Elevated Levels
2/01/2020	Bushfire smoke
3/01/2020	Bushfire smoke
4/01/2020	Bushfire smoke
5/01/2020	Bushfire smoke
6/01/2020	Bushfire smoke
19/08/2020	Non Bulga Coal source. Strong wind and regional wind erosion.
27/08/2020	Non Bulga Coal source. Strong wind and regional wind erosion.
31/08/2020	Non Bulga Coal source. Strong wind and regional wind erosion.

*Extraordinary air quality event determined by the Department of Planning, Industry and Environment. As per Schedule 3 Condition 16 of SSD-4960 extraordinary events include bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed to by the Secretary.

6.4.3 Comparison against Predictions

A comparison of 2020 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 (2021) (attached as **Appendix B**). The assessment identified that there was generally a good agreement between modelling predictions and measured results excluding extraordinary event days.

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 (2021) (**Appendix B**). The assessment concluded that the annual average levels excluding extraordinary events were similar to the previous years and below the relevant annual criteria.

6.4.5 Implemented / Proposed Improvements

There were no changes to the air quality management during 2020.

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 26**.

Table 26 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 2020.

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 2021. 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 *BMP*. The locations of ecological monitoring sites are shown in **Figure 12**. The ecological monitoring of mine rehabilitation is covered in **Section 8.6**.

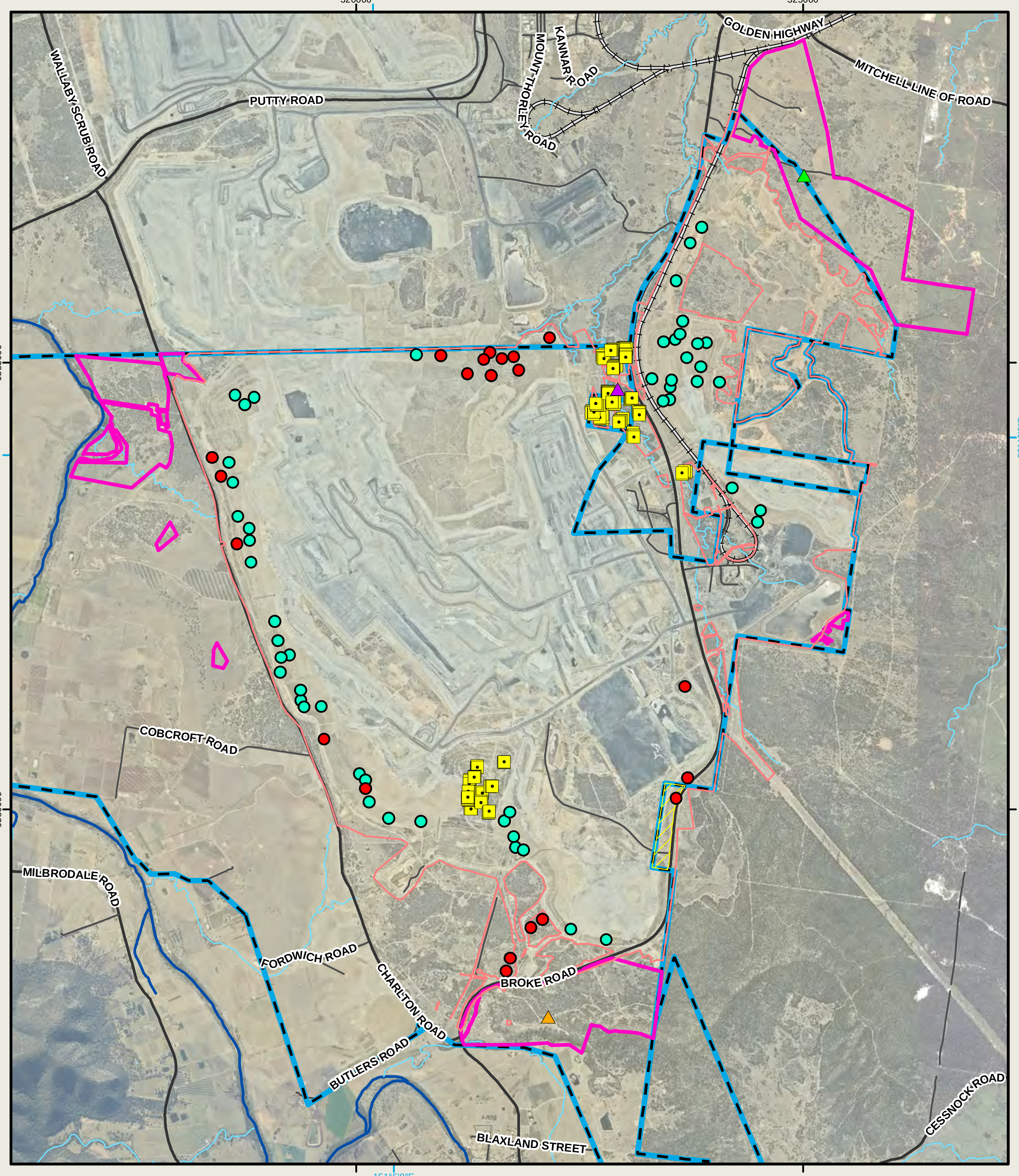
6.6.1.1 Annual Ecological Monitoring Program - Flora

The annual ecological monitoring program for flora 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 rehabilitation 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 Biodiversity Assessment Methodology (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 12 - ECOLOGICAL AND REHABILITATION MONITORING 2020



Symbol	Legend	Symbol	Legend
	Approved Disturbance Boundary		Initial Establishment Monitoring
	Mining Lease		Long Term Monitoring
	Mining Lease AMA		Spotted Gum-Ironbark-Grey Box Woodland Reference Site
	Major road		Box Ironbark Woodland Reference Site
	Minor road		Swamp Oak Reference Site
	Railway		2020 Nest Box Monitoring
	Wollombi Brook		Offset Area
	Minor Watercourse		

0 0.5 1 2
Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:60,000 @ A4

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6.6.1.2 Annual Ecological Monitoring Program – Fauna

Ecological monitoring for fauna was completed by RPS (2020) and results provided in the 2020 Annual Ecological Monitoring Report, available on the Bulga Coal website. 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 for flora was conducted at three reference sites in 2020 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.

Remnant 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 2019 monitoring results), however exotic species have increased including those in the High Threat category. BM24 continues to be dominated by exotic species (including seven High Threat species), however has seen a slight increase in native species since 2018. Attention should 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 and summer of 2020. The surveys recorded 58 different bird species, an increase of eight unique species from the previous year. This is the first year 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. Five threatened bird species were recorded, being the Blue-billed Duck (*Oxyura australis*), Grey-crowned Babbler (*Pomatostomus temporalis temporalis*), Speckled Warbler (*Chthonicola sagittata*), Spotted Harrier (*Circus assimilis*) and Dusky Woodswallow (*Artamus cyanopterus cyanopterus*). Three threatened species had previously been recorded at Bulga and two are new records.

A total of eight microbat species were detected during the 2020 surveys, which is one less than the number of species recorded in 2019. One of the species recorded in 2020 were listed as threatened under the *Biodiversity Conservation Act 2016* and the *EPBC Act*; the Large-eared Pied Bat (*Chalinolobus dwyeri*). This species has previously been recorded at Bulga.

6.6.3 Implemented / Proposed Improvements

Recommendations from monitoring reports have been incorporated, where appropriate, into the Environment and Community operating budgets for 2021. These recommendations focus on land management practices to improve the health of vegetation and quality of habitat in surrounding vegetation. Other recommendations include ongoing weed management (particularly focussing on Lantana (*Lantana camara*) and Spiny Rush (*Juncus acutus*), pest animal management and re-using salvaged habitat resources in 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 62 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 12** 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 12**.

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 12**) within two years of the approval of SSD-4960 Mod 3 (approved in July 2020).

6.7.1 Broke Road BOA

6.7.1.1 Environmental Management

Environmental management activities undertaken at the Broke Road BOA in 2020 included:

- Weed control works focussing in particular on Lantana (*Lantana camara*), Boxthorn (*Lycium ferocissimum*), Galenia (*Galenia pubescens*), Spiny Rush (*Juncus acutus*) and Saffron Thistle (*Carthumnus lanatus*);
- Wild dog and fox baiting during autumn and spring months (17 dogs, 7 Fox (*Vulpes vulpes*) takes);
- Kangaroo culls;
- Six monthly inspections; and
- Ongoing ecological monitoring program.

6.7.1.2 Monitoring Results

Flora

Monitoring in 2020 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.

Significant rainfall in spring and summer of 2020 broke the drought conditions experienced since 2017. Relative to 2019, there was an increasing trend in species diversity of native species and weeds in 2020, in response to better growing conditions (Bell, Murray & Sims 2021a). 110 plant species were recorded within the nine transects, comparable to 2019 and 2018 (117 and 118) and a decrease on 2017 (116), 2016 (144) and 2015 (142) results. There was an increase in the number of weed species recorded in 2020 (68) 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 BOA: PCT 1605 (Narrow-leaved Ironbark - Native Olive Shrubby Open Forest of the Central and Upper Hunter). For forest and grassland transects, only Native Ground Cover (grass) and Native Ground Cover (other) exceed benchmark values, although Native Plant Species exceeds or approaches benchmark for most transects. Number of Tree Hollows and Fallen Logs for both Forest and Grassland transects are well below benchmark, but will take considerable time to improve. All three revegetation transects are, as expected, almost all below benchmark values, except for transect BRO06R which exceeds benchmark for Native Ground Cover (grass), and BRO08R which meets benchmark for Native Ground Cover (other).

A single Tiger Orchid which was in flower in November 2020 (*Cymbidium canaliculatum*) (an endangered population in the Hunter) remains in the Narrow-leaved Ironbark (*Eucalyptus crebra*) adjacent to transect BRO04.

During 2020 monitoring, a more detailed mapping project was undertaken across the 30 ha to locate all stands of *Eucalyptus glaucina* (including intergrades with *E. tereticornis*), position additional monitoring plots where suitable, and observe the extent of naturally occurring recruitment. Both monitoring plots established within the *Eucalyptus glaucina* population showed good evidence of new recruitment following a well-watered 2020, a feature repeated throughout the whole population.

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 49 bird species in 2020, compared to 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 two new species were recorded in 2020; the Blue-faced Honeyeater (*Entomyzon cyanotis*) and Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*).

No camera monitoring was conducted at Broke Road BOA in 2020 due to modification of survey effort in the *Biodiversity Offset Management Plan* (BOMP). However, it is recommended that this technique be re-instated due to its efficiency in detecting fauna ((Bell, Murray & Sims 2021a). In 2020, larger mammals recorded included the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*) and wild Dog (*Canis lupus familiaris*). Smaller terrestrial mammals recorded by camera include Common Brushtail Possum (*Trichosurus vulpecula*), Brown Hare (*Lepus europaeus*) and European Rabbits. The vulnerable Grey-headed Flying-fox (*Pteropus poliocephalus)* (listed under the *Biodiversity Conservation Act 2016* and the *EPBC Act*) was also recorded in 2020, foraging for blossom and nectar in flowering Narrow-leaved Ironbark trees.

Eleven microchiropteran bat species were recorded in 2020 by echolocation call recordings. Of the eleven species recorded, three species are vulnerable, the Eastern Coastal Freetailed-bat (*Micronomus norfolkensis*) (listed under the *Biodiversity Conservation Act 2016),* the Little Bentwing-bat (*Miniopterus australis)* 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.

Four reptile species were recorded in 2020, the Eastern Long-necked Tortoise (*Chelodina longicollis*) the Bearded Dragon (*Pogona barbata*), Lace Monitor (*Varanus varius*) and Tree Skink (*Egernia striolata*).

During the 2020 surveys two frog species were heard calling: the Whistling Tree Frog (*Litoria verreauxii*) and the Common Eastern Froglet (*Crinia signifera*).

6.7.1.3 Implemented / Proposed Improvements

Weed Control

Creeping Lantana (*Lantana montevidensis*) had good growing conditions in 2020 this species has become prominent in the grassy woodlands. Monitoring and control of its spread over coming years is recommended, and spot application of herbicide may be appropriate. 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. Monitoring and control of its spread over coming years is recommended, and spot application of herbicide may be appropriate. Stands of Saffron Thistle (*Carthamus lanatus*) will continue to be monitored and controlled through slashing, as required.

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 2021a).

Pest Management

Surveys and control activities undertaken in 2020 indicate that feral pig numbers are continuing to decline. Feral pigs that do occur at the Broke Road BOA are part of the wider surrounding landscape and will require a co-operative approach with input from several stakeholders to manage effectively.

Wild Dog (*Canis lupus familiaris*) and Fox (*Vulpes vulpes*) take decreased during the 2020 baiting programs. This is likely a combination of increased effort (two programs per year) and the co-operative approach being undertaken by Local Land Services (LLS).

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 addition to bird species recorded during the census monitoring, counts of birds were recorded for the Noisy Miner removal program conducted at nearby Wollombi Brook VCA. Counts were conducted at Broke Rd VCA as a comparison (or control) site to Wollombi Brook VCA. Due to the intensive survey effort associated with the Noisy Miner removal program, bird counts were higher in 2020 compared to previous monitoring periods.

6.7.2 Condran BOA

6.7.2.1 Environmental Management

Activities undertaken at the Condran BOA in 2020 included:

- Minor repairs to boundary fences;
- Weed controls works, focusing on:
    - Coolatai Grass (*Hyparrhenia hirta*);
    - Whisky grass (*Andropogon virginicus*);
    - Spiny Rush (*Juncus acutus ssp. acutus*);
    - Prickly Pear (*Opuntia stricta*);
- Six monthly inspections; and
- Continuation of the ecological monitoring program established in 2013.

6.7.2.2 Monitoring Results

Flora

Monitoring in 2020 at the Condran BOA continued with the eight transects, six permanent monitoring transects established in 2013 and the two additional temporary revegetation plots established in 2018.

173 plant species (117 natives, 56 weeds) were recorded within the eight transects at the Condran BOA during 2020 surveys. Relative to 2019 data, there was an increasing trend in species diversity of native species and weeds in 2020, a likely reflection of better growing conditions. 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 2020 due to good rainfall. Biometric data from the eight monitoring plots have been compared against benchmark values for the relevant Plant Community Types (PCTs) present at Condran BOA: 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, Native Ground Cover (grasses), Native Ground Cover (other) and Native Plant Species for Ironbark exceed benchmark values, but all other attributes are yet to be reached. Grassland data for PCT 1605 show Native Ground Cover (grasses) and Native Ground Cover (other) to be at or exceeding benchmarks, while only Native Ground Cover (other) reaches benchmark in the Revegetation MU within PCT 1605. For PCT 1607, Native Ground Cover (other) and Native Plant Species exceed benchmark for the Redgum MU (CON01F), but all other attributes are generally below benchmark.

Increased survey effort for the threatened Pine Donkey Orchid (*Diuris tricolor*) was instigated across the main western Condran population in 2020 to better inform population size, where eight visits at 10-day intervals were carried out. Monitoring occurred in September, October and November 2020.

The 2020 monitoring identified 59 individual *Diuris tricolor* present within the Condran BOA. Only 17 (29%) individuals released seed from at least one mature capsule, grazing (invertebrate and vertebrate, including cattle) and flower withering (from weather or non-pollination) prevented capsule dehiscence in 33 (56%) individuals. Nine individuals (15%) from this population emerged but did not produce an inflorescence in 2020. Although this data is from a single season only, it never-the-less demonstrates that more than two thirds of all *Diuris tricolor* individuals within this population fail to produce mature capsules and disperse seed, a characteristic likely repeated elsewhere. High rainfall in July (57 mm above average) ensured that a better orchid season would occur for Spring-flowering species, while the wet October (69 mm above average) allowed flowering orchids to persist and progress to fruiting (Bell, Murray & Sims 2021b).

Fruiting was observed within the Condran population of *Diuris tricolor* in 2020, confirming the presence of a pollinating population of insects.

Fauna

29 bird species were recorded by diurnal census in 2020 which compares with 49 species in 2019 and 27 species in 2018. This was a significant decrease from 2019, despite the property recovering from severe drought in the previous 5 years. The major factor likely to have influenced the low species diversity was the hot weather conditions experienced during the survey. At times of hot weather, bird activity is subdued, and fewer active birds were either heard calling or visually identified flying or being active in the canopy. Additionally, the timing of the surveys in mid-morning and late-afternoon will also have influenced the species diversity and abundance.

Two vulnerable bird species (listed under the *Biodiversity Conservation Act 2016*) were recorded in 2020, the Masked Owl (*Tyto novaehollandiae*) and Grey-crowned Babbler (*Pomatostomus temporalis*). While the Grey-crowned Babbler (*Pomatostomus temporalis*) has previously been recorded nesting at Condran BOA the Masked Owl (*Tyto novaehollandiae*) has not been previously been recorded at Condran VCA, despite being known from the immediate locality.

Three of the four previously sighted macropod species were recorded by opportunistic observations and camera photographs in 2020; the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*) and Common Wallaroo (*Macropus robustus*). Other mammals recorded include Dingo (*Canis lupis dingo*) / wild Dog (*Canis lupus familiaris*), Long-nosed Bandicoot (*Perameles nasuta*), Short-beaked Echidan (*Tachyglossus aculeatus*) and Brown Hare (*Lepus europaeus*) (Bell, Murray & Sims 2021b).

No Arboreal species were detected in Condran BOA in 2020.

During 2020, microbats surveying equipment and cameras were installed at Sites ConFA1 and ConFA2. No echolocation calls of microchiropteran bat species were recorded at the two fauna monitoring sites (ConFA1 and ConFA2) in 2020. The chirping call of crickets occurs at low frequency and is recorded by the Anabat detectors. Due to the high number of recordings, this may have confounded opportunities for microbats being detected. Weather conditions during the nocturnal monitoring was warm to hot, which greatly increase insect activity. It should also be noted that several offset sites recorded very low microbat activity during the spring 2020 surveys. Ongoing monitoring of microbats will determine whether the decline in microbat activity in both 2019 and 2020 is an annual fluctuation. Since commencement of monitoring at Condran BOA, the cumulative total of microbat species is 12, which is comparable to other offsets in the local area (Bell, Murray & Sims 2021b).

6.7.2.3 Implemented / Proposed Improvements

Weeds

Bulga Coal will continue targeted control of Coolatai Grass (*Hyparrhenia hirta*). Ample effort has already been spent on eradicating this species from the BOA, but given its presence in neighbouring lands, it will require follow-up control. 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, and additional small stands were noted in 2020. 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.

Blue Heliotrope (*Heliotrope amplexicaule*) and Red Natal Grass (*Melinis repens*) have been increasing in some portions of the property. Both are particularly problematic within the main population of *Diuris tricolor*, which introduces additional difficulties for control. Low-moderate intensity burning at this location may be one management option, which would also benefit *Diuris tricolor* habitat. In addition, the native woody shrub *Bursaria spinosa* is also impinging on the open grassy habitats favoured by this orchid.

For Condran, 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 2021b).

Pest Animals

Based on 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.

6.7.3 Reedy Valley BOA

6.7.3.1 Environmental Management

The activities undertaken at the Reedy Valley BOA in 2020 included:

- Weed control works in natural regeneration areas, focussing on:
    - Prickly Pear (*Cylindropuntia spp*);
    - Galenia (*Galenia pubescens*);
    - African Boxthorn (*Lycium ferocissimum*);
    - African Olive (*Olea europaea subsp. cuspidata*)
    - Cotton Bush (*Gomphocarpus fruticosus*);
    - Saffron Thistle (*Carthamnus lanatus*);
    - Spear Thistle (*Carthamnus lanatus*); and
    - Tiger pear (*Opuntia aurantiaca*).

- Feral animal control continued in conjunction with the wider program being completed by LLS and surrounding property owners. Wild Dog (*Canis lupus familiaris*) and feral animal baiting during autumn and spring months resulted in 6 wild dog and 8 fox takes;
- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.3.2 Monitoring Results

Flora

Monitoring in 2020 at the Reedy Valley BOA continued with 10 of the 12 permanent monitoring transects which were established in 2015 (two were denied access in 2020 due to dense thistle growth).

Relative to 2019, there was an increasing trend in species diversity of native species and weeds in 2020, in response to better growing conditions (Bell, Murray & Sims 2021c). Survey of transects revealed the presence of 179 species, comprising 114 natives and 65 weeds. This is an increase from 2019 (106), and 118 in 2018 and an overall increase from that recorded in previous years. This is to be expected given the good growing conditions during 2020.

Biometric data from ten of the twelve monitoring plots have been compared against benchmark values for the two Plant Community Types (PCTs) present at Reedy Valley BOA: PCT 483 (Grey Box x White Box Grassy Open Woodland on Basalt Hills in the Merriwa Region, Upper Hunter Valley) and PCT 623 (Narrow-Leaved Ironbark +/- Grey Box Grassy Woodland of the Upper Hunter Valley, mainly Sydney Basin Bioregion). For Forest transects in PCT 483, benchmark values were attained for some transects for Native Over-storey Cover, Native Ground Cover (shrubs), Native Ground Cover (other), Native Plant Species and Fallen Logs. For Grassland transects in PCT 483, only Native Ground Cover (shrubs) and Native Ground Cover (other) exceeded benchmarks for some transects. For Forest transects in PCT 623, transect REE04F exceeds benchmark values for Fallen Logs, all three transects exceed benchmark for Native Ground Cover (other), and some transects meet or exceed benchmark for Native Mid-storey, Native Ground Cover (shrubs) and Native Plant Species. For Grassland transects in PCT 623, two transects (REE01G and REE05G) exceed benchmark for Native Ground Cover (other), but all others remain below benchmark. With few exceptions, Number of Trees with Hollows and Fallen Logs for both PCTS are well below benchmark in both Forest and Grassland, and will take considerable time to improve following past land management practices.

Despite the presence of a high number of exotic weeds at Reedy Valley, there are few highly invasive species that require ongoing monitoring and management. Thistles (*Carthamnus*, *Carduus*, *Cirsium*), the worst of these, are widespread and abundant across the area during good rainfall years (particular on basalt soils) and were particularly numerous during the 2020 monitoring period. Continual management of these species will be required into the future, including regular assessment of growth during wetter years, combined with alternate control strategies.

For Reedy Valley, 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 2021c).

Fauna

Diurnal bird census surveys were conducted at 12 sites in 2020, with a total of 70 bird species detected, compared with 74 species in 2019. The Reedy Valley BOA supports the most diverse assemblage of bird species of the Bulga Coal biodiversity offsets due to its size and variety of vegetation communities and fauna habitats.

Comparison of bird species diversity scores across all monitoring sites at Reedy Valley reveal the remnant vegetation sites score the highest average diversity, but there was not a significant difference. Three vulnerable bird species listed under the *Biodiversity Conservation Act 2016* were recorded at Reedy Valley BOA in 2020. These were:

- Masked Owl (*Tyto novaehollandiae*) (first sighting recording of this species in the Reedy Valley BOA);
- Brown Treecreeper (*Climacteris picumnus*); and
- Speckled Warbler (*Chthonicola sagittatus*).

The use of remote cameras for monitoring of larger terrestrial mammals is not included in current prescriptions of the BOMP. Consequently, only one camera was installed at a Reedy Valley BOA monitoring site in 2020, RV03. Through camera monitoring of Reedy Valley, four native macropods were observed, including the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*), Common Wallaroo (*Macropus robustus*) and Swamp Wallaby (*Wallabia bicolor*). One arboreal mammal species were detected during spotlight searches in 2020, the Common Brushtail Possum (*Trichosurus vulpecula*).

11 microchiropteran bat species were recorded at Reedy Valley BOA in 2020 which compares with 13 in 2019 and 12 in 2018. Three vulnerable microbats listed under the *Biodiversity Conservation Act 2016* and the *EPBC Act* were recorded, the Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing-bat (*Miniopterus fuliginosus*) and Eastern Cave Bat (*Vespadelus troughtoni*). The most commonly recorded bat during 2020 was the Little Forest Bat (*Vespadelus vulturnus*) with 842 calls.

Five reptile species were recorded in 2020, the Hunter River Turtle (*Emydura macquarii gunabarra*), Eastern Water Dragon (*Intellagama lesueurii*), Bearded Dragon (*Pogona barbata*), Gould's Monitor (*Varanus gouldii*) and Tree Skink (*Egernia striolata*).

Two frog species were recorded in 2020, the Common Eastern Froglet (*Crinia signifera*) and Eastern Dwarf Tree Frog (*Litoria fallax*).

Detection of pest species was relatively low in 2020 with five feral animal species being detected (pig, deer, goat, rabbit, brown hare) and two domesticated species (cattle and sheep). Damage to saplings by deer was evident in several locations. Sightings of pigs and goats were made along the creek line, while sheep were sighted at higher country. While introduced herbivores are still present, there is a significant reduction from 2018 and 2019.

6.7.3.3 Implemented / Proposed Improvements

Pest Management

Management of pest species is a significant issue for the Reedy Valley BOA. Whilst new fencing has been installed along the boundary of the offset areas, there is still evidence of cattle and sheep in parts of the offset. Ongoing monitoring will determine if cattle persist. Other pest species, including feral pigs, deer, fox and goat occur in the 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

Despite the presence of a relatively high number of exotic weeds at Reedy Valley, there are few highly invasive species that require ongoing monitoring and management. Thistles (*Cathamnus, Carduus, Cirsium*) are the most important of these with a significant increase being observed during 2020. This was due to good growing conditions and normal slashing maintenance of these areas was not possible due to wet soils. Continued management of these species will be required into the future, including regular assessment of their growth during wetter years and slashing as required.

6.7.4 Wollombi Brook Conservation Area

6.7.4.1 Environmental Management

The activities undertaken at the Wollombi Brook Conservation Area in 2020 included:

- Weed control works focussing on:
    - Prickly Pear (*Cylindropuntia spp*);
    - Tiger Pear (*Opuntia aurantiaca*);
    - African Boxthorn (*Lycium ferocissimum*);
    - Balloon vine (*Cardiospermum grandiflorum*);
    - 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;
- Wild dog and fox baiting autumn and spring months (8 dogs, 3 Fox (*Vulpes vulpes*) takes);
- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.4.2 Monitoring Results

Flora

Monitoring in 2020 at the Wollombi Brook Conservation Area continued within the eight transects, six permanent monitoring transects established in 2015 and two new temporary revegetation plots established in 2019.

Relative to 2019, there was an increasing trend in diversity of native species and weeds in 2020, in response to better growing conditions. In total, 121 plant species (82 native and 39 weeds) were recorded within the eight transects compared with 63 natives and 23 weeds in 2020. No new threatened plant species were recorded in 2020. 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. However, mean species diversity of native and weed species has increased in 2020 following favourable growing conditions, and these increases in thinned plots have been similar to those in reference plots (Bell, Murray & Sims 2021d).

Biometric data from the six monitoring plots have been compared against benchmark values for the two Plant Community Types (PCTs) present at Wollombi Brook VCA: 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, benchmark values were exceeded for some transects in Native Ground Cover (grass) and Native Ground Cover (other) and approached benchmark for Native Plant Species. For PCT 1658, Native Over-storey Cover, Native Ground Cover (shrubs) and Native Ground Cover (other) approach or exceed benchmark for some transects. Number of Tree Hollows and Fallen Logs for both PCTS are well below benchmark and will take considerable time to improve.

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 2020. WOL04R recorded 65% compared with 64% in 2019, with eight out of ten planted species still present. WOL01R recorded 69% compared with 50% in 2019, with seven out of ten species still present.

Fauna

A total of 37 bird species were recorded at the Wollombi Brook Conservation Area by census survey in 2020 and a further 30 species were identified during other field tasks. This is a decrease compared to previous years. The significant reduction in diversity/ abundance at WB02 (remnant woodland) is unknown, perhaps due to timing (time of day sampled).

In 2020, three vulnerable bird species listed under the *Biodiversity Conservation Act 2016* were recorded:

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

The Noisy Miner removal trial commenced in late 2019 and during 2020, with no trends evident since commencement of the trial.

Wollombi Brook Conservation Area recorded three macropod species, the Eastern Grey Kangaroo (*Macropus giganteus*), Red-necked Wallaby (*Macropus rufogriseus*) and Swamp Wallaby. The Common Wombat (*Vombatus ursinus*) and Common Brushtail Possum (*Trichosurus vulpecula*) were also identified.

Echolocation calls of microchiropteran bat species recorded the presence of eight bat species in 2020. These included the vulnerable Eastern Coastal Freetailed-Bat (*Micronomus norfolkensis*).

Four frog species, the Common Eastern Froglet (*Crinia signifera*), Eastern Dwarf Tree Frog (*Litoria fallax*), Broad Palmed Frog (*Litoria latopalmata*), Whistling Tree Frog (*Litoria verreauxii*) were recorded in 2020. Three reptiles, the Lace Monitor (*Varanus varius*), *Ctenotus robustus* and Red-bellied Black-snake (*Pseudechis porphyriacus*) were recorded in 2020 (Bell, Murray & Sims 2021d).

6.7.4.3 Implemented / Proposed Improvements

Weeds

Four key invasive species Weeping Lovegrass (*Eragrostis curvula*), Natal Grass (*Melinis repens*), Eastern prickly pear (*Opuntia humifusa*) and Blue Heliotrope (*Heliotropium amplexicaule)* and several exotic herbs will require ongoing monitoring and management in the Wollombi Brook Conservation Area, as their persistence and spread may adversely affect the biodiversity value of existing and regenerating Endangered Ecological Communities (EECs).

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 52 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. It is recommended that remaining Bulloak trees (*Allocasuarina luehmannii*) within the two thinned Bulloak plots be removed to allow further light to reach the ground surface. Cut stems should be laid over the ground surface to prevent excessive erosion and provide micro-habitat for colonizing species.

For Wollombi Brook 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 2021d).

Pest Management

Feral animal presence was low in 2020. Through opportunistic observations and nocturnal spotlight searches Pig (*Sus scrofa*), 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.

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 2020 included:

- Weed control works focussing on Saffron Thistle (*Carthamus lanatus*);
- Six-monthly inspections; and
- Ongoing ecological monitoring.

6.7.5.2 Monitoring Results

Monitoring of Weeping Myall within the two WMMAs during 2020 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 an increase of both native and weed species in 2020 when compared to previous years, and now approaches or exceeds that last seen in 2015-16 before the recent drought. 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 six 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.

Twenty-four months after establishment, there has been an increase of up to 31% in the number of *Acacia pendula* stems evident within the growth monitoring plots established in 2018, with an average increase of 12% across all 6 plots over this period. Increases were most marked in the Grassy Woodland stratum, and least evident in the Grassland (where *Acacia pendula* is only beginning to colonise).

The maximum height of *Acacia pendula* within plots ranged from 1.6 to 1.9 m in 2020, showing a continuing increasing trend from baseline data in 2018. Species diversity within all plots increased from 2019 data, and approaches 2018 baseline levels for native species and exceeded them for weeds. Three 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. Over time, as thickets increase in size and number of stems, decreases in diversity and abundance are expected to occur (Bell 2021).

6.7.5.3 Implemented / Proposed Improvements

Flowering

It is proposed to continue to informally monitor for flowering on the Weeping Myall trees, in the event another flowering event occurs.

Weeds

Further monitoring of the mistletoe plants on mature Weeping Myall plants should continue. Bulga Coal will monitor the prevalence of Saffron Thistle (*Cartamus lanatus*) within WMMA # 2 and remove plants as necessary.

Monitoring

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

6.7.6 Vere Offset

During November 2020 a land management inspection was conducted at the 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, 2020) are summarised below:

- Repair and install fences;
- Treat weeds including Lantana (*Lantana camara*), African Boxthorn (*Lycium ferocissimum*), Blackberry (*Rubus fruiticosus*), Pampas Grass (*Cortaderia selloana*) etc.
- Complete bi-annual baiting and trapping programs to control wild dogs and foxes;
- Complete pig and feral cat trapping;
- Complete open range shoot/s to manage foxes, rabbits, pigs and other vertebrate pests observed;
- Maintain tracks; and
- Remove rubbish.

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 2020 in conjunction with the coordinated program being organised by LLS. As part of the program, 1080 baiting was conducted, targeting wild dog Wild dog (*Canis lupus familiaris*) and fox (*Vulpes vulpes*) populations within the landholdings. Additionally, soft jaw trapping was conducted in June and December 2020. As part of feral pest management in 2020 approximately 200 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 had a total of 66 baits taken, which represented 37% of the available baits and a slight decrease on 2019 results. The Spring program had 35 baits taken which represented 19% of the available baits. This was consistent with previous year's results which generally range from 20 to 30%.

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 2021.

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 2020 Quarterly Monitoring

A program for quarterly monitoring of Aboriginal heritage sites began in 2013 at Bulga Coal. Due to site based social distancing measures associated with the COVID-19 pandemic, no RAPs attended the Quarter 2 and Quarter 3 monitoring. Quarterly monitoring reports are available on the Bulga Coal website and the results are summarised as follows:

- Quarter 1 monitoring was undertaken on 4 March 2020. 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 27 May 2020, this included a review of sites to the west of Charlton Road;
- Quarter 3 monitoring was undertaken on 12 August 2020. This monitoring was focused on sites to the west of Charlton Road and in the Broke Road Biodiversity Offset Area; and
- Quarter 4 monitoring occurred on 11 November 2020 and included sites associated with Nine Mile Creek and the Bulga Underground area.

6.9.2.2 New Aboriginal heritage Sites

During the Quarter 4 monitoring program three new Aboriginal heritage sites were recorded in a vegetated area associated with Loders Creek. This area, although not impacted by approved mining activities, is within the approved disturbance area for the Bulga Optimisation Project (BOP). The sites are within the site extent of BOP SC-8 (37-6-2852) which were salvaged during the BOP salvage program in 2015.

The recorded sites include:

- A number of artefacts along a drainage bund at the very south of the vegetated area;

- A single mudstone core within the vegetated area; and
- Two asymmetrical backed blades (bondi points) within the vegetated area.

All artefacts recorded are either in danger of being harmed by approved mining activity or by erosion. It is therefore intended that in 2021 the artefacts be collected in accordance with the ACHMP. The artefacts were fenced following their recording as a management measure.

6.9.2.3 Salvages During 2020

No salvages occurred during 2020.

6.9.2.4 Wollombi Brook Conservation 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 progress of constructing the Aboriginal cultural teaching place and artefact storage facility was discussed at the annual RAP meeting held on 3 December 2020. The proposed building layout includes a secure artefact room, presentation room, toilets, kitchen and outdoor assembly area. There will be access to the waterhole at the Wollombi Brook, barbeque facilities and interpretive signage telling the Wonnarua story.

Bulga Coal finalised the building contract and aims to complete construction by the end of 2021.

6.9.2.5 Loders Creek Grinding Grooves Conservation Area

Photographic monitoring of the Loders Creek Grinding Grooves Conservation Area occurs annually, and the site is monitored once a year as part of the Quarterly Monitoring Program. In March 2020, 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 2020. **Photo 1**, **Photo 2, Photo 3** and **Photo 4** present the 2017, 2018, 2019 and 2020 condition from Photo Point 3 for comparison. Results are summarised below:

- **Group A**

  Slabs are stable apart from an area where sandstone is exfoliating. A portion of slab appears to be detaching. Should this small portion of rock detach it will slightly compromise the integrity of the two grooves.

- **Group B**

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

- **Group C**

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

- **Group D**

  Slab is stable with no sign of exfoliation or cracking. There has been no discernible weathering since the relocation.

- **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 2020.

Photo 1 LCGG Photographic Monitoring – 2017 view from Photo Point 3

Photo 2 LCGG Photographic Monitoring – 2018 view from Photo Point 3

Photo 3 LCGG Photographic Monitoring – 2019 view from Photo Point 3

Photo 4 LCGG Photographic Monitoring – 2020 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 2020.

6.9.4 Implemented / Proposed Improvements

The ACHMP and HHMP were both revised and submitted to DPIE in November 2020. 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.

The cultural teaching place and artefact storage facility is proposed to be completed by the end of 2020.

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 is awaiting approval by DPIE.

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.

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 2020; one in the Woodlands Hill Pit in May and one on the raw coal stockpile in November. In both incidences the hot material were 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 April and September 2020. The main revisions in the Bushfire Management Plan included:

- An update to reflect controls currently implemented onsite;
- An update to contact details in response to the 2019/2020 NSW bushfire season; and
- An update following SSD-4960 Mod 3 and Mod 7 approval in July 2020.

Additionally, an Emergency Response Plan specific to Rural Fire Service (RFS) was drafted (A3).

The following activities were undertaken during the reporting period:

- Consultation with RFS to discuss upcoming bushfire management including the emergency response process and how the plan works;
- Slashing around powerlines in June 2020;
- Re-establishment of an Asset Protection Zone APZ around the Bulga Underground Operations flares;
- 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
- Implement hazard reduction measures including slashing 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 27**. 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 27 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	2018/2019	2019/2020
Fossil Fuel	210,690	219,659	6	6
Fugitive Emission - Post Mining	440,123	315,048	-	-
Fugitive Emission - Extraction of Coal/Flaring/Electricity Generation	-	-	211,722	142,027
Decommissioned Mine	-	-	123,766	70,765
Total Scope 1 Emissions	***650,813***	***534,707***	***335,494***	***212,798***
Electricity from Grid	64,321	51,323	382	350
Total Scope 2 Emissions	***64,321***	***51,323***	***382***	***350***

Emissions Source Electricity consumption (grid)	Bulga Open Cut (t CO_2-e)		Bulga Underground Operations (t CO_2-e)	
	2018/2019	2019/2020	2018/2019	2019/2020
Total Emissions (Scope 1 and 2)	**715,134**	**586,030**	**335,876**	**213,148**

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 18% when compared to the 2018/2019 reporting period. The majority of the decrease is attributable to fugitive emissions from ROM coal. Bulga Coal also had site shut downs in September and December due to the impacts of COVID-19 on the business.

Emissions from Bulga Underground Operations were approximately 37% lower during 2019/2020 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 2019/2020 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 28.**

Table 28 Comparison of 2019/2020 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)	19/20 Data (t CO_2-e)	19/20 Totals (t CO_2-e)
Scope 1 (Direct)	Diesel use	240,885	1,011,888	219,659	534,707
	Fugitive emissions	771,003		315,048	
Scope 2 (Indirect)	Electricity	55,042	55,042	51,323	51,323
Total Annual Operation			**1,066,930**		**586,030**

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 45% 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.

6.14 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 13**; and
- Hydrocarbon monitoring at the locations listed in **Table 29**. Surface water sites are monitored quarterly, following rain. Groundwater sites are monitored six-monthly.

FIGURE 13 - BULGA COAL HYDROCARBON SURFACE AND GROUNDWATER MONITORING

Mining Lease
Hydrocarbon groundwater monitoring point
Hydrocarbon surface water monitoring point
Clean water

0 62.5 125 250 375 500 Meters

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6.14.2 Environmental Performance

Surface water and groundwater monitoring was conducted at the locations listed in **Table 29** and shown on **Figure 13**. Results were assessed against the Hydrocarbon Trigger Action Response Plan (TARP) triggers in **Table 30**.

Table 29 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 30 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

Sampling Location	Contaminant	Trigger (µg/L)
	Benzo(a) pyrene	0.1

Groundwater monitoring results in 2020 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 2020.

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 31**. 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 31 Bulga Coal 2020 Water Balance

Bulga Coal 2020 Water Balance	Volume (ML)
Water Inventory and Capacity	
Total estimated water stored on site 1 January 2020 (3930 ML predicted to be in the underground goaf)	5,809
Total estimated water stored on site 31 December 2020 (4,300 ML predicted to be in the underground goaf)	9,898
Change in water inventory	4,089
Inflows	
Water extracted from Hunter River (monitored)	1,342
Rainfall and runoff intercepted from mine areas	6,753
Groundwater inflow (Groundwater model prediction)	346
Pumped from dewatering bores	100
Water entrained in CHPP feed material	607
Potable supply	10
Total Inflows	**9,158**
Outflows	
Evaporation	1,576
Discharge to Hunter River under Hunter River Salinity Trading Scheme (HRTS)	0
Water entrained in product coal, coarse rejects and tailings	1,464
Open Cut Dust suppression	1,463
Bulga Underground Operations Water Consumption	0
Potable water consumption	10
Other losses	5
Total outflows	**4,508**

7.1.2 Water Take

Water taken by Bulga Coal during the previous water year (1 July 2019 to 30 June 2020) is summarised in **Table 32**.

Table 32 Water Take 2019-2020

Water Licence #	Water Sharing Plan, Source and Management Zone	Entitlement (ML)	Passive take/inflows	Active Pumping	Total
Groundwater					
WAL41687	Mining: Sydney Basin-North Coast Groundwater Source	500	0	0	0
WAL41546	Mining: Sydney Basin-North Coast Groundwater Source	365	0	0	0
WAL41543	Mining: Sydney Basin-North Coast Groundwater Source	500	0	346	346
WAL41544	Mining: Sydney Basin-North Coast Groundwater Source	500	0	0	0
WAL41545	Mining: Sydney Basin-North Coast Groundwater Source	500	0	0	0
WAL36221	Mining: Wollombi Brook Aquifer leakage to Permian coal measures	300	0	0	0
Surface Water					
Singleton Council Agreement	Hunter River	2,219*	0	2,093	2,093

* Includes annual Singleton Council agreement allocation along with additional temporary transfers in 2019/2020. Temporary transfers from other mines included 100 ML from Mangoola Coal Operations Pty Ltd (Mangoola Mine) under licence 20AL200457 and 589 ML from Resource Pacific Pty Ltd (Ravensworth Mine) under licence 20AL201239.

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 revised in 2020 and is awaiting approval by DPIE.

EPL 563 was revised in August 2020 to include a Condition R5.3 which requires turbidity analysis against discharge EPL ID 11 – Northern Dam to be reported in the EPL Annual Return.

7.2.2 Environmental Performance

A summary of surface water monitoring results is shown in **Table 33**. The location of surface water monitoring sites is shown on **Figure 8**. Monitoring data is available on the Bulga Coal website.

Table 33 Summary of Surface Water Monitoring Results – 2020 Annual Averages

Sample Point	pH (range)	EC (µS/cm)	TSS (mg/L)	Temperature (°C)
LR1	6.4 – 7.3	513	29	17
LR2	7.0 – 7.9	1,376	47	17
LR5	6.4 – 7.5	652	9	18
W2	6.4 – 7.3	570	9	18
W4	6.4 – 8.3	669	10	19
SDL1	6.7 – 7.6	363	26	17
NDL1	7.1 – 7.7	379	39	22
W9	7.0 – 8.1	2,561	11	18
W10	7.1 – 8.4	8,227	25	20
NMC1	7.2 – 8.0	738	25	30

The results remained within historical ranges at all monitoring locations (refer **Section 7.2.4**).

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 14** and **Figure 15** show the gauging station records for 2019 to 2020 for the upstream and downstream sites, respectively.

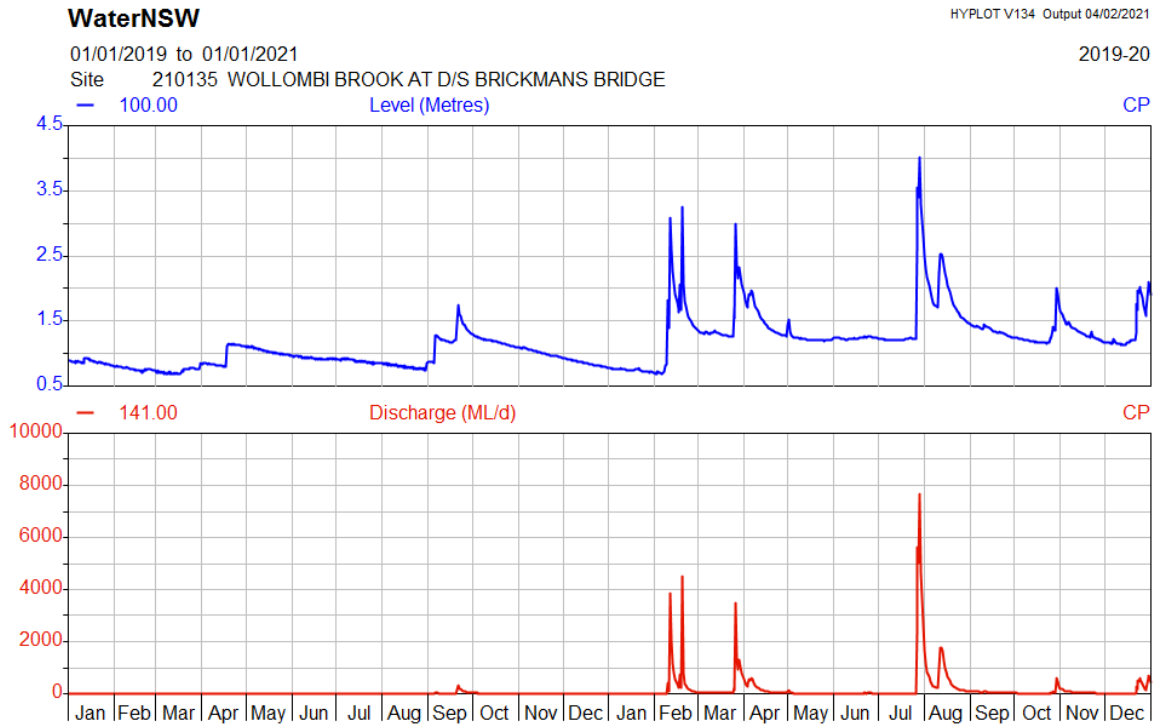


Figure 14 Wollombi Brook Brickmans Bridge Gauging Station 210135 (Upstream)

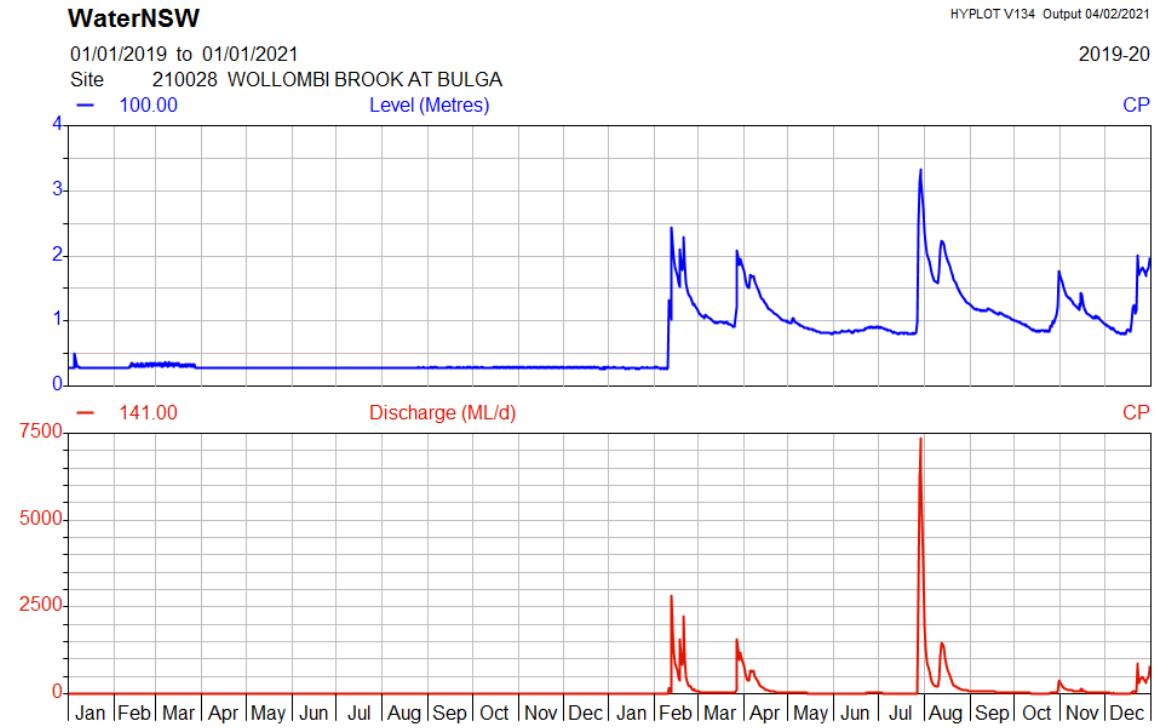


Figure 15 Wollombi Brook – Bulga Gauging Station (210028) (Downstream)

The data presented in **Figure 14** and **Figure 15** indicates that the water level in Wollombi Brook continues to fluctuate in response to rainfall events with an overall decline reflective of the ongoing dry weather/ drought and increased irrigation demand of landholders during 2019 and an overall increase during 2020 reflective of consistent rainfall events.

7.2.2.1 Hunter River Salinity Trading Scheme

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

- EPL ID 11 – Northern Dam.

Following discussion with EPA HRSTS discharge point 4 was removed during the August EPL 563 variation.

