WAMBO COAL PTY LTD
2019 ANNUAL REVIEW

1 January – 31 December 2019

Name of operation	Wambo Coal Mine
Name of operator	Wambo Coal Pty Ltd
Development consent /Project Approval #	DA305-7-2003, DA177-8-2004, EPBC 2003/1138, EPBC 2016/7636, EPBC 2016/7816
Name of holder of development consent	Wambo Coal Pty Ltd
Title/Mining lease #	CL365, CL374, CL397, CCL743, ML1402, ML1572, ML1594, MLA 557, A444, EL7211
Name of holder of mining lease	Wambo Coal Pty Ltd
Water licence #	As per **Table 3**
Name of holder of water licence	Wambo Coal Pty Ltd
MOP start date	September 2019
MOP end date	31 December 2020
Annual Review start date	1 January 2019
Annual Review end date	31 December 2019

I, Albert Scheepers, certify that this audit report is a true and accurate record of the compliance status of Wambo Coal Mine for the period 1 January 2019 to 31 December 2019 and that I am authorised to make this statement on behalf of Wambo Coal 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	Albert Scheepers
Title of authorised reporting officer	General Manager
Signature of authorised reporting officer	
Date	31/3/20

Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
EPL529	No
DA305-7-2003 (Modification 16)	No
DA305-7-2003 (Modification 17)	No
DA177-8-2004	Yes
EPBC 2003/1138	No
EPBC 2016/7636	Yes
EPBC 2016/7816	Yes
CL365	No
CL374	No
CL397	No
CCL743	No
ML1402	No
ML1572	No
ML1594	No
MLA557	N/A
A444	Yes
EL7211	Yes
Water licences (as per **Table 3**)	Yes

Compliance Status Key

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	Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions).

Non-Compliances

Relevant Approval	Condition #	Condition Description (summary)	Compliance Status	Comment	Where addressed in Annual Review
DA305-7-2003 (Modification 16)	B22 (Sch. 2)	Blasting Criteria	Non-compliant	Exceedance of airblast overpressure at BM05 on one occasion.	Section 10.1
EPL529	L5.3	Air Blast Overpressure Limits	Non-compliant		
EPL529	M4.1	Meteorological Monitoring Requirements	Non-compliant	Non-continuous monitoring of weather data.	Section 10.2
EPL529	M2.2	Air Quality Monitoring Requirements	Non-compliant	PM_{10} monitors ceased logging for varying periods of time at AQ01, AQ02, AQ03 and AQ04.	Section 10.3
DA305-7-2003 (Modification 17)	5B (Sch. 4)	Air Quality Operating Conditions	Non-compliant	Failure to minimise off-site air pollution.	Section 10.4
DA305-7-2003 (Modification 17)	41 (Sch. 4)	Conservation Agreement	Non-compliant	The VCAs that were updated to include RWEA E in December 2017 have not been finalised by the Biodiversity Conservation Trust.	Section 10.5
CL374, ML1572, ML1594	Condition 2	Mining Operations Plan	Non-compliant	Topsoil management had not been undertaken in accordance with the approved Mining Operations Plan.	Section 10.6
ML1402, CCL743	Condition 3				
CL365, CL397	Condition 3				
EPL529	M2.3	Surface Water Monitoring Requirements	Non-compliant	Due to continued drought, samples were unable to be collected at required frequency.	Section 10.7
EPL 529	M2.3	Groundwater Monitoring Requirements	Non-compliant	Due to insufficient water, representative samples were unable to be collected at required frequency.	Section 10.8
EPBC Approval 2003/1138	Condition 1 (part)	The approved plan must be implemented	Non-compliant	Management actions not undertaken in accordance with the commitments or strategy within the Biodiversity Management Plan	Section 10.9

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APPENDICES

1.0 Introduction

The Wambo Coal Mine (the Mine) is situated approximately 15 kilometres (km) west of Singleton, near the village of Warkworth, New South Wales (NSW) (**Figure 1**). The Mine is owned and operated by Wambo Coal Pty Limited (WCPL), a subsidiary of Peabody Energy Australia Pty Limited.

A range of open cut and underground mine operations have been conducted at the Mine since mining operations commenced in 1969. Mining under the current Development Consent (DA305-7-2003) commenced in 2004 and permits both open cut and underground operations and associated activities to be conducted. The approved run-of-mine (ROM) coal production rate is 14.7 million tonnes per annum and all product coal is transported from the Mine by rail.

Figure 2 shows the approved Mine layout including mining lease boundaries, current operational disturbance footprint and Remnant Woodland Enhancement Areas (RWEAs). **Figure 3** shows the approved Mine longwall layout.

This Annual Review details WCPL's environmental and community performance for the reporting period 1 January 2019 – 31 December 2020. This Annual Review has been prepared in accordance with the NSW Department of Planning and Environment (now Department of Planning, Industry and Environment [DPIE]) *Post-approval requirements for State significant mining developments – Annual Review Guideline – October 2015* (DPE 2015) and WCPL's statutory approvals (**Section 2.1**).

The Annual Review is not intended to be an exhaustive description of WCPL's operations, approvals and activities rather it is a summary of WCPL's compliance status with respect to WCPL's statutory approvals.

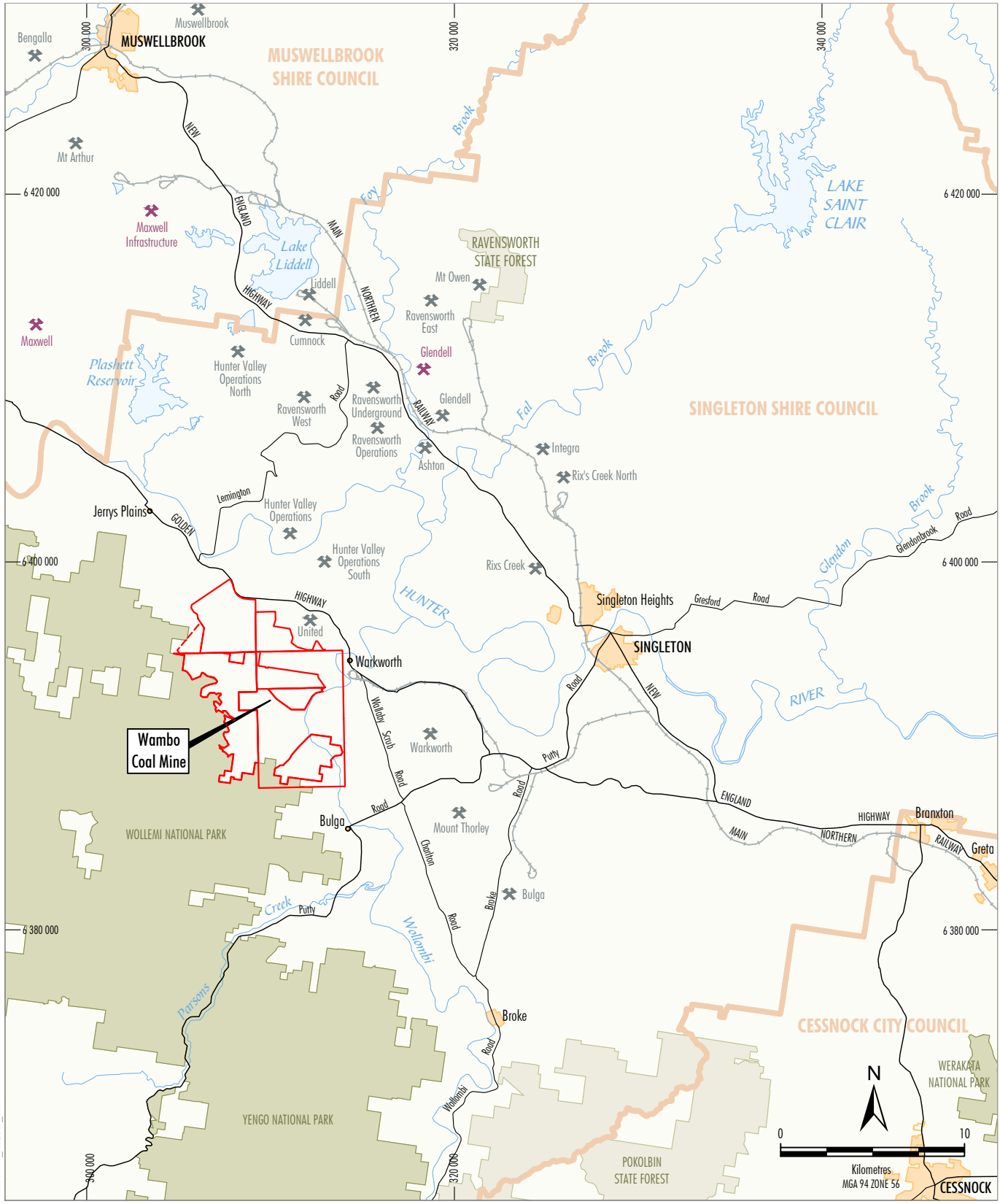
This Annual Review is distributed to a range of stakeholders including government authorities, Singleton Shire Council and members of the WCPL Community Consultative Committee (CCC). A copy of the Annual Review will be made available on the Peabody Energy website (www.peabodyenergy.com).

1.1 Mine Contacts

The contact details of key WCPL personnel who are responsible for the environmental management of the Mine are listed in **Table 1.**

Table 1: Contact Details of Key WCPL Personnel

Name	Role	Phone No.
Peter Jaeger	Manager: Environment & Community	(02) 6570 2206
Albert Scheepers	General Manager	(02) 6570 2208



WAM-09-15_AR 2019_101A

LEGEND
- Mining and Coal Lease Boundary
- Mining Lease Application Boundary
- Local Government Boundary
- Mining Operation
- Proposed Mining Operation (Application lodged)

Source: NSW Spatial Services (2019); Geoscience Australia (2009)

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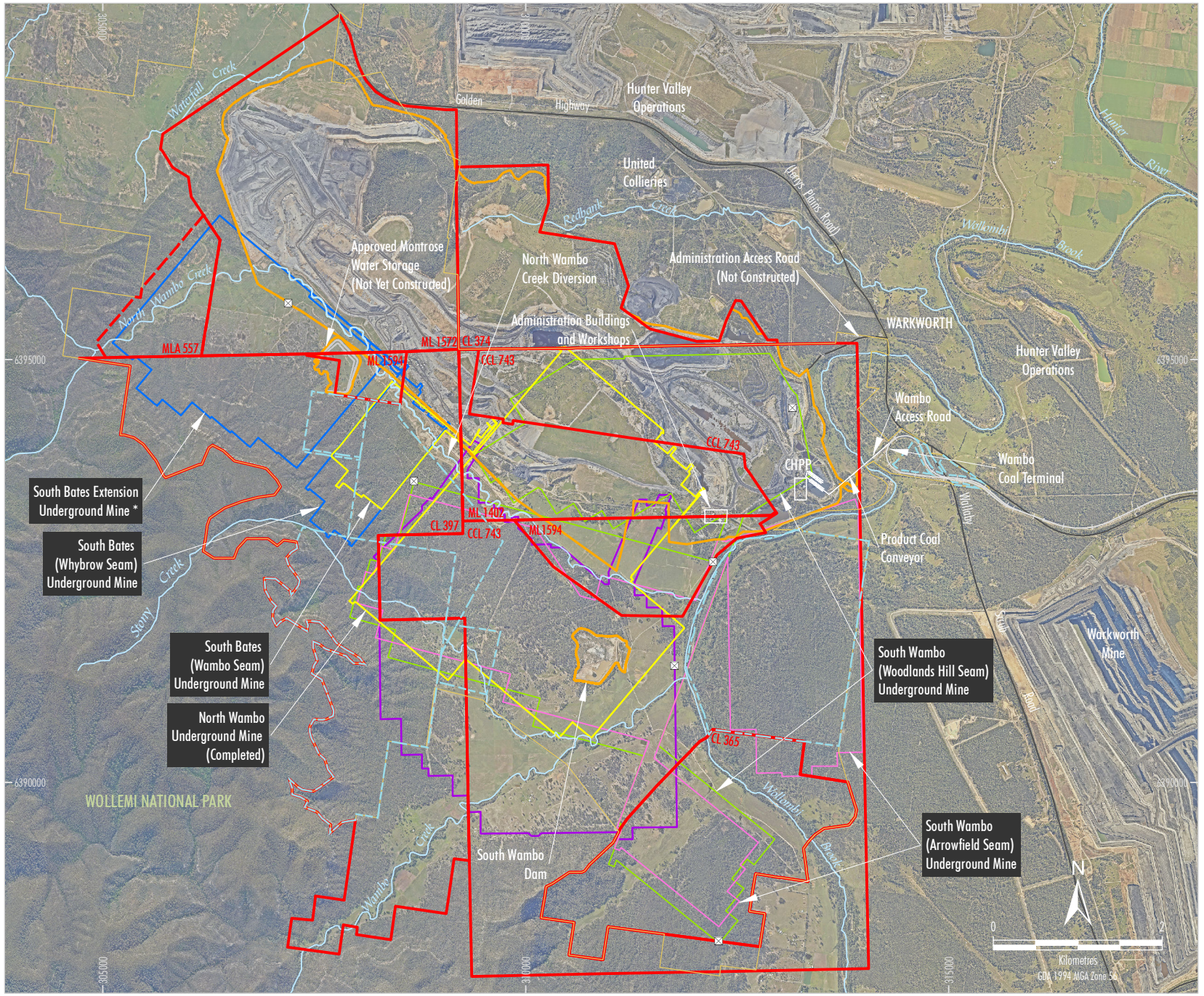
WAMBO COAL MINE

Regional Location

Figure 1



LEGEND

- Mining and Coal Lease Boundary
- Mining Lease Application Boundary
- WCPL Owned Land
- Existing/Approved Surface Development Area
- Ventilation Shaft
- Remnant Woodland Enhancement Program (RWEP) Area

Approved Underground Development

- Whybrow Seam
- Wambo Seam
- Woodlands Hill Seam
- Arrowfield Seam
- Previous Underground Workings in Whybrow Seam

Source: WCPL (2018); NSW Spatial Services (2018)
Orthophoto: WCPL (May 2019)

* Approved underground development as per South Bates Extension Underground Mine Modification Environmental Assessment. The actual longwall layouts may include minor revisions but are contained within this boundary.

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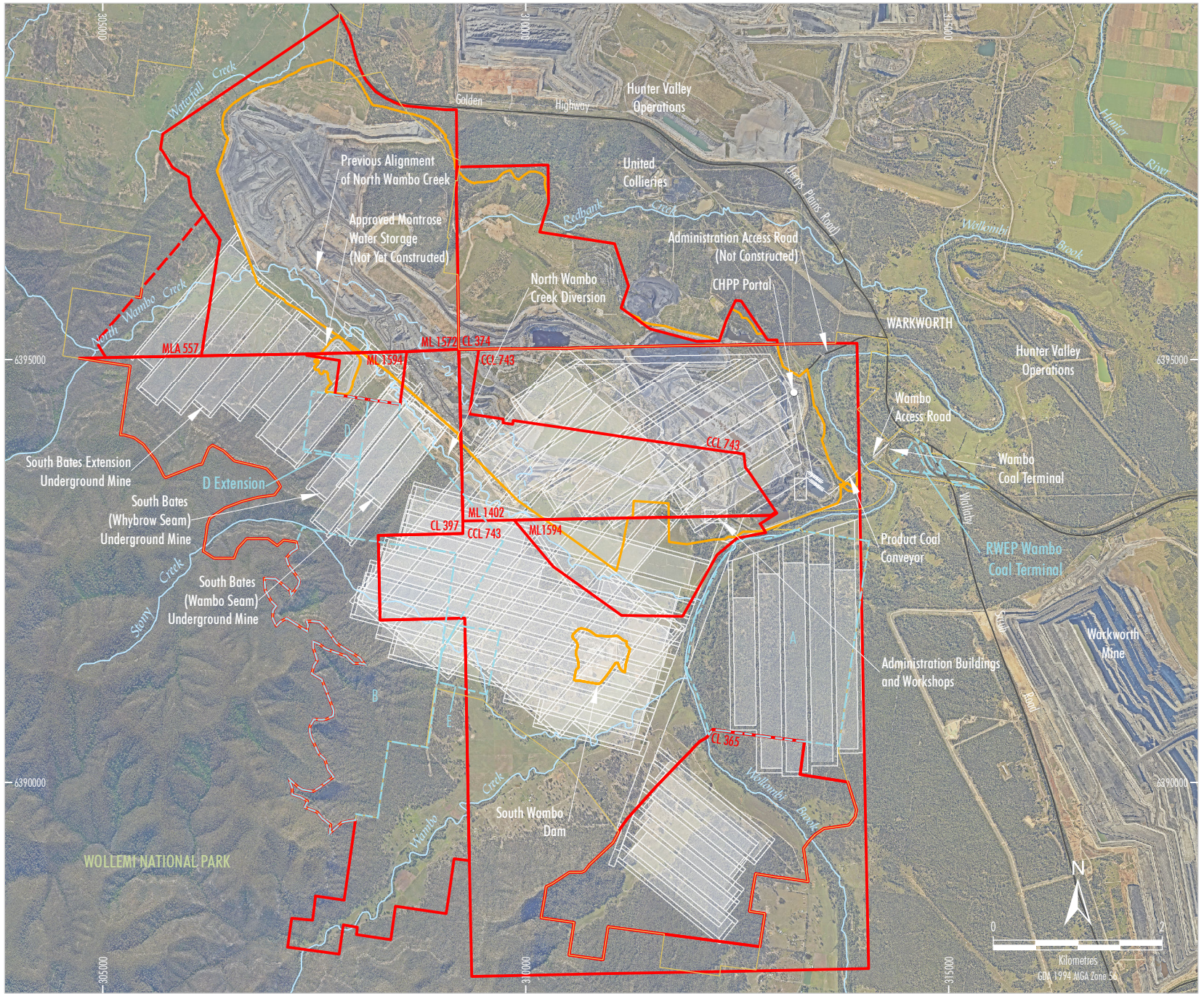
WAMBO COAL MINE

Approved Wambo Coal Mine General Arrangement

Figure 2

WAM-09-15_AR 2019_201A



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WAMBO COAL MINE

Approved Wambo Coal Mine Layout

Figure 3

2.0 Approvals

2.1 Current Approvals

WCPL has a number of statutory approvals, leases and licences that regulate activities at the Mine (**Table 2** and **Table 3**). Conditions from WCPL's approvals that specifically relate to this Annual Review are detailed in **Appendix A.**

Table 2: WCPL's Statutory Approvals

Type	Description	Issued By[1]	Issue Date	Expiry Date
Development Approval	DA305-7-2003[2]	DPIE	04/02/2004	31/12/2042
Development Approval	DA177-8-2004[3]	DPIE	16/12/2004	16/12/2025
EPBC Approval[4]	EPBC 2003/1138	AWE	23/11/2004	31/12/2029
EPBC Approval[4]	EPBC 2016/7636	AWE	30/4/2017	01/03/2037
EPBC Approval[4]	EPBC 2016/7816	AWE	4/5/2018	31/12/2039
Mining Lease	ML1402	DRG	23/09/1996	14/08/2022
Mining Lease	ML1572	DRG	21/12/2005	20/12/2026
Mining Lease	ML1594	DRG	01/05/2007	30/04/2028
Mining Lease Application[5]	MLA557	DRG	-	-
Consolidated Coal Lease	CCL743	DRG	09/03/1990	14/08/2022
Coal Lease	CL365	DRG	19/09/1990	19/09/2032
Coal Lease	CL374	DRG	06/12/1991	21/03/2026
Coal Lease	CL397	DRG	04/06/1992	04/06/2034
Exploration Licence	A444[6]	DRG	04/10/2007	16/05/2021
Exploration Licence[7]	EL7211	DRG	-	-
Environment Protection Licence	EPL529	EPA	17/08/2017	-
S101 Approval[8]	Approval to discontinue use of the North East Tailings Dam (NETD)	DRG	03/09/2009	-

1. AWE = Federal Department of Agriculture, Water and the Environment (formerly Department of the Environment and Energy), DRG = Division of Resources and Geosciences (formerly known as the Division of Resources and Energy), EPA = NSW Environment Protection Authority.
2. DA305-7-2003 has been modified 17 times since the original approval was granted in 2004. One modification application was withdrawn subsequent to WCPL submitting the application. The latest modification (MOD16), for the United Wambo Joint Venture Project (UWJV), was granted approval in August 2019.
3. DA177-8-2004 has been modified three times since the original approval was granted in 2004. The last modification (MOD3), for the UWJV, was granted approval in August 2019.
4. EPBC = *Environment Protection and Biodiversity Conservation Act 1999.*
5. At the time of preparing this Annual Review, grant of this Mining Lease Application is pending.
6. A444 is an Authority to Prospect granted under the *Coal Mining Act 1973* and is deemed to be an Exploration Licence for the purposes of the *Mining Act 1992*.
7. A renewal application was submitted in October 2019, at the time of preparing this Annual Review, the application was still pending.
8. Section 101 of the *Coal Mine Health and Safety Act 2002.*

Table 3: WCPL's Water Licences

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry Date
Hunter Regulated River Water Source							
WAL 718 (20SL060212)	Hunter River Pump	Perpetuity	1,000 unit shares (high security)	Regulated River (high security)	20AL200631	20WA200632	30/06/2027
WAL 8599 (20SL061206)	Hunter River Pump	Perpetuity	6 unit shares (high security)	Regulated River (high security)	20AL201457	20CA201459	25/09/2028
WAL 8600 (20SL061206)	Hunter River Pump	Perpetuity	868 unit shares (general security)	Regulated River (general security)	20AL201458	20CA201459	25/09/2028
WAL 8604 (20BL061206)	Hunter River Pump	Perpetuity	240 unit shares (supplementary water)	Supplementary Water	20AL203044	20CA201459	25/09/2028
Hunter Regulated River Water Source – Shared with United Colliery							
WAL 929 (20SL050661)	Other Pump	Perpetuity	3 unit shares	Domestic and Stock	20AL201147 (NOW Reference Number)	20WA201148	06/12/2027
WAL 1369 (20SL060416)	80 mm CP	Perpetuity	15 unit shares (supplementary water)	Supplementary Water	20AL203071 20AL204246 20AL204247	20CA201654	30/11/2028
WAL 15459 (20SL204246)	80 mm CP	Perpetuity	21 unit shares (general security)	Regulated River (general security)	20AL204246	20CA201654	30/11/2028
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL 18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	20AL208641	20WA208642	31/07/2022
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	20AL211371	20WA211372	31/07/2022
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin – North Coast Groundwater Source)							
WAL 42373[2]	-	Perpetuity	1,549 unit shares	Aquifer	20AL219997	20MW065010	-
WAL 41532 (20BL172156)	Dewatering	Perpetuity	98 unit shares	Aquifer	20AL218994	20MW065010	-
20BL168997	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry Date
20BL168998	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL168999	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL169000	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL170638	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172237	Monitoring Bore (GW14, GW18, GW21)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172238	Monitoring Bore (GW12)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172240	Monitoring Bore (GW15)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172242	Monitoring Bore (GW16, GW17)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172244	Monitoring Bore (GW20)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172255	Monitoring Bore (GW22)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172256	Monitoring Bore (GW13)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172257	Monitoring Bore (GW19)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172332	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173290	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173291	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry Date
20BL173292	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173293	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173946	Monitoring	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173999	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	5/12/2023
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214848	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214849	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214850	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214851	-
-	Spearpoints	Perpetuity	Stock/Domestic	Basic Rights	-	20WA215574	-

WAL = water access licence; mm = millimetres.

1. 20BL prefix bore licences with allocations have been replaced with Water Access Licences (WALs).
2. WAL 42373 was issued in 2019 to consolidate six of WCPL's previous WALs under the North Coast Fractured and Porous Rock groundwater Sources (Sydney Basin – North Coast Groundwater Source) including WAL 39735, WAL 39738, WAL 39803, WAL 41494, WAL 41528 and WAL 41520.

2.2 Changes to Approvals

During the reporting period the following changes were made to WCPL's approvals:

- The Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 was submitted in April 2018, and approved for the extraction of Longwall 17 only on 7 September 2018[1]. On 1 March 2019, WCPL submitted an amended Extraction Plan for Longwalls 17 to 20. DPIE approved the amended Extraction Plan on 4 June 2019.
- A new Mining Operations Plan (MOP)/Rehabilitation Management Plan (RMP) (for the period 2019-2020) was lodged with Resources Regulator (RR) in October 2019 and was approved on 11 November 2019.
- In October 2019, WCPL applied to the DPIE to shorten the commencing end of Longwall 19 by 369 m due to previously unidentified geological features. DPIE approved the shortening of Longwall 19 on 13 November 2019.

In October 2019, WCPL made an Application for a renewal of Exploration Licence EL7211. At the time of preparing this Annual Review, the application is still pending. A444 was renewed on 22 January 2019.

On 29 August 2019, the UWJV (State Significant Development [SSD] 7142, DA305-7-2003 [Modification 16] and DA177-8-2004 [Modification 3]) was determined. As described in the UWJV Environmental Impact Statement (EIS) (Umwelt 2016), United (or another Glencore related company) will operate all future open cut mining in the Project Area. The Wambo Open Cut will operate under its existing approvals (i.e. DA305-7-2003 [Modification 16] and DA177-8-2004 [Modification 3]) until the point at which mining operations comprising the UWJV have commenced (currently scheduled for December 2020), at which point it is appropriate for such operations to be regulated by a new development consent for the UWJV (i.e. SSD 7142).

The UWJV will use available approved capacity in WCPL's existing CHPP and train loading facilities. WCPL will continue to operate these facilities in accordance with the approved throughput provided by its current approvals (and continued as part of the UWJV), with the UWJV delivering ROM coal to these facilities for coal washing, handling and loading coal onto trains for transportation. These facilities will continue to be managed and operated under WCPL's existing development consents. The Wambo Coal Mine underground operations do not form part of the UWJV and will continue to be owned and managed by WCPL. The Wambo Coal Mine underground operations will continue to use the Wambo CHPP and train loading facility.

WCPL is currently in the process of preparing an updated suite of management plans to address the Development Consents issued following determination of the UWJV. WCPL is required to have these plans approved prior to the commencement of Phase 2[2] at the Wambo Coal Mine.

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[1] On 4 September 2018, WCPL provided DPE with correspondence explaining that geological structures had been encountered that may require changes to the main headings and finishing ends of Longwalls 18, 19 and 20. Accordingly, WCPL requested that DPE approve the Extraction Plan for Longwalls 17 to 20 for extraction of Longwall 17 only. On 7 September 2018, DPE approved the extraction of Longwall 17 only, on the basis that WCPL would prepare an amended Extraction Plan for Longwalls 18, 19 and 20.

[2] In accordance with DA305-7-2003, Phase 2 refers to "*the phase of the development that comprises underground mining operations at Wambo underground mine, the operation of Wambo mine infrastructure within the green operational area identified in Figure 2 of Appendix 2 and associated surface development.*"

2.3 Environmental Management System

WCPL operates an Environmental Management System to manage compliance and advance continual improvement across the Mine. During the reporting period, a number of management plans were revised and submitted for approval. A summary of the status of required management plans is presented in **Table 4.**

In accordance with Schedule 2, Condition D15(a) of DA305-7-2003, copies of these management plans have been made available to the public on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.

In accordance with Schedule 2, Condition B15 of DA305-7-2003, WCPL will review and, if necessary, revise the strategies, plans and programs required under DA305-7-2003 within three months of the submission of this Annual Review to relevant government regulators.

Table 4: Status of WCPL's Environmental Management Plans

Management Plan	Status	Approved Version[1]
North Wambo Extraction Plan for Longwalls 8 to 10A (and associated component plans)	Approved – 2015	April 2015
South Bates Underground Mine Extraction Plan for Longwalls 11 to 16 (and associated component plans)	Approved – 2017	July 2017[2]
South Bates Extension Underground Mine Extraction Plan for Longwalls 17 to 20 (and associated component plans)	Approved – 2019	Revision C (June 19)[3]
Environmental Management Strategy	Approved – 2018	Version 5 (Mar 18)
Blast Management Plan[4] (BMP)	Approved – 2019	Version 10 (Nov 19)
Noise Management Plan (NMP)	Approved – 2018	Version 8 (Jan 18)
Air Quality & Greenhouse Gas Management Plan (AQGGMP)	Approved – 2017	Version 5 (Aug 17)[5]
Biodiversity Management Plan (BioMP) (previously the Flora and Fauna Management Plan)	Approved – 2019	Version 16 (May 19)
Bushfire Management Plan	Approved – 2014[6]	Version 4 (Aug 13)[6]
Site Water Management Plan	Approved – 2018	Various[7] (April 18)
MOP/RMP	Approved – 2019	MOP 2019-2020 (Oct 19)[8]
Conservation Management Plan (European) (CMP)	Approved – 2019	Version 6 (May 19)
Aboriginal Heritage Management Plan for RWEP A	Approved – 2018	Version 5 (Jul 18)

1. Approved version as at the end of the reporting period.
2. On 11 October 2017, DPE (now DPIE) approved the South Bates Underground Mine Longwalls 11 to 16 Extraction Plan with the exception of the Site Water Management Plan (and associated component plans), which were unable to be approved until they were updated in consultation with Department of Industry – Water (DI-Water) (now Department of Primary Industries – Water [DPIE-Water]). In 2018, the South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan (including the Site Water Management Plan which had been updated in consultation with DI-Water) was approved by DPE (now DPIE).
3. On 4 September 2018, WCPL provided DPE (now DPIE) with correspondence explaining that geological structures had been encountered that may require changes to the main headings and finishing ends of Longwalls 18, 19 and 20. Accordingly, WCPL requested that DPE (now DPIE) approve the Extraction Plan for Longwalls 17 to 20 for extraction of Longwall 17 only. On 7 September 2018, DPE (now DPIE) approved the extraction of Longwall 17 only, on the basis that WCPL would prepare an amended Extraction Plan for Longwalls 18, 19 and 20. On 1 March 2019, WCPL submitted an amended Extraction Plan for Longwalls 17 to 20. DPIE approved the amended Extraction Plan on 4 June 2019.
4. Includes WCPL's Blast Fume Management Strategy (Version 4) which was approved in November 2019.
5. Version 7 of the AQGGMP has been submitted to DPIE for approval.
6. The Bushfire Management Plan was revised during 2017 and a copy of the revised plan was provided to the Singleton Shire Council and the NSW Rural Fire Service (RFS). Comments have not yet been received from Singleton Shite Council. WCPL will address comments once received and provide the updated plan to DPE (now DPIE) for approval.
7. Includes WCPL's Surface Water Monitoring Program (Version 12) (SWMP), Groundwater Monitoring Program (Version 12) (GWMP), Erosion and Sediment Control Plan (Version 10) (ESCP), Surface and Groundwater Response Plan (Version 12) and Site Water Balance (Version 1). In 2019, the South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan (including the Site Water Management Plan which had been updated in consultation with DI-Water) was approved by DPE (now DPIE).
8. A new MOP (for the period September 2019 to 31 December 2020) was lodged with the NSW Resources Regulator in October 2019 and was approved on 11 November 2019.

3.0 Operations Summary

3.1 2019 Mining Operations

The Mine operates seven days a week, 24 hours a day on a rotating shift basis.

During the reporting period, the following mining operations were undertaken at the Mine:

- South Bates Extension Underground Mine (current longwall mining area):
  - Longwall 17 (completed 16 May 2019); and
  - Longwall 18 (completed 8 December 2019).
- Open Cut:
  - Continued mining operations (strip 1) in Montrose East Crown;
  - Continued mining operations (strip 29 to 46) in Montrose Central pit;
  - Continued mining operations (strip 1 onwards) in Hilldale;
  - Continued mining operations (strip 1) in Montrose West pit; and
  - Continued mining operations (strip 1) in Homestead.

Table 5 shows the production summary for 2019, compared to the production for 2018 and the forecast production for 2019 and 2020.

Table 5: Production Summary

Material	Unit	Approved limit	2018 reporting period (actual)	2019 reporting period (forecast)	2019 reporting period (actual)	2020 reporting period (forecast)
Waste Rock/ Overburden	bcm	-	34,562,229	26,490,000	37,195,422	36,794,452
ROM Coal/ Ore	Mt	14.7[1]	7.71	7.59	7.98	7.75
Coarse Reject	Mt	-	2.61	2.25	2.54	2.39
Fine Reject (Tailings)	Mt	-	0.46	0.40	0.44	0.42
Saleable Product	Mt	15[2]	4.81	5.02	4.996	4.94

Note: bcm = bank cubic metres, Mt = million tonnes.

1. DA305-7-2003, Condition A16 Schedule 1.
2. DA177-8-2004, Condition A8 Schedule 1. Refers to product coal transported off-site.

During the reporting period, a total of 4.91 Mt of product coal was transported off-site via rail (no coal was hauled off-site by trucks). A summary of 2019 daily train movements, required by Schedule 2, Condition B29(b) of DA177-8-2004 is provided in **Appendix B**.

A total of 572 trains were loaded during the reporting period with 40 trains were loaded on Friday evening (between 6 pm to 9 pm) and Sunday morning (9 am to 12 am). In accordance with Schedule 2, Condition A12 of DA177-8-2004, WCPL took all reasonable steps to minimise train movements within these hours.

The excess saleable product produced during the reporting period (i.e. approximately 0.085 Mt) was stored at the stockpile on-site. The actual ROM coal production (7.98 Mt) was more than the forecast ROM coal production (7.59 Mt) as the forecast volumes for 2019 were calculated under the assumption that the UWJV would commence throughout the year, reducing open cut production. However, the UWJV did not commence in 2019 but is now scheduled to commence in late 2020. The actual waste rock/overburden produced was greater than forecast for the same reason (i.e. continued open cut operation at the Wambo Coal Mine). **Figure 4** shows the amount of saleable product coal transported off-site on a weekly basis.

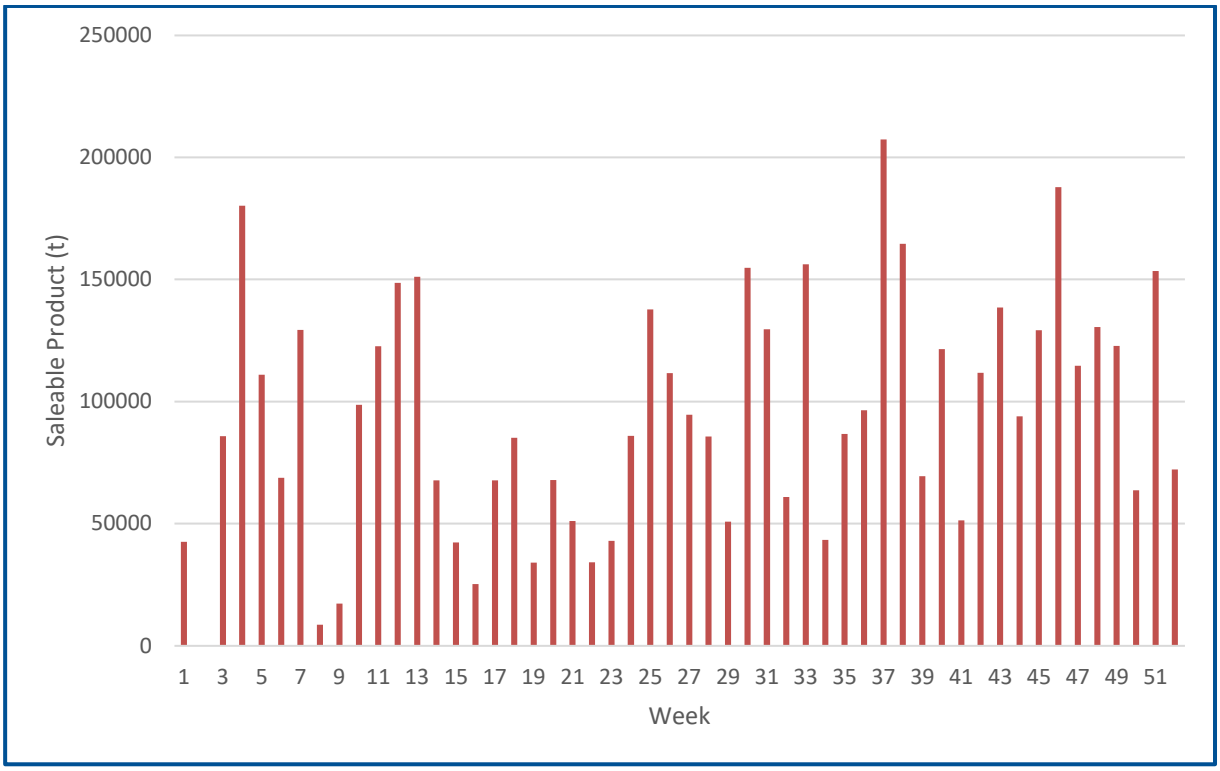

Figure 4: Coal Transported Off-site during the Reporting Period

3.2 Next Reporting Period

Operations during the next reporting period will be undertaken in accordance with the approved MOP and will include:

- Continued mining operations (strip 1) in Homestead;
- Continued mining operations (strip 29 to 46) in Montrose Central;
- Continued mining operations (strip 1 onwards) in Hilldale;
- Continued mining operations (strip 1) in Montrose West pit; and
- Continued mining at the South Bates Extension Underground Mine, including Longwall 19 (commenced in January 2020), Longwall 20 (anticipated to commence in May 2020) and Longwall 21 (anticipated to commence October 2020).

4.0 Actions Required from Previous Annual Reviews

A number of actions and improvements have been identified in previous Annual Reviews undertaken by WCPL. Actions and improvements recommended in the 2015 Annual Review, 2016 Annual Review, 2017 Annual Review and 2018 Annual Review and their current status are summarised in **Table 6**, **Table 7**, **Table 8** and **Table 9** respectively. In addition, further information/actions requested by DPIE and DRG/RR are also addressed in these tables.

Table 6: Actions from the 2015 Annual Review

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
A full review and update of the following plans and strategies:	WCPL	-	-
• Bushfire Management Plan;		Ongoing. WCPL revised the Bushfire Management Plan and provided a copy to the Singleton Shire Council and the NSW RFS in December 2017. Comments have not yet been received from Singleton Shire Council. WCPL will address comments once received and provide the updated plan to DPIE for approval.	Section 2.3
Installation of GPS units on-site water carts pending review of budgets.		Complete. In June/July 2019, WCPL fitted four water carts with GPS units to monitor the frequency and movement of the water carts across the site.	Section 5.3.4
Commissioning of an audit of the Hunter River Salinity Trading Scheme (HRSTS) discharge system to ensure its effectiveness;		Ongoing. The HRSTS discharge system was reviewed during 2016. This review consisted of updating the communication hardware in consultation with Water NSW, regular calibration of instrumentation and development of operating procedures. A guideline for a HRSTS system audit was completed in 2018. The audit was unable to be completed as WCPL was unable to discharge through the HRSTS in 2018 or 2019. During the next reporting period, WCPL will undertake the HRSTS system audit if discharges through the HRSTS occur.	Section 6.3.4

Table 7: Actions from the 2016 Annual Review

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
WCPL will submit a Conceptual Mine Closure Plan (CMCP) to DPE (now DPIE) in the first half of 2017.	WCPL	No longer required under the Development Consent (DA305-7-2003; Modification 16). This commitment was removed following the determination of the UWJV as the open cut operations will continue under SSD 7142. Underground mining at Wambo is approved until 2042 under Modification 16.	Section 2.2
Works associated with the North East Tailings Dam Rehabilitation Strategy (NETDRS), including the construction of a trial abutment and any additional works undertaken (if the trial is successful).		Ongoing. Cone Penetration Testing (CPT) of the NETD commenced in Q1 2020 and in the Hunter Pit Tailings Dam (HPTD) in Q3 2019. The capping design for NETD and HPTD was finalised in Q4 2019. Intermittent disposal of double flocculated tailings in the NETD and HPTD will commence in Q4 2020.	Section 7.1.1
WCPL will undertake a review and update of the following management plans and strategies:		-	-
• Conservation Management Plan for the Wambo Homestead Complex (WHC).		Complete. The Wambo Homestead Complex Conservation Management Plan was submitted for approval in May 2019 following comments received from DPIE. The plan was approved on 31 May 2019.	Section 2.3
• Bushfire Management Plan.		Ongoing. WCPL revised the Bushfire Management Plan and provided a copy to the Singleton Shire Council and the NSW RFS in December 2017. Comments have not yet been received from Singleton Shire Council. WCPL will address comments once received and provide the updated plan to DPIE for approval.	Section 2.3

Table 8: Actions from the 2017 Annual Review[3]

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
The remaining 11 exploration holes will be inspected to determine rehabilitation status.	WCPL	Ongoing. Due to climatic conditions, the follow up inspections were rescheduled to Quarter 2 of 2020. Inspections will be undertaken in accordance with draft Exploration Rehabilitation Management Plan, and necessary amendments will be made to ensure exploration rehabilitation continues to progress.	Section 5.10
Works associated with the NETDRS will continue. CPT will commence after the main deposition finishes in the Hunter Pit Tailings Dam (HPTD), scheduled for quarter two 2018. It is anticipated that CPT will be complete by quarter three 2018. Following CPT, details regarding capping design and capping works will be finalised.		Ongoing. CPT of the NETD commenced in Q1 2020 and in the HTD in Q3 2019. The capping design for NETD and HPTD was finalised in Q4 2019. Intermittent disposal of double flocculated tailings in the NETD and HPTD will commence in Q4 2020.	Section 7.1
The following management plans and strategies will be finalised:		-	-
• Bushfire Management Plan;		Ongoing. WCPL revised the Bushfire Management Plan and provided a copy to the Singleton Shire Council and the NSW RFS in December 2017. Comments have not yet been received from Singleton Shire Council. WCPL will address comments once received and provide the updated plan to DPIE for approval.	Section 2.3
• CMP (European) for the WHC; and		Complete. The Wambo Homestead Complex Conservation Management Plan was submitted for approval in May 2019 following comments received from DPIE. The plan was approved on 31 May 2019.	Section 2.3
The Annual Environmental Management Report (AEMR) is accepted subject to the following items:	RR[1]	-	-

[3] In correspondence dated 7 September 2018, DPE confirmed that the 2017 Annual Review generally satisfied the requirements of the relevant approvals, and did not request any actions/improvements for future annual reviews.

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
1. It is understood that a remediation plan for the North Wambo Creek Diversion (NWCD) is being developed to address deficiencies identified in an independent audit required under consent. The final remediation plan is to be incorporated into the Mining Operations Plan (as an appendix) within three months of finalization, with remediation progress reported in the AEMR.		In progress. The NWCD Plan was sent to DPIE and other relevant parties for consultation on 24 April 2019. WCPL is currently updating the NWCD Plan to address comments.	Section 5.6.4
2. The hydrocarbon management procedure is reviewed to ensure that contamination is prevented in the first instance and contaminated material is appropriately managed so that it is not a risk to rehabilitation. Key management actions are to be described in the next revision of the Mining Operations Plan.		Complete. WCPL has reviewed the hydrocarbon management procedure to ensure that contamination is prevented in the first instance and contaminated material is appropriately managed so that it is not a risk to rehabilitation.	-

1. Letter from the NSW Resources Regulator (RR) to WCPL indicating satisfaction with the 2017 Annual Review (subject to the terms outlined), dated 5 October 2018.

Table 9: Actions from the 2018 Annual Review

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
The CMP (European) will be submitted for approval.	WCPL	Complete. The Wambo Homestead Complex Conservation Management Plan was submitted for approval in May 2019 following comments received from DPIE. The plan was approved on 31 May 2019.	Section 2.3
WCPL will address any comments received from Singleton Shire Council or the NSW RFS on the Bushfire Management Plan and provide the updated plan to DPE (now DPIE) for approval.		Ongoing. WCPL revised the Bushfire Management Plan and provided a copy to the Singleton Shire Council and the NSW RFS in December 2017. Comments have not yet been received from Singleton Shire Council. WCPL will address comments once received and provide the updated plan to DPIE for approval.	Section 2.3
The CMCP will be submitted to the NSW Resources Regulator and other relevant stakeholders within six months of the determination of the United Wambo Open Cut Coal Mine Project (MOD16).		No longer required under the Development Consent (DA305-7-2003; Modification 16). This commitment was removed following the determination of the UWJV as the open cut operations will continue under SSD 7142. Underground mining at Wambo is approved until 2042 under Modification 16.	Section 2.2
The remaining 11 exploration holes will be inspected as part of the comprehensive rehabilitation program scheduled for commencement in March-April 2019.		Ongoing. Due to climatic conditions, the follow up inspections were rescheduled to Quarter 2 of 2020. Inspections will be undertaken in accordance with draft Exploration Rehabilitation Management Plan, and necessary amendments will be made to ensure exploration rehabilitation continues to progress.	Section 5.10
An Independent Noise Review will be undertaken as requested by a landowner (located on Redmanvale Road, Jerrys Plans).		Complete. The Independent Noise Review was undertaken during 2019.	Section 5.1.4
A description of subsidence remediation activities that are undertaken in areas overlying Longwalls 11 to 16 at the South Bates Underground Mine will be provided.		Ongoing. Temporary repairs were conducted during 2018 with more comprehensive remediation works scheduled for the reporting period (i.e. 2019). A subsidence remediation action plan was developed in 2018 proposing to conduct final remediation works over the South Bates Underground Mine and other historical subsidence areas in 2019. In 2019, subsidence monitoring and remediation focused on the South Bates Underground Mine with 37 subsidence sites rehabilitated. The remediation campaign occurred over a three month period in April, May and June 2019. The sites ranged from small potholes to large cracks several meters in length. Subsidence monitoring will continue to monitor further subsidence, vegetation coverage and weeds in the next reporting period.	Section 5.9.3

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
An update on the comprehensive rehabilitation project of exploration sites scheduled to be undertaken in March and April 2019.		Ongoing. To date, no holes have been signed off as completely rehabilitated, however a comprehensive rehabilitation project is currently planned for commencement in Quarters 1 and 2 of 2020. By the end of this rehabilitation project, all sites drilled during the reporting period will have the preliminary rehabilitation completed, and will require a follow up inspection to determine final rehabilitation status.	Section 5.10
A HRSTS system audit will be undertaken if discharges through the HRSTS occur during the next reporting period.		Ongoing. The HRSTS discharge system was reviewed during 2016. This review consisted of updating the communication hardware in consultation with Water NSW, regular calibration of instrumentation and development of operating procedures. A guideline for a HRSTS system audit was completed in 2018. The audit was unable to be completed as WCPL was unable to discharge through the HRSTS in 2018 or 2019. During the next reporting period, WCPL will undertake the HRSTS system audit if discharges through the HRSTS occur.	Section 6.3.4
The NWCD Plan will be revised and submitted to DPE (now DPIE) for approval in April 2019. Within three months of approval of the NWCD Plan, the Action Plan will be incorporated into the MOP as an appendix.		In progress. The NWCD Plan was sent to DPIE and other relevant parties for consultation on 24 April 2019. WCPL is currently updating the NWCD Plan to address comments.	Section 5.6.4
WCPL will notify NSW Land Registry Services of the approval issued by WaterNSW to consolidate six WALs on 20 December 2018.		Complete. Six WCPL groundwater licences (WAL 39738, WAL 39803, WAL 41528, WAL 39375, WAL 41520, WAL 41494) have been consolidated into WAL 42373.	Section 6.5

5.0 Environmental Performance

5.1 Noise

Noise Impact Assessment Criteria for the Mine are defined in Table 3 and 4 of DA305-7-2003 (Condition B12 and B14, Schedule 2) and EPL529 (Condition L4). Additional noise conditions relating to land acquisition, operating hours, rail noise, noise monitoring and WCPL's NMP are also detailed in these approval documents.

The noise monitoring network consists of three real time noise monitors (unattended noise monitoring) and six attended noise monitoring locations (two of which are coincident with real time noise monitors).

During 2019, attended noise monitoring was undertaken monthly at N01, N03, N16, N20A, N21 and N26. For further detail, refer to WCPL's NMP.

5.1.1 Approval Criteria/EIS Predictions and Management Plan Requirements

During the reporting period, the UWJV was determined and WCPL received updated Development Consents (DA305-7-2003 [Modification 16] and DA177-8-2004 [Modification 3]). Accordingly, DA305-7-2003 (Modification 17) was applicable from 1 January to 28 August 2019 and DA305-7-2003 (Modification 16) was applicable from 29 August to 31 December 2019.

A summary of the approval criteria for noise in relation to sensitive receivers is included in **Table 10**.

Between 1 January and 28 August 2019, the noise impact assessment criteria in DA305-7-2003 (Modification 17) did not apply under meteorological conditions of:

- wind speeds greater than 3 metres per second (m/s) at 10 metres (m) above ground level;
- during rain; and/or
- temperature inversion conditions with atmospheric stability class G.

Between 29 August and 31 December 2019, the noise impact assessment criteria in DA305-7-2003 (Modification 16) did not apply under meteorological conditions of:

1. *The noise criteria in condition B12 are to apply under all meteorological conditions except the following:*
    a. *where 3°C/100 metres (m) lapse rates have been assessed, then:*
        i. *wind speeds greater than 3 metres per second (m/s) measured at 10 m above ground level;*
        ii. *temperature inversion conditions between 1.5°C/100 m and 3°C/100 m and wind speeds greater than 2m/s measured at 10 m above ground level; or*
        iii. *temperature inversion conditions greater than 3°C/100 m.*
    b. *where Pasquill Stability Classes have been assessed, then:*
        i. *wind speeds greater than 3m/s at 10m above ground level;*
        ii. *stability category F temperature inversion conditions and wind speeds greater than 2m/s at 10m above ground level;*
        iii. *stability category G temperature inversion conditions.*

Table 10: Impact Assessment Criteria for Noise

Receiver	Noise Impact Assessment Criteria Applicable from 1 January 2019 to 28 August 2019			Noise Impact Assessment Criteria Applicable from 29 August 2019 to 31 December 2019[1]		
	Day $L_{Aeq,15minute}$ (dB)	Evening/Night $L_{Aeq,15minute}$ (dB)	Night $L_{A1,1minute}$ (dB)	Day $L_{Aeq,15minute}$ (dB)	Evening/Night $L_{Aeq,15minute}$ (dB)	Night $L_{A1,1minute}$ (dB)
R019	Acquisition rights, no applicable criteria			59	59	N/A
R003	35	40	50	40	40	50
R016	35	40	50			
R025	35	40	50			
R029	Not referenced in DA305-7-2003 (Modification 17)					
R033	35	40	50			
R039	35	40	50			
R042	Not referenced in DA305-7-2003 (Modification 17)					
R320 (previously 15B)	35	40	50			
R345 (previously 15B)	35	40	50			
R006	35	39	50	39	39	50
R007	35	39	50			
R048	35	39	50			
R343 (previously 37)	35	39	50			
R017	35	38	50	38	38	50
R030 (previously 38)	35	38	50			
R035	Not referenced in DA305-7-2003 (Modification 17)					
R049	35	38	50			
R075	35	38	50			
R346	Not referenced in DA305-7-2003 (Modification 17)					
R348	Not referenced in DA305-7-2003 (Modification 17)					
R379 (previously 91)	35	38	50			
R043	35	37	50	37	37	50
R163	35	37	50			
R344 (previously 137)	35	37	50			
R380 (previously 246)	35	37	50			
R381 (previously 178)	35	36	50	36	36	50

Receiver	Noise Impact Assessment Criteria Applicable from 1 January 2019 to 28 August 2019			Noise Impact Assessment Criteria Applicable from 29 August 2019 to 31 December 2019[1]		
	Day $L_{Aeq,15minute}$ (dB)	Evening/Night $L_{Aeq,15minute}$ (dB)	Night $L_{A1,1minute}$ (dB)	Day $L_{Aeq,15minute}$ (dB)	Evening/Night $L_{Aeq,15minute}$ (dB)	Night $L_{A1,1minute}$ (dB)
All other privately-owned residences	35	35	50	35	35	50
94 – Curlewis	35	40	50	N/A	N/A	N/A
4B – Circosta	35	40	50	N/A	N/A	N/A
23C – Kannar	35	40	50	N/A	N/A	N/A
28A & B – Garland	35	40	50	N/A	N/A	N/A
40 – Muller	35	40	50	N/A	N/A	N/A
254A – Algie	35	40	50	N/A	N/A	N/A
5 – Strachan	35	39	50	N/A	N/A	N/A
1 – Brosi	35	38	50	N/A	N/A	N/A
18 – Denney	35	38	50	N/A	N/A	N/A
63 – Abrocuff	35	38	50	N/A	N/A	N/A
27 – Birralee	35	37	50	N/A	N/A	N/A
13B – Skinner	35	36	50	N/A	N/A	N/A
188 – Fuller	35	36	50	N/A	N/A	N/A
262A, B & C – Moses	35	36	50	N/A	N/A	N/A

Note: dB = decibels.

[1] N/A indicates that these receivers are no longer referenced under the Development Consent following determination of Modification 16 as these receivers are mine-owned.

Condition L4.1 of EPL529 includes similar noise emission limits to those identified in DA305-7-2003. Condition L4.5 and L4.6 of EPL529 specifies that the noise emission limits identified in Condition L4.1 do not apply under meteorological conditions of:

- wind speeds greater than 3 m/s at 10 m above the ground level; and/or
- temperature inversion conditions of greater than 3°C/100 m and wind speeds greater than 2 m/s at 10 m above the ground.

As lapse rates were not measured directly, meteorological conditions have been assessed against the Pasquill Stability Classes detailed in Appendix 5, Condition 1(b) of DA305-7-2003 (Modification 16).

A summary of the UWJV EIS predictions for noise is included in **Appendix C**, along with WCPL's performance against these predictions during the reporting period. For more information on the UWJV EIS predictions, refer to the UWJV EIS (Umwelt 2016).

In addition to the statutory requirements detailed in DA305-7-2003, WCPL is also required to meet additional requirements detailed within the approved WCPL NMP. These requirements include reporting of monthly attended monitoring results on WCPL's website (or when there is an exceedance of criteria) and provision of results to the WCPL CCC.

5.1.2 Performance during the Reporting Period

During the reporting period, WCPL complied with all statutory noise conditions and requirements detailed in the WCPL NMP.

The attended noise-monitoring undertaken by Global Acoustics identified exceedances of the DA305-7-2003 noise impact assessment criteria on one occasion (17 January) and the EPL529 criteria on one occasion (11 November). On both occasions, the corresponding re-measure and follow up measurements were undertaken with resulting levels below the relevant limits.

Results of monitoring were published on the WCPL website and details were provided to the WCPL CCC during meetings, in accordance with the WCPL NMP.

Forty-six (46) complaints were received relating to noise during the reporting period (**Section 8.3**).

WCPL did not receive any written requests for acquisition from the landowners of the land listed in Table 1 of DA305-7-2003 (Condition 1, Schedule 4) nor did it exceed the Land Acquisition Criteria listed in Table 10 of DA305-7-2003 (Condition 7, Schedule 4).

One landowner (located on Redmanvale Road, Jerrys Plains) wrote to DPIE and requested an Independent Noise Review during the previous reporting period (2018). The Independent Noise Review was completed during the reporting period and concluded that there were no identified breaches of the noise consent conditions (**Section 8.3.1**).

5.1.2.1 Comparison with UWJV EIS Predictions

An annual report summarising the attended noise monitoring data and comparisons against the UWJV EIS noise predictions is included in **Appendix C** (Global Acoustics 2020).

Global Acoustics (2020) compared predicted noise levels from the Year 2 scenario in the UWJV EIS (Umwelt 2016) against the actual noise levels measured during 2019.

The comparison indicated that

- At N01, measured Mine noise levels were not comparable to Year 2 predictions.
- At N03 and NA16, measured Mine L_{Aeq} noise levels were not comparable with Year 2 predictions. Measured L_{A1} noise levels were occasionally higher than predicted.
- At N21, measured Mine L_{Aeq} noise levels were lower than Year 2 predictions.
- At N20A and N26, measured Mine noise levels were lower than Year 2 predictions.

5.1.3 Trends and Key Management Implications

Global Acoustics (2020) considered that noise levels at most monitoring locations increased through 2018 (i.e. the previous reporting period) as mining operations progressed to the northwest and were initially less shielded. From 2018 to 2019, site noise levels decreased at most monitoring locations, likely due to mining activity being deeper in the pit and therefore more shielded from receptors (**Appendix C**).

At N21, site-only L_{Aeq} noise levels increased slightly from 2018 to 2019, however, there were no potential exceedances at this location during either calendar year.

As with previous reporting periods, wind speeds and/or temperature inversion conditions were at levels greater than which the development consent conditions would apply for the Mine activities in some instances.

5.1.4 Implemented or Proposed Management Actions

WCPL will continue to implement the noise management measures detailed in the WCPL NMP, including documenting the timing and scale of any operational changes made in response to adverse conditions or noise alarms from monitoring units.

During the next reporting period, WCPL will prepare a revised NMP to incorporate DA305-7-2003 (Modification 16).

5.2 Blasting

Air Blast Overpressure Limits and Ground Vibration Impact Assessment Criteria for the Mine are defined in Condition B22, Schedule 2 of DA305-7-2003 and Condition L5 of EPL 529. Additional conditions relating to blasting hours and frequency, property inspections, assessments and investigations, cumulative impacts, operating conditions, blasting near the WHC, blast monitoring, blast fume and WCPL's BMP are also detailed in these approval documents.

5.2.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the approval criteria for blasting is included in **Table 11**.

A summary of the EIS predictions for blasting is included in **Section 5.2.2.1**, along with WCPL's performance against these predictions during the reporting period. For more information on the EIS predictions, refer to the EIS (Resource Strategies 2003).

In addition to the statutory requirements detailed in **Table 11 ,** WCPL is also required to meet additional requirements detailed within the approved WCPL BMP. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL BMP (**Table 12**).

Table 11: Approval Criteria for Blasting

Location	Airblast overpressure (dB(Lin Peak))	Ground Vibration[1] (mm/s)	Allowable Exceedance
Residence on privately-owned land	120	10	0%
	115	5	5% of total number of blasts over a calendar year
Wambo Homestead	120	5	0%
All other heritage items[2]	133	5	0%
Prescribed dams[2]		50 (unless otherwise directed by the DSC)	0%
Public roads[2]		100	0%
All other public infrastructure[2]		50 (or a limit determined by the structural design methodology in AS 2187.2 – 2006, or other alternative limit for public infrastructure, to the satisfaction of the Planning Secretary).	0%

Note: DSC = Dams Safety Committee; AS = Australian Standards.

1. For St Philip's Church, WCPL shall ensure that ground vibration peak particle velocity generated by the Mine does not exceed 2.5 millimetres per second (mm/s).
2. Additional locations have been included as part of the revised DA 305-7-2003 in response to Mod 17 approved 29 August 2019.

Table 12: Blast Management Plan Performance Indicators

Performance Indicator
Blast monitoring results show 100% compliance with the Blast Criteria.
Blast monitoring results show 100% compliance with the 5 mm/s criteria applied to Wambo Homestead Complex.
No 'Rating 3' fume events leaving the Approved Surface Development Area (Project Area) or closed portion of a public road.
No 'Rating 4' or 'Rating 5' fume events.

5.2.2 Performance during the Reporting Period

Ground vibration levels recorded during the monitoring period complied with the approval criteria at all monitoring locations. A single air blast overpressure exceedance event was recorded at BM05 Muller. A total of 90 blasts were undertaken at the Mine during the reporting period.

Table 13 provides a summary of the results recorded at the blast monitoring sites compared to the approval criteria. It should be noted that BM01 and BM03 are used for performance-based monitoring and therefore any exceedances would not represent a non-compliance with the approval criteria. Two blasts were recorded at BM01 above the airblast overpressure level of 115 dB however these results do not represent a non-compliance with the approval criteria.

A summary of the blast monitoring data is included in **Appendix D**.

Table 13: Blast Monitoring Results 2019

Parameter	Criteria	Results Exceeding Approval Criteria					
		BM02		BM05		BM07	
		No.	%	No.	%	No.	%
Airblast Overpressure Level (dB Lin Peak [dBL])	115	0	0	1*	1	1	1
	120	0	0	1*	1	0	0
Ground Vibration Peak Particle Velocity (mm/s)	5	0	0	0	0	0	0
	10	0	0	0	0	0	0

Note: dBL = low frequency noise levels.

* Only one event resulted in an airblast overpressure greater than 115 dBL at BM05. This event was also over 120 dBL and has been recorded against both of these criteria.

Less than 5% of all blasts recorded overpressure greater than 115 dBL, and no blasts at BM02 or BM07 recorded overpressure greater than 120 dBL. One blast during the reporting period recorded an overpressure over 120 dB (120.6 dB) at BM05 on 13 September 2019. The corresponding ground vibration for this blast was 1.17 mm/s.

No blasts recorded ground vibration greater than 5 mm/s (i.e. less than 5%), and therefore no blasts had a recorded ground vibration greater than 10 mm/s.

No blast fume events with Rating 3 (as defined in the *Australian Explosives Industry and Safety Group [AEISG], Code of Practice - Prevention and management of blast generated NOx Gases in surface blasting*) were recorded leaving the Approved Surface Development Area (Project Area) or closed portion of a public road during the reporting period. No Rating 4 or Rating 5 (AEISG) fume events were recorded at the Mine during the reporting period.

Six (6) complaints were received regarding blasting (i.e. relating to vibrations, dust and fumes) from the Mine during the reporting period (**Section 8.3**).

5.2.2.1 Comparison with EIS Predictions

A comparison of WCPL's blast performance against the Year 13 predictions (Resource Strategies 2003) is summarised in **Table 14**.

Table 14: Comparison of EIS Predictions and 2019 Monitoring Data – Blasting

Land Holder	Midpoint Distance to Dwellings[1]	Predicted Levels		Closest WCPL Blast Monitor to Land Holder	Maximum Recorded Level During Report Period	
		Airblast (dB re 20 µPa)	Vibration (mm/s)		Airblast (dB re 20 µPa)	Vibration (mm/s)
2 Lambkin	4,500 m	112 dBL	1.6 mm/s	BM03[2]	105.5	0.37
25 Fenwick	3,300 m	114 dBL	1.9 mm/s	BM03[2]	105.5	0.37
13(B) Skinner	1,000 m	123 dBL	4.0 mm/s	N/A[3]	N/A[3]	N/A[3]
24 Long	600 m	127 dBL	5.4 mm/s	N/A[3]	N/A[3]	N/A[3]

Note: µPa = micropascals.

1. Based on planned production/mine progression.
2. BM03 is used for performance based monitoring only. It is located on WCPL owned land to the south of the Mine, closer to the Mine than the dwellings.
3. This property is now owned by WCPL.

During the reporting period, a maximum air blast overpressure level of 105.5 dBL was recorded at BM03 (13 September 2019), which is located closer to blasting activity than the Fenwick and Lambkin dwellings. This was 8.5 dB below the predicted airblast overpressure level for Fenwick (114 dBL) and 6.5 dB below the predicted airblast overpressure level for Lambkin (112 dBL). For comparison, the overpressure level recorded at the other WCPL blast monitors during this blast was:

- 115.5 dBL at BM01 (approximately 3 km north of BM03 [also located on WCPL land]);
- 98.1 dBL at BM02 (approximately 5 km north east of BM03);
- 96.9 dBL at BM05 (approximately 10 km north west of BM03); and
- 83.4 dBL at BM07 (approximately 10 km north west of BM03).

The maximum ground vibration level recorded at BM03 was 0.37 mm/s (on 18 January 2019). This is well below the predicted levels for both Lambkin and Fenwick.

5.2.3 Trends and Key Management Implications

A total of were 90 blasts were recorded during 2019, compared with 96 in 2018, 96 in 2017, 106 in 2016, 79 in 2015, 75 in 2014 and 62 in 2013. Air blast overpressure and ground vibration levels recorded during the 2019 blasts were similar to those recorded in the previous reporting periods. One blast during the reporting period resulted in an exceedance of the criteria for overpressure (120 dBL) at BM05 on 21 September 2019. The corresponding ground vibration for this blast was 1.17 mm/s.

In accordance with the BMP, WCPL notified the EPA and DPIE immediately, conducted an investigation and provided an incident report on 27 September 2019. No complaints were received at the time of the event. Further detail in relation to the incident is provided in **Section 10.1**.

Prior to 2019, no exceedances of the blasting limits had been recorded at compliance monitoring sites (i.e. BM02, BM05 and BM07) during the last five reporting periods.

During the reporting period, blasting was undertaken within 2 km of the WHC on three occasions (31 July 2019, 13 September 2019 and 20 December 2019). In accordance with Condition B22, Schedule 2 of DA305-7-2003, ground vibration and air blast levels were recorded for each event. Condition B33, Schedule 2 of DA305-7-2003 requires that blasting on the site does not cause exceedances of 120 dBL (overpressure) or 5 mm/s (vibration) at the WHC. No exceedances of these criteria were identified during the reporting period. The results of these blasts are discussed further in the WHC Structural Assessment Annual Report (Bill Jordan & Associates, 2020). The report prepared by Bill Jordan & Associates (2020) has been provided to the NSW Heritage Office.

WCPL achieved a data capture rate of 100% for overpressure and 100% for vibration during the reporting period[4].

5.2.4 Implemented or Proposed Management Actions

During the next reporting period, WCPL will continue to implement the approved WCPL BMP.

A copy of the report prepared by Bill Jordan & Associates (2020), which incorporates the six-monthly report and the results of blasting within 2 km of the WHC, has been forwarded to the NSW Heritage Office.

5.3 Air Quality

Air Quality Criteria for the Mine are defined in Table 6 of DA305-7-2003 (Condition B42, Schedule 2) and EPL529 (Condition P1). Additional conditions relating to air quality, odour and greenhouse gas emissions, land acquisition, operating conditions and WCPL's AQGGMP are also detailed in these documents.

5.3.1 Approval Criteria/EIS Predictions and Management Plan Requirements

The Development Consent (DA 305-7-2003) was modified following the determination of Modification 16 on 29 August 2019 to incorporate changes to the approval criteria for air quality. The DPIE was consulted regarding the correct approach for reporting against the criteria in the Development Consents that were applicable during the reporting period. DPIE's advice was:

- *A limit of 30 µg/m^3 applies from 1 January to 28 August. The air quality data over this period is averaged over a 241 day period (i.e. dividing by 241 rather than 365 to obtain the average over this period).*
- *A limit of 25 µg/m^3 applies from 29 August to 31 December. The air quality data over this period is average over a 124 day period (i.e. dividing by 124 rather than 365 to obtain the average over this period).*

A summary of the approval criteria for air quality applicable during the reporting period is included in **Table 15**.

[4] Homestead (structural monitoring; BM01) and Harris (performance monitoring; BM03) monitors have been excluded from the above calculations due to not being compliance based monitoring points.

Table 15: Approval Criteria for Air Quality

Modification Approval	Pollutant	Averaging Period	Criterion
Mod 17 – Air Quality Assessment Criteria (1 Jan – 28 Aug)	TSP matter	Annual	[a,c] 90 µg/m^3
	Particulate Matter <10 µm (PM_{10})	Annual	[a,c] 30 µg/m^3
		24 hour	[b,c] 50 µg/m^3
	Deposited Dust [d]	Annual	[b,d] 2 g/m^2/month (maximum increase)
			[a,d] 4 g/m^2/month (maximum total)
Mod 17 – Air Quality Acquisition Criteria (1 Jan – 28 Aug)	TSP matter	Annual	[a,c] 90 µg/m^3
	Particulate Matter <10 µm (PM_{10})	Annual	[a,c] 30 µg/m^3
		24 hour	[a,c] 150 µg/m^3
		24 hour	[b,c] 50 µg/m^3
	Deposited Dust [d]	Annual	[b,d] 2 g/m^2/month (maximum increase)
			[a,d] 4 g/m^2/month (maximum total)
Mod 16 – Air Quality Assessment Criteria (29 Aug – 31 Dec)	Particulate Matter <10 µm (PM_{10})	Annual	[a,c] 25µg/m^3
		24 hour	[b] 50 µg/m^3
	Particulate Matter < 2.5 µm ($PM_{2.5}$)	Annual	[a,c] 8 µg/m^3
		24 hour	[b] 25 µg/m^3
	TSP matter	Annual	[a,c] 90 µg/m^3

Note: TSP = total suspended particles, PM_{10} = particulate matter with a diameter less than 10 micrometers, $PM_{2.5}$ = particulate matter with a diameter less than 2.5 micrometers, µg/m^3 = micrograms per cubic metre, g/m^2/month = grams per square metre per month.

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 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.

Following the determination of the UWJV, the appropriate EIS documentation to refer to is the UWJV EIS (Umwelt 2016).

A summary of the UWJV EIS predictions for air quality is included in **Section 5.3.2.1**, along with WCPL's performance against these predictions during the reporting period. For more information on the UWJV EIS predictions refer to the UWJV EIS (Umwelt 2016).

In addition to the statutory requirements detailed in **Table 15**, WCPL is also required to meet additional requirements outlined in the approved WCPL AQGGMP. These requirements include reporting of greenhouse gas monitoring data in the Annual Review (**Section 5.4**).

5.3.2 Performance during the Reporting Period

Air quality monitoring was undertaken during the reporting period, in accordance with the approved WCPL AQGGMP. A review of the air quality monitoring data for the reporting period was undertaken by Jacobs (2020) and is included in **Appendix D.**

During the reporting period, WCPL complied with all statutory conditions relating to air quality, with the exception of continuous monitoring of 24 hour PM_{10} levels at PM02 on one occasion, PM03 on two occasions and PM04 on four occasions, AQ01 on 8 occasions, AQ03 on 14 occasions and AQ04 on 30 occasions (**Section 10.3**). These breaks in continuous monitoring were a result of storms, Ausgrid maintenance, power outages, and communication errors and were addressed as quickly as possible following identification of the issue.

WCPL complied with all additional air quality requirements detailed in the WCPL AQGGMP.

Late 2019 coincided with a period of unprecedented bushfires in Australia, predominantly across southeast Australia. These bushfires adversely affected air quality across many parts of NSW, including the Hunter Valley, and a total of 66 days in 2019 were considered to be extraordinary events for the purposes of determining compliance with the Development Consent (DA 305-7-2003) criteria.

Jacobs (2020) concluded that:

- Including extraordinary events, there were 79 unique days when the 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at one or more monitoring locations (20 days up to 28 August 2019 and 59 days from 29 August to 31 December 2019).
    - For the period up to 28 August 2019, exceedances of 50 µg/m^3 (24-hour average PM_{10}) were likely to have been influenced by activities at Wambo Mine on four of the 20 exceedance days. None of the calculated site contributions were above the applicable Development Consent criterion.
    - For the period from 29 August to 31 December 2019, there was one day when the calculated site contribution exceeded the 50 µg/m^3 incremental criterion (10 December). This day was declared as an extraordinary event and measured 24-hour average PM_{10} concentrations at all Wambo monitoring sites were in the order of 150 to 200 µg/m^3. The calculated WCPL contribution at monitoring site D4 was 76 µg/m^3. The production logs indicated that all reasonable and feasible avoidance and mitigation measures were employed. As such, this event is not considered to represent a non-compliance with WCPL's 24-hour average PM_{10} criterion as it was unlikely to have been caused by the Mine (refer to **Table 20**). **Section 5.3.3.2** describes the operational controls applied on this day.
- The annual average PM_{10} concentration, excluding data from days considered extraordinary events, did not exceed the 25 µg/m^3 criterion.
- Including extraordinary events, there were 20 unique days when the 24-hour average $PM_{2.5}$ concentration (monitored at Singleton) exceeded 25 µg/m^3 (0 days up to 28 August 2019 and 20 days from 29 August 2019 to 31 December 2019).
    - Nineteen of the 20 days were considered extraordinary events.

- For the period from 29 August to 31 December 2019, there was one day when the 24 hour average $PM_{2.5}$ concentration (monitored at Singleton) exceeded the 25 µg/m^3 criterion (29 October). Air quality conditions on 29 October 2019 would have been influenced by the bushfire activity in late October (24 to 28 October and 30 October to 2 November were considered extraordinary events) and because $PM_{2.5}$ particles remain airborne for a longer period of time than PM_{10}. This event is not considered to represent a non-compliance with WCPL's 24-hour average $PM_{2.5}$ criterion.

- The annual average $PM_{2.5}$ concentration (monitored at Singleton), excluding data from days considered extraordinary events, did not exceed the 8 µg/m^3 criterion.

Three (3) complaints were received regarding dust from the Mine during the reporting period (**Section 8.3**).

WCPL did not receive any written requests for acquisition from the landowners of the land listed in Table 11 of DA305-7-2003 (Condition C1, Schedule 2).

On 30 September 2019, WCPL received an official caution and penalty notice in relation to visible air pollution identified by a community member on 6 December 2018 and 22 February 2019. Additional information in relation to the non-compliance with Condition 5B, Schedule 4 of DA305-7-2003 (now Condition B45[a][ii], Schedule 2 of DA305-7-2003 [Modification 17]) (i.e. minimisation of visible off-site air pollution) is available in **Section 10.4**.

There were no other incidents relating to air quality, odour or greenhouse gases during the reporting period.

5.3.2.1 Comparison with UWJV EIS Predictions

The UWJV EIS (Umwelt 2016) included predicted cumulative TSP, PM_{10} and dust deposition levels for four operational scenarios (Years 2, 6, 11 and 16). These years approximately translate to 2022, 2026, 2031 and 2036. Accordingly, the Year 2 scenario best represents current operations at the Mine.

A summary of the predicted cumulative annual average TSP, PM_{10} and dust deposition levels for the Year 2 and 6 scenarios at the WCPL air quality monitoring sites assessed in the UWJV EIS (Umwelt 2016) air quality assessment, is provided in **Table 16**. The annual average TSP, PM_{10} and dust deposition levels recorded during the reporting period are also provided in **Table 16**. The UWJV EIS (Umwelt 2016) did not provide predictions for $PM_{2.5}$ at the Singleton monitoring site. An onsite $PM_{2.5}$ monitor is scheduled for installation in 2020.

The annual average TSP concentrations were slightly above the predicted cumulative TSP concentrations at HV02 and HV04 and below the predicted cumulative TSP concentrations at HV01 and HV03 (**Table 16**).

The annual average PM_{10} concentrations were below the predicted cumulative annual average PM_{10} concentrations at AQ01 and slightly above the predicted cumulative annual average PM_{10} concentrations at AQ02, AQ03 and AQ04.

The monitored dust deposition rates were above the predicted cumulative dust deposition rates at the relevant residences assessed in the EIS (Resource Strategies 2003) (**Table 16**). This is consistent with the 2014, 2015, 2016 and 2017 results.

The difference between the predicted and monitored TSP, PM_{10} and dust deposition levels is considered to be due to a number of factors, including natural variability in background air quality (e.g. dust storms and bush fires).

Table 16: Comparison of UWJV EIS Predictions and 2019 Monitoring Data – Air Quality

Parameter	UWJV EIS Predictions			2019 Monitoring
	Site	Year 2 (2022)	Year 6 (2026)	
Annual Average TSP ($\mu g/m^3$)[1]	HV01	66	63	60
	HV02	51	51	62.5
	HV03	52	51	45
	HV04	57	54	62.5
Annual Average PM_{10} ($\mu g/m^3$)	AQ01 (PM01)	34	33	24.1
	AQ02 (PM02)	16	16	25
	AQ03 (PM03)	17	16	18.8
	AQ04 (PM04)	22	21	25.1
Average Annual Deposited Dust (g/m^2/month)[2]	D11	2.3	2.3	2.1
	D19	3.8	3.4	3.8
	D21	2.6	2.4	1.7
	D22	2.9	2.7	3.7

Source: After Umwelt (2016) and Jacobs (2020).

1. TSP is estimated from PM_{10} monitoring data based on the relationship that 33% of TSP is PM_{10}.
2. Deposited Dust is not required to be monitored under DA305-7-2003 (MOD 16) therefore average does not take into account data after August 2019.

5.3.3 Trends and Key Management Implications

During the reporting period, the WCPL Environmental Department provided training to the open cut workforce, which included real time noise and dust monitoring training with operators responsible for on-shift monitoring of noise and dust.

WCPL also shut down or modified its open cut operations proactively as required in response to adverse wind conditions and utilised drone fly-overs and in-pit cameras to visually monitor and manage in-pit dust and post blast dust.

There were no other air quality, odour or greenhouse gas management implications arising from WCPL's operations for the reporting period.

5.3.3.1 TSP

A study on co-located TSP and PM_{10} monitors conducted in the Hunter Valley by the NSW Minerals Council (2010) indicated that dust generated from predominately coal mining sources has long-term average PM_{10} concentrations that are approximately 40% of the corresponding TSP concentration (or equivalently, TSP concentrations are approximately 2.5 times PM_{10} concentrations). This ratio was found to be reasonably accurate for long-term averages (e.g. annual averages).

The long-term average ratio of PM_{10} to TSP over the four co-located monitoring sites at the Mine over a six year period was 33% (or equivalently, TSP concentrations are approximately three times PM_{10} concentrations). Using this ratio, TSP levels during the reporting period were lower than those previously recorded in 2017 and 2018, as shown in **Table 17** and **Figure 5**. The data shows there was a general increase in recorded TSP levels from 2011 to 2014, with a dip in 2015 and 2016, before increasing again in 2017 and 2018 and then decreasing again in 2019.

Table 17: TSP Annual Averages (µg/m³) (2011-2019)

HVAS	2011	2012	2013	2014	2015	2016	2017	2018	2019
HV01	56.7	64.8	61.0	66.0	54.8	47.8	68.8	77.1	60.0
HV02	48.8	61.4	62.0	58.0	51.5	47.7	61.6	70.8	62.5
HV03	49.0	38.9	41.0	48.0	40.6	39.5	50.0	55.8	45.0
HV04	41.0	58.6	49.0	63.0	60.6	56.6	64.1	75.3	62.5

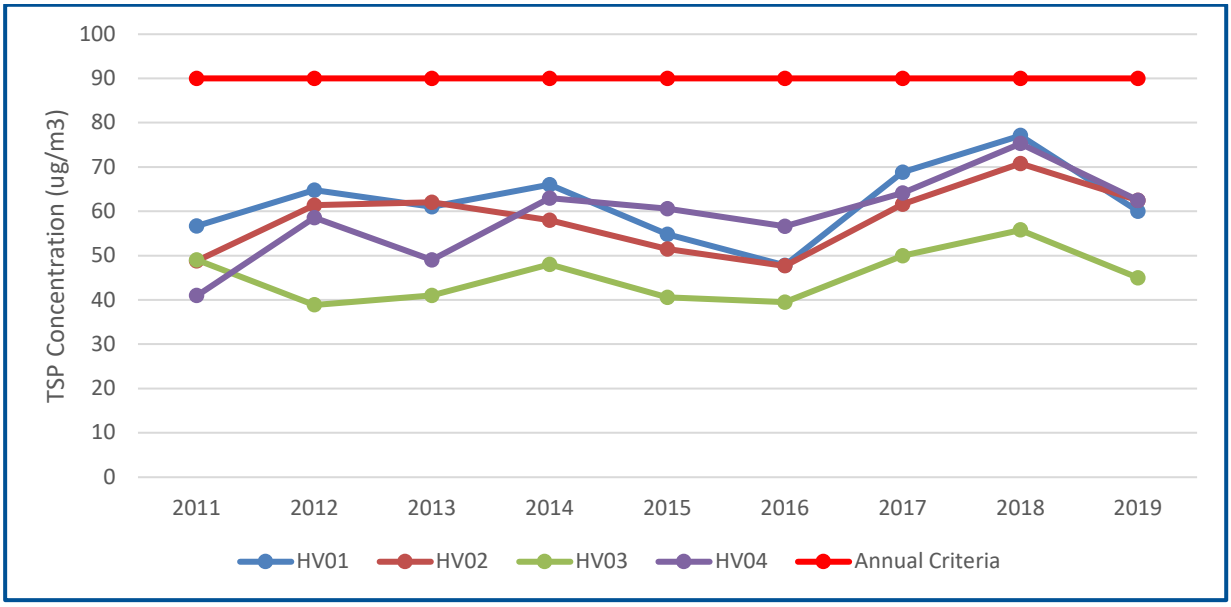

Figure 5: TSP Annual Averages (2011-2019)

Compared to the UWJV EIS predictions for Year 2 (Umwelt 2016), cumulative TSP concentrations were slightly above predictions at HV02 and HV04 and below predictions at HV01 and HV03 (**Table 16**).

5.3.3.2 PM_{10}

PM_{10} concentrations recorded by WCPL's four Tapered Element Oscillating Microbalance Analyser (TEOMs) during the reporting period are shown in **Table 18** and **Figure 6**. The data shows that PM_{10} concentrations remained relatively consistent from 2011 to 2017, with the highest concentrations recorded to date observed in 2018 and 2019. This is considered to be due to open cut mining moving to a more exposed location in the Montrose Open Cut Pit during 2018 and 2019. Levels are anticipated to reduce as mining progresses.

Table 18: PM_{10} Annual Averages (µg/m³) (2011-2019)

TEOM	2011	2012	2013	2014	2015	2016	2017	2018	2019
Annual Average in µg/m³									
AQ01 (PM01)	16.8	21.0	19.3	18.0	15.7	15.6	20.6	25.7	24
AQ02 (PM02)	17.2	21.1	22.3	19.0	16.0	17.5	19.1	23.6	18
AQ03 (PM03)	16.7	16.6	16.5	15.3	12.9	14.1	14.6	18.6	25
AQ04 (PM04)	16.2	18.3	16.8	17.7	16.5	16.3	17.2	25.1	25
Maximum 24-hour Average in µg/m³									
AQ01 (PM01)	49	47	65	55	52	49	66	151.9[1]	59
AQ02 (PM02)	83	76	97	70	55	49	52	163.5[1]	54
AQ03 (PM03)	43	47	71	51	43	39	39	143.8[1]	64
AQ04 (PM04)	43	45	65	56	71	44	49	125.0[1]	73
Number of Days Above 24-hour Average Criteria									
AQ01 (PM01)	0	0	4	2	1	0	5	15	9
AQ02 (PM02)	2	7	20	2	3	0	2	9	1
AQ03 (PM03)	0	0	1	1	0	0	0	6	9
AQ04 (PM04)	0	0	3	1	2	0	0	12	6

1. If the results on 22 and 23 November 2018 are discounted as they were the result of a state-wide dust storm, the maximum 24-hour averages are; 80.6 µg/m³ at AQ01, 66.0 µg/m³ at AQ02, 58.70 µg/m³ at AQ03 and 70.9 µg/m³ at AQ04.

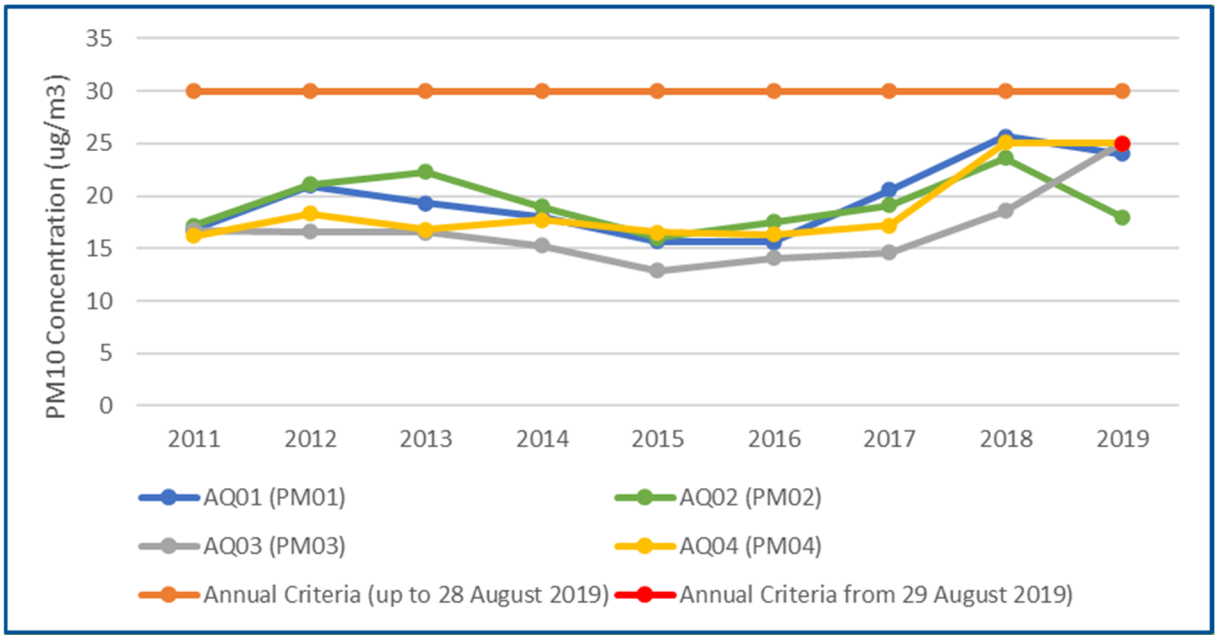

Figure 6: PM_{10} Annual Averages (2011-2019)

A review of the PM_{10} data for 2019 was completed by Jacobs (2020) and is included in **Appendix D**. The review estimated the contribution from WCPL on each day where 24-hour PM_{10} concentrations exceeded 50 µg/m^3. This estimation is conservative as it estimates the site contribution based on downwind concentration minus upwind concentration, on the assumption that no other sources are present. **Table 20** outlines the operational responses on each of the days during the reporting period with PM_{10} concentrations exceeding the 24-hour average criterion with the site-only contribution (i.e. incremental contribution).

5.3.3.3 $PM_{2.5}$

$PM_{2.5}$ concentrations were recorded by the DPIE Singleton Monitoring Station during the reporting period and results are shown in **Table 19**. There were 20 days when the monitored $PM_{2.5}$ concentration exceeded 25 µg/m^{3}at the Singleton station and 19 of these days were declared as extraordinary events. One day, 29 October 2019, recorded 31 µg/m^3. Air quality conditions on 29 October 2019 would have been influenced by the bushfire activity in late October given that 24 to 28 October and 30 October to 2 November were declared as extraordinary events and because $PM_{2.5}$ particles remain airborne for a longer period of time than PM_{10}. The annual average $PM_{2.5}$ concentration for both 1 January 2019 to 31 December 2019 and 29 August 2019 to 31 December 2019 did not exceed the 8 µg/m^3 criterion. It has been inferred that $PM_{2.5}$ concentrations in the vicinity of Wambo Mine would also have been below the 8 µg/m^3 criterion.

Table 19: Summary of $PM_{2.5}$ Concentrations Measured at Singleton in 2019

Statistic	All Data	All Data Except Extraordinary Events
1 Jan to 31 Dec (365 days)		
Days of data available	356	299
Maximum 24-hour average (µg/m^3)	69	31
Number of days above 50 µg/m^3	20	1
Average (µg/m^3)	**11**	**8**
29 Aug to 31 Dec (125 days)		
Days of data available	121	68
Maximum 24-hour average (µg/m^3)	69	31
Number of days above 50 µg/m^3	20	1
Average (µg/m^3)	**16**	**7**

Table 20: Operational Actions Implemented on Days of Elevated PM_{10}

Date	Measured 24-hour Average PM_{10} Concentration in $\mu g/m^3$ (estimated site contribution by Jacobs in parentheses)				Time of Peak Dust	Operational Response	Comment on Compliance
	D1 Muller (AQ04)	D2 Caban (AQ03)	D3 Coralie (AQ01) [1]	D4 Thelander (AQ02)			
10/12/2019	149 (0)	197 (10)	150 (0)	208 (76)	11.00pm	Site analysis tool run to determine WCPL contribution.	The exceedance occurred on a day declared as an extraordinary event and measured 24-hour average PM_{10} concentrations at all Wambo monitoring sites were in the order of 150 to 200 $\mu g/m^3$. WCPL contribution at D4 was 76 $\mu g/m^3$. The measured hourly PM_{10} concentrations on 10 December as well as the concurrent wind conditions show that the PM_{10} concentrations at the downwind monitor (D4 Thelander) deviated most significantly from the concentrations at the upwind monitors (D2 Caban and D3 Coralie) at around 11 pm. This deviation led to the calculated site contribution of 76 $\mu g/m^3$, averaged over the 24-hours. Of relevance to managing impacts to air quality, WCPL's production logs for 10 December 2019 showed that: • The first bucket was at approximately 5:10 am and the last bucket was at 8:30 pm for all excavators. • All trucks loads were on standby for the majority of the shift and worked between 0.6 and 7 hours of the 10.5 hour shift (depending on the truck). • The open cut pit shut at 8:30 pm and the underground shut at 9.00 pm for "smoky conditions due to regional bush fire event". Observations were of "extreme haze, poor visibility, poor respiratory conditions". • Observed conditions included "Extreme heat 40+ degrees with a cool change coming in". • All available [water carts] x4 utilised and running to procedure. • The dust monitoring records in the production report indicated elevated levels until 1.00 am. This indicates that all reasonable and feasible avoidance and mitigation measures were employed so that particulate matter emissions generated by the Wambo Mine did not cause exceedances of the criteria. As such, 10 December 2019 does not represent a non-compliance with regards to the 50 $\mu g/m^3$ criterion.

5.3.3.4 Dust Deposition

Dust deposition levels were recorded by WCPL's dust deposition gauges (DDGs) during the reporting period until August 2019 as it is no longer required under DA305-7-2003 (MOD16) (**Table 21**). No exceedances of the annual average 4 g/m^2/month were identified during the reporting period.

Table 21: Dust Deposition Annual Averages (g/m^2/month) (2011-2019)[1]

DDG	2011	2012	2013	2014	2015	2016	2017	2018	2019
Privately Owned Land									
D11	2.0	2.2	2.2	2.5	2.2	2.3	1.4	1.9	2.1
D21	1.2	1.4	1.9	1.9	2.0	1.7	1.2	1.6	1.7
D22	1.2	1.4	2.0	2.2	2.0	2.2	2.4	2.5	3.7
WCPL Owned Land									
D19	2.5	2.9	3.1	2.9	3.1	2.5	2.3	3.0	3.8

1. Sources of foreign material including bird droppings, insects, sticks and other organic matter can be identified in samples when analysed. Contamination is assessed based on field observations, laboratory observations, and historical data and wind patterns. All monthly dust results deemed to be contaminated were excluded from the annual average.

5.3.4 Implemented or Proposed Management Actions

During the reporting period, WCPL continued to conduct training sessions with the open cut workforce on real-time noise and dust monitoring and in particular, for the operators responsible for on-shift monitoring of noise and dust.

During the reporting period, WCPL fitted four water carts with GPS units to monitor the frequency and movement of the water carts across the site.

WCPL will continue to implement the approved WCPL AQGGMP.

5.4 Greenhouse Gas

There are no approval criteria for greenhouse gas emissions in WCPL's statutory approvals.

5.4.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the EIS predictions for carbon dioxide (CO_2) emissions is included in **Section 5.4.2**, along with WCPL's performance against these predictions from 2014 to 2019. For more information on the EIS predictions refer to the EIS (Resource Strategies 2003).

WCPL is required to report greenhouse gas monitoring data in the Annual Review, in accordance with the approved WCPL AQGGMP.

5.4.2 Performance during the Reporting Period

WCPL calculates and reports on greenhouse gas emissions at the end of every financial year, hence the summary data provided in **Table 22** below is for the period 1 July 2018 to 30 June 2019. Data for the second half of the 2019 reporting period will be included in the 2020 Annual Review.

A total of 186,220 tonnes of CO_2 was emitted by the Mine's ventilation systems in 2019 compared to the predicted 2,644,503 tonnes.

The emissions predictions in the 2003 EIS were based on the assumption that the simultaneous mining of two longwalls (Arrowfield and Bowfield) in conjunction with Arrowfield/Bowfield gas drainage occurring during 2019. During this reporting period, only one longwall was operational which accounts for actual emissions only being approximately 30% of the predicted volumes.

A total of 567,479 tonnes of carbon dioxide equivalent (CO_2-e) was emitted from the operation from all other sources. This is higher than the predicted 120,393 tonnes of CO_2-e due to the inclusion of 355,759 tonnes of CO_2-e from the decommissioned North Wambo Underground Mine. Ventilation emissions have been gradually decreasing over the years due to the change from methane rich coal seam gas to CO_2 rich coal seam gas, as the Mine has progressed from the North Wambo Underground Mine to the South Bates (Whybrow and Wambo Seam) Underground Mine. This change is part of a regional gas change that happens to occur across the Wambo lease. The 2018-19 financial year was the third National Greenhouse and Energy Reporting (NGER) year that Wambo had emissions from a decommissioned mine due to North Wambo Underground Mine closing in April 2016.

The total emissions emitted from the Mine during the reporting period (753,699 tonnes of CO_2-e) is less than in previous reporting periods (**Table 22**).

5.4.3 Trends and Key Management Implications

Levels of total CO_2 emissions monitored from the main ventilation shafts in 2014 to mid-2016 were indicative of the active mining at the North Wambo Underground Mine. Following the closing of the North Wambo Underground Mine in 2016, a significant proportion of the methane (CH4) emissions previously recorded at the main ventilation shaft shifted to being presented under a 'closed mine calculation'. The overall annual emissions from the Mine during the last five reporting periods have remained relatively consistent.

Annual emissions from diesel and other sources associated with production-related electrical generation have overall remained relatively consistent with EIS predictions and between reporting periods.

5.4.4 Implemented or Proposed Management Actions

WCPL did not undertake any targeted energy saving projects during 2019, however energy efficiency is considered during the design and construction of haul roads and mine planning.

Table 22: Comparison of EIS Predictions and Monitoring Data – Greenhouse Gas

Parameter	Monitoring Point	Monitoring Frequency	Emissions Calculated	Calculated CO_2-e tonnes for 2014 – 2015	Calculated CO_2-e tonnes for 2015 – 2016	Calculated CO_2-e tonnes for 2016 – 2017	Calculated CO_2-e tonnes for 2017 – 2018	Calculated CO_2-e tonnes for 2018– 2019	EIS predicted CO_2-e tonnes for 2019[1]
Ventilation Systems									
Methane (CH4)	Main Ventilation Shaft	Real-time continuous	Emission factor to convert from tonnes of CH4 to tonnes of CO_2-e	703,596	618,127	137,521	227,824	145,110	
Carbon Dioxide (CO_2)	Main Ventilation Shaft	Real-time continuous	Tonnes of CO_2-e	26,750	30,552	33,184	43,471	41,007	
Total				**730,346**	**648,679**	**170,705**	**270,295**	**186,117**	**2,644,503**
Other (Diesel and Electrical Power)									
Diesel Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	92,935	97,983	97,274	92,034	101,556	
Oil Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	280 (plus 321 kL not combusted)	339 (plus 104 kL not combusted)	44 (plus 206 kL not combusted)	163 (plus 643.5 kL not combusted)	23	
Grease Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	0 (plus 63 kL not combusted)	0 (plus 42 kL not combusted)	0 (plus 26 kL not combusted)	0 (plus 67.1 kL not combusted)	0	
Electricity Use	Calculated from invoices	Annually	Emission factor to convert from kWh use to tonnes of CO_2-e	78,576	76,506	63,435	64,185	63,213	
ROM Coal Production	Calculated from weight meter and survey	Monthly	Fugitive emissions factor based on ROM production[3]	59,124 (UG Stockpile residual emissions) 31,899 (OC Fugitives)	80,543 (UG Stockpile residual emissions) 24,634 (OC Fugitives)	69,202 (UG Stockpile residual emissions) 518,263 (closed mine calculation) 45,227 (OC Fugitives)	45,880 (UG Stockpile residual emissions) 472,331 (closed mine calculation) 18,231 (OC Fugitives)	46,992 (UG stockpile residual) 355,759 (closed mine calculation) 6,212 (OC Fugitives)	
Gas Drainage[4]	-	Annually	Tonnes of CO_2-e	-	-	-	145	0	
Sub-Total (Scope 1 and 2)				**262,814**	**280,005**	**793,445**	**692,969**	**573,755**	**120,393**
Total				**993,160**	**928,684**	**964,150**	**963,264**	**759,872**	**2,764,896**

Note: kL = kilolitres, OC = Open Cut, UG = Underground, kWh = kilowatt hours.

1. Refer to Tables 16 and 17 of Appendix B of the WCPL EIS (Resource Strategies 2003).
2. Anomalous results recorded during 2014 for non-combustible grease and oil use are believed to be due to human error in internal accounting procedures.
3. Wambo Open Cut uses Method 2 in situ measured emissions calculations for fugitive emissions. This involves the application of a gas model to as-mined pit shells for the year to generate the measured emissions number.
4. Financial Year 17/18 was the first time that a gas drainage plant was used. The plant was used intermittently.

5.5 Meteorology

WCPL are required to maintain a meteorological monitoring station at the Mine and monitor the parameters specified in Condition B50 of Schedule 2 (DA305-7-2003) and EPL529 (Condition M4), using the specified units of measure, averaging period, frequency and sampling method described in the tables. In July 2017, WCPL replaced the meteorological monitoring station.

WCPL maintains the meteorological monitoring station in accordance with AS 2923-1987. The following parameters are monitored by the meteorological monitoring station, in accordance with WCPL's statutory conditions:

- temperature (at 2 m and 10 m);
- rainfall;
- lapse rate[5];
- wind speed (at 10 m);
- wind direction (at 10 m);
- solar radiation (at 10 m);
- humidity; and
- sigma theta.

Table 23 summarises the annual rainfall, temperature and wind direction data for 2019, compared to previous reporting periods.

Table 23: Environmental Performance – Meteorology (2014-2019)

Parameter	2014	2015	2016	2017	2018	2019
Rainfall (mm)	556.44	789.49	721.18	442.50	536.2	387.4
Maximum Temperature (°C)[1]	45.3 (Nov)	40.8 (Nov)	41.6 (Dec)	46.8 (Feb)	43.8 (Jan)	44 (December)
Minimum Temperature (°C)[1]	-1.7 (June)	-0.85 (June)	-3.4 (July)	-3.5 (July)	-5.5 (July)	-2.9 (August)
Mean Temperature (°C)[1]	18.1	19.2	18.4	18.5	18.7	19.2
Predominant Wind Direction	E/SE (summer) W/NW (winter)	S/SE (summer) W/SW (winter)[2]	S/SE (summer) SW (winter)	S/SE (summer) W/SW (winter)	S/SE/E (summer) NW (winter)	E/SE (summer) WNW/NW (winter)

Note: °C = degrees Celsius, E = East, SE = South-east, W = West, NW = North-west, S = South, SW = South-west, mm = millimetres.

1. Measured at 2 m above ground.
2. The winter data (2015) was influenced by the use of the Charlton Ridge weather station which may explain the change in weather direction as WCPL's weather station was experiencing software issues.

The 2019 EPA Annual Return reported a non-compliance with the monitoring frequency requirements of Condition M4.1 of EPL 529. Further detail is provided in **Section 10.2**.

5 WCPL calculates the lapse rate from measurements made at 2 m and 10 m, in accordance with DA305-7-2003.

5.6 Biodiversity

During the reporting period, WCPL updated the BioMP (previously called the Flora & Fauna Management Plan [FFMP]) as a component of the Extraction Plan for Longwalls 17 to 20 at the South Bates Extension Underground Mine (Version 16). The BioMP (Version 16) was approved in June 2019 and incorporates the Biodiversity Offset Management Strategy required under Condition B75 (g), Schedule 2 of DA305-7-2003. It also addresses the requirements within the Voluntary Conservation Agreements (VCA) prepared under Condition B75 (g), Schedule 2 of DA305-7-2003, and the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approvals (EPBC 2003/1138, EPBC 2016/7636 and EPBC 2016/7816).

The BioMP also meets the requirement for a Biodiversity Management Plan under Condition B7(f), Schedule 2 of DA305-7-2003 in support of the Extraction Plan for the South Bates Underground Mine Longwalls 11 to 16 and the Extraction Plan for the South Bates Extension Underground Mine Longwalls 17 to 20.

The BioMP applies to all activities undertaken within WCPL's mining authorisations and approved mining areas that may impact on biodiversity, as well as biodiversity in WCPL's RWEAs and Open Cut Revegetation Areas. The BioMP has been developed to:

- identify lands to be managed in accordance with this BioMP;
- provide a framework for the management of biodiversity in the RWEAs and Open Cut Revegetation Areas;
- provide a clear, concise set of management actions and a schedule for the coordinated and effective delivery of biodiversity enhancement;
- define realistic Completion Criteria for RWEAs and Open Cut Revegetation Areas that can be quantitatively evaluated through a seasonally based monitoring program;
- define a seasonally based monitoring program suitable for determining management success (or otherwise);
- provide suitable contingency measures and associated Trigger Action Response Plans (TARPs) that adequately address any deviation from the Completion Criteria; and
- define the responsibilities for implementing, reviewing and reporting on the BMP.

5.6.1 Approval Criteria/EIS Predictions and Management Plan Requirements

Performance measures for subsidence impacts on biodiversity are detailed in Condition B1, Schedule 2 of DA305-7-2003 (**Section 5.9.2**). WCPL are required to monitor and report on biodiversity in accordance with the conditions of DA305-7-2003, DA177-8-2004, EPBC 2003/1138, EPBC 2016/7636, EPBC 2016/7816 and the approved BioMP.

As part of the development of the BioMP, WCPL transferred across to a combined Landscape Function Analysis (LFA) and biometric monitoring methodology. The LFA target scores and floristic performance criteria are provided in **Table 24** and **Table 25**, respectively**.**

Table 24: LFA Target Scores

Site Type	LOI[1]	SI[1]	INFI[1]	NI[1]
Woodland Rehabilitation	>0.87	>59	>43	>36
Pasture Rehabilitation	>0.93	>61	>29	>25
NWCD	>0.84	>62	>41	>37
Wambo Creek	>0.84	>62	>41	>37

1. LOI = landscape organisation index, SI = stability index, INFI =infiltration, NI = nutrient index.

Table 25: Floristic Performance Criteria for Plant Community Types in RWEAs and Performance Targets for Older Woodland Areas and Rehabilitation Sites

	Attribute[1]									
	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Rehabilitation										
Older Woodland Areas with a canopy of Sugar Gum	>15	15-40	5-40	5-15	5-10	5-15	<20	1	-	5
Areas of Narrow-leaved Ironbark – Bull Oak - Grey Box open forest	>20	10-40	5-10	15-50	5-10	5-40	<20	1	-	-
RWEAs										
PCT42[2]	>20	10-50	10-50	20-60	1-5	5-30	<10	1	-	-
PCT1658[2]	>20	10-40	10-50	4-20	5-30	5-35	<10	1	-	-
PCT1603[2]	>25	10-40	5-10	15-50	5-10	5-40	<5	1	-	-
PCT1604[2]	>35	15-40	5-20	30-50	5-15	5-40	<5	1	-	-
PCT1176[2]	>21	15-40	5-30	5-30	0-25	2-10	<5	1	-	-
PCT1584[2]	>45	15-45	5-40	5-40	10-20	5-20	0	1	-	-

1. NPS = the number of native plant species (native to NSW), NOS (%) (including *E.cladocalyx*) = projected native foliage cover of canopy, NMS (%) (including *A.saligna*) = projected native midstorey cover, NGCG = native groundcover of grasses, NGCS = native groundcover of shrubs, NGCO = native groundcover of other plant types (sedges, herbs etc.), EPC = exotic plant cover, OR = overstorey regeneration over the whole vegetation zone, HBT = hollow bearing trees, FL= length of fallen logs >10 cm diameter within the vegetation plot, PCT = plant community type.
2. PCT42: River Red Gum/River Oak riparian woodland wetland in the Hunter Valley.
   PCT1658: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak – Coast Banksia woodland on sands of the Warkworth area.
   PCT1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter.
   PCT1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter.
   PCT1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion.
   PCT1584: White Mahogany - Spotted Gum – Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley.

5.6.2 Performance during the Reporting Period

VCAs for the offset areas were drafted in consultation with the Office of Environment and Heritage (OEH) (now the Biodiversity Conservation Division [BCD]) during 2015 and were registered in 2017, in accordance with Condition B75 (g), Schedule 2 of DA305-7-2003. WCPL applied to revise the VCAs to include RWEA E in December 2017.

As at the end of the reporting period, the revised VCA had not been finalised by the Biodiversity Conservation Trust despite multiple attempts from WCPL. A summary of the actions undertaken by WCPL to date, and its compliance status is provided in **Section 10.5**.

During the reporting period, WCPL commissioned Eco Logical to monitor the fauna and vegetation structure within the RWEAs. Floristic surveys, bird surveys, LFA and riparian condition surveys were all conducted during September 2019 across both remnant woodland and post-mining rehabilitation areas. A copy of the 2019 Annual Flora and Fauna Monitoring Report (Eco Logical 2020) is included in **Appendix F.**

Remnant woodland sites within RWEA areas are generally performing well, with reasonable numbers of native species, low cover of exotic species and suitable fauna habitat features. Native ground cover scores within several PCTs were falling short of completion criteria (**Table 24** and **Table 25**), however this is considered to reflect the ongoing dry conditions – below average rainfall has been recorded for the past three years. No additional remedial activities are recommended within RWEAs. It is anticipated that these values will recover naturally after higher rainfalls, although weed management will be critical at this time to allow native species to recover (Eco Logical 2020).

Exotic species cover remains high in the River Red Gum / River Oak riparian woodland where historic disturbance has been greatest. Some sites in this area exceed completion criteria and VCA targets for exotic plant cover. Continued weed management will be required to achieve performance criteria in these riparian and floodplain areas. Plantings of canopy species could be considered in the open grassland areas on the Wollombi Brook floodplain in RWEA A, where natural regeneration is unlikely to occur in a reasonable timeframe. Plantings may also reduce issues with exotic flora species in these areas.

Bird surveys in remnant woodland sites reflected the good condition of these woodland areas with RWEAs continuing to support a large diversity of bird species including several threatened bird species. Numbers of bird species, numbers of birds and bird communities were largely consistent with the data available from previous monitoring years (Eco Logical 2020).

As reported previously, the NWCD has not yet met completion criteria for landscape function and this area will require continued active management actions to ensure that all completion criteria and other commitments are met in the near future. Woodland rehabilitation areas generally met most landscape function completion criteria, having a high cover of resource trapping leaf litter but fell below biometric completion criteria, with monitoring sites having relatively few native species and almost no groundcover or mid-storey.

Riparian condition scores for North Wambo Creek, Wambo Creek and Stony Creek have stabilised after declines were recorded in 2018 and were slightly higher in all three creeks in 2019. Understorey vegetation remains stressed due to drought conditions, however sites without evidence of grazing pressure appeared to have greater understorey cover and more stable soils.

During the surveys, subsidence cracks were observed in several locations, including RWEA C, however no significant effects on flora and fauna or performance criteria exceedances were recorded. Future monitoring should continue to document and assess subsidence impacts across the site.

Aquatic monitoring was conducted by Niche Environment and Heritage in 2016 to assess the river health of drainages occurring above the North Wambo Underground Mine area, open cut operations and associated infrastructure. Aquatic monitoring is conducted every five years, as required by the BioMP, and is next scheduled for 2021.

5.6.3 Trends and Key Management Implications

The majority of remnant woodland areas remain in good condition with high numbers of native species, few exotic species present and with low cover and abundance. No major issues were identified that require urgent management. However, exotic species cover remains relatively high in riparian and floodplain areas (V1 and V2 plots of RWEA A) and continues to exceed performance criteria and also VCA targets in certain locations. Continued weed management will be required to achieve performance criteria in these riparian and floodplain areas.

Several weed species listed under the NSW *Biosecurity Act 2015* were observed in these areas that have potential to become problematic in the wider region e.g. *Olea europaea* subsp. *cuspidata* (African Olive).

The average number of native species detected within all communities was generally within the range of values recorded in previous monitoring years and was similar to the results from the previous two years when dry conditions were experienced. Monthly rainfall data from 2019 from Bulga (Down Town) (Bureau of Meteorology 2020) reveals that below average rainfall was recorded in all months in 2019 except March.

The number of native species recorded in Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland met the performance criteria in 2019, consolidating a recovery recorded in 2019 after a low diversity was recorded in 2017. This suggests the community has some resilience to the dry conditions and canopy dieback experienced in recent years. Targets were met or acceptable for the other performance criteria.

RWEA and other remnant woodland sites at WCPL continue to support a large diversity of bird species and no introduced bird species were detected within RWEAs. One hundred and twenty-one bird species have been recorded during timed bird surveys over the last four years, with 85 (70%) of these recorded during 2019, including three species not recorded in previous years. The number of species recorded had been declining each year since the highest diversity was recorded 2013, however the result in 2019 arrests this trend and is the fourth highest diversity recorded since surveys began in 2007. The average number of birds recorded per survey has remained relatively constant since 2014, when this data was first collected.

As vegetation and habitat attributes in RWEA areas have remained relatively stable over time, this variability in species richness between years is likely explained by a combination of factors such as varying numbers of nomadic and migratory bird species, weather and climate, sampling methods, differences in the skill of observers, the timing of surveys and surveys coinciding with the flowering of trees and also broader landscape scale changes across the Hunter Valley.

Comparison of numbers of threatened species (2015-2018) and the number of sites they were recorded at (2009 & 2014-2017) show that both the Speckled Warbler and Varied Sittella were recorded more widely during surveys in 2014. However additional survey effort during the 2014 monitoring may partially explain this observation, as the number of sites where these species have been recorded have remained similar since the 2015 monitoring.

The number of individual Speckled Warbler recorded in 2019 had increased since 2018. The number of individual Dusky Woodswallow recorded in 2019 was the highest recorded and more than double the number of the previous highest record in 2015. This result is due to a large flock recorded flying high overhead during an afternoon survey. The number of individuals recorded for Grey-crowned Babbler in 2019 was less than in the previous three years. The cause of this result is unclear, future monitoring should seek to establish whether this result is a sign of a local population decline. The number of individuals for other threatened species recorded was within the range of those previously recorded suggesting no obvious declines are evident from the available data.

The aquatic monitoring report (Niche Environment and Heritage 2016) found that comparison with previous survey data showed no significant temporal trends attributable to current catchment management. Aquatic monitoring will be completed in 2021 as required by the BioMP.

5.6.4 Implemented or Proposed Management Actions

WCPL will continue to give priority to weed species listed under the NSW *Biosecurity Act 2015* that have the potential to become problematic in the wider region (e.g. *Olea europaea* subsp. *cuspidata* [African Olive]).

With mining of Longwalls 11 to 16 complete, rehabilitation works for the NWCD, including rehabilitation of subsidence effects, can be planned for areas overlying, and downstream of, Longwall 16. Development of a detailed rehabilitation plan for NWCD upstream of Longwall 16 is not considered practical at this time due to the number of current and future underground mining activities that may affect processes and condition of the watercourse. Some of those activities may also impact areas overlying, and downstream of, Longwall 16, and their influence will be considered as part of the proposed rehabilitation actions for that section of the diversion.

In late 2018, WCPL commissioned Alluvium to prepare a detailed five (5) Year NWCD Rehabilitation and Maintenance Plan. **Table 26** provides an outline of the rehabilitation and maintenance works proposed.

Table 26: Outline of NWCD Rehabilitation and Maintenance Plan

2018	2019	2020	2021
Continue inspections.	Commence implementation of NCWD Rehabilitation and Maintenance Plan.	Continue implementation of NCWD Rehabilitation and Maintenance Plan.	Continue implementation of NCWD Rehabilitation and Maintenance Plan.
Annual Diversion and Subsidence Monitoring.	Annual Diversion and Subsidence Monitoring.	Technical panel review of actions implemented, monitoring results and update of rehabilitation plan as required.	
Subsidence remediation measures (if required) as outlined in the approved Extraction Plan - South Bates Underground Mine Longwalls 11 to 16.	Subsidence remediation measures (if required) as outlined in the approved Extraction Plan - South Bates Underground Mine Longwalls 11 to 16.	Annual Diversion and Subsidence Monitoring.	Annual Diversion and Subsidence Monitoring.
Rehabilitation maintenance works, including: • Weed management (particular focus on *Galenia puescens*); • Repair areas of erosion; • Re-seeding with selected native pasture and tree species; • Revegetation trials with native grass species in selective areas of the diversion to assist in controlling weeds; and • Collection of native grass seeds within pasture areas on adjacent WCPL owned pasture lands.			
Prepare and commence implementation of a detailed five (5) Year NCWD Rehabilitation and Maintenance Plan.			

During the reporting period, WCPL commissioned Soil Conservation Services (SCS) to conduct a stability assessment and remediation proposal. SCS has commenced the design and construction of remediation works within a section (referred to as Section 1) of the NWCD which consists of:

- Excavation and formation of the Batter Chutes 8, 9, 10, 11 and 12.
- Formation of the overland flow directing bunds associated with the Batter Chutes 8, 9, 10, 11 and 12.
- Revegetation as per North Wambo Creek Diversion Revegetation Management Plan (Cumberland Plain Seeds, 2019).

Section 1 works are due to be completed in 2020.

5.7 Aboriginal Heritage

WCPL manages Aboriginal heritage on-site in accordance with the relevant conditions of DA305-7-2003 and the conditions of Aboriginal Heritage Impact Permits (AHIPs) #2222, #C0001474, #C0002000 and #C0003213. These AHIPs allow for the disturbance and/or salvage of all known and unknown Aboriginal objects within the extent of the relevant AHIP boundaries. Any Aboriginal objects salvaged under these permits are managed in accordance with a Care Agreement.

In 2016, WCPL developed a Heritage Management Plan (HMP) for the Mine, to consolidate all statutory requirements into one document and assist in the management of Aboriginal cultural heritage on-site. The Heritage Management Plan was updated and approved in June 2019 as part of the preparation of the amended Extraction Plan for Longwalls 17 to 20 at the South Bates Extension Underground Mine.

Consistent with the requirements of the approved Heritage Management Plan, WCPL has implemented a Surface Disturbance Permit (SDP) procedure and checklist, applicable to all surface works at Wambo Coal Mine. During the SDP assessment process, WCPL undertake a due diligence assessment to ensure that no artefacts that may have been identified in the area are damaged.

WCPL completed the following Aboriginal archaeological surveys and salvage operations during the reporting period:

- Due diligence surveys for seven exploratory drill holes in January 2019 and May 2019. All of the drill holes were located outside the mine lease area and area covered by any AHIPs. A total of seven sites were investigated, and no heritage evidence was identified during the survey or has been previously reported in these immediate locations. It was considered that the potential for impacts of significance to occur was consequently very low.
- Salvage of 19 open artefact sites (Wambo Sites 23-26, 239, 369, 383, 401, 454-464), that were anticipated to be subject to potential impacts from approved activities. The salvage of Wambo Sites 24, 25, 26, 369, 456, 457, 458, 459, 460, 462 and 463 (in accordance with the conditions of AHIP #C0002000 and the Wambo HMP) and the Wambo Sites 23, 239, 383, 401, 454, 455, 461 and 464 (in accordance with the conditions of AHIP #2222 and the Wambo HMP), was undertaken from 26 April to 16 May 2019. Salvage of five newly identified sites (Wambo Sites 508, 509, 510, 511 and 512) occurred in accordance with the conditions of AHIP #C0002000 and AHIP #2222 and the HMP. A total of 1,296 artefacts were salvaged from the open artefact sites.
- Salvage of eight open artefact sites (Wambo Sites 382, 384, 385, 449, 450, 451, 452 and 471) that were anticipated to be subject to potential impacts from approved activities. The salvage of these sites occurred in accordance with the conditions of AHIP #2222 and the Wambo HMP and was undertaken on 28 February 2019. A total of 66 artefacts were salvaged from the open artefact sites.

Copies of the due diligence and salvage reports were forwarded to BCD and made available to all of the Registered Aboriginal Parties for the Mine. WCPL plans to continue due diligence surveys as required during the next reporting period. No change in the current procedure is planned.

5.8 Non-Aboriginal Heritage

WCPL is required to prepare a HMP for the WHC in accordance with Condition B90, Schedule 2 of DA305-7-2003. A CMP was prepared by WCPL in 2006 and reviewed in 2012 by heritage consultants Godden Mackay Logan. In 2018, the CMP was revised and comments were incorporated from DPE (now DPIE) and NSW Heritage Office. The CMP was approved during 2019.

An annual photographic record of the elevations of all structures at the WHC was completed during the reporting period and lodged with the Singleton Shire Council, in accordance with Condition B92, Schedule 2 of DA305-7-2003.

During the reporting period, WCPL undertook blasting that was within 2 km of the WHC on one occasion. Blasting was undertaken in accordance with the approved WCPL BMP and results of monitoring undertaken at the WHC indicated compliance with all criteria (**Section 5.2**). Copies of the ground vibration assessment reports for the WHC have been forwarded to NSW Heritage Office, in accordance with Condition B35, Schedule 2 of DA305-7-2003.

5.9 Subsidence

During the reporting period, underground mining occurred at Longwalls 17 and 18 of the South Bates Extension Underground Mine.

5.9.1 Relevant Extraction Plans

Subsidence monitoring was undertaken in the reporting period for Longwalls 14 to 16 at the South Bates Underground Mine and Longwall 17 at the South Bates Extension Underground Mine.

5.9.1.1 Extraction Plan for South Bates Underground Mine Longwalls 11 to 16

The following reporting is required to be undertaken as part of the Extraction Plan for South Bates Underground Mine Longwalls 11 to 16:

- Incident Report – to be prepared as required and submitted (by email) to DPIE (Manager, Mining Projects), DRG (Subsidence Executive Officer), Subsidence Advisory NSW (District Manager) and other regulators as specified in management plans.
- Subsidence Management Status Reports – to be updated fortnightly and submitted (by email) if new impacts are identified or upon request, to DPIE (Manager, Mining Projects), DRG (Subsidence Executive Officer) and BCD (National Parks and Wildlife Service [NPWS]).
- Six Monthly Report – to be updated annually for the period 1 January to 30 June and submitted (by email) to DPIE (Manager, Mining Projects), DRG (Subsidence Executive Officer), Subsidence Advisory NSW (District Manager), BCD/EPA (General Contact/NPWS) and DPIE-Water (Manager Strategic Stakeholder Liaison).
- Annual Review – to be updated annually for the period 1 January to 31 December and submitted (by email and post) to DPIE (Manager, Mining Projects), DRG (Subsidence Executive Officer), DRG (Director – Environmental Sustainability), Subsidence Advisory NSW (District Manager), BCD/EPA (General Contact/NPWS), DPIE-Water (Manager Strategic Stakeholder Liaison), Singleton Shire Council (General Manager) and CCC Members.

5.9.1.2 Extraction Plan for South Bates Underground Mine Longwalls 17 to 20

In April 2018, WCPL submitted the South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan to the DPIE. On 4 September 2018, WCPL provided DPIE with correspondence explaining that geological structures had been encountered that may require changes to the main headings and finished ends of longwalls 18, 19 and 20. Approval was received for Longwall 17 only, on the basis that WCPL would prepare an amended Extraction Plan for Longwalls 18, 19 and 20.

In February 2019, WCPL submitted a revised Extraction Plan and associated sub-plans for Longwalls 17 to 20 at the South Bates Underground Mine to the DPIE in accordance with Conditions 22C and 22D of Schedule 4 of the Development Consent (DA 305-7-2003). WCPL received approval for the South Bates Underground Extraction Plan for Longwalls 17 to 20 (revised layout) on 4 June 2019.

The following reporting is required to be undertaken as part of the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20:

- Incident Report – to be prepared as required and submitted (by email) to DPIE (Manager, Mining Projects), NSW Resources Regulator (Subsidence Executive Officer), Subsidence Advisory NSW (District Manager) and other regulators as specified in management plans.
- Subsidence Management Status Reports – to be updated fortnightly and submitted (by email) if new impacts are identified or upon request, to DPIE (Manager, Mining Projects) and NSW Resources Regulator (Subsidence Executive Officer).
- Six Monthly Report – to be updated annually for the period 1 January to 30 June and submitted (by email) to DPIE (Manager, Mining Projects) and NSW Resources Regulator (Subsidence Executive Officer).
- Annual Review – to be updated annually for the period 1 January to 31 December and submitted (by email and/or post) to DPIE (Manager, Mining Projects), NSW Resources Regulator (Subsidence Executive Officer), NSW Resources Regulator (Manager Environmental Sustainability), Subsidence Advisory NSW (District Manager), BCD/EPA (General Contact), DPIE-Water (Water Regulation), Singleton Shire Council (General Manager) and CCC Members.

The component management plans of the South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan reference components of a number of existing Environmental Management Plans (EMPs) to avoid duplication. If these EMPs are revised separately in accordance with DA305-7-2003, the EMPs in the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 will be updated accordingly.

5.9.2 Approval Criteria/EIS Predictions and Management Plan Requirements

In accordance with Conditions B1 and B4 of the Development Consent (DA305-7-2003), WCPL must ensure that there are no exceedances of the Subsidence Impact Performance Measures detailed in Tables 1 and 2 of the Development Consent (see **Table 27**).

Underground mining was undertaken at South Bates Extension Underground Mine Longwalls 17 and 18 during the reporting period.

No longwall panels encroached upon the Wollombi Brook, Warkworth Sands Woodland Community or the White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community.

South Bates Extension Underground Mine Longwall 17 undermined approximately 20 m of the NWCD during the reporting period.

Longwalls 17 and 18 are offset from the base of the Wollemi National Park escarpment by a minimum 26.5 degree angle of draw. No impacts to the escarpment were observed during the reporting period (**Section 5.9.3)**.

Table 27: Subsidence Impact Performance Measures

Aspect	Performance Measures[1]
Water – Wollombi Brook	Negligible subsidence impacts and environmental consequences. Release of water from the site only in accordance with EPL requirements.
Land – Low level cliffs within the South Bates Extension Area	Minor environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing that in total do not impact more than 5% of the total face area of such features).
Biodiversity – Wollemi National Park	Negligible subsidence impacts and environmental consequences.
Biodiversity – Warkworth Sands Woodland Community	Minor cracking and ponding of the land surface or other subsidence impacts. Negligible environmental consequences.
Biodiversity – White Box, Yellow Box, Blakely's Red Gum Woodland/ Grassy White Box Woodland Community	Minor cracking and ponding of the land surface or other subsidence impacts. Negligible environmental consequences.
Biodiversity – Central Hunter Valley Eucalypt Forest and Woodland Ecological Community	Minor cracking and ponding of the land surface or other subsidence impacts. Negligible environmental consequences.
Biodiversity – Conservation Areas (including the proposed Wambo offset area under SSD 7142)	Negligible reduction to previously identified biodiversity credits.
Heritage – Wambo Homestead Complex	Negligible impact on heritage values, unless approval has been granted by the Heritage Branch and/or the Minister.
All Built Features (including public infrastructure and all structures on privately-owned land)	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.
Public Safety	Negligible additional risk.

1. Note, the requirements of this condition only apply to the impacts and consequences of mining operations undertaken following the date of approval of Modification 9.

Wambo does not have approval for undermining of the WHC and as such no evidence of subsidence related impacts were identified during the reporting period. No impacts to non-Mine built features or threats to public safety resulting from the discussed mining activities were identified during the reporting period.

5.9.3 Performance during the Reporting Period

5.9.3.1 Subsidence Surveys

During the reporting period, WCPL undertook longwall mining in the South Bates Extension Underground Mine Longwall 17 and 18 (**Section 3.1**). Subsidence monitoring was undertaken in accordance with the approved South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan. Subsidence monitoring was undertaken in the reporting period for Longwalls 14 to 16 at the South Bates Underground Mine and Longwall 17 at the South Bates Extension Underground Mine.

Table 28 summarises the actual versus predicted subsidence results for Longwalls 14 to 16 at the South Bates (Wambo Seam) Underground Mine and the subsidence monitoring results for Longwall 17 at the South Bates (Whybrow Seam) Underground Mine. The monitoring shows that the actual maximum subsidence recorded for both sets of longwalls was similar to the predicted range with the exception of the 8XL-line which predicted 30% less subsidence than predicted.

Table 28: Subsidence Monitoring – Actual versus Predicted for South Bates Underground Mine Longwalls 14 to 17

Monitoring Line ID	Predicted S_{max} (mm)[1]	Actual S_{max} (mm)[1]	Difference (mm)	Consistent With Predicted Range
South Bates (Wambo Seam) Underground Mine Longwalls 14 to 16				
7X L-Line	4100	3915	185	Y
CL11B-Line	4100	3994	106	Y
CL13B-Line	4000	3734	266	Y
South Bates Extension (Whybrow Seam) Underground Mine Longwall 17				
8XL-Line	1850	1418	432	Y[2]
CL17B-Line	1850	1619	231	Y

1. *South Bates Underground Mine and South Bates Extension Underground Mine: Subsidence Review Report for South Bates Underground Mine WYLW11 to WYLW13 and WMLW14 to WMLW16 and the South Bates Extension Underground Mine WYLW17* (Mine Subsidence Engineering Consultants [MSEC], 2019).
2. Ground movements measured along the 8XL-Line are reasonably consistent with the predictions. The subsidence model appears to be providing conservative predictions based on single-seam mining conditions (MSEC, 2019).

5.9.3.2 LiDAR Surveys

Ground movements resulting from the extraction of Longwalls 14 to 16 at the South Bates Underground Mine have been measured using LiDAR surveys (i.e. by comparing a survey undertaken in September 2015 [before extraction of Longwall 11 began] and in December 2018 [after the completion of Longwall 16]). It should be noted that LiDAR surveys have an accuracy in the order of ±50 to ±150 mm. The accuracy of the observed changes in surface levels (i.e. the difference between the two surveys), therefore is in the order of ±100 to ±300 mm.

LiDAR survey results for Longwalls 11 to 16 (MSEC, 2019) are as follows:

- The profiles of the observed changes in surface levels reasonably match the predicted profiles of vertical subsidence. However, the measured profiles are slightly broader than the predicted profiles, resulting in higher subsidence adjacent to the longwall maingates and tailgates.
- The maximum measured changes in surface level along each of the cross lines (i.e. perpendicular to the longwalls) are similar to the maximum predicted vertical subsidence above each of the longwalls. The measured changes in surface level above the chain pillars reasonably match the predicted value.
- There are localised and irregular observed changes in surface level outside the extents of the longwalls, in the order of ± 100 to ± 300 mm, that are associated with the accuracies of the LiDAR surveys.
- The maximum measured changes in surface level along each of the long-sections (i.e. parallel to the longwall) reasonably match the predicted profiles of vertical subsidence.
- The maximum measured changes along each of the parallel longwall sections are similar to, but slightly greater than the predicted values. The exceedances are similar to the order of accuracy of the LiDAR surveys.
- The measured changes in surface level above the south-western ends of the longwalls are greater than predicted due to the effects of the steep slopes associated with the spur, Stony Creek and beneath the escarpment. Measured values are also irregular near the finishing ends of longwalls due to the steep slopes associated with the NWCD and the Bates South Open Cut Pit.
- Ground movements measured using LiDAR are considered consistent with predictions provided in the Extraction Plan Application.

The changes in surface level due to the extraction of Longwall 17 have been determined by taking the differences between the surface levels measured in the LiDAR surveys carried out in December 2018 (after approximately 50 m of extraction) and December 2019 (after Longwall 17 and during the extraction of Longwall 18).

LiDAR survey results for Longwall 17 are as follows (MSEC 2019):

- The profiles of the measured changes in surface level along the cross-section and long-section reasonably match predicted profiles of vertical subsidence.
- The maximum measured changes in surface level along these sections are less than the maximum predicted vertical subsidence.
- The measured profiles are slightly broader than the predicted profile along the cross-section resulting in slightly higher subsidence adjacent to the longwall maingate and tailgate. However, the differences are in the order of accuracy of LiDAR surveys.
- The measured changes in surface level are greater than predicted above the south-western end of Longwall 17 due to the effects of steep slopes beneath the escarpment on the LiDAR surveys. However, the differences are in the order of accuracy of LiDAR surveys.
- The measured changes in surface level are also slightly greater than predicted above the north-eastern end of Longwall 17 as the measured profile is slightly flatter than predicted. However, the differences are in the order of accuracy of LiDAR surveys.
- Ground movements measured using LiDAR are considered to be consistent with the predictions provided in the Extraction Plan Application.

5.9.3.3 Visual Inspections

MSEC (2019) has also considered the results from visual inspections undertaken during and after the extraction of each of the longwalls at the South Bates Underground Mine and South Bates Extension Underground Mine. MSEC also carried out visual inspections in March 2017, November 2018, December 2018 and August 2019. Surface cracks have been mapped by SLR Consulting Pty Ltd.

The surface crack observations recorded during visual inspections are summarised as follows:

- Longwalls 11 to 13:
  - Crack widths were less than 50 mm for 88% of cases, between 50 and 100 mm for 11% of cases, and greater than 100 mm in the remaining 1% of cases.
  - Localised crack widths up to approximately 300 mm.
  - Observed surface deformations were typically within the limits of predictions in the Extraction Plan Application.
- Longwalls 14 to 16:
  - Crack widths were less than 150 mm for 70% of cases, between 150 and 300 mm in 22% of cases, between 300 and 500 mm in 6% of cases and greater than 500 mm in the remaining 2% of cases.
  - Localised crack widths up to between 1 and 2 m. While cracks larger than those predicted developed, these were due to several cracks concentrating within a confined zone, rather than the cracks developing with a wider separation (i.e. potholing). These larger impacts represent less than 1% of the total length of mapped surface deformations due to Longwalls 14 to 16.
  - Generally consistent with predictions in the Extraction Plan Application.
- Longwall 17:
  - Crack widths were less than 40 mm for 84% of cases, between 40 and 100 mm in 15% of cases and greater than 100 mm in the remaining 1% of cases.
  - Localised crack widths up to approximately 400 mm.
  - Observed surface deformations were typically within the limits of predictions in the Extraction Plan Application.

Observed impacts have been compared to assessed impacts by MSEC (2019) with field investigations undertaken during and after mining Longwalls 11 to 17 from March 2017 to August 2019. Upon field investigations MSEC (2019) observed no adverse impacts to Wollemi National Park, ephemeral drainage lines, Stony Creek, cliffs associated with the Wollemi escarpment, low level cliffs, cliffs along the spur and steep slopes.

5.9.3.4 Bi-annual Audits of Subsidence Impacts

Bi-annual audits (May and November) of subsidence impacts were undertaken by SLR Consulting Pty Ltd (SLR) during the reporting period to identify new subsidence impacts over the South Bates Underground Mine and to determine the status of known subsidence impacts (e.g. have they self-repaired, are they stable but pose a risk to long-term sustainable landuse, or are they deteriorating in condition).

The November 2018 audit identified a total of 93 sites with subsidence impacts across the site. Of these, SLR (2018) recommended that 41 be remediated and the remainder be monitored in case future remediation is required. The majority of the sites recommended for remediation overlie Longwalls 11 to 16 of the South Bates Underground Mine. In November 2018, all mining was completed in Longwalls 11 to 16 of the South Bates Underground Mine, with no further predicted subsidence impacts.

During the reporting period, subsidence monitoring and remediation focused on the South Bates Underground Mine with 37 subsidence sites rehabilitated. The remediation campaign occurred over a three month period in April, May and June 2019. The sites ranged from small potholes to large cracks several meters in length.

The methodology used for the majority of remediation sites included:

- Excavate the subsided area using an excavator. Store topsoil and subsoil in separate piles for later use.
- Excavate site until no subsurface void is identified or to the limit of the excavator.
- Insert geofabric to line the floor of the excavated pit.
- Backfill the pit using the excavated material mixed with gypsum at 2%.
- Compact the excavated material in layers using the back of the excavator bucket up to surface level.
- Topsoil and seed the disturbed area.

Due to low rainfall in the second half of the reporting year, vegetation establishment and growth has been limited. Grazing impacts from kangaroos also impacted the vegetation cover on remediated sites.

Subsidence monitoring will continue to monitor further subsidence, vegetation coverage and weeds in the next reporting period.

5.9.3.5 Remediation of Subsidence Impacts to 'Kharlibe'

In 2018, a Subsidence Remediation Plan (SRP) was developed for the 'Kharlibe' property located in Bulga, approximately 20 km west-southwest of Singleton in the Upper Hunter Valley of NSW. This plan was further updated in 2019.

Between 1991 and 2000, the property was undermined by the former Homestead Mine (owned by WCPL, now a subsidiary of Peabody Energy Australia Pty Ltd). The mining occurred within CL 397 and CCL 743 held by WCPL. The longwall mining resulted in the surface of the ground being lowered, and the formation of subsidence cracks – some of which took time to migrate through the alluvium to reach the surface.

Historical subsidence remediation works have been undertaken across the property by various contractors and consultants since the late 1990's. The success of these works was mixed and, in some instances, require remedial works.

In February 2018, the RR issued a Notice under Section 240 (1)(b) and (c) of the *Mining Act 1992* (Mining Act) that required WCPL to prepare a SRP for Kharlibe. SLR and SCT Operations Pty Ltd (SCT) were approved as suitably qualified experts to prepare the SRP in consultation with the landholder and the Resources Regulator.

A second Section 240 Notice was issued by the Resources Regulator on 19 September 2019, requiring WCPL to:

- implement subsidence remediation works and associated works in accordance with the Subsidence Remediation Plan (with timing of works and associated monitoring bound by the Project Gantt Chart); and
- to provide quarterly Subsidence Remediation Reports including field observations, remediation works methodologies and results of any monitoring.