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

There were no discharges from licenced discharge points during 2020.

7.2.2.2 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 stability assessment for Nine Mile Creek sites BM21 and BM22 maintained Stable classifications, due to the consistency in channel condition over consecutive surveys. Both of these sites support a continuous riparian corridor and good ground cover throughout the channel areas.

The stability assessment for Loders Creek sites varied between Active and Stable over the length of the study area and for the most part, classifications remained consistent with recent survey results. Site BM35 (located immediately downstream of the Nine Mile Creek and Loders Creek confluence) remains Active due to exposed and unconsolidated nature of the channel wall sediments which were actively eroding in parts. Further downstream in Loders Creek site BM34 recorded a Stable classification, owing to the continuous and dense vegetation along channel walls and floor, and the shallower slope of the channel walls.

Wollombi Brook site BM35 channel conditions were mostly unchanged for the 2020 survey, and this was reflected in the site stability assessment score which remained as Stable.

7.2.2.3 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).

Overall, the 2020 Stream Health RARC results showed some improvements in riparian condition when compared to the 2019 survey season, presumably in response to the increased rainfall compared to the previous year. The Nine Mile Creek monitoring sites BM21 and BM22 recorded RARC scores of Very Poor and Good respectively. At BM21 there were decreases in the quantities of Spiny Rush (*Juncus acutus)* and minor increases in the prevalence of groundcover species however dense cover of Casuarina needles probably continues to inhibit establishment from other groundcover species such as grasses, sedges and shrubs.

The Loders Creek confluence site BM35 recorded a lower RARC rating (Average) compared to the further downstream site BM34 (Good). Both sites contain dense Spiny Rush (*Juncus acutus)* stands and other weeds in the channel and throughout the riparian, however there were increases in the quantities of native grasses.

Wollombi Brook monitoring site BM36 recorded a minor increase in indicator score total which shifted the RARC classification from the upper end of Poor to lower end of Average. This was mostly due to subtle increases in the amounts of riparian zone groundcover (mostly grasses and weeds) due to consistent wet conditions. Overall, the riparian zone at BM36 shows signs of improvement with newly established Casuarina and Eucalypt seedlings and native grasses, however the established (mature) riparian corridor for much of the site is generally narrow (<20m width).

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 2020 data has been made in **Table 34.**

Table 34 Comparison of Surface Water Monitoring Results (2020) against Background (2013 Bulga Optimisation Project EIS)

Sample Point	pH		EC (µS/cm)		TSS (mg/L)	
	2020 Range	EIS Range	2020 Average	EIS Range	2020 Average	EIS Range
LR1	6.4 – 7.3	6.6 - 8.8	513	4 - 9,470	29	1 - 72
LR2	7.0 – 7.9	6.3 - 8.8	1,376	130 - 6,230	47	3 - 440
LR5	6.4 – 7.5	6.7 - 8.4	652	196 - 3,470	9	2 - 144
W2	6.4 – 7.3	6.6 - 8.2	570	195 - 1,470	9	1 - 114
W4	6.4 – 8.3	6.5 - 8.2	669	200 - 1,760	10	2 - 42

The results presented in **Table 34**, show that while the 2020 data is variable, it is generally within the historical ranges for each site. The only deviances from these were for pH where the pH was 0.1-0.3 below the historical ranges at all sample points excluding LR2. pH also exceeded the upper limit of the historical range by 0.1 at W4. These variances are minor in nature and considered to be natural fluctuations in the water quality. The downward trend in pH during 2020 may have been a result of the fires at the end of 2019 and beginning of 2020, and then the very high level of groundcover in 2020.

7.2.4 Long Term Trend Analysis

Figure 16, Figure 17 and **Figure 18** show surface water monitoring results recorded by Bulga Coal during the period 2005 to 2020 for EC, pH and TSS, respectively.

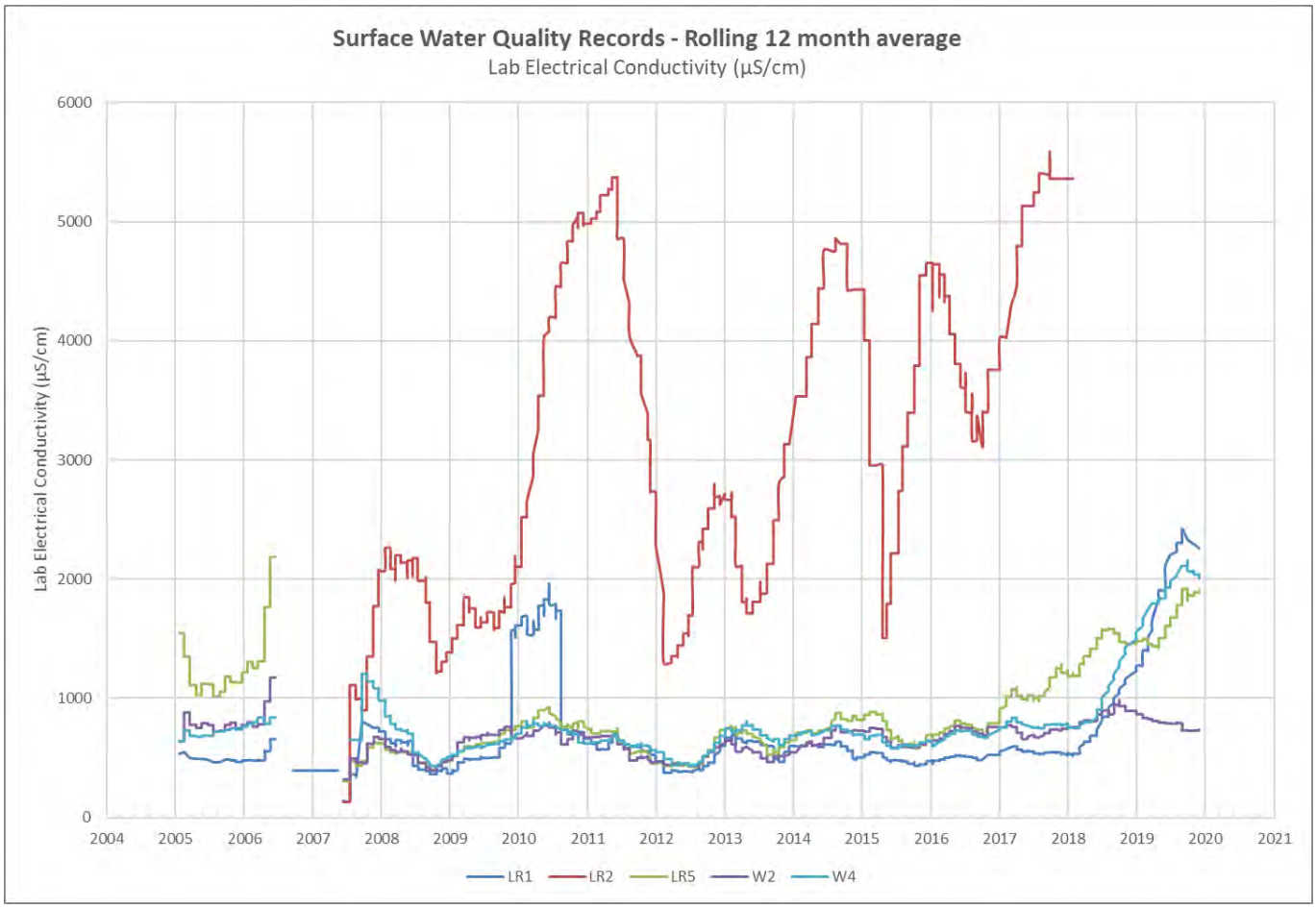


Figure 16 Long Term Surface Water EC Results

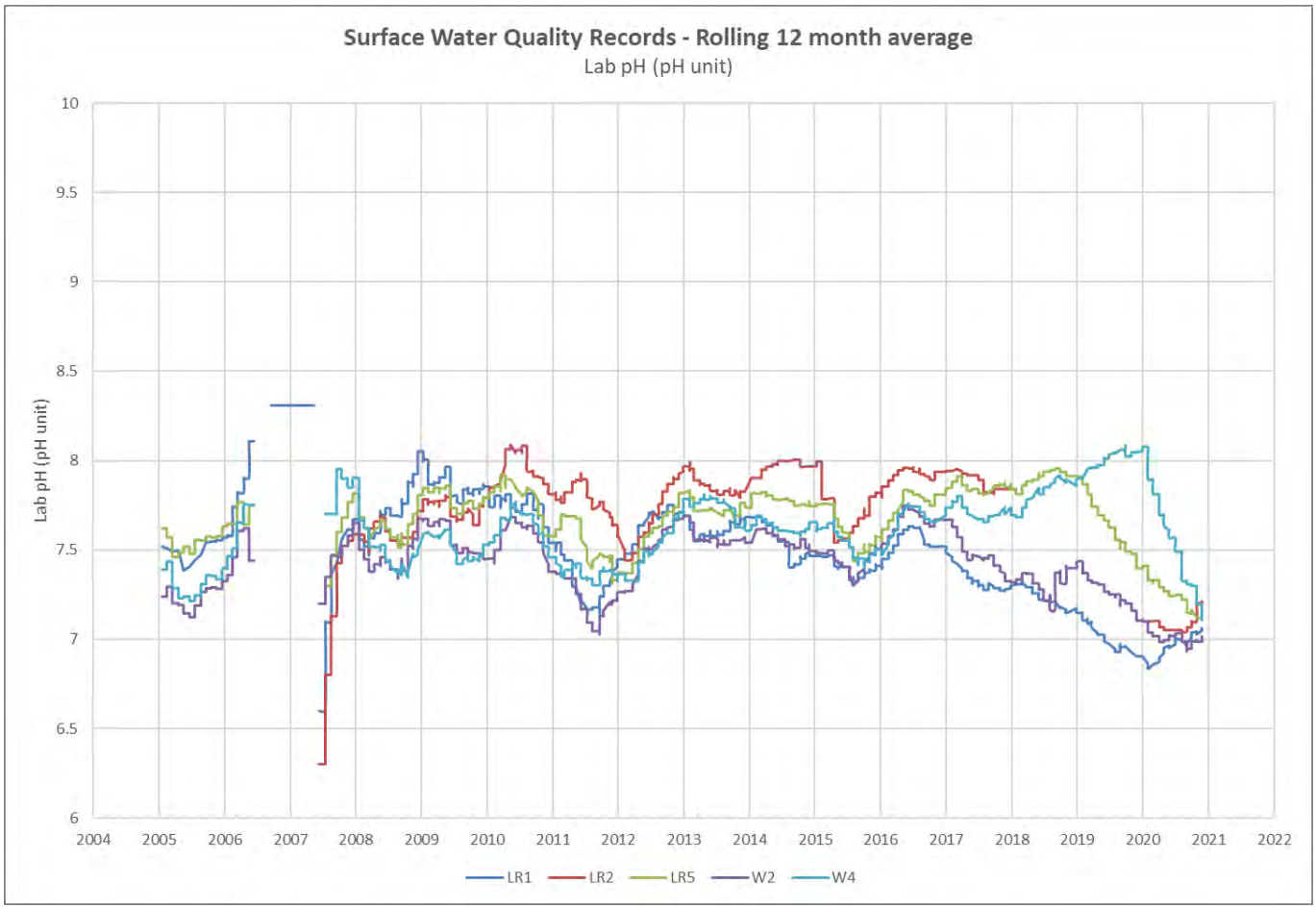


Figure 17 Long Term Surface Water pH Results

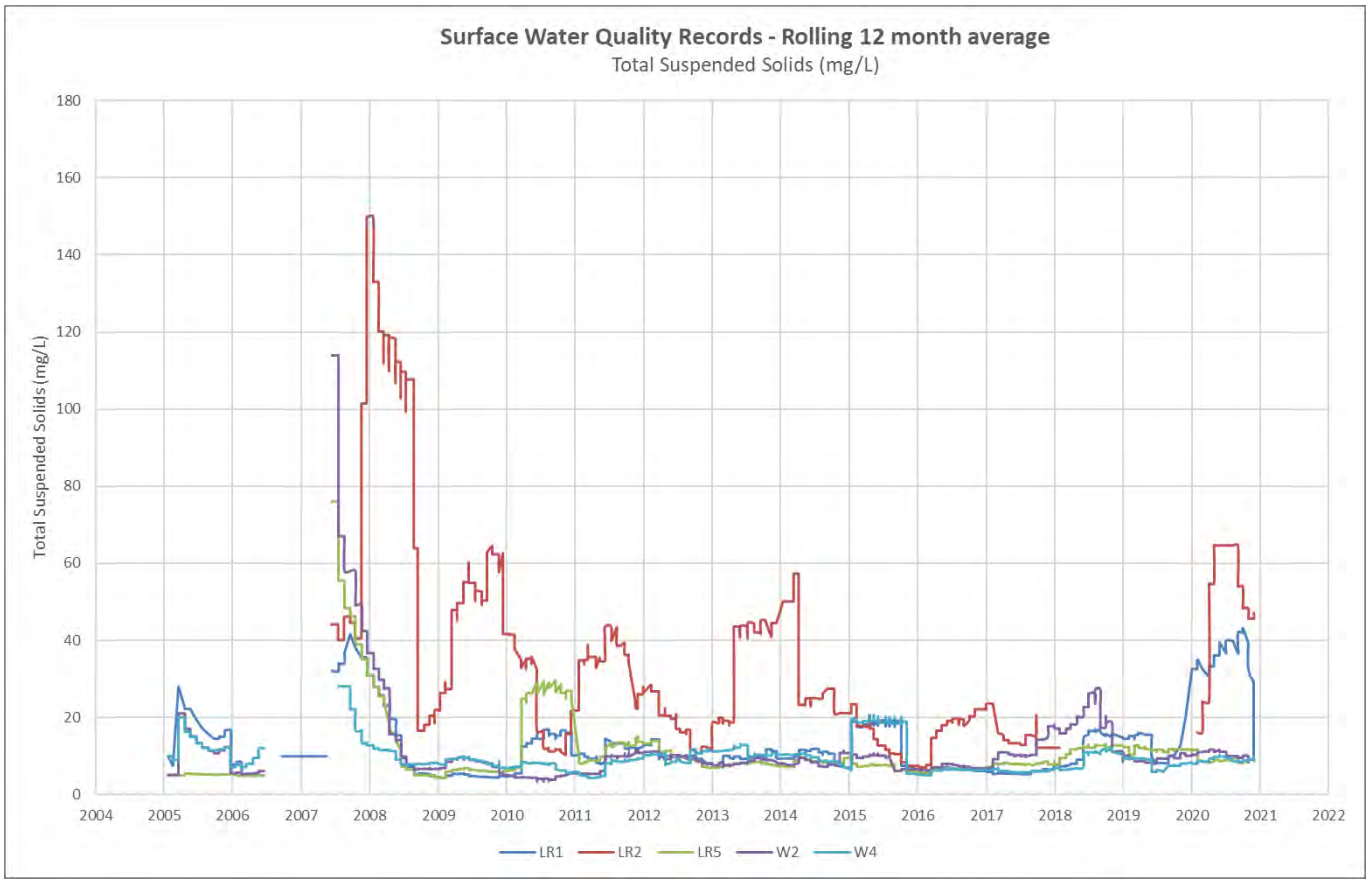


Figure 18 Long Term Surface Water TSS Results

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 34**.

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 approved *Bulga Coal Erosion and Sediment Control Plan* which was revised in 2020 and is awaiting approval by DPIE. 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.

In December 2019 two new shallow monitoring bores; sites LC1 and LC2, were installed in the Loders Creek alluvium. The sites were installed to provide baseline data, to allow for early detection of potentially altered baseflow in the alluvial aquifer (if present). Monitoring of LC1 and LC2 commenced in February 2020. The LC1 bore is dry and monitoring results were not recorded in 2020.

The groundwater monitoring network consists of the groundwater monitoring points shown in **Figure 8**. The monitoring network comprises both standpipe piezometers and multilevel vibrating wire piezometers.

The groundwater monitoring program currently comprises:

- Bi-monthly water level monitoring in all standpipe piezometers including the measurement of EC and pH;
- Continuous monitoring of pressure heads in 15 multi-level vibrating wire piezometers;
- Continuous monitoring of water levels in 22 standpipe piezometers which are equipped with dataloggers; and
- Comprehensive geochemical sampling and analysis undertaken on a half yearly basis in all 49 standpipe piezometers (including major ions and metals).

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 is shown in **Table 35**, with detailed groundwater monitoring results available on the Bulga Coal website.

Table 35 Summary of Groundwater Monitoring Results – 2020 Annual Averages

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Lab pH	Lab EC (µS/cm)
Broke Area Alluvials				

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Lab pH	Lab EC (µS/cm)
GW1	4.2	88.1	6.9	3,537
GW2	2.4	83.9	7.0	5,497
GW3	2.1	75.9	7.0	5,545
GW4	2.0	78.6	7.3	1,743
GW5	1.8	80.2	7.1	5,163
GW6	3.0	74.1	7.4	7,345
GW7	1.6	73.5	7.0	4,365
GW8	3.6	71.5	6.7	5,068
GW9	1.8	72.0	6.9	2,847
GW10	1.4	71.9	7.8	4,545
V3	7.2	68.3	6.8	2,215
Broke Area Wollombi Seam				
P2	6.7	67.9	7.2	11,628
P5A	7.5	68.6	7.7	3,888
P6A	21.6	63.5	7.4	1,921
Northern Area Shallow Alluvials				
F1	7.2	63.0	7.7	1,345
F2	5.8	64.3	7.3	1,767
WBR50A	6.9	58.2	7.5	4,835
V1	7.2	63.9	7.7	1,609
V2	7.0	60.3	6.6	257
SBC/Broke Area Lower Whybrow Seam				
P6B	100.5	-15.4	8.3	6,598
P8	14.4	73.8	7.2	1,240
Northern Area Lower Whybrow Seam				
WBR50	39.6	25.0	7.6	7,807
Northern Alcheringa Seam				
WBD62A	17.1	63.1	7.2	986
Beltana Area Miscellaneous Bores and Wells				
Dwyers	8.3	61.8	7.7	1,647
Fernance	8.3	63.3	7.9	1,327
McG1	19.9	92.5	7.9	238
White1	6.3	64.2	7.2	2,517
WBR15	18.1	60.0	7.3	1,389
Beltana Area NPZ				
NPZ3-A	Blocked and flooded during 2017 not accessible.			
NPZ3-B	12.9	59.9	-	-
NPZ4-A	23.5	59.2	6.9	683
NPZ4-B	32.7	49.4	7.7	1,315
NPZ5-A	11.6	62.9	7.0	917

Piezometer No.	Depth to water (m)	Water elevation (mAHD)	Lab pH	Lab EC (µS/cm)
NPZ5-B	24.5	49.4	7.5	2,713
NPZ7-1	12.7	56.3	7.6	1,225
NPZ7-2A	7.5	63.0	7.4	1,864
NPZ7-2B	17.5	52.8	7.8	1,309
NPZ7-3A	-[1]	-	-	-
NPZ7-3B	17.2	56.4	7.7	1,280
Wollombi Alluvials and Shallow Coal Measures				
WBD160	10.0	63.8	7.0	1,085
WBR180	34.3	35.6	7.2	19,367
WBR181	7.5	61.1	7.3	2,828
WBR182	7.8	61.8	-	-
WBR183	14.2	60.4	7.1	3,655
SBD196	5.7	67.3	7.0	4,198
WBR240	6.6	58.9	7.2	24,940
WBR241	7.5	60.7	6.5	506
Loders Creek Alluvials				
LC1	-[1]	-	-	-
LC2	3.3	22.2	7.6	4,490

1 – no results available for 2020.

Note: P1 and P7B are located on AGL land and no longer accessible.

2020 Bulga Coal Complex Annual Groundwater Monitoring Report

Jacobs have produced the *2020 Bulga Coal Complex Annual Groundwater Monitoring Report* (Jacob, 2021) which is attached as **Appendix C**.

The report includes a review of standpipe and vibrating wire piezometer data to understand any change since the completion of underground operations at Blakefield South Mine. It was concluded that shallow groundwater in the alluvium (Wollombi Creek and Monkey Place Creek), generally shows a recovery following the 2016-2019 drought, which is in line with the increasing rainfall excess recorded since early-2020. Hydrograph analysis of Wollombi Brook and Monkey Place Creek alluvial data indicates that the water table is strongly influenced by rainfall and to a lesser extent by other factors such as irrigation.

The majority of alluvium bores show a decrease in EC trends, which is in line with the increasing rainfall excess since early-2020.

7.4.3 Comparison against Predictions

With the cessation of underground mining the combined Blakefield and Whybrow Seam workings are now filling with groundwater. 100 ML was drawn from the Beltana goaf (Whybow Seam) in 2020 with a net increase in storage of approximately 370 ML largely consistent with the groundwater model inflow predictions of 346 ML.

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 2020. Overall, there does not appear to be any measurable impact from mining operations on the alluvial aquifers (Jacobs 2021). It is of note that in most of the alluvial aquifer piezometers the recent groundwater levels are still above those recorded before the 2007 Pasha Bulker storm event. Detailed groundwater monitoring trend graphs are presented in the *Annual Groundwater Report* (Jacobs, 2021) which is attached as **Appendix C**.

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. Monthly and annual rehabilitation inspections are 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 D.**

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 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 2020 were:

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

- Installation of habitat features (e.g. stag trees, woody debris);
- Spreading of topsoil or organic matter;
- Application of ameliorants;
- Re-ripping of prepared surface; and
- Revegetation.

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 2020 is presented in **Table 36** and is shown in the plan included as **Appendix E**.

Table 36 Rehabilitation Status at Bulga Coal

Mine Area Type	Previous Reporting Period (Actual) 2019	This Reporting Period (Actual) 2020	Next Reporting Period (Forecast) 2021
Total mine footprint	3,361.30	3,440.80	3,468.10
Total active disturbance	2,422.20	2,325.42	2,341.90
Land being prepared for rehabilitation	131.20	38.39	28.00
Land under active rehabilitation	960.40	1,115.34	1,126.23
Completed rehabilitation*	0	0	0

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

8.2.2 2020 Rehabilitation – Bulga Open Cut

During 2020, Bulga Open Cut completed rehabilitation in the Eastern Emplacement Area (90 ha). Maintenance of BOC and BUO rehabilitation occurred throughout the year.

Rehabilitation and disturbance at Bulga Open Cut is shown on **Figure 18.**

8.2.2.1 Landform Details

During 2019, a Geofluv natural landform design was developed for the Eastern Emplacement Area southern dump. This design was implemented over a 65 hectare area of rehabilitation in 2020, the remaining 25 hectares was shaped in 2019 and included a detailed design for contour drains and a drop structure, shown in **Photo 5**.

Photo 5 Example of traditional rehabilitation practices with contour banks (shaped in 2019 - right) next to natural landform design (shaped in 2020 - left).

The natural land design follows fluvial geomorphic principles that outlines how landforms develop and function naturally through the power of water flow. The design considers the natural terrain features of the surrounding area and incorporates micro-relief, shown in **Photo 6**.

Photo 6 Built natural landform design surface, Eastern Emplacement Area Southern Dump

The design is incorporated into the mine planning process to develop dump designs to assist in shaping of the landform. The ridges and drainage lines are dumped in a way to reduce the volume of material required to be pushed to build the final landform, as shown in **Photo 7**.

Photo 7 Dump design surface, showing the shape of ridges and drainage lines dumped out for each bench.

8.2.2.2 Cover Materials

Direct emplacement of topsoil from Eastern Emplacement Area Extension 3 clearing area occurred throughout 2020 on rehabilitation areas. 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 have elevated sulfur. 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 2020 focussed on the establishment of the Central Hunter Grey Box – Ironbark Woodland community on the Eastern Emplacement Area. The seed mix for these areas focussed 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 2020, 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 83 hectares of temporary rehabilitation was undertaken over the Old Tailing Dam (76 hectares) and North Blakefield Dump (seven hectares) in 2020. A pasture seed mix was developed for these areas to stabilise slopes and reduce the potential for generating dust.

8.2.2.7 Rehabilitation Maintenance

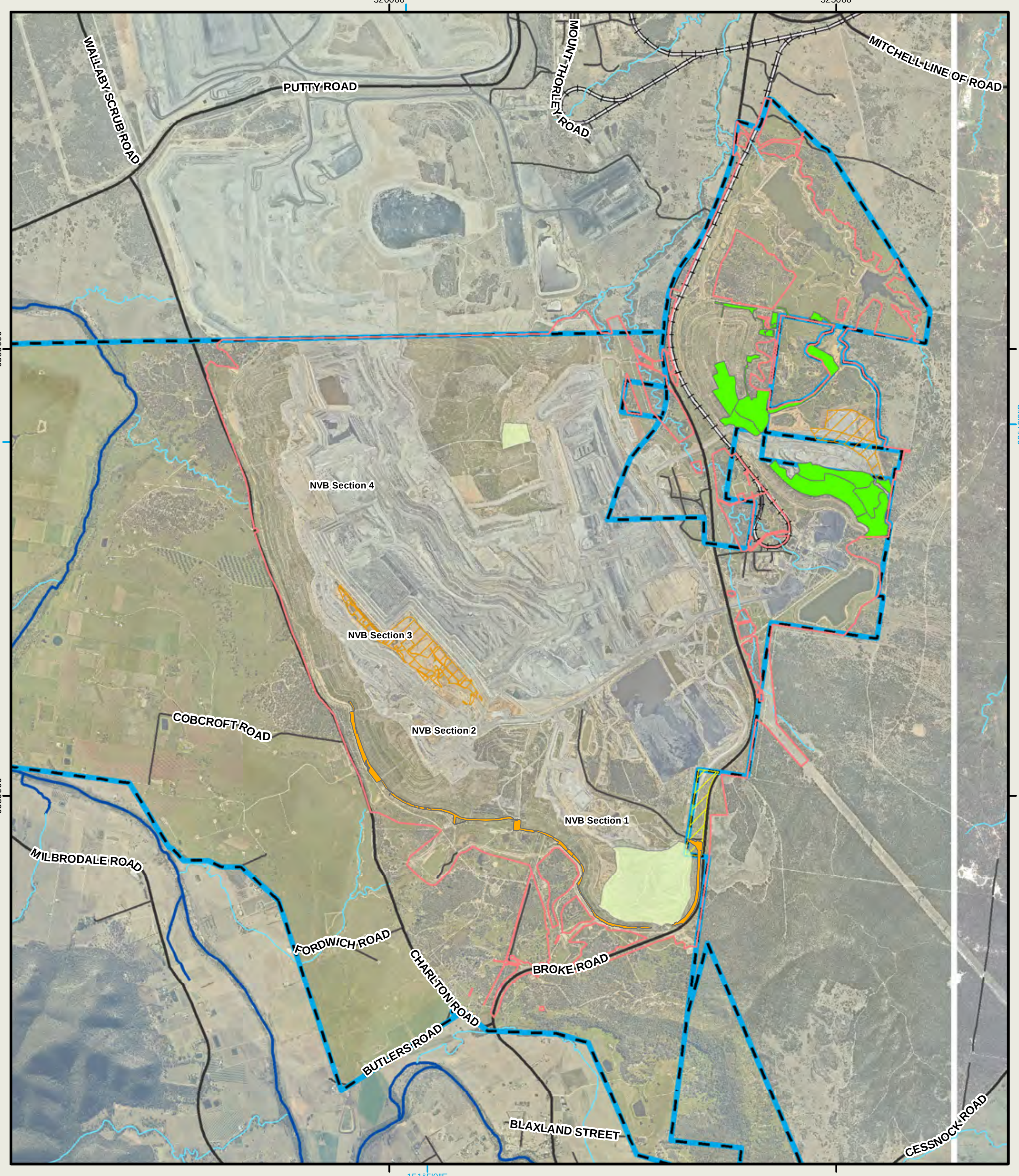
Rehabilitated areas at Bulga Open Cut are subject to an ongoing monitoring and maintenance program to ensure that the completion criteria are achieved. Inspections are conducted annually by an external rehabilitation consultant. A summary of these care and maintenance activities undertaken during 2020 are outlined in the following sections and in **Table 37.**

Table 37 Maintenance Activities on Rehabilitated Land for Bulga Open Cut

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
	2020 (actual)	2021 (planned)	
Additional erosion control works (drains re-contouring, rock protection)	<1	10	Some contour bank breaches and other rilling was repaired during 2020. Further drop structure, contour and rilling repairs are planned for 2021 along the Noise and Visual Bund.
Re-seeding/replanting (species density, season etc.)	0	2	Re-seeding repairs will occur along the Noise and Visual Bund in 2021.
Adversely affected by weeds (type and treatment)	240	300	Weed control works in 2020 focused mainly on the Noise and Visual Bund, Eastern Emplacement Area and Mount Thorley Warkworth Common Boundary Area. This will continue in 2021 with new rehabilitation areas being added to the program as required. The main weeds being controlled are Galenia, Acacia Saligna and Lantana.

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
	2020 (actual)	2021 (planned)	
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.

FIGURE 19 - BOC REHABILITATION AND DISTURBANCE 2020



Ref: \\ausydsrvc5590\biGIS\Mapping\Reporting\AEMR\2020\2020_AEMR_FIGURE20_BOC_REHAB_AND_DISTURBANCE_GDA2020.mxd

- Approved Disturbance Boundary
- Mining Lease
- Mining Lease AMA
- Major road
- Minor road
- Railway
- Wollombi Brook
- Minor Watercourse
- 2020 Rehabilitation (Woodland)
- 2020 Temporary Rehabilitation (Pasture)
- 2020 Disturbed
- 2020 BEP Power Line Disturbance

0 0.5 1 2
Kilometres

Coordinate System
GDA2020 MGA Zone 56
1:60,000 @ A4

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Weed control works were continued based on the findings of monthly inspections.

8.2.3 2020 Rehabilitation – Bulga Underground Operations

Rehabilitation during the reporting period focussed on remediation of land affected by mine subsidence and the 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

In general, disturbance and subsequent rehabilitation activities at Bulga Underground Operations require minimal modification of the existing landform. 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 2020 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 2020 are outlined in **Table 38**.

Table 38 Maintenance Activities on Rehabilitated Land for Bulga Underground Operations

Nature of Treatment	Area Treated (ha)		Comment/control Strategies/Treatment Details
	2020(actual)	2021 (planned)	
Additional erosion control works (drains re-contouring, rock protection)	As required	As required	Maintaining temporary controls around disturbance and active rehabilitation areas as identified in routine and scheduled inspections.
Soil treatment (fertiliser, lime, gypsum etc.)	<1	<1	Fertiliser used in seed mix for rehabilitation.
Re-seeding/replanting (species density, season etc.)	<1	<1	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 2020 and focused mainly on the Vere and Johnsons 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 2020 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 2020 Bulga Open Cut infrastructure continued to be demolished and/or dismantled including:

- Temporary relocatable office buildings; and
- CHPP bathroom and shower facility.

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

In 2020, 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 39 summarises the rehabilitation progress at Bulga Coal (including Bulga Open Cut and Bulga Underground Operations) during 2020 against the MOP predictions.

Table 39 Bulga Coal MOP Rehabilitation Predictions against 2020 Data

Mine Area Type	2020 Actual Data (Bulga Coal)	MOP Prediction 2020
Rehabilitation (ha)	154.94 (65.59 temporary rehabilitation)	86.20
Disturbance (ha)	69.71 (Jul-Dec)	48.10 (July-Dec)

During 2020, the rehabilitation target was exceeded by approximately 3.15 ha of Central Hunter Box Ironbark Woodland, completed in the Eastern Emplacement Area (including 0.75 ha disturbance of rehabilitation).

Disturbance was 21.6 ha more than that proposed in the MOP. The completed disturbance areas were in the same locations as proposed in the MOPs, with the additional area being in the Southern Extension Area. This disturbance was discussed with the Resource Regulators prior to disturbance activities (RR acceptance of change to the MOP on 28 October 2020).

In December 2020, a 66 kV powerline was installed along the base of the Noise and Visual Bund and Old Tailings Dam, in accordance with Bulga Open Cut SSD-4960 (Mod 3) and Bulga Underground DA 376-8-2003 (Mod 7). This activity was not captured in the 2020-2023 MOP due to the final location of the powerline not being determined prior to MOP submission. This area has been disturbed and seeded with a native/non-invasive pasture mix and reclaimed as completed rehabilitation.

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. 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 and landform stability. 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

Since 2017, rainfall has been lower than average and temperature has been 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.

Resulting signs of vegetation recovery have been observed in both remnant and rehabilitated vegetation. Most change comes from increases in the cover and abundance of both native and exotic species. Other signs of vegetation recovery included increased ground coverage and mid-story species recovering under new foliage.

Recent *Galenia pubescens* spraying in the western areas along Charleton Road appears to have been effective by way of dead/dying plants.

Signs of native species regeneration was observed at all sites.

A small number of sites recorded erosion patches, with these generally being minor only. One site in particular warrants monitoring for erosion, being SGGBI_01 (this site has deep gullies which are stabilised (vegetation cover), however has deep channels which may erode further). This site appears to be an isolated incidence of erosion and should be monitored for loss of vegetation cover which may increase severity of erosion.

Evidence of feral animals in the remnant vegetation 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. Feral dogs were observed in the northern sections of the rehabilitation, and fox scats were also observed.

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 three reference sites in 2020 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.

Reference 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 2019 monitoring results), however exotic species have increased including those in the High Threat category. BM_24 continues to be dominated by exotic species (including seven High Threat species), however has seen a slight increase in native species since 2019. Attention should continue to be paid to managing exotic species in these communities.

8.6.1.3 Woodland Rehabilitation Site Monitoring

The 2020 monitoring saw new sites being established under the new methodology. This season monitored three LTM sites in Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC and 19 sites in the Central Hunter Grey Box – Ironbark Woodland EEC.

Overall, the 2020 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 returned similar results 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. Key exotic species across all of these sites include *Bidens pilosa, Carthamus lanatus, Galenia pubescens*, and *Chloris gayana* at two sites.

Species richness varied between the Central Hunter Grey Box – Ironbark Woodland EEC sites, with a range of 17 to 43 total species recorded. Sites GBIW_10 to GBIW_15 were the most diverse, all recording over 30 species. These younger GBIW rehabilitation sites returned generally higher species diversities than the older sites, as would be expected. The most commonly recorded High Threat exotics included *Bidens pilosa, Galenia pubescens*, *Senecio madagascariensis* and *Chloris gayana*.

Rehabilitation monitoring data indicates that most areas are progressing well towards most completion criteria. 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 SGGBI_01 IEM monitoring site; and
- 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

Remote Sensing Trial

Bulga Coal has been developing a remote sensing research project since 2018, initially looking into vegetation classification and health over a two-hectare area of rehabilitation adjacent the Bulga Underground Operation entry from Broke Road. This project was expanded in 2019 to cover 312 hectares assessing vegetation classification and health, weed species cover, bare areas, erosion and slope angle.

The 2020 remote sensing of mine rehabilitation increased the survey area to approximately 380 hectares and refined the features surveyed in 2019. Outcomes of the 2020 project include:

- Improved the accuracy of locating weed species through verification of imagery;
- Mapped bare areas into classes defined in the closure criteria (i.e. > or < than 400m^2) and included slope angle as a feature to determine risk; and
- Mapping rill/gully erosion based on slope angle, length and width of erosion.

Bulga Coal are still developing the vegetation health classification. This feature requires further research to provide usable data.

In 2021, we will continue to progress the remote sensing research, focusing on comparing results from 2020 following maintenance efforts, including weed control and erosion maintenance along the Noise and Visual Bund, and increase the survey area of the project.

Soil Profile Assessment

In 2020 a Soil Profile Assessment (SPA) was conducted targeting the health and structure of the reinstated topsoil for selected rehabilitation areas at BOC. The selected rehabilitated areas were lands that have undergone rehabilitation using woodland vegetation species.

Twenty (20) profile sites were pre-selected in consultation with Bulga Open Cut prior to commencement of the fieldwork. Selection of profile sites was on the basis of ensuring several years of completed rehabilitation was represented.

Soil samples were collected from the surface (A horizon) and subsurface (B horizon) horizons from representative profile sites. Following collection of soil samples, representative samples were couriered under chain of custody documentation to Environmental Analysis Laboratory (EAL) at the Southern Cross University in Lismore. EAL is a laboratory with National Association of Testing Authorities (NATA) accreditation for the majority of analyses required.

The SPA concluded the rehabilitated soils are mildly to very strongly alkaline. The newly rehabilitated soils remain predominantly sodic and saline with sodicity and salinity decreasing in the older rehabilitated sites. The Ca concentration is mostly low compared to the Mg in the soil. The available N and P concentrations are also likely to limit plant growth. Trace elements occur at naturally high levels at the site and do not require amelioration.

Based on the soil profile assessment, to provide a favourable environment for vegetation establishment and to stabilise the bare areas, it is recommended to apply N, P, and Ca supplements. Gypsum is to be added at a rate of 2 t/ha as a source of Ca and to reduce the ESP (sodicity) in the soil.

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.

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;
- 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 2020 were Lantana (*Lantana camara*), Boxthorn (*Lycium ferocissimum*), African Olive (*Olea africana*), Galenia (*Galenia pubescens*) and Saffron Thistle (*Carthumnus lanatus*).

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 2020 some minor rilling was found on the Eastern Emplacement Area and these areas were repaired and seeded with native woodland seed mix. Two contour banks which had minor failures were also repaired in 2020.

Ongoing rehabilitation inspections will identify any maintenance required throughout 2021.

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 2020 as outlined in **Section 6.8.**

8.7.2.2 Erosion and Water Quality

Maintenance of erosion controls identified during scheduled and routine inspections was undertaken during 2020. Drains such as contour banks and diversions required little to no maintenance.

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 2021

Bulga Coal plans to undertake the following rehabilitation and disturbance works during 2021:

- 32.05 ha of disturbance;
- 42.85 ha of rehabilitation (levelled/re-contoured, topsoiled and seeded);
- 27.57 ha of disturbance of rehabilitation;
- 4.39 ha of rehabilitation of former temporary rehabilitation;
- Maintenance tasks as required on existing rehabilitation areas;
- Progressive decommissioning and rehabilitation of gas drainage infrastructure and boreholes (gas, services, geology etc.); and

- Subsidence repairs as required.

The proposed 2021 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

From mid-March 2020, the COVID-19 pandemic changed the way we delivered stakeholder engagement. During the year we modified methods of engagement to meet the company and government health guidelines. A number of planned local events were also cancelled. At the beginning of the pandemic, Bulga Coal organised the delivery of complimentary fruit and vegetable hampers to elderly members of the community and the Community Consultative Committee (CCC).

9.1.1 Community Barbeque Program

Bulga Coal did not hold community barbeques in 2020 based on advice from the Government regarding large meetings.

9.1.2 Newsletters

Community newsletters were distributed to letterboxes in Broke, Milbrodale and Bulga in May and December 2020.

9.1.3 Community Consultative Committee

Bulga Coal enjoys an open and honest dialogue with community representatives and Singleton Council through a combined CCC for Bulga Underground Operations and Bulga Open Cut. Bulga Coal hosted a virtual meeting in May and a face to face meeting in October 2020. Minutes from the CCC meetings are available on the Bulga Coal website.

9.1.4 Voluntary Planning Agreement

A Voluntary Planning Agreement Committee was formed in 2015 with members of the Broke and Bulga communities, Singleton Council and Bulga Coal to administer funds associated with the Village Master Plan. All funds have been allocated to projects in the local area.

In July 2020, the skate park at McTaggart Park Broke, including new table seatings and barbeque area was completed. The Council organised an opening event in August 2020, attended by representatives from Bulga Coal. In the September school holidays, Bulga Coal organised free skating workshops for local kids with around 30 kids attending across six sessions.

A variation to the VPA is being prepared as part of the SSD-4960 Modification 3.

Photo 8 Free skate workshops at the Broke Skate Park

9.1.5 Quarterly and Annual Stakeholder Meeting

Bulga Coal cancelled the quarterly meetings with Aboriginal stakeholders in 2020 and emailed RAPs with the progress of the Teaching and Keeping Place and other relevant issues. An annual meeting was held with eight stakeholders in December 2020. The minutes of the meetings are available on the Bulga Coal website. Aboriginal heritage is discussed in **Section 6.9**.

9.2 Community Sponsorship and Donations

Bulga Coal contributed approximately $55,000 in sponsorships and donations in 2020 to the projects and organisations listed below. A further $110,000 worth of contributions were paid to Council for local projects in the Voluntary Planning Agreement Part A: Implementation of Master Plan (see **Section 9.1.4**).

9.2.1 Broke School

The school purchased future focused school furniture and money towards a mobile kitchen with the annual contribution in Bulga Coal's Voluntary Planning Agreement.

The playground equipment purchased with funding from a Glencore P&C grant round (in 2019) was installed during 2020.

Photo 9 New playground equipment installed as part of the Glencore P&C Grant Round

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 2020 Bulga Coal attended committee meetings and participated in Autumn plantings. The planned school event was rescheduled for 2021 due to COVID-19.

9.2.3 Heritage Trail

In early March, Bulga Coal hosted a morning tea with 25 community members to gather feedback on the development of heritage signs and a trail in Broke and Bulga.

Photo 10 Morning Tea hosted by Bulga Coal

9.2.4 Sponsorships

Organisations and events that were sponsored by Bulga Coal during 2020 included:

- Singleton Library – Summer Reading Program;
- Broke Public School – future focused school furniture and funds towards a mobile kitchen;
- Broke Fordwich Wine and Tourism Association – A Little Bit of Italy Festival (note this event did not go ahead);
- Broke Bulga Landcare;
- Broke Public School;
- Singleton Tidy Towns Adopt a Spot Broke Road Clean-up; and
- Broke Residents Association – Community Markets.

9.2.5 Donations

Donations were made to these recipients in 2020:

- Broke Fire Brigade;
- Lake Glenbawn Water Ski Club;
- Beresfield Junior Touch Club;
- Kurri Kurri Junior Motorcycle Club;
- Singleton Track and Field;
- Singleton Neighbourhood Centre;
- Salvation Army Corps Singleton;
- The Long Run – Prostate Cancer;
- Ronald McDonald House Newcastle;

- A Bygone Era – a tribute to local milk and cream carriers – local history book printing; and
- Special Children's Christmas Party.

9.3 Community Complaints

During the reporting period, 17 community complaints were recorded from 10 stakeholders. 12 of the 17 complaints related to noise, received from six stakeholders. The other complaints related to lighting (2), dust (1), blast overpressure (1) and blast vibration (1).

Table 40 shows a comparison of the environmental complaints received by Bulga Coal during the reporting period against the previous five years.

Table 40 Summary of Complaints by Issue 2015 – 2020

Complaint Type	2015	2016	2017	2018	2019	2020
Blast vibration/ overpressure	0	3	0	0	1	2
Lighting	11	5	3	3	5	2
Dust	4	0	3	3	4	1
Noise	13	10	9	14	11	12
Traffic	0	0	1	0	0	0
Visual Amenity	0	0	0	2	2	0
Odour	0	0	0	0	0	0
Fume	0	0	0	0	0	0
Other	0	0	1	0	1	0
Total	**28**	**18**	**17**	**22**	**24**	**17**

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.

Bulga Coal received positive feedback from community members about the skate park, which was funded through Bulga Coal VPA money and a government grant. It was noted that the community would like future VPA funds to be spent on local projects.

10 Independent Audit

In November 2018, an independent environmental audit (IEA) was undertaken for Bulga Coal. The Audit was submitted to the DPIE on 15 February 2019. The audit assessed Bulga Coal's compliance with approvals DA-41-03-99, DA 376-8-2003, SSD-4960, EPL 563, relevant mining leases, exploration licences, water licences and subsidence management plan approvals (now expired). The audit also included additional provisions from DPIE and BCD.

A total of 942 conditions and commitments were assessed as part of this audit, which identified 22 issues and resulted in 41 non-compliances. Some of the non-compliances noted in the audit related to the same issue which, due to the duplication of commitments between consent documents and management plans, raised the same non-compliance several times.

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

Table 41 Non-Compliance Findings and Action Status from 2019 IEA Report

Non-Compliance Reference	Finding	Action Proposed by Bulga Coal	By When	Action Status
DA-41-03-99 Schedule 2, Condition 6.3.5 & Condition 6.3.6	Cumulative noise impact assessment 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 provided, to determine if the cumulative noise impact assessment criteria are being achieved.	Relinquish DA 41-03-99	June 2020.	Outstanding. Bulga Coal had an extension to relinquish DA 41-03-99 until 23 December 2020. On 16 December 2020 Bulga requested a further extension until 31 June 2021.
DA-41-03-99 Schedule 2, Condition 8.2	The Air Quality Management Plan does not include a quality assurance section as per this condition. The Water Management Plan has no references to quality assurance.	Relinquish DA 41-03-99	June 2020.	Outstanding. Bulga Coal had an extension to relinquish DA 41-03-99 until 23 December 2020. On 16 December 2020 Bulga requested a further extension until 31 June 2021.

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 Air Quality

The 24-hour average PM_{10} exceeded the consent criterion of 50 µg/m³ on multiple days at the Mitchell Line Rd (D11) TEOM. These were caused by wind erosion of dust from other sources upwind of Bulga Open Cut or dust storms moving through the region. Prolonged drought in NSW increased the amount of exposed area susceptible to wind erosion.

Additional dust controls were typically implemented during strong winds and poor air quality. These included changing to less wind exposed dumps, stopping equipment and hot seating water carts through crib breaks.

Exceedances were investigated and reported to the DPIE. The investigations reviewed the mining activities occurring and air quality management controls implemented to prevent or minimise dust and estimated the maximum contribution from the mine.

The maximum contribution from the mine was estimated to be the total level recorded by the monitor during the period in which it was downwind of Bulga Open Cut, minus the underlying background level recorded at upwind monitors. Weather data from the onsite weather station and PM_{10} data from the Bulga Coal air quality monitoring network and Upper Hunter Air Quality Monitoring Network was used. Further information on exceedances is provided in the Annual Air Quality Report in **Appendix B**.

11.2 Pollution of Waters

On 6 April 2020, during a work place inspection it was noticed that a drain on the western side of the CHPP raw coal stockpile had spilled into a dry tributary of Nine Mile Creek. At the time the Incident was identified, there was no water leaving the mine water drain. While the incident was not witnessed, it is estimated that a small undefined volume of water overtopped the drain and was released into the tributary. The release of water would have occurred sometime during rainfall between 3 April and 6 April 2020. The discharge was caused by a piece of wood which blocked a culvert in the drain.

Bulga Coal received an Official Caution for breaching Section 120 of the *Protection of the Environment Operations Act 1997 (POEO Act) – Prohibition of pollution of waters*.

The crossing over the drain and culvert were removed from the drain to prevent the drain overtopping again. There was insufficient fine sediment to warrant removal from the streambed, however the gravel that eroded off the causeway was removed.

11.3 Administrative Non-compliances

11.3.1 Failure to Continuously Monitor Weather

Weather data was not monitored continuously at EPA Point 20, Point 21 and Point 23 due to the equipment failure during the EPL Annual Return reporting period.

The cause of the break downs were investigated promptly, and the monitors were fixed. Details were reported to the EPA in the 2019-2020 Annual Return.

11.3.1.1 Failure to Monitor Depositional Dust at F2

Depositional dust was not monitored at F2(DR) which was included in Bulga Coal *Air Quality Management Plan* and approved in October 2020. The dust gauge was not installed and operational at the time the management plan was approved.

A directional depositional dust gauge has been installed at this location since and the site is being monitored.

12 Activities to Be Completed in the Next Reporting Period

12.1 Bulga Underground Operations

The works listed in **Table 42** have been/will be completed in 2021 at Bulga Underground Operations.

Table 42 Bulga Underground Operations Proposed Activities in 2021

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
Construction	Blakefield South Longwall 9E gas drainage borehole and pipeline to the Goaf Plant.	Q2 2021
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 43** have been/will be completed in 2021 at Bulga Open Cut.

Table 43 Bulga Open Cut Proposed Activities in 2021

Topic	Proposed Activity	By When
Construction & Demolition	Commence construction of new Aboriginal Teaching and Keeping Place at the Wollombi Brook Conservation Area.	Q1 2021
	Demolition of the old bulk fuel farm to allow for continuation of mining the East Pit.	Q3 2021
	Construction of the tailings relocation infrastructure.	Q1 2022
Approvals	Relinquish DA 41-03-99.	Q2 2021
Archaeology & Heritage	Salvage the three new Aboriginal heritage sites within the site extent of BOP SC-8 (37-6-2852) (refer to **Section 6.9.2.2** for further details).	Q1 2021
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

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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.	505 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.	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 7 of May 2019. On 17 January 2020 all final signed copies of the Conservation Agreements were received by Bulga Coal and written evidence of compliance against this condition was provided to the DAWE on 20 January 2020.	Non-Compliance
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 DAWE 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 (following SSD-4960 Mod 3 approval) was submitted to DPIE in November 2020 and will be submitted to DAWE once initial comments are received.	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 DAWE in April 2017.	Compliant

Condition	Actions During the Reporting Period	Status
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 DAWE in February 2017. A revised version of the Water Management (following SSD-4960 Mod 3 approval) was submitted to DPIE in September 2020 and will be submitted to DAWE once initial comments are received.	Compliant
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. The Water Management Plan was approved by the DAWE in February 2017.	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. The Water Management Plan was approved by the DAWE in February 2017.	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.	The Conservation Agreements were signed by the NSW Minister for the Environment on 7 May 2019. On 17 January 2020 all final signed copies of the Conservation Agreements were received by Bulga Coal and the detailed documentation as specified in this condition was provided to the DAWE on 20 January 2020.	Compliant
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 DAWE 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 Bulga Coal Annual Review was published on the website and provided to the DAWE on 31 March 2020.	Compliant

Condition	Actions During the Reporting Period	Status
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.	Bulga Coal reported the non-compliance with condition 2 to the Department on 21 December 2017, which was within two days of Bulga becoming aware of the potential non-compliance.	Compliant
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.	This condition was not triggered during the reporting period.	Not Applicable
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.	Noted.	Not Applicable
13. Condition 13 has been revoked.	Noted.	Not Applicable

Condition	Actions During the Reporting Period	Status
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 and Water Management Plan were approved by the DAWE in April 2017 and February 2017 respectively. The approved plans are available on the Bulga Coal website.	Compliant

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 12 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 has commenced the work. Pending completion.	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 12 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 has commenced the work. Pending completion.	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 as yet.	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 (following SSD-4960 Mod 3 approval) was submitted to DPIE in November 2020 and will be submitted to DAWE once initial comments are received.	Compliant
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 the 9 September 2020.	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.	Bulga Coal commenced the action on 22 September 2020 and notified the DAWE on 24 September 2020.	Compliant

Condition	Actions During the Reporting Period	Status
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.	Bulga Coal commenced the action on 22 September 2020 and notified the DAWE on 24 September 2020.	Compliant
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.	Bulga Coal has commenced the work. Pending completion.	Compliant
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.	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

Condition	Actions During the Reporting Period	Status
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 31 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
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

Condition	Actions During the Reporting Period	Status
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

Note - EPBC Approval 2018/8300 was granted on 22 September 2020, and the audit period is from the date it was granted to 31 December 2020.

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 3l, 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. An annual compliance report for the 1 July 2019 to 30 June 2020 reporting period was submitted on the 1 July 2020. No non-compliances were identified.	Compliant

APPENDIX B

Air Quality Monitoring Data Review and Analysis at Bulga Complex 2020
(Todoroski, 2021)

AIR QUALITY MONITORING DATA REVIEW AND ANALYSIS AT BULGA COMPLEX 2020

Bulga Coal

11 February 2021

Job Number 14070348P

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Air Quality Monitoring Data Review and Analysis at Bulga Complex 2020

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This report has been prepared in accordance with the scope of works between Todoroski Air Sciences Pty Ltd (TAS) and the client. TAS relies on and presumes accurate the information (or lack thereof) made available to it to conduct the work. If this is not the case, the findings of the report may change. TAS has applied the usual care and diligence of the profession prevailing at the time of preparing this report and commensurate with the information available. No other warranty or guarantee is implied in regard to the content and findings of the report. The report has been prepared exclusively for the use of the client, for the stated purpose and must be read in full. No responsibility is accepted for the use of the report or part thereof in any other context or by any third party.

TABLE OF CONTENTS

1 INTRODUCTION 1
2 PROJECT SETTING AND METEOROLOGY 2
3 COMPARISON OF MEASURED 2020 DATA AND MODEL PREDICTIONS 5
3.1 Annual average $PM_{2.5}$ 5
3.2 Annual average PM_{10} 6
3.3 Annual average TSP 8
3.4 Annual average deposited dust 9
4 AIR QUALITY CRITERIA 10
4.1 Particulate Matter 10
4.1.1 DPIE air quality criteria 10
4.1.2 Summary of applicable criteria for this assessment 11
5 LONG TERM REVIEW 12
5.1 $PM_{2.5}$ monitoring data 12
5.2 PM_{10} monitoring data 17
5.3 TSP monitoring data 25
5.4 Deposited dust data 28
6 POLLUTION ROSES 30
6.1 $PM_{2.5}$ data 30
6.2 PM_{10} data 31
7 CONCLUSIONS 38
8 REFERENCES 39

APPENDIX

Appendix A: Extraordinary event days
Appendix B: Elevated 24-hour average particulate days
Appendix C: How to read a windrose and pollution rose

LIST OF TABLES

Table 4-2: Long term criteria for particulate matter 10
Table 4-3: Short term criteria for particulate matter 10
Table 4-4: Long term criteria for deposited dust 10
Table 4-4: 24-hour average particulate impact assessment criteria used in this assessment 11
Table 4-5: Annual average particulate impact assessment criteria used in this assessment 11
Table 4-6: Deposited dust impact assessment criteria used in this assessment 11
Table 5-1: Summary of recorded BAM $PM_{2.5}$ levels 12
Table 5-2: Summary of the recorded TEOM PM_{10} levels 17
Table 5-3: Summary of the recorded HVAS PM_{10} levels 18
Table 5-4: Summary of the recorded HVAS TSP levels 25
Table 5-5: Summary of the annual average deposited dust levels (g/m^2/month) at compliance dust gauges 28

LIST OF FIGURES

Figure 2-1: Site Location 2
Figure 2-2: Annual windroses (2020) 3
Figure 2-3: Windroses for each season of 2020 for the Bulga Complex, Bulga High Wall, Southern Extension and Flares weather stations 4
Figure 3-1: Air quality monitoring locations 5
Figure 3-2: 2020 $PM_{2.5}$ annual average monitoring data (excluding extraordinary events) superimposed over the predicted $PM_{2.5}$ annual average modelling contour (Year 2022 cumulative) 6
Figure 3-3: 2020 PM_{10} annual average monitoring data (excluding extraordinary events) superimposed over the predicted PM_{10} annual average modelling contour (Year 2022 cumulative) 7
Figure 3-4: 2020 TSP annual average monitoring data (excluding extraordinary events) superimposed over the predicted TSP annual average modelling contour (Year 2022 cumulative) 8
Figure 3-5: 2020 deposited dust annual average monitoring data superimposed over the predicted deposited dust annual average modelling contour (Year 2022 cumulative) 9
Figure 5-1: 24-hour average $PM_{2.5}$ concentrations 14
Figure 5-2: Annual average $PM_{2.5}$ concentrations 15
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 16
Figure 5-4: 24-hour average PM_{10} concentrations at TEOM monitors 20
Figure 5-5: 24-hour average PM_{10} concentrations at HVAS monitors 21
Figure 5-6: Annual average PM_{10} concentrations at TEOM and HVAS monitors 22
Figure 5-7: 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 23
Figure 5-8: 30-day running average of the 24-hour average PM_{10} concentrations at the HVAS monitors with the 31-day running average of daily rainfall and mean daily temperature 24
Figure 5-9: 24-hour and annual average TSP concentrations 26
Figure 5-10: 30-day running average of the 24-hour average TSP concentrations with the 31-day running average of daily rainfall and mean daily temperature 27
Figure 5-11: Annual and monthly averages deposited dust at the statutory compliance dust gauges 29
Figure 6-1: Pollution rose for D2 BAM $PM_{2.5}$ data (2020) 30
Figure 6-2: Pollution rose for D10 BAM $PM_{2.5}$ data (2020) 31
Figure 6-3: Pollution rose for D1 TEOM PM_{10} data (2020) 32
Figure 6-4: Pollution rose for D3 TEOM PM_{10} data (2020) 33
Figure 6-5: Pollution rose for D5 TEOM PM_{10} data (2020) 34
Figure 6-6: Pollution rose for D11 TEOM PM_{10} data (2020) 35
Figure 6-7: Pollution rose for D8 E-BAM PM_{10} data (2020) 36
Figure 6-8: Pollution rose for D9 E-BAM PM_{10} data (2020) 37

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 2020 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 2020.

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.

It is noted that in 2020 there were 24 days considered to be "extraordinary events" for Bulga. The predominant cause of these extraordinary events was smoke associated with the 2019/2020 bushfires. This assessment considers both the annual averages calculated for all days and excluding these extraordinary event days. **Appendix A** provides a list of the extraordinary event days in 2020.

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 2020 annual wind distributions at the weather stations. It is noted that the meteorological station at Bulga High Wall was decommissioned on 21 April 2020 and relocated to the Southern Extension location on 13 May 2020.

The weather stations experienced generally similar wind patterns with relatively strong winds from the northwest quadrant, east, east-southeast and south directions 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. The Bulga High Wall weather station experienced a high proportion of winds from the northeast quadrant from January to April, while the Southern Extension weather station which was only established in May, recorded fewer winds from the northeast quadrant than the Bulga Complex weather station.

Figure 2-3 shows the seasonal windroses at the weather stations for 2020 where there is sufficient data available. The weather stations generally experienced similar seasonal wind patterns. 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.

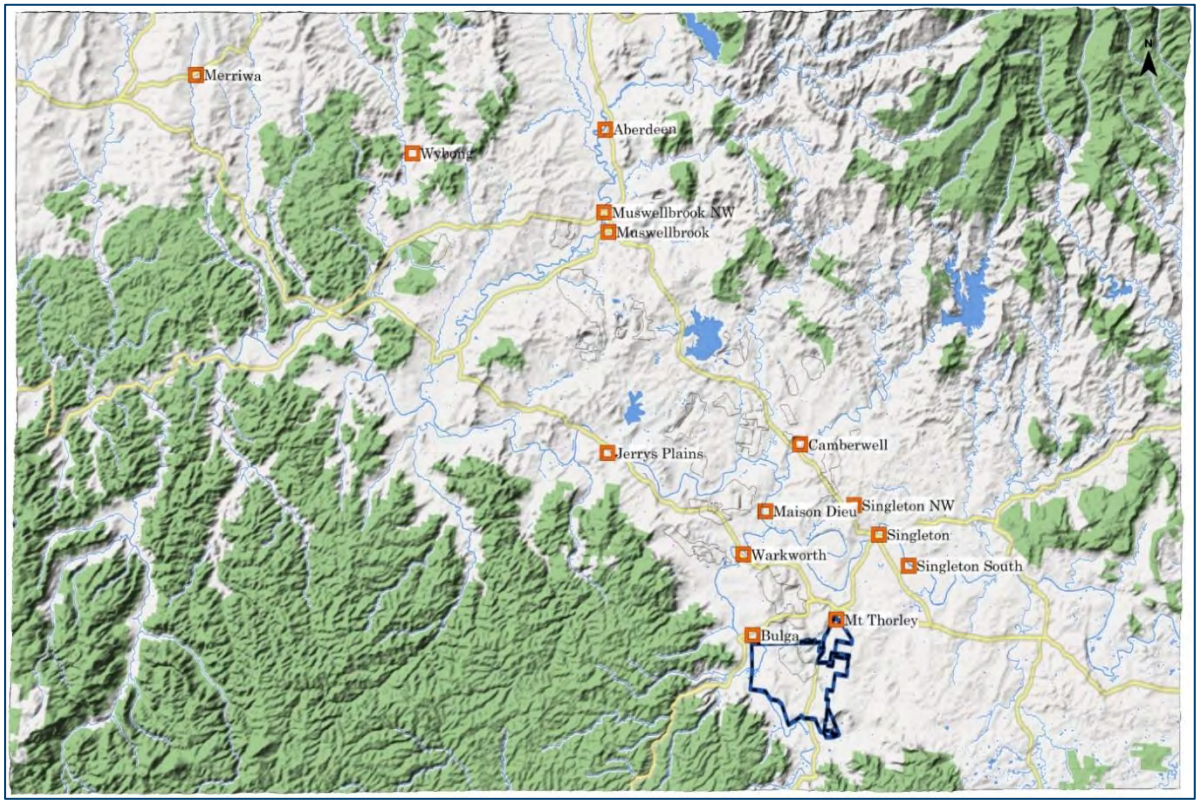
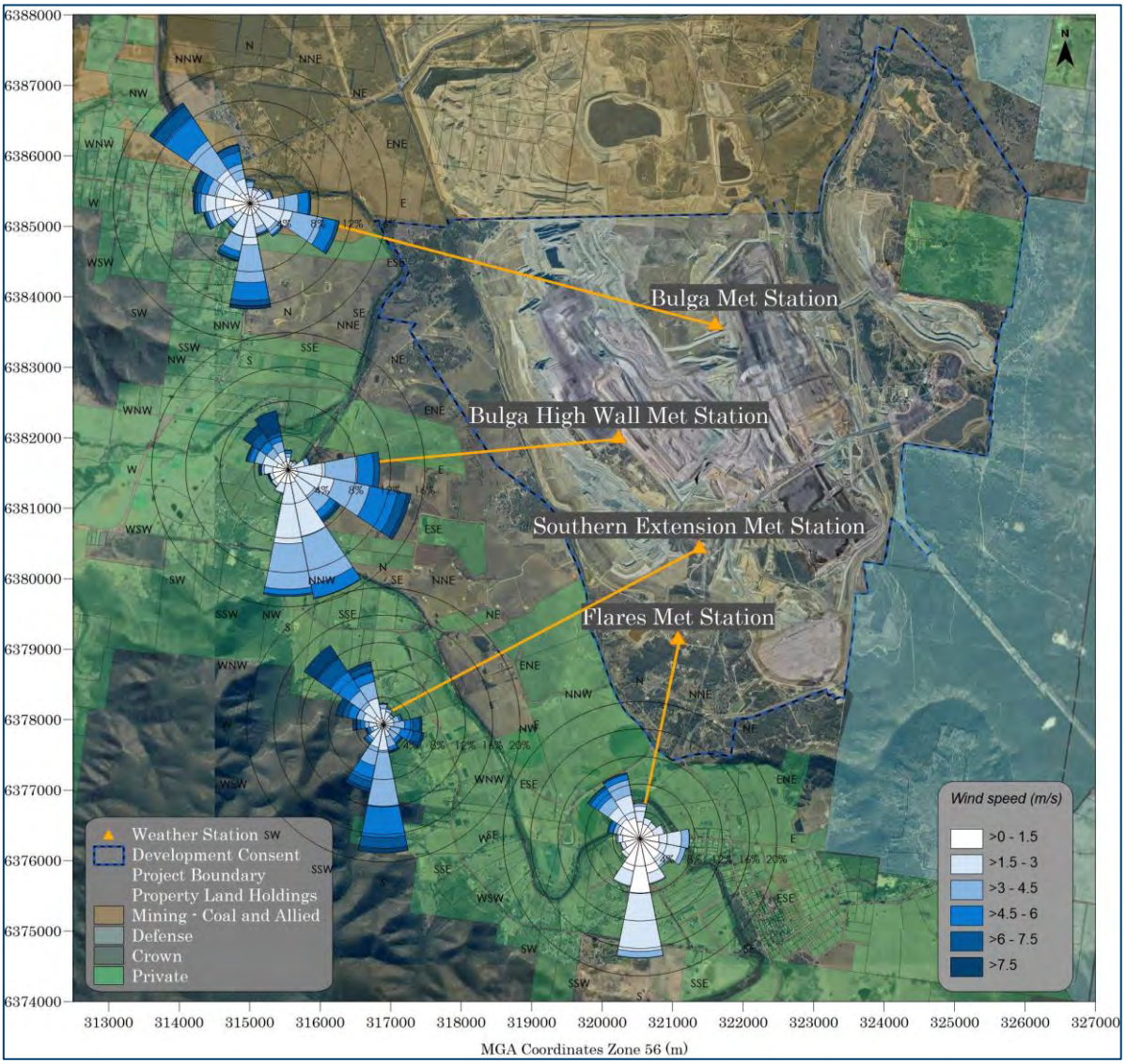


Figure 2-1: Site Location



Note: the windroses presented for Bulga High Wall (decomissioned 21/04/2020) and Southern Extension (installed 13/05/2020) are not representative of the complete 2020 period.

Figure 2-2: Annual windroses (2020)

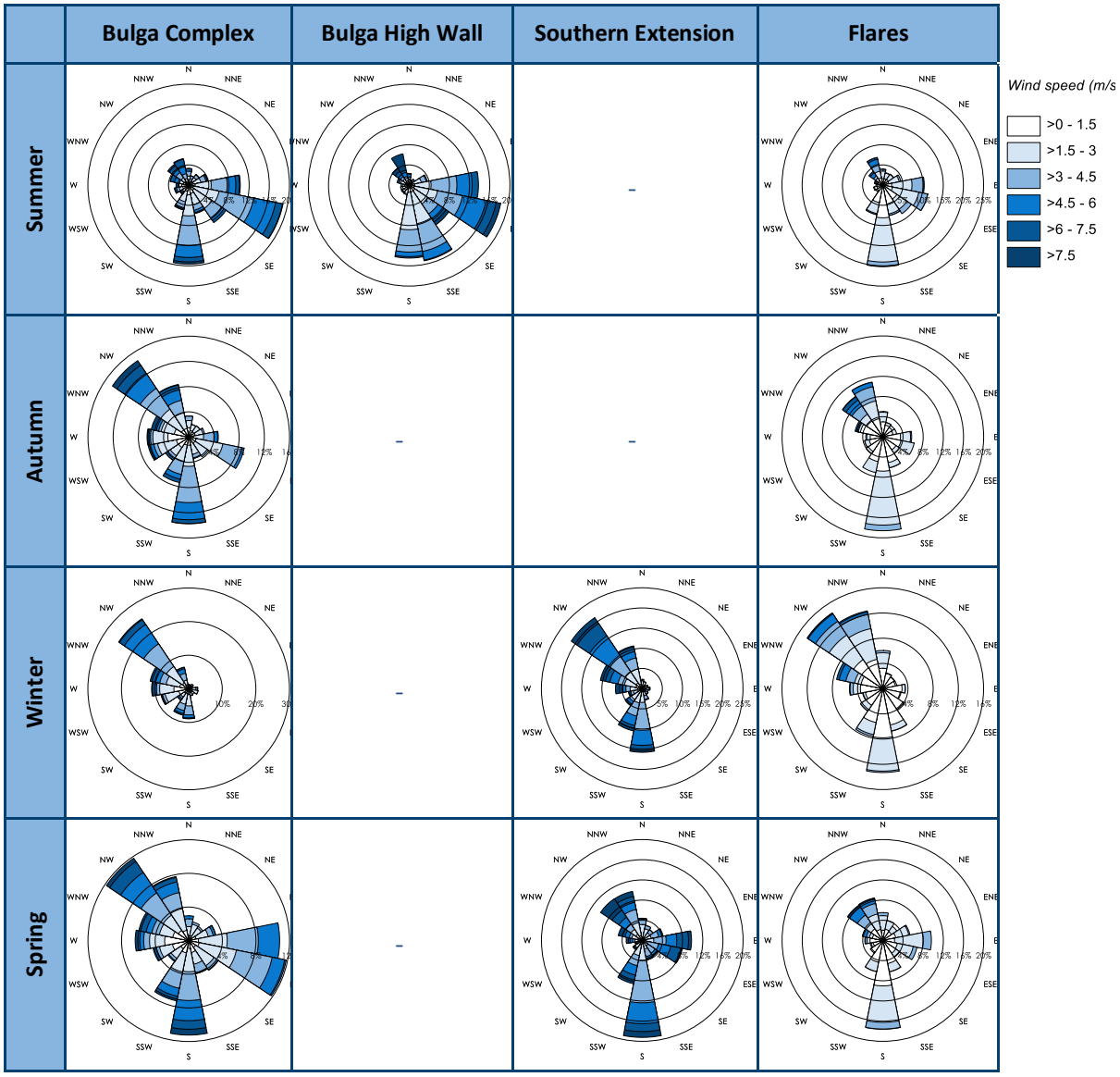


Figure 2-3: Windroses for each season of 2020 for the Bulga Complex, Bulga High Wall, Southern Extension and Flares weather stations

3 COMPARISON OF MEASURED 2020 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**.

Monitoring data collected at these locations during 2020 were compared with modelling predictions for the approximate year (Year 2022) per the *Bulga Coal Complex Modification 3 Air Quality Impact Assessment* (**Jacobs, 2019**).

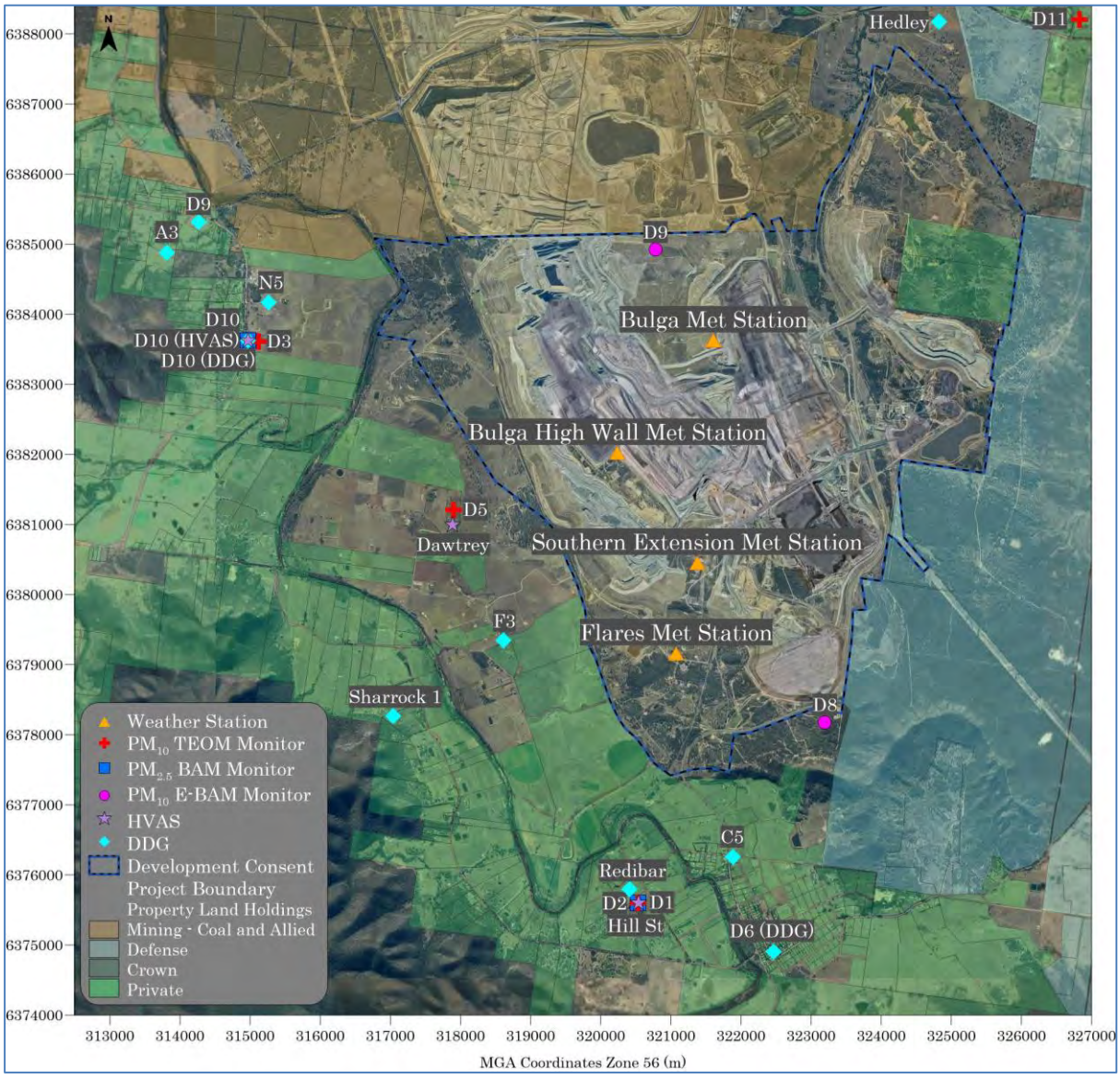


Figure 3-1: Air quality monitoring locations

3.1 Annual average $PM_{2.5}$

Figure 3-2 presents the measured 2020 annual average $PM_{2.5}$ data, excluding extraordinary events, 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.

The measured $PM_{2.5}$ levels excluding extraordinary events in **Figure 3-2** appear generally in agreement with the model predictions.

Source: **Jacobs, 2019**

Figure 3-2: 2020 $PM_{2.5}$ annual average monitoring data (excluding extraordinary events) 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 2020 annual average PM_{10} data, excluding extraordinary events, 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.

The measured PM_{10} levels excluding extraordinary events in **Figure 3-3** are generally in agreement with the model predictions. There appears to be a slight overestimation of the modelled levels compared with the measured levels to the northwest of Bulga at the D3 and D10 HVAS monitoring locations.

Source: **Jacobs, 2019**

Figure 3-3: 2020 PM_{10} annual average monitoring data (excluding extraordinary events) 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, excluding extraordinary events, were used to calculate the 2020 annual average TSP concentrations.

The figures present an overlay of the 2020 TSP annual averages over the dispersion modelling predictions. The measured and predicted data in the figures include dust levels from Bulga and other sources.

The measured TSP levels excluding extraordinary events in **Figure 3-4** appear generally in agreement with the model predictions.

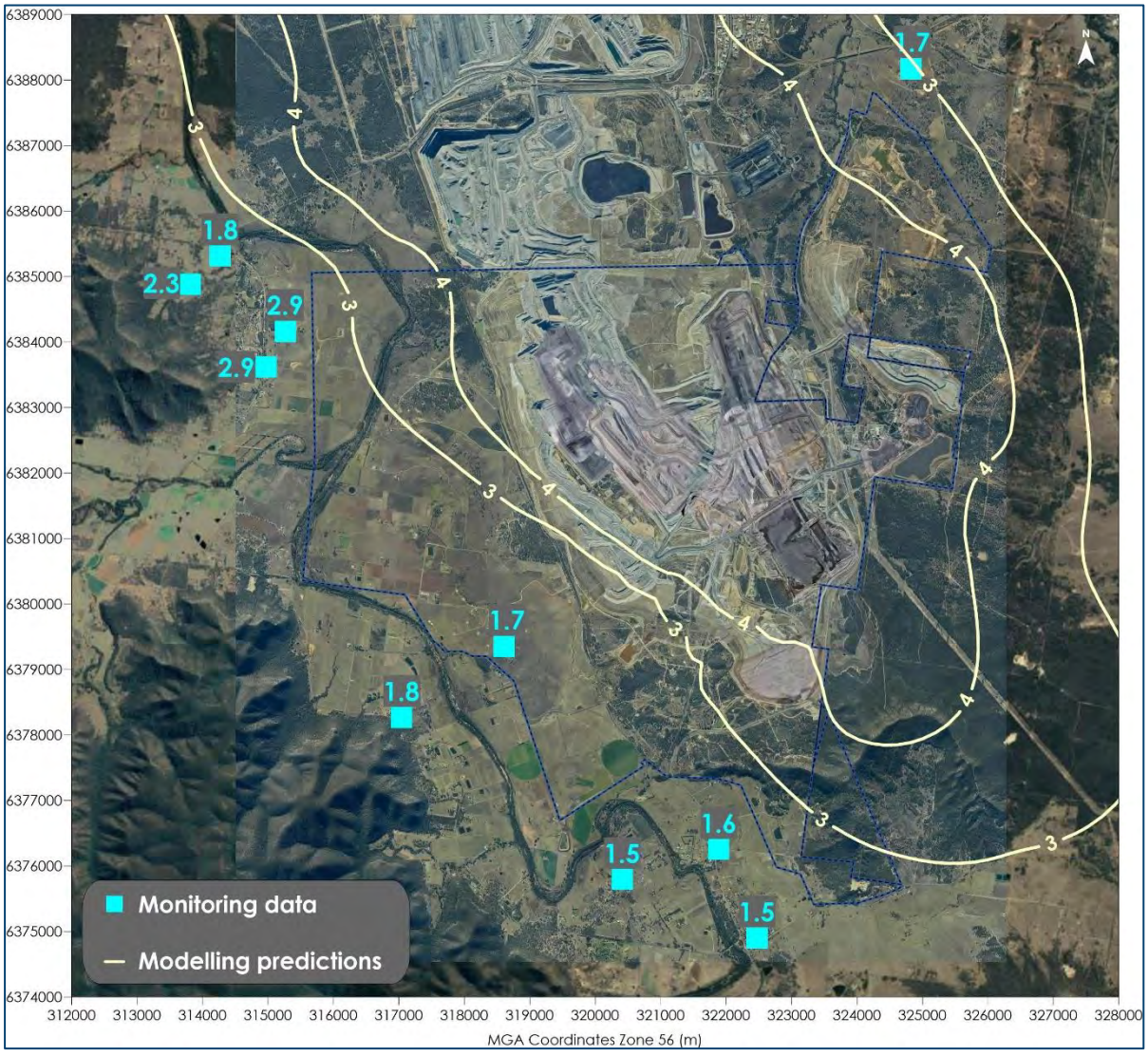
Source: **Jacobs, 2019**

Figure 3-4: 2020 TSP annual average monitoring data (excluding extraordinary events) 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 2020 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 deposited dust levels are generally in agreement with the modelled predictions. There appears to be a slight overestimation of the modelled levels compared with the measured levels to the northeast of Bulga at the Hedley monitoring location.



Source: **Jacobs, 2019**

Figure 3-5: 2020 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). It is noted that the consent was revised in July 2020 for the Modification 3 project with updates to the PM_{10} and $PM_{2.5}$ criteria. One major difference is that for 24-hour average PM_{10}, the criterion has changed from total impact to incremental impact and no longer excludes extraordinary events.

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	[c]Criterion as per MOD 2 (August 2018)	[a,c]Criterion as per MOD 3 (July 2020)
Total suspended particulates (TSP)	Annual	[a]90µg/m³	90µg/m³
Particulate Matter < 10µm (PM_{10})	Annual	[a]30µg/m³	25µg/m³
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual	-	8µg/m³

Table 4-2: Short term criteria for particulate matter

Pollutant	Averaging Period	[c]Criterion as per MOD 2 (August 2018)	[b]Criterion as per MOD 3 (July 2020)
Particulate Matter < 10µm (PM_{10})	24-hour	[a]50µg/m³	50µg/m³
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	-	25µg/m³

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/m²/month	[a]4g/m²/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.

4.1.2 Summary of applicable criteria for this assessment

Table 4-4 summarises the applicable 24-hour average air quality criteria for this assessment as per SSD-4960 consent dated July 2020. The criteria apply to the incremental impact and therefore investigation trigger levels are used to determine when a contribution estimation is required to assess compliance.

Table 4-4: 24-hour average particulate impact assessment criteria used in this assessment

Pollutant	Averaging Period	Investigation trigger for measured level	Incremental impact criteria
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m³	25µg/m³
Particulate Matter < 10µm (PM_{10})	24-hour	50µg/m³	50µg/m³

Note: Prior to July 2020, the 24-hour average criteria excludes extraordinary events days and thus investigations were not required to be conducted to determine Bulga's incremental contribution on extraordinary events days.

Table 4-5 summarises the applicable annual average air quality criteria for this assessment. The annual average criteria as per the SSD-4960 consent dated July 2020 has been adopted for the purpose of this assessment.

Table 4-5: Annual average particulate impact assessment criteria used in this assessment

Pollutant	Averaging Period	Total impact criteria
Total suspended particulates (TSP)	Annual	90µg/m³
Particulate Matter < 10µm (PM_{10})	Annual	25µg/m³
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual	8µg/m³

Note: Excludes extraordinary events

Table 4-6 summarises the applicable criteria for deposited dust used in this assessment.

Table 4-6: Deposited dust impact assessment criteria used in this assessment

Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2g/m²/month	4g/m²/month

5 LONG TERM REVIEW

Figure 5-1 to **Figure 5-11** 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 2020 calendar year. The data in the figures include extraordinary event days. These plots are discussed in more detail in the following sections.

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 $PM_{2.5}$ concentration recorded at D10 in 2020 was above the relevant criterion of 8µg/m³ but was below the criterion when extraordinary events were excluded. Annual average $PM_{2.5}$ concentrations at D2 were below the relevant criteria of 8µg/m³ in 2020.

The maximum 24-hour average $PM_{2.5}$ concentrations were above the relevant criterion of 25µg/m³ for a number of days in 2020. The maximum 24-hour average level recorded at D10 was significantly higher than that recorded at D2. There was only one exceedance at D10 in 2020 which occurred on a day not considered an extraordinary event. **Appendix B** presents a summary of the likely primary causes of elevated days in 2020. As described in **Section 4.1.1**, from July 2020, the 24-hour average $PM_{2.5}$ criterion applies to the incremental impact (i.e. incremental increase in concentrations due to the development on its own) and no longer excludes extraordinary events. There was one elevated level recorded at D10 in July 2020. An investigation indicated that Bulga contributed less than 25µg/m³ to the elevated 24-hour $PM_{2.5}$ level recorded and thus it is not considered to have been a non-compliance per SSD-4960 Schedule 2 Condition 16.

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

Year	Annual average $PM_{2.5}$ (µg/m³)				
	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
Year	**Maximum 24-hour average $PM_{2.5}$ (µg/m³) (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^

(#%) 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.

^Applicability of criterion was updated mid-2020, refer to Section 4.1.1

Figure 5-1 presents the 24-hour average $PM_{2.5}$ concentrations at the D2 and D10 BAM monitors. It can be seen that the $PM_{2.5}$ levels at the start of 2020 are significantly elevated. The levels were affected by bushfire smoke across NSW during the 2019/2020 bushfire season.

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 2020 however it would also have been elevated. The annual average $PM_{2.5}$ level at the D2 monitor in 2020 is similar to the levels prior to 2019 however the level at the D10 monitor including extraordinary events is somewhat elevated. This is possibly as the D10 monitor appears to have been more significantly impacted by extraordinary events than the D2 monitor.

Figure 5-3 presents the 31-day running averages for the 24-hour average $PM_{2.5}$ concentrations (including extraordinary events), 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 2020). The data from the two $PM_{2.5}$ BAM monitors are in relatively good agreement with each other, until 2020 when the D10 monitor reads slightly higher than the D2 monitor. With the exception of 2020, the figures indicate 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 an increase in rainfall during 2020 from the previous years and lower temperatures toward the end of 2020 compared with previous years.

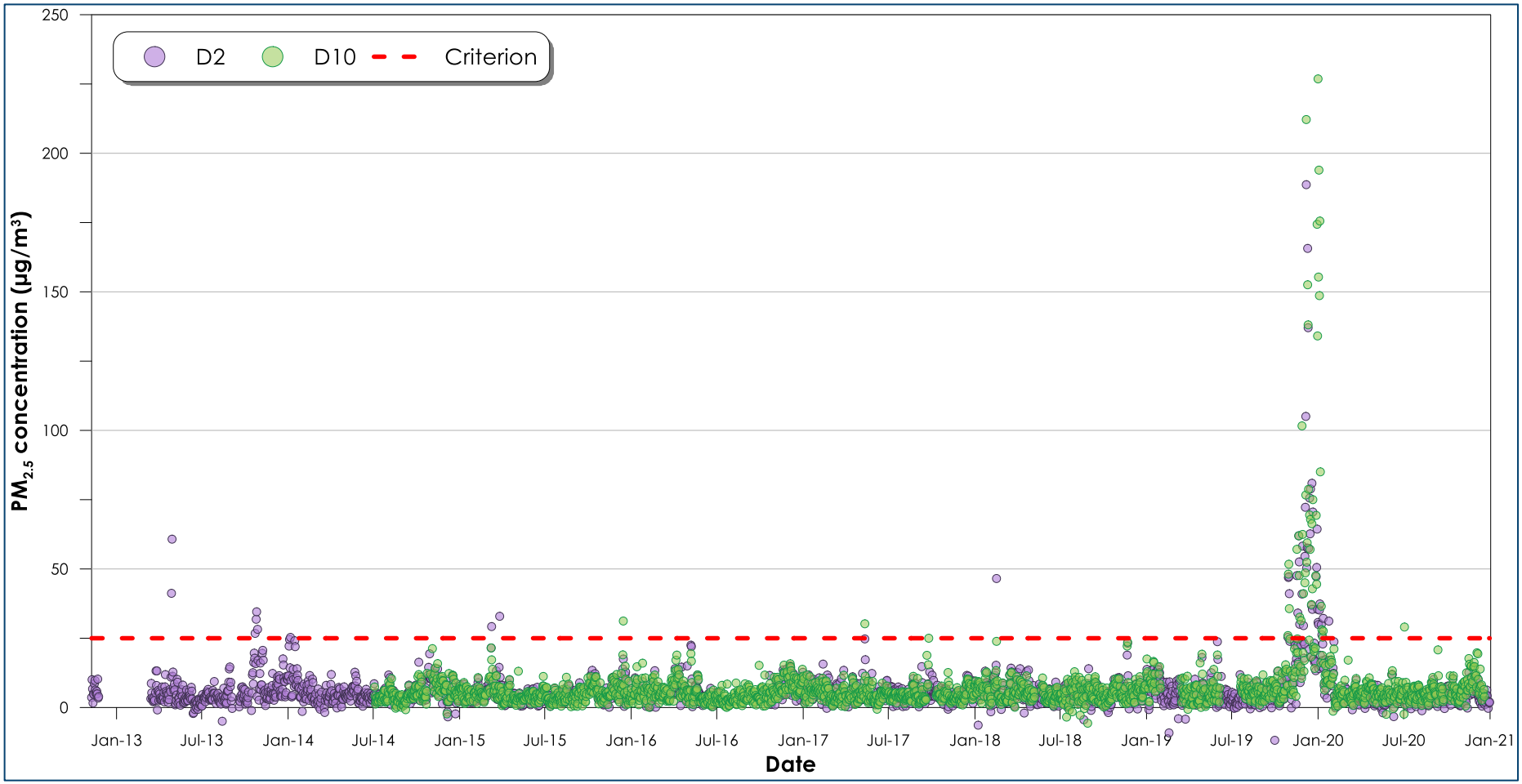


Figure 5-1: 24-hour average $PM_{2.5}$ concentrations

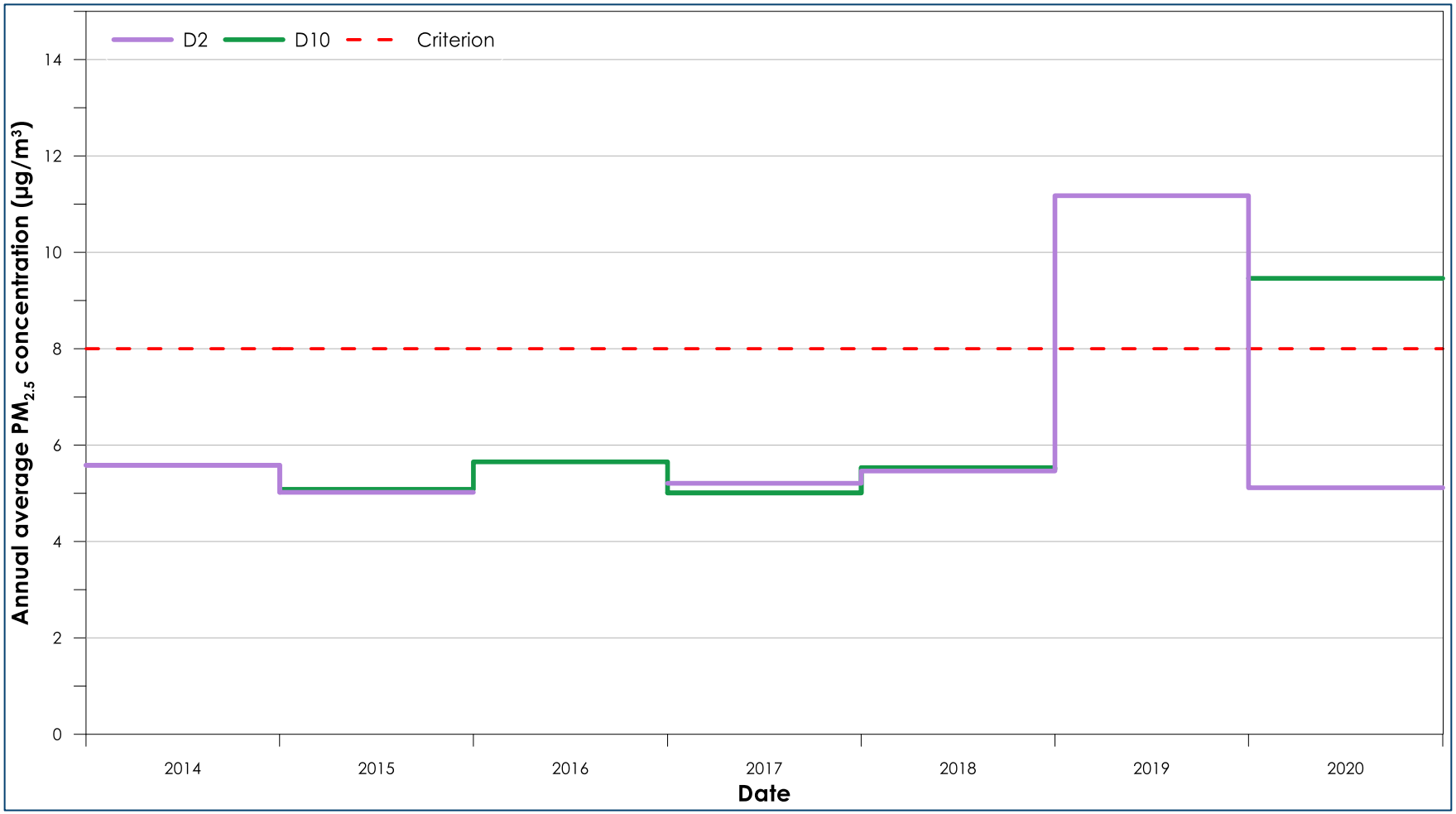


Figure 5-2: Annual average $PM_{2.5}$ concentrations

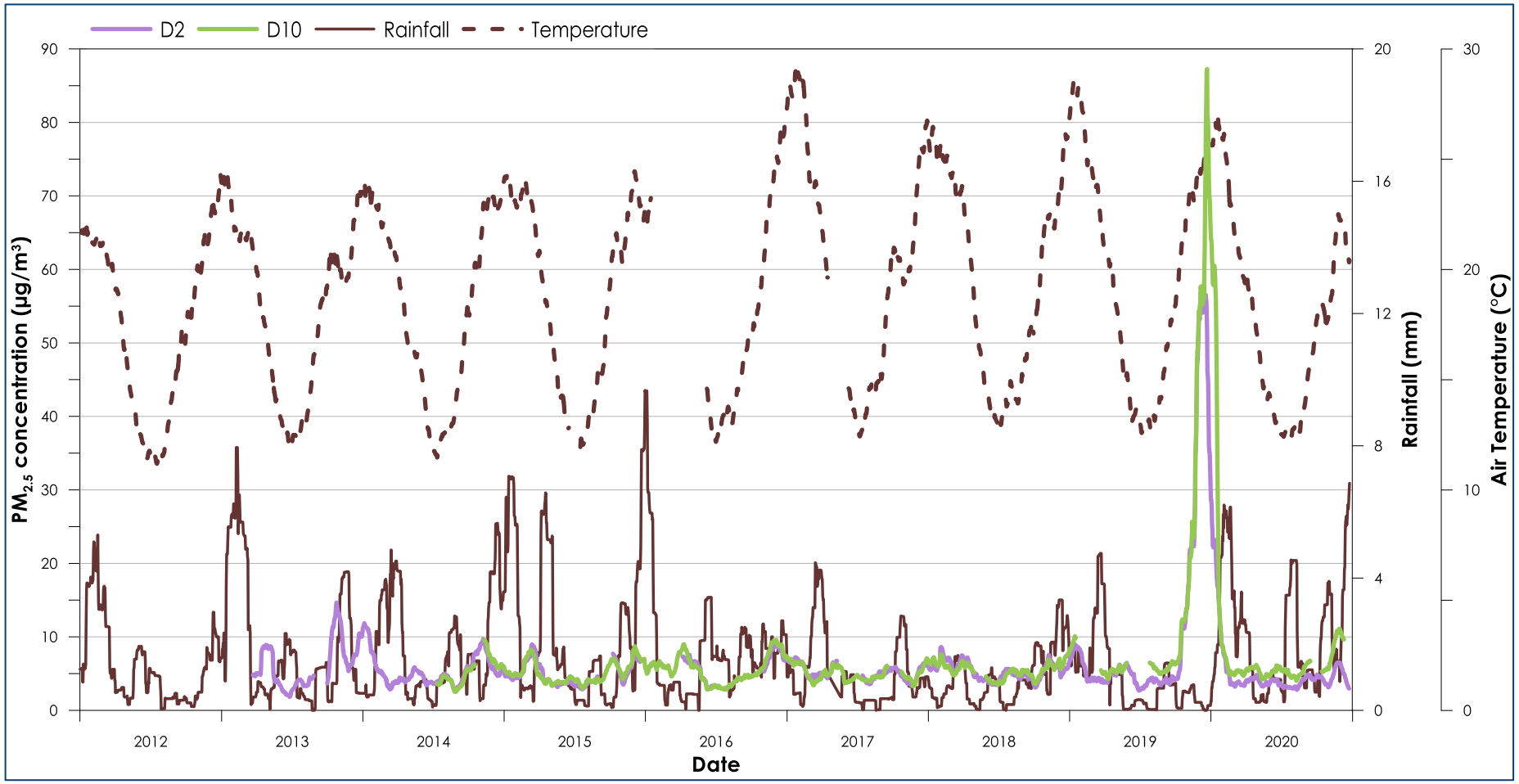


Figure 5-3: 31-day running average of the 24-hour average $PM_{2.5}$ concentrations with the 31-day running average of daily rainfall and mean daily temperature

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 2020 were below the relevant criteria of 25µg/m^3.

The maximum 24-hour average PM_{10} concentrations were above 50µg/m^3 in 2020. The D11 monitor recorded a higher number of exceedances compared with the other TEOM monitors. The majority of these days were considered to be extraordinary events (e.g. bushfires, dust storms, etc). **Appendix B** presents a summary of the likely primary causes of elevated days in 2020.

As described in **Section 4.1.1**, from July 2020, the 24-hour average PM_{10} criterion applies to the incremental impact (i.e. incremental increase in concentrations due to the development on its own) and no longer excludes extraordinary events. There were two elevated levels recorded at D11 after July 2020. Investigations indicate that Bulga contributed less than 25µg/m^3 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 5-2: Summary of the recorded TEOM PM_{10} levels

Year	Annual average PM_{10} (µg/m^3)								
	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
Year	**Maximum 24-hour average PM_{10} (µg/m^3) (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^

(#%) 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.

^Applicability of criterion was updated mid-2020, refer to Section 4.1.1

Table 5-3 presents a summary of the recorded PM_{10} levels at the HVAS monitors.

The annual average PM_{10} concentrations were below the relevant criterion of 25µg/m^3 at Dawtrey and D10 in 2020.

The maximum 24-hour average PM_{10} concentrations were above the relevant criterion of 50µg/m^3. These elevated levels occurred on days considered to be extraordinary events (e.g. bushfires, dust storms, etc). As described in **Section 4.1.1**, from July 2020, the 24-hour average PM_{10} criterion applies to the incremental impact (i.e. incremental increase in concentrations due to the development on its own) and no longer excludes extraordinary events.

Table 5-3: Summary of the recorded HVAS PM_{10} levels

Year	Annual average PM_{10} (µg/m^3)				
	Dawtrey		D10		Criteria
2005	13.8		14.5		25 / 30
2006	16.1		14.4		25 / 30
2007	18.4		17.1		25 / 30
2008	16.5		17.1		25 / 30
2009	17.3		16.2		25 / 30
2010	12.8		12.8		25 / 30
2011	12.2		12.7		25 / 30
2012	13.2		13.1		25 / 30
2013	12.6		12.3		25 / 30
2014	14.5		13.9		25 / 30
2015	11.9		11.1		25 / 30
2016	12.8		13.4		25 / 30
2017	13.6		14.0		25 / 30
2018	18.3		18.0		25 / 30
2019	**28.8**	*15.5	**31.6**	*17.0	25 / 30
2020	16.8	*15.5	17.1	*14.4	25
Year	**Maximum 24-hour average PM_{10} (µg/m^3) (No. of days > criterion)**				
	Dawtrey		**D10**		**Criterion**
2005	41 (0)		41 (0)		50
2006	40 (0)		39 (0)		50
2007	**61 (3)**		**63 (3)**		50
2008	**61 (3)**		**58 (3)**		50
2009	49 (0)		50 (0)		50
2010	**55 (1)**		**51 (1)**		50
2011	40 (0)		47 (0)		50
2012	38 (0)		50 (0)		50
2013	41 (0)		45 (0)		50
2014	41 (0)		47 (0)		50
2015	35 (0)		30 (0)		50
2016	**56 (1)**		**68 (1)**		50
2017	**67 (1)**		**58 (1)**		50
2018	**54 (1)**		**52 (1)**		50
2019	**270 (7)**	*49 (0)	**266 (7)**	***53 (1)**	50
2020	**54 (1)**	*39 (0)	**80 (2)**	*41 (0)	50^

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

*Excluding extraordinary events

^Applicability of criterion was updated mid-2020, refer to Section 4.1.1

Figure 5-4 and **Figure 5-5** show the 24-hour average PM_{10} concentrations at the TEOM and HVAS monitors, respectively. **Figure 5-6** presents the annual average PM_{10} concentrations at both the TEOM and HVAS monitors including extraordinary events.