Initial (Phase 1) remediation works were undertaken at two sites on 21 and 22 May 2019. These features included an isolated sinkhole, a close spaced row of sink holes and five small depressions. The purpose of this initial remediation works was to identify constraints and opportunities to guide future remediation works.

The Phase 2 remediation works were undertaken from 17 – 21 June 2019 as they were considered high priority works. These works included the remediation of 20 sites.

Phase 3 remediation works were undertaken from 15 July – 20 December 2019 and included landform design and remediation works. Phase 3 works in 2019 included the remediation of 51 sites, with 33 completed in October to December 2019.

Detailed quarterly reports have been provided to the Resource Regulator detailing remediation activities and monitoring results throughout each quarter. These reports can be provided upon request.

5.9.3.6 Visual Inspections of Wollemi Escarpment (via Drone)

Baseline cliff top mapping of the Wollemi National Park escarpment in the vicinity of the South Bates Underground Mine was undertaken during 2015 utilising an Unmanned Aerial Vehicle (Microdrone MD4-1000) and a high resolution camera along a designated route. Photos were taken of the cliff top at designated intervals and stitched to form a high resolution panoramic image which can be used to assess subsidence. The route has been recorded and programmed to be repeatable from year to year.

The cliffs associated with the Wollemi Escarpment were visually inspected using drones that were flown in January 2016, June 2016, February 2017, September 2017, October 2018 and October 2019. There were no cliff instabilities identified along the escarpment from these surveys.

5.9.4 Trends and Key Management Implications

It is considered by MSEC (2019) that the observed ground movements for South Bates Underground Mine Longwalls 11 to 16 and South Bates Extension Underground Mine Longwall 17 were consistent with predictions. It is also considered that the impacts on the natural and built environment are similar to those assessed and predicted.

In 2020, scheduled works on the Kharlibe property include restoration works on Stony Creek, subsidence remediation works and continued remediation monitoring.

5.9.5 Implemented or Proposed Management Actions

During the next reporting period, WCPL will continue to implement the approved Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20.

WCPL will also continue with the program of works for the remediation of the subsidence impacts identified by the bi-annual subsidence audits in areas away from active subsidence (**Section 5.9.3**).

5.10 Exploration

During the reporting period, 86 exploration holes were drilled in WCPL's exploration licence and mining lease areas. Of these holes, 54 were non-core, 6 were fully cored holes and 26 were partially cored holes.

Twenty six (26) holes were drilled within EL7211 and A444 and as such, these holes were subject to the Exploration Activity Application and Assessment Process. Thirteen of these holes were drilled as part of a groundwater/alluvial investigation in the vicinity of North Wambo Creek. The remainder were drilled within WCPL's mining leases and were managed under WCPL's SDP system, the 2018-2020 MOP and 2019-2020 MOP (where relevant).

Rehabilitation of exploration sites is undertaken continuously throughout the exploration program and begins immediately after holes are geophysically logged. Of the 86 holes drilled, 43 holes have been grouted to surface and preliminary rehabilitation has commenced on all sites. To date, no holes have been signed off as completely rehabilitated, however a comprehensive rehabilitation project is planned to continue in 2020. By the end of this rehabilitation project, all sites drilled during the reporting period will have the preliminary rehabilitation completed, and will require a follow up inspection to determine final rehabilitation status.

An update on the status of the exploration rehabilitation project will be provided in the Annual Review for the next reporting period.

5.11 Waste

Waste management at WCPL is undertaken by a licensed waste management company under the basic principles of the Total Waste Management System (TWMS). Significant benefits of the TWMS include:

- segregation of waste at the source;
- expansion of recycling capabilities;
- reduction in the risk of contaminating non-hazardous waste;

- comprehensive monthly reports detailing volumes, recycling, disposal and transportation of waste; and
- improved data capture to increase the efficiency and accuracy when reporting.

During the reporting period, a total of 4,993,128 kilograms (kg) of waste was generated by the Mine. Of this, 74.3% was taken to landfill or disposed of off-site as hazardous waste. Of the waste disposed off-site, 75.15% was recycled.

The total waste sent off-site by the Mine in 2019 (3,711,628 kg) was similar to 2018 (3,989,905 kg), more than in 2017 (3,298,988 kg), 2016 (2,709,881 kg), 2015 (2,252,922 kg) and 2013 (1,615,289 kg) and less than in 2014 (4,860,142 kg) (**Figure 7**).

It should be noted that:

- The 2014 waste report incorrectly included sediment-laden water pumped from various on-site locations (and disposed of on-site) in the recycled effluent figure. This water should not have been included in WCPL's waste report. If this water is removed from the 2014 waste report the total waste generated in 2014 would be less.
- The 2014 waste report also included 668,723 kg of waste recycled from the wash bay. There was no waste removed from the wash bay in 2015 or 2016.

The overall recycling rate for 2019 (75.15%) was consistent with or more than that reported in 2018 (75.8%), 2017 (75.7%), 2016 (71.8%) and 2015 (67.9%) but less than that reported for 2014 (82.8%) and 2013 (82.1%), however it is noted that the recycling rate for 2014 was heavily influenced by the incorrect inclusion of sediment-laden water in the recycled effluent figure.

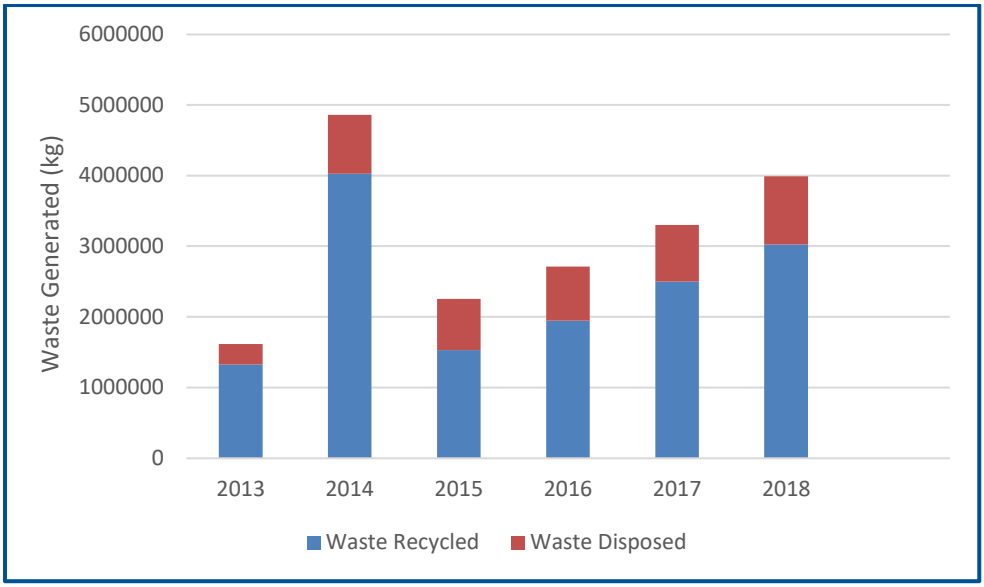

Figure 7: Waste Volumes (2013-2019)

5.12 Visual Amenity and Lighting

All mobile lighting plants are strategically positioned to avoid light being directed towards WCPL's neighbours and other identified potential sensitive receptors.

There were two (2) complaints received during the reporting period relating to lighting impacts from WCPL's mining operations (**Section 8.3**). In response, lights on the back of excavators were repositioned and/or dimmed.

5.13 Contaminated Land

No contaminated land event, that posed a threat of potential or material harm to the environment, occurred during the reporting period. Where possible, any contaminated material is managed on-site in the site bio-remediation area.

5.14 Topsoil Management

During the reporting period, WCPL undertook an inventory of topsoil stockpiles on-site, including location, volume and condition. This inventory (as at the end of the reporting period) is summarised in **Table 29** below. Topsoil stockpile locations, as at the end of the reporting period, are shown on **Figure 8**.

Table 29: Topsoil Inventory

Stockpile Reference Number	Location	Volume (m^3)
1a	RL160	3,195
1	RL160	2,607
2	RL160	1,905
3	RL160 Dump	1,470
4	Sarah Marie Dump	8,605
5	Sarah Marie Dump	8,671
7	Ridge Reload	52,945
8	Ridge Dump	1,805
15	Charlies Hole Dump	13,606

Note: m^3 = cubic metres.

Topsoil is managed at the Mine in accordance with the Wambo Coal Topsoil Management Procedure.

During an audit conducted on 11 June 2019, the RR identified that topsoil management was not being undertaken in accordance with the approved MOP (2018-2020) and issued an official caution letter on 30 October 2019 (**Section 10.6**).

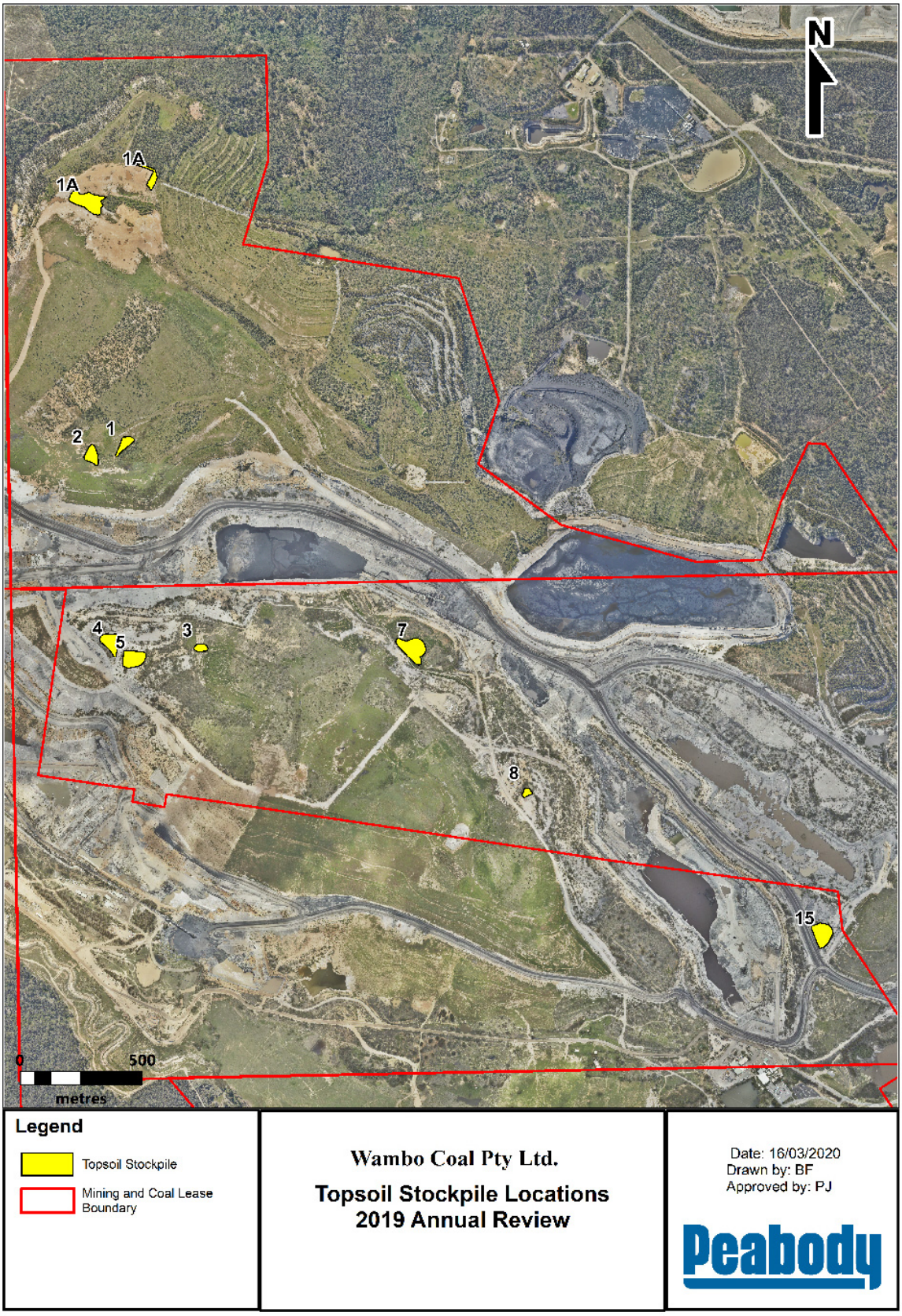

Figure 8: Topsoil Locations

5.15 Weed and Pest Management

WCPL commissioned REM to undertake management and control of weed species within the rehabilitation and offset areas of the Mine during 2019. Weed management techniques included spraying and manual removal (cut and paint). During the reporting period, a total of 20 days of weed control work at the Mine was undertaken by a two person crew (REM 2019).

Weed management along the North Wambo Creek Diversion is ongoing with specific targets including Galenia and Boxthorn.

A summary of the total areas of specific weeds treated by REM (2019) is provided in **Table 30** and shown in **Figure 9**.

Table 30: Approximate Area of Weeds Treated at the Mine during 2019

Weeds Treated	Comment	Area (ha)
Prickly pear species (scattered)	Main access and Homestead Paddocks	3.8
Galenia	North Wambo Creek Diversion	8.1
African boxthorn	Wambo Creek and Homestead Paddocks	121.5
African Olive	Wollombi Brook	19.0
Acacia saligna	Woodland Rehabilitation area (thinning out coverage)	138.5
Prickly pear & African boxthorn	Fire Trails & RWEA tracks	29.7
Total		**320.6**

Note: ha = hectares.

During the reporting period, WCPL also undertook a vertebrate pest management program as part of the Hunter Local Land Services Pest Species Management program, along with other mines in the area, in Autumn (April and May) and Spring (October), targeting wild dogs, pigs and foxes.

The results of the baiting program were considered to be positive due to the high rate of baits being taken by the target species. A total of 1080 baits were used with a take rate of 35% in Autumn and 65% in Spring. Pig traps were also utilised; however, no pigs were caught. As hares were sighted throughout the year, WCPL intends to work with Regional Coordinators from Local Land Services to participate in the future pest control programs.

WCPL prepared an Annual Weed Treatment Plan in 2019 which will guide weed management activities in 2020 and beyond. Pest and weed management will continue as required on-site and on agistment managed properties throughout the next reporting period.

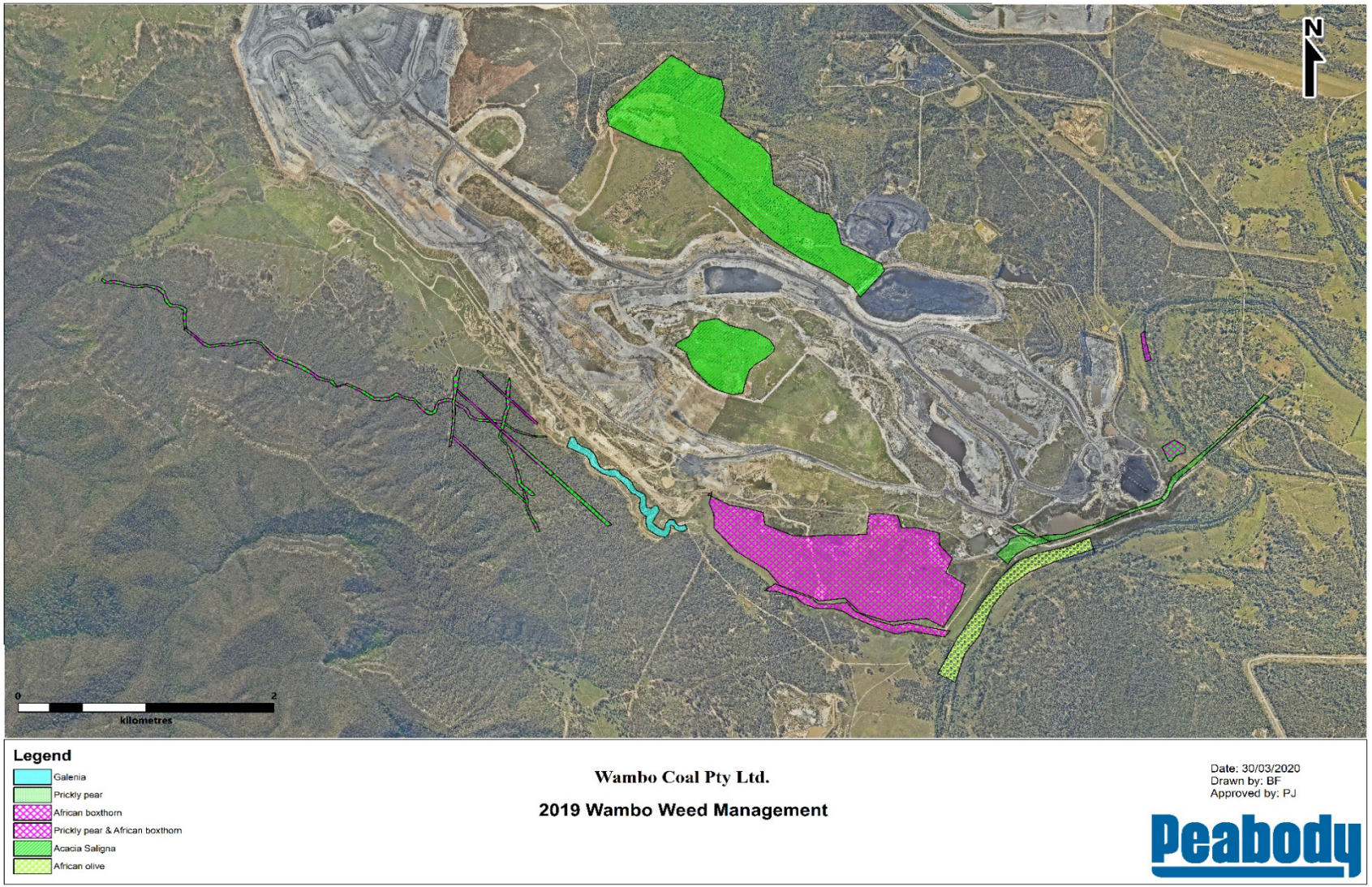

Figure 9: Weed Control Overview for the Mine (REM 2019)

5.16 Bushfire Management

No grassfires or bushfires were reported within the Mine during the reporting period. WCPL undertakes proactive grass slashing and maintenance around all site infrastructure and boundary fences where practical.

A copy of the revised Bushfire Management Plan was provided to the Singleton Shire Council and the NSW RFS in December 2017. Comments have not yet been received from Singleton Shire Council. WCPL will address comments once received and provide the updated plan to DPIE for approval.

As part of the Bushfire Management Plan update, and to address recommendations made in the Bushfire Risk Assessment (undertaken in 2017), WCPL has designated a dam suitable for filling aerial vehicles (i.e. helicopters) and has identified water resources available for fire control activities.

5.17 Spontaneous Combustion Management

Inspections for spontaneous combustion form part of daily WCPL inspections across the three main operating areas (i.e. Open Cut, Underground and Coal Handling and Preparation Plant [CHPP]).

The 2017 Independent Environmental Audit (IEA) (Hansen Bailey 2017) noted a minor (<1 m^3) spontaneous combustion event, which WCPL has managed and monitored.

No spontaneous combustion events were identified by WCPL during the reporting period.

6.0 Water Management

Water management performance measures for the Mine are defined in Table 8 of DA305-7-2003 (Condition B26, Schedule 2) and EPL529 (Condition L2). Additional conditions relating to water supply, water and salt balances, discharge volume, effluent application to land, monitoring and recording requirements (including for the HRSTS), the NWCD, Chitter Dump Dam, South Wambo Dam, WCPL's Water Management Plan and independent water audits are also detailed in these documents. WCPL must also operate in accordance with the conditions of various water licences issued under the *Water Act 1912* and *Water Management Act 2000* as well as conditions of DA177-8-2004.

6.1 Surface Water Monitoring

WCPL undertakes surface water monitoring at the Mine in accordance with the approved SWMP, which is a component of the WCPL Water Management Plan. The SWMP has been developed to ensure WCPL complies with its statutory conditions relating to surface water monitoring at the Mine.

The SWMP was revised in March 2018 (Version 12) and submitted with the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20. On 7 September 2018, DPIE approved the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 (including the SWMP).

6.1.1 Approval Criteria/EIS Predictions and Management Plan Requirements

WCPL's EPL529 details the approval criteria for off-site water discharges (**Section 6.3.1**).

WCPL has developed impact assessment criteria for surface water quality and stream flow as part of the approved SWMP (Version 12).

For the surface water quality criteria, where actual site specific water quality monitoring data is available, the criteria have been set based on the 20th and 80th percentile for the available dataset. Where insufficient data is available, WCPL has adopted the applicable Australian and New Zealand Environment and Conservation Council (ANZECC) default guidelines values for slightly to moderately disturbed ecosystems (ANZECC 2000) or the Water Quality Objectives for the Hunter River. Applicable criteria are included in **Table 31** and **Table 32.**

Triggers for the local ephemeral creeks in the approved SWMP are based on the unexpected absence of flow in climatic situations when flows would be expected. The triggers would be met if there was no flow recorded at the flow monitoring site either on the day or the day after the recorded rainfall was equal to or greater than the nominated amount.

Table 31: Surface Water Quality Impact Criteria[1,2]

Sampling Site	Parameter[3]	Lower Limit	Upper Limit
SW02 – Wollombi Brook	pH	7.4	8.1
	EC (µS/cm)	599	1,947
	TSS (mg/L)	17 (low flow) to 308 (high flow)[4]	
SW05 – North Wambo Creek	pH	7.3	7.9
	EC (µS/cm)	1,155	2,246
	TSS (mg/L)	53 (low flow) to 1,110 (high flow)[4]	
SW07 – Wambo Creek	pH	7.4	7.9
	EC (µS/cm)	360	724
	TSS (mg/L)	29 (low flow) to 331 (high flow)[4]	
SW08 – Stony Creek	pH	6.8	7.4
	EC (µS/cm)	288	416
	TSS (mg/L)	5 (low flow) to 15 (high flow)[4]	
SW39 – Waterfall Creek	pH	7.3	7.8
	EC (µS/cm)	159	429
	TSS (mg/L)	582 (low flow) to 1,922 (high flow)[4]	

1. From Table 12, Version 12 of the WCPL SWMP.
2. An exceedance occurs when water quality results exceed the 80th Percentile Trigger Value (**Table 31**) after three consecutive sampling events.
3. EC = electrical conductivity, TSS = total suspended solids, µS/cm = microSiemens per centimetre, mg/L = milligrams per litre.
4. Low flow condition based on 80th percentile of recorded concentrations and high flow criteria based on maximum recorded concentrations.

Table 32: Surface Water Flow Impact Assessment Condition[1]

Watercourse and Flow Monitoring Site	Daily Rainfall when Flow Commenced on 80% of Recorded Occasions
Stony Creek (FM13)	20 mm
South Wambo Creek (FM15)	20 mm
North Wambo Creek (FM4)	20 mm

1. From Table 11, Version 12 of the WCPL SWMP.

In addition to the surface water monitoring requirements detailed in **Table 31** and **Table 32,** WCPL is also required to meet additional requirements, in accordance with the approved SWMP. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL SWMP (**Table 33**)**.**

Table 33: Surface Water Monitoring Program Performance Indicators

Performance Indicator
Number of complaints received relating to surface water.
Number of non-compliances received relating to surface water.
Number of exceedances of surface water impact assessment criteria[1].
Number of reportable environmental incidents relating to surface water.

1. An exceedance occurs when water quality results exceed the 80th Percentile Trigger Value (**Table 31**) after three consecutive sampling events.

6.1.2 Performance during the Reporting Period

An exceedance of the surface water quality triggers is considered to have occurred when water quality results exceed the 80th Percentile Trigger Value (**Table 31**) for three consecutive sampling events.

WCPL recorded no exceedances of the surface water quality impact assessment criteria during the reporting period. WCPL reported to the EPA that water quality samples were unable to be collected at monitoring locations SW01, SW02, SW03, SW27/SW27a, SW32/SW32a and SW08 during the reporting period, resulting in a non-compliance with Condition M2.3 of EPL529 (**Section 10.7**).

No complaints relating to surface water were received during the reporting period.

A summary of the surface water quality monitoring data is included in **Appendix D.**

The WCPL stream flow monitoring system consists of (**Figure 10**):

- five monitoring stations on North Wambo Creek (US-FM1, FM1, FM2, FM3 and FM4);
- three monitoring stations on South Wambo Creek (FM9, FM15 and FM16);
- two monitoring stations on Stony Creek (FM12 and FM13); and
- one monitoring station on a major tributary to Stony Creek (FM14).

During the reporting period, stream flow data was recorded at FM2, FM3 and FM4.

There were no recordable flow events at US-FM1, FM1, FM9, FM12, FM13, FM14, FM15 and FM16.

There were four days during the reporting period when 20 mm or greater rainfall was recorded at the WCPL meteorological station (21 January, 16 March, 17 March and 30 March 2019). No flow events were observed at FM13 or FM15 on the day of, or day after, these rainfall events. Flow was recorded at FM4 on 21 January and 30 March, but not on or after 16 and 17 March.

WCPL has concluded that the likely cause of the triggers is the ongoing climatic conditions (i.e. drought) and is undertaking further investigation of the triggers of the performance indicator in accordance with the WCPL Surface and Groundwater Response Plan.

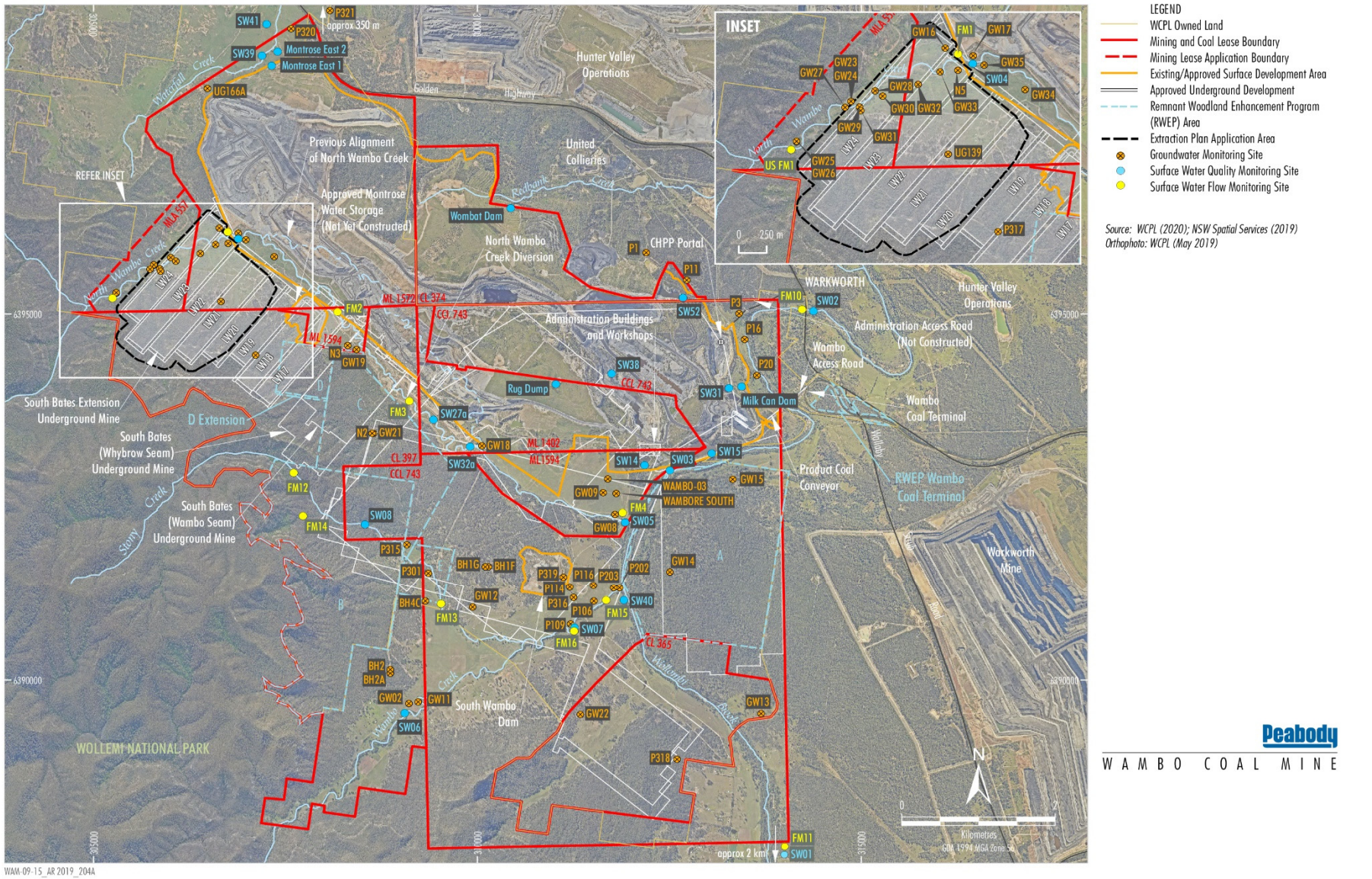

Figure 10: WCPL Surface and Groundwater Monitoring Locations

6.1.3 Trends and Key Management Implications

Consistent with the previous reporting period, there were no exceedances of the surface water quality triggers during the reporting period.

With the exception of the barometric correction sensor associated with the absolution pressure sensor along North Wambo Creek, the flow monitoring stations (and back up sensors) functioned successfully during the reporting period.

There were no other trends or key management implications identified.

6.1.4 Implemented or Proposed Management Actions

During the next reporting period, WCPL will continue to implement the approved SWMP (Version 12).

AECOM recommended that the percentage of battery used in the in-situ sensors at the flow stations along Stony and South Wambo Creek be closely monitored. Once the percentage used is greater than 50% consideration should be given to obtaining replacement loggers.

6.2 Groundwater Monitoring

WCPL undertakes groundwater monitoring at the Mine in accordance with the approved GWMP, which is a component of the WCPL Water Management Plan. The GWMP has been developed to ensure WCPL complies with its statutory conditions relating to groundwater monitoring at the Mine.

The GWMP was revised in April 2018 (Version 12) and submitted with the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20. On 7 September 2018, DPIE approved the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 (including the GWMP).

During the reporting period, WCPL installed nine new monitoring bores (GW27 to GW35) in the North Wambo Creek Alluvium to improve their understanding of the nature of the alluvial groundwater system. The GWMP (and **Figure 10**) will be updated during the next reporting period to include these bores.

6.2.1 Approval Criteria/EIS Predictions and Management Plan Requirements

The GWMP includes triggers for groundwater levels and quality in shallow bores. These triggers have been developed using statistical analysis of baseline monitoring data and data acquired to 2014 (from a number of monitoring bores on and around the Mine site) and the predicted effects presented in the EIS (Resource Strategies 2003) and subsequent Environmental Assessments.

The trigger values are not assessment criteria but are used to initiate investigations into the groundwater levels or groundwater quality as reported by the groundwater monitoring program. A summary of the groundwater triggers for shallow bores, as detailed in WCPL's approved GWMP (Version 12), is included in **Table 34**. In order to avoid false triggering, as a trigger would be initiated 20% of the time due to natural causes, triggers for groundwater level are defined to occur when two consecutive bi-monthly observations (over a 2-month interval) exceed or fall below the specified depth to groundwater.

Table 34: Water Quality and Level Trigger Values – Shallow Bores

Bore	Depth to Groundwater (mBTOC[1])		Conductivity (µS/cm)	pH	
	Min (10th percentile)	Max (90th percentile)	Maximum (Three Consecutive Bi-Monthly Exceedances)	Minimum (Two Consecutive Bi-Monthly Exceedances)	Maximum (Two Consecutive Bi-Monthly Exceedances)
P106	6.6	10.7	941	6.7	7.9
P109	4.6	6.7	NA	NA	NA
P114	5.4	7.6	6,141	6.5	7.8
P116	4.8	7.3	5,972	6.6	7.5
P202	7.8	9.6	8,172	6.7	7.7
P203	16.1	21.6	2,630	7.3	8.1
P301[2]	NA	NA	NA	NA	NA
P315	4.4	9.1	552	6.0	7.4
GW02	5.8	8.5	715	6.7	7.4
GW08[3]	NA	NA	NA	NA	NA
GW09[3]	NA	NA	NA	NA	NA
GW11	4.0	6.5	592	6.8	7.5
GW12	9.9	12.9	NA	NA	NA
GW13	4.8	5.4	4,370	6.9	7.1
GW15	10.4	11.1	730	6.7	7.2
GW16[4]	NA	NA	NA	NA	NA
GW17[4]	NA	NA	NA	NA	NA
P16	7.1	7.8	10,832	7.0	7.7
P20	7.1	8.2	10,625	7.0	7.6

1. mBTOC = metres below top of casing.
2. P301 is predicted to go dry by HydroSimulations (2014), therefore no trigger level has been established – i.e. the purpose of trigger levels is to identify unanticipated impacts.
3. WCPL will install replacement bores in the North Wambo Creek alluvium in areas that are not located above the old Wambo No. 1 Seam workings. Trigger levels will be established for these bores based on modelled groundwater levels and will replace GW08 and GW09 in this table.
4. GW16 and GW17 are located upstream of the NWCD and in close proximity to the approved open cut. There are no groundwater users located in the vicinity of North Wambo Creek upstream of the NWCD. Therefore, a trigger level for these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.

In addition to the groundwater monitoring triggers detailed in **Table 34,** WCPL is also required to meet additional requirements, in accordance with the approved GWMP, Extraction Plan for the South Bates Underground Mine Longwalls 11 to 16 and Extraction Plan for the South Bates Extension Underground Mine Longwalls 17 to 20. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL GWMP (**Table 35).**

Table 35: Groundwater Monitoring Program Performance Indicators

Performance Indicator
The performance indicators will be considered to have been exceeded if Wambo receives complaints from groundwater users.
The performance indicators will be considered to have been exceeded if monitoring data suggests significant divergences away from the modelled groundwater.
The performance indicators will be considered to have been exceeded if the groundwater levels in alluvial bores exceed the groundwater level criteria listed in Table 9 of the GWMP.
The performance indicators will be considered to have been exceeded if the groundwater quality in alluvial bores exceeds the groundwater quality criteria listed in Table 10 of the GWMP.

Groundwater monitoring data from the Permian monitoring bores is assessed and reviewed as part of the Annual Review. Data is also used to validate the groundwater model.

6.2.2 Performance during the Reporting Period

Monitoring of groundwater levels and quality in alluvial and Permian bores was undertaken in accordance with WCPL's approved GWMP (Version 12).

Monitoring locations P106, P114, P315, GW08 and GW09 were monitored but samples were unable to be taken on 8 February, 3 April, 5 June, 6 August, 3 October and 3 December as the locations were dry or had insufficient water to provide a representative sample. This is a non-compliance with Condition M2.3 of EPL529 (**Section 10.8**).

No complaints from groundwater users were received during the reporting period.

A number of trigger level exceedances were recorded for groundwater levels and EC during the reporting period (**Table 36**). These exceedances are summarised in **Section 6.2.3** and discussed further in the report *Wambo – 2019 Annual Review Groundwater* (SLR 2020) (**Appendix G**).

Hydrographs for relevant groundwater monitoring bores were assessed to determine whether observed trends were due to climatic conditions or mining, and shallow bores were assessed for compliance with the groundwater level and water quality performance indicators (SLR 2020).

No bores were decommissioned during the reporting period.

Table 36: Groundwater Trigger Level Exceedances

Bore	Number of Trigger Level Exceedances[1]				
	Depth to Groundwater - Min (10th percentile)	Depth to Groundwater - Max (90th percentile)	EC	pH min	pH max
P106		6 (dry)			
P109					
P114		6 (dry)			
P116					
P202		2			
P206		6			
P301	N/A				
P315		6 (dry)			
GW02		6 (1 dry)			
GW08	N/A – Bore Dry				
GW09	N/A – Bore Dry				
GW11		6	5	1	4
GW12		6 (dry)	N/A		
GW13		6			
GW15		6			
GW16	N/A				
GW17	N/A				
P16		6			
P20		6			
Total	**0**	**68**	**5**	**1**	**4**

Source: *Wambo – 2019 Annual Review Groundwater* (SLR 2020).

1. Blank cells represent no trigger exceedances.

6.2.3 Trends and Key Management Implications

Groundwater monitoring data collected during the reporting period has been reviewed and assessed against the triggers in the approved GWMP (**Table 34**) by SLR (2020).

During the reporting period, there were no exceedances of the 10th percentile trigger for depth to groundwater.

The 90th percentile trigger for depth to groundwater allows identification of anomalously deep depths to groundwater. During the reporting period, exceedances of the 90th percentile level were recorded at P106, P114, P202, P206, P315, GW02, GW11, GW12, GW13, GW15, P16 and P20.

HydroSimulations (2019) recommended field investigation into the depth and borehole integrity of P106 to further investigate the dry readings at this bore in 2018. This was undertaken by WCPL in 2019 and it was revealed that an obstruction at 9.6 mbToC was the cause of false dry depth to water readings. The bore remained blocked throughout 2019.

SLR concluded that the other trigger level exceedances did not warrant further investigation as these can be attributed to landholder pumping (at GW02 and GW11), natural variability, climatic conditions and/or predicted impacts.

No exceedances of triggers for EC or pH occurred during the reporting period (SLR 2020), with the exception of readings at GW11 (pH and EC).

The exceedance of EC at GW11 is expected to be the result of a greater proportion of brackish water sourced from Permian strata contributing to the groundwater system due to the reduction in rainfall.

The pH trigger exceedances at GW11 remain within recommended ANZECC ranges for irrigation and stock water (pH 6 to 8.5) and Australian Drinking Water Guidelines for groundwater fit for human consumption (pH 6.5 to 8.5). SLR (2020) considered that, with the change in pH being so marginal, it is not considered to have caused, or be likely to cause, a long-term, negative impact to the groundwater quality in the vicinity of these bores. SLR (2020) recommended that trigger levels may need to be reassessed as they are consistently outside their trigger ranges as defined in the GWMP.

Hydrographs of observed groundwater levels were reviewed by SLR in combination with a review of subsidence parameters and WCPL's groundwater model. SLR (2020) concluded that the groundwater model performs well and remains fit for purpose to predict the timing and magnitude of impacts to groundwater caused by the Mine. There are updates scheduled for 2020 to keep the model predictions current and to address the outstanding issues from the above points. Additional detail is available in **Appendix G**.

SLR conducted an assessment against the performance indicators and relevant subsidence impact performance measures for North Wambo Underground Longwalls 8 to 10A, South Bates Underground Mine Longwalls 11 to 16 and South Bates Extension Underground Mine Longwalls 17 and 18.

It was concluded by SLR (2020) that the subsidence impact performance measure of *Negligible impact to Wollombi Brook* was upheld for the extraction of North Wambo Underground Longwalls 8 to 10A, South Bates Underground Mine Longwalls 11 to 16 and South Bates Extension Underground Mine Longwalls 17 and 18.

WCPL will continue to monitor the bores in accordance with the approved GWMP.

6.2.4 Implemented or Proposed Management Actions

During the reporting period, nine new monitoring locations were added as part of the North Wambo Creek alluvium investigation. One more site is scheduled to be installed in Quarter 2 of 2020. The GWMP will be reviewed and updated in 2020 to reflect the additional locations.

SLR (2020) recommended:

- Consider removing GW02 and GW11 from future revisions of the GWMP if pumping continues at both bores. A replacement monitoring bore may be useful in a nearby location.
- Additional assessment of P206 against trigger levels in future versions of the GWMP. This should be assessed considering the screened depth of the bore and the magnitude of predicted impacts due to mining.
- P109 to be considered as a replacement site for P106 until the identified obstruction can be cleared.
- Future revisions to the groundwater model should consider updating the representation of Homestead underground mining to better capture impacts near Wambo Creek and Wollombi Brook.
- Future revisions to the groundwater model should consider updating model layer structure using the most recent WCPL geology model and any additional geological information.

During the next reporting period, WCPL will continue to implement the approved GWMP.

6.3 HRSTS Discharges

WCPL is permitted to discharge water to the Hunter River in accordance with the conditions of EPL529 and the HRSTS guidelines. These guidelines include the following conditions:

- notification from DPIE-Water of discharge opportunity must be received;
- flow of water in Wollombi Brook at the DPIE-Water Bulga Gauging Station (FM11) needs to be more than 500 megalitres per day (ML/day);
- pH will be measured continuously throughout the discharge with an inline instrument;
- EC will be measured continuously in µS/cm throughout the discharge with an instrument designed to measure between 0 and 10,000 µS/cm; and
- TSS will be measured once a day during discharge. A representative sample will be collected every day and sent to the lab for analysis.

WCPL has 51 credits under the HRSTS until 30 June 2020, after which WCPL will retain 21 credits and any additional credits obtained during the annual auction.

6.3.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the approval criteria for off-site discharges (from EPL529) is included in **Table 37.**

Table 37: EPL529 Approval Criteria for Off-site Discharge

Parameter	Criteria[1]
pH	6.5-9.5[2]
TSS	120 mg/L[2]
EC	N/A
Volume	250 ML/day

1. Criteria as per EPL529.
2. 100th percentile concentration limit.

6.3.2 Performance during the Reporting Period

During the reporting period, WCPL did not discharge any water from Licensed Discharge Point (LDP) No. 4.

6.3.3 Trends and Key Management Implications

There were no discharge events in 2019 compared with none in 2018, none in 2017, eleven in 2016, six in 2015 and one in 2014. The total volume of water discharged in 2019 (0 ML) was the same as in 2018 (0 ML), the same as in 2017 (0 ML) and less than in 2016 (416 ML), 2015 (140.1 ML) and 2014 (9.6 ML).

6.3.4 Implemented or Proposed Management Actions

A written report of the activities undertaken by WCPL under the HRSTS (for the period 1 July 2018 to 30 June 2019) was submitted to the EPA on 15 August 2019, in accordance with Condition R4 of EPL529.

The HRSTS discharge system was reviewed during 2016. This review consisted of updating the communication hardware in consultation with WaterNSW, continued regular calibration of instrumentation and development of operating procedures. A guideline for a HRSTS system audit was completed in 2018. The audit was unable to be completed as WCPL was unable to discharge through the HRSTS in 2018 or 2019. During the next reporting period, WCPL will undertake the HRSTS system audit if discharges through the HRSTS occur.

During the next reporting period, WCPL forecasts compliance with the HRSTS requirements, and predicts that, if the opportunity arises, it will use all of its HRSTS credits, as dictated by River Register releases.

6.4 North Wambo Creek Diversion Discharge Flows

The NWCD Plan was approved by the then NSW Department of Planning (now DPIE) in April 2008. A requirement of the approval was to comply with the requirements of the then Department of Water and Energy (now DPIE-Water). These requirements included reporting on the performance of the NWCD annually in the Annual Review.

During the reporting period, WCPL monitored flow within the North Wambo Creek at five locations:

- US-FM1, approximately 1 km upstream of FM1 (installed in December 2017);
- FM1, upstream of the NWCD;
- FM2, middle of the NWCD, downstream of FM1;
- FM3, middle of the NWCD, downstream of FM2; and
- FM4, downstream of the NWCD.

A review of the flow events at each monitoring site during the reporting period was undertaken by AECOM (2020) and a summary is provided in **Table 38**. There were no recordable flow events at FM1 (including the backup sensor), or US-FM1 during the period 1 January to 31 December 2019. Flow monitoring data is included in the AECOM report (**Appendix H**).

Table 38: NWCD Discharge Flow Monitoring – 2019

Flow Monitoring Station	No. of Flow Events Recorded	Maximum Stream Height Recorded (m)	Maximum Theoretical Flow Rate Recorded (ML/day)
FM2	3	0.20	11.3
FM3	6	0.14	8.1
FM4	2	0.33	146

6.5 Water Take

WCPL maintains a variety of WALs under the *Water Management Act 2000* which consist of High, General and Supplementary securities, as detailed in **Table 39**.

During the reporting period, WCPL was issued a new WAL (WAL 42373) which consolidated six other WALs held by WCPL (WAL 39735, WAL 39738, WAL 39803, WAL 41494, WAL 41528 and WAL 41520) into a single entitlement under the North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin – North Coast Groundwater Source).

During the 1 July 2018 to 30 June 2019 water year, WCPL extracted a total of 1,646.3 ML of water from the Hunter River (1,000 ML under WAL 718 and 646.3 ML under WAL 8600), 95.2 ML of water from Wollombi Brook (under WAL 929), 70 ML of groundwater from Wollombi Brook alluvials (under WAL 23897) and 1,243 ML from porous rock groundwater sources (under WAL 42373). As show in **Table 39**, all water take during the 2018-2019 water year was less than the allowable limits under the relevant WALs.

No water was used for irrigation purposes between 1 July 2018 to 30 June 2019 (from licence 20WA200632).

Table 39: Environmental Performance – Water Take (1 July 2018 to 30 June 2019)

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Passive take/ inflows (ML)	Active pumping (ML)	Total (ML)
Hunter Regulated River Water Source							
WAL 718 (20SL060212)	Hunter River Pump	Perpetuity	1,000 unit shares (high security)	Regulated River (high security)	0	1,000	1,000
WAL 8599 (20SL061206)	Hunter River Pump	Perpetuity	6 unit shares (high security)	Regulated River (high security)	0	0	0
WAL 8600 (20SL061206)	Hunter River Pump	Perpetuity	868 unit shares (general security)	Regulated River (general security)	0	646.3	646.3
WAL 8604 (20BL061206)	Hunter River Pump	Perpetuity	240 unit shares (supplementary water)	Supplementary Water	0	0	0
Hunter Regulated River Water Source – Shared with United Colliery							
WAL 929 (20SL050661)	Other Pump	Perpetuity	3 unit shares	Domestic and Stock	0	0	0
WAL 1369 (20SL060416)	80 mm CP	Perpetuity	15 unit shares (supplementary water)	Supplementary Water	0	0	0
WAL 15459 (20SL204246)	80 mm CP	Perpetuity	21 unit shares (general security)	Regulated River (general security)	0	0	0
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL 18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	0	95.2	95.2
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	70 (open cut seepage)	0	70
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)							
WAL 42373[2]	-	Perpetuity	1,549 unit shares	Aquifer	90 (underground seepage) 184 (open cut seepage)	969 (dewatering Bores 2A and 4C)	1,243
WAL 41532 (20BL172156)	Dewatering	Perpetuity	98 unit shares	Aquifer	0	0	0

1. 20BL prefix bore licences with allocations have been replaced with WALs.
2. WAL 42373 was issued in 2019 to consolidate six of WCPL's previous WALs under the North Coast Fractured and Porous Rock groundwater Sources (Sydney Basin – North Coast Groundwater Source) including WAL 39735, WAL 39738, WAL 39803, WAL 41494, WAL 41528 and WAL 41520.

6.6 Compensatory Water

WCPL did not provide any compensatory water to any water users during the reporting period.

6.7 Site Water Balance

WCPL reviewed the Site Water Balance at the end of the reporting period, in accordance with the requirements of the WCPL Water Management Plan. A summary of the WCPL site water balance for the period 1 January to 31 December 2019 is provided in **Table 40**.

Table 40: Site Water Balance (1 January to 31 December 2019)

Water Sources	Volume (ML)
Hunter River	2,150
Wollombi Brook	395
United Collieries	19
Rainfall/Runoff	602
Underground Seepage	90
Dewatering Bores 2A and 4C	1,094
Open Cut Seepage	254
Total Water Inputs	**4,604**
Water Usage	**Volume (ML)**
Dust Suppression	962
CHPP Consumption	1,966
Underground	395
United Collieries	19
CHPP/UG Potable Water	7
Workshop Water	Not metered
Domestic Usage	12
Total Water Usage	**3,360**
Water Loss	**Volume (ML)**
Evaporation – Mine Water & Tailings Dam	748
Evaporation – Pit Floor	184
HRSTS Discharge	0
Seepage	0
CHPP Process (washdown)	504
Total Losses	**1,436**
Storages	**Volume (ML)**
Initial (January 2019)	419
Final (December 2019)	190
Change in Storage	**-229**
Water Balance (ML)	**37**

A total of 2,150 ML was extracted from the Hunter River and 395 ML was extracted from the Wollombi Brook during the reporting period. This total is above the EIS forecast annual average extraction volume of 106 ML (Resource Strategies 2003).

As no water was sourced from the United Collieries during the reporting period, this brings the total volume of water imported to approximately 57.6% of the total water input. This is considerably higher than the EIS forecast of an average of 2.6% (Resource Strategies 2003).

This increase is considered to be due to the ongoing dry conditions and increased demand for raw water in the CHPP.

A total of 602 ML of runoff from rainfall was intercepted during the reporting period, 377 ML less than intercepted during 2018 (979 ML).

Underground seepage represented 2% of total supply compared to the 2003 forecast of 13.8% (Resource Strategies 2003) and down from 7.3% of total supply during 2018. The MOD17 Groundwater Assessment (HydroSimulations 2017) predicted that there would be an average seepage of 212 ML per annum (ML/a) and a maximum seepage of 376 ML/a from the combined sources of the South Bates Underground Mine and South Bates Extension Underground Mine. The underground seepage recorded during the reporting period (90 ML/a) is considerably lower than these predictions and is likely influenced by the ongoing dry conditions.

No water was exported off-site during the reporting period. No water was discharged during the reporting period.

6.7.1 Salt Balance

WCPL reviewed the Salt Balance at the end of the reporting period, in accordance with the requirements of the WCPL Water Management Plan. A summary of the WCPL salt balance for the period 1 January to 31 December 2019 is provided in **Table 41**.

Table 41: Salt Balance (1 January to 31 December 2019)

Inputs	Salt (t)
Raw water- Hunter	875
Raw water- Wollombi	161
Runoff	405
Groundwater (ROM coal)	2,425
Groundwater (Bores)	6,981
Groundwater (Seepage)	574
Total	**11,421**
Outputs	
Product Coal	3,168
Dust suppression	4,233
Release to HRSTS	-
Total	**7,401**
Balance	**4,020**

6.8 Erosion and Sediment Control

WCPL has developed an ESCP to address the relevant consent conditions and regulatory requirements.

6.8.1 Performance during the Reporting Period

During the reporting period, WCPL complied with all requirements detailed in the ESCP (Version 10).

No complaints were received relating to erosion and sediment control.

6.8.2 Trends and Key Management Implications

No trends or key management implications for erosion and sediment control were identified during the reporting period.

6.8.3 Implemented or Proposed Management Actions

During the reporting period, Rug Dump was shaped, seeded and contour banks completed, with the drop structure to be constructed in Quarter 2 of 2020.

WCPL is currently reviewing draft designs to better manage the catchment area for the Hales Crossing sump and pump arrangement, based upon recommendations made in the 2019 assessment.

7.0 Rehabilitation

7.1 Rehabilitation Performance during the Reporting Period

Proposed rehabilitation and disturbance activities for the reporting period are detailed in WCPL's approved MOP (2019-2020).

7.1.1 Status of Disturbance and Rehabilitation

A summary of the proposed and actual rehabilitation activities undertaken in 2019 is provided in **Table 42**.

Table 42: Actual versus Proposed Rehabilitation Activities (2019)

	2019 Proposed	2019 Actual	2020 Proposed
Total Disturbance (ha)	57.89	7.2	59.56
Total Rehabilitation (ha)	33.69	33.6[1]	45.26[2]
Cumulative Rehabilitation (ha)	684.9	684.9	730.16

1. Consists of 20.5 ha at Wombat Dump and 13.1 ha at Rug Dump.
2. Consists of 8.6 ha at RL160, 18.52 ha at Waterfall Ramp and 18.14 ha at Montrose East.

The actual disturbance during the reporting period was less than proposed as the Highwall Miner Project was not undertaken during the reporting period.

Figure 11 and **Figure 12** show the rehabilitation areas progressed during the reporting period.

Details of mining operations completed at the Mine during the reporting period are included in **Section 3.1**. At the end of the reporting period, the total mine disturbance and total rehabilitation undertaken were consistent with the forecast areas.

At the end of the reporting period, WCPL was actively mining in the following areas (as shown on **Figure 13**):

- South Bates Extension Underground Mine Longwall 18;
- Montrose Central Pit (strip 29 to 46);
- Hilldale Pit (strip 1 onwards);
- Homestead Pit (strip 1);
- Montrose West Pit (strip 2); and
- Montrose East Pit (up to strip 3).

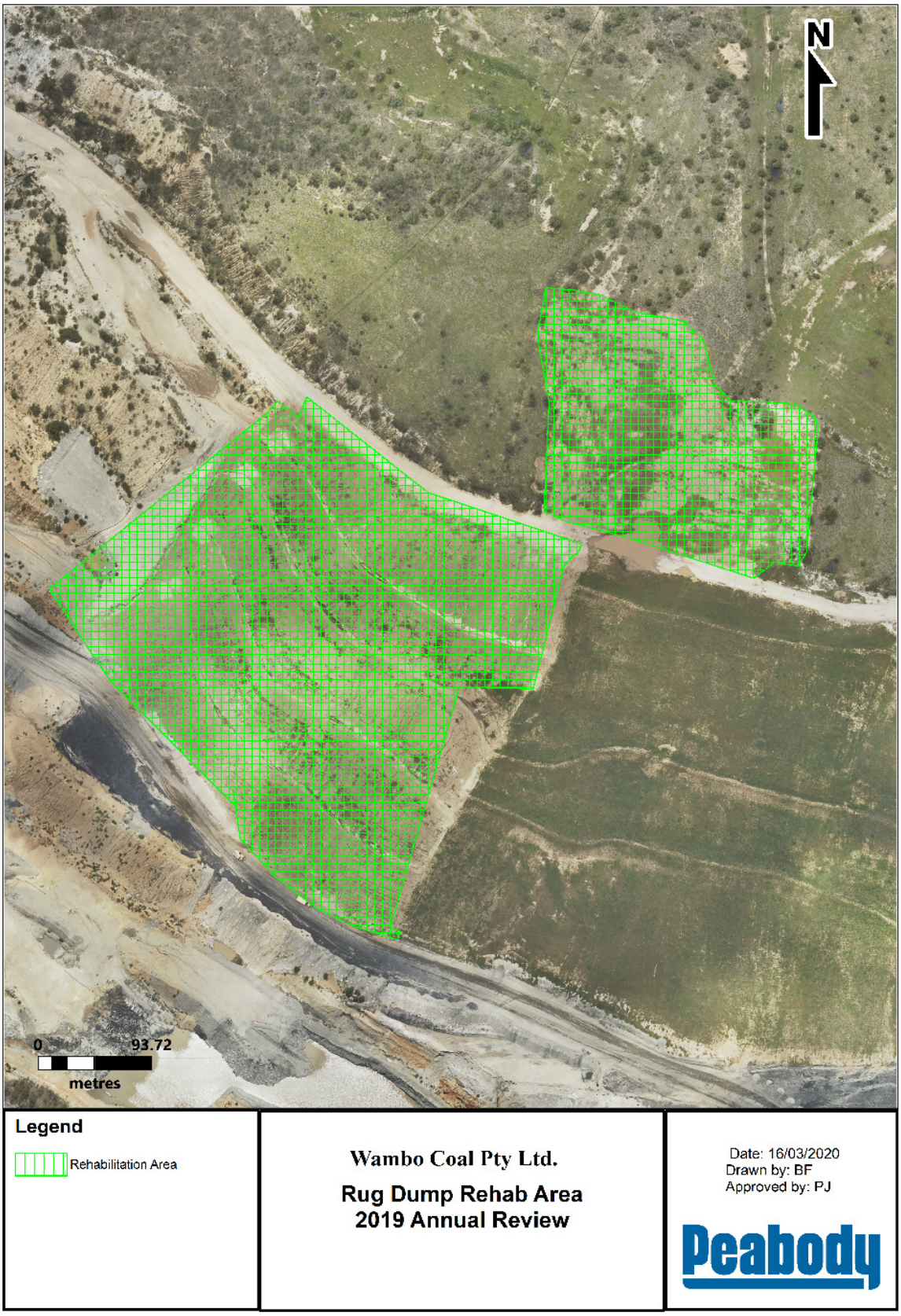

Figure 11: Rug Dump Rehabilitation Undertaken in 2019

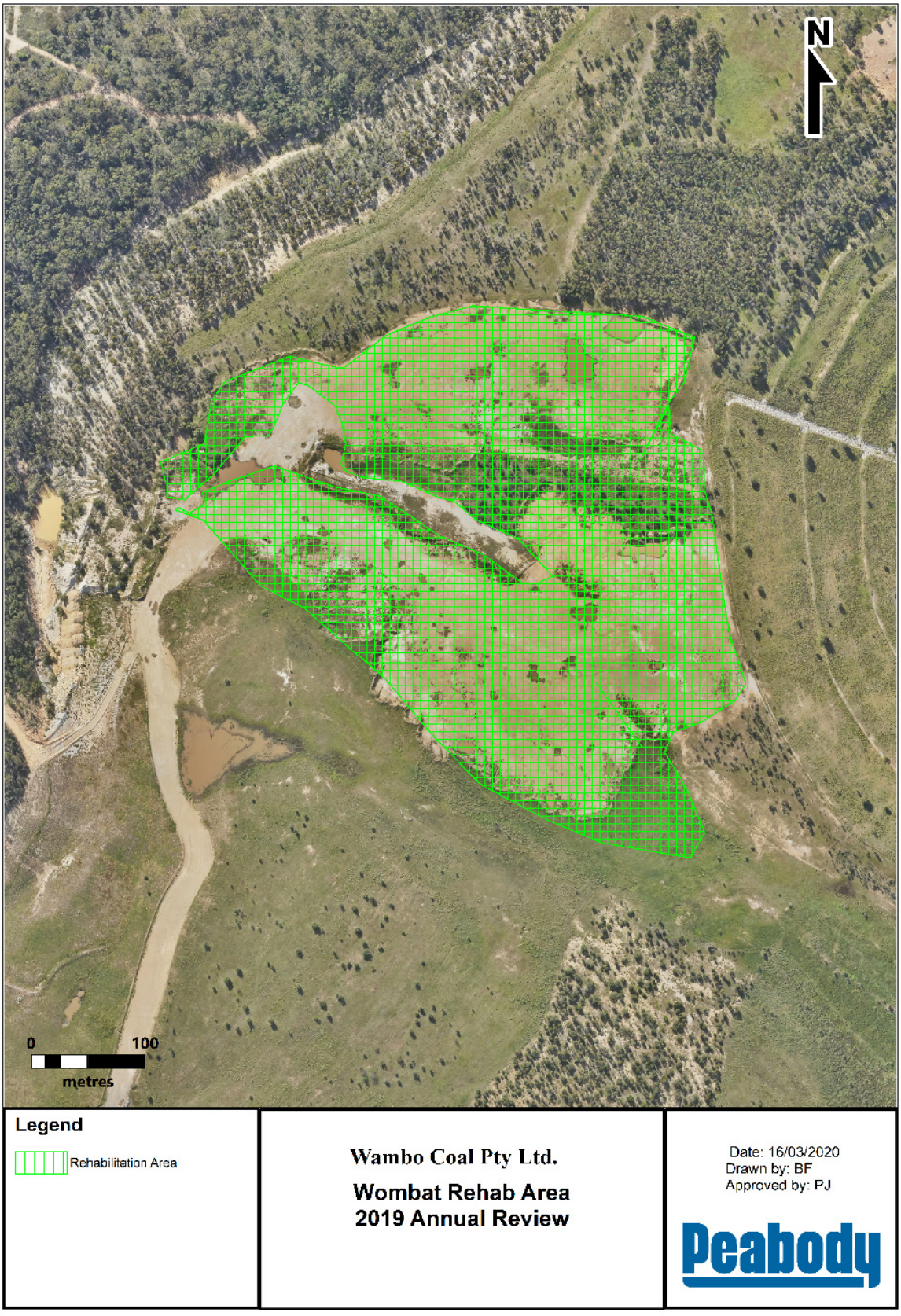

Figure 12: Wombat Dump Rehabilitation Undertaken in 2019

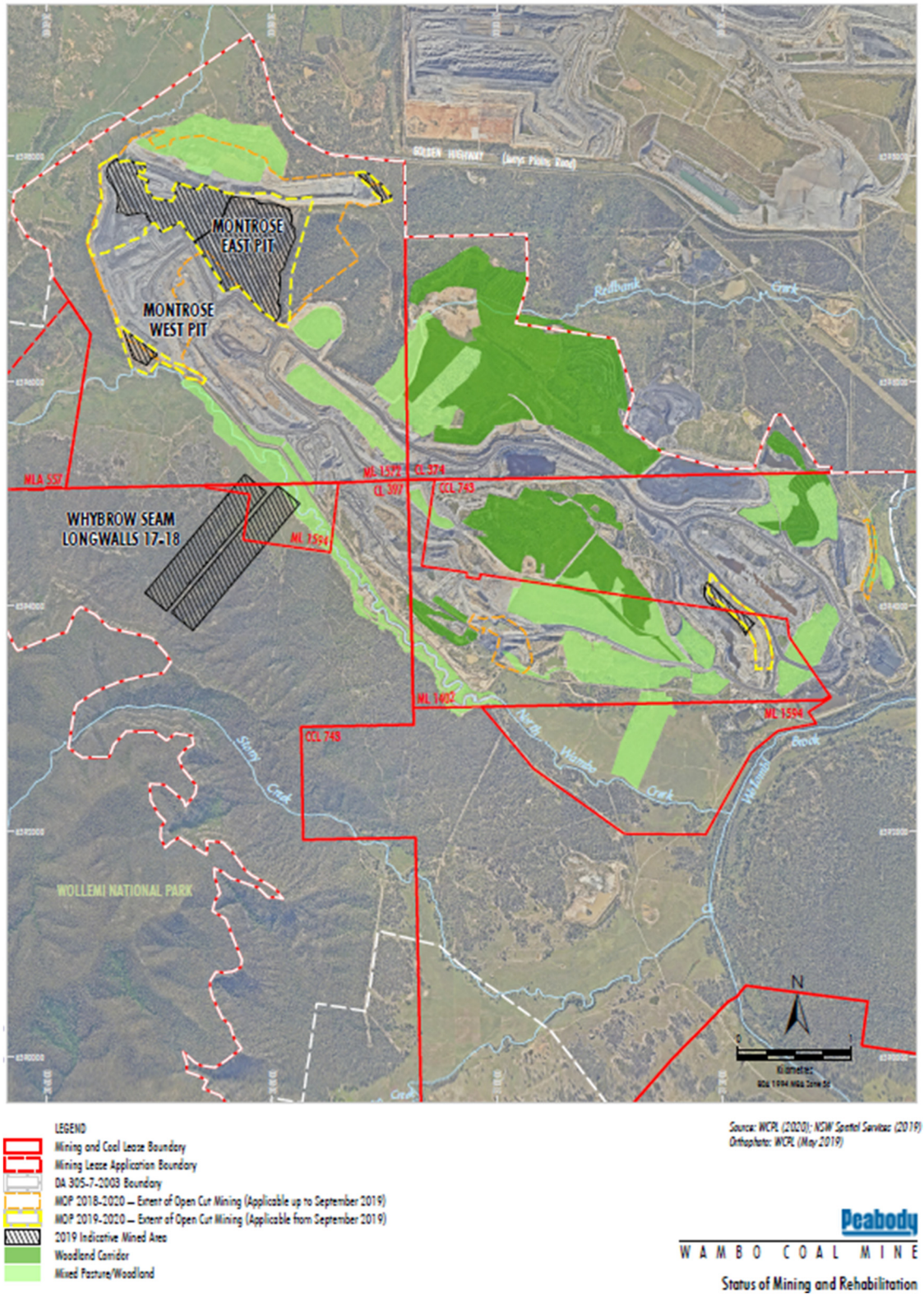

Figure 13: Status of Mining and Rehabilitation

On 27 June 2016, WCPL was issued with a condition requiring the development of a rehabilitation strategy for the NETD to the satisfaction of the Minister for Industry, Resources & Energy (for inclusion in a MOP). WCPL finalised and submitted the NETDRS to DRG on 22 November 2016. In March 2017, the DRG provided confirmation that the NETDRS could not be approved, as the final landform was not consistent with the current development consent conditions for maximum emplacement heights. As a result, WCPL was required by the DRG to resubmit the NETDRS by the 31 May 2017.

As an alternate capping method, WCPL had commenced a trial using secondary flocculation in July 2016, with a flocculation plant located on the crest of the HPTD embankment. The trial consisted of a cell within the HPTD. The undrained shear strength data for secondary flocculated tailings in the trial cell as measured on-site with a hand shear vane on 2 March 2017 ranged from 30 kilopascals (kPa) up to about 350 kPa (Fitton Tailings Consultants 2017).

With the success of the HPTD trial, WCPL are developing a capping design viability study using intermittent disposal methodology of layering 200 mm of secondary flocculated tailings at a time. Each 200 mm layer of flocculated material deposited will be allowed to dry, to finally form a layered crust ~3 m thick as part of the capping final design.

As recommended by WCPL's tailings consultant (Fitton Tailings Consultants 2017), CPT has commenced to improve WCPL's understanding of the geotechnical characteristics of the tailings over the full depth of the facility, over a multiple location testing regime in both NETD and the HPTD facilities. This testing will enable a final capping design to be prepared that contains far fewer critical assumptions.

The following is a summary of key project milestones proposed by WCPL regarding the capping method for both the NETD and HPTD:

- CPT in the HPTD commenced in Quarter 3 2019.
- CPT and Shear Vane testing in the NETD commenced in Quarter 1 2020.
- Analysis of testing results and development of capping strategy for NETD to be undertaken during 2020.
- Implementation of capping strategy to commence in Quarter 4 2020.

7.1.2 Agreed Post Rehabilitation Land Use

The agreed post rehabilitation land use for the Mine is detailed in WCPL's EIS (Resource Strategies 2003), DA305-7-2003 and MOP (2019-2020). The final landform for WCPL proposes a balanced rehabilitation outcome which recognises the alternative land uses that exist in the region, and therefore aims to establish the potential for both sustainable agriculture and endemic woodland habitat. The proposed design of final landforms and the revegetation strategy are described in the MOP (2019-2020).

All rehabilitation activities undertaken during the reporting period were undertaken with consideration to the agreed post rehabilitation land use goals.

7.1.3 Key Rehabilitation Performance Indicators

Table 43 summarises WCPL's rehabilitation status at the end of the reporting period, compared to the previous reporting period, as well as the forecast for the next reporting period.

Land being prepared for rehabilitation in 2020 is consistent with the scheduled rehabilitation detailed in the MOP (2019-2020).

Table 43: 2019 Rehabilitation Status and Forecast

Mine Area Type	2018 (Actual) (ha)	2019 (Forecast) (ha)	2019 (Actual) (ha)*	2020 (Forecast) (ha)
A. Total mine footprint[1]	1,881.8	1,881.8	1,881.8	1,881.8
B. Total active disturbance[2]	1,011.7	1,092.4	1,174.8	1,189.1
C. Land being prepared for rehabilitation[3]	0	0	0	0
D. Land under active rehabilitation[4]	651.3*	701.3	684.9	730.16
E. Completed rehabilitation[5]	0	0	0	0

1. Total mine footprint includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands (as defined in DRE MOP/RMP Guidelines). Please note that subsidence remediation areas are excluded.
2. Total active disturbance includes all areas ultimately requiring rehabilitation such as: on-lease exploration areas, stripped areas ahead of mining, infrastructure areas, water management infrastructure, sewage treatment facilities, topsoil stockpile areas, access tracks and haul roads, active mining areas, waste emplacements (active/unshaped/in or out-of-pit), and tailings dams (active/unshaped/uncapped).
3. Land being prepared for rehabilitation – includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development (as defined in DRE MOP/RMP Guidelines).
4. Land under active rehabilitation - includes areas under rehabilitation and being managed to achieve relinquishment – includes the following rehabilitation phases as described in the DRE MOP/RMP Guidelines – "ecosystem and land use establishment" (area seeded OR surface developed in accordance with final land use) and "ecosystem and land use sustainability" (revegetation assessed as showing signs of trending towards relinquishment OR infrastructure development).
5. Completed rehabilitation – requires formal sign-off by DRE that the area has successfully met the rehabilitation land use objectives and completion criteria.

* The actual disturbance and rehabilitation values have been updated from the values previously reported in WCPL's 2018 Annual Review as a result of corrections made using GIS. Previously reported value in 2018 Annual Review was 657.5 ha.

7.1.4 Renovation or Removal of Buildings

No buildings were renovated or removed during the reporting period.

7.1.5 Other Rehabilitation Activities

In consultation with DRE (now DRG), an extensive audit of historical exploration works commenced during 2015. The scope of the audit was to identify all historical exploration sites, rehabilitate as required and relinquish the sites to DRG. Of the identified sites:

- 9 sites were rehabilitated;
- 21 sites were inspected;
- 8 sites were identified as suitable for relinquishment; and
- 13 sites were identified as mined through.

In 2016, the scope of the audit was finalised and a total of 222 sites associated with historical exploration were identified in A444 and 17 in EL7211. The sites were identified as requiring inspection, possible rehabilitation and eventual relinquishment.

Both the EL7211 and A444 audits were completed during 2017. Copies of these reports were provided to DRG on 17 April 2017. In December 2017, DRG requested an ESF2 Form (Rehabilitation Completion and/or Review of Rehabilitation Cost Estimate) be completed to accompany the Audit Reports. The ESF2 form was submitted to DRG on 14 December 2017. Follow up required for remaining holes associated with this audit were delayed due to the ongoing drought conditions. These bores will be inspected in Quarter 2 2020 as part of the exploration rehabilitation program (refer to **Section 5.10**).

7.1.6 Trials, Research Projects and Other Initiatives

The MOP was updated during the reporting period to cover the period September 2019 to December 2020.

The following rehabilitation trials were undertaken during the reporting period:

- Capping trials of NETD.
- CPT of NETD and HPTD.
- Finalisation of capping design.
- Intermittent disposal of double flocculated tailings commenced in the NETD in Quarter 3 2019 and in the HPTD in Quarter 4 2019.
- Subsidence repair trials (based on the program of works being developed by WCPL following the subsidence impact audit).
- Application of gypsum to improve soil sodicity and structure in rehabilitation outcomes.

During the previous reporting period, subsidence remediation trials were conducted on areas of historical subsidence. Trials were conducted in several areas using different methodologies dependent on the identified surface impact. Due to the extended dry period throughout the second half of the reporting period, reoccurrences of slumping and potholing typically caused by water ingress have not been identified on the remediated trial sites. Continued monitoring of subsidence remediation will identify any further subsidence or requirement for reworks. As of the end of the reporting period, remediated sites remained sound.

7.1.7 Variations in Activities Proposed in the MOP

During the reporting period, rehabilitation was undertaken in accordance with the activities proposed in the approved MOP (2019-2020).

7.1.8 Key Issues That May Impact Successful Rehabilitation

Poorer than average rainfall for 2017, 2018 and 2019 has impacted on germination and pioneer growth. No additional seeding was undertaken in 2019 due to continued drought. Revegetation will be assessed in 2020 for areas that require additional seeding.

7.2 Actions for the Next Reporting Period

7.2.1 Final Rehabilitation Outcomes

During the next reporting period, WCPL will develop a Rehabilitation Management Plan in accordance with Schedule 2, Condition B108 of DA305-7-2003.

7.2.2 Rehabilitation Trials, Research Projects and Other Initiatives

The following rehabilitation trials will continue or commence in 2020:

- CPT and Shear Vane testing in North East Tailings Storage Facility in Q1 2020.
- Analysis of testing results and development of capping strategy for North East Tailings Storage Facility to be develop during 2020.
- Commence implementation of capping strategy Q4 2020.

7.2.3 Proposed Rehabilitation in the Next Reporting Period

The following areas, detailed in the MOP (2019-2020), are scheduled for rehabilitation during the next reporting period:

- RL160 Embankment (8.61 ha);
- Waterfall Ramp (18.52 ha); and
- Montrose East (18.4 ha).

8.0 Community

WCPL operates a 24 hour Community Enquiry Line (02 6570 2245), a Blasting information Hotline (02 8250 5205), a SMS text messaging Blast notification service and a dedicated community email account (wambocommunity@peabodyenergy.com), to enable community members to make enquiries or lodge complaints regarding the operation of the Mine.

8.1 Community Engagement Activities and Initiatives

8.1.1 Community Consultative Committee

The WCPL CCC is made up of residents from the surrounding district, a representative of Singleton Shire Council and WCPL management. The CCC representatives act as the point of contact between the mine and the community. The CCC is chaired by an independent chairperson.

During the reporting period WCPL held three CCC meetings:

- Tuesday 9 April;
- Tuesday 23 July; and
- Tuesday 10 December.

Minutes of these meetings are available on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.

8.1.2 Newsletters

The following newsletters were published by WCPL during the reporting period:

- Autumn Pest Baiting Program Letter (April 2019).
- Research Opportunity Letter (Wambo Homestead) sent to University of Newcastle, Western Sydney University and University of Sydney (May 2019).
- Wambo Homestead Curtilage Tour Invitation sent to Singleton High School, Jerrys Plains Public School, St. Catherine's Catholic College Singleton (June 2019).
- Annual ad in Singleton Argus regarding inquiry line (July 2019).
- Spring Pest Baiting Program Letter (September 2019).

8.1.3 Other Community Engagement Activities

During the reporting period, WCPL also conducted an educational site visit for Mining Engineering students studying at the University of Wollongong.

8.2 Community Contributions

During the reporting period, WCPL contributed to the community through the following:

- Singleton PCYC Youth Boxing Sponsorship for 2019;
- Singleton Business Chambers – Excellence Award Sponsorship;
- Newcastle and Hunter Combined Schools ANZAC Service;
- contribution to Wildlife Aid;
- contribution to Farmers Mental Health Fundraiser;
- sponsorship of Simon Mead's 1,000 km bicycle ride;
- Hunter Valley Mining Charity – Rugby League Knockout Competition Sponsorship;
- Millfield Public School – Community Fair Day Sponsorship;
- sponsorship of Farmers Aid Concert;
- Indigenous Girls Academy Award Sponsorship;
- Singleton Welcoming Committee – Biggest Morning Tea Sponsorship;
- Sponsorship of the Coastal Cruisers bike ride from Armidale to South West Rocks for cancer research;
- Contribution to Jerry's Plains Cricket Club;
- Hunter Coal Festival Sponsorship; and
- Wambo Singleton Hall of Fame.

8.3 Community Complaints

WCPL received a total of 58 community complaints during the reporting period, including six (6) for blasting, four (4) for dust, two (2) for lighting and forty-six (46) for noise (**Figure 14**).

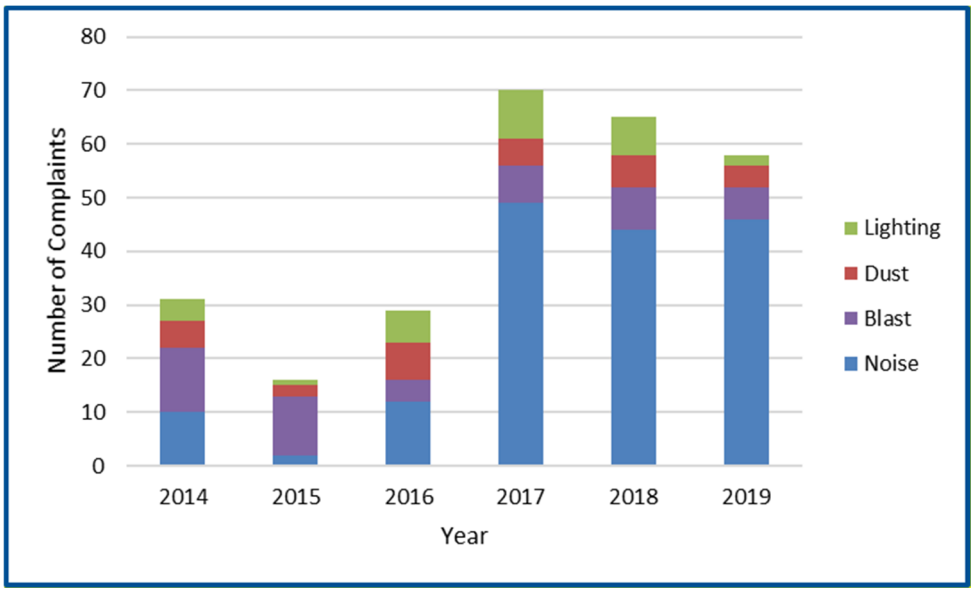

Figure 14: Community Complaints (2014-2019)

Complaints relating to blasting have reduced, with six (6) complaints recorded during 2019 (five [5] for vibration and one [1] for blast fume), compared with eight (8) complaints in 2018 (one [1] for blast fume, four [4] for vibration and three [3] for dust), seven (7) in 2017 (one [1] for blast fume, four [4] for vibration, one [1] for dust and one [1] general), four (4) in 2016 (three [3] for vibration and one [1] for fume), eleven (11) in 2015 (all for vibration), and twelve (12) in 2014 (three [3] for blast fume, seven [7] for noise and vibration, one [1] for dust and [1] general).

The number of noise complaints remained relatively consistent in 2019 when compared to 2018. All complaints were reviewed, noise levels assessed against available data and followed up with as soon as possible.

During the reporting period, the number of dust complaints reduced, with four (4) complaints received in 2019, compared with six (6) in 2018, five (5) in 2017, seven (7) in 2016, two (2) in 2015, and five (5) in 2014.

Two (2) complaints were received relating to lighting in 2019. This is reduced compared with the number of complaints received in 2018 (seven [7]) and 2017 (nine [9]). The complaints typically related to impacts from lighting plants operating in the open cut pit at night.

When requested, detailed reports on WCPL operations at the time of the complaints were provided to DPIE and EPA. A summary of the detailed reports provided to the DPIE and EPA in response to the complaints is provided in **Section 10.10**.

8.3.1 Independent Noise Review

Conditions C7 to C9, Schedule 2 for DA 305-7-2003 require that:

C7. If a landowner considers the development to be exceeding any relevant air quality, noise or blasting criterion in PART B of this consent, they may ask the Planning Secretary in writing for an independent review of the impacts of the development on their residence or land.

C8. If the Planning Secretary is not satisfied that an independent review is warranted, the Planning Secretary will notify the landowner in writing of that decision, and the reasons for that decision, within 21 days of the request for a review.

C9. If the Planning Secretary is satisfied that an independent review is warranted, within 3 months, or other timeframe agreed by the Planning Secretary and the landowner, of the Planning Secretary's decision, the Applicant must:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Planning Secretary, to:

(i) consult with the landowner to determine their concerns;

(ii) conduct monitoring to determine whether the development is complying with the relevant criterion in PART B of this consent; and

(iii) if the development is not complying with the relevant criterion, identify measures that could be implemented to ensure compliance with the relevant criterion;

(b) give the Planning Secretary and landowner a copy of the independent review; and

(c) comply with any written requests made by the Planning Secretary to implement any findings of the review.

In March 2019, a landholder on Redmanvale Road contacted DPIE expressing their concerns arising from the noise caused by WCPL's mining activity. WCPL engaged Wilkinson Murray to conduct an Independent Noise Review having received confirmation from the DPIE that Wilkinson Murray's nominated director was a suitably qualified person to undertake the assessment and reporting.

The audit was conducted between 11 April 2019 and 27 June 2019.

Of the 94 attended measurements conducted, noise levels exceeded relevant criteria by more than 2 dB on eight occasions. Critically, after each non-compliance, noise levels were reduced within the allowable timeframe.

As a result, there were no identified breaches of the noise consent conditions.

9.0 Independent Audits

9.1 2015 Independent Environmental Audit for South Bates Underground Mine Extraction Plan

In 2015, WCPL commissioned an independent audit of subsidence, surface water and groundwater impacts prior to the submission of an Extraction Plan for Longwalls 11 to 13, in accordance with Condition 37, Schedule 4 of DA305-7-2003 (no longer required by the Development Consent).

The report was finalised in June 2015 and submitted to DPIE. **Table 44** summarises the recommendations from this audit and WCPL's progress against these recommendations.

9.2 2016 Independent Rehabilitation Audit for Annual Environment Management Report

In 2015, WCPL commissioned GHD to undertake an independent audit (GHD 2016) of the rehabilitation at the Mine to identify any potential deficiencies of the rehabilitation and improvement strategies. The audit report was finalised in June 2016 and submitted to DRG. **Table 45** provides an update on the status of the audit recommendations, including:

- Matters that have been addressed in MOP amendments.
- A strategy and timeframe for addressing matters that are still outstanding.
- Matters that are subject to further refinement (i.e. pending the results of monitoring).

9.3 2017 Independent Environmental Audit

An IEA was undertaken by Hansen Bailey in November and December 2017 to assess compliance against DA305-7-2003 (Modification 17) and DA177-8-2004 (Modification 2). The audit also assessed compliance against EPL529 and ML1572. The audit report was finalised in December 2017 and submitted to DPIE in accordance with Condition 7, Schedule 6 of DA305-7-2003. Following review of the IEA, DPIE advised their agency requirements had not been addressed in the audit and requested the IEA be revised to include them. The revised IEA was submitted to DPIE on 19 September 2018 and approved 31 January 2019. A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

Thirty-six (36) non-compliances, comprised of 25 issues were identified during the audit, including eight (8) which were classed as "administrative". The non-compliances were risk ranked. No high risks were identified during the audit. Eleven issues were identified as low risk and one issue as medium risk. The report also included numerous recommendations for improvement.

Table 46 and **Table 47** summarise WCPL's actions taken to address the non-compliances and continual improvement recommendations, respectively.

The next IEA for DA305-7-2003 and DA177-8-2004 is due in 2020.

9.4 2019 Independent Environmental Audit for EPBC 2003/1138 and Biodiversity Management Plan

An Independent Environmental Audit (IEA) was undertaken by Cumberland Ecology in 2019 to assess compliance against EPBC Approval 2003/1138, the Biodiversity Offset Strategy (BOS), and the commitments made in WCPL's BioMP. The audit report was finalised in January 2020 and submitted to DPIE in accordance with Condition 4 of EPBC 2003/1138 and Condition 50, Schedule 4 of DA305-7-2003 (no longer a requirement under the Development Consent). A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

Seven (7) non-compliances and three (3) items that were unable to be verified were identified during the audit. **Table 48** summarises the outstanding recommendations from this audit and WCPL's progress against the action plan developed to address these recommendations.

There is no longer a requirement for WCPL to undertake an IEA for EPBC 2003/1138 and the BOS, therefore no future audits will be undertaken unless requested by the Planning Secretary or Commonwealth Department of Agriculture, Water and the Environment.

Table 44: Outstanding Action from the 2015 IEA for South Bates Underground Mine Longwalls 11 to 13 Extraction Plan

No.	Recommendation	Action Plan Progress
Groundwater		
8	It is recommended that Wambo investigate the cause(s) of the water level and water quality changes at GW08 and GW09, and if appropriate recommend response actions.	Investigations are ongoing. WCPL will install a replacement bore in 2020.

Table 45: Actions from the 2016 Rehabilitation Audit

No.	Recommendation	Action Plan Progress
21	Incorporate seed germination testing in the MOP and ensure that certificates for all seed collected or supplied by an external contractor is obtained. This provides quality assurance of seed and expected germination rates.	Seed germination testing will be incorporated in the next amendment to the MOP. WCPL currently ensures that certificates for all seed collected or supplied by an external contractor are obtained.

Table 46: Non-Compliances Identified by the 2017 IEA for DA305-7-2003 and DA177-8-2004

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
Previous Audit Non-Compliances				
5.8, 5.18, 5.24	-	Review actions recommended by previous audit which have not been completed. Update management plans as required to address recommendations that are relevant to contemporary operations Refs 4.5 – 4.9). • North Wambo Creek Diversion Plan not yet revised to include the required section on mechanism for the return of intercepted groundwater;	Noted. The design for the return of intercepted groundwater remains in draft. This condition has been included in the 2019 revision of the North Wambo Creek Diversion Plan. The NWCD Plan was submitted for consultation 24 April 2019. WCPL is currently updating the NWCD Plan to address comments. This condition has been removed from the consent following determination of the UWJV (i.e. Modification 16).	N/A
DA 305-7-2003 Non-Compliance Recommendations				
Schedule 4, Condition 8 and Condition 9	Low	Recommend that documented coordination with nearby mines and an agreed protocol is developed to manage cumulative noise impacts to the satisfaction of the Secretary.	WCPL will continue to manage noise impacts and contact neighbouring mines and develop a protocol to manage cumulative noise impacts. A copy of the Protocol will be submitted to the Secretary upon completion.	Ongoing
Schedule 4, Condition 23A	Medium	This non-compliance relates to an unlicensed release of runoff from a sump located adjacent to Wollombi Creek at Hales Crossing. Consideration should be given to the current Hales Crossing sump and pump arrangement to remove the risk of sump inundation. Options include relocating the sump and pump apparatus to a location outside the flood extents of Wollombi Brook.	Options to improve the Hales Crossing sump and pump arrangement are being considered, including relocating the existing sump or placing the pump onto a raised platform.	Complete
Schedule 4, Condition 30 and 30A	Administrative	Site Water Management Plan should be updated to include the predicted salt balance.	A salt balance was completed in support of MOD17 to DA305-7-2003 and the results will be added to the next revision of the Site Water Management Plan.	2020

Table 47: Continual Improvement Recommendations Made by the 2017 IEA for DA305-7-2003 and DA177-8-2004

Ref	Description	WCPL Response	Timing
DA 305-7-2003 Continual Improvement Recommendations			
Schedule 4, Condition 15	A notification of entitlement to property inspection is sent to landowners within 2 km of the site that to ensure current owners are aware of this entitlement.	Agreed.	Complete
Schedule 4, Condition 22	The Reject Emplacement Strategy (RES) should be submitted to DRG (not DPIE) and followed up to approval. It is noted that the plan is likely to require review following any positive determination of the United and Wambo Open Cut Coal Mine Project.	Noted.	
Schedule 4, Condition 25	Improvements could be made in terms of the overall site water management if specific groundwater inflows to the open cut via alluvium and Permian could be pumped and/or metered.	Recommendations considered in 2018 Annual Review Groundwater Analysis by HydroSimulations. Changes such as the comparison of measured and predicted inflow volumes will be adopted in a future revision of the WCPL Groundwater Monitoring Program.	Next review of GWMP
Schedule 4, Condition 29	It is understood that a salt balance model has been developed for the site for the United/Wambo project. It is suggested that this salt balance be updated annually to include the seepage quality monitoring data. There is no recommendation in terms of frequency of monitoring. WCPL should determine the frequency of monitoring to apply for the salt balance model.	A salt balance will be completed and provision will be made for the balance to be updated annually. WCPL will determine the frequency of monitoring to apply for the salt balance model.	Complete (refer **Section 6.7.1**)
Schedule 4, Condition 34	Update GWMP to include Montrose Dam prior to its construction.	Current MOP refers construction likely being in 2023. Montrose Dam will be added to the GWMP prior to construction.	Prior to likely construction in 2023
Schedule 4, Condition 34	Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open-cut workings.	Addressed in 2018 Annual Review of Groundwater prepared by HydroSimulations for the WCPL Annual Review Samples will be taken at active underground areas, to complement the extensive groundwater monitoring network.	Ongoing
Schedule 4, Condition 40	Offset area E is required to be secured under a conservation agreement by December 2017 and included in the Biodiversity Management Plan and MOP. A draft has been sent to OEH. This should aim to finalise by the due date.	WCPL submitted the Conservation Agreement variation in March 2018. BCD returned the document 9 April 2019. As at the end of the reporting period, the revised VCA had not been finalised by the Biodiversity Conservation Trust despite multiple attempts from WCPL (via emails dated 15 April, 3 May, 24 May, 19 July and 10 October 2019).	Ongoing

Ref	Description	WCPL Response	Timing
Schedule 4, Condition 47	Recommend that identification of 'Acacia anuera' is finalised and amended in the development consent to Acacia pendula at next modification, if required.	*Acacia anuera* was identified to most likely be *Acacia pendula* in 2004. Further investigations were undertaken in 2006 and 2008 with no conclusive identification of the species. WCPL follows the precautionary approach and treats the species as *Acacia pendula* due to its listing in the *Threatened Species Conservation Act* (and in the more recent *Biodiversity Conservation Act 2016*) and EPBC Act. Further investigations will be conducted during flowering season, to conclusively identify the species. The current consent condition references the *Acacia anuera* community identified in the 2003 EIS. WCPL will consider amending the Development Consent once further investigations are carried out. A sample was collected by the ecologist during annual monitoring in October 2018, however this was unable to be positively identified as flowers or nuts were not present.	Ongoing (appropriate flowering season as determined by the WCPL Ecologist)
Schedule 4, Condition 56	Seek to recover this contribution if regulators confirm that it has not been expended, or if it has seek the documented outcome of the Trust Fund.	Payment of $50 000 was made to the Hunter Aboriginal Cultural Heritage Trust Fund 7 November 2005. WCPL will seek to recover this contribution.	Ongoing
Schedule 4, Condition 71	Consistent with previous audit, recommend consultation occurs and correspondence received from RMS is sought confirming the new intersection is not required or they are satisfied for inclusion in next IEA.	WCPL will follow up this recommendation prior to the next audit (2020).	2020
Schedule 4, Condition 94A	Recommend soil surveys are undertaken the Soil Management Protocol is updated for any remaining areas to be stripped showing specific depths for specific areas.	Soil Management Protocol was updated in 2018, next revision will include any remaining areas to be stripped showing specific depths for specific areas.	During next review
DA 177-8-2004 Continual Improvement Recommendations			
Schedule 4, Condition 6	Reviewed Australian Rail Track Corporation (ARTC) EPL 3142 and email from Matt Pearce of Aurizon dated 12/09/13. Email confirms that locomotives are required to be tested by the rail operator for compliance with noise requirements. Recommend that this is updated to remain contemporary.	WCPL tried unsuccessfully to have this correspondence updated with ARTC, prior to the audit in 2017. Another attempt will be made to satisfy this condition.	Prior to the next IEA in 2020
Schedule 4, Condition 23	Recommend this condition is revised to remove at next modification.	This condition relates to minimising road safety impacts from train headlight glare on motorists. Audit confirms screening is in place and that no complaints or incidents occurred as a result of rail loop lighting. WCPL will investigate removing this condition during the next modification.	During the next DA 305-7-2003 Modification.

Ref	Description	WCPL Response	Timing
Schedule 4, Condition 32	The following are recommendations for the ESCP: • A description of the existing as-built ESC arrangements for each sediment-affected catchment would enhance the current understanding of the site ESC arrangements; and • A description of the known issues and actions would be useful in demonstrating that the ESCP is operating effectively and areas for improvement. Additionally, the ESCP structure and text would benefit from a review to improve the general readability of the document. This could involve ensuring that the plan structure is logical, the scope and progression of each section is clear, and overly lengthy or repetitious text is rationalised.	ESCP was approved by DP&E in June 2018 and currently there is no plan to review this document. To be addressed in the next review, most likely following the determination of the UWJV.	Currently being revised, will be re-submitted for approval in 2020
Schedule 5, Condition 1	Confirmation from DPIE should be sought in future to confirm this condition is not required to be triggered.	The AQGGMP contains a Landowner Notification Procedure as Appendix D. Section 4.6.1 of the Noise Management Plan addresses landowner notification. WCPL will consider this requirement and seek confirmation from DPIE if deemed necessary.	Complete
Other			
NA	AGE made the following recommendations for future groundwater modelling and assessments (see Appendix F): • Future groundwater modelling updates/reports need a clear description of the interactions/connectivity of the open cut and underground area and how this is represented in the modelling; • Future groundwater modelling updates/reports should comment on the interaction/connectivity of the open cut and underground areas and whether it is visible in the observational data; and • Future annual groundwater monitoring reviews should comment on the interaction/connectivity of the open cut and underground area and on the degree of match of the predicted versus observed water levels. The predictions, actual and licensing requirements should be included in a tabular format in each Annual Review.	Complete. The groundwater model has been rerun by SLR incorporating relevant recommendations from AGE.	2020

Ref	Description	WCPL Response	Timing
N/A	The status of the single groundwater licence under the *Water Management Act* 2000 should be regularly followed up with DPI-Water	Six WCPL groundwater licences have been consolidated – WAL39738, 39803, 41528, 39375, 41520, 41494. New WAL42373 has been issued by NSW Land Registry Services.	Complete
N/A	Recommendations for future management of the North Wambo Creek Diversion: • The current diversion management and monitoring objectives are contained in several documents. It is recommended these are consolidated into a single management plan for the diversion. It is noted that Wambo is committed to the preparation and implementation of a new Diversion and Rehabilitation Plan;	The NWCD Plan was sent to DPIE and other relevant parties for consultation on 24 April 2019. WCPL is currently updating the NWCD Plan to address comments.	Complete
N/A	• The diversion management program should be implemented to improve the operation of the diversion;	Agreed. The revised NWCD Plan contains a detailed rehabilitation plan including: • Table 13: 5 Year NWCD Rehabilitation and Maintenance Plan. • Appendix C – Detailed Rehabilitation Plan.	SCS has completed stability assessment and remediation proposal. Works are scheduled to commence early 2020.
N/A	• Ongoing management is required in order to ensure that soil erosion is minimised and ground cover is given adequate opportunity to become established; and		
N/A	• Rehabilitation of subsided areas of the diversion is required in accordance with an Extraction Plan (or SMP), including repairing surface subsidence cracks and undertaking subsidence remediation where necessary in areas where the diversion has been subsided.		
N/A	The area in RWEA B is rehabilitated to prevent further damage and reduce risks to the surrounding Central Hunter Grey Box-Ironbark Woodland Endangered Ecological Community (EEC) as per Ecological Australia's recommendations.	Most appropriate method of rehabilitation to be determined, in order to reduce impacts if rehabilitation is undertaken with machinery.	Ongoing
N/A	Subsidence affected sites identified as 'intolerable' by SLR Consulting should be remediated to an acceptable standard as per SLR's recommendations. Photos of completion should be kept within the database along with a report checklist with date and signature demonstrating works were completed.	Most appropriate method of rehabilitation to be determined, in order to reduce impacts if rehabilitation is undertaken with machinery.	Ongoing
N/A	Update the Weed Plan.	Agreed.	Complete
N/A	Future Annual Reviews include figures of areas that have been treated for weeds during the annual review period with a focus on *Acacia saligna*.	Figures of areas treated completed for the 2017 and 2018 Annual Reviews, *Acacia saligna* will be targeted in 2019 weed management program.	Complete

Table 48: Outcomes of 2019 IEA for EPBC Approval 2003/1138 and Biodiversity Management Plan

Ref	Audit Finding	Description	WCPL Response	Timing
EPBC Approval 2003/1138				
Condition 2	Non-compliant	The approved plan must be implemented.	See detailed responses below.	Ongoing
Biodiversity Management Plan Commitments (Appendix E of the Audit)				
Section 6.3.1	Non-compliant	**Fencing, gates and signage** • Boundary fence integrity will be inspected quarterly and maintained during all management periods. • New fencing erected within or on the boundary of the RWEAs will use post and two or three strand non-barbed (plain) wire only. If required boundary fences to these areas may use a top barbed wire (or electric fencing). • Existing fencing within the boundaries of the Domains will be removed in areas where it is providing no benefit to revegetation outcomes.	Whilst fencing inspections were not completed or documented in accordance with the BMP, fencelines continue to be well maintained. Fencelines were audited by a registered surveyor in 2016 and 2019. WCPL spent in excess of $25,000 on RWEA fencing in 2019. **WCPL Remedial/Improvement Actions** 1. Quarterly inspections of fencelines have resumed and documentation has been improved. 2. WCPL is seeking an amendment to the BioMP to include a commitment for a three (3) yearly fence line audit (next scheduled for 2022) to replace the quarterly inspection. Periodic fence line inspections will continue and maintenance will be conducted as required. A copy of the updated BioMP will be provided to DPIE for review.	Ongoing
Section 6.3.2	Non-compliant	**Seed collection and propagation** • WCPL has implemented a native seed collection and propagation program. • The collection of locally sourced native seed will be carried out annually by a licensed provider with the Florabank guidelines used to guide the seed collection process. • The seed collection program will take into account seasonality of seed availability and the specific target seed lists.	Whilst there is no evidence of seed collection during the 2015-2018 period, rehabilitation activities were undertaken using the approved seed species list contained in Appendix G of the BioMP. Seed was purchased from a local supplier and included some locally sourced species. Seed collection at WCPL was undertaken in summer 2019 and a report provided by the seed collection contractor. **WCPL Remedial/Improvement Actions** 1. Seed collection will continue annually.	Ongoing

Ref	Audit Finding	Description	WCPL Response	Timing
Section 6.3.2.2	Non-compliant	**Weed management** • WCPL's weed management program will involve six monthly inspections of the RWEAs and Revegetation Areas. • An annual routine weed management program will be implemented whereby herbaceous weed species are treated to prevent further spread. • Treatment of all weeds will be undertaken by suitably qualified and experienced personnel.	Whilst evidence was not located for six monthly inspections, a weed control program has been undertaken every year and reported in the Annual Review. WCPL completes Annual Flora and Fauna monitoring in accordance with the requirements of the BioMP which reports on weed management. The new Weed Management Treatment Plan will improve the strategic approach to weed management. The weed survey conducted in 2019 will be conducted annually and the Weed Management Treatment Plan updated to provide the framework for weed treatment in the following year. **WCPL Remedial/Improvement Actions** 1. Six monthly inspections of the RWEAs and Revegetation Areas will be reinstated. 2. WCPL will update the BioMP to reference the Weed Management Treatment Plan (2019) and remove the requirement for six monthly weed inspections. This commitment will be replaced with inspections completed during weed control activities and the weed survey conducted during the Annual Flora and Fauna Monitoring.	Ongoing
Section 6.3.2.3	Non-compliant	**Vertebrate pest management** • The WCPL operated pest control program is complemented by a year round agister-managed pest control program. • The agister-managed program primarily targets feral pigs on grazing and buffer lands surrounding WCPL's open cut mine site. • The agister-managed program utilises WCPL-owned night vision cameras to monitor the movement of pest species. • Humane trapping and shooting practices are employed to capture and euthanize targeted feral species.	Non-compliance relates to the agister managed program and a lack of documentation in this regard. **WCPL Remedial/Improvement Actions** 1. As recommended by Cumberland Ecology, the BioMP will be revised to detail biannual vertebrate pest management, consistent with the requirements of the relevant Conservation Agreements. 2. Documentation for the agister-managed pest control program will be improved.	Ongoing

Ref	Audit Finding	Description	WCPL Response	Timing
Section 6.3.3	Non-compliant	**Waste management** • Routine inspections of the RWEAs and Revegetation Areas will include monitoring of potential waste management issues, including illegal dumping of waste, and removal of waste if/when required. • All waste removed from these areas will be managed in accordance with WCPL's Waste Management Plan.	Whilst evidence of inspections was not located, there has been no illegal dumping of waste in RWEAs or Revegetation Areas. **WCPL Remedial/ Improvement Actions** 1. Documentation around inspections for illegal dumping of waste will be improved.	Ongoing
Section 6.3.4	Non-compliant	**Erosion, sedimentation and soil management** • Routine inspections of the RWEAs and Revegetation Areas will include monitoring of potential erosion, sedimentation and soil management issues. • All erosion and sediment control works will be carried out in accordance with the WCPL ESCP.	Whilst inspections were not well documented or reported in the Annual Reviews, opportunistic inspections are completed and maintenance work undertaken as required. **WCPL Remedial/ Improvement Actions** 1. Erosion and sediment control works will continue to be carried out in accordance with the WCPL ESCP. 2. Documentation around inspections of erosion and sediment control structures in the RWEAs and revegetation areas will be improved.	Ongoing
Three Year Management Strategy (Appendix F of the Audit)				
Weed Control	Not verified	Year 1 to Year 3 commitments around Primary weed control, consisting of bush regeneration by qualified bush regeneration contractor, applying a range of techniques.	Refer to line 6.3.2 above for further information **WCPL Remedial/ Improvement Actions** 1. Future invoices for weed control will detail breakdown of costs and number of hours spent in each RWEA, to enable assessment against this requirement. 2. A weed management report will be prepared annually by the qualified bush regeneration contractor to document that the works have been undertaken in accordance with the required actions.	Ongoing
	Not verified	Management Effort Required: RWEAs A-D: between approximately 300 and 500 hours up to a maximum of $30,000/year (depending on contract rate and chemical requirement). RWEA Coal terminal: between approximately 100 and 167 hours up to a maximum of $10,000/year (depending on contract rate and chemical requirement).		

Ref	Audit Finding	Description	WCPL Response	Timing
Fencing	Not verified	Erect/repair and maintain stock proof fencing on boundaries of RWEAs. RWEAs A-D: Erect 2450 metres stock proof fence on boundary of RWEAs and repair 2.1 km of existing fence on other boundaries of the RWEAs as required. RWEA Coal terminal: Erect 340 metres stock proof fence on boundary of RWEA and repair 3.82 km of existing fence on other boundaries of the RWEA as required. RWEA E: Erect fencing on the boundary of the RWEA and/or repair existing fencing as required.	Refer to line 6.3.1 above for further information **WCPL Remedial/ Improvement Actions** 1. Future invoices for fencing will include details on location and type of fencing work completed. 2. Repairs, maintenance and new fencing will continue to finalise the requirement of this commitment.	Ongoing

10.0 Incidents and Non-compliances during the Reporting Period

One incident related to an exceedance of the blasting criteria for overpressure was identified by WCPL during the reporting period.

The following incidents and non-compliances were identified during the reporting period (refer **Statement of Compliance** at the front of this document):

- Incident involving exceedance of the air blast over pressure criteria (**Section 10.1**).
- Failure to continuously monitor meteorological conditions (**Section 10.2**).
- Failure to continuously monitor PM_{10} levels at four sites (**Section 10.3**).
- Failure to minimise visible off-site air pollution (**Section 10.4**).
- Failure to finalise Conservation Agreement including RWEA E with BCD (**Section 10.5**).
- Failure to undertaken topsoil management in accordance with the approved MOP (**Section 10.6**).
- Failure to collect surface water samples at required frequency (**Section 10.7**).
- Failure to collect groundwater samples at required frequency (**Section 10.8**).
- Management actions not undertaken in accordance with the commitments or strategy within the Biodiversity Management Plan (**Section 10.9**).

In addition to the above, DPIE and EPA requested detailed reports on WCPL operations following the receipt of a number of complaints during the reporting period. On each occasion, WCPL conducted a review of relevant monitoring data and operational activities at the time of the complaint and provided a summary to DPIE and/or EPA (**Section 10.10**).

10.1 Airblast Overpressure Exceedance

On 21 September 2019, WCPL initiated a scheduled blast within the WCPL Open Cut at 12:09 pm. The blast resulted in an airblast overpressure measurement of 120.6 dBL and 115.9 dBL at the WCPL blast monitoring locations BM05 and BM07, respectively. No complaints were received at the time of the event. The monitoring result from BM05 exceeded the criteria set out in Condition L5.3 of EPL529 and Condition B22, Schedule 2 of Development Consent 305-7-2003 (MOD 16). The overpressure exceedance was recorded on mine-owned property and no adverse effects were identified.

The following actions were undertaken by WCPL in response to the airblast overpressure exceedance event:

- WCPL self-reported the incident to the NSW EPA and DPIE on 21 September 2019 (Reference Number; EPA103592);
- Enactment of the Pollution Incident Response Management Plan (PIRMP) on 21 September 2019;
- Internal review of drone footage of the blast event;
- Internal review of blast design and process;
- External review of blast design and procedure, and blast modelling;

- External review of blast monitoring data and meteorological data; and
- Inspection and calibration of blast monitoring equipment at BM05.

On 27 September 2019, WCPL submitted an incident investigation report to DPIE and EPA. An initial review of the blast design, the video footage and other factors was completed in response to the airblast overpressure exceedance event. The following conclusions and observations were made:

- At the time of firing, nothing perceptibly out of the ordinary was observed (neither loud noise or excessive flyrock).
- There have been no complaints from neighbouring properties.
- Review of the blast indicates no fundamental flaws in the design process.
- Wave trace of overpressure from blast indicates an immediate spike with no build up.
- Review of video footage supports this with no dramatic burden failure or stemming relief.
- Possible low frequency mass air movement generated from free face geometry and piston movement.
- Dyke through the blast may have led to weaker than normal rock strength parallel to the open face, leading to stemming relief and possible propagation of airblast.
- After review of post drilling photographs no cutting piles showed an intersection with the dyke but review of muck-pile and video indicate that the dyke structure was larger than anticipated.
- The two open faces may have focused the initial pulse of air movement.
- Blast modelling by Dyno Nobel identified that it is possible that one of the holes has reinforced with one or more other holes, however no definitive explanation could be provided as to what caused the airblast overpressure exceedance.
- Peer review of design and video supports the above findings.

WCPL has committed to the following mitigation measures regarding airblast overpressure:

- improve identification and potential of geological structures on blasting outcomes;
- additional increase of burden on open face if geological structures are identified running parallel to them;
- current practice is to download (increase stemming) any holes that are identified to intersect a dyke (by colour of cuttings); moving forward, and with more focus on dyke mapping, holes adjacent to these structures will also have an increase in stemming applied; and
- consider findings of blast modelling that has been conducted by Dyno Nobel in future timing designs.

The WCPL Blast Management Plan will also be reviewed and updated.

Prior to 2019, no exceedances of the blasting limits had been recorded at compliance monitoring sites (i.e. BM02, BM05 and BM07) during the last five reporting periods.

10.2 Meteorological Monitoring

During the reporting period, a non-compliance with Condition M4.1 of EPL529 was recorded as a result of four outages of the meteorological station (7 hours between 8 March and 9 March, 0.5 hours on 9 April, 2 hours and 20 minutes on 6 October and 24 hours on 4 December), where weather monitoring data was not logged. Despite these outages, WCPL achieved a data capture rate of 99.6% (52,360 points out of a potential 52,560).

In addition, the rain bucket was blocked on two separate occasions on 4 June and 8 August, resulting in no rainfall data being collected.

During outages, field service technicians inspected, cleaned and repaired the equipment for any faults, blockages, or software issues. WCPL is committed to preventing and reconciling any issues by continued inspections and maintenance.

10.3 PM_{10} Monitoring

During the reporting period, PM_{10} readings were not obtained on 60 occasions.

Air quality monitoring stations AQ01 and AQ02 stopped logging data on 8 separate occasions, AQ03 on 14 separate occasions and AQ04 on 30 separate occasions. The PM_{10} monitors ceased logging for varying lengths of time. These breaks in continuous monitoring were a result of storms, Ausgrid maintenance, power outages, and communication errors and were addressed as quickly as possible following identification of the issue.

Previously all computing hardware was housed with the AQ04 monitoring station. To minimise the re-occurrence of the non-compliance, WCPL contracted a field technician to virtualise the computing hardware individually for each monitoring locations. Now all monitoring stations are remotely controlled by internal contractor equipment minimising the likelihood of data being lost as a result of faults/communication errors/ power outages. Regular preventative maintenance will continue on all four PM_{10} monitors.

10.4 Minimisation of Visible Off-site Air Pollution

On 6 December 2018, between 5.00 pm and 6.30 pm, a community member observed dust generation from the mine from an excavator operating in the vicinity of the Golden Highway and Pinegrove Road, Jerrys Plains. The DPIE issued a show cause notice, and subsequently considered WCPL's response before issuing an official caution in relation to compliance with Condition 5B, Schedule 4 of DA305-7-2003 (now Condition B45[a][ii], Schedule 2 of DA305-7-2003 [Modification 17]) (i.e. minimisation of visible off-site air pollution), on 30 September 2019.

On 22 February 2019, between 3.00 pm and 5.30 pm, a community member observed dust generation from the mine from an excavator operating in the vicinity of the Golden Highway and Pinegrove Road, Jerrys Plains. The DPIE issued a show cause notice, and subsequently considered WCPL's response before issuing a penalty notice in relation to compliance with Condition 5B, Schedule 4 of DA305-7-2003 (now Condition B45[a][ii], Schedule 2 of DA305-7-2003 [Modification 17]) (i.e. minimisation of visible off-site air pollution), on 30 September 2019.

Following receipt of the official caution and penalty notice, WCPL reviewed the training processes with the operators and dispatch and identified a need to include additional detail in shift notes (i.e. to record operational measures implemented or any visible off-site air pollution identified).

10.5 Conservation Agreement

Condition 41, Schedule 4 of DA305-7-2003 (Modification 17) required (no longer a condition under DA305-7-2003 [Modification 16]) that:

> *By the end of December 2017, unless otherwise agreed by the Secretary, the Applicant must:*
>
> *(a) enter into a conservation agreement/s pursuant to section 69B of the* National Parks and Wildlife Act 1974 *covering all offset areas listed in Table 16 (see condition 40) …*
>
> *…*

VCAs for the offset areas were drafted in consultation with the OEH during 2015 and were registered in 2017, in accordance with Condition 41, Schedule 4 of DA305-7-2003. WCPL applied to revise the VCAs to include RWEA E in December 2017.

In February 2018, WCPL requested that DPE (now DPIE) approve an extension to the timeframe for entering into a Conservation Agreement as required by Condition 41, Schedule 4 of DA305-7-2003 on the basis that WCPL was in the process of varying the existing VCAs to include RWEA E, however it may take some time for the Biodiversity Conservation Trust to process the variation request.

DPIE approved the request for an extension to 31 July 2018, based on advice provided by the Biodiversity Conservation Trust that this would be a reasonable completion date.

WCPL contacted OEH and were advised in March 2019 that the agreements had been approved by the Biodiversity Conservation Trust and would be forwarded to WCPL for signing.

Despite multiple follow up attempts from WCPL during the reporting period (emails dated 15 April, 3 May, 24 May, 19 July and 10 October 2019) the variation to the Conservation Agreement has not yet been finalised. WCPL will continue to follow up with BCD to finalise the Conservation Agreement during the next reporting period.

10.6 Topsoil Management

During an audit conducted on 11 June 2019, the RR identified that topsoil management was not being undertaken in accordance with the approved MOP (2018-2020) and issued an official caution letter on 30 October 2019. The RR identified the following issues:

- Stockpiles inspected were observed not to be in accordance with the location and construction requirements outlined in the MOP.
- There was evidence that the maintenance of existing stockpiles had not been implemented as outlined in the MOP.
- Establishment of a cover crop on stockpile 5 appeared to have failed and there was no evidence of monitoring of vegetation establishment as specified in the MOP.

- There were indications that the requirement in the MOP to assess weed infestations on stockpiles to determine if individual stockpiles require herbicide application and/or 'scalping' of weed species prior to topsoil spreading had not been undertaken.

WCPL has implemented an action plan to address the identified issues.

10.7 Surface Water Sampling

Condition M2.3 of EPL 529 requires 30 samples be collected, however due to dry conditions and subsequent reductions to runoff in catchments, adequate samples were unable to be collected at monitoring locations SW01, SW02, SW03, SW27/SW27a, SW32/SW32a and SW08. The non-compliance is considered to be a result of the prevailing climatic conditions during the reporting period (i.e. drought).

WCPL will continue to implement the Surface Water Monitoring Program and monitoring on a monthly basis.

10.8 Groundwater Sampling

Groundwater samples were not collected on 38 occasions due to insufficient water as a result of extended drought. Monitoring locations P106, P114, P315, GW08 and GW09 were monitored but samples were unable to be taken on 8 February, 3 April, 5 June, 6 August, 3 October and 3 December as the locations were dry or had insufficient water to provide a representative sample.

10.9 Management Actions Within the Biodiversity Management Plan

The 2019 IEA of EPBC Approval 2003/1138 found that whilst evidence of implementation of a number of management actions exists, a number of the actions had not been undertaken in accordance with the commitments or strategy (e.g. reduced frequency of implementation).

Seven (7) non-compliances and three (3) items that were unable to be verified were identified during the audit. **Table 48** summarises the outstanding recommendations from this audit and WCPL's progress against the action plan developed to address these recommendations (**Section 9.4**).

10.10 Requests for Information

During the reporting period, DPIE and EPA made a number of requests for information relating to complaints received as a result of WCPL operations (**Section 8.3**).

A summary of the information requests, relevant complaints and actions taken is provided in **Table 49**.

Table 49: DPIE and EPA Requests for Information

Date of Complaint or Event	Relevant Agency	Comment
Noise		
5 February	EPA	On 5 February WCPL received a notice from the EPA regarding two noise complaints on 3 and 4 February 2019, and a request that WCPL investigate the complaints and provide a written response. WCPL provided the requested response.
15 May	EPA	A noise complaint was received by the EPA on 15 May 2019 regarding noise complaints from the 13 -15 May 2019. On 15 May, EPA requested WCPL investigate and provide a response. WCPL provided the requested response.
20 September	EPA	A noise complaint was received by the EPA on 11 September 2019. The complainant located on Redmanvale Road described the noise as “excessive” and did not provided the specific time periods. On 20 September 2019, the EPA requested WCPL investigate the above compliant and provide a response. WCPL provided the requested response.
Rainfall		
1 May	EPA	Rainfall data was requested by EPA on 5 May 2019. WCPL provided the requested data.
Blasting		
21 September	DPE (now DPIE)	On 21 September 2019, WCPL initiated a scheduled blast within the WCPL Open Cut at 12:09pm. The blast resulted in an airblast overpressure measurement of 120.6 dBL and 115.9 dBL at the WCPL blast monitoring locations BM05 and BM07 respectively. No complaints were received at the time of the event. The monitoring result from BM05 exceeded the criteria set out in Condition L5.3 of EPL529 and Condition B22, Schedule 2 of Development Consent 305-7-2003 (MOD 16). WCPL self-reported the incident to the EPA and DPIE on 21 September 2019 and enacted the WCPL PIRMP. As per the WCPL Blast Management Plan, WCPL has conducted an investigation in response to the blast monitoring results and provided an incident report. The following corrective actions have been proposed by WCPL. • Improve identification and potential influence of geological structures on blast outcomes; • Additional increase of burden on open faces if geological structures are identified running parallel to them; • Current practice is to download (increase stemming) any holes that are identified to intersect a dyke (by colour of cuttings); moving forward, and with more focus on dyke mapping, holes adjacent to these structures will also have an increase in stemming applied; and • Consider findings of the blast modelling that has been conducted by Dyno Nobel in future timing designs. Additional information is provided in **Section 10.1**.

11.0 Activities to be Reported in the next Reporting Period

The following activities will be undertaken and reported on by WCPL during the next reporting period:

- WCPL will address any comments received from Singleton Shire Council on the Bushfire Management Plan and provide the updated plan to DPIE for approval;
- a comprehensive rehabilitation project for the exploration bores (including the remaining 11 exploration holes drilled in the previous reporting period) is currently planned for commencement in Quarters 1 and 2 of 2020;
- a HRSTS system audit will be undertaken if discharges through the HRSTS occur during the next reporting period;
- the NWCD Plan will be updated to address comments received in 2019 and submitted to DPIE for approval;
- WCPL will install replacement bores for GW08 and GW09 in the North Wambo Creek alluvium in areas that are not located above the old Wambo No. 1 Seam workings;
- WCPL will continue to follow up with BCD to finalise the Conservation Agreement during the reporting period; and
- WCPL will prepare updated management plans to address the modified Development Consent (DA305-7-2003) (Modification 16) issued following determination of the UWJV.

Where required, updated management plans and strategies will be submitted to relevant government authorities for approval and uploaded to the WCPL website.

12.0 References

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- Cumberland Ecology, 2020. *Independent Environmental Audit Against Conditions of EPBC 2003/1138.*
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- Resource Strategies, 2003. *Wambo Development Project Environmental Impact Statement.* Prepared for Wambo Coal Pty Ltd. July 2003.
- Rural & Environmental Management Pty Ltd, 2019a*. Wambo Coal Autumn Vertebrate Pest Management Reports.*
- Rural & Environmental Management Pty Ltd, 2019b. *Wambo Coal Spring Vertebrate Pest Management Reports.*
- Rural & Environmental Management Pty Ltd, 2019c. *Weed Management Services 2019 Summary.* Report prepared for Wambo Coal Pty Ltd. January 2020.
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- SLR Consulting Pty Ltd, 2020. *Wambo – 2019 Annual Review Groundwater*. March 2020.
- Soil Conservation Service, 2019. *North Wambo Creek Diversion Stability Assessment and Remediation Proposal 2019*.
- Umwelt, 2016. *United Wambo Open Cut Coal Mine Project Environmental Impact Statement*. August 2016.

APPENDIX A

APPROVAL CONDITIONS SPECIFICALLY RELATING TO THE ANNUAL REVIEW

Approval	Condition	Description	Where addressed
DA305-7-2003	Condition B49, Schedule 2	For the life of the development, the Applicant must: (a) monitor the greenhouse gas emissions generated by the development; (b) investigate ways to reduce greenhouse gas emissions generated by the development; and (c) report on greenhouse gas monitoring and abatement measures in the Annual Review.	Section 5.4
DA305-7-2003	Condition B53, Schedule 2	The Applicant must report on water extracted or discharged from the site each year (direct and indirect) in the Annual Review, including water taken under each licence.	Sections 6.3 to 6.7
DA305-7-2003	Condition B66, Schedule 2	The applicant must prepare a Water Management Plan for the Wambo Mining Complex to the satisfaction of the Planning Secretary. This Plan must: (a) be prepared by a suitably qualifies and experiences person/s whose appointment has been endorsed by the Planning Secretary; (b) be prepared in consultation with DPIE Water and the EPA; (c) describe the measures to be implemented to ensure that the Applicant complies with the water management performance measures: … (vi) a protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in condition D10.	Section 6
DA305-7-2003	Condition B100, Schedule 2	The Applicant must: (a) take all reasonable steps to minimise the water (including coals rejects and tailings) generated by the development; (b) dispose of all waste at appropriately licensed waste facilities; (c) manage on-site sewage treatment and disposal in accordance with the requirements of Council; and (d) monitor and report of the effectiveness of the water minimisation and management measures in the Annual Review referred to in condition D10.	Section 6
DA305-7-2003	Condition B111, Schedule 2	The Applicant must: (a) keep accurate records of the amount of coal transported from the site (on a daily basis); and (b) include these records in the Annual Review.	Section 3

Approval	Condition	Description	Where addressed
DA305-7-2003	Condition D10, schedule 2	By the end of March each year or other timeframe agreed by the Planning Secretary, a report must be submitted to the Department reviewing the environmental performance of the development, to the satisfaction of the Planning Secretary. This review must: (a) describe the development (including any rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year; (b) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, including a comparison of these results against the: (i) relevant statutory requirements, limits or performance measures/ criteria; (ii) requirements of any plan or program required under this consent; (iii) monitoring results of previous years; and (iv) relevant predictions in the documents listed in condition A2(c); (c) identify any non-compliance or incident which occurred in the previous calendar year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid reoccurrence; (d) evaluate and report on: (i) The effectiveness of the noise and air quality management systems; and (ii) Compliance with the performance measures, criteria and operating conditions in this consent; (e) identify any trends in the monitoring of data over the life of the development; (f) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and (g) describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.	This Annual Review
EPBC 2016/7636	Condition 5	The person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions 5 and 12 of schedule 6 of the **state development consent**. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.	Appendix I

Approval	Condition	Description	Where addressed
EPBC 2016/7816	Condition 5	By 31 March of each year after the commencement of the action, the person taking the action must: publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans and strategies required by conditions 22, 22C, 220 and 23 - 39 of Schedule 4 the state development consent over the previous calendar year; and provide documentary evidence providing proof of the date of publication to the Department, by email to EPBCMonitoring@environment.gov.au (or another email address as stipulated by the Department). The person taking the action must continue publishing annual compliance reports and make all reports available on their website for the life of the approval, unless agreed in writing by the Minister.	Appendix I
S101 Approval (NETD)	Condition h)	The North East Tailings Dam shall be reported on within the Annual Environmental Management Report for Wambo Coal. Consideration shall also be given to the rehabilitation performance for this site.	Sections 7.1.6 and 7.2.2
CL365, CL397	Condition 3(f)	(f) The lease holder must prepare a Rehabilitation Report to the satisfaction of the Minister. The report must: (i) provide a detailed review of the progress of rehabilitation against the performance measures and criteria established in the approved MOP; (ii) be submitted annually on the grant anniversary date (or at such other times as agreed by the Minister); (iii) be prepared in accordance with any relevant annual reporting guidelines published on the Department's website at www.resources.nsw.gov.au/environment. Note. The Rehabilitation Report replaces the Annual Environmental Management Report.	This Annual Review
CCL743, ML1402	Conditions 4-5	The lease holder must lodge Environmental Management Reports (EMR) with the Director-General annually or at dates otherwise directed by the Director-General. The EMR must: a) report against compliance with the MOP; b) report on progress in respect of rehabilitation completion criteria; c) report on the extent of compliance with regulatory requirements; and d) have regard to any relevant guidelines adopted by the Director-General.	This Annual Review

Approval	Condition	Description	Where addressed
ML1594, ML1572, CL374	Condition 3	(1) Within 12 months of the commencement of mining operations and thereafter annually or, at such other times as may be allowed by the Director-General, the lease holder must lodge an Annual Environmental Management Report (AEMR) with the Director-General. (2) The AEMR must be prepared in accordance with the Director-General's guidelines current at the time of reporting and contain a review and forecast of performance for the preceding and ensuing twelve months in terms of: a) the accepted Mining Operations Plan; b) development consent requirements and conditions; c) Department of Environment and Conservation and Department of Planning licences and approvals; d) any other statutory environmental requirements; e) details of any variations to environmental approvals applicable to the lease area; and f) where relevant, progress towards final rehabilitation objectives. (3) After considering the AEMR the Director-General may, by notice in writing, direct the lease holder to undertake operations, remedial actions or supplementary studies in the manner and within the period specified in the notice to ensure that operations on the lease area are conducted in accordance with sound mining and environmental practice. (4) The lease holder shall, as and when directed by the Minister, co-operate with the Director-General to conduct and facilitate review of the AEMR involving other government agencies and the local council.	This Annual Review
Water Licence 20AL200631, 20AL203044, 20AL201457	Condition 1	The licence holder must provide the Minister with figures recording the quantity of water taken via the nominated water supply works approval, when required to do so, and in the form specified by the Minister.	Section 6.5
Water Licence 20WA200632	Condition 9	The account holder must provide the Minister, in the approved form, with the following information when requested: A) A report detailing the quantity of water taken through the authorised work(s) and recorded by the approved measuring device, or where the work does not have a measuring device fitted to it, advise the Minister of the duration of any pumping, and B) Where the water is used for irrigation, the area of land irrigated, the planting date, area and yield of all crops grown on the property for each season. These details must include: i) The volume of water taken from the water source and applied directly to crops and/or pasture; ii) The volume of water taken from the water source and held in on-farm storages; iii) The volume of water taken from on-farm storages and applied to crops (including pasture); iv) The type and area of each crop (including pasture) irrigated; v) The method of irrigation for each class of crop and/or pasture; and vi) The volume of water applied to each individual class of crop and/or pasture.	Section 6.5

APPENDIX B

2019 DAILY TRAIN MOVEMENT SUMMARY

Table B1: Daily Train Movements

Date	No Trains per Day	Date	No Trains per Day	Date	No Trains per Day	Date	No Trains per Day
01/02/2019	2	03/10/2019	2	05/03/2019	1	07/02/2019	3
01/03/2019	1	03/12/2019	3	05/04/2019	1	07/03/2019	2
01/04/2019	1	03/13/2019	2	05/05/2019	1	07/04/2019	2
01/05/2019	1	03/15/2019	1	05/06/2019	4	07/05/2019	1
01/19/2019	3	03/16/2019	1	05/07/2019	2	07/06/2019	1
01/20/2019	3	03/17/2019	4	05/08/2019	1	07/07/2019	1
01/21/2019	4	03/18/2019	4	05/13/2019	1	07/08/2019	1
01/22/2019	3	03/19/2019	4	05/18/2019	1	07/09/2019	2
01/23/2019	5	03/20/2019	3	05/19/2019	2	07/10/2019	1
01/24/2019	2	03/21/2019	1	05/20/2019	5	07/11/2019	3
01/25/2019	2	03/22/2019	3	05/24/2019	1	07/12/2019	1
01/26/2019	2	03/23/2019	2	05/25/2019	2	07/13/2019	1
01/27/2019	4	03/24/2019	3	05/26/2019	2	07/14/2019	1
01/28/2019	3	03/25/2019	2	05/27/2019	1	07/15/2019	1
01/29/2019	1	03/26/2019	5	05/28/2019	1	07/16/2019	2
01/30/2019	1	03/27/2019	2	05/30/2019	1	07/17/2019	1
01/31/2019	2	03/28/2019	2	05/31/2019	1	07/18/2019	2
02/01/2019	2	03/29/2019	1	06/01/2019	1	07/22/2019	1
02/02/2019	2	03/30/2019	3	06/07/2019	1	07/23/2019	2
02/03/2019	3	03/31/2019	3	06/08/2019	1	07/24/2019	1
02/04/2019	2	04/01/2019	2	06/09/2019	1	07/25/2019	1
02/05/2019	1	04/02/2019	2	06/10/2019	2	07/26/2019	4
02/06/2019	1	04/03/2019	3	06/11/2019	1	07/27/2019	4
02/08/2019	1	04/04/2019	1	06/12/2019	1	07/28/2019	1
02/09/2019	2	04/06/2019	1	06/13/2019	1	07/29/2019	5
02/10/2019	1	04/07/2019	1	06/14/2019	1	07/30/2019	3
02/11/2019	2	04/12/2019	2	06/15/2019	2	07/31/2019	2
02/12/2019	2	04/13/2019	2	06/16/2019	1	08/01/2019	1
02/13/2019	3	04/15/2019	1	06/17/2019	3	08/02/2019	2
02/14/2019	2	04/16/2019	1	06/18/2019	1	08/03/2019	2
02/15/2019	1	04/20/2019	1	06/19/2019	3	08/04/2019	2
02/16/2019	2	04/22/2019	1	06/20/2019	2	08/05/2019	3
02/17/2019	3	04/23/2019	2	06/21/2019	3	08/06/2019	1
02/18/2019	2	04/24/2019	1	06/22/2019	3	08/11/2019	4
02/22/2019	1	04/26/2019	2	06/24/2019	4	08/12/2019	2
03/03/2019	1	04/27/2019	1	06/25/2019	2	08/13/2019	3
03/04/2019	1	04/28/2019	1	06/26/2019	3	08/14/2019	1
03/05/2019	2	04/29/2019	1	06/27/2019	5	08/15/2019	4
03/06/2019	3	04/30/2019	1	06/28/2019	1	08/16/2019	4
03/08/2019	1	05/01/2019	1	06/30/2019	1	08/17/2019	1
03/09/2019	4	05/02/2019	1	07/01/2019	1	08/18/2019	3

Date	No Trains per Day	Date	No Trains per Day	Date	No Trains per Day
08/19/2019	2	10/13/2019	2	12/01/2019	2
08/23/2019	2	10/14/2019	2	12/02/2019	1
08/25/2019	3	10/15/2019	2	12/03/2019	3
08/28/2019	1	10/16/2019	3	12/04/2019	1
08/29/2019	2	10/17/2019	2	12/05/2019	1
08/30/2019	2	10/18/2019	2	12/06/2019	2
08/31/2019	2	10/19/2019	2	12/07/2019	2
09/01/2019	2	10/20/2019	1	12/08/2019	3
09/02/2019	1	10/21/2019	1	12/09/2019	2
09/03/2019	1	10/25/2019	2	12/10/2019	1
09/05/2019	1	10/26/2019	4	12/12/2019	4
09/06/2019	2	10/27/2019	4	12/15/2019	1
09/07/2019	2	10/28/2019	6	12/16/2019	1
09/08/2019	3	10/29/2019	3	12/17/2019	6
09/09/2019	3	10/30/2019	3	12/18/2019	2
09/10/2019	2	10/31/2019	1	12/19/2019	2
09/11/2019	2	11/01/2019	1	12/22/2019	5
09/13/2019	4	11/03/2019	1	12/23/2019	2
09/14/2019	6	11/04/2019	2	12/24/2019	4
09/15/2019	4	11/05/2019	1	12/27/2019	2
09/16/2019	6	11/06/2019	1	12/28/2019	2
09/17/2019	3	11/07/2019	1		
09/18/2019	2	11/08/2019	2		
09/19/2019	2	11/09/2019	3		
09/20/2019	4	11/10/2019	3		
09/21/2019	4	11/11/2019	4		
09/22/2019	2	11/12/2019	3		
09/23/2019	2	11/13/2019	4		
09/24/2019	1	11/14/2019	3		
09/27/2019	3	11/15/2019	3		
09/28/2019	1	11/16/2019	4		
09/29/2019	1	11/17/2019	1		
09/30/2019	2	11/18/2019	4		
10/01/2019	2	11/22/2019	2		
10/02/2019	2	11/23/2019	6		
10/04/2019	3	11/24/2019	5		
10/05/2019	3	11/26/2019	3		
10/06/2019	2	11/27/2019	2		
10/07/2019	2	11/28/2019	4		
10/08/2019	1	11/29/2019	1		
10/12/2019	1	11/30/2019	2		

Table B2: Train Movements within Church Service Hours

Date	Time
Friday, 4 January 2019	7:31:00 PM
Sunday, 20 January 2019	10:33:00 AM
Sunday, 27 January 2019	12:00:00 AM
Sunday, 17 February 2019	11:46:20 AM
Friday, 22 February 2019	7:56:00 PM
Sunday, 3 March 2019	11:40:00 AM
Sunday, 10 March 2019	9:07:00 AM
Sunday, 17 March 2019	9:15:00 AM
Sunday, 17 March 2019	10:05:00 AM
Friday, 22 March 2019	8:46:00 PM
Friday, 12 April 2019	8:04:54 PM
Friday, 3 May 2019	6:07:34 PM
Sunday, 5 May 2019	11:04:53 AM
Sunday, 26 May 2019	10:18:00 AM
Friday, 7 June 2019	6:50:39 PM
Sunday, 9 June 2019	10:07:00 AM
Sunday, 16 June 2019	9:08:24 AM
Friday, 21 June 2019	7:57:19 PM
Sunday, 14 July 2019	11:53:00 AM
Friday, 26 July 2019	8:14:00 PM
Sunday, 1 September 2019	9:25:00 AM
Friday, 6 September 2019	7:58:00 PM
Friday, 13 September 2019	7:16:00 PM
Sunday, 22 September 2019	9:21:00 AM
Friday, 27 September 2019	8:05:00 PM
Friday, 4 October 2019	7:41:00 PM
Sunday, 6 October 2019	9:02:00 AM
Sunday, 13 October 2019	11:41:00 AM
Sunday, 27 October 2019	9:21:00 AM
Sunday, 3 November 2019	10:29:00 AM
Sunday, 10 November 2019	9:33:00 AM
Friday, 15 November 2019	7:20:05 PM
Friday, 22 November 2019	8:56:00 PM
Sunday, 24 November 2019	9:36:00 AM
Sunday, 24 November 2019	10:46:00 AM
Friday, 6 December 2019	6:53:00 PM
Friday, 6 December 2019	8:37:00 PM
Sunday, 8 December 2019	9:54:00 AM
Sunday, 15 December 2019	9:58:00 AM
Sunday, 22 December 2019	9:48:00 AM
Total	**40**

APPENDIX C

ANNUAL NOISE MONITORING REPORT

Wambo Coal Mine

Annual Environmental Monitoring Report 2019

Prepared for

Wambo Coal Pty Ltd

Global Acoustics

Noise and Vibration Analysis and Solutions

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Wambo Coal Mine

Annual Environmental Monitoring Report 2019

Reference: 20082_R02
Report date: 26 March 2020

Prepared for

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Prepared:	Jesse Tribby Consultant	QA Review:	Robert Kirwan Consultant

Global Acoustics Pty Ltd ~ Environmental noise modelling and impact assessment ~ Sound power testing ~ Noise control advice ~ Noise and vibration monitoring ~ OHS noise monitoring and advice ~ Expert evidence in Land and Environment and Compensation Courts ~ Architectural acoustics ~ Blasting assessments and monitoring ~ Noise management plans (NMP) ~ Sound level meter and noise logger sales and hire

EXECUTIVE SUMMARY

Global Acoustics was engaged by Wambo Coal Pty Ltd to provide an Annual Environmental Monitoring Report for 2019, in order to compare noise monitoring results against both relevant criteria and predictions in the most recently approved Environmental Impact Statement (EIS) for the United Wambo project.

This report summarises monthly attended noise monitoring surveys conducted at six monitoring locations around Wambo Coal Mine (WCM) during the reporting period 1 January to 31 December 2019. The purpose of the surveys was to quantify and describe the acoustic environment around the site and compare results with specified limits.

Attended noise monitoring described in this report was conducted on a monthly basis in accordance with the relevant development consents, Environment Protection Licence (EPL), and the WCM Noise Management Plan (NMP).

January to December 2019 Compliance

Noise levels from WCM complied with the relevant development consent and EPL criteria at all sites during 2019 attended monitoring, with a single exception. The following exceedance of EPL criteria was measured during 2019 monitoring:

- On the night of 11/12 November 2019, WCM exceeded the L_{Aeq} criterion at N16 by 2 dB. A re-measure and follow-up measurement were undertaken with resulting levels below the relevant limits.

Additional to the exceedance above, the following exceedance of development consent criteria (only) was measured during 2019 monitoring:

- On the night of 17/18 January 2019, WCM exceeded the L_{Aeq} criterion at N16 by 2 dB. A re-measure was undertaken with resulting levels below the relevant limits.