Figure 5-4 shows that generally there were a significant number of elevated PM_{10} levels at the start of 2020. The levels were affected by bushfire smoke across NSW during the 2019/2020 bushfire season.

The HVAS PM_{10} levels in **Figure 5-5** show generally similar trends to TEOM PM_{10} levels in **Figure 5-4**.

Figure 5-6 shows that the monitors recorded lower annual average PM_{10} levels in 2020 than in 2019, likely due to the decrease in the number of bushfire impacted days.

Figure 5-7 and **Figure 5-8** show the 31-day running averages of the 24-hour average PM_{10} concentrations at the TEOM monitors and HVAS monitors respectively 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 have been used in 2020). With the exception of 2020, the figures indicate 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 an increase in rainfall during 2020 from the previous years and lower temperatures toward the end of 2020 compared with previous years.

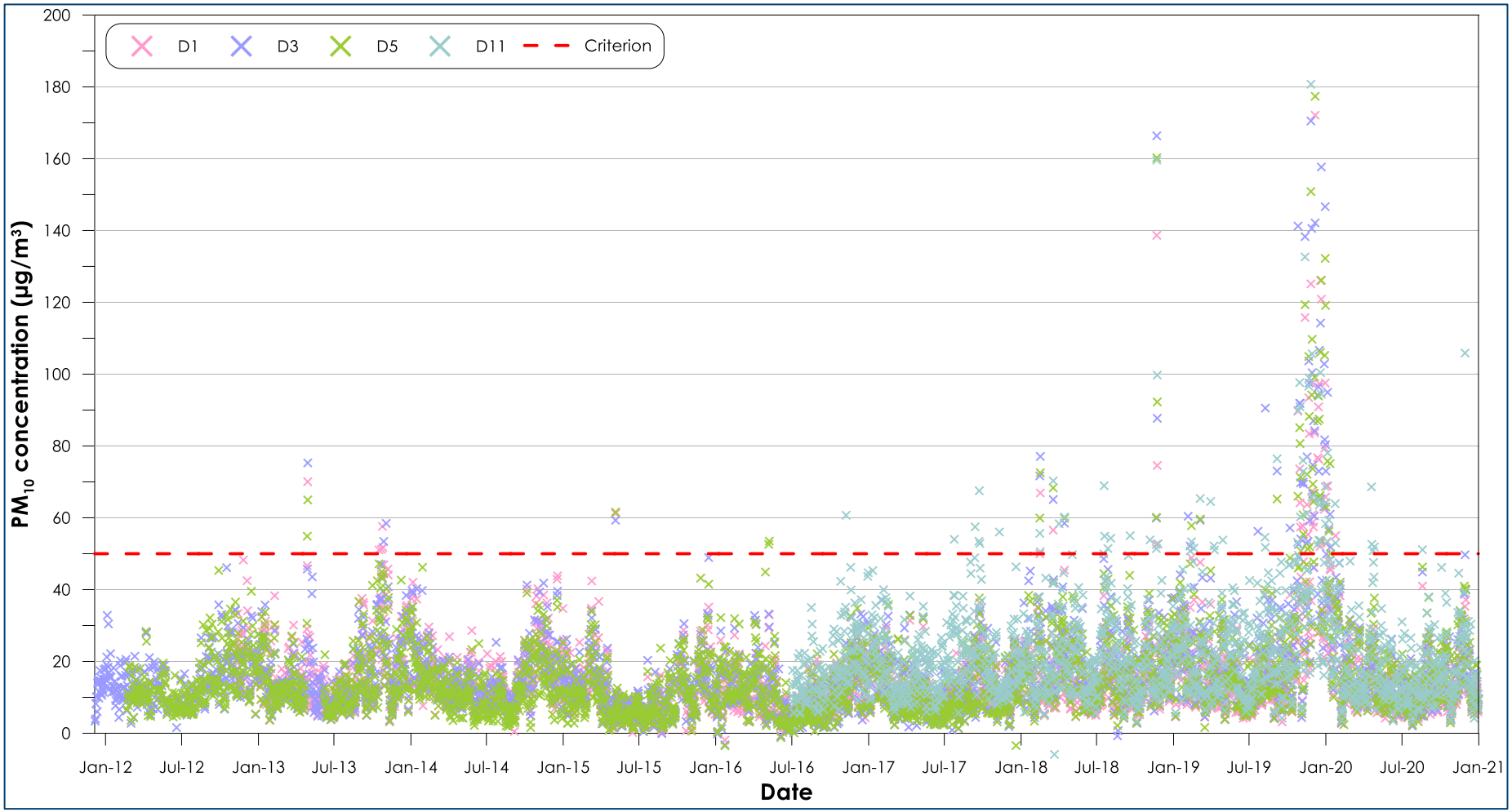


Figure 5-4: 24-hour average PM_{10} concentrations at TEOM monitors

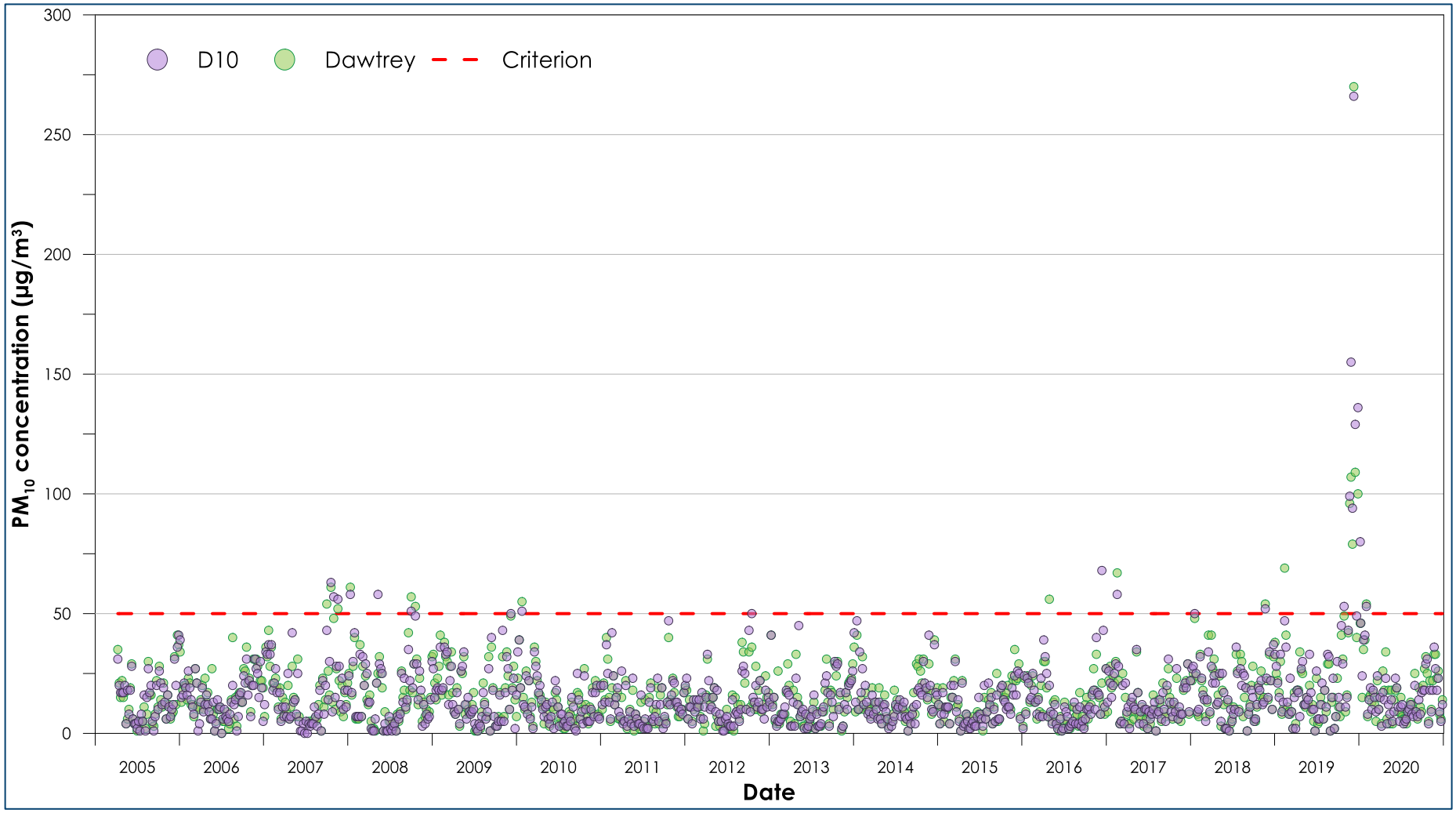


Figure 5-5: 24-hour average PM_{10} concentrations at HVAS monitors

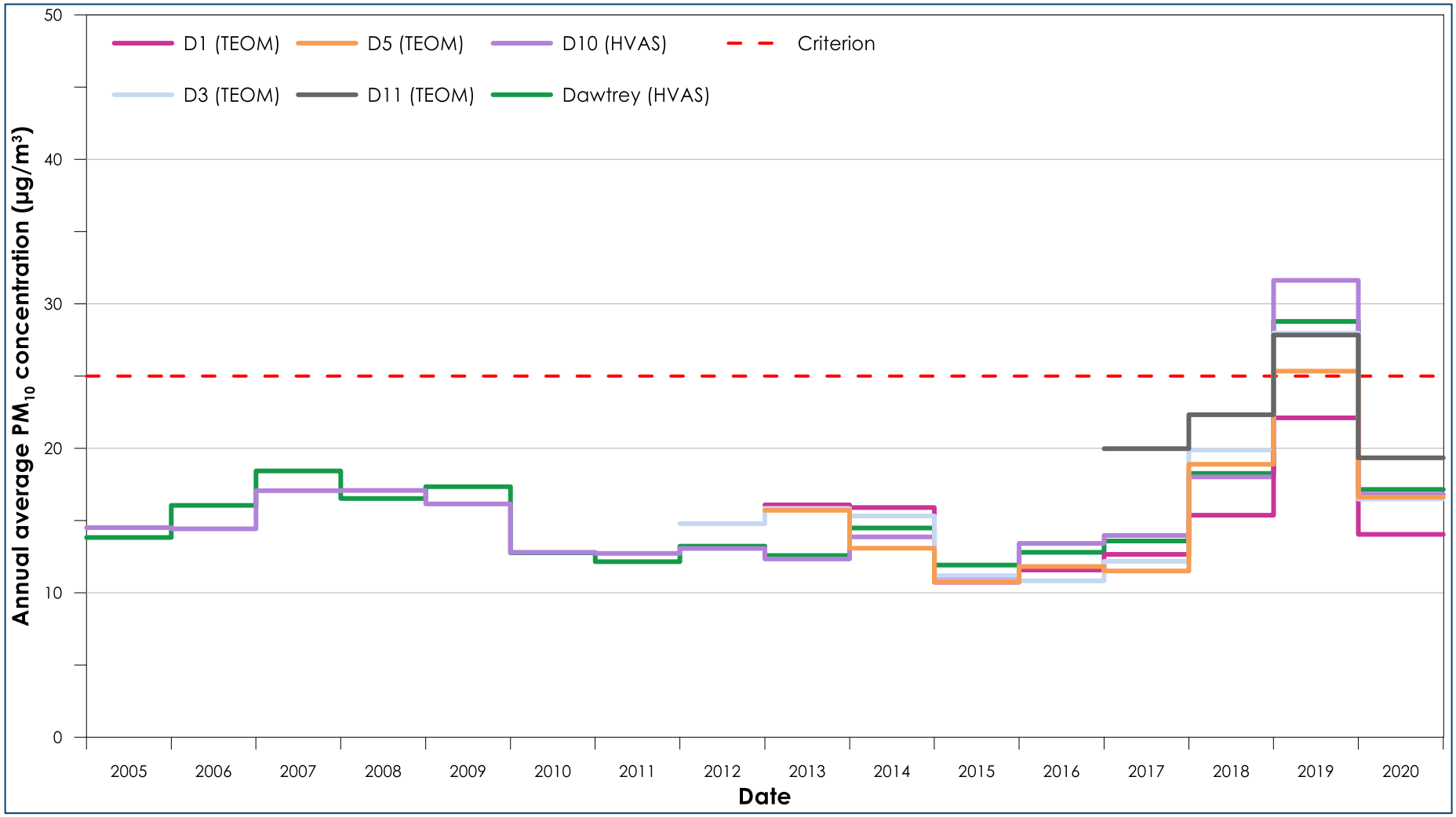


Figure 5-6: Annual average PM_{10} concentrations at TEOM and HVAS monitors

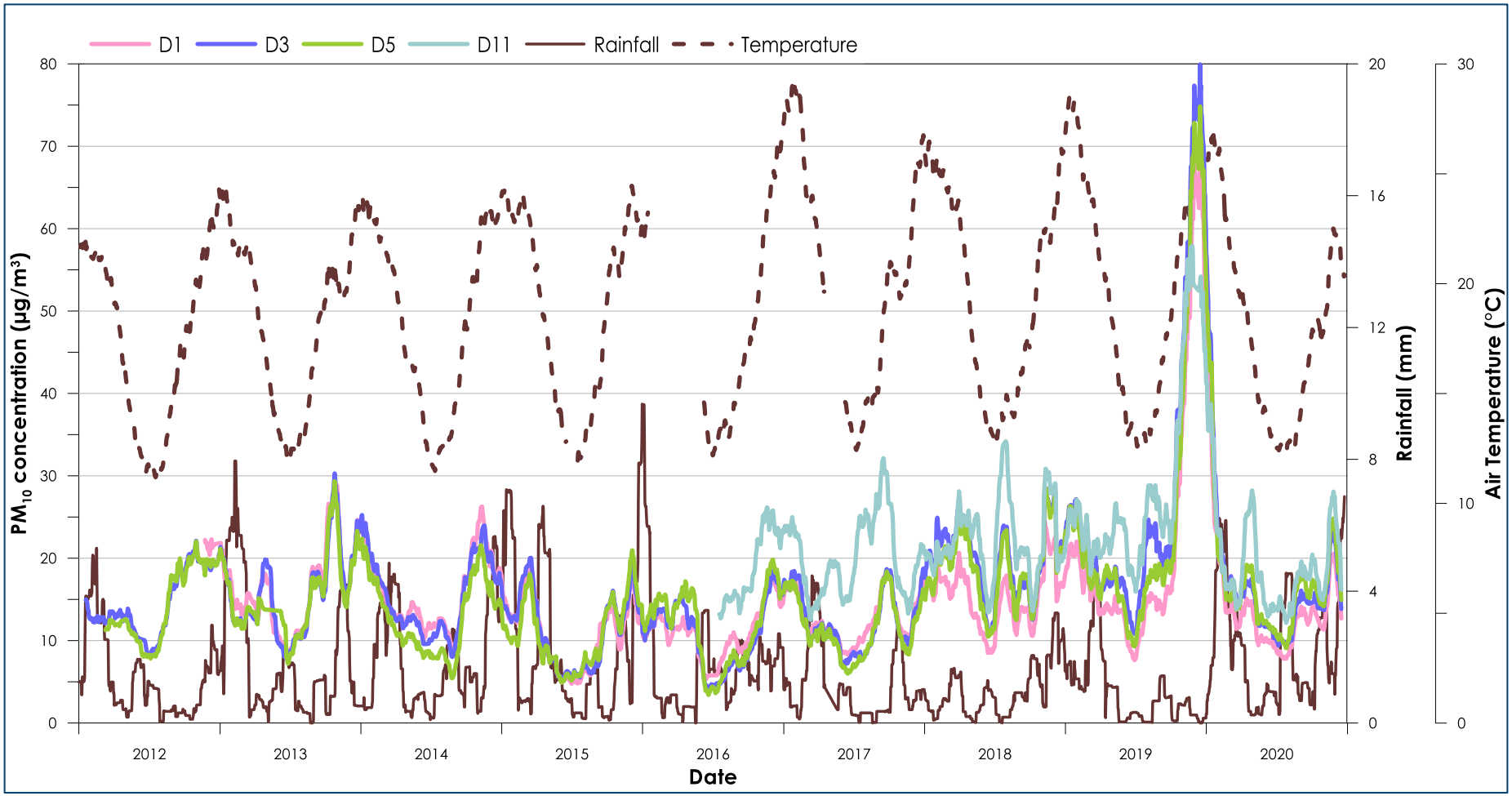


Figure 5-7: 31-day running average of the 24-hour average PM_{10} concentrations at the TEOM monitors with the 31-day running average of daily rainfall and mean daily temperature

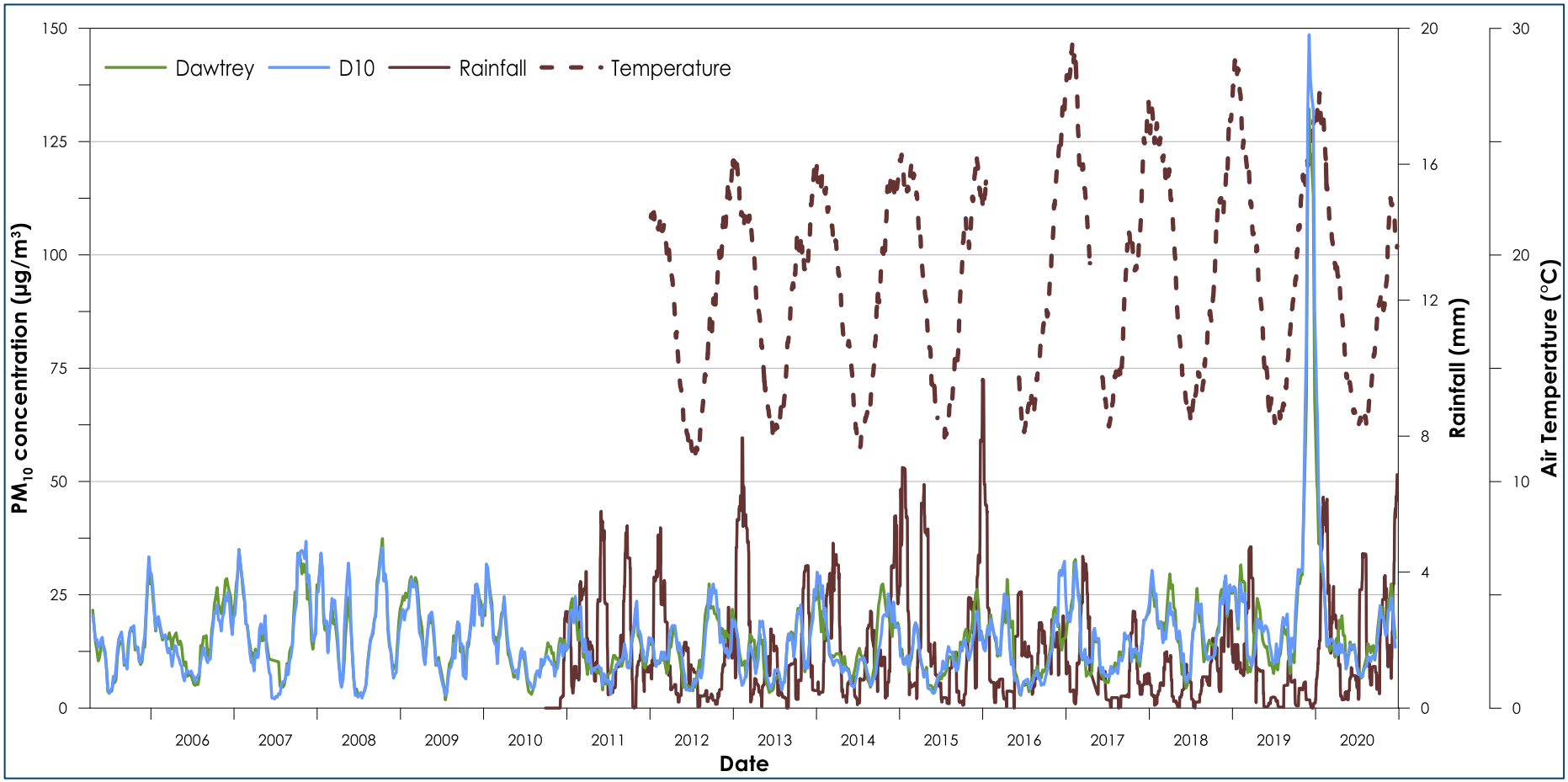


Figure 5-8: 30-day running average of the 24-hour average PM_{10} concentrations at the HVAS monitors with the 31-day running average of daily rainfall and mean daily temperature

5.3 TSP monitoring data

Table 5-4 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 for all days and excluding extraordinary events in 2020.

Table 5-4: 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

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

*Annual average excluding extraordinary events

Figure 5-9 shows the 24-hour and annual average TSP concentrations including extraordinary events at the HVAS monitors. The annual average data from the TSP HVAS monitors show that the levels remained below the criterion of 90µg/m^3 throughout the period, and the levels recorded in 2020 are generally similar to the levels recorded prior to 2019.

The data show an increase in the 24-hour TSP levels at the start of 2020. The levels were affected by bushfire smoke across NSW during the 2019/2020 bushfire season.

Figure 5-10 shows the 31-day running average of the TSP concentrations including extraordinary events, rainfall readings and mean daily temperatures. With the exception of 2020, the levels show a general trend of lower TSP concentrations during periods of higher rainfall and lower temperatures. There was an increase in rainfall during 2020 from the previous years and lower temperatures toward the end of 2020 compared with previous years.

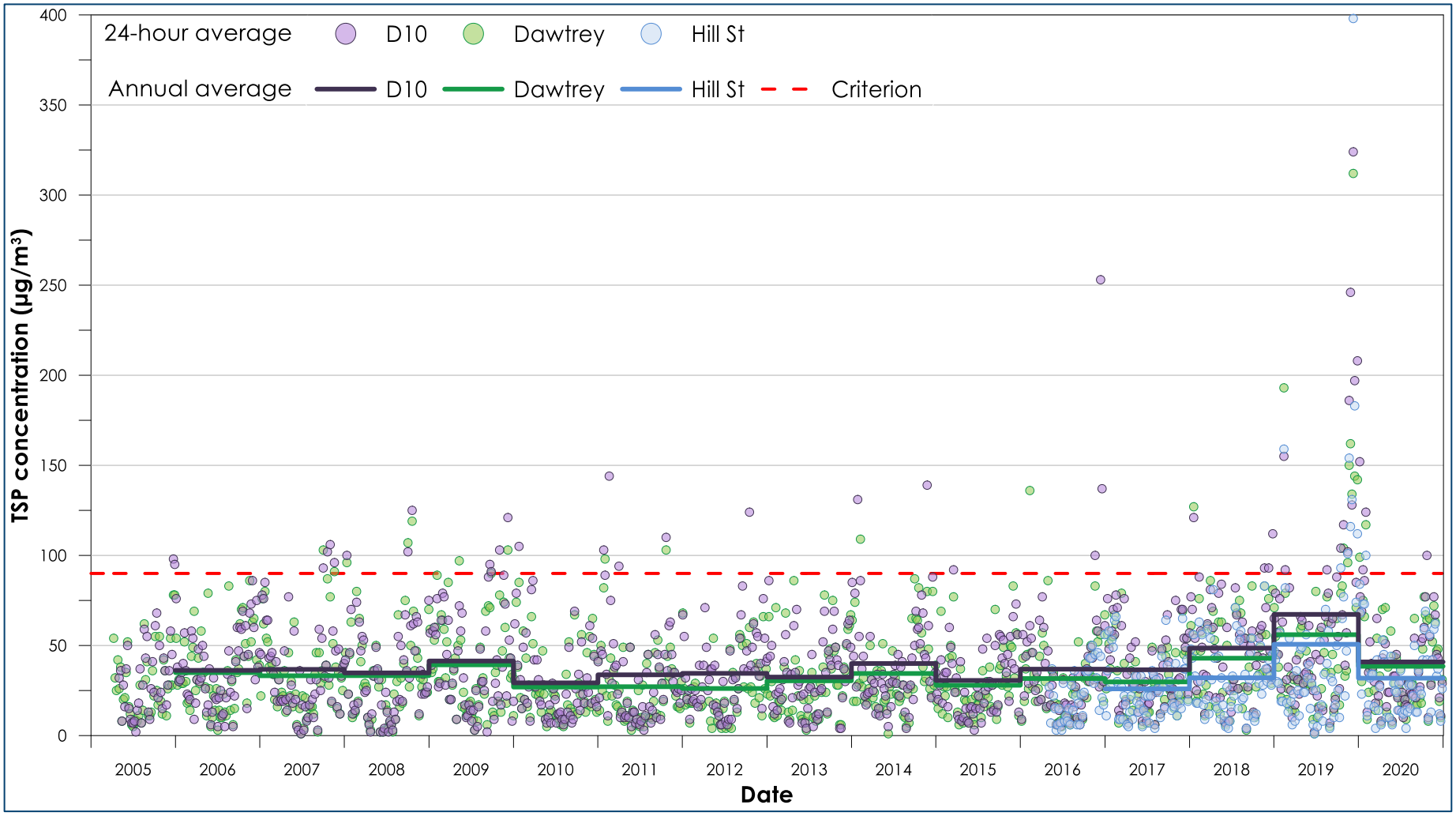


Figure 5-9: 24-hour and annual average TSP concentrations

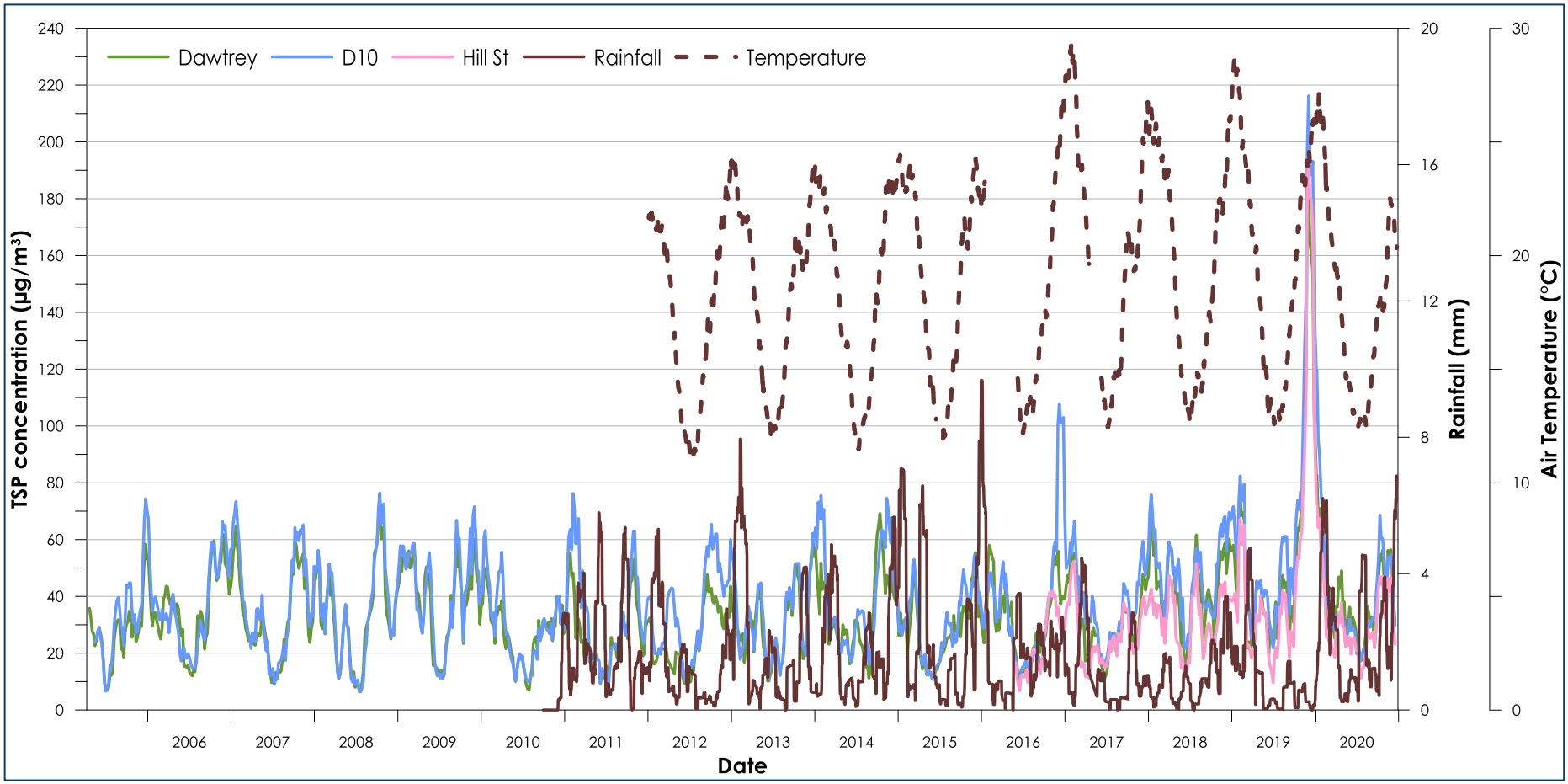


Figure 5-10: 30-day running average of the 24-hour average TSP concentrations with the 31-day running average of daily rainfall and mean daily temperature

5.4 Deposited dust data

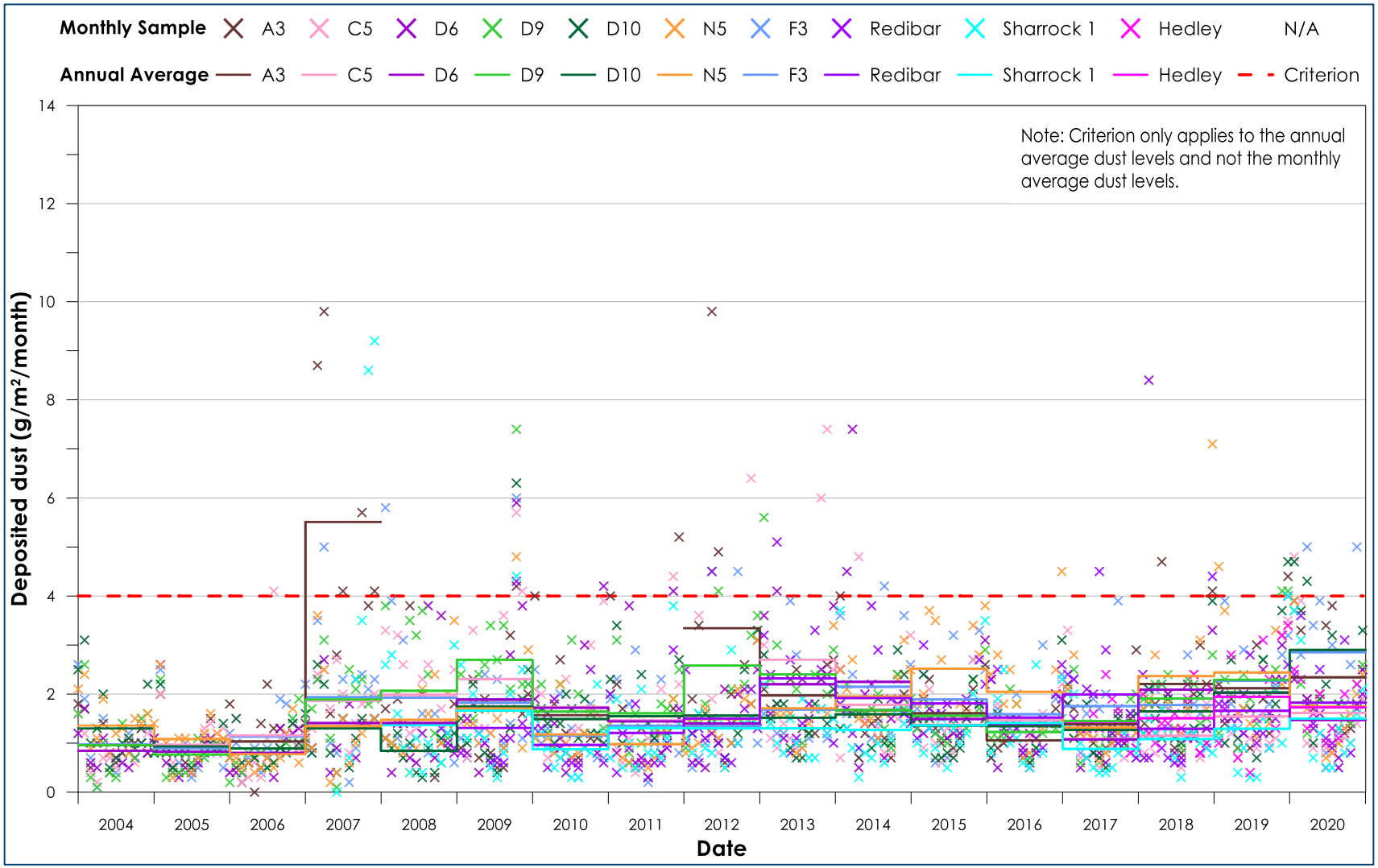
Table 5-5 presents a summary of the annual average deposited dust levels at the statutory compliance dust gauges. The results show that in 2020 the deposited dust levels were below the annual average limit of 4g/m^2/month at the compliance monitoring locations.

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

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

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 5-11 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 2020 calendar year. The levels at the monitors generally show relatively similar trends over time. There was a slight increase in the deposited dust levels at the D10 and F3 monitors during 2020 compared with the previous years.



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 5-11: 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 2020. The meteorological data used in generating the figures are taken from the Bulga Complex weather station.

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 2020. The figures show that generally high $PM_{2.5}$ levels occurred at the monitors when winds were from the southeast quadrant. The D10 monitor recorded a greater number of high levels than the D2 monitors. The data indicate a moderate effect on $PM_{2.5}$ dust levels from the direction of the Bulga Complex and also high levels arising from extraordinary events at D10.

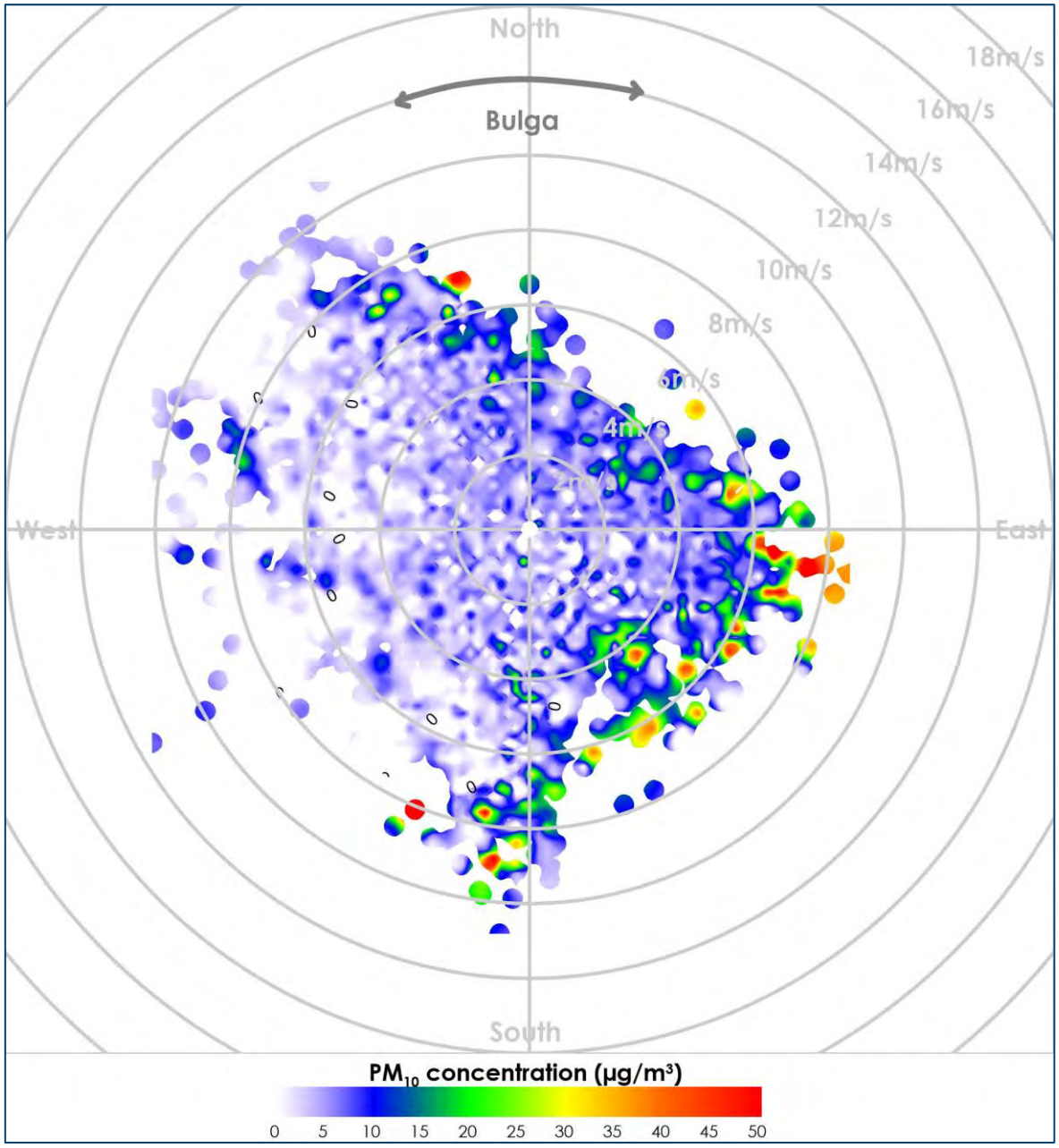


Figure 6-1: Pollution rose for D2 BAM $PM_{2.5}$ data (2020)

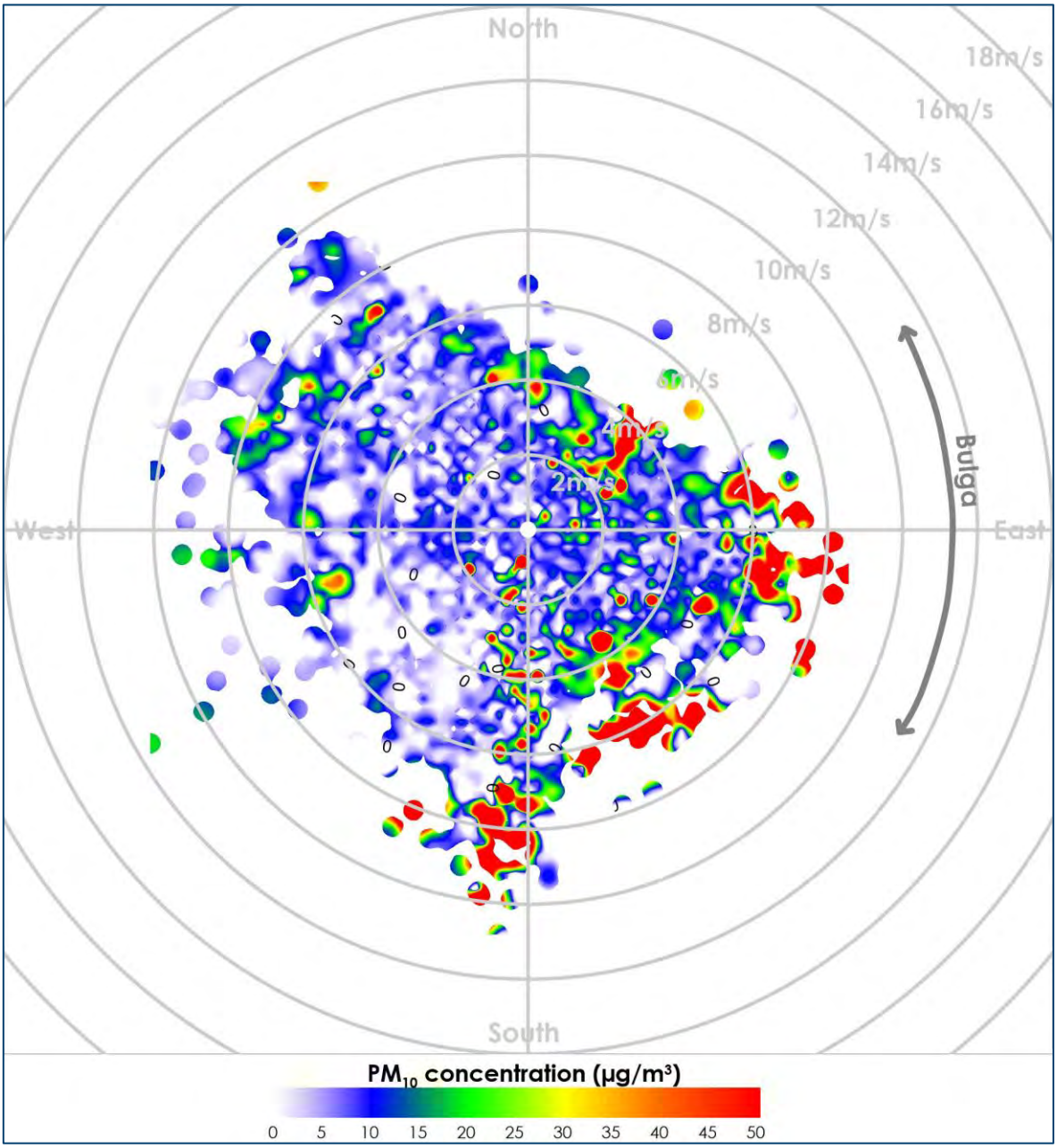


Figure 6-2: Pollution rose for D10 BAM $PM_{2.5}$ data (2020)

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 2020. **Figure 6-7** and **Figure 6-8** present the pollution roses for the D8 and D9 PM_{10} E-BAM monitors respectively for 2020.

The figures show generally similar patterns at the TEOM monitors regardless of position relative to the mine, with occasional high levels from the west to south directions (moving clockwise) and lower levels from the southwest. Generally the figures, with the exception of D11, show a mild 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. High levels occur in all directions at the D8 and D9 monitors, however the D9 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.

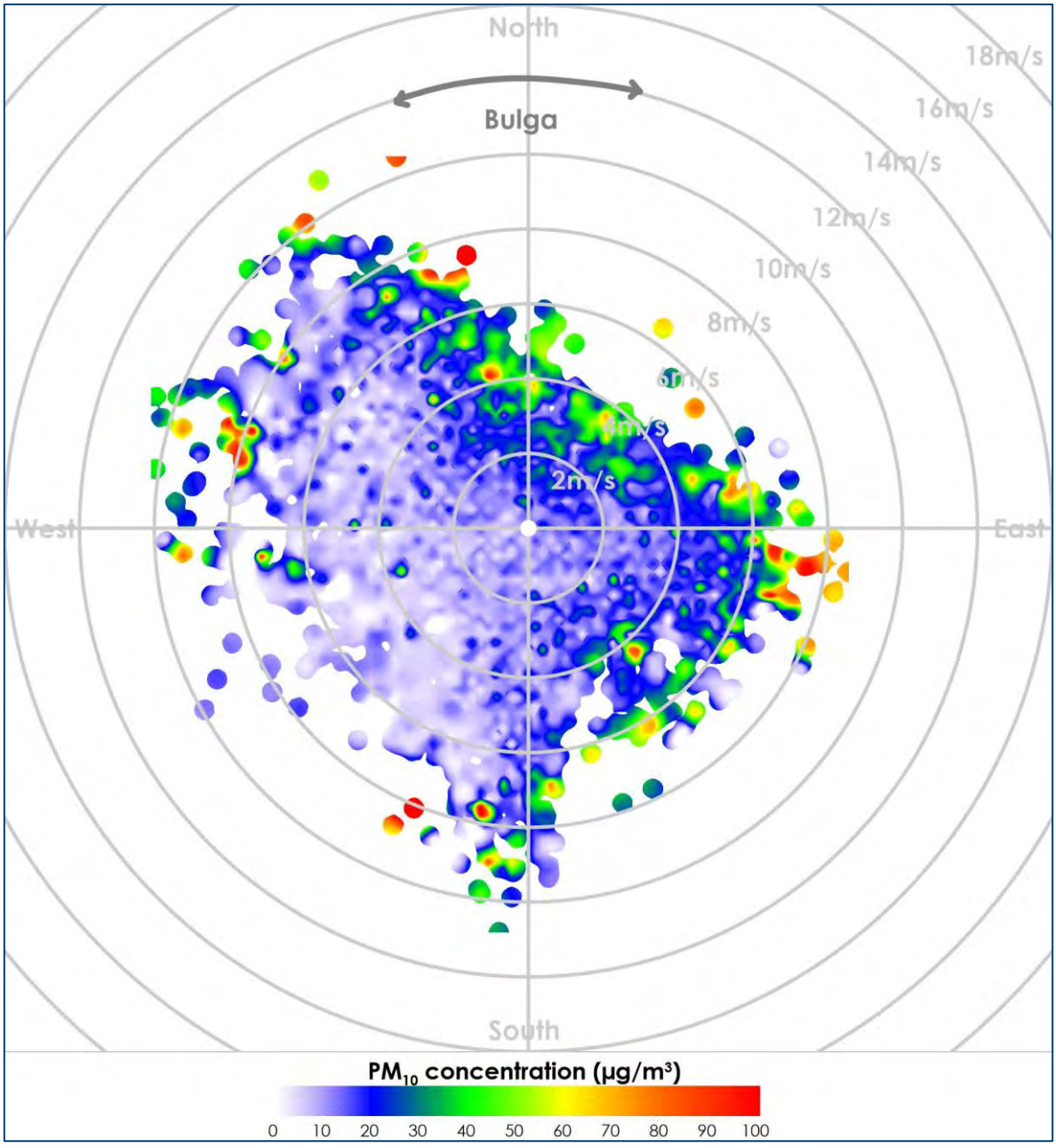


Figure 6-3: Pollution rose for D1 TEOM PM_{10} data (2020)

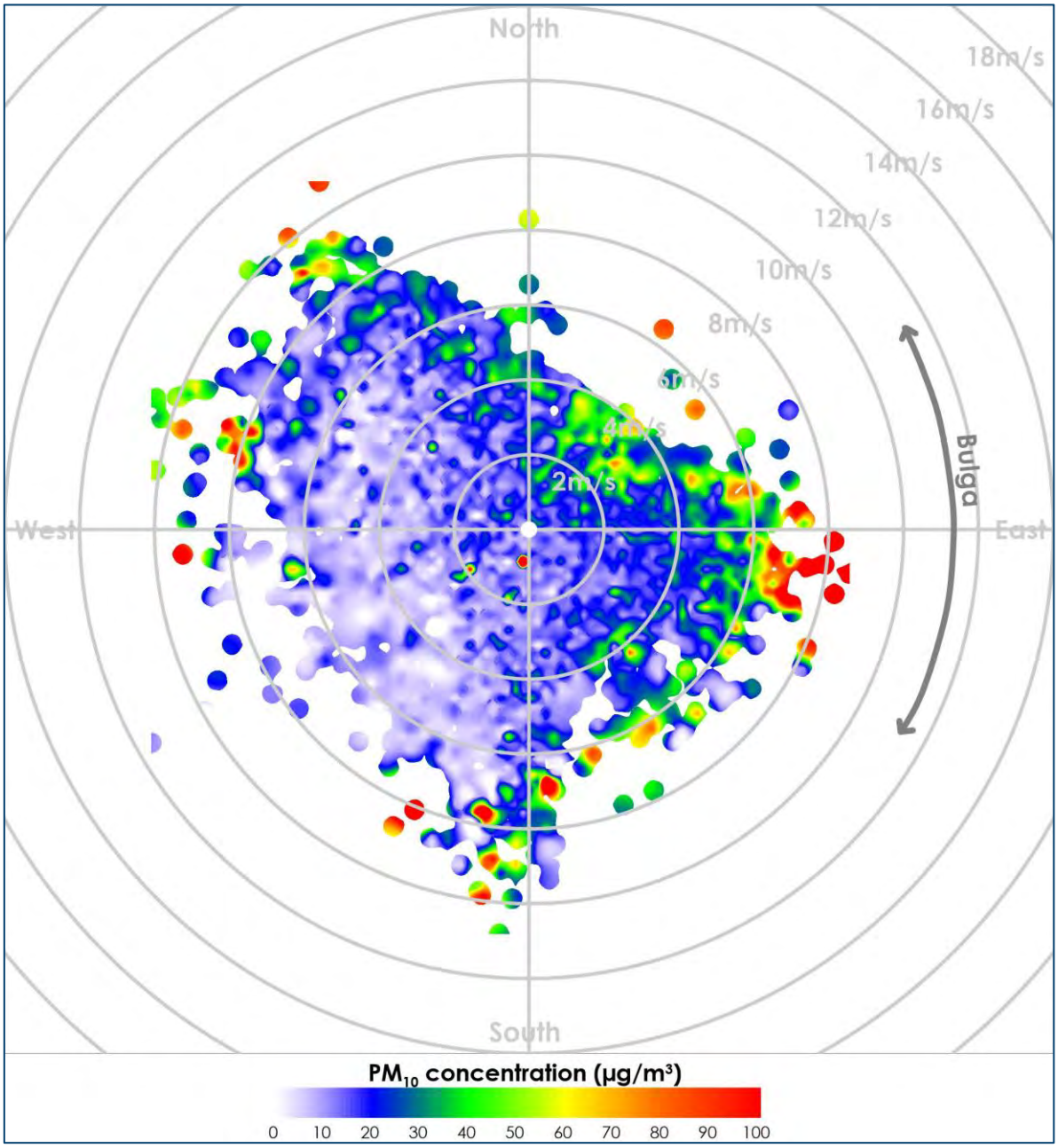


Figure 6-4: Pollution rose for D3 TEOM PM_{10} data (2020)

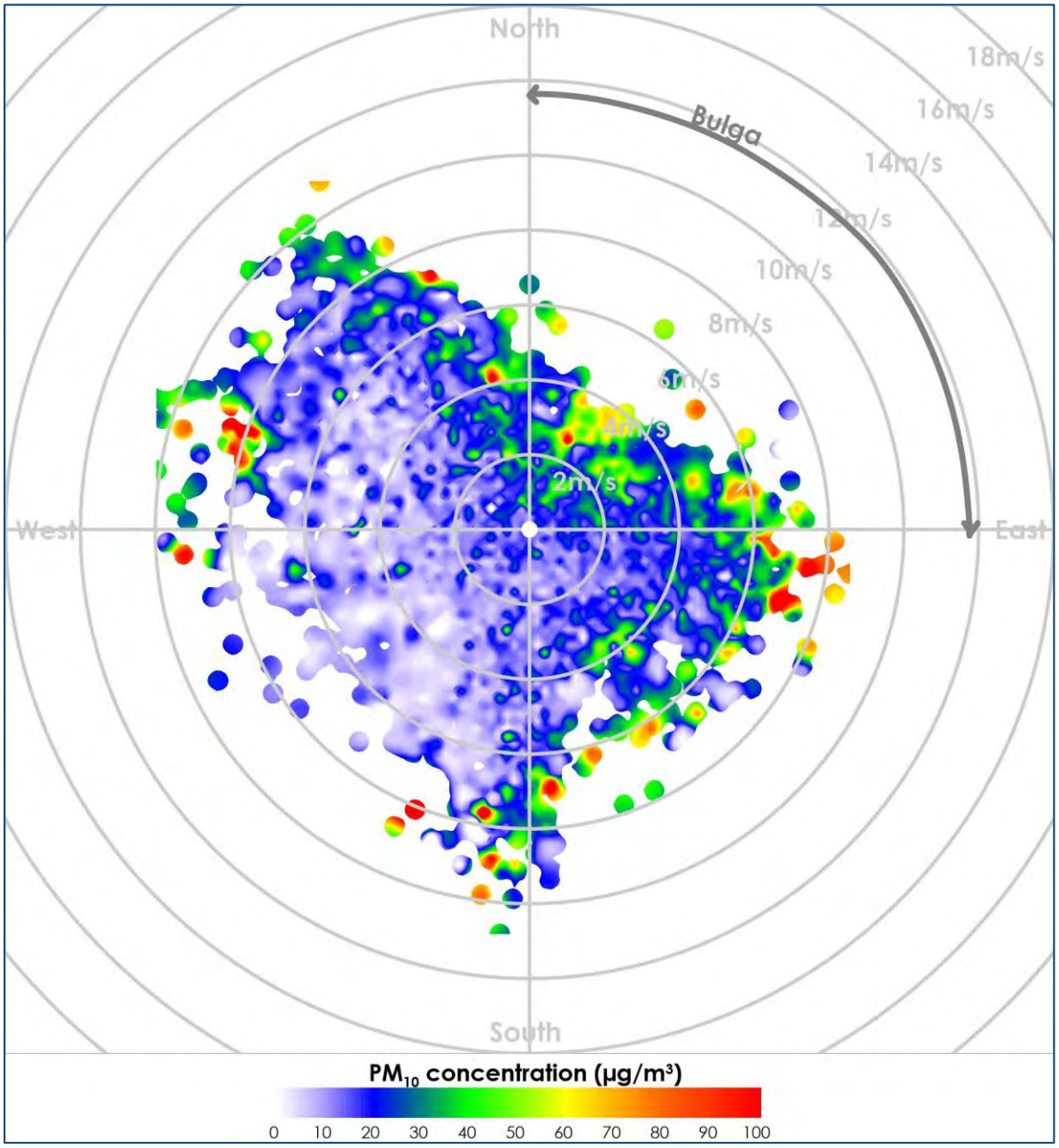


Figure 6-5: Pollution rose for D5 TEOM PM_{10} data (2020)

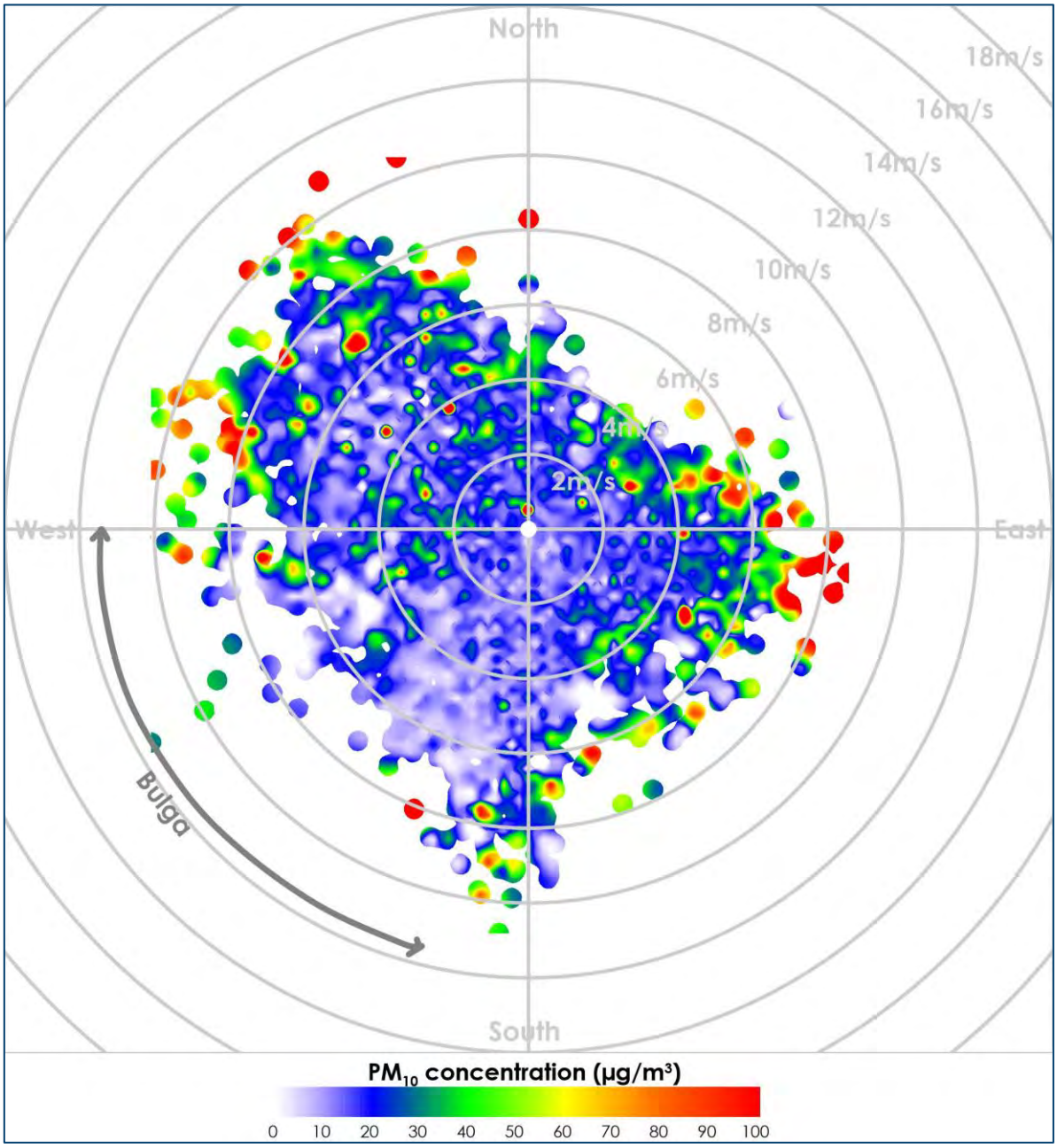


Figure 6-6: Pollution rose for D11 TEOM PM_{10} data (2020)

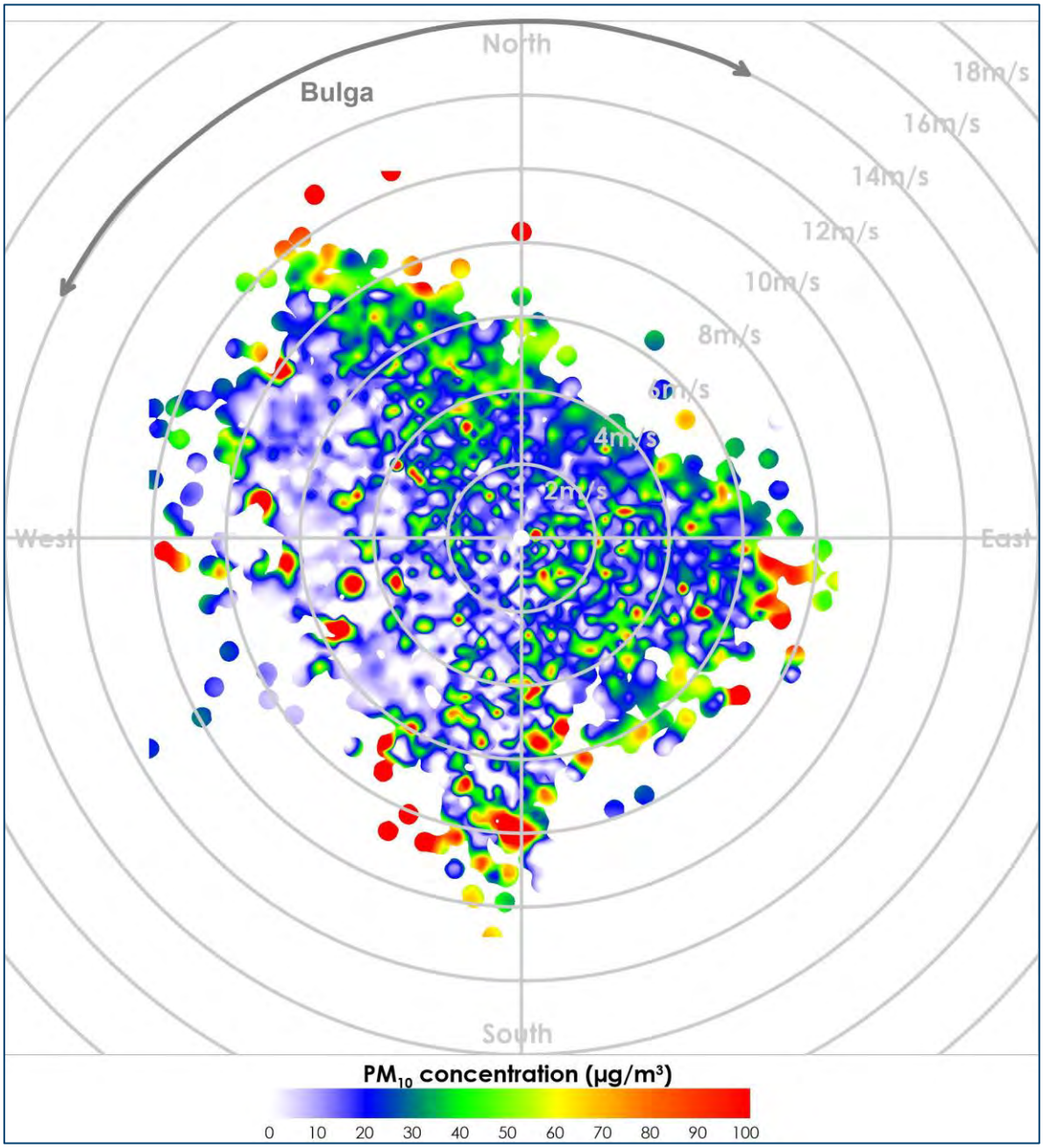


Figure 6-7: Pollution rose for D8 E-BAM PM_{10} data (2020)

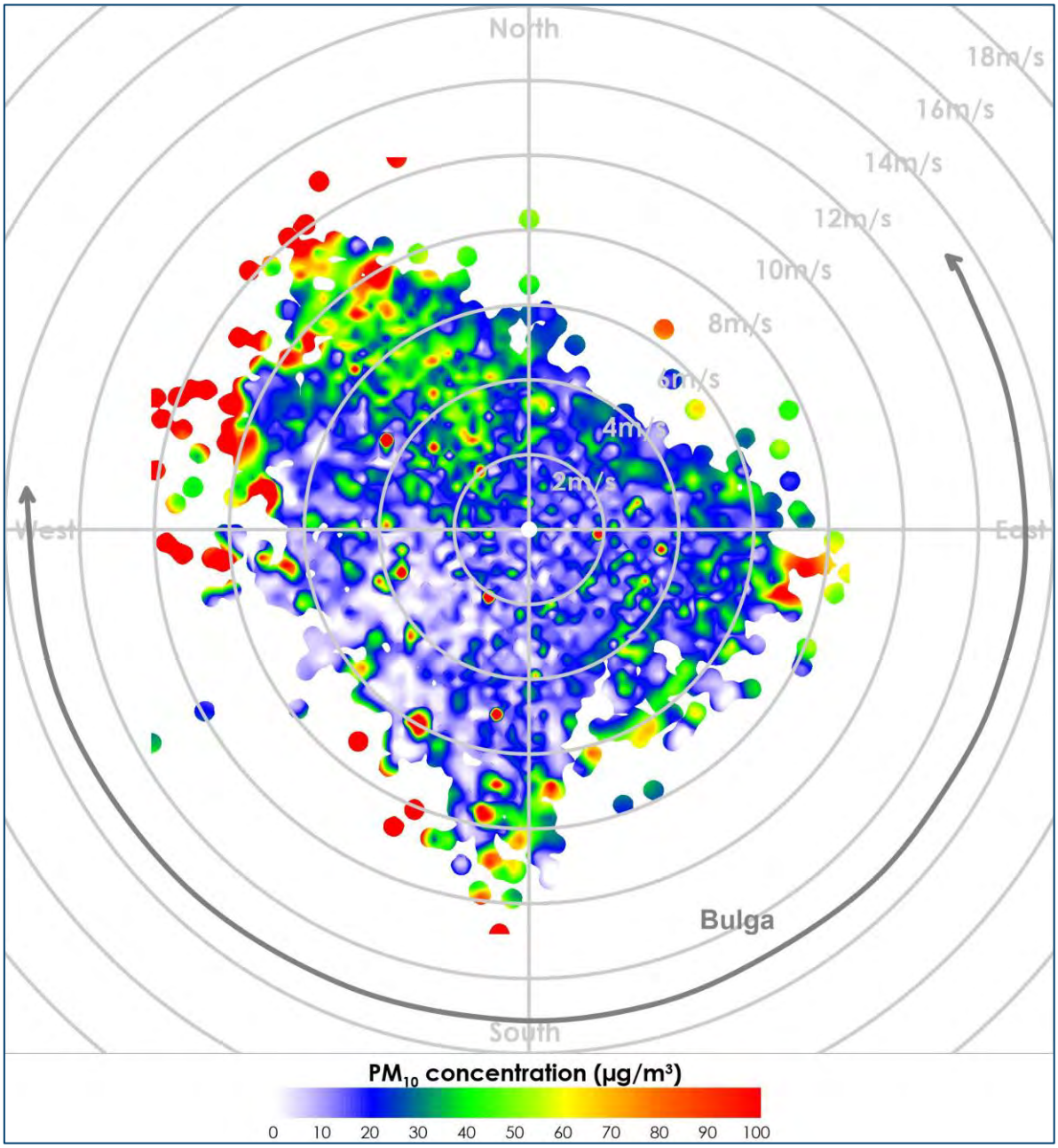


Figure 6-8: Pollution rose for D9 E-BAM PM_{10} data (2020)

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 2020 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 there was generally good agreement between the annual modelling predictions and the measured results excluding extraordinary event days.

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 2020. The analysis shows that the annual average levels excluding extraordinary events were similar to the previous years and below the relevant annual criteria.

There were a number of elevated short term PM_{10} and $PM_{2.5}$ levels recorded during 2020. The majority of these occurred on extraordinary event days. There were considered to have been no instances of non-compliance with the applicable 24-hour average criteria in 2020.

An analysis of the pollution roses for 2020 generally shows minor effects from the direction of Bulga Complex on dust levels and also high levels arising from extraordinary events.

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.

NEPC (2016)

"National Environment Protection (Ambient Air Quality) Measure", National Environment Protection Council, February 2016.

NSW EPA (2017)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, January 2017.

Appendix A *Extraordinary event days*

Extraordinary events in 2020 (Total 24)

The following days were considered to be extraordinary events in 2020 for Bulga:

- 1/01/2020
- 2/01/2020
- 3/01/2020
- 4/01/2020
- 5/01/2020
- 6/01/2020
- 7/01/2020
- 8/01/2020
- 9/01/2020
- 10/01/2020
- 11/01/2020
- 12/01/2020
- 15/01/2020
- 20/01/2020
- 21/01/2020
- 23/01/2020
- 24/01/2020
- 25/01/2020
- 1/02/2020
- 2/02/2020
- 4/02/2020
- 19/02/2020
- 19/08/2020
- 29/11/2020

Appendix B *Elevated 24-hour average particulate days*

Elevated 24-hour average particulate days

The following elevated days in 2020 were investigated to determine the likely cause of the elevated level. The likely primary cause of each elevated day was determined in individual investigation reports or the quarterly monitoring reports.

Figure B-1: Summary of elevated particulate days

Date	Monitors with elevated 24-hour average levels	Primary cause of elevated levels
1/01/2020	D1, D3, D5, D11, D2, D10	Bushfire smoke
2/01/2020	D10	Bushfire smoke
3/01/2020	D10	Bushfire smoke
4/01/2020	D1, D11, D2, D10	Bushfire smoke
5/01/2020	D1, D3, D5, D11, D2, D10	Bushfire smoke
6/01/2020	D10	Bushfire smoke
7/01/2020	D10 HVAS	Bushfire smoke
8/01/2020	D3, D11, D2, D10	Bushfire smoke
9/01/2020	D2, D10	Bushfire smoke
11/01/2020	D3, D5, D10	Bushfire smoke
12/01/2020	D3, D2, D10	Bushfire smoke
23/01/2020	D11	Bushfire smoke & strong winds
24/01/2020	D1, D11, D2	Bushfire smoke & strong winds
2/02/2020	D10 HVAS, Dawtrey HVAS	Bushfire smoke
19/04/2020	D11	Localised source
20/04/2020	D11	Non-Bulga source
23/04/2020	D11	Non-Bulga source
26/04/2020	D11	Non-Bulga source
3/07/2020	D10	Very localised source or invalid data
19/08/2020	D11	Dust storm
29/11/2020	D11	Strong winds & regional wind erosion/ dust storm

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

Windrose

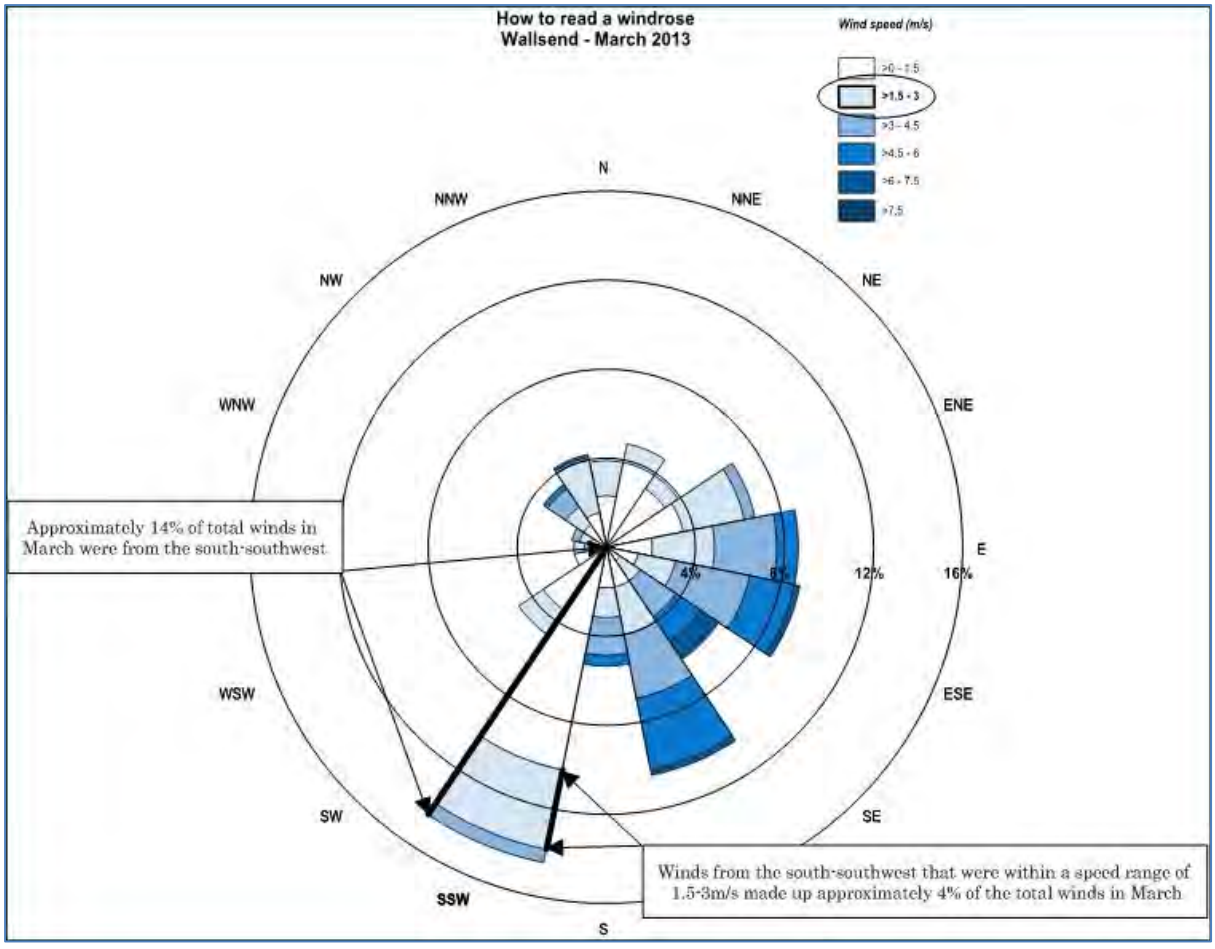


Figure C-1: How to read a windrose

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.

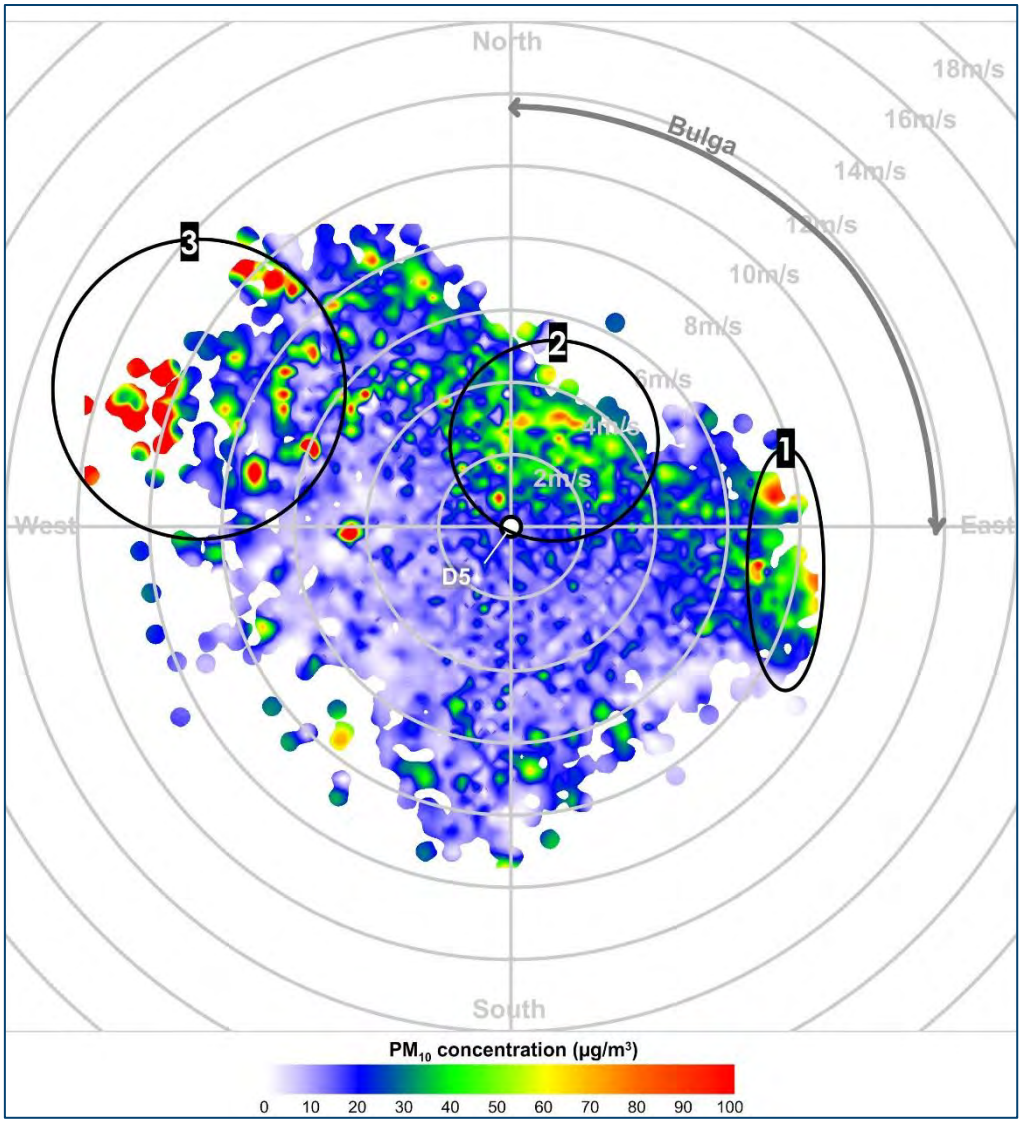


Figure C-2: Example Pollution Rose

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 C

Annual Groundwater Monitoring Report (Jacobs, 2020)

Bulga Coal Complex

Annual Groundwater Monitoring Report - 2020 Monitoring Period

IA256400 | FINAL Rev0

19 March 2021

Bulga Coal Management Pty Limited

Bulga Coal Complex

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Project Manager:	Costante Conte
Author:	Costante Conte
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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
V 01.01		Draft for client review	CConte	CConte	GSheppard	CConte
V 01.02		Final	CConte	CConte	GSheppard	CConte
V 02.01		Correction of missing data (LC1 and LC2)	CConte	CConte	CConte	CConte

Contents

1. Introduction 2
1.1 Background 2
1.2 Study Area 2
1.3 Geology 2
1.4 Hydrogeology 4
2. Groundwater Monitoring Network 5
3. Groundwater level responses during 2020 2
3.1 Shallow Groundwater System 2
3.2 Interburden and shallow coal measures 4
3.3 Coal Seams 4
3.4 Clustered Standpipe Monitoring bores 5
3.5 Vibrating Wire Piezometers 6
3.6 Groundwater Flow in Alluvium 7
3.7 Groundwater Chemistry 9
4. Summary and Conclusions 11
5. Recommendations 12
6. References 13

Appendix A. Additional Information 14

Important note about your report

The sole purpose of this report is to present a review of the groundwater data collected during 2020 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.

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1. Introduction

Bulga Coal Management Pty Ltd (BCM), as managers for the Bulga Joint Venture, manage the Bulga Coal Complex (BCC). Bulga Coal Management Pty Ltd is a subsidiary of Glencore Coal Assets Australia Pty Ltd. This study was commissioned following a conversation between BCC and Jacobs Staff (email Northey/Conte 25 Jan 2021).

This report was prepared to support the Annual Environmental Report for BCC. It documents groundwater conditions following cessation of underground operations at Blakefield South (BFS) during the 2020 reporting period, between 01 January 2020 and 31 December 2020.

The factual background information within the following Sections 1 and 2 is based largely on the that presented in the 2018 annual groundwater monitoring report (David, 2019).

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 (refer Figure 1). BCC is managed by Bulga Coal Management Pty Ltd and comprises both open cut (Bulga Surface Operations) and an underground mine BUO.

BUO previously comprised two operations, BFS which ceased operation in 2018 and historical Beltana No.1 mine. Beltana No.1 underground mine ceased operation in 2011 and extracted coal from the Whybrow Seam directly south-west of the open cut and north-west of BFS. In 2010, BFS operations commenced extraction of the Blakefield Seam that underlies the previously extracted Whybrow Seam. Mining operations at BUO were undertaken using the longwall retreat mining method. The BFS LW9 and 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 (Figure1).

The extraction of coal from BFS started in 2010 with BFS LW1A but was suspended in January 2011 due to fire. The most recently extracted panel BFS LW1B was a continuation of BFSLW1A and was completed in April 2018. Intact coal was left in place between BFS LW1A and BFS LW1B.

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 Subroup	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 has 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 1). These are distributed throughout the three broad hydrostratigraphic groups (Section 1.4.1).

Groundwater monitoring is undertaken in accordance with the BUO 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 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
- Loder Creek alluvium - In December 2019, two new shallow monitoring bores (LC1 and LC2) were installed in the Loders Creek alluvium. Monitoring of LC1 and LC2 commenced in February 2020.
- 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 presented on Table 2.2.

Table 2.1: Summary of standpipe monitoring bores

Site Name	Easting (MGA56)	Northing (MGA56)	Top of casing elevation (mAHD)	Formation monitored	Depth of installation (m bgl)	Continuous loggers
Dwyers	317704.52	6379357.94	70.09	Wollombi Creek alluvium	<30	
F1	316152	6381601	70.15	Wollombi Creek alluvium	17.4	Y
F2	317916	6379142	70.09	Wollombi Creek alluvium	14	Y
Fernance	317697.38	6379366.74	71.63	Wollombi Creek alluvium	Unknown	
V1	316720.3	6380086.18	71.04	Wollombi Creek alluvium	<30	
V2	316959.49	6383505.26	67.25	Wollombi Creek alluvium	<30	
V3	321479.59	6377087.42	75.45	Wollombi Creek alluvium	<30	
WBD160	316435	6380857	73.83	Wollombi Creek alluvium	18	
WBR181	316735.26	6383229.55	68.54	Wollombi Creek alluvium	9	
WBR182	316570.5	6382623.04	69.62	Wollombi Creek alluvium	11.5	
White1	318248.9	6378942.98	70.55	Wollombi Creek alluvium	Unknown	
WBR241	316931.63	6383671.92	68.25	Wollombi Creek alluvium	13.5	Y
GW1	326035.56	6375616.55	92.28	Monkey Place Creek alluvium	Unknown	Y
GW10	322177.66	6376728.28	73.32	Monkey Place Creek alluvium	16	Y
GW2	325328.77	6375636.4	86.34	Monkey Place Creek alluvium	Unknown	Y
GW3	323342.37	6375423.79	77.98	Monkey Place Creek alluvium	13.2	Y
GW4	324107.37	6375104.12	80.59	Monkey Place Creek alluvium	Unknown	Y
GW5	324731.96	6375152.53	82.00	Monkey Place Creek alluvium	Unknown	Y
GW6	322800.98	6375050.58	77.04	Monkey Place Creek alluvium	13.3	
GW7	322738.39	6375581.53	75.11	Monkey Place Creek alluvium	10	Y
GW8	322120.98	6375817.87	75.15	Monkey Place Creek alluvium	16	Y
GW9	322319.08	6376212.93	73.78	Monkey Place Creek alluvium	13	Y
LC1	322855.98	6384872.9	58.46	Loder Creek alluvium	5	
LC2	323727.48	6387927.32	44.97	Loder Creek alluvium	7.6	
McG1	317425.87	6381405.39	112.41	Regolith /sill/ alluvium	Unknown	
WBR15	317578.48	6379805.69	78.11	Regolith /sill/ alluvium	24	Y
NPZ3-B	318116.79	6379199.73	72.76	Interburden Sandstone	51.4	
NPZ4-B	316824.26	6380615.32	82.04	Interburden Sandstone	63.3	
NPZ5-B	316448.35	6381790.37	73.90	Interburden Sandstone	51.3	
NPZ7-1	317566.2	6379556.28	68.99	Interburden Sandstone	50	
NPZ7-2B	317623.98	6379598.15	70.26	Interburden Sandstone	57.5	
NPZ7-3B	317680.71	6379639.51	73.62	Interburden Sandstone	54	
P2	321283.35	6377492.59	74.60	Shallow coal measures	52	
P5A	321682.07	6376660.68	76.15	Shallow coal measures	<100	
P6A	322839.83	6376615.27	85.10	Shallow coal measures	<100	

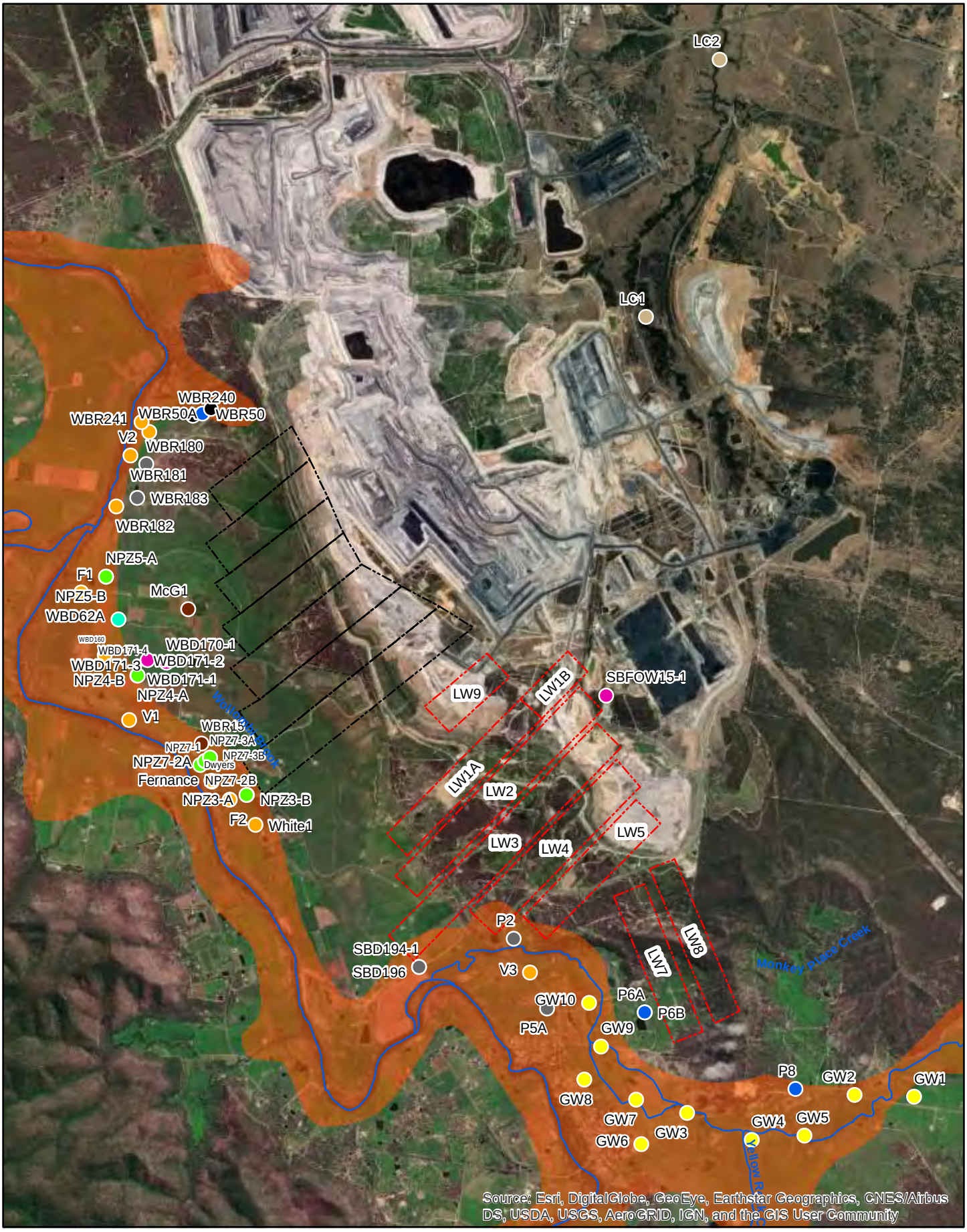
Site Name	Easting (MGA56)	Northing (MGA56)	Top of casing elevation (mAHD)	Formation monitored	Depth of installation (m bgl)	Continuous loggers
SBD196	320164.75	6377155.89	73.00	Shallow coal measures	Unknown	
WBR180	316926.13	6383123.84	69.90	Shallow coal measures	46	
WBR183	316802.5	6382733.61	74.64	Shallow coal measures	30.6	
WBR240	317495	6383685	65.42	Shallow Permian	9	Y
WBR50A	317619.47	6383700.52	65.10	Shallow Permian	18	Y
NPZ3-A	318117.71	6379200.51	Unknown	Alcheringa Seam	17	
NPZ4-A	316820.6	6380615.83	82.67	Alcheringa Seam	42.4	Y
NPZ5-A	316448.35	6381790.37	74.48	Alcheringa Seam	15.7	Y
NPZ7-2A	317623.98	6379598.15	70.55	Alcheringa Seam	10	Y
NPZ7-3A	317680.71	6379639.51	73.95	Alcheringa Seam	17	Y
WBD62A	316593.58	6381282.77	80.20	Alcheringa Seam	27	Y
P6B	322839.83	6376615.27	85.10	Lower Whybrow Seam	390	
P8	324628.23	6375708.24	88.18	Lower Whybrow Seam	392.4	
WBR50	317604.5	6383719.6	64.57	Lower Whybrow Seam	125	Y

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 2019-2020

Figure 1: Bulga Coal Complex showing Blakefield South and associated groundwater monitoring locations



LEGEND

Monitoring Bores - Piezometers
- Loder Creek Alluvium
- Monkey Place Creek Alluvium
- Wollombi Alluvium
- Regolith / Alluvium
- Shallow Permian
- Alcheringa Seam
- Sandstone Interburden
- Shallow Coal Measures
- Lower Whybrow Seam
- VWP

Hydrology
- Watercourse

Geology
- Alluvium

Underground Workings
- Extracted Blakefield South workings
- Extracted Beltana underground workings

0 1 2
Kilometres
A4 1:60,000
[GDA94 | MGA56]

F:\jacobs\Glencore\Bulga AEMR 2021\IH195800\01 Data\GIS\fig 1 Bulga 21.mxd Produced: 19/03/2021

3. Groundwater level responses during 2020

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, 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 3.5km south of the BFS workings. Rainfall data for the last 128 years from station 061100 were used to calculate the long-term monthly average rainfall. Recent data (2013-2020) 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.

As the HARTT analysis simply 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 considered of value to repeat the assessment for the 2020 monitoring data as 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

During the reporting period, groundwater levels in the Wollombi Brook alluvium showed moderate to significant recoveries following the increased rainfall compared to previous years. This rainfall is reflected in the rainfall excess / deficit curve. All bores show an increase in groundwater levels, and 5 of the 12 Wollombi Brook alluvium monitoring bores (Dwyers, Fernance, V2, WBR182 and WBR241) have returned to pre-2016-2019 drought water levels.

Most monitoring bores show a steady increase in groundwater level, with increases of between 0.5 m to over 1.5 m over the course of the reporting period. A number of bores show short term responses to individual rainfall events, whereas this response is muted in the Wollombi Brook alluvium monitoring bores.

While it is clear from a visual review of the data that there is a correlation between rainfall excess / deficit and alluvial groundwater levels (indicating no significant influence of non-climate related stresses), 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).

Evidence of this is presented in Figure 2 where a localised depression in the alluvium groundwater contours and disruption of natural gradients for Dec 2020 is seen between bores V1 and White 1.

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 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 .

The prolonged period of rainfall deficit that occurred between 2016 and 2019 was halted by rain in early 2020. The manually recorded groundwater levels in the Monkey Place Creek alluvium monitoring bores all show increasing groundwater levels during the 2020 reporting period. All of the Monkey Place Creek bore water levels have returned to pre-2016-2019 drought levels. These increases correspond to the increased rainfall starting from early 2020, as shown in the rainfall excess / deficit curve on the hydrographs (refer Appendix 1). Levels generally increased between 0.5 m and 2 m; however, while a number of Wollombi Creek alluvial monitoring bores show short term responses to individual rainfall events, this response is muted in the Monkey Place Creek alluvium monitoring bores.

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 Loder Creek alluvium

In December 2019, two new shallow monitoring bores; sites LC1 and LC2, were installed in the Loders Creek alluvium (refer Figure 1). Loders Creek and its associated tributaries flow to the Hunter River and are located east of the Mt Thorley/Warkworth Mine complex. LC1 and LC2 were installed to provide baseline data, to allow for early detection of potentially altered baseflow in the alluvial aquifer (if present). Monitoring of LC1 and LC2 commenced in February 2020. The LC1 bore is dry and monitoring results were for LC2 for 2020 are discussed below.

LC2 has shown signs of recovery in the order of 0.5 m, which is likely due to the elevated rainfall over 2020. The groundwater elevations range from 41.23 mAHD to 41.77m AHD, which are consistent with a tributary of the Hunter River at this location. The Hunter river elevation is in the order of 40 mAHD at the confluence of the two water bodies.

Currently there is insufficient data to assess for mining impacts.

3.1.4 Regolith/volcanic sill/alluvium

McG1 and WBR15 monitoring bores are installed in regolith/volcanic sill/alluvium and are located west of BFS. Following heavy rain at the start of the 2020 reporting period, groundwater levels in McG1 showed a noticeable increase in elevation that caused levels to return to pre-2016-2019 drought levels. Groundwater levels in this bore 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 gradually increase of over the 2020 reporting period, starting from the heavy rain in early-2020. The December 2020 water level is approximately 1.3 m higher that the lowest historical measurement recorded in early 2020. This bore shows very different groundwater level fluctuations to those in McG1 with a much smoother seasonal changes, which seem only generally relatable to rainfall excess / deficit.

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).

The sandstone monitoring bores show two types of responses. Those installed in a cluster directly to the west of BFS (NPZ7-1, NPZ7-2B, NPZ7-3B, NPZ3-B, WBR240 and WBR50A) all show very similar responses which generally reflect the rainfall excess / deficit curve. Levels in 2020 show a gradually increase of over the 2020 reporting period, starting from the heavy rain in early-2020. Water levels have still not returned to pre-2016-2019 drought.

The two sandstone monitoring bores located further north (NPZ4-B and NPZ5-B), to the north-west of BFS, show quite a different response with a sharp decline following installation in 2005 followed by a general increase since 2010. These bores are directly west of the Beltana No.1 underground workings where extraction of coal from the Whybrow Seam ceased in 2011 and appear to show a clear recovery response. In 2020, levels in NPZ4-B showed a very slight increase in 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.

Groundwater levels in 2020 in the two shallow Permian interburden sandstone monitoring bores show an increase that is in the order of 1 m.

3.2.2 Undifferentiated Coal Measures

Shallow coal measures monitoring bores are located to the south of BFS (P2, P5A, P6A and SBD196) with two (WBR180 and WBR183) located at to the northwest at a distance of over 2 km, north-east of the northern end of the Beltana No.1 underground workings.

The three of the four monitoring bores to the south of BFS (P2, P5A and SBD196) all show increasing groundwater levels during the reporting period. The increases are of between 0.4 m and 1.3 m and generally reflect the rainfall excess since early-2020. P6A is also located south of BFS and the groundwater levels have continued to decline over 2020 from the previous period, despite the monitoring bore showing a response to the heavy rainfall in early-2020.

The two monitoring bores to the north-west of BFS (WBR180 and WBR183) both show much more subdued trends. The groundwater level in WBR180 has stabilised and remained relatively unchanged over the 2020 reporting period. Groundwater levels in WBR183 increased by 0.6 m over the reporting period, 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. During the reporting period, the groundwater levels in NPZ7-2A, NPZ7-3A and NPZ4Ashow somewhat erratic levels before and during the 2016-2019 drought, followed by an increase in levels during the reporting period. These monitoring bores have broadly matched the rainfall excess / deficit curve since installation in 2005.

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 2020, this monitoring bore showed a continuation of the decline from the previous period with a delayed response to the rainfall excess and increasing groundwater levels in the latter half of 2020.

A subdued increase in water levels in monitoring bore NPZ5A reflects the rainfall excess / deficit trend and the increased rainfall from early-2020.

Following a significant decline in 2008-2011, NPZ3-A began to recover slowly, although no data is available for 2019-2020.

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 2020, groundwater levels in P6B were somewhat erratic although there was minimal net increase from the start to the end of 2020. This increase represents a change from the 80 m of depressurisation recorded between the start of 2015 and the end of 2018 and may be a reflection the cessation of mining activity at BFS combined with the increase rainfall since early-2020.

In P8, levels have been somewhat erratic over the course of the record with large step increases in 2005 and 2008. Since 2016, approximately 15 m of depressurisation has been observed coinciding with the rainfall deficit over the period, although in 2020 the median level value is in line with the previous 18 months of data reflecting the cessation of mining activity at BFS. There were two measurements outside of the data ranges for 2020, the first in February 2020 and is likely a response to the high rainfall, and the measurement in December 2020 that is approximately 7 m below the 2020 median value. The latter measurement may be an error and will need to be reviewed following the next monitoring round.

At WBR50, levels were also erratic during 2020. The measurements show a minor increase in water levels as a result of the rainfall in 2020. 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 2020, 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.

NPZ4 – the downward vertical hydraulic gradient remained relatively constant with the pressure reduction in the both units recovering slightly due to the elevated rainfall in 2020.

NPZ5 – the downward vertical hydraulic gradient decreased slightly with a continued gentle pressure reduction in the Alcheringa Seam and slight pressure increase in the sandstone. Water levels in both units have increase 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.

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.

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. This situation continued through 2020.

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 2020, aside from the recovery in the P6B that is likely due to the rainfall in 2020. Levels in P6A do not show any major response to the rainfall over 2929, but the bore does show a 0.41 m decrease during 2020.

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 Vibrating Wire Piezometers

VWP arrays were installed to the south-west, north-east, and north-west of the BFS to measure piezometric heads at multiple depths at the one location. The arrays comprise between 4 and 9 VWP pressure sensors installed at different depths, grouted into one borehole to measure vertical hydraulic gradients over time. This is intended to assists in understanding vertical connectivity between hydrostratigraphic units. Four VWP arrays are monitored as part of the groundwater network for BFS, including:

- WBR170 and WBR171 – Installed to the north-west of the BFS and directly west of the Beltana workings, on the eastern edge of the Wollombi Alluvium
- SBD194 – Immediately adjacent to the south-west of the BFS (at the south-western end of BFSLW3)
- SBFOW15 – immediately adjacent and to the north-east of the BFS

VWP installation depths and corresponding formations are provided in Table 2.2. Recent (December 2020) pressure profiles are presented for each of these VWPs in Appendix A.

The Whybrow Seam and undifferentiated Permian overburden are monitored in VWP WBR170 and WBR171 to the north-west of BFS. Both installations have four sensors, with three in the undifferentiated Permian overburden and the lowest sensor set in the Whybrow Seam. Only limited data was available to download for these VWPs but the 2018 groundwater monitoring report includes the full record of approximately 6 monthly data going back to Dec 2007 and 2009.