Modifying factors were assessed in accordance with the NPfI. Site-only L_{Aeq} noise levels have been adjusted, where applicable, by modifying factors. Criteria may not always be applicable due to meteorological conditions at the time of monitoring.

Long-Term Noise Trends

During the 5-year period analysed, WCM noise levels at most monitoring locations increased through 2018 as mining operations progressed to the northwest and were initially less shielded. From 2018 to 2019, site noise levels decreased at most monitoring locations, likely due to mining activity being deeper in pit and therefore more shielded from receptors.

At N21, site-only L_{Aeq} noise levels increased slightly from 2018 to 2019. However, there were no potential exceedances at this location during either calendar year.

EIS Comparison

WCM noise levels measured during attended monitoring were compared to predicted noise levels in the MOD 16 EIS during all measurements when site contributions were directly quantifiable and meteorological conditions corresponded with modelled meteorological conditions.

- At N01, measured WCM noise levels were not comparable to Year 2 predictions in the EIS.
- At N03 and NA16, measured WCM L_{Aeq} noise levels were not comparable with Year 2 predictions in the EIS. Measured $L_{A1,1minute}$ noise levels were occasionally higher than predicted in the EIS.
- At N21, measured WCM L_{Aeq} noise levels were lower than Year 2 predictions in the EIS. Measured $L_{A1,1minute}$ noise levels were significantly higher than predicted in the EIS.
- At N20A and N26, measured WCM noise levels were lower than Year 2 predictions in the EIS.

Global Acoustics Pty Ltd

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Appendices

1 INTRODUCTION

1.1 Background

Global Acoustics was engaged by Wambo Coal Pty Ltd to provide an Annual Environmental Monitoring Report (AEMR) for 2019, in order to compare noise monitoring results against noise modelling predictions and relevant noise criteria.

This report summarises monthly attended noise monitoring surveys conducted at six monitoring locations around WCM during the reporting period 1 January to 31 December 2019. The purpose of the surveys was to quantify and describe the acoustic environment around the site and compare results with specified limits.

1.2 Monitoring Locations & Frequency

Monitoring locations, type, and frequency are detailed in Table 1.1 and shown in Figure 1. It should be noted that Figure 1 shows the actual monitoring position, not the location of residences.

Table 1.1: WAMBO COAL MONITORING LOCATIONS AND FREQUENCY[1]

Site Reference	Residence	Monitor Type	Consent Requirements	Frequency
N01	Wambo Road Residence	Attended	Mine & Rail Spur	Monthly
N03	Kelly Residence	Real-Time & Attended	Mine & Rail Spur	Continuous & Monthly
N16	Jerrys Plains Road	Attended	Mine	Monthly
N20A	Redmanvale Road Central	Attended	Mine	Monthly
N20 [2]	*Redmanvale Road Central*	*Real-Time*	*Mine*	*Continuous*
N21	Wambo South	Real-Time & Attended	Mine & Rail Spur	Continuous & Monthly
N26	Redmanvale Road South	Attended	Mine	Monthly

Notes:

1. *Sourced from the NMP – WA-ENV-MNP-503, January 2018; and*
2. *N20 is not an attended noise monitoring location, but is the location of a real-time continuous noise monitor.*

Figure 1: WCM Attended Noise Monitoring Sites

1.3 Terminology & Abbreviations

Definitions of terms and abbreviations which may be used in this report are provided in Table 1.2.

Table 1.2: TERMINOLOGY & ABBREVIATIONS

Descriptor	Definition
dB(A)	Noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise.
L_{Amax}	The maximum A-weighted noise level over a time period.
L_{A1}	The noise level which is exceeded for 1 per cent of the time.
$L_{A1,1minute}$	The noise level which is exceeded for 1 per cent of the specified time period of 1 minute.
L_{A10}	The noise level which is exceeded for 10 percent of the time.
L_{Aeq}	The average noise A-weighted energy during a measurement period.
L_{A50}	The noise level which is exceeded for 50 per cent of the time and the median noise level during a measurement period.
L_{A90}	The level exceeded for 90 percent of the time. The L_{A90} level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes.
L_{Amin}	The minimum A-weighted noise level over a time period.
L_{Ceq}	The average C-weighted noise energy during a measurement period. The "C" weighting scale is used to take into account low-frequency components of noise within the audibility range of humans.
SPL	Sound pressure level. Fluctuations in pressure measured as 10 times a logarithmic scale, with the reference pressure being 20 micropascals.
Hertz (Hz)	The frequency of fluctuations in pressure, measured in cycles per second. Most sounds are a combination of many frequencies together.
AWS	Automatic weather station used to collect meteorological data, typically at an altitude of 10 metres
VTG	Vertical temperature gradient in degrees Celsius per 100 metres altitude.
Sigma-theta	The standard deviation of the horizontal wind direction over a period of time.
SC	Stability class (or category) is determined from measured wind speed and either sigma-theta or VTG.
IA	Inaudible. When site noise is noted as IA then there was no site noise at the monitoring location.
NM	Not Measurable. If site noise is noted as NM, this means some noise was audible but could not be quantified.
Day	This is the period 7:00am to 6:00pm.
Evening	This is the period 6:00pm to 10:00pm.
Night	This is the period 10:00pm to 7:00am.

2 REGULATOR REQUIREMENTS AND NOISE CRITERIA

2.1 WCM Development Consent

The most current development consent for WCM is DA 305-7-2003 (MOD 16, 29 August 2019), which superseded DA 305-7-2003 (MOD 17, 20 December 2017). MOD 16 contains updated noise limits and specified meteorological conditions which differ from those in MOD 17. Monitoring results in this report have been assessed against MOD 17 requirements through August 2019 and MOD 16 requirements from September 2019 onward.

2.2 WCRS Development Consent

The most current development consent for Wambo Rail Loop is WCRS DA 177-8-2004 (MOD 3, 29 August 2019), which superseded DA 177-8-2004 (MOD 2, 17 February 2012). Noise limits were provided in MOD 2, but these criteria were not applicable due to property ownership and acquisition rights in the area. Subsequently, noise limits have been removed from MOD 3, but monitoring is still conducted in accordance with Condition B1 of Schedule 2.

2.3 Environment Protection Licence

WCM holds EPL No. 529 issued by the Environment Protection Authority (EPA) most recently on 13 December 2019.

2.4 Noise Criteria

2.4.1 Development Consent

Environmental noise criteria for WCM and WCRS have been provided separately for the reporting period from January through August 2019 and from September 2019 onward.

Based on MOD 17, noise criteria detailed in Table 2.1 have been adopted for each monitoring location from January to August 2019.

Table 2.1: WCM NOISE IMPACT ASSESSMENT CRITERIA – JANUARY TO AUGUST 2019

Location	Day $L_{Aeq,15minute}$ dB	Evening/Night $L_{Aeq,15minute}$ dB	Night $L_{A1,1minute}$ dB
N01[1]	NA	NA	NA
N03[1]	NA	NA	NA
N16	35	40	50
N20A	35	40	50
N21	35	40	50
N26	35	40	50

Notes:

1. *N01 and N03 were listed as Acquisition Upon Request in Schedule 4, Condition 1 of MOD 17. In accordance with Condition 6 of Schedule 4, noise criteria were NA 'not applicable' at these properties.*

Based on MOD 16, noise criteria detailed in Table 2.2 have been adopted for each monitoring location from September 2019.

Table 2.2: WCM OPERATIONAL NOISE CRITERIA – SEPTEMBER TO DECEMBER 2019

Location	Day $L_{Aeq,15minute}$ dB	Evening/Night $L_{Aeq,15minute}$ dB	Night $L_{A1,1minute}$ dB
N01[1]	40	40	50
N03[2]	NA	NA	NA
N16	40	40	50
N20A	40	40	50
N21	40	40	50
N26	40	40	50

Notes:

1. *N01 was acquired and removed from MOD 16. Noise criteria for the nearest privately-owned property (R003 – Birrell) have been adopted; and*
2. *N03 was acquired. There are no other privately-owned properties in this area and noise criteria are NA 'not applicable'.*

2.4.2 Environment Protection Licence

Noise criteria detailed in Table 2.2 have been adopted for each monitoring location based on Condition L4.1 of the EPL. Noise limits were unchanged during 2019.

Table 2.3: WCM EPL NOISE LIMITS – JANUARY TO DECEMBER 2019

Location	Day $L_{Aeq,15minute}$ dB	Evening/Night $L_{Aeq,15minute}$ dB	Night $L_{A1,1minute}$ dB
N01[1]	35	40	50
N03[2]	NA	NA	NA
N16	35	40	50
N20A	35	40	50
N21	35	40	50
N26	35	40	50

Notes:

1. *N01 was acquired and removed from the EPL. Noise criteria for the nearest privately-owned property (3 – Birrell) have been adopted; and*
2. *N03 was acquired and removed from the EPL. There are no other privately-owned properties in this area and noise criteria are NA 'not applicable'.*

2.5 Noise Management Plan

Noise monitoring requirements are detailed in the *Wambo Coal Noise Management Plan WA-ENV-MNP-503* (NMP, January 2018), prepared in accordance with the WCM and WCRS consents. The NMP states that monitoring will be conducted to assess noise levels from WCM and WCRS activities.

2.6 Meteorological Conditions

Meteorological conditions required for noise criteria to apply are not consistent between the consent and EPL.

2.6.1 EPL Meteorological Conditions

Condition L4.5 and L4.6 of the EPL detail meteorological conditions required for noise limits to apply:

L4.5 The noise emission limits identified in condition L4.1 apply under meteorological conditions of:

a) Wind speeds of up to 3m/s at 10 metres above the ground level; or
b) Temperature inversion conditions of up to 3ºC/100m and wind speeds of up to 2m/s at 10 metres above the ground.

L4.6 In regard to condition 4.5(b) of the Licence, temperature inversion conditions must be identified using the sigma-theta method in the EPA's Noise Policy for Industry, October 2017, from data obtained from the premises weather station at EPA monitoring point 17.

The sigma-theta method outlined in the EPA's 'Noise Policy for Industry' (NPfI, 2017) allows stability class to be determined from sigma-theta and wind speed data. However, temperature inversion gradient (VTG) must be measured directly and cannot be determined by the sigma-theta method.

Prior to September 2019, VTG conditions were assumed based on the corresponding stability category calculated by the sigma-theta method. From September 2019, meteorological conditions have been assessed in accordance with Condition 1(b) in Appendix 5 of MOD 17.

2.6.2 Consent Meteorological Conditions

Prior to September 2019, a note on Table 9 of MOD 17 stated that certain meteorological conditions need to be considered in accordance with the NSW Industrial Noise Policy (INP, 2000). In accordance with this requirement, it has been assumed that noise limits apply under all weather conditions except during:

- rain;
- wind speeds (at 10m above ground) greater than 3 m/s; and/or
- atmospheric Stability Category G.

From September 2019, Appendix 5 of MOD 16 details specific meteorological conditions required for noise criteria to be applicable:

APPENDIX 5 NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

1. The noise criteria in condition B12 are to apply under all meteorological conditions except the following:
   (a) where 3°C/100 metres (m) lapse rates have been assessed, then:
      (i) wind speeds greater than 3 metres/second (m/s) measured at 10m above ground level;
      (ii) temperature inversion conditions between 1.5°C and 3°C/100m and wind speeds greater than 2m/s measured at 10m above ground level; or
      (iii) temperature inversion conditions greater than 3°C/100m.
   (b) where Pasquill Stability Classes have been assessed, then:
      (i) wind speeds greater than 3m/s at 10m above ground level;
      (ii) stability category F temperature inversion conditions and wind speeds greater than 2m/s at 10m above ground level;
      (iii) stability category G temperature inversion conditions.

As lapse rates (VTG) were not measured directly, meteorological conditions have been assessed against Pasquill Stability Classes detailed in 1(b).

2.7 Modifying Factors

The EPA NPfI was approved for use in NSW in October 2017, and supersedes the EPA's 'Industrial Noise Policy' (INP, 2000). Assessment and reporting of modifying factors is to be carried out in accordance with Fact Sheet C of the NPfI.

NPfI modifying factors, as they are applicable to mining noise, are described in more detail below.

2.7.1 Tonality and Intermittent Noise

As defined in the NPfI:

> *Tonal noise contains a prominent frequency and is characterised by a definite pitch.*
>
> *Intermittent noise is noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB(A); for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.*

2.7.2 Low-Frequency Noise

As defined in the NPfI:

> *Low frequency noise is noise with an unbalanced spectrum and containing major components within the low-frequency range (10 – 160 Hz) of the frequency spectrum.*

The NPfI contains the current method of assessing low-frequency noise, which is a 2 step process as detailed below:

> *Measure/assess source contribution C-weighted and A-weighted $L_{eq,T}$ levels over the same time period. The low frequency noise modifying factor correction is to be applied where the C-A level is 15 dB or more and:*
>
> • *where any of the 1/3 octave noise levels in Table C2 are exceeded by* ***up to and including*** *5 dB and cannot be mitigated, a 2 dBA positive adjustment to measured A weighted levels applies for the*

evening/night period; and

*• where any of the 1/3 octave noise levels in Table C2 are exceeded by **more than** 5 dB and cannot be mitigated, a 5 dBA positive adjustment to measured A weighted levels applies for the evening/night period and a 2 dBA positive adjustment applies for the daytime period.*

Table C2 and associated notes from the NPfI is reproduced below:

Table C2: One-third octave low-frequency noise thresholds.

Hz/dB(Z)	One-third octave $L_{Zeq,15min}$ threshold level												
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Notes:

- dB(Z) = decibel (Z frequency weighted).
- For the assessment of low-frequency noise, care should be taken to select a wind screen that can protect the microphone from wind-induced noise characteristics at least 10 dB below the threshold values in Table C2 for wind speeds up to 5 metres per second. It is likely that high performance larger diameter wind screens (nominally 175 mm) will be required to achieve this performance (Hessler, 2008). In any case, the performance of the wind screen and wind speeds at which data will be excluded needs to be stated.
- Low-frequency noise corrections only apply under the standard and/or noise-enhancing meteorological conditions.
- Where a receiver location has had architectural acoustic treatment applied (including alternative means of mechanical ventilation satisfying the Building Code of Australia) by a proponent, as part of consent requirements or as a private negotiated agreement, alternative external low-frequency noise assessment criteria may be proposed to account for the higher transmission loss of the building façade.
- Measurements should be made between 1.2 and 1.5 metres above ground level unless otherwise approved through a planning instrument (consent/approval) or environment protection licence, and at locations nominated in the development consent or licence.

3 METHODOLOGY

3.1 Overview

Attended environmental noise monitoring was conducted in general accordance with Australian Standard AS1055 'Acoustics, Description and Measurement of Environmental Noise', relevant NSW EPA requirements, and the NMP. Meteorological data was obtained from the WCM automatic weather station (AWS) which allowed correlation of atmospheric parameters with measured noise levels.

3.2 Attended Noise Monitoring

Monthly attended monitoring was undertaken during the night period at each location. The duration of each measurement was 15 minutes. Atmospheric condition measurement was also undertaken at each monitoring location.

Attended monitoring is preferred to the use of noise loggers when determining compliance with prescribed limits as it allows an accurate determination of the contribution, if any, to measured noise levels by the source of interest (in this case WCM and/or WCRS).

Each survey presents noise levels gathered during attended monitoring that are the result of many sounds reaching the sound level meter microphone during monitoring. Received levels from various noise sources were noted during attended monitoring and particular attention was paid to the extent of WCM/WCRS's contribution, if any, to measured levels. At each receptor location, WCM/WCRS's $L_{Aeq,15minute}$ and $L_{A1,1minute}$ (in the absence of any other noise) was measured directly, where possible, or, determined by frequency analysis.

If the exact contribution of the source of interest cannot be established, due to masking by other noise sources in a similar frequency range, but site noise levels are observed to be well below (more than 5 dB lower than) any relevant criterion, a maximum estimate of the potential contribution of the site might be made based on other measured site-only noise descriptors in accordance with Section 7.1 of the NPfI. This is generally expressed as a 'less than' quantity, such as <20 dB or <30 dB.

The terms 'Inaudible' (IA) or 'Not Measurable' (NM) may also be used in this report. When site noise is noted as IA, no site noise was audible at the monitoring location. When site noise is noted as NM, this means some noise was audible but could not be quantified. If site noise was NM due to masking but estimated to be significant in relation to a relevant criterion, we would employ methods (e.g. measure closer and back calculate) to determine a value for reporting.

All sites noted as NM in this report are due to one or more of the following reasons:

- Site noise levels were extremely low and unlikely, in many cases, to be even noticed;
- Site noise levels were masked by another relatively loud noise source that is characteristic of the environment (e.g. breeze in foliage or continuous road traffic noise) that cannot be eliminated by moving closer; and/or
- It was not feasible, nor reasonable to employ methods such as move closer and back calculate. Cases may include, but are not limited to, rough terrain preventing closer measurement, addition/removal of significant

source to receiver shielding caused by moving closer, and meteorological conditions where back calculation may not be accurate.

A measurement of $L_{A1,1minute}$ corresponds to the highest noise level generated for 0.6 second during one minute. In practical terms this is the highest noise level, or L_{Amax}, received from the site during the entire measurement period (i.e. the highest level of the worst minute during the 15 minute measurement).

3.3 Meteorological Data

Meteorological data was obtained from the WCM meteorological station; this was logged at 10-minute intervals. Atmospheric parameters include wind speed, wind direction, rainfall and sigma theta. When meteorological data is provided in less than 15 minute intervals, an analysis must be conducted to determine the meteorological conditions present for the majority of each measurement period and whether those conditions result in noise criteria being applicable or not.

3.4 Modifying Factors

Years of monitoring have indicated that noise levels from mining operations, particularly those measured at significant distances from the source are relatively continuous and broad spectrum. Given this, noise levels from WCM at the monitoring locations are unlikely to be intermittent or tonal.

Assessment of low-frequency modifying factors is necessary when application of the maximum correction could potentially result in an exceedance of the relevant site-only L_{Aeq} criterion. Low-frequency analysis is therefore undertaken for measurements in this report where:

- meteorological conditions resulted in criteria being applicable;
- contributions from WCM were audible and directly measurable, such that the site-only L_{Aeq} was not “NM” or less than a maximum cut off value (e.g. “<20 dB” or “<30dB”);
- contributions from WCM were within 5 dB of the relevant L_{Aeq} criterion, as 5 dB is the maximum penalty that can be applied by low-frequency modifying factors; and
- WCM was the only low-frequency noise source.

All measurements meeting these conditions were evaluated for possible low-frequency penalty applicability in accordance with the NPfI.

3.5 Comparison with United Wambo EIS Model Predictions

The MOD 17 environmental assessment (EA) and MOD 16 EIS both make reference to the noise impact assessment (NIA) prepared in July 2016 to support application for the United Wambo Joint Venture project. The NIA includes noise impacts associated with ongoing operations at WCM and United Wambo. As part of the modelling assessment, noise levels from WCM were predicted for representative operating scenarios, time periods and weather conditions.

The NIA uses a cumulative distribution methodology wherein all meteorological conditions are considered and weighted based on how often they occur. Using this weighting, measured noise levels are expected to be greater than predicted noise levels provided in the NIA approximately 10% of the time. Measured noise levels are expected to be lower than noise levels predicted in the NIA the remaining 90% of the time. In order to compare measured and predicted noise levels, comparison should only occur when noise-enhancing atmospheric conditions are present.

Noise-enhancing conditions have been determined for each monitoring location in accordance with the NPfI. Meteorological parameter bounds used to identify corresponding meteorological conditions during attended monitoring are summarised in Table 3.1.

Table 3.1: APPLICABLE METEOROLOGICAL CONDITION DEFINITIONS

Location	Condition	Wind speed (m/s)	Wind direction (°)	Stability category
N01	Wind Only	Up to 3.0	W (267.5°-292.5°)	D and E
	Inversion	Up to 2.0	W (267.5°-292.5°)	F
N03	Wind Only	Up to 3.0	NW (292.5°-337.5°)	D and E
	Inversion	Up to 2.0	NW (292.5°-337.5°)	F
N16	Wind Only	Up to 3.0	SE (112.5°-157.5°)	D and E
	Inversion	Up to 2.0	SE (112.5°-157.5°)	F
N20A	Wind Only	Up to 3.0	SE (112.5°-157.5°)	D and E
	Inversion	Up to 2.0	SE (112.5°-157.5°)	F
N21	Wind Only	Up to 3.0	NNW (315°-360°)	D and E
	Inversion	Up to 2.0	NNW (315°-360°)	F
N26	Wind Only	Up to 3.0	SE (112.5°-157.5°)	D and E
	Inversion	Up to 2.0	SE (112.5°-157.5°)	F

In the NIA, a subset of meteorological conditions were used to determine worst-case sleep disturbance and low-frequency noise impacts, reproduced below:

- 3 m/s wind from the south east (a vectored wind condition that can occur greater than 30% of the time during the evening and night time)
- 3 m/s wind from the north-west (a vectored wind condition that can occur up to 20% of the time during the day time)
- F Class stability, modelled as 4°C/100 metre inversion 1.3 m/s drainage flow from the south (the vectored wind condition can occur greater than 30% of the time during inversion conditions during winter night times (6pm to 7am)).

Predicted noise levels for "3 m/s wind from the north-west" atmospheric conditions were based on occurrence during the day period and have not been compared to attended monitoring results for sleep disturbance, which can only occur during the night period. Subsequently, three comparisons against predicted noise levels were feasible:

- Sleep disturbance noise predictions for "calm" atmospheric conditions are compared to attended measurements where wind speeds were less than 0.5 metres per second (m/s), including all wind directions, and Stability Category was D or E according to Table D2 of the NPfI;
- Sleep disturbance noise predictions for "3 m/s wind from the SE" atmospheric conditions are compared to attended measurements where wind speeds were in the range 0.5 to 3.0 m/s and Stability Category was D or E according to Table D2 of the NPfI. The modelled wind direction was SE (135 degrees). Wind directions 22.5 degrees either side of the modelled direction were included; and
- Sleep disturbance noise predictions for "F Class stability" atmospheric conditions are compared to attended measurements where wind speeds were up to 2.0 m/s and Stability Category was F according to Table D2 of the NPfI. The modelled wind direction was S (180 degrees). Wind directions 22.5 degrees either side of the modelled direction were included.

Meteorological parameter bounds used to identify corresponding meteorological conditions during attended monitoring are summarised in Table 3.2.

Table 3.2: APPLICABLE METEOROLOGICAL CONDITION DEFINITIONS

Parameter	Condition (Night Only)		
	Calm	SE Wind	Inversion
Wind speed (m/s)	0.0 – 0.5	0.5 – 3.0	0.0 – 2.0
Wind direction (°)	all	112.5°-157.5°	157.5°-202.5°
Stability category	D and E	D and E	F

Noise predictions for Year 2 were compared with measured levels from attended compliance monitoring for corresponding meteorological conditions.

4 RESULTS

4.1 Attended Noise Monitoring – January 2019

Overall noise levels measured at each location during attended measurement in January 2019 are provided in Table 4.1.

Table 4.1: MEASURED NOISE LEVELS – JANUARY 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	17/01/2019 23:47	44	42	40	37	35	34	31	57
N03	18/01/2019 00:24	87	67	43	59	38	35	31	67
N16	17/01/2019 23:20	48	45	44	42	41	39	35	60
N16[2]	24/01/2019 22:00	48	44	42	40	39	37	35	62
N20A	17/01/2019 22:21	43	40	39	37	37	35	32	57
N21	17/01/2019 23:15	44	41	38	37	37	35	31	58
N26	17/01/2019 22:48	68	67	66	63	64	54	49	63

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS; and*
2. *Follow-up measurement.*

4.1.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. None of the measurements satisfied the conditions outlined in Section 3.4 when assessing low-frequency noise.

Therefore no further assessment of modifying factors was undertaken.

4.1.2 Attended Noise Monitoring Results

Table 4.2 and Table 4.3 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during January 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.2: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – JANUARY 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{Aeq,15min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{Aeq,15min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	17/01/2019 23:47	0.2	3.0	F	40/NA	No/NA	<30	NA
N03	18/01/2019 00:24	0.4	3.0	F	NA	NA	<30	NA
N16	17/01/2019 23:20	0.3	3.0	F	40	No/Yes	**42**	NA/**2**
N16[7]	24/01/2019 22:00	3.0	-1.0	D	40	No/Yes	38	NA/Nil
N20A	17/01/2019 22:21	0.9	0.5	E	40	Yes	NM	Nil
N21	17/01/2019 23:15	0.3	3.0	F	40	No/Yes	32	NA/Nil
N26	17/01/2019 22:48	0.8	-1.0	D	40	Yes	<30	Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable;*
6. *Bold results in red indicate a potential exceedance of relevant criterion; and*
7. *Follow-up measurement.*

Table 4.3: $L_{A1,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – JANUARY 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{A1,1min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{A1,1min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	17/01/2019 23:47	0.2	3.0	F	50/NA	No/NA	<30	NA
N03	18/01/2019 00:24	0.4	3.0	F	NA	NA	40	NA
N16	17/01/2019 23:20	0.3	3.0	F	50	No/Yes	48	NA/Nil
N16[7]	24/01/2019 22:00	3.0	-1.0	D	50	No/Yes	41	NA/Nil
N20A	17/01/2019 22:21	0.9	0.5	E	50	Yes	35	Nil
N21	17/01/2019 23:15	0.3	3.0	F	50	No/Yes	38	NA/Nil
N26	17/01/2019 22:48	0.8	-1.0	D	50	Yes	30	Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{A1,1minute}$ attributed to WCM;*
6. *Bold results in red indicate an exceedance of relevant criterion; and*
7. *Follow-up measurement.*

4.2 Attended Noise Monitoring – February 2019

Overall noise levels measured at each location during attended measurement in February 2019 are provided in Table 4.4.

Table 4.4: MEASURED NOISE LEVELS – FEBRUARY 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	11/02/2019 22:28	39	38	35	30	27	26	24	54
N03	11/02/2019 23:44	87	70	50	61	38	36	33	67
N16	11/02/2019 22:53	49	41	38	35	33	28	26	55
N20A	11/02/2019 22:25	49	42	35	32	30	26	22	54
N21	11/02/2019 22:00	38	34	32	30	30	28	24	56
N26	11/02/2019 22:00	41	34	30	27	26	23	20	53

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.2.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. None of the measurements satisfied the conditions outlined in Section 3.4 when assessing low-frequency noise.

Therefore no further assessment of modifying factors was undertaken.

4.2.2 Attended Noise Monitoring Results

Table 4.5 and Table 4.6 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during February 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.5: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – FEBRUARY 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{Aeq,15min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{Aeq,15min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	11/02/2019 22:28	0.8	3.0	F	40/NA	No/NA	<25	NA
N03	11/02/2019 23:44	0.5	3.0	F	NA	NA	38	NA
N16	11/02/2019 22:53	0.4	3.0	F	40	No/Yes	35	NA/Nil
N20A	11/02/2019 22:25	0.8	3.0	F	40	No/Yes	<30	NA/Nil
N21	11/02/2019 22:00	0.7	3.0	F	40	No/Yes	30	NA/Nil
N26	11/02/2019 22:00	0.7	3.0	F	40	No/Yes	<25	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable; and*
6. *Bold results in red indicate a potential exceedance of relevant criterion.*

Table 4.6: $L_{A1,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – FEBRUARY 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{A1,1min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{A1,1min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	17/01/2019 23:47	0.2	3.0	F	50/NA	No/NA	<30	NA
N03	18/01/2019 00:24	0.4	3.0	F	NA	NA	40	NA
N16	17/01/2019 23:20	0.3	3.0	F	50	No/Yes	47	NA/Nil
N16[7]	24/01/2019 22:00	3.0	-1.0	D	50	No/Yes	35	NA/Nil
N20A	17/01/2019 22:21	0.9	0.5	E	50	No/Yes	38	Nil
N21	17/01/2019 23:15	0.3	3.0	F	50	No/Yes	30	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{A1,1minute}$ attributed to WCM; and*
6. *Bold results in red indicate an exceedance of relevant criterion.*

4.3 Attended Noise Monitoring – March 2019

Overall noise levels measured at each location during attended measurement in March 2019 are provided in Table 4.7.

Table 4.7: MEASURED NOISE LEVELS – MARCH 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	19/03/2019 22:24	53	44	39	37	36	35	32	55
N03	20/03/2019 00:03	87	68	52	61	49	48	47	69
N16	19/03/2019 23:00	55	45	43	40	39	36	32	55
N20A	19/03/2019 22:27	49	43	40	37	36	34	30	57
N21	19/03/2019 22:00	41	36	31	28	26	25	23	54
N26	19/03/2019 22:00	44	36	33	32	31	29	27	54

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.3.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. One of the measurements in this survey satisfied the conditions outlined in Section 3.4 and were assessed for low-frequency modifying factors in Table 4.8.

Table 4.8: LOW-FREQUENCY MODIFYING FACTOR ASSESSMENT – MARCH 2019

Location	Start Date and Time	Measured WCM Only L_{Aeq} dB	Measured WCM Only L_{Ceq} dB	WCM Only $L_{Ceq} - L_{Aeq}$ dB[1]	Max exceedance of ref spectrum [2]	Penalty dB[3]
N16	12/11/2019 00:34	37	51	14	NA	Nil
N16	12/11/2019 01:30	37	53	16	Nil	Nil

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq} \geq 15$ dB further assessment of low- frequency noise required as detailed in Sections 2.7.2 and 3.4 of this report. NA indicates that $L_{Ceq} - L_{Aeq}$ was not ≥ 15 dB and further assessment is not required;*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low-frequency modifying factor is triggered and application of penalty is required; and*
3. *Bold results indicate that NPfI low-frequency modifying factor has been triggered and application of correction is required.*

4.3.2 Attended Noise Monitoring Results

Table 4.9 and Table 4.10 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during March 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.9: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – MARCH 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{Aeq,15min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{Aeq,15min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	19/03/2019 22:24	0.4	3.0	F	40/NA	No/Yes	IA	NA
N03	20/03/2019 00:03	0.5	3.0	F	NA	NA	49	NA
N16	19/03/2019 23:00	0.9	3.0	F	40	No/Yes	37	NA/Nil
N20A	19/03/2019 22:27	0.4	3.0	F	40	No/Yes	37	NA/Nil
N21	19/03/2019 22:00	0.2	3.0	F	40	No/Yes	IA	NA/Nil
N26	19/03/2019 22:00	0.2	3.0	F	40	No/Yes	<30	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable; and*
6. *Bold results in red indicate a potential exceedance of relevant criterion.*

Table 4.10: $L_{A1,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – MARCH 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{A1,1min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{A1,1min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	19/03/2019 22:24	0.4	3.0	F	50/NA	No/NA	IA	NA
N03	20/03/2019 00:03	0.5	3.0	F	NA	NA	53	NA
N16	19/03/2019 23:00	0.9	3.0	F	50	No/Yes	43	NA/Nil
N16[7]	19/03/2019 22:27	0.4	3.0	F	50	No/Yes	42	NA/Nil
N20A	19/03/2019 22:00	0.2	3.0	F	50	No/Yes	IA	Nil
N21	19/03/2019 22:00	0.2	3.0	F	50	No/Yes	33	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{A1,1minute}$ attributed to WCM; and*
6. *Bold results in red indicate an exceedance of relevant criterion.*

4.4 Attended Noise Monitoring – April 2019

Overall noise levels measured at each location during attended measurement in April 2019 are provided in Table 4.11.

Table 4.11: MEASURED NOISE LEVELS – APRIL 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	04/04/2019 22:54	62	41	38	37	36	34	31	-[2]
N03	04/04/2019 23:58	56	49	44	42	41	39	36	65
N16	04/04/2019 22:54	53	48	45	41	40	37	33	57
N20A	04/04/2019 22:27	46	38	37	35	34	33	31	55
N21	04/04/2019 22:29	65	47	38	38	35	34	31	56
N26	04/04/2019 22:00	43	39	38	36	36	34	31	55

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS; and*
2. *Unavailable due to storage error of the raw measurement instrument file.*

4.4.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. None of the measurements satisfied the conditions outlined in Section 3.4 when assessing low-frequency noise.

Therefore no further assessment of modifying factors was undertaken.

4.4.2 Attended Noise Monitoring Results

Table 4.12 and Table 4.13 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during April 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.12: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – APRIL 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{Aeq,15min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{Aeq,15min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	04/04/2019 22:54	0.9	0.5	E	40/NA	Yes/NA	IA	Nil/NA
N03	04/04/2019 23:58	1.4	-1.0	D	NA	NA	39	NA
N16	04/04/2019 22:54	0.9	0.5	E	40	Yes	35	Nil
N20A	04/04/2019 22:27	1.8	-1.0	D	40	Yes	<30	Nil
N21	04/04/2019 22:29	1.8	-1.0	D	40	Yes	IA	Nil
N26	04/04/2019 22:00	1.8	0.5	E	40	Yes	35	Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable; and*
6. *Bold results in red indicate a potential exceedance of relevant criterion.*

Table 4.13: $L_{A1,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – APRIL 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{A1,1min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{A1,1min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	04/04/2019 22:54	0.9	0.5	E	50/NA	Yes/NA	IA	Nil/NA
N03	04/04/2019 23:58	1.4	-1.0	D	NA	NA	56	NA
N16	04/04/2019 22:54	0.9	0.5	E	50	Yes	43	Nil
N20A	04/04/2019 22:27	1.8	-1.0	D	50	Yes	<30	Nil
N21	04/04/2019 22:29	1.8	-1.0	D	50	Yes	IA	Nil
N26	04/04/2019 22:00	1.8	0.5	E	50	Yes	37	Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{A1,1minute}$ attributed to WCM; and*
6. *Bold results in red indicate an exceedance of relevant criterion.*

4.5 Attended Noise Monitoring – May 2019

Overall noise levels measured at each location during attended measurement in May 2019 are provided in Table 4.14.

Table 4.14: MEASURED NOISE LEVELS – MAY 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	07/05/2019 22:24	52	42	30	31	27	26	24	56
N03	07/05/2019 23:57	87	64	42	59	38	37	34	65
N16	07/05/2019 22:55	62	58	46	44	31	28	26	53
N20A	07/05/2019 22:28	49	43	39	37	37	35	32	57
N21	07/05/2019 22:00	43	34	32	31	30	29	27	55
N26	07/05/2019 22:02	53	37	33	29	25	23	21	54

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.5.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. None of the measurements satisfied the conditions outlined in Section 3.4 when assessing low-frequency noise.

Therefore no further assessment of modifying factors was undertaken.

4.5.2 Attended Noise Monitoring Results

Table 4.15 and Table 4.16 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during May 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.15: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – MAY 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{Aeq,15min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{Aeq,15min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	07/05/2019 22:24	2.2	3.0	F	40/NA	No/NA	28	NA
N03	07/05/2019 23:57	3.5	-1.0	D	NA	NA	38	NA
N16	07/05/2019 22:55	2.9	0.5	E	40	Yes	IA	Nil
N20A	07/05/2019 22:28	2.2	3.0	F	40	No/Yes	IA	NA/Nil
N21	07/05/2019 22:00	1.8	3.0	F	40	No/Yes	31	NA/Nil
N26	07/05/2019 22:02	1.8	3.0	F	40	No/Yes	IA	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable; and*
6. *Bold results in red indicate a potential exceedance of relevant criterion.*

Table 4.16: $L_{A1,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – MAY 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{A1,1min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{A1,1min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	07/05/2019 22:24	2.2	3.0	F	50/NA	No/NA	31	NA
N03	07/05/2019 23:57	3.5	-1.0	D	NA	NA	50	NA
N16	07/05/2019 22:55	2.9	0.5	E	50	Yes	IA	Nil
N20A	07/05/2019 22:28	2.2	3.0	F	50	No/Yes	IA	NA/Nil
N21	07/05/2019 22:00	1.8	3.0	F	50	No/Yes	34	NA/Nil
N26	07/05/2019 22:02	1.8	3.0	F	50	No/Yes	IA	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{A1,1minute}$ attributed to WCM; and*
6. *Bold results in red indicate an exceedance of relevant criterion.*

4.6 Attended Noise Monitoring – June 2019

Overall noise levels measured at each location during attended measurement in June 2019 are provided in Table 4.17.

Table 4.17: MEASURED NOISE LEVELS – JUNE 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	20/06/2019 22:25	43	36	33	31	30	28	26	55
N03	20/06/2019 23:37	57	48	42	39	36	34	32	60
N16	20/06/2019 23:03	50	47	44	41	41	38	35	58
N20A	20/06/2019 22:33	46	41	38	36	35	32	28	55
N21	20/06/2019 22:00	39	36	33	31	31	29	27	56
N26	20/06/2019 22:06	48	37	34	32	31	30	27	56

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.6.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. None of the measurements satisfied the conditions outlined in Section 3.4 when assessing low-frequency noise.

Therefore no further assessment of modifying factors was undertaken.

4.6.2 Attended Noise Monitoring Results

Table 4.18 and Table 4.19 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during June 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.18: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – JUNE 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{Aeq,15min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{Aeq,15min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	20/06/2019 22:25	0.2	3.0	F	40/NA	No/NA	IA	NA
N03	20/06/2019 23:37	0.4	3.0	F	NA	NA	36	NA
N16	20/06/2019 23:03	0.5	3.0	F	40	No/Yes	38	NA/Nil
N20A	20/06/2019 22:33	0.4	3.0	F	40	No/Yes	34	NA/Nil
N21	20/06/2019 22:00	0.7	3.0	F	40	No/Yes	<25	NA/Nil
N26	20/06/2019 22:06	1.1	0.5	E	40	No/Yes	31	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable; and*
6. *Bold results in red indicate a potential exceedance of relevant criterion.*

Table 4.19: $L_{A1,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – JUNE 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{A1,1min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{A1,1min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	20/06/2019 22:25	0.2	3.0	F	50/NA	No/NA	IA	NA
N03	20/06/2019 23:37	0.4	3.0	F	NA	NA	39	NA
N16	20/06/2019 23:03	0.5	3.0	F	50	No/Yes	48	NA/Nil
N20A	20/06/2019 22:33	0.4	3.0	F	50	No/Yes	42	NA/Nil
N21	20/06/2019 22:00	0.7	3.0	F	50	No/Yes	33	NA/Nil
N26	20/06/2019 22:06	1.1	0.5	E	50	No/Yes	37	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{A1,1minute}$ attributed to WCM; and*
6. *Bold results in red indicate an exceedance of relevant criterion.*

4.7 Attended Noise Monitoring – July 2019

Overall noise levels measured at each location during attended measurement in July 2019 are provided in Table 4.20.

Table 4.20: MEASURED NOISE LEVELS – JULY 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	18/07/2019 22:35	45	32	26	25	23	22	20	55
N03	19/07/2019 00:19	52	47	43	40	39	37	33	61
N16	18/07/2019 23:23	59	51	41	39	25	23	22	53
N20A	18/07/2019 22:47	53	37	30	30	28	26	24	53
N21	18/07/2019 22:10	49	33	31	29	28	26	23	55
N26	18/07/2019 22:14	40	34	28	26	23	22	20	54

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.7.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. None of the measurements satisfied the conditions outlined in Section 3.4 when assessing low-frequency noise.

Therefore no further assessment of modifying factors was undertaken.

4.7.2 Attended Noise Monitoring Results

Table 4.21 and Table 4.22 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during July 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.21: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – JULY 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{Aeq,15min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{Aeq,15min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	18/07/2019 22:35	1.2	0.5	E	40/NA	Yes/NA	<25	Nil/NA
N03	19/07/2019 00:19	0.8	3.0	F	NA	NA	40	NA
N16	18/07/2019 23:23	1.2	3.0	F	40	No/Yes	<25	NA/Nil
N20A	18/07/2019 22:47	1.1	0.5	E	40	Yes	28	NA/Nil
N21	18/07/2019 22:10	1.0	3.0	F	40	No/Yes	29	NA/Nil
N26	18/07/2019 22:14	0.7	3.0	F	40	No/Yes	<25	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable; and*
6. *Bold results in red indicate a potential exceedance of relevant criterion.*

Table 4.22: $L_{A1,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – JULY 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{A1,1min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{A1,1min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	18/07/2019 22:35	1.2	0.5	E	50/NA	Yes/NA	29	Nil/NA
N03	19/07/2019 00:19	0.8	3.0	F	NA	NA	52	NA
N16	18/07/2019 23:23	1.2	3.0	F	50	No/Yes	<25	NA/Nil
N20A	18/07/2019 22:47	1.1	0.5	E	50	Yes	34	NA/Nil
N21	18/07/2019 22:10	1.0	3.0	F	50	No/Yes	36	NA/Nil
N26	18/07/2019 22:14	0.7	3.0	F	50	No/Yes	<25	NA/Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{A1,1minute}$ attributed to WCM; and*
6. *Bold results in red indicate an exceedance of relevant criterion.*

4.8 Attended Noise Monitoring – August 2019

Overall noise levels measured at each location during attended measurement in August 2019 are provided in Table 4.23.

Table 4.23: MEASURED NOISE LEVELS – AUGUST 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	05/08/2019 23:18	49	41	34	32	31	29	26	56
N03	06/08/2019 00:44	57	50	43	41	37	35	33	59
N16	06/08/2019 00:08	43	40	37	34	33	31	26	54
N20A	05/08/2019 22:55	43	31	25	23	22	20	18	53
N21	05/08/2019 22:20	47	41	39	37	37	35	32	59
N21[2]	05/08/2019 22:46	46	38	35	32	31	29	27	56
N26	05/08/2019 23:31	39	27	25	23	22	20	18	53

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS; and*
2. *Remeasure.*

4.8.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. One of the measurements in this survey satisfied the conditions outlined in Section 3.4 and were assessed for low-frequency modifying factors in Table 4.2.

Table 4.24: LOW-FREQUENCY MODIFYING FACTOR ASSESSMENT – AUGUST 2019

Location	Start Date and Time	Measured WCM Only L_{Aeq} dB	Measured WCM Only L_{Ceq} dB	WCM Only $L_{Ceq} - L_{Aeq}$ dB[1]	Max exceedance of ref spectrum[2]	Penalty dB[2]
N21	05/08/2019 22:20	37	54	17	3 dB @ 50 Hz	**2**

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq} \geq 15$ dB further assessment of low- frequency noise required as detailed in Section Table 4.24 of this report; and*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low-frequency modifying factor is triggered and application of penalty is required; and*
3. *Bold results indicate that NPfI low-frequency modifying factor has been triggered and application of correction is required.*

4.8.2 Attended Noise Monitoring Results

Table 4.25 and Table 4.26 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during August 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.25: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – AUGUST 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{Aeq,15min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{Aeq,15min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	05/08/2019 23:18	0.2	3.0	F	40/NA	No/NA	IA	NA
N03	06/08/2019 00:44	0.6	3.0	F	NA	NA	38	NA
N16	06/08/2019 00:08	0.6	3.0	F	40	No/Yes	34	Nil
N20A	05/08/2019 22:55	1.0	-1.0	D	40	Yes	<25	Nil
N21	05/08/2019 22:20	0.6	3.0	F	40	No/Yes	39	Nil
N21[7]	05/08/2019 22:46	0.5	0.5	E	40	Yes	32	Nil
N26	05/08/2019 23:31	0.1	3.0	F	40	No/Yes	23	Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable;*
6. *Bold results in red indicate a potential exceedance of relevant criterion; and*
7. *Follow-up measurement.*

Table 4.26: $L_{A1,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – AUGUST 2019

Location	Start Date and Time	Wind Speed m/s	VTG °C/100m[1]	Stability Category[2]	EPL/Consent Criterion $L_{A1,1min}$ dB[3]	EPL/Consent Criterion Applies? [4]	WCM $L_{A1,1min}$ dB [5,6]	EPL/Consent Exceedance [4,6]
N01	05/08/2019 23:18	0.2	3.0	F	50/NA	No/NA	IA	NA
N03	06/08/2019 00:44	0.6	3.0	F	NA	NA	49	NA
N16	06/08/2019 00:08	0.6	3.0	F	50	No/Yes	41	NA/Nil
N20A	05/08/2019 22:55	1.0	-1.0	D	50	Yes	<25	NA/Nil
N21	05/08/2019 22:20	0.6	3.0	F	50	No/Yes	47	Nil
N21[7]	05/08/2019 22:46	0.5	0.5	E	50	Yes	38	NA/Nil
N26	05/08/2019 23:31	0.1	3.0	F	50	No/Yes	27	Nil

Notes:

1. *VTG assumed based on Stability Category calculated using sigma-theta method provided by NPfI;*
2. *Stability Category calculated using sigma-theta method provided by NPfI;*
3. *NA indicates location was acquisition upon request and noise criteria were not applicable. Refer to Section 2.4 for additional information;*
4. *NA indicates atmospheric conditions did not satisfy requirements of EPL or development consent, or there was no applicable criterion. Refer to Section 2.6 for information regarding meteorological requirements;*
5. *Site-only $L_{A1,1minute}$ attributed to WCM;*
6. *Bold results in red indicate an exceedance of relevant criterion; and*
7. *Follow-up measurement.*

4.9 Attended Noise Monitoring – September 2019

Overall noise levels measured at each location during attended measurement in September 2019 are provided in Table 4.27.

Table 4.27: MEASURED NOISE LEVELS – SEPTEMBER 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	11/09/2019 23:03	46	40	37	35	34	32	29	56
N03	11/09/2019 23:53	52	47	44	41	39	37	35	60
N16	11/09/2019 22:55	55	48	44	42	41	38	35	57
N20A	11/09/2019 22:25	47	40	37	35	35	33	31	55
N21	11/09/2019 22:32	44	40	39	36	36	34	31	59
N26	11/09/2019 22:00	45	38	36	34	34	33	30	56

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.9.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. One of the measurements in this survey satisfied the conditions outlined in Section 3.4 and were assessed for low-frequency modifying factors in Table 4.28.

Table 4.28: LOW-FREQUENCY MODIFYING FACTOR ASSESSMENT – SEPTEMBER 2019

Location	Start Date and Time	Measured WCM Only L_{Aeq} dB	Measured WCM Only L_{Ceq} dB	WCM Only $L_{Ceq} - L_{Aeq}$ dB[1]	Max exceedance of ref spectrum [2]	Penalty dB[3]
N21	11/09/2019 22:32	36	55	19	2 dB @ 80 Hz	**2**

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq} \geq 15$ dB further assessment of low- frequency noise required as detailed in Sections 2.7.2 and 3.4 of this report;*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low-frequency modifying factor is triggered and application of penalty is required; and*
3. *Bold results indicate that NPfI low-frequency modifying factor has been triggered and application of correction is required.*

4.9.2 Attended Noise Monitoring

Table 4.29 and Table 4.30 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during September 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.29: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – SEPTEMBER 2019

Location	Start Date and Time	Wind Speed m/s [1,2]	Stability Class [1,2]	Criterion dB	Criterion Applies? [2,3]	WCM $L_{Aeq,15min}$ dB [4,5]	Exceedance [6]
N01	11/09/2019 23:03	0.5	E	40	Yes	NM	Nil
N03	11/09/2019 23:53	0.6	D	NA	NA	37	NA
N16	11/09/2019 22:55	0.6	E	40	Yes	37	Nil
N20A	11/09/2019 22:25	0.9	E	40	Yes	34	Nil
N21	11/09/2019 22:32	0.9	E	40	Yes	38	Nil
N26	11/09/2019 22:00	0.9	D	40	Yes	34	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *NA indicates that criterion is not applicable as this location has been acquired;*
3. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level, or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
4. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable;*
5. *Bold results in red indicate an exceedance of relevant criterion; and*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in EPL and so criterion is not applicable or there is no applicable criterion.*

Table 4.30: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – SEPTEMBER 2019

Location	Start Date and Time	Wind Speed m/s [1,2]	Stability Class [1,2]	Criterion dB	Criterion Applies? [2,3]	WCM $L_{A1,1min}$ dB [4,5]	Exceedance [6]
N01	11/09/2019 23:03	0.5	E	50	Yes	NM	Nil
N03	11/09/2019 23:53	0.6	D	NA	NA	40	NA
N16	11/09/2019 22:55	0.6	E	50	Yes	45	Nil
N20A	11/09/2019 22:25	0.9	E	50	Yes	40	Nil
N21	11/09/2019 22:32	0.9	E	50	Yes	44	Nil
N26	11/09/2019 22:00	0.9	D	50	Yes	39	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *NA indicates that criterion is not applicable as this location has been acquired;*
3. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level, or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
4. *Site-only $L_{A1,1minute}$ attributed to WCM, including modifying factors if applicable;*
5. *Bold results in red indicate an exceedance of relevant criterion; and*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in EPL and so criterion is not applicable or there is no applicable criterion.*

4.10 Attended Noise Monitoring – October 2019

Overall noise levels measured at each location during attended measurement in October 2019 are provided in Table 4.31.

Table 4.31: MEASURED NOISE LEVELS – OCTOBER 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	15/10/2019 22:40	70	65	53	52	32	28	24	55
N03	16/10/2019 00:03	60	56	43	42	37	31	28	61
N16	15/10/2019 23:04	61	43	40	37	34	29	26	55
N20A	15/10/2019 22:34	44	35	30	28	27	25	23	54
N21	15/10/2019 22:17	73	44	34	40	30	28	25	54
N26	15/10/2019 22:06	46	42	38	36	36	32	28	54

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.10.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. One of the measurements in this survey satisfied the conditions outlined in Section 3.4 and were assessed for low-frequency modifying factors in Table 4.32.

Table 4.32: LOW-FREQUENCY MODIFYING FACTOR ASSESSMENT – OCTOBER 2019

Location	Start Date and Time	Measured WCM Only L_{Aeq} dB	Measured WCM Only L_{Ceq} dB	WCM Only $L_{Ceq} - L_{Aeq}$ dB[1]	Max exceedance of ref spectrum [2]	Penalty dB[3]
N16	15/10/2019 23:04	35	48	13	NA	Nil

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq} \geq 15$ dB further assessment of low- frequency noise required as detailed in Sections 2.7.2 and 3.4 of this report. NA indicates that $L_{Ceq} - L_{Aeq}$ was not ≥ 15 dB and further assessment is not required;*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low-frequency modifying factor is triggered and application of penalty is required; and*
3. *Bold results indicate that NPfI low-frequency modifying factor has been triggered and application of correction is required.*

4.10.2 Attended Noise Monitoring

Table 4.33 and Table 4.34 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during October 2019 with EPL noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.33: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – OCTOBER 2019

Location	Start Date and Time	Wind Speed m/s [1,2]	Stability Class [1,2]	Criterion dB	Criterion Applies? [2,3]	WCM $L_{Aeq,15min}$ dB [4,5]	Exceedance [6]
N01	15/10/2019 22:40	2.2	D	40	Yes	<20	Nil
N03	16/10/2019 00:03	0.6	F	NA	NA	35	NA
N16	15/10/2019 23:04	1.6	F	40	Yes	35	Nil
N20A	15/10/2019 22:34	2.2	D	40	Yes	<25	Nil
N21	15/10/2019 22:17	1.4	D	40	Yes	30	Nil
N26	15/10/2019 22:06	1.5	D	40	Yes	33	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *NA indicates that criterion is not applicable as this location has been acquired;*
3. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level, or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
4. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable;*
5. *Bold results in red indicate an exceedance of relevant criterion; and*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in EPL and so criterion is not applicable or there is no applicable criterion.*

Table 4.34: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – OCTOBER 2019

Location	Start Date and Time	Wind Speed m/s [1,2]	Stability Class [1,2]	Criterion dB	Criterion Applies? [2,3]	WCM $L_{A1,1min}$ dB [4,5]	Exceedance [6]
N01	15/10/2019 22:40	2.2	D	50	Yes	<20	Nil
N03	16/10/2019 00:03	0.6	F	NA	NA	41	NA
N16	15/10/2019 23:04	1.6	F	50	Yes	42	Nil
N20A	15/10/2019 22:34	2.2	D	50	Yes	28	Nil
N21	15/10/2019 22:17	1.4	D	50	Yes	35	Nil
N26	15/10/2019 22:06	1.5	D	50	Yes	45	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *NA indicates that criterion is not applicable as this location has been acquired;*
3. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level, or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
4. *Site-only $L_{A1,1minute}$ attributed to WCM, including modifying factors if applicable;*
5. *Bold results in red indicate an exceedance of relevant criterion; and*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in EPL and so criterion is not applicable or there is no applicable criterion.*

4.11 Attended Noise Monitoring – November 2019

Overall noise levels measured at each location during attended measurement in November 2019 are provided in Table 4.35.

Table 4.35: MEASURED NOISE LEVELS – NOVEMBER 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	11/11/2019 22:41	51	40	37	35	34	32	30	57
N03	12/11/2019 00:54	57	51	49	47	46	44	42	66
N16	12/11/2019 00:34	55	46	44	43	42	41	38	58
N16[2]	12/11/2019 01:30	49	40	38	36	35	33	31	53
N16[3]	14/11/2019 22:21	46	38	28	26	22	21	19	54
N20A	11/11/2019 23:24	41	33	30	28	27	24	21	53
N21	11/11/2019 22:16	52	40	36	34	33	31	28	54
N26	11/11/2019 23:56	46	36	33	30	29	27	24	54

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS;*
2. *Re-measure; and*
3. *Followup measurement.*

4.11.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey. One of the measurements in this survey satisfied the conditions outlined in Section 3.4 and were assessed for low-frequency modifying factors in Table 4.36.

Table 4.36: LOW-FREQUENCY MODIFYING FACTOR ASSESSMENT – NOVEMBER 2019

Location	Start Date and Time	Measured WCM Only L_{Aeq} dB	Measured WCM Only L_{Ceq} dB	WCM Only $L_{Ceq} - L_{Aeq}$ dB[1]	Max exceedance of ref spectrum [2]	Penalty dB[3]
N16	12/11/2019 00:34	42	56	14	NA	NA
N16	12/11/2019 01:30	36	50	14	NA	NA

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq} \geq 15$ dB further assessment of low- frequency noise required as detailed in Sections 2.7.2 and 3.4 of this report. NA indicates that $L_{Ceq} - L_{Aeq}$ was not ≥ 15 dB and further assessment is not required;*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low-frequency modifying factor is triggered and application of penalty is required; and*
3. *Bold results indicate that NPfI low-frequency modifying factor has been triggered and application of correction is required.*

4.11.2 Attended Noise Monitoring

Table 4.37 and Table 4.38 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during November 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.37: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – NOVEMBER 2019

Location	Start Date and Time	Wind Speed m/s [1,2]	Stability Class [1,2]	Criterion dB	Criterion Applies? [2,3]	WCM $L_{Aeq,15min}$ dB [4,5]	Exceedance [6]
N01	11/11/2019 22:41	0.7	D	40	Yes	34	Nil
N03	12/11/2019 00:54	0.1	F	NA	NA	47	NA
N16	12/11/2019 00:34	0.2	F	40	Yes	**42**	**2**
N16[6]	12/11/2019 01:30	0.2	E	40	Yes	36	Nil
N16[7]	14/11/2019 22:21	2.0	F	40	Yes	IA	NA
N20A	11/11/2019 23:24	0.5	D	40	Yes	<30	Nil
N21	11/11/2019 22:16	0.7	F	40	Yes	34	Nil
N26	11/11/2019 23:56	0.2	F	40	Yes	30	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *NA indicates that criterion is not applicable as this location has been acquired;*
3. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level, or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
4. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable;*
5. *Bold results in red indicate an exceedance of relevant criterion;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in EPL and so criterion is not applicable or there is no applicable criterion;*
7. *Re-measure; and*
8. *Followup measurement.*

Table 4.38: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – NOVEMBER 2019

Location	Start Date and Time	Wind Speed m/s [1,2]	Stability Class [1,2]	Criterion dB	Criterion Applies? [2,3]	WCM $L_{A1,1min}$ dB [4,5]	Exceedance [6]
N01	11/11/2019 22:41	0.7	D	50	Yes	36	Nil
N03	12/11/2019 00:54	0.1	F	NA	NA	51	NA
N16	12/11/2019 00:34	0.2	F	50	Yes	50	Nil
N16[6]	12/11/2019 01:30	0.2	E	50	Yes	40	Nil
N16[7]	14/11/2019 22:21	2.0	F	50	Yes	IA	NA
N20A	11/11/2019 23:24	0.5	D	50	Yes	33	Nil
N21	11/11/2019 22:16	0.7	F	50	Yes	42	Nil
N26	11/11/2019 23:56	0.2	F	50	Yes	36	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *NA indicates that criterion is not applicable as this location has been acquired;*
3. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level, or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
4. *Site-only $L_{A1,1minute}$ attributed to WCM, including modifying factors if applicable;*
5. *Bold results in red indicate an exceedance of relevant criterion;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in EPL and so criterion is not applicable or there is no applicable criterion;*
7. *Re-measure; and*
8. *Followup measurement.*

4.12 Attended Noise Monitoring – December 2019

Overall noise levels measured at each location during attended measurement in December 2019 are provided in Table 4.39.

Table 4.39: MEASURED NOISE LEVELS – DECEMBER 2019[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	05/12/2019 22:52	38	35	34	31	31	29	27	54
N03	06/12/2019 00:08	45	42	37	34	32	28	26	61
N16	05/12/2019 23:13	51	37	26	26	21	20	17	54
N20A	05/12/2019 22:09	49	43	38	35	34	30	26	49
N21	05/12/2019 22:22	41	29	23	22	21	20	18	54
N26	05/12/2019 22:38	50	47	46	44	44	39	35	47

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.12.1 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the EPA's NPfI.

There were no intermittent or tonal noise sources, as defined in the NPfI, audible from site during the survey.

None of the measurements satisfied the conditions outlined in Section 3.4 when assessing low-frequency noise. Therefore no further assessment of modifying factors was undertaken.

4.12.2 Attended Noise Monitoring

Table 4.40 and Table 4.41 compare WCM $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels during December 2019 with EPL and development consent noise limits. Noise criteria are applicable if weather conditions were within specified parameters during the measurement.

Table 4.40: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – DECEMBER 2019

Location	Start Date and Time	Wind Speed m/s [1,2]	Stability Class [1,2]	Criterion dB	Criterion Applies? [2,3]	WCM $L_{Aeq,15min}$ dB [4,5]	Exceedance [6]
N01	05/12/2019 22:52	1.0	D	40	Yes	IA	Nil
N03	06/12/2019 00:08	0.8	F	NA	NA	32	NA
N16	05/12/2019 23:13	1.1	D	40	Yes	IA	Nil
N20A	05/12/2019 22:09	2.8	D	40	Yes	IA	Nil
N21	05/12/2019 22:22	2.4	D	40	Yes	<25	Nil
N26	05/12/2019 22:38	1.3	E	40	Yes	IA	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *NA indicates that criterion is not applicable as this location has been acquired;*
3. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level, or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
4. *Site-only $L_{Aeq,15minute}$ attributed to WCM, including modifying factors if applicable;*
5. *Bold results in red indicate an exceedance of relevant criterion; and*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in EPL and so criterion is not applicable or there is no applicable criterion.*

Table 4.41: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE LIMITS – DECEMBER 2019

Location	Start Date and Time	Wind Speed m/s [1,2]	Stability Class [1,2]	Criterion dB	Criterion Applies? [2,3]	WCM $L_{A1,1min}$ dB [4,5]	Exceedance [6]
N01	05/12/2019 22:52	1.0	D	40	Yes	IA	Nil
N03	06/12/2019 00:08	0.8	F	NA	NA	34	NA
N16	05/12/2019 23:13	1.1	D	50	Yes	IA	Nil
N20A	05/12/2019 22:09	2.8	D	50	Yes	IA	Nil
N21	05/12/2019 22:22	2.4	D	50	Yes	<25	Nil
N26	05/12/2019 22:38	1.3	E	50	Yes	IA	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *NA indicates that criterion is not applicable as this location has been acquired;*
3. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level, or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
4. *Site-only $L_{A1,1minute}$ attributed to WCM, including modifying factors if applicable;*
5. *Bold results in red indicate an exceedance of relevant criterion; and*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in EPL and so criterion is not applicable or there is no applicable criterion.*

5 LONG TERM NOISE TRENDS

Site-only L_{Aeq} noise levels measured during monthly attended environmental noise monitoring over a 5-year period from January 2015 to December 2019 have been collated and graphed to summarise WCM long-term noise performance. Less than five years of data was available at three locations due to monitoring commencing at those locations during the 5-year period.

Due to the qualitative nature of some attended noise monitoring descriptors, calculation of site noise statistics such as mean, median, and standard deviation is not always possible. Subsequently, site-only L_{Aeq} noise levels for each monitoring event have been grouped into one of three categories:

1. WCM-only L_{Aeq} was either inaudible (IA), not measurable (NM), or less than 30 dB, which together are represented by green bars;
2. WCM-only L_{Aeq} was between 30 dB and 40 dB (inclusive) represented by blue bars; or
3. WCP-only L_{Aeq} was greater than 40 dB for that location, represented by red bars.

For each calendar year, the percentage of occurrence for each of these categories is shown, as well as annual trend lines over the entire five-year period. Figures show site-only L_{Aeq} noise levels, including adjustments due to modifying factors, as defined by the EPA NPfI.

Meteorological conditions and applicability of noise criteria have not been considered.

5.1 Noise Trend Graphs

Site-only L_{Aeq} noise levels measured during attended environmental noise monitoring over a 5-year period have been collated and graphed to summarise long-term noise trends. Figure 2 to Figure 7 provide percentage occurrence information for WCM noise levels at eight monitoring locations.

As meteorological conditions and applicability of noise criteria have not been considered in long-term trend analysis, potential exceedances indicated in the following graphs may not have been applicable depending on weather conditions at the time of monitoring.

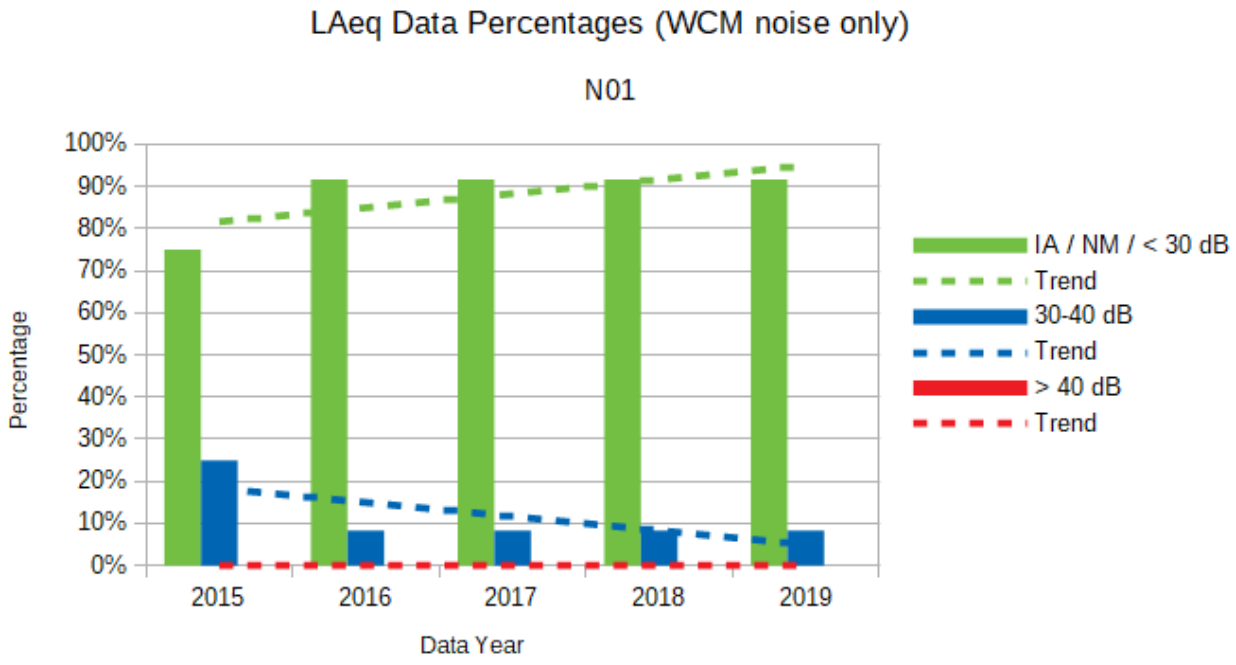

Figure 2: Attended noise monitoring data, N01

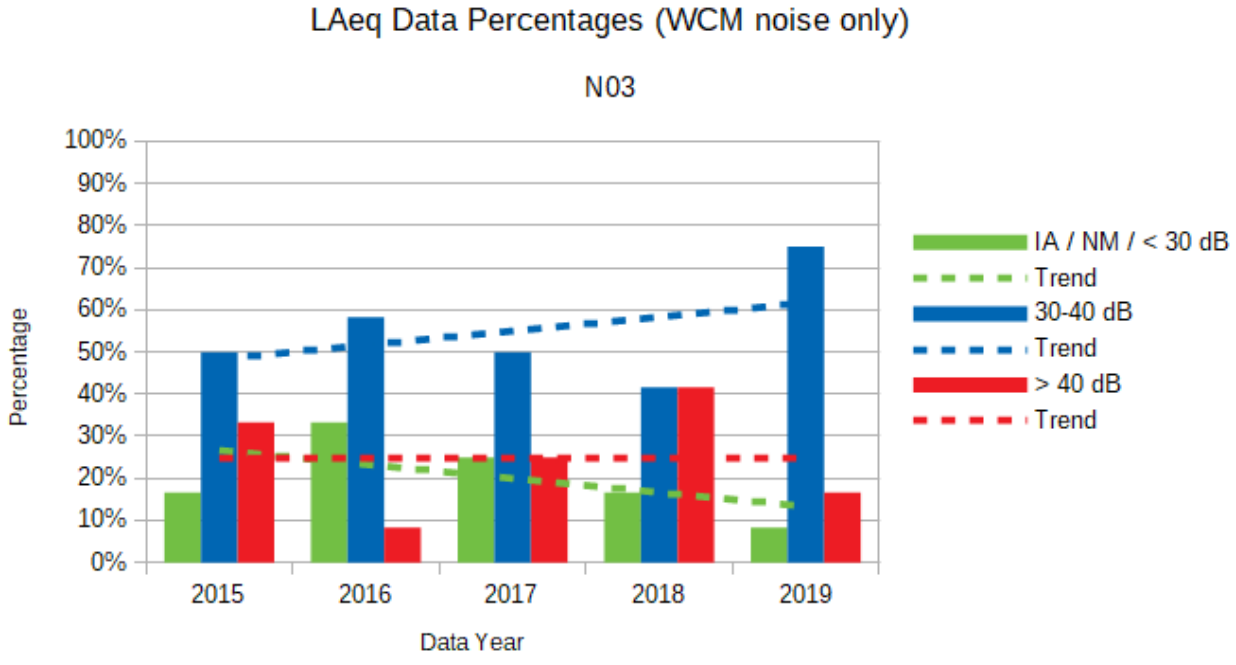

Figure 3: Attended noise monitoring data, N03

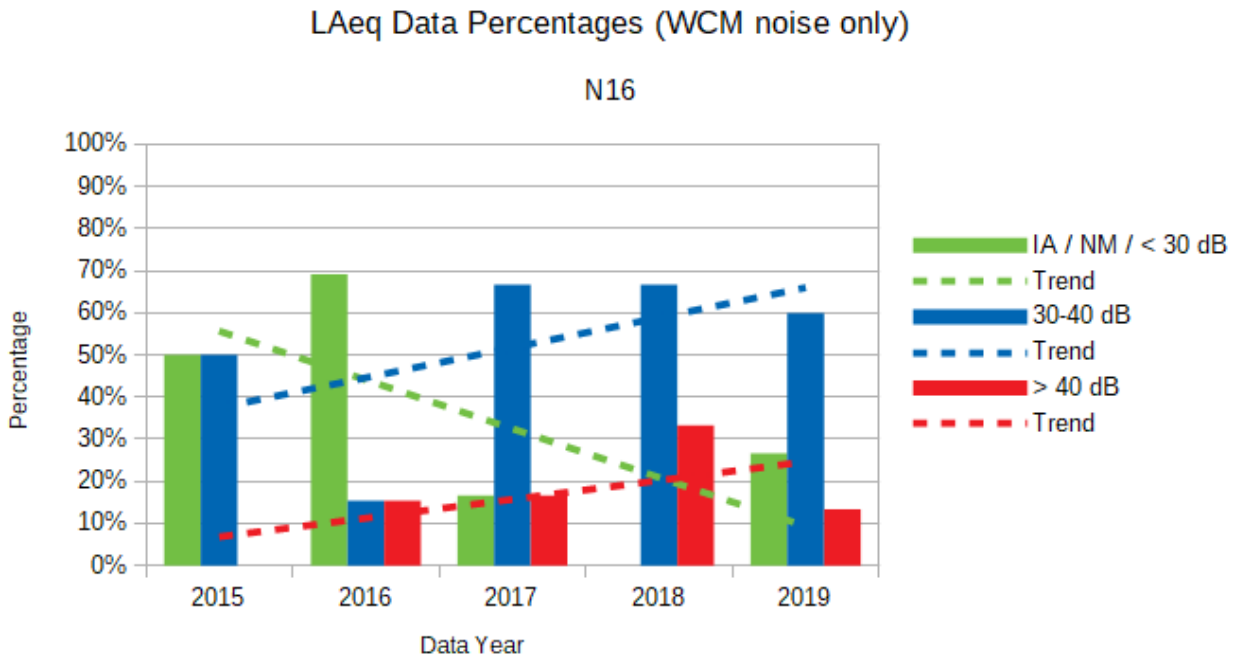

Figure 4: Attended noise monitoring data, N16

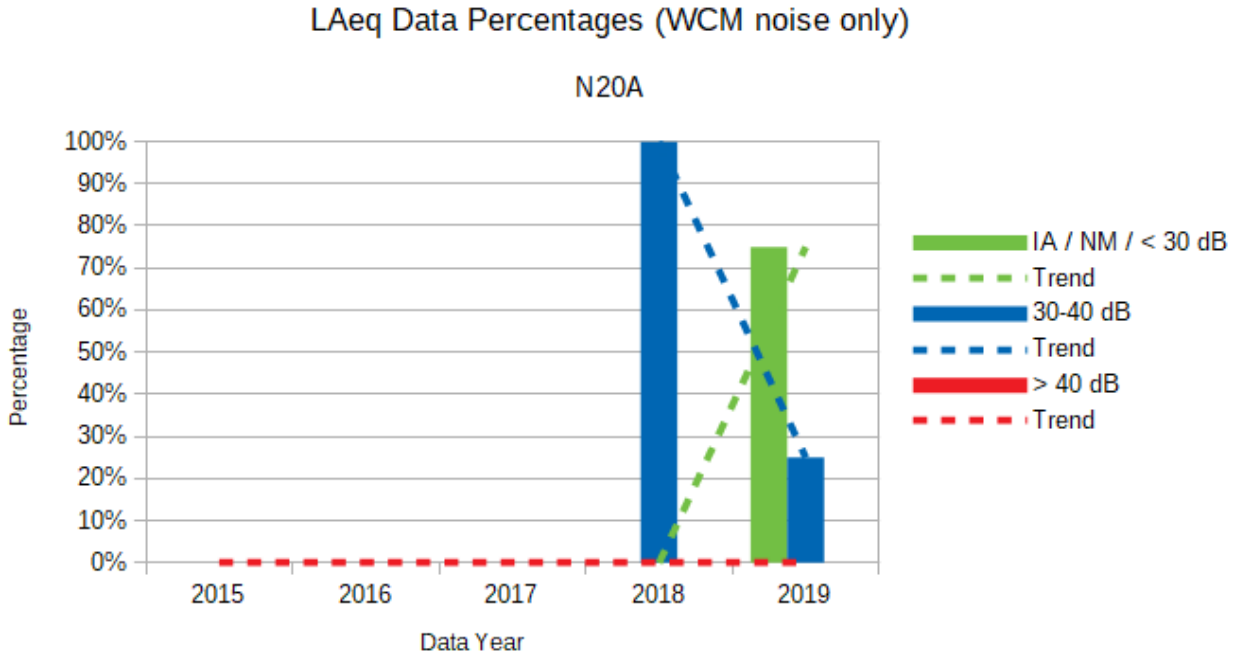

Figure 5: Attended noise monitoring data, N20A

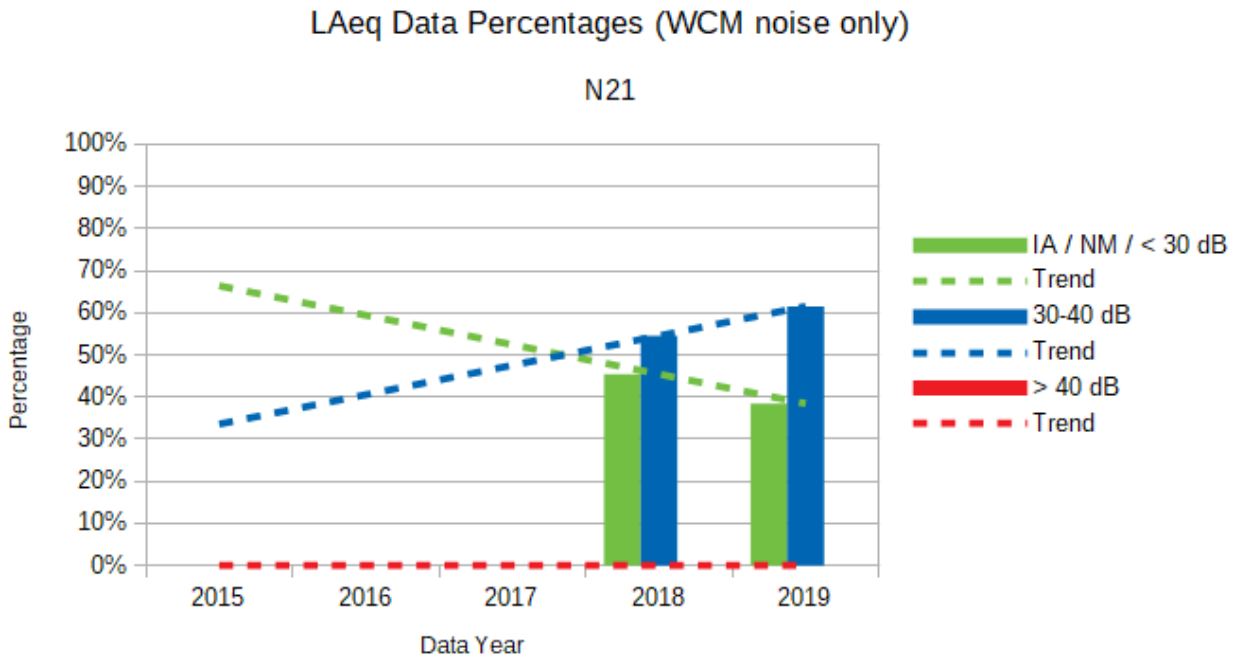

Figure 6: Attended noise monitoring data, N21

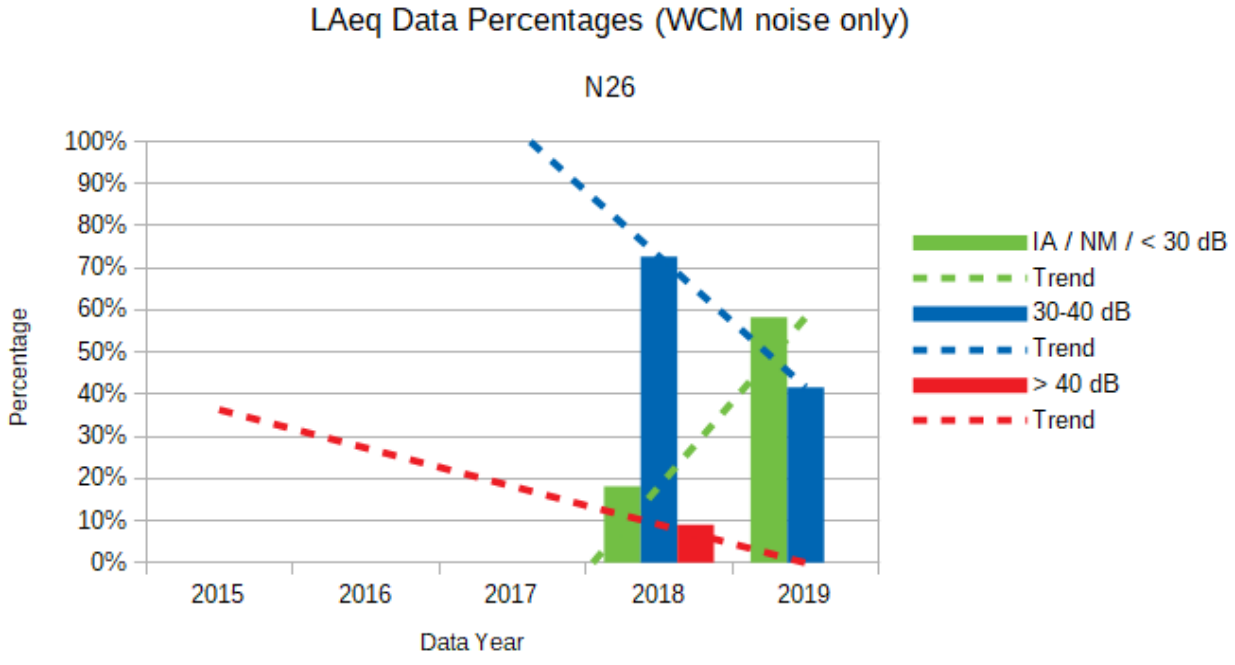

Figure 7: Attended noise monitoring data, N26

5.2 Discussion

During the 5-year period analysed, WCM noise levels at most monitoring locations increased through 2018 as mining operations progressed to the northwest and were initially less shielded. From 2018 to 2019, site noise levels decreased at most monitoring locations, likely due to mining activity being deeper in pit and therefore more shielded from receptors.

Additional discussion of individual monitoring locations is provided below:

- At N01, site-only L_{Aeq} noise levels were low (either IA, NM, or less than 30 dB) for a large majority of measurements;
- At N03, site-only L_{Aeq} noise levels were largely constant over the five-year period. However, there are no longer privately-owned residences at this location;
- At N16, N20A, and N26, site-only L_{Aeq} noise levels decreased significantly from 2018 to 2019; and
- At N21, site-only L_{Aeq} noise levels increased slightly from 2018 to 2019. However, there were no potential exceedances at this location during either year.

6 COMPARISON WITH EIS MODELLED PREDICTIONS

A NIA was prepared in July 2016 as part of the EIS to support application for the United Wambo project. As part of the modelling assessment, cumulative noise levels from WCM and United Wambo were predicted for representative operating scenarios, time periods and weather conditions.

Predicted noise levels for Year 2 have been used for comparison to measured noise levels, as it most closely aligned to the 2019 reporting year. Table 6.1 summarises predicted $L_{Aeq,1minute}$ noise levels for specific monitoring locations detailed in Table F.1 of the NIA. These have been compared to noise-enhancing meteorological condition defined in Section 3.5 of this report.

Table 6.1: WCM OPERATIONAL PREDICTIONS, YEAR 2 – dB

Monitoring Location ID	Location	Nearest Property ID	Night $L_{Aeq,15minute}$ Non-Winter	Night $L_{Aeq,15minute}$ Winter
N01	Wambo Road Residence	3	33	36
N03	Kelly Residence	19[1]	48	56
N16	Jerrys Plains Road	39	45	46
N20A	Redmanvale Road Central	343	36	37
N21	Wambo South	25	34	38
N26	Redmanvale Road South	345	36	33

Notes:

1. *This property is now mine owned. Comparisons to predicted levels have been provided for informational purposes only.*

Table 6.2 summarises sleep disturbance noise levels for specific monitoring locations detailed in Table F.4 of the NIA under certain meteorological condition defined in Section 3.5 of this report.

Table 6.2: WCM SLEEP DISTURBANCE PREDICTIONS, YEAR 2 – dB

Monitoring Location ID	Location	Nearest Property ID	Night $L_{A1,1minute}$ Calm	Night $L_{A1,1minute}$ SE Wind	Night $L_{A1,1minute}$ Inversion
N01	Wambo Road Residence	3	<30	<30	32
N03	Kelly Residence	19[1]	48	51	54
N16	Jerrys Plains Road	39	33	45	45
N20A	Redmanvale Road Central	33[2]	<30	44	43
N21	Wambo South	25	<30	<30	33
N26	Redmanvale Road South	346[3]	<30	37	46

Notes:

1. *This property is now mine owned. Comparisons to predicted levels have been provided for informational purposes only;*
2. *Sleep disturbance prediction for Property 343 was not provided. Property 33 was the nearest residence with predicted noise levels; and*
3. *Sleep disturbance prediction for Property 345 was not provided. Property 346 was the nearest residence with predicted noise levels.*

Table 6.3 to Table 6.8 of this report compare the measured operational levels to predicted noise levels in the NIA for Year 2. A positive difference indicates the measured level is greater than the predicted level and a negative difference indicates the measured levels are less than predicted in the NIA.

When meteorological conditions during the attended monitoring measurement do not correspond with those that are modelled, the meteorological conditions are considered “not applicable” (NA) and no further analysis is undertaken. When meteorological conditions during the measurement correspond with modelled conditions, but measured WCM noise levels were not directly quantifiable, measured and modelled noise levels are “not comparable” (NC) and no further analysis is required.

6.1.1 N01, Wambo Road Residence

Table 6.3: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N01, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	<30	-	NA	NA	<30	-	NA
February	NA	<25	-	NA	NA	<30	-	NA
March	NA	IA	-	NA	NA	IA	-	NA
April	NA	IA	-	NA	NA	IA	-	NA
May	NA	28	-	NA	NA	31	-	NA
June	NA	IA	-	NA	NA	IA	-	NA
July	NA	<25	-	NA	NA	29	-	NA
August	NA	IA	-	NA	NA	IA	-	NA
September	NA	NM	-	NA	Calm	NM	<30	NC
October	NA	<20	-	NA	NA	<20	-	NA
November	NA	34	-	NA	NA	36	-	NA
December	NA	IA	-	NA	NA	IA	-	NA

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison; and*
3. *NC indicates measured WCM noise levels were IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable.*

At N01, measured noise levels were not comparable to Year 2 predictions in the EIS.

6.1.2 N03, Kelly Residence

Table 6.4: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N03, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	<30	-	NA	NA	40	-	NA
February	NA	38	-	NA	NA	40	-	NA
March	NA	49	-	NA	NA	53	-	NA
April	NA	39	-	NA	SE Winds	56	51	+5
May	NA	38	-	NA	NA	50	-	NA
June	NA	36	-	NA	NA	39	-	NA
July	NA	40	-	NA	NA	52	-	NA
August	NA	38	-	NA	Inversion	49	54	-5
September	NA	37	-	NA	NA	40	-	NA
October	NA	35	-	NA	NA	41	-	NA
November	NA	47	-	NA	NA	51	-	NA
December	NA	32	-	NA	NA	34	-	NA

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison; and*
3. *NC indicates measured WCM noise levels were IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable.*

At N03, measured L_{Aeq} noise levels were not comparable with Year 2 predictions in the EIS. Measured $L_{A1,1minute}$ noise levels were occasionally higher and lower than predicted in the EIS.

6.1.3 N16, Jerrys Plains Road

Table 6.5: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N16, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	42	-	NA	Inversion	48	45	+3
January[4]	NA	38	-	NA	NA	41	-	NA
February	NA	35	-	NA	NA	47	-	NA
March	NA	37	-	NA	NA	43	-	NA
April	NA	35	-	NA	NA	43	-	NA
May	NA	IA	-	NA	NA	IA	-	NA
June	NA	38	-	NA	NA	48	-	NA
July	NA	<25	-	NA	Inversion	<25	45	NC
August	NA	34	-	NA	NA	41	-	NA
September	NA	37	-	NA	NA	45	-	NA
October	NA	35	-	NA	Inversion	42	45	-3
November	NA	42	-	NA	NA	50	-	NA
November[4]	NA	36	-	NA	Calm	40	33	+7
November[4]	NA	IA	-	NA	NA	IA	-	NA
December	NA	IA	-	NA	NA	IA	-	NA

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison;*
3. *NC indicates measured WCM noise levels IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable; and*
4. *Remeasure.*

At N16, measured L_{Aeq} noise levels were not comparable with Year 2 predictions in the EIS. Measured $L_{A1,1minute}$ noise levels were occasionally higher than predicted in the EIS.

6.1.4 N20A, Redmanvale Road Central

Table 6.6: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N20A, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	NM	-	NA	NA	35	-	NA
February	NA	<30	-	NA	NA	35	-	NA
March	NA	37	-	NA	NA	42	-	NA
April	NA	<30	-	NA	NA	<30	-	NA
May	NA	IA	-	NA	NA	IA	-	NA
June	NA	34	-	NA	NA	42	-	NA
July	NA	28	-	NA	NA	34	-	NA
August	NA	<25	-	NA	NA	<25	-	NA
September	NA	34	-	NA	NA	40	-	NA
October	NA	<25	-	NA	NA	28	-	NA
November	NA	<30	-	NA	Calm	33	<30	NC
December	NA	IA	-	NA	NA	IA	-	NA

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison; and*
3. *NC indicates measured WCM noise levels were IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable.*

At N20A, measured noise levels were not comparable with Year 2 predictions in the EIS.

6.1.5 N21, Wambo Road South

Table 6.7: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N21, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	32	-	NA	Inversion	38	33	+5
February	NA	30	-	NA	Inversion	38	33	+5
March	NA	IA	-	NA	NA	IA	-	NA
April	NA	IA	-	NA	NA	IA	-	NA
May	Inversion (Non-winter)	31	34	-3	NA	34	-	NA
June	NA	<25	-	NA	NA	33	-	NA
July	NA	29	-	NA	Inversion	36	33	+3
August	NA	39	-	NA	Inversion	47	33	+14
August[4]	NA	32	-	NA	Calm	38	<30	>+8
September	NA	38	-	NA	NA	44	-	NA
October	NA	30	-	NA	NA	35	-	NA
November	NA	34	-	NA	NA	42	-	NA
December	NA	<25	-	NA	NA	<25	-	NA

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison;*
3. *NC indicates measured WCM noise levels IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable; and*
4. *Remeasure.*

At N21, measured L_{Aeq} noise levels were lower than Year 2 predictions in the EIS. When comparable to modelled noise levels, measured $L_{A1,1minute}$ noise levels were significantly higher than predicted in the EIS.

6.1.6 N26, Redmanvale Road South

Table 6.8: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N26, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	Wind Only (Non-winter)	<30	36	NC	SE Wind	30	37	-7
February	NA	<25	-	NA	Inversion	30	46	-16
March	Wind Only (Non-winter)	<30	36	NC	NA	33	-	NA
April	NA	35	-	NA	NA	37	-	NA
May	NA	IA	-	NA	NA	IA	-	NA
June	NA	31	-	NA	NA	37	-	NA
July	Wind Only (Winter)	<25	33	NC	NA	<25	-	NA
August	Wind Only (Winter)	23	33	-10	NA	27	-	NA
September	NA	34	-	NA	NA	39	-	NA
October	NA	33	-	NA	NA	45	-	NA
November	NA	30	-	NA	Inversion	36	46	-10
December	NA	IA	-	NA	NA	IA	-	NA

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison; and*
3. *NC indicates measured WCM noise levels were IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable.*

At N26, measured noise levels were lower than Year 2 predictions in the EIS.

7 SUMMARY

Global Acoustics was engaged by WCM to provide an AEMR for 2019, in order to compare noise monitoring results against both relevant criteria and predictions in the most recently approved EIS for the United Wambo project.

This report summarises monthly attended noise monitoring surveys conducted around WCM during the reporting period 1 January to 31 December 2019. The purpose of the surveys was to quantify and describe the acoustic environment around the site and compare results with specified limits. The duration of each measurement was 15 minutes.

Attended noise monitoring described in this report was conducted on a monthly basis in accordance with DA 305-7-2003 (MOD 16), EPL No. 529, and the WCM NMP.

7.1 January to December 2019 Compliance

Noise levels from WCM complied with the relevant development consent and EPL criteria at all sites during 2019 attended monitoring, with a single exception. The following exceedance of EPL criteria was measured during 2019 monitoring:

- On the night of 11/12 November 2019, WCM exceeded the L_{Aeq} criterion at N16 by 2 dB. A re-measure and follow-up measurement were undertaken with resulting levels below the relevant limits.

Additional to the exceedance above, the following exceedance of development consent criteria (only) was measured during 2019 monitoring:

- On the night of 17/18 January 2019, WCM exceeded the L_{Aeq} criterion at N16 by 2 dB. A re-measure was undertaken with resulting levels below the relevant limits.

Modifying factors were assessed in accordance with the NPfI. Site-only L_{Aeq} noise levels have been adjusted, where applicable, by low-frequency modifying factors. Criteria may not always be applicable due to meteorological conditions at the time of monitoring.

There were no changes to train refuelling procedures so no monitoring for the WCRS was undertaken during 2018.

7.2 Long-Term Noise Trends

During the 5-year period analysed, WCM noise levels at most monitoring locations increased through 2018 as mining operations progressed to the northwest and were initially less shielded. From 2018 to 2019, site noise levels decreased at most monitoring locations, likely due to mining activity being deeper in pit and therefore more shielded from receptors.

At N21, site-only L_{Aeq} noise levels increased slightly from 2018 to 2019. However, there were no potential exceedances at this location during either calendar year.

7.3 EIS Comparison

WCM noise levels measured during attended monitoring were compared to predicted noise levels in the MOD 16 EIS during all measurements when site contributions were directly quantifiable and meteorological conditions corresponded with modelled meteorological conditions.

At N01, measured WCM noise levels were not comparable to Year 2 predictions in the EIS.

At N03 and NA16, measured WCM L_{Aeq} noise levels were not comparable with Year 2 predictions in the EIS. Measured $L_{A1,1minute}$ noise levels were occasionally higher than predicted in the EIS.

At N21, measured WCM L_{Aeq} noise levels were lower than Year 2 predictions in the EIS. Measured $L_{A1,1minute}$ noise levels were significantly higher than predicted in the EIS.

At N20A and N26, measured WCM noise levels were lower than Year 2 predictions in the EIS.

Global Acoustics Pty Ltd

APPENDIX D

ENVIRONMENTAL MONITORING DATA SUMMARIES

Blast ID	Date	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s
M_27WRA_341	4/01/2019 12:04	92.2	0.04	88.9	0.06	91.1	0.04	107.6	0.52	98.7	0.58
HD_WWA_340	9/01/2019 11:07	102.4	0.17	103.8	0.15	94.7	0.08	105.9	0.45	98.4	0.3
M_27WTA_350	18/01/2019 11:55	97.2	0.29	103	0.63	99	0.37	92.6	0.04	92.5	0.04
M_27WRA_346	18/01/2019 12:07	87.9	0.04	90.5	0.03	89.7	0.11	105	0.5	99.2	0.59
ME_WMA_349	23/01/2019 13:54	97.2	0.39	100.1	0.27	92.2	0.19	108.3	1.88	99.8	1.16
M_27WRA_351	30/01/2019 14:15	94.8	0.12	96.3	0.09	89.4	0.06	110.7	0.4	99	0.28
M_27WRC_347	30/01/2019 14:20	91.4	0.07	90.3	0.06	90.6	0.05	107.6	0.66	99.8	0.48
M_27WRA_353	8/02/2019 14:28	93.4	0.15	98.1	0.13	92.2	0.08	99.1	0.37	94.1	0.24
M_27WRC_355	8/02/2019 14:34	97.7	0.11	101.9	0.11	98.4	0.08	106.6	0.43	104	0.39
HD_WWA_352	8/02/2019 14:43	101.9	0.15	104.7	0.18	99.6	0.09	106	0.37	98.3	0.19
M_27WMA_356	18/02/2019 11:00	103.6	0.2	108.7	0.12	102.6	0.12	108.9	1.96	100.7	2.23
M_27WRA_348	18/02/2019 11:10	95.6	0.1	96	0.06	91.8	0.06	105.7	0.31	96.2	0.2
M_27WRA_357/359	5/03/2019 15:54	93.6	0.26	97.9	0.22	94	0.11	100.5	0.41	93.2	0.3
M_27WRC_360	5/03/2019 16:11	96.3	0.11	94.5	0.06	97.5	0.07	106.5	1.05	97.2	1.18
ME_2WMB_363 & M_27WRC_108_362	5/03/2019 16:15	96.8	0.09	94.8	0.1	95	0.07	107.1	0.93	102.3	0.78
M_27WMA_358	12/03/2019 12:03	100.5	0.25	99.9	0.09	97	0.12	104.5	1.85	97.4	1.91
ME_2WTA_354	12/03/2019 12:23	98.2	0.09	93.1	0.07	94.8	0.07	109.3	1.29	103.7	0.96
HD_WWA_371	25/03/2019 15:55	101.7	0.09	101.7	0.1	99.2	0.05	110	0.18	103.2	0.11
HD_RCA_367/369	25/03/2019 16:01	100.4	0.02	101.6	0.05	81.1	0.02	98.3	0.1	ND	ND
M_27WRC_365	25/03/2019 16:08	106.7	0.11	106.8	0.09	100.5	0.08	107.3	1.1	105.6	1.08
M_27WRC_364	29/03/2019 11:06	96.9	0.08	97.2	0.06	95.6	0.05	110.8	0.76	103.4	0.82
M_27MWA_366	8/04/2019 12:06	101.1	0.32	103.3	0.39	98.1	0.3	110.4	1.68	97.6	1.53
M_27WRA_375 & M_27WRA_377	8/04/2019 12:17	101.1	0.16	102.3	0.12	99.4	0.05	110.1	0.56	101	0.24

Blast ID	Date	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s
M_27WRA_372 & HD_RCA_373	8/04/2019 12:25	98.8	0.1	103.8	0.06	91.6	0.05	108.2	0.27	98	0.16
HD_RCA_378 & HD_WWA_380	13/04/2019 10:00	94.8	0.07	NA	NA	NA	NA	NA	NA	NA	NA
D_RCA_378 & HD_WWA_380	13/04/2019 10:01	NA	NA	82.6	0.01	89	0.03	89	0.03	89	0.03
M_27WMA_374	26/04/2019 10:08	101.3	0.21	85.7	0.12	79.5	0.1	107.7	2.4	99.7	1.84
HD_RCA_376	26/04/2019 10:20	94	0.03	83.5	0.02	83	0.01	91.9	0.09	89.4	0.06
M_27WMA_379	26/04/2019 10:27	98.8	0.25	90.9	0.3	80.9	0.2	109.6	1.08	99.3	0.88
M_27WRA_381	2/05/2019 11:12	102.1	0.05	77.5	0.05	74.4	0.02	101.1	0.19	95.4	0.14
M_27WRA_382	2/05/2019 11:22	95	0.13	98.9	0.12	75.3	0.04	101.9	0.26	96.5	0.16
M_27WMA_385	7/05/2019 14:31	109.6	0.09	84.6	0.1	88.7	0.04	109.6	0.71	101.9	0.69
M_27WMA_383	7/05/2019 14:36	105.4	0.11	105.5	0.09	101.8	0.08	108.6	1.53	103.8	0.79
M_27WRC_384	7/05/2019 14:41	103.5	0.09	83.7	0.11	95.1	0.05	101.9	0.34	93.7	0.22
M_27WRC_386	10/05/2019 12:04	102.4	0.05	80.7	0.06	74.4	0.04	105.6	0.37	96.2	0.42
HD_RCA_387	14/05/2019 11:24	103.5	0.05	88.1	0.03	83	0.02	95.4	0.09	90.5	0.05
M_27WRC_389	14/05/2019 11:30	94.2	0.13	101	0.22	79.7	0.06	101.5	0.33	93.2	0.23
HD_RCA_388/391	24/05/2019 11:09	98.7	0.06	82.2	0.06	72.9	0.03	100.5	0.14	94.1	0.09
M_WEST_DOZER_390	24/05/2019 11:16	95.3	0.12	81.5	0.1	87.2	0.06	101.6	0.44	92.2	0.33
M_27WRC_392	24/05/2019 11:28	109	0.3	82.4	0.16	89.2	0.2	106.2	0.74	98	1.64
M_27WMA_393	31/05/2019 12:02	105.1	0.19	75.2	0.17	95.9	0.17	100.5	2.57	97	2.59
M_27WRC_396 & M_27WMA_399	6/06/2019 11:13	91	0.17	82.2	0.21	77.8	0.14	107.2	0.99	99.3	0.95
M_27WRC_402	6/06/2019 11:24	94.1	0.16	79.5	0.14	72.4	0.05	99.4	0.28	95.6	0.21
M_27WMA_401	12/06/2019 14:21	93.6	0.04	78.9	0.04	85.6	0.02	94.7	0.41	90.7	0.33
HD_RCA_395	12/06/2019 14:34	91.7	0.05	77	0.05	96.8	0.03	97.1	0.1	91.3	0.07

Blast ID	Date	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s
M_27WMA_397	18/06/2019 14:25	96	0.2	79.2	0.21	80.6	0.11	98.9	2.45	96.2	2.65
M_27WMA_403	29/06/2019 12:03	107.6	0.34	80.7	0.24	80.4	0.1	104.8	2.71	96.6	1.87
W_27WMA_407	29/06/2019 12:13	99.7	0.24	89.4	0.28	80.2	0.24	113.6	1.04	100.8	1.2
M_WRA_404	29/06/2019 12:24	93.2	0.14	79.5	0.08	85.1	0.05	98.7	0.34	93.8	0.19
M_27WMA_405	17/07/2019 15:46	101.6	0.17	79.5	0.14	76.8	0.18	100.6	2.17	93.2	1.88
M_27WRA_408 & 409	17/07/2019 15:58	102.5	0.24	95	0.1	76.8	0.09	107.6	0.42	101.6	0.31
M_27WTA_414	19/07/2019 12:01	103.1	0.09	102.4	0.04	91.1	0.04	104.8	0.48	98.2	0.68
M_27WRA_410/411	19/07/2019 12:08	101.3	0.22	92.5	0.18	87.8	0.09	103.4	0.73	96.5	0.36
M_27WRA_413 & 416	26/07/2019 11:32	101.7	0.25	81.2	0.2	73.9	0.11	104.7	0.52	96.2	0.28
HS_WRA_406	31/07/2019 12:03	114.8	0.74	102.1	0.54	100.1	0.1	103	0.04	85.5	0.03
M_27WTA_420	7/08/2019 14:34	103.7	0.04	79.2	0.05	94.2	0.03	96.9	0.52	92.5	0.33
M_27WRC_417	7/08/2019 14:38	108.4	0.11	94.6	0.07	97.9	0.04	97.7	0.29	95	0.21
M_WMA_412	7/08/2019 14:48	97.4	0.14	80.2	0.09	78.1	0.08	104.2	1.12	98.8	1.45
M_27WRA_418	15/08/2019 15:16	106.5	0.16	100.7	0.15	71.1	0.07	105.7	0.48	97.8	0.19
M_27WMA_421	16/08/2019 12:29	103.8	0.44	103	0.31	82.1	0.24	107.8	1.2	101	0.81
M_27WMA_419	28/08/2019 14:44	104.5	0.23	83.3	0.14	85.4	0.2	104.3	1.07	101	1.1
M_27WRA_423	28/08/2019 14:50	99.1	0.18	101.9	0.14	83.8	0.08	110.5	0.36	100.9	0.23
M27WRC_422	28/08/2019 14:58	110.4	0.16	82.4	0.12	89	0.08	102.9	0.52	95.8	0.37
M_27WMA_426	6/09/2019 12:00	98.3	0.06	79.9	0.04	93.1	0.03	107.3	0.47	106	0.41
MW_WWA_427	12/09/2019 15:50	101.1	0.31	76.2	0.15	94.4	0.3	108.5	0.82	104.4	1.35
HS_WMA_430	13/09/2019 11:59	115.5	1.09	98.1	0.78	105.5	0.16	96.9	0.05	83.4	0.06
M_WTA_431	21/09/2019 11:59	94.9	0.09	85.9	0.11	72.9	0.07	105.7	1.52	95.7	1.67
M_WMA_433	21/09/2019 12:09	95.4	0.32	80.2	0.21	79.7	0.24	120.6	1.17	115.9	0.89
M_27WMA_432	27/09/2019 12:08	103.4	0.13	95.1	0.1	90.3	0.12	103.2	0.81	92.7	0.84

Blast ID	Date	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s
M_27WMA_435	27/09/2019 12:15	100.3	0.23	105.5	0.15	98.9	0.14	104.6	0.81	91.3	0.58
M_WTA_436	4/10/2019 12:03	104	0.03	88.1	0.06	103.3	0.02	98	0.3	90	0.26
M_WMA_424	4/10/2019 12:17	100.5	0.13	90.9	0.1	101.9	0.08	107.6	1.61	103.1	1.83
M_WMA_438	16/10/2019 14:42	100.7	0.19	97	0.12	97	0.08	108.4	0.32	103.5	0.22
M_WTA_441	16/10/2019 14:52	107.2	0.03	78.2	0.04	77.5	0.01	89.1	0.24	85.2	0.22
M_WMA_429	16/10/2019 14:56	111.7	0.1	80.2	0.12	85.5	0.12	109.2	1.05	101.9	0.65
M_WMA_437	18/10/2019 12:01	93.9	0.28	87.6	0.22	91.8	0.17	100.4	0.82	99.4	0.65
M_27WMA_434	18/10/2019 12:06	98.8	0.02	92.5	0.02	86.1	0.01	95	0.3	93	0.24
M_WMA_442	25/10/2019 12:04	99.7	0.33	94.8	0.21	88	0.25	95.7	0.66	100.2	0.37
M_WRC_440	25/10/2019 12:12	103.6	0.22	99.6	0.12	82.5	0.08	103.3	0.34	96.2	0.25
M_West Dozer_448	6/11/2019 14:30	100.7	0.09	87.4	0.05	91	0.07	98	0.24	98.1	0.24
M_WMA_444	6/11/2019 14:39	91.5	0.29	85.3	0.17	93.5	0.16	100.3	0.82	96.3	0.57
M_WRC_443	6/11/2019 14:48	111.5	0.17	110.1	0.13	87.5	0.11	100.4	0.26	93.6	0.17
M_27WMA_450/452	8/11/2019 12:10	118.4	0.04	107.4	0.05	96	0.03	99.6	0.21	95.2	0.12
M_WMA_445	14/11/2019 15:49	96.9	0.33	90	0.1	84.4	0.08	91.2	0.39	92.7	0.33
M_MWA_449	14/11/2019 15:58	112	0.31	88.3	0.27	102.8	0.15	101.2	1.02	95.7	0.6
M_WTA_454	14/11/2019 16:04	105.9	0.06	84.8	0.06	92.2	0.04	107.5	0.78	99.5	0.6
ME_WTA_455	21/11/2019 15:35	95	0.19	96.5	0.2	79.7	0.08	98.4	0.23	93.6	0.11
M_WRA_453	21/11/2019 15:51	93.7	0.13	94.6	0.08	92.1	0.05	99	0.17	92.1	0.16
M_WMA_451	21/11/2019 15:57	95.7	0.29	80.2	0.17	96.6	0.2	98	1.01	90.3	0.45
M_WRC_457	3/12/2019 15:39	110.3	0.23	95.3	0.09	85.2	0.1	108.4	0.46	94.9	0.19
M_WMA_458	3/12/2019 15:46	114.3	0.05	102.5	0.04	92.8	0.03	101.7	0.72	101.1	0.55
M_27WTA_462 & M_27WMA_460	6/12/2019 12:24	110.3	0.03	101.8	0.03	101.7	0.03	100.2	0.27	91.9	0.23
M_27WMA_461	10/12/2019 15:34	91	0.02	82.9	0.02	71.1	0.02	96.8	0.26	88.5	0.18

Blast ID	Date	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s
M_27WMA_465	10/12/2019 15:37	89.1	0.09	89.8	0.17	77.5	0.08	101	0.47	93.1	0.3
M_27WRC_456	19/12/2019 15:46	94.7	0.24	78.9	0.1	81.3	0.11	97	0.35	92.4	0.31
M_27WMA_464	19/12/2019 15:53	96.8	0.11	77.8	0.08	70.4	0.07	103	0.52	98.2	0.45
HS_WRA_466	20/12/2019 11:59	113.4	0.97	103.2	0.44	100	0.11	109	0.02	82.8	0.03

ND = no data available for this blast.

Date	D11			D19			D21			D22		
	Ash Residue (g/m2/ month)	Insoluble Solids (g/m2/ month)	AR/IS Ratio	Ash Residue (g/m2/ month)	Insoluble Solids (g/m2/month)	AR/IS Ratio	Ash Residue (g/m2/ month)	Insoluble Solids (g/m2/month)	AR/IS Ratio	Ash Residue (g/m2/ month)	Insoluble Solids (g/m2/ month)	AR/IS Ratio
Jan-19	2.70		53.06	4.70		88.93	2.00		72.09	4.30		81.81
Feb-19	2.60	3.30	78.79	3.60	5.10	70.59	2.20	2.90	75.86	3.60	5.10	70.59
Mar-19	2.00	2.40	83.33	5.40	7.40	72.97	1.70	2.00	85.00	3.30	3.90	84.62
Apr-19	1.00	1.30	76.92	2.50	3.90	64.10	1.50	2.10	71.43			NA
May-19	1.70	2.20	77.27	1.50	2.40	62.50	1.20	1.40	85.71	2.90	3.50	82.86
Jun-19	1.10	1.50	73.33	0.70	1.10	70.00	0.60	1.00	60.00	1.90	2.60	73.08
Jul-19	1.30	1.80	72.22	2.10	3.10	67.74	0.70	0.90	77.78	2.40	2.80	85.71
Aug-19			80.00			75.00			80.00			83.33
Sep-19	1.60	2.40	66.67	2.30	3.30	69.70	1.00	1.50	66.67	3.30	4.20	78.57
Oct-19			73.33			67.21			76.00			75.61
Nov-19			78.79			64.06			87.50			86.00
Dec-19			77.36			72.86			84.00			82.69
Average	1.75	2.13	76.18	2.85	3.76	68.79	1.36	1.69	77.27	3.10	3.68	80.31

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
1/01/2019	28.4	28.40	23.2	23.20	20.8	20.80	22.5	22.50
2/01/2019	53.8	41.10	38.3	30.75	37.7	29.25	56.3	39.40
3/01/2019	58.0	46.73	36.9	32.80	41.0	33.17	41.0	39.93
4/01/2019	50.3	47.63	34.4	33.20	34.7	33.55	39.9	39.93
5/01/2019	38.9	45.88	25.0	31.56	30.4	32.92	27.7	37.48
6/01/2019	5.6	39.17	6.6	27.40	4.0	28.10	10.3	32.95
7/01/2019	19.1	36.30	14.3	25.53	12.5	25.87	21.4	31.30
8/01/2019	26.4	35.06	22.3	25.13	18.3	24.93	26.1	30.65
9/01/2019	18.8	33.26	20.4	24.60	16.2	23.96	21.3	29.61
10/01/2019	24.5	32.38	18.4	23.98	21.3	23.69	23.2	28.97
11/01/2019	25.0	31.71	18.5	23.48	21.0	23.45	21.8	28.32
12/01/2019	23.9	31.06	24.6	23.58	21.9	23.32	24.3	27.98
13/01/2019	34.2	31.30	25.6	23.73	32.9	24.05	37.6	28.72
14/01/2019	26.8	30.98	29.1	24.11	25.1	24.13	31.6	28.93
15/01/2019	31.6	31.02	29.1	24.45	25.4	24.21	43.7	29.91
16/01/2019	50.8	32.26	39.0	25.36	44.4	25.48	55.1	31.49
17/01/2019	45.0	33.01	50.0	26.81	49.8	26.91	60.8	33.21
18/01/2019	36.3	33.19	31.2	27.05	28.5	26.99	34.2	33.27
19/01/2019	52.9	34.23	34.0	27.42	32.3	27.27	34.5	33.33
20/01/2019	29.0	33.97	19.9	27.04	19.3	26.88	25.4	32.94
21/01/2019	16.8	33.15	12.4	26.34	12.9	26.21	16.3	32.14
22/01/2019	30.8	33.04	25.3	26.30	20.9	25.97	30.8	32.08
23/01/2019	25.7	32.72	23.1	26.16	17.7	25.61	22.3	31.66
24/01/2019	37.3	32.91	25.3	26.12	28.6	25.73	29.7	31.58
25/01/2019	42.8	33.31	27.3	26.17	28.4	25.84	36.1	31.76
26/01/2019	36.7	33.44	33.7	26.46	27.8	25.92	43.1	32.19
27/01/2019	52.0	34.13	33.5	26.72	30.9	26.10	46.2	32.71
28/01/2019	33.3	34.10	24.0	26.62	28.4	26.18	27.0	32.51
29/01/2019	25.7	33.81	23.6	26.52	32.7	26.41	41.4	32.81
30/01/2019	41.5	34.06	33.2	26.74	26.6	26.41	44.7	33.21
31/01/2019	33.4	34.04	32.6	26.93	25.6	26.39	34.9	33.26
1/02/2019	12.5	33.37	15.2	26.56	10.4	25.89	28.0	33.10
2/02/2019	16.1	32.85	9.4	26.04	9.7	25.40	16.2	32.59
3/02/2019	31.0	32.79	18.1	25.81	20.5	25.25	33.7	32.62
4/02/2019	41.0	33.03	24.7	25.78	24.5	25.23	41.6	32.88
5/02/2019	39.7	33.21	23.7	25.72	24.4	25.21	44.2	33.19
6/02/2019	39.6	33.38	19.2	25.54	18.2	25.02	30.9	33.13
7/02/2019	28.2	33.25	20.8	25.42	17.6	24.82	31.3	33.08
8/02/2019	29.0	33.14	22.7	25.35	19.3	24.68	23.8	32.84
9/02/2019	17.5	32.75	15.9	25.11	11.1	24.34	10.5	32.29
10/02/2019	56.1	33.32	48.8	25.69	18.9	24.21	52.2	32.77
11/02/2019	27.5	33.18	22.3	25.61	19.2	24.09	31.0	32.73
12/02/2019	32.9	33.17	30.7	25.73	26.4	24.14	28.7	32.63

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
13/02/2019	74.2	34.10	60.3	26.51	69.5	25.18	64.9	33.37
14/02/2019	39.1	34.22	33.0	26.66	34.4	25.38	32.6	33.35
15/02/2019	31.8	34.16	20.9	26.53	27.9	25.43	34.8	33.38
16/02/2019	30.7	34.09	18.1	26.35	18.5	25.29	18.1	33.06
17/02/2019	26.4	33.93	24.2	26.31	17.8	25.13	29.9	32.99
18/02/2019	35.6	33.96	33.8	26.46	25.1	25.13	52.5	33.39
19/02/2019	53.8	34.36	55.7	27.05	18.8	25.00	55.7	33.84
20/02/2019	11.5	33.91	13.4	26.78	11.8	24.75	28.9	33.74
21/02/2019	18.9	33.62	11.5	26.48	12.3	24.51	18.7	33.45
22/02/2019	19.2	33.35	12.0	26.21	12.5	24.28	24.2	33.28
23/02/2019	13.8	32.99	8.3	25.88	8.5	23.99	16.2	32.96
24/02/2019	24.9	32.84	18.0	25.74	17.2	23.86	32.5	32.95
25/02/2019	31.4	32.82	20.7	25.65	26.2	23.91	30.8	32.91
26/02/2019	26.7	32.71	23.3	25.61	22.7	23.88	33.9	32.93
27/02/2019	28.0	32.63	18.5	25.48	26.6	23.93	29.4	32.87
28/02/2019	20.7	32.43	15.7	25.32	18.4	23.84	20.1	32.65
1/03/2019	33.8	32.45	21.0	25.25	20.1	23.78	35.3	32.70
2/03/2019	36.2	32.51	19.1	25.14	17.5	23.67	27.9	32.62
3/03/2019	27.9	32.44	23.0	25.11	17.4	23.57	26.3	32.52
4/03/2019	34.4	32.47	34.0	25.25	27.9	23.64	37.9	32.60
5/03/2019	47.7	32.70	35.1	25.40	23.8	23.64	42.0	32.75
6/03/2019	78.1	33.40	77.0	26.20	68.1	24.33	72.0	33.35
7/03/2019	35.0	33.43	28.4	26.23	32.2	24.45	35.9	33.39
8/03/2019	40.2	33.53	31.9	26.32	26.6	24.48	37.0	33.44
9/03/2019	NaN	33.53	NaN	26.32	NaN	24.48	NaN	33.44
10/03/2019	NaN	33.53	NaN	26.32	NaN	24.48	NaN	33.44
11/03/2019	55.8	33.86	46.0	26.61	41.8	24.73	43.3	33.59
12/03/2019	38.1	33.92	31.5	26.68	26.1	24.75	41.6	33.71
13/03/2019	54.3	34.21	30.3	26.73	31.2	24.84	50.5	33.95
14/03/2019	40.8	34.30	35.1	26.85	28.5	24.90	35.6	33.97
15/03/2019	15.0	34.03	14.1	26.67	11.3	24.71	24.5	33.84
16/03/2019	15.2	33.78	11.6	26.46	11.5	24.53	14.8	33.58
17/03/2019	8.4	33.43	6.0	26.19	6.2	24.28	6.1	33.21
18/03/2019	8.6	33.10	7.4	25.94	5.6	24.03	5.8	32.84
19/03/2019	13.5	32.84	11.0	25.74	10.5	23.85	14.3	32.60
20/03/2019	17.7	32.65	11.5	25.55	15.9	23.75	16.2	32.38
21/03/2019	18.6	32.47	9.7	25.35	11.5	23.59	15.3	32.16
22/03/2019	17.0	32.27	11.9	25.18	13.5	23.46	17.7	31.98
23/03/2019	16.6	32.08	16.0	25.07	11.7	23.32	15.7	31.78
24/03/2019	26.7	32.01	24.1	25.05	19.0	23.26	22.2	31.66
25/03/2019	21.8	31.88	17.5	24.96	14.6	23.16	17.8	31.49
26/03/2019	35.0	31.92	31.5	25.04	28.0	23.22	31.0	31.48
27/03/2019	48.5	32.12	26.7	25.06	26.1	23.25	33.6	31.51

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
28/03/2019	28.7	32.08	21.5	25.02	22.1	23.24	29.6	31.49
29/03/2019	27.1	32.02	31.2	25.09	20.0	23.20	39.0	31.57
30/03/2019	18.9	31.87	13.9	24.96	11.2	23.06	12.0	31.35
31/03/2019	60.4	32.19	48.4	25.23	56.6	23.44	46.8	31.53
1/04/2019	20.6	32.06	15.9	25.12	13.8	23.33	14.0	31.33
2/04/2019	9.8	31.82	7.2	24.92	8.4	23.17	17.7	31.18
3/04/2019	16.6	31.65	14.9	24.81	15.4	23.08	20.9	31.06
4/04/2019	15.3	31.47	12.4	24.68	12.8	22.97	20.5	30.95
5/04/2019	12.8	31.27	11.0	24.53	10.7	22.84	19.0	30.82
6/04/2019	15.2	31.10	18.8	24.47	11.4	22.72	13.2	30.63
7/04/2019	18.2	30.96	19.9	24.42	12.1	22.61	14.3	30.46
8/04/2019	21.8	30.87	28.7	24.47	16.8	22.54	18.2	30.33
9/04/2019	27.4	30.83	24.6	24.47	19.5	22.51	20.9	30.24
10/04/2019	19.6	30.72	19.6	24.42	19.6	22.48	26.4	30.20
11/04/2019	19.3	30.60	13.9	24.31	18.5	22.44	20.6	30.10
12/04/2019	15.6	30.45	12.0	24.19	15.6	22.38	18.9	29.99
13/04/2019	22.8	30.38	18.2	24.13	13.9	22.29	20.0	29.89
14/04/2019	25.1	30.33	23.7	24.13	27.5	22.34	31.6	29.91
15/04/2019	21.1	30.24	16.0	24.05	15.7	22.28	23.5	29.84
16/04/2019	17.0	30.11	17.0	23.98	13.5	22.19	27.1	29.82
17/04/2019	15.9	29.97	9.9	23.85	14.2	22.12	15.3	29.68
18/04/2019	15.9	29.84	16.7	23.78	17.9	22.08	19.3	29.58
19/04/2019	19.7	29.75	21.4	23.76	18.5	22.04	21.8	29.51
20/04/2019	15.6	29.61	13.1	23.66	17.8	22.00	25.5	29.47
21/04/2019	18.3	29.51	15.3	23.58	19.6	21.98	25.6	29.44
22/04/2019	19.6	29.42	15.9	23.51	17.9	21.95	33.9	29.48
23/04/2019	19.3	29.33	11.2	23.40	16.2	21.89	23.8	29.43
24/04/2019	15.7	29.21	25.5	23.42	18.1	21.86	27.6	29.41
25/04/2019	29.8	29.21	41.7	23.58	29.2	21.92	41.7	29.52
26/04/2019	32.1	29.24	47.6	23.79	26.7	21.97	23.8	29.47
27/04/2019	30.9	29.25	35.5	23.89	37.1	22.10	38.7	29.55
28/04/2019	22.6	29.20	32.9	23.97	20.5	22.08	28.3	29.54
29/04/2019	35.3	29.25	31.7	24.04	36.9	22.21	42.1	29.64
30/04/2019	25.9	29.22	46.3	24.23	20.0	22.19	39.5	29.73
1/05/2019	27.6	29.21	58.1	24.51	20.0	22.17	33.0	29.76
2/05/2019	2.4	28.98	57.8	24.79	19.0	22.15	38.4	29.83
3/05/2019	18.8	28.90	27.1	24.81	15.5	22.09	14.3	29.70
4/05/2019	7.2	28.72	5.7	24.65	5.3	21.96	6.4	29.51
5/05/2019	7.0	28.54	8.4	24.52	5.0	21.82	8.6	29.34
6/05/2019	11.6	28.41	7.7	24.38	4.8	21.68	6.4	29.15
7/05/2019	10.8	28.27	19.7	24.34	7.8	21.57	7.9	28.98
8/05/2019	18.0	28.18	26.2	24.36	15.0	21.52	14.6	28.87
9/05/2019	14.8	28.08	21.4	24.34	10.6	21.43	15.5	28.76

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
10/05/2019	18.3	28.00	17.3	24.28	12.2	21.36	13.2	28.64
11/05/2019	9.7	27.86	14.7	24.21	7.5	21.25	8.2	28.48
12/05/2019	10.1	27.72	13.3	24.12	10.7	21.17	22.6	28.44
13/05/2019	18.4	27.65	30.0	24.17	15.2	21.12	29.3	28.45
14/05/2019	15.6	27.56	24.6	24.17	15.2	21.08	32.3	28.47
15/05/2019	19.1	27.50	25.9	24.18	19.9	21.07	42.0	28.58
16/05/2019	18.2	27.43	22.7	24.17	16.0	21.03	22.9	28.53
17/05/2019	24.5	27.41	34.8	24.25	16.6	21.00	34.6	28.58
18/05/2019	24.7	27.39	25.9	24.26	15.8	20.96	26.4	28.56
19/05/2019	23.5	27.36	35.8	24.35	18.3	20.94	32.4	28.59
20/05/2019	18.4	27.29	24.0	24.35	12.4	20.88	16.0	28.50
21/05/2019	17.4	27.22	25.0	24.35	11.7	20.81	14.0	28.39
22/05/2019	16.1	27.14	35.4	24.43	15.0	20.77	19.5	28.33
23/05/2019	32.3	27.18	41.6	24.55	25.7	20.81	42.2	28.43
24/05/2019	21.5	27.14	53.5	24.75	18.3	20.79	18.0	28.36
25/05/2019	19.1	27.08	30.1	24.79	13.7	20.74	14.3	28.26
26/05/2019	18.4	27.02	32.2	24.84	12.4	20.68	13.6	28.16
27/05/2019	34.2	27.07	47.5	25.00	15.4	20.65	14.1	28.06
28/05/2019	13.6	26.98	17.5	24.95	11.7	20.59	11.8	27.95
29/05/2019	17.5	26.92	20.1	24.92	13.5	20.54	13.3	27.85
30/05/2019	10.3	26.80	15.7	24.85	7.6	20.45	8.2	27.72
31/05/2019	11.5	26.70	24.8	24.85	8.8	20.37	9.6	27.59
1/06/2019	22.5	26.67	27.5	24.87	25.6	20.41	25.7	27.58
2/06/2019	23.8	26.65	25.8	24.88	23.1	20.42	22.8	27.55
3/06/2019	8.3	26.53	13.3	24.80	6.2	20.33	7.5	27.42
4/06/2019	8.2	26.41	12.3	24.72	5.1	20.23	7.0	27.28
5/06/2019	8.3	26.30	13.3	24.64	6.6	20.14	13.3	27.19
6/06/2019	14.7	26.22	21.7	24.63	6.4	20.05	13.1	27.10
7/06/2019	30.4	26.25	22.4	24.61	17.5	20.04	32.2	27.14
8/06/2019	28.1	26.26	20.7	24.59	23.5	20.06	33.2	27.17
9/06/2019	11.3	26.17	17.0	24.54	12.5	20.01	9.0	27.06
10/06/2019	13.9	26.09	14.4	24.47	7.3	19.93	12.8	26.97
11/06/2019	14.7	26.02	21.9	24.46	9.7	19.87	22.5	26.94
12/06/2019	21.7	25.99	21.1	24.44	12.0	19.82	16.2	26.87
13/06/2019	17.4	25.94	24.0	24.44	10.2	19.76	12.8	26.79
14/06/2019	9.7	25.84	15.3	24.38	9.9	19.70	13.5	26.71
15/06/2019	18.3	25.79	27.5	24.40	10.4	19.64	24.5	26.69
16/06/2019	22.5	25.77	28.9	24.43	17.6	19.63	27.3	26.70
17/06/2019	9.1	25.67	25.7	24.43	5.5	19.54	9.0	26.59
18/06/2019	17.9	25.62	26.3	24.44	7.1	19.47	13.2	26.51
19/06/2019	9.7	25.53	11.9	24.37	7.6	19.40	25.3	26.50
20/06/2019	12.8	25.45	43.4	24.48	15.2	19.37	24.2	26.49
21/06/2019	9.3	25.36	38.3	24.56	13.7	19.34	15.3	26.42

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
22/06/2019	14.5	25.30	17.4	24.52	7.8	19.27	19.6	26.38
23/06/2019	9.9	25.21	12.6	24.45	8.4	19.21	14.0	26.31
24/06/2019	5.1	25.09	4.7	24.34	5.6	19.13	9.8	26.22
25/06/2019	6.1	24.98	4.3	24.22	5.6	19.05	13.4	26.14
26/06/2019	15.2	24.93	5.3	24.11	9.9	19.00	15.1	26.08
27/06/2019	14.4	24.87	6.6	24.02	9.7	18.95	18.6	26.04
28/06/2019	9.0	24.78	11.5	23.94	10.5	18.90	29.1	26.05
29/06/2019	9.7	24.69	13.6	23.89	8.6	18.84	14.2	25.99
30/06/2019	16.9	24.65	14.9	23.84	10.0	18.79	11.8	25.91
1/07/2019	17.1	24.61	18.7	23.81	7.9	18.73	18.4	25.87
2/07/2019	21.2	24.59	32.8	23.86	15.2	18.71	16.8	25.82
3/07/2019	23.0	24.58	19.8	23.84	18.6	18.71	23.9	25.81
4/07/2019	8.6	24.49	7.8	23.75	8.1	18.66	9.5	25.72
5/07/2019	16.2	24.45	6.5	23.65	8.8	18.60	15.6	25.66
6/07/2019	12.8	24.38	5.8	23.56	7.4	18.54	18.9	25.62
7/07/2019	12.9	24.32	8.1	23.47	16.3	18.53	29.8	25.65
8/07/2019	8.3	24.24	7.7	23.39	5.7	18.46	8.1	25.55
9/07/2019	6.5	24.14	7.3	23.30	3.7	18.38	4.6	25.44
10/07/2019	8.9	24.06	10.0	23.23	4.8	18.31	5.7	25.34
11/07/2019	15.3	24.01	15.9	23.20	11.7	18.28	12.1	25.27
12/07/2019	16.7	23.98	15.0	23.15	11.7	18.24	11.6	25.20
13/07/2019	17.3	23.94	9.7	23.08	8.0	18.19	8.9	25.11
14/07/2019	13.7	23.89	21.0	23.07	7.2	18.13	8.4	25.02
15/07/2019	12.0	23.83	12.9	23.02	5.7	18.07	6.4	24.93
16/07/2019	12.4	23.77	21.3	23.01	6.8	18.01	7.2	24.84
17/07/2019	9.8	23.70	18.8	22.99	5.9	17.95	6.4	24.74
18/07/2019	9.5	23.62	21.4	22.98	6.8	17.89	7.4	24.66
19/07/2019	12.0	23.57	22.3	22.98	12.3	17.86	22.1	24.64
20/07/2019	14.4	23.52	16.6	22.95	13.1	17.84	28.2	24.66
21/07/2019	23.8	23.52	26.0	22.96	15.4	17.83	17.3	24.62
22/07/2019	21.9	23.51	26.4	22.98	16.3	17.82	23.3	24.62
23/07/2019	18.4	23.49	29.0	23.01	11.3	17.79	13.3	24.56
24/07/2019	18.2	23.46	25.6	23.02	12.2	17.76	21.1	24.54
25/07/2019	21.4	23.45	35.2	23.08	18.2	17.76	27.7	24.56
26/07/2019	23.5	23.45	27.1	23.10	14.8	17.75	15.7	24.52
27/07/2019	23.2	23.45	30.2	23.13	18.5	17.75	36.0	24.57
28/07/2019	21.2	23.44	34.2	23.19	17.6	17.75	33.1	24.61
29/07/2019	18.1	23.41	24.8	23.20	12.8	17.73	18.6	24.58
30/07/2019	12.0	23.36	13.5	23.15	13.2	17.70	30.6	24.61
31/07/2019	13.8	23.31	13.2	23.10	8.6	17.66	33.5	24.66
1/08/2019	15.6	23.28	16.3	23.07	13.4	17.64	19.2	24.63
2/08/2019	20.0	23.26	17.5	23.04	16.7	17.64	27.0	24.64
3/08/2019	21.9	23.26	23.5	23.05	12.2	17.61	13.3	24.59

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
4/08/2019	30.5	23.29	21.8	23.04	21.8	17.63	31.4	24.62
5/08/2019	17.5	23.26	29.1	23.07	11.1	17.60	20.8	24.60
6/08/2019	15.2	23.23	52.4	23.20	9.3	17.56	10.6	24.54
7/08/2019	23.4	23.23	25.9	23.22	15.8	17.55	9.4	24.47
8/08/2019	48.7	23.34	25.5	23.23	23.2	17.58	54.4	24.60
9/08/2019	51.3	23.47	58.2	23.39	37.4	17.67	33.0	24.64
10/08/2019	12.9	23.42	15.9	23.35	9.1	17.63	9.0	24.57
11/08/2019	12.3	23.37	10.1	23.29	8.4	17.59	6.2	24.49
12/08/2019	9.5	23.31	17.0	23.26	4.1	17.53	4.6	24.40
13/08/2019	16.2	23.28	18.6	23.24	8.4	17.49	16.8	24.37
14/08/2019	20.5	23.27	20.3	23.23	10.4	17.46	21.1	24.35
15/08/2019	26.4	23.28	24.2	23.23	12.4	17.43	9.2	24.28
16/08/2019	26.0	23.29	34.8	23.28	10.2	17.40	10.2	24.22
17/08/2019	34.0	23.34	33.4	23.33	25.5	17.44	35.6	24.27
18/08/2019	30.9	23.37	43.0	23.42	28.6	17.49	38.8	24.33
19/08/2019	41.8	23.45	33.1	23.46	28.3	17.53	25.5	24.34
20/08/2019	16.4	23.42	27.3	23.47	8.8	17.49	9.3	24.27
21/08/2019	20.1	23.41	32.2	23.51	10.2	17.46	11.8	24.22
22/08/2019	20.6	23.40	23.2	23.51	16.9	17.46	19.8	24.20
23/08/2019	24.5	23.40	28.0	23.53	26.5	17.50	28.1	24.22
24/08/2019	30.5	23.43	39.0	23.60	25.0	17.53	22.7	24.21
25/08/2019	30.9	23.46	38.2	23.66	29.2	17.58	38.5	24.27
26/08/2019	24.8	23.47	28.2	23.68	22.9	17.60	41.4	24.34
27/08/2019	17.4	23.44	23.0	23.68	22.3	17.62	25.2	24.35
28/08/2019	23.1	23.44	23.5	23.67	14.2	17.61	20.3	24.33
29/08/2019	18.4	23.42	29.0	23.70	12.8	17.59	23.5	24.33
30/08/2019	4.9	23.34	4.2	23.62	3.7	17.53	6.4	24.25
31/08/2019	6.1	23.27	5.8	23.54	5.4	17.48	7.2	24.18
1/09/2019	13.1	23.23	11.7	23.49	10.7	17.45	16.7	24.15
2/09/2019	14.8	23.19	17.3	23.47	13.1	17.43	20.9	24.14
3/09/2019	20.4	23.18	25.9	23.48	14.4	17.42	39.2	24.20
4/09/2019	29.1	23.21	30.6	23.51	17.3	17.42	20.2	24.18
5/09/2019	36.8	23.26	34.8	23.55	26.5	17.46	34.8	24.23
6/09/2019	92.8	23.54	106.9	23.89	67.2	17.66	62.3	24.38
7/09/2019	20.6	23.53	15.7	23.86	16.9	17.66	15.3	24.34
8/09/2019	12.4	23.49	8.7	23.80	6.5	17.61	6.7	24.27
9/09/2019	17.6	23.46	12.4	23.75	8.3	17.58	8.2	24.21
10/09/2019	16.3	23.44	16.1	23.72	13.8	17.56	21.9	24.20
11/09/2019	23.6	23.44	47.0	23.81	22.0	17.58	42.1	24.27
12/09/2019	25.6	23.44	33.8	23.85	17.6	17.58	18.9	24.25
13/09/2019	47.0	23.54	42.1	23.92	34.3	17.64	46.1	24.34
14/09/2019	39.9	23.60	31.3	23.95	29.2	17.69	35.6	24.38
15/09/2019	28.3	23.62	30.0	23.98	16.7	17.69	19.3	24.36

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
16/09/2019	46.6	23.71	62.7	24.13	25.2	17.71	36.8	24.41
17/09/2019	8.5	23.65	9.7	24.07	7.3	17.67	14.6	24.37
18/09/2019	6.6	23.58	6.6	24.00	6.9	17.63	8.1	24.31
19/09/2019	16.4	23.56	13.6	23.96	16.4	17.63	21.0	24.30
20/09/2019	16.3	23.53	13.0	23.92	15.1	17.62	25.6	24.30
21/09/2019	32.0	23.56	26.1	23.93	22.6	17.64	39.5	24.36
22/09/2019	31.9	23.59	29.7	23.95	27.8	17.68	32.9	24.39
23/09/2019	13.8	23.56	12.8	23.91	10.2	17.65	10.5	24.34
24/09/2019	19.8	23.54	22.9	23.91	12.6	17.63	20.5	24.32
25/09/2019	25.2	23.55	25.3	23.91	25.2	17.66	28.3	24.34
26/09/2019	43.7	23.62	29.8	23.93	27.1	17.69	33.2	24.37
27/09/2019	27.2	23.64	24.0	23.93	16.0	17.69	12.2	24.33
28/09/2019	33.2	23.67	37.1	23.98	23.6	17.71	25.0	24.33
29/09/2019	35.5	23.72	30.8	24.01	29.5	17.75	35.2	24.37
30/09/2019	32.8	23.75	25.6	24.01	34.4	17.81	30.7	24.39
1/10/2019	28.5	23.77	28.6	24.03	23.7	17.83	27.8	24.40
2/10/2019	28.7	23.78	36.9	24.08	20.8	17.85	38.7	24.46
3/10/2019	33.4	23.82	42.0	24.14	31.4	17.89	42.6	24.52
4/10/2019	47.8	23.91	59.5	24.27	40.4	17.98	36.4	24.57
5/10/2019	24.8	23.91	29.9	24.29	25.9	18.01	24.7	24.57
6/10/2019	24.1	23.91	37.1	24.34	20.7	18.02	44.1	24.64
7/10/2019	54.0	24.02	62.2	24.47	59.6	18.16	61.8	24.77
8/10/2019	36.1	24.06	36.1	24.52	30.7	18.21	30.3	24.79
9/10/2019	22.6	24.06	20.8	24.50	20.7	18.22	28.2	24.80
10/10/2019	21.5	24.05	29.3	24.52	27.3	18.25	40.5	24.86
11/10/2019	20.7	24.04	19.6	24.50	21.2	18.26	37.4	24.90
12/10/2019	11.0	23.99	9.3	24.45	12.9	18.24	14.1	24.87
13/10/2019	13.3	23.95	12.4	24.41	15.5	18.23	18.2	24.84
14/10/2019	23.1	23.95	25.8	24.41	19.5	18.24	37.3	24.89
15/10/2019	34.7	23.99	36.4	24.45	39.2	18.31	53.3	24.99
16/10/2019	48.9	24.07	55.9	24.56	35.4	18.37	35.0	25.02
17/10/2019	45.1	24.15	46.4	24.64	38.2	18.44	29.7	25.04
18/10/2019	26.3	24.15	31.9	24.66	19.7	18.44	17.2	25.01
19/10/2019	37.0	24.20	49.4	24.75	33.6	18.50	29.4	25.02
20/10/2019	26.5	24.21	28.6	24.76	26.3	18.52	36.0	25.06
21/10/2019	31.5	24.23	31.2	24.78	32.5	18.57	45.8	25.13
22/10/2019	41.8	24.29	44.8	24.85	37.9	18.64	45.6	25.20
23/10/2019	35.0	24.33	49.3	24.94	28.1	18.67	34.8	25.24
24/10/2019	47.5	24.41	70.0	25.09	41.2	18.74	45.4	25.30
25/10/2019	42.2	24.47	63.2	25.22	33.1	18.79	27.0	25.31
26/10/2019	92.6	24.70	151.8	25.64	78.0	18.99	63.1	25.44
27/10/2019	55.8	24.80	53.6	25.74	41.0	19.07	55.2	25.54
28/10/2019	53.5	24.90	38.7	25.78	44.3	19.15	57.6	25.64