At WBR170, the pressure profile shows obvious depressurisation in the lowest undifferentiated Permian overburden sensor. Comparison of the 2017 data to the 2020 data shows continued recovery (re-pressurisation)

at both the lowest undifferentiated Permian sensor and in the Whybrow Seam. This is a continuation of the re-pressurisation trend seen in the longer-term dataset since 2008 (2018 report, David, K. 2019). The shallower undifferentiated Permian sensors show a slight pressure reduction since 2017 possibly as a result of the rainfall deficit of the 2016-2019 drought.

At WBR171, the pressure profile shows continued re-pressurisation at both the lowest undifferentiated Permian sensor and in the Whybrow Seam. This is a continuation of the re-pressurisation trend seen in the longer-term dataset going back to 2008 (2018 report, David, K. 2019). The shallowest undifferentiated Permian sensor shows a slight pressure reduction since 2017 possibly as a result of the rainfall deficit of the 2016-2019 drought. The middle undifferentiated Permian sensor shows virtually no recovery over the recent monitoring period.

VWP SBD194 has nine vibrating wire piezometers installed in major seams including the Blakefield Seam (-190 mAHD), lower Whybrow Seam (-100 mAHD) and the interburden sandstone. Following the completion of mining, there has been re-pressurisation of the Blakefield Seam, apparently partly by depressurisation of the immediately overlying (Wambo Seam) and underlying strata (Glen Munro Seam), which continued during 2020. The Blakefield Seam has an overall re-pressurisation of 40-45 m to date.

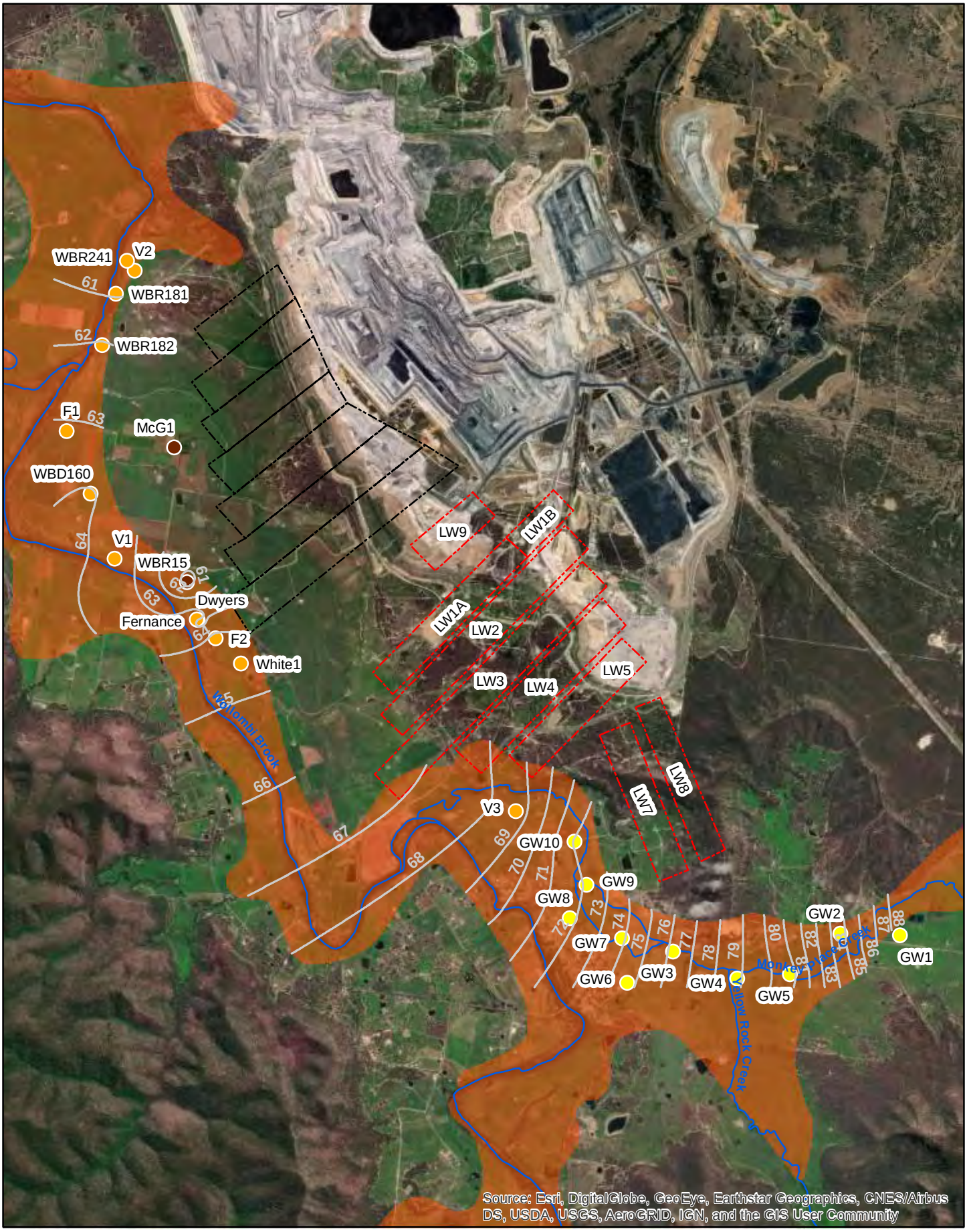
No data was available for SBFOW15 in 2019/2020. Previous reporting states that there is a clear vertical hydraulic gradient with an obvious de-pressurisation at -70m AHD in the Blakefield Seam. The longer-term data presented in the 2018 monitoring report also indicates there has also been a fairly uniform depressurisation of the underlying strata of approximately 20m with limited recovery to date.

3.6 Groundwater Flow in Alluvium

Groundwater contours for the Wollombi Alluvium and Monkey Place Creek Alluvium, based on data for December 2020, are presented in Figure 2. 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 track of alluvium. Groundwater levels have generally recovered compared to 2019 and previous drought years. A groundwater depression is interpreted from the data in the vicinity of Dwyers monitoring bore (Figure 2) west of BFS, 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.

The alluvium water elevation for Loders Creek was not included in the groundwater flow plan, considering it is a single observation point in that alluvium body. That said, groundwater elevations range for LC2 (refer Section 3.1.3) is consistent with a tributary of the Hunter River at this location.

Figure 2: Groundwater contours for the alluvium (December 2020)



LEGEND

Bulga alluvium dec 2020 no label mod

Monitoring Bores - Piezometers

- Monkey Place Creek Alluvium
- Wollombi Alluvium
- Regolith / Alluvium

Hydrology

Watercourse

Geology

Alluvium

Underground Workings

Extracted Blakefield South workings

Extracted Beltana underground workings

0 1 2

Kilometres

A4 1:60,000

[GDA94 | MGA56]

F:\jacobs\Glencore\Bulga AEMR 2021\IH195800\01 Data\GIS\Bulga_Wollombi_alluvium_cont.mxd Produced: 10/03/2021

3.7 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. A Piper plot comparing major ion chemistry data for Dec 2020 for coal seams, alluvium and sandstone/regolith is presented in Figure 3.1.

The time series EC data for the alluvium bores displays trends that reflect the rainfall excess / deficit trend with drier periods resulting in higher EC in alluvial groundwater and higher rainfall periods resulting in lower EC. This trend continued during 2020 with slightly increasing EC observed in many bores in response to the increasing rainfall deficit at the end of 2019 and early-2020, and the majority of bores also show a declining EC due to rainfall recharge throughout 2020 (refer time series EC data graph in Appendix A)

Figure 3.1 presents major ion chemistry data for groundwater samples from bores screened in alluvium, coal seams and sandstone/regolith, collected in December 2020. 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-bicarbonate water types through to sodium-chloride, with some classified as calcium-chloride water types. 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 calcium-chloride and sodium-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 some classified as sodium-chloride water types. 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.

The 2020 interpreted water types correspond to previous Piper plot analysis of the water samples.

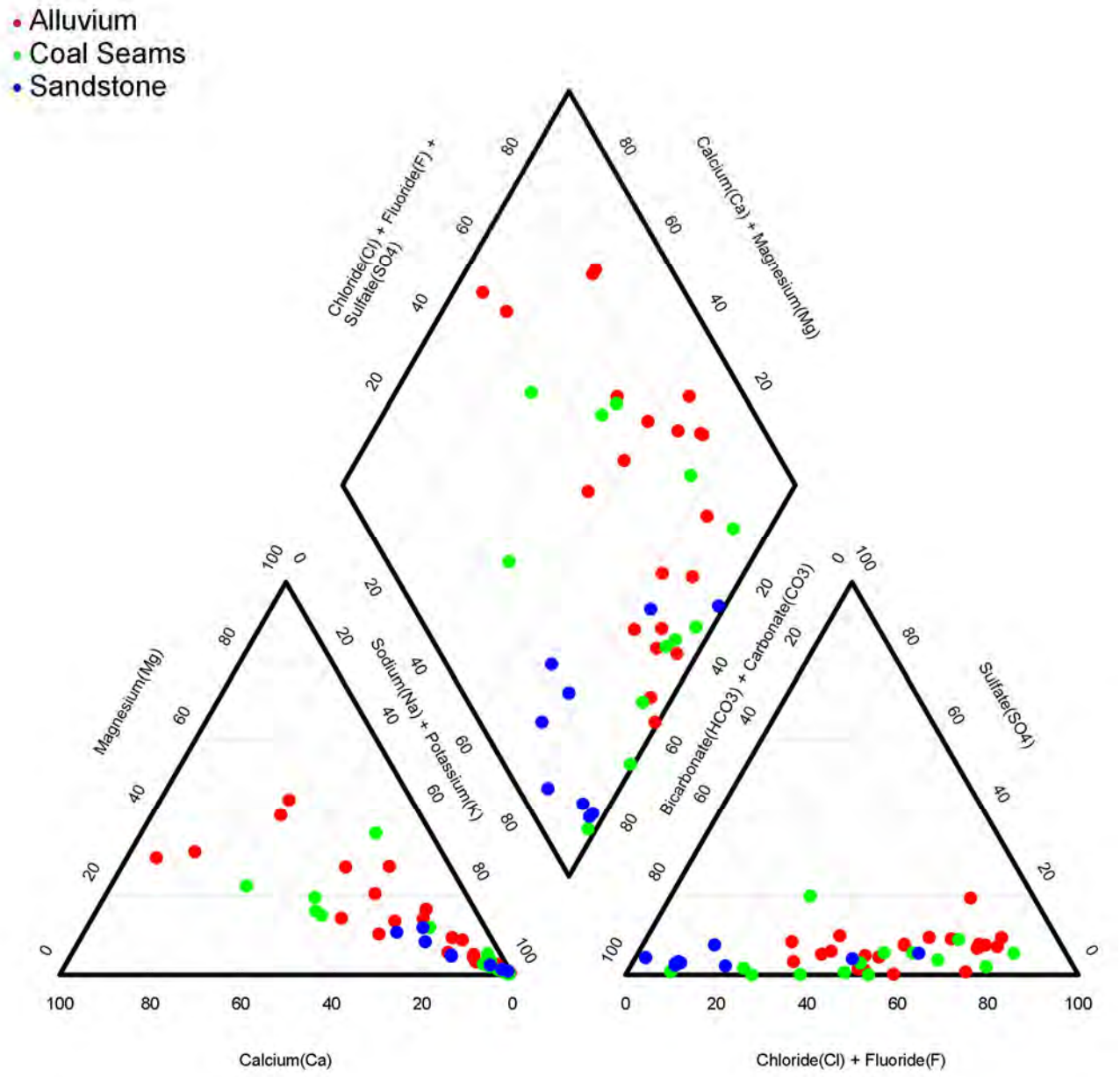


Figure 3.1: Piper plot comparison of major ion groundwater chemistry for the alluvium, coal seams and sandstone interburden (samples collected 15-16 Dec 2020).

4. Summary and Conclusions

This groundwater report documents groundwater conditions during 2020, following the cessation of mining at BFS in April 2018. 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 and south and extends 5 km to the north and northwest of the BFS footprint. The current groundwater monitoring network is comprehensive and includes 48 monitoring locations in the alluvium, overburden strata (sandstone and coal seams), Whybrow Seam, Blakefield Seam and underlying and overlying strata. Four VWP arrays (only three of which are operational) monitor the changing vertical gradients (re-pressurisation and depressurisation) above and below the Blakefield Seam;
- Overburden pressures in the top 50 m to 100 m from surface remain relatively stable following the cessation of extraction at BFS in 2018, with a slight recovery of levels observed in shallow coal measures strata likely related to the increasing rainfall excess during 2020.
- The vertical head profiles in the VWP arrays show continued re-pressurisation of the Whybrow Seam at WBDR170 and WBD171, with a slight increase of pressures in the shallowest sensors that is likely related to the increasing rainfall excess during 2020.
- At SBD194, re-pressurisation of the Blakefield Seam continues at the same time as depressurisation of the overlying Wambo Seam and underlying Glen Munro Seam. Re-pressurisation of around 40-45 m is observed to date in the Blakefield Seam (at SBD194 to the west of BFS).
- Shallow groundwater in the alluvium (Wollombi Creek and Monkey Place Creek), generally shows a recovery following the 2016-2019 drought, which is in line with the increasing rainfall excess recorded since early-2020. Hydrograph analysis of selected alluvial bores (using the HAART method) in the 2018 monitoring report indicates that there may be other influences on groundwater levels in the alluvium such as irrigation, extraction and surface water-groundwater interaction. However, rainfall is the major influence on alluvium groundwater levels with no apparent influence from mining operations;
- Field measured EC in alluvial groundwater shows a close relationship to rainfall with EC measured during 2020. The majority of alluvium bores show a decrease in EC trends, which is in line with the increasing rainfall excess since early-2020;
- The major ion chemistry for groundwater samples collected in December 2020 is very similar to the December 2018 and December 2019 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.

5. Recommendations

A number of automated water level dataloggers were found to have recorded erroneous data, including GW1, GW2, GW3, GW4, GW5, GW7, GW8 GW9, GW10, WBR240 and WBR50. The correct functioning and/or calibration of these datalogger should be confirmed, and any malfunctioning dataloggers should be replaced.

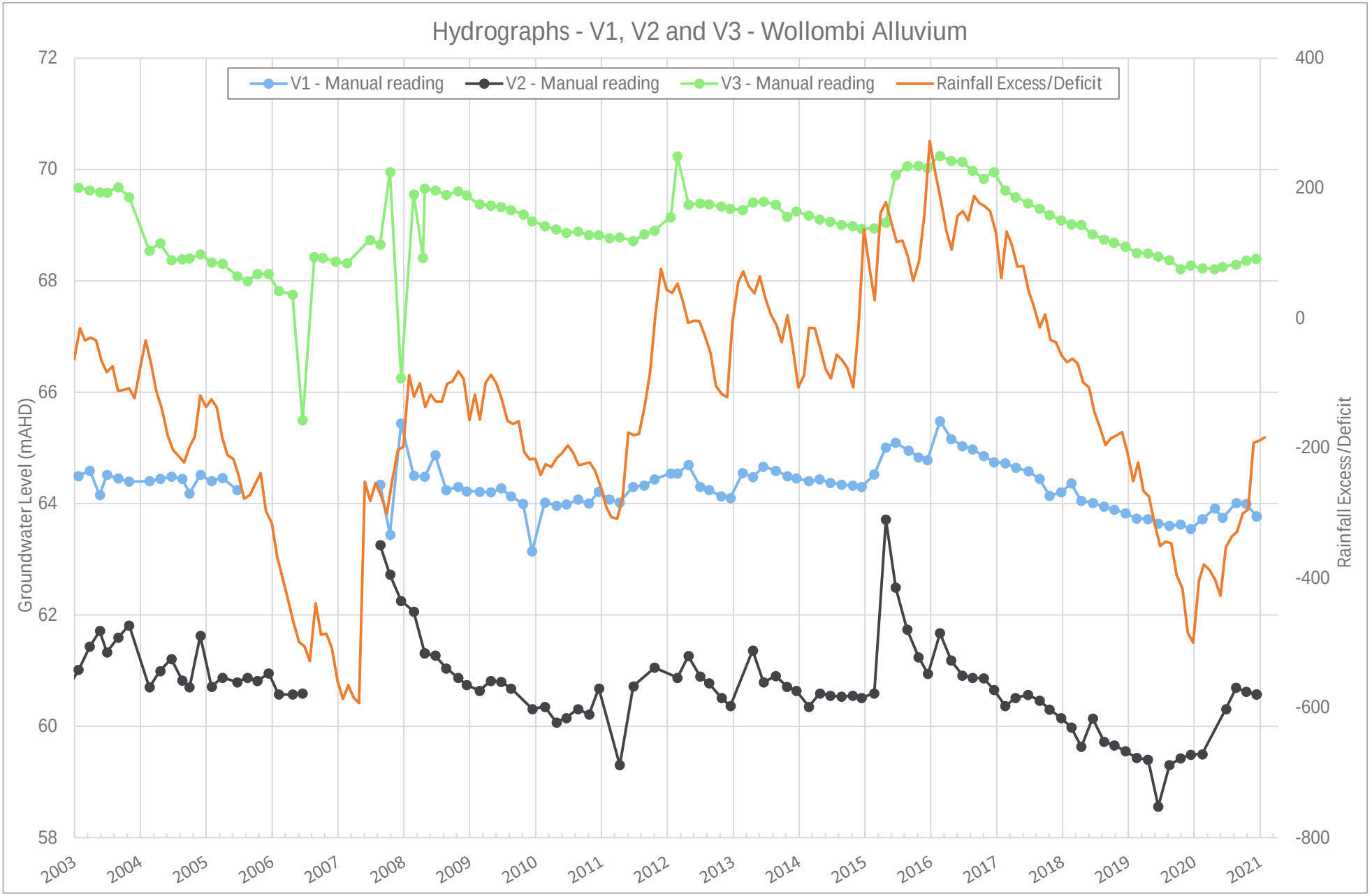
6. References

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.

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. Additional Information


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
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2006
2007
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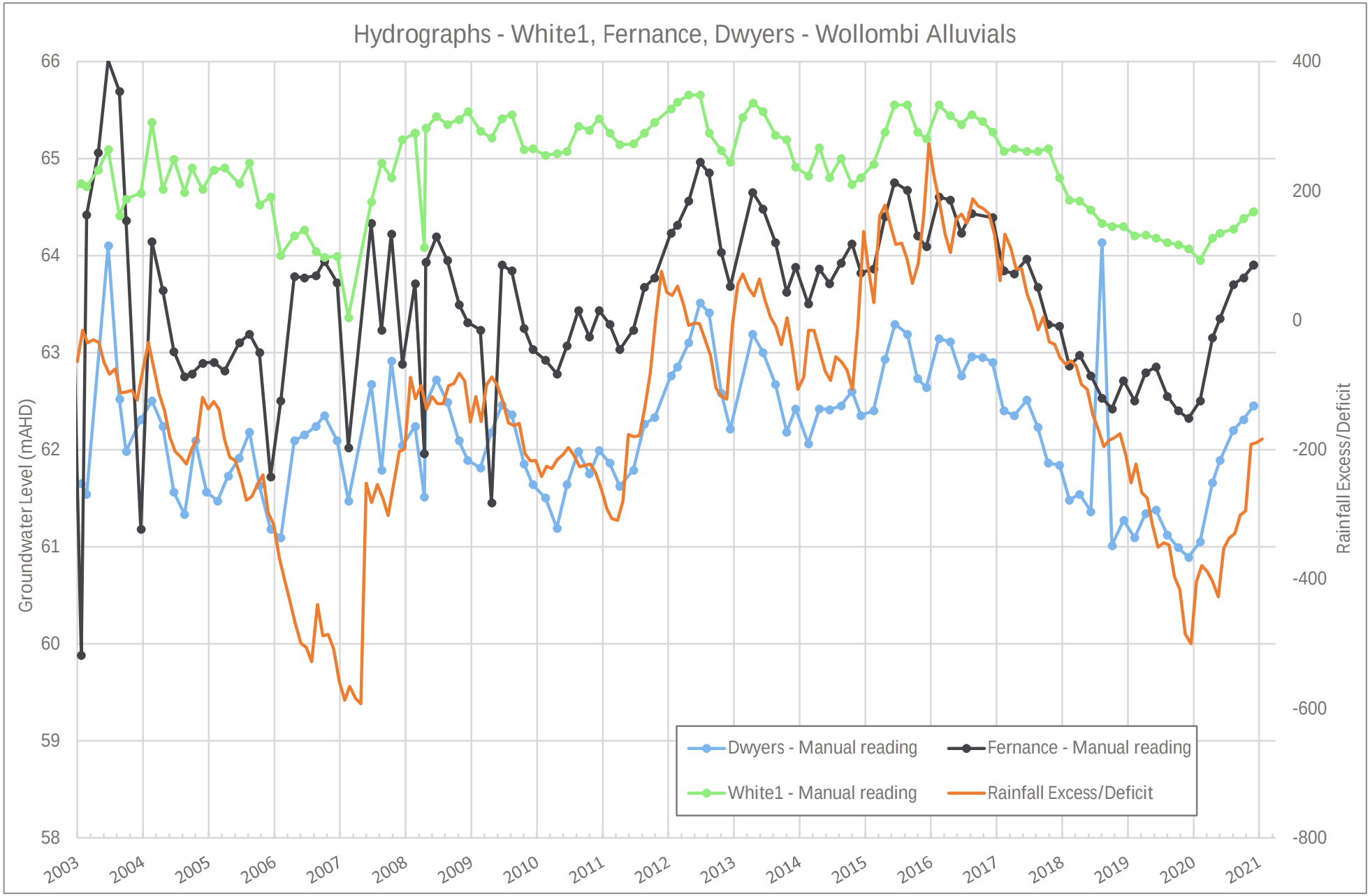
2019
2020
2021


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
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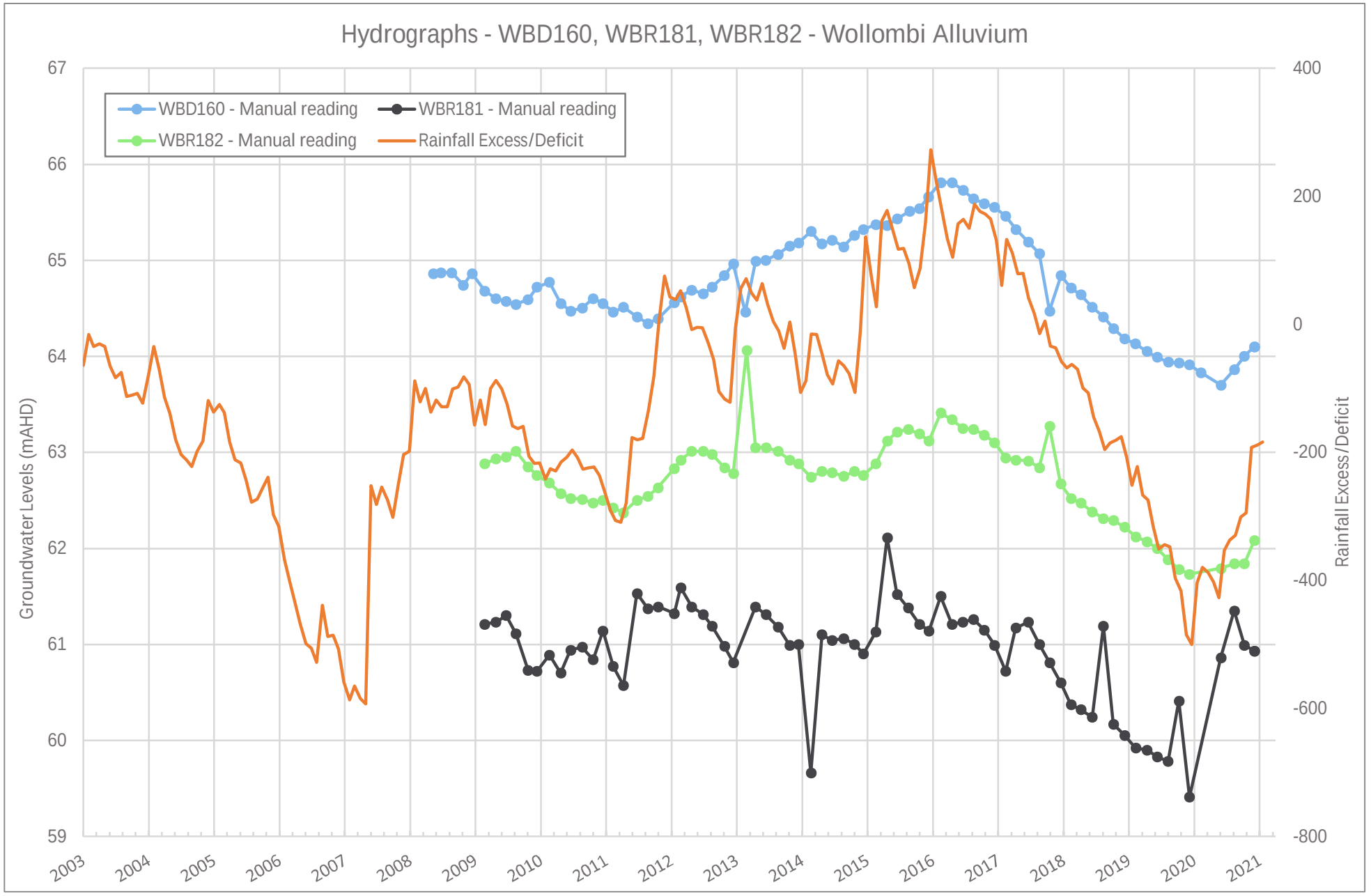
2017
2018
2019
2020
2021
Dwyers - Manual reading
Fernance - Manual reading
White1 - Manual reading
Rainfall Excess/Deficit


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
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2006
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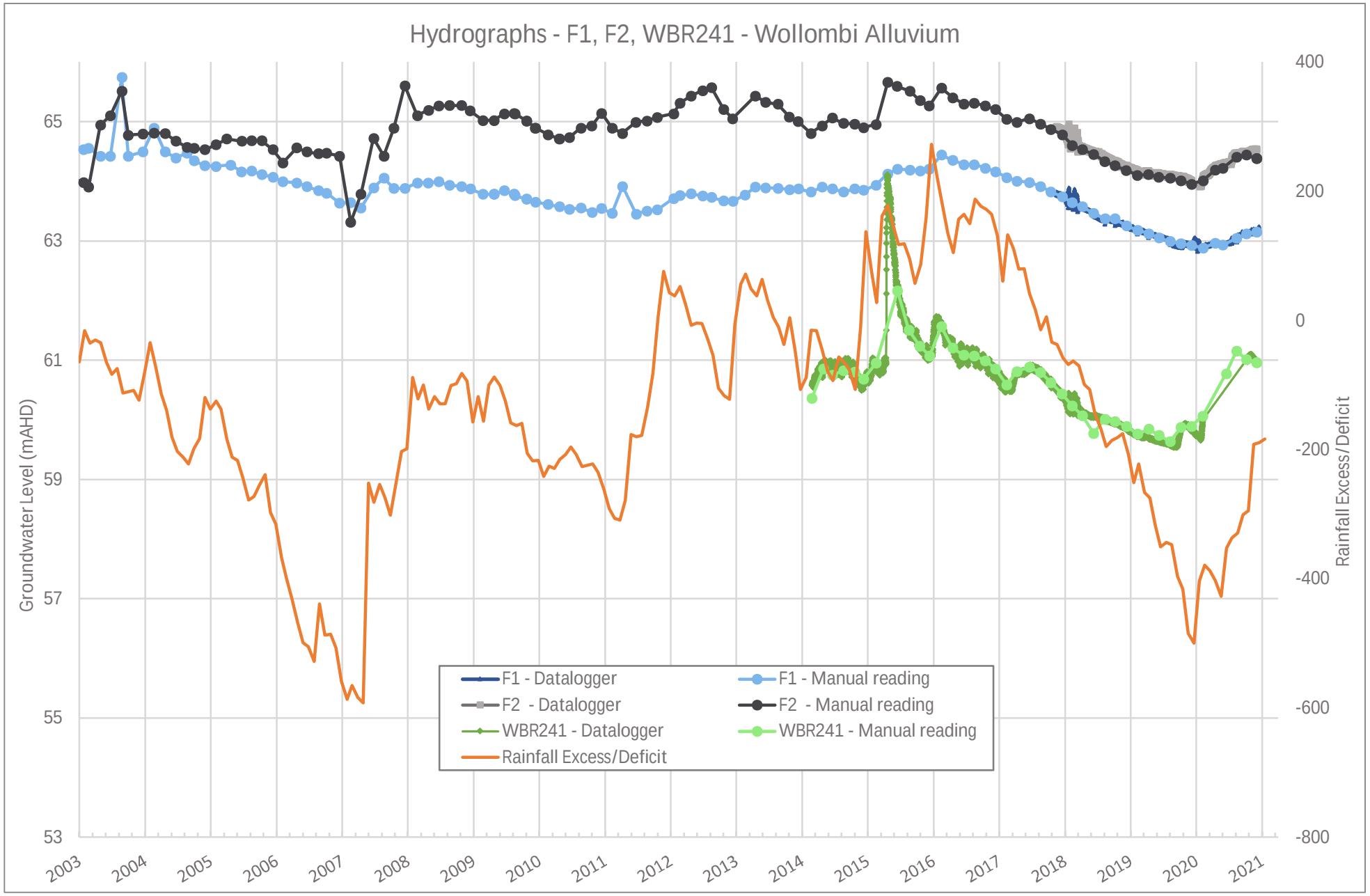
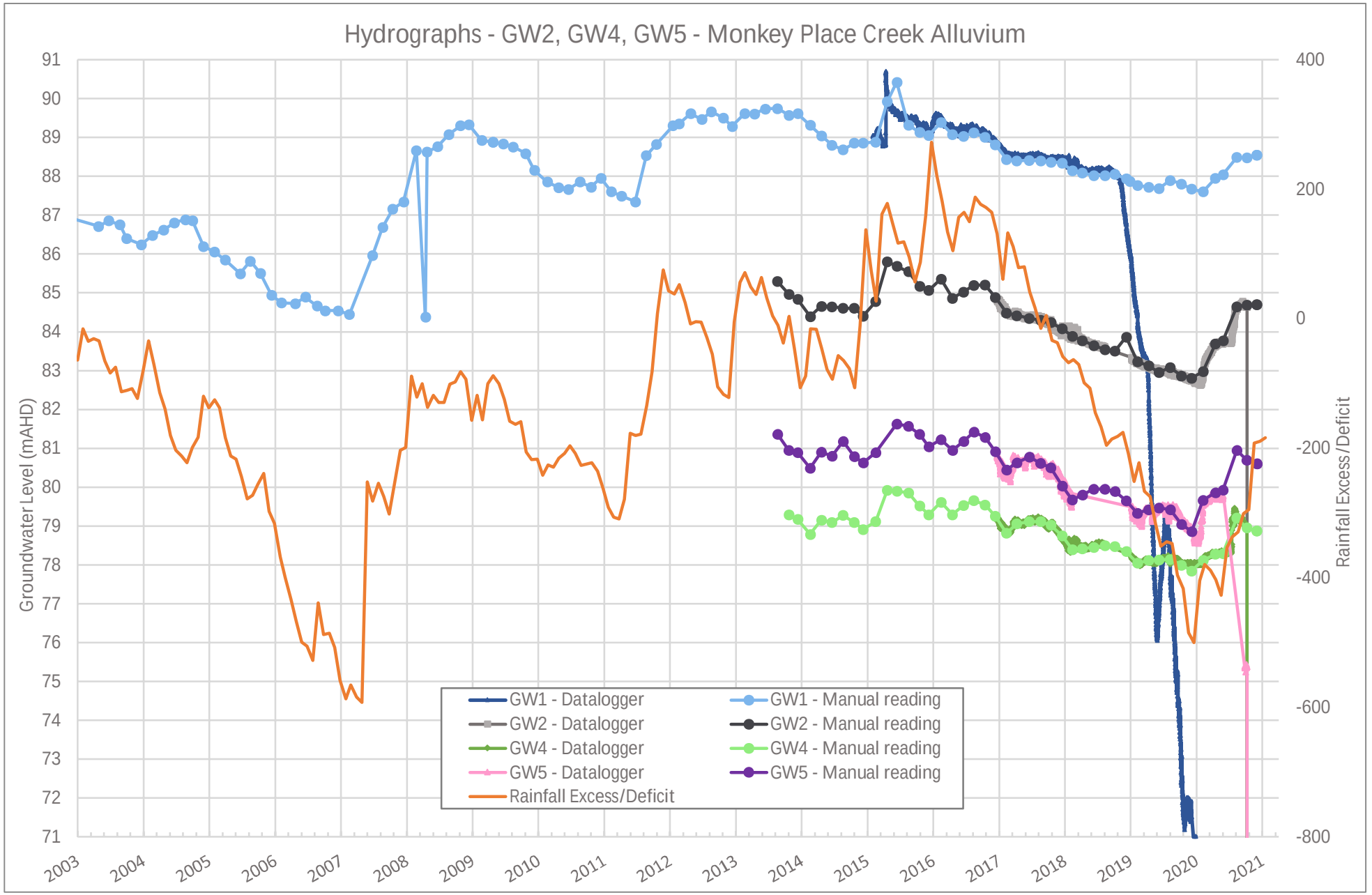
2013
2014
2015
2016
2017
2018
2019
2020
2021


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
F1 - Datalogger
F1 - Manual reading
F2 - Datalogger
F2 - Manual reading
WBR241 - Datalogger
WBR241 - Manual reading
Rainfall Excess/Deficit


Hydrographs - 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
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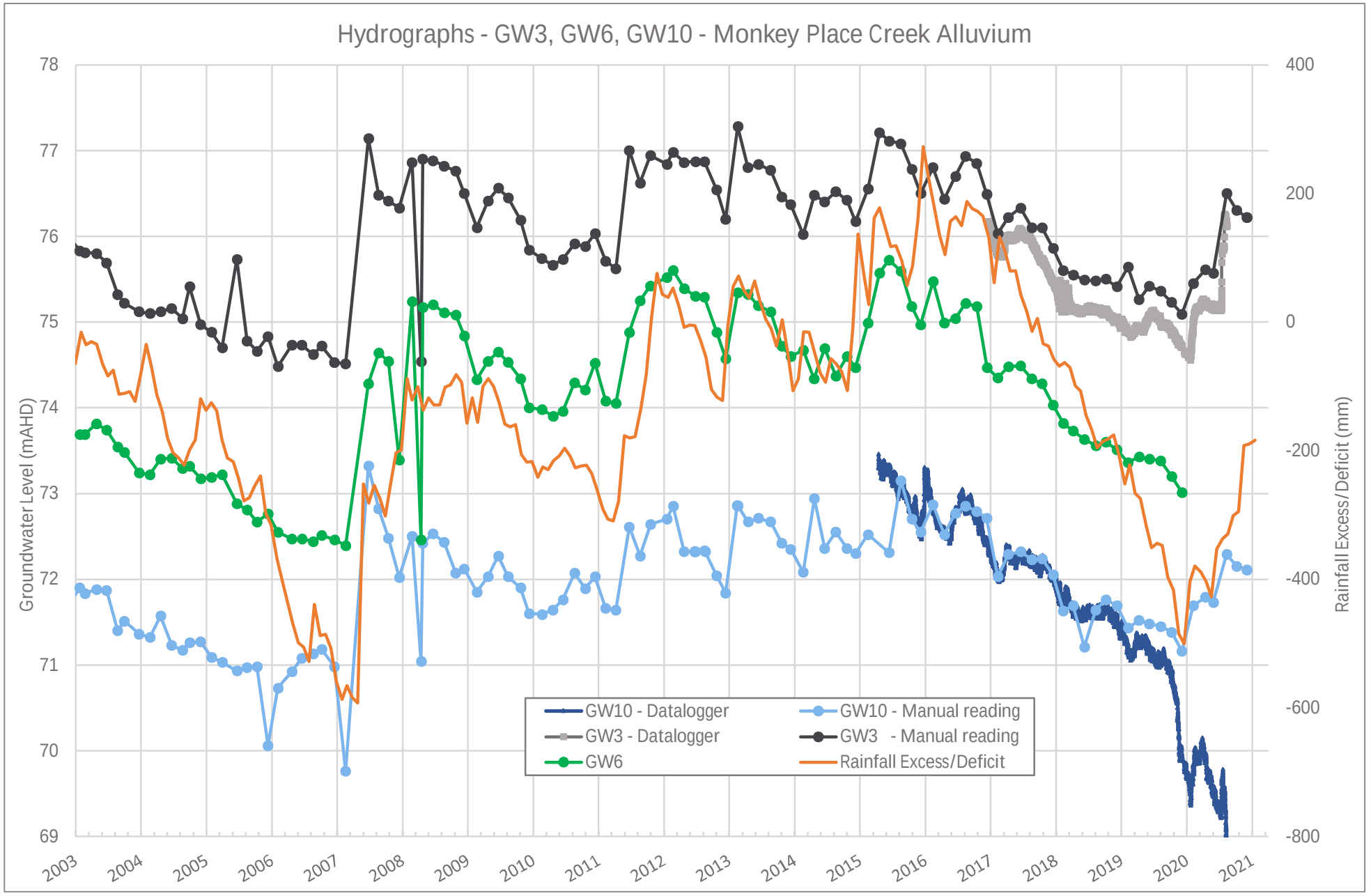
2015
2016
2017
2018
2019
2020
2021
GW1 - Datalogger
GW1 - Manual reading
GW2 - Datalogger
GW2 - Manual reading
GW4 - Datalogger
GW4 - Manual reading
GW5 - Datalogger
GW5 - Manual reading
Rainfall Excess/Deficit


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
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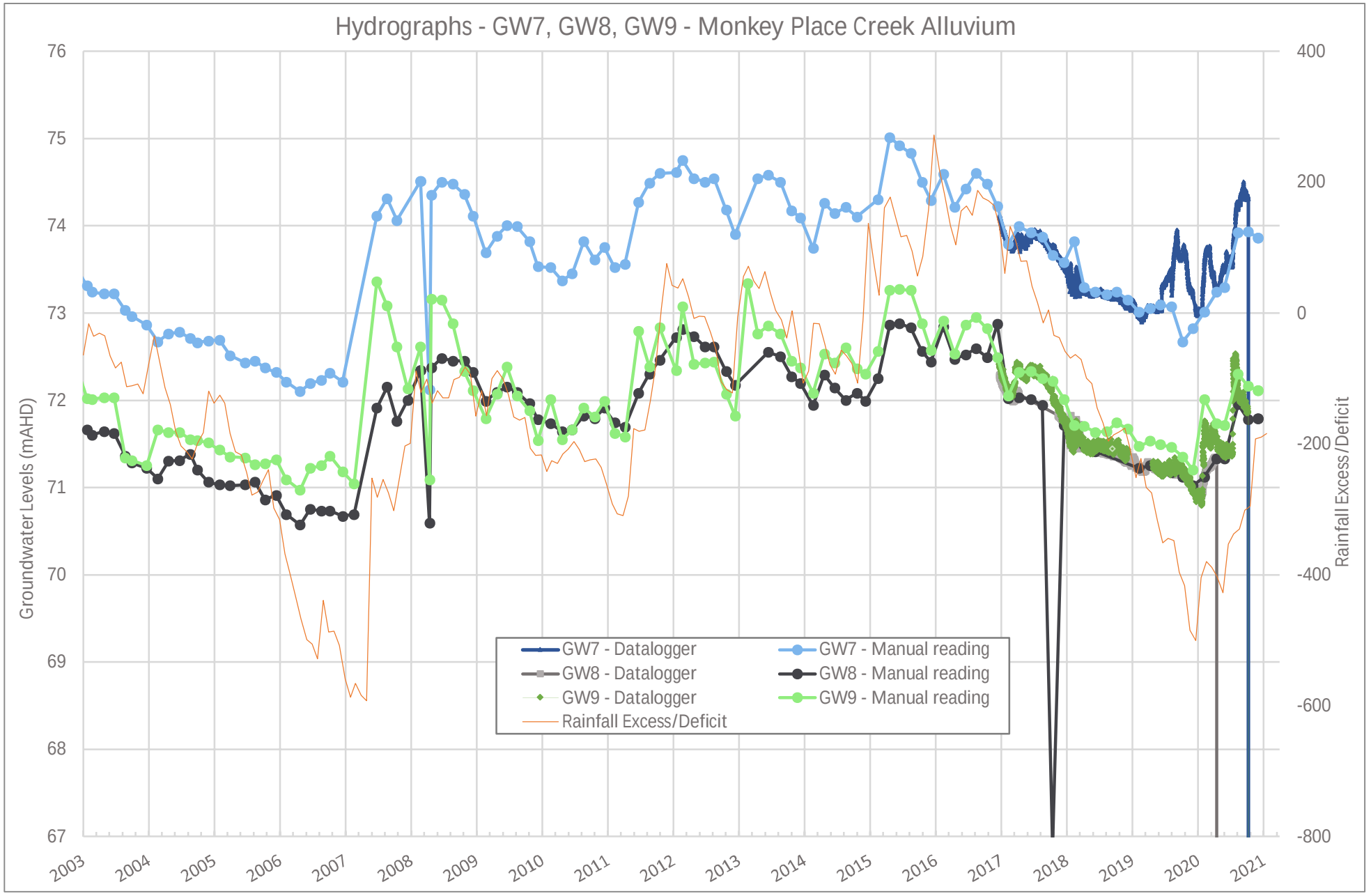
2014
2015
2016
2017
2018
2019
2020
2021
GW10 - Datalogger
GW10 - Manual reading
GW3 - Datalogger
GW3 - Manual reading
GW6
Rainfall Excess/Deficit


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
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2011
2012
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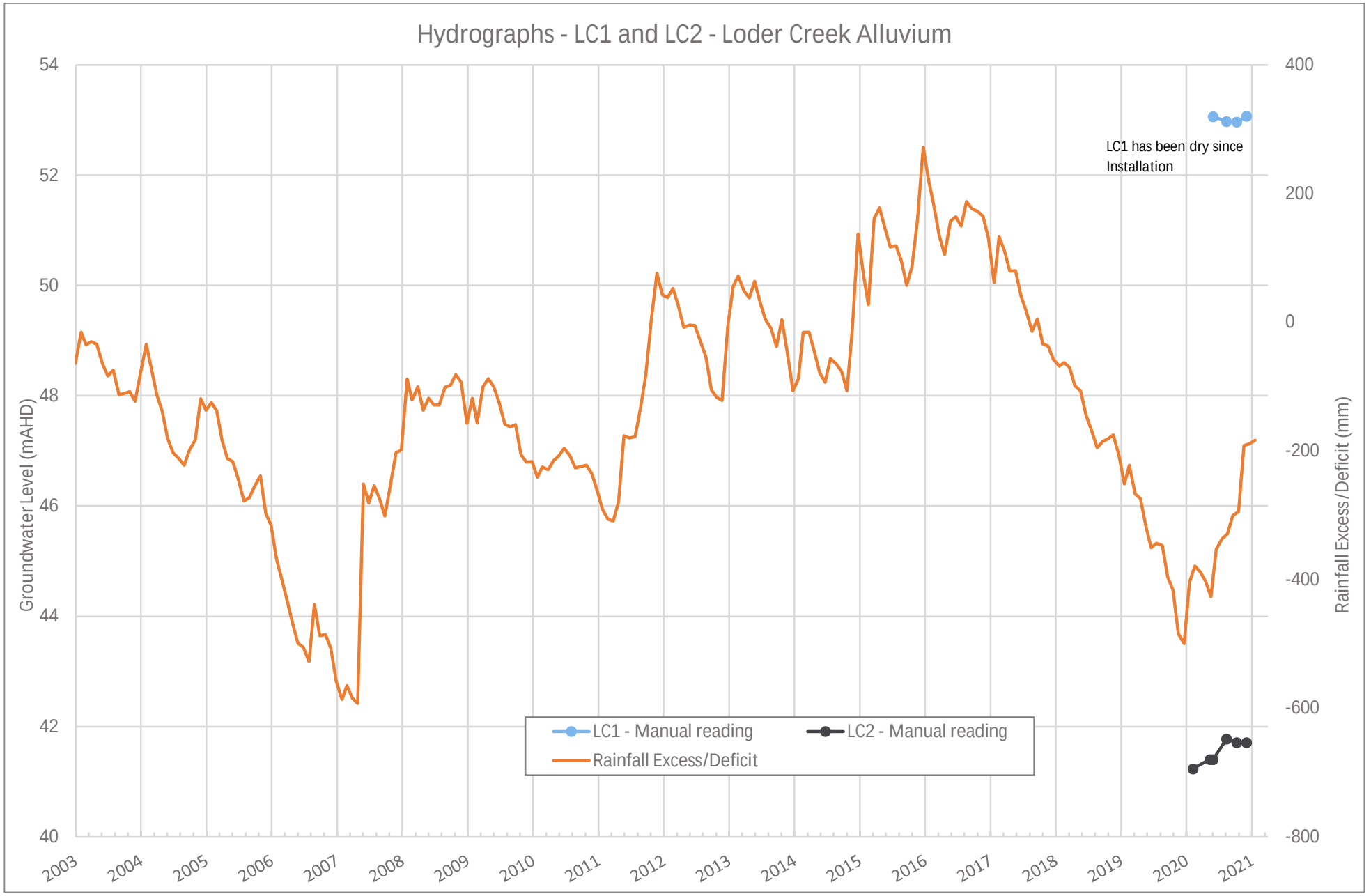
2015
2016
2017
2018
2019
2020
2021
GW7 - Datalogger
GW7 - Manual reading
GW8 - Datalogger
GW8 - Manual reading
GW9 - Datalogger
GW9 - Manual reading
Rainfall Excess/Deficit