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
29/10/2019	52.5	24.99	51.3	25.87	52.8	19.26	72.1	25.80
30/10/2019	84.9	25.19	104.4	26.13	85.6	19.48	95.1	26.03
31/10/2019	102.0	25.44	117.0	26.43	86.5	19.71	103.8	26.29
1/11/2019	82.9	25.63	85.1	26.62	83.5	19.92	96.5	26.52
2/11/2019	48.4	25.71	58.5	26.73	45.4	20.00	68.3	26.66
3/11/2019	39.4	25.75	52.1	26.81	41.3	20.07	47.8	26.73
4/11/2019	10.0	25.70	8.8	26.75	6.0	20.02	8.2	26.66
5/11/2019	14.1	25.66	10.7	26.70	14.1	20.00	14.0	26.62
6/11/2019	11.4	25.62	20.0	26.68	10.0	19.97	10.0	26.57
7/11/2019	68.6	25.76	79.6	26.85	66.6	20.12	51.4	26.65
8/11/2019	69.1	25.89	72.9	27.00	70.7	20.29	56.7	26.75
9/11/2019	28.7	25.90	17.0	26.96	18.3	20.28	15.7	26.71
10/11/2019	22.4	25.89	29.9	26.97	27.6	20.30	21.4	26.69
11/11/2019	22.1	25.88	27.3	26.97	14.2	20.28	22.6	26.68
12/11/2019	106.4	26.14	139.8	27.33	104.4	20.55	84.1	26.86
13/11/2019	38.7	26.18	38.3	27.37	35.9	20.60	30.6	26.88
14/11/2019	33.9	26.20	40.5	27.41	25.4	20.62	21.1	26.86
15/11/2019	34.6	26.23	46.9	27.47	23.5	20.62	21.5	26.84
16/11/2019	69.7	26.36	76.0	27.62	69.7	20.78	67.4	26.97
17/11/2019	79.5	26.53	84.0	27.80	86.9	20.99	71.7	27.11
18/11/2019	46.8	26.59	49.1	27.87	38.3	21.04	37.4	27.14
19/11/2019	49.1	26.66	70.9	28.00	42.0	21.11	67.5	27.27
20/11/2019	50.4	26.74	61.5	28.10	72.5	21.26	66.8	27.39
21/11/2019	108.2	26.99	116.2	28.38	114.1	21.55	115.4	27.66
22/11/2019	90.5	27.19	111.5	28.63	107.8	21.82	106.5	27.90
23/11/2019	56.9	27.28	64.6	28.74	75.1	21.98	58.6	28.00
24/11/2019	23.6	27.27	24.9	28.73	28.1	22.00	24.4	27.99
25/11/2019	33.0	27.28	29.0	28.73	36.0	22.04	32.6	28.00
26/11/2019	166.4	27.71	197.6	29.25	186.7	22.55	148.9	28.37
27/11/2019	48.4	27.77	45.4	29.30	57.8	22.65	67.0	28.49
28/11/2019	132.6	28.09	143.8	29.64	116.9	22.94	117.9	28.76
29/11/2019	105.0	28.32	130.6	29.95	122.9	23.24	105.5	28.99
30/11/2019	72.4	28.45	85.1	30.12	75.0	23.40	75.8	29.13
1/12/2019	72.1	28.58	73.5	30.25	79.2	23.56	64.4	29.24
2/12/2019	84.0	28.75	88.5	30.42	79.9	23.73	53.9	29.31
3/12/2019	84.0	28.92	88.5	30.59	79.9	23.90	53.9	29.39
4/12/2019	49.4	28.98	60.9	30.68	43.6	23.96	35.0	29.40
5/12/2019	51.8	29.04	67.4	30.79	54.6	24.05	43.2	29.44
6/12/2019	103.7	29.27	114.4	31.04	78.2	24.21	63.3	29.54
7/12/2019	238.4	29.88	156.0	31.41	158.2	24.61	212.7	30.08
8/12/2019	57.0	29.96	13.6	31.36	12.1	24.57	73.1	30.21
9/12/2019	82.7	30.12	64.4	31.45	65.0	24.69	92.3	30.39
10/12/2019	146.0	30.46	192.3	31.92	203.0	25.21	145.1	30.73

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average	PM_{10} 24 Hour Result (ug/m^3)	YTD Average
11/12/2019	144.4	30.79	149.8	32.27	50.5	25.28	142.6	31.05
12/12/2019	112.2	31.02	127.8	32.55	127.6	25.58	97.1	31.25
13/12/2019	40.1	31.05	50.7	32.60	35.6	25.61	40.5	31.27
14/12/2019	84.6	31.21	101.1	32.80	94.8	25.81	90.3	31.44
15/12/2019	64.1	31.30	78.7	32.93	58.2	25.90	53.6	31.51
16/12/2019	71.3	31.42	107.1	33.14	118.6	26.17	79.8	31.65
17/12/2019	39.0	31.44	40.1	33.16	49.7	26.24	42.2	31.68
18/12/2019	60.1	31.52	59.7	33.24	59.1	26.33	77.0	31.81
19/12/2019	98.9	31.71	171.3	33.63	90.5	26.51	99.1	32.00
20/12/2019	57.7	31.78	82.0	33.77	59.0	26.61	76.5	32.12
21/12/2019	128.8	32.06	187.0	34.20	117.1	26.86	115.9	32.36
22/12/2019	54.7	32.12	65.6	34.29	57.2	26.95	76.8	32.49
23/12/2019	43.7	32.16	50.6	34.34	37.8	26.98	53.6	32.55
24/12/2019	33.6	32.16	34.7	34.34	30.8	26.99	36.8	32.56
25/12/2019	23.0	32.13	32.4	34.33	24.5	26.98	22.9	32.53
26/12/2019	36.8	32.15	42.7	34.36	41.2	27.02	42.6	32.56
27/12/2019	70.4	32.25	61.8	34.43	67.8	27.13	81.0	32.69
28/12/2019	64.4	32.34	70.0	34.53	66.9	27.25	72.0	32.80
29/12/2019	55.3	32.41	83.6	34.67	58.2	27.33	74.0	32.92
30/12/2019	81.5	32.54	123.8	34.91	100.6	27.53	72.0	33.02
31/12/2019	73.5	32.66	93.9	35.08	70.9	27.65	65.7	33.11

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW01	21-Jan				No flow, pool
SW01	27-Feb	6.1	1990		Pool
SW01	18-Mar				Pool
SW01	1-Apr				Pool
SW01	1-Apr				Pool
SW01	31-May				Pool
SW01	24-Jun				Pool
SW01	25-Jul				No flow
SW01	27-Aug				No flow
SW01	27-Sep				Pool
SW01	29-Oct				Pool
SW01	27-Nov				Pool
SW01	3-Dec				Pool
SW02	21-Jan				No flow, pool
SW02	27-Feb				Pool
SW02	18-Mar				Dry
SW02	1-Apr				Dry
SW02	1-Apr				Dry
SW02	31-May				Dry
SW02	24-Jun				No flow
SW02	25-Jul				No flow
SW02	27-Aug				Dry
SW02	27-Sep				Pool
SW02	29-Oct				Dry
SW02	27-Nov				Dry
SW02	3-Dec				Dry
SW03	21-Jan				No flow, pool
SW03	27-Feb				No flow
SW03	18-Mar				Pool
SW03	1-Apr				Pool
SW03	1-Apr				Pool
SW03	31-May				Pool
SW03	24-Jun				Dry
SW03	25-Jul				No flow
SW03	27-Aug				No flow
SW03	27-Sep				Pool
SW03	29-Oct				No flow
SW03	27-Nov				Dry
SW03	3-Dec				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW04	21-Jan				Dry
SW04	27-Feb				Dry
SW04	18-Mar				Dry
SW04	1-Apr				Dry
SW04	1-Apr				Dry
SW04	31-May				Dry
SW04	24-Jun				Dry
SW04	25-Jul				Dry
SW04	27-Aug				Dry
SW04	27-Sep				Dry
SW04	29-Oct				Dry
SW04	27-Nov				Pool
SW04	3-Dec				Dry
SW05	21-Jan				Dry
SW05	27-Feb				No flow
SW05	18-Mar				Dry
SW05	1-Apr				Dry
SW05	1-Apr				Dry
SW05	31-May				Dry
SW05	24-Jun				Dry
SW05	25-Jul				Dry
SW05	27-Aug				Dry
SW05	27-Sep				Dry
SW05	29-Oct				Dry
SW05	27-Nov				Dry
SW05	3-Dec				Dry
SW06	21-Jan				No flow, pool
SW06	27-Feb				Dry
SW06	18-Mar				Dry
SW06	1-Apr				Dry
SW06	1-Apr				Dry
SW06	31-May				Dry
SW06	24-Jun				Dry
SW06	25-Jul				Dry
SW06	27-Aug				Dry
SW06	27-Sep				Dry
SW06	29-Oct				Dry
SW06	27-Nov				Dry
SW06	3-Dec				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW07	21-Jan				No flow, pool
SW07	27-Feb				Dry
SW07	18-Mar				Dry
SW07	1-Apr				Dry
SW07	1-Apr				Dry
SW07	31-May				Dry
SW07	24-Jun				Dry
SW07	25-Jul				Dry
SW07	27-Aug				Dry
SW07	27-Sep				Dry
SW07	29-Oct				Dry
SW07	27-Nov				Dry
SW07	3-Dec				Dry
SW08	21-Jan				No flow, pool
SW08	20-Feb				Dry
SW08	18-Mar				Dry
SW08	1-Apr				Dry
SW08	1-Apr				Dry
SW08	31-May				Dry
SW08	24-Jun				Dry
SW08	25-Jul				Dry
SW08	27-Aug				Dry
SW08	27-Sep				Dry
SW08	29-Oct				Dry
SW08	27-Nov				Dry
SW08	3-Dec				Dry
SW12	20-Feb	8.56	6000	56	
SW12	26-Mar	8.95	4160	31	
SW12	1-Apr	8.8	2860	40	
SW12	21-May	8.9	7290	20	
SW12	25-Jun	8.6	7000	21	
SW12	26-Jul	8.81	8820	526	
SW12	20-Aug	8.66	7200	36	
SW12	18-Sep	8.8	6370	50	
SW12	29-Oct	8.6	7400	96	
SW12	20-Nov	8.6	7370	75	
SW12	3-Dec	8.7	6880	16	

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW14	21-Jan	8.9	414	26	
SW14	20-Feb	9.29	415	24	
SW14	26-Mar	8.3	531	14	
SW14	1-Apr	8.3	531	14	
SW14	21-May	8.6	621	11	
SW14	25-Jun				No Access
SW14	26-Jul	8.64	847	8	
SW14	20-Aug	8.39	707	10	
SW14	18-Sep	8.9	503	22	
SW14	29-Oct	9	480	14	
SW14	20-Nov	8.9	871	<5	
SW14	3-Dec	8.9	814	5	
SW15	2-Jan	9.21	6360	36	
SW15	21-Jan	9.16	5430	287	
SW15	20-Feb	8.72	6240	46	
SW15	18-Mar	9.02	4420	187	
SW15	1-Apr	8.98	2740	91	
SW15	1-Apr	9	2750	74	
SW15	21-May	8.9	3800	36	
SW15	25-Jun	8.6	3580	30	
SW15	26-Jul				No access
SW15	20-Aug	8.83	4000	62	
SW15	18-Sep	8.6	5510	97	
SW15	29-Oct	8.7	7110	48	
SW15	20-Nov	8.6	5820	40	
SW15	3-Dec	8.8	3460	70	
SW27	2-Jan				No flow, pool
SW27	21-Jan				No flow, pool
SW27	20-Feb				Dry
SW27	18-Mar				Dry
SW27	1-Apr				Pool
SW27	1-Apr				Pool
SW27	21-May				Dry
SW27	24-Jun				Dry
SW27	25-Jul				Dry
SW27	27-Aug				Dry
SW27	27-Sep				Dry
SW27	29-Oct				Dry
SW27	27-Nov				Dry
SW27	3-Dec				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW31	Jan	9.36	3210	54	
SW31	20-Feb	9.23	5420	44	
SW31	18-Mar	3.67	5020	168	
SW31	1-Apr	9.2	3330	200	
SW31	21-May	9.1	4800	41	
SW31	25-Jun	8.7	1480	22	
SW31	26-Jul	8.49	651	34	
SW31	20-Aug	8.71	1380	28	
SW31	18-Sep	8.8	807	100	
SW31	29-Oct	8.7	1050	58	
SW31	20-Nov	8.8	770	20	
SW31	3-Dec	8.6	500	25	
SW32a	2-Jan				No flow, pool
SW32a	21-Jan	7.53	289	1890	
SW32a	20-Feb	7.4	327	470	
SW32a	18-Mar				Pool
SW32a	1-Apr				Pool
SW32a	1-Apr				Pool
SW32a	31-May				Dry
SW32a	24-Jun				Dry
SW32a	25-Jul				Dry
SW32a	27-Aug				Dry
SW32a	27-Sep				Dry
SW32a	29-Oct				Dry
SW32a	27-Nov				Dry
SW32a	3-Dec				Dry
SW38	21-Jan	9.19	8310	36	
SW38	20-Feb	9.14	9000	10	
SW38	18-Mar	9.2	3270	15	
SW38	1-Apr	9.2	3270	15	
SW38	21-May	8.9	9020	6	
SW38	25-Jun	8.7	8380	26	
SW38	26-Jul	8.68	9810	<5	
SW38	20-Aug	8.8	9100	41	
SW38	18-Sep	9.2	7130	123	
SW38	29-Oct	8.6	9260	58	
SW38	20-Nov	8.9	9810	12	
SW38	3-Dec	8.9	9490	30	

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW39	2-Jan				Dry
SW39	21-Jan				Dry
SW39	20-Feb				Dry
SW39	18-Mar				Pool
SW39	1-Apr				Pool
SW39	1-Apr				Pool
SW39	21-May				Pool
SW39	24-Jun				Dry
SW39	26-Jul				Dry
SW39	Aug				
SW39	27-Sep				Dry
SW39	29-Oct				Dry
SW39	27-Nov				Dry
SW39	3-Dec				Dry
SW40	2-Jan				No flow, pool
SW40	21-Jan				No flow, pool
SW40	20-Feb				Pool
SW40	18-Mar				Pool
SW40	1-Apr				Pool
SW40	1-Apr				Pool
SW40	21-May				Dry
SW40	24-Jun				Dry
SW40	25-Jul				No flow
SW40	27-Aug				No flow
SW40	27-Sep				Pool
SW40	29-Oct				Pool
SW40	27-Nov				Pool
SW40	3-Dec				Dry
SW41	Jan-21				Dry
SW41	Feb-20				Dry
SW51	21-Jan	9.03	1780	546	
SW51	20-Feb	9.35	3010	313	
SW51	26-Mar	9.01	1560	1690	
SW51	1-Apr	8.8	991	658	
SW51	21-May	8.7	1220	192	
SW51	25-Jun	8.8	1330	212	
SW51	26-Jul	8.81	1640	188	
SW51	20-Aug	8.79	1650	91	
SW51	18-Sep	9.1	1020		
SW51	29-Oct				Dry
SW51	27-Nov				Dry
SW51	3-Dec				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW52	21-Jan	9.64	2020	154	
SW52	20-Feb	10	2430	33	
SW52	18-Mar	9.84	6791	200	
SW52	1-Apr	9.6	821	172	
SW52	21-May	8.8	882	42	
SW52	25-Jun	8.8	874	43	
SW52	26-Jul	8.47	1080	50	
SW52	2-Aug	8.75	1020	48	
SW52	18-Sep	8.8	1010	90	
SW52	29-Oct	9	1190	14	
SW52	27-Nov	9.7	1280	20	
SW52	3-Dec	10.5	1440	16	
Wombat Dam	2-Jan				Dry
Wombat Dam	21-Jan				Dry
Wombat Dam	20-Feb				Dry
Wombat Dam	18-Mar				Insufficient water
Wombat Dam	1-Apr	7.55	318	59	
Wombat Dam	1-Apr	7.57	318	44	
Wombat Dam	21-May				No access
Wombat Dam	24-Jun				No access
Wombat Dam	26-Jul				No access
Wombat Dam	27-Aug				No access
Wombat Dam	18-Sep				No access
Wombat Dam	29-Oct				Dry
Wombat Dam	20-Nov				Dry
Wombat Dam	3-Dec				Dry
Milk Can Dam	2-Jan	9.51	6520	87	
Milk Can Dam	21-Jan	9.63	2500	634	
Milk Can Dam	20-Feb	9.41	8250	107	
Milk Can Dam	18-Mar	9.78	2050	402	
Milk Can Dam	1-Apr	8.08	645	95	
Milk Can Dam	1-Apr	8.13	418	72	
Milk Can Dam	21-May	8.7	2750	46	
Milk Can Dam	25-Jun	8.5	3310	172	
Milk Can Dam	26-Jul	8.77	4510	34	
Milk Can Dam	20-Aug	8.95	5410	38	
Milk Can Dam	18-Sep	9.3	5840	200	
Milk Can Dam	29-Oct				Dry
Milk Can Dam	20-Nov				Dry
Milk Can Dam	3-Dec				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
Rug Dump Dam	2-Jan	8.92	1250	126	
Rug Dump Dam	21-Jan	9.13	1490	181	
Rug Dump Dam	20-Feb	9.42	8170	320	
Rug Dump Dam	18-Mar	8.58	430	628	
Rug Dump Dam	1-Apr	7.96	418	278	
Rug Dump Dam	21-May	8.4	817	91	
Rug Dump Dam	25-Jun	8.5	1090	20	
Rug Dump Dam	26-Jul	8.76	1570	110	
Rug Dump Dam	20-Aug	8.84	2040	92	
Rug Dump Dam	18-Sep	9.1	1980	840	
Rug Dump Dam	29-Oct				Dry
Rug Dump Dam	20-Nov				Dry
Rug Dump Dam	3-Dec				Dry
Montrose East 1	2-Jan	9.48	740	271	
Montrose East 1	21-Jan	9.26	888	109	
Montrose East 1	20-Feb	8.18	571	298	
Montrose East 1	18-Mar	7.64	316	353	
Montrose East 1	1-Apr	7.75	247	754	
Montrose East 1	1-Apr	7.75	249	639	
Montrose East 1	21-May	9.1	413	39	
Montrose East 1	25-Jun	8.5	562	41	
Montrose East 1	26-Jul	8.12	746	156	
Montrose East 1	20-Aug	8.29	757	102	
Montrose East 1	18-Sep	8.3	728	516	
Montrose East 1	29-Oct				Dry
Montrose East 1	20-Nov				Dry
Montrose East 1	3-Dec				Dry
Montrose East 2	2-Jan	8.93	688	31	
Montrose East 2	21-Jan	8.8	773	22	
Montrose East 2	20-Feb	9.24	595	72	
Montrose East 2	18-Mar	7.77	325	279	
Montrose East 2	1-Apr	8.27	258	391	
Montrose East 2	1-Apr	8.27	257	279	
Montrose East 2	21-May	8.6	424	12	
Montrose East 2	25-Jun	8.7	500	14	
Montrose East 2	26-Jul	8.5	651	23	
Montrose East 2	20-Aug	8.44	691	20	
Montrose East 2	18-Sep	8.5	715	90	
Montrose East 2	29-Oct	8.4	970	146	
Montrose East 2	20-Nov				Dry
Montrose East 2	3-Dec				Dry

APPENDIX E

WAMBO MINE 2019 AIR QUALITY MONITORING REVIEW

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23 March 2020

Attention: Brent Frondall
Wambo Coal Pty Ltd
PMB 1, Singleton NSW 2330

Project Name: Wambo Coal
Project Number: IA230800

Dear Brent

Wambo Mine 2019 Air Quality Monitoring Review

I have completed a review of Wambo Coal's air quality monitoring data for 2019. Please see attached for the outcomes of the analyses.

Yours sincerely

Shane Lakmaker
Principal (Air Quality)
(02) 4979 2663
shane.lakmaker@jacobs.com

1. Background

Wambo Coal has a network of air quality and meteorological monitoring equipment around Wambo Mine which is designed to meet relevant conditions under its Development Consent (DA 305-7-2003; Mod 17 and Mod 16). Figure 1 shows the location of the four Tapered Element Oscillating Microbalance (TEOM) instruments which are setup to continuously measure PM_{10} concentrations. The monitors are referred to by the following identification labels:

- D1 – Muller – AQ04
- D2 – Caban – AQ02
- D3 – Coralie – AQ01
- D4 – Thelander – AQ03

Data from the TEOMs are managed by Novecom's Sentinex system. Also shown in Figure 1 is the location of Wambo Coal's automatic weather station (see legend).

A review of the Wambo Coal's PM_{10} monitoring data has been carried out. The purpose of the review was to identify all days in 2019 when the PM_{10} concentration at one or more locations exceeded 50 $\mu g/m^3$, in order to assess compliance with the 24-hour average criteria specified in the Development Consent. The contribution of Wambo Coal activities to the measured results on these days has also been estimated.

Monitoring of $PM_{2.5}$ is anticipated to commence on site in 2020 and data from the updated monitoring network will be included in the 2020 air quality monitoring review. In the interim, data from the Singleton Station in the Upper Hunter Air Quality Monitoring Network (UHAQMN) have been used to assist with Wambo Coal's management program and reporting. The UHAQMN is shown in Figure 2.

A review of the Wambo Coal Air Quality & Greenhouse Gas Management Plan will be completed in 2020.

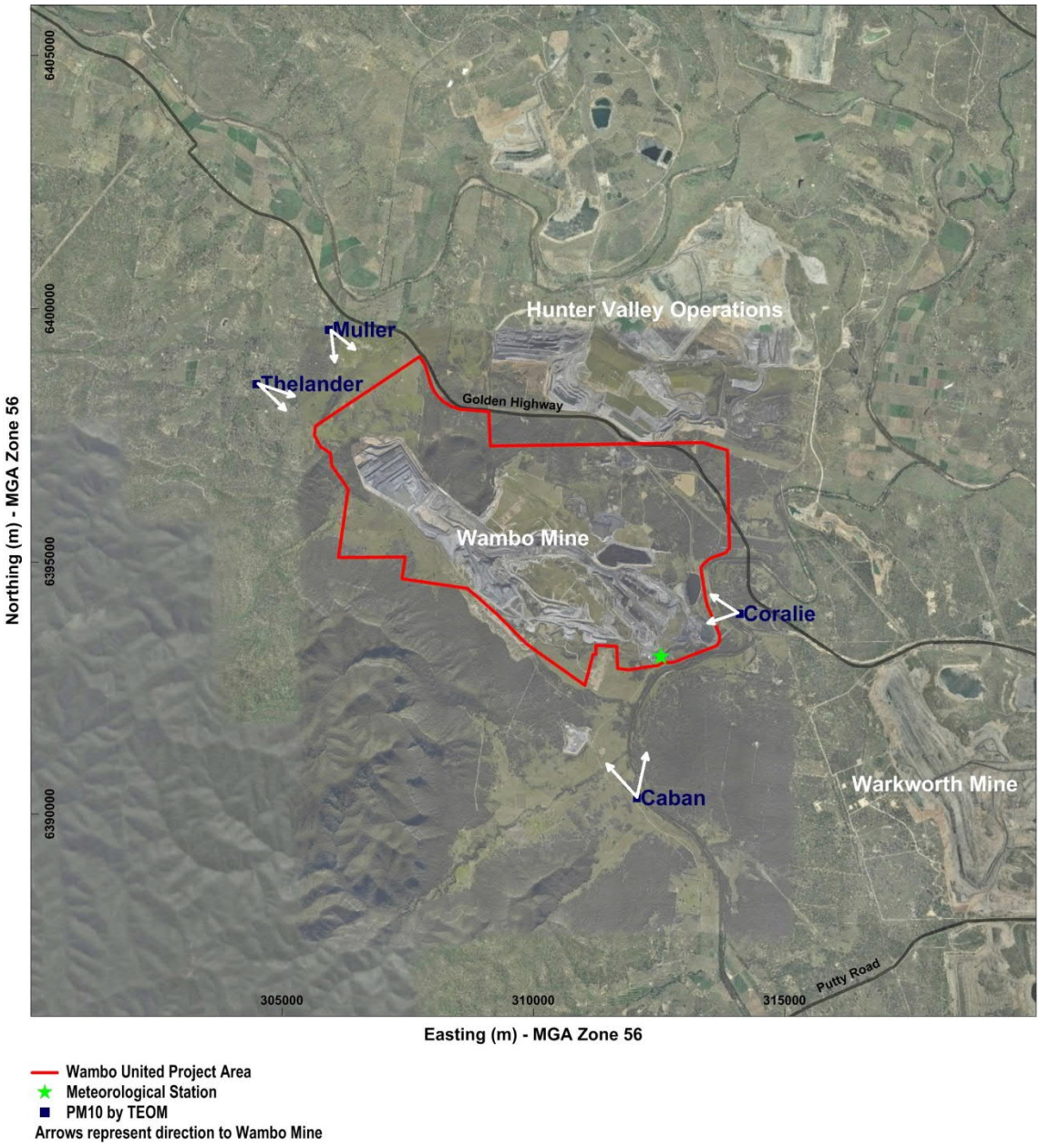


Figure 1 Location of monitoring stations around Wambo Mine

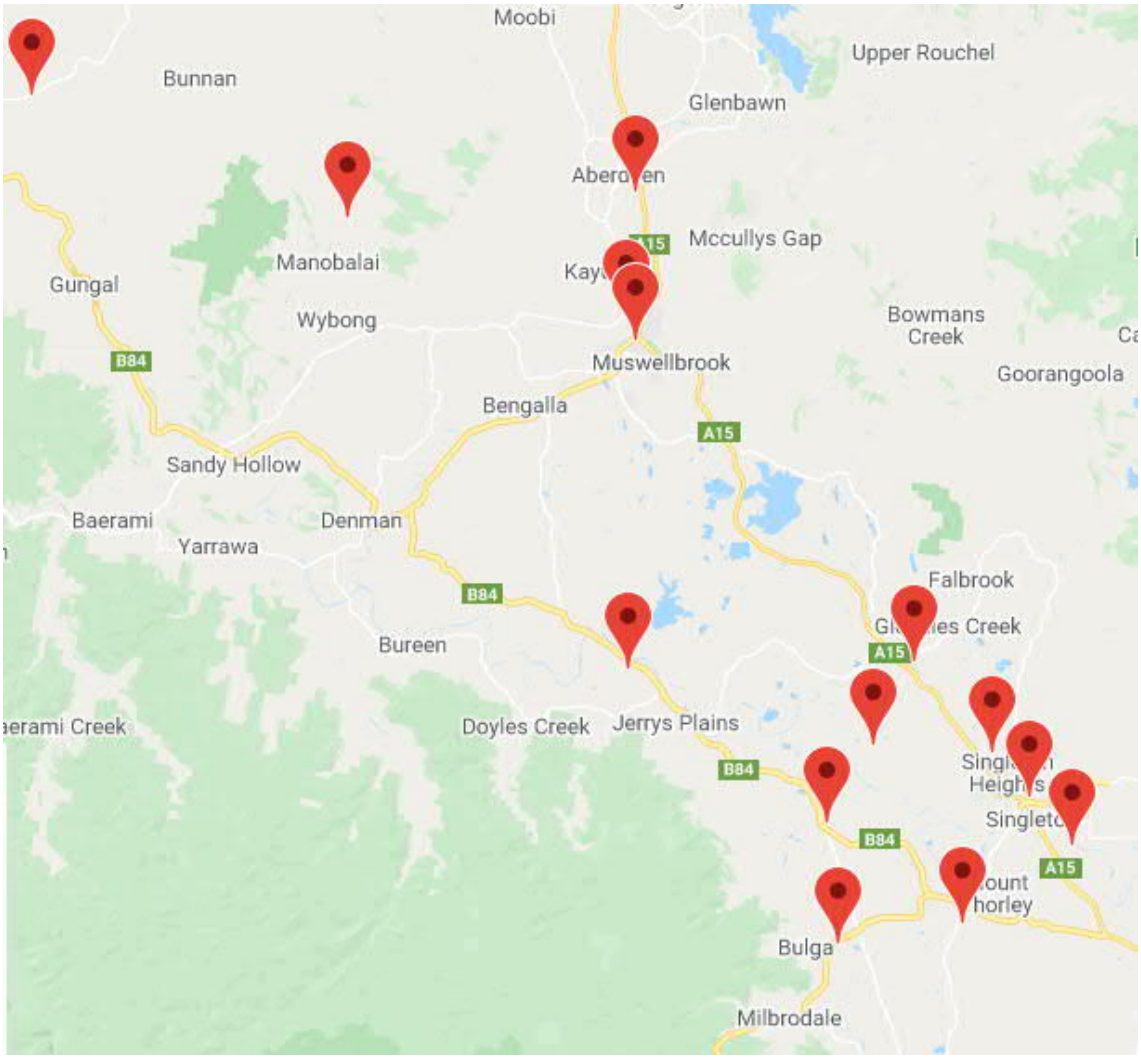


Figure 2 Upper Hunter Regional Air Quality Monitoring Network

Table 1 shows the Development Consent criteria that were applicable up to 28 August 2019. There are two relevant criteria for 24-hour average PM_{10}, as follows:

- 50 µg/m^3 as a total impact due to the development and other sources ("impact" criterion)
- 50 µg/m^3 as an incremental increase due to the development on its own ("acquisition" criteria)

Table 1 Development consent criteria from DA 305-7-2003 Modification 17

Substance	Averaging time	[d] Impact assessment criteria (applicable to 28 Aug 2019)	[e] Purpose
Particulate matter (PM_{10})	Annual	[a] 30 µg/m^3	Compliance and acquisition
	24 hour	[a] 50 µg/m^3	Compliance
		[a] 150 µg/m^3	Acquisition
		[b] 50 µg/m^3	Acquisition

[a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).
[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own).
[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.
[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.
[e] Upon written request for acquisition from a landowner listed in Schedule 4, Condition 1 of DA305-7-2003 (refer Appendix A), WCPL shall acquire the land in accordance with the procedures in Schedule 5, Conditions 9 to 11 of DA305-7-2003

Table 2 shows the Development Consent criteria that were applicable from 29 August 2019 onwards. In this case the 24-hour average criterion relates to an incremental impact.

Table 2 Development consent criteria from DA 305-7-2003 Modification 16

Substance	Averaging time	Criterion (applicable from 29 Aug 2019)
Particulate matter (PM_{10})	Annual	[a, c] 25 µg/m^3
	24 hour	[b] 50 µg/m^3
Particulate matter ($PM_{2.5}$)	Annual	[a, c] 8 µg/m^3
	24 hour	[b] 25 µg/m^3

[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 by the Planning Secretary.

2. Approach to Review

The review of PM_{10} monitoring data involved:

- Obtaining and collating the monitoring data into hourly average records of PM_{10} concentrations and hourly average records of wind speed and wind direction. Data from the 2019 calendar year were examined. All data were supplied to Jacobs by Wambo Coal. It was assumed that the data were validated.
- Preparing summary statistics. These statistics included, for each of the four sites, the maximum 24-hour average, the number of days above 50 $\mu g/m^3$, and the annual average.
- Analysing all days in 2019 when the PM_{10} concentration at one or more location exceeded 50 $\mu g/m^3$. The data for each "exceedance" day was analysed by preparing graphs showing the hourly average PM_{10} concentrations at each monitoring location, with wind conditions, for each day of interest.
- Summarising the exceedance days and calculating the likely contribution of Wambo Coal activities to the measured results.

There is no standard prescribed methodology for determining site contributions to air quality for mining operations. The methodology described below is based on the use of concurrent hourly meteorological and air quality monitoring data from suitably located monitoring stations around the mine site to estimate site contributions. This method is referred to as an upwind / downwind calculation approach.

The contribution of Wambo Mine activities to the measured results was calculated by first determining the wind direction ranges which represented a wind direction from Wambo Mine towards each monitor. Table 3 shows the wind direction ranges that represented the direction to Wambo Mine from each monitor.

Table 3 Wind directions to Wambo Mine activities

Monitoring site	Directions to Wambo Mine activities
Muller	Between 130 and 180 degrees from true north
Caban	Between 320 and 10 degrees from true north
Coralie	Between 255 and 300 degrees from true north
Thelander	Between 110 and 140 degrees from true north

The site contribution to each monitor was calculated for every 1-hour average record for every day of 2019 based on the concurrent wind direction and from a downwind concentration minus upwind concentration calculation. Table 4 shows the data representing upwind and downwind conditions for each monitoring site. The downwind minus upwind result was only calculated downwind for hours with wind speeds greater than 0 m/s.

Table 4 Data for upwind and downwind calculations

Monitoring site	Data representing conditions upwind	Data representing conditions downwind
Muller	Caban	Muller
Caban	Muller	Caban
Coralie	Thelander	Coralie
Thelander	Coralie	Thelander

The site contribution to each monitor was then calculated as 24-hour and annual averages, not including negative values.

The limitation with this method is that the calculated contribution may not consider dust that is generated by the mining activities but transported towards a monitor at an earlier or later time under different wind conditions (that is, re-suspended dust). In addition, this procedure does not account for any dust generating activities which may have been located between the mine and the monitor. These factors mean that the calculated site contribution will have some embedded uncertainty.

The review of $PM_{2.5}$ monitoring data involved:

- Obtaining 24-hour average $PM_{2.5}$ monitoring data for 2019 from the DPIE's Singleton station. It was assumed that the data were validated.
- Preparing summary statistics. These statistics included the maximum 24-hour average, the number of days above 25 $\mu g/m^3$, and the annual average.
- Comparing the monitored results to Wambo Coal's Development Consent criteria, taking into consideration any declared extraordinary events where relevant.

Outcomes of the review are provided in Sections 4 and 5.

3. Extraordinary Events

Late 2019 coincided with a period of unprecedented bushfires in Australia, predominantly across southeast Australia, but also affecting a reported 4 million hectares of land in NSW since early November 2019. Additional detail can be found at:

- https://www.environment.nsw.gov.au/topics/air/air-quality-statement

The bushfires adversely affected air quality across many parts of NSW and a total of 66 days in 2019 were subsequently declared as extraordinary events. Table 5 identifies the days that have been declared as extraordinary events.

Table 5 Days declared as extraordinary events in 2019

Month	Day(s)
Jan	16, 17
Feb	13, 19
Mar	6, 31
Apr	26
May	-
Jun	-
Jul	-
Aug	8, 9
Sep	6
Oct	7, 8, 18, 19, 24, 25, 26, 27, 28, 30, 31
Nov	1, 2, 7, 8, 12, 16, 17, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30
Dec	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 27, 28, 29, 30, 31

The reporting of Wambo Coal's 24-hour average PM_{10} concentration data up to 28 August 2019 has excluded records from the days listed as extraordinary in Table 5 above, as per the provisions of the, then applicable, Development Consent.

4. Monitored PM_{10} Results

The data capture rates are shown in Table 6. Generally, a data capture rate of 90 to 95% or more is considered acceptable for air quality monitoring networks as this takes into account downtime from servicing, maintenance, calibrations and reasonable periods to deal with breakdowns. All sites achieved greater than 90% data capture.

Table 6 Data capture rates

Year	D1 – Muller	D2 – Wambo	D3 – Coralie	D4 - Thelander
2019	98.0%	99.3%	99.4%	97.5%

Figure 3 shows all measured 24-hour average concentrations from each monitoring site in 2019 and Table 7 summarises the data. The majority of days above 50 µg/m^3 were measured in November and December which, as noted in Section 3, were mainly related to extraordinary events.

Table 7 Summary of measured PM_{10} concentrations in 2019

Statistic	All data				All data except extraordinary events			
	D1 Muller	D2 Caban	D3 Coralie	D4 Thelander	D1 Muller	D2 Caban	D3 Coralie	D4 Thelander
1 Jan to 31 Dec (365 days)								
Maximum 24-hour average (µg/m^3)	216	203	243	208	73	64	59	54
Number of days above 50 µg/m^3	58	62	60	46	6	9	9	1
Average (µg/m^3)	34	36	33	28	25	25	24	18
Days of data available	364	365	365	365	299	299	299	299
1 Jan to 28 Aug (240 days)								
Maximum 24-hour average (µg/m^3)	74	79	81	73	57	59	59	47
Number of days above 50 µg/m^3	9	9	14	3	4	4	8	0
Average (µg/m^3)	25	24	24	18	24	23	23	17
Days of data available	239	241	241	241	231	231	231	231
29 Aug to 31 Dec (125 days)								
Maximum 24-hour average (µg/m^3)	216	203	243	208	73	64	54	54
Number of days above 50 µg/m^3	49	53	46	43	2	5	1	1
Average (µg/m^3)	51	58	51	47	29	30	27	23
Days of data available	125	125	125	125	68	68	68	68

In summary there were 79 unique days when the monitored PM_{10} concentration exceeded 50 µg/m^3 at one or more locations; 20 days up to 28 August 2019 and 59 days from 29 August 2019 to 31 December 2019.

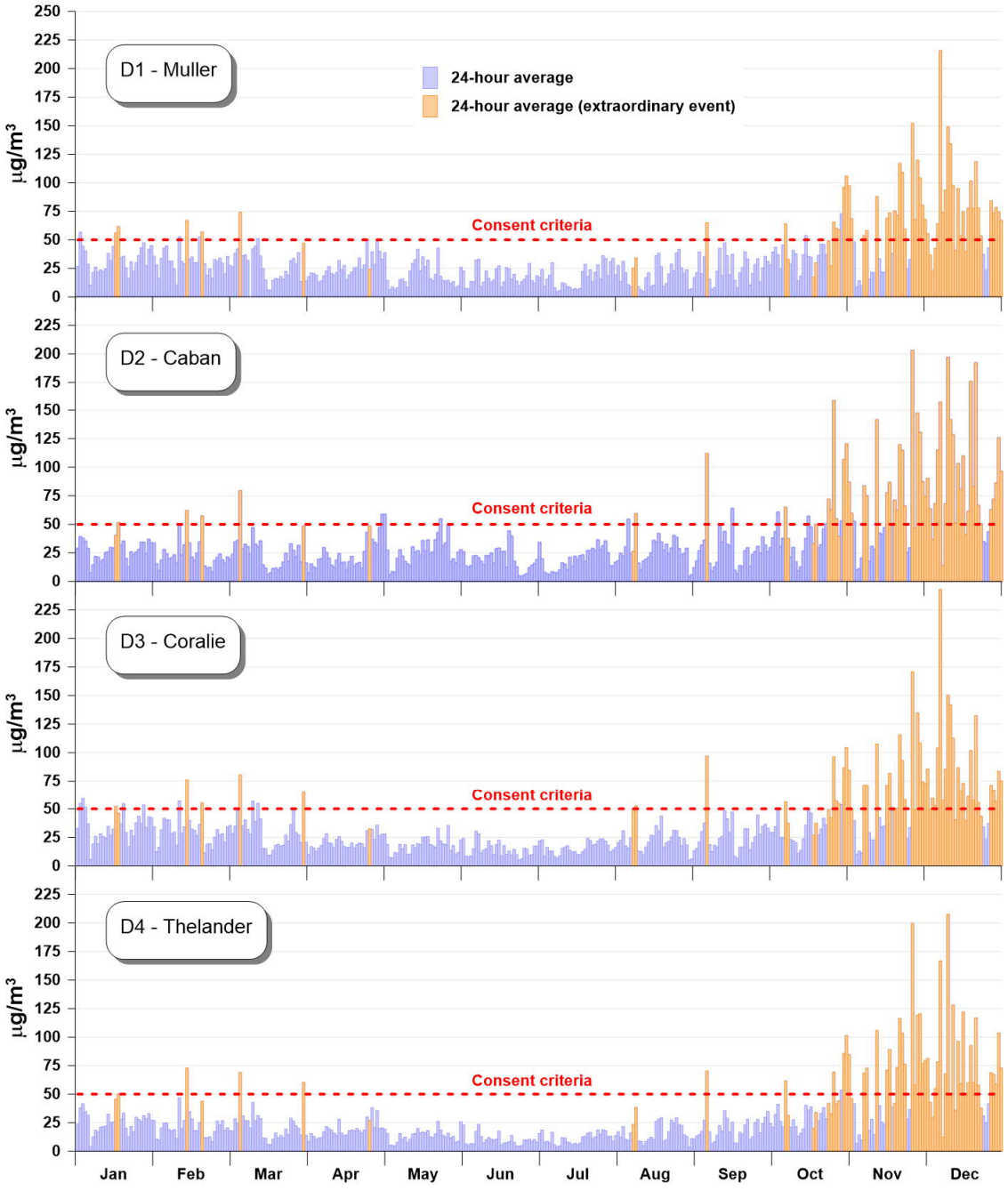


Figure 3 Measured 24-hour average PM_{10} concentrations

Table 8 lists the 79 days when the 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at one or more locations, along with the calculated site contribution for each of these days based on analyses of the PM_{10} data and concurrent wind observations. A determination of the compliance outcome has also been made.

Appendix A provides the graphical analyses of the monitoring data for all days when the PM_{10} concentration exceeded 50 µg/m^3 at one or more locations in 2019, excluding extraordinary events. These analyses, and accompanying data, were used to determine if activities at Wambo Mine were likely to have influenced the measured exceedance at one or more of the monitoring locations.

Table 8 Site contribution for days above 50 µg/m^3 PM_{10} at one or more locations

Exceedance day	Measured 24-hour average PM_{10} concentration in µg/m^3 (calculated site contribution in parentheses)				Determination
	D1 Muller	D2 Caban	D3 Coralie	D4 Thelander	
DA 305-7-2003 Modification 17 applies					
2/01/2019	57 (14)	39 (0)	55 (0)	38 (0)	Mine caused exceedance of 50 Compliance, increment <50
3/01/2019	44 (1)	38 (0)	59 (0)	42 (2)	Already above 50 Compliance, increment <50
4/01/2019	40 (9)	35 (3)	52 (0)	35 (1)	Already above 50 Compliance, increment <50
16/01/2019	56 (6)	40 (0)	52 (0)	46 (1)	Extraordinary event, excluded
17/01/2019	62 (13)	52 (0)	46 (0)	50 (1)	Extraordinary event, excluded
19/01/2019	36 (4)	35 (0)	55 (3)	33 (3)	Already above 50 Compliance, increment <50
27/01/2019	47 (7)	34 (1)	54 (0)	31 (0)	Already above 50 Compliance, increment <50
10/02/2019	53 (8)	50 (0)	57 (0)	47 (0)	Mine caused exceedance of 50 Compliance, increment <50
13/02/2019	67 (2)	62 (0)	76 (0)	73 (1)	Extraordinary event, excluded
18/02/2019	53 (6)	35 (4)	36 (0)	25 (2)	Mine caused exceedance of 50 Compliance, increment <50
19/02/2019	57 (9)	57 (0)	55 (1)	44 (1)	Extraordinary event, excluded
6/03/2019	74 (0)	79 (2)	81 (2)	69 (0)	Extraordinary event, excluded
11/03/2019	42 (1)	47 (0)	57 (1)	43 (0)	Already above 50 Compliance, increment <50
13/03/2019	51 (3)	30 (0)	55 (0)	31 (0)	Mine caused exceedance of 50 Compliance, increment <50
31/03/2019	47 (0)	48 (0)	65 (2)	60 (0)	Extraordinary event, excluded
1/05/2019	33 (0)	59 (0)	28 (0)	20 (0)	Already above 50 Compliance, increment <50

Exceedance day	Measured 24-hour average PM_{10} concentration in $\mu g/m^3$ (calculated site contribution in parentheses)				Determination
	D1 Muller	D2 Caban	D3 Coralie	D4 Thelander	
2/05/2019	39 (0)	59 (0)	28 (0)	19 (0)	Already above 50 Compliance, increment <50
24/05/2019	18 (0)	55 (3)	22 (0)	19 (0)	Already above 50 Compliance, increment <50
6/08/2019	11 (0)	54 (0)	16 (0)	10 (0)	Already above 50 Compliance, increment <50
9/08/2019	34 (0)	59 (2)	53 (15)	38 (0)	Extraordinary event, excluded
DA 305-7-2003 Modification 16 applies					
6/09/2019	65 (1)	112 (5)	97 (19)	70 (0)	Extraordinary event Compliance, increment <50
16/09/2019	37 (20)	64 (1)	47 (1)	25 (0)	Compliance, increment <50
4/10/2019	37 (6)	61 (4)	49 (3)	41 (3)	Compliance, increment <50
7/10/2019	64 (1)	65 (2)	56 (2)	62 (1)	Extraordinary event Compliance, increment <50
15/10/2019	54 (2)	38 (0)	36 (0)	40 (2)	Compliance, increment <50
16/10/2019	36 (2)	57 (1)	50 (2)	36 (0)	Compliance, increment <50
24/10/2019	49 (3)	72 (4)	49 (0)	42 (1)	Extraordinary event Compliance, increment <50
25/10/2019	27 (0)	63 (2)	42 (2)	33 (0)	Extraordinary event Compliance, increment <50
26/10/2019	66 (0)	158 (2)	96 (31)	69 (0)	Extraordinary event Compliance, increment <50
27/10/2019	60 (15)	55 (2)	57 (0)	42 (0)	Extraordinary event Compliance, increment <50
28/10/2019	59 (2)	39 (0)	55 (0)	44 (2)	Extraordinary event Compliance, increment <50
29/10/2019	73 (15)	53 (0)	54 (0)	54 (3)	Compliance, increment <50
30/10/2019	96 (7)	107 (5)	87 (0)	86 (1)	Extraordinary event Compliance, increment <50
31/10/2019	106 (14)	120 (3)	104 (11)	101 (0)	Extraordinary event Compliance, increment <50
1/11/2019	97 (13)	87 (3)	85 (0)	85 (1)	Extraordinary event Compliance, increment <50
2/11/2019	69 (1)	60 (2)	49 (0)	46 (0)	Extraordinary event Compliance, increment <50
3/11/2019	48 (0)	53 (0)	40 (5)	42 (0)	Compliance, increment <50

Exceedance day	Measured 24-hour average PM_{10} concentration in $\mu g/m^3$ (calculated site contribution in parentheses)				Determination
	D1 Muller	D2 Caban	D3 Coralie	D4 Thelander	
7/11/2019	54 (0)	84 (3)	71 (4)	68 (0)	Extraordinary event Compliance, increment <50
8/11/2019	58 (0)	75 (4)	71 (1)	73 (0)	Extraordinary event Compliance, increment <50
12/11/2019	88 (0)	142 (0)	108 (5)	106 (0)	Extraordinary event Compliance, increment <50
16/11/2019	69 (6)	78 (0)	71 (1)	71 (1)	Extraordinary event Compliance, increment <50
17/11/2019	74 (2)	87 (4)	82 (1)	89 (0)	Extraordinary event Compliance, increment <50
19/11/2019	75 (5)	71 (1)	49 (1)	42 (0)	Extraordinary event Compliance, increment <50
20/11/2019	71 (17)	62 (0)	51 (0)	73 (4)	Extraordinary event Compliance, increment <50
21/11/2019	117 (5)	120 (0)	116 (0)	116 (9)	Extraordinary event Compliance, increment <50
22/11/2019	109 (5)	115 (0)	93 (1)	103 (2)	Extraordinary event Compliance, increment <50
23/11/2019	59 (3)	66 (0)	58 (0)	76 (1)	Extraordinary event Compliance, increment <50
26/11/2019	152 (0)	203 (0)	171 (4)	200 (0)	Extraordinary event Compliance, increment <50
27/11/2019	68 (15)	47 (1)	49 (0)	58 (1)	Extraordinary event Compliance, increment <50
28/11/2019	120 (14)	147 (0)	135 (0)	119 (0)	Extraordinary event Compliance, increment <50
29/11/2019	104 (0)	130 (7)	108 (3)	121 (0)	Extraordinary event Compliance, increment <50
30/11/2019	80 (3)	87 (0)	74 (3)	77 (0)	Extraordinary event Compliance, increment <50
1/12/2019	68 (3)	74 (0)	73 (4)	79 (0)	Extraordinary event Compliance, increment <50
2/12/2019	55 (0)	90 (0)	86 (14)	81 (0)	Extraordinary event Compliance, increment <50
3/12/2019	37 (0)	63 (0)	50 (8)	43 (0)	Extraordinary event Compliance, increment <50
5/12/2019	42 (0)	68 (0)	53 (4)	55 (0)	Extraordinary event Compliance, increment <50

Exceedance day	Measured 24-hour average PM_{10} concentration in $\mu g/m^3$ (calculated site contribution in parentheses)				Determination
	D1 Muller	D2 Caban	D3 Coralie	D4 Thelander	
6/12/2019	64 (0)	115 (0)	104 (3)	78 (0)	Extraordinary event Compliance, increment <50
7/12/2019	216 (19)	157 (0)	243 (0)	167 (10)	Extraordinary event Compliance, increment <50
8/12/2019	74 (36)	14 (0)	58 (0)	12 (0)	Extraordinary event Compliance, increment <50
9/12/2019	94 (20)	68 (0)	85 (0)	68 (2)	Extraordinary event Compliance, increment <50
10/12/2019	149 (0)	197 (10)	150 (0)	208 (76)	Extraordinary event Potential non-compliance, increment >50 (investigated)
11/12/2019	134 (10)	142 (0)	142 (0)	50 (3)	Extraordinary event Compliance, increment <50
12/12/2019	98 (0)	128 (0)	113 (0)	128 (30)	Extraordinary event Compliance, increment <50
13/12/2019	41 (2)	51 (0)	40 (0)	36 (2)	Extraordinary event Compliance, increment <50
14/12/2019	95 (8)	103 (13)	87 (0)	96 (0)	Extraordinary event Compliance, increment <50
15/12/2019	54 (1)	81 (7)	66 (2)	59 (0)	Extraordinary event Compliance, increment <50
16/12/2019	75 (0)	110 (1)	73 (0)	122 (7)	Extraordinary event Compliance, increment <50
17/12/2019	40 (3)	41 (0)	40 (0)	51 (0)	Extraordinary event Compliance, increment <50
18/12/2019	78 (11)	61 (0)	61 (0)	60 (0)	Extraordinary event Compliance, increment <50
19/12/2019	102 (5)	176 (8)	102 (0)	93 (0)	Extraordinary event Compliance, increment <50
20/12/2019	78 (2)	83 (0)	58 (0)	60 (4)	Extraordinary event Compliance, increment <50
21/12/2019	119 (0)	192 (4)	132 (7)	117 (0)	Extraordinary event Compliance, increment <50
22/12/2019	78 (6)	66 (0)	55 (0)	58 (7)	Extraordinary event Compliance, increment <50
23/12/2019	53 (6)	50 (0)	44 (0)	38 (1)	Extraordinary event Compliance, increment <50

Exceedance day	Measured 24-hour average PM_{10} concentration in $\mu g/m^3$ (calculated site contribution in parentheses)				Determination
	D1 Muller	D2 Caban	D3 Coralie	D4 Thelander	
27/12/2019	84 (7)	63 (0)	71 (0)	69 (11)	Extraordinary event Compliance, increment <50
28/12/2019	74 (6)	72 (7)	66 (0)	67 (1)	Extraordinary event Compliance, increment <50
29/12/2019	78 (1)	86 (7)	57 (0)	59 (1)	Extraordinary event Compliance, increment <50
30/12/2019	74 (3)	126 (3)	84 (0)	104 (0)	Extraordinary event Compliance, increment <50
31/12/2019	67 (3)	96 (2)	75 (6)	73 (0)	Extraordinary event Compliance, increment <50

For the period up to 28 August 2019, the air quality and meteorological monitoring data indicated that exceedances of 50 $\mu g/m^3$ (24-hour average PM_{10}) were likely to have been influenced by activities at Wambo Mine on 4 of the 20 exceedance days. None of the calculated site contributions were above Wambo Coal's Development Consent acquisition criterion that was applicable during this period.

For the period from 29 August to 31 December 2019, the air quality and meteorological monitoring data indicated that there was potentially one day, 10 December, when the calculated site contribution exceeded the 50 $\mu g/m^3$ incremental criterion. This day was declared as an extraordinary event and measured 24-hour average PM_{10} concentrations at all Wambo monitoring sites were in the order of 150 to 200 $\mu g/m^3$. The calculated site contribution was 76 $\mu g/m^3$ and the conditions on this day have been further investigated.

Figure 4 shows the measured hourly average PM_{10} concentrations on 10 December 2019 as well as the concurrent wind conditions. These data show that the PM_{10} concentrations at the downwind monitor (D4 Thelander) deviated most significantly from the concentrations at the upwind monitors (D2 Caban and D3 Coralie) at around 11 pm. This deviation led to the calculated site contribution of 76 $\mu g/m^3$, averaged over the 24-hours, based on the methodology described in Section 2.

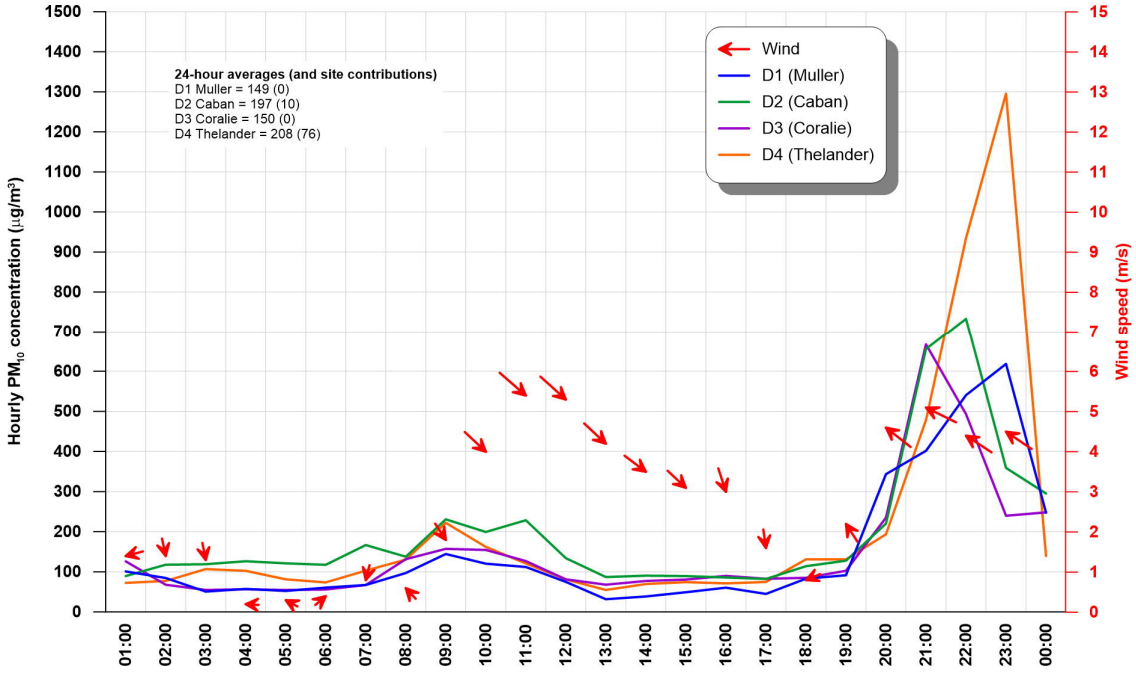


Figure 4 Hourly PM_{10} concentrations and wind conditions on 10 December 2019

Wambo Coal has provided a copy of the production report for 10 December 2019. Of relevance to managing impacts to air quality, this report showed that:

- The first bucket was at approximately 5:10 am and the last bucket was at 8:30 pm for all excavators.
- All trucks loads were on standby for the majority of the shift and worked between 0.6 and 7 hours of the 12 hour shift (depending on the truck).
- The open cut pit shut at 8:30 pm and the underground shut at 9 pm for “smoky conditions due to regional bush fire event”. Observations were of “extreme haze, poor visibility, poor respiratory conditions”.
- Observed conditions included “Extreme heat 40+ degrees with a cool change coming in”.
- All available [water carts] x4 utilised and running to procedure.
- The dust monitoring records in the production report indicated elevated levels until 1 am.

The production logs indicated that all reasonable and feasible avoidance and mitigation measures were employed so that particulate matter emissions generated by the Wambo Mine did not cause exceedances of the criteria. As such, 10 December 2019 would not represent a non-compliance of Wambo Coal’s 50 µg/m^3 criterion.

Annual average PM_{10} concentrations have also been examined and these results were included in Table 7. As noted in Section 1, the annual average PM_{10} criterion was revised from 30 µg/m^3 to 25 µg/m^3 on 29 August 2019 as part of Modification 16.

The two periods relating to the applicable criteria, 1 January to 28 August and 29 August to 31 December, represented 66% (240 days) and 34% (125 days) of one year respectively. Excluding extraordinary events the two periods represented 63% (231 days) and 19% (68 days)

of one year respectively. These percentages do not meet the minimum 90% data capture rate that is required for applications of air quality data analysis (see for example EPA 2016 and US EPA 2000) and are consequently not appropriate to reflect annual averages. Therefore a determination of compliance has been made by comparing the averages for the full year, excluding extraordinary events, with the revised criterion (25 µg/m^3). This comparison, from Table 7, shows that the measured average PM_{10} concentrations, based on 82% (299 days) of one year, did not exceed 25 µg/m^3 at any of the four monitors.

5. Monitored $PM_{2.5}$ Results

Figure 3 shows all measured 24-hour average $PM_{2.5}$ concentrations at Singleton (part of the UHAQMN). All days above 25 µg/m^3 were measured between October and December which, as noted in Section 3, were mainly related to extraordinary events.

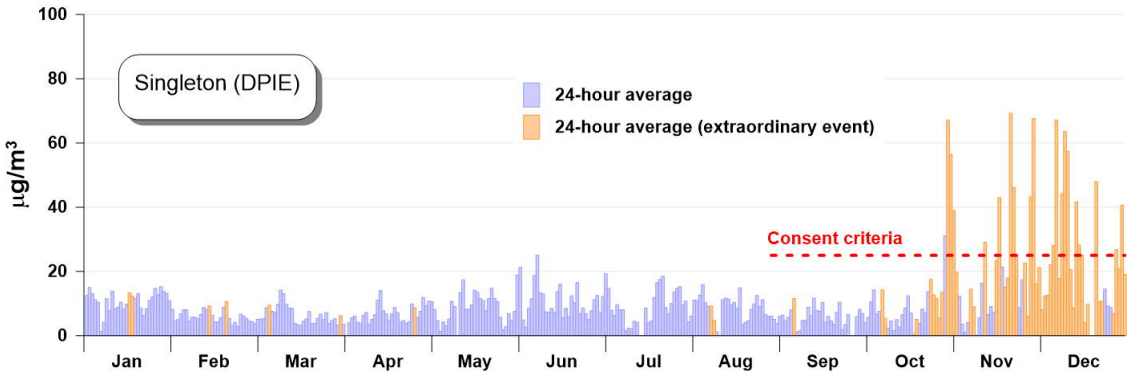


Figure 5 Measured 24-hour average PM_{10} concentrations

Table 9 summarises the $PM_{2.5}$ data. There were 20 days when the monitored $PM_{2.5}$ concentration exceeded 25 µg/m^3 at the Singleton station and 19 of these days were declared as extraordinary events. One day, 29 October 2019, recorded 31 µg/m^3. Air quality conditions on 29 October 2019 would have been influenced by the bushfire activity in late October given that 24 to 28 October and 30 October to 2 November were declared as extraordinary events and because $PM_{2.5}$ particles remain airborne for a longer period of time than PM_{10}. The annual average $PM_{2.5}$ concentration for both 1 Jan to 31 Dec and 29 Aug to 31 Dec did not exceed the 8 µg/m^3 criterion. It has been inferred that $PM_{2.5}$ concentrations in the vicinity of Wambo Mine would also have been below the 8 µg/m^3 criterion.

Table 9 Summary of measured $PM_{2.5}$ concentrations in 2019

Statistic	All data	All data except extraordinary events
	Singleton	Singleton
1 Jan to 31 Dec (365 days)		
Maximum 24-hour average (µg/m^3)	69	31
Number of days above 25 µg/m^3	20	1
Average (µg/m^3)	11	8
Days of data available	356	299
29 Aug to 31 Dec (125 days)		
Maximum 24-hour average (µg/m^3)	69	31
Number of days above 50 µg/m^3	20	1
Average (µg/m^3)	16	7
Days of data available	121	68

6. Conclusions

The main conclusions of this monitoring data review were as follows:

- Late 2019 coincided with a period of unprecedented bushfires in Australia, predominantly across southeast Australia. These bushfires adversely affected air quality across many parts of NSW, including the Hunter Valley, and a total of 66 days in 2019 were subsequently declared as extraordinary events.
- Including extraordinary events, there were 79 unique days when the PM_{10} concentration exceeded 50 µg/m^3 at one or more monitoring locations; 20 days up to 28 August 2019 and 59 days from 29 August 2019 to 31 December 2019.
- For the period up to 28 August 2019, exceedances of 50 µg/m^3 (24-hour average PM_{10}) were likely to have been influenced by activities at Wambo Mine on 4 of the 20 exceedance days. None of the calculated site contributions were above the applicable Development Consent acquisition criterion.
- For the period from 29 August to 31 December 2019, there was one day, 10 December, when the calculated site contribution exceeded the 50 µg/m^3 incremental criterion. This day was declared as an extraordinary event and measured 24-hour average PM_{10} concentrations at all Wambo monitoring sites were in the order of 150 to 200 µg/m^3. The calculated site contribution was 76 µg/m^3. The production logs indicated that all reasonable and feasible avoidance and mitigation measures were employed so that particulate matter emissions generated by the Wambo Mining Complex did not cause exceedances of the criteria. As such, this event did not represent a non-compliance of Wambo Coal's 50 µg/m^3 criterion.
- Average PM_{10} concentrations, excluding extraordinary events, did not exceed the 25 µg/m^3 annual average criterion.
- Monitored $PM_{2.5}$ concentrations at Singleton, excluding extraordinary events, did not exceed Wambo Coal's consent criteria. It has been inferred that $PM_{2.5}$ concentrations in the vicinity of Wambo Mine would also not have exceeded Wambo Coal's consent criteria.

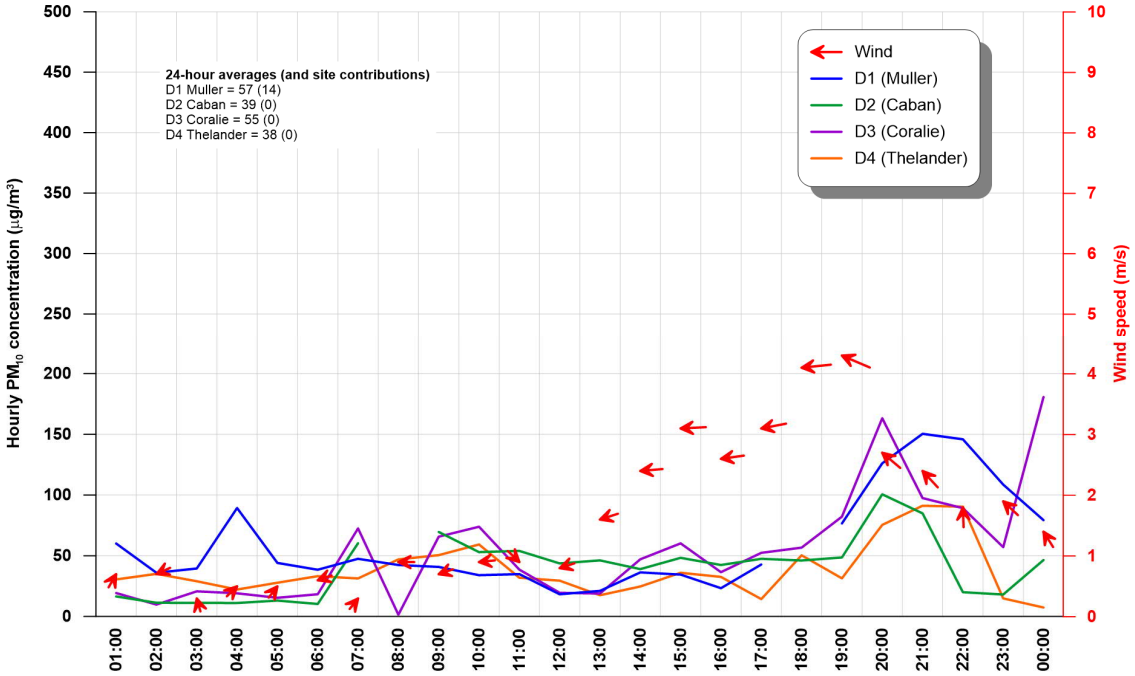
7. References

EPA (2016) “Approved Methods for the Modelling and Assessment of Air Pollutants in NSW”. Environment Protection Authority.

US EPA (2000) “Meteorological Monitoring Guidance for Regulatory Modeling Applications”. United States Environmental Protection Agency. Office of Air Quality, Planning and Standards, Research Triangle Park NC 27711. EPA-454/R-99-005, February 2000.

Appendix A Exceedance Day Analyses

2/01/2019



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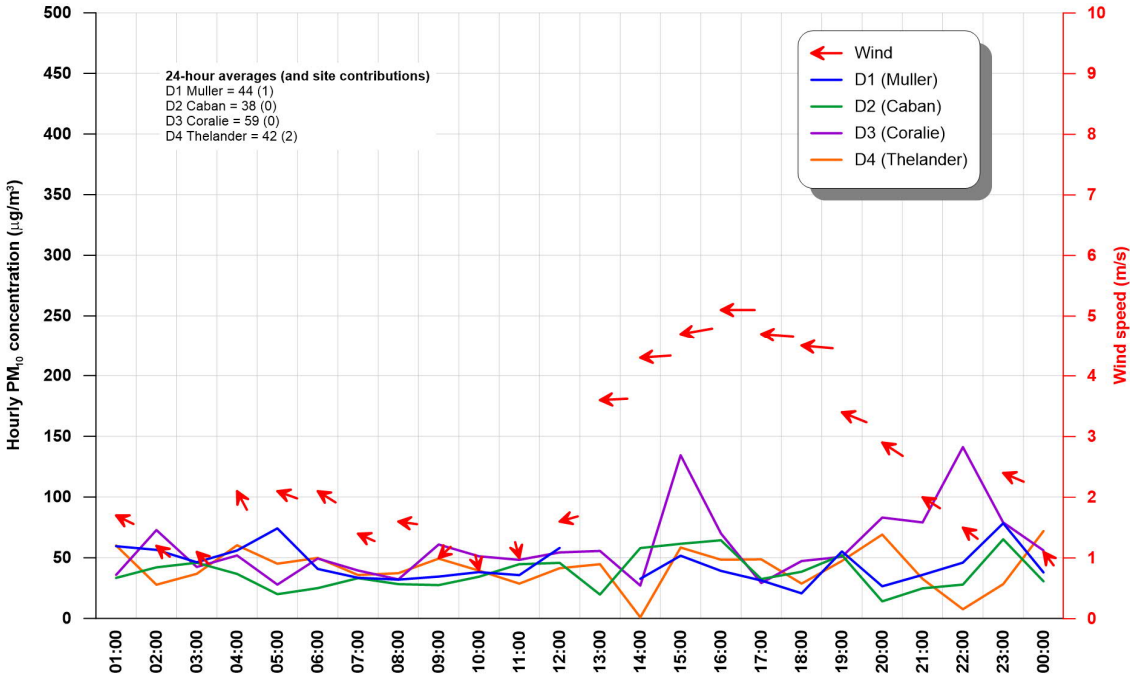

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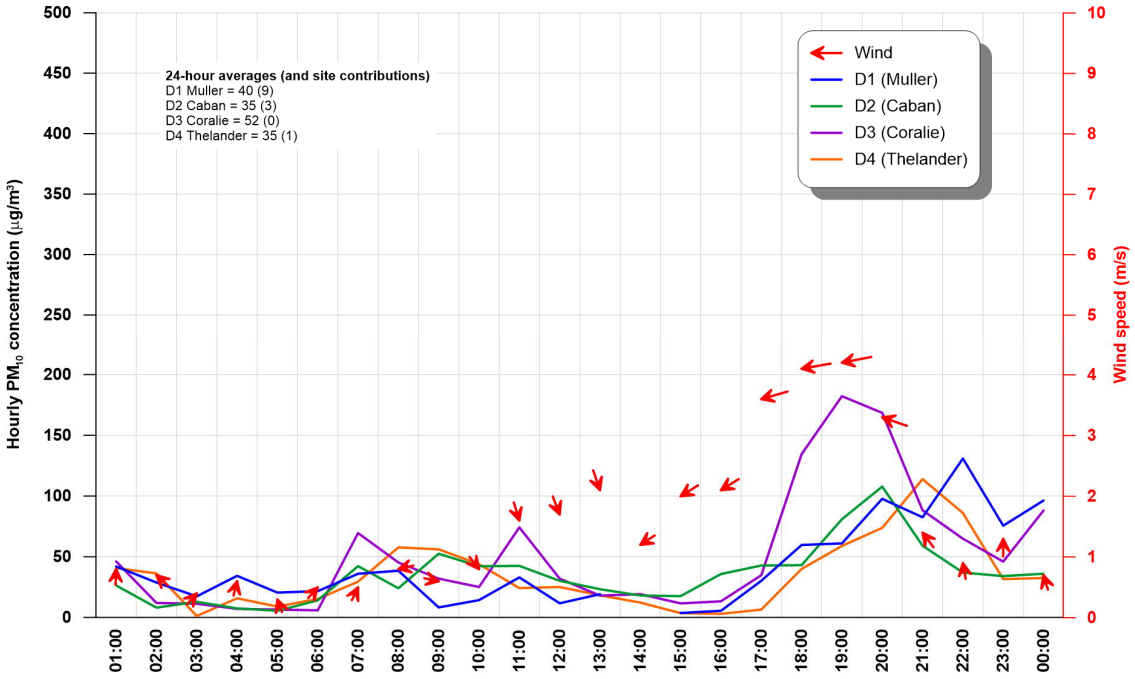

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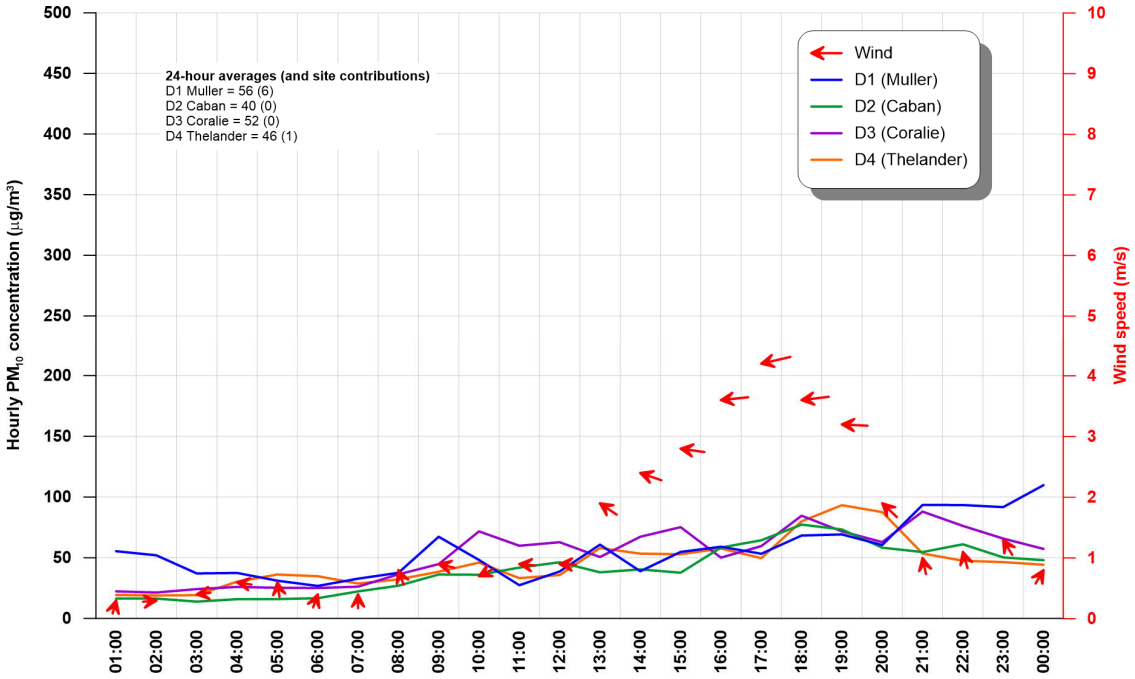

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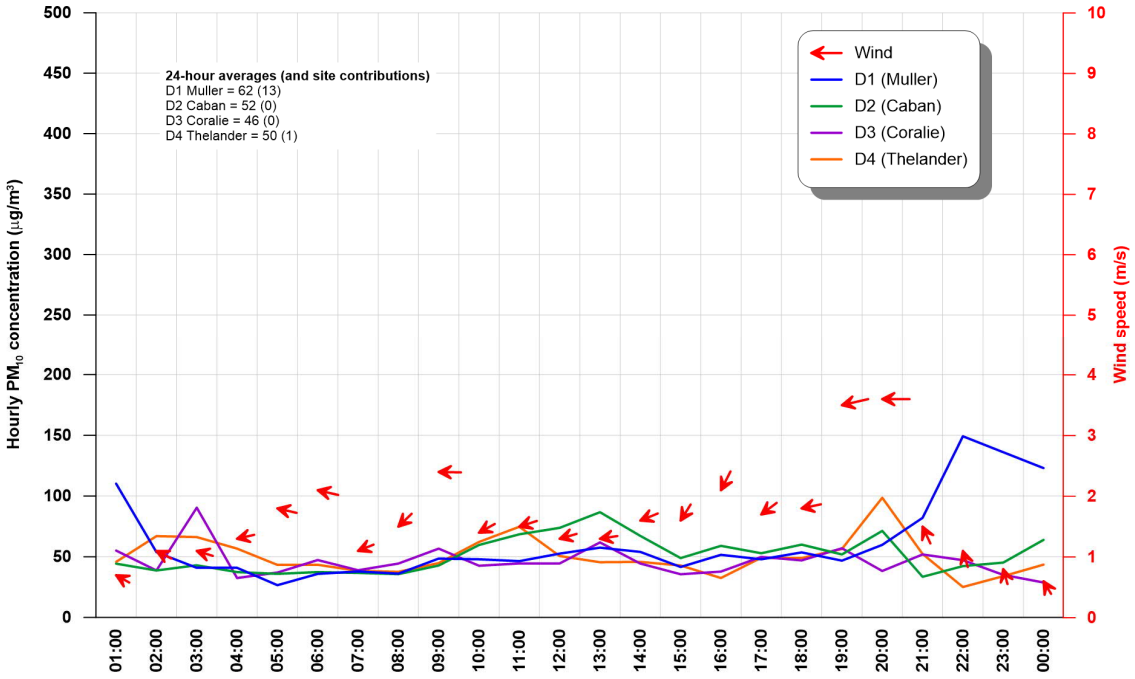

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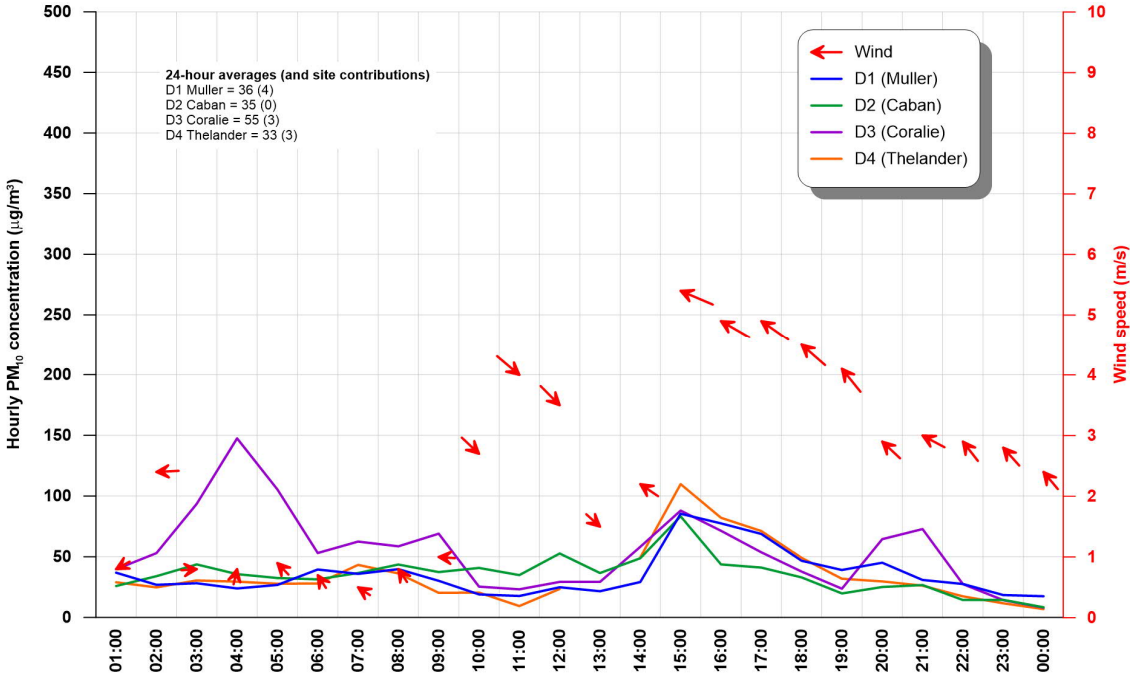

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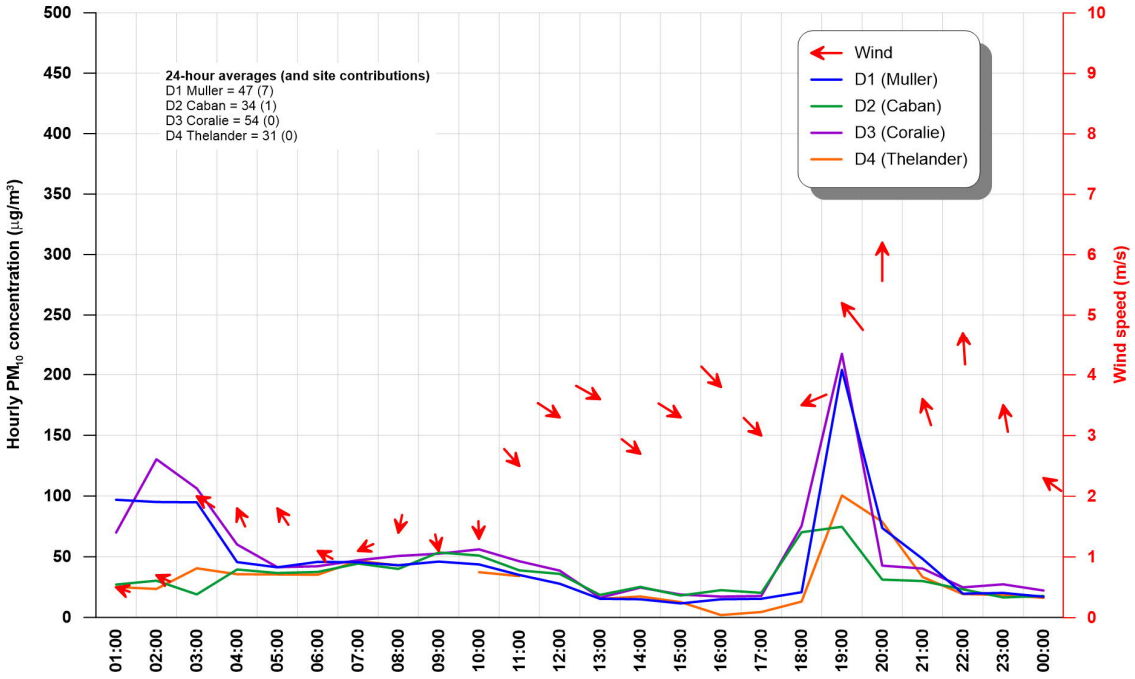

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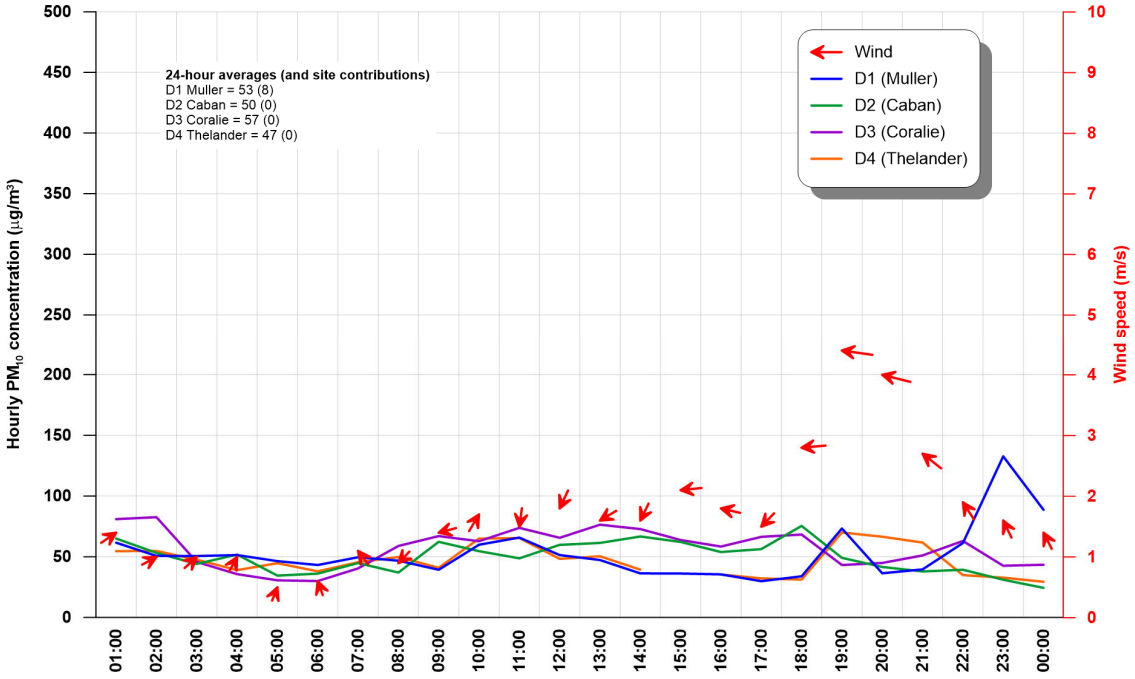

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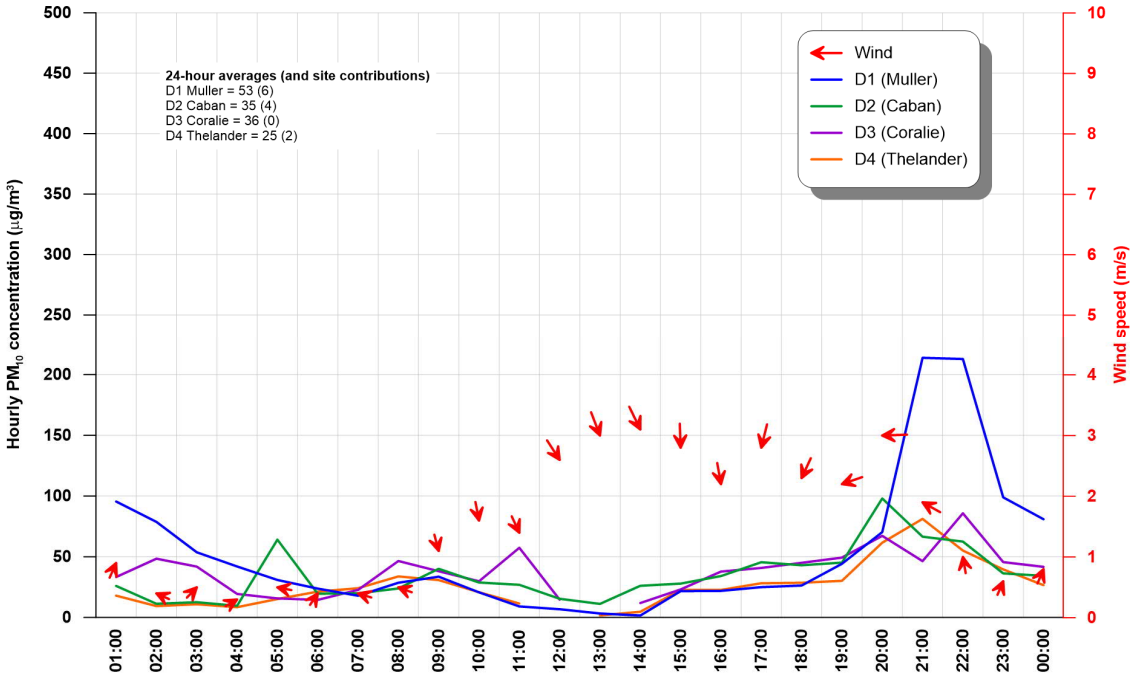

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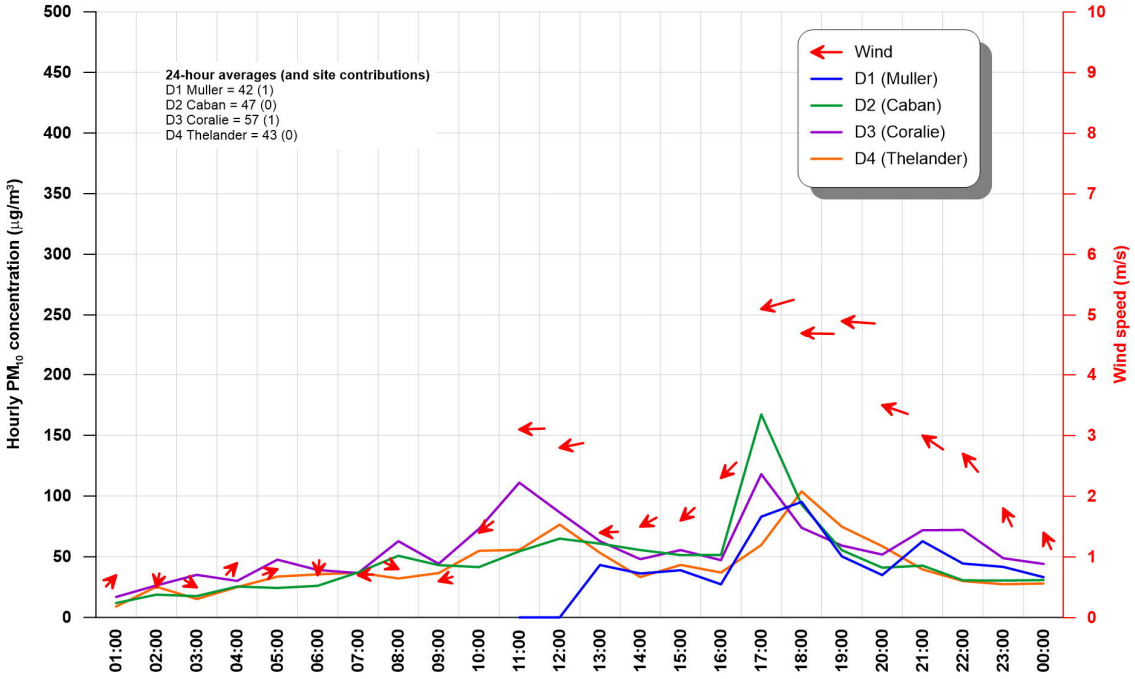

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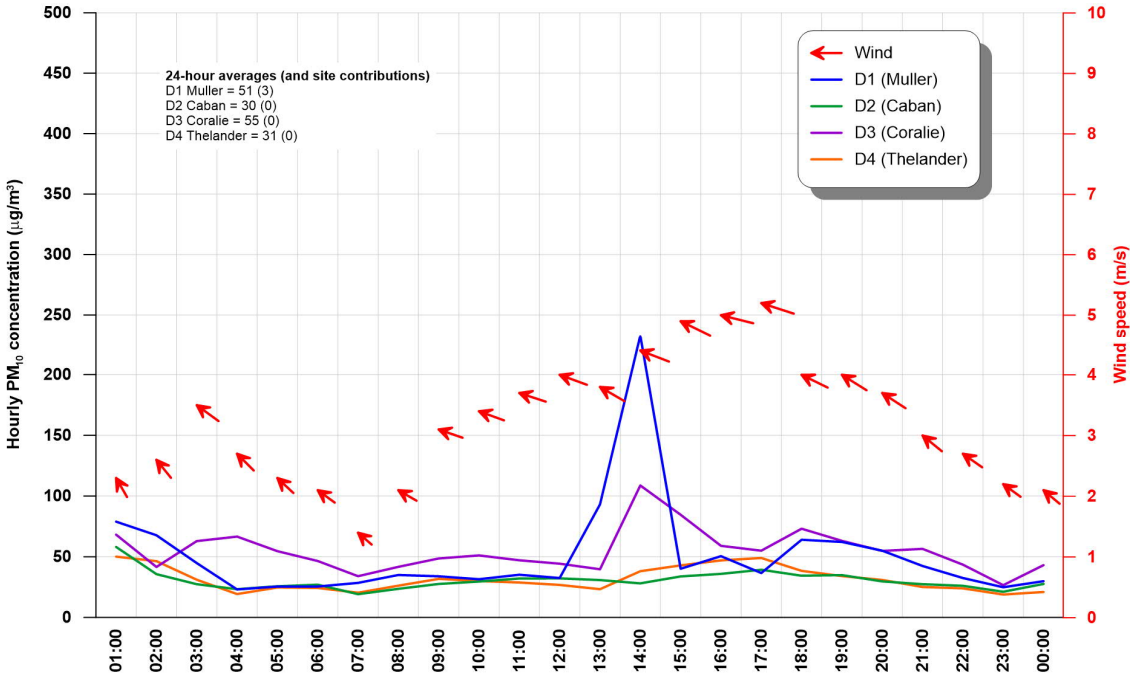

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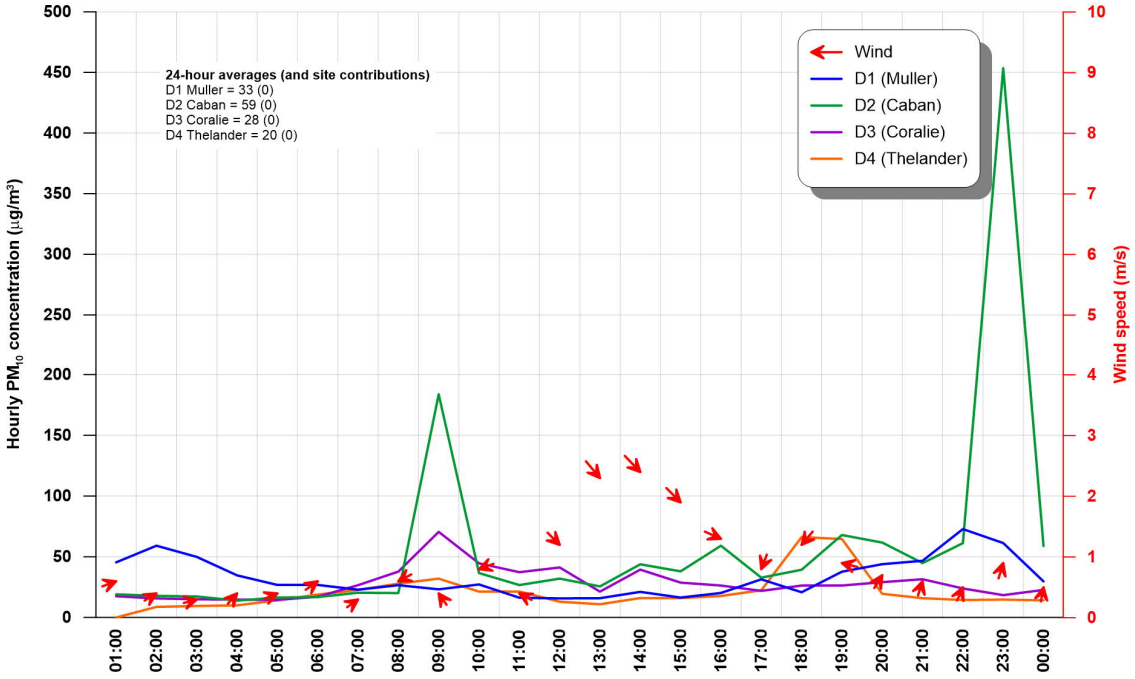

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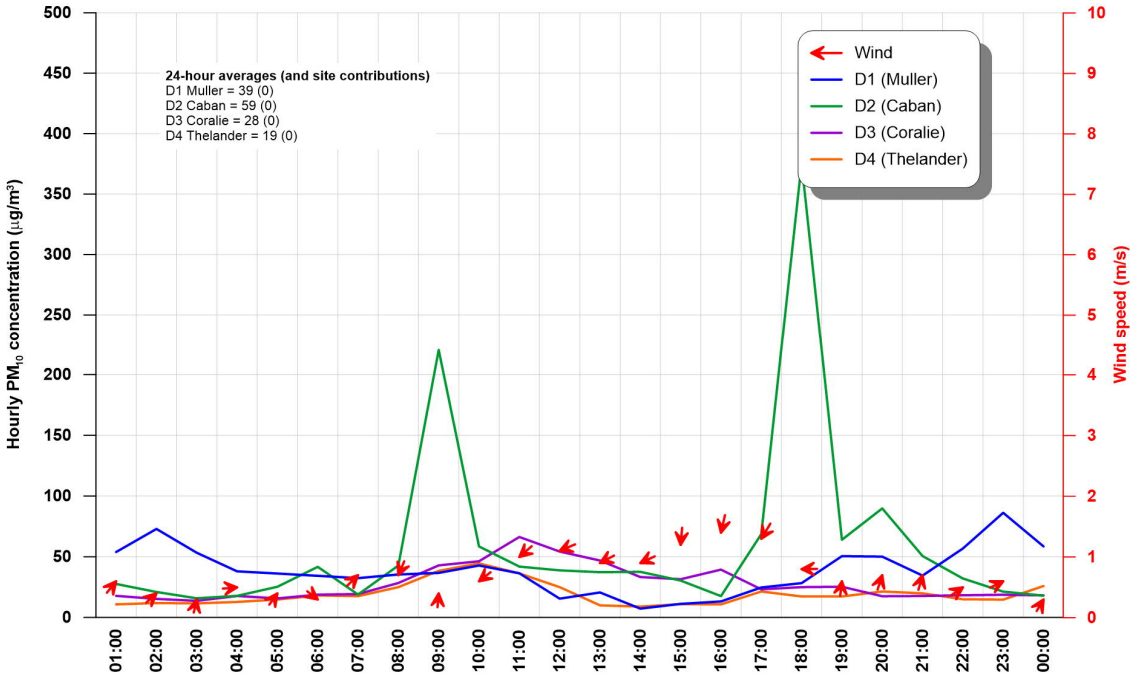

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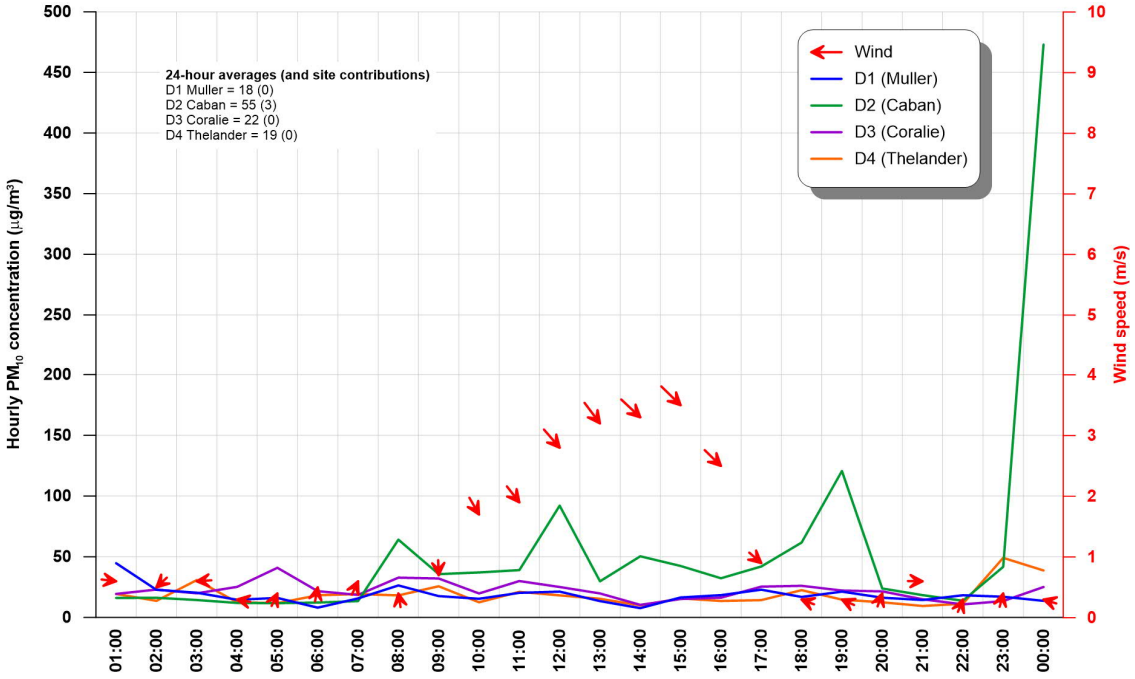

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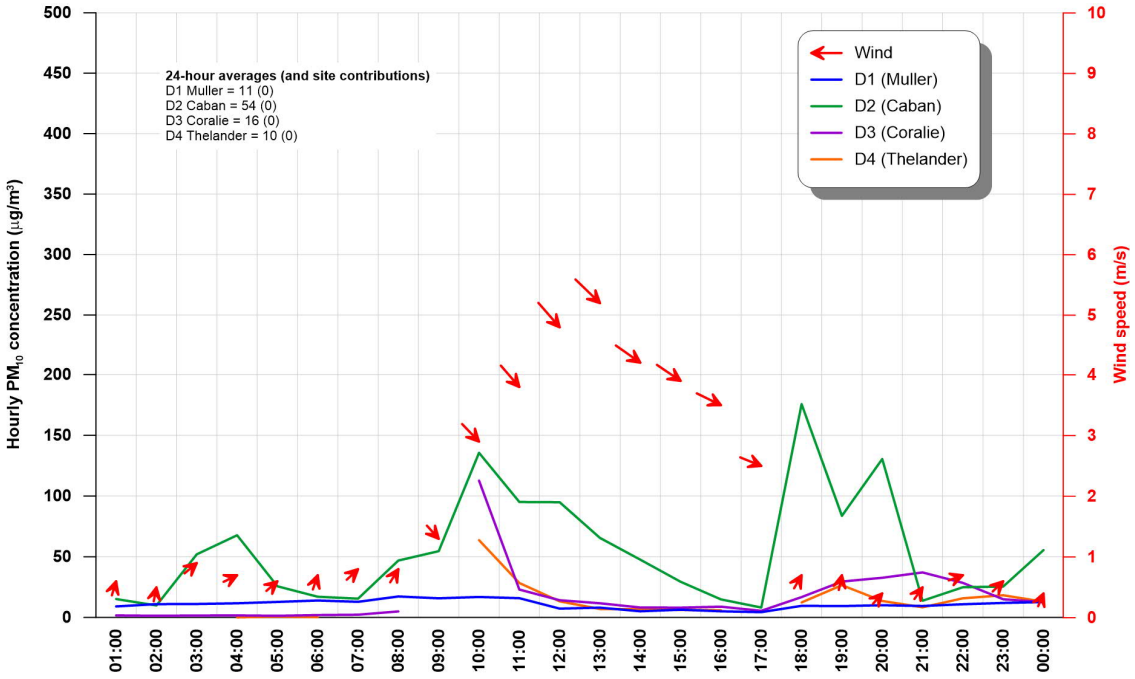

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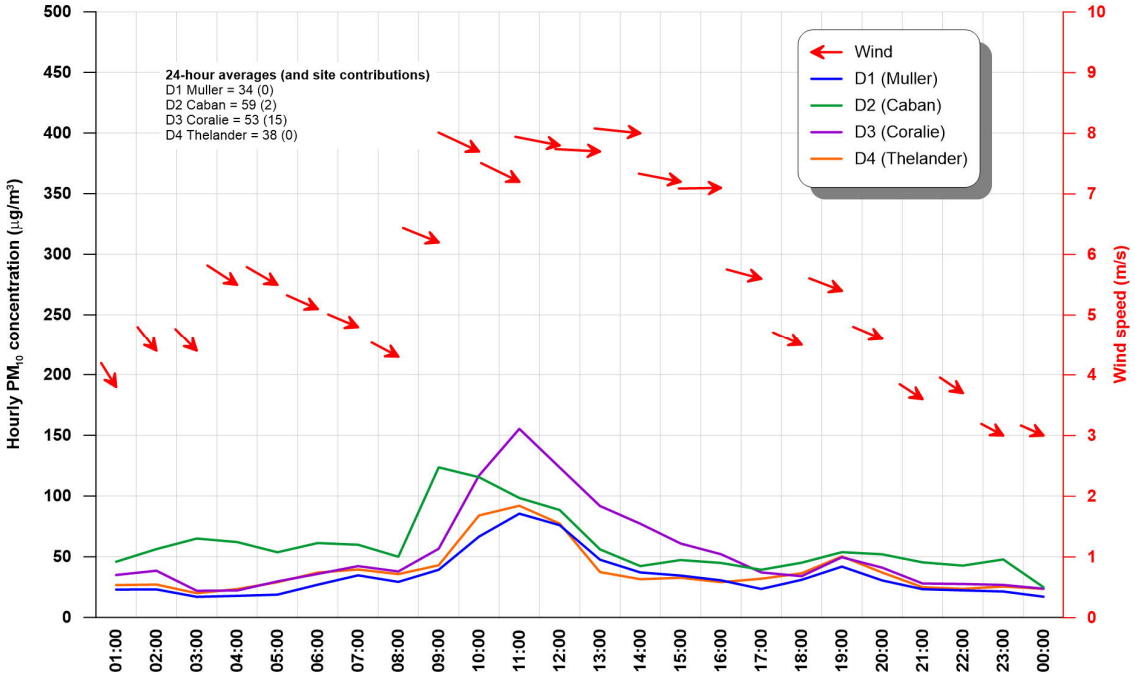

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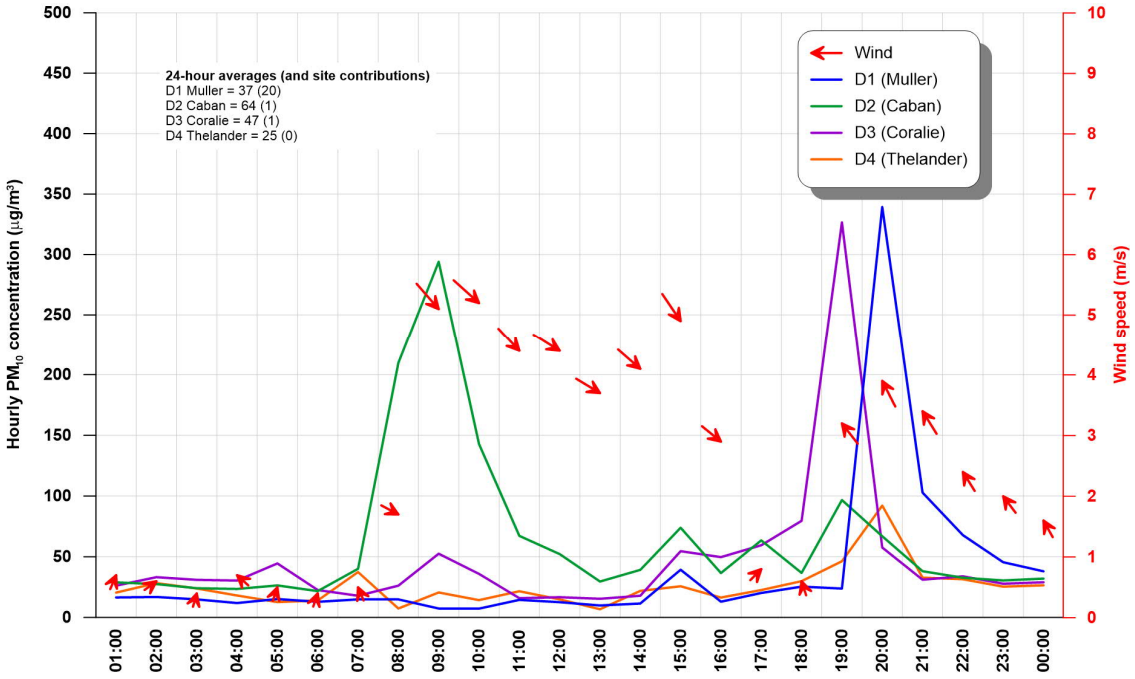

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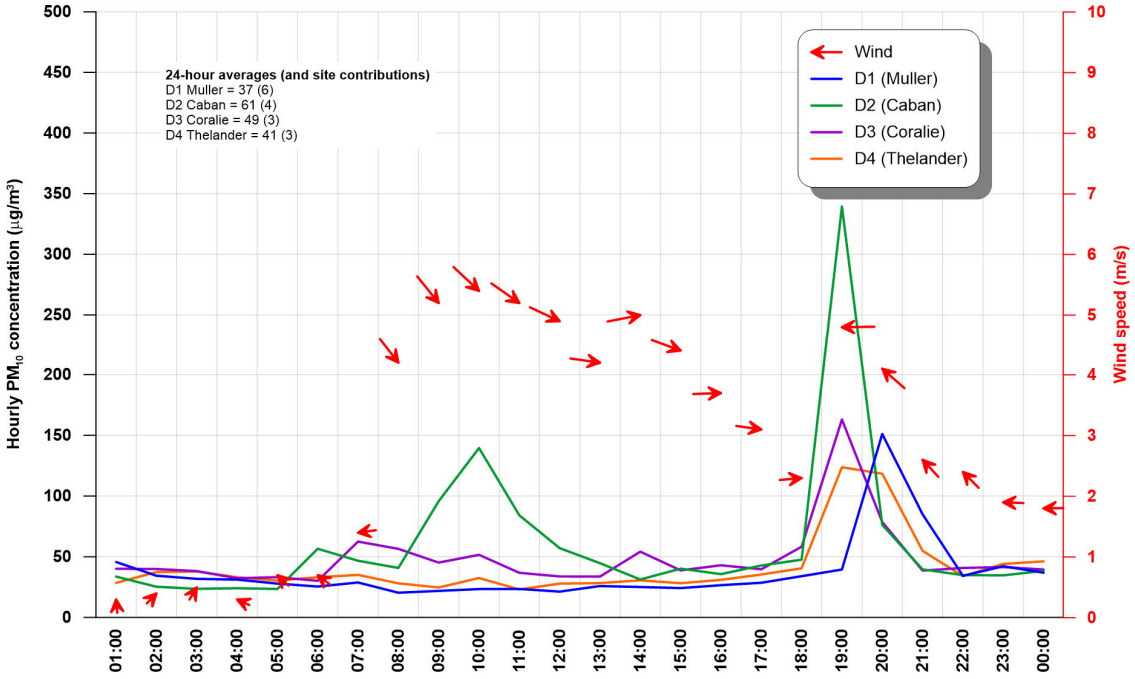

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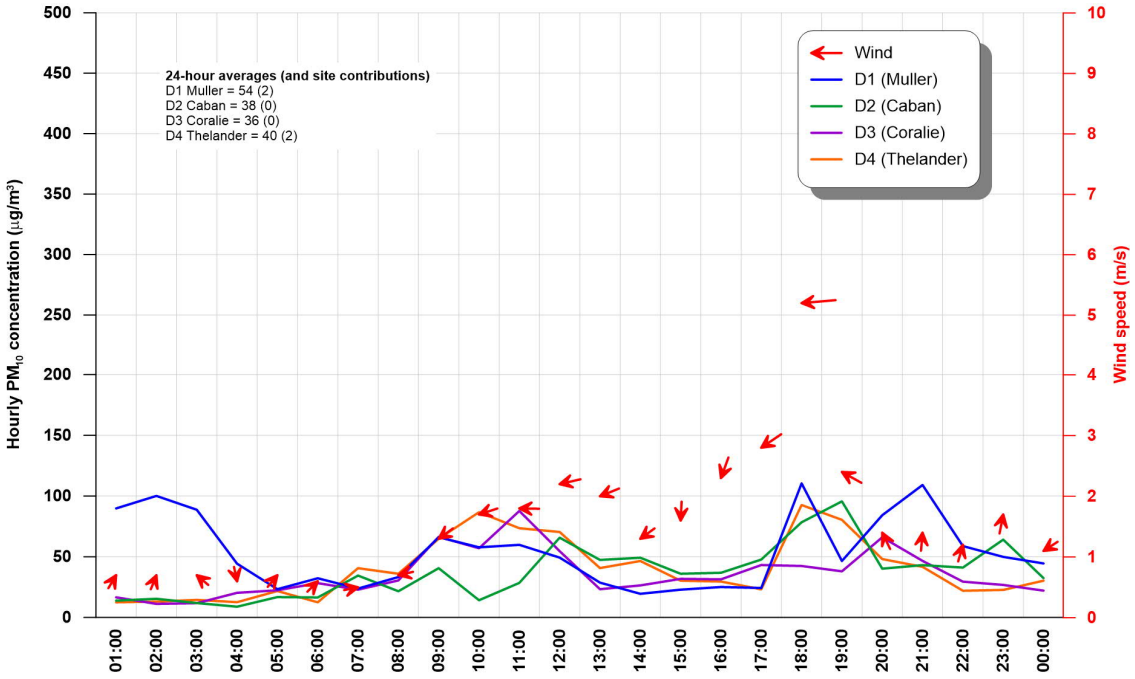

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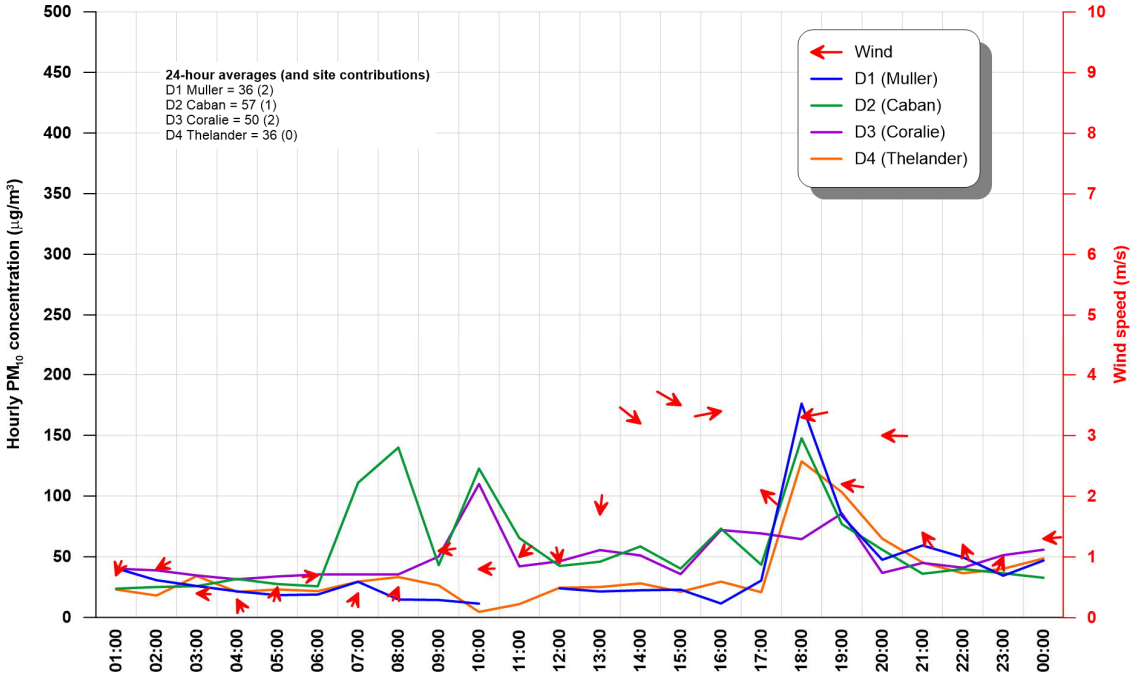

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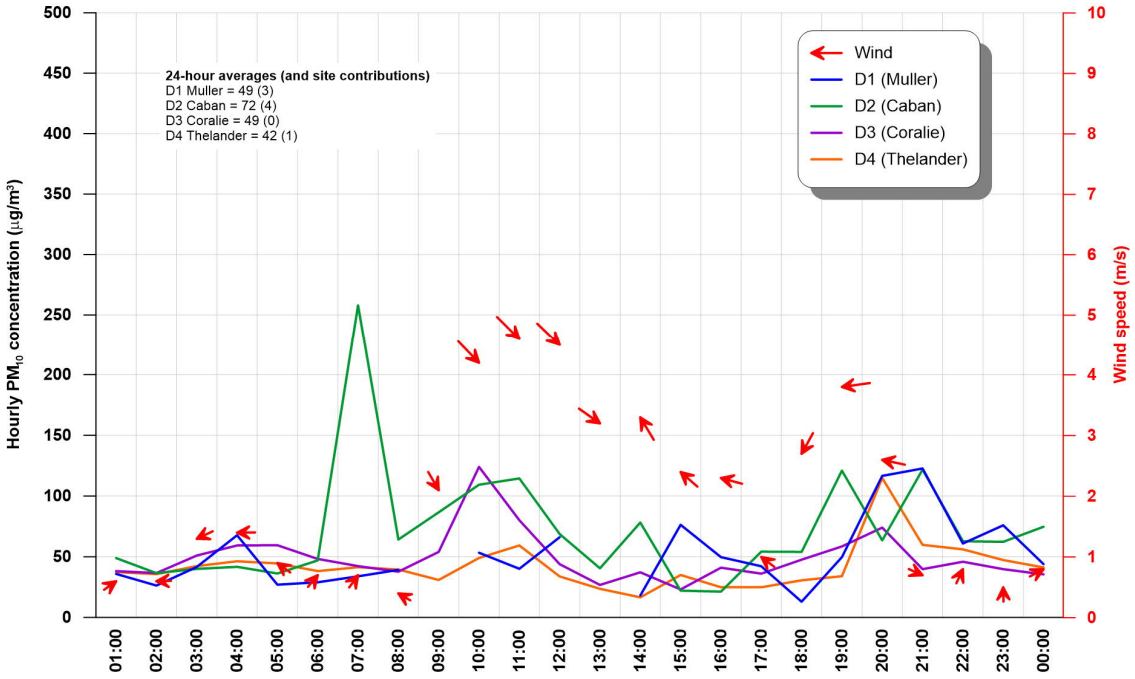

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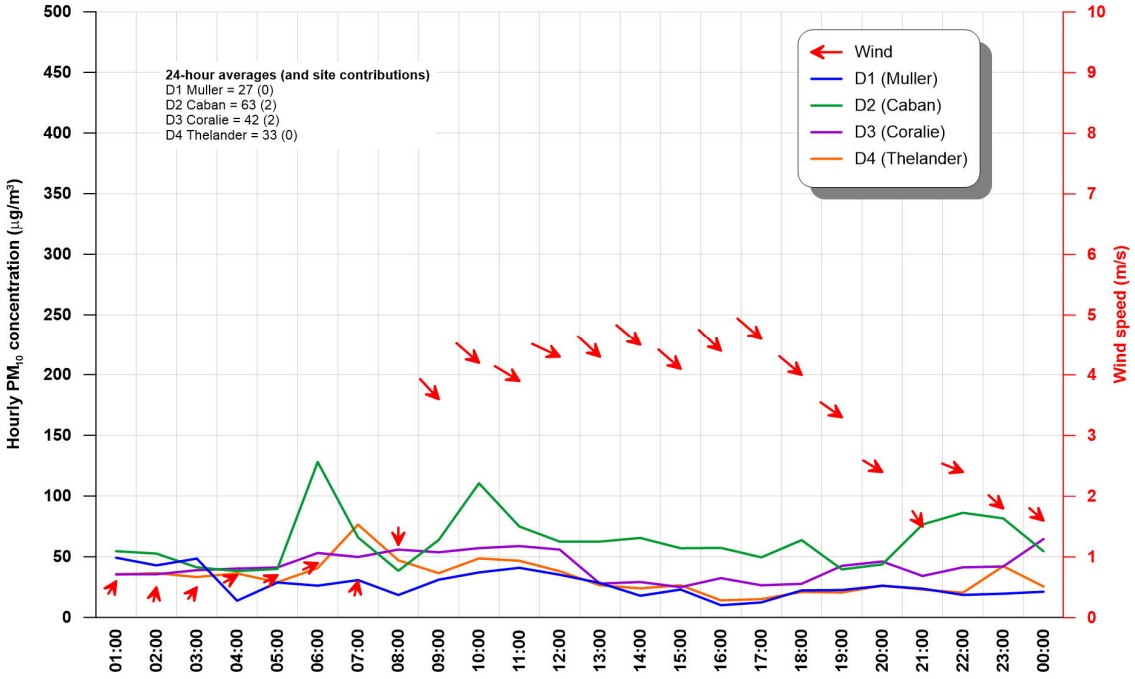

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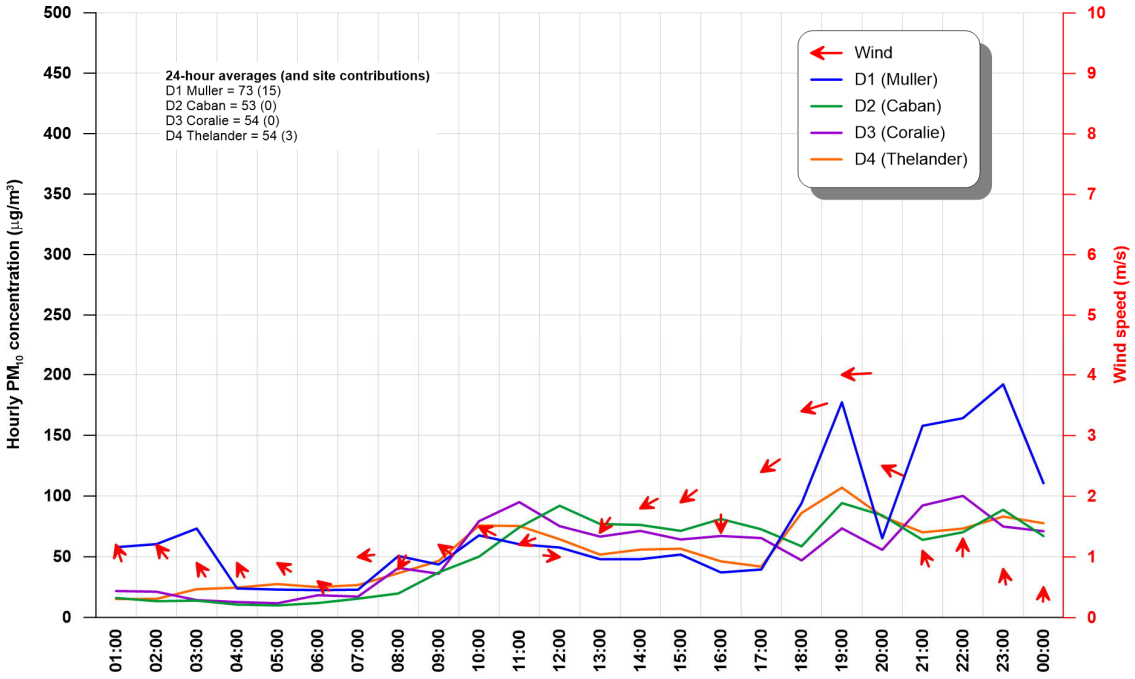

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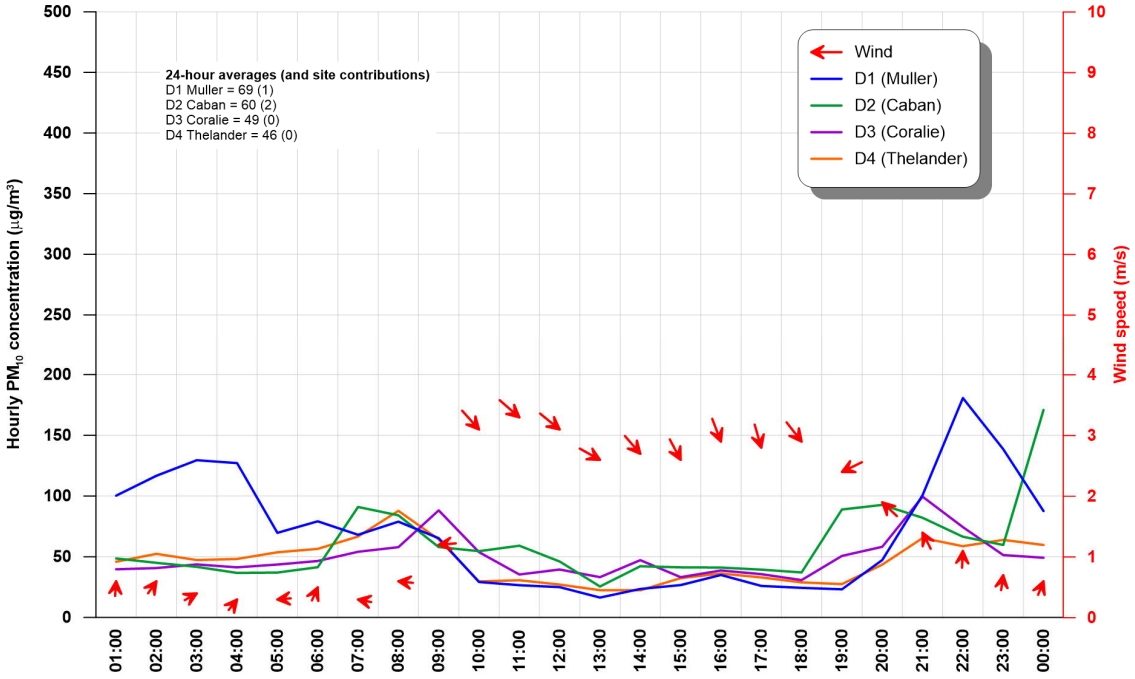

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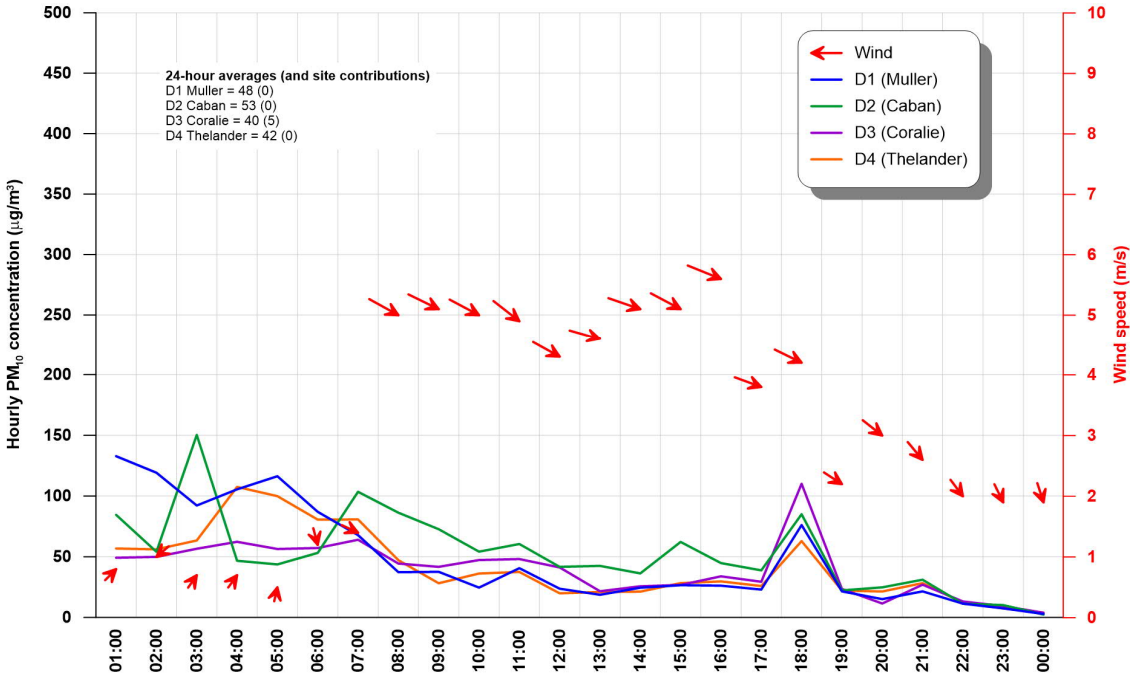

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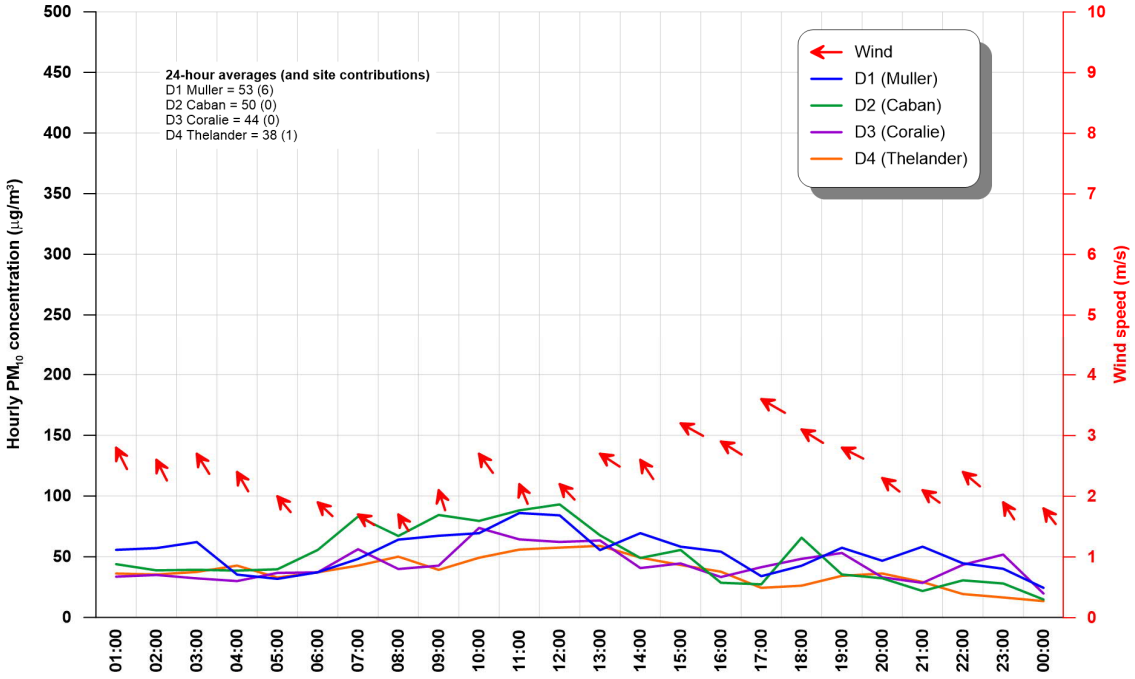

APPENDIX F

ANNUAL FLORA AND FAUNA MONITORING REPORT 2019

Wambo Coal Mine

Annual Flora and Fauna Monitoring Report 2019 – Volume 1

Wambo Coal Pty Ltd

ecological AUSTRALIA
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Template 2.8.1

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Abbreviations

Abbreviation	Description
AEMR	Annual Environmental Management Report
BC Act	NSW Biodiversity Conservation Act 2016
BS	Bare soil cover
BOA	Biodiversity Offset Area
BMP	Biodiversity Management Plan
BVT	Biometric Vegetation Type
CEEC	Critically Endangered Ecological Community
DBH	Diameter at Breast Height
DPI	NSW Department of Primary Industries
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EPBC Act	Federal Environment Protection and Biodiversity Conservation Act 1999
EPC	Exotic Plant Cover
FL	The length of Fallen Logs >10 cm diameter
GDE	Groundwater Dependent Ecosystem
HBT	Hollow-bearing Tree
INFI	Infiltration Index
LFA	Landscape Function Analysis
LI	Leaf litter cover
LOI	Landscape Organisation Index
NGCG	Native Ground Cover - Grasses
NGCO	Native Ground Cover - Other
NGCS	Native Ground Cover - Shrubs
NI	Nutrient Index
NMS	Native Mid-storey Cover – the projected native foliage cover of mid-storey (%)
NOS	Native Overstorey – the projected native foliage cover of canopy (%)
NPS	The number of Native Plant Species
OEH	NSW Office of Environment and Heritage
OR	Overstorey Regeneration
PCT	Plant Community Type
RWEA	Remnant Woodland Enhancement Area

Abbreviation	Description
RWEP	Remnant Woodland Enhancement Program
SI	Stability Index
SSA	Soil Surface Assessment
TEC	Threatened Ecological Community
VCA	Voluntary Conservation Area
WCPL	Wambo Coal Pty Ltd
WONS	Weed of National Significance

Executive summary

The Wambo Coal Mine annual flora and fauna monitoring program was undertaken by Eco Logical Australia (ELA) in 2019. Several different components make up this monitoring program. Floristic surveys, bird surveys, Landscape Function Analysis and riparian condition surveys were conducted during September 2019 across both remnant woodland and post-mining rehabilitation areas. Groundwater dependent ecosystem monitoring sites were also established, and baseline data collected during the 2019 spring monitoring period.

Remnant woodland sites within Remnant Woodland Enhancement Area (RWEA) areas are generally performing well, with reasonable numbers of native species, low cover of exotic species and suitable fauna habitat features. Native ground cover scores within several Plant Community Types (PCTs) were below performance targets, however this is considered to reflect the ongoing dry conditions – below average rainfall has been recorded for the past three years. No additional remedial activities are recommended within RWEAs. It is anticipated that these values will recover naturally after higher rainfalls, although weed management will be critical at this time to allow native species to recover.

Exotic species cover remains high in River Red Gum / River Oak riparian woodland where historic disturbance has been greatest. Some sites in this area exceed completion criteria and voluntary conservation area (VCA) targets for exotic plant cover and continued weed management will be required to achieve performance criteria in these riparian and floodplain areas. Plantings of canopy species could be considered in the open grassland areas of on the Wollombi Brook floodplain in RWEA A, where natural regeneration is unlikely to occur in a reasonable timeframe. Plantings may also assist weed control.

Bird survey results from remnant woodland sites reflected the good condition of these woodland areas with RWEA areas continuing to support a large diversity of birds including several threatened species. Bird diversity and communities were largely consistent with the data available from previous monitoring years and bird abundance was the highest recorded to date.

The North Wambo Creek Diversion has not yet met completion criteria for landscape function and this area will require continued active management actions to ensure that all completion criteria and other commitments are met in the near future. Gully erosion and areas of bare soil exceeding completion criteria were recorded.

Woodland rehabilitation areas generally met landscape function completion criteria, having a high cover of resource trapping leaf litter but fell below biometric completion criteria, with monitoring sites having relatively few native species and almost no groundcover or mid-storey. Recommendations to improve woodland rehabilitation areas have been presented by ELA in previous monitoring reports and include focussing on the correct application of subsoil and topsoil and consideration of species diversity, structural diversity, local provenance as well as species performance in new areas of woodland rehabilitation.

Pasture rehabilitation areas are generally meeting landscape function performance targets for all attributes with the exception of landscape organisation, which showed improvement from the previous

two years. Some patches of bare soil within pasture rehabilitation areas exceed completion criteria and require active management to aid the establishment of vegetation and reduce erosion.

Riparian condition scores for North Wambo Creek, Wambo Creek and Stony Creek have stabilised after declines were recorded in 2018 and were slightly higher in all three creeks in 2019. Understorey vegetation remains stressed due to drought conditions, however sites without evidence of grazing pressure appeared to have greater understorey cover and more stable soils. Recommendations from previous monitoring reports, such as preventing stock from accessing riparian areas and planting native trees in over-cleared areas are likely to improve condition of these riparian areas.

Subsidence was observed in several locations across the site including RWEA C, however no significant effects on flora and fauna or performance criteria exceedances were recorded. Repairs to tracks and subsidence cracks were observed within RWEAs. Monitoring should continue to document and assess subsidence impacts across the site.