Hydrographs - LC1 and LC2 - Loder Creek Alluvium
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
54
52
50
48
46
44
42
40
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
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2011
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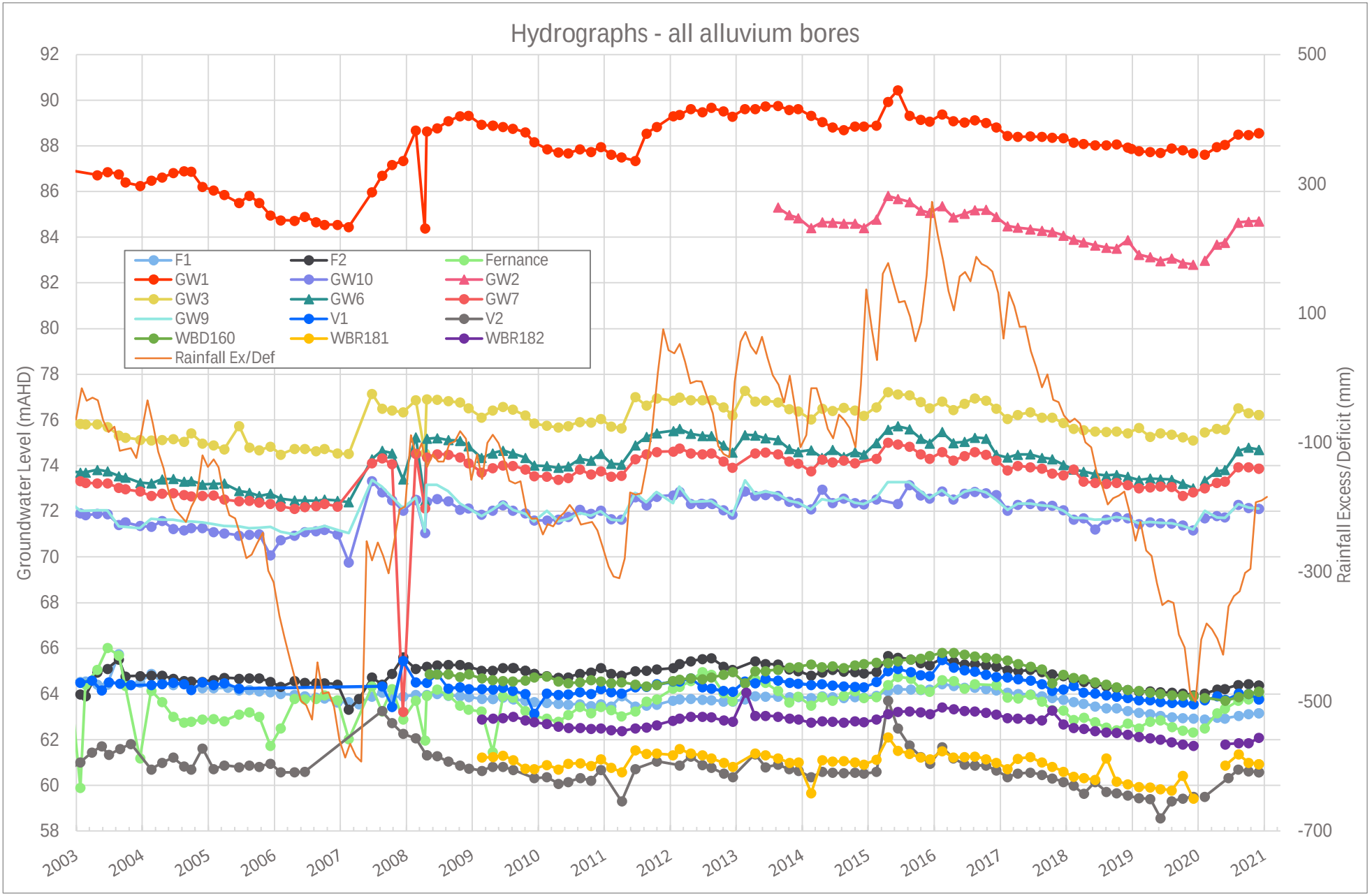
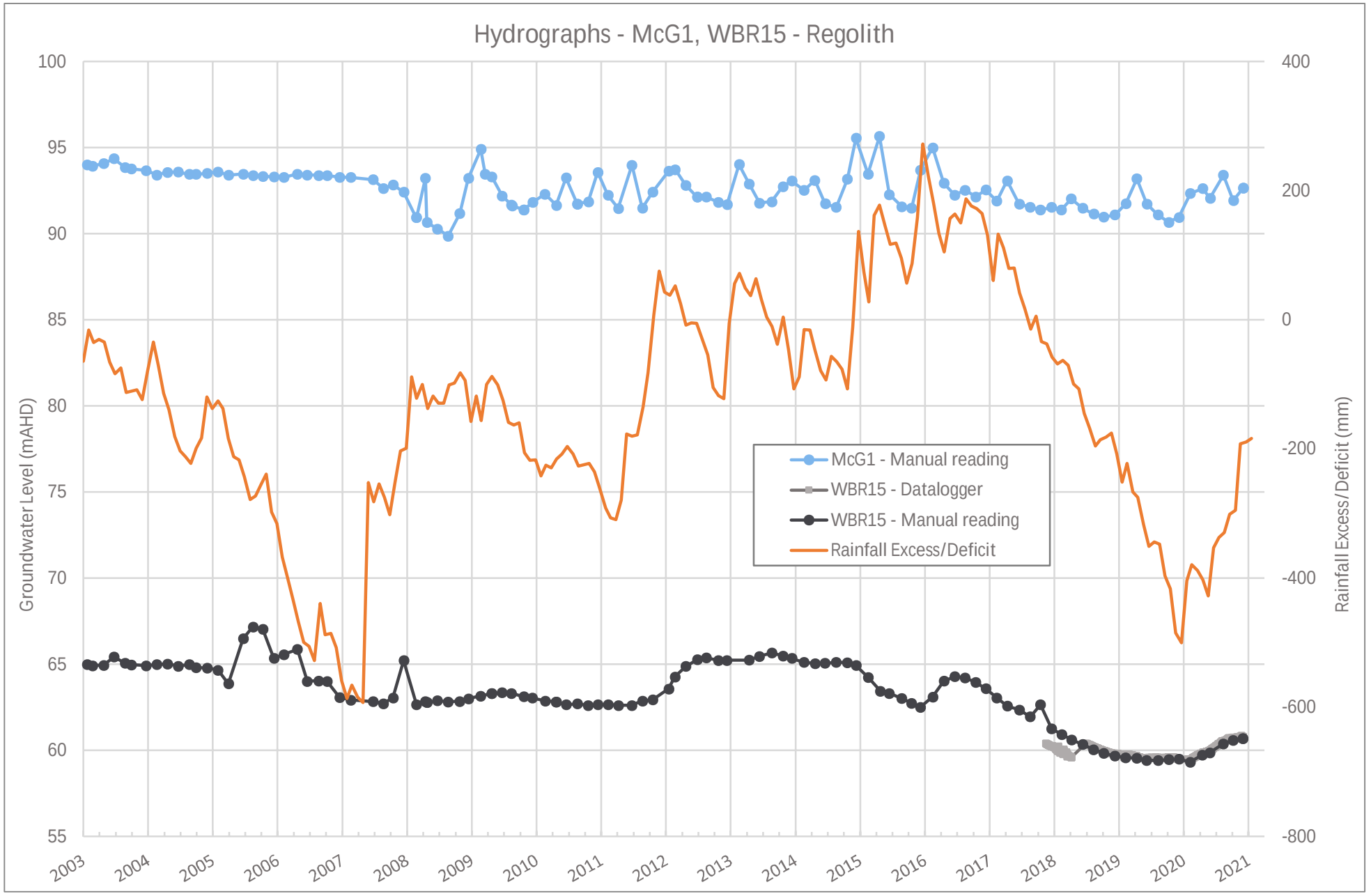
2017
2018
2019
2020
2021
LC1 has been dry since Installation
LC1 - Manual reading
LC2 - Manual reading
Rainfall Excess/Deficit


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
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
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2020
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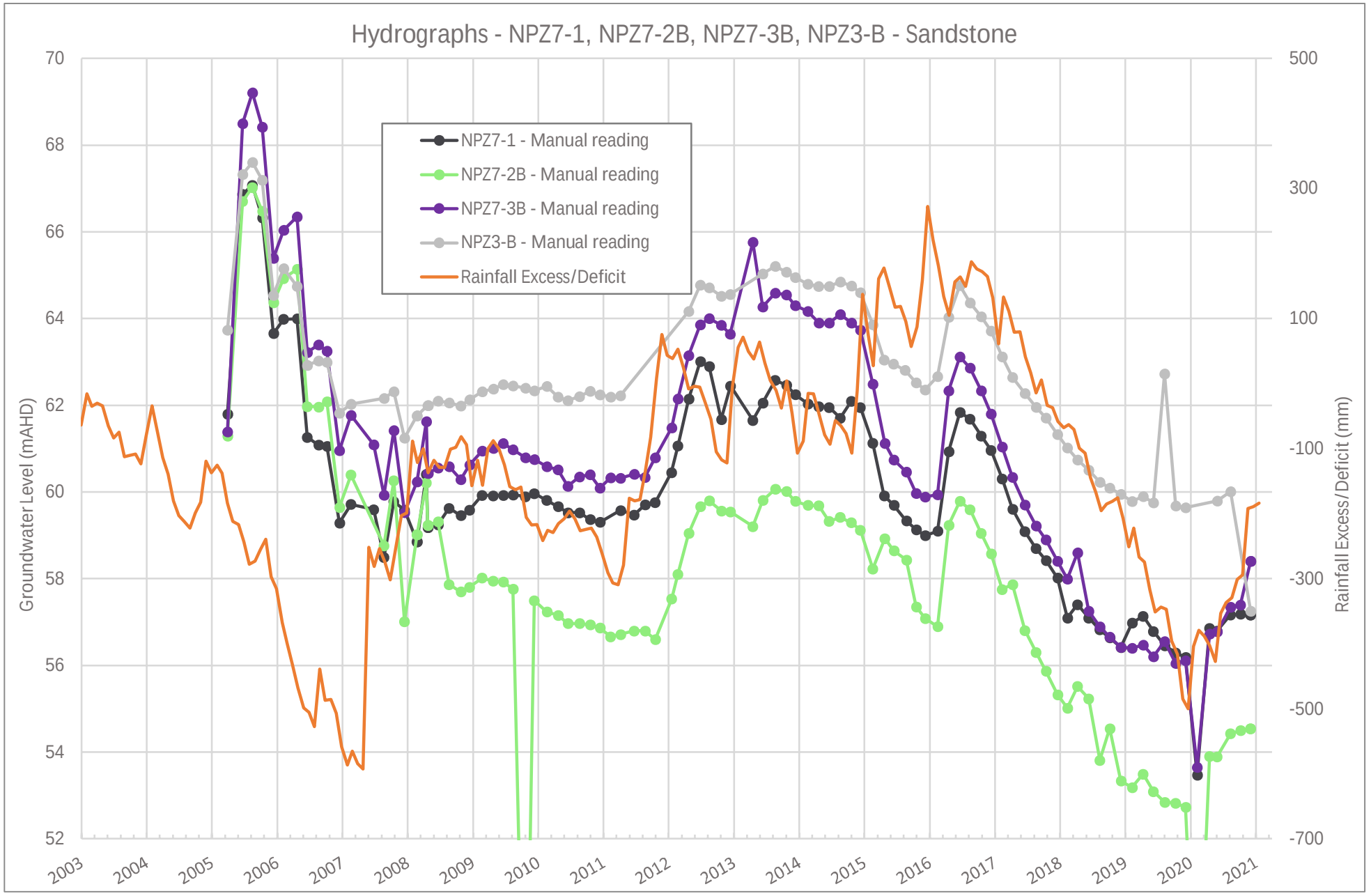
McG1 - Manual reading
WBR15 - Datalogger
WBR15 - Manual reading
Rainfall Excess/Deficit


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)
70
68
66
64
62
60
58
56
54
52
500
300
100
-100
-300
-500
-700
2003
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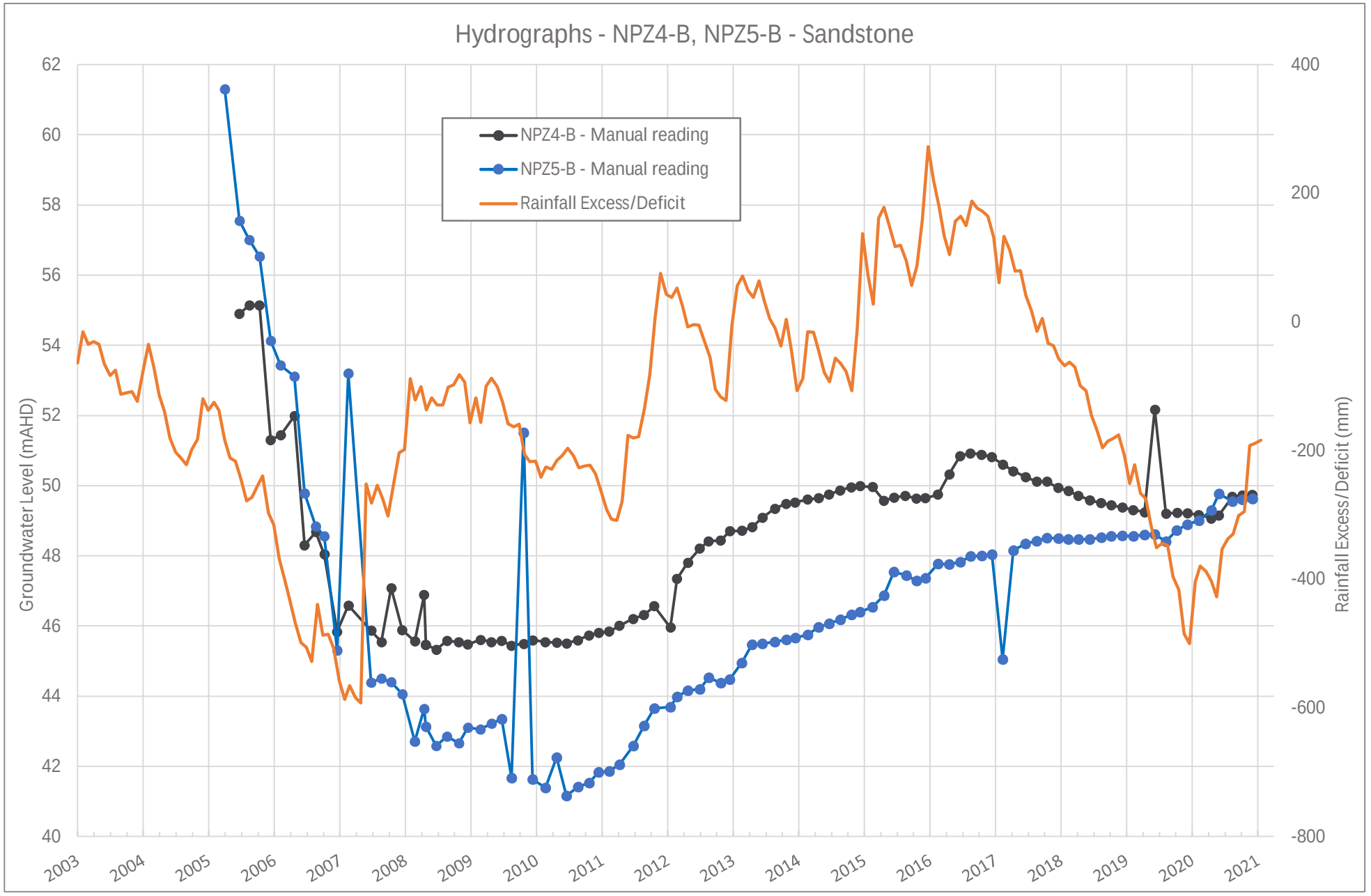
2021


Hydrographs - NPZ4-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
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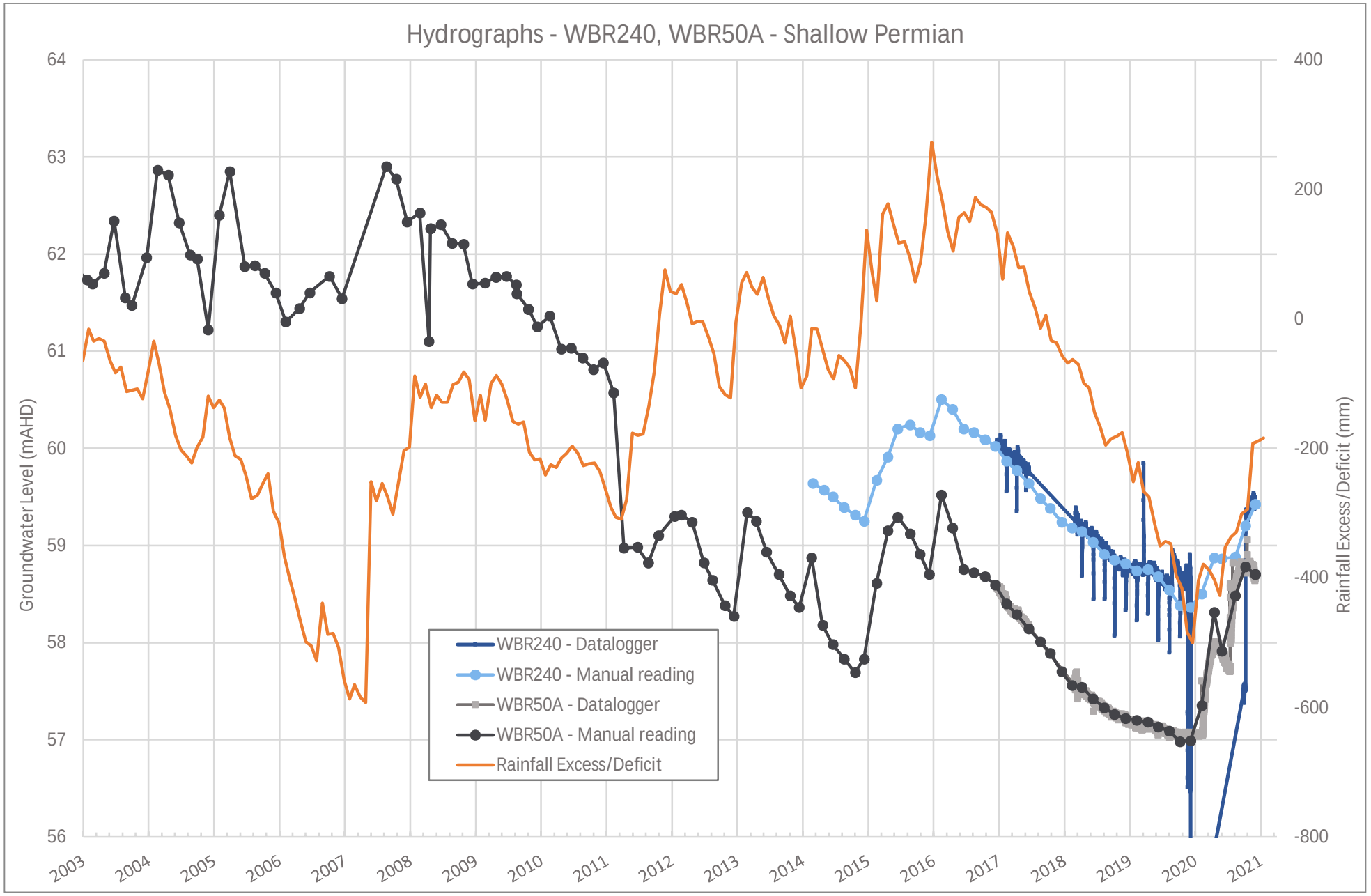
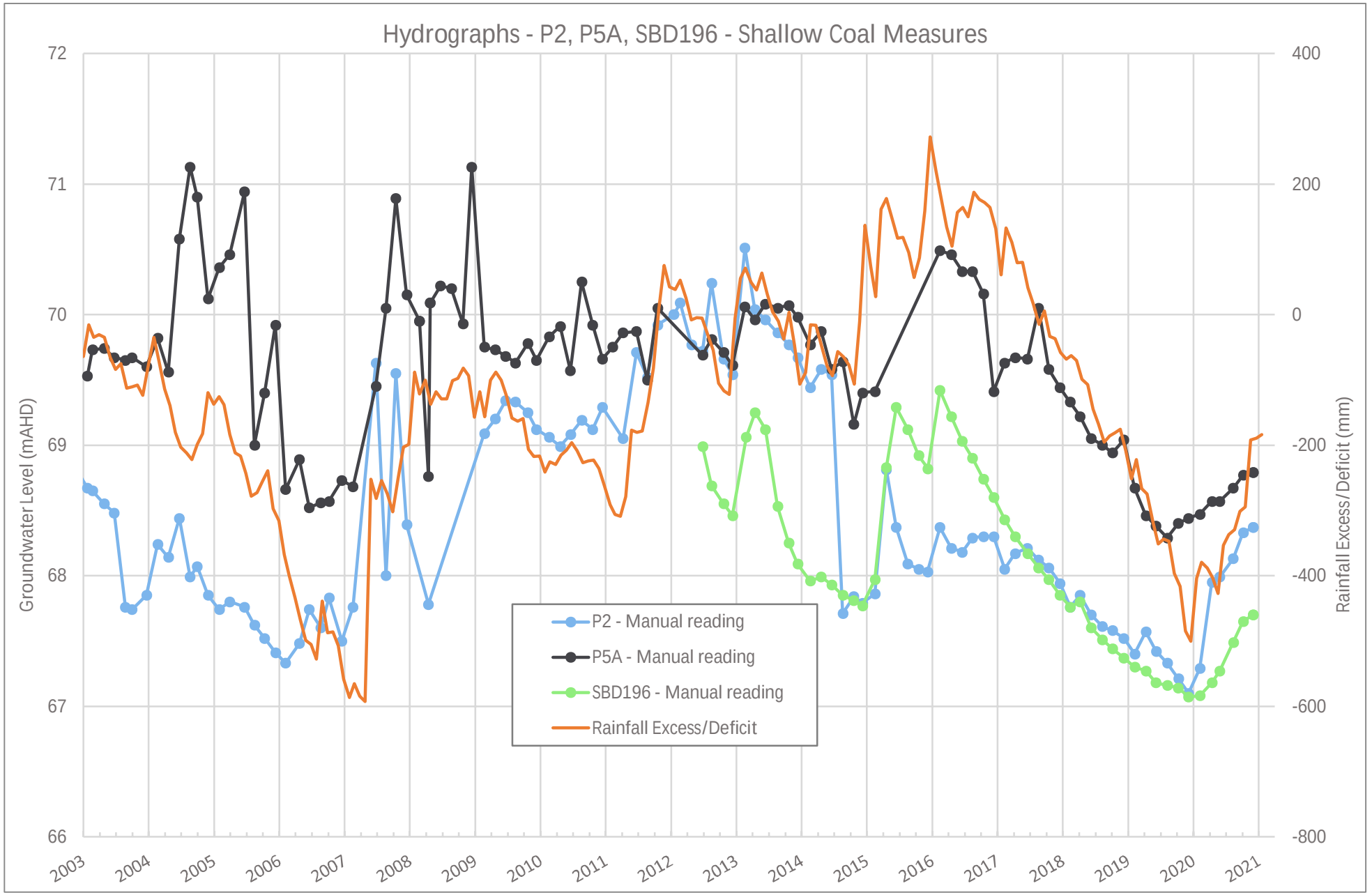
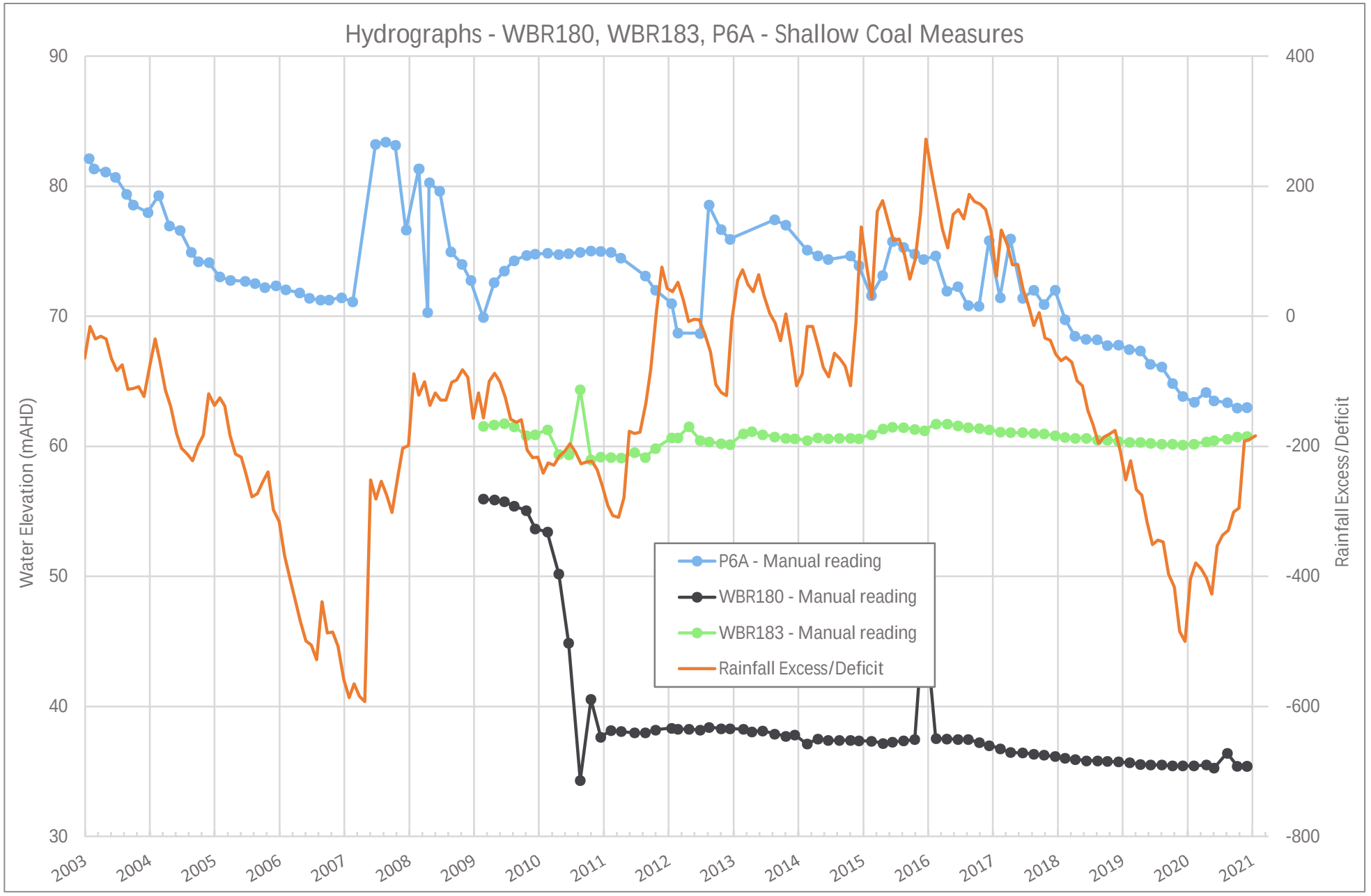
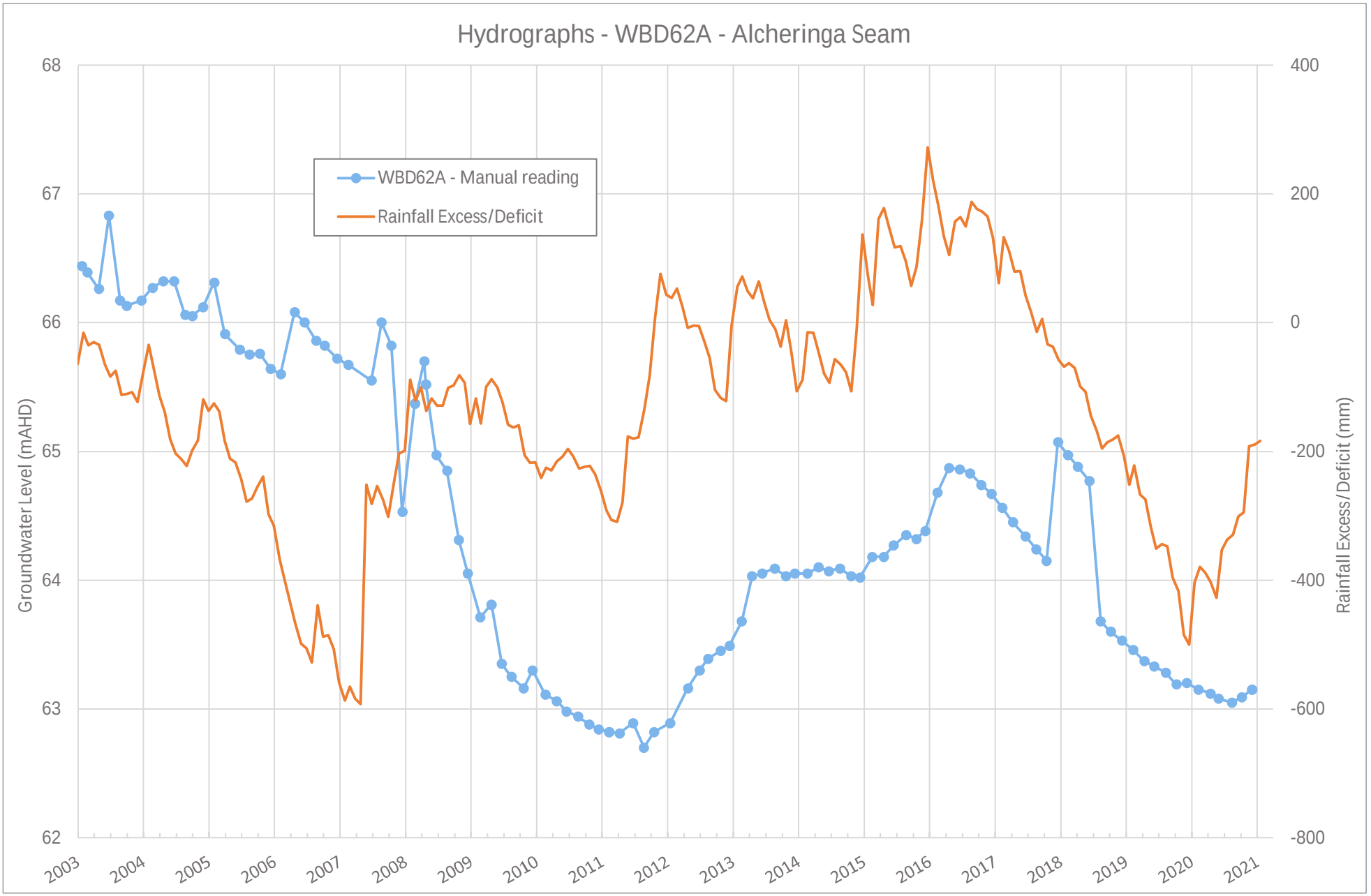
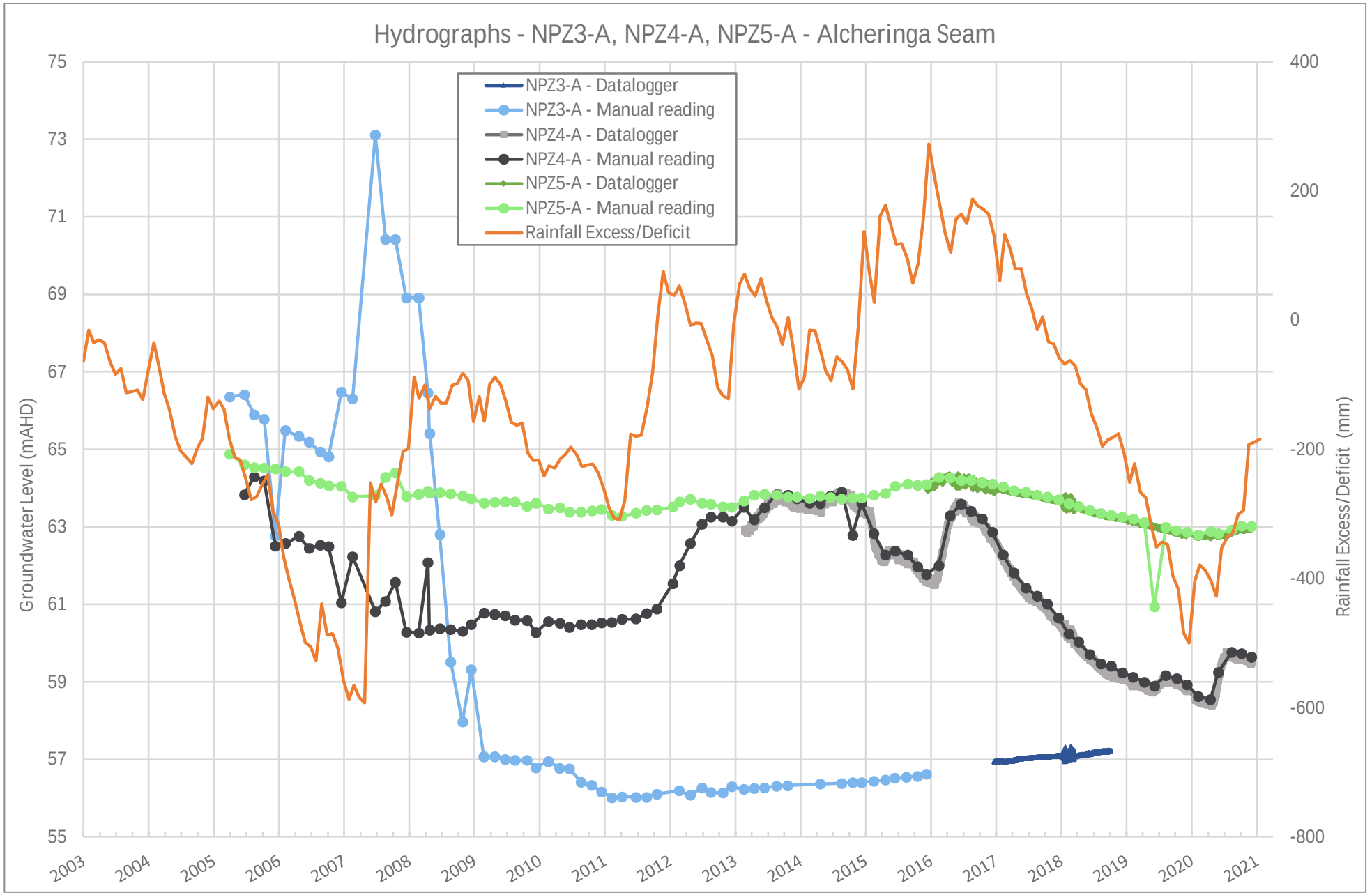
2020
2021

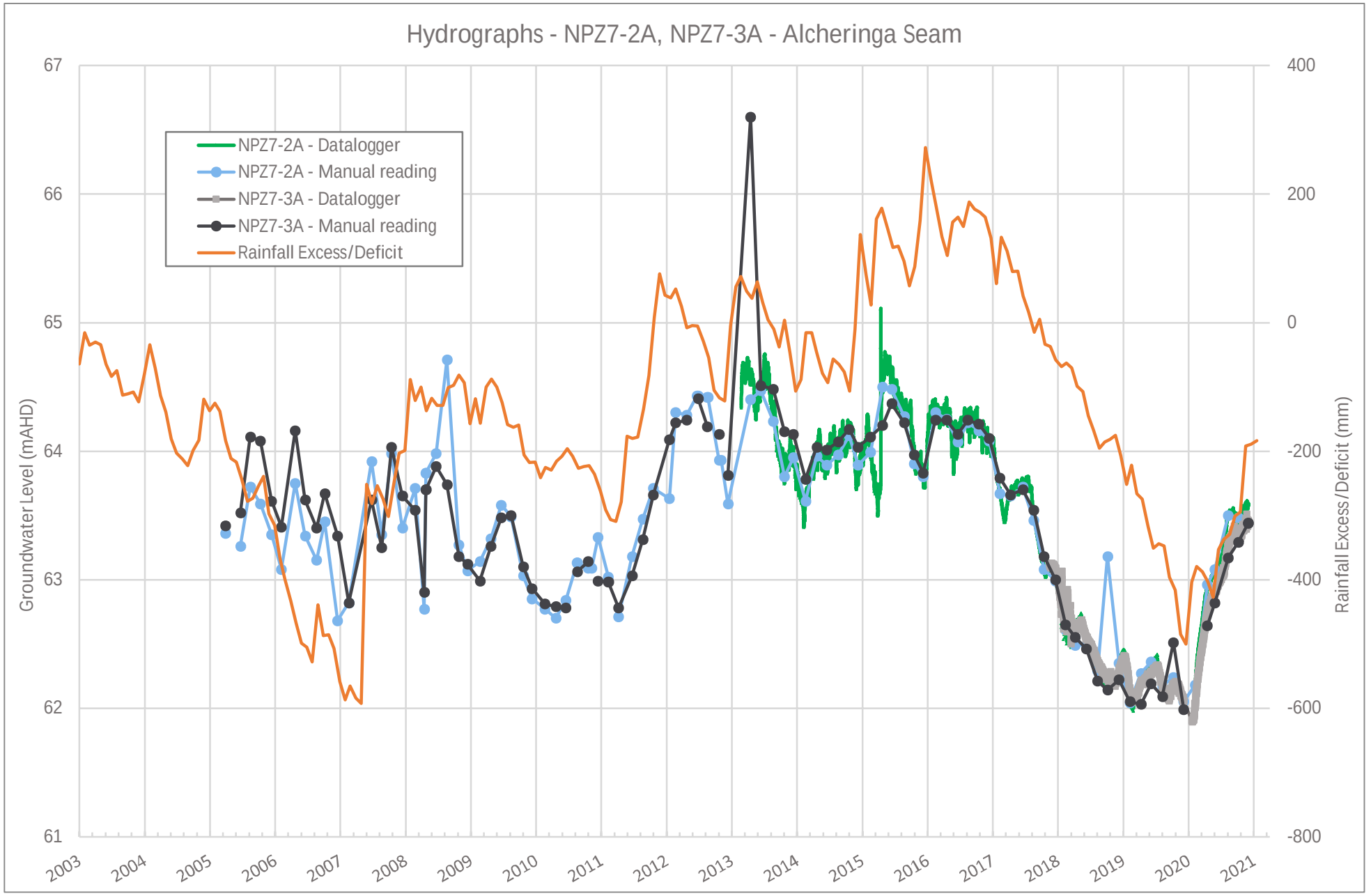

Hydrographs - WBR240, WBR50A - Shallow Permian
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
64
63
62
61
60
59
58
57
56
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
WBR240 - Datalogger
WBR240 - Manual reading
WBR50A - Datalogger
WBR50A - Manual reading
Rainfall Excess/Deficit

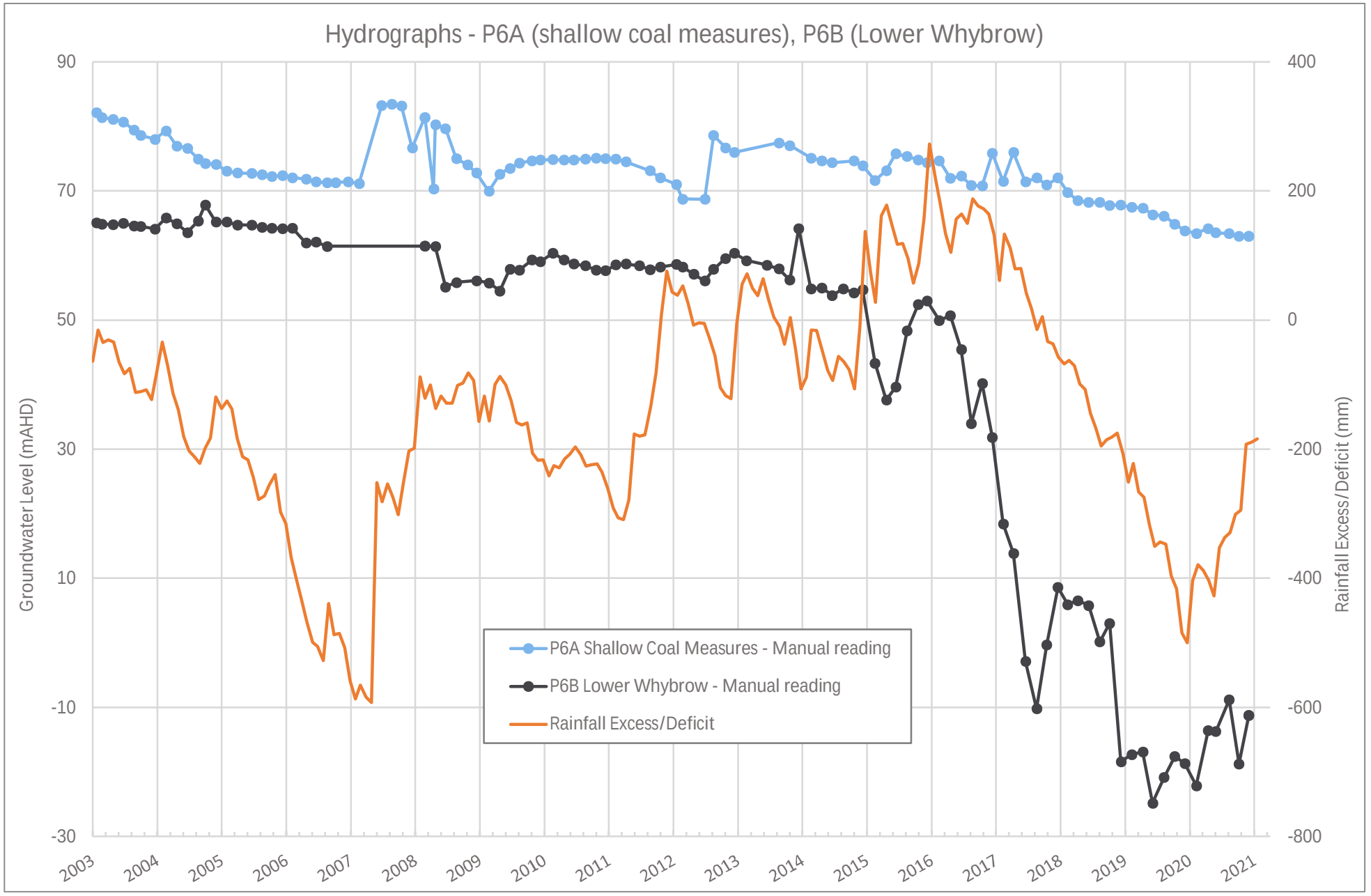

Hydrographs - P2, P5A, SBD196 - Shallow Coal Measures
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
72
71
70
69
68
67
66
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
P2 - Manual reading
P5A - Manual reading
SBD196 - Manual reading
Rainfall Excess/Deficit

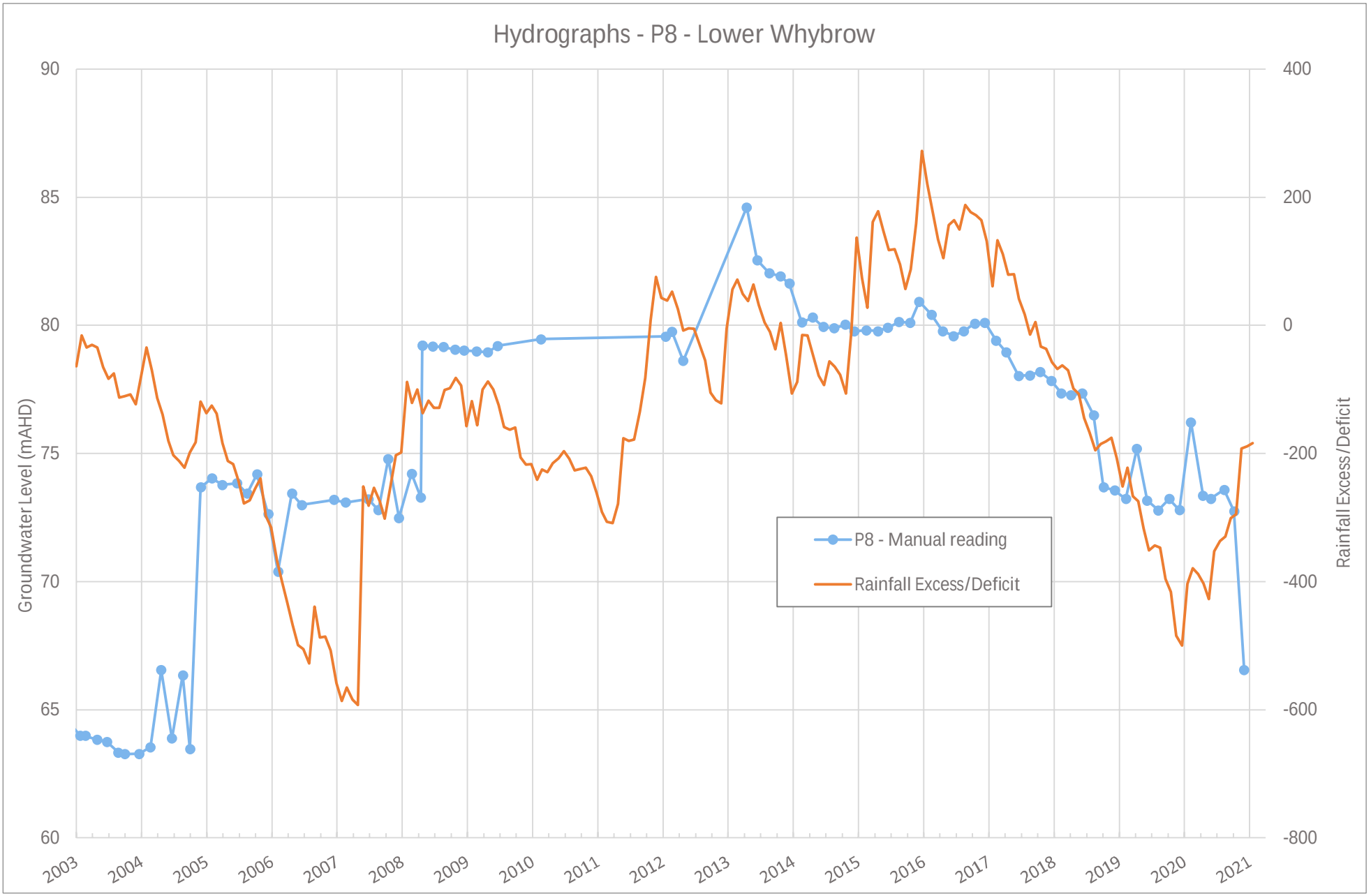

Hydrographs - WBR180, WBR183, P6A - Shallow Coal Measures
Water Elevation (mAHD)
Rainfall Excess/Deficit
90
80
70
60
50
40
30
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
P6A - Manual reading
WBR180 - Manual reading
WBR183 - Manual reading
Rainfall Excess/Deficit

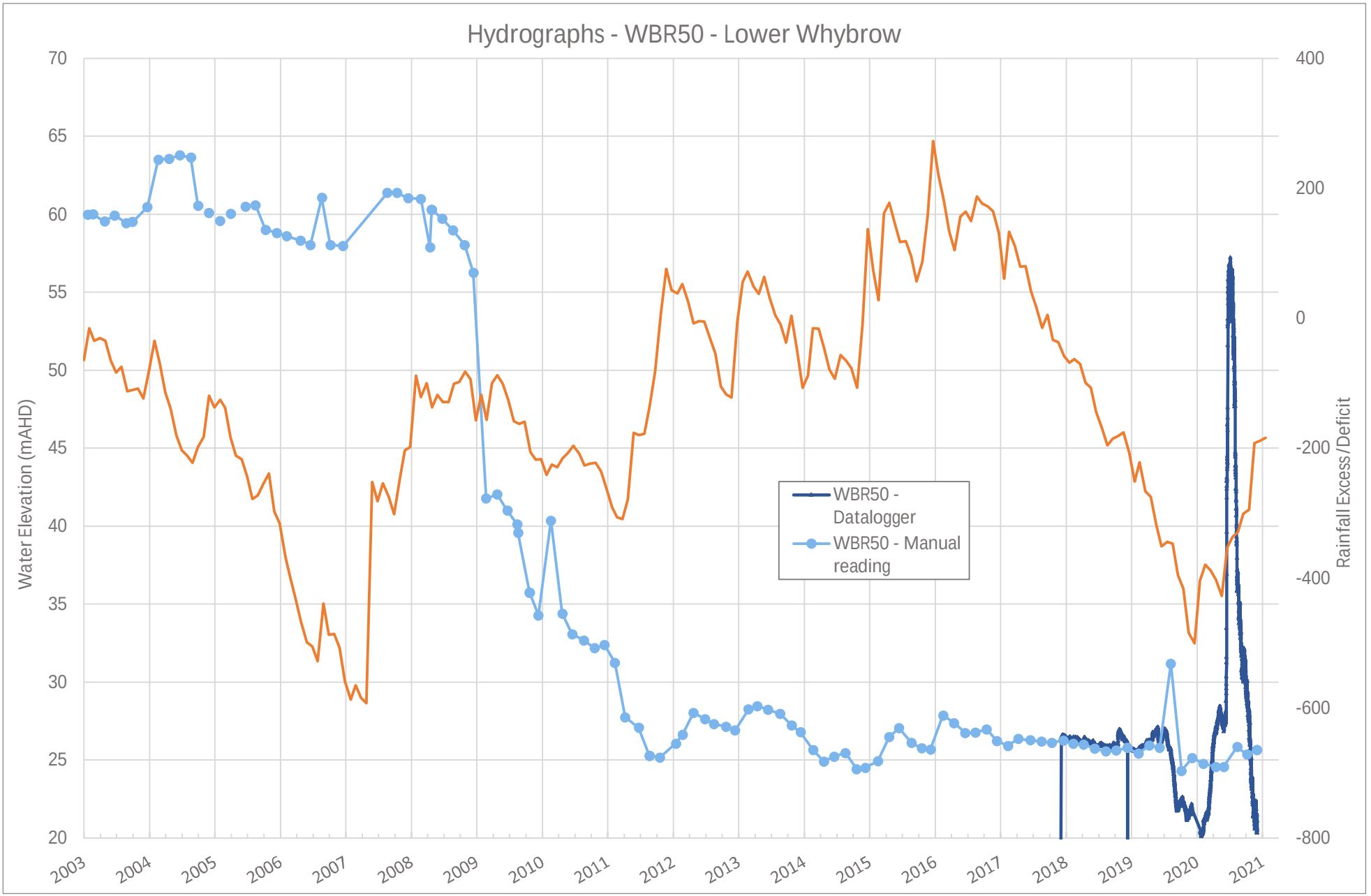

Hydrographs - WBD62A - Alcheringa Seam
WBD62A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
68
67
66
65
64
63
62
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