1. Introduction

Wambo Coal Pty Limited (WCPL) is situated approximately 15 kilometres (km) west of Singleton, near the village of Warkworth, New South Wales (NSW). A range of open cut and underground mine operations have been conducted at WCPL since mining operations commenced in 1969. Mining under the current Development Consent (DA 305-7-2003) commenced in 2004 and permits both open cut, underground operations and associated activities to be conducted. As part of the development consent, a Remnant Woodland Enhancement Program (RWEP) has been established as a biodiversity offset for lands disturbed by open cut coal mining activities. The RWEP aims to conserve local and regional biodiversity by protecting and enhancing the habitat for flora and fauna within these areas through a conservation agreement.

HLA - Envirosciences Pty Ltd initially established a program to monitor the fauna and vegetation structure within the RWEP areas, as well as to monitor stream and riparian condition within North Wambo, Wambo and Stony Creeks, with the aim of measuring and documenting the status and change in ecological condition. Eco Logical Australia (ELA) was commissioned by WCPL to undertake this monitoring program during spring 2019. This monitoring program is conducted in response to the 2004 Development Consent condition (DA 305-7-2003 Schedule 4 Condition 48) and informs WCPL's Annual Environmental Management Report (AEMR).

ELA's scope of works was to:

- collect floristic and fauna habitat data from established monitoring locations throughout land owned by WCPL, including remnant woodland enhancement areas (RWEA) (otherwise known as Biodiversity Offset Areas (BOA) or Voluntary Conservation Areas (VCA))
- conduct Landscape Function Analysis (LFA) at established sites along the North Wambo Creek Diversion and mine rehabilitation areas
- conduct riparian condition monitoring at North Wambo, South Wambo and Stony Creeks
- conduct bird monitoring at established monitoring locations throughout land owned by WCPL, primarily in land set aside as part of the RWEP
- report on any mine subsidence observations
- document results and compare to performance criteria or past results (where relevant) and identify what and where management actions may be required.
- provide a summary of management actions.

1.1 Report structure

This report has been set out in the following manner:

- **Key findings –** summary of the key findings of the monitoring works
- **Introduction –** provides background information to the current report
- **Remnant woodland enhancement areas (RWEAs) –** provides methods, results and interpretation of data, as well as recommendations from flora and bird surveys primarily within RWEA areas
- **Rehabilitation areas –** provides methods, results and interpretation of data from LFA and biometric flora survey plots (woodland rehabilitation only) from the North Wambo Creek Diversion and areas of post-mining land rehabilitation
- **Riparian condition assessment –** provides methods, results and interpretation of data, as well as management recommendations for riparian transects at North Wambo, Wambo and Stony Creeks
- **Groundwater Dependent Ecosystem monitoring –** provides methods, and baseline data for monitoring of Groundwater Dependent Ecosystems at WCPL, undertaken for the first time in 2019
- **Mine subsidence observations and other management issues –** provides observations of mine subsidence and other management issues on land owned by WCPL
- **Summary of management actions –** provides a summary of required and recommended actions.

Raw data and photographs from monitoring sites are included in **Volume 2**.

2. Remnant Woodland Enhancement Areas (RWEAs)

2.1 Floristic monitoring

2.1.1 Introduction

The aim of floristic and fauna habitat monitoring is to measure the current condition of vegetation within the RWEA's in terms of floristics and habitat complexity. The results aim to provide direction to management of these areas and for the monitoring program in the future.

2.1.2 Methods

Data was collected by ELA ecologists Lily Gorrell and Liam Scanlan from 23-27 and 30 September 2019. A standard biometric plot 50 x 20 m (**Figure 1**) was used to measure the following parameters and collect data following the BioBanking methodology (DECC 2008a):

- full floristic species list (including cover abundance scores) in a nested 0.04 ha plot (20 m x 20 m)
- canopy regeneration over whole vegetation zone
- estimation of projected native foliage cover of ground cover from 50 points and canopy and mid-storey layer from 10 points along the 50 m transect
- occurrence and abundance of weed species in 0.04 ha plot (20 m x 20 m)
- number of hollow-bearing trees and length of logs (>10cm diameter) in the plot
- photograph of each plot (at start of 50 m transect).

The abundance of each species in the 0.04 ha plot was estimated, using a modified Braun-Blanquet scale, as used in previous floristic monitoring at WCPL. These are listed below:

- 1 = few, small cover (<5%)
- 2 = numerous (<5%)
- 3 = 5 – 25%
- 4 = 25 – 50%
- 5 = 50 – 75%
- 6 = >75%.

All vascular plants species were recorded and identified to the lowest taxonomic level possible, with samples of unknown species collected for further identification where possible. Nomenclature followed the Flora of New South Wales (Harden 1992; 1993; 2000; 2002), and any subsequent recent taxonomic changes as presented on PlantNet (RBGDT 2015).

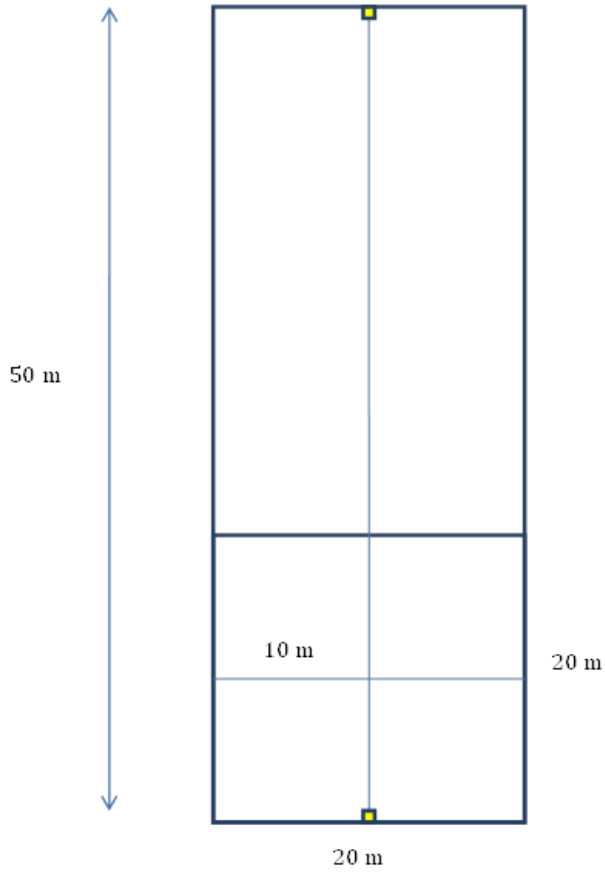


Figure 1: Biometric vegetation plot dimensions

Flora monitoring plots were located within the ten vegetation communities originally mapped and described by Orchid Research (2003). Since this time, a number of changes in vegetation mapping standards in NSW have occurred. Previously a set list of plant communities known as Biometric Vegetation Types (BVT) were used as a state-wide standard by the NSW Office of Environment and Heritage (OEH). These BVTs have now been modified and are now known as Plant Community Types (PCT's). As such, the ten vegetation communities originally mapped and described by Orchid Research (2003) have been converted to their equivalent PCT within this report. Several of these communities are also listed under both State and Federal legislation as Endangered Ecological Communities (EECs) under different nomenclature. **Table 1** clarifies the conversion of vegetation communities.

Data was collected from the 34 locations previously surveyed as part of this monitoring program, with the exception of site V13-B1, which was moved slightly to the north-west to better sample the intended vegetation community during monitoring undertaken in 2016. Plot locations are shown in **Figure 2**.

Floristic data was also collected from an additional four sites in woodland rehabilitation areas to measure biometric attributes in addition to LFA. The results from these plots are included in **Section 3.**

Table 1: Original vegetation classification, plant community type classification and TEC status for each monitoring plot in remnant vegetation

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	TEC	Plot name
River Oak / Rough-barked Apple Forest	PCT 42: River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Listed *Biodiversity Conservation Act 2016* (BC Act), E: Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	V1-A1
			V1-A2
			V1-B1
			V1-B2
			V1-B3
River Red Gum Woodland			V2-A1
			V2-B1
			V2-B2
Yellow Box / Blakely's Red Gum / Rough-barked Apple Forest			V3-B1
Coast Banksia / Rough-barked Apple / Blakely's Red Gum Forest	PCT 1653: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	Listed BC Act, E: Warkworth Sands Woodland in the Sydney Basin Bioregion, also listed as CE under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as Warkworth Sands Woodland of the Hunter Valley	V5-B1
			V5-B2
			V5-B3
			V5-B4
Narrow-leaf Ironbark/Grey Box/Bulloak/Honeymyrtle Forest	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions, may also be listed as CE under the EPBC Act as Central Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	V6-A1c
			V6-A3
			V6-B1
			V6-B1c
			V6-B2
			V6-B2c
			V6-B3
			V6-B4
Grey Gum/Narrow-leaf/ Ironbark/Bulloak/Honeymyrtle Forest			V11-B1
			V11-B2
Spotted Gum/Narrow-leaf Ironbark/Bulloak/Paperbark Forest	PCT 1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	Listed BC Act, E: Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions, may also be listed as CE under the EPBC Act as Central	V9-A1
			V9-B1

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	TEC	Plot name
		Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	V9-B2
			V10-B1
Slaty Gum/Narrow-leaf Ironbark/Bulloak/Paperbark Forest	PCT 1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion, may also be listed as CE under the EPBC Act as Central Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	V10-A1
			V10-A2
			V10-B3
White Mahogany/Rough-barked Apple Forest	PCT 1584: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	-	V13-B1
Brush Wilga/Native Olive Shrubland	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	V14-A1
			V14-B1
			V14-B2

*TEC – Threatened Ecological Community; CE – Critically Endangered, E – Endangered, V- vulnerable

Cover/abundance scores for each species within each plot in the RWEAs was provided by WCPL from 2010 onwards, with the exception of woodland rehabilitation sites, which were only sampled for the first time by ELA during monitoring undertaken in 2015. Biometric plot data using the current method was collected for the first time during monitoring undertaken in 2014.

Data was examined for changes in native species richness within each sampled plant community over ten monitoring periods from 2010 to 2019 and cover of exotic species over the last four monitoring periods (2016 to 2019). Monitoring point photographs were also compared where possible to determine if major structural elements of each community had changed since the earliest photos available were taken (generally in 2013). Data from each vegetation community was compared to established performance criteria, biometric benchmarks and compared with reference sites outside of the RWEA areas where possible.

Vegetation community condition benchmarks (developed by OEH for each PCT) have been modified to provide realistic, ambitious but achievable performance criteria for each PCT. Monitoring results can then be compared to these criteria to determine if management actions are likely to be required.

A green, yellow, amber and red colour system has been developed to rank each measured attribute according to performance and management actions required (**Table 2**). The structure of this table has been derived from (DECC 2008b). The number of hollow-bearing trees and length of fallen logs have been presented as a measure of fauna habitat attributes. However, no performance criteria have been

set for these attributes in remnant vegetation, as in situations where historical logging or clearing has been intensive, it may take many years for a suitable density of hollows and logs to form naturally.

Table 2: Colour ranking system for floristic attributes and performance targets

Attribute	Red (needs greater improvement)	Orange (in need of improvement)	Yellow (not meeting target but values still acceptable)	Green (excellent – within target range)
Native species richness	0–10%	>10 – <50% of target range	50 – <100% of target range	≥ target range
Native overstorey cover % (*pfc)	0 – 10% or >200% of target range	> 10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native mid-storey cover %(*pfc)	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – grasses %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – shrubs %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – other %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Proportion of native overstorey species regenerating	0	0-0.5	0.5-1	1
Exotic cover	>66%	33-66	5-33	0-5%

Several abbreviations for measured attributes are used in tables throughout the following section. An explanation of these is provided below.

- NPS– the number of native plant species
- NOS (%) - projected native foliage cover of canopy
- NMS (%) – projected native mid-storey cover
- NGCG (%) – native groundcover of grasses
- NGCS (%) – native groundcover of shrubs
- NGCO (%) – native groundcover of other plant types (sedges, herbs etc.)

- EPC (%) – exotic plant cover
- OR – proportion of overstorey species regenerating over the whole vegetation zone
- HBT – number of hollow-bearing trees present in the 20 x 50 m vegetation plot
- FL – length of fallen logs >10 cm diameter

In addition to those performance criteria listed above, Annexure C of the VCAs for the RWEA areas requires that WCPL aim for an exotic plant cover within the Conservation Areas that does not exceed the percentages detailed in **Table 3**. Photo-monitoring points established as part of the VCAs in 2013 were compared to photos at the same location during the current vegetation monitoring.

Table 3: Exotic plant cover criteria for VCA areas

RWEA	Aim	Timing
Coal Terminal	Exotic plant cover within the Conservation Area must not be permitted to exceed: - 5% of the foliage cover at monitoring site CT1*; and - 15% of the foliage cover at monitoring site CT2*.	In Year 1 and at the end of Year 5
RWEAs A, B, C and D	Exotic plant cover within the Conservation Area must not be permitted to exceed: - 70% of the foliage cover at monitoring site A1 within Area A; - 20% of the foliage cover at monitoring site A2 within Area A; - 30% of the foliage cover at monitoring site A3 within Area A; - 10% of the foliage cover at monitoring site A4 within Area A; - 5% of the foliage cover at monitoring site B1 within Area B; - 5% of the foliage cover at monitoring site B2 within Area B; - 5% of the foliage cover at monitoring site C1 within Area C; and - 5% of the foliage cover at monitoring site D1 within Area D,	In Year 1
	Exotic plant cover within the Conservation Area must not be permitted to exceed: - 60% of the foliage cover at monitoring site A1 within Area A; - 15% of the foliage cover at monitoring site A2 within Area A; - 20% of the foliage cover at monitoring site A3 within Area A; - 5% of the foliage cover at monitoring site A4 within Area A; - 5% of the foliage cover at monitoring site B1 within Area B; - 5% of the foliage cover at monitoring site B2 within Area B; - 5% of the foliage cover at monitoring site C1 within Area C; and - 5% of the foliage cover at monitoring site D1 within Area D,	Years 2-5

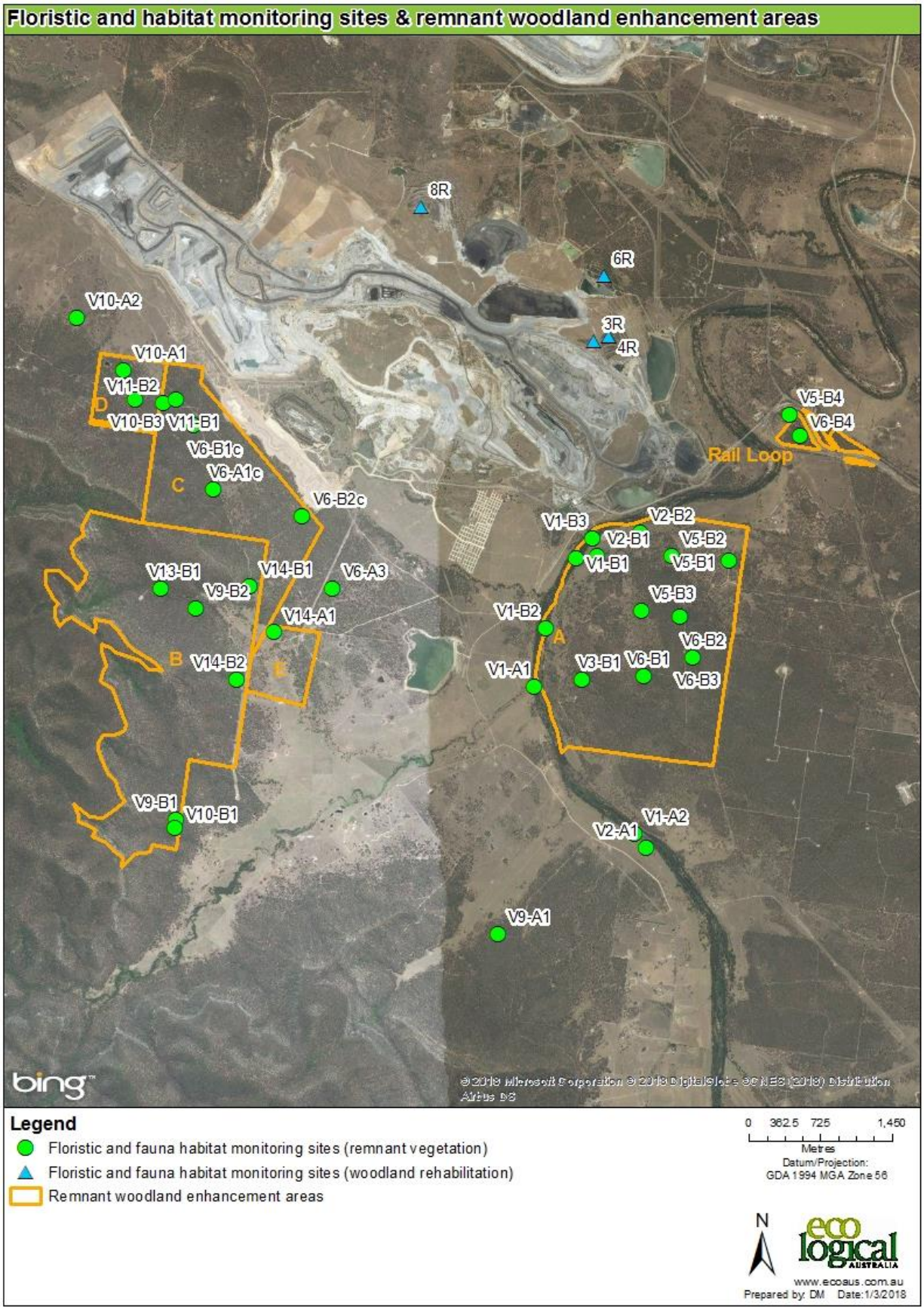


Figure 2: Floristic and habitat monitoring sites and RWEAs

2.1.3 Results

The floristic and biometric data collected during floristic and fauna habitat monitoring is summarised below, with the full floristic plot data and other data including plot photographs provided in **Volume 2**.

2.1.4 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley

This community is one of the most disturbed vegetation communities on WCPL land, as it occurs on more fertile soils on the banks and floodplains of Wollombi Brook, is naturally disturbed by flood events and has been historically used more intensively for agricultural purposes.

River Red Gum / River Oak riparian woodland is distinguished by an overstorey of *Eucalyptus camaldulensis* (River Red Gum), *Casuarina cunninghamiana* subsp*. cunninghamiana* (River Oak), *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus melliodora* (Yellow Box) on floodplains and riparian areas. This PCT conforms to the NSW BC Act listed EEC *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions.* This community also contains the endangered Hunter Valley population of *Eucalyptus camaldulensis* listed under the BC Act.

The River Red Gum / River Oak riparian woodland at WCPL is typical of other remaining stands throughout the Hunter Valley, with generally a high cover of weed species and a reduced number of native species (**Plate 1**).

Plate 1: River Red Gum / River Oak riparian woodland wetland on North Wambo Creek in 2019 (Site V1-A1 within the Wollombi Brook channel)

Nine monitoring plots are located within this PCT. V1 monitoring sites are located within *Casuarina cunninghamiana* dominated forest along the banks of Wollombi Brook. V2 monitoring sites are located on the partially cleared red gum dominated floodplains of Wollombi Brook and the V3 monitoring site is located in a slightly wetter site on the boundary of the floodplain and sand dunes supporting Warkworth Sands type vegetation.

Three sites (V1-A1, V1-A2 and V2-A1) appear to have been originally intended as reference sites at the commencement of the monitoring program, as they are located outside of the RWEP areas. However, cattle have been fenced out of the immediate riparian zone on Wollombi Brook (including sites V1-A1, V1-A2) and thus treatments for both reference sites and management sites are similar.

Floristic results for this vegetation zone in relation to performance criteria are presented in Table 5.

Native ground cover (grasses and other) did not meet targets. Targets were met or acceptable for the other performance criteria.

2.1.4.1 Trends over time

The average number of native species recorded per monitoring plot in River Red Gum / River Oak riparian woodland within RWEAs peaked in 2017 and has declined for past two years. The number of native species recorded is the lowest since 2014, but higher than all years prior to 2015. The average number of native species at the three reference sites has remained relatively consistent in the past few years, with a slight increase recorded 2019. Although the RWEA sites scores are still higher than for the reference site, they had been significantly above the reference site for the previous three years until 2019. Monitoring should ensure RWEA site scores do not continue to decline.

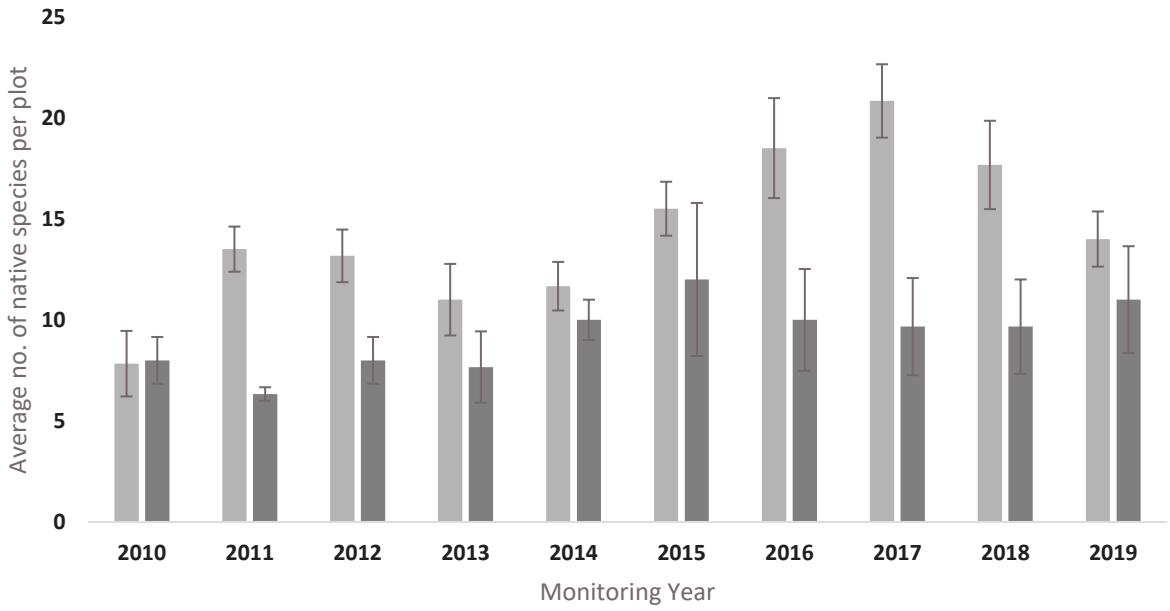


Figure 3: Average number of native species per plot in monitoring sites within riparian woodland in RWEA A (light grey) and from three reference sites outside the boundary of RWEA's (dark grey). Error bars represent standard error

Total cover of exotic species has been recorded since 2014 and results are quite variable over time (Figure 4), even within each site. Total exotic cover was lower than in 2019 at all RWEA sites except for V1-B3. Exotic cover at riparian woodland monitoring sites in 2019 was the lowest recorded to date, this result is likely to be caused by the prolonged dry conditions in the region.

Several priority weeds are present within this PCT, these are listed in **Table 4** below, along with their biosecurity duty according to NSW Department of Primary Industries (DPI 2017). All plants listed under the NSW *Biosecurity Act 2015* are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

In 2019 the same weed species were generally recorded at sites where they have been recorded previously, and with a similar or lower cover/abundance score to the previous monitoring periods. Some weeds were not recorded at sites where they were previously recorded, however this is likely a result of dry conditions rather than active management, and weeds are likely to re-appear under wetter conditions.

Photo monitoring points in this PCT, show no obvious changes within this PCT between years 2015 and 2019 (**Plate 2** & **Plate 3**), and 2013 and 2019 monitoring (**Plate 3** & **Plate 4**), though evidence of recent dry seasonal conditions is evident in the understorey of the 2019 photos.

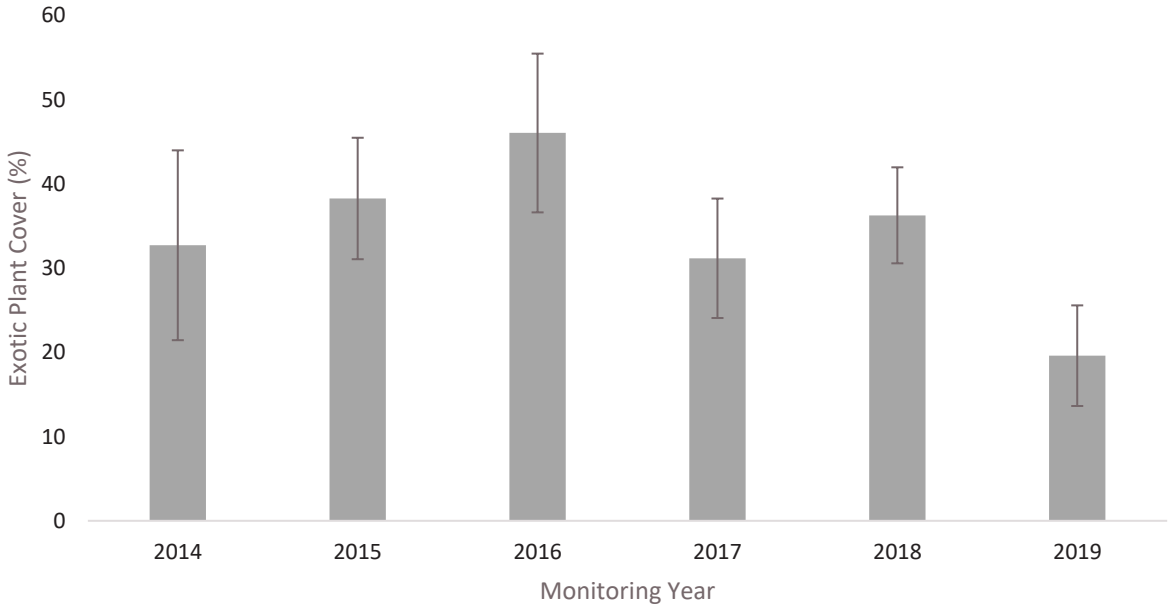


Figure 4: Average exotic plant species cover (%) within all riparian woodland monitoring sites per year

Table 4: Declared weeds observed within the River Red Gum / River Oak riparian woodland PCT plots in 2019

Scientific Name	Common Name	Site	Biosecurity duty (NSW Biosecurity Act 2015)
Asparagus asparagoides	Bridal Creeper	V2-B1, V2-B2	**Prohibition on dealings -** Must not be imported into the State or sold
Echium plantagineum	Patterson's Curse	V1-A2, V1-B3, V2-B1	**Regional Recommended Measure** - Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment.
Lycium ferocissimum	African Boxthorn	V1-A2, V1-B2,	**Prohibition on dealings -** Must not be imported into the State or sold
Olea europaea subsp. *cuspidata*	African Olive	V1-B3, V2-B2	**Regional Recommended Measure** - Land Area 1: Singleton and Maitland. Land Area 2: outbreaks in Hunter region except Singleton and Maitland. Land Area 1: Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. Land Area 2: Land managers should mitigate spread from their land. Land managers should mitigate the risk of new weeds being introduced to their land. Plant should not be bought, sold, grown, carried or released into the environment.
Opuntia aurantiaca	Tiger Pear	V2-B1,	**Regional Recommended Measure** - Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land.
Opuntia stricta	Prickly Pear	V1-B3, V2-B1, V2-B2	**Prohibition on dealings -** Must not be imported into the State or sold
Salix species	Willows	V1-A1	**Prohibition on dealings -** Must not be imported into the State or sold
Senecio madagascariensis	Fireweed	V1-A2, V1-B3, V2-A1, V2-B1, V2-B2	**Prohibition on dealings -** Must not be imported into the State or sold

Plate 2: Flora monitoring site V3-B1 during 2015

Plate 3: Flora monitoring site V3-B1 during 2019

Plate 4: Monitoring site A3 during 2013

Plate 5: Monitoring site A3 during 2019

Table 5: Floristic results and performance criteria for River Red Gum / River Oak riparian woodland wetland

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL (m)
River Oak / Rough-barked Apple Forest	PCT 42: River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Outside of RWEP	V1-A1	7	10	0	6	0	0	10	1	0	38
		Outside of RWEP	V1-A2	10	3.6	3.5	14	0	0	32.5		0	44
		A	V1-B1	11	8.5	0	0	0	4	0		0	22
		A	V1-B2	11	8.9	10.6	0	0	0	32		0	16
		A	V1-B3	15	2.6	11.1	2	0	0	50		0	19
River Red Gum Woodland		Outside of RWEP	V2-A1	16	3.8	21	16	0	2	0		0	7.5
		A	V2-B1	13	13	3.8	0	0	0	26		0	7
		A	V2-B2	14	6	4.9	0	2	0	26		1	9
Yellow Box / Blakely's Red Gum / Rough-barked Apple Forest		A	V3-B1	20	7	0	0	4	2	0		0	35
Average values for RWEA monitoring sites				14.0	7.7	5.1	0.3	1	1	22.3	1	0.2	18.0
Performance criteria				>20	10-50	10-50	20-60	1-5	5-30	<10	1	-	-

2.1.5 Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area

Within WCPL owned land, this community is mostly restricted to the eastern side of Wollombi Brook, primarily within the RWEP area A (**Plate 6**). This PCT corresponds to the Commonwealth EPBC Act listed Critically Endangered Ecological Community (CEEC) *Warkworth Sands Woodland of the Sydney Basin Bioregion* and is also listed under the NSW BC Act. This PCT occurs on aeolian sand deposits and is restricted to the Warkworth area.

Plate 6: Warkworth Sands Woodland within RWEA A

The average number of native species met the performance criteria in 2019, consolidating a recovery recorded in 2018 after a low diversity was recorded in 2017 (**Figure 5**). This result suggests the community has some resilience to the dry conditions and canopy dieback experienced in recent years. Targets were met or acceptable for the other performance criteria.

As with previous years of monitoring, exotic species cover was relatively low across most of the monitoring plots. However, as reported in recent years, the environmental weed *Bryophyllum* sp. (Mother of Millions) was observed to be abundant in certain locations within this vegetation community, both within RWEA A and inside the Rail Loop area. *Bryophyllum* sp. is listed as a priority weed in the Hunter under the NSW *Biosecurity Act 2015*. It is understood that this species is currently the focus of a weed management program.

Photo-monitoring point A2 within this PCT shows little change in vegetation structure between the 2013 and 2019 monitoring periods (**Plate 7** & **Plate 8**)**.** Canopy dieback of *A. floribunda* in some areas of this community was observed during the 2016 monitoring program. These trees displayed abundant epicormic growth in 2017, and during 2018 and 2019 this recovery continued, and it appears most trees have survived this dieback event to date (**Plates 9** & **10**). Canopy and mid-storey cover scores collected by ELA from the 2015 to 2019 monitoring periods have remained generally similar between years.

Banksia integrifolia (Coast Banksia) was observed to be suffering die-off in some areas of this vegetation type, potentially as a result from the dry conditions, and was only recorded in one plot, compared to three in the previous year.

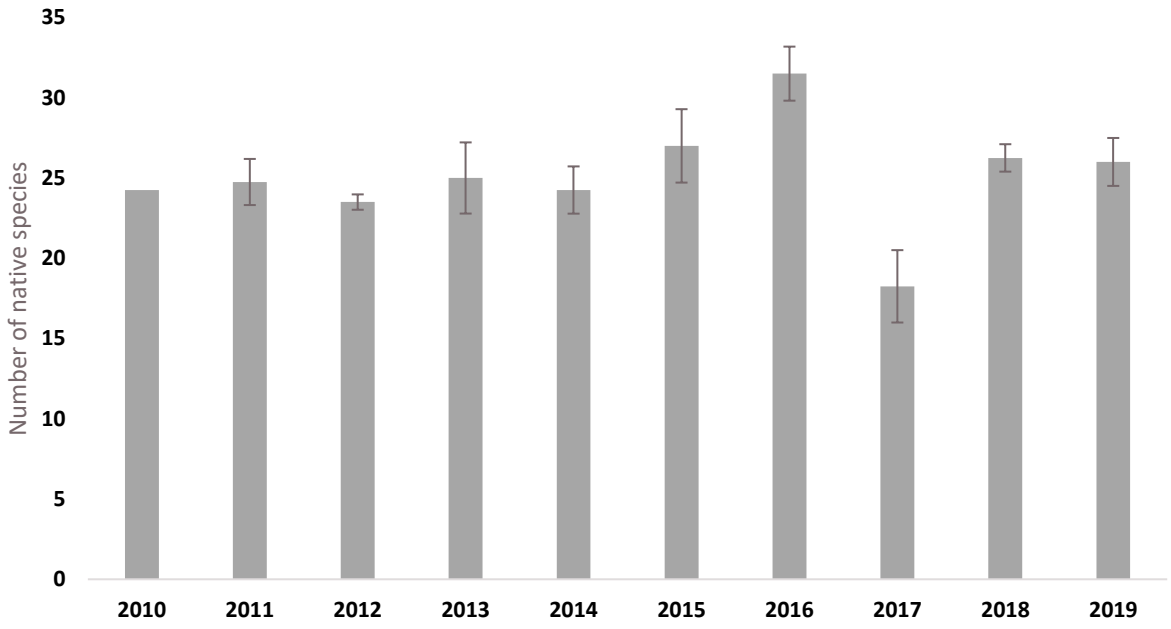


Figure 5: The average number of native species recorded within Warkworth Sands Woodland monitoring plots over time.

Plate 7: Photo monitoring point A2 during 2013

Plate 8: Photo monitoring point A2 during 2019

Plate 9: Severe *Angophora floribunda* canopy dieback in parts of Warkworth Sands Woodland in RWEA A during 2016

Plate 10: Continued recovery of *Angophora floribunda* canopy dieback observed in 2019

Table 6: Floristic results in regards to performance criteria for Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Coast Banksia / Rough-barked Apple / Blakely's Red Gum Forest	PCT 1658: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	A	V5-B1	26	10.2	0.6	10	0	8	0.5	1	0	7
		A	V5-B2	28	11.3	8	6	0	40	4		0	10
		A	V5-B3	25	7.2	8.1	4	16	24	0		1	37
		Rail Loop	V5-B4	25	14.3	7.3	38	2	0	0		0	7.5
Average values for RWEP and Rail Loop monitoring sites				26	10.8	6	14.5	4.5	18	1.1	1	0.25	15.4
Performance criteria				>20	10-40	10-50	4-20	5-30	5-35	<10	1	-	-

2.1.6 Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter

This community on land owned by WCPL is generally dominated by the canopy species *Eucalyptus crebra* (Narrow-leaved Ironbark) and occasionally *Eucalyptus moluccana* (Grey Box) (**Plate 11**). A sparse mid-storey or shrub layer of *Allocasuarina luehmannii* (Bull Oak), *Bursaria spinosa* subsp. *spinosa* (Blackthorn) and *Notelaea microcarpa* var. *microcarpa* (Mock Olive), with a grassy understorey is often present. *Eucalyptus punctata* (Grey Gum) and *Melaleuca decora* also occur in patches.

Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest forms the NSW BC Act listed EEC *Central Hunter Grey Box-Ironbark Woodland* in the New South Wales North Coast and Sydney Basin Bioregions. Sections of this community in good condition with a Eucalypt canopy are also likely to be the *Central Hunter Valley eucalypt forest and woodland* CEEC listed under the Commonwealth EPBC Act.

This community appears to be performing well with generally very low cover of exotic species and high diversity of native species present at each monitoring plot. The number of native species recorded dropped slightly from 2018, but still achieved the target for the performance criteria for this attribute (**Table 7**). The number of native species recorded at the reference site also dropped from 2018. Performance criterion were met or acceptable for all other attributes, except for Native Ground Cover Other. Examination of biometric data reveals that no significant changes in exotic cover, canopy or mid-storey have occurred in the majority of these monitoring plots since 2014 when biometric data was first collected. This stability over time can be seen in the photo monitoring point A4 (**Plates 12-13**) with no major changes visible between the 2013 and 2019 monitoring periods.

Minor mine subsidence cracks are present at four of the eight monitoring plots within this PCT. However, no significant vegetation damage has been observed.

Plate 11: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest at WCPL (site V6-A3 in 2019)

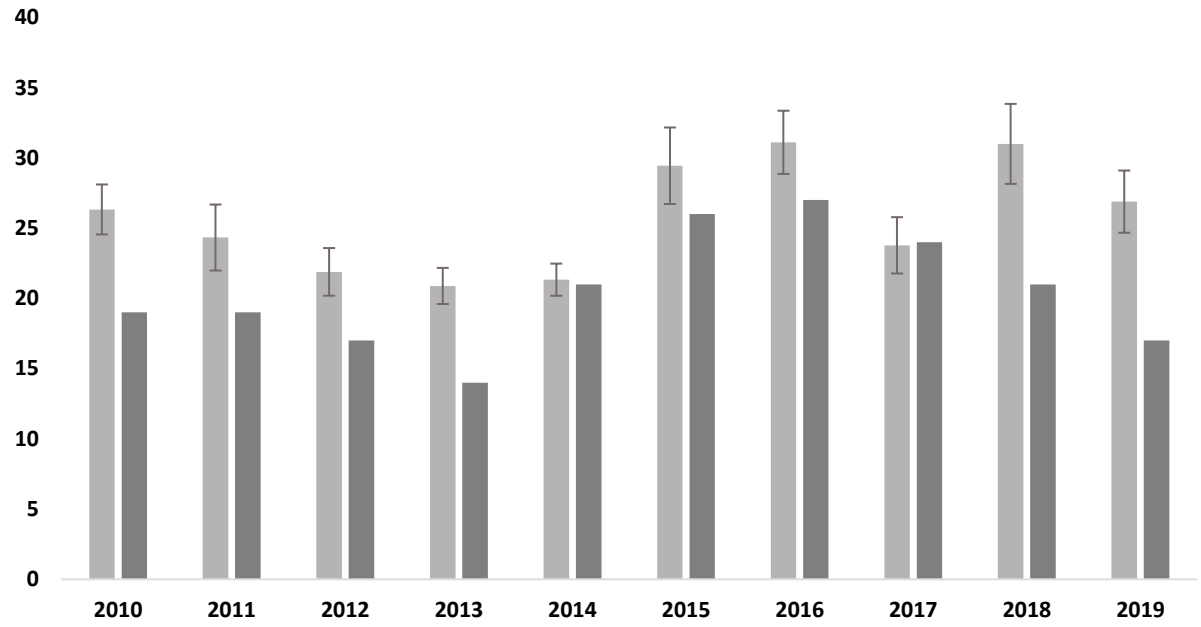


Figure 6: Average number of native species recorded in Narrow-leaved Ironbark - Bull Oak - Grey Box open forest within RWEAs (light grey) compared to reference site V6-A3 (dark grey). Error bars represent the standard error of the mean

Plate 12: Photo-monitoring point A4 during 2013

Plate 13: Photo-monitoring point A4 during 2019

Table 7 : Floristic results and performance criteria for Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Narrow-leaf Ironbark / Grey Box / Bulloak / Honeymyrtle Forest	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	C	V6-A1c	31	11.8	10.4	18	0	4	0	1	1	39
		Outside of RWEP	V6-A3	17	8	4	20	0	0	0		0	11.25
		A	V6-B1	32	0.5	11.7	4	0	0	0		0	45
		C	V6-B1c	25	7.7	7.2	8	10	0	0		0	10
		A	V6-B2	30	9.4	3.8	12	18	2	0		0	65
		C	V6-B2c	30	15.7	3.9	12	2	4	0		0	17
		A	V6-B3	29	7.8	5.3	12	6	0	0		1	30
		Rail Loop	V6-B4	12	15.8	0	0	8	0	0		0	4
Grey Gum / Narrow-leaf Ironbark / Bulloak / Honeymyrtle Forest		C	V11-B1	21	6.1	5.4	10	10	0	0		0	34
		C	V11-B2	32	6.4	9.1	28	0	4	0		0	34
Average values for RWEP and Rail loop monitoring sites				26.9	9	6.3	11.6	6	1.5	0	1	0.2	30.9
Performance criteria				>25	10-40	5-10	15-50	5-10	5-40	<5	1	-	-

2.1.7 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter at WCPL is characterised by an overstorey of *Eucalyptus crebra*, *Corymbia maculata* (Spotted Gum) and *Eucalyptus moluccana*. *Eucalyptus punctata* and *Eucalyptus dawsonii* (Slaty Gum) are also occasionally present. The mid-storey or shrub layer often includes Melaleuca decora, Bursaria spinosa subsp. spinosa, *Allocasuarina luehmannii* and *Olearia elliptica* (Sticky Daisy Bush). This community corresponds to the EEC *Central Hunter Ironbark -Spotted Gum –Grey Box Forest* listed under the NSW BC Act. Sections of this community in good condition with a Eucalypt canopy are also likely to be the *Central Hunter Valley eucalypt forest and woodland* CEEC, listed under the Commonwealth EPBC Act.

This PCT appears to be performing well in regard to performance criteria with large numbers of native species present at each monitoring plot, despite falling just short of the performance criteria for this attribute. The number of native species in this PCT was slightly lower than recent years at both RWEA and reference sites (**Figure 7**). Native ground cover of grasses and other were below the performance criteria, likely reflecting dry conditions. Other attributes were acceptable or meeting the performance criteria (**Table 8**). Generally, few weed species are present within this PCT, with the exception of small infrequent occurrences of *Opuntia* spp. (Prickly Pear, Creeping Pear or Tiger Pear), exotic plant species did not contribute to plant cover in the biometric transects at any of the monitoring plots.

Photo-monitoring points in this community show little change in vegetation structure between the 2013 and 2019 monitoring periods (**Plate 14 & Plate 15**).

Plate 14: Photo-monitoring point B2 during 2013

Plate 15: Photo-monitoring point B2 during 2019

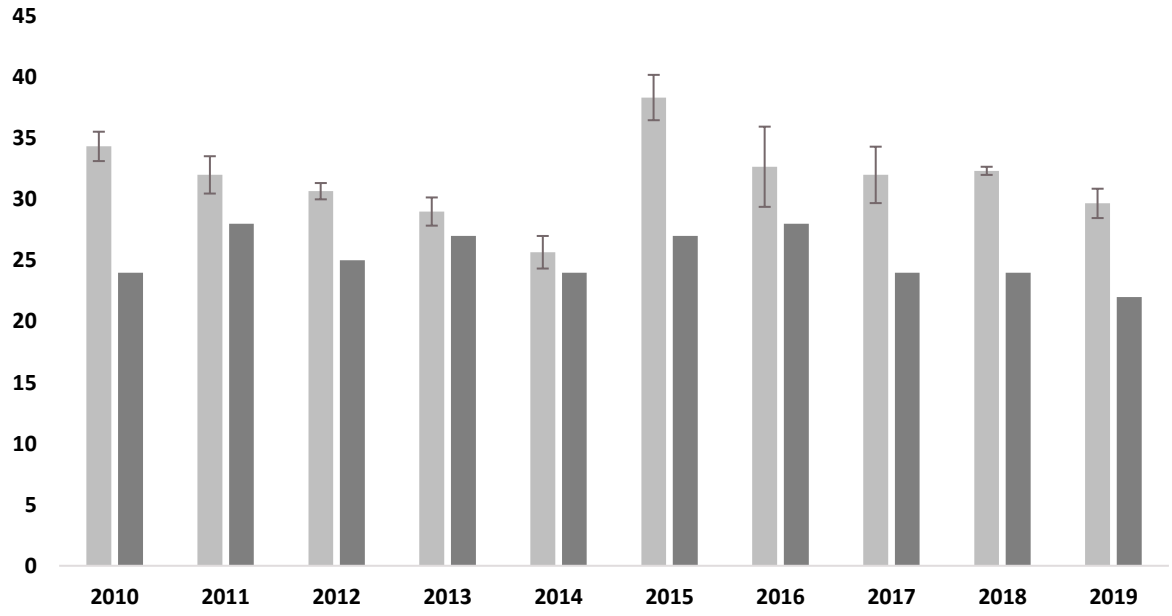


Figure 7: The average number of native species in Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland within RWEAs (light grey) compared to the recorded number at reference site V9-A1 (dark grey). Error bars represent the standard error of the mean

Table 8: Floristic results, performance criteria and OEH benchmarks for Narrow-leaved Ironbark - Grey Box - Spotted Gum woodland at Wambo

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Spotted Gum / Narrow-leaf Ironbark/ Bulloak / Paperbark Forest	PCT1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass of the central and lower Hunter	Outside of RWEP	V9-A1	22	12.7	6.6	6	4	0	0	1	0	8
		B	V9-B1	28	11	6.8	4	12	0	0		1	37
		B	V9-B2	32	10.4	2	8	10	0	0		0	24
		B	V10-B1	29	8.3	8.2	0	14	2	0		1	30
Average values for RWEP monitoring sites				29.7	9.9	5.7	4	12	0.7	0	1	0.7	30.3
Performance criteria				>35	15-40	5-20	30-50	5-15	5-40	< 5	1	-	-

2.1.8 Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion

The canopy of Slaty Box - Grey Gum shrubby woodland is typically dominated by *Eucalyptus dawsonii* and several other species including *E. punctata*, *E. moluccana* and *E. crebra. Acacia salicina* (Cooba) and *Allocasuarina luehmannii* may form a small tree layer or be part of the upper-most canopy. The shrub layer includes species such as *Olearia elliptica*, *Acacia cultriformis* (Knife-leaved Wattle), *Canthium odoratum* (Shiny-leaved Canthium), *Notelaea microcarpa var. microcarpa* and *Dodonaea viscosa* subsp. *cuneata* (Wedge-leaf Hopbush). The groundcover is generally sparse to very sparse and is relatively species poor (**Plate 16**). This community is listed under the NSW BC Act as the EEC *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion.* Sections of this community in good condition with a Eucalypt canopy are also likely to be the *Central Hunter Valley eucalypt forest and woodland* CEEC under the Commonwealth EPBC Act.

At WCPL, this PCT primarily occurs on the smaller ridge tops and slopes and is patchily distributed at lower elevations. *Eucalyptus crebra* is often present and may co-dominate the canopy with *E. dawsonii*.

This PCT is generally in good condition, particularly on the slopes and ridgetops where historical disturbance from forestry and grazing has been minimal. A large number of native species, few weed species and a sparse weed cover was recorded. Occasional occurrences of the priority weed *Opuntia* spp. were observed at low densities, similar to other woodland areas at WCPL. Very minor changes in exotic species cover values has occurred between 2014 and the present, with exotic cover remaining very low.

The monitoring sites in this community are located in or near RWEA D. All performance criteria were met in 2019, except for NOS and NGCG which were below the target range. Plot photographs show the canopy in good condition and the lower score is likely a result of observer bias. Native ground covers are likely to be lower due to drought conditions. No management actions are recommended above general weed control. The recorded number of native species in 2019 was within the range previously recorded and similar to recent years (**Figure 8**).

Plate 16: A typical example of Slaty Box woodland at WCPL during 2019 (site V10-B3)

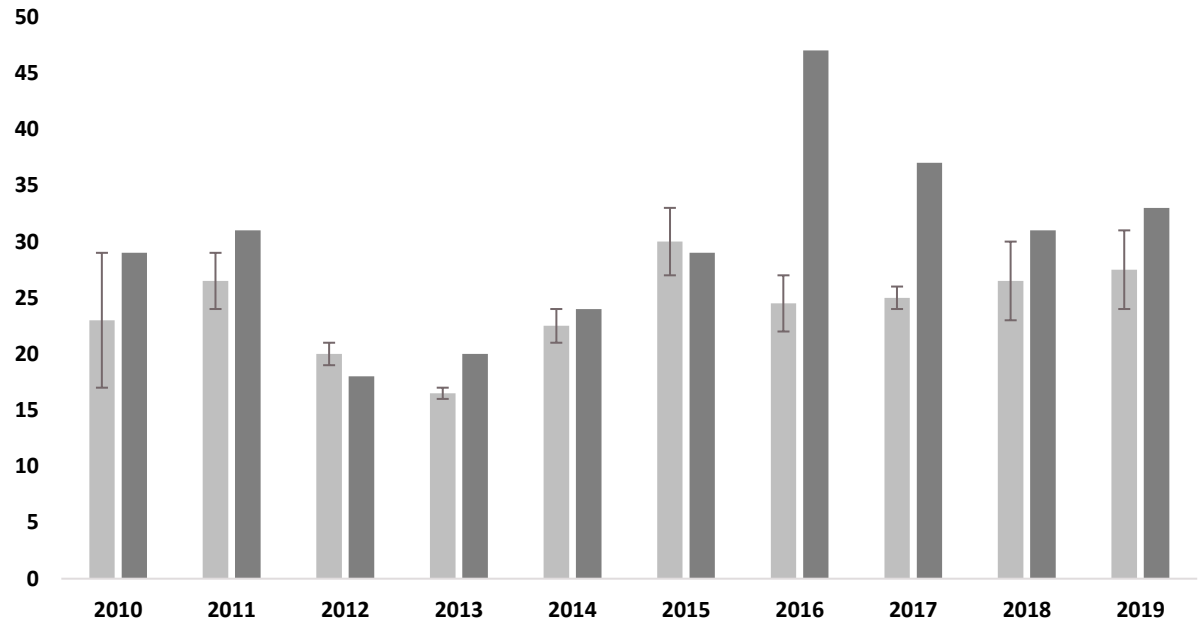


Figure 8: The average number of native species recorded in Slaty Box shrubby woodland within RWEAs (light grey) compared to reference site V10-A2 (dark grey). Error bars represent the standard error of the mean

Table 9: Floristic results, performance criteria and OEH benchmarks for Slaty Box - Grey Gum shrubby woodland

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Slaty Gum / Narrow-leaf Ironbark / Bulloak / Paperbark Forest	1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	D	V10-A1	31	10	10.3	14	2	2	0	1	0	44
		Outside of RWEP	V10-A2	33	14	6	4	12	0	0		0	16
		D	V10-B3	24	8.4	2.8	4	4	0	2		1	47
Average values for RWEP monitoring sites				27.5	9.2	6.5	9	3	1	1	1	0.5	25.6
Performance criteria				21	15-40	5-30	5-30	0-25	2-10	< 5	1	-	-

2.1.9 White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley

At WCPL, this community occurs along Stony Creek and is sheltered by steep sandstone escarpments to the south and a large ridgeline to the north. This PCT is in good condition with many native species and occasional large remnant trees with hollows. One monitoring plot (V13-B1) samples this PCT. Exotic plant species cover is very low and sparse with no exotic cover recorded along the biometric transect (Table 10).

This monitoring site fell short of the target number of native species, with the recorded number still being relatively high with 34 native species recorded in the 20 x 20 plot, although this is the equal lowest number of native species recorded at this site. Native ground cover Grasses was recorded as zero from the biometric transect and failed to meet the criteria. However, examination of plot data shows five species of native grass were recorded in the plot, therefore cover is likely to be low due to the dry conditions but the species are persisting and cover will likely improve in better seasonal conditions after rainfall. Recorded values for this community generally met the performance criteria or were in the acceptable range and no additional management is required.

Plate 17: White Mahogany - Spotted Gum - Grey Myrtle forest at V13-B1 in 2019

Table 10: Biometric scores and performance citeria for White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest at Wambo

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
White Mahogany / Rough-barked Apple Forest	PCT 1584: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	B	V13-B1	34	8.5	12.6	0	6	8	0	1	1	43
Performance criteria				>45	15-45	5-40	5-40	10-20	5-20	0	1	-	-

2.1.10 Brush Wilga/Native Olive Shrubland

The monitoring plots within this PCT are dominated by the shrubs *Notelaea microcarpa var. microcarpa*, *Geijera salicifolia* (Brush Wilga), *Olearia elliptica* and the small tree *Brachychiton populneus* (Kurrajong) (**Plate 18**). Occasional *Eucalyptus crebra* or *E. moluccana* are present as canopy species. The PCT sampled by floristic monitoring may be partially a derived community, resulting from the historic removal of overstorey species in Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest combined with a south facing aspect. These areas are in good condition, with a large number of native species and few exotic species. Exotic species cover has remained consistently very low over time at these monitoring plots.

The average number of native species recorded within this PCT in the RWEA areas was slightly less than performance criteria this year but the number of native species recorded has increased from 2018 (**Figure 9, Table 11**)**.** The reference site V14-A1 mirrors this pattern closely, suggesting that the cause of these fluctuations also affected areas outside of the RWEA and is likely to be primarily due to variance in annual rainfall and other factors unrelated to management actions within RWEAs. Scores general met or were acceptable for performance criteria in this PCT and no additional management actions are recommended.

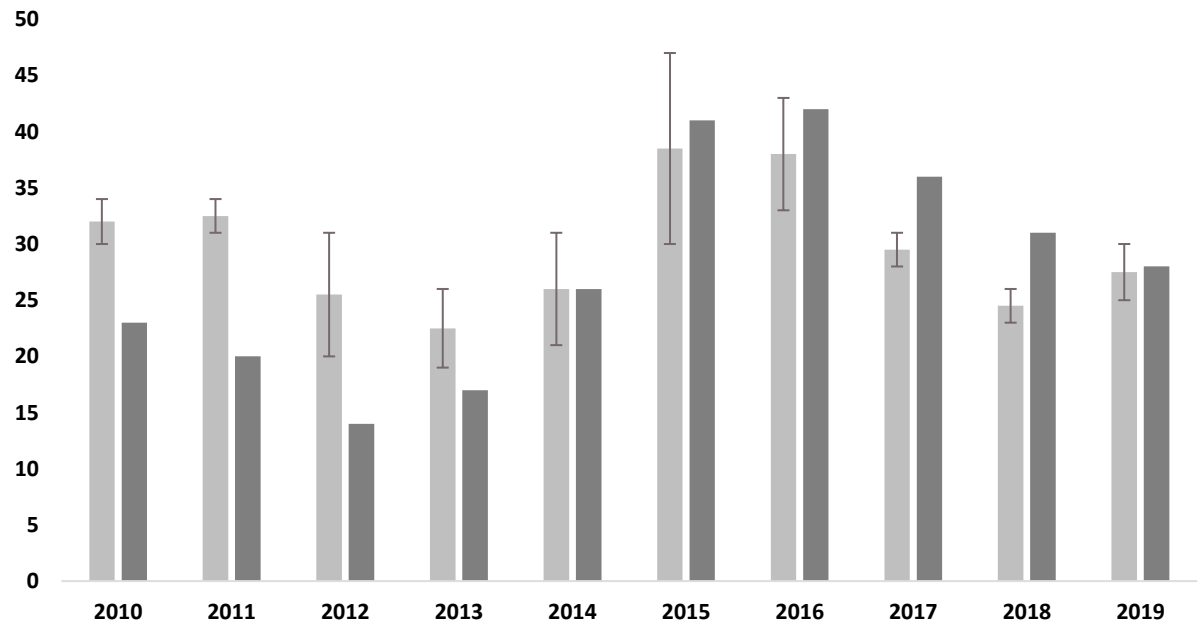


Figure 9: The average number of native species recorded in Brush Wilga/Native Olive shrubland within RWEAs (light grey) compared to reference site V10-A2 (dark grey)

Plate 18: Brush Wilga/Native Olive Shrubland at V14-A1 in 2019

Table 11: Biometric scores and performance citeria for Brush Wilga/Native Olive Shrubland at WCPL

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NNS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Brush Wilga/Native Olive Shrubland	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter *	Outside of RWEP	V14-A1	28	3	25.5	0	0	0	0	1	0	7.5
		B	V14-B1	25	3.2	13.8	18	2	4	0		1	25
		B	V14-B2	30	9.1	16.5	16	16	6	0		0	6.5
Average values for RWEP monitoring sites				27.5	6.2	15.2	17.0	9.0	5.0	0.0	1	0.5	15.8
Performance criteria				>30	5-40	5-40	30-50	5-10	10-40	<5	1	-	-

*considered a variant of this PCT

2.1.11 Conservation agreement requirements and photo monitoring points

Annexure C of the VCAs requires that WCPL aim for an exotic plant cover within the Conservation Areas that does not exceed the exotic cover percentages detailed in **Table 3**. Target limits for Years 2-5 are used as no further limits are presented.

One of the ten monitoring plots (Site A3) exceeded the exotic cover limits for the 2-5 year targets, Site A3 (Table 12). At Site A3, within the riparian zone of Wollombi Brook, *Ehrharta erecta* (Panic Veldtgrass) and *Bidens subalternans* (Greater Beggar's Ticks) are dominant, with ten other common exotic flora species also recorded in the groundcover and climbers.

Site A2 recorded very low total exotic cover (0.5 %), down significantly from 18% in 2018. This data is derived from the Biometric transect from Plot V5-B1. Review of the floristic data and cover abundance scores for exotic species from this plot suggest the actual exotic cover is at least 10 %, as two exotic species (*Bidens subalternans* and *Richardia humistrata)* were assigned cover abundance scores of 3 (5-25% cover). Several other common pasture weeds and scattered *Opuntia* spp. (Tiger Pear, Prickly Pear and Creeping Pear) were also recorded.

Site A1 falls below the exotic cover limit and the total exotic cover continues to reduce. However, exotic cover remains high (26 %), dominated by *Bidens subalternans, Galenia pubescens* (Galenia), with several other common weeds of pasture/native grasslands such as *Echium plantagineum* (Patterson's Curse) and *Ehrharta erecta*.

Exotic cover is very low or zero at the remaining sites, and all these fell below the exotic cover limits. No exotic cover was recorded at Site CT2, the same result as 2017 and 2018. In 2016 this site had a very high exotic cover (52%) which was dominated by *Melinis repens* (Red Natal Grass). It is suspected that the dry conditions over the past three years have impacted *Melinis repens*, it was only recorded from one plot in 2018 and 2019.

Table 12: Exotic plant cover at monitoring sites in regard to VCA targets

RWEA	Site Code for VCA	Corresponding flora monitoring plot	Exotic cover limits yr 1	Exotic cover limits yrs 2-5	Total exotic cover from biometric plots in 2019
Coal Terminal (Rail Loop)	CT1	V6-B4	5	5	0
Coal Terminal (Rail Loop)	CT2	V5-B4	15	15	0
A	A1	V2-B1	70	60	26
A	A2	V5-B1	20	15	0.5
A	A3	V1-B2	30	20	32
A	A4	V6-B1	10	5	0
B	B1	V13-B1	5	5	0
B	B2	V9-B1	5	5	0
C	C1	V11-B1	5	5	0
D	D1	V10 -B3	5	5	2

Comparison of photo-monitoring sites between 2013 and 2019 monitoring show little change in vegetation over this time period. Dry conditions during the 2019 monitoring are apparent in some photographs, with less green vegetative growth visible in the understorey, but in general, no major changes in species composition or structure are apparent. Similar dry conditions were also observed and reported in 2017 and 2018, indicating a prolonged drought. These observations correspond to the floristic data collected within biometric plots with lower native ground cover scores recorded across most PCTs this year.

Although not visible from the photo-monitoring site, approximately half of the transect had been recently burnt in a low intensity fire at site D1 (V10-B3).

2.1.12 Discussion and recommendations

The majority of remnant woodland areas remain in good condition with high numbers of native species, few exotic species present and with low cover and abundance. No major issues were identified that require urgent management. However, as reported in previous years, exotic species cover remains relatively high in riparian and floodplain areas (V1 and V2 plots of RWEA A) and continues to exceed performance criteria and also VCA targets in certain locations. Continued weed management will be required to achieve performance criteria in these riparian and floodplain areas.

The number of native species in RWEA sites within the River Red Gum / River Oak riparian woodland community have declined after being significantly above the reference sites for the previous three years. Monitoring should ensure these scores do not continue to decline significantly below the reference sites or performance targets.

Several weed species listed under the NSW *Biosecurity Act 2015* were observed in these areas that have potential to become problematic in the wider region e.g. *Olea europaea* subsp. *cuspidata* (African Olive). It is recommended to give priority to species such as this in the mine's weed control program. As discussed in previous monitoring reports, planting of canopy species should be considered in RWEA 'A', where natural regeneration is unlikely to occur in a reasonable timeframe (i.e. the open grassland areas of on the Wollombi Brook floodplain). Once established, these plantings may also reduce issues with exotic flora species in these areas.

The average number of native species detected within all communities was generally within the range of values recorded in previous monitoring years and was similar to the results from the previous two years when dry conditions were experienced. Monthly rainfall data from 2019 from Bulga (Down Town) (BOM 2019) reveals that for below average rainfall was recorded in all months of 2019 except March, and that the annual rainfall in 2019 is likely to be well below average. Longer term statistics also reveal that 2017 and 2018 also received lower than average rainfall. This data corresponds to observations of the site being generally very dry and under drought conditions. It is likely that a greater diversity of flora species is present at many of the monitoring sites, however they are not detectable due to the dry conditions. These conditions are considered to be the main factor contributing to low scores for native ground covers across many communities, and although this has resulted in scores below performance criteria, no additional management actions are recommended in RWEAs or any native woodland areas of the site.

The Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland (in RWEA A) suffered *Angophora floribunda* dieback in 2016 (observed throughout the

locality) and recorded low native species diversity in 2017 (possibly after the understorey was exposed to harsher conditions following dieback). The 2019 data suggests recovery of the community continues, although *Banksia integrifolia* die-off in the mid-storey was observed in 2019. This community is listed as a CEEC under the Commonwealth EPBC Act, and future monitoring should continue to record the condition of this community.

2.2 Bird Monitoring within RWEA's

The bird monitoring program is a requirement of the current Development Consent conditions and has been designed in an effort to measure the performance of the WCPL RWEP. The consent conditions (DA 305-7-2003) specify that "Terrestrial fauna surveys should be conducted to monitor the usage of enhancement areas by vertebrate fauna. Monitoring may include fauna species diversity and abundance or, alternatively, the use of indicator species to measure the effectiveness of enhancement measures".

Methods, results (including a comparison with previous monitoring), and interpretation of results, are included below.

Data from previous year's bird surveys was limited to:

- RPS Australia East (RPS) 2009. Annual Ecological Monitoring Report. Remnant Woodland Enhancement Monitoring Program Riparian and Bed and Bank Stability Monitoring, Stoney Creek, South Wambo Creek and North Wambo Creek. Prepared for Wambo Coal Pty Limited.
- Niche 2014b. EMP010 Monitoring 2014 – Indicator Species (birds). Prepared for Wambo Coal Pty Limited.
- Eco Logical Australia (ELA) 2016a. Wambo Coal Mine Flora and Fauna Monitoring Report (2015) - Volume 1. Prepared for Wambo Coal Pty Ltd.
- Eco Logical Australia (ELA) 2017a. Wambo Coal Mine Flora and Fauna Monitoring Report (2016) - Volume 1. Prepared for Wambo Coal Pty Ltd.
- Eco Logical Australia (ELA) 2018a. Wambo Coal Mine Flora and Fauna Monitoring Report (2017) - Volume 1. Prepared for Wambo Coal Pty Ltd.
- Eco Logical Australia (ELA) 2019. Wambo Coal Mine Annual Flora and Fauna Monitoring Report (2018) - Volume 1. Prepared for Wambo Coal Pty Ltd.

2.2.1 Methods

Bird monitoring during spring 2019 was consistent with the three previous monitoring events in methods and general timing of surveys. During the survey, two observers spent 10 minutes recording birds seen and heard within 50 m radius (0.8 ha) of a central point, followed by an additional 10 minutes searching the balance of a 2 ha plot, and recording the total numbers of birds detected (seen and heard). One morning and one afternoon survey was conducted per site.

The twenty-six (26) sites (**Figure 12**) were surveyed between 24-29 September 2019.

The total number of bird species recorded each year 2007-19, average number of bird species per 20-minute bird survey, average number of birds per survey, bird density and the distribution and relative abundance of threatened species were examined. Broad comparisons between the bird species recorded in previous years and the current year were also made.

2.2.2 Results

The 2019 monitoring observed a total of 84 bird species from 26 monitoring sites during formal bird surveys. This number is higher than the median from all 26 sites in previous monitoring periods (2007-2018 - 78 species), and is within range of previous surveys, which have varied between a low of 64 species in 2012 to a high of 96 species in 2013 (**Figure 10)**.

Figure 10: Number of bird species recorded at monitoring plots 2007 - 2019

The average number of bird species per 20-minute bird survey in 2019 was 15.34, this count is higher than previous monitoring periods, 2015 (12.4), 2016 (12.1), 2017 (9.94) and 2018 (12.26).

In 2019, the number of species detected at each site varied between 16 (at site BP5) and 31 (at BP8), with an average of 23 species recorded per monitoring site. This is the highest average species diversity per site that has been recorded from the years with available data, with the next highest being 20 in 2018 (**Figure 11)**.

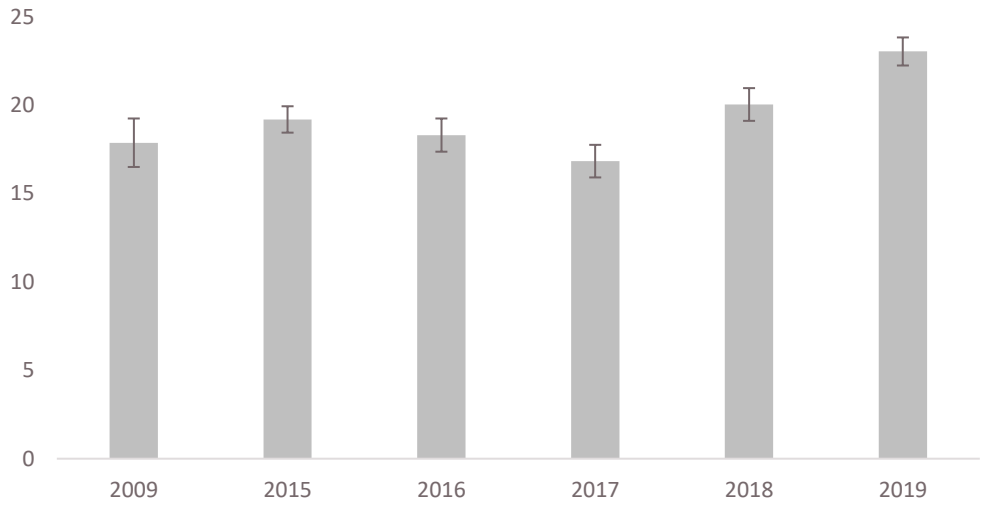


Figure 11: Average number of bird species recorded per monitoring site during 2009 and 2015-2019

The average number of birds recorded per survey was similar to that recorded in recent years with 26.5 birds recorded per survey during 2019 and a bird density of 13.3 birds/ha/20 mins. This result is similar to numbers previously recorded which range between 25.5 (2018) and 30.8 (2014) birds per survey. Numbers of birds were not presented in RPS (2009) and it is assumed only bird species were recorded.

The most species-diverse site during 2019 was BP8 (31 species). Other species-diverse sites included BP13 and BP18 (28 species), and BP11 and BP15 (27 species). BP11, was the most diverse site in the years previous to 2019. BP5 had the lowest species diversity in 2019, with 16 species recorded.

Bird assemblages over time were not compared statistically, however, assemblages appear broadly similar to the previous four years and also to data from 2009 monitoring. When comparing the 20 most widely recorded species from each year, the results from 2019 contain an average of 14 of the same species recorded in the top 20 for previous years. The most widely recorded species in 2019 were *Pachycephala rufiventris* (Rufous Whistler), *Lichenostomus chrysops* (Yellow-faced Honeyeater), and *Corvus coronoides* (Australian Raven), all of which were also regularly recorded in previous years.

Six threatened species listed under the NSW BC Act were recorded during 2019 surveys; *Artamus cyanopterus* (Dusky Woodswallow), *Pomatostomus temporalis temporalis* (Grey-crowned Babbler), *Daphoenositta chrysoptera* (Varied Sittella), *Glossopsitta pusilla* (Little Lorikeet), *Chthonicola sagittata* (Speckled Warbler) and *Climacteris picumnus victoriae* (Brown Treecreeper (eastern subspecies)). This result is lower than the eight threatened species recorded in 2017, but within the range recorded from 2014 to 2018 (five to eight species). These threatened species form a group that are regularly recorded during the monitoring surveys, with all six of these species being recorded every year from 2014 to 2019, with the exception of Brown Treecreeper and Little Lorikeet which were not recorded in 2014.

Comparison of numbers of threatened species between the 2015-2019 monitoring periods and the number of sites they were recorded at during the 2009 and 2014 to 2019 monitoring periods shows that the number of Grey-Crowned Babbler (8) is the lower than the previous three years. The number of Dusky Woodswallow records in 2019 is the highest number of individuals ever recorded (47) from the highest number of sites (6) when compared across the monitoring periods 2015-2019. The number of

Speckled Warbler recorded (21) is also the highest number of individuals when compared across the monitoring periods 2015-2019. Speckled Warblers were recorded across a wider number of sites (12) than in the previous four years. Results for the remaining species fall within the range of previously recorded values.

2.2.3 Discussion

RWEA and other remnant woodland sites at WCPL continue to support a large diversity of bird species and no introduced bird species were detected within RWEA areas. One hundred and twenty-one bird species have been recorded during timed bird surveys over the last four years, with 85 (70%) of these recorded during 2019, including three species not previously recorded during bird monitoring surveys.

As vegetation and habitat attributes in RWEA areas have remained relatively stable over time (see previous section), this variability in species richness between years are likely explained by a combination of factors such as varying numbers of nomadic and migratory bird species, weather and climate, sampling methods, differences in the skill of observers, the timing of surveys and surveys coinciding with the flowering of trees and also broader landscape scale and seasonal changes across the Hunter Valley. The total number of bird species detected each year has varied over time and the 85 species recorded during 2019 is within the range of previous years. The number of species recorded had been declining each year since the highest diversity was recorded in 2013, however the 90 species recorded in 2018 arrested this trend and is the third highest diversity recorded since surveys began in 2007. The average number of birds recorded per survey has remained relatively constant since 2014, when this data was first collected.

Comparison of numbers of threatened species (2015-2019) and the number of sites they were recorded at (2009 & 2014-2017) show that both the Speckled Warbler and Varied Sittella were recorded more widely during surveys in 2014. However additional survey effort during the 2014 monitoring may partially explain this observation, as the number of sites where these species have been recorded have remained similar since the 2015 monitoring.

Surveys in 2019 found that the Speckled Warbler was recorded more widely across the sites than in 2018. The number of individual records of Speckled Warbler recorded in 2019 demonstrated an increase in recorded numbers since 2018.

The number of individual Dusky Woodswallow recorded in 2019 was the highest recorded and more than double the number of the previous highest record in 2015. This result is due to a large flock recorded flying high overhead during an afternoon survey.

The number of individuals recorded for Grey-crowned Babbler in 2019 was less than in the previous three years. The cause of this result is unclear, future monitoring should seek to establish whether this result is a sign of a local population decline. The number of individuals for other threatened species recorded was within the range of those previously recorded suggesting no obvious declines are evident from the available data.

Figure 12: Bird monitoring locations and remnant woodland enhancement areas

3. Rehabilitation areas

3.1 Introduction

Rehabilitation areas are monitored using a combination of LFA and biometric plots (woodland rehabilitation areas).

LFA is currently used to monitor the progress of the North Wambo Creek diversion, woodland rehabilitation and pasture rehabilitation towards achieving a suitable condition for their intended land use post-mining. The rehabilitation objectives for the North Wambo Creek Diversion (WCPL 2015) include:

- To establish pasture species consistent with revegetation strategy
- Tree species established along creek lines consistent with the riparian zone
- Creek diversion stable and will not present a greater safety hazard than surrounding land
- Creek diversion able to shed water safely without causing excessive erosion, jeopardising landform integrity or increasing pollution of downstream watercourses
- All watercourses subject to subsidence impacts shall be hydraulically and geomorphologically stable, with riparian vegetation established that is the same or better than prior to commencement of mining.

Completion criteria for the North Wambo Creek diversion, mixed woodland/pasture areas and woodland corridors for LFA have been developed using previous monitoring results from relatively undisturbed and natural landscapes surrounding the mine. These are listed in each results table below.

Additional completion criteria for these rehabilitation areas is listed in the Mining Operations Plan (WCPL, 2015) and include ensuring that:

- Minimum 70% of area has a vegetative cover
- No single bare area >20m^2
- Biometric monitoring confirms exotic cover <33%
- No tunnel or gully erosion is to be present
- Rill erosion is to be limited to <200 mm deep and/or <200 mm wide.

Woodland rehabilitation monitoring sites currently occur within plantings of *Eucalyptus cladocalyx* (Sugar Gum) that do not match up with the species composition of natural vegetation communities surrounding the mine and completion criteria based for biometric monitoring has also been developed for these areas. As existing woodland rehabilitation areas have been designed and implemented applying old techniques that do not reflect the current best practice of utilising species of local provenance, performance criteria for these older rehabilitation areas have been developed by modifying condition benchmarks for *Grey Box –Slaty Box shrub – grass woodland*, which is expected to have a similar vegetation structure, albeit different species composition, to the mature rehabilitated woodland community.

LFA monitoring at WCPL focusses on scores for Landscape Organisation, Stability, Infiltration/Runoff and Nutrient Cycling. **Landscape organisation** relates to the proportion of the transect occupied by patches - patches being landscape elements that are relatively permanent and provide stable, resource

accumulating structures, such as grassy tussocks and other ground cover, leaf litter and logs. Therefore, a larger Landscape Organisation Index (LOI) number implies a more stable transect that traps water and nutrients and is less prone to soil erosion.

A Soil Surface Assessment (SSA) is completed for each patch type on each LFA transect. Five 'query zones' are selected for each patch type where possible. Scores are recorded for rain splash protection, vegetation cover, plant litter cover, cryptogam cover (cover of algae, mosses and liverworts, lichen and fungi), crust brokenness, erosion type and severity, deposited materials, surface roughness, surface nature and the stability and texture of the soil. These soil surface indicators are then used to give Stability, Infiltration/Runoff and Nutrient Cycling scores for each transect.

Stability is defined as the ability of the soil to withstand erosive forces, and to reform after disturbance. The stability index is derived from data collected during the SSA's, such as crust broken-ness, surface resistance, slake tests, erosion type and severity, deposited materials, cryptogam cover, rain splash protection and leaf litter cover.

Infiltration concerns the way water interacts with soil to become soil water (and becomes available for plants) or runoff water where water is lost from the system or transports materials (such as soil, nutrients and seed) away. Scores for vegetation cover, surface roughness, slake tests, litter cover, origin and decomposition, surface resistance to disturbance and soil texture contribute to the infiltration index.

Nutrient cycling is defined as how efficiently organic matter is cycled back into the soil. Scores for vegetation cover, litter cover, origin and decomposition, cryptogam cover and surface roughness contribute to nutrient cycling values.

3.2 Methods

LFA data was collected from a total of 23 monitoring sites, including eight in the riparian rehabilitation areas at the North Wambo Creek Diversion, four in woodland rehabilitation areas and ten in pasture rehabilitation areas and one on Wambo Creek (**Figure 13**). LFA methods followed the method for Landscape organisation and SSA, as provided in Tongway and Hindley (2004). LFA data was collected between 9-13 and 17 September 2019 by ELA ecologists Tom Schmidt and Dee Ryder.

No site locations were adjusted in 2019. Refer to previous reports (ELA 2017, 2018, 2019) for past site adjustments.

Raw numerical values from previous years were available for Landscape organisation, Stability, Infiltration and Nutrient cycling indices. Data for pasture and woodland sites was available for the 13 monitoring periods from 2006 – 2018, while creek diversion sites were first sampled at the completion of the creek diversion construction and subsequent seeding in 2008. Trends in these values over time along with general field observations were used to inform management recommendations.

Performance criteria have previously been developed from a range of scores from previous monitoring years from nearby sites with relatively undisturbed riparian habitat. The following colour system is used to highlight the performance of each LFA site as shown below in **Table 13.**

Table 13: Colour system devised to highlight the performance of each LFA site

Green	Yellow	Orange	Red
Area generally meets or exceeds target values and values do not show trend of decline over time – where monitoring sites are meeting targets and values are relatively consistent, reduce monitoring to infrequent LFA when changes in landscape or management practices occur i.e. fire or grazing)	Area generally falls below target values but within 75% of targets or appears to be on a trajectory of improvement without the need for management intervention – further monitoring required	Area generally falls between 75% and 50% of target values or shows little sign of improvement over several monitoring events – further monitoring and possibly management actions required	Area falls below 50% of target and is unlikely to improve without management actions or shows trend of decline which is unlikely to improve without management actions

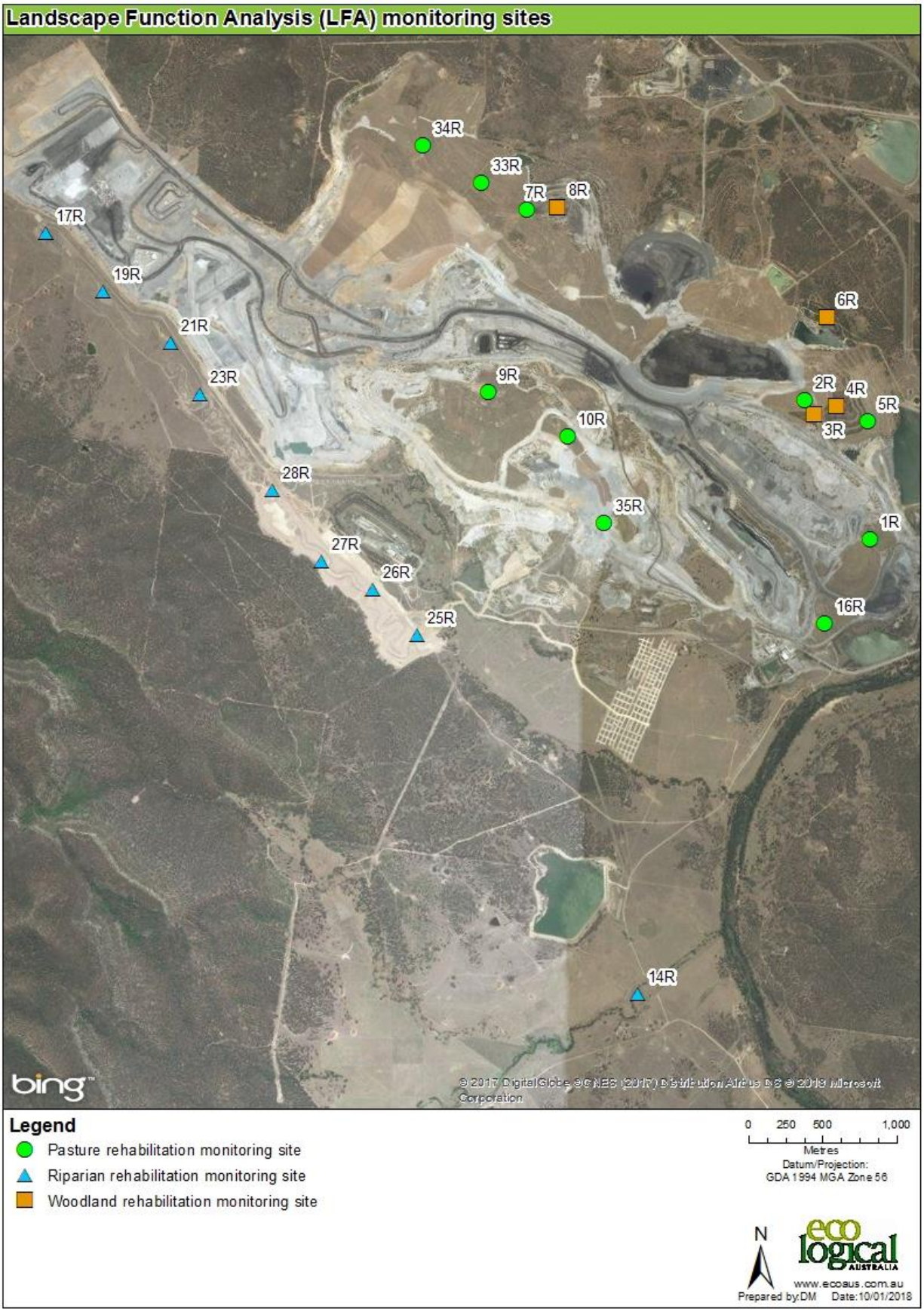


Figure 13: LFA monitoring sites

3.3 Results

3.3.1 North Wambo Creek Diversion

Monitoring sites within the North Wambo Creek Diversion area are variable in condition, with monitoring sites described in **Table 15**. All monitoring sites are open pasture areas and generally have few native plant species and consist of predominantly low pasture, primarily *Cynodon dactylon* (Common Couch), with tussocks of *Chloris gayana* (Rhodes Grass) and *Setaria* sp. (**Plate 19**). Native *Acacia* sp. and *Eucalyptus* sp. seedlings and shrubs observed in the south of the diversion area as a result of direct seeding works are continuing to grow and develop in some areas. Natural establishment of *Casuarina cunninghamiana* and *Eucalyptus* sp. in the creek bed, particularly in the north of the creek diversion, also continues. Erosion was observed in some areas of the creek channel, including gully erosion (**Plate 20**).

Plate 19: North Wambo Creek Diversion during 2019 at site 26R showing grasses with native shrubs and some bare soil

Plate 20: Gully erosion within the North Wambo Creek Diversion (near site 23R)

Table 14: North Wambo Creek Diversion LFA results in 2019 (Plots are organised by location - upstream to downstream)

Monitoring Plot	LOI	ST	INFI	NI
17R	0.78	57.8	33.6	28.6
19R	0.83	63.6	33.1	28.1
21R	0.71	57.9	35.5	27.0
23R	0.43	48.2	27.5	21.1
28R	0.62	54.3	31.2	24.3
27R	0.92	54.3	34.8	25.7
26R	0.81	61.6	44.6	43.7
25R	0.83	65.7	39.9	36.0
Average score	0.74	57.9	35	29.3
Target score	>0.84	>62	>41	>37
14R (reference site)	0.39	42.7	42	23.7

The average **LOI** score did not meet the performance target, although the scores appear to be on a trajectory of improvement for the last four years.

Site 23R had the lowest scores, resulting from a bare slope in the middle of the transect, which is a lower slope of the broader creek diversion channel. Site 23R and adjacent areas have issues with erosion (also noted in previous reports), with rills, scalds and eroding creek banks recorded close by. Several rills are likely to exceed the depth specified in the completion criteria in regard to erosion control (WCPL 2015).

Site 27R had a large increase in score from and met the performance target, with grass and woodchips contributing the most cover. Monitoring sites 27R and 28R have previously been ripped and reshaped in an effort to control weeds, establish cover and prevent erosion. Both sites recorded an increase in LOI score in 2019, although low grass is establishing better on the ripped slope at Site 27R.

The reference site 14R recorded a significant decrease in score from 1 in 2018 (indicating no bare soil) to 0.39 in 2019 (indicating 61% bare soil). This result appeared to be from a combination of grazing pressure, pest animals (rabbits) and dry conditions.

LOI scores generally increased or were similar to recent years at most monitoring sites and the average scores show a trend towards achieving the performance criteria. The addition of four sites in the more recently constructed southern portion of the diversion during 2015 is observable in the data via a drop in LOI scores and the very low scores reported from the first monitoring year in 2008 may reflect the bare soil of the newly created diversion followed by the establishment of a cover crop in the following years (**Figure 14**).

The average **stability** index at creek diversion sites in 2019 did not meet the performance target, however the score is very close to the target and has remained similar over time. The lowest stability scores were recorded at the sites 23R, 27R and 28R which had higher proportion of bare soil and hence a larger propensity for soil erosion. The average stability index (57%) is higher than the score recorded at the analogue site 14R (43%) which also recorded the lowest score.

The average **infiltration** index fell below the performance target, although these scores are the highest recorded since 2011 and reveal a trend towards achieving the performance criteria (**Figure 16**). The highest infiltration improvement was recorded at site 26R (45%) this result is higher than the target of 41. The reference site 14R also achieved the target score.

The average **nutrient** index fell below performance targets, although these scores are the highest recorded since 2011 and reveal a trend towards achieving the performance criteria (**Figure 17**). The highest nutrient index was recorded at site 26R (44%), this result is higher than the target score of 37.

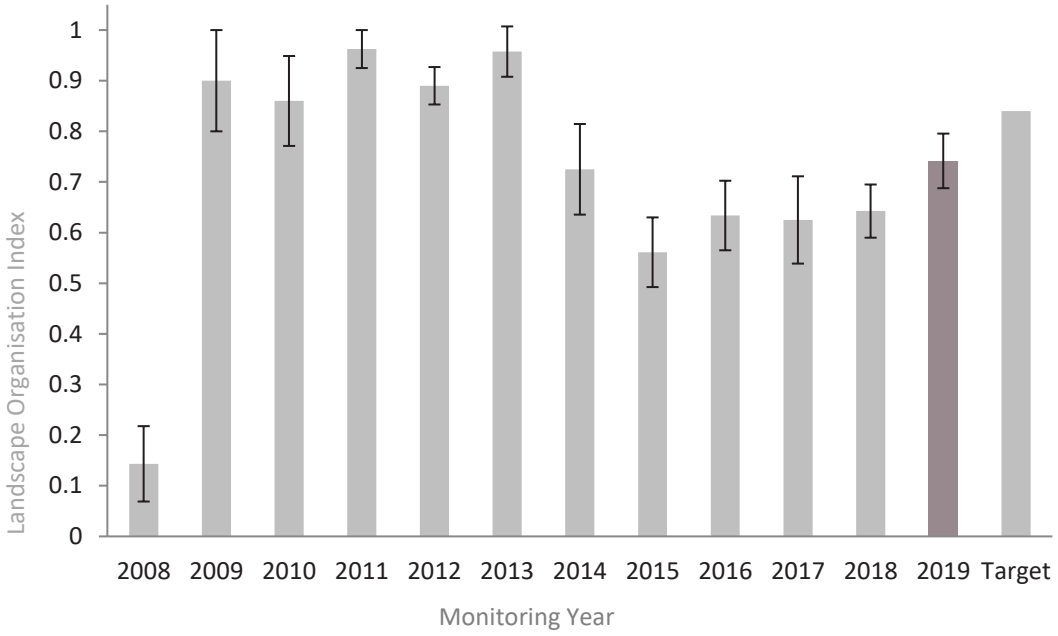


Figure 14: Average landscape organisation scores from the creek diversion sites. Average scores onwards from 2015 incorporate four additional sites (25r, 26R, 27R and 28R). Error bars represent standard error of the mean. Only 3 sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Landscape Organisation Index.

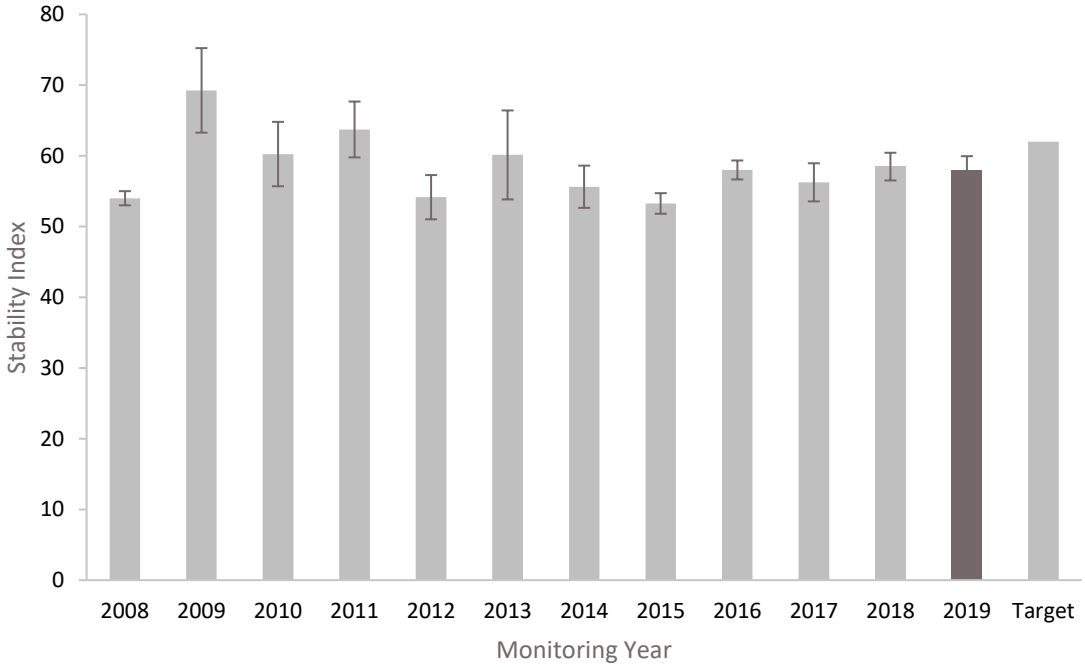


Figure 15: Average stability index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year since 2009-2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Stability Index.

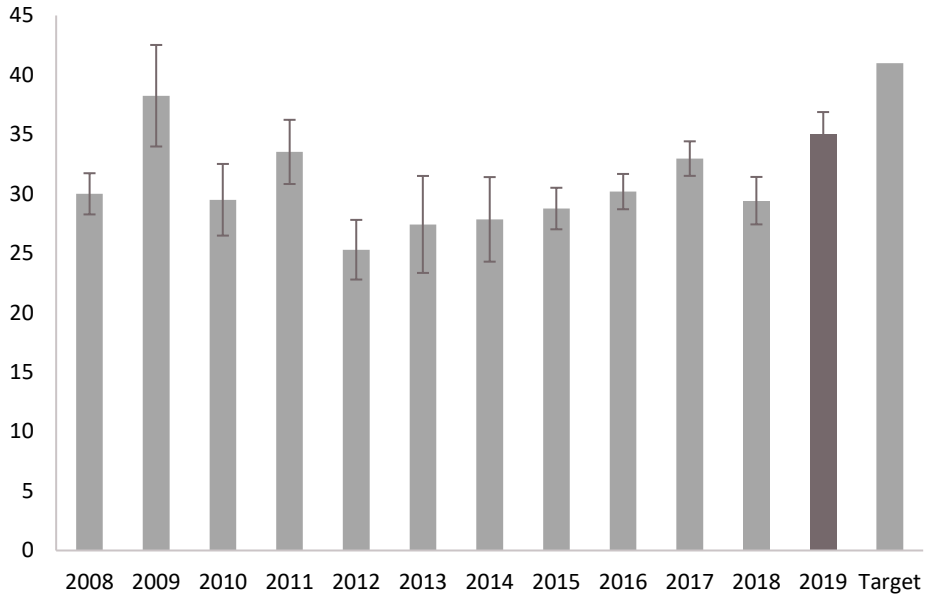


Figure 16 : Mean infiltration index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year between 2009 -2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Infiltration Index.

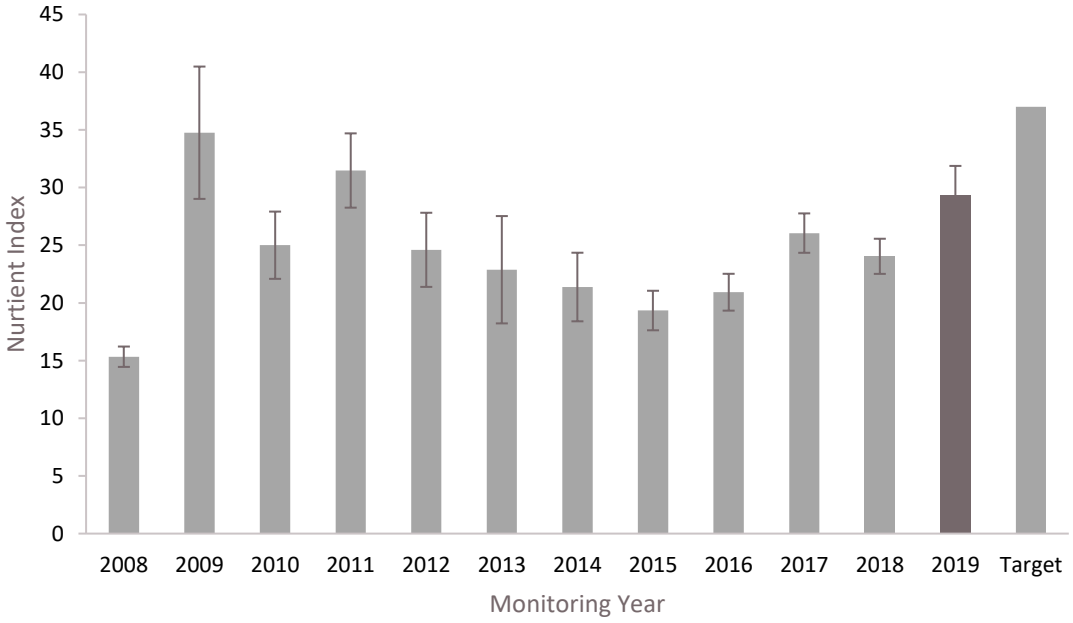
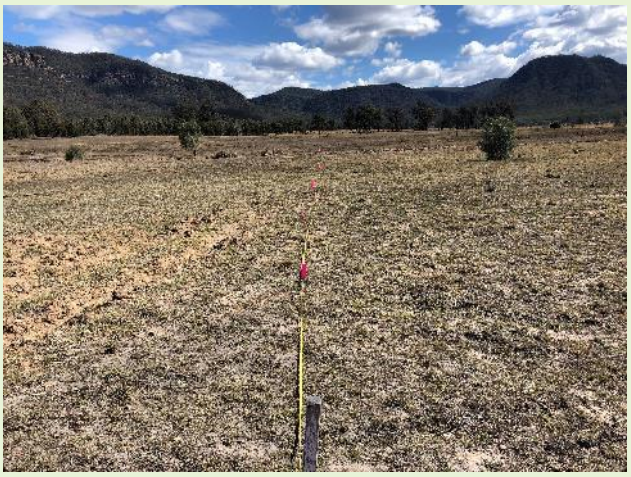


Figure 17: Mean nutrient index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year between 2009 -2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Nutrient Index.

Table 15: Site description of each creek diversion transect

Transect	Notes	Photograph
17R	This transect consists of relatively flat ground covered in pasture. Low grass (primarily *Cynodon dactylon*) and grass tussocks (primarily exotic *Chloris* gayana) make up 78% of the transect. Lower grass and tussock cover suggests the grass cover may have been dying off in the dry conditions.	
19R	Transect relatively flat and comprised primarily of low grass (81%) dispersed with patches of bare soil (17%). The percentage of grass has increased since 2018, resulting in an improved LOI score for this site. Young *Eucalyptus* and *Acacia* species are growing on creek banks downstream. Evidence of ripping activity from 2018 is visible near this transect, and the soil has been disturbed by vehicle tracks.	
21R	Transect relatively flat grassland dominated by low grass (42%) and bare soil (29%). Low grass and soil percentages have remained reasonably stable when compared to 2018. Annual vegetation cover was 29%.	

Transect	Notes	Photograph
23R	Low grass occurs over 41% of the transect, an increase of 5% from 2018. Large bare patches of stony soil occur towards the middle and end of transect where there is a slope. Bare soil patches cover 57% of the area. Some areas of active erosion including some 30cm deep rills occur in the surrounding area. The creek bank is in this area has been undercut and there is slumping on western bank. Regenerating *Casuarina cunninghamiana* (up to 5m) and some Eucalypts and *Acacia* sp. are present in and near the channel.	
28R	Transect primarily samples the relatively steep eastern creek bank. The majority of this transect was ripped to control *Galenia pubescens* and erosion prior to the 2017 monitoring. The dominant components were low grass 56% and bare soil comprises 37%. *Galenia pubescens* (6%) cover has reduced by 6% since 2018. Logs and dense tussock grasses are present at the bottom of the slope. Subsidence cracks were observed near this transect. Minimal vegetation has developed on the ripped slope and minor new erosion is evident.	
27R	Transect samples the relatively steep western bank of the cutting. The majority of this transect was ripped to control *Galenia pubescens* and erosion prior to the 2017 monitoring. Low sparse grasses and logs dominate the flat area adjacent to the creek channel. The transect is dominated by low grass (53%), litter (23%) and tussocks (9%). Bare soil (9%) and logs (6%) comprise the remainder. The low grass *Cynodon dactylon* has continues to establish contributing to an improved LOI score for this site.	

Transect	Notes	Photograph
26R	Transect samples the relatively steep eastern bank to the edge of the creek channel. Low grass (56%) and tussocks (17%) dominated this transect in 2019. Bare soil areas (19%) and logs (8%) make up the remainder. *Acacia* sp. shrubs are continuing to establish on some sections of the bank near this transect.	
25R	Grass areas have shown an improvement of 13% within the sampled transect. This slope is relatively steep with low grass dominating 74% of transect and having the highest contribution to soil stability. Bare soil is most prevalent at the top of transect where some minor erosion is occurring and makes up 17% of the transect. Large tussock grasses (*Chloris gayana*) and logs are present at the bottom of the transect near the creek channel. *Acacia* sp. shrubs are continuing to develop on the bank near this transect.	

3.3.2 Woodland rehabilitation

Vegetation in woodland rehabilitation areas consisted primarily of *Eucalyptus cladocalyx* and occasionally *Corymbia maculata* (**Plate 21**). *Acacia saligna* (Golden Wreath Wattle) forms the dominant mid-storey species at site 4R and is also present at 8R, however, this species has mostly died-off within the woodland rehabilitation areas. *E. cladocalyx* is native to South Australia and *Acacia saligna* is native to the south of Western Australia, but both have been planted widely in eastern Australia.

The substrate in these areas consists of fine grey sediment intermixed with rocks and forms a sandy clay, it appears topsoil was not used in the establishment of these woodland rehabilitation areas. As a result, the understorey in these areas remains very sparse with occasional native species present at low densities including *Enchylaena tomentosa* (Ruby Saltbush), *Calotis* spp. (Burr-Daisy) and several native grasses including *Cymbopogon refractus* (Barbed Wire Grass).

No significant issues with exotic weeds were identified in these areas, however patches of *Galenia pubescens* were common in monitoring plot 6R and *Opuntia sp.* (Prickly pear) is scattered around the transect site in monitoring plot 3R. Results from these woodland rehabilitation areas have remained similar since their first floristic sampling in 2015. With the exception of site 6R, the number of native species remains very low when compared to natural woodland sites nearby. The mid-storey and

groundcover that is present remains very sparse, with groundcover vegetation scoring zero along biometric transects for two of the four monitoring sites.

Plate 21: Woodland rehabilitation area dominated by *E. cladocalyx* at site 8R in 2019

Monitoring site 6R is different to the other three woodland rehabilitation sites with more than double the number of local native species (22 species), greater canopy cover and more groundcover than the other patches of woodland rehabilitation.

As these areas have been established using outdated rehabilitation techniques, performance criteria have been developed for these older rehabilitation areas. However, a generally small number of native species and very low native groundcover mean that these sites generally fall below the performance criteria.

Table 16: Biometric scores for woodland rehabilitation areas and performance criteria for older woodland rehabilitation areas

Vegetation Type	Plot Name	NPS (native to NSW)	NOS (%) (including *E. cladocalyx*)	NMS (%) (including *A. saligna*)	NGCG	NGCS	NGCO	EPC*	OR	HBT	FL
Woodland Rehabilitation	3R	8	14	0	10	0	0	0	0	0	0
	4R	7	19.5	0	0	0	0	0	0	0	0
	6R	17	22.5	0	2	0	0	0	0	0	25.5
	8R	8	8	0.5	2	0	0	0	0	0	0
Average values		10	16	0.13	3.5	0	0	0	0	0	6.38
Performance criteria for older woodland rehabilitation areas		> 15	15-40	5-40	5-15	5-10	5-15	<20	1	-	5

Woodland rehabilitation areas were sampled as per the previous monitoring design, with four LFA monitoring locations at sites 3R, 4R, 6R and 8R. LFA results are presented in **Table 17** below.

Table 17: LFA scores and performance criteria for woodland rehabilitation areas

Monitoring Plot	LOI	SI	INFI	NI
3R	0.75	48.7	41.3	37.4
4R	0.89	59.2	59.2	54.4
6R	0.90	63.5	47.1	43.2
8R	0.70	56.2	36.0	29.7
Average score	0.81	56.9	45.9	41.2
Target score	>0.87	>59	>43	>36
Reference site range (2010-2014)	0.57 - 1.00	48.30 - 70.50	35.90 - 58.46	31.10 - 54.46

Scores fell within the range of the recorded scores from 3 reference sites sampled over 5 years starting in 2010 and ending in 2014.

Sites 4R and 6R were the highest performing sites and met all performance targets. LOI at sites 3R and 8R did not meet the performance targets, with these sites having large areas of exposed bare soil. Sites 3R and 8R did not meet the performance target for soil stability and had lower scores for stability than in 2018. Leaf litter was the main patch type at all woodland rehabilitation sites and the main contributor to stability of soil, water infiltration/runoff and nutrient cycling.

Both photos taken at the sites and collected data, show that these sites have remained quite stable over the last five years notwithstanding some dieback of *Acacia saligna* and growth of trees (**Plate 22** and **Plate 23**).

Some very low scores that are possibly erroneous are present in the provided database between the 2006 and 2008 monitoring periods. This has been discussed in previous monitoring reports.

Woodland monitoring plot score averages recorded in 2019 achieved target scores for both infiltration and nutrient indices. The average score for LOI was lower than the target score with a very slight improvement on scores from previous years. The stability score was lower than the stability average index for the previous three years.

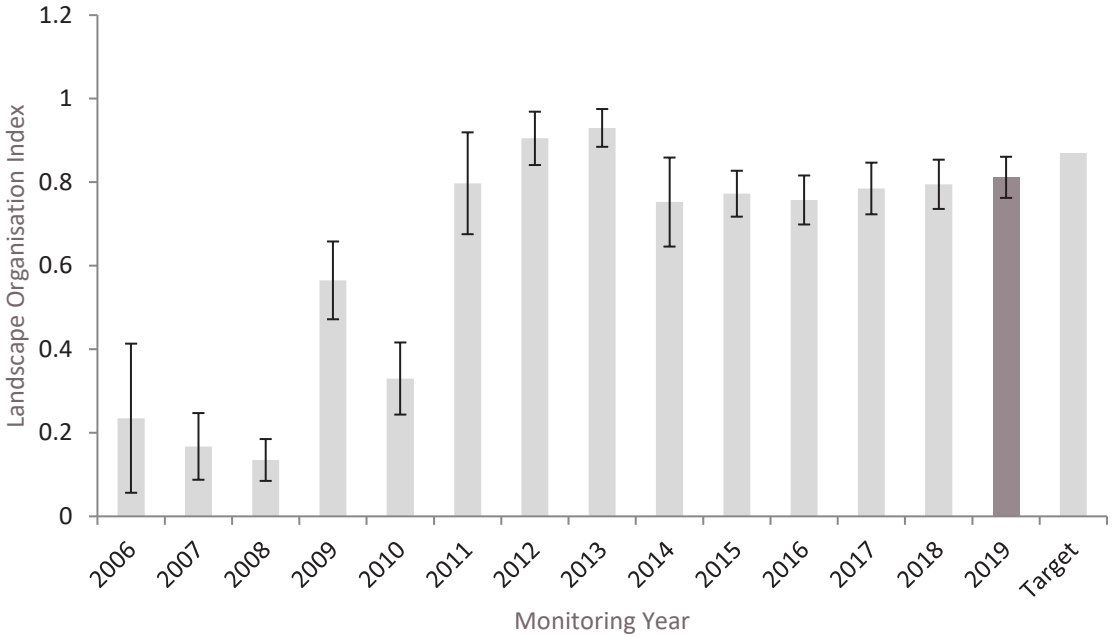


Figure 18: Average landscape organisation scores across the four woodland rehabilitation sites since 2006

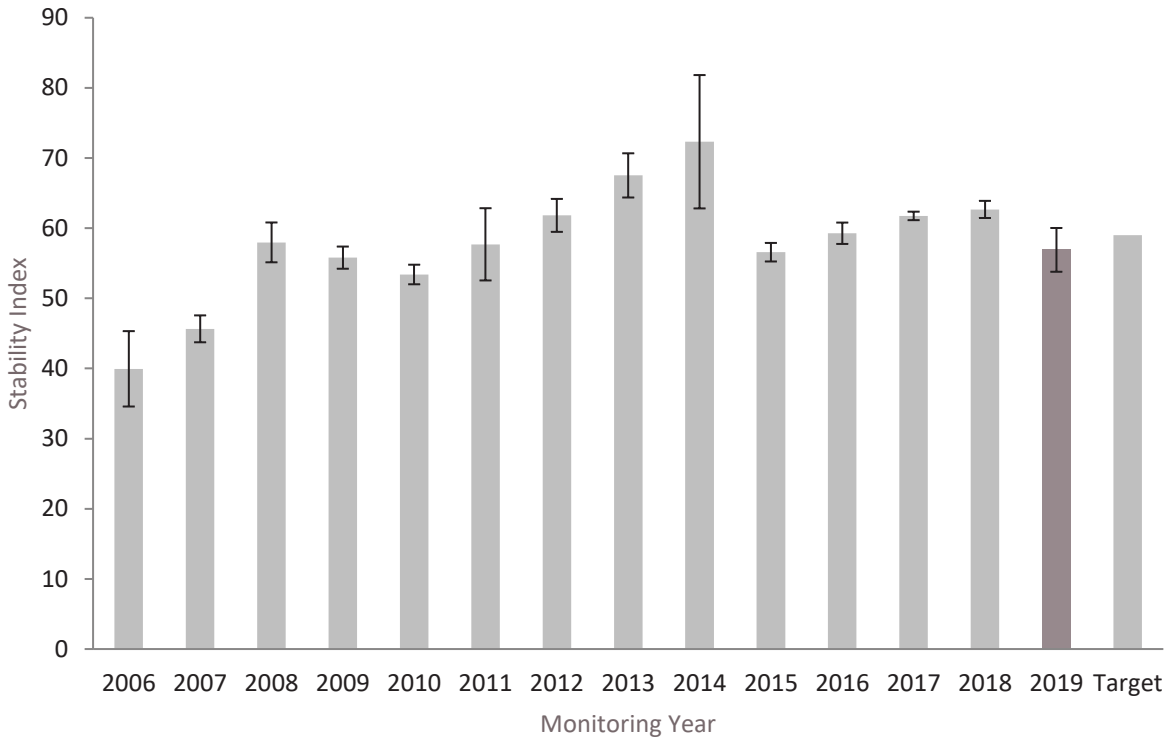


Figure 19: Average stability scores across the four woodland rehabilitation sites 2006-2019

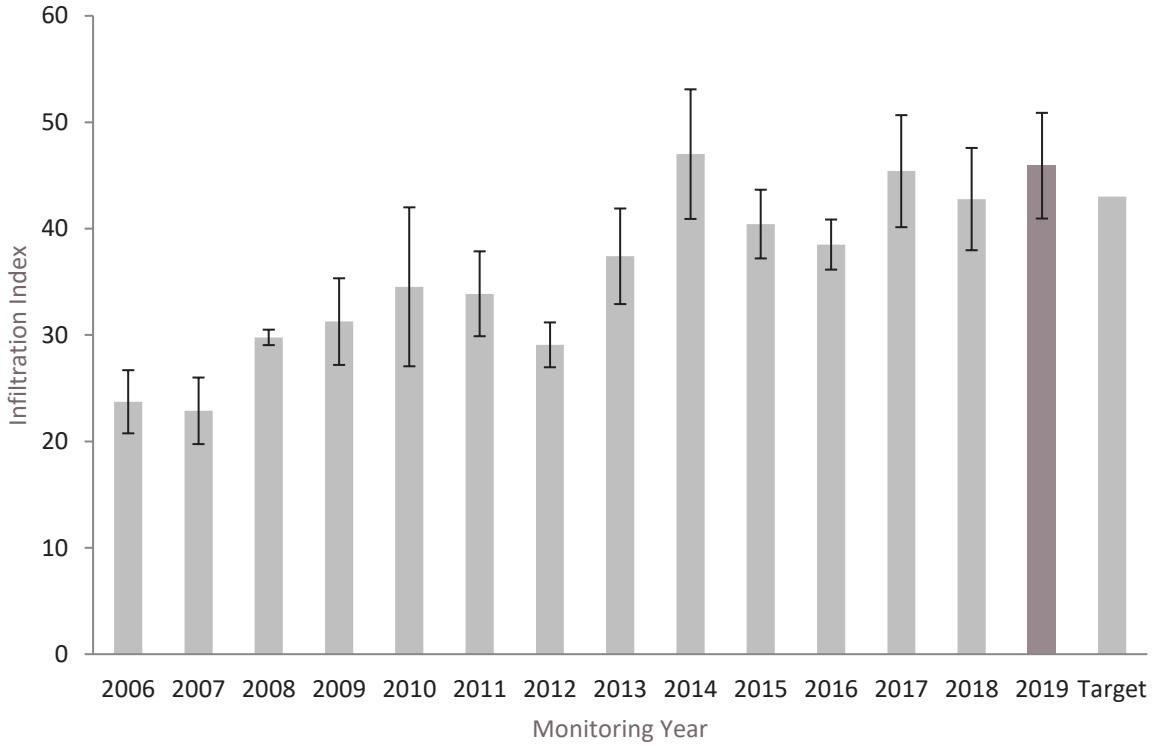


Figure 20: Average infiltration scores across the four woodland rehabilitation sites 2006-2019

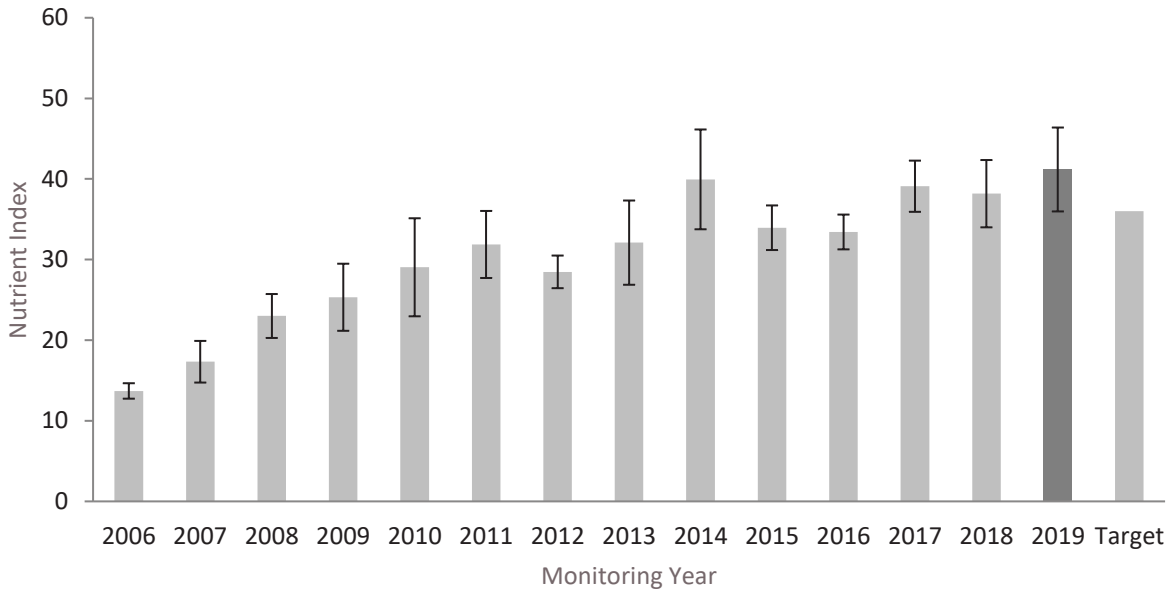


Figure 21 Average nutrient index scores across the four woodland rehabilitation sites 2006-2019

Plate 22: Site 3R during 2014

Plate 23: Site 3R during 2019

Table 18: Site description of each woodland rehabilitation transect

Transect	Notes	Photograph (2019)
3R	A relatively flat transect through a planting of *Eucalyptus cladocalyx*. Scattered and sparse *Corymbia maculata* are also present. Three native groundcover species (*Enchylaena tomentosa*, *Cymbopogon refractus* and *Chloris divaricata*) were recorded in the 20 x 20 m plot, although the cover of these species remains very sparse. The weed *Opuntia sp.* (Prickly pear) is scattered around the site. Leaf litter is the major patch type making up 75% of the LFA transect, bare rocky soil areas make up the remaining 25% of the transect.	

Transect	Notes	Photograph (2019)
4R	This transect travels along a small ridge and slopes slightly towards the end. The transect is surrounded by plantings of *Eucalyptus cladocalyx*, *Corymbia maculata and Acacia saligna*. Understory vegetation is very sparse to absent across the plot. Leaf litter is the major patch type on the LFA transect, covering 87% of the transect. Patches of bare soil make up 11%, with logs making up the remainder.	
6R	This site is the best performing woodland rehabilitation monitoring site. A canopy of *Eucalyptus cladocalyx* is present with several native mid-storey species and native grasses and herbs. The weed *Galenia pubescens* also occurs in small patches. A dense and deep cover of leaf-litter is present (85% of transect length) and is by far the major contributor to site stability, infiltration and nutrient cycling scores	
8R	This transect is located on a lightly sloping site with plantings of *Eucalyptus cladocalyx* and *Corymbia maculata*. A few native grasses are scattered across the site. Leaf litter covers 70% of the transect length, with 30% bare soil and the remainder of rock.	

3.3.3 Pasture rehabilitation

Pasture rehabilitation is currently meeting performance targets for all attributes with the exception of LOI, which still had a relatively high average score, with 88% of transect area covered by resource accumulating patches (**Table 19**). The average LOI was reduced by the influence of sites 2R and 34R, which performed the worst in terms of LOI with 23% and 21% respectively of the transect being comprised of bare soil.

LOI scores during 2019 improved across the monitoring sites when compared to 2018 scores (with the exception of site 9R which was marginally lower than 2018). There was an average 12% reduction in the area of bare soil patches from 2018. Site 9R had marginally lower LOI score than in 2018, with a 3% increase in bare soil which corresponded to a reduction in short grassy patches. Site 35R had a 30% increase in resource accumulating patches with grassy patches increased by 14%, a high proportion of the transect was covered by litter (53%) along with an increase in the growth of the weed *Galenia pubescens* (13%).

From the 2010 to 2012 monitoring periods and again in the 2014 monitoring period, most sites (all sites in 2012) recorded a LOI score of 1 or very close to 1, indicating that there were no bare soil patches present in the transects at all. While no raw data sheets prior to the 2015 monitoring are available to investigate these results, examination of site photos suggest some of these previous high LOI scores may be erroneous.

Average indices for stability, infiltration and nutrient cycling generally remained consistent with previous monitoring years (**Figure 23, Figure 24** and **Figure 25**).

Comparison with site photos from 2014 monitoring indicate that the native *Acacia salicina* (Willow Wattle) has grown substantially and has spread through pasture site 2R, while vegetation at other sites remains very similar.

Plate 24: Pasture rehabilitation area dominated by *Chloris gayana* (Rhodes Grass), near site 33R in 2019

Table 19: LFA scores and performance criteria for pasture rehabilitation areas 2019

Monitoring Plot	LOI	ST	INFI	NI
1R	0.90	61.3	38.0	30.5
2R	0.77	61.01	33.4	29.8
5R	0.80	63.7	35.2	30.6
7R	0.96	62.8	47.4	37.6
9R	0.83	68.3	37.5	35.6
10R	0.98	66.6	43.4	38.5
16R	0.94	67.8	42.5	37.6
33R	0.97	64.3	47.0	42.3
34R	0.79	62.7	37.0	31.3
35R	0.86	66.4	36.1	31.2
Average score	0.88	64.4	39.76	34.5
Target score	0.93	61	29	25

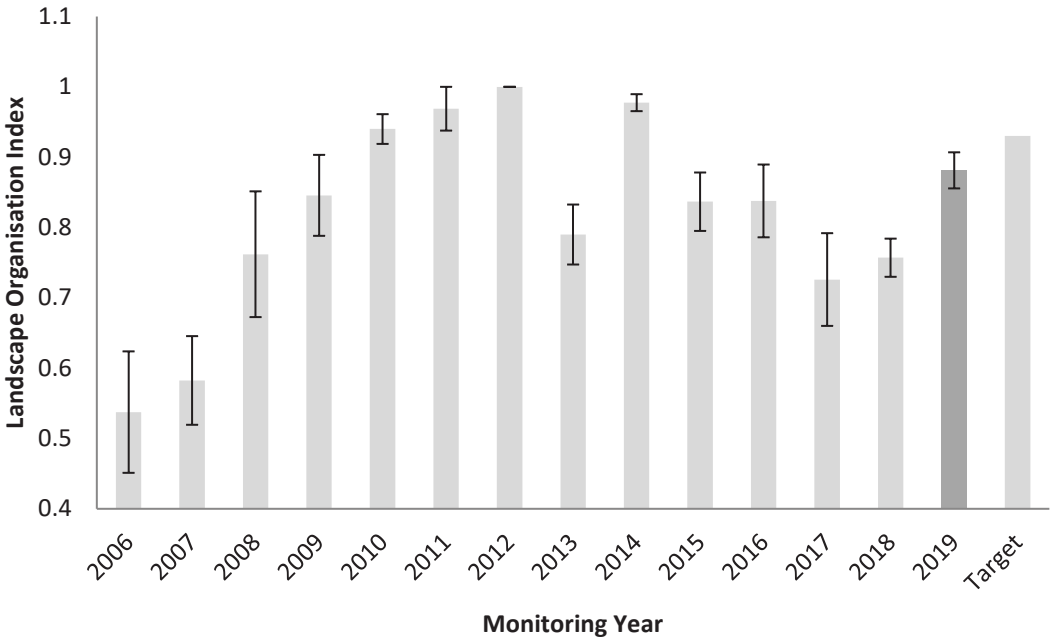


Figure 22: Average Landscape Organisation Index scores from pasture rehabilitation sites 2006-2019. Error bars represent standard error and the target bar represents performance criteria. Only four sites were sampled in 2006 and 2007, increasing to nine sites in 2010.

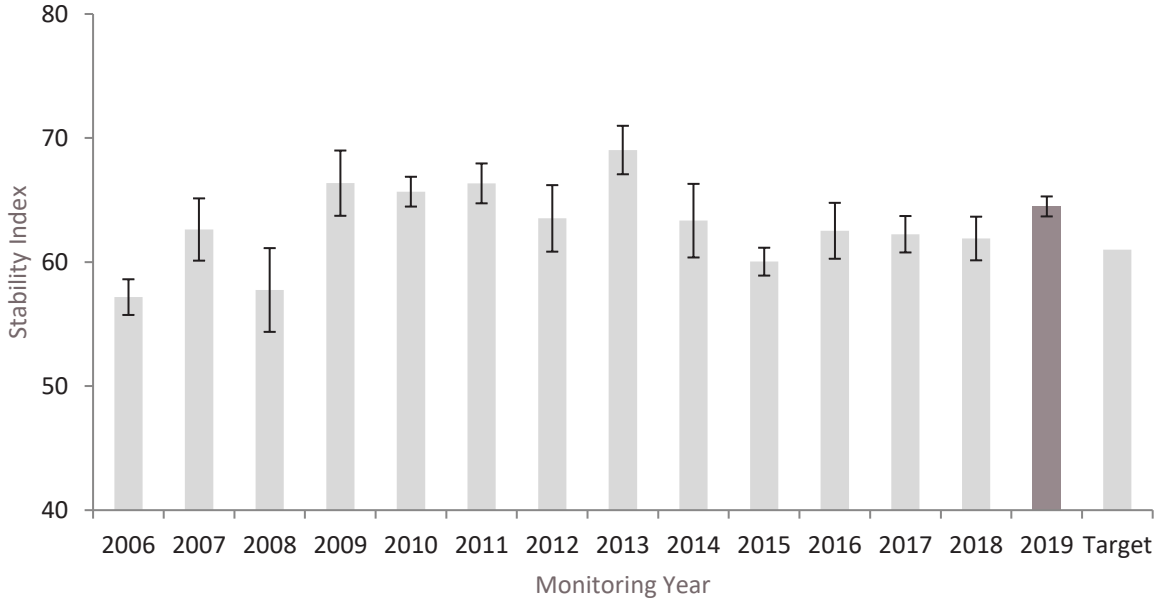


Figure 23: Average Stability Index scores from pasture rehabilitation sites 2006-2019. Error bars represent standard error and the target bar represents performance criteria.

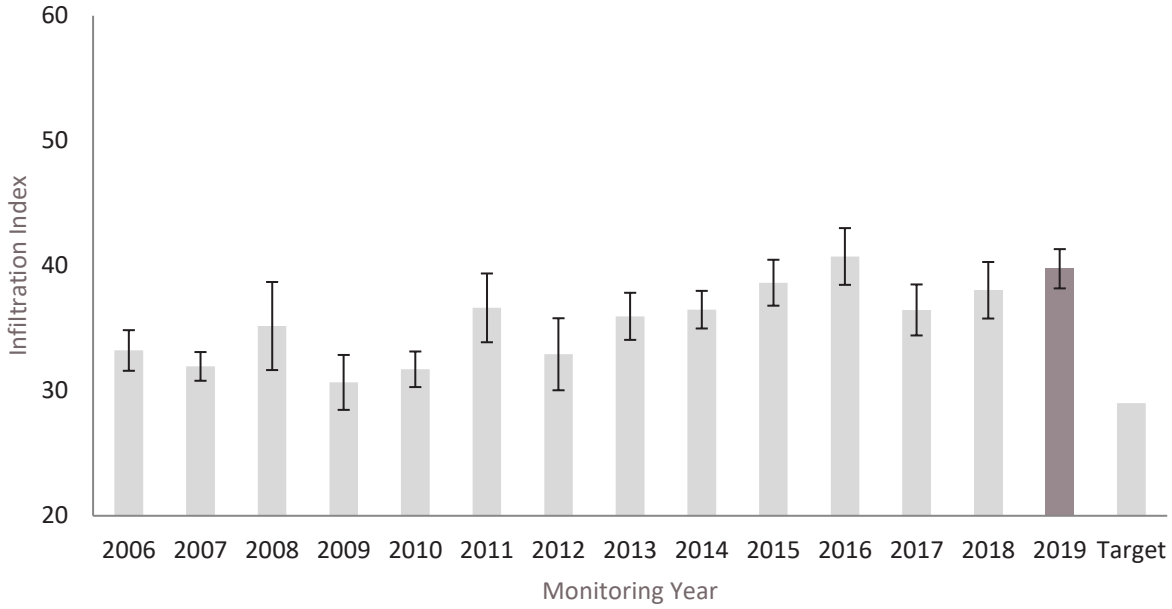


Figure 24: Average Infiltration Index scores from pasture rehabilitation sites 2006-2019. Error bars represent standard error and target bar represents performance criteria.

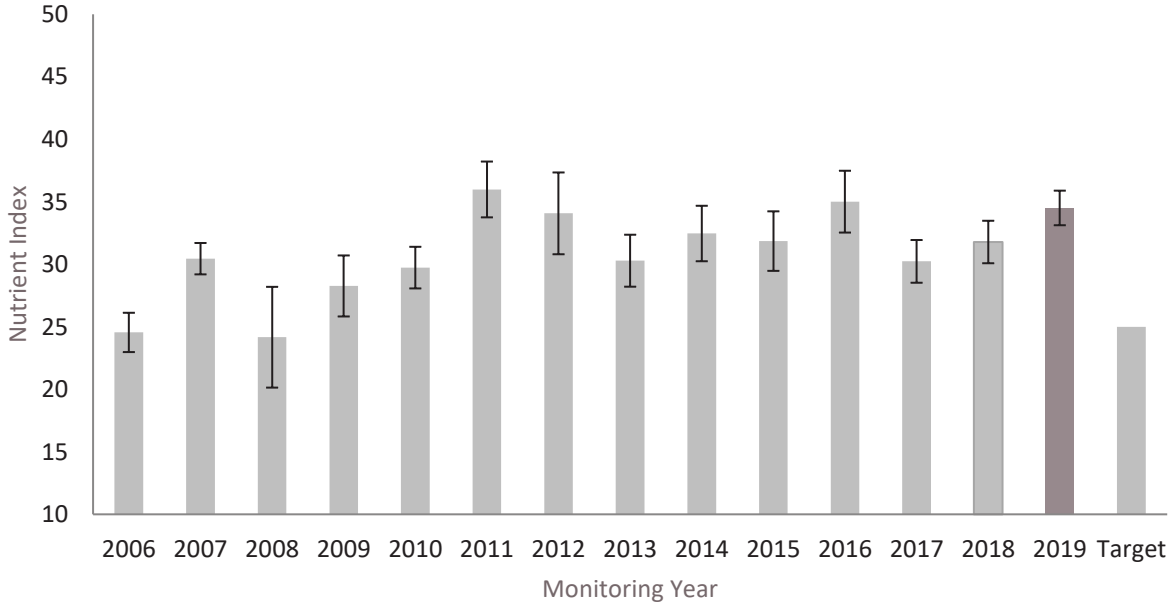


Figure 25: Average Nutrient Index scores from pasture rehabilitation sites 2006-2019. Error bars represent standard error and target bar represents performance criteria.

Table 20: Site description of each pasture rehabilitation transect

Transect	Notes	Photograph (2019)
1R	Low grassy patches (56%), tussocks of the exotic *Chloris gayana* (22%), associated grassy leaf litter (12%) dominate the transect and are the main stabilising features of this rehabilitation area near the coal preparation plant. These features also contribute toward infiltration and nutrient cycling. Bare soil (15%) does not contribute toward the capture and utilisation of resources for the landscape, reducing the LOI score to below the performance criteria.	
2R	This transect runs down a very slight slope and was dominated by grassy patches (60.5%), bare soil (23%) and tussocks (13%). When compared to 2018 results, grass cover had improved by 38% and bare soil has also reduced. This site is meeting the target scores for stability, infiltration and nitrogen cycling, however the LOI target has not been met. The LOI score has improved since 2018, however 23% bare soil continues to reduce the ability of the landscape to capture and utilise resources. The LOI score for this site is the lowest result recorded during the 2019 survey, indicating this site has the largest amount of bare soil.	
5R	This site is dominated by exotic tussock grasses (*Setaria* sp.) (41.5%) and litter (39%). The remainder of the site is bare soil (19.5%). Scattered large *A. salicina* are present surrounding the transect area. Tussock grass and litter results have improved when compared to 2018 results, however the site is still failing to meet the target score for LOI. Bare soil (23% of the transect) continues to reduce the ability of the landscape to capture and utilise resources.	

Transect	Notes	Photograph (2019)
7R	Transect was dominated by litter (52%), short grass (19%) and exotic *Chloris gayana* tussocks (12%). The remainder of the cover comprised of exotic *Galenia pubescens* (13%) and bare soil (4%). The reduction in bare soil from 2018 corresponds to a 30% increase in litter cover and a 14% increase in short grass and the exotic weed *Galenia pubescens.* The locally native *Acacia salicina* continues to colonise the rehabilitation in this area. This site is meeting all performance criteria including the LOI target.	
9R	A large rocky soil scald dominates the start of this transect, however grassy patches and tussock growth has resulted in a stability index for this site above the performance criteria. Grassy patches (78%) and tussocks (5%) dominate the plot, the soil scald and other bare patches cover 17% of the transect. The LOI score did not meet the performance criteria target, indicating a significant proportion of the transect is bare soil.	
10R	Dense tussocks of *Chloris gayana* (52%), leaf litter fallen from the dense tussocks and dry dead exotic perennial vegetation (32 %) and grassy patches (12%) made up the majority of this transect. Bare soil patches were minimal making up just 2% of the transect length. This scores for this site meet all performance criteria. This site has the highest LOI score recorded in the 2019 surveys, indicating this transect has the least bare soil.	

Transect	Notes	Photograph (2019)
16R	Transect primarily composed of grassy patches (39%) and litter (29%) in between tussocks of *Chloris gayana* (26% of the transect length) and bare soil. This site is exceeding all performance criteria including the LOI target. A decrease in bare soil (6% of transect) has contributed to the LOI score exceeding the performance criteria.	
33R	Transect primarily composed of litter (65%) and dense tussocks of *C. gayana* (17%) and low grass and (15%). Bare soil patches made up 3% of the transect. The 2018 survey showed that this site was primary composed of dense tussocks of *C. gayana*, it appears that these tussocks have broken down and contributed to the high litter composition present in 2019 surveys. This site is meeting all performance criteria including the LOI target.	
34R	Transect is composed of low spreading grassy patches (30%), dense tussocks of *C. gayana* (27%) with fallen dead grass (leaf litter - 23%) and bare soil patches (20%). Grassy patches and tussocks were the primary contributor to the site stability and infiltration scores which exceed the targets for this site. The LOI score has not been met for this transect due to the amount of bare soil (interpatch).	

Transect	Notes	Photograph (2019)
35R	Low grass (86%) dominated this new area of rehabilitation, with bare soil (14%) making up most the remaining transect. The LOI score has not been met for this transect due to the amount of bare soil (interpatch).	

3.4 Conclusion and recommendations

3.4.1 North Wambo Creek Diversion

The North Wambo Creek Diversion did not meet the completion targets for any LFA index based on average scores across all sites. However, the scores were all above 75% of the target values and generally show a trajectory of improvement.

The 2019 results for nutrient index and infiltration have shown improvements after lower scores were recorded in 2018. As such, no additional monitoring or intensive management actions are required relating to these results.

While some *Casuarina* and *Eucalyptus* sp. have begun to establish within the creek channel and patches of small *Acacia* and *Eucalyptus* seedlings are present in places, as a whole the creek diversion remains primarily open pasture which is dominated by exotic species such as *Chloris gayana*. Riparian vegetation is considered unlikely to be 'better' than prior to the diversion and the proposed net increase in riparian vegetation (which included establishing *Angophora floribunda*, *Casuarina cunninghamiana* and a selection of native grasses in the riparian zone) (Resource Strategies, 2003) has yet to be achieved.

Overall the creek diversion appears relatively stable without excessive erosion. However, some areas of erosion that exceed completion criteria targets are present, with some gully erosion, deeper rills and large areas of bare soil observed at and near some monitoring sites.

It is recommended to continue active management of the diversion area to encourage the establishment of native species, particularly tree and shrub species, while preventing excessive erosion issues including areas of bare soil.

3.4.2 Woodland rehabilitation

Woodland rehabilitation monitoring sites met LFA performance targets for infiltration and nutrient index and were just below the target scores for LOI and stability.

The high scores are largely due to the presence of leaf litter layers which provide protection from soil erosion and reduce the area of bare soil. All sites appear visually similar to the previous three years of monitoring and this similarity was also observed in the recorded data, with similar landscape organisation and biometric scores recorded as previous years.

Comparison of the earliest available photos from 2014, appear to show a dieback in the non-local native *Acacia saligna* which occurs as a mid-storey species at most woodland rehabilitation sites. Other than this and an apparent slight growth of trees, rehabilitated woodland monitoring sites in 2019 all appear very similar to photos taken in 2014.

Issues with the woodland rehabilitation monitoring sites have been addressed in previous monitoring reports and include:

- a lack of groundcover and mid-storey at most sites
- poor native species diversity when compared to remnant woodland sites
- the dominant Eucalypt species at these sites is not locally endemic to the Hunter Valley and originates in South Australia
- two large and deep holes, possibly related to mine subsidence, were observed near site 4R in areas of woodland rehabilitation.

Most of these issues likely relate to either a lack of, or no topsoil being used in these areas prior to tree planting. This is clearly visible where pasture rehabilitation areas with red-brown topsoil adjoin woodland rehabilitation areas with pale grey soil and rock.

Previous recommendations to improve LFA results include increasing the complexity of ground cover or woody debris to improve LOI scores and over time improve stability, infiltration and nutrient indices. However due to the large effort and cost involved in trying to enhance older rehabilitation areas, WCPL could instead focus on ensuring new areas of woodland rehabilitation are planned and implemented using best practice techniques.

3.4.3 Pasture rehabilitation

Average LFA scores for pasture rehabilitation generally met completion criteria, with the exception of LOI, which was still quite high and improved from the previous two years, despite not meeting the criteria.

Average scores were reduced by sites 2R and 5R which had a relatively high proportion of bare soil along the LFA transect.

Sites 2R and 5R remain the worst performing sites within pasture rehabilitation areas in regard to LFA indices. However, areas surrounding 2R have several native species present and both sites have *Acacia salicina* colonising the area and pasture sites with some of the best LFA scores have large dense tussocks of *Chloris gayana.* It is important to consider the final intended land-use and that LFA completion targets for pasture rehabilitation have been based on scores from areas of pasture surrounding the mine and do not directly reflect the suitability of the land to support grazing.

Some large patches of bare soil which exceed the completion criteria were observed within pasture rehabilitation areas (e.g. near 33R). Actions to improve pasture rehabilitation areas could involve the

slashing of large grass tussocks and subsequent mulching of bare areas to improve the soil profile and encourage establishment of vegetation in bare areas. Large areas of bare soil can be readily identified in pasture rehabilitation areas by reviewing recent, high-quality aerial imagery.

4. Riparian condition assessment

4.1 Introduction

The riparian EFA monitoring program is a requirement of the 2004 Development Consent conditions. The objective of the monitoring program is to evaluate how the riparian environment is responding to management initiatives (such as cattle exclusion) and document any impacts arising from mine subsidence.

North Wambo Creek drains the mid and eastern sections of the North Wambo Underground Mine development area and flows south-east into Wollombi Brook, approximately 600 m south of the Mine. North Wambo Creek has been highly disturbed both by historic and present grazing activities and by the North Wambo Creek Diversion. The diversion channels the creek around the open-cut mining operation.

Stony Creek drains from Mount Wambo in a north-east direction and meanders across the western boundary of coal lease (CL) 397 near the south-western boundary of the North Wambo Underground Mine and passes in a south-easterly direction through the existing underground development area of WCPL to join Wambo Creek. Wambo Creek then runs east to join Wollombi Brook. Much of the riparian zone along Wambo Creek has been disturbed by historic agricultural activities.

4.2 Methods

Field sampling for the riparian monitoring was undertaken between 23 and 27 September 2019. The *Rapid Appraisal of Riparian Condition* method, developed by Jansen et. al. (2005) and used during the 2016 to 2018 monitoring, was utilised during the 2019 survey period. Using this method, an overall score is obtained at each monitoring site by examining the width of riparian vegetation, proximity to large patches of native vegetation, vegetation cover, debris (leaf litter, standing dead trees and fallen logs) and other features (native canopy and understory regeneration, tussock grasses and reeds on creek banks). Areas monitored included:

- North Wambo Creek
- Wambo Creek
- Stony Creek.

Methods followed Jansen et. al. (2005) with four 40 m long cross-section transects sampled at each monitoring site (an approximate 500 m length of riparian zone). Three monitoring sites were measured along each creek. The location of monitoring sites and transects is illustrated in **Figure 26** with photographs presented in **Volume 2**.

The three creeks and sample sites were compared in regard to the following sub-indices:

- *Habitat* - longitudinal continuity of canopy vegetation (> 5 m wide); width of riparian canopy vegetation; and proximity to nearest patch of native vegetation > 10 ha
- *Cover* - vegetation cover and structural complexity
- *Native* - dominance of native species versus exotic species
- *Debris* - leaf litter; standing dead trees; hollow-bearing trees; and fallen logs

- *Features* - other indicative features such as regeneration, presence of large native tussock grasses (e.g. *Austrostipa* spp.) and reeds.

The five sub-indices were assessed across the three separate reaches of each creek and were combined to create a *Total Score.* Site photos and scores from previous monitoring reports (ELA (2016 to 2018) were compared. Although not directly comparable due to differing site locations and methodologies, data and photos from Niche (2014d) and RPS (2009)) were also reviewed.

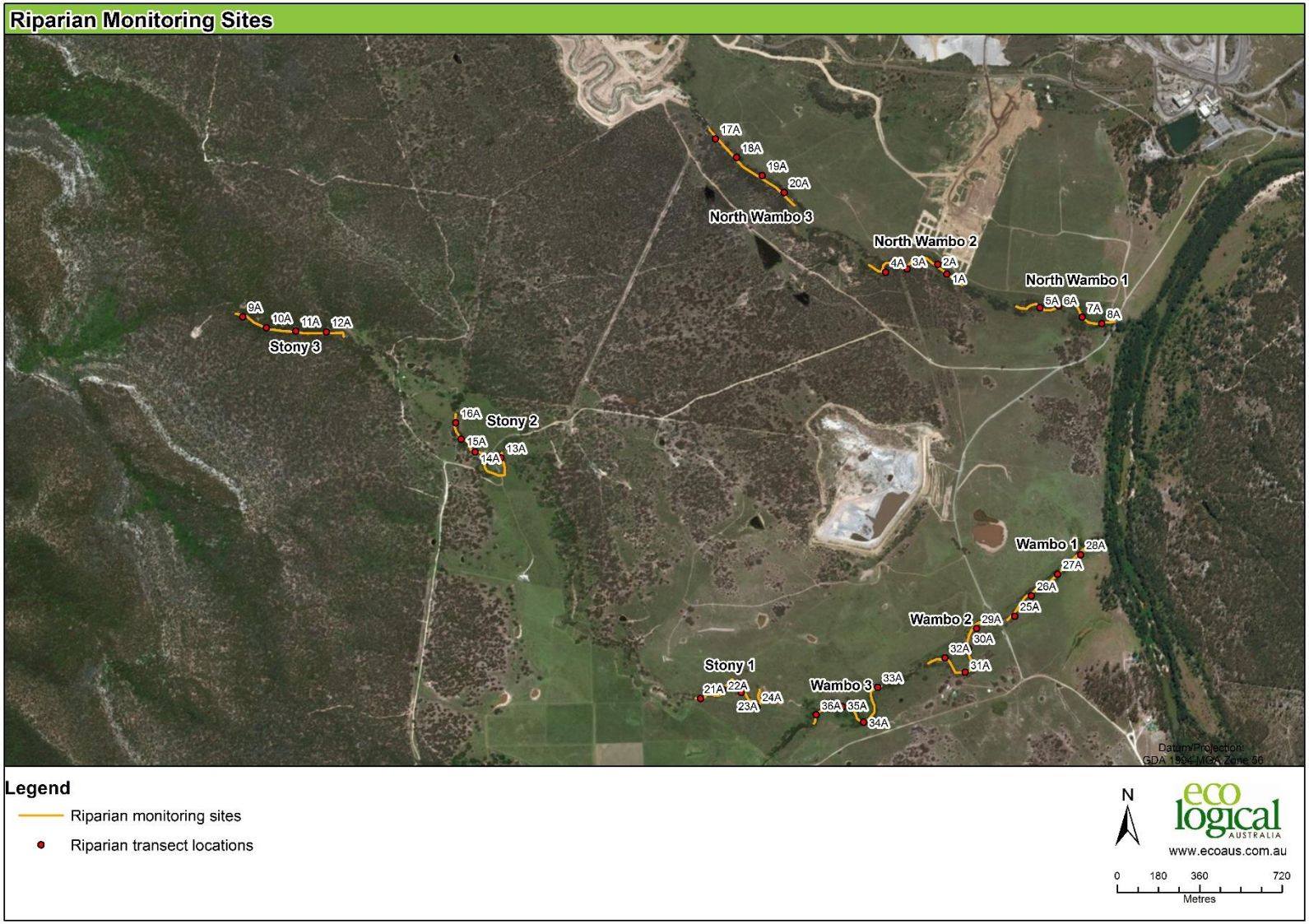


Figure 26: Location of riparian monitoring cross-sections and transects

4.3 Results

The results of the riparian condition monitoring are presented below, with raw data included in **Volume 2**.

The average total score for all three creeks in 2019 were similar to results recorded in 2018. South Wambo Creek and Stony Creek average total scores were lower than records in 2016-2017, while the average total score for North Wambo Creek remained above the 2016 score (**Figure 27**). Importantly, overall scores for all creeks have stabilised and not shown any declines from 2018 monitoring when all creeks scored lower than the previous year.

South Wambo Creek remains the lowest scoring creek system based on the sub-indices measured.

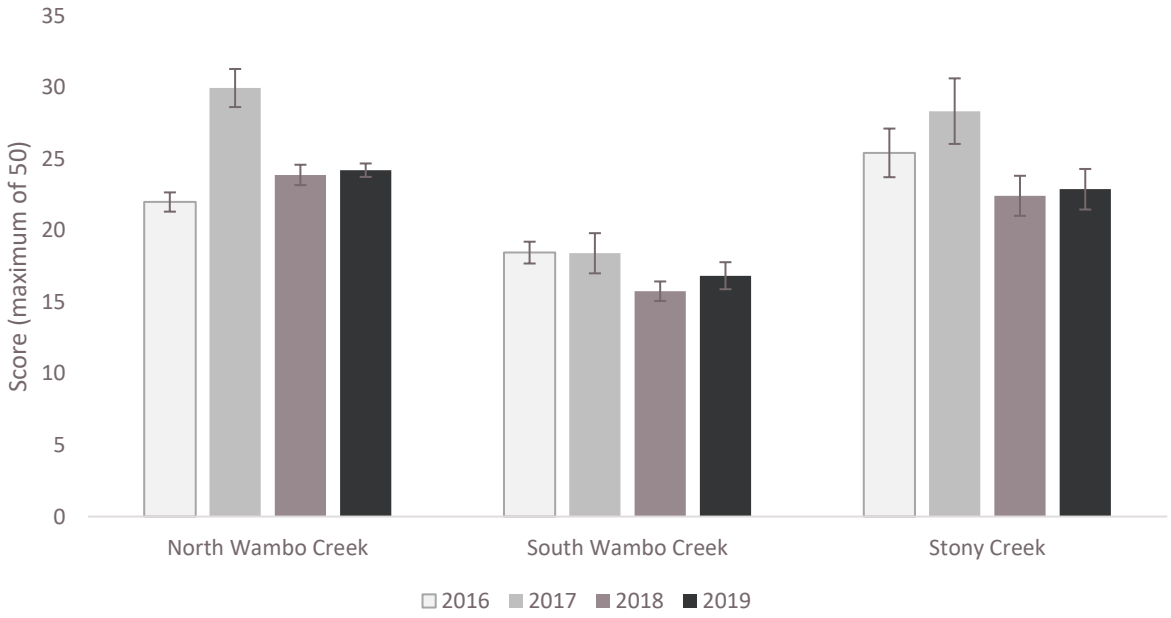


Figure 27: Average "Total Score" for North Wambo Creek, South Wambo Creek, and Stony Creek, from surveys in 2016 - 2019

Each creek system had one sub-index which scored higher than in 2018; slightly higher scores were recorded for *features* at North Wambo Creek, and higher scores were recorded for *habitat* at both Stony Creek and South Wambo Creek.

Evidence of cattle grazing was recorded at some sites along Stony Creek and North Wambo Creek. Grazing pressure reduces the ground cover and destabilises the soils leaving these areas more prone to erosion. Grazing has impacted the scores in these systems. No evidence of cattle grazing was recorded within South Wambo Creek sites and site photographs show the ground layer vegetation to be in better condition than in parts of the other creek systems, although the overall scores were reduced by other indices.

Large variability in the *habitat* and *debris* sub-indices was observed between longitudinal transects at Stony Creek and reflect the differences in vegetation and habitat features between the cleared lower reaches that are currently grazed by cattle and the heavily forested upper reaches.

No recent subsidence impacts were recorded at North Wambo Creek, Wambo Creek, or Stony Creek during the 2019 riparian condition survey.

Site scores from available past monitoring reports (Niche (2014) and RPS (2009)) show similar results with Stony Creek (particularly the upper reaches) being regarded as in good condition, North Wambo Creek as being either in good or moderate condition and Wambo creek being in moderate condition. General comparison of riparian area photos from 2019 with those from 2014 show that although conditions are currently much drier, the riparian vegetation generally remains similar.

4.4 Conclusions and recommendations

The similarity between the average scores for all creeks between 2019 and the previous year likely reflect the ongoing dry conditions and similar grazing regimes. The low average scores of all creeks when compared to 2016-17 were influenced most strongly by the sub-indices *cover* and *natives* which are associated with understorey vegetation cover, condition and exotics. Understorey vegetation remains stressed due to drought conditions, however sites without evidence of grazing pressure appeared to have greater understorey cover and more stable soils. These areas are likely to recover more quickly and be less affected by erosion and exotic species after rainfall.

Sub-indices relating to more permanent features such as habitat connectivity, tree canopy and logs and hollows remained similar.

The recommendations in previous monitoring reports still applicable to these areas. These include restricting cattle access to riparian areas to encourage tree regeneration and prevent erosion. During the dry conditions, cattle exclusion is particularly important as the understorey vegetation is under stress and cattle grazing places additional pressure on the vegetation and is more likely to increase erosion. Plantings of trees in over-cleared riparian areas (that are unlikely to regenerate naturally with cattle exclusion) will also be beneficial to riparian area and the surrounding environment.

5. Groundwater Dependent Ecosystem monitoring

5.1 Introduction

Monitoring of Groundwater Dependent Ecosystems (GDEs) is a new component to the annual biodiversity monitoring program in 2019. The GDE Vegetative Assessment Report (Hunter Eco, 2019) identified two likely GDEs in the area above the South Bates Underground Extension: River Oak riparian tall woodland and M*elaleuca decora* low forest.

The South Bates Underground Extension has the potential to impact groundwater in the vicinity of the two GDEs. Hunter Eco (2019) recommended the establishment of a GDE monitoring program including:

- Vegetation condition and extent assessed by aerial imagery and on-ground inspection over time
- Document tree height and diameter at breast height (DBH) of selected River Oak saplings and mature trees.

5.2 Methods

GDE monitoring was undertaken on 27 and 30 September 2019. The following methods were used to establish the baseline conditions for the GDEs.

Vegetation survey plots

Two vegetation monitoring plots (standard biometric plot 50 x 20 m - refer to (**Section 2.1.2**)) were established and marked in each of the GDEs. Vegetation structure and function data compliant with the Biodiversity Assessment Method (BAM) plot method (current standard method for ecological impact assessment) was also collected.

Photo monitoring points

Photo monitoring points were established at the starting point of each vegetation plot and at additional locations to achieve an even distribution across each GDE area, all photo monitoring points will be permanently marked. At each photo monitoring plot, images will be captured at 0, 90, 180, and 270 degrees, as well as one at the ground.

Tree measurements

Thirty *Casuarina cunninghamiana* trees (15 mature trees and 15 saplings) were selected for monitoring across the River Oak riparian tall forest GDE area along North Wambo Creek. Each tree was permanently marked with a numbered metal tree tag and the DBH was measured. The point of DBH measurement (1.3m above the ground) was sprayed with paint so that the measurement location can be replicated during subsequent monitoring.

Crown extent was assessed for each of the 30 tagged trees. Crown extent was assessed as the percentage of the assessable crown (all live and dead branches on the tree) in which there are live leaves. Two observers each recorded a crown extent estimate from opposite sides of the tree to the nearest 5%, and the average of the two scores was recorded.

Mapping of vegetation extent

Mapping the extent of the River Oak riparian tall woodland community along the upper reach of North Wambo Creek was completed in a GIS at 1:1000 scale using georeferenced aerial imagery (18 August

2019, NearMap). Polygons were drawn with reference to Rapid Data Points (RDPs) and photos collected during the monitoring survey.

5.3 Results

The results of the GDE monitoring are presented below, with raw data and photographs included in **Volume 2**.

5.3.1 Vegetation survey plots

Two monitoring plots were established within each GDE (Figure 28) and Biometric data from each plot is presented in Table 21.

Table 21. Biometric data for GDE monitoring plots established in 2019

Groundwater Dependent Ecosystem (Hunter Eco 2019)	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL	LI	BS
Melaleuca decora low forest	GDE Plot 1	22	5.3	5.8	10	0	2	0	1	0	36	82	22
	GDE Plot 2	24	5.1	4.5	6	28	4	14	1	0	22	84	0
River Oak riparian tall forest	GDE Plot 3	14	13	0.1	0	0	0	14	0	1	55	56	46
	GDE Plot 4	17	13.5	0	0	0	4	22	1	0	23	64	24

5.3.2 Photo monitoring points

Photo monitoring points were established at the starting point of each vegetation plot and at additional locations to achieve an even distribution across the GDE area (Figure 28), all photo monitoring points were permanently marked with a star picket. At each photo monitoring plot, images were captured at facing North, East, South and West (0, 90, 180, and 270 degrees).

5.3.3 Tree measurements

Thirty *Casuarina cunninghamiana* (River Oak) trees (15 mature trees and 15 saplings) were selected for monitoring across the River Oak riparian tall forest GDE area along North Wambo Creek (Table 22; Figure 30).

Crown extent was assessed for each of the 30 tagged trees. Crown extent was assessed as the percentage of the assessable crown (all live and dead branches on the tree) in which there are live leaves. Two observers each recorded a crown extent estimate from opposite sides of the tree to the nearest 5%, and the average of the two scores was recorded (Table 22).

Table 22. River Oak tree monitoring results

Tree Tag No.	Age class	DBH (cm)	Canopy Extent (%)	Easting	Northing
1	Adult	76	55	306275	6395900
2	Adult	34.3	50	306164	6395894
3	Sapling	22.15	95	306090	6395881
4	Adult	77.5	78	306050	6395868
5	Adult	32.15	8	305952	6395693
6	Adult	99	63	305964	6395705
7	Sapling	19.5	78	305811	6395612
8	Sapling	10.6	90	305753	6395618
9	Adult	56	55	305785	6395619
10	Sapling	11.5	80	305529	6395440
11	Sapling	19.5	93	305470	6395438
12	Adult	63.5	55	305442	6395439
13	Sapling	1.4	78	305380	6395409
14	Adult	56.7	38	305379	6395410
15	Sapling	3.8	48	305573	6395454
16	Sapling	8.45	75	305587	6395457
17	Sapling	9	50	305593	6395493
18	Adult	99.5	38	305566	6395521
19	Adult	79.9	58	305571	6395591
20	Sapling	15	70	305607	6395612
21	Adult	107	50	305338	6395325
22	Adult	57.4	63	305307	6395248
23	Sapling	18.1	55	305264	6395213
24	Adult	49.8	18	305218	6395224
25	Sapling	16.5	73	305202	6395237
26	Adult	47.5	48	305171	6395235
27	Sapling	15.9	78	305038	6395194
28	Adult	46	63	305035	6395190
29	Sapling	6.9	58	305021	6395183
30	Sapling	6.2	55	305004	6395173

5.3.4 Mapping of River Oak riparian tall woodland vegetation extent

A total area of 5.07 ha of River Oak riparian tall woodland was mapped (Figure 29).

5.4 Conclusions and recommendations

GDE monitoring sites were established and baseline data was collected. Ongoing monitoring of these sites is required to assess whether any impacts to GDEs occurs as a result from planned mining activities in this area.

Baseline data should continue to be collected during annual monitoring until undermining begins in this area. Monitoring should then continue to determine whether any impacts to GDEs are occurring. Several groundwater monitoring wells have been established in the vicinity of the GDE along North Wambo Creek and the data from these is also likely to assist with determining whether any impacts to GDEs are likely to occur.

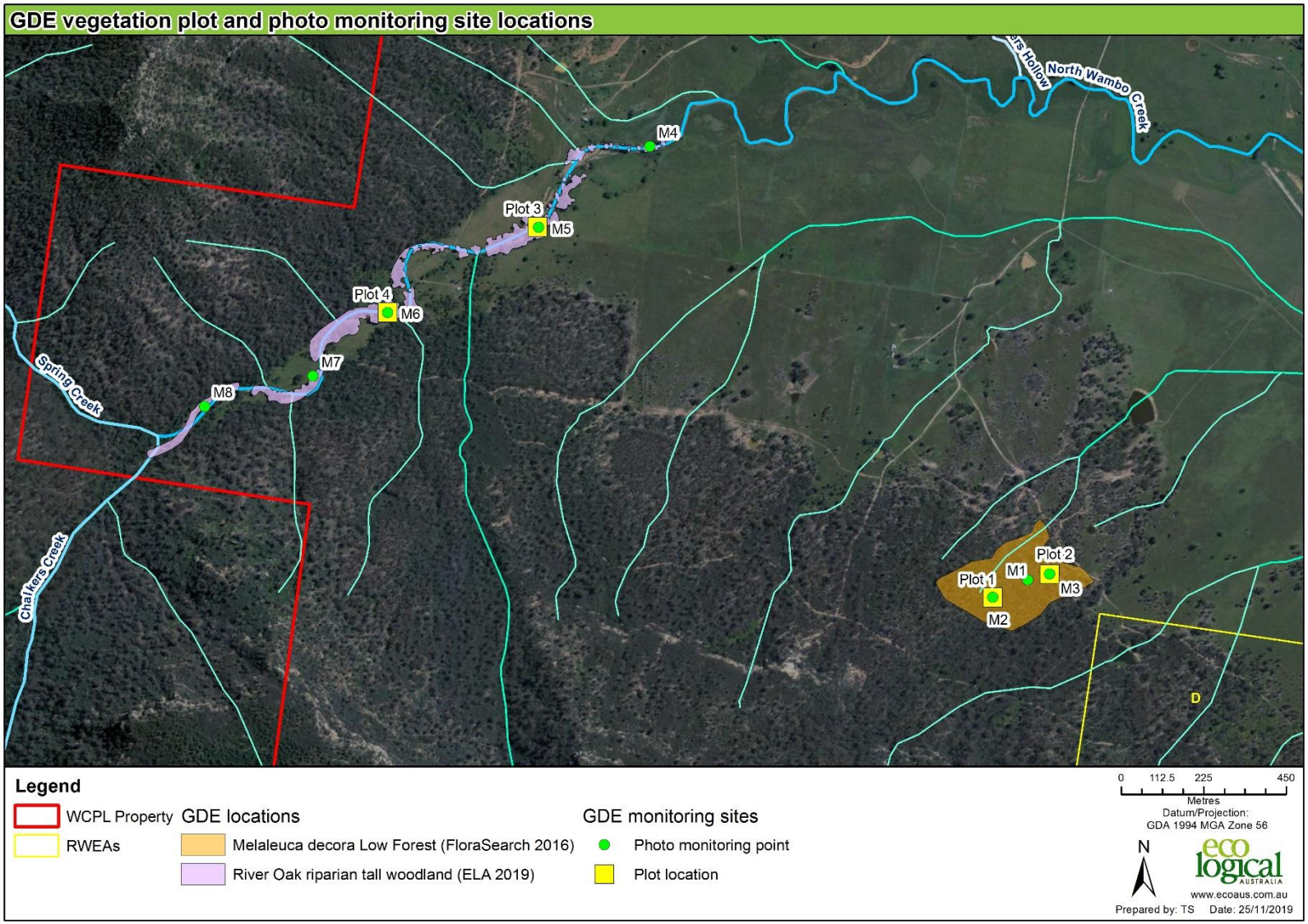


Figure 28. GDE monitoring site locations established in 2019

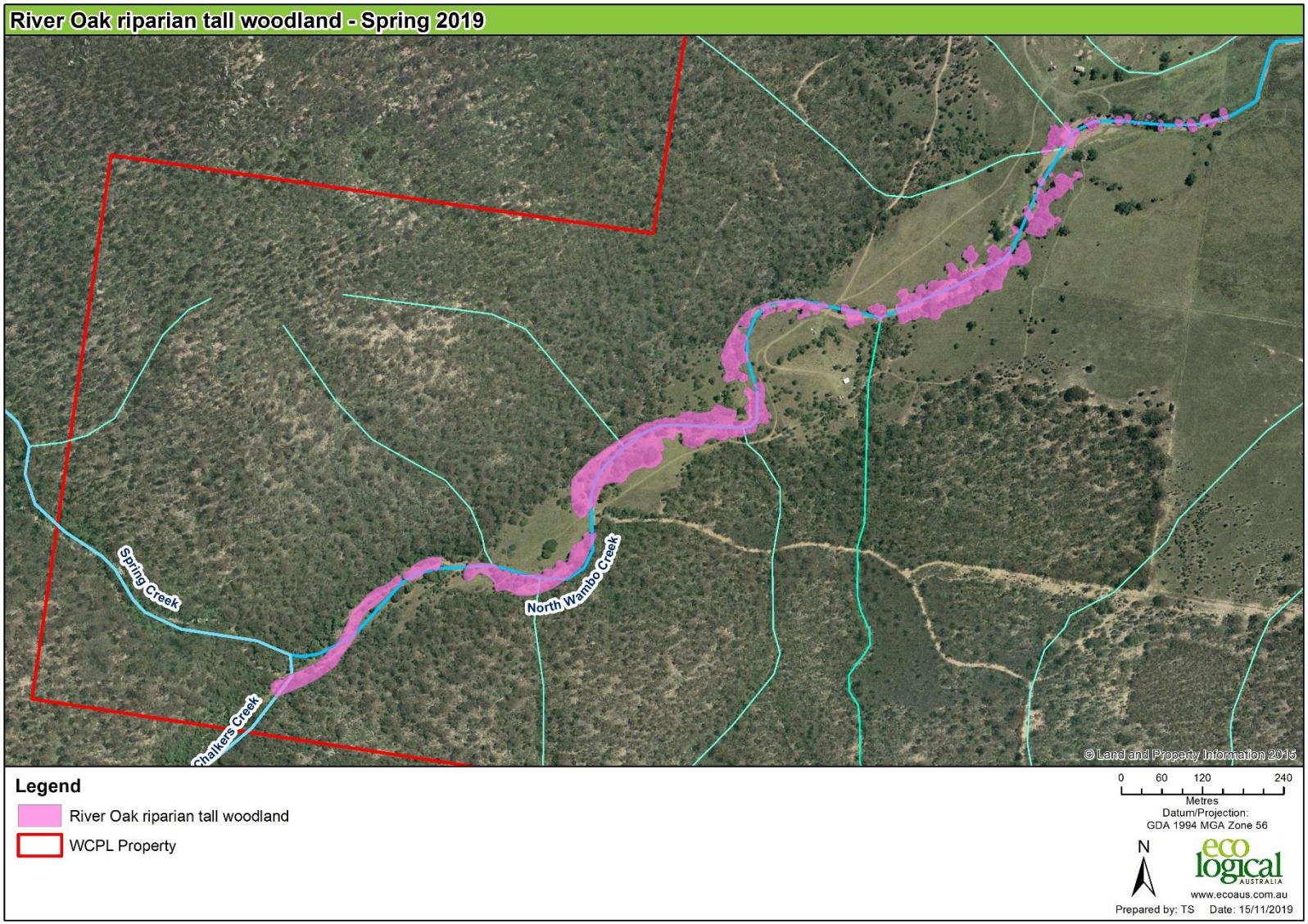


Figure 29. Extent of River Oak riparian tall woodland mapped in spring 2019

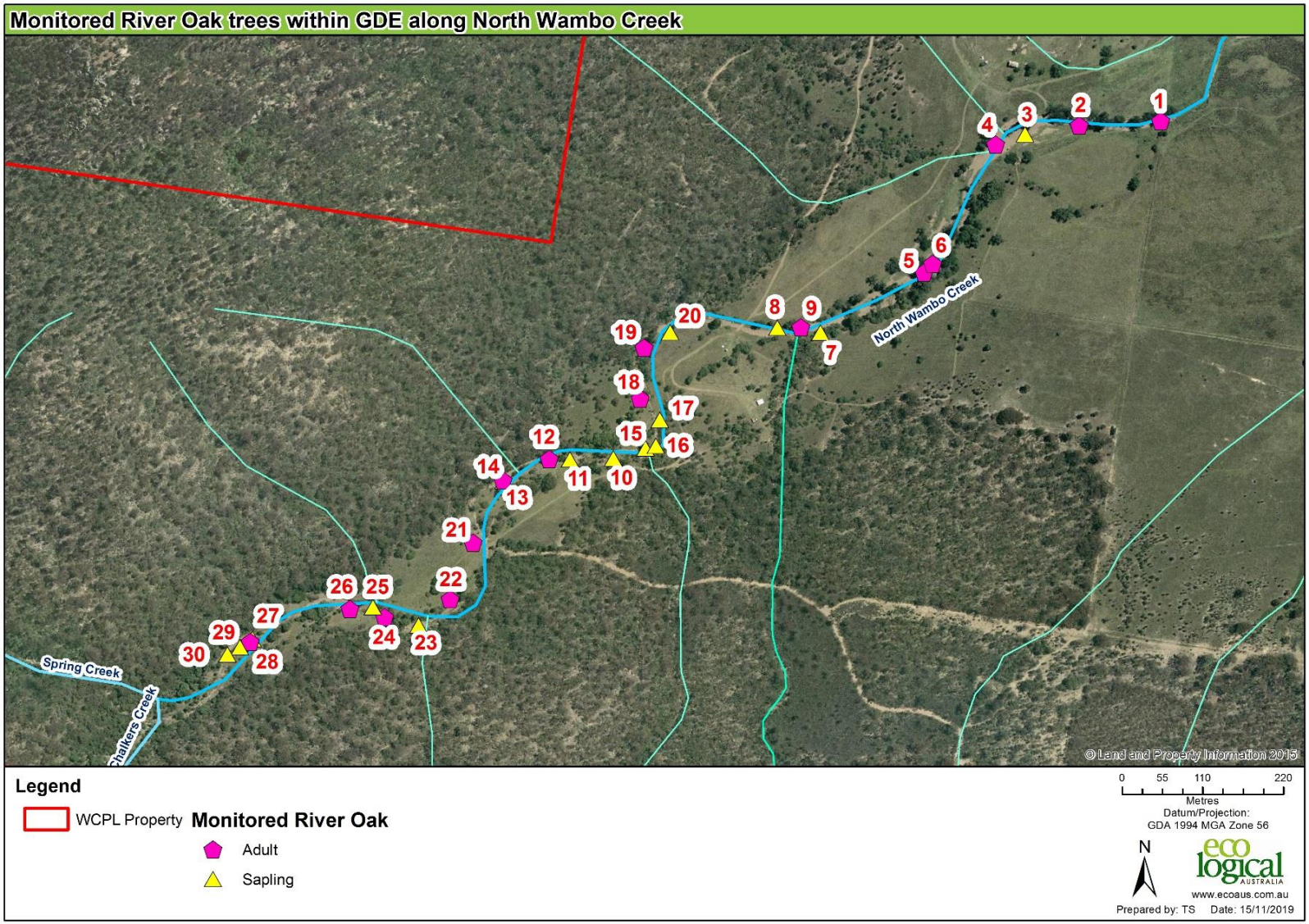


Figure 30. Monitored River Oak trees along North Wambo Creek

6. Mine subsidence observations and other management considerations

Mine subsidence and land management issues observed during the 2019 monitoring surveys across the RWEAs and rehabilitated landforms are summarised in Table 23.

Table 23. Mine subsidence and other land management observations recorded during 2019 Spring monitoring (# corresponds to the labels on Figure 31)

#	Type	Location	Notes
1	Subsidence	North Wambo Creek Diversion	25m x 5cm
2	Subsidence	North Wambo Creek Diversion	10m x 10cm, slump on bank slope
3	Subsidence	North Wambo Creek Diversion	50m x 15cm, many moderate cracks adjacent to road at top of bank and on embankment
4	Subsidence	Rehabilitation area	2 x 2m wide and 1m deep, slump hole in woodland rehabilitation near start of 4R
5	Subsidence	Rehabilitation area	20m x 15cm, crack at top of rehabilitation bank
6	Subsidence	RWEA C	20m x 40cm
7	Subsidence	RWEA C	1.5 x 1.5m wide and 2m deep
8	Subsidence	RWEA D	20m x 10cm
9	Subsidence	RWEA C	>30m long x 0.5m wide, very deep. Larger than in 2018
10	Subsidence	RWEA C	1m wide. Very large crack, both sides of side of road. Continues from Vegetation Plot v11-b1
11	Pest animal	North Wambo Creek Diversion	Rabbit warrens
12	Pest animal	General surface area	Pig rooting
13	Pest animal	RWEA A	Wild dog/dingo with 2 pups
14	Fire	RWEA D	Evidence of a recent low intensity fire
15	Fallen tree on track	RWEA D	Fallen tree blocking track
16	Erosion	North Wambo Creek Diversion	Erosion on lower creek bank
17	Erosion	North Wambo Creek Diversion	Rill erosion near 23R
18	Erosion	North Wambo Creek Diversion	Erosion of bank of creek diversion channel near LFA site 26R
19	Erosion	North Wambo Creek Diversion	Erosion near LFA site 26R. Topsoil eroded from bank, trough ripping failed. Topsoil deposited at base of slope. Bank now bare and pebbly
20	Erosion	Rehabilitation area	Erosion sheet and fill in pasture rehabilitation
21	Erosion	Rehabilitation area	Gully erosion in woodland rehabilitation
22	Erosion	General surface area	12m x 2m erosion
23	Erosion	General surface area	8m x 2.5m erosion
24	Erosion	General surface area	Minor erosion

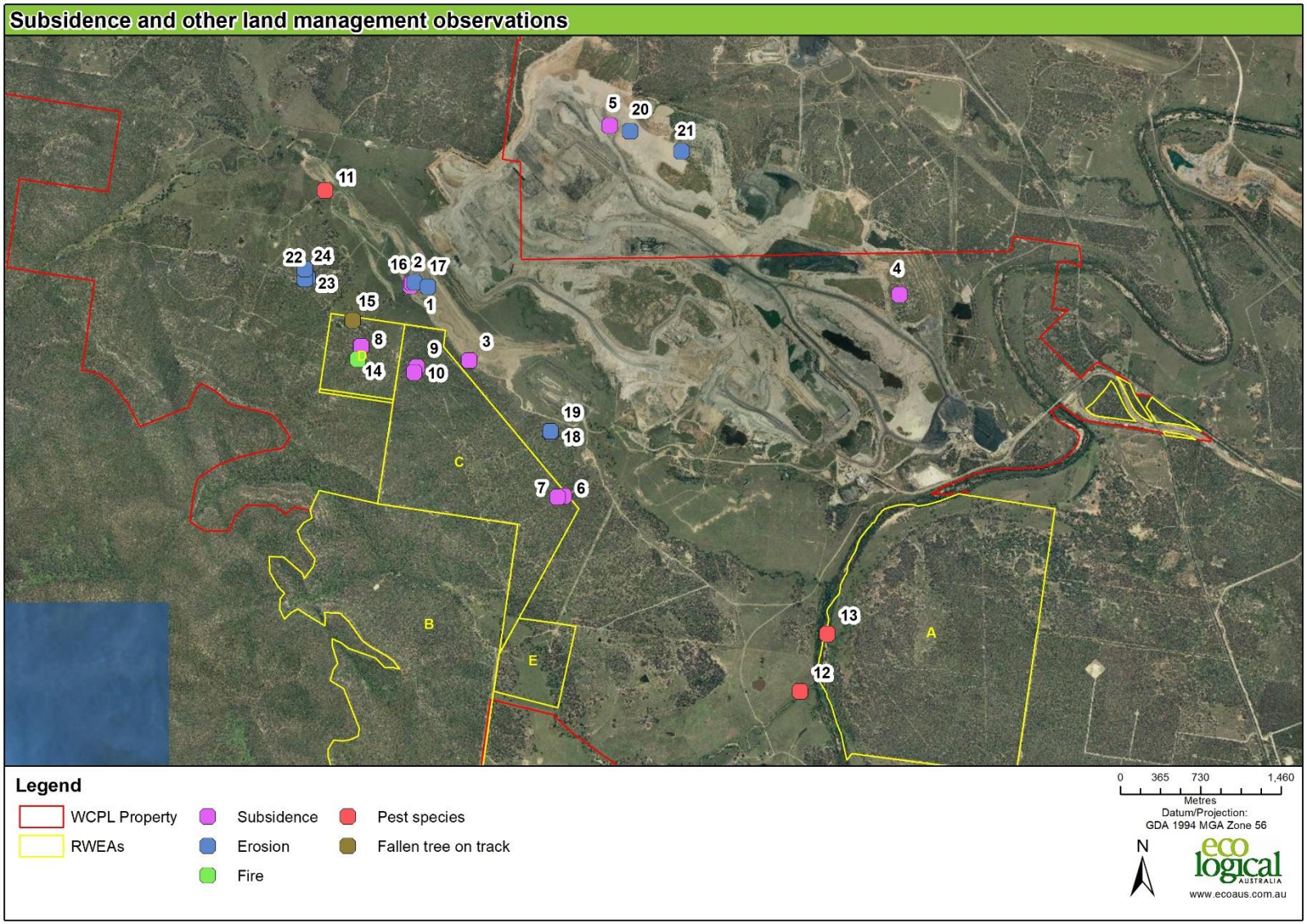


Figure 31. Subsidence and other land management observations from Spring 2019 biodiversity monitoring surveys

6.1 Remnant woodland enhancement areas

6.1.1 Subsidence observations

Subsidence cracks were noted during flora field work within RWEA C and RWEA D, within the Narrow-leaved Ironbark and Slaty Gum communities. The largest subsidence cracks were noted near flora site V11-B1 (**Plate 25** and **Plate 26**). The cracking was not having any observable significant impacts on vegetation at the current time, with the adjacent trees and shrubs surviving.

Plate 25: Large subsidence cracks near flora monitoring site V11-B1

Plate 26: Large subsidence cracks near flora monitoring site V11-B1

6.1.2 Other management observations

Evidence of a recent low intensity fire was recorded from the Slaty Gum community in RWEA D near bird monitoring site BP25. The fire had burnt the understorey and parts of the mid-storey, with limited impact to the canopy (**Plate 27**).

Track repairs have been undertaken in the west of RWEA C since 2018 and many subsidence cracks have been filled in.

Plate 27. Recent low intensity fire has burnt within RWEA D near BP 25.

6.1.3 Performance criteria and results

Performance criteria and findings during the 2019 monitoring for subsidence impacts are presented in Table 24, which is based on Table 20 in the *Wambo Coal Biodiversity Management Plan* (WCPL 2017). These performance criteria exclude any impacts and consequences of mining that occurred prior to February 2011 in accordance with Condition 22, Schedule 4, of Development Consent DA 305-7-2003.

Table 24: Subsidence performance measures, indicators and 2019 findings

Biodiversity feature	Performance measure	Performance indicator (WCPL 2017)	2019 findings
Wollemi National Park	Negligible subsidence impacts and	The performance indicators will be considered to have been exceeded if conventional vertical subsidence exceeds 20 millimetres (mm) or the limit of	N/A - Vertical subsidence as the base of escarpment or cliff or rock face instability not inspected as part of the flora

Biodiversity feature	Performance measure	Performance indicator (WCPL 2017)	2019 findings
	environmental consequences	survey accuracy (whichever is greater) at the base of the Wollemi National Park escarpment. The performance indicators will be considered to have been exceeded if visual inspections identify cliff or rock face instability at the Wollemi National Park escarpment.	and fauna monitoring program in 2019.
Other species, populations or communities listed under the Biodiversity Conservation Act 2016 or Environmental Protection and Biodiversity Conservation Act 1999	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.	The performance indicator will be considered to have been exceeded if annual monitoring at flora monitoring sites V6-B1c and V11-B1 or bird monitoring sites (BP14, BP16, BP20, BP21) above Longwalls 11 to 16 indicate a statistically significant downward trend or change between monitoring periods not observed at analogue/reference sites.	Bird monitoring sites showed no downward trend or indication that bird populations have declined (**Figure 32**). Subsidence cracks were recorded at both sites V6-B1c and V11-B1. No significant vegetation damage was observed at these sites. Flora monitoring sites V6-B1c and V11-B1 show a decline in the number of native species recorded, however similar declines were recorded at the reference site (Figure 33), indicating no significant effect of undermining was recorded. The same trend was also recorded across the majority of flora sites in 2019. Vegetation at these sites and in the wider area remains in relatively good condition at the time of survey considering the dry conditions.
Warkworth Sands Woodland Community		The Warkworth Sands Woodland Community is absent from the South Bates Underground Mine area. Monitoring and performance indicators relevant to mine subsidence in the Warkworth Sands Woodland Community will be addressed in future revisions of the BMP prior to any extraction under the Warkworth Sands Woodland Community	Area not currently undermined – no subsidence observations.
White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community		The White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community is absent from the South Bates Underground Mine area. Monitoring and performance indicators relevant to mine subsidence in the White Box, Yellow Box, Blakely's Red Gum	Area not currently undermined – no subsidence observations.

Biodiversity feature	Performance measure	Performance indicator (WCPL 2017)	2019 findings
		Woodland/Grassy White Box Woodland Community will be addressed in future revisions of the BMP prior to any extraction under the White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community.	
Central Hunter Valley Eucalypt Forest and Woodland Ecological Community		Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.	No additional observations of damage to this community beyond that described in the 2016 flora and fauna monitoring report (ELA 2016). Predominantly minor surface cracks observed.

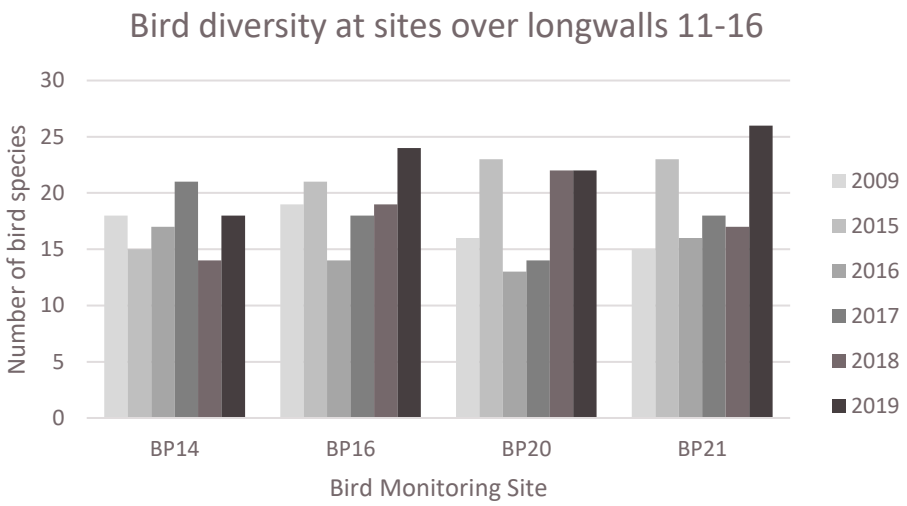


Figure 32: Total number of bird species recorded at sites located over longwalls 11 to 16 in 2009 and 2015-19

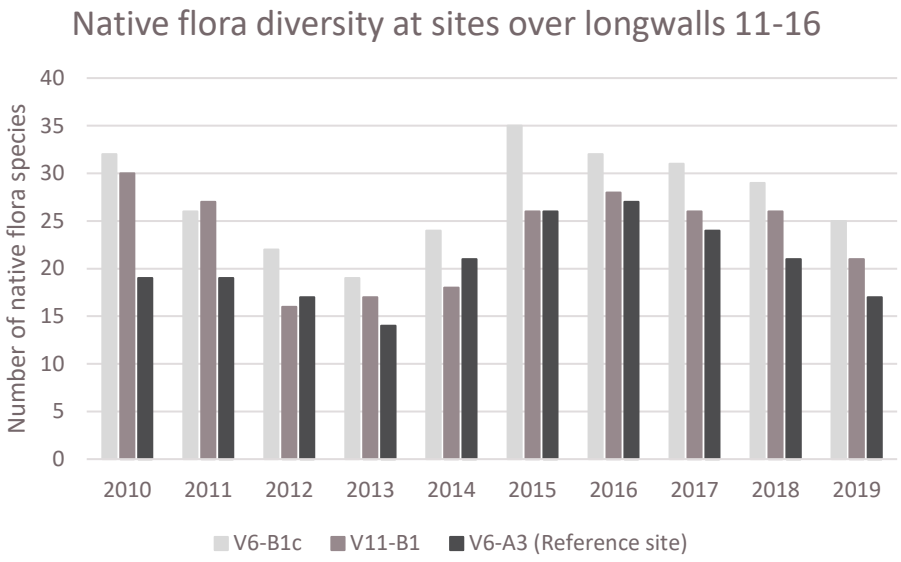


Figure 33. Number of native flora species recorded at sites located over longwalls 11-16 and reference site 2010-19

6.1.4 Conclusion and recommendations

Subsidence was observed in the RWEA C above Longwalls 11 to 16. Monitoring data does not indicate any exceedance of the performance criteria or any significant effects on flora and fauna at this stage, however future monitoring should continue to document and assess subsidence impacts across the site.

6.2 Rehabilitation areas and other land

The condition of rehabilitated land has been discussed in **Section 3**, however, some relevant opportunistic observations relating to land management and biodiversity were made while traversing the mine site.

Along the North Wambo Creek Diversion erosion and minor subsidence issues were recorded near sites 23R and 28R (**Plate 28**). Erosion and subsidence/slumping of land were recorded within pasture and woodland rehabilitation areas (**Plate 29**). Several areas of erosion and bare soil observed exceed the completion criteria for rehabilitated areas listed in the Mining Operations Plan (WCPL 2015).

Evidence of pest species were recorded, including pigs (lower reaches of Stony Creek) and rabbits (warrens observed in the upper sections of the North Wambo Creek Diversion between 17R and 19R).

Plate 28. Subsidence cracks, erosion and bare soil along the North Wambo Creek Diversion near site 23R

Plate 29. Large area of erosion/bare soil at failed pasture rehabilitation near site 33R (exceeding completion criteria)

6.3 Weed issues

Environmental weeds have largely been discussed in previous sections. No new observations of significant weed issues were recorded during the 2019 monitoring, however, management of weeds across WCPL land should continue, particularly for priority weeds and Weeds of National Significance (WONS), to prevent their spread. A new Weed Management Plan for the site is currently in preparation (ELA, in prep.).

6.4 Nest boxes

In 2018, a total of 50 nest boxes were installed in five groups within RWEAs B, C and D. The nest boxes were installed in response to recommendations made in the 2015 Independent Environmental Audit, however no recommendations regarding monitoring were made.

A nest box monitoring program should be established to document the use and effectiveness of the nest boxes and ensure they are maintained in usable condition. ELA recommends that nest boxes are inspected every two years, beginning in 2020. Nest box monitoring and reporting could be incorporated into the current WCPL biodiversity monitoring program.

7. Summary of management actions required

A summary of the management actions required and recommended to be undertaken by WCPL based on the results of the 2019 annual biodiversity monitoring program is provided in Table 25.

Table 25: Summary of management actions required

Area/Feature	Performance criteria	Result	Action required
RWEA A	VCA Target: Exotic plant cover limit of 20% at site A2 (V1-B2)	Exotic plant cover 32%. Dominant exotic species *Ehrharta erecta* (Panic Veldtgrass), *Bidens subalternans* (Greater Beggar's Ticks) and *Cardiospermum grandiflorum* (Balloon Vine).	Continue weed management in RWEA A
RWEAs	Performance target: Native ground cover (various)	Native ground cover scores within several sites/PCTs were below targets	Result likely due to drought conditions. Continue monitoring and weed management in RWEAs
North Wambo Creek Diversion	Mining Operations Plan: No tunnel or gully erosion is to be present	Gully erosion observed in creek diversion near 23R	Continue active management of creek diversion to encourage establishment of native species and address erosion issues
North Wambo Creek Diversion	Mining Operations Plan: No single bare area >20m^2	Several areas of bare soil larger than 20m^2 observed along creek diversion	
Pasture rehabilitation	Mining Operations Plan: No single bare area >20m^2	Several areas of bare soil larger than 20m^2 observed within pasture rehabilitation areas	Undertake active management of bare soil patches to control erosion and encourage establishment of vegetation
Woodland rehabilitation	Performance targets: Native plant species, Native mid-storey, native ground cover and regeneration	Scores below targets for several attributes at most sites	Ensure new areas of woodland rehabilitation are planned and implemented using best practice techniques
Riparian areas	N/A	Riparian areas with evidence of cattle grazing in poorer condition	Exclude cattle from riparian areas to improve vegetation condition and increase resilience to drought. Consider planting native trees in over-cleared riparian areas
RWEAs	N/A	Nest boxes were installed in 2018 and are not currently monitored	Initiate nest box monitoring program to ensure nest boxes are in working order and are achieving intended purpose

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Template 2.8.1

Contents

List of Tables

1. Introduction

This document provides raw data and photographs collected during spring 2019 monitoring at Wambo Coal Pty Ltd.

2. Flora monitoring

2.1 Monitoring data

Data collected during the 2019 floristic surveys are presented below in **Table 1.**

Several abbreviations for measured attributes are used in tables throughout the following section. An explanation of these is provided below:

- NPS – the number of native plant species within 20 x 20 plot
- NOS (%) - projected native foliage cover of canopy
- NMS (%) – projected native midstorey cover
- NGCG – native groundcover of grasses
- NGCS – native groundcover of shrubs
- NGCO – native groundcover of other plant types (sedges, herbs etc.)
- EPC – exotic plant cover
- OR – proportion of overstorey species regenerating over the whole vegetation zone
- HBT – number of hollow-bearing trees present in the 20 x 50 m vegetation plot
- FL – length of fallen logs >10 cm diameter
- LI (%) – leaf litter cover
- BS (%) – bare soil cover

Table 1: Biometric plot data for remnant woodland areas

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	LI	BS
V1-A1	7	10	0	6	0	0	10	0	1	38	84	12
V1-A2	10	3.6	3.5	14	0	0	32.5	0	0	44	78	0
V1-B1	11	8.5	0	0	0	4	0	0	0	22	96	10
V1-B2	11	8.9	10.6	0	0	0	32	0	0	16	94	0
V1-B3	15	2.6	11.1	2	0	0	50	0	0	19	76	2
V2-A1	16	3.8	21	16	0	2	0	0	1	7.5	76	24
V2-B1	13	13	3.8	0	0	0	26	0	0	7	82	8
V2-B2	14	6	4.9	0	2	0	26	1	1	9	90	6
V3-B1	20	7	0	0	4	2	0	0	1	35	98	4
V5-B1	26	10.2	0.6	10	0	8	0.5	0	0	7	98	0
V5-B2	28	11.3	8	6	0	40	4	0	0	10	90	4
V5-B3	25	7.2	8.1	4	16	24	0	1	1	37	100	0
V5-B4	25	14.3	7.3	38	2	0	0	0	1	7.5	94	0
V6-A1c	31	11.8	10.4	18	0	4	0	1	1	39	98	0
V6-A3	17	8	4	20	0	0	0	0	1	11.25	98	2
V6-B1	32	0.5	11.7	4	0	0	0	0	1	45	98	2
V6-B1c	25	7.7	7.2	8	10	0	0	0	1	10	96	2
V6-B2	30	9.4	3.8	12	18	2	0	0	0	65	96	2
V6-B2c	30	15.7	3.9	12	2	4	0	0	1	17	96	14
V6-B3	29	7.8	5.3	12	6	0	0	1	1	30	100	2
V6-B4	12	15.8	0	0	8	0	0	0	1	4	88	26
V11-B1	22	12.7	6.6	6	4	0	0	0	1	8	98	0
V11-B2	28	11	6.8	4	12	0	0	1	1	37	72	12
V9-A1	32	10.4	2	8	10	0	0	0	1	24	94	6
V9-B1	31	10	10.3	14	2	2	0	0	1	11.3	98	2
V9-B2	33	14	6	4	12	0	0	0	1	9.5	90	20
V10-A1	29	8.3	8.2	0	14	2	0	1	1	30	98	2
V10-A2	24	8.4	2.8	4	4	0	2	1	1	40	54	44
V10-B1	21	6.1	5.4	10	10	0	0	0	1	34	92	14
V10-B3	32	6.4	9.1	28	0	4	0	0	1	34	90	4
V13-B1	34	8.5	12.6	0	6	8	0	0	1	43	96	0
V14-A1	28	3	25.5	0	0	0	0	0	1	7.5	82	16
V14-B1	25	3.2	13.8	18	2	4	0	1	1	25	80	18
V14-B2	30	9.1	16.5	16	16	6	0	0	0	6.5	80	14

Table 2: Biometric plot data for woodland rehabilitation monitoring plots

Plot Name	NPS	OS	MS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	LI	BS
3R	8	14	0	10	0	0	0	0	Planted	0	60	30
4R	7	19.5	0	0	0	0	0	0		0	92	8
6R	17	22.5	0	2	0	0	0	0		25.5	90	8
8R	8	8	0.5	2	0	0	0	0		0	52	48

Table 3: Flora species lists from RWEA monitoring plots

Scientific Name	Common Name	Native /Exotic	V1 A1	V1 A2	V1 B1	V1 B2	V1 B3	V2 A1	V2 B1	V2 B2	V3 B1	V5 B1	V5 B2	V5 B3	V5 B4	V6 A1	V6 A3	V6 B1	V6 B1c	V6 B2	V6 B2c	V6 B3	V6 B4	V9 A1	V9 B1	V9 B2	V10-A1	V10-A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14-A1	V14-B1	V14-B2
Abutilon oxycarpum	Lantern Bush	N																	1			1										1	1	1	1
Acacia amblygona	Fan Wattle	N															1	1	1		3			2		2		1			2				
Acacia binervia	Coast Myall	N																											3	2		3				
Acacia decora	Western Silver Wattle	N																												3						
Acacia decurrens	Black Wattle, Green Wattle	N		2			1							3	2																					
Acacia falciformis	Broad-leaved Hickory	N																									1									
Acacia filicifolia	Fern-leaved Wattle	N						1		3																										
Acacia implexa	Hickory Wattle	N																			2															
Acacia parramattensis	Parramatta Wattle	N							3																											
Acacia salicina	Cooba	N																												2				?		
Acacia sp.		N	1															1									1									
Acetosella vulgaris	Sorrel, Sheep Sorrel	E						1																												
Adiantum aethiopicum	Common Maidenhair	N																														1				
Allocasuarina luehmannii	Bulloak	N										1		2	2	2	4	2		1	4		4	3		3	2	2			2	3				
Alternanthera sp.		N																						1			1									
Amyema congener subsp. congener		N							1																					1						1
Amyema gaudichaudii	Paperbark Mistletoe	N																									3		1							
Anagallis arvensis	Scarlet/Blue Pimpernel	E	3	2	2	1	3	1	3	2																	1							1		
Angophora floribunda	Rough-barked Apple	N									1	3	4	2	4																					
Aristida ramosa	Purple Wiregrass	N						1			2	2	1	2	2	2	1	2		3	2	1	3	2			1	2			2		2		2	1	2
Aristida sp. (giant 1.2m)	Wiregrass	N																														1				
Aristida vagans	Threeawn Speargrass	N									1	1	1	2	3	2	2	1	3	1	2	2					3	1	1	1		2	3	1		2	1
Arthropodium milleflorum	Vanilla Lily	N										2							1	1																
Asparagus asparagoides	Bridal Creeper	E							1	2												1														
Asparagus officinalis		E							1				1																							
Asparagus sp.		E			1																															
Aster spp.		E					1																													
Austrodanthonia spp.		N														1										1										
Austrostipa ramosissima	Stout Bamboo Grass	N		1		3			1							2													1				3			4
Austrostipa scabra subsp. scabra		N														1																		1	2	2
Austrostipa sp. (tussock)		N																									1			2						
Austrostipa verticillata	Slender Bamboo Grass	N																																1		
Backhousia myrtifolia	Grey Myrtle	N				1																														
Banksia integrifolia	Coast Banksia	N											2																							
Bidens pilosa	Cobbler's Pegs	E	3	1								3	4					1																		
Bidens subalternans	Greater Beggar's Ticks	E			1	3	1		5	1																										
Brachychiton populneus subsp. populneus	Kurrajong	N							2			1	2							2	1					1	1						1	3	1	
Breynia oblongifolia	Coffee Bush	N					1					3	2	1	1	1						1			1	1	1			1	1	1	1		1	1
Breynia sp.		N			2																															
Briza minor	Shivery Grass	E					2																													
Brunoniella australis	Blue Trumpet	N														2	2			1		1		1	1	1			1	1		1		1	1	2

Scientific Name	Common Name	Native /Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10-A1	V10-A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14-A1	V14-B1	V14-B2
Bryophyllum delagoense	Mother of Millions	E											2																							
Bursaria spinosa	Native Blackthorn	N										1			1	1			2						4	3	2	3	4	1	3	2	2			2
Callitris glaucophylla	White Cypress Pine	N																										1								
Cardiospermum grandiflorum	Balloon Vine	E	1	3	1	2	2																													
Carex inversa	Knob Sedge	N									1																									
Cassinia arcuata	Sifton Bush	N																1																		
Cassinia cunninghamii		N																										3								
Cassytha pubescens	Common Devil's Twine	N																															1			
Casuarina cunninghamiana	River Oak	N	5	3	4	4	4																													
Cayratia clematidea	Slender Grape	N																																		1
Centella asiatica	Pennywort	N			1						2		1																							
Centipeda minima	Spreading Sneezeweed	N									1							1																		
Cheilanthes distans	Bristly Cloak Fern	N				3			2			2	2			3		2		4		3					2						2	1	3	2
Cheilanthes sieberi subsp. sieberi		N					2	1	2	1	1	2	1	2	2		1	2	2			2	1	2	2	2	1	2	2	2	2	2		1		1
Chloris divaricata var. divaricata		N					2									1																			
Chloris gayana	Rhodes Grass	E	1																																	
Chloris sp.		N									1							2		2	1	1					1			1			1		
Chloris truncata	Windmill Grass	N						1												1		1														
Chloris ventricosa	Tall Chloris	N														1																		1		
Choretrum candollei	White Sour Bush	N						1																	2	1		2	1			1				
Chrysocephalum apiculatum	Common Everlasting, Yellow Buttons	N						2																												
Cirsium vulgare	Spear Thistle	E		1			1																													
Clematis aristata	Old Man's Beard	N			1		1																													
Commelina cyanea	Scurvey Weed	N					1									1												1								
Conyza sumatrensis	Tall fleabane	E					2																													
Corymbia maculata	Spotted Gum	N																					3	2	4			3				3				
Cotoneaster pannosus		E										1																								
Cymbonotus lawsonianus	Bear's Ear	N																										1	1							
Cymbopogon refractus	Barbed Wire Grass	N						3		1	2	2	2		2	2	2	2	2	2	3	2		2	2	2	2	1	1	1	2	1	1		2	1
Cynodon dactylon	Common Couch	N	3	4	1	1	1	4	1	2	3	2	1	2	1					1		1	1				2	1				1			
Cyperus gracilis	Slender Flat-sedge	N														1	1							1									1		
Cyperus polystachyos		N																					1	1											
Cyperus spp.		N											1									1			1		1					1	1		
Daucus spp.		N					1																													
Daviesia genistifolia	Broom Bitter Pea	N																1																		
Desmodium brachypodum	Large Tick-trefoil	N																	2	1	2	2			1								2		2
Desmodium rhytidophyllum		N																								2									
Desmodium varians	Slender Tick-trefoil	N														3		1	1							1		1	1			2			2
Dianella caerulea		N													1																					
Dianella longifolia		N																								1									
Dianella prunina		N											1			1					1										2	2				

Scientific Name	Common Name	Native /Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10-A1	V10-A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14-A1	V14-B1	V14-B2
Dianella revoluta var. revoluta		N														1		1	1		3		1		1	1	1	2		1	1	2				
Dianella sp.		N																						1												
Dichelachne sp.		N																																2		
Dichondra repens	Kidney Weed	N											2					2		3	1	3		1	2	1	1	2	2			1	1	2	1	2
Digitaria spp.		N																				1												1		
Dodonaea viscosa subsp. cuneata		N															1		1					1	1	2					4					
Echinopogon caespitosus	Bushy Hedgehog-grass	N												1																						
Echium plantagineum	Patterson's Curse	E		2			2		1																											
Ehrharta erecta	Panic Veldtgrass	E	3	3	2	4	3		2	3		2	2					1						1												
Einadia hastata	Berry Saltbush	N					1		3				2	3						1														1	2	2
Einadia nutans		N											1			1	1							1												1
Einadia sp.1		N																		1							2								
Einadia sp.2 (trigonos)		N																										1							
Enchylaena tomentosa		N																		1															
Entolasia marginata	Bordered Panic	N																															1		
Entolasia stricta	Wiry Panic	N																						1		1				1	3	3			3	
Epacris sp.		N																							1										
Eragrostis benthamii		N																	2												2					
Eragrostis brownii	Brown's Lovegrass	N													1			3					2		1		1									
Eragrostis curvula	African Lovegrass	E	4				2								1																					
Eragrostis elongata		N									1																									
Eragrostis leptostachya	Paddock Lovegrass	N										1		2	1	1			2		1									2		1				
Eragrostis sp.		N									1																									
Eremophila debilis	Amulla	N																1	1	2	1	2												1		
Eremophila longifolia		N																												3						
Eucalyptus blakelyi	Blakely's Red Gum	N									4			1																						
Eucalyptus camaldulensis	River Red Gum	N						3	4	4																										
Eucalyptus crebra	Narrow-leaved Ironbark	N									1					4	4	1	4		4	1	1	4	3	3	3	4	2		4	3	3			2
Eucalyptus dawsonii	Slaty Gum	N										1															3			3						
Eucalyptus moluccana	Grey Box	N														2		3		3	3	3											4		3	
Eucalyptus punctata	Grey Gum	N																							1				3		4	3				
Exocarpus strictus	Cherry Ballart	N							1	3	1			1											1											
Facelis retusa	Annual Trampweed	E				1	2																													
Gahnia aspera	Rough Saw-sedge	N																								1	1	2	1	1		2	2	1	2	1
Galenia pubescens	Galenia	E		3				1	4																											
Galium propinquum	Maori Bedstraw	N																																1		
Geijera salicifolia var. salicifolia		N																																	1	2
Geitonoplesium cymosum	Scrambling Lily	N																												1			1			
Glycine clandestina		N											2		2			1		1	1				1		1	1					1	1	1	
Glycine microphylla		N						1				2	2	1	1		2									1			1			1				1
Glycine tabacina	Variable Glycine	N								1					1	1	1			1		1			1		1	1					1			
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	E										1																								

Scientific Name	Common Name	Native /Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10-A1	V10-A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14-A1	V14-B1	V14-B2
Goodenia rotundifolia		N																	1						2	1			1		2	2				
Grevillea montana		N												3												3		2			1	1				
Grevillea robusta	Silky Oak	N			1																															
Heliotropium amplexicaule	Heliotrope	E		1		2	3	1	4	3			1					1																		
Hibbertia diffusa		N										2																								
Hibbertia sp.		N											1	2														1				1				
Hibiscus heterophyllus subsp. heterophyllus	Native Rosella	N																															1			
Hovea sp.		N												1																						
Hypochoeris radicata	Catsear	E	2	1	1	1	3	3	1			2	2		1																						
Imperata cylindrica		N										2	3																							
Isopogon dawsonii	Nepean Conebush	N												4																						
Jacksonia scoparia		N																						1				1								
Juncus polyanthemus		N									2				1																					
Juncus sp.		N			1																															
Laxmannia gracilis	Slender Wire Lily	N																			1			3												
Lepidium sp.		E										1	1																							
Lepidosperma laterale		N																															3	1		
Leptospermum petersonii	Lemon-scented Teatree	N				3																														
Leptospermum polyanthum		N		2	1			1																												
Leptospermum sp.		N					5			1																										
Leucopogon muticus	Blunt Beard-heath	N													1																		2			
Lomandra confertifolia subsp. pallida		N																				2				2									
Lomandra filiformis	Wattle Matt-rush	N																			1							2							
Lomandra filiformis subsp. coriacea		N								1						2		1		2		1	1	1	1				2			2			1	
Lomandra filiformis subsp. filiformis		N						2																						1	2					
Lomandra longifolia	Spiny-headed Mat-rush	N	1	3	1							4	4	5																		2	2			
Lomandra multiflora	Many-flowered Mat-rush	N										2										2				1		1							
Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush	N									2		2	2	2	2		1			3												1	1	
Lomandra sp.		N								1	1				2		2		2	1			1		1	2	1	2	1	2	1		1			1
Lomandra sp.	hairy lomandra	N													1																					
Lycium ferocissimum	African Boxthorn	E	2			1						1												1												
Macroxamia sp.		N																											1						
Macrozamia flexuosa		N																	1						1										
Macrozamia reducta		N																								2									
Maireana microphylla	Small-leaf Bluebush	N																1															1			
Maytenus silvestrus		N																						1					1						1
Melaleuca decora		N																2	3	3	2	3	1	3	4		4		3		3	3				
Melaleuca nodosa		N																										3								
Melia azedarach	White Cedar	N							1	1		1																								

Scientific Name	Common Name	Native /Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10-A1	V10-A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14-A1	V14-B1	V14-B2
Melinis repens	Red natal grass	E													2																					
Microlaena stipoides var. stipoides	Weeping Grass	N		2		2	2		1	2		1															1	1					1		1
Modiola caroliniana		E	1																																	
Notelaea longifolia	Large Mock-olive	N																		1				1									1			
Notelaea microcarpa var. microcarpa		N				3			2	2	1	2	2	3	1	4	1	1	2	3	1	1			1	2	3		2	3		3	4	4	4	5
Olea europaea subsp. cuspidata		E					1			1																					1				
Olearia elliptica	Sticky Daisy Bush	N														1	1		4	3	2			1	3	3			2	2	3	3	1	1	2	3
Oplismenus aemulus		N	1		2		2																													
Opuntia aurantiaca	Tiger Pear	E							1			1			1			1		1				2		1					1	1				
Opuntia humifusa	Creeping pear	E								1	1	1	2	2						2		1														
Opuntia stricta	Prickly Pear	E					1		2	1			1		2	1	1	1	1		1		2	3	1	1	1		1	2	1	1		1		1
Oxalis corniculata	Creeping Oxalis	E		2		1			2	1		1	2	2				1																		
Oxalis perennans		N						2					1														1						1		1
Oxalis spp.		N					1								1							1										1			
Oxylobium cordifolium		N																								2									
Pandorea pandorana	Wonga Wonga Vine	N																														1			
Panicum effusum		N										1								2																
Panicum sp.		N						1					2					2			1												1			
Paspalidium aversum	Bent Panic	N																													2					
Pavonia hastata		E	1	2?		2	2		2	5	2																									
Pennisetum clandestinum	Kikuyu Grass	E	1																																	
Persoonia linearis	Narrow-leaved Geebung	N												2											1				1		1				
Petrorhagia nanteuilii		E					1																													
Phragmites australis	Common Reed	N	3	2		1	1																													
Pimelea linifolia	Slender rice flower	N										1		1	3																					
Pimelea latifolia subsp. hirsuta		N																														1				
Plantago debilis		N																		1																
Plantago lanceolata	Lamb's Tongues	E						1																												
Pratia purpurascens	Whiteroot	N								1	1																									
Pteridium esculentum		N										3	3	2																						
Pultenaea spinosa	Spiny Bush-pea	N																								1		1								
Richardia humistrata		E						2			1	3	3								1															
Rubus parvifolius	Native Raspberry	N	1																																	
Rytidosperma spp.		N														1			1		1															
Salix spp.	Willow	E	2																																	
Schoenus brevifolius		N																	1																
Senecio madagascariensis	Fireweed	E		1			2	2	1	1					1						1						1						1		
Setaria sp.		E									1	1			1																					
Sida corrugata		N						1												1	1	1					1									
Sida rhombifolia	Paddy's Lucerne	E	1	1		1														1																
Sida sp.		N														1																				

Scientific Name	Common Name	Native /Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10-A1	V10-A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14-A1	V14-B1	V14-B2
Solanum nigrum	Black-berry Nightshade	E	1	1		1	2																													
Solanum prinophyllum	Forest Nightshade	N											1					1	1	1		2										1				
Solanum spp.		N																																		1
Solivia sessilis	Bindii	E					1																													
Sonchus asper	Prickly Sowthistle	E			1		1																													
Sonchus oleraceus	Common Sowthistle	E	2	1	1		1																													
Spartothamnella juncea	Bead-bush	N												1		1		1		1		1				2						1	3	3	2
Sporobolus creber	Western Rat's Tail Grass	N																1			1		1				1									
Sporobolus elongatus		N						1																												
Stellaria media	Chickweed	E					2																													
Stephania japonica		N	2	2	2																															
Swainsona galegifolia	Smooth Darling Pea	N																														1				
Tagetes minuta	Stinky Roger	E							1				2																							
Tetragonia tetragonioides	New Zealand Spinach	N		1		1																														
Tradescantia fluminensis	Wandering Jew	E						1																												
Unidentified small flat weed		E					2																													
Unidentified succulent		N																	1																	
Verbena bonariensis	Purpletop	E	2																																	
Verbena rigida	Veined Verbena	E						2		1																										
Veronica plebeia	Trailing Speedwell	N										1	1					1										1								
Vittadinia cuneata		N																		2		2														
Vittadinia sp.		N																1																		
Vittadinia sulcata		N						1	1	1			3								1						2	1		1			1	1	1	

Table 4: Woodland rehabilitation species list and cover scores

Scientific Name	Common Name	Native/Exotic	4R	8R	3R	6R
Acacia amblygona	Fan wattle	N				1
Acacia decora	Showy Wattle	N				1
Acacia saligna		NLN	3	1		
Acacia sp.1		N		1	1	1
Allocasuarina sp.		N			1	
Aristida ramosa	Purple Wiregrass	N		1		
Asteraceae sp.		N		1		
Austrostipa ramosissima	Stout Bamboo Grass	N				3
Austrostipa sp.		N				1
Bothriochloa macra	Red Grass	N	1		1	1
Bursaria spinosa	Native Blackthorn	N				1
Calotis cuneifolia	Purple Burr-Daisy	N	2		1	2
Calotis lappulacea	Yellow Burr-daisy	N				2
Chloris ventricosa	Tall Chloris	N				1
Corymbia maculata	Spotted Gum	N	2	2	1	2
Cymbopogon refractus	Barbed Wire Grass	N	1	2	1	2
Dichondra repens	Kidney Weed	N				2
Enchylaena tomentosa	Ruby Saltbush	N	2	1	1	2
Eucalyptus cladocalyx		NLN	3	4	4	4
Eucalyptus crebra	Narrow-leaved Ironbark	N		1		
Eucalyptus fibrosa	Red Ironbark	N				2
Galenia pubescens	Galenia	E	1			2
Glycine sp.		N				1
Plantago debilis		N				1
Sida rhombifolia	Paddy's Lucerne	E				1
Eucalyptus sp.		N	1			
Chloris divaricata		N			1	
Chloris sp.		N	1	1		

NLN = non-local Australian native species

2.2 Floristic monitoring plot photographs

A photograph has been taken at the start and end of the 50 m central transect of each biometric monitoring plot.

2.2.1 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley

Plate 1: V1-A1 – start

Plate 2: V1-A1 – end

Plate 3: V1-A2 – start

Plate 4: V1-A2 – end

Plate 5: V1-B1 – start

Plate 6: V1-B1 – end

Plate 7: V1-B2 – start

Plate 8: V1-B2 – end

Plate 9: V1-B3 – start

Plate 10: V1-B3 – end

Plate 11: V2-A1 – start

Plate 12: V2-A1 – end

Plate 13: V2-B1 – start

Plate 14: V2-B1 end

Plate 15: V2-B2 – start

Plate 16: V2-B2 – end

Plate 17: V3-B1 – start

Plate 18: V3-B1 – end

2.2.2 Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area

Plate 19: V5-B1 – start

Plate 20: V5-B1 – end

Plate 21: V5-B2 – start

Plate 22: V5-B2 – end

Plate 23: V5-B3 – start

Plate 24: V5-B3 – end

Plate 25: V5-B4 – start

Plate 26: V5-B4 – end

2.2.3 Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter

Plate 27: V6-A1c – start

Plate 28: V6-A1c – end

Plate 29: V6-A3 – start

Plate 30: V6-A3 – end

Plate 31: V6-B1 – start

Plate 32: V6-B1 – end

Plate 33: V6-B1c – start

Plate 34: V6-B1c – end

Plate 35: V6-B2 – start

Plate 36: V6-B2 – end

Plate 37: V6-B2c – start

Plate 38: V6-B2c – end

Plate 39: V6-B3 – start

Plate 40: V6-B3 – end

Plate 41: V6-B4 – start

Plate 42: V6-B4 – end

Plate 43: V11–B1 – start

Plate 44: V11-B1 – end

Plate 45: V11-B2 – start

Plate 46: V11-B2 – end

2.2.4 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Plate 47: V9-A1 – start

Plate 48: V9-A1 – end

Plate 49: V9-B1 – start

Plate 50: V9-B1 – end

Plate 51: V9-B2 – start

Plate 52: V9-B2 – end

Plate 53: V10-B1 – start

Plate 54: V10-B1 – end

2.2.5 Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion

Plate 55: V10-A1 – start

Plate 56: V10-A1 – end

Plate 57: V10-A2 – start

Plate 58: V10-A2 – end

Plate 59: V10-B3 – start

Plate 60: V10-B3 – end

2.2.6 White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley

Plate 61: V13-B1 – start

Plate 62: V13-B1 – end

2.2.7 Brush Wilga/Native Olive Shrubland

Plate 63: V14-A1 – start

Plate 64: V14-A1 – end

Plate 65: V14-B1 – start

Plate 66: V14-B1 – end

Plate 67: V14-B2 – start

Plate 68: V14-B2 – end

2.2.8 Groundwater Dependent Ecosystems

Plate 69: GDE P1 – start

Plate 70: GDE P1 – end

Plate 71: GDE P2 – start

Plate 72: GDE P2 – end

Plate 73: GDE P3 – start

Plate 74: GDE P3 – end

Plate 75: GDE P4 – start

Plate 76: GDE P4 - end

2.3 Floristic monitoring point photographs

Plate 77: A1 – 2013

Plate 78: A1 – 2019

Plate 79: A2 – 2013

Plate 80: A2 – 2019

Plate 81: A3 – 2013

Plate 82: A3 – 2019

Plate 83: A4 – 2013

Plate 84: A4 – 2019

Plate 85: B1 – 2013

Plate 86: B1 – 2019

Plate 87: B2 – 2013

Plate 88: B2 – 2019

Plate 89:C1 – 2013

Plate 90: C1 – 2019

Plate 91: C2 – 2013

Plate 92: C2 – 2019

Plate 93: CT1 – 2013

Plate 94: CT1 – 2019

Plate 95: CT2 – 2013

Plate 96: CT2 – 2019

Plate 97: D1 – 2013

Plate 98: D1 – 2019

2.3.1 Groundwater Dependent Ecosystems

Plate 99: GDE M1 – 2019

Plate 100: GDE M2 – 2019

Plate 101: GDE M3 - 2019

Plate 102: GDE M4 – 2019

Plate 103: GDE M5 – 2019

Plate 104: GDE M6 – 2019

Plate 105: GDE M7 - 2019

Plate 106: GDE M8 – 2019

3. Groundwater Dependent Ecosystem Tree Monitoring

3.1 GDE Trees photographs

Plate 107: GDE Tree 1 - 2019

Plate 108: GDE Tree 2 - 2019

Plate 109: GDE Tree 3 - 2019

Plate 110: GDE Tree 4 - 2019

Plate 111: GDE Tree 5 - 2019

Plate 112: GDE Tree 6 - 2019

Plate 113: GDE Tree 7 - 2019

Plate 114: GDE Tree 8 - 2019

Plate 115: GDE Tree 9 - 2019

Plate 116: GDE Tree 10 - 2019

Plate 117: GDE Tree 11 - 2019

Plate 118: GDE Tree 12 – 2019

Plate 119: GDE Tree 13 - 2019

Plate 120: GDE Tree 14 - 2019

Plate 121: GDE Tree 15 - 2019

Plate 122: GDE Tree 16 - 2019

Plate 123: GDE Tree 17 – 2019

Plate 124: GDE Tree 18 - 2019

Plate 125: GDE Tree 19 - 2019

Plate 126: GDE Tree 20 - 2019

Plate 127: GDE Tree 21 – 2019

Plate 128: GDE Tree 22 – 2019

Plate 129: GDE Tree 23 - 2019

Plate 130: GDE Tree 24 – 2019

Plate 131: GDE Tree 25 – 2019

Plate 132: GDE Tree 26 – 2019

Plate 133: GDE Tree 27 - 2019

Plate 134: GDE Tree 28 – 2019

Plate 135: GDE Tree 29 – 2019

Plate 136: GDE Tree 30 - 2019

4. Landscape function analysis

4.1 Landscape function analysis monitoring photographs

4.1.1 North Wambo Creek diversion and riparian areas

Plate 137: 17R

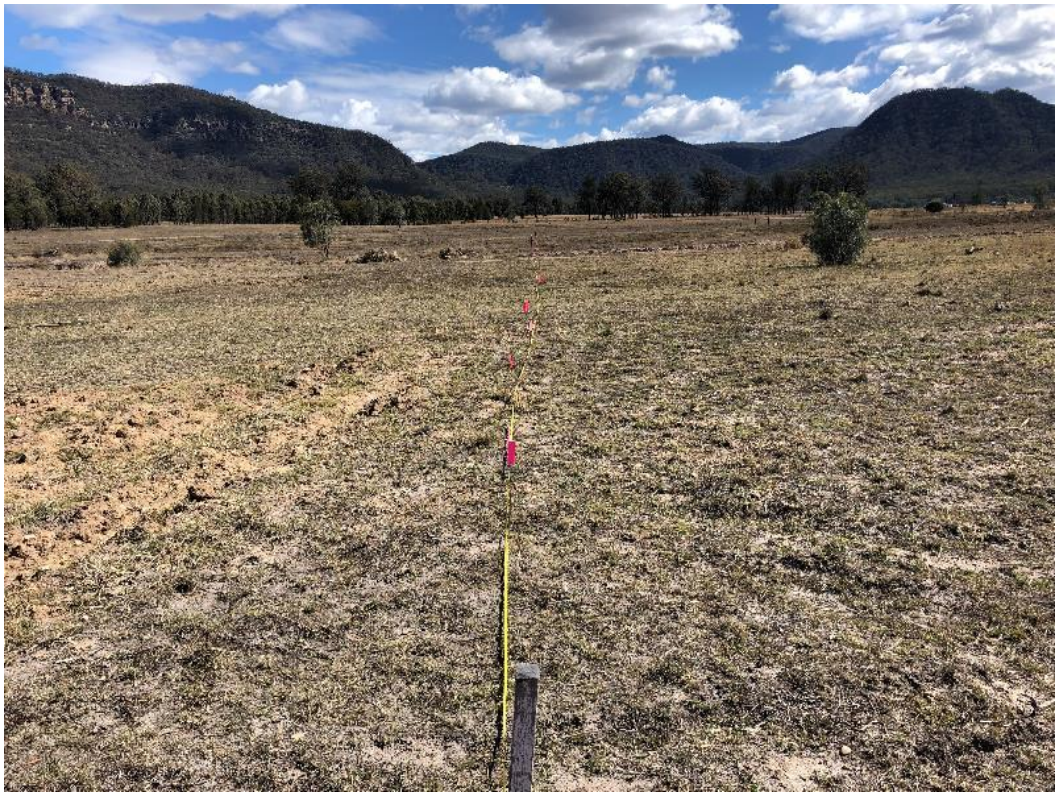

Plate 138: 19R

Plate 139: 21R

Plate 140: 23R

Plate 141: 25R

Plate 142: 26R

Plate 143: 27R

Plate 144: 28R

4.1.2 Woodland rehabilitation areas

Plate 145: 3R

Plate 146: 4R

Plate 147: 6R

Plate 148: 8R

4.1.3 Pasture rehabilitation areas

Plate 149: 1R

Plate 150: 2R

Plate 151: 5R

Plate 152: 7R

Plate 153: 9R

Plate 154: 10R

Plate 155: 16R

Plate 156: 33R

Plate 157: 34R

Plate 158: 35R

5. Riparian condition assessment

5.1 Riparian condition data

Table 5: Riparian condition scores

Site	Habitat	Cover	Natives	Debris	Features	Total
Maximum Score	**11**	**12**	**9**	**10**	**8**	**50**
North Wambo 1	5.25	6.5	3	4.5	2.63	21.88
North Wambo 2	8.75	6.75	3	4.25	3.75	26.5
North Wambo 3	7.75	6.25	3.25	4.5	2.5	24.25
Wambo 1	2.25	5.75	2.5	2.25	1.25	14
Wambo 2	3	6	2.5	2.5	1.25	15.25
Wambo 3	9.25	6.5	2	3	0.5	21.25
Stony Creek 1	3	5.25	2.25	3.75	2.25	16.5
Stony Creek 2	7	6	3.25	4	1.88	22.13
Stony Creek 3	11	7	4	6	2	30

5.2 Riparian condition assessment photographs

5.2.1 North Wambo Creek

Plate 159: North Wambo Creek 1 - 8a

Plate 160: North Wambo Creek 1 - 7a

Plate 161: North Wambo Creek 1 - 6a

Plate 162: North Wambo Creek 1 - 5a

Plate 163: North Wambo Creek 2 – 1a

Plate 164: North Wambo Creek 2 - 2a

Plate 165: North Wambo Creek 2 - 3a

Plate 166: North Wambo Creek 2 - 4a

Plate 167: North Wambo Creek 3 – 20a

Plate 168: North Wambo Creek 3 - 19a

Plate 169: North Wambo Creek 3 - 18a

Plate 170: North Wambo Creek 3 - 17a

5.2.2 Wambo Creek Riparian condition assessment

Plate 171: Wambo Creek 1 – 28a

Plate 172: Wambo Creek 1 - 27a

Plate 173: Wambo Creek 1 – 26a

Plate 174: Wambo Creek 1 - 25a

Plate 175: Wambo Creek 2 – 29a

Plate 176: Wambo Creek 2 - 30a

Plate 177: Wambo Creek 2 - 31a

Plate 178: Wambo Creek 2 - 32a

Plate 179: Wambo Creek 3 - 33a

Plate 180: Wambo Creek 3 – 34a

Plate 181: Wambo Creek 3 - 35a

Plate 182: Wambco Creek 3 - 36a

5.2.3 Stony Creek Riparian condition assessment

Plate 183: Stony Creek 1 – 24a

Plate 184: Stony Creek 1 - 23a

Plate 185: Stony Creek 1 - 22a

Plate 186: Stony Creek 1 - 21a

Plate 187: Stony Creek 2 – 13a

Plate 188: Stony Creek 2 - 14a

Plate 189: Stony Creek 2 - 15a new

Plate 190: Stony Creek 2 - 15a old

Plate 191: Stony Creek 2 - 16a

Plate 192: Stony Creek 3 – 12a

Plate 193: Stony Creek 3 - 11a

Plate 194: Stony Creek 3 - 10a

Plate 195: Stony Creek 3 - 9a

6. Bird monitoring

6.1 Bird monitoring data

Table 6: Species and maximum count of birds, heard and observed over two site visits; morning and afternoon during spring 2019 surveys

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	4	0	0	7	3
Acanthiza lineata	Striated Thornbill	0	0	0	0	0	3	0	3	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	9	4
Acanthiza nana	Yellow Thornbill	1	6	0	5	2	2	0	0	0	4	0	0	2	0	3	0	0	9	2	4	0	0	4	7	0	0	51	13
Acanthiza pusilla	Brown Thornbill	3	0	0	0	0	0	0	3	0	4	0	1	0	2	1	0	1	0	0	7	2	1	0	0	0	0	25	10
Acanthiza reguloides	Buff-rumped Thornbill	0	4	0	0	1	2	0	0	0	0	0	0	2	4	1	0	0	0	0	2	0	0	0	2	0	0	18	8
Accipiter fasciatus	Brown Goshawk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Aegotheles cristatus	Australian Owlet-nightjar	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Alisterus scapularis	Australian King-Parrot	0	0	0	0	0	0	7	2	6	0	1	0	6	0	0	6	0	0	0	4	16	0	0	0	2	2	52	10
Anthochaera carunculata	Red Wattlebird	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
Aquila audax	Wedge-tailed Eagle	0	0	0	0	2	0	0	0	0	1	0	0	0	1	4	0	1	0	0	0	1	1	0	0	0	0	11	7
Artamus cyanopterus	Dusky Woodswallow	0	0	0	0	25	0	2	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	9	5	47	6
Artamus superciliosus	White-browed Woodswallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	15	0	19	2
Cacatua galerita	Sulphur-crested Cockatoo	0	0	2	1	0	1	0	0	1	0	0	0	0	0	0	0	1	3	0	0	0	0	7	2	0	0	18	8
Cacatua sanguinea	Little Corella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	1
Cacomantis flabelliformis	Fan-tailed Cuckoo	2	0	1	0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	2	3	0	0	0	0	0	15	11
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1
Chalcites lucidus	Shining Bronze-Cuckoo	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	3
Chthonicola sagittata	Speckled Warbler	0	1	0	0	2	0	0	1	0	2	0	0	1	3	1	1	1	0	0	0	3	0	2	3	0	0	21	12
Climacteris erythrops	Red-browed Treecreeper	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	2
Climacteris picumnus	Brown Treecreeper	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Colluricincla harmonica	Grey Shrike-thrush	0	0	0	1	0	0	0	1	1	3	3	3	0	1	0	0	0	0	0	1	3	0	2	0	1	2	22	12
Coracina novaehollandiae	Black-faced Cuckoo-shrike	0	0	1	1	1	1	0	0	2	0	0	0	1	1	0	2	0	1	0	1	3	1	0	1	0	2	19	14
Corcorax melanorhamphos	White-winged Chough	0	0	4	0	0	0	0	0	0	0	0	0	0	6	6	0	0	0	1	0	0	3	0	0	6	6	32	7
Cormobates leucophaea	White-throated Treecreeper	0	1	0	1	0	0	0	4	1	1	2	2	1	1	1	2	0	1	1	2	3	1	0	0	1	0	26	17
Corvus coronoides	Australian Raven	2	1	1	2	0	2	3	1	1	2	1	1	2	0	1	2	2	2	2	1	0	0	2	3	1	1	36	22
Cracticus nigrogularis	Pied Butcherbird	0	1	1	0	0	0	1	0	0	2	0	0	1	0	0	0	0	0	1	0	0	2	0	0	0	0	9	7
Cracticus tibicen	Australian Magpie	1	0	0	0	0	0	2	0	0	2	0	0	2	0	1	0	2	3	0	0	0	0	0	2	0	1	16	9
Cracticus torquatus	Grey Butcherbird	0	2	0	1	0	0	2	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	10	8
Dacelo novaeguineae	Laughing Kookaburra	2	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	2	2	2	0	0	13	9
Daphoenositta chrysoptera	Varied Sittella	0	0	0	0	0	0	0	0	0	2	0	0	0	3	1	0	0	0	0	10	0	2	2	2	0	0	22	7

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Dicaeum hirundinaceum	Mistletoebird	1	0	0	0	2	1	3	3	1	0	1	0	0	0	4	1	0	2	1	0	0	2	0	0	0	1	23	13
Egretta novaehollandiae	White-faced Heron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Eolophus roseicapillus	Galah	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	6	2
Eopsaltria australis	Eastern Yellow Robin	2	1	1	1	0	0	1	2	0	5	3	3	1	2	0	4	1	0	1	0	3	2	1	1	2	1	38	20
Falco cenchroides	Nankeen Kestrel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2	2
Falcunculus frontatus	Crested Shrike-tit	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	3
Geopelia humeralis	Bar-shouldered Dove	0	0	1	0	0	0	3	0	3	1	0	0	2	0	0	4	1	3	1	0	2	1	0	0	1	2	25	13
Gerygone albogularis	White-throated Gerygone	1	0	1	1	2	2	2	0	0	1	0	0	2	0	1	1	0	0	0	2	1	0	0	0	0	0	17	12
Gerygone fusca	Western Gerygone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2	2
Glossopsitta concinna	Musk Lorikeet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	1
Glossopsitta pusilla	Little Lorikeet	0	0	0	0	0	0	3	0	4	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	11	4
Grallina cyanoleuca	Magpie-lark	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	4	4
Hirundo neoxena	Welcome Swallow	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	2
Lalage sueurii	White-winged Triller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
Leucosarcia picata	Wonga Pigeon	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	6	6
Lichenostomus chrysops	Yellow-faced Honeyeater	0	2	3	2	12	2	0	4	1	4	3	2	5	3	2	3	3	3	6	1	2	14	2	2	0	0	81	22
Lichenostomus leucotis	White-eared Honeyeater	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Lichenostomus melanops	Yellow-tufted Honeyeater	0	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	2
Lichenostomus penicillatus	White-plumed Honeyeater	0	0	0	0	0	0	8	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	6	6	27	5
Macropygia amboinensis	Brown Cuckoo-Dove	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Malurus cyaneus	Superb Fairy-wren	5	0	5	0	0	0	0	2	0	0	4	0	0	0	0	3	8	3	0	0	2	0	0	4	1	0	37	10
Malurus lamberti	Variegated Fairy-wren	3	0	0	0	0	0	0	0	0	3	0	0	2	0	0	1	0	1	0	0	0	0	0	0	0	0	10	5
Manorina melanocephala	Noisy Miner	1	1	4	1	0	1	0	0	0	0	0	0	0	0	3	0	3	3	0	0	0	0	0	2	1	2	22	11
Meliphaga lewinii	Lewin's Honeyeater	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	7	5
Melithreptus brevirostris	Brown-headed Honeyeater	0	0	1	1	0	0	0	1	0	2	0	4	2	0	5	7	0	0	1	0	2	2	0	2	0	0	30	12
Melithreptus lunatus	White-naped honeyeater	0	0	0	0	0	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2
Merops ornatus	Rainbow Bee-eater	2	1	1	0	1	0	2	0	0	1	0	2	0	0	1	0	1	1	0	0	0	1	2	0	0	0	16	12
Microeca fascinans	Jacky Winter	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	5	3
Neochmia temporalis	Red-browed Finch	0	0	0	0	0	0	0	4	0	0	6	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	14	3
Ocyphaps lophotes	Crested Pigeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	2
Oriolus sagittatus	Olive-backed Oriole	0	0	1	2	1	1	0	2	2	0	3	0	0	1	1	1	0	1	1	0	3	0	1	1	1	2	25	17
Pachycephala pectoralis	Golden Whistler	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0	2	0	1	0	0	8	7
Pachycephala rufiventris	Rufous Whistler	0	1	1	1	1	2	4	3	3	5	4	1	3	1	2	3	1	0	3	0	1	3	2	2	5	3	55	23
Pardalotus punctatus	Spotted Pardalote	0	0	0	0	7	2	1	1	0	0	0	2	3	0	0	3	3	2	0	2	2	2	1	6	0	0	37	14
Pardalotus striatus	Striated Pardalote	1	0	3	0	2	1	0	2	0	0	0	0	6	2	0	3	2	0	0	1	2	0	0	0	0	0	25	11

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Petrochelidon ariel	Fairy Martin	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	9	2
Petroica goodenovii	Red-capped Robin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Phaps chalcoptera	Common Bronzewing	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Philemon corniculatus	Noisy Friarbird	1	3	0	2	0	2	0	2	1	2	1	4	2	1	1	1	3	1	2	1	3	2	1	0	1	0	37	21
Platycercus elegans	Crimson Rosella	2	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	11	4
Platycercus eximius	Eastern Rosella	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	2
Plectorhyncha lanceolata	Striped Honeyeater	1	1	1	2	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	1	0	1	2	2	15	11
Pomatostomus temporalis	Grey-crowned Babbler	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	8	2
Psophodes olivaceus	Eastern Whipbird	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	8	5
Ptilonorhynchus violaceus	Satin Bowerbird	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Rhipidura albiscapa	Grey Fantail	0	1	0	0	0	1	0	0	0	1	1	0	0	0	1	4	1	1	1	1	1	1	2	3	0	0	20	14
Rhipidura leucophrys	Willie Wagtail	2	0	1	0	0	0	4	1	3	0	3	0	0	0	0	0	0	1	0	0	0	0	0	1	4	3	23	10
Scythrops novaehollandiae	Channel-billed Cuckoo	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	4	4
Sericornis frontalis	White-browed Scrubwren	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3	2
Smicrornis brevirostris	Weebill	0	0	0	0	1	0	0	0	0	6	0	5	4	1	10	3	2	0	3	0	3	3	2	0	0	0	43	12
Strepera graculina	Pied Currawong	2	1	3	0	0	1	0	3	2	2	1	0	0	1	2	0	0	2	0	1	1	2	1	0	3	2	30	17
Taeniopygia bichenovii	Double-barred Finch	0	2	0	0	0	0	3	2	0	2	4	2	6	0	0	0	0	0	0	0	2	0	0	0	4	0	27	9
Todiramphus sanctus	Sacred Kingfisher	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2
Zosterops lateralis	Silvereye	2	4	0	0	0	0	0	0	0	18	0	1	0	0	0	0	0	0	0	2	0	3	1	0	0	0	31	7
TOTAL number of species recorded at site		**23**	**19**	**20**	**18**	**16**	**18**	**26**	**31**	**24**	**27**	**27**	**18**	**28**	**18**	**27**	**24**	**25**	**28**	**17**	**22**	**26**	**24**	**22**	**24**	**22**	**26**		

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APPENDIX G

WAMBO ANNUAL REVIEW GROUNDWATER ANALYSIS

WAMBO- 2019 ANNUAL REVIEW

Groundwater

Prepared for:

Wambo Coal Pty Ltd
Peabody Energy Australia
PMB 1, Singleton NSW, 2330

SLR Ref: 665.10008.00006-R01
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BASIS OF REPORT

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

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

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

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
665.10008.00006-R01-v2.0	31 March 2020	Adam Skorulis		Claire Stephenson
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APPENDICES

1 Introduction

1.1 Overview

The Wambo Coal Pty Ltd (WCPL) mining complex is located approximately 20 km north-west of Singleton, NSW. As part of compliance with mine approval conditions, routine groundwater monitoring is conducted across WCPL, and the data reviewed and analysed on an annual basis. The annual groundwater review is required to:

- Compare groundwater levels and quality to trigger levels. Recorded groundwater data is also compared to rainfall to identify trends. Modelled groundwater levels will also be compared to monitored data with model revisions recommended if necessary (**Section 4.4** GWMP).
- The annual review will also assess for lines of evidence for the seepage of mine water from the Chitter Dam and South Wambo Dam towards Wollombi Brook (**Section 4.4** GWMP). Both these sites are not currently used to store mine water.
- Assess volumes and water quality of inflows to Open Cut Pits and Underground Workings (**Sections 4.1.4** and **4.1.5** WCPL GWMP (Peabody, 2018)). Inflow volumes to underground workings are assessed against peak groundwater model inflow predictions.
- Report against specific performance indicators developed for the subsidence impact performance measures relating to groundwater for North Wambo Underground (NWU), South Wambo Underground (SWU) and South Bates Extension (SBE) mine areas (**Section 3.3** GWMP).

This report presents the annual groundwater review for WCPL, developed in accordance with the approval conditions and requirements outlined within the Groundwater Management Plan (GWMP) (Peabody, 2018).

Reporting against specific performance indicators developed for the subsidence impact performance measures relating to groundwater for North Wambo Underground (NWU), South Bates Underground (SWU) and South Bates Extension (SBE) mine areas is undertaken in SLR report *665.10008.R02*, which accompanies this document.

1.2 Scope

This report contains the analysis and information required to address the following components of the Annual Environmental Management Review (AEMR) for WCPL for the 2019 calendar year:

1. Review hydrographs for relevant groundwater monitoring bores and conduct a cause-and-effect analysis to determine whether trends are due to climatic conditions or mining.
2. Assess shallow bores for compliance with the groundwater level and water quality performance indicators (Tables 9 and 10 of the GWMP (Peabody, 2018)).
3. Compare groundwater monitored levels to model predictions from the South Bates Extension LW21-24 Extraction Management Plan (SLR, 2020).

Each scope item is addressed separately in the following sections.

2 Wambo Complex

The following section provides a description of the WCPL Complex of relevance to this annual groundwater review. The general site layout is presented in **Figure 1**

2.1 Mine operations

Table 1 presents a summary of mine areas across WCPL, approved mining timeframes and activities conducted over 2019. Overall, mining was active at South Bates Extension during 2019.

Table 1 Summary of WCPL Activities

Mine Area	Seam Mined To	Approved Life of Mining	2019 Activities
North Wambo Underground (NWU)	Wambo Seam	2007 to 2015	Mining complete
South Bates Underground (SBU)	Wambo Seam and Whybrow Seam	2016 to 2018	Mining complete
South Bates Underground Extension (SBE)	Whybrow Seam	2018 to 2022	Mining of SBE LW17 and LW18 during 2019

As of the 20th December 2017 the NSW Planning Assessment Commission granted consent for the Wambo Coal Mine MOD 17. These approved operations are reflected in **Table 1**, which involves mining of the Whybrow seam in the SBE.

2.2 Groundwater Impacts

Groundwater impacts associated with the approved operations at WCPL have been progressively assessed for each mining area, including:

- Wambo Development Project Groundwater Impact Assessment (AGE, 2003);
- North Wambo Underground Mine Modification Groundwater Assessment (Heritage Computing, 2012);
- North Wambo Underground – Longwall 10A – Modification Assessment (HydroSimulations, 2014a);
- Wambo Coal Mine Open Cut Modification Groundwater Assessment (HydroSimulations, 2014b);
- South Bates Underground Mine Modification – Groundwater Assessment (HydroSimulations, 2015);
- South Wambo Underground Mine Modification Groundwater Assessment (HydroSimulations, 2016a):
- South Wambo Box Cut – Groundwater Assessment (HydroSimlations, 2016b);
- South Bates Extension Modification Groundwater Assessment (HydroSimulations, 2017); and
- Wambo Knowledge to inform North Wambo Creek GDE Study (HydroSimulations, 2019).

The most recent groundwater assessment that captures operations across Wambo is the Groundwater Assessment in Support of South Bates Extension LW21-24 Extraction Plan (SBE LW21-24 EP). The groundwater assessment for SBE LW21-24 EP was completed by SLR (2020) and included an updated version of the HydroSimulations (2017a) and HydroSimulations (2019b) numerical groundwater model to represent groundwater response to approved mine activities. Mining is expected to commence in Longwall 21 around October 2020.

The key findings of this groundwater assessment review are:

- The alluvium adjacent to the SBE footprint has been disconnected from the regional alluvial system due to the removal of alluvium downstream of the longwalls by the approved open cut mining operations (and associated construction of the NWCD).
- The alluvium adjacent to the SBE footprint has been affected by open cut mining activities, with several metres of drawdown in the alluvium and regolith observed to date.
- There is expected to be negligible impact on the highly productive alluvium associated with the Wollombi Brook and Hunter River as a result of extraction of Longwalls 21 to 24.
- Extraction of Longwalls 21 to 24 would not result in reduced beneficial uses of the alluvium (from a water quality perspective).
- There are no bores above the SBE footprint that are used for irrigation, domestic or stock use. There are no private registered bores that would be likely to be affected by 2 m drawdown or more if Longwalls 21 to 24 were to occur in isolation.
- Site monitoring bores have the potential to be impacted during mining, therefore review of the condition of the monitoring network will be undertaken during each sampling event, and bores remediated/replaced as required, to maintain a long-term monitoring network.
- Drawdowns up to 200 m, due to extraction of Longwalls 21 to 24, are expected in the Whybrow Seam in accordance with the depth of cover.

- Extraction of Longwalls 21 to 24 would not have a significant impact on water levels in the Permian coal measures from a regional perspective due to the regional zone of depressurisation within the Permian coal measures created by historical and ongoing open cut and underground mining.
- Extraction of Longwalls 21 to 24 would not lower the beneficial use category of the groundwater within the Permian aquifers, as there would be no migration of groundwater away from the underground mining areas in the Permian aquifers either during mining or following completion of mining activities.
- There is an expectation of enhanced leakage from the NWC if the creek happens to flow during the period of extraction of Longwalls 21 to 24 underneath the diversion.
- Negligible loss of baseflow to the natural NWC is expected due to extraction of Longwalls 21 to 24, however, surface remediation is required to maintain the long-term flow regime along NWC (MSEC 2020).

The groundwater data analysis, based on currently available records, has shown that there are no observed material impacts from longwall mining beyond what was foreseen for the cumulative impacts described in the South Bates Extension Modification – Groundwater Assessment (HydroSimulations, 2017).

2.3 Groundwater Licensing

Under the *Water Act 1912* and *Water Management Act 2000*, adequate water licences are required for approval of the mine developments. Groundwater licenses held for WCPL are outlined in **Table 3**.

Table 2 WCPL Groundwater Entitlement and Licenses

Licence Number	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry date	Comment
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)								
WAL18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	20AL208641	20WA208642	31/07/2022	
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	20AL211371	20WA211372	31/7/2022	
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)								
WAL42373	Dewatering	Perpetuity	1549 unit shares	Aquifer	20AL219997	20MW065010	-	6 x WALs consolidated 20/12/18
WAL41532 (20BL172156)[1]	Dewatering	Perpetuity	98 unit shares	Aquifer	20AL218994	20MW065010	-	
20BL168997	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL168998	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL168999	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL169000	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL170638	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	

Licence Number	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry date	Comment
20BL172237	Monitoring Bore (GW14, GW18, GW21)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172238	Monitoring Bore (GW12)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172240	Monitoring Bore (GW15)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172242	Monitoring Bore (GW16, GW17)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172244	Monitoring Bore (GW20)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172255	Monitoring Bore (GW22)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172256	Monitoring Bore (GW13)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172257	Monitoring Bore (GW19)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172332	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173032	Monitoring		Groundwater monitoring	NA			-	
20BL173290	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173291	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173292	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173293	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173946	Monitoring	Perpetuity		NA				

Licence Number	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry date	Comment
20BL173999	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL009818	Bore	Perpetuity	Stock	NA		-	-	
20BL009819	Bore	Perpetuity	Stock	NA		-	-	
20BL009820	Bore	Perpetuity	Stock	NA		-	-	
20BL009821	Bore	Perpetuity	Stock	NA		-	-	
20BL143779	Bore	Perpetuity	Stock/Domestic	NA		-	-	

WAL = water access licence, ML/year = megalitres per year.

2.4 Groundwater Conditions

In accordance with the development consent approval requirements of DA305-7-2003 and various groundwater licences, WCPL are required to prepare and implement a Groundwater Monitoring Program (GWMP). **Table 3** presents a summary of the relevant groundwater conditions from the development consent and GWMP.

Table 3 DA305-7-2003 Requirements for the GWMP

Schedule	Condition	Condition*
4	29	The applicant must: … (e) monitor regional ground water levels and quality in the alluvial and overburden aquifers during the development and at least 10 years after mining; and (f) periodically assess groundwater pressure response in the coal measures; to the satisfaction of the EPA, CLWD and the Secretary.
4	30	Before carrying out any development, the Applicant must prepare a Site Water Management Plan for the development in consultation with DRE and CLWD, and to the satisfaction of the Secretary. This plan must include: … (f) a Ground Water Monitoring Program;
4	34	The Ground Water Monitoring Program must include: (a) detailed baseline data on ground water levels and quality, based on statistical analysis, to benchmark the pre-mining natural variation in groundwater levels and quality; (b) ground water impact assessment criteria; (c) a comprehensive and detailed program to monitor the volume and quality of ground water seeping into the open cut and underground mining workings; (d) a detailed program to monitor regional ground water levels and quality in the alluvial and overburden aquifers; (e) a program to investigate and monitor potential water loss from the Chitter Dump Dam and South Wambo Dam, and Montrose East Dam, including potential migration of stored water toward Wollombi Brook.
4	34A	Prior to submitting the first Extraction Plan for the Longwall Domains, the Applicant must revise the Groundwater Monitoring Program to: (a) include the installation of paired monitoring bores for the South Wambo Underground Mine, in consultation with CLWD, to assess potential fracture interconnections between surface water resources, alluvial and hardrock aquifers; and (b) provide detailed information on the groundwater levels within the alluvial and hardrock aquifers within the Longwall Domains
4	34B	Within 3 months of the approval of Modification 17, or as otherwise agreed with the Secretary, the Applicant must revise the Groundwater Monitoring Program, in consultation with CLWD, to include the installation of: (a) clustered monitoring bores for the South Bates Extension Area, located in proximity to the Hunter Lowland Redgum Forest along North Wambo Creek, and characterise the geological and hydrogeological systems in the vicinity of this vegetation community, including an assessment of the presence and extent of any shallow groundwater; and (b) monitoring vibrating wire piezometers, located above the South Bates Extension Area, both within and beyond the areas with potential for connective cracking. The Applicant must complete the installation of the bores and piezometers required under this condition and establish a program to continually monitor them within 12 months of the Secretary's approval of the revised Ground Water Monitoring Program.
4	36A	Within 12 months of the approval of Modification 17, or as otherwise agreed with the Secretary, the Applicant must commission and provide to the Secretary for approval, a Groundwater Dependent Ecosystem Study report. This study must:

Schedule	Condition	Condition*
		(a) be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Secretary; (b) be developed in consultation with CLWD; (c) adopt any available data collected from the revised Ground Water Monitoring Program; (d) provide advice on the likely level of groundwater dependence of the vegetation in the South Bates Extension Area given current groundwater levels and expert knowledge of the vegetation communities in the region; (e) in the event it is considered that vegetation communities in the vicinity of the South Bates Extension Area are groundwater dependent (either entirely or partially), provide advice on the likelihood that subsidence associated with the South Bates Extension Area could cause adverse impacts and how any such impacts would manifest; (f) consider to what degree the cumulative impacts of adjacent mining operations may have already impacted groundwater dependent vegetation across the South Bates Extension Area; (g) provide any recommendations regarding the revised Ground Water Monitoring Program required under condition 34B, and in particular provide any recommendations that would assist in assessing the potential fracture interconnections between surface water resources and hard rock aquifers that may impact on groundwater dependent vegetation; and (h) include a management and/or remediation program that describes measures that could be implemented to ensure compliance with the performance measures in Table 14A for any groundwater dependent endangered ecological community.
4	36B	The Applicant must take into account the findings of the Groundwater Dependent Ecosystem Study and not less than 2 years of monitoring results obtained under condition 34B in the preparation of any Extraction Plan for Longwalls 23 – 25.
6	3	**Adaptive Management** The Applicant must assess and manage project-related risks to ensure that there are no exceedances of the criteria and/or performance measures in schedule 4. Any exceedance of these criteria and/or performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation. Where any exceedance of these criteria and/or performance measures has occurred, the Applicant must, at the earliest opportunity: (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur; (b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and (c) implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary
6	4	Management Plan Requirements The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include: (a) detailed baseline data; Section 2.0 (b) a description of: - the relevant statutory requirements (including any relevant consent, licence or lease conditions); Section 1.4 - any relevant limits or performance measures/criteria; - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures; Section 3.3 (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/ criteria; Section 4.0

Schedule	Condition	Condition*
		(d) a program to monitor and report on the: - impacts and environmental performance of the Wambo Mining Complex; Sections 4.0 and 6.0 - effectiveness of any management measures (see c above); (e) a contingency plan to manage any unpredicted impacts and their consequences; Refer SGWRP (f) a program to investigate and implement ways to improve the environmental performance of the Wambo Mining Complex over time; Section 6.2 (g) a protocol for managing and reporting any: - incidents; Section 6.4 - complaints; Section 5.0 - non-compliances with statutory requirements; and Refer SGWRP - exceedances of the impact assessment criteria and/or performance criteria; and Refer SGWRP (h) a protocol for periodic review of the plan.

*An update to the GWMP is being prepared to address DA305-7-2003 (modification 16) which was approved 29 August 2019.

Groundwater monitoring is conducted in accordance with the Groundwater Monitoring Program outlined within the WCPL GWMP. The program outlines groundwater monitoring frequency, parameters to be tested and groundwater triggers for electrical conductivity (EC) and pH. The GWMP was updated in October 2018, including updates to the monitoring network and trigger levels. This annual review is based upon the monitoring and reporting requirements documented within the October 2018 version of the GWMP. Further discussion on the groundwater monitoring program and triggers is included in **Section 4**.

3 Hydrogeological Setting

This section presents a brief summary of the hydrogeological setting for WCPL. This includes discussion on climate, terrain, drainage, geology and groundwater bearing units.

3.1 Climate, Terrain and Drainage

3.1.1 Climate

The climate of the Wambo region can be classed as temperate and is characterised by hot summers and mild dry winters. Rainfall data is available from the Bulga, South Wambo (BOM Station: 0611191) which has been recording daily rainfall data since January 1959. Climatic data was obtained between 01/01/1959 to 01/01/2020. **Table 4** provides the average monthly rainfall data, as well as the 2019 monthly data from the Bulga, South Wambo station.

A cumulative deviation from mean (CDM) rainfall plot is provided as a comparative tool to illustrate long term climate trends and their influence on groundwater in the Wambo area. The CRD graphically shows trends in recorded rainfall compared to long-term averages and provides a historical record of relatively wet and dry periods. A rising trend in slope in the CRD graph indicates periods of above average rainfall, whilst a declining slope indicates periods when rainfall is below average. A level slope indicates average rainfall conditions.

Table 4 Long Term Average and 2019 Climate Data

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Historical	86.2	84.2	66.7	45.9	40.3	44.1	30.0	34.2	38.5	50.1	61.8	71.5	**65.6**
2019 Rainfall	59.6	21	145.6	3.4	11.8	36.4	13.4	21.8	21.4	4.4	30.8	0.2	**339.8**

3.1.2 Terrain and Drainage

WCPL is located in the Upper Hunter Valley region where landforms are characterised by gently sloping floodplains associated with the Hunter River and the undulating foothills, ridges and escarpments of the Mount Royal Range and Great Dividing Range. Elevations in the vicinity of WCPL range from approximately 60 metres Australian Height Datum (mAHD) at Wollombi Brook to approximately 650 mAHD at Mount Wambo within the Wollemi National Park to the west of WCPL (WCPL, 2003).

WCPL is situated adjacent to the Wollombi Brook, south-west of its confluence with the Hunter River **Figure 1**). Wollombi Brook drains an area of approximately 1,950 square kilometres (km^2) and joins the Hunter River some 5 km north-east of Wambo. The Wollombi Brook sub-catchment is bound by the Myall Range to the south-east, Doyles Range to the west, the Hunter Range to the south-west and Broken Back Range to the north-east (Hunter Catchment Management Trust, 2002).

The majority of lands within WCPL mining tenements drain via Wambo, Stony, North Wambo and Redbank Creeks to Wollombi Brook, while Waterfall Creek drains directly to the Hunter River. These watercourses are generally characterised by ephemeral and semi-perennial flow regimes (Gilbert and Associates, 2003).

3.2 Geology

WCPL is situated within the Hunter Coalfield subdivision of the Sydney Basin, which forms the southern part of the Sydney-Gunnedah-Bowen Basin. The stratigraphy in the Wambo area comprises the Triassic Narrabeen Group, Permian coal measures and more recent (Quaternary) alluvial deposits associated with major drainage pathways. Folding, faulting and igneous intrusions have affected the Permian sediments after deposition. The target Seams for WCPL underground mining lie within the Jerrys Plains Subgroup of the Wittingham Coal Measures.

Along the Wollombi Brook, Wambo Creek, North Wambo Creek and Stony Creek thin Quaternary alluvial deposits unconformably overlie the Permian strata. The alluvial deposits comprise surficial fine grained sediments (i.e. sands, silts and clays). Along major watercourses (i.e. Wollombi Brook) the surficial sediments overly basal sands and gravels that are between 7 m to 20 m thick. **Table 5** presents a summary of site geology.

Table 5 Wambo Generalised Stratigraphy

Age	Stratigraphic Unit		Description
Cainozoic	Quaternary sediments - alluvium (Qa)	Surficial alluvium (Qhb)	Shallow sequences of clay, silty sand and sand.
		Productive basal sands/gravel (Qha)	Basal sands and gravels along major watercourses (i.e. Hunter River).
	Silicified weathering profile (Czas)		Silcrete
	Alluvial terraces (Cza)		Silt, sand and gravel
Jurassic	Volcanics (Jv)		Flows, sills and dykes
Permian	Whittingham Coal Measures	Jerrys Plains Sub-group (Pswj)	Coal bearing sequences interbedded with sandstone and siltstone. Coal seams (youngest to oldest) include Whybrow Seam, Redbank Creek Seam, Wambo Seam, Whynot Seam, Blakefield Seam, Glen Munro Seam, Woodlands Hill Seam, Arrowfield Seam, Bowfield Seam, Warkworth Seam, Mt Arthur Seam, Piercefield Seam, Vaux Seam, Broonie Seam and Bayswater Seam.

3.2.1 Groundwater Units

The hydrogeological regime of the Wambo area and surrounds comprises two main systems:

- A Quaternary alluvial aquifer system of channel fill deposits associated with Wollombi Brook, North Wambo Creek, Wambo Creek and Stony Creek; and
- Underlying Permian strata of hydrogeologically "tight" and hence very low yielding to essentially dry sandstone and lesser siltstone and low to moderately permeable coal seams which are the prime water-bearing strata within the Permian coal measures. Triassic strata, namely the Narrabeen Group, are present to the south-west of the North Wambo Underground Mine and underlie some parts of the alluvium.

3.2.2 Alluvium

Groundwater flow patterns within the shallow alluvial aquifer reflect topographic levels and the containment of alluvium within the principal drainage pathways. Evidence from temporal groundwater monitoring hydrographs (**Appendix A**) within the alluvium indicates that the shallow aquifer is responsive to rainfall recharge and it is likely that the alluvium plays an important role in supplying recharge to the underlying Permian strata as well as, in places, contributing to baseflow of the perennial surface water features. In some areas upward or lateral flow may occur from the Permian and Triassic rock, but downward leakage seems to be the more common behaviour.

3.2.3 Permian Coal Measures

Prior to the commencement of mining operations in the region, the piezometric surface within the Wambo area most probably reflected the topography, with elevated water levels/pressures in areas distant from the major drainages and reduced levels in areas adjacent to the alluvial lands. Historical and ongoing open cut and underground mining within the Wambo area and adjoining mining operations have now created significant groundwater sinks. This has generated a regional zone of depressurisation within the Permian coal measures.

The Permian groundwater system within the Wambo area is continuous through the major geological formations. The various sedimentary rocks at Wambo have low permeability due to their fine-grained nature, the predominance of cemented lithic sandstones and the common occurrence of a clayey matrix in the sandstones and conglomerates. The permeability of the groundwater system is related to the joint spacing and aperture width. Permeability of the rock units generally decreases with depth of burial as the joints tighten and become less frequent.

The laminated fabric of the interbedded sandstone/siltstone/mudstone strata suggests that vertical hydraulic conductivities are significantly lower than horizontal hydraulic conductivities. Due to the laminar nature of the coal measures, groundwater flow generally occurs within or along the boundaries between stratigraphic layers.

The permeability of the coal measures is generally low, with rock mass permeabilities more than two orders of magnitude lower than the unconsolidated alluvial aquifers. Within the coal measures, the most permeable horizons are the coal seams, which commonly have hydraulic conductivity one to three orders of magnitude higher than the siltstones, shales and sandstone units.

The coal seams are generally more brittle and therefore more densely fractured than the overburden and interburden strata, which causes the higher permeability. Within the coal seams, groundwater flows predominantly through cleat fractures, although there is some evidence of structure-related fracturing and this may play an important role in groundwater flow paths.

The impact of fault structures such as the Redmanvale Fault is not known with certainty. However, it is likely that groundwater flow dynamics are complex in the vicinity of these structures.

4 Groundwater Monitoring

4.1 Groundwater Monitoring Programme

Groundwater monitoring is conducted at WCPL in accordance with the Groundwater Monitoring Plan (GWMP) (Peabody, 2018),. The purpose of the GWMP is to monitor and manage groundwater quality and levels to detect potential impacts on surrounding groundwater users, assess the performance of the mine against the performance indicators and to ensure that relevant legislative and policy requirements are met

The overall objectives of the GWMP are to establish baseline groundwater quality and water level data and implement a program of data collection that can be utilised to assess potential impacts of mining activities on the area's groundwater resources. From a hydrogeological perspective, the Wambo region is relatively complex. This is due to the various areas of alluvium, proximity to Wollemi National Park and number of historical and current mining developments.

The monitoring programme at WCPL measures the Standing Water Level (SWL) in monitoring bores, reported as elevation (mAHD). The data is compared against background data, EIS predictions and historical trends as a means of assessing any WCPL related impacts to the quantity of groundwater in the various aquifers.

Ongoing groundwater monitoring requirements at WCPL are as follows:

- Groundwater monitoring bores to monitor groundwater sources above and in close proximity to mine workings;
- Monitoring of potential groundwater leakage from Wollombi Brook and associated alluvial aquifers;
- Monitoring of groundwater inflows to underground and open cut mining operations; and
- Monitor for potential water loss from the Chitter Dam and Wambo South Water Dam, including potential migration of sub-surface water toward Wollombi Brook.

The monitoring programme at WCPL also assesses the quality of groundwater against background data and historical trends. Bi-monthly monitoring of groundwater levels, pH and EC will be undertaken at all standpipe bores in the groundwater monitoring program. Comprehensive analysis of major ions will occur at each standpipe bore annually.

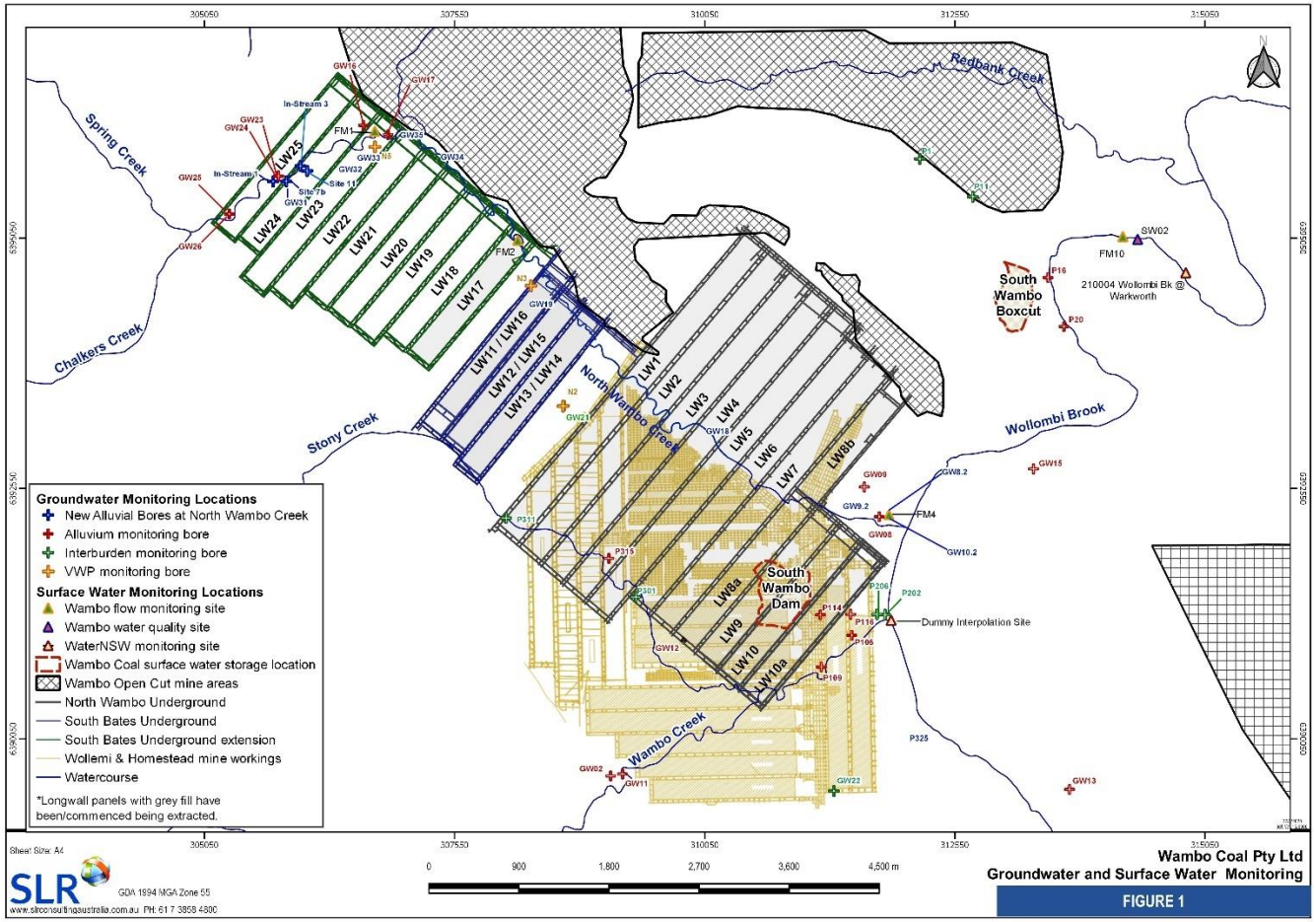

Figure 1 WCPL Monitoring Network

4.2 Groundwater Monitoring Methodology

Groundwater monitoring will consider the Murray-Darling Basin Groundwater Quality. Sampling Guidelines. Technical Report No 3 (Murray-Darling Basin Commission [MDBC, 1997]).

In general, the groundwater monitoring methodology will include the following:

- Gauging of groundwater levels;
- Grab sampling techniques using a bailer in accordance with WCPL instructions;
- Measurement of groundwater field parameters (pH and EC) using a calibrated water quality meter;
- If groundwater samples are to be collected, they are to be transferred into suitably preserved laboratory supplied sample containers once field parameters have stabilised;
- All sample containers are to be clearly labelled with sample number, sample location, sample depth and sample date. The sample containers are to be transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory. A Chain-of-Custody (CoC) form should be forwarded with the samples to the testing laboratory; and
- Decontamination of all non-dedicated sampling equipment between monitoring locations.

4.3 Groundwater Triggers

Trigger levels are used to initiate investigations into the groundwater levels or groundwater quality at WCPL. The trigger levels, as specified WCPL Groundwater Monitoring Program (Peabody 2018; Table 9 and Table 10), are based on statistical analysis on pre-mining baseline monitoring data. The trigger levels are presented in **Table 6**. Trigger levels for groundwater levels occur when two consecutivebi-monthly observation exceeds the maximum or falls below the minimum specified groundwater level. Triggers for EC occur when three consecutive bi-monthly observations (a 6-month period) exceed the specified trigger level. Triggers for pH occur when two consecutive bi-monthly observations (a 4-month period) exceed or fall below the specified trigger level.

Table 6 Groundwater Level and Groundwater Quality Trigger Levels (Peabody, 2018)

Bore	Groundwater Level (mAHD)			Groundwater Quality	
	Maximum (10^{th} percentile depth)	Minimum (90^{th} percentile depth)	EC (µS/cm)	pH Minimum	pH Maximum
P106	54.47	50.37	941	6.7	7.9
P109	57.84	55.74	#N/A	-	-
P114	56.04	53.84	6141	6.5	7.8
P116	54.24	51.74	5972	6.6	7.5
P202	52.47	50.67	8172	6.7	7.7
P206	44.13	38.63	2630	7.3	8.1
P301[1]	#N/A	-	-	-	-
P315	90.34	85.64	552	6.0	7.4
GW02	76.70	74.00	715	6.7	7.4
GW08[2]	#N/A	-	-	-	-

Bore	Groundwater Level (mAHD)			Groundwater Quality	
	Maximum (10^{th} percentile depth)	Minimum (90^{th} percentile depth)	EC (µS/cm)	pH Minimum	pH Maximum
GW09[2]	#N/A	-	-	-	-
GW11	76.00 (73.7)*	73.50 (71.2)*	592	6.8	7.5
GW12	77.38	74.38	#N/A		
GW13	57.76	57.16	4370	6.9	7.1
GW15	51.96	51.26	730	6.7	7.2
GW16[3]	#N/A	-	-	-	-
GW17[3]	#N/A	-	-	-	-
P16	50.38	49.68	10832	7	7.7
P20	50.30	49.20	10625	7	7.6

#N/A= Not applicable

* Recommended revised trigger levels for WS11 based on re-surveyed elevations

[1]P301 is predicted to go dry by HydroSimulations (2014), therefore no trigger level has been established – i.e. the purpose of trigger levels is to identify unanticipated impacts.

[2]WCPL has installed replacement bores for GW08 and GW09. Trigger levels will be established for these bores based on modelled groundwater levels and will replace the GW08 and GW09 in this table.

[3]GW16 and GW17 are located upstream of the North Wambo Creek Diversion and in close proximity to the approved open cut. There are no groundwater users located in the vicinity of North Wambo Creek upstream of the North Wambo Creek Diversion. Therefore, a trigger level for these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.

5 Monitoring Results

A summary of the water level results is provided for each of the main water bearing units below. Routine water level readings for 2019 are tabulated in Section 5.2. Hydrographs for each key site are shown in Figure 2 to Figure 23 contained in Appendix A.

Key data assessment results of time series groundwater level and electrical conductivity (EC) data, in relation to trigger levels prescribed in the GWMP (Peabody, 2018for the 2019 monitoring period, are outlined below. Bores at key sites were selected by HydroSimulations (2017b) to identify potential impacts from recent areas:

- North Wambo Underground (completed in 2016);
- Montrose Open Cut; and
- South Bates Underground - LW15, LW16
- South Bates Underground Extension - LW17 and LW18.

5.1.1 North Wambo Underground

Available EC and groundwater level monitoring data for North Wambo Underground (NWU) have been assessed at key locations P114, P116, P202, P206, P106 and P109.

5.1.1.1 P114 - Alluvium/ Weathered Permian

5.1.1.1.1 Groundwater Level

Bore P114 is located over NWU longwall LW10a, which commenced extraction in July 2015. Groundwater levels versus rainfall residual mass are presented in **Figure 2**. From August 2016 to December 2019 the bore has been recorded as dry. The rapid decline in groundwater levels following the start of extraction is interpreted as an NWU mining impact.

5.1.1.1.2 Groundwater Quality

EC levels over time for bore P114 are shown in **Figure 2**. Prior to October 2011, all EC observations since 1998 were below 1000 µS/cm. From December 2011 to August 2016 EC increase to a maximum of 10,360 µS/cm. The increased salinity observed during this period is likely to be controlled by declining groundwater levels intercepting saline Permian groundwater at the base of the Wambo Creek Alluvium, related to the period of below average rainfall and a NWU LW 10A mining effect. EC data has not been recorded since August 2016 as the bore is dry.

5.1.1.2 P116 - Alluvium/ Weathered Permian

5.1.1.2.1 Groundwater Level

Bore P116 is located 100 m from NWU longwall LW10a, which commenced extraction in July 2015. Groundwater levels versus rainfall residual mass and Wollombi Brook stage height is presented in **Figure 3**. Historically, groundwater levels show a moderate response to long term rainfall trends and good correlation with the interpolated Wollombi Brook stage height. Since LW10a extraction in late 2015, groundwater levels have declined towards the lower groundwater trigger level which reflects the 90th percentile of historic groundwater measurements up to April 2015. This declining trend continues during 2019 and is related to the ongoing period of below average rainfall, with the groundwater level below the recorded base of alluvium (50.67 mAHD). Groundwater levels below the 90th percentile trigger level were recorded in October 2019 (50.64 mAHD) and December 2019 (50.45 mAHD).

5.1.1.2.2 Groundwater Quality

EC levels over time for bore P116 are shown in **Figure 3**. From 1999 to 2019 EC levels have ranged from ~450 µS/cm to 6570 µS/cm. Throughout 2019 salinity has continued to rise above values recorded over the last 10 years, with EC of 3,310 µS/cm recorded in December 2019. As with previous changes in EC, the increased salinity for 2019 is highly likely to be controlled by declining groundwater levels intercepting saline Permian groundwater at the base of the Wambo Creek Alluvium, related to the period of below average rainfall. This relationship between groundwater levels and salinity is consistent with assessments regarding the mechanisms of saline water observed at the mine conducted by HydroSimulations (2016, 2017b, 2019).

5.1.1.3 P202 – Permian Interburden/ overburden

5.1.1.3.1 Groundwater Levels

Bore P202 is located 350 m from NWU Longwall 10A, which commenced extraction in July 2015. Groundwater levels versus rainfall residual mass are presented in **Figure 4**. During 2018, groundwater levels steadily dropped by approximately 1 m, and in 2019 they declined by a further 0.5 m. In December 2019, the groundwater level (50.45 mAHD) was 0.22 m below the 90th percentile level of 50.67 mAHD. The declining water level is likely to be controlled by the low rainfall conditions as stage height at Wollombi Brook exhibits a similar declining trend.

5.1.1.3.2 Groundwater Quality

EC levels over time for bore P202 are shown in **Figure 4**. From 1999 to 2019 EC levels have ranged from 1920 µS/cm to 10520 µS/cm, with frequent fluctuations between fresher and more saline conditions occurring. EC continued to rise slowly throughout 2018 with measurements in December 2018 reaching 4,400 µS/cm. In the first quarter of 2019, EC levels freshened to 3,570 µS/cm followed by an increase to 4,000 µS/cm. Over the 2019 reporting period EC is, on average, brackish (approximately 4,000 µS/cm to 5,000 µS/cm), well below the trigger level of 8,172 µS/cm.

5.1.1.4 P206 - Permian Interburden/ overburden

5.1.1.4.1 Groundwater Levels

Bore P206 is located over 350 m NWU longwall 10A, which commenced extraction in July 2015. Groundwater levels versus rainfall residual mass are presented in **Figure 5**. During 2018 groundwater levels showed no significant change, trending down slightly, just below the 90th percentile trigger level of 38.63 mAHD. Groundwater levels continued to decline in 2019, decreasing by 1.3 m to approximately 37 mAHD. The decline in groundwater levels in the Permian coal measures at P206 is consistent with predictions for approved operations. However, it is noted that the observed levels are not recovering in line with predicted groundwater level recovery. It is recommended that site activities and model assumptions be reviewed and if necessary, updates made in the next iteration of the groundwater model to better replicate and predict groundwater trends and the influence of mining.

5.1.1.4.2 Groundwater Quality

EC levels over time for bore P206 are shown in **Figure 5**. From 1999 to 2019 EC levels have ranged from 481 µS/cm to 5560 µS/cm. Since February 2013, EC has been consistently less than the trigger level of 2,630 µS/cm, ranging between 1,000 µS/cm and 2,300 µS/cm. In 2019, EC remained between 2020 µS/cm and 2,140 µS/cm. Since October 2016, pH has ranged between 7.8 and 8.0, with the exception of December 2019, when pH was reported to be 8.1. This is the first time pH has been reported at or above the trigger level of 8.1 since June 2010.

5.1.1.5 P106 - Alluvium

5.1.1.5.1 Groundwater Level

Bore P106 is located 250 m from NWU longwall 10A, which commenced extraction in July 2015. Bore P106 also overlies Wollemi Homestead Longwall 9A which was extracted from the Whybrow seam in 1998/99. Groundwater levels versus rainfall residual mass are presented in **Figure 6**. Larger fluctuations in groundwater levels are observed at P106 in comparison with bores P114, P116, P202 and P206. This is likely to be indicative of the connectivity of groundwater in P106 with the ephemeral flow in Wambo Creek, or lower specific yield in its associated alluvium.

All observations since 2017, record bore P106 as dry. Data available to SLR indicates the depth of P106 to be 14 mbToC (47.07 mAHD). An investigation by WCPL in 2019 revealed that an obstruction at 9.6 mbToC to be the cause of false dry depth to water readings. The bore remained blocked throughout 2019.

5.1.1.5.2 Groundwater Quality

EC levels over time for bore P106 are shown in **Figure 6**. From 1999 to 2016 EC levels have ranged from 391 µS/cm to 1100 µS/cm. EC at P106 was relatively fresh (<1,000 µS/cm) and prior to the blockage responded to the climatic influence on groundwater levels.

5.1.1.6 P109

5.1.1.6.1 Groundwater Level

Bore P109 is located 210 m from NWU longwall 10A, which commenced extraction in July 2015. Bore P109 also overlies the main workings from Wollemi Homestead underground mine which extracted coal from the Whybrow Seam in the 1990's. Groundwater levels versus rainfall residual mass are presented in **Figure 7**. A strong climatic response can be observed, with larger fluctuations in groundwater levels likely indicative of ephemeral flow in Wambo Creek or lower specific yield in the associated alluvium. In 2019, groundwater levels continued to decline, dropping by 0.32 m to approximately 55.66 mAHD, which is below the 90th percentile level of 55.74 mAHD. This is likely due to the ongoing period of below average rainfall and lack of flow in Wambo Creek.

5.1.1.6.2 Groundwater Quality

EC levels over time for bore P109 are shown in **Figure 7**. From 1998 to 2019 EC levels have generally ranged from 600 µS/cm to 1,000 µS/cm. During 2019, EC reduced slightly, dropping from 764 µS/cm in February to 636 µS/cm in December 2019.

pH levels from 2001 to 2019 ranged from 6.2 to 8.7. In February 2019 pH was 6.2, which is less than the lower trigger level and the lowest reported level to date. In April 2019, and during the four subsequent monitoring rounds, pH levels were within the trigger levels of 6.5 to 7.6, increasing gradually from 6.5 to 6.7 between April and December 2019.

5.1.1.7 North Wambo Underground Mining and Dewatering Impact

GW08 and GW09 are located to the east of NWU. The closest NWU longwalls to GW09 are LW9 (extracted mid-2014 to early 2015) and LW8b (extracted late 2015 to early 2016). The closest NWU longwalls to GW08 are LW10 and LW10a (extracted consecutively from early to late 2015). Since April 2012, the groundwater levels in bores GW08 and GW09 have decreased by approximately 4 m (**Figure 8**).

The water levels in these bores show only a minor response to rainfall indicating that the stresses causing the declining levels are greater than the capacity of the alluvium to respond to rainfall events. No data was collected between December 2014 and April 2016. Since this time GW09 has been dry, while GW08 continued to show declining water levels. The further reduction in groundwater levels following April 2016 indicates that extraction of LW8b affected groundwater levels at both bores, suggesting that the earlier decline from 2013 to 2014 was not solely due to the effect of the dewatering bores.

Groundwater levels at GW08 increased in April 2017, corresponding with a short period of above average rainfall, followed by a gradual decline in groundwater levels of approximately 1.3 m to December 2018 consistent the below average rainfall conditions indicated by the long-term rainfall trend. Both GW08 and GW09 were recorded as dry for all six monitoring events in 2019. Although a NWU mining effect may be ongoing, any possible recovery is likely be masked by the below average rainfall. It should be noted that the base of bore GW08 appears to be incorrect. HydroSimulations (2019) noted that the base of the bore is documented as 53 mAHD, however, water levels at this bore were reported to be less than 53 mAHD throughout 2018. Hydrosimulations has previously recommended replacement of GW08 and GW09. WCPL has committed to replacing these bores in early 2020.

5.1.2 Montrose Open Cut

Groundwater level data has been assessed at GW16, GW17 and VWP N5 to determine the level of impact on groundwater levels in the area from the Montrose Open Cut, which is approximately 300 m away from the monitoring sites assessed in this section. Water level and water quality data has been collected since 2010 for bores GW16 and GW17, which intersect the weathered Permian coal measures along North Wambo Creek, near the Montrose Open Cut and the beginning of the North Wambo Creek Diversion. Bore GW16 intersects silts and sands to 7 m depth overlying weathered sandstone and bore GW17 intersects silts and sands to 2 m depth overlying weathered sandstone, conglomerate and siltstone. Observations have been made at N5 since July 2015.