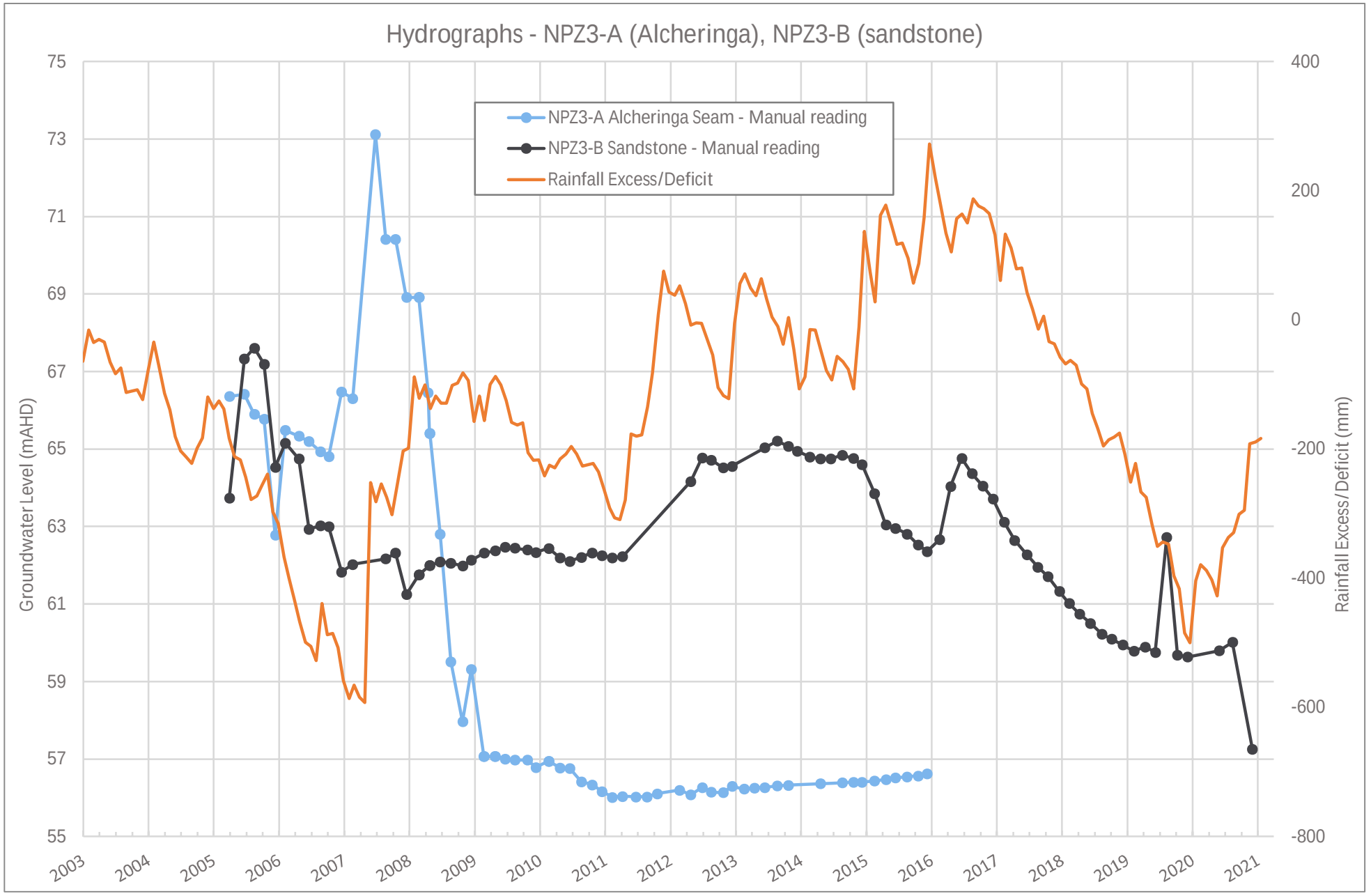

Hydrographs - NPZ3-A, NPZ4-A, NPZ5-A - Alcheringa Seam
NPZ3-A - Datalogger
NPZ3-A - Manual reading
NPZ4-A - Datalogger
NPZ4-A - Manual reading
NPZ5-A - Datalogger
NPZ5-A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
75
73
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

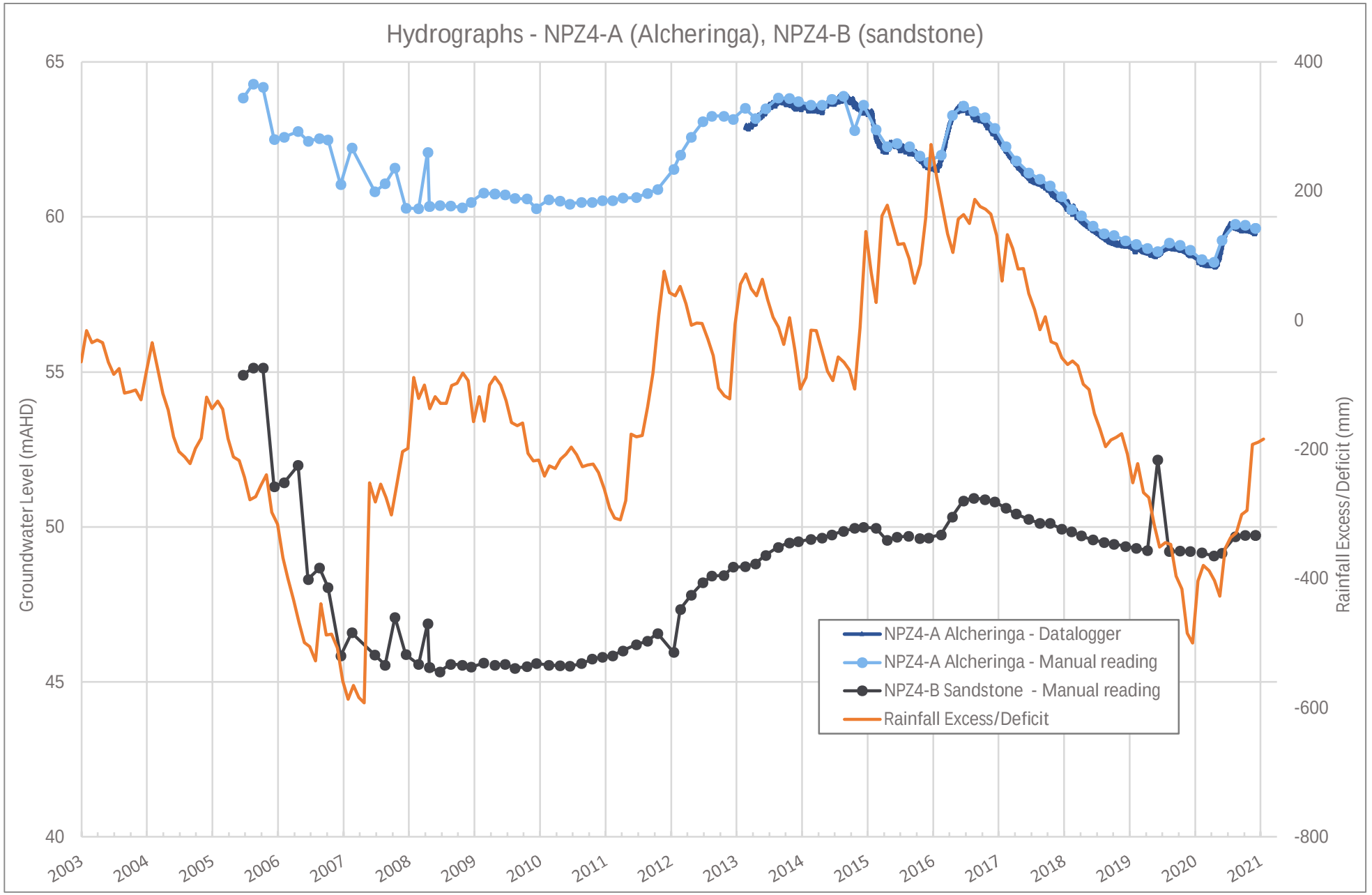

Hydrographs - NPZ7-2A, NPZ7-3A - Alcheringa Seam
NPZ7-2A - Datalogger
NPZ7-2A - Manual reading
NPZ7-3A - Datalogger
NPZ7-3A - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
67
66
65
64
63
62
61
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

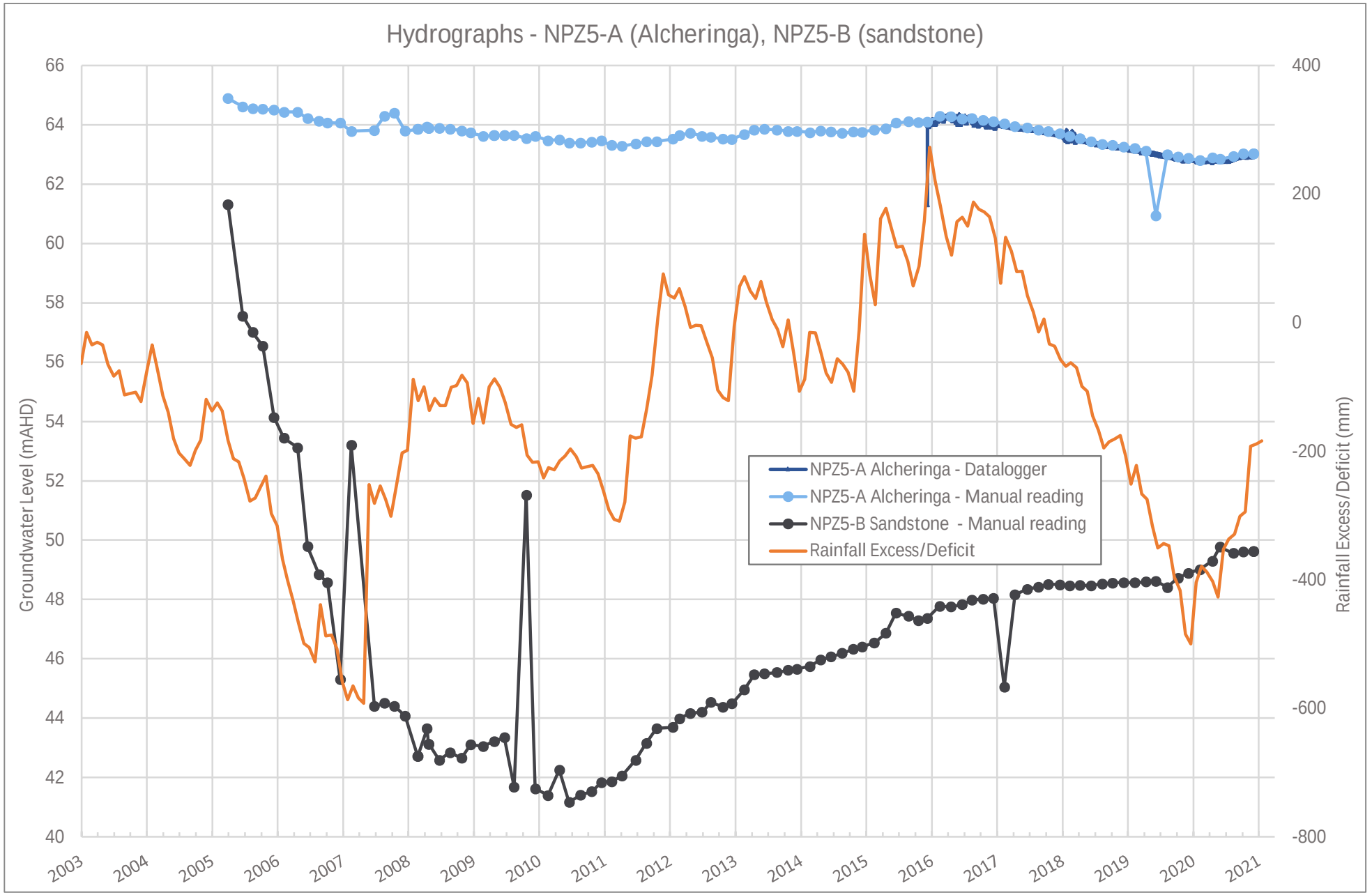

Hydrographs - P6A (shallow coal measures), P6B (Lower Whybrow)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
90
70
50
30
10
-10
-30
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
P6A Shallow Coal Measures - Manual reading
P6B Lower Whybrow - Manual reading
Rainfall Excess/Deficit

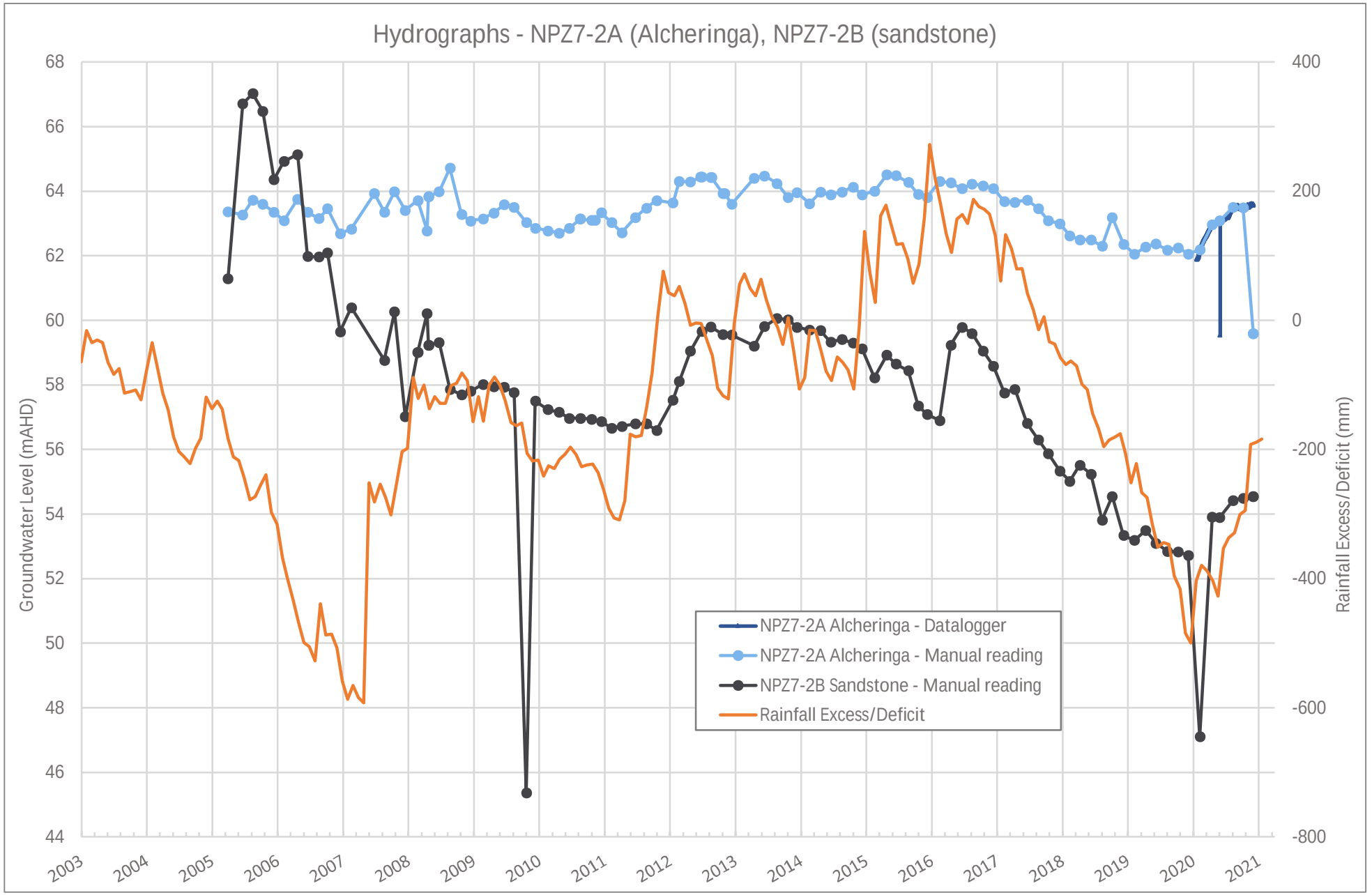

Hydrographs - P8 - Lower Whybrow
Groundwater Level (mAHD)
Rainfall Excess/Deficit
90
85
80
75
70
65
60
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
P8 - Manual reading
Rainfall Excess/Deficit

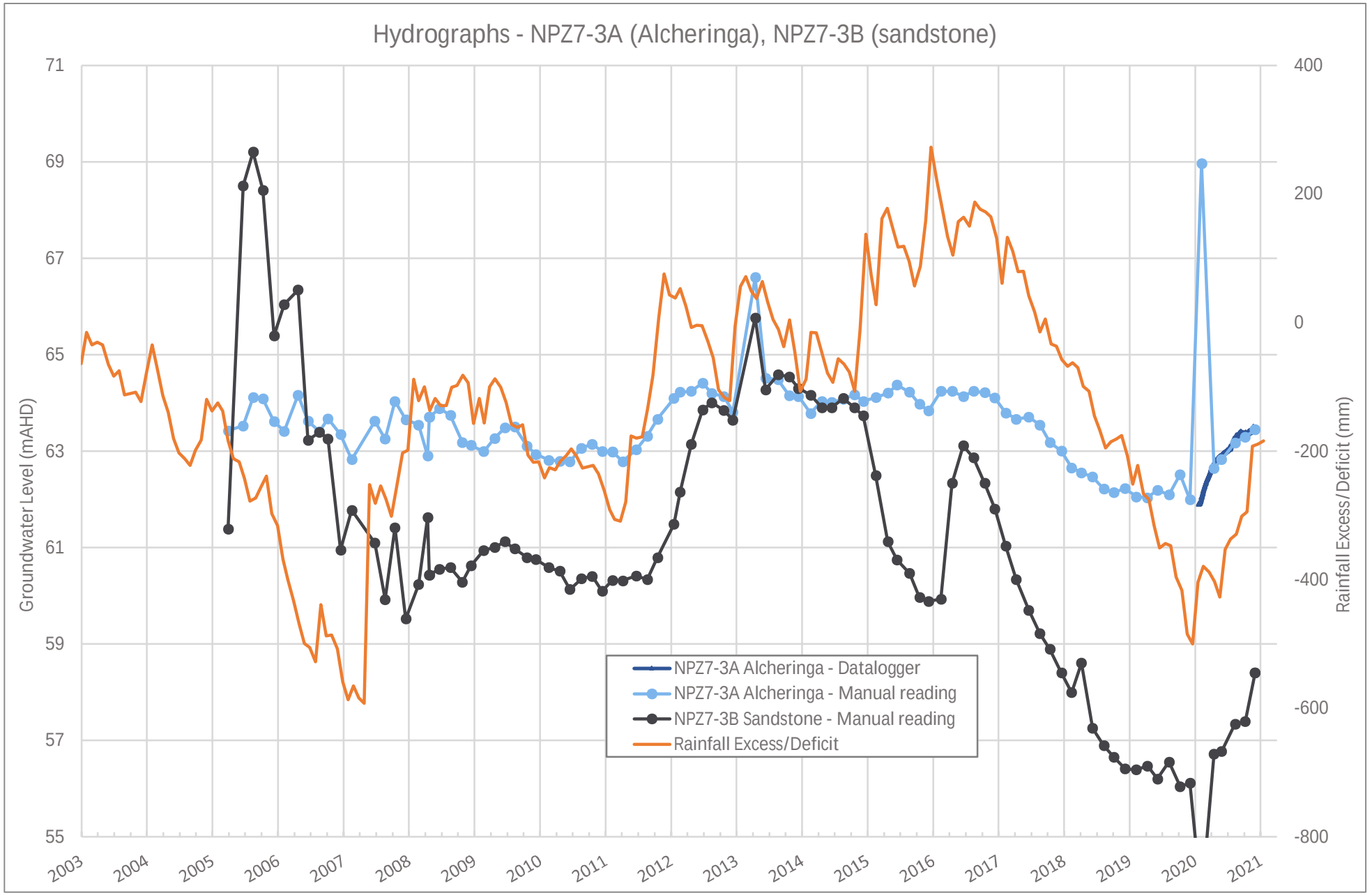

Hydrographs - WBR50 - Lower Whybrow
Water Elevation (mAHD)
Rainfall Excess/Deficit
70
65
60
55
50
45
40
35
30
25
20
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
WBR50 - Datalogger
WBR50 - Manual reading

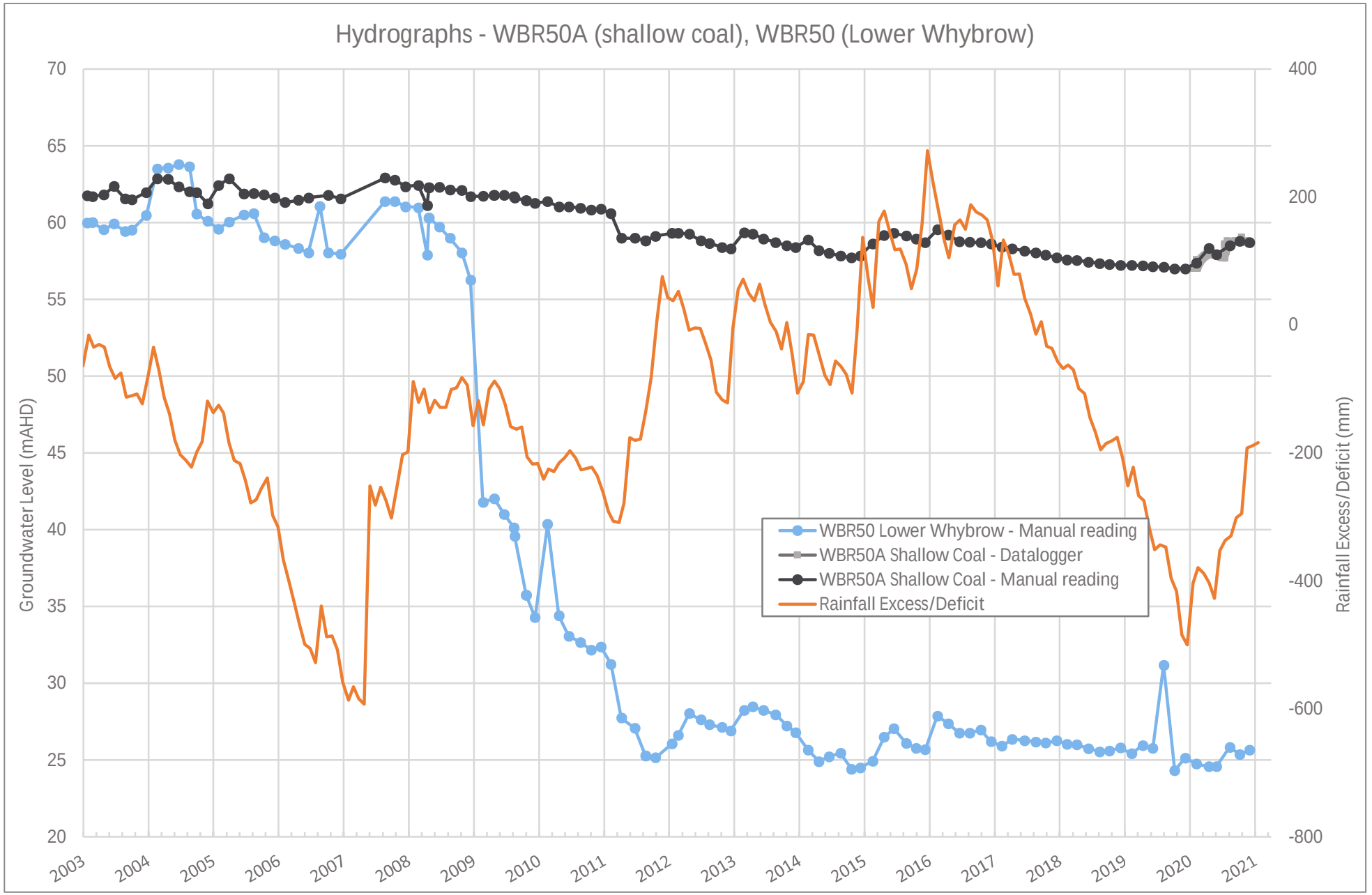

Hydrographs - NPZ3-A (Alcheringa), NPZ3-B (sandstone)
NPZ3-A Alcheringa Seam - Manual reading
NPZ3-B Sandstone - Manual reading
Rainfall Excess/Deficit
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
75
73
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

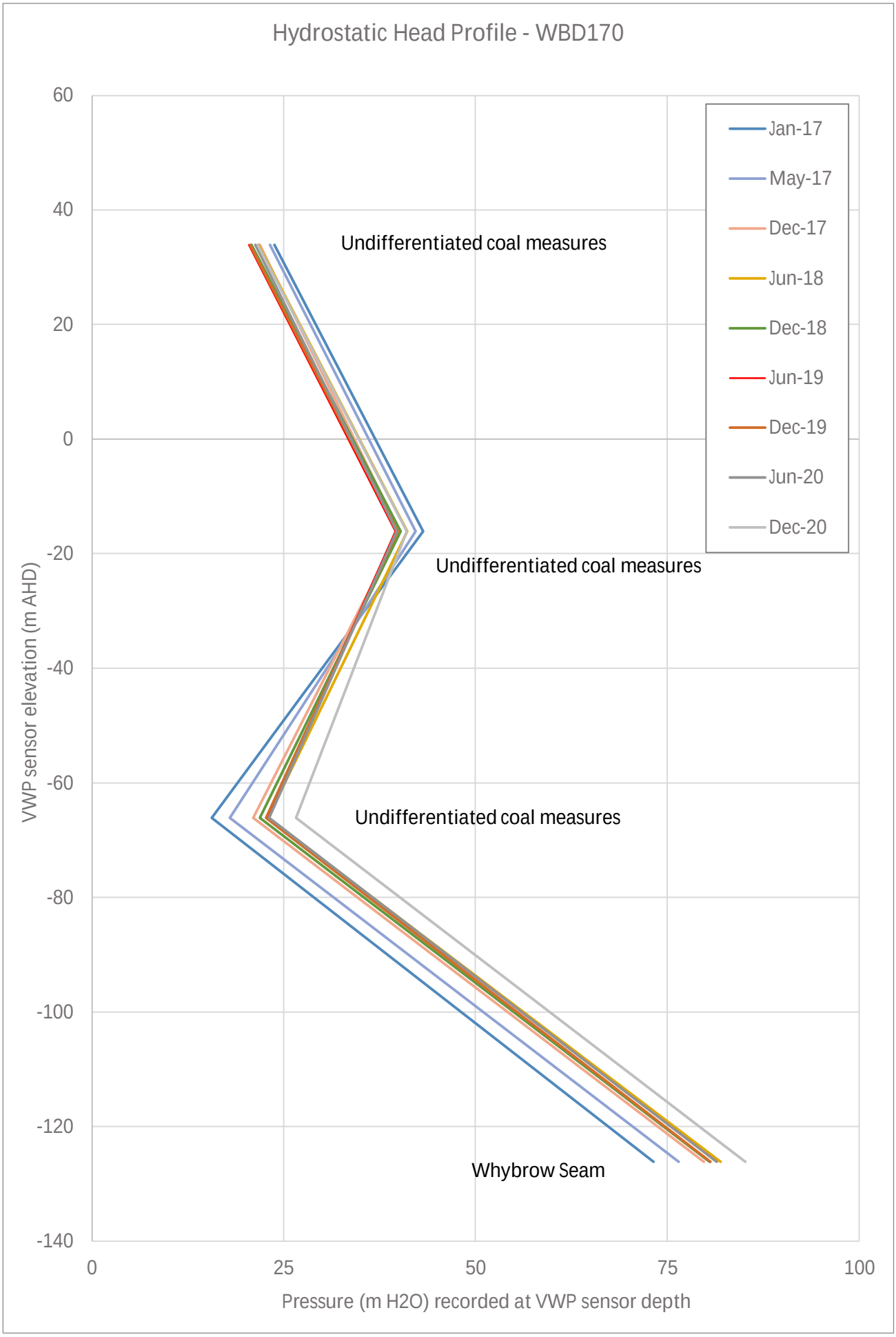

Hydrographs - NPZ4-A (Alcheringa), NPZ4-B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
65
60
55
50
45
40
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
NPZ4-A Alcheringa - Datalogger
NPZ4-A Alcheringa - Manual reading
NPZ4-B Sandstone - Manual reading
Rainfall Excess/Deficit

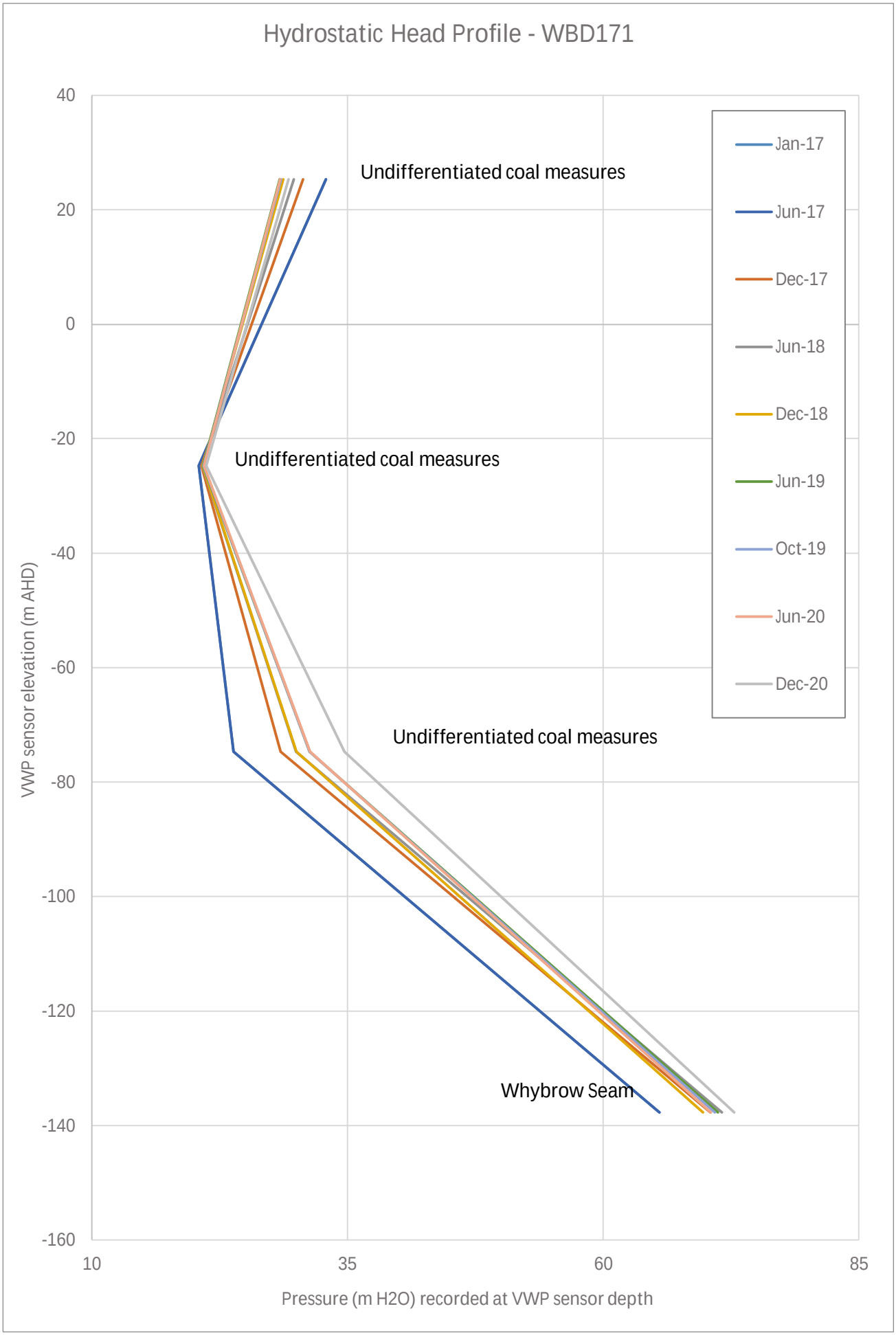

Hydrographs - NPZ5-A (Alcheringa), NPZ5-B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
66
64
62
60
58
56
54
52
50
48
46
44
42
40
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
NPZ5-A Alcheringa - Datalogger
NPZ5-A Alcheringa - Manual reading
NPZ5-B Sandstone - Manual reading
Rainfall Excess/Deficit

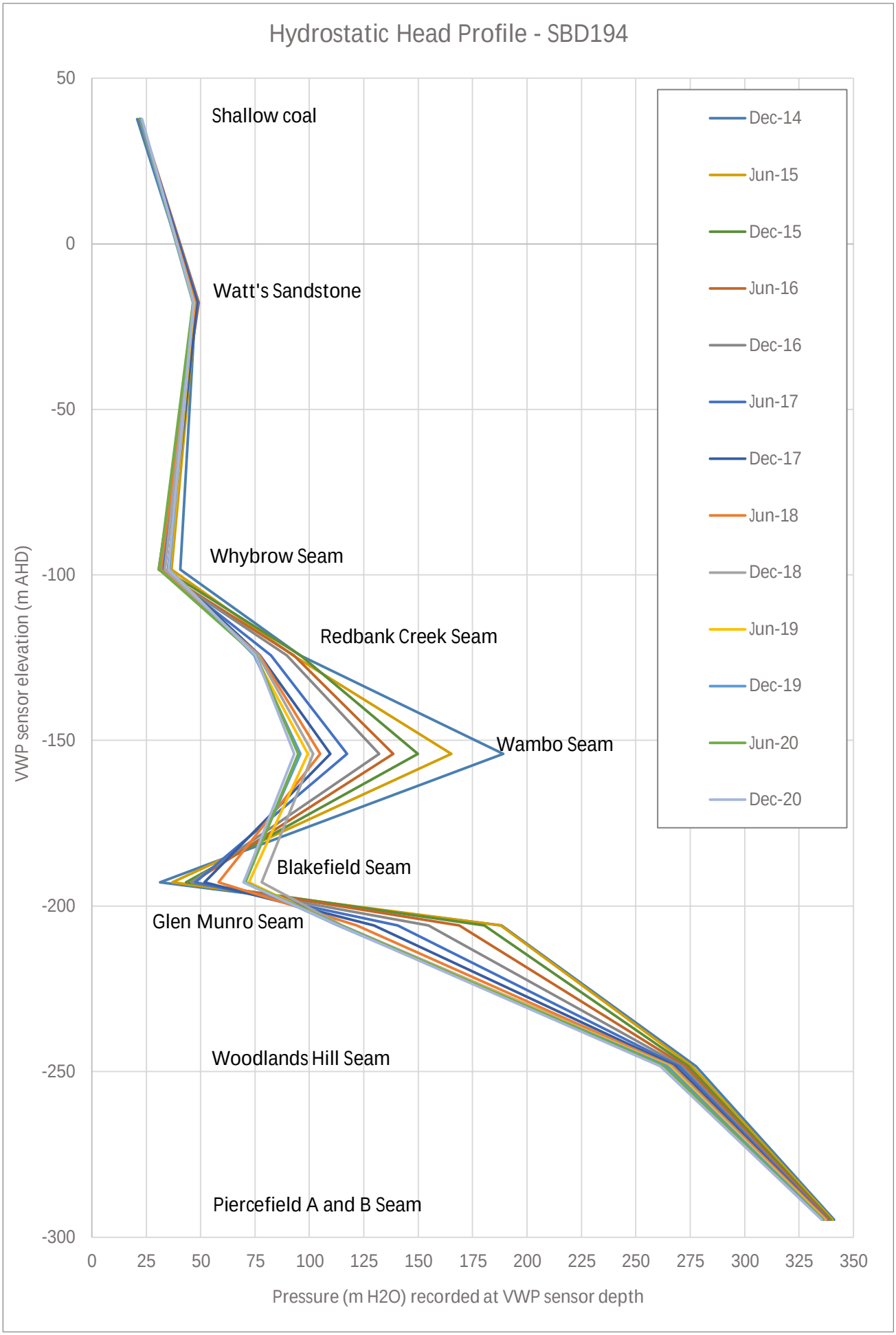

Hydrographs - NPZ7-2A (Alcheringa), NPZ7-2B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
68
66
64
62
60
58
56
54
52
50
48
46
44
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
NPZ7-2A Alcheringa - Datalogger
NPZ7-2A Alcheringa - Manual reading
NPZ7-2B Sandstone - Manual reading
Rainfall Excess/Deficit

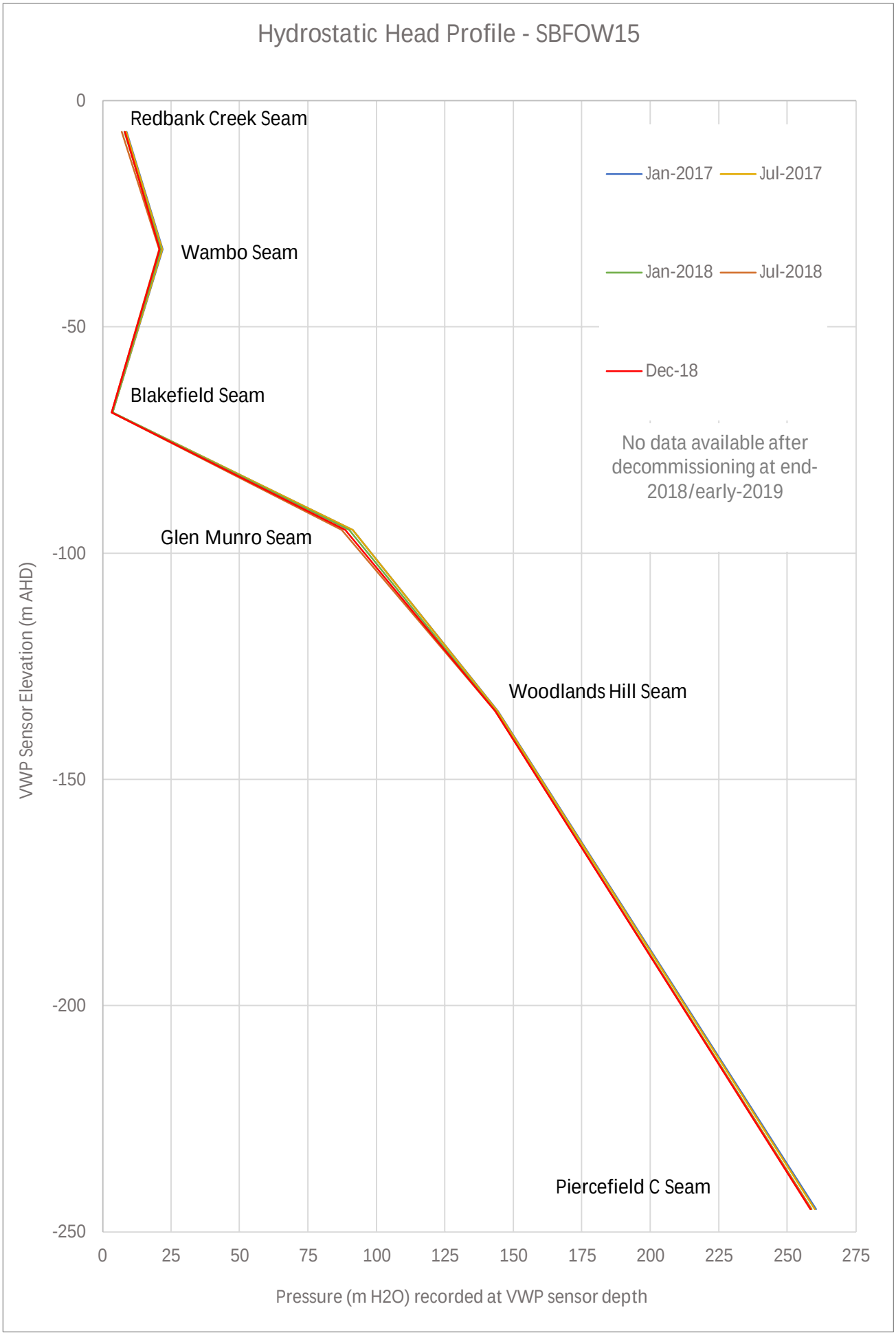

Hydrographs - NPZ7-3A (Alcheringa), NPZ7-3B (sandstone)
Groundwater Level (mAHD)
Rainfall Excess/Deficit (mm)
71
69
67
65
63
61
59
57
55
400
200
0
-200
-400
-600
-800
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
NPZ7-3A Alcheringa - Datalogger
NPZ7-3A 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
WBR50 Lower Whybrow - Manual reading
WBR50A Shallow Coal - Datalogger
WBR50A Shallow Coal - Manual reading
Rainfall Excess/Deficit


Hydrostatic Head Profile - WBD170
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
VWP sensor elevation (m AHD)
0
25
50
75
100
Pressure (m H2O) recorded at VWP sensor depth
Jan-17
May-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Undifferentiated coal measures
Undifferentiated coal measures
Undifferentiated coal measures
Whybrow Seam


Hydrostatic Head Profile - WBD171
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
VWP sensor elevation (m AHD)
10
35
60
85
Pressure (m H2O) recorded at VWP sensor depth
Undifferentiated coal measures
Undifferentiated coal measures
Undifferentiated coal measures
Whybrow Seam
Jan-17
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Oct-19
Jun-20
Dec-20


Hydrostatic Head Profile - SBD194
Shallow coal
Watt's Sandstone
Whybrow Seam
Redbank Creek Seam
Wambo Seam
Blakefield Seam
Glen Munro Seam
Woodlands Hill Seam
Piercefield A and B Seam
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
VWP sensor elevation (m AHD)
50
0
-50
-100
-150
-200
-250
-300
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
Pressure (m H2O) recorded at VWP sensor depth


Hydrostatic Head Profile - SBFOW15
0
-50
-100
-150
-200
-250
VWP Sensor Elevation (m AHD)
Redbank Creek Seam
Wambo Seam
Blakefield Seam
Glen Munro Seam
Woodlands Hill Seam
Piercefield C Seam
Jan-2017
Jul-2017
Jan-2018
Jul-2018
Dec-18
No data available after decommissioning at end-2018/early-2019
0
25
50
75
100
125
150
175
200
225
250
275
Pressure (m H2O) recorded at VWP sensor depth

Field Electrical Conductivity - Shallow Alluvium

Dwyers F2 Fernance GW10 GW9 V1 V2 V3 WBR181 WBR182 White1 LC2 Rainfall Excess/Deficit

Field Electrical Conductivity (µS/cm)

Rainfall def/exc (mm)

12000 10000 8000 6000 4000 2000 0

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

APPENDIX D

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.

Table Error! No text of specified style in document.**.1 Comparison of Monitoring Results Against Performance Indices – Ecological Rehabilitation (EEC)**

Rehabilitation Objective	Completion Criteria	Performance Indices	GBIW_01	GBIW_02	GBIW_03	GBIW_04	GBIW_05	GBIW_06	GBIW_07	GBIW_08	GBIW_09	GBIW_10	GBIW_11	GBIW_12	GBIW_13	GBIW_14	GBIW_15	GBIW_16	GBIW_17	GBIW_18	GBIW_19	ISGGB_1	ISGGB_2	ISGGB_3
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 (1.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																						

Rehabilitation Objective	Completion Criteria	Performance Indices	GBIW_01	GBIW_02	GBIW_03	GBIW_04	GBIW_05	GBIW_06	GBIW_07	GBIW_08	GBIW_09	GBIW_10	GBIW_11	GBIW_12	GBIW_13	GBIW_14	GBIW_15	GBIW_16	GBIW_17	GBIW_18	GBIW_19	ISGGB_1	ISGGB_2	ISGGB_3
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	GBIW_01	GBIW_02	GBIW_03	GBIW_04	GBIW_05	GBIW_06	GBIW_07	GBIW_08	GBIW_09	GBIW_10	GBIW_11	GBIW_12	GBIW_13	GBIW_14	GBIW_15	GBIW_16	GBIW_17	GBIW_18	GBIW_19	ISGGB_1	ISGGB_2	ISGGB_3
Ecological Rehabilitation Objective 3																								
Levels of ecosystem function have been established that demonstrate the rehabil1tat1on 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																						

Rehabilitation Objective	Completion Criteria	Performance Indices	GBIW_01	GBIW_02	GBIW_03	GBIW_04	GBIW_05	GBIW_06	GBIW_07	GBIW_08	GBIW_09	GBIW_10	GBIW_11	GBIW_12	GBIW_13	GBIW_14	GBIW_15	GBIW_16	GBIW_17	GBIW_18	GBIW_19	ISGGB_1	ISGGB_2	ISGGB_3
	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 w1th1n 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																							

Green indicates completion criteria achieved

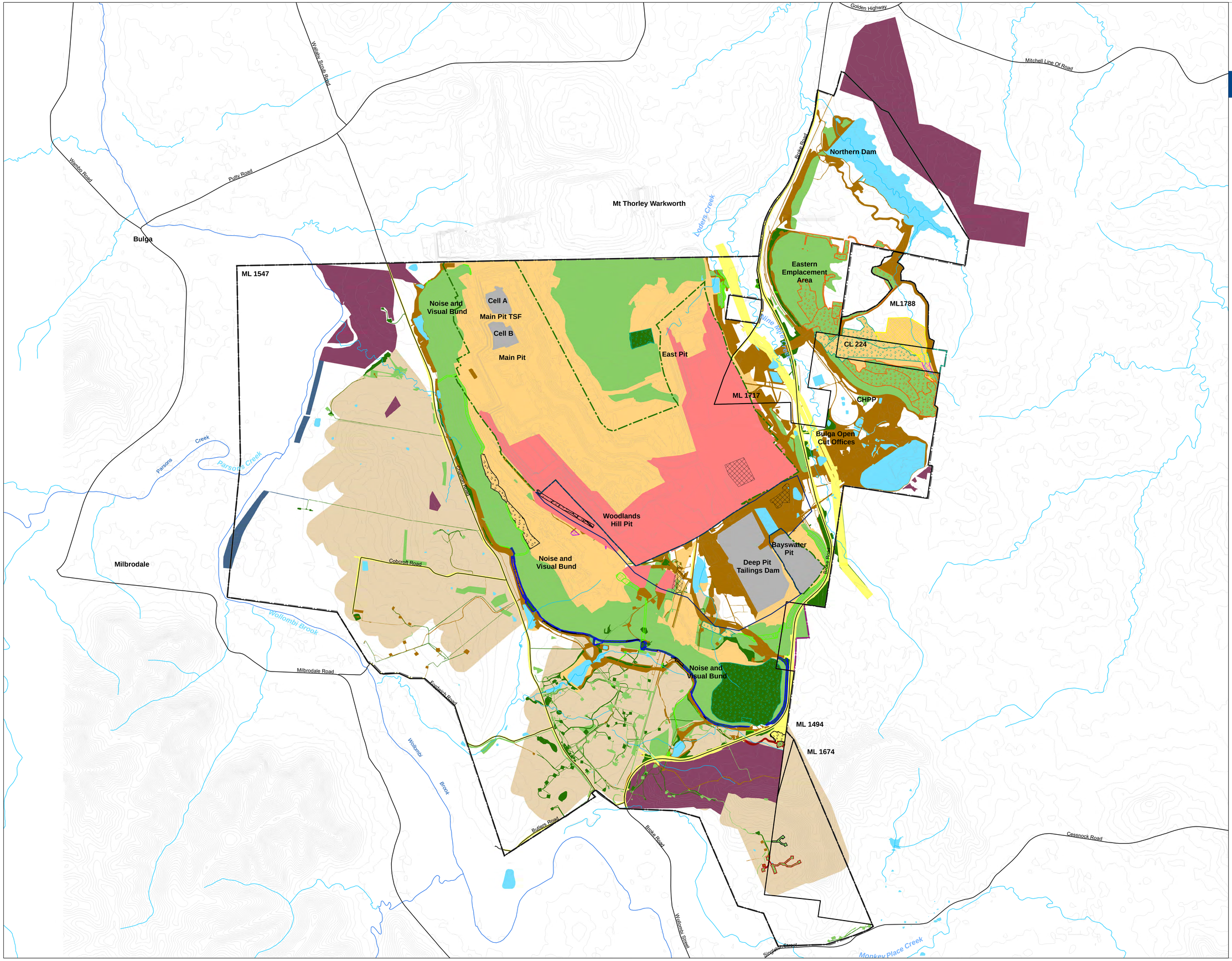
Orange indicates performance partially compliant

Red indicates performance not compliant

APPENDIX E

Annual Review Plan

Bulga Coal Annual Review 2020 Domain Plan



- Road
- Watercourse
- Minor Watercourse
- Contours 10m
- South Pit Extension Area
- In-pit Stockpiles
- Mining Lease
- Coal Lease
- Commonwealth Licence Agreement
- Colliery Holding
- Approved Mine Workings Outline – Open Cut

Primary Domains

- Domain 1 - Infrastructure
- Domain 2 - Emplacement Areas
- Domain 3 - Active Mining
- Domain 4 - Tailings Emplacement
- Domain 5 - Rehabilitation Woodland
- Domain 6 - Rehabilitation Pasture
- Domain 7 - Surface Water / Dams
- Domain 8 - Conservation Area
- Domain 9 - Vegetation Re-establishment Area
- Domain 10 - Subsidence Management
- Public Infrastructure

2020– 2021 Activity

- 2021– Disturbance
- 2021 - Rehabilitation
- 2021 - Rework of Temporary Rehabilitation
- 2020– Disturbance
- 2020 - Disturbance and Rehabilitation
- 2020 - Disturbance and Temporary Rehabilitation
- 2020 - Rehabilitation
- 2020 - Temporary Rehabilitation

0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 56
Scale:	1:17,000 at A0
Project Number:	630.30025
Date:	25-Mar-2021
Drawn by:	JG

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