5.1.2.1 GW16 and GW17

5.1.2.2 Groundwater Levels

Groundwater levels at bore GW16 (**Figure 9**) ranged between 3.5 mbgl and 9.5 mbgl until 2016, after which levels fell below the base of the unconsolidated material (7 mbgl). The initial water level readings for GW16 appear to correlate to periods of above average rainfall, reaching levels of up to approximately 109 mAHD, indicating a saturated thickness of unconsolidated material of approximately 3 m. The decline in groundwater levels from 2016 may relate to nearby open cut mining and below average rainfall.

Groundwater levels at bore GW17 (**Figure 10**) have remained below the base of the sands and gravels since monitoring began, indicating the unconsolidated material is unsaturated at this location.

As reported in HydroSimulations (2018a), it is suspected that due to the amplitude of change in groundwater levels at GW16 and GW17, mining occurring at the adjacent Montrose Open Cut pit is likely to be affecting groundwater levels at these bores. However, the continued low level of rainfall over the 2019 monitoring period is also likely to be contributing to suppressed groundwater levels at both bores. The extent to which mining has affected GW16 and GW17 remains uncertain.

5.1.2.2.1 Groundwater Quality

During 2019, EC gradually increased at bore GW17 which is likely related to a lack of freshwater recharge associated with below average rainfall conditions. EC levels at GW16 are fresher than at GW17, ranging between 300 µS/cm and 1500 µS/cm. Both GW16 and GW17 show a similar trend of increased salinity associated with low rainfall and decreasing groundwater level. During 2019, EC increased from 1,100 µS/cm to 1,500 µS/cm consistent with a declining groundwater level associated with below average rainfall and impacts from the nearby Montrose Open Cut.

The negligible changes in EC at GW17 is likely to be due to the bore being located upgradient of the Montrose Open Cut pit. However, with groundwater levels recorded within Permian strata, no effect to EC should occur at GW17 as a result of the Open Cut operation.

At GW16, decreasing groundwater levels associated with Montrose Open Cut mining and the extended period of below average rainfall, mean that observations at are more frequently taken from groundwater within Permian strata. This has resulted in a gradual increase in EC observed at GW16. The increase is not occurring within the alluvium and is representative of natural groundwater conditions within the Permian strata at WCPL.

5.1.2.3 N5

5.1.2.3.1 Groundwater Levels

N5 (**Figure 11**), is a multi-sensor vibrating wire piezometer (VWP) bore located 2 km north of current mining in the South Bates Extension Underground Mine (SBE) (**Figure 1**) at an elevation of 110.1 mAHD. N5 has four vibrating wire piezometer sensors installed at depths of 30 m (N5-4: Permian Overburden), 73 m (N5-3: Whybrow Seam), 89.5 m (N5-2: Whybrow–Wambo Seam Interburden) and 133 m (N5-1: Wambo Seam) that have been recording since July 2015.

The shallowest Permian sensor (N5-4) has recorded consistent groundwater levels that show a good correlation with the rainfall residual mass until mid-March 2019. In March 2019 there was a sudden drop of approximately 1 m in one week, after which levels appeared to stabilise at 88.5 mAHD. Declines were reported at N5-2 and N5-3 at the same time. N5-2 dropped by approximately 5 m over the 20-hour period to 6:15 am on the 16th of March, after which the levels increased by around 1.3 m and again stabilised. N5-3 dropped by 0.9 m over a period of six days before stabilising at 42.2 mAHD. The alignment and sudden nature of these drops suggest is not captured at other nearby monitoring bores (GW16 and GW17) and may indicate erroneous data, Further investigation is required to determine the cause of these sudden water level declines. . With the exception of sudden decline in March 2019, water levels in the Whybrow seam (N5-3) and Whybrow-Wambo interburden (N5-2) sensors were relatively stable and consistent throughout the 2019 monitoring period. Sensor N5-1 (Wambo Seam) continued to decline over 2019, with levels dropping by 1.6 m over the reporting period.

Aside from possible erroneous data in March 2019, the uppermost sensor, N5-4, continues to show a good correlation with the long-term rainfall trend. Groundwater levels in the middle sensors, N5-3 and N5-2, have stabilised following regional depressurisation that occurred as a result of open cut mining, and extraction of the Wambo Seam at North Wambo Underground and the Whybrow Seam and Wambo Seam at South Bates Underground. Dewatering that is still occurring within the Montrose Open Cut may also be occurring in the South Bates Underground Wambo Seam workings which are likely to be controlling the continued, yet gradual, depressurisation observed in sensor N5-1 within the Wambo Seam.

5.1.3 South Bates Underground

Groundwater level data have been assessed at VWPs N2 and N3 and bore GW21 to identify the impact of the extraction of South Bates Underground (SBU) Whybrow Seam (LW11, LW12, LW13), and Wambo Seam workings (LW14, LW15 and LW16). Data at the VWPs has been recorded since July 2015 and bore GW21 has recorded bi-monthly data since October 2010. N3 overlies the gate road to the north side of SBU Whybrow LW11, while both N2 and GW21 lie south-east of SBU Whybrow LW14 and are separated from SBU workings by a fault.

5.1.3.1 N2

5.1.3.1.1 Groundwater Levels

VWP N2 (**Figure 12**) is located between NWU and SBU (**Figure 1**), at an elevation of 122.5 mAHD. It is a multi-piezometer grouted bore with six VWPs installed at depths of 40 m (N2-6: Permian overburden), 70 m (N2-5: Permian overburden), 100 m (N2-4: Permian overburden) and 140 m (N2-3: Whybrow Seam), 173 m (N2-2: Whybrow to Wambo Seam interburden), and 204 m (N2-1: Wambo Seam). These WVPs commenced recording in July 2015. N2-4 groundwater levels were at or below the sensor elevation between early 2017 till March 2019 and may no longer be reliable. Two sudden 20 m spikes in head occurred at N2-4 between March and May 2019. These spikes may be related to a small period of above average rainfall but are not observed at other N2 sensors. The magnitude of the increase may indicate ongoing unreliability of the observations at N2-4. SLR recommends that communication between WCPL and a specialist vibrating wire technician be undertaken (such as HMA Geotechnical). Additional analysis may help determine the quality of data produced at sensors such as N2-4.

Sensors N2-2 (Whybrow-Wambo Interburden) and N2-3 (Whybrow Seam) have both shown a gradual decline in groundwater levels since recording began. These declines do not show a specific response to individual SBU longwall extraction and may be somewhat protected by the fault between NWU and SBU. Between 2015 and 2019 water levels have declined by approximately 10 m at N2-2 (2.2 m additional in 2019) and approximately 6 m at N2-3 (1 m additional in 2019). An upward flow gradient from the Whybrow-Wambo seam interburden to the Whybrow seam is evident in the N2-2 and N2-3 data.

The three uppermost sensors located in the Permian overburden at N2 are either no longer recording data (N2-6) or recording groundwater levels at or below their respective sensors during 2019 (N2-5 and N2-4). The groundwater level declines at these sensors appear to be related to SBU mining activity, with impacts occurring following the start of SBU LW11 extraction in the Whybrow Seam. The declining groundwater levels in the Wambo-Whybrow interburden (N2-2) and Whybrow Seam sensors (N2-3) show evidence of a mining effect that likely began during the extraction of NWU longwalls, that has continued due to and during SBU longwall extraction.

5.1.3.2 N3

5.1.3.2.1 Groundwater Levels

VWP N3 (**Figure 13**), located above the northern edge of SBU LW11, has a ground elevation of 104.9 mAHD. It is a multi-piezometer grouted bore with six sensors installed at depths of 30 m (N3-6: Permian overburden), 55 m (N3-5: Permian overburden), 75 m (N3-4: Permian overburden), 109 m (N3-3: Whybrow Seam), 142 m (N3-2: Whybrow to Wambo Seam interburden) and 190 m (N3-1: Wambo Seam). Recording commenced in July 2015. All sensors besides N3-5, within Permian Overburden at 55 m depth, have not recorded accurate groundwater levels since May 2016, with the behaviour of these sensors before failure described in previous Annual Reviews (HydroSimulations 2016, 2017).

5.1.3.3 GW21

5.1.3.3.1 Groundwater Levels

Bore GW21 (**Figure 14**) is located within 10 m of VWP N2 (**Figure 1**), between NWU LW1 and SBU LW13. A mining effect is likely at GW21 resulting from NWU longwall extraction prior to the first observation made. Due to dry conditions at this bore a mining effect caused by SBU is not observed. A lack of an expected mining effect from SBU longwall extraction has previously been suggested due to the mitigating effect of a fault between GW21 and SBU (HydroSimulations, 2017a). However, analysis of the Permian Overburden sensors in N2 shows a clear SBU mining effect and desaturation of the same strata in which GW21 is located. During 2019, no further mining effect can be observed at GW21 due to the groundwater level being below the base of the bore. It should be noted that the examination of data from a new bore drilled between LW14 and the fault could be of interest to determine the behaviour of groundwater in the area.

5.1.3.3.2 Groundwater Quality

Only two groundwater quality observations have been made at GW21, in October 2010 and August 2011, due to the persistent dry observations at the bore . Both samples have near neutral pH (7.2) and high EC (~16,000 µS/cm). Due to a lack of data, no trigger levels have been developed and no clear groundwater trends in relation to groundwater level and climate can be developed.

5.1.4 North Wambo Creek Alluvium

From 2017 to 2019 a total of 13 investigative bores were drilled into the North Wambo Creek Alluvium to gain a better understanding of the nature of the alluvial groundwater system in this area (SLR, 2017; AGE, 2019a; AGE, 2019b). Four to five bores from each drilling investigation were converted into monitoring bores to provide monitoring and assessment whether alluvial water levels have been affected by mining activity occurring in the South Bates Extension and Montrose Open Cut.

Table 7 lists each of the new alluvial bores and their associated depths and screen elevation, as well as the thickness of alluvium encountered. The monitoring bores drilled by AGE in 2018 to2019, were recorded as being dry at the time of drilling and for the remaining observations taken in 2019, therefore no hydrographs have been included in this annual review. The paired monitoring bores GW23 and GW24, and GW25 and GW26, were installed by SLR in 2017. Hydrographs showing available water level and EC data are presented in **Figure 15** and **Figure 16**, and an assessment of this data is presented below. Refer to **Figure 1** for the geographical location of each of these bores.

Table 7 New Alluvial Monitoring Sites at North Wambo Creek

Bore ID (Installation Report)	Wambo ID	Easting (m)	Northing (m)	Screen Elevation (mbgl)	Alluvium thickness (m)	Total Depth (mbgl)	Date Drilled
Site 7a2	**GW31**	305877	6395582	7.0 – 10.0	10.0	12.5	20/06/2019
Site 13	**GW32**	306394	6395829	4.0 – 7.0	7.0	8.0	24/06/2019
Site 16	**GW33**	306592	6395946	4.0 – 7.0	7.0	10.0	24/06/2019
Site 20	**GW35**	306988	6396012	6.0 – 9.0	9.0	11.0	21/06/2019
Site 23	**GW34**	307357	6395779	2.5 – 4.0	5.0	10.0	26/06/2019
In-Stream 1	**GW27**	305736	6395614	1.1 – 2.6	2.0	2.6	18/12/2018

Bore ID (Installation Report)	Wambo ID	Easting (m)	Northing (m)	Screen Elevation (mbgl)	Alluvium thickness (m)	Total Depth (mbgl)	Date Drilled
In-Stream 3	**GW28**	306008	6395769	2.85 – 5.85	6.0	6.7	17/12/2018
Site 7b	**GW29**	305867	6395617	4.14 – 7.14	7.0	7.2	17/12/2018
Site 11	**GW30**	306076	6395720	5.5 – 8.5	7.0	8.5	18/12/2018
GW23 (shallow)	**GW23**	305789	6395670	5.2 – 8.2	6.0	8.4	14/11/2017
GW24 (deep)	**GW24**	305791	6395668	11.7 – 13.2	6.0	15.0	14/11/2017
GW25 (shallow)	**GW25**	305297	6395291	2.6 – 5.6	5.0	6.0	16/11/2017
GW26 (deep)	**GW26**	305299	6395288	11.7 – 13.2	6.0	15.0	16/11/2017

5.1.4.1 GW23, GW24, GW25 and GW26

5.1.4.1.1 Groundwater Levels

Paired bores GW23 and GW24 are located on the northern bank of North Wambo Creek overlying the proposed South Bates Extension LW25. The site is 1.2 km south of the Montrose Open Cut and 2.1 km from LW17, where extraction commenced in December 2018. The shallow bore GW23 has a screen installed in the unconsolidated alluvium at this location. The deeper bore, GW24, is screened in the consolidated bedrock (SLR, 2017).

The hydrograph in **Figure 15** shows the shallow monitoring bore, GW23, is dry from June 2018 onwards. Groundwater levels in bore GW24 recorded between November 2017 and December 2019 show a steady decline, with water levels dropping 3 m over this time. The decline at both bores correlates well with the gradual decline in rainfall residual mass, indicating it is likely that climate is responsible for this behaviour. This is further supported by the results of streamflow monitoring assessments conducted by both AECOM (2019) and EIS (2019) for watercourses within the WCPL mining lease. The absence of flow events at monitoring station FM1 (**Figure 1**) in North Wambo Creek during 2018 and 2019 further supports this analysis.

The presence of water at GW24 compared to the dry conditions at GW23 indicates that the consolidated strata has greater water storage capacity and is less likely to be adversely affected by drought conditions compared to the unconsolidated alluvium.

Paired monitoring bores GW25 and GW26 are located approximately 600 m upstream of GW23 and GW24. The hydrograph in **Figure 16** shows similar trends in groundwater level decline at GW25 and GW26 as those discussed above. The unconsolidated strata (GW25) has been dry since the February 2018. The consolidated bedrock bore (GW26) declined steadily during 2018 and 2019, consistent with the extended period of below average rainfall.

5.1.4.1.2 Groundwater Quality

EC data has been collected for deep bores GW24 and GW26. No EC data has been collected for GW25 and only two observations have been collected at GW23 due to ongoing dry conditions. The two EC observations at GW23 show reasonably saline groundwater (4,500 µS/cm to 5,000 µS/cm). EC observations at GW24 and GW26show relatively elevated EC before declining to a consistent level. Bore GW24 recorded an EC of 3,400 µS/cm before declining to approximately 1,700 µS/cm to 1,800 µS/cm from April 2018 onward. Bore GW26 had an initial EC of approximately 1,400 µS/cm before declining to a consistent level between 1,050 and 1,310 µS/cm until the end of 2019.

It is possible that saline conditions exist within the unconsolidated material associated with North Wambo Creek, while the underlying bedrock contains fresh groundwater. When the unconsolidated material is saturated (bores GW23 and GW25), saline groundwater is transmitted into the underlying bedrock. When the unconsolidated material is dry, no transmission of saline water occurs to the bedrock giving rise to the trends observed in **Figure 15** and **Figure 16**. It is also possible that initial sampling at GW24 and GW26, with higher than normal EC readings, may not be representative of natural groundwater conditions. The presence of remnant drilling fluids/ muds associated with the construction of the bores may have caused the initial high EC readings.

All new monitoring bores drilled in the North Wambo Creek alluvium during 2019 were reported as dry upon installation (AGE, 2019).

5.2 Trigger Level Exceedances

5.2.1 Groundwater Level Trigger Exceedances

The 10th and 90th percentile statistics for groundwater levels at nominated water level trigger sites for the 2019 monitoring period are shown in **Table 8** below. Trigger levels for groundwater levels occur when two consecutive bi-monthly observation exceeds the maximum or falls below the minimum specified groundwater level (Peabody, 2018). Triggers for EC occur when three consecutive bi-monthly observations (a 6-month period) exceed the specified trigger level. Triggers for pH occur when two consecutive bi-monthly observations (a 4-month period) exceed or fall below the specified trigger level (Peabody, 2018).

Table 8 2019 10th and 90th Percentile Groundwater Levels

Bore	Groundwater Level (mAHD)		Depth to Groundwater (m bToC)	
	2019 Minimum (90th percentile depth)	2019 Maximum (10th percentile depth)	2019 Minimum (10th percentile)	2019 Maximum (90th percentile)
P106	Dry		Dry	
P109	56.0	56.2	6.2	6.4
P114	Dry		Dry	
P116	52.0	52.2	6.8	7.1
P202	51.0	51.3	9	9.3
P206	38.7	39.3	21	21.5
P301	70.8	71.8	16.4	17.3
P315	Dry		Dry	
GW02	73.3	73.9	8.6	9.2

Bore	Groundwater Level (mAHD)		Depth to Groundwater (m bToC)	
	2019 Minimum (90^{th} percentile depth)	2019 Maximum (10^{th} percentile depth)	2019 Minimum (10^{th} percentile)	2019 Maximum (90^{th} percentile)
GW08	52.5	52.9	7.1	7.5
GW09	Dry		Dry	
GW11	70.4	71.0	6.7	7.2
GW12	74.6	74.6	12.7	12.7
GW13	55.8	56.3	6.2	6.8
GW15	50.7	51.0	11.4	11.6
P16	48.2	48.5	9.0	9.3
P20	48.6	48.9	8.5	8.8

mAHD = metres above height datum

m bToC = metres below top of casing

Over 2019, bores P106, P114, P202, P206, P315, GW02, GW11, GW12, GW13, GW15, P16 and P20 exceeded the trigger level for the 90^{th} percentile (maximum) depth to water. Bore GW11 exceeded both the EC trigger level and the pH trigger level during 2019. The number of trigger level exceedances for groundwater level and groundwater quality over 2019 are shown in **Table 9** below.

Table 9 2019 Trigger Level Exceedances

Bore	Number of Trigger Level Exceedances in 2019				
	Depth to Water Minimum (10^{th} percentile) *	Depth to Water Maximum (90^{th} percentile) **	EC	pH minimum	pH maximum
P106	-	6 (Dry)	-	-	-
P109	-		N/A		
P114	-	6 (Dry)	-	-	-
P116	-		-	-	-
P202	-	2	-	-	-
P206***	-	6	-	-	-
P301	N/A				
P315	-	6 (Dry)	-	-	-
GW02	-	6 (1 Dry)	-	-	-
GW08	Bore Dry				
GW09	Bore Dry				
GW11	-	6	5	1	4
GW12	-	6 (Dry)	N/A		
GW13	-	6	-	-	-
GW15	-	6	-	-	-
GW16	N/A				

Bore	Number of Trigger Level Exceedances in 2019				
	Depth to Water Minimum (10th percentile) *	Depth to Water Maximum (90th percentile) **	EC	pH minimum	pH maximum
GW17	N/A				
P16	-	6	-	-	-
P20	-	6	-	-	-

N/A = Not applicable

*Minimum depth-to-water is equivalent to maximum groundwater level (mAHD)

**Maximum depth-to-water is equivalent to minimum groundwater level (mAHD)

*** P206 also known as P203 – triggers defined in GWMP (Peabody, 2018)

5.2.1.1 P106

All of the 2019 observations for bore P106 (**Figure 6**) are dry and therefore observed groundwater level are below the maximum depth-to-water trigger level. Review of the condition of P106 indicates the bore is obstructed with tree roots (SLR, 2019). It is recommended that roots are cleared from the bore if possible, to enable ongoing monitoring. If the blockage is unable to be cleared, it is recommended that bore P109 be assessed against water quality triggers as a replacement for P106.

5.2.1.2 P114

The low groundwater levels at P114 (**Figure 2**) are a clear effect from the mining of LW10a in conjunction with the ongoing period of below average rainfall. Every observation in the 2019 monitoring period falls below the maximum depth-to-water trigger level with the bore recorded as dry.

5.2.1.3 P315

Groundwater levels at bore P315 (**Figure 17**) have exceeded the 90th percentile trigger for water level since February 2018, and have since been recorded as dry. This trigger level exceedance was previously investigated by HydroSimulations (2018b) and again reported by HydroSimulations (2019a). The investigation concluded that the dry conditions at the bore can be attributed to below average rainfall. This is expected to still be the case.

5.2.1.4 GW02

Groundwater levels at GW02 (**Figure 18**) were below the 90th percentile depth-to-water trigger for observations in 2019. Depth-to-water trigger exceedances were also investigated in HydroSimulations (2019b). From this report and the current assessment of water levels it appears that rainfall deficit continues to be controlling the declining groundwater levels at GW02. Water levels at the bore were recorded dry for the first time in December 2019. Site investigations at GW02 and GW011 have revealed that landholder pumping has likely been in operation at GW02, this may exacerbate the declining groundwater level during dry conditions. The inclusion of GW02 in the GWMP is recommended for revision in future updates to the GWMP. Unknown duration and quantity of landholder extraction interferes with accurate assessment of potential WCPL impacts.

5.2.1.5 GW11

Groundwater levels in bore GW11 (**Figure 19**) have consistently been below the maximum depth-to-water trigger level over 2019. Following exceedances in 2016, previous AEMR reports (HydroSimulations, 2017b) proposed that the alluvial water loss may have been caused by drawdown associated with mining at NWU in downstream alluvial sources at Wambo Creek. The decline in water levels during the 2019 monitoring period correlates well with the decline in rainfall residual mass also observed for this period. Landholder pumping has likely been in operation at GW11, possibly exacerbating the declining groundwater level during dry conditions. The inclusion of GW11 in the GWMP is recommended for revision in future updates to the GWMP. Unknown duration and quantity of landholder extraction interferes with accurate assessment of potential WCPL impacts.

It is recommended that future drilling programs at WCPL consider the installation of a dedicated groundwater monitoring site near to GW02 and GW11.

5.2.1.6 GW13

Over 2019, groundwater levels in bore GW13 exceeded the maximum depth-to-water trigger level, with water levels in December 2019 being 2 m below the 90th percentile trigger level (**Figure 20**). The exceedance has been occurring at GW13 since June 2016. The cause of this exceedance was assessed in HydroSimulations (2019b) where it was concluded that the combination of low rainfall and potential drawdown associated with extraction at the Warkworth Open Cut (2.8 km from GW13) is likely to be driving these exceedances. It was also noted that the number and magnitude of exceedances is likely to be a result of creating trigger levels using a baseline period that was insufficient in length and not wholly characteristic of the groundwater response to climate at GW13.

5.2.1.7 GW15

Over 2019, groundwater levels at bore GW15 have been below the 90th percentile trigger level (**Figure 21**). As concluded in HydroSimulations (2019b), the low groundwater levels correspond to trends observed in the rainfall residual mass and the interpolated stage height for Wollombi Brook, both indicating declining levels since March 2016. While the approaching Warkworth Open Cut may be responsible for some decline in groundwater levels at GW15, it is difficult to determine with the current below average rainfall conditions. It is most likely that climatic conditions are responsible for the groundwater level trigger exceedances at GW15.

5.2.1.8 P16

Bore P16 is located approximately 4.5km from LW11, adjacent to Wollombi Brook and downstream of underground mining at WCPL (**Figure 1**). P16 is less than 200 m from excavation that occurred at the South Wambo Boxcut (also known as the Glen Munro Pit), which was completed in July 2017. Bore P16 was constructed as part of an assessment to identify whether the alluvial aquifer located to the east of Wollombi Brook extended to the west of the channel, overlying the United Underground longwalls (GeoTerra, 2003). The study found that colluvial and silty alluvial material ranging in thickness from 1.9 m to 11.5 m existed at sites to the west of Wollombi Brook, but that this material is not part of the Wollombi Brook Alluvial Aquifer. The colluvial and silty alluvial material in bore P16 was 11 m thick.

Bore P16 groundwater level and EC are shown in **Figure 22** with the rainfall residual mass curve and interpreted Wollombi Brook stage height to aid interpretation.

Current rainfall and stream level trends indicate decreased recharge, and the groundwater level at P16 is currently the lowest on record by approximately 1.4 m. While some of the decline in groundwater level at P16 can be attributed to recent weather conditions, excavation at the South Wambo Boxcut appears to have caused additional drawdown in the range of 1 m.

The amount of drawdown in P16 is consistent with the groundwater assessment for the South Wambo Boxcut by HydroSimulations (2016) which predicted a small amount of additional drawdown in Permian strata at P16 due to the excavation of the boxcut, on top of broader regional depressurisation from mining activity such as NWU, United Underground and the United Wambo Joint Venture.

5.2.1.9 P20

Groundwater levels at bore P20 have been recorded below the 90th percentile trigger level since August 2017 (**Figure 23**). The baseline monitoring period included observations during the millennium drought, capturing the groundwater level response for a broad range of climatic conditions. Bore P20 has received decreased recharge from both rainfall and Wollombi Brook over the period of trigger level exceedance. Although P20 is further from the excavation activity at the South Wambo Boxcut, it is also currently reporting its lowest groundwater levels on record; 0.5 m below the previous maximum depth to groundwater. While the decline in groundwater level is strongly linked to the rainfall deficit at this site, a minor effect caused by excavation activity at South Wambo Boxcut is likely observed at P20.

HydroSimulations (2016b) predicted drawdown in Permian strata at bore P20 due to excavation of the South Wambo Boxcut, while no drawdown is predicted in unconsolidated material as is it simulated as dry. The predicted drawdown was of a smaller magnitude at P20 than at P16 due to the increased distance from the boxcut. This matches well with the observed data as the apparent impact at P20 is about half of the impact at P16.

5.2.1.10 P202

In 2019, bore P202 recorded groundwater levels below the 90th percentile trigger level for the first time since 2006, where the Millennium Drought was likely influencing groundwater level (**Figure 4**). Groundwater levels have a good correlation with the Wollombi Brook interpolated stage height, and a moderate correlation with the long-term rainfall trend. The declining conditions are to be expected until above average rainfall and streamflow in Wollombi Brook is recorded.

5.2.1.11 P206

Monitoring bore P206 (**Figure 5**) is located approximately 250 m southeast of the nearest longwall (NWU LW10a) and adjacent to Wambo Creek (**Figure 1**). Groundwater levels have declined by approximately 10 m since late 2015 with the 90th percentile trigger level exceeded in every bi-monthly observation since February 2019. The decline in groundwater levels appears to be sustained even in periods of above average rainfall, indicating the potential influence of depressurisation associated with mining. However, the extended period of below average rainfall observed from late 2016 means it is difficult to determine the components of this groundwater level decline that are related to either mining or climatic effects. As P206 is deeper than other bores assessed with a trigger level (approximately 51 m), and intersects coal measures, additional assessment is recommended regarding the inclusion of P206 in future versions of the GWMP. This is due to the screened depth of the bore and magnitude of predicted impacts due to mining.

5.2.1.12 GW12

Over 2019, bore GW12 was recorded as dry. The monitoring data of GW12 indicates that since July 2018, the bore has been mostly dry and was also dry from April to October 2017.These occurrences have been attributed to ongoing mining effects from North Wambo Underground longwall extraction and due to below average rainfall trends since 2016 (HydroSimulations, 2019b). It is believed that longwall LW8a extraction has reduced the ability for the strata at GW12 to retain storage of groundwater outside periods of above average rainfall.

GW12 is currently considered an alluvium/regolith monitoring bore. As part of the annual review investigation into trigger exceedances, the geological log reported in Parsons-Brinkerhoff (2009) was sourced. The log indicates the bore was drilled to 12.1 m depth and intersected alluvium (sandy clay and clayey sand) to 3 m depth, then intersected weathered tuffaceous claystone, sandstone and coal from 3 m to 12.1 m. The bore is apparently screened from 6 m – 12 m depth, within fine to medium grained weathered sandstone. GW12 should instead be considered as shallow Permian monitoring bore.

5.2.2 EC Trigger Exceedances

EC trigger levels were only exceeded at bore GW11 during the 2019 monitoring period. This bore has exhibited high EC since 2017. All but one of the 2019 readings were above the 592 µS/cm trigger level. The maximum EC value recorded at GW11 during the 2019 monitoring period was 656 µS/cm, 64 µS/cm above the trigger level in October 2019. The increased EC at GW11 is expected to be the result of a greater proportion of brackish water sourced from Permian strata contributing to the groundwater system associated with the reduction in rainfall.

5.2.3 pH Trigger Exceedances

Five pH trigger exceedances occurred during 2019, one below the minimum (Bore GW11), and four above the maximum (Bore GW11). The pH at GW11 fell below the minimum pH trigger of 6.8 in February 2019 by 0.1 units and recorded exceedances of the maximum pH trigger level of 7.5 from June onwards, with the sampled pH being 0.1 to 0.5 units above the defined trigger level.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, ARMCANZ, 2000) recommend that groundwater used for irrigation and stock watering falls within a pH range of 6 – 8.5 in order to prevent fouling or corrosion of infrastructure. The Australian Drinking Water Guidelines (NHMRC, MRMMC, 2011) outline that groundwater with a pH between 6.5 and 8.5 is fit for human consumption. The pH values at GW11 that triggered the exceedance still remain within both of these recommended ranges. With the change in pH being so marginal, it is not considered to have caused or be likely to cause a long-term, negative impact to the groundwater quality in the vicinity of these bores. pH observations that are consistently outside their trigger level ranges, as defined in the GWMP, that are not able to be correlated with WCPL or other man-made impacts, may have their trigger levels reassessed.

6 Verification of Model Predictions

In February 2020, SLR undertook groundwater modelling as part of the Groundwater Assessment in Support of Extraction Plan. The hydrographs of the modelled groundwater levels versus observed groundwater levels at key sites are presented in **Figure 24** to **Figure 35** located in **Appendix B**.

The model predictions used in this report are from an updated version of the HydroSimulations (2017a) and HydroSimulations (2019b) which has been used as part of the South Bates Extension LW21-24 Extraction Management Plan. Key updates to this groundwater model since the HydroSimulations (2017a) include:

- Refined alluvial thickness and extent at North Wambo Creek;
- Revision of topography within model to incorporate site LiDAR in the North Wambo Creek area;
- Quadtree refinement within the North Wambo Creek alluvial zone to improve representation of alluvial and channel topography; and
- A revision to the stress period timing within the model to include more temporal detail and better capture seasonal trends:
  - Transient historical period from January 2003 to December 2019 with monthly stress periods;
  - Transient predictive period from January 2020 to December 2029 with monthly stress periods; and
  - Transient predictive period from December 2029 to December 2040, with quarterly stress periods.

The following sections contain an assessment of the SLR (2020) modelled groundwater levels where mining impacts might be observed.

6.1 Montrose Open Cut

The elevation of modelled heads at GW16 (**Figure 24**) and GW17 (**Figure 25**) are reasonably close to the overall elevation of water levels observed at each monitoring location. However, the variability that appears in the observed data is not replicated by the model. The location of these bores in respect to the North Wambo Creek channel, elevated on a terrace to the north of the creek, means that stage height in North Wambo Creek, is not likely to be a key influence on groundwater levels at these locations. Revision of alluvial aquifer properties and infiltration rates is recommended in future model updates to improve calibration quality at GW16 and GW17.

The modelled water levels for GW17 are quite conservative, with the predicted mine impact being greater than observed. As GW17 is closer to the open cut, it is predicted to be impacted at an earlier time and to a greater extent than GW16. This observed trend is well replicated in the model outputs, but the simulated decline in groundwater levels at both GW16 and GW17 is greater than those observed at the end of 2019. This overestimation of groundwater level decline is likely to be a function of simplified model layer discretisation at these locations not fully capturing local scale geology such as a weathered Permian layer.

The performance of the modelled heads at N5 (**Figure 26**) is poor, with modelled heads much higher than those within the observed data. The timing of the observed drawdown due to the open cut is accurate, but the vertical hydraulic head gradients have not been reproduced. As reported in the 2018 AEMR (HydroSimulations, 2019a), the model requires lower vertical hydraulic conductivities in this area, which if implemented would have the effect of providing greater protection for the alluvium from underground mining effects.

6.2 North Wambo Underground

The performance of modelled heads at six standpipes in **Figure 28** to **Figure 33** (P114, P116, GW08, GW09, P106 and P109) have been assessed against observed data where North Wambo Underground (NWU) mining activity may impact groundwater levels.

Previous reporting for P114 (HydroSimulations, 2016) had underestimated the drawdown associated with NWU LW10a extraction. Following an interrogation of the groundwater model, as further explained in HydroSimulations (2017a), it was found that the underestimation was only apparent due to the model's inability to represent the layering at a fine vertical scale, and that the base of P114 actually extends into layer 2 of the model. The modelled heads presented for P114 (**Figure 27**) are a weighted average from layer 1 and layer 2 heads according to the degree of partial penetration. The resulting calibration is a very good representation of the observed data. However, an assessment of 2019 predictions was unable to be carried out due to the bore being dry. Subsidence in the vicinity of P114 following the extraction of LW10a, ranges from 1.5 m to 1.8 m (MSEC, 2017).

Modelled heads for P116 (**Figure 28**) are generally well correlated with observed heads, showing a gradual decline in groundwater levels similar to the gradient of observed data. However, climatic variation is not apparent in the modelled heads as it is in the observed heads. The lack of variation in the modelled data may be occurring for the flowing reasons:

- As in previous assessments, the SLR (2020) groundwater model simulates a constant long-term average stage height in Wambo Creek. This may suppress variation within the shallow groundwater system near Wambo Creek; and
- An overestimation of simulated specific yield may also be responsible for the overestimation of groundwater head elevation in the model, due to the location of the bore within the official alluvial extent but outside the limits determined by geophysics. Accordingly, it should be attributed to regolith instead of alluvium in future updates to the groundwater model.

As P116 does not lie directly over NWU workings, predicted drawdown as a result of mining activity is limited. Only a minor drawdown response in both simulated and observed heads following the extraction of NWU LW10a is shown.

HydroSimulations' modelled heads at GW08 (**Figure 29**) show a good match with the overall trends seen in the observed data. The timing of mining related drawdown in both modelled and observed heads, following the extraction of NWU LW5 is well correlated despite simulated heads being lower than observed. At GW08, observed water levels fell below simulated heads in 2013. This relationship continues during the 2019 monitoring period with modelled heads showing a milder response to drawdown than that seen in the observed heads. Despite this, the difference in elevation between modelled and observed heads is quite small, being within 1 m of one another. GW08 was dry from the beginning of 2019, limiting the ability to compare modelled versus observed groundwater levels for the reporting period.

Calibration performance at GW09 (**Figure 30**) in SLR (2020) is poorer than previously reported in HydroSimulations (2017a). Simulated groundwater levels at GW09 show a response to climatic inputs of a similar magnitude to the observed data but do not show any drawdown associated with NWU LW5 mining. GW09 observations indicate drawdown in the order of 3 m at GW09 prior to going dry in December 2014 in response to NWU mining. It is possible that the interaction between NWU and the overlying historical Homestead Underground Mine has not been sufficiently captured within the SLR (2020) model. The revision fracture zone parameters and extents associated with longwall extraction is recommended for consideration within future model updates.

The simulated groundwater levels at P106 (**Figure 31**) follow the observed declining trend. However, the amount of water level change is not reproduced, this may be due to the absence of streamflow dynamics in the model, or specific yield values within the alluvium/regolith being too high. Since 2017, P106 was recorded as dry, making the comparison between simulated and observed data difficult. As is identified in **Section 5.1.1.5**, an obstruction has been identified in P106, limiting the collection of groundwater data.

There is a good correlation between simulated groundwater levels and observed groundwater levels at P109 (**Figure 32**) from 2003 to 2007. However, the model has a declining trend in contrast to generally higher and more dynamic water level observations. The model is probably missing a component of enhanced recharge from intermittent streamflow along Wambo Creek. As a result, the model overestimates drawdown impacts in this area. During the 2019 monitoring period, simulated groundwater level decline matches the gradient of the observed declining trend in groundwater levels relatively well.

6.3 South Bates Underground

The performance of modelled heads at the GW21 standpipe bore (**Figure 33**), N2 (**Figure 34**) VWP and N3 (**Figure 35**) VWP have been assessed against observed data where South Bates Underground (SBU) mining activity may impact groundwater levels.

As reported in the 2018 AEMR (HydroSimulations, 2018a), GW21 modelled heads show little correlation with observed groundwater levels (**Figure 33**). Comparisons between modelled and observed heads are complicated by observed data being collected following the extraction of LW1, which is likely to have caused water levels at this location to decline. Water levels at GW21 have been recorded as dry since 2017. The model results indicate a strong, ongoing mining effect caused by both NWU and SBU longwall extraction. Longwall extraction completed at SBU and currently occurring at South Bates Extension (SBE) is expected to be causing observed water levels to fall below the base of bore GW21. The simulated magnitude of drawdown at GW21 is expected to be greater than any observations due to a simplified model layer discretisation at this location (model layer 2 is 140 m thick), and the comparatively shallow depth of GW21 (approximately 37 m).

There was difficulty with the modelled heads accurately representing groundwater levels in the Permian overburden sensors in VWP N2 (**Figure 34**) and VWP N3 (**Figure 35**). The three sensors in each VWP are located within one model layer. Water levels for the remaining active sensor for N3 (N3-5, Permian Overburden), are overestimated by the model. However, the model shows good correlation with the gradual declining trend apparent in the observed heads from 2017 to 2019. The 70 m sensor at N2 (N2-5) shows an excellent match with observed data until the end of December 2019. The lower sensors in N2 overestimate groundwater levels but are accurate in indicating an ongoing mining effect from NWU that continues through the beginning of SBU mining. The modelled head in the Wambo Seam (N2-1) does not match the increase in groundwater level observed at the end of December 2018 that is maintained through 2019. This may be due to inherent difficulties in representing the fault that divides NWU and SBU. It may also be related to an inaccurate representation of the end of dewatering at NWU, which would limit the recovery of modelled heads to match observed data.

6.4 Assessment

The groundwater levels, as predicted by SLR (2020), generally show a good match with the magnitude and timing of impacts associated with mining at WCPL. Areas where the model is not performing well can be attributed to:

- Difficulties in accurately simulating complex geological features, such as the fault between SBU and NWU;
- Multiple sensors being simulated in a single model layer;

- Model parameters in surficial layers not configured to match the variations in observed data;
- Long-term average stage heights in some watercourses within the model domain; or
- Issues related to the simplification of local geology within the groundwater model layering.

Overall, the groundwater model performs well and remains fit for purpose to predict the timing and magnitude of impacts to groundwater caused by mining at WCPL. There are updates scheduled for 2020 to keep the model predictions current and to address the outstanding issues from the above points.

7 Inflow to WCPL workings

Section 4.1 in the GWMP (Peabody, 2018) requires quantification of the volume and quality of groundwater inflows to both open cut and underground mine workings at WCPL. This section assesses compliance of WCPL against the requirements and measurement criteria in the GWMP (Peabody, 2018).

The assessment of licence compliance regarding the interception of groundwater is undertaken in **Section 6.5** of the main WCPL Annual Review document.

7.1 Inflows to Open-Cut pits

Metering of daily dewatered volumes from each of the Wambo open cut pits is required, with these dewatered volumes incorporated into the site water balance on an annual basis to determine the inflows from groundwater sources, including alluvial aquifers, and to verify whether WCPL holds sufficient groundwater licence entitlements.

The water quality of inflows to the open cut are measured indirectly through monthly water quality monitoring of mine water storages. This is the most practical method to routinely sample for water quality. An unexpected increase in water make or change in water quality of mine water storages would be investigated by Wambo. If warranted, direct measurement of water quality at the source of inflow may be conducted.

7.1.1 Open Cut Inflow Assessment

No active pumping of groundwater inflow into WCPL open cut operations was required in 2019. Evaporation, the placement and development of spoil dumps, a lower than planned rate of mine progression, and the ongoing period of below average rainfall experienced from 2017 to 2019 are all likely to be factors contributing the apparent lack of groundwater inflow.

For water balance and licencing purposes, WCPL has estimated groundwater inflow to open cut operations using the Hydro Engineering & Consulting (2017) overall site water balance predictions, which accompanied the South Bates Extension Modification impact assessment. Groundwater inflow to WCPL open cut operations is estimated to be 184 ML.

The South Bates Extension Extraction Plan for Longwalls 21-24 (SLR, 2020) predicts flow from the shallow groundwater system near the NWCD into the open cut during 2019 to occur at around 0.2 ML/day. As observation data and exploratory drilling (AGE, 2019) indicate the NWC alluvium is dry during 2019, this predicted inflow can be assumed to come from the weathered sandstone underlying the alluvium. The water source for this groundwater is the Sydney Basin - North Coast Groundwater Source of the North Coast Fractured and Porous Rock Groundwater Sources - Water Sharing Plan, of which WCPL hold 1,647 units.

7.2 Inflows to Underground Workings

Active SBE and SBU workings in the Whybrow and Wambo Seams are currently being dewatered, with dewatering volumes and underground water levels required to be recorded daily during pumping according to **Section 4.1.5** of the GWMP (Peabody, 2018). Annual assessments for mine inflows are assessed against the peak simulated mine inflow from HydroSimulations (2017) of 316 mL/yr (Peabody, 2018). An exceedance of this predicted inflow by greater than 50% (i.e. an annual inflow of > 474 ML/yr) will require WCPL to:

- Investigate if there is a change in the predicted take of water from the Lower Wollombi Brook Water Source from mining related activities;
- Where there is an increased take from the Lower Wollombi Brook Water Source, investigate any influence on low flow cease-to-pump criteria specified in the HUA WSP;
- Define the Mine inflow volume value triggering this response procedure; and Groundwater Monitoring Program WA-ENV-MNP-509.1 Version: 12 Uncontrolled when printed 45
- Submit a report summarising the assessment to DoI Water. WCPL must notify DoI Water as soon as practicable on becoming aware of any take of water in excess of its licensed entitlement.

Predictions of annual inflows based on the actual mine progression for 2019 was captured in modelling for the South Bates Extension Extraction Plan (SLR, 2020). Recent modelling predicted up to 90 ML/year inflows to the South Bates Extension and South Bates Underground mine areas over 2019. This is significantly lower than the previously predicted inflows of 316 ML/year, largely due to a reduction in the actual mined extent and below average climate conditions.

These predictions are consistent with observations by WCPL, who identified that the underground workings had very low seepage in the active workings during 2019.

As with the open cut areas, the water quality of inflows to the underground workings are generally measured indirectly through monthly water quality monitoring of mine water storages. During 2019, WCPL staff attempted to take water quality samples directly from the underground workings but were unable to do so due to a lack of seepage in accessible areas.

7.2.1 Underground Inflow Assessment

The cumulative metered pump-out rates from the underground workings at South Bates during 2019 are 95ML. This value is a conservative estimate of groundwater inflow to the underground workings as it likely includes a recirculated component associated with underground dust suppression.

Modelled inflow values have been provided for 2019 based on the South Bates Extension LW21-24 Extraction Plan groundwater modelling (SLR, 2020). The recently submitted groundwater model has an updated representation of rainfall recharge for 2017-2019 that considers recently observed below average rainfall conditions. It is therefore likely to be more informative in regard to the model's suitability to provide inflow estimates.

As was described in the 2018 Annual Review (HydroSimulations, 2019), the underground seepage values are calculated for the combined sources of SBU and SBE. This is done by calculating the volume of water intercepted by the MODFLOW Drain package, which is used within the model to represent areas of active mining/ dewatering in our groundwater models. In 2019, drain cells active in all historical SBU workings in the Whybrow and Wambo Seams, as well as all mined areas in the Whybrow Seam workings at SBE. The current conceptualisation of South Bates mining is that the mains at the north-eastern end of South Bates panels are required to be dry while any South Bates mining is progressing. This effectively limits the ability for groundwater to recover across the whole South Bates area, and justifies keeping the drain cells active across the whole mine area.

Total inflow values for 2019 (SLR, 2020) are simulated to occur at a rate of 90ML/yr, with inflow to Whybrow seam workings predicted to occur at a rate of 50ML/yr. These values are more indicative of actual inflows to the South Bates underground due to current below average rainfall conditions.

Both simulated (90 ML) and metered (95 ML) underground inflow estimates are below the 474 ML/yr required to trigger further investigation.

The water source for this groundwater is the Sydney Basin - North Coast Groundwater Source of the North Coast Fractured and Porous Rock Groundwater Sources - Water Sharing Plan, of which WCPL hold 1,647 units.

8 Independent Environmental Audit

In September 2017 an Independent Environmental Audit against Development Consents DA 305-7-2003 and DA 177-8-2004 was conducted for the Department of Planning & Environment (DP&E). Two recommendations relating to groundwater inflows and seepage were made as follows:

- Schedule 4, Condition 25: Improvements could be made in terms of the overall site water management if specific groundwater inflows to the open cut via alluvium and Permian could be pumped and/or metered.
- Schedule 4, Condition 34: Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open cut workings.

Both recommendations have been considered in 2019.

8.1 Schedule 4, Condition 25

Due to the location of a spoil dump at the high wall near North Wambo Creek, the physical observation of seepage from the alluvium and Permian strata to the open cut is not feasible. Recent (SLR, 2020) and scheduled model updates will be tailored to replicating groundwater conditions within and underlying the North Wambo Creek alluvium. This will provide reliable estimates of localised groundwater interception to the open cut.

8.2 Schedule 4, Condition 34

Attempts were made throughout 2019 to sample seepage from the active workings of SBU and SBE mine areas in line with the Schedule 4, Condition 34 recommendation. However, no samples were able to be taken due to dry conditions within the underground. Regional depressurisation associated with historical and ongoing mining in the Wambo region, as well as very low rainfall during 2019, may be responsible for the dry underground conditions.

9 Recommendations

- Consider removing GW02 and GW11 from future revisions of the GWMP if pumping continues at both bores. A replacement monitoring bore may be useful in a nearby location.
- Additional consideration relating to the assessment of P206 against trigger levels in future versions of the GWMP. This should be assessed considering the screened depth of the bore and the magnitude of predicted impacts due to mining.
- P109 to be considered as a replacement site for P106 until the identified obstruction can be cleared. Trigger levels can be adopted for P109 based on observations from the baseline period.
- A review of the condition of VWPs by a field technician is recommended to the check the condition of the equipment and the reliability of the data. the representation of Homestead underground mining to better capture impacts near Wambo Creek and Wollombi Brook.
- Future revisions to the groundwater model should consider updating model layer structure using the most recent WCPL geology model and any additional geological information.

10 References

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APPENDIX A

Groundwater Level and Groundwater Quality Graphs

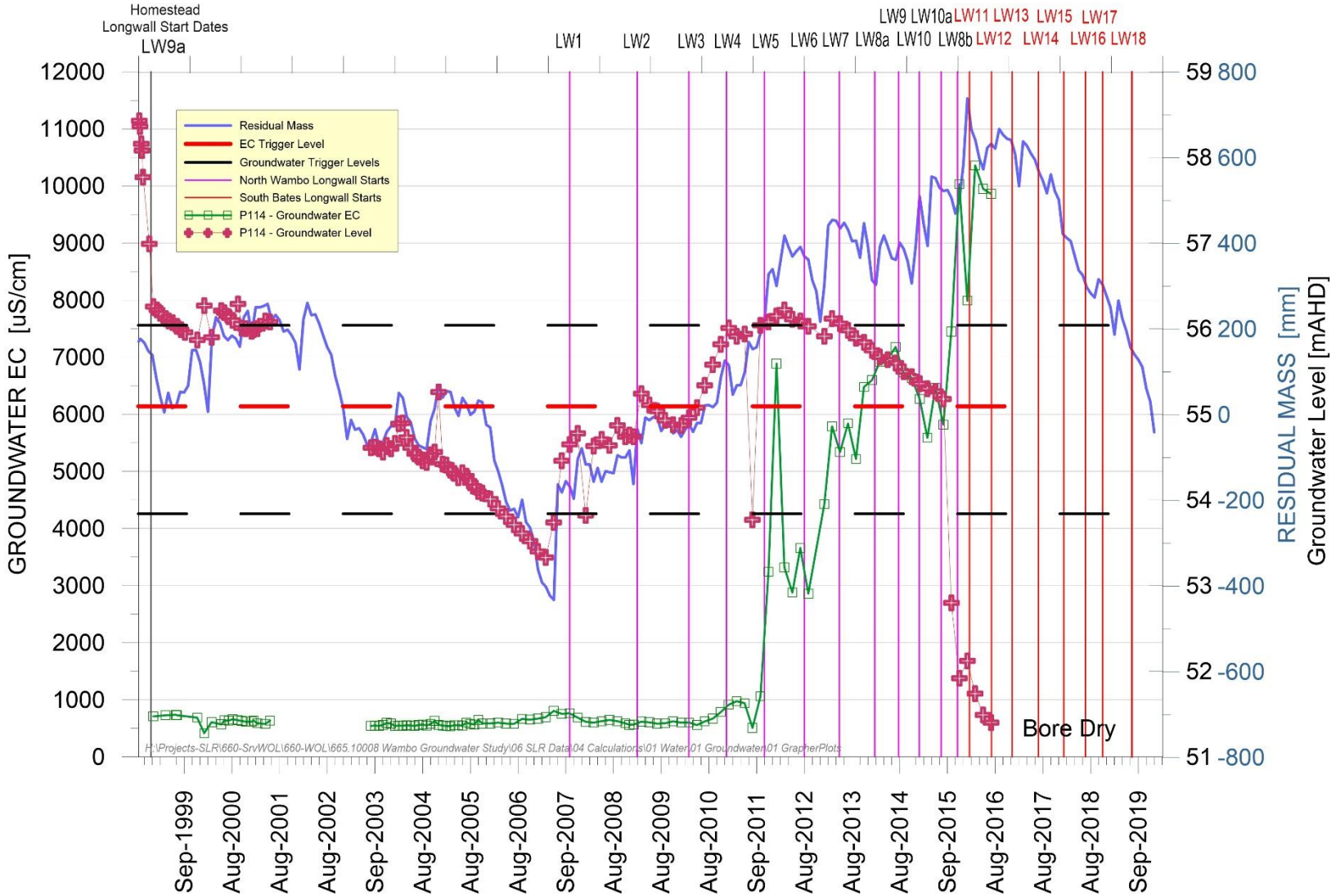

Figure 2 P114 Groundwater Level and EC

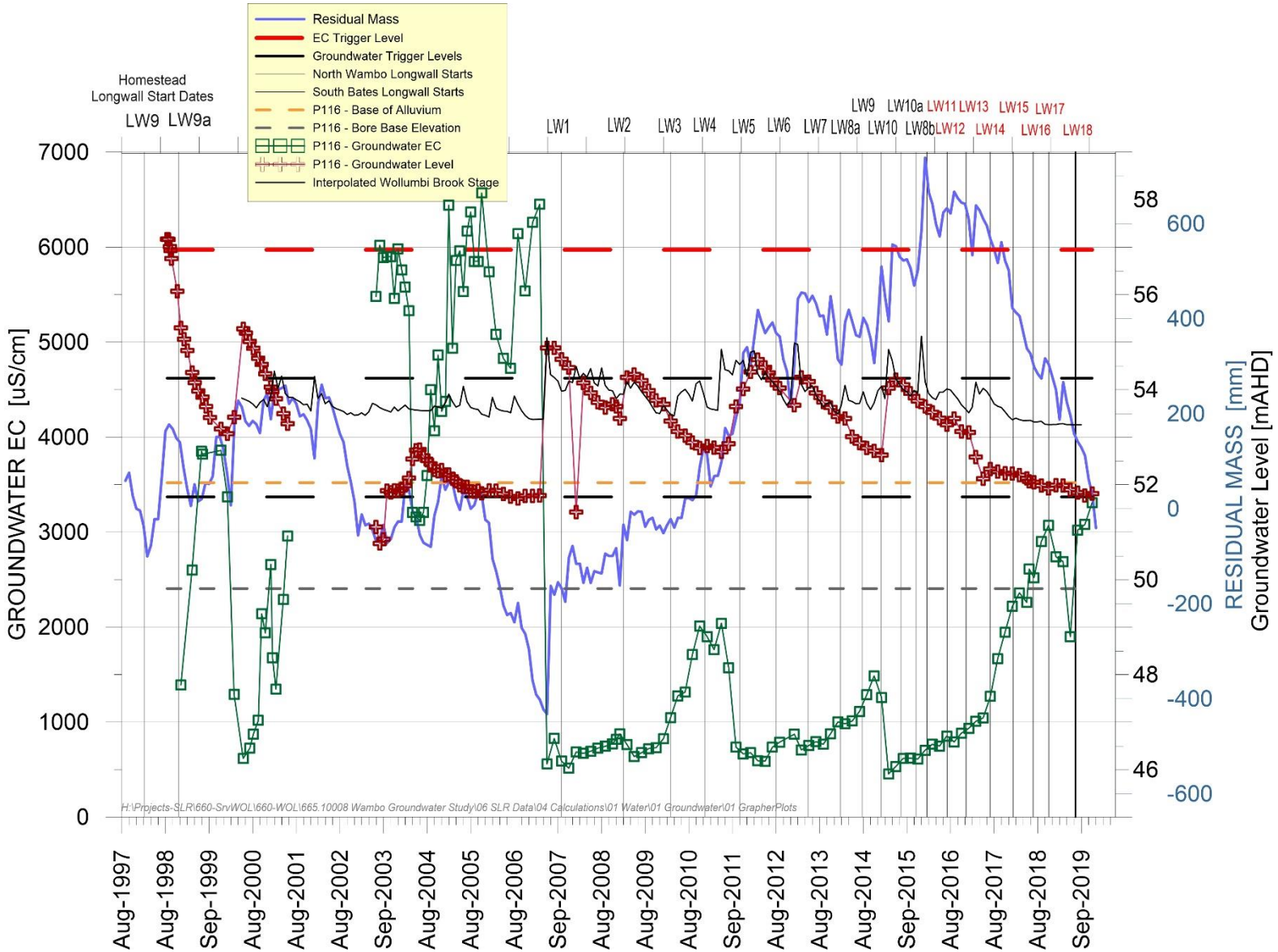

Figure 3 P116 Groundwater Level and EC

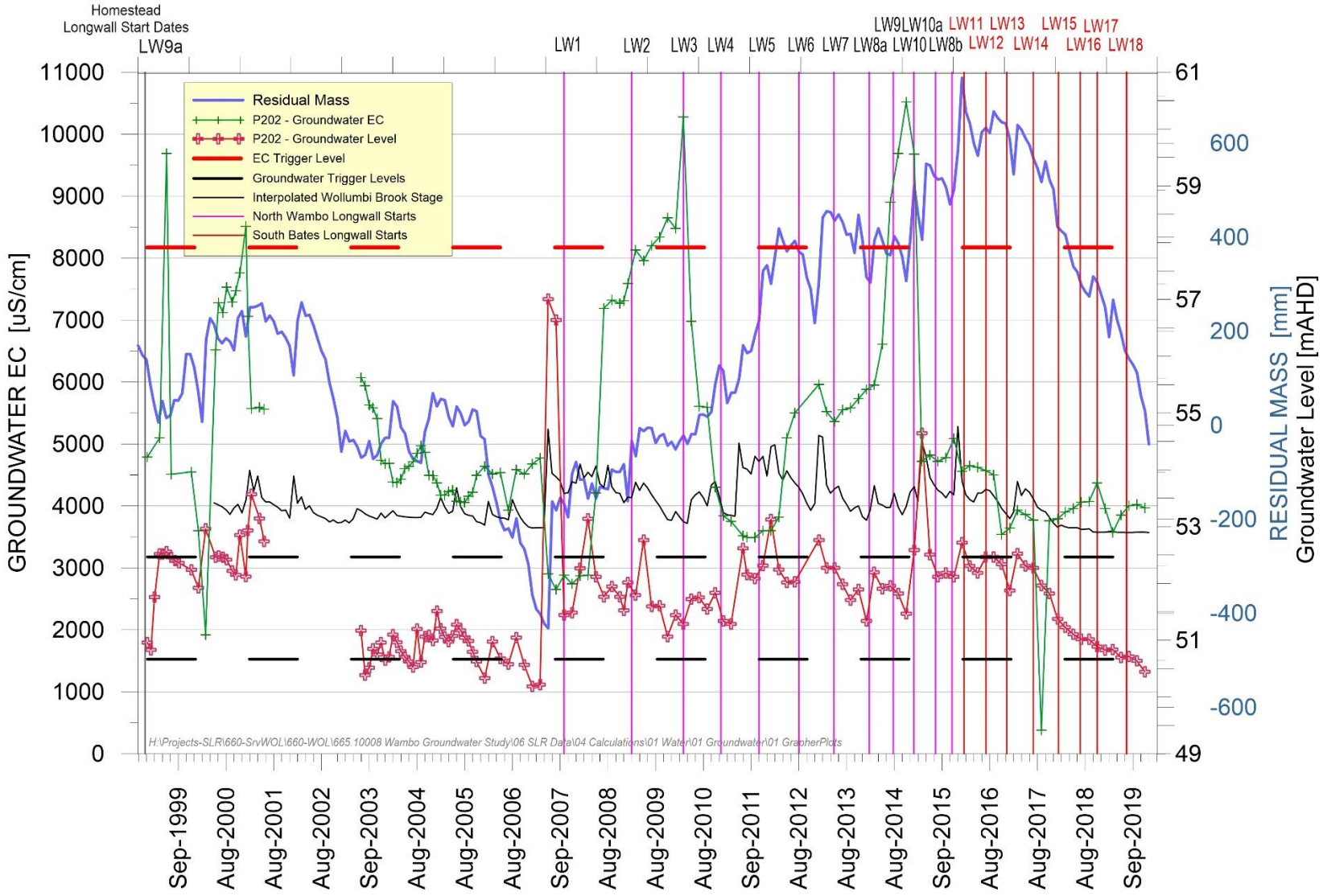

Figure 4 P202 Groundwater Level and EC

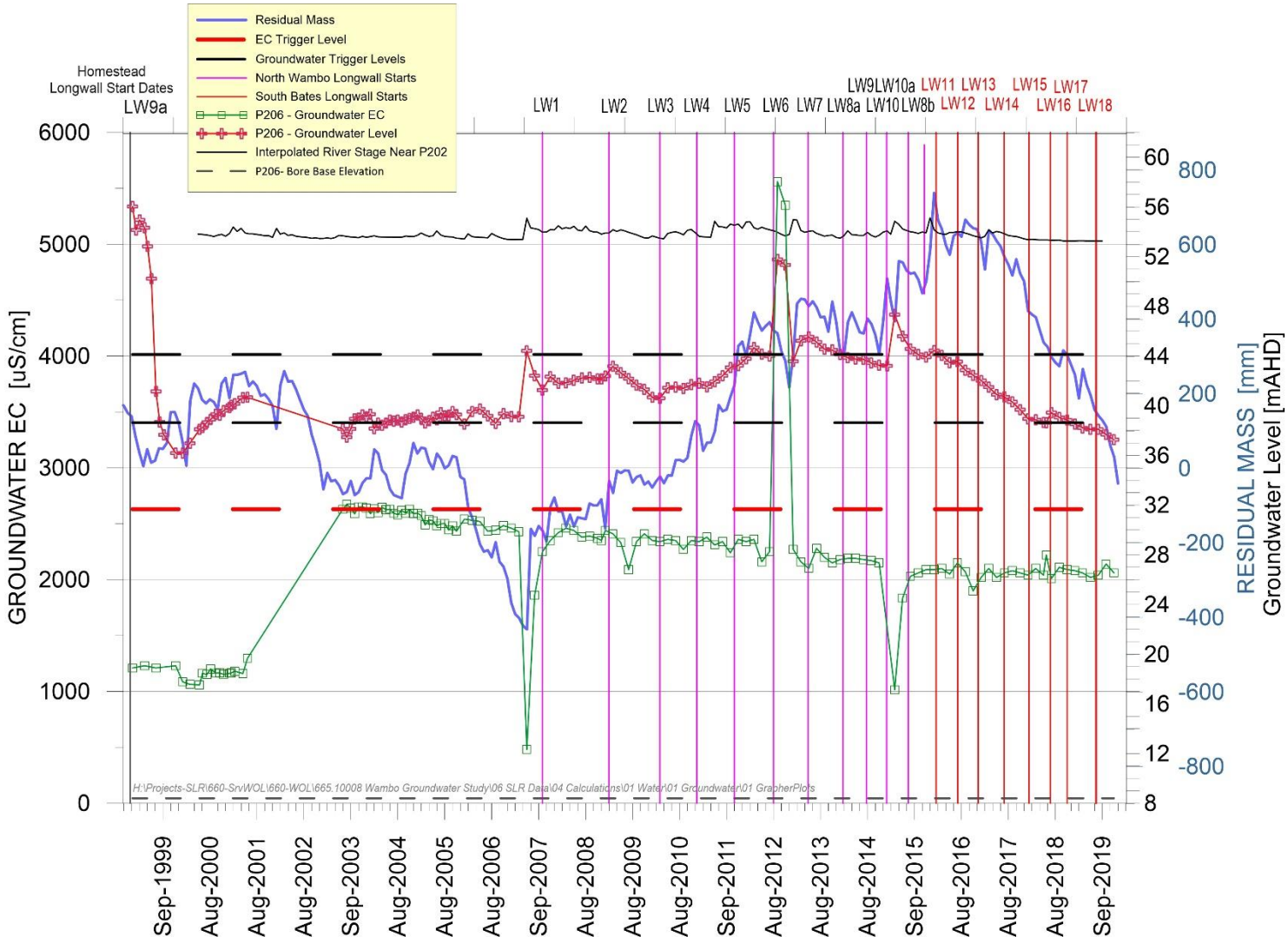

Figure 5 P206 Groundwater Level and EC

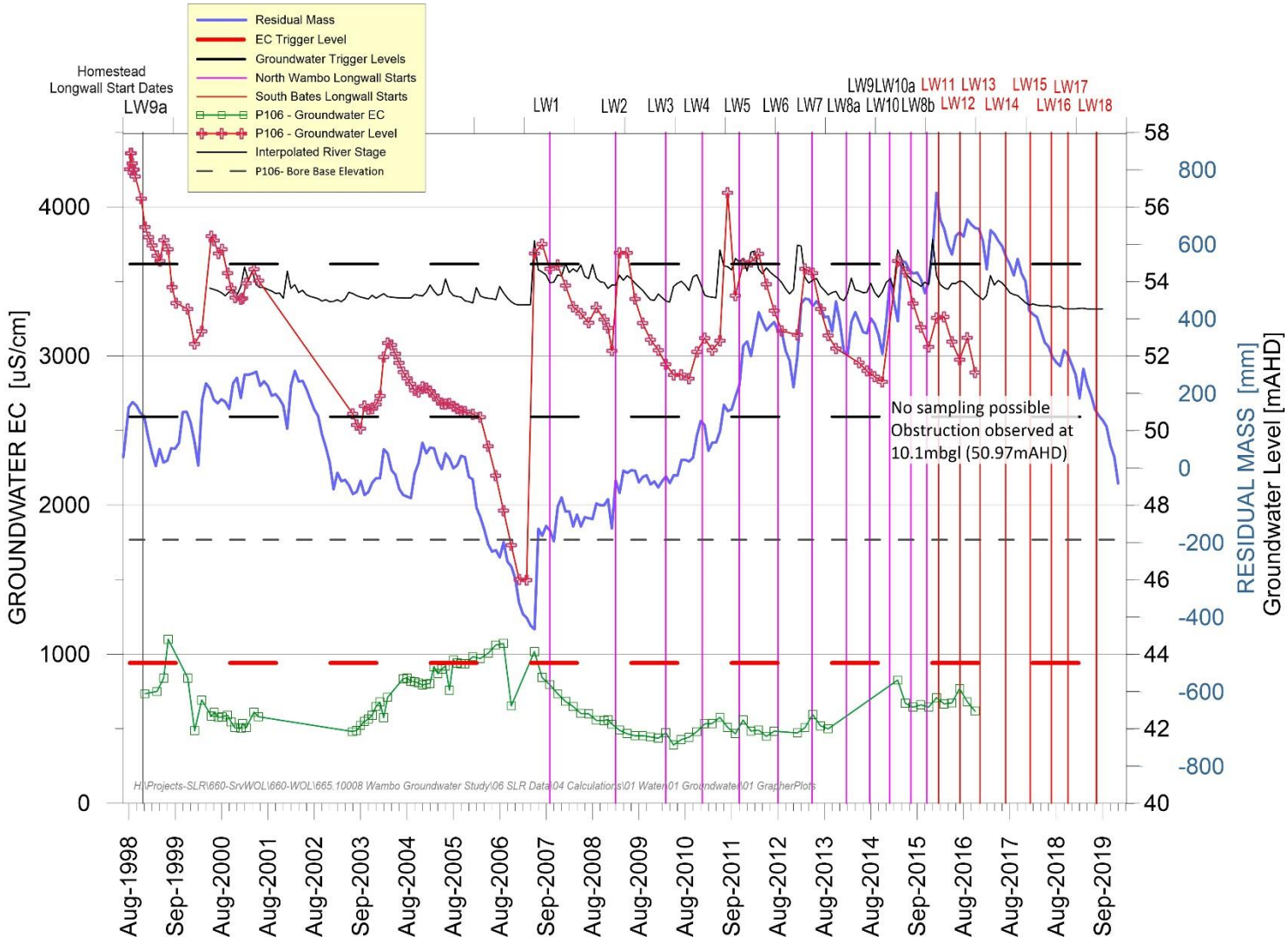

Figure 6 P106 Groundwater Level, EC and Interpolated Wollombi Brook stage height

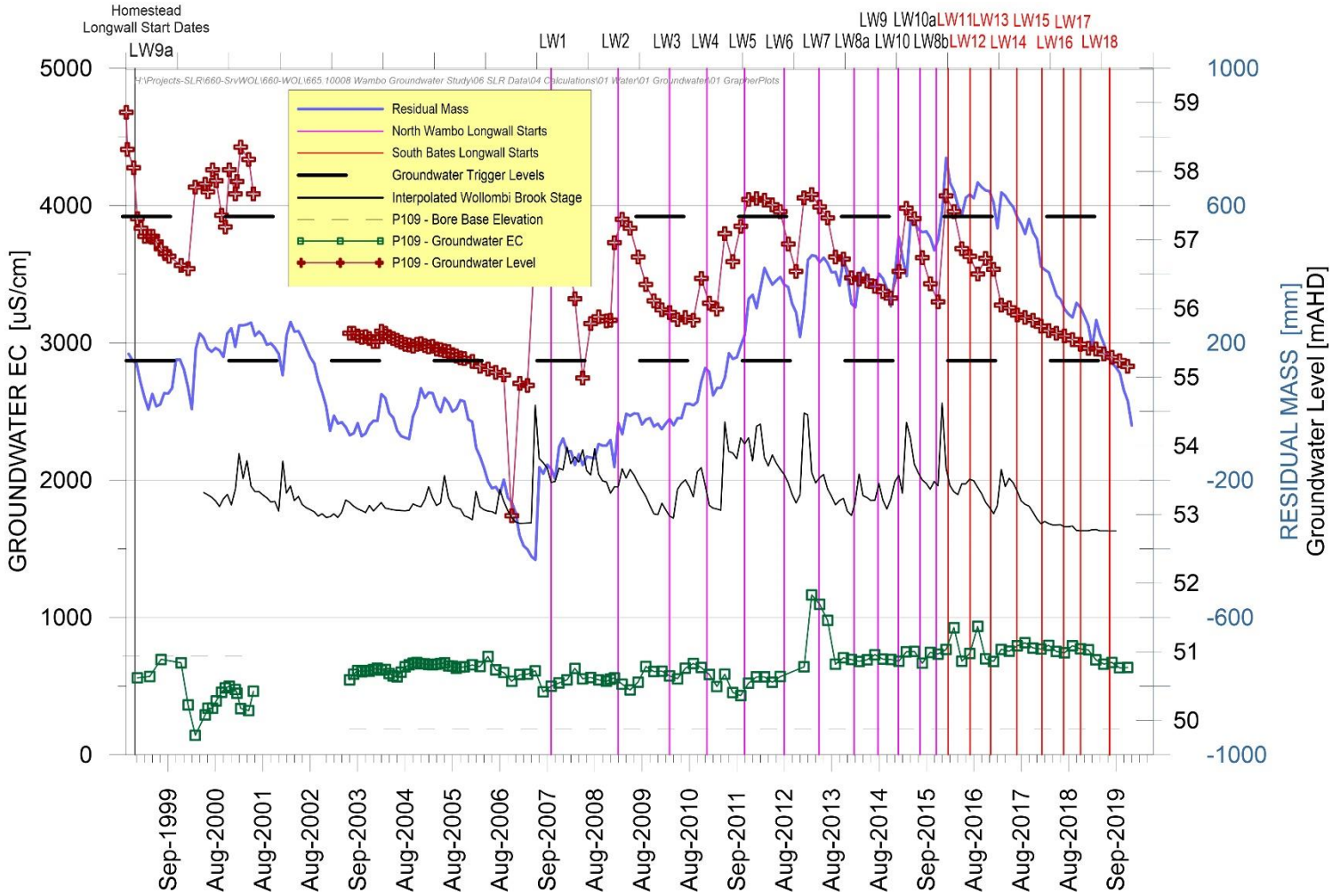

Figure 7 P109 Groundwater Level, EC and Interpolated Wollombi Brook stage height

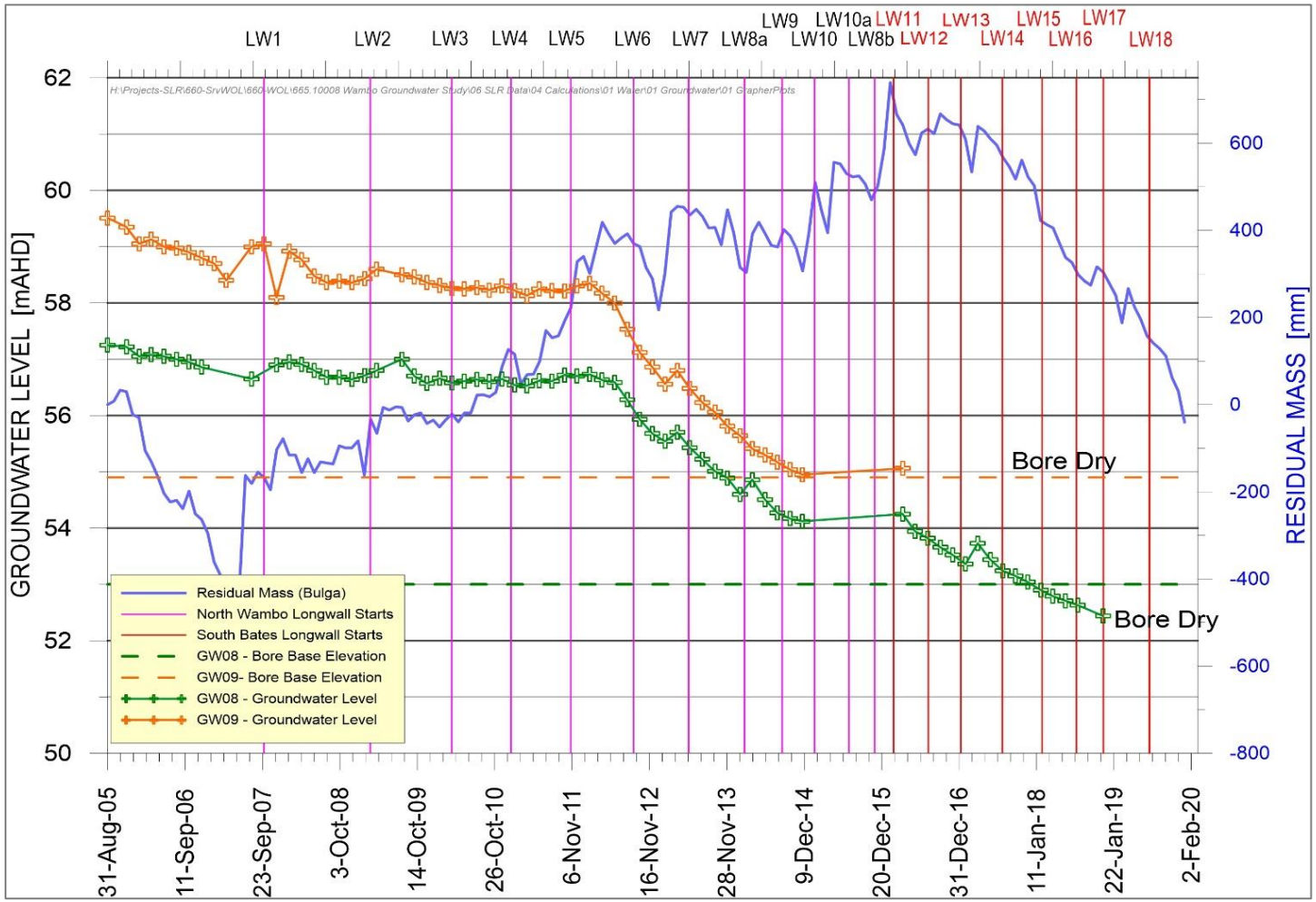

Figure 8 GW08 and GW09 Hydrographs

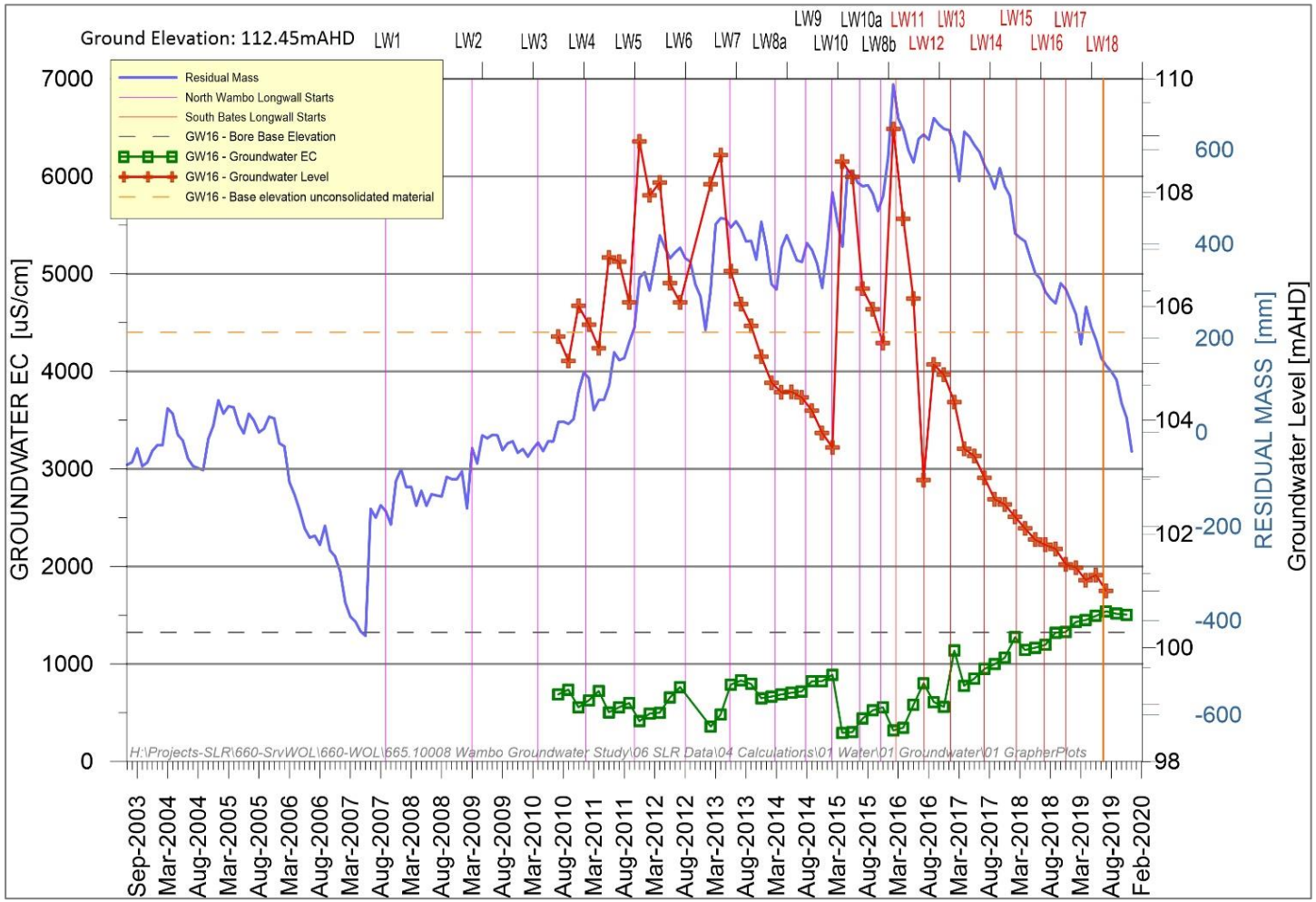

Figure 9 GW16 groundwater level and EC

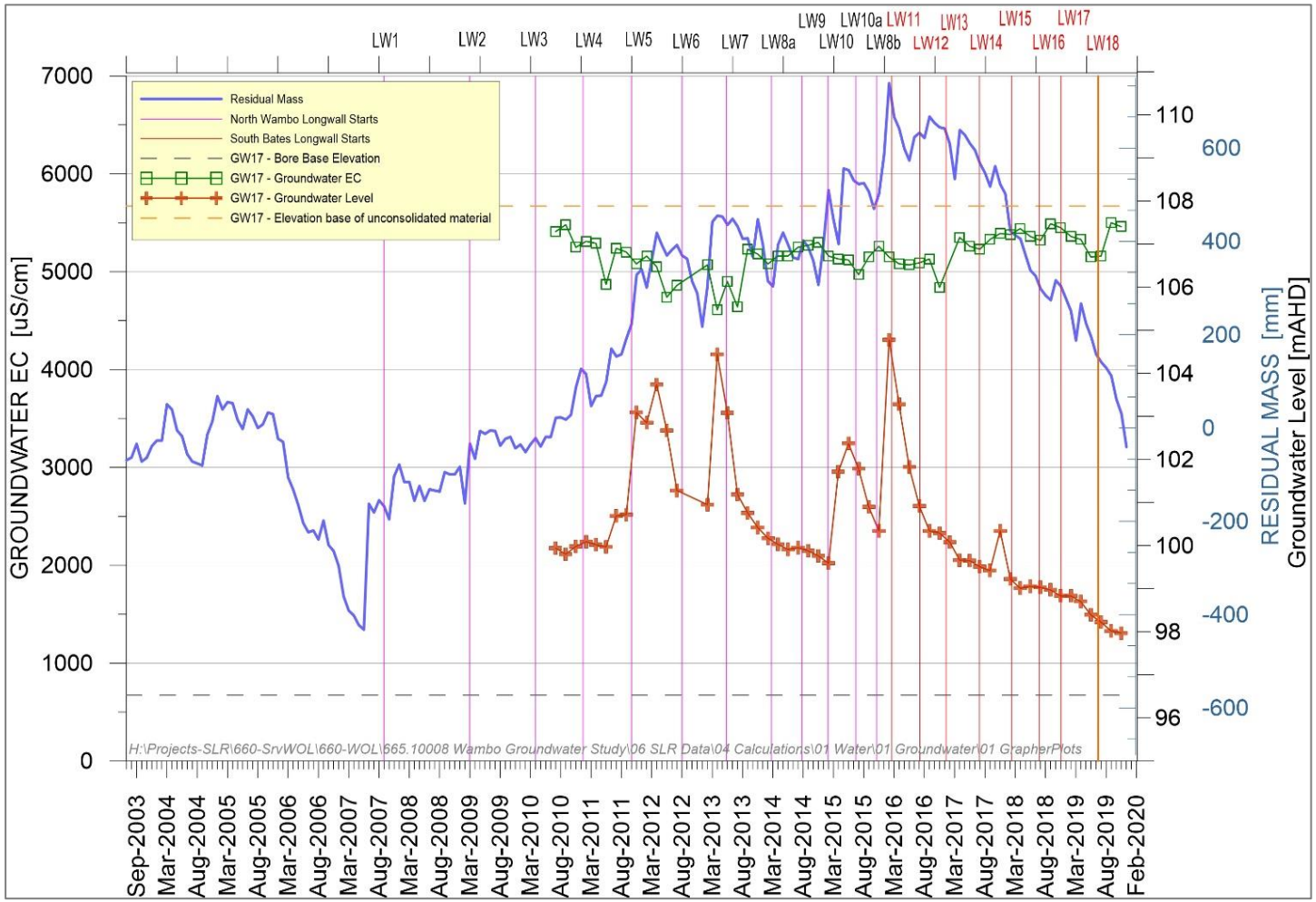

Figure 10 GW17 Groundwater Level and EC

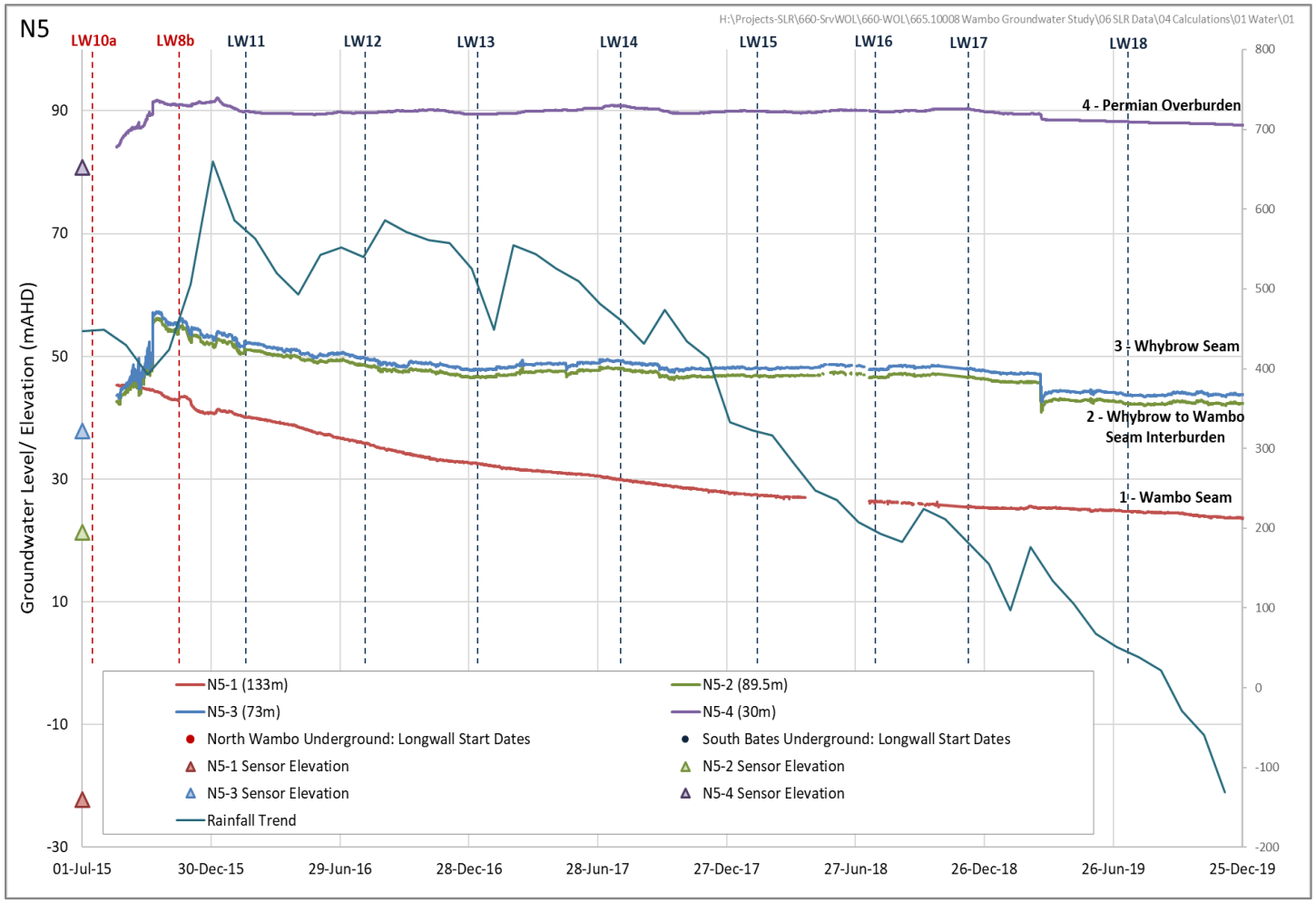

Figure 11 N5 Hydrograph

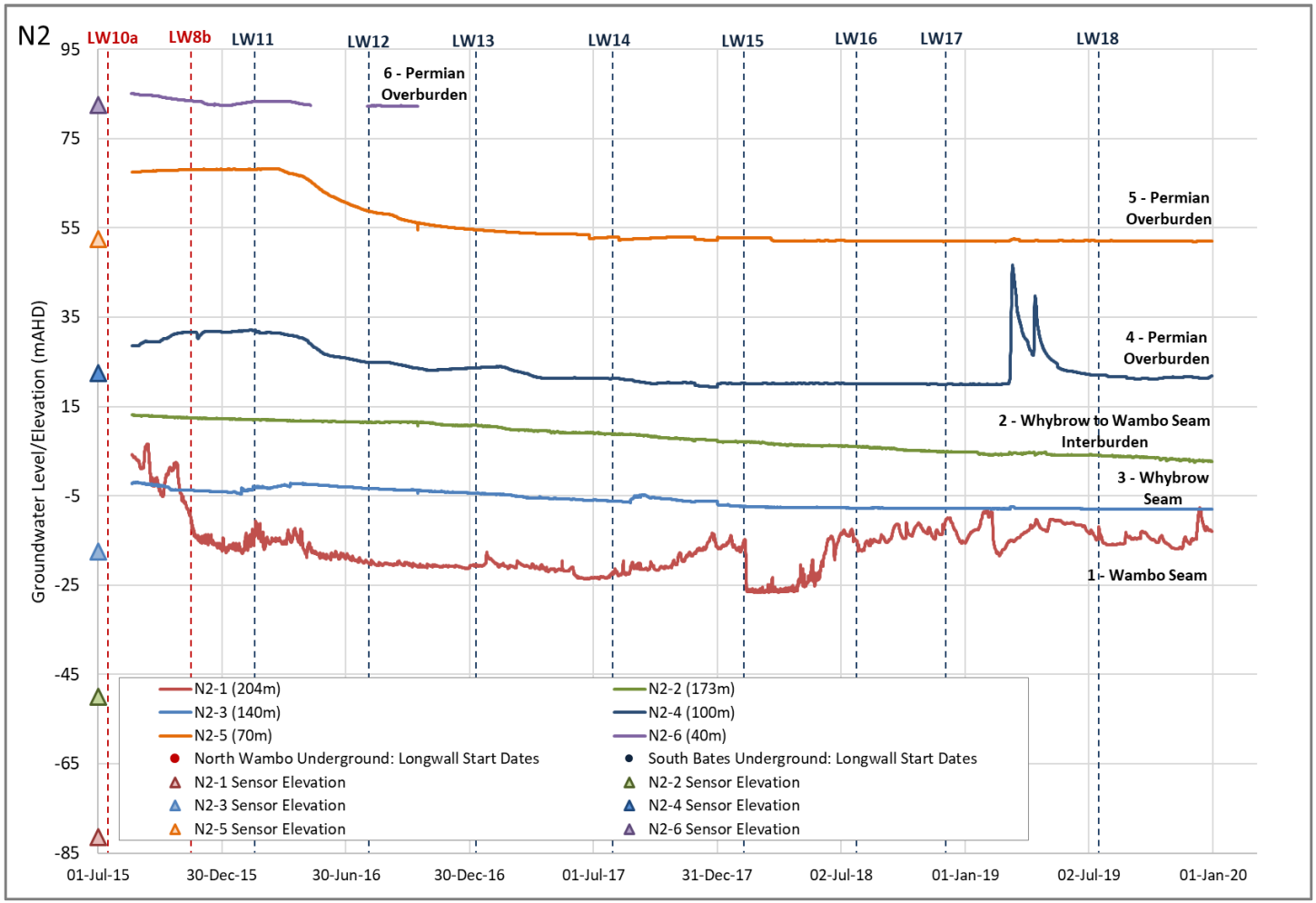

Figure 12 N2 Hydrograph

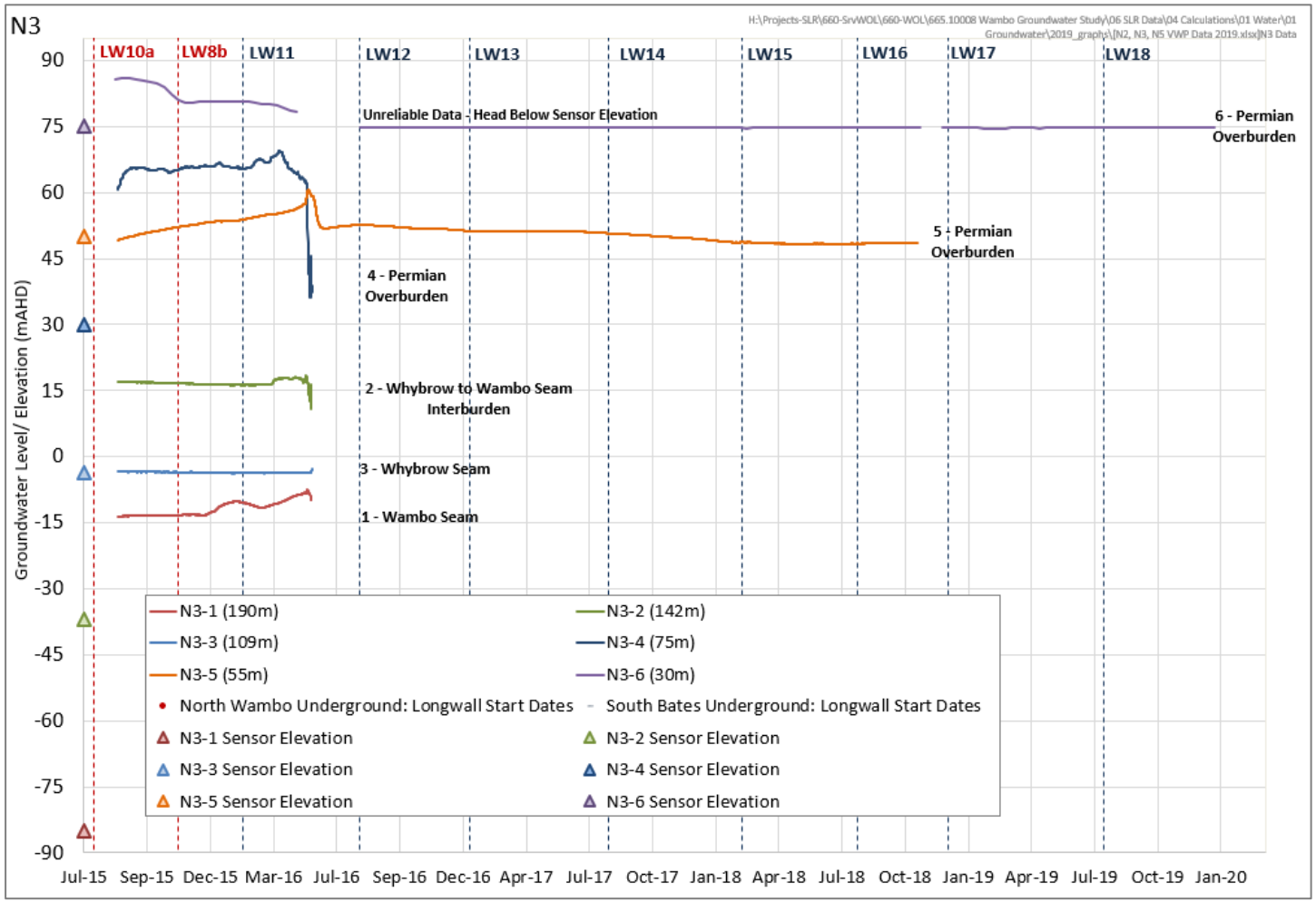

Figure 13 N3 Hydrograph

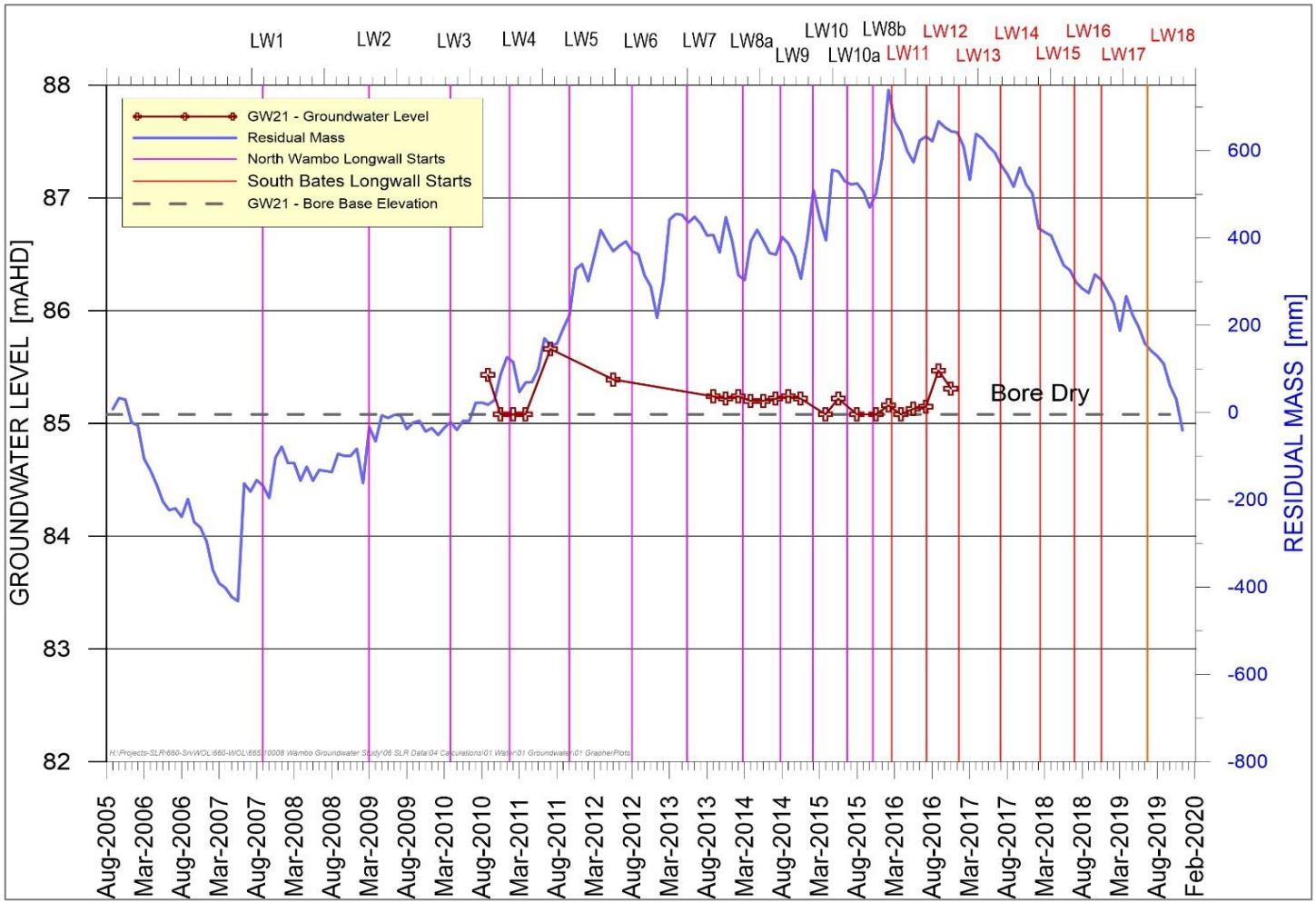

Figure 14 GW21 Groundwater Level

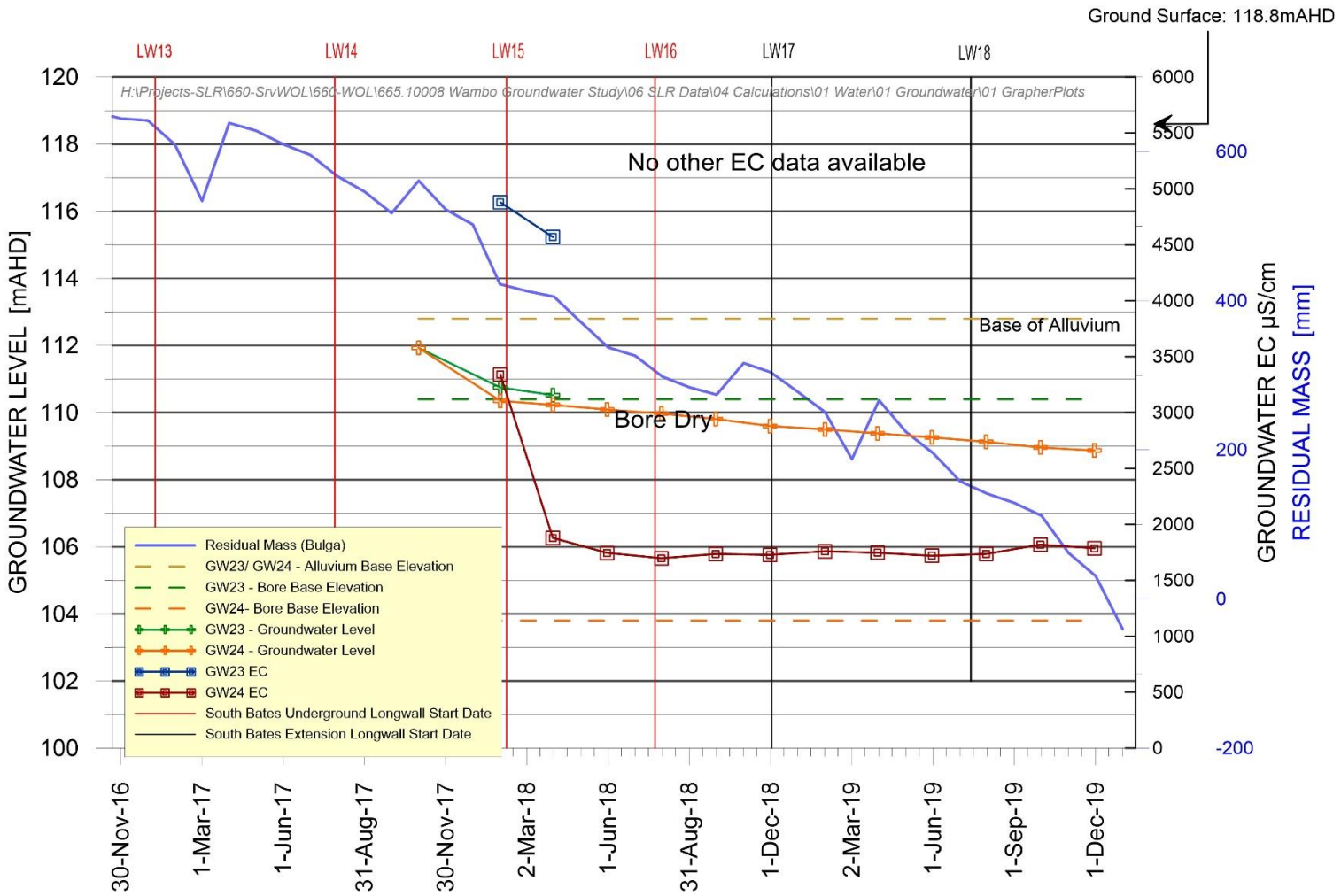

Figure 15 GW23 and GW24 Groundwater Level and EC

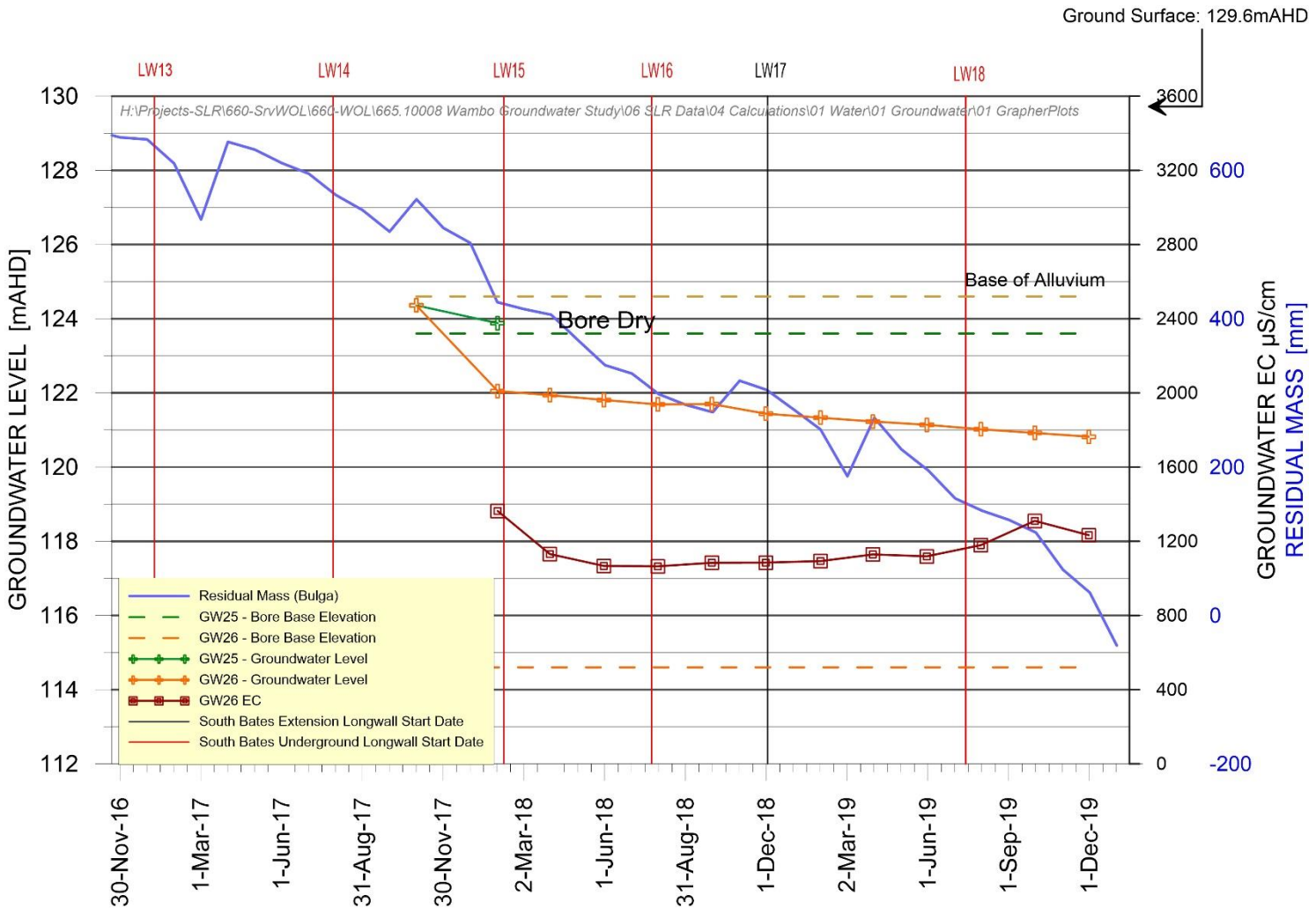

Figure 16 GW25 and GW26 Groundwater Level and EC

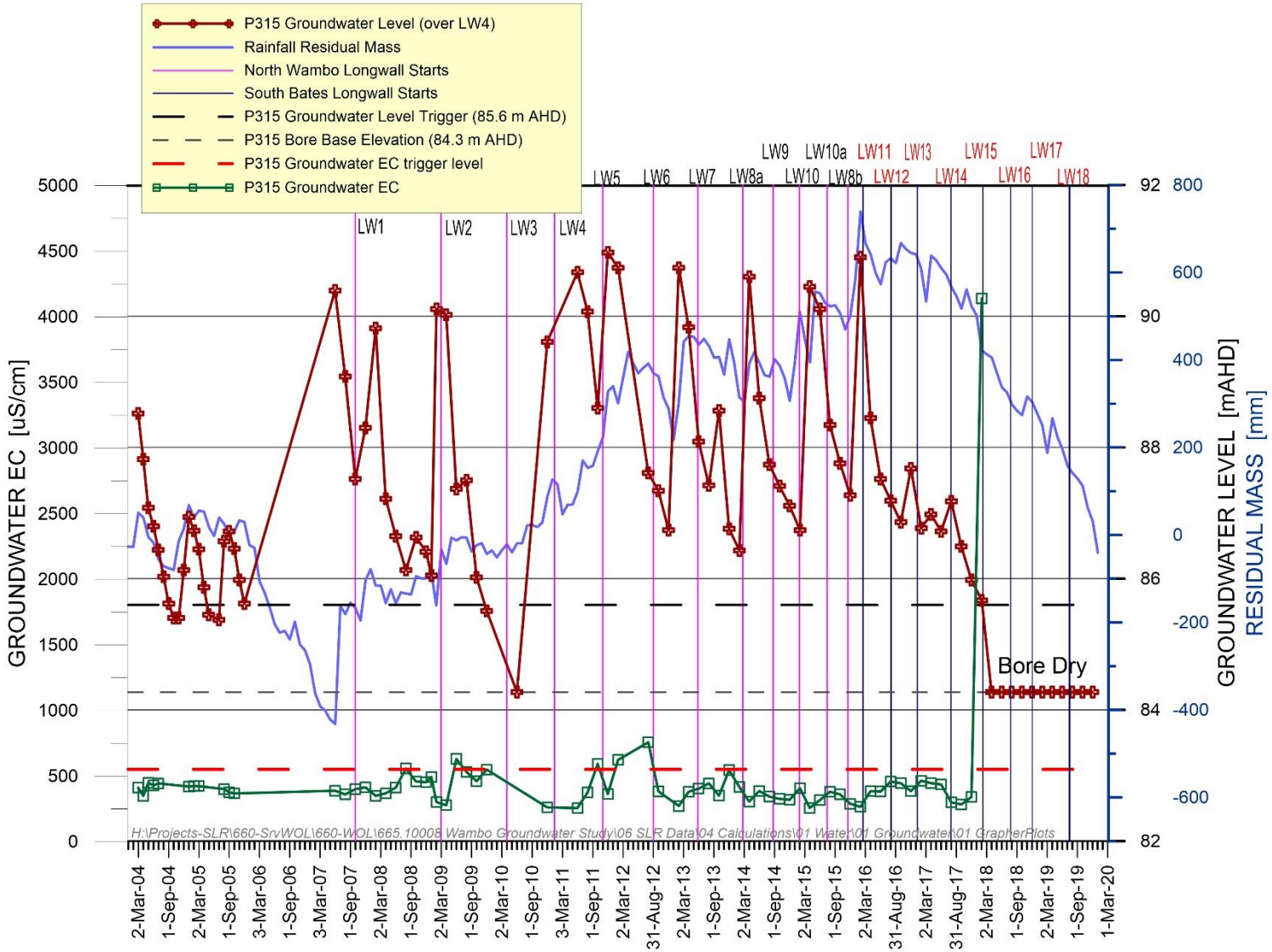

Figure 17 P315 groundwater level and EC

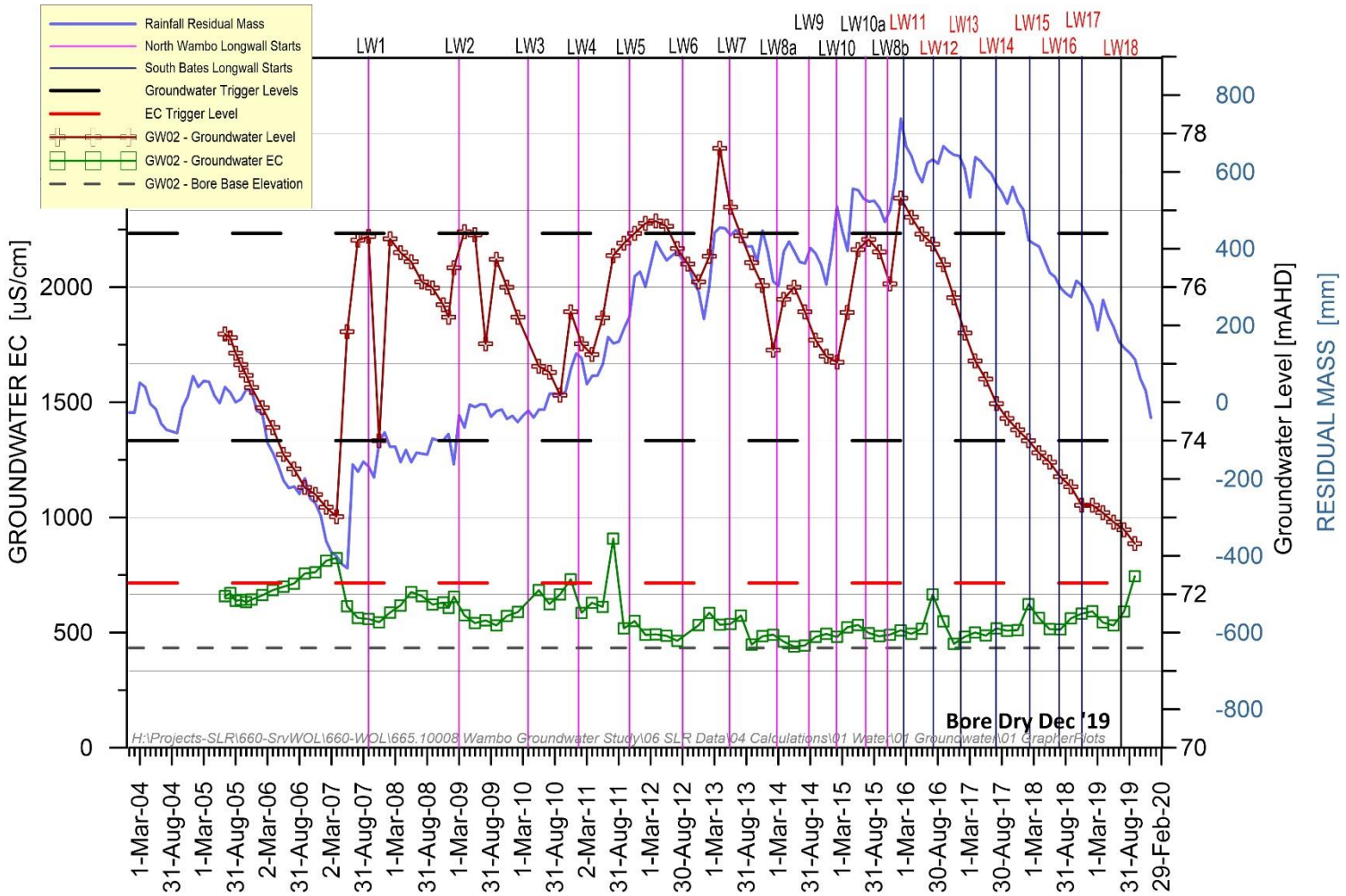

Figure 18 GW02 groundwater level and EC

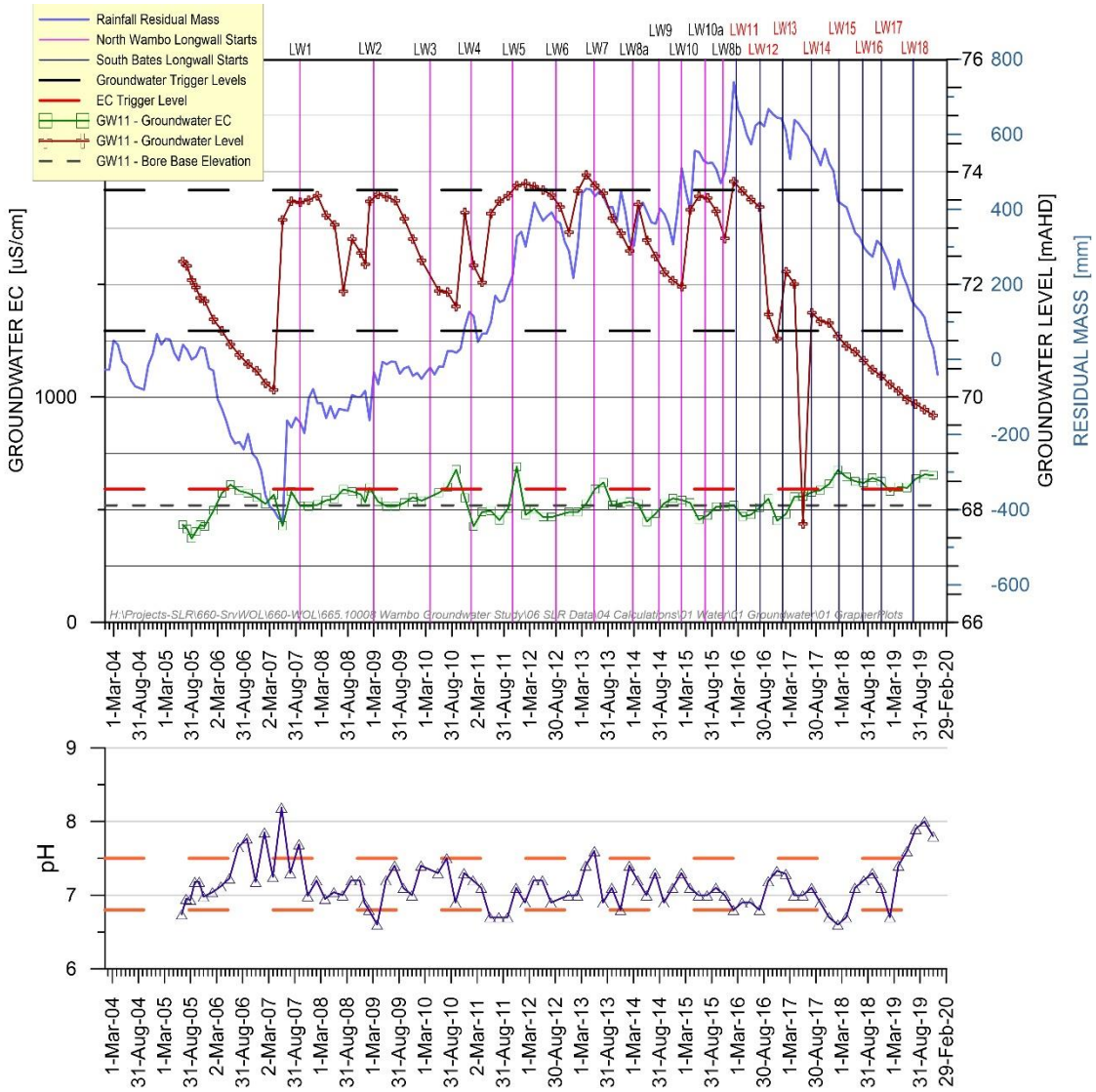

Figure 19 GW11 Groundwater Level

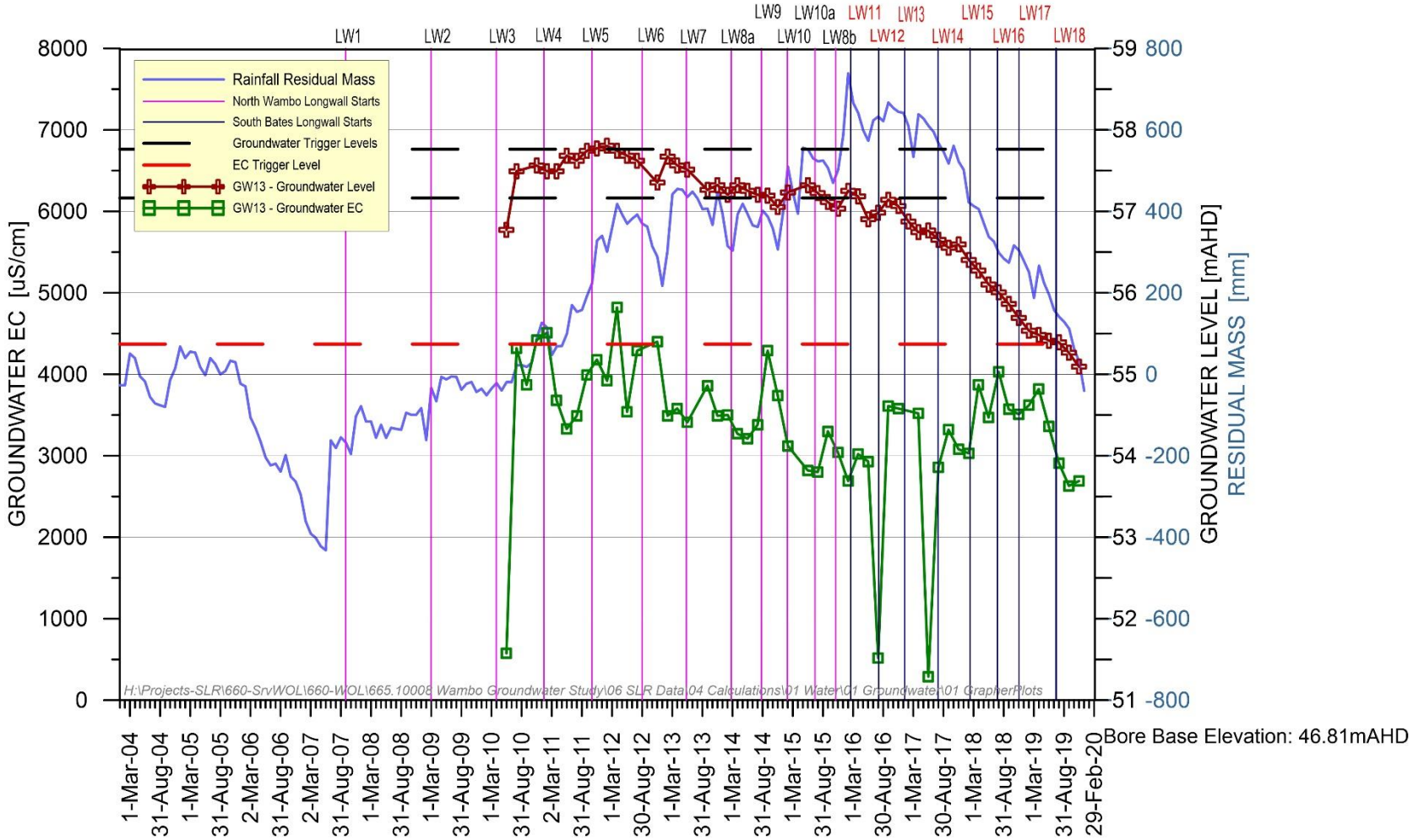

Figure 20 GW13 Groundwater Level

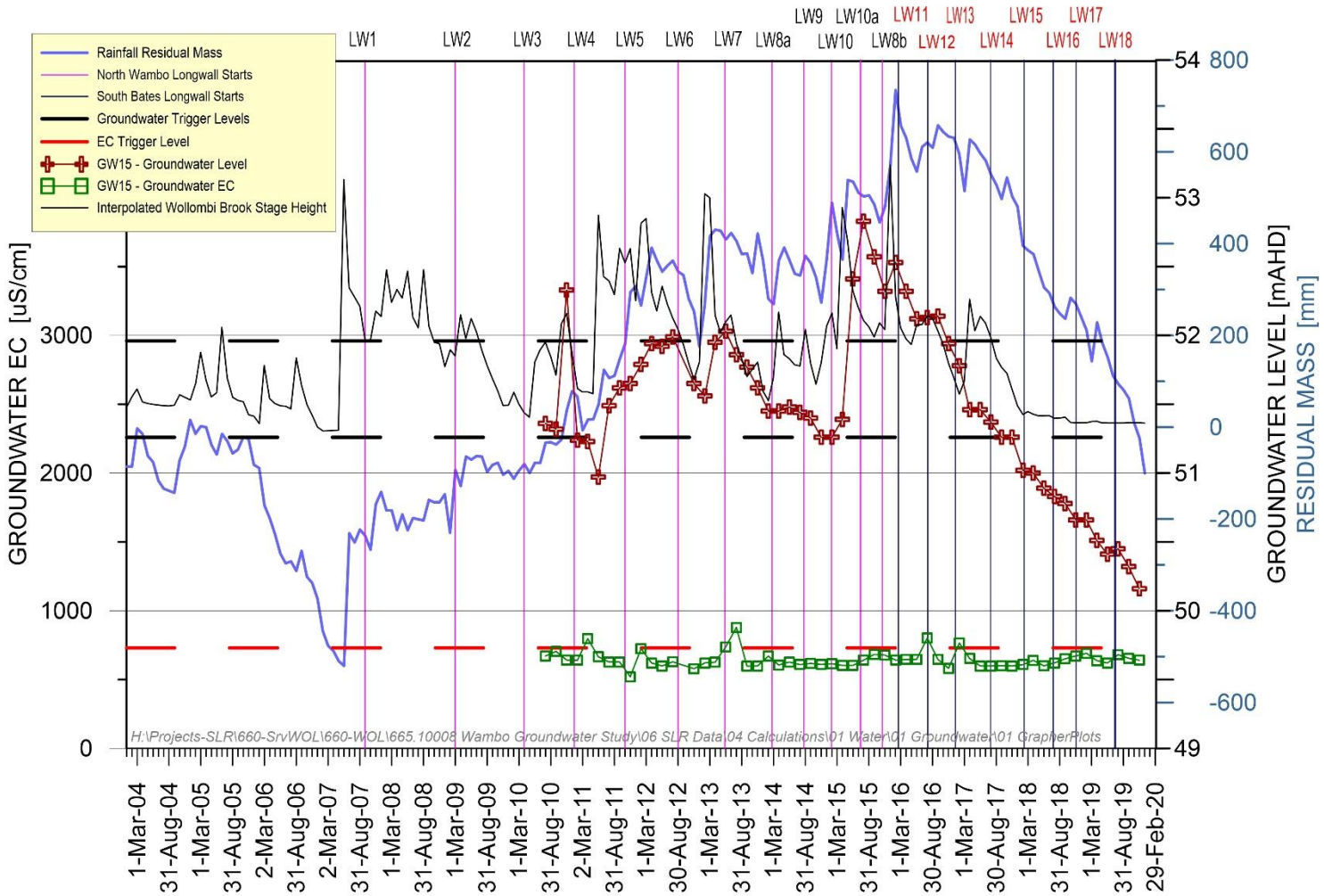

Figure 21 GW15 Groundwater Level

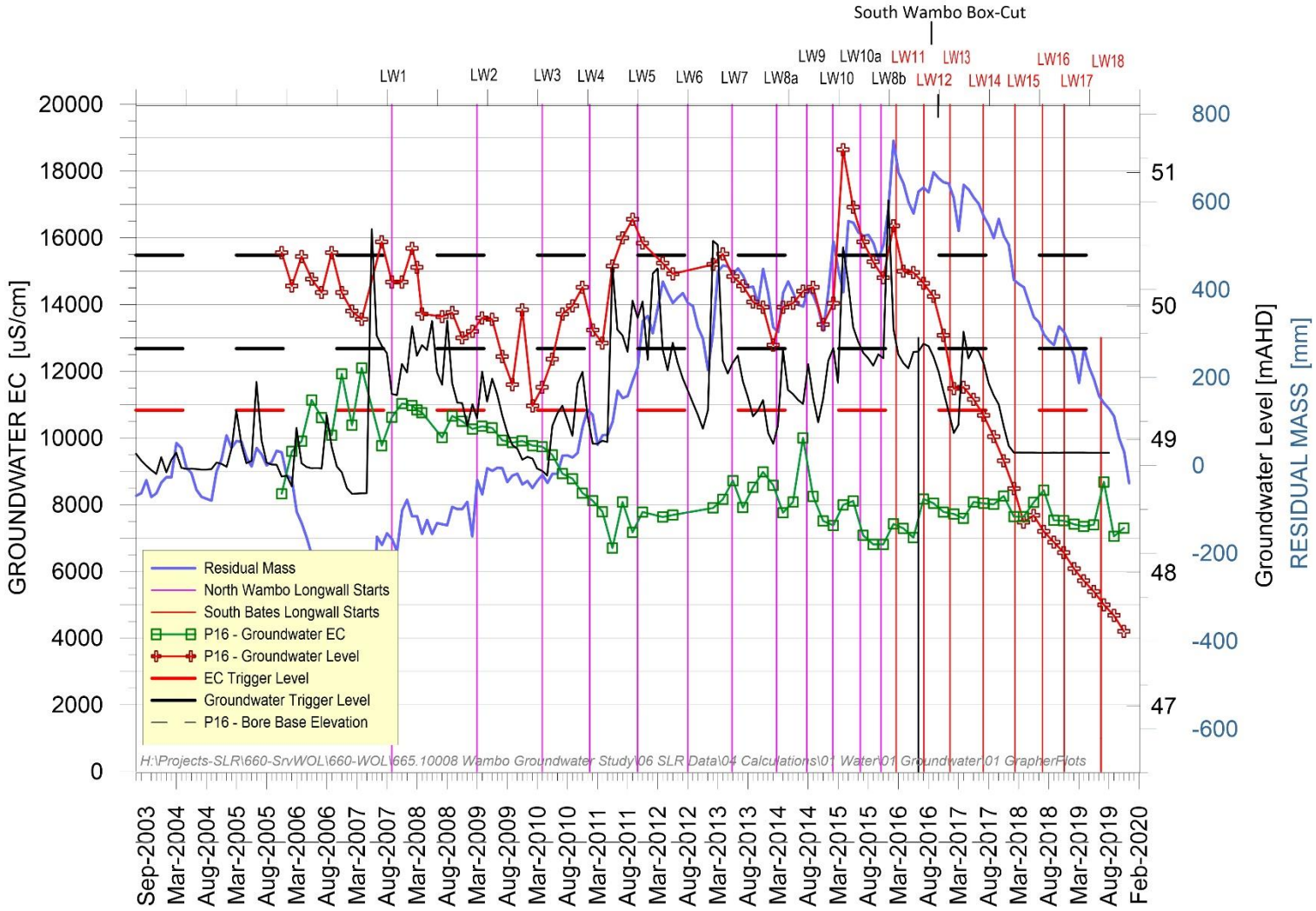

Figure 22 P16 Groundwater Level

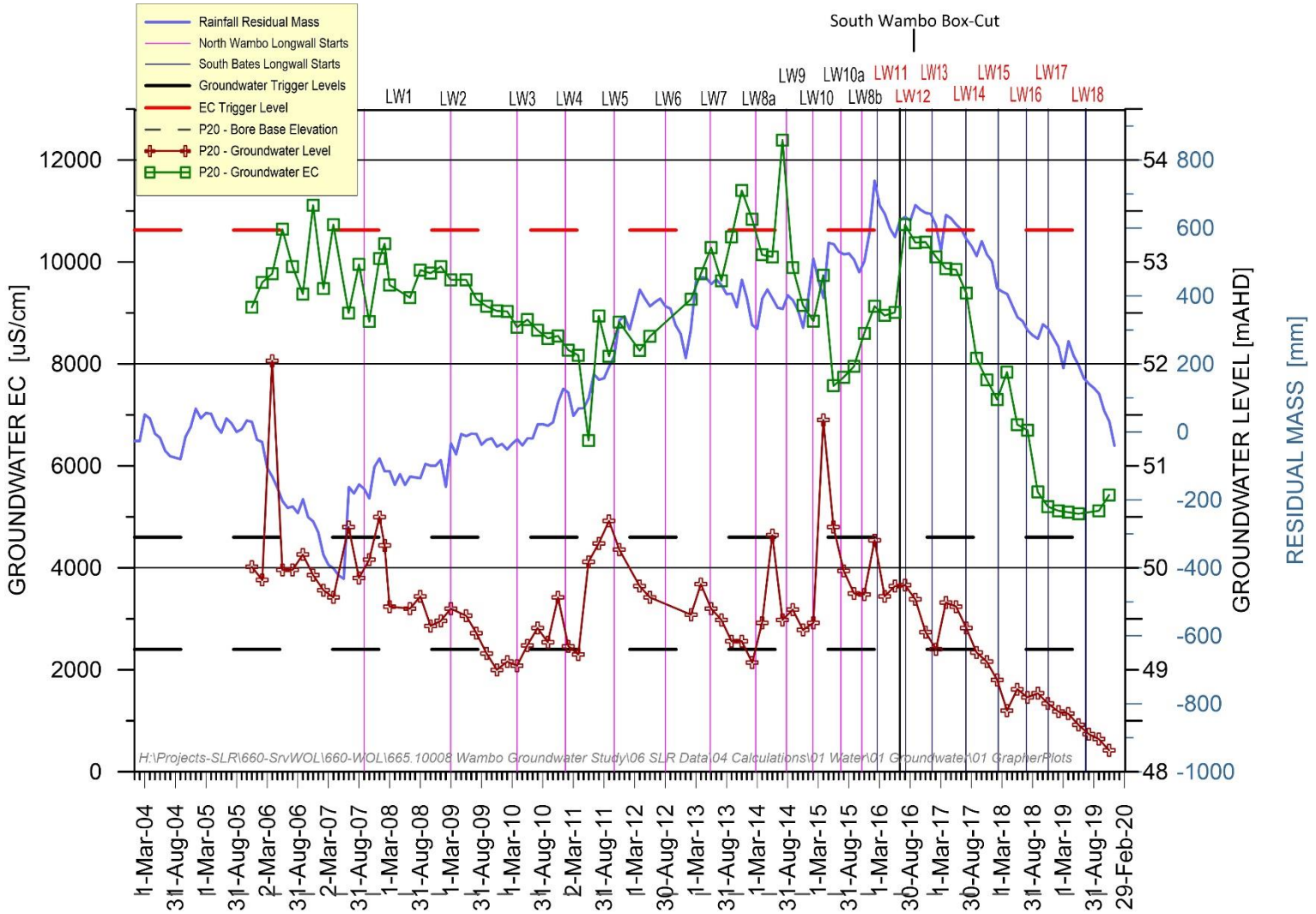

Figure 23 P20 Groundwater Level

APPENDIX B

Calibration Hydrographs

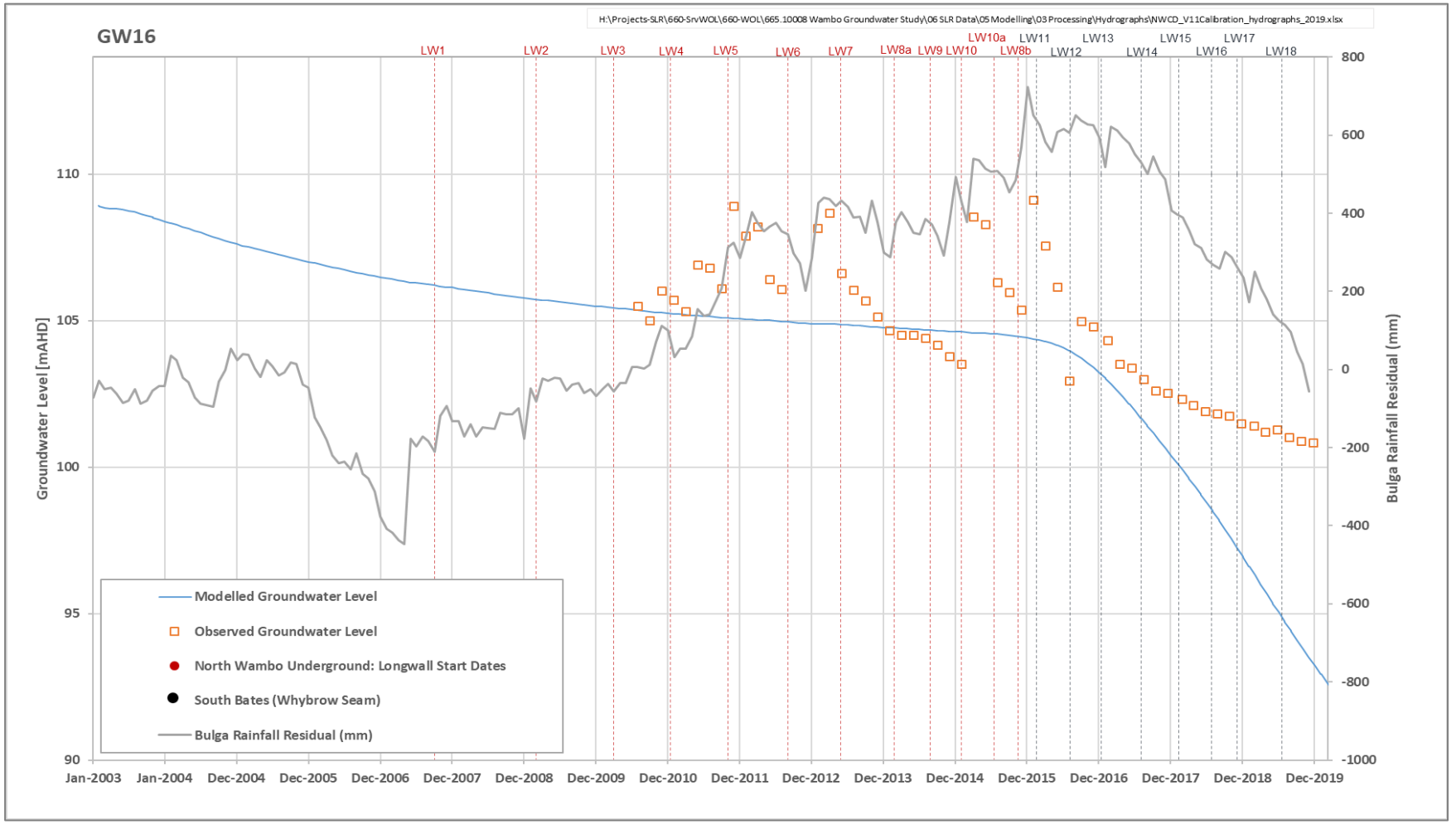

Figure 24 GW16 Calibration Hydrographs

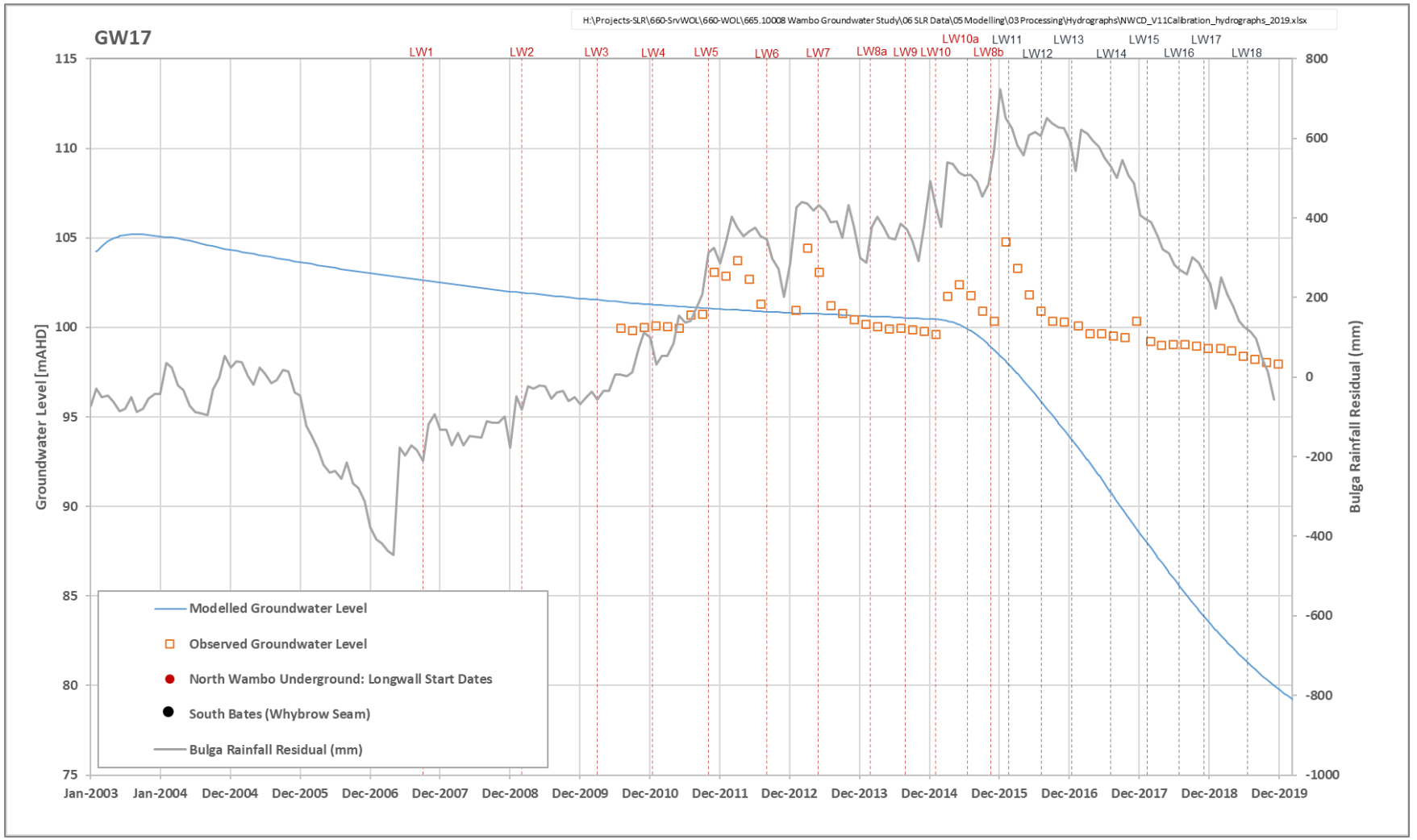

Figure 25 GW17 Calibration Hydrographs

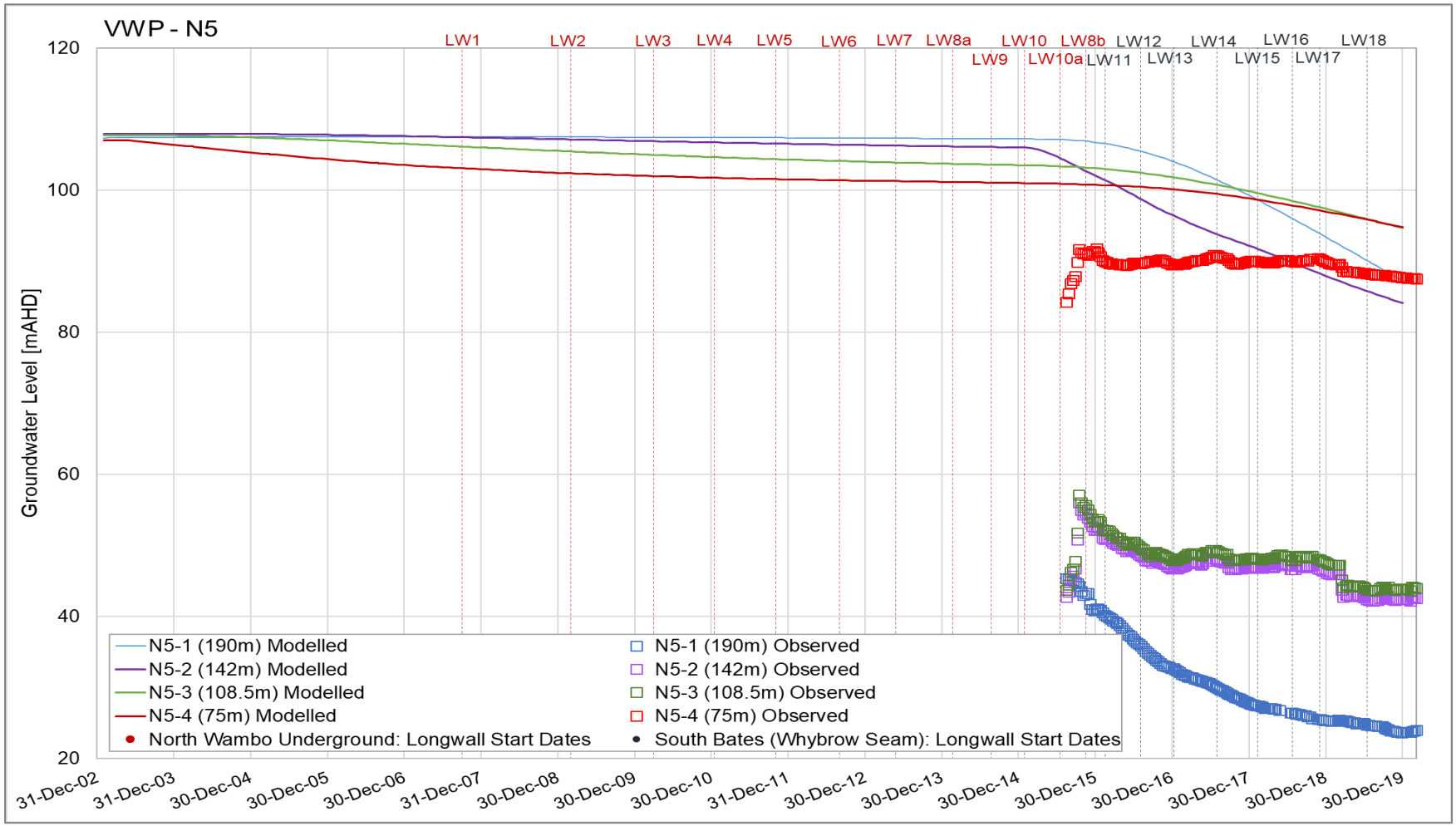

Figure 26 N5 Calibration Hydrographs

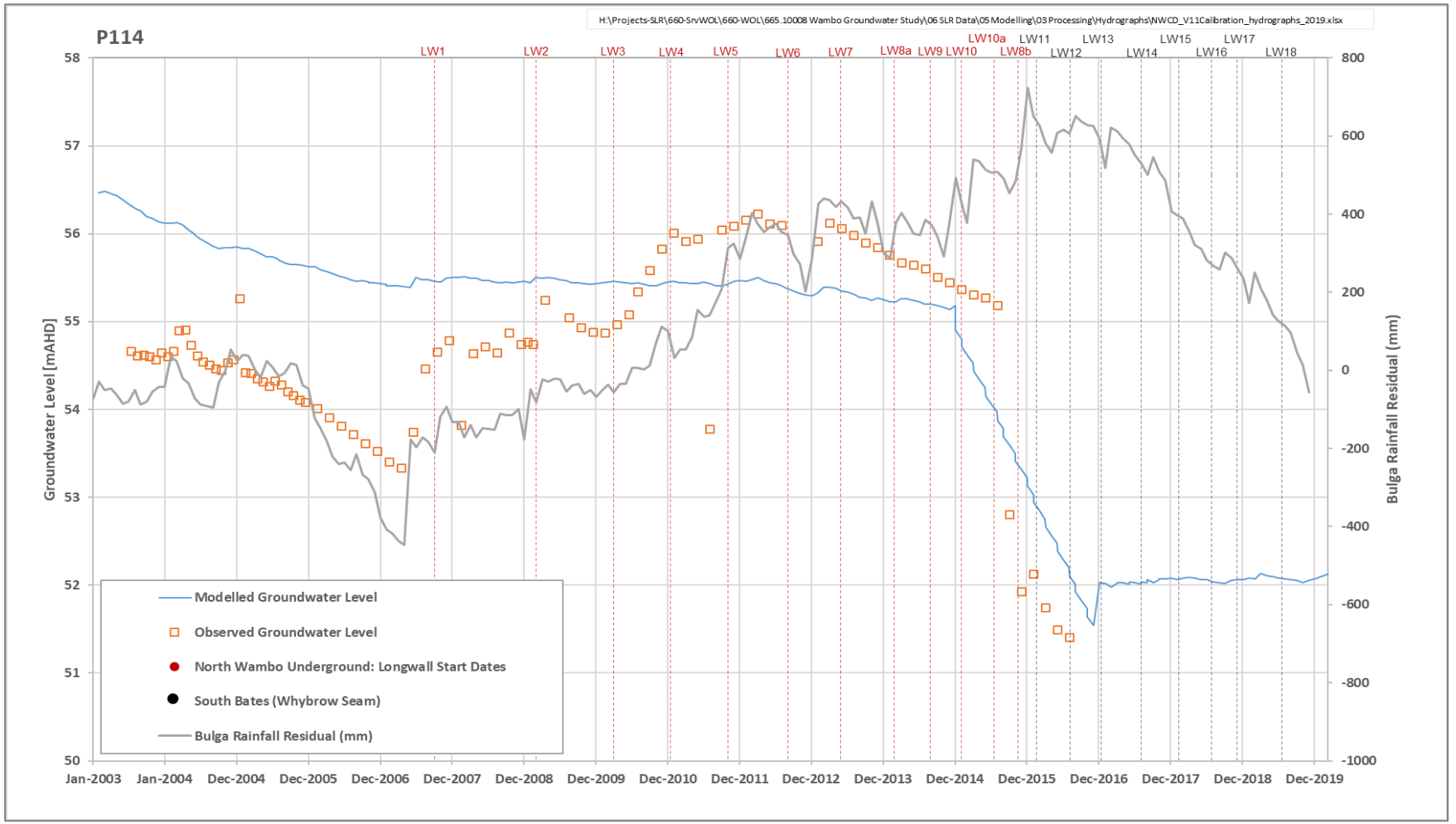

Figure 27 P114 Calibration Hydrographs

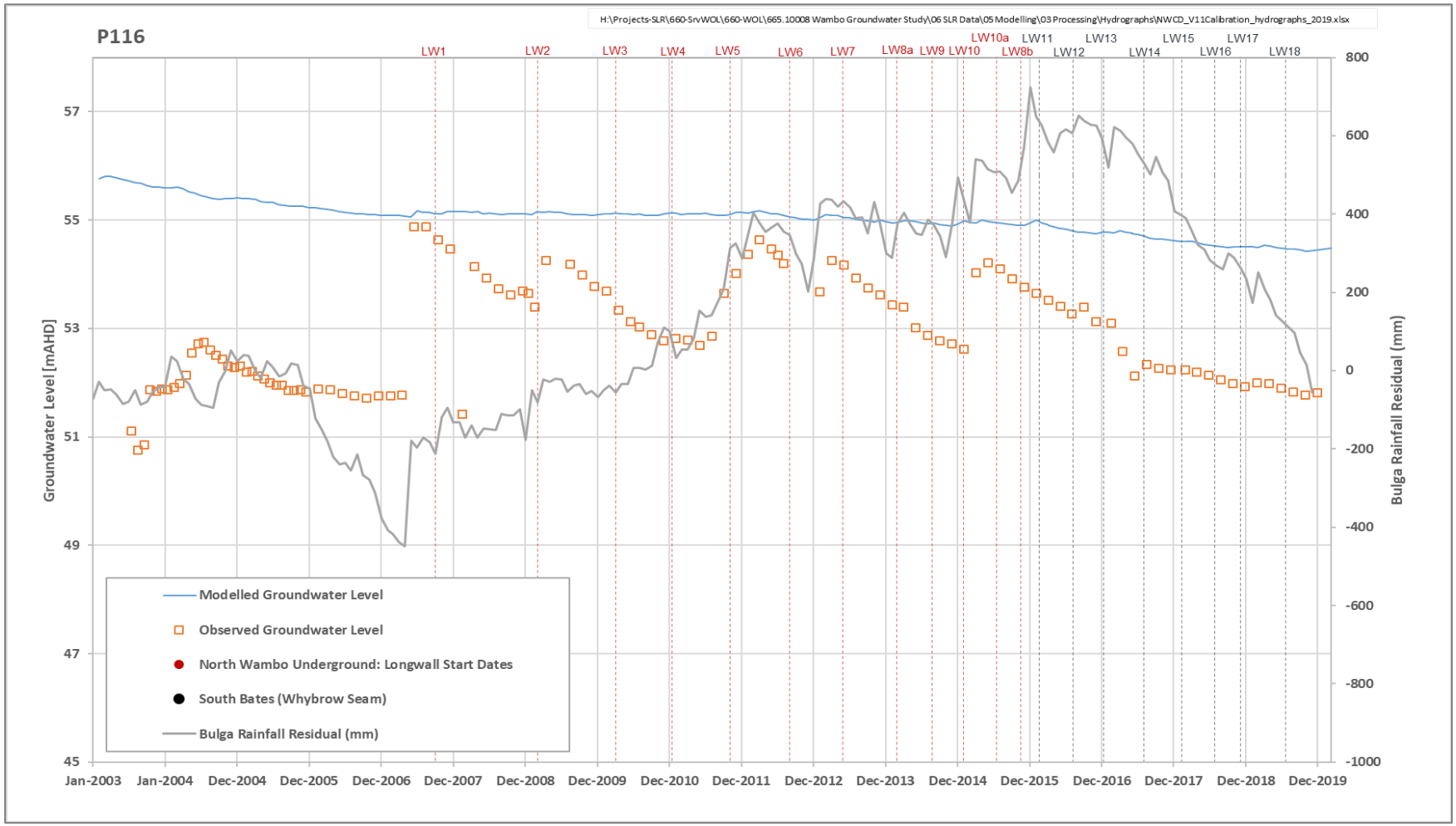

Figure 28 P116 Calibration Hydrographs

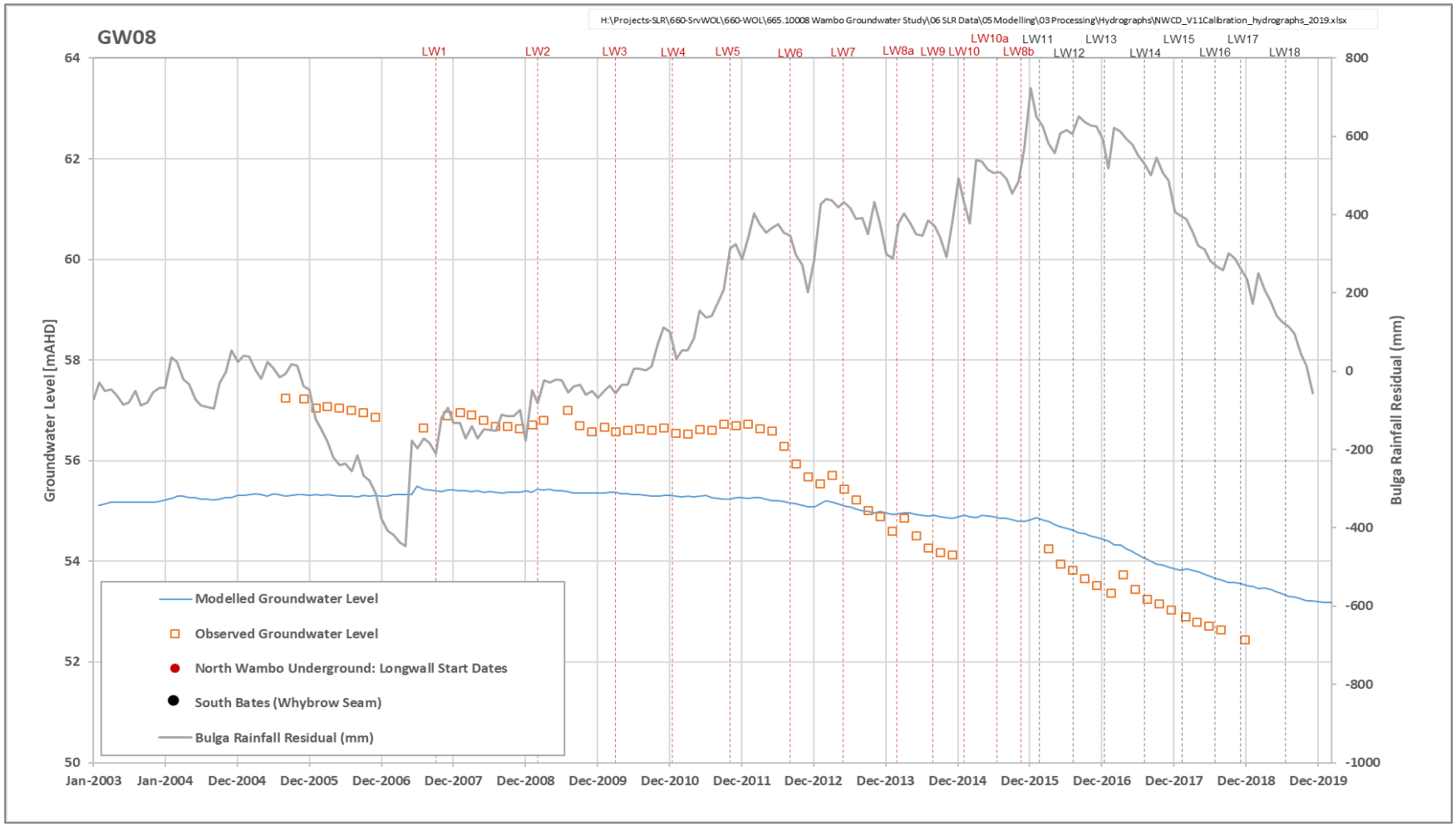

Figure 29 GW08 Calibration Hydrographs

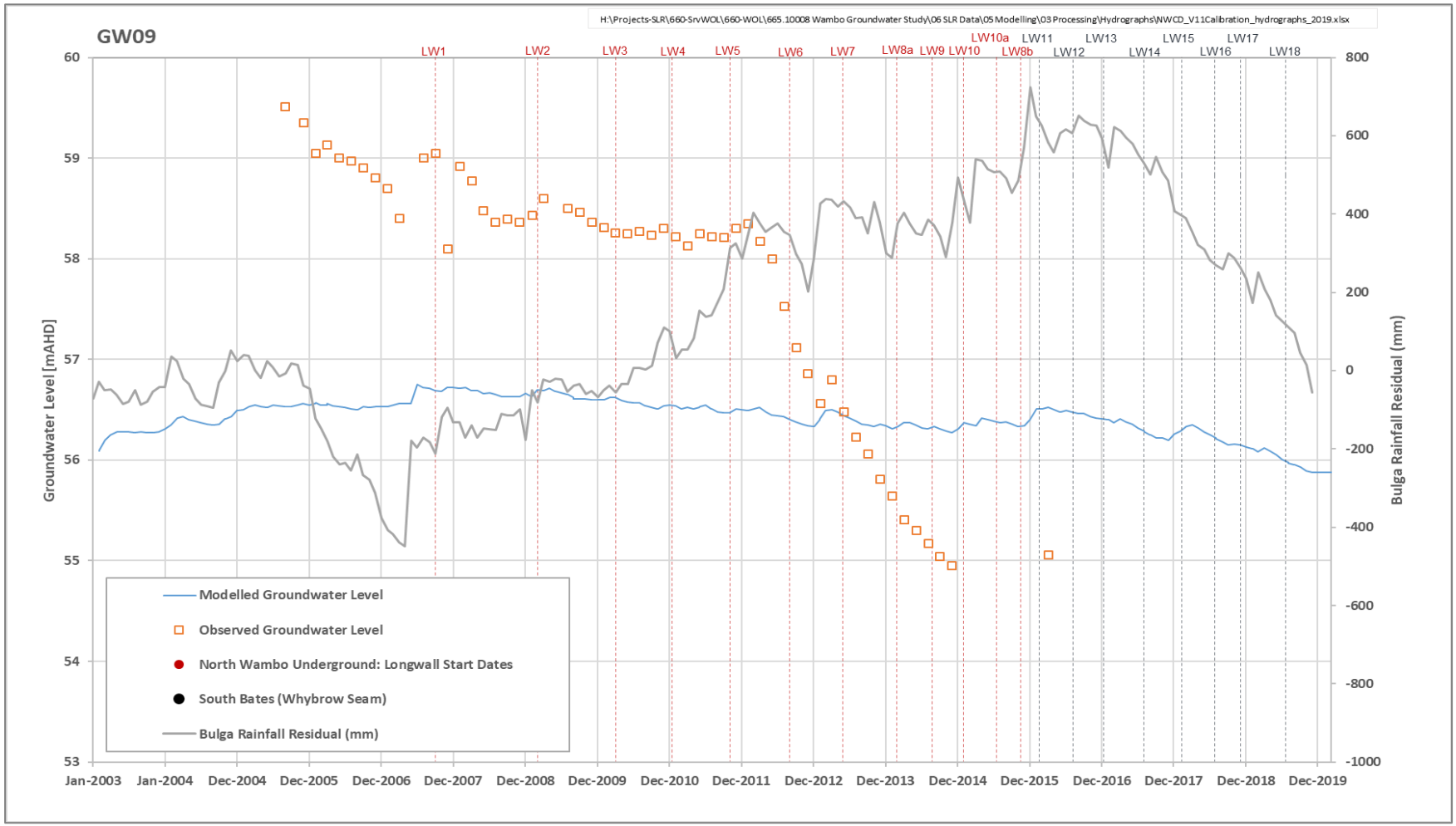

Figure 30 GW09 Calibration Hydrographs

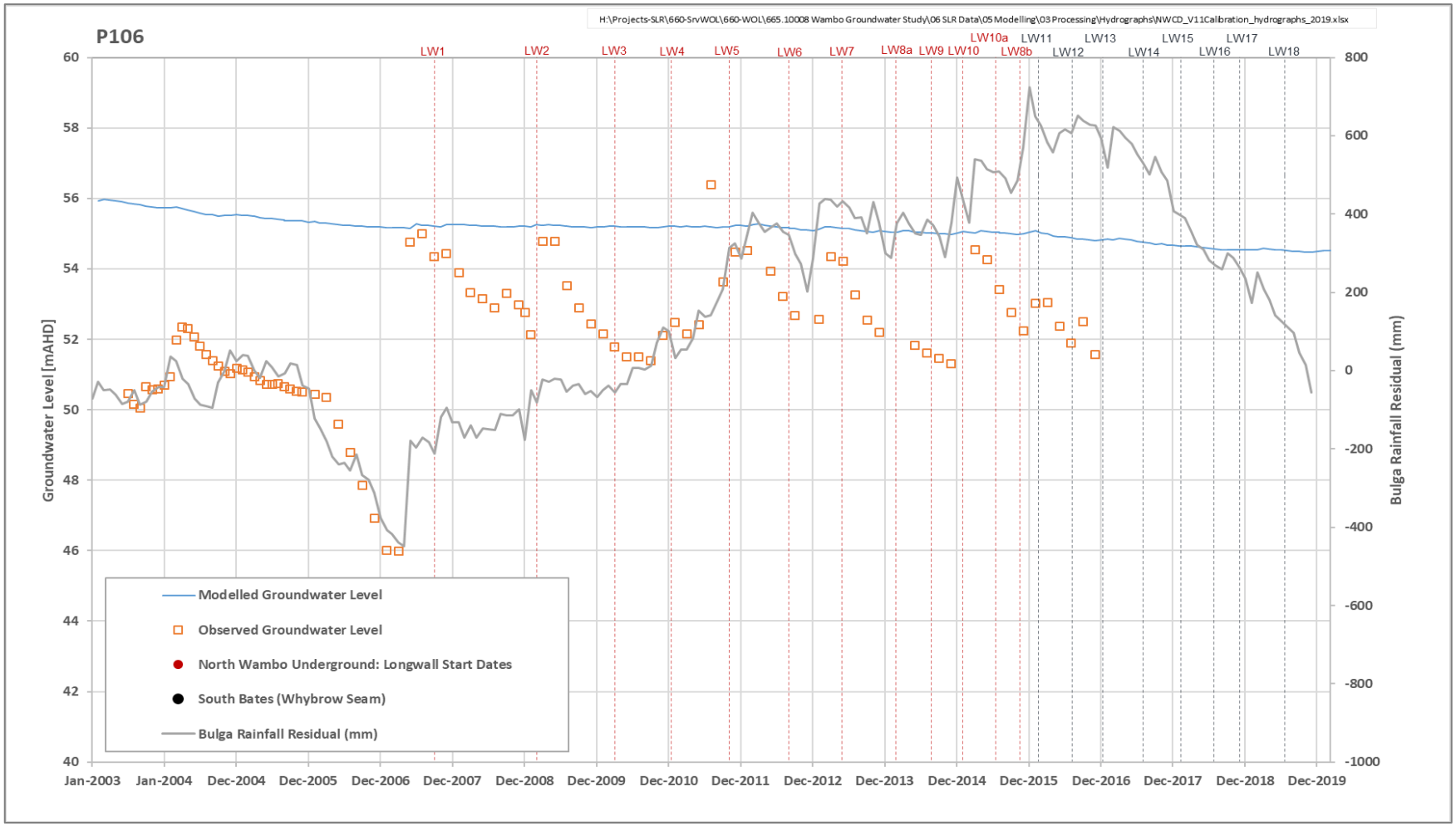

Figure 31 P106 Calibration Hydrographs

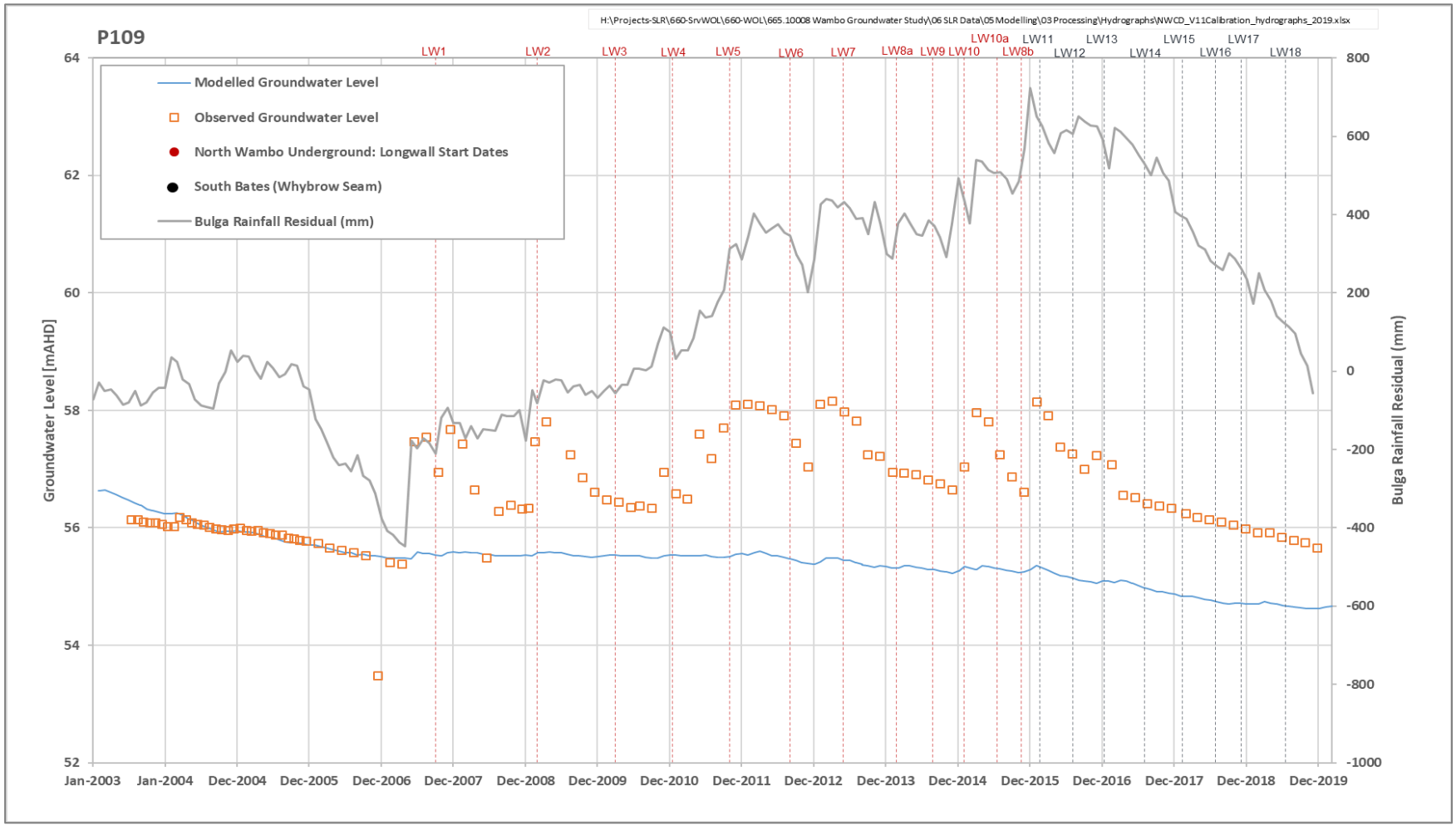

Figure 32 P109 Calibration Hydrographs

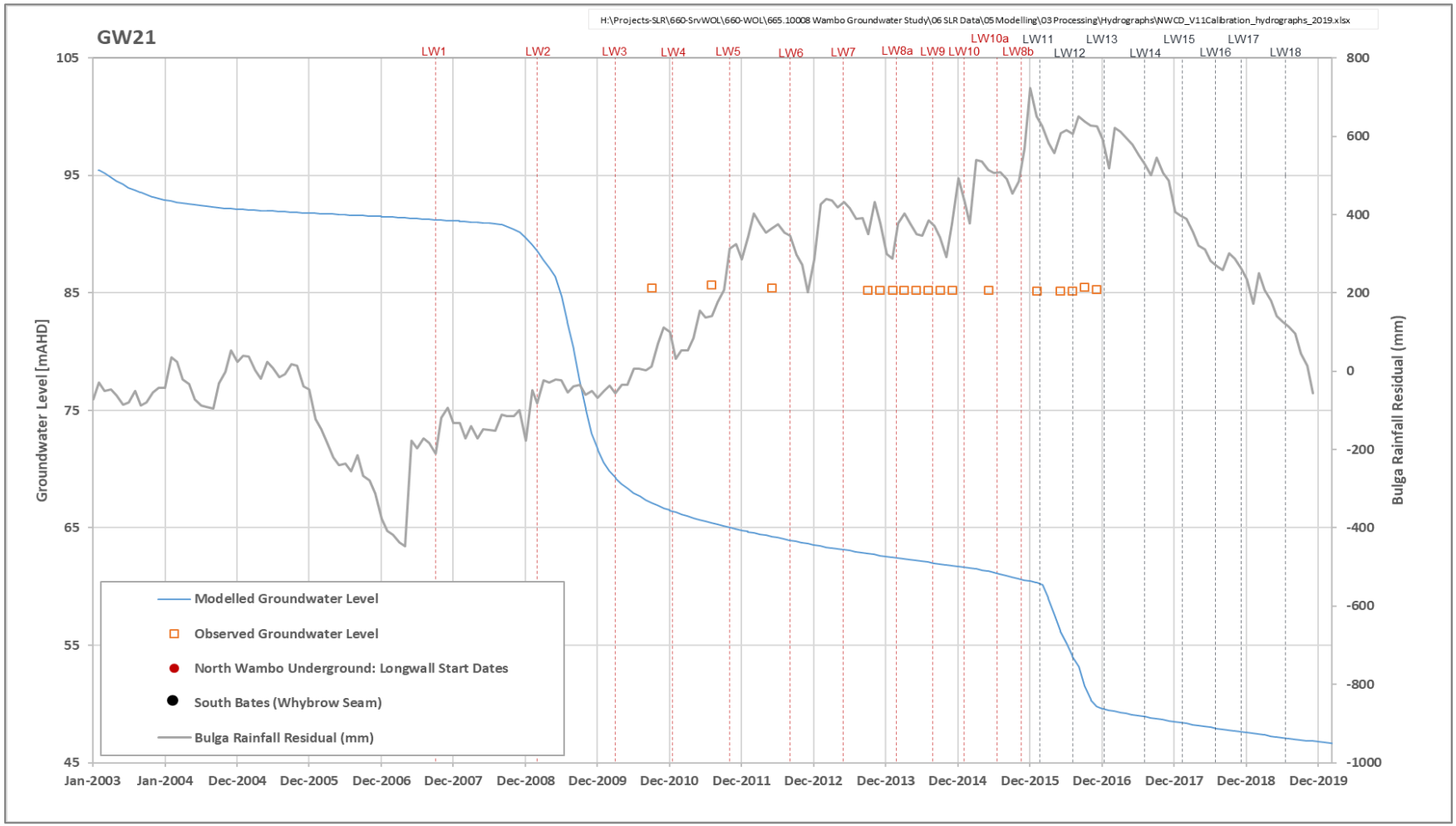

Figure 33 GW21 Calibration Hydrographs

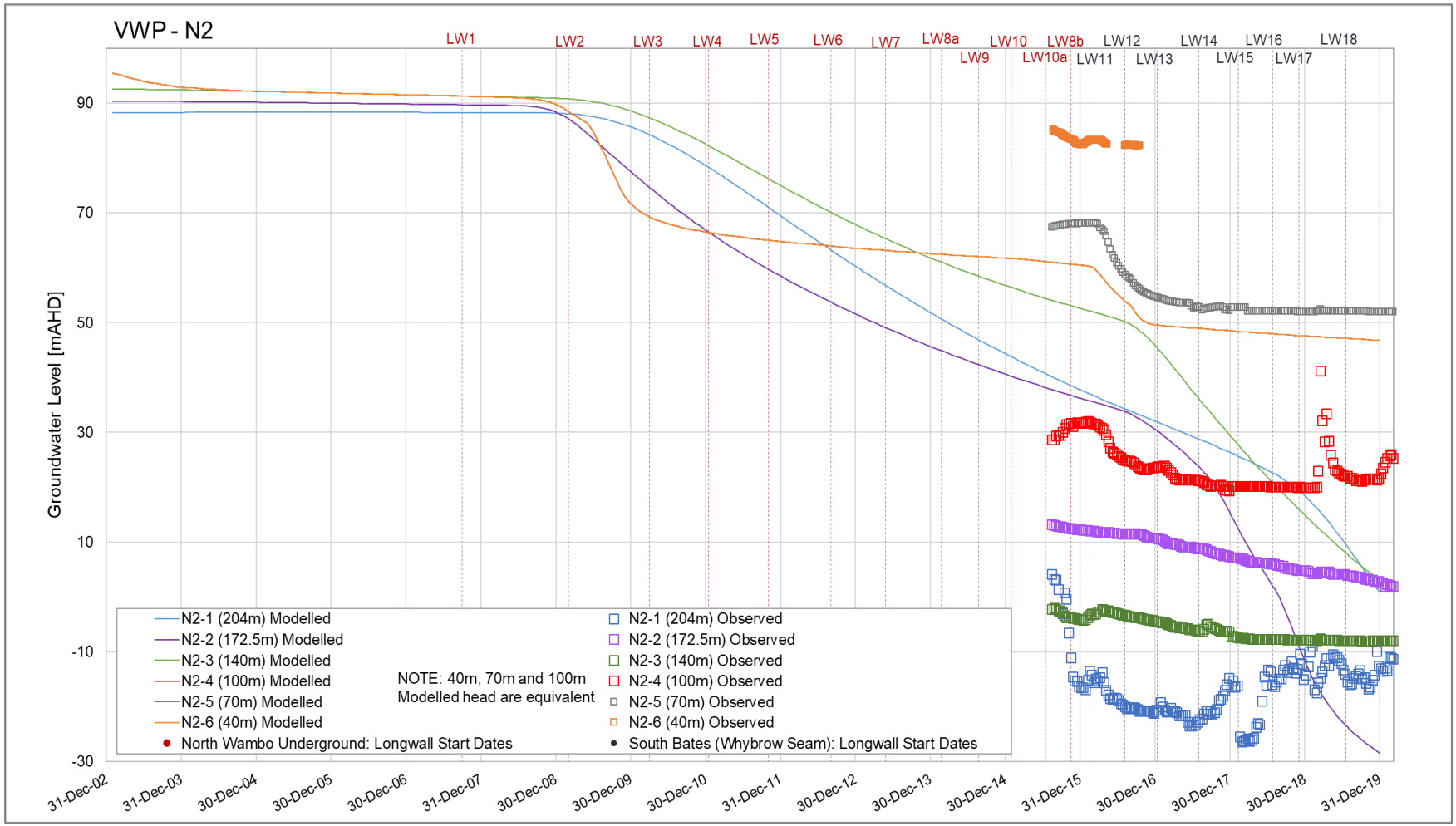

Figure 34 N2 Calibration Hydrographs

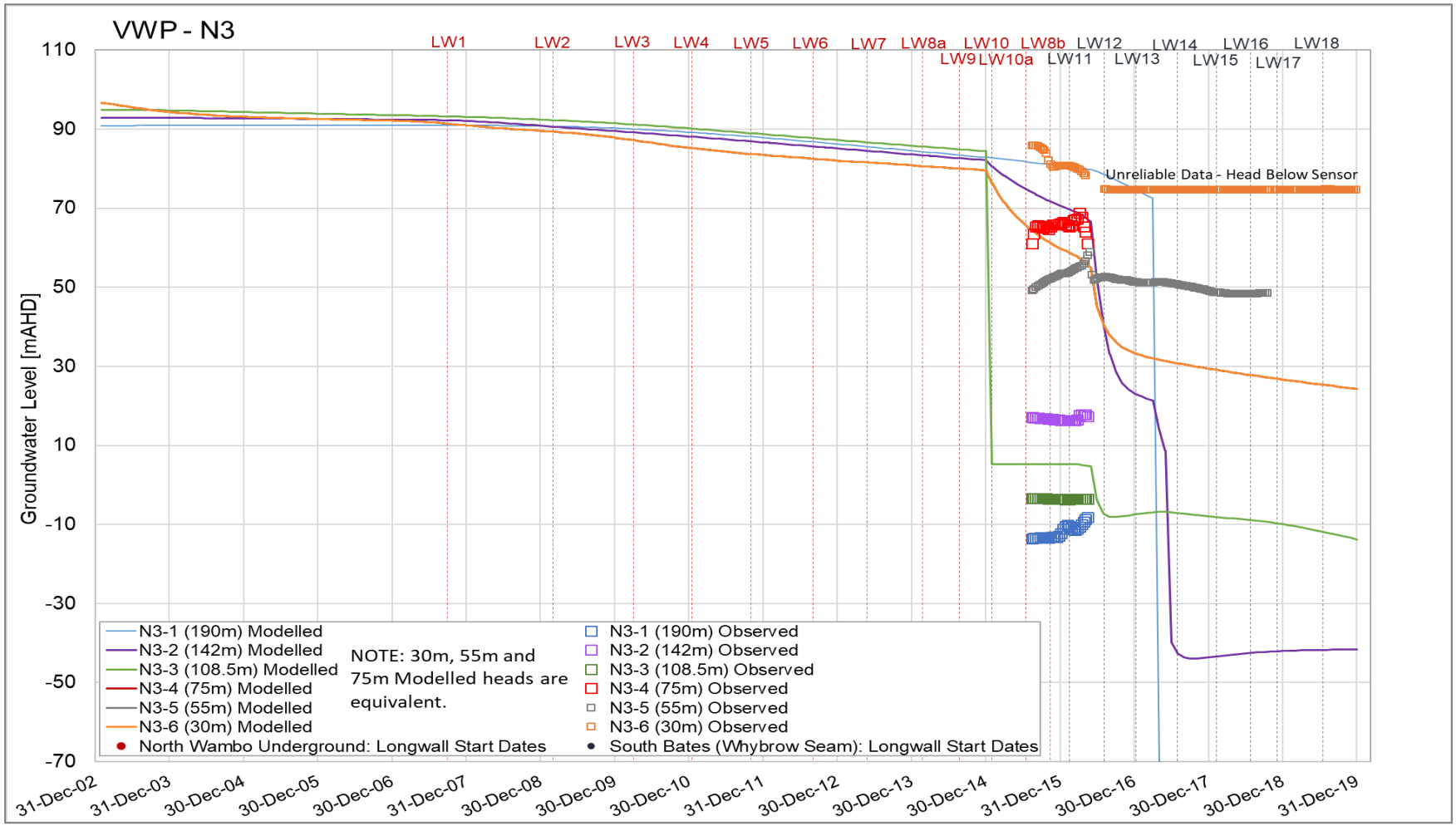

Figure 35 N3 Calibration Hydrographs

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APPENDIX H

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17 March 2020

Commercial-in-Confidence

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PMB 1
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Dear Nicole,

Report on stream flow events along North Wambo, South Wambo and Stoney Creeks for the period 1 January to 31 December 2019.

Please find contained within this report a summary of probable flow events which occurred along North Wambo, South Wambo and Stony Creeks from and inclusive of 1 January to 31 December 2019.

1.0 Locations, Configurations and Observations

The flow monitoring network now comprises of eleven flow monitoring stations. These flow monitoring stations are distributed along the following creeks: -

- North Wambo Creek has five flow monitoring stations;
- South Wambo Creek has three flow monitoring stations, and;
- Stony Creek has two monitoring stations with an additional flow monitoring station located on a major tributary to Stony Creek.

Details of the location (**Table 1, Table 2, Figure 1** and **Figure 2**), configuration (**Table 3**) and observations (**Table 4**) for each flow monitoring station are provided below.

Table 1 Flow Station Locations

Station ID	Location	Easting	Northing
FM1	North Wambo Creek adjacent to the mine	307014	6396139
USFM1	North Wambo Creek upstream of mine	305257	6395201
FM2	Midway along old North Wambo Creek diversion	308217	6395056
FM3	Midway along new North Wambo Creek diversion	309226	6393663
FM4	North Wambo Creek upstream of the confluence of Wollombi Brook	311906	6392160
FM15	South Wambo Creek upstream of the confluence of Wollombi Brook	311814	6391224
FM16	South Wambo Creek upstream of washout of Wambo Mine Road	311279	6390673
FM9	South Wambo Creek downstream	308666	6389176
FM12	Stony Creek upstream of proposed area to be mined	307711	6392744
FM14	Major tributary of Stony Creek upstream of proposed area to be mined	307723	6392242
FM13	Stony Creek downstream of proposed area to be mined	309537	6391090

Table 2 Atmospheric Pressure Correcting Station Locations

Station ID	Location	Easting	Northing
PM2	Midway along old North Wambo Creek diversion at Flow Station FM2 data logging housing	308196	6395042
PM6	South Wambo Creek upstream of washout of Wambo Mine Road inside the data logger housing for old Flow Station FM6	311253	6390711
PM8	Stony Creek upstream on the old Flow Station FM8 infrastructure	307996	6392278
PM7	Stony Creek downstream on the old Flow Station FM7 infrastructure	309400	6391443

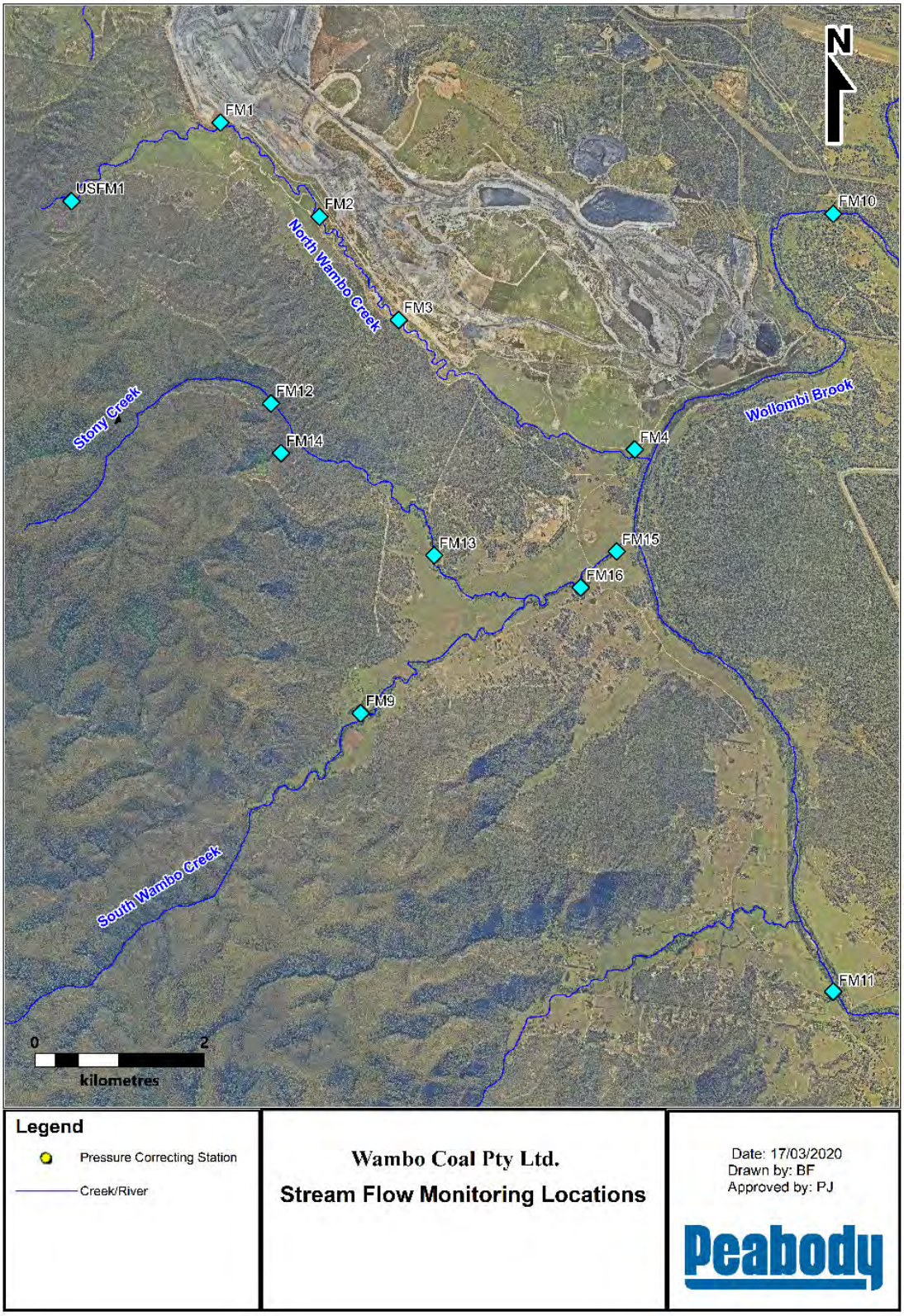

Figure 1 Stream Flow Locations

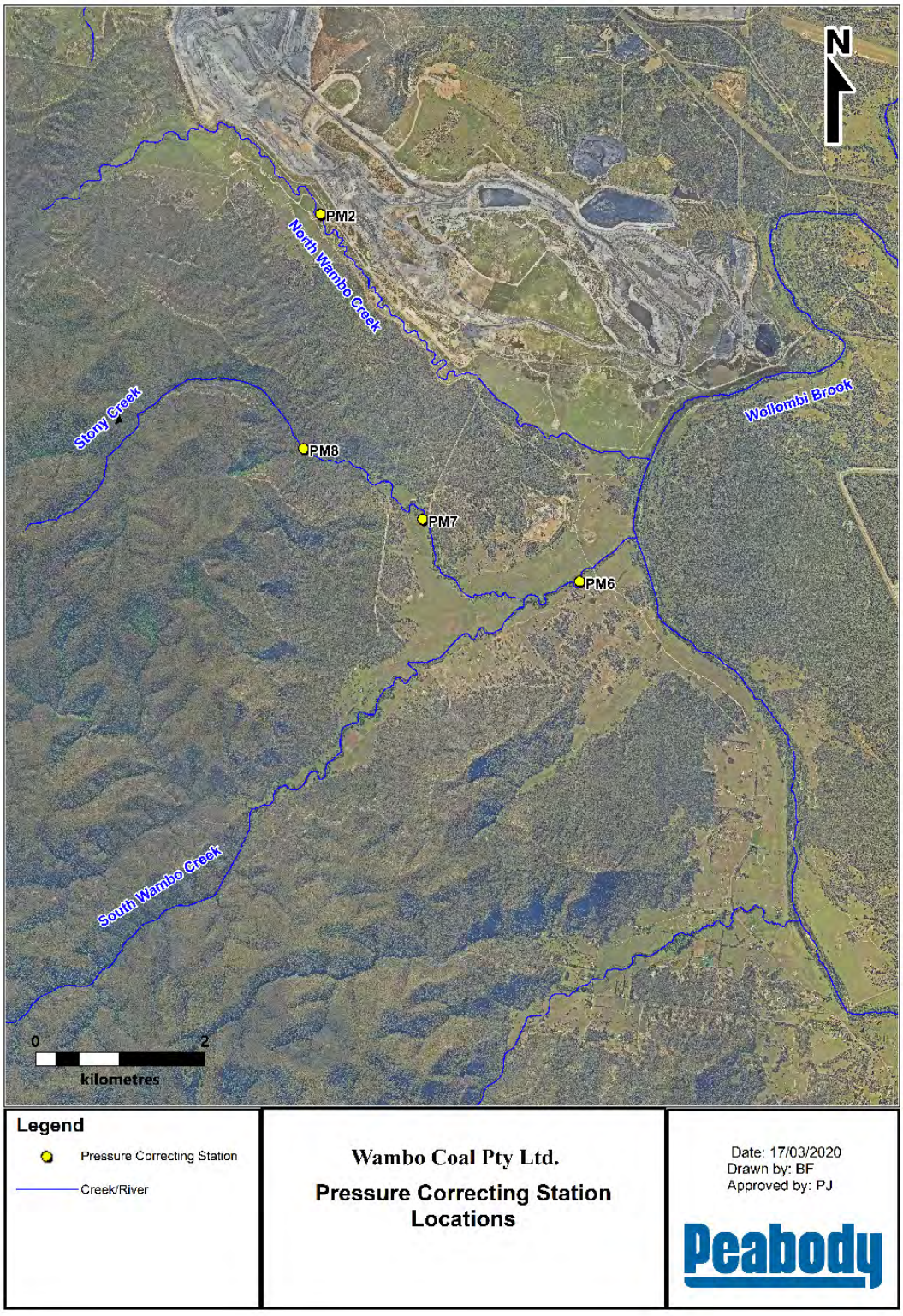

Figure 2 Pressure Correcting Station Locations

Table 3 Monitoring Location Equipment Configurations

Station ID	Equipment	Corresponding Correction Station
FM1	Campbell Scientific (CSA) CS451 SDI-12 pressure transducer connected to a CSA CR800 series data logger, powered by a 12-volt lead acid battery with solar charging. Data is logged hourly. A backup Insitu Rugged TROLL 100 absolute pressure sensor logging data at 10-minute intervals is also installed.	**PM2**
USFM1	Insitu Rugged TROLL 100 absolute pressure sensor. Data is logged at 10-minute intervals	**PM2**
FM2	CSA CS450 SDI 12 pressure transducer connected to a CSA CR200X series data logger, powered by a 12-volt lead acid battery with solar charging. Data is logged at 10-minute intervals.	N/A
FM3	CSA CS450 SDI 12 pressure transducer connected to a CSA CR200X series data logger, powered by a 12-volt lead acid battery with solar charging. Data is logged at 10-minute intervals.	N/A
FM4	CSA CS450 SDI 12 pressure transducer connected to a CSA CR200X series data logger, powered by a 12-volt lead acid battery with solar charging. Data is logged at 10-minute intervals. A backup Insitu Rugged TROLL 100 absolute pressure sensor logging data at 10-minute intervals is also installed.	**PM2**
FM15	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals.	**PM6**
FM16	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals.	**PM6**
FM9	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals.	**PM6**
FM12	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals	**PM8**
FM14	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals	**PM8**
FM13	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals	**PM7**
PM2	Insitu Rugged BaroTROLL. Data is logged at 10-minute intervals	N/A
PM6	Insitu Rugged BaroTROLL. Data is logged at 10-minute intervals	N/A
PM8	Insitu Rugged BaroTROLL. Data is logged at 10-minute intervals	N/A
PM7	Insitu Rugged BaroTROLL. Data is logged at 10-minute intervals	N/A

Table 4 Monitoring Location General Observations

Station ID	Observations
FM1	Originally located at the top of North Wambo Creek upstream of surface water monitoring site SW04; re-located approximately 300 to 400m further downstream in December 2017 – downstream of surface water monitoring site SW04
USFM1	New station installed on North Wambo Creek during December 2017; located approximately 1 kilometre upstream of the original site of FM1
FM2	Located downstream from relocated Flow Station FM1 approximately midway along the old North Wambo Creek diversion
FM3	Originally located on North Wambo Creek between the old Wambo Underground Surface Infrastructure and the Open Cut Overburden: relocated in May 2013 to approximately midway along the new diversion of North Wambo Creek downstream of Flow Station FM2
FM4	Located at the Wambo Mine Road culvert which crosses North Wambo Creek upstream of the confluence of North Wambo Creek and Wollombi Brook
FM15	Located on South Wambo Creek just upstream of the confluence of South Wambo Creek and Wollombi Brook; relocated to approximately 100 to 200m downstream in December 2016
FM16	Located on South Wambo Creek approximately 200 to 300 metres up stream of the washout on Wambo Mine Road
FM 9	Located approximately 2 kilometres upstream from its original location following a recommendation from Environmental Instrument Solutions' hydrographer
FM12	Re-located during September 2018 approximately 50 metres downstream from its original location following a recommendation from Environmental Instrument Solutions' hydrographer
FM14	Installed in December 2015
FM13	Re-located during September 2018 approximately 50 metres upstream from its original location following a recommendation from Environmental Instrument Solutions' hydrographer.
PM2	In November 2018 data collection it was identified that this BaroTROLL failed during October 2018. A replacement sensor was installed on 24 January 2019
PM6	N/A
PM8	N/A
PM7	N/A

2.0 Methodology

The results represent a theoretical flow and have been calculated using polynomial equations derived from theoretical flow rating curves. These theoretical flow curves were constructed from data received by AECOM from Wambo Coal and Environmental Instrument Solutions with the exception of the relocated Stony Creek flow monitoring station and the new monitoring station FM9 on South Wambo Creek.

Theoretical flow curves generated by AECOM were utilised to calculate theoretical flow along Stony Creek and its tributary when probable flow events occurred. No probable flow events were detected at the Stony Creek Flow Monitoring Station FM12 and FM13 after their relocation in September 2018.

The data for each theoretical flow rating curve has been generated from cross and long section surveys. From the surveys a cross sectional area and the wetted perimeter for various theoretical stream heights were derived.

From these derived values the hydraulic radius was calculated for each theoretical stream height. The hydraulic radius is calculated as follows:

Rh = A/P

Where:-

Rh = Hydraulic Radius

A = Calculated cross section area for a give stream height

P = Calculated wetted perimeter for a given stream height

The stream slope was calculated from the long section surveys and the Manning's coefficient of rugosity was determined from the conditions observed in the stream bed and surrounding flood plain.

These values were then entered into the Manning's equation and a theoretical stream velocity was calculated. The Manning's equation is as follows: -

$V = (Rh^{2/3} \times Sw^{1/2})/n$

Where: -

Rh = Hydraulic radius for a given stream height

Sw = Stream slope derived from the long section survey

n = Manning's coefficient of rugosity

The Manning's coefficient of rugosity was sourced from AS 3778.3.3 - 2001 *"Measurement of water flow in open channels, part 3.3: Velocity - area methods – Measurement by slope – area methods".*

The theoretical velocity, derived from the Manning's equation, was then multiplied by the calculated cross-sectional area for a given stream height to give a theoretical flow rate Q. The resultant theoretical flow rates were calculated for a series of stream heights and graphed to generate theoretical flow rating curves. **Appendix B** contains these theoretical flow rating curves for each Flow Monitoring Stations.

Note: AECOM did not perform the re-cross section and re-long section surveys at Flow Monitoring Stations 2 and 4. However a long section only survey at Flow Monitoring Station 3 was performed following the re-adjustment of the sensor height in relation to the cease to flow point. Therefore, depicted stream cross section profiles as presented in **Appendix C** are as presented in previous reports for these flow monitoring stations.

The data collected from each Flow Station was presented as a pressure reading in kPa. This pressure was converted to a stream height in metres using the following equation: -

Stream Height (m) = Stream Height (kPa) X 0.101972 (m/kPa)

The calculated stream height was then compared to the cease to flow point at each site. The cease to flow point was identified in conjunction with the long section surveys and represents a point in the reach/stream which the height of the stream must attain before it starts to flow.

The relative level of the cease to flow point was compared to the relative level of the sensor at each station. The difference in height between the cease to flow point and the sensor was calculated. This difference was used to screen the data collected from each station for probable flow events.

Once a flow event had been recognised at a flow monitoring station the resultant stream height was applied to the polynomial equation derived from theoretical flow rating curve, for that flow station, to give a theoretical stream flow rate for the identified flow event at the station. In some instances, more than one polynomial equation was required; see flow rating curves in **Appendix B**.

3.0 Results

There were no recordable flow events at the following flow stations during the period 1 January to 31 December 2019: -

- Re-Located Flow Monitoring Station FM1 and its backup sensor – North Wambo Creek;
- New Flow Monitoring Station USFM1 – Upper North Wambo Creek;
- Flow Monitoring Station FM15 – South Wambo Creek;
- Flow Monitoring Station FM16 – South Wambo Creek;
- Flow Monitoring Station FM9 – South Wambo Creek;
- Flow Monitoring Station FM12 – Stony Creek upstream;
- Flow Monitoring Station FM14 – Major tributary of Stony Creek, and;
- Flow Monitoring Station FM13 – Stony Creek downstream.

Table 5, Table 6 and **Table 7** below present a summary of probable flow events for each flow station (including the backup sensors located at flow stations FM1 and FM4) for the period from 1 January to 31 December 2019.

All results displayed in the following tables in respect to stream flow are theoretical and should be treated as such. Note the barometric sensor (baroTROLL) utilised to correct for barometric fluctuations in the data collected from the sensors and backup sensor along North Wambo Creek failed after 8 October 2018. Data from that date to 24 January 2019 cannot be corrected reliably for atmospheric pressure fluctuations and has been excluded.

Table 5 Flow Monitoring Station FM2 North Wambo Creek Mid Old Diversion – Summary of Results – 1 January to 31 December 2019.

Flow Event No.	Start Date & Time	End Date & Time	Duration (Days)	Average Stream Height (m)	Maximum Stream Height (m)	Average Theoretical Flow Rate		Maximum Theoretical Flow Rate	
						m^3/s	ML/d	m^3/s	ML/d
1	18/03 01:00	18/03 10:20	0.39	0.012	0.034	0.008	0.68	0.023	1.96
2	23/03 20:30	23/03 21:20	0.03	0.006	0.018	0.004	0.34	0.012	1.01
3	30/03 03:10	30/03 17:20	0.59	0.056	0.20	0.037	3.23	0.13	11.3

Table 6 Flow Monitoring Station FM3 North Wambo Creek Mid New Diversion – Summary of Results – 1 January to 31 December 2019.

Flow Event No.	Start Date & Time	End Date & Time	Duration (Days)	Average Stream Height (m)	Maximum Stream Height (m)	Average Theoretical Flow Rate		Maximum Theoretical Flow Rate	
						m^3/s	ML/d	m^3/s	ML/d
1	21/01 00:40	21/01 04:50	0.17	0.025	0.068	0.017	1.45	0.045	3.88
2	17/03 15:20	17/03 17:20	0.08	0.023	0.040	0.015	1.31	0.026	2.28
3	17/03 18:00	17/03 19:50	0.08	0.013	0.022	0.009	0.74	0.015	1.25
4	18/03 00:50	18/03 06:10	0.22	0.023	0.036	0.015	1.33	0.024	2.07
5	23/03 20:50	23/03 22:00	0.05	0.008	0.017	0.006	0.49	0.012	1.00
6	30/03 03:00	30/03 10:30	0.31	0.059	0.14	0.039	3.37	0.093	8.07

Table 7 Flow Monitoring Station FM4 North Wambo Creek upstream of the confluence of Wollombi Brook – Summary of Results – 1 January to 31 December 2019.

Flow Event No.	Start Date & Time	End Date & Time	Duration (Days)	Average Stream Height (m)	Maximum Stream Height (m)	Average Theoretical Flow Rate		Maximum Theoretical Flow Rate	
						m^3/s	ML/d	m^3/s	ML/d
1	21/01 01:10	21/01 04:50	0.15	0.12	0.33	0.45	39	1.69	146
2	30/03 04:30	30/03 11:10	0.28	0.15	0.28	0.56	49	1.27	110

A summary of total monthly rain fall data presented in **Table 8** below was derived from the Wambo Coal's Meteorological Station located next to the helicopter pad near the Mine Infrastructure Area.

Table 8 Monthly Total Rain Fall Data – 1 January to 31 December 2019.

Month	Wambo Coal's Meteorological Station Total Rain Fall (mm)	Number of Days Rain Fell in the Month
January	78.2	13
February	29.2	8
March	166.2	11
April	6.6	8
May	12.4	7
June	5.4	7
July	16.8	9
August	28.6	5
September	23.4	5
October	1.2	4
November	19.4	6
December	0.0	0

The daily rain fall data was used to cross reference the raw data collected from the Flow Monitoring Stations to help identify periods where a flow event may have occurred.

Appendix C contains, where theoretical flow events were recognised, graphical depictions on stream height and theoretical flow in conjunction with daily and cumulative rain in three-month increments.

- Increment one – 1 January to 31 March 2019;
- Increment two – 1 April to 30 June 2019 (No graphs constructed due to no flow events during this period);
- Increment three – 1 July to 30 September 2019 (No graphs constructed due to no flow events during this period), and;
- Increment four – 1 October to 31 December 2019 (No graphs constructed due to no flow events during this period).

The results presented in the above tables should be read with the following qualifying statements in mind: -

- All flow events represent a theoretical flow and have been derived from stream height data. The stream height data was then applied to polynomial equations derived from theoretical flow rating curves to give a theoretical flow. These theoretical flow rating curves were generated using cross and long section surveys in conjunction with the Manning's equation. These theoretical flow rating curves were constructed by AECOM in 2019 on data provided by Environmental Instrument Solutions;
- North Wambo, South Wambo and Stony Creeks are ephemeral and as such only flow after significant rainfall events, therefore the theoretical flow rating curves in **Appendix B** have not been calibrated/checked against actual physical measurements of flow using a current meter;
- Some flow events may have been overlooked due to, but not limited to, poor data quality, data missing, inconsistent data, sensor failure or loss, logger failure, power supply problems and changes to stream bed characteristics, and;
- The three flow monitoring stations installed on Stony Creek and its associated tributary have been positioned such as to be outside a proposed underground mine area and designed to monitor stream flow and any associated effect of underground mining on stream flow. These stations were installed by AECOM on 7 December 2016 and replace flow monitoring stations 7 and 8.

4.0 Recommendations

During the period 1 January to 31 December 2019 no issues were encountered with the stream monitoring network.

Due to the failure of the Barometric correction sensor associated the absolution pressure sensor along North Wambo Creek resulting in unusable data from October 2018 to 24 January 2019 AECOM recommends that the percentage battery used in the remaining Insitu sensors at the flow stations along Stony and South Wambo Creek be closely monitored. Once the percentage battery used is great than 50% and as delivery lead times are unpredictable (estimated 4 to 6 weeks) consideration should be given to obtaining replacement loggers.

In addition, AECOM suggests that future reports contain an additional Appendix (Appendix D) in which a photographic record of stream bed characteristics can be presented for each flow monitoring station for the reporting period. Two photographs would be taken at each site at each data collection event, one facing upstream and the other facing downstream from the station's sensor.

If Wambo Coal wishes AECOM to proceed with the one or both of the above recommendations, please contact us.

If you have any questions or require any clarification of aspects in this report, please contact us in the Singleton office.

Yours faithfully

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encl: Appendix A - Flow Station Field Sheets and Station Data Logger Status Sheets.
Appendix B - Theoretical Flow Rating Curves.
Appendix C - Stream Height, Theoretical Flow, Daily and Cumulative Rainfall Charts.

Addendum: Comparison of Flow Monitoring Data with the Surface Water Monitoring Plan (SWMP)

Section 3.2 of the SWMP states:

"Flow impact assessment criteria for the local mine site ephemeral creeks are based on the unexpected absence of flow in climatic situations when flows would be expected. The impact assessment criteria would be met if there was no flow recorded at the flow monitoring site either on the day or the day after the recorded rainfall was equal to or greater than the nominated amount. The resulting runoff generating rainfall values are given in Table 11" of the SWMP which has been reproduced as **Table 9** below.

Table 9 Surface Water Flow Impact Assessment Condition

Watercourse and flow monitoring site	Daily rainfall when flow commenced on 80% of recorded occasions
Stony Creek – FM13	20mm
South Wambo Creek – FM5	20mm
North Wambo Creek – FM4	20mm

Table 10 below lists the dates from 1 January to 31 December 2019 when 20mm or greater of rainfall was recorded at the Wambo Coal's Meteorological Station located next to the helicopter pad near the Mine Infrastructure Area and corresponding flow events, if any, at flow monitoring sites FM13, FM5 and FM4.

Table 10 Dates of Rainfall Greater than 20mm and Corresponding Flow Events

Date	24 hour Rainfall (mm)	Site FM13	Site FM5	Site FM4
21/01/2019	40.2	No flow event	No flow event	Flow event 21/01/2019 1:10 to 4:50
16/03/2019	21.2	No flow event	No flow event	No flow event
17/03/2019	26.2	No flow event	No flow event	No flow event
30/03/2019	65.8	No flow event	No flow event	Flow event 30/03/2019 4:30 to 11:10

Appendix A

Flow Station Field Sheets & Data Logger Status Sheets

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60248386 - Wambo Coal - Quarterly Flow Station Field Sheet

Flow Station No.	Location (Creek)	Date	Time	Logger Type	Solar Panel Output (V)	Battery(V)	Solar Panel Cleaned	Battery Replaced	Memory Used (%)	Battery Used (%)	Data Collected	Sensor Operating	Logger Operating	Stream Observations	Height of Water Above Sensor (mm)	Comments
Upstream old FM1	North Wambo	6/02/2019	10:30	RuggedTroll	-	-	-	-	50	9	Y	Y	Y	Dry	0	Data wrap on
Old FM1	North Wambo	6/02/2019	10:50	RuggedTroll	-	-	-	-	6	0	Y	Y	Y	Dry	0	Data wrap on New logger
FM1 New Location	North Wambo	6/02/2019	11:15	CS-CR800	20.00	13.85	Y	N	-	-	Y	Y	Y	Dry	0	
FM1 New Location BU	North Wambo	6/02/2019	11:30	RuggedTroll	-	-	-	-	50	9	Y	Y	Y	Dry	0	Data wrap on New logger
FM2	North Wambo	6/02/2019	12:00	CS-CR200	21.55	13.24	Y	N	-	-	Y	Y	Y	Dry	0	
BarroLogger NWC	North Wambo	6/02/2019	12:20	BaroTroll	-	-	-	-	6	0	Y	Y	Y	-	-	Data wrap on New barrologger
FM3	North Wambo	6/02/2019	9:40	CS-CR200	20.13	13.26	Y	N	-	-	Y	Y	Y	Dry	0	
FM4	North Wambo	6/02/2019	9:05	CS-CR200	17.58	13.27	Y	Y	-	-	Y	Y	Y	Dry	0	
FM4 BU	North Wambo	6/02/2019	9:20	RuggedTroll	-	-	-	-	7	0	Y	Y	Y	Dry	0	Data wrap on New logger
FM12 SCUP	Stoney	5/02/2019	10:35	RuggedTroll	-	-	-	-	100	28	Y	Y	Y	Dry	0	Data wrap on
FM14 SCtrib	Stoney Ck Trubutary	5/02/2019	9:50	RuggedTroll	-	-	-	-	100	28	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Up Barro	Stoney	5/02/2019	11:10	BaroTroll	-	-	-	-	100	26	Y	Y	Y	-	-	Data wrap on
FM13 SCDown	Stoney	5/02/2019	12:20	RuggedTroll	-	-	-	-	100	28	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Down Barro	Stoney	5/02/2019	12:40	BaroTroll	-	-	-	-	100	26	Y	Y	Y	-	-	Data wrap on
FM9 Brossi	South Wambo	5/02/2019	11:50	RuggedTroll	-	-	-	-	21	13	Y	Y	Y	Dry	0	Data wrap on
FM15 (FM5)	South Wambo	5/02/2019	13:15	RuggedTroll	-	-	-	-	90	17	Y	Y	Y	Dry	0	Data wrap on
FM16 (FM6)	South Wambo	5/02/2019	13:50	RuggedTroll	-	-	-	-	90	17	Y	Y	Y	Dry	0	Data wrap on
Barro Logger SWC	South Wambo	5/02/2019	14:05	BaroTroll	-	-	-	-	90	17	Y	Y	Y	-	-	Data wrap on
Upstream old FM1	North Wambo	23/05/2019	10:55	RuggedTroll	-	-	-	-	62	11	Y	Y	Y	Dry	0	Data wrap on
Old FM1	North Wambo	23/05/2019	11:25	RuggedTroll	-	-	-	-	18	2	Y	Y	Y	Dry	0	Data wrap on
FM1 New Location	North Wambo	23/05/2019	11:35	CS-CR800	20.00	13.87	Y	N	-	-	Y	Y	Y	Dry	0	
FM1 New Location BU	North Wambo	23/05/2019	11:50	RuggedTroll	-	-	-	-	62	11	Y	Y	Y	Dry	0	Data wrap on
FM2	North Wambo	23/05/2019	12:20	CS-CR200	22.03	13.34	Y	N	-	-	Y	Y	Y	Dry	0	
BarroLogger NWC	North Wambo	23/05/2019	12:40	BaroTroll	-	-	-	-	18	2	Y	Y	Y	-	-	Data wrap on
FM3	North Wambo	23/05/2019	10:10	CS-CR200	20.48	13.41	Y	N	-	-	Y	Y	Y	Dry	0	Sensor required cleaning Caked in dry mud
FM4	North Wambo	23/05/2019	9:20	CS-CR200	20.20	13.47	Y	N	-	-	Y	Y	Y	Dry	0	
FM4 BU	North Wambo	23/05/2019	9:55	RuggedTroll	-	-	-	-	18	2	Y	Y	Y	Dry	0	Data wrap on
FM12 SCUP	Stoney	24/05/2019	9:35	RuggedTroll	-	-	-	-	100	29	Y	Y	Y	Dry	0	Data wrap on
FM14 SCtrib	Stoney Ck Trubutary	24/05/2019	9:00	RuggedTroll	-	-	-	-	100	30	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Up Barro	Stoney	24/05/2019	10:05	BaroTroll	-	-	-	-	100	29	Y	Y	Y	-	-	Data wrap on
FM13 SCDown	Stoney	24/05/2019	11:20	RuggedTroll	-	-	-	-	100	30	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Down Barro	Stoney	24/05/2019	11:35	BaroTroll	-	-	-	-	100	29	Y	Y	Y	-	-	Data wrap on
FM9 Brossi	South Wambo	24/05/2019	10:05	RuggedTroll	-	-	-	-	34	15	Y	Y	Y	Dry	0	Data wrap on
FM15 (FM5)	South Wambo	24/05/2019	12:05	RuggedTroll	-	-	-	-	100	19	Y	Y	Y	Dry	0	Data wrap on
FM16 (FM6)	South Wambo	24/05/2019	12:25	RuggedTroll	-	-	-	-	100	19	Y	Y	Y	Dry	0	Data wrap on
Barro Logger SWC	South Wambo	24/05/2019	12:35	BaroTroll	-	-	-	-	100	19	Y	Y	Y	-	-	Data wrap on

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60248386 - Wambo Coal - Quarterly Flow Station Field Sheet

Flow Station No.	Location (Creek)	Date	Time	Logger Type	Solar Panel Output (V)	Battery(V)	Solar Panel Cleaned	Battery Replaced	Memory Used (%)	Battery Used (%)	Data Collected	Sensor Operating	Logger Operating	Stream Observations	Height of Water Above Sensor (mm)	Comments
Upstream old FM1	North Wambo	19/07/2019	10:05	RuggedTroll	-	-	-	-	68	12	Y	Y	Y	Dry	0	Data wrap on
Old FM1	North Wambo	19/07/2019	10:24	RuggedTroll	-	-	-	-	25	3	Y	Y	Y	Dry	0	Data wrap on
FM1 New Location	North Wambo	19/07/2019	10:35	CS-CR800	20.00	14.12	Y	N	-	-	Y	Y	Y	Dry	0	
FM1 New Location BU	North Wambo	19/07/2019	10:50	RuggedTroll	-	-	-	-	68	12	Y	Y	Y	Dry	0	Data wrap on
FM2	North Wambo	19/07/2019	11:10	CS-CR200	22.53	13.59	Y	N	-	-	Y	Y	Y	Dry	0	
BarroLogger NWC	North Wambo	19/07/2019	11:20	BaroTroll	-	-	-	-	25	3	Y	Y	Y	-	-	Data wrap on
FM3	North Wambo	19/07/2019	9:30	CS-CR200	21.47	13.71	Y	N	-	-	Y	Y	Y	Dry	0	
FM4	North Wambo	19/07/2019	8:40	CS-CR200	14.52	13.17	Y	Y	-	-	Y	Y	Y	Dry	0	
FM4 BU	North Wambo	19/07/2019	9:00	RuggedTroll	-	-	-	-	25	3	Y	Y	Y	Dry	0	Data wrap on
FM12 SCUP	Stoney	18/07/2019	9:35	RuggedTroll	-	-	-	-	100	30	Y	Y	Y	Dry	0	Data wrap on
FM14 SCtrib	Stoney Ck Trubutary	18/07/2019	9:10	RuggedTroll	-	-	-	-	100	31	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Up Barro	Stoney	18/07/2019	10:05	BaroTroll	-	-	-	-	100	30	Y	Y	Y	-	-	Data wrap on
FM13 SCDown	Stoney	18/07/2019	10:55	RuggedTroll	-	-	-	-	100	31	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Down Barro	Stoney	18/07/2019	11:00	BaroTroll	-	-	-	-	100	30	Y	Y	Y	-	-	Data wrap on
FM9 Brossi	South Wambo	18/07/2019	10:30	RuggedTroll	-	-	-	-	40	16	Y	Y	Y	Dry	0	Data wrap on
FM15 (FM5)	South Wambo	18/07/2019	11:25	RuggedTroll	-	-	-	-	100	20	Y	Y	Y	Dry	0	Data wrap on
FM16 (FM6)	South Wambo	18/07/2019	11:40	RuggedTroll	-	-	-	-	100	20	Y	Y	Y	Dry	0	Data wrap on
Barro Logger SWC	South Wambo	18/07/2019	11:50	BaroTroll	-	-	-	-	100	20	Y	Y	Y	-	-	Data wrap on
Upstream old FM1	North Wambo	24/10/2019	12:05	RuggedTroll	-	-	-	-	81	14	Y	Y	Y	Dry	0	Data wrap on
Old FM1	North Wambo	24/10/2019	12:25	RuggedTroll	-	-	-	-	34	5	Y	Y	Y	Dry	0	Data wrap on
FM1 New Location	North Wambo	24/10/2019	12:40	CS-CR800	NA	13.73	Y	N	-	-	Y	Y	Y	Dry	0	
FM1 New Location BU	North Wambo	24/10/2019	12:45	RuggedTroll	-	-	-	-	81	14	Y	Y	Y	Dry	0	Data wrap on
FM2	North Wambo	24/10/2019	13:05	CS-CR200	NA	13.25	Y	N	-	-	Y	Y	Y	Dry	0	
BarroLogger NWC	North Wambo	24/10/2019	13:10	BaroTroll	-	-	-	-	34	5	Y	Y	Y	-	-	Data wrap on
FM3	North Wambo	24/10/2019	11:25	CS-CR200	NA	13.24	Y	N	-	-	Y	Y	Y	Dry	0	Sensor required cleaning
FM4	North Wambo	24/10/2019	8:15	CS-CR200	NA	13.50	Y	N	-	-	Y	Y	Y	Dry	0	
FM4 BU	North Wambo	24/10/2019	8:15	RuggedTroll	-	-	-	-	34	5	Y	Y	Y	Dry	0	Data wrap on
FM12 SCUP	Stoney	24/10/2019	9:55	RuggedTroll	-	-	-	-	100	32	Y	Y	Y	Dry	0	Data wrap on
FM14 SCtrib	Stoney Ck Trubutary	24/10/2019	9:15	RuggedTroll	-	-	-	-	100	34	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Up Barro	Stoney	24/10/2019	10:25	BaroTroll	-	-	-	-	100	32	Y	Y	Y	-	-	Data wrap on
FM13 SCDown	Stoney	24/10/2019	10:50	RuggedTroll	-	-	-	-	100	34	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Down Barro	Stoney	24/10/2019	11:05	BaroTroll	-	-	-	-	100	32	Y	Y	Y	-	-	Data wrap on
FM9 Brossi	South Wambo	25/10/2019	8:30	RuggedTroll	-	-	-	-	50	19	Y	Y	Y	Dry	0	Data wrap on
FM15 (FM5)	South Wambo	25/10/2019	9:05	RuggedTroll	-	-	-	-	100	22	Y	Y	Y	Dry	0	Data wrap on
FM16 (FM6)	South Wambo	25/10/2019	9:25	RuggedTroll	-	-	-	-	100	22	Y	Y	Y	Dry	0	Data wrap on
Barro Logger SWC	South Wambo	25/10/2019	9:35	BaroTroll	-	-	-	-	100	22	Y	Y	Y	-	-	Data wrap on

AECOM

60248386 - Wambo Coal - Quarterly Flow Station Field Sheet

Flow Station No.	Location (Creek)	Date	Time	Logger Type	Solar Panel Output (V)	Battery(V)	Solar Panel Cleaned	Battery Replaced	Memory Used (%)	Battery Used (%)	Data Collected	Sensor Operating	Logger Operating	Stream Observations	Height of Water Above Sensor (mm)	Comments
Upstream old FM1	North Wambo	16/01/2020	9:45	RuggedTroll	-	-	-	-	90	16	Y	Y	Y	Dry	0	Data wrap on
Old FM1	North Wambo	16/01/2020	10:05	RuggedTroll	-	-	-	-	43	7	Y	Y	Y	Dry	0	Data wrap on
FM1 New Location	North Wambo	16/01/2020	10:20	CS-CR800	13.85	13.50	Y	N	-	-	Y	Y	Y	Dry	0	
FM1 New Location BU	North Wambo	16/01/2020	10:25	RuggedTroll	-	-	-	-	90	16	Y	Y	Y	Dry	0	Data wrap on
FM2	North Wambo	16/01/2020	10:40	CS-CR200	19.90	13.29	Y	N	-	-	Y	Y	Y	Dry	0	
BarroLogger NWC	North Wambo	16/01/2020	10:45	BaroTroll	-	-	-	-	42	7	Y	Y	Y	-	-	Data wrap on
FM3	North Wambo	16/01/2020	9:10	CS-CR200	19.08	13.08	Y	N	-	-	Y	Y	Y	Dry	0	
FM4	North Wambo	16/01/2020	8:10	CS-CR200	14.19	13.36	Y	Y	-	-	Y	Y	Y	Dry	0	
FM4 BU	North Wambo	16/01/2020	8:30	RuggedTroll	-	-	-	-	43	7	Y	Y	Y	Dry	0	Data wrap on
FM12 SCUP	Stoney	22/01/2020	9:10	RuggedTroll	-	-	-	-	100	34	Y	Y	Y	No Flow	130	Data wrap on
FM14 SCtrib	Stoney Ck Trubutary	22/01/2020	8:30	RuggedTroll	-	-	-	-	100	36	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Up Barro	Stoney	22/01/2020	9:40	BaroTroll	-	-	-	-	100	34	Y	Y	Y	-	-	Data wrap on
FM13 SCDown	Stoney	22/01/2020	10:35	RuggedTroll	-	-	-	-	100	36	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Down Barro	Stoney	22/01/2020	10:50	BaroTroll	-	-	-	-	100	34	Y	Y	Y	-	-	Data wrap on
FM9 Brossi	South Wambo	22/01/2020	10:10	RuggedTroll	-	-	-	-	59	21	Y	Y	Y	Dry	0	Data wrap on
FM15 (FM5)	South Wambo	22/01/2020	11:15	RuggedTroll	-	-	-	-	100	24	Y	Y	Y	Dry	0	Data wrap on
FM16 (FM6)	South Wambo	22/01/2020	11:30	RuggedTroll	-	-	-	-	100	24	Y	Y	Y	Dry	0	Data wrap on
Barro Logger SWC	South Wambo	22/01/2020	11:35	BaroTroll	-	-	-	-	100	24	Y	Y	Y	-	-	Data wrap on

60248386 – Wambo Flow Station 1 CR800 Data Logger Status Summary
6/02/2019 11:25:09

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 35.44 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 0

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39
Run Signature: 52401
Program Signature: 58453
Results for Last Program Compiled: CPU:WaterLevel_V2_1A_10.CR8 -- Compiled in SequentialMode.
Memory Free: 21644 bytes

Program Errors

Program Errors: 0
Skipped Scans: 0
Skipped Slow Scans: 0
Skipped System Scans: 0
Skipped Records in Hourly: 0
Skipped Records in Daily: 0
Skipped Records in BatteryData: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.83
Lithium Battery: 3.41
Number of times the datalogger's 12V supply has dropped below operating threshold: 0
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary
23/05/2019 11:43:25

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 30.91 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 0

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39
Run Signature: 52401
Program Signature: 58453
Results for Last Program Compiled: CPU:WaterLevel_V2_1A_10.CR8 -- Compiled in SequentialMode.
Memory Free: 21644 bytes

Program Errors

Program Errors: 0
Skipped Scans: 0
Skipped Slow Scans: 0
Skipped System Scans: 0
Skipped Records in Hourly: 0
Skipped Records in Daily: 0
Skipped Records in BatteryData: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.89
Lithium Battery: 3.39
Number of times the datalogger's 12V supply has dropped below operating threshold: 0
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary
19/07/2019 10:38:04

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 15.80 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 0

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39
Run Signature: 52401
Program Signature: 58453
Results for Last Program Compiled: CPU:WaterLevel_V2_1A_10.CR8 -- Compiled in SequentialMode.
Memory Free: 21644 bytes

Program Errors

Program Errors: 0
Skipped Scans: 0
Skipped Slow Scans: 0
Skipped System Scans: 0
Skipped Records in Hourly: 0
Skipped Records in Daily: 0
Skipped Records in BatteryData: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 14.10
Lithium Battery: 3.30
Number of times the datalogger's 12V supply has dropped below operating threshold: 0
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary 24/10/2019 13:41:01

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 38.38 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 0

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39
Run Signature: 52401
Program Signature: 58453
Results for Last Program Compiled: CPU:WaterLevel_V2_1A_10.CR8 -- Compiled in SequentialMode.
Memory Free: 21644 bytes

Program Errors

Program Errors: 0
Skipped Scans: 0
Skipped Slow Scans: 0
Skipped System Scans: 0
Skipped Records in Hourly: 0
Skipped Records in Daily: 0
Skipped Records in BatteryData: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.74
Lithium Battery: 3.42
Number of times the datalogger's 12V supply has dropped below operating threshold: 0
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary 16/01/2020 10:21:43

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 29.65 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 0

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39
Run Signature: 52401
Program Signature: 58453
Results for Last Program Compiled: CPU:WaterLevel_V2_1A_10.CR8 -- Compiled in SequentialMode.
Memory Free: 21644 bytes

Program Errors

Program Errors: 0
Skipped Scans: 0
Skipped Slow Scans: 0
Skipped System Scans: 0
Skipped Records in Hourly: 0
Skipped Records in Daily: 0
Skipped Records in BatteryData: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.52
Lithium Battery: 3.37
Number of times the datalogger's 12V supply has dropped below operating threshold: 0
Number of times voltage has dropped below 5V: 0

60248386 – Wambo Flow Station 2 CR200 Series Data Logger Status Summary 6/02/2019 12:14:32

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 2
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.30

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary 23/05/2019 12:31:46

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 2
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.40

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 2 Cr200 Series Data Logger Status Summary 19/07/2019 11:14:06

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 2
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.65

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary 24/10/2019 14:04:52

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 2
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.27

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary 16/01/2020 10:45:19

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 2
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.38

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 – Wambo Flow Station 3 CR200 Series Data Logger Status Summary 6/02/2019 09:57:18

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.26

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 3 CR200 Series Data Logger Status Summary 23/05/2019 10:23:04

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.37

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 3 CR200 Series Data Logger Status Summary 19/07/2019 09:41:40

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.69

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 3 CR200 Series Data Logger Status Summary 24/10/2019 12:28:12

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.22

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 3 CR200 Series Data Logger Status Summary 16/01/2020 09:11:14

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.33

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 – Wambo Flow Station 3 CR200 Series Data Logger Status Summary 6/02/2019 09:12:06

Datalogger Information

OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA_V2a.CR2

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.31

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 4 CR200 Series Data Logger Status Summary 23/05/2019 09:45:07

Datalogger Information

OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA_V2a.CR2

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.45

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 4 CR200 Series Data Logger Status Summary 19/07/2019 08:52:32

Datalogger Information

OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA_V2a.CR2

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.75

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 4 CR200 Series Data Logger Status Summary 25/10/2019 08:01:48

Datalogger Information

OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA_V2a.CR2

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.20

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 4 CR200 Series Data Logger Status Summary 15/01/2020 08:19:18

Datalogger Information

OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA_V2a.CR2

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.42

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

Appendix B

Stream Theoretical Flow Rating and Profile Curves

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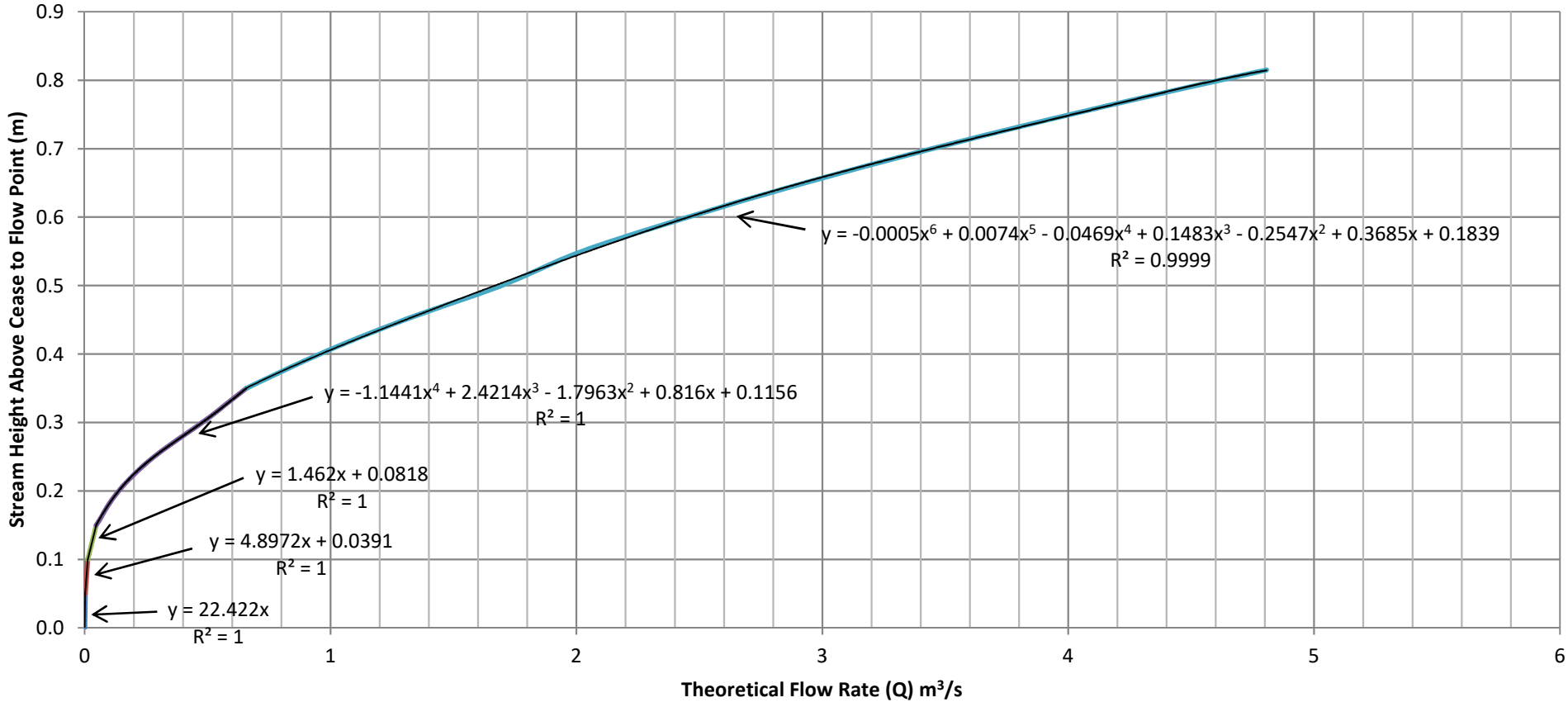
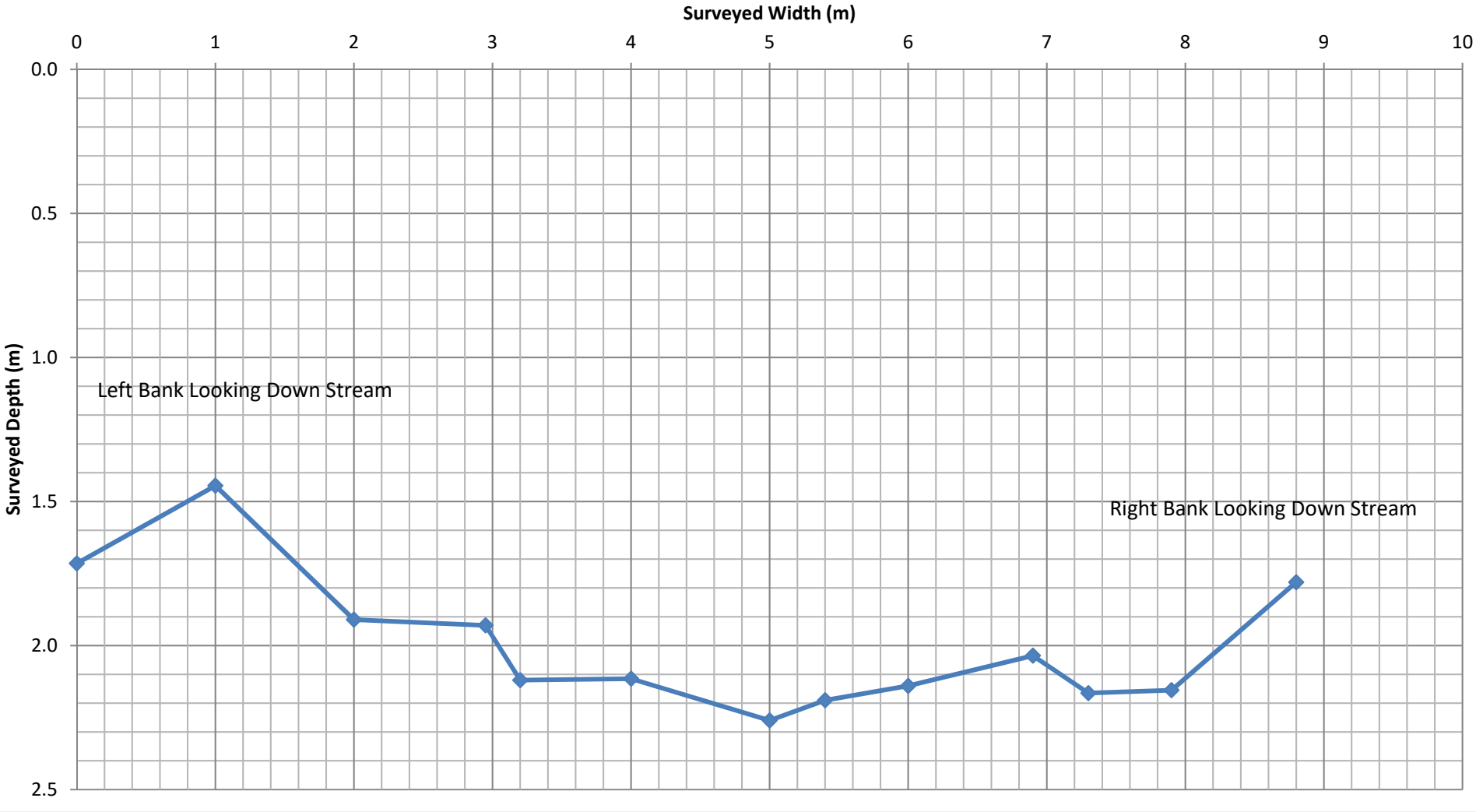
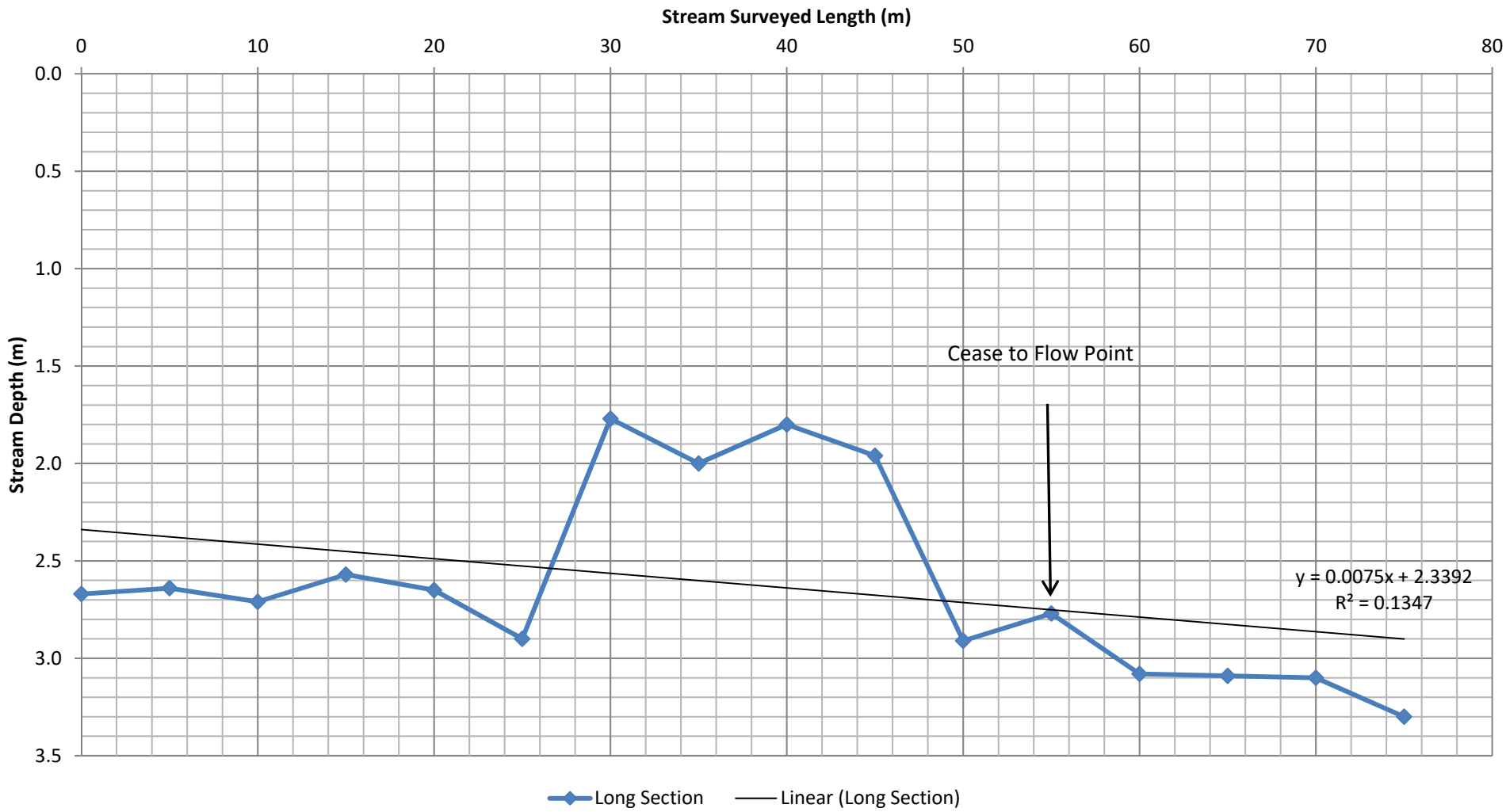
Flow Monitoring Station North Wambo Creek Upstream of Flow Monitoring Station 1 (Old) Theorectical Flow Rating Curve, January 2018



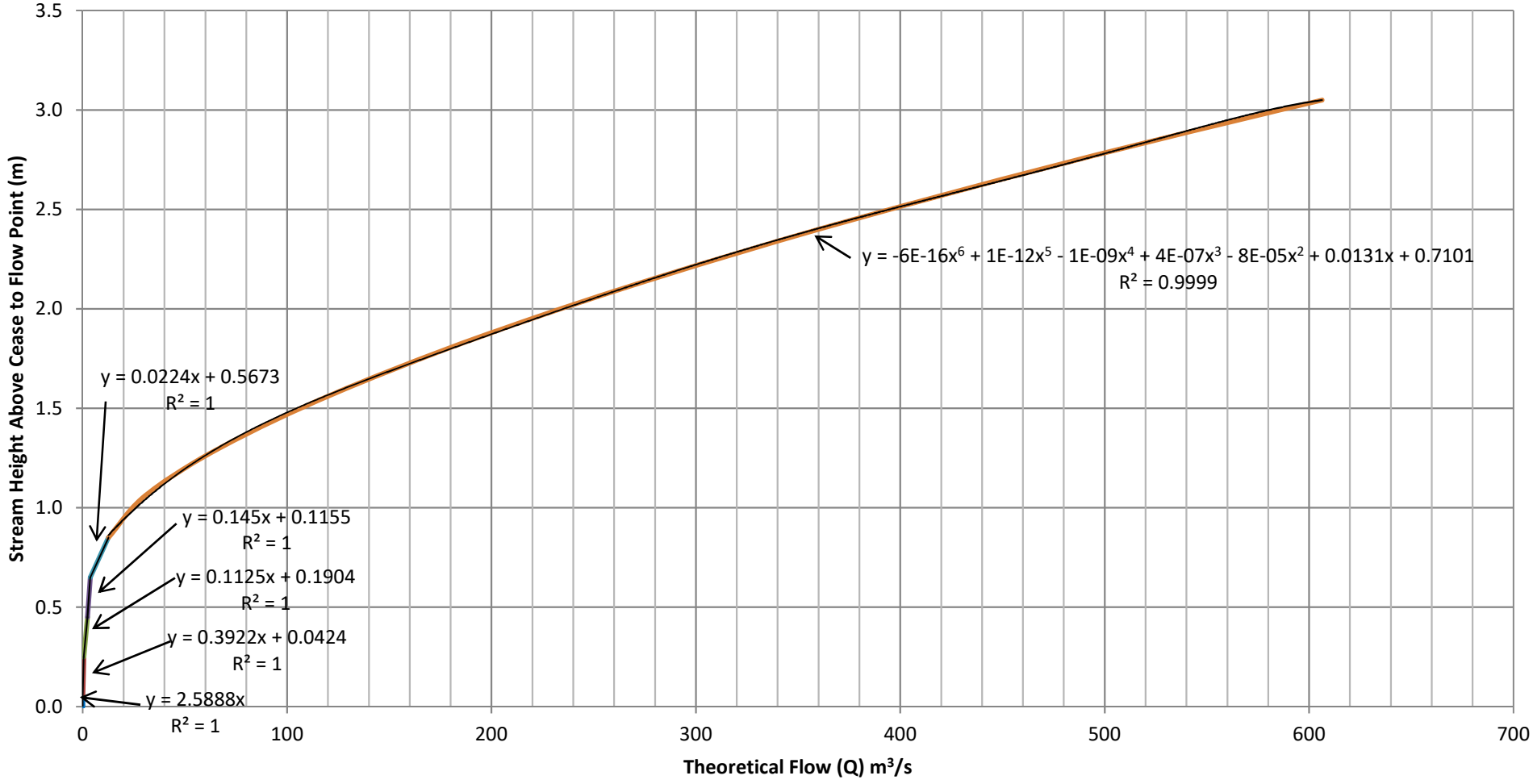
New Flow Monitoring Station North Wambo Creek Upstream of Flow Station 1 (Old) Cease to Flow Point Cross Section Survey January 2018



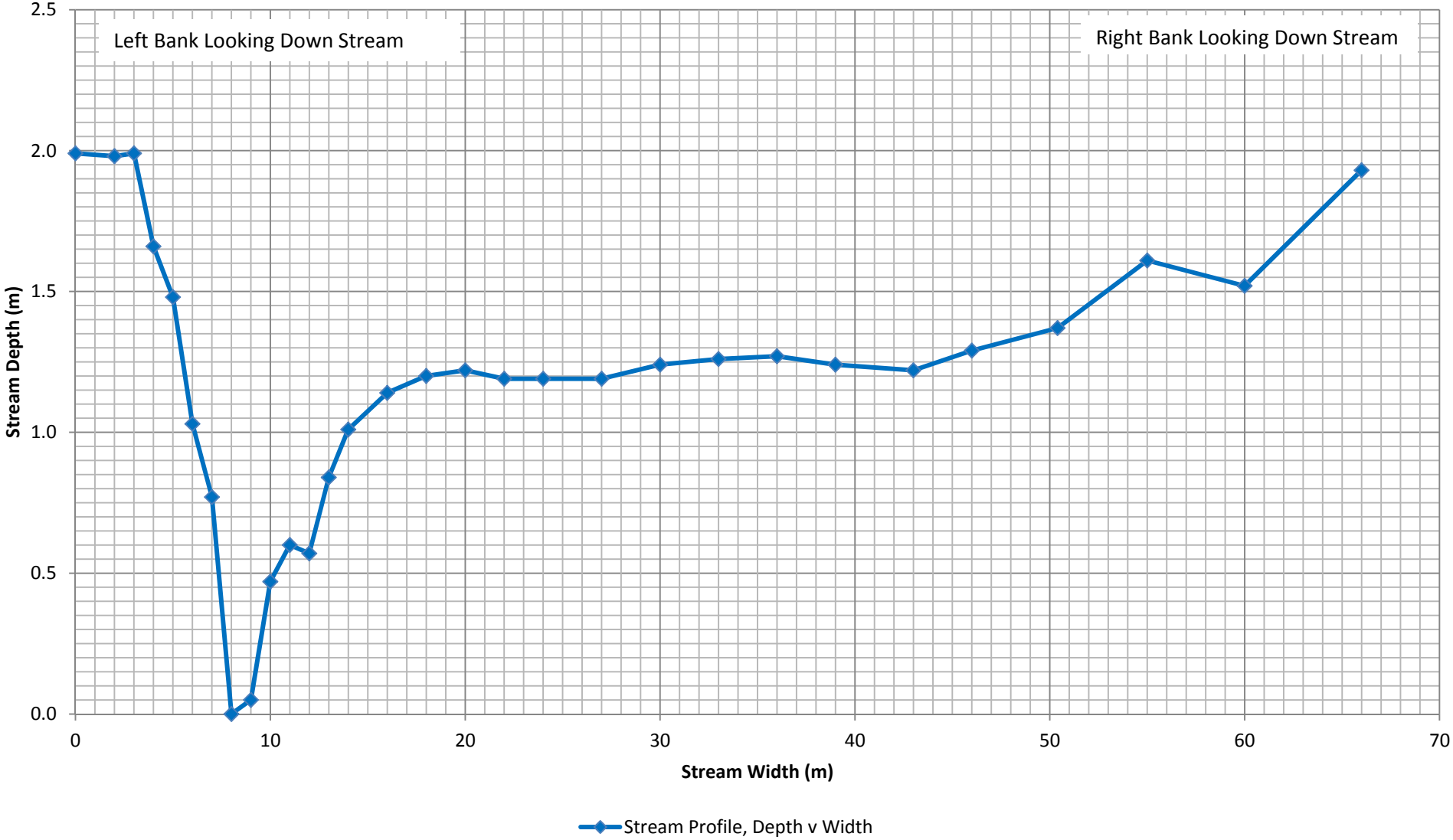
New Flow Monitoring Station North Wambo Creek Upstream of Flow Station 1 (Old) Long Section Profile Through Cease to Flow Point January 2018



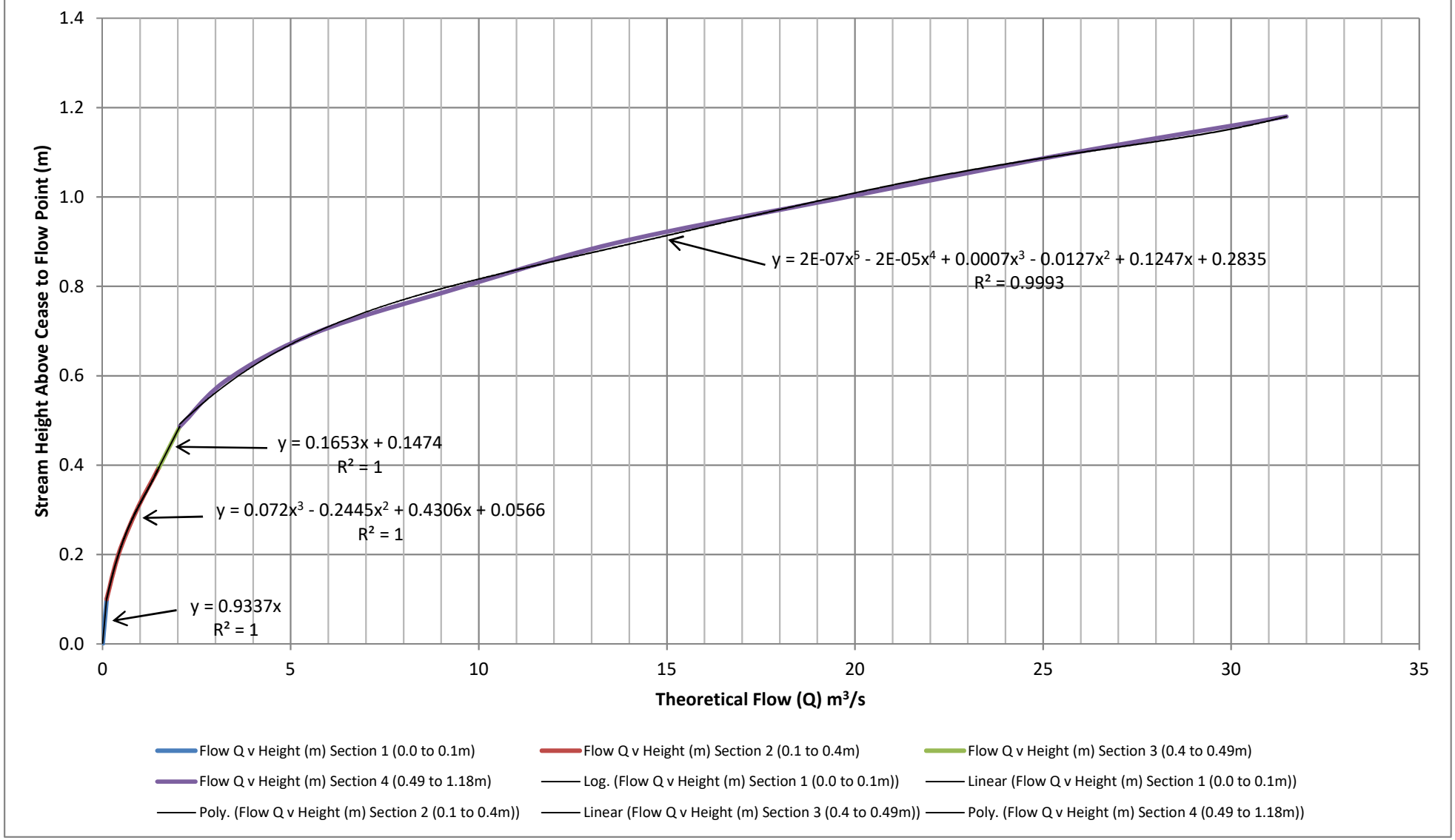
Flow Monitoring Station 1 (Old) North Wambo Creek Theoretical Flow Rating Curve, May 2013



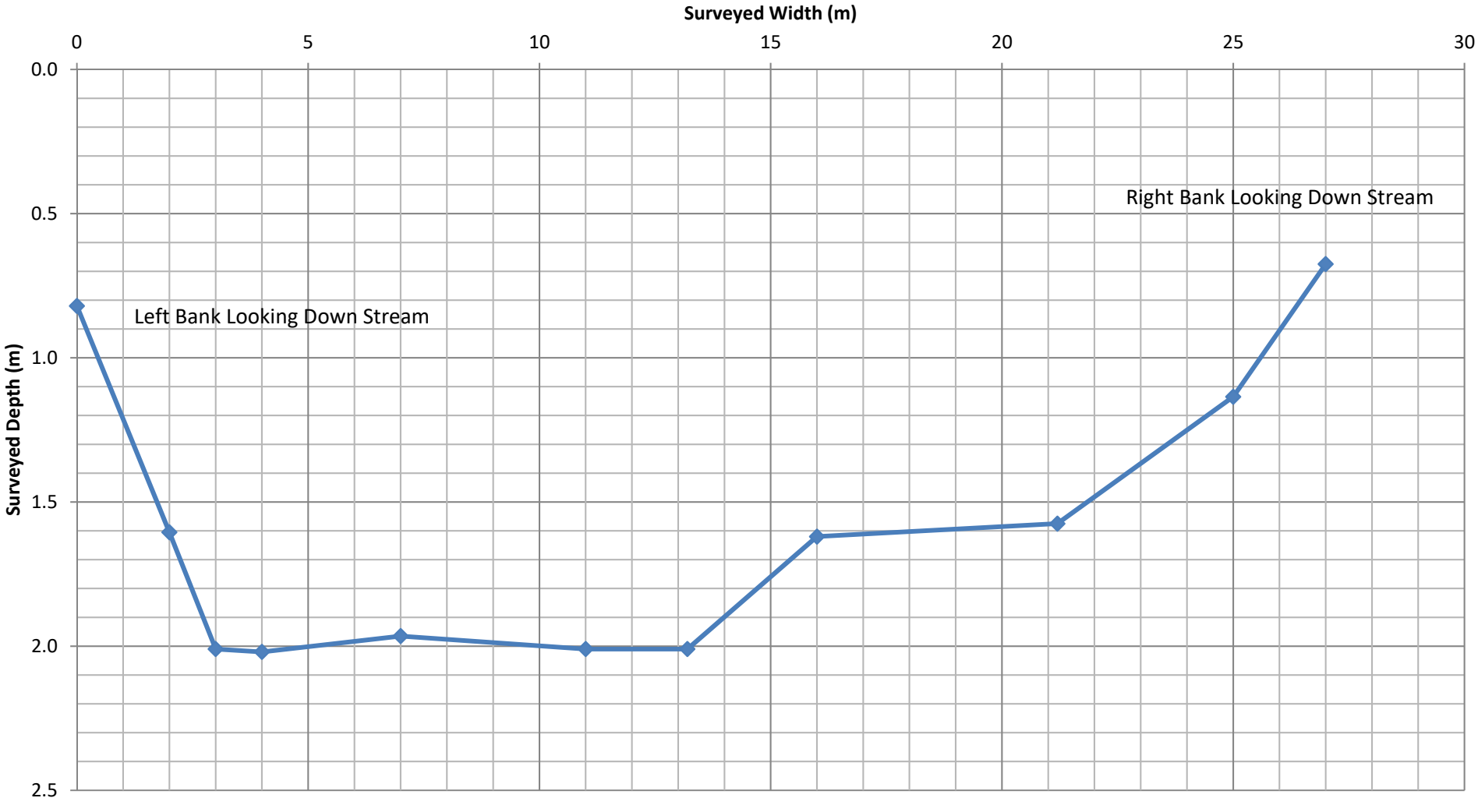
Flow Monitoring Station 1 (Old) North Wambo Creek Stream Bed Cross Section Profile, May 2013



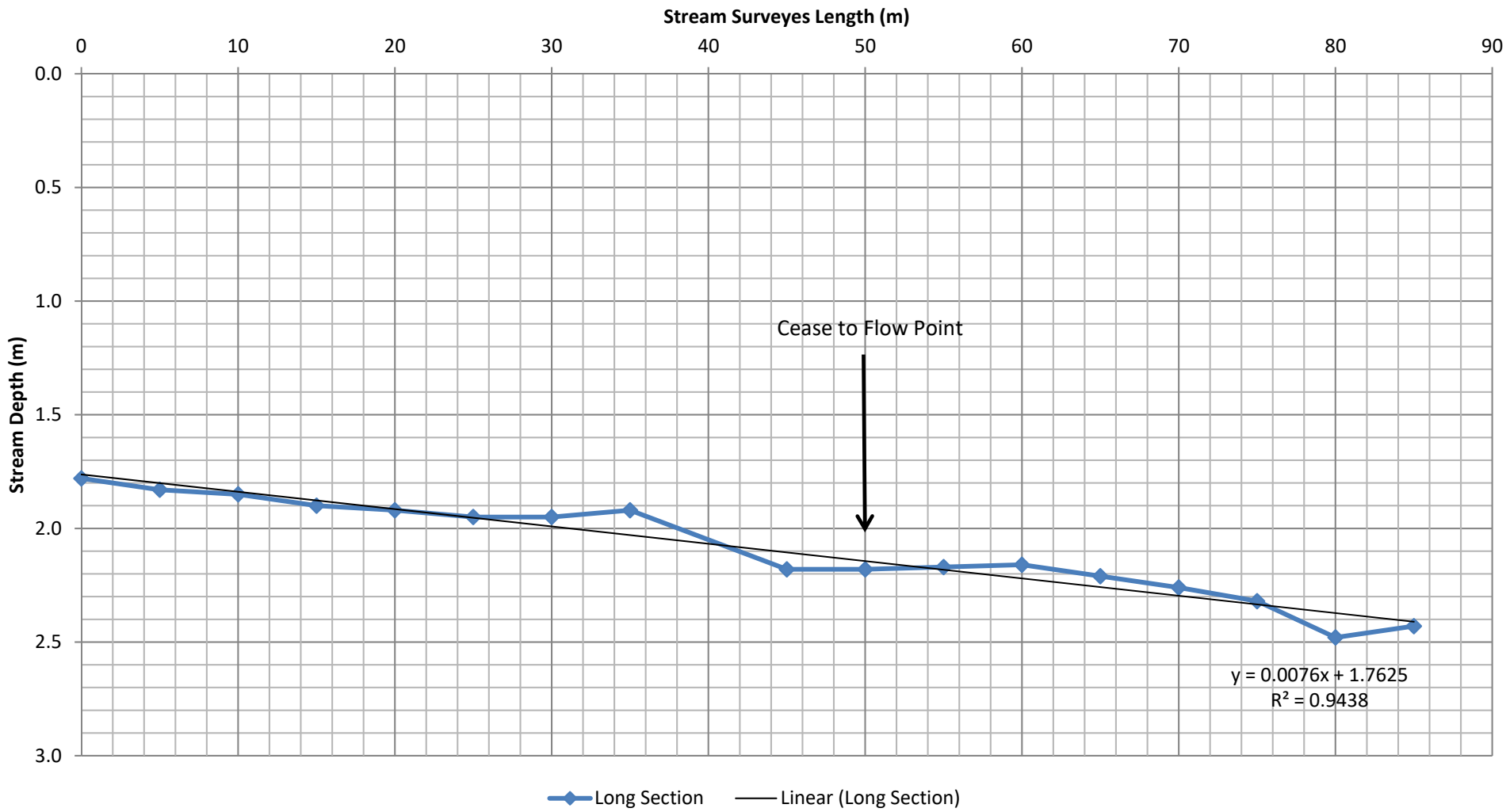
Flow Monitoring Station 1 at New Location North Wambo Creek Theoretical Flow Rating Curve, January2018



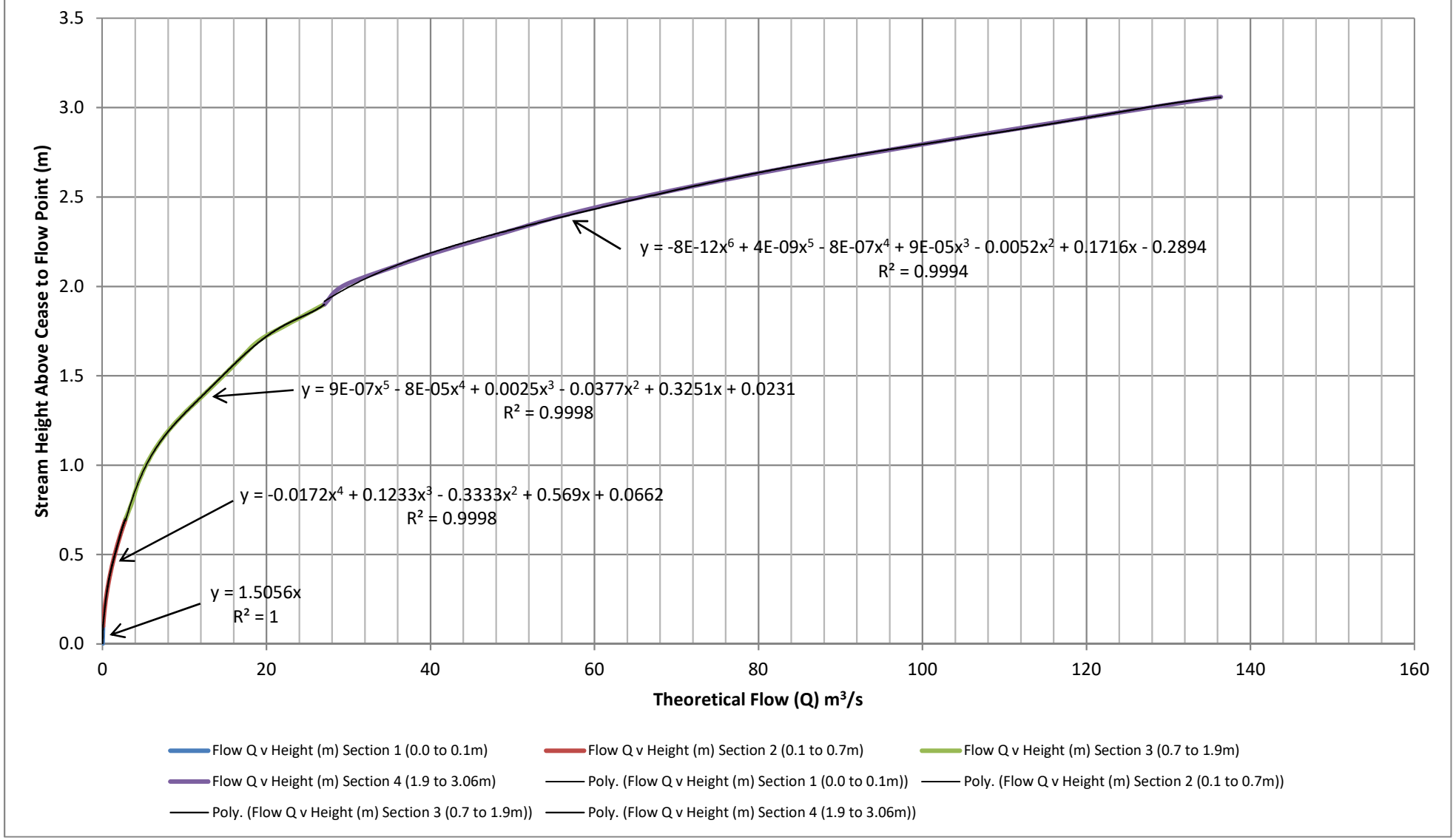
Flow Monitoring Station 1 at New Location North Wambo Creek Cease to Flow Point Cross Section Survey January 2018



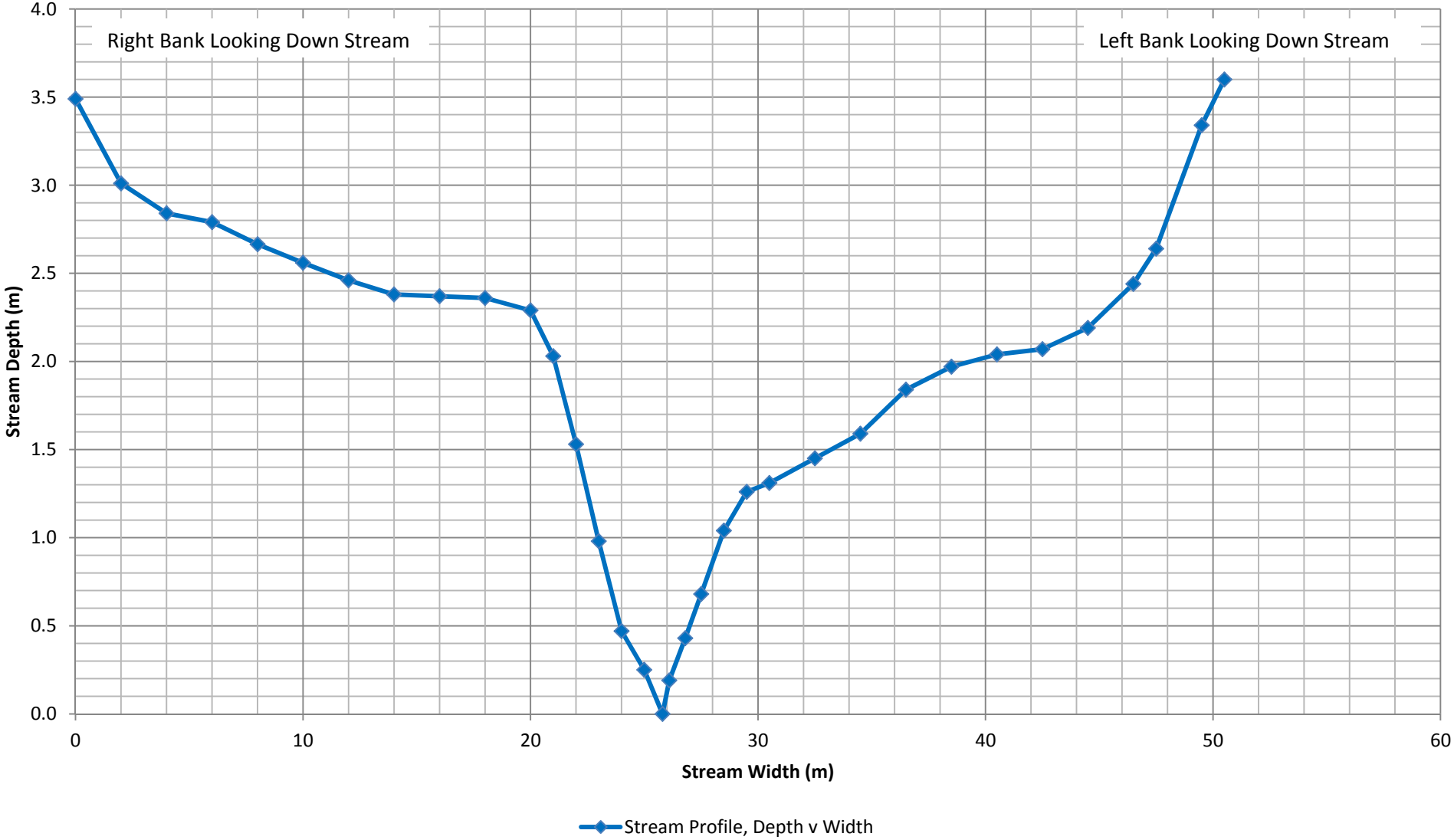
Flow Monitoring Station 1 at New Location North Wambo Creek Long Section Profile Through Cease to Flow Point January 2018



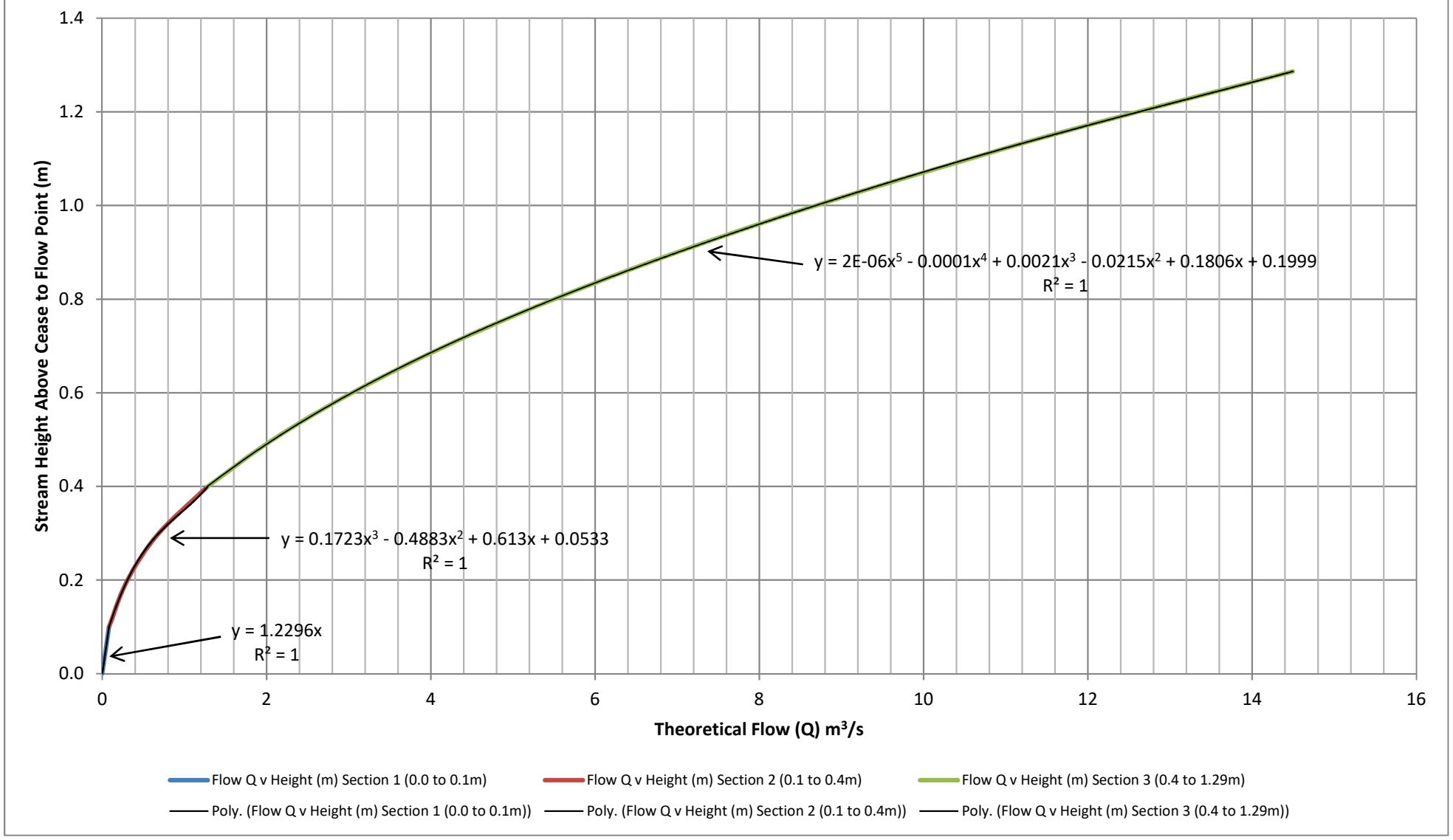
Flow Monitoring Station 2 North Wambo Creek Theoretical Flow Rating Curve, January 2018



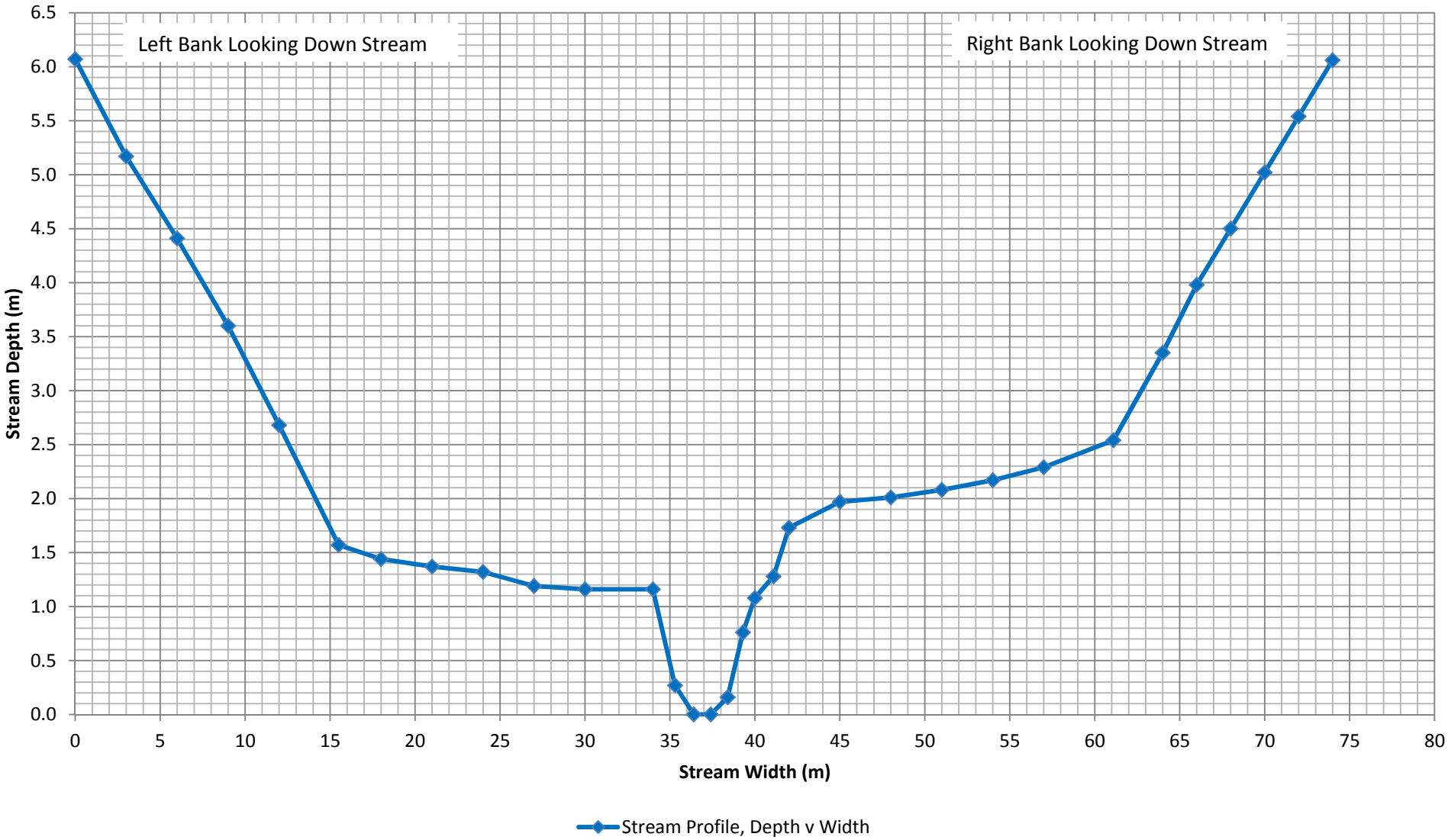
Flow Monitoring Station 2 North Wambo Creek Stream Bed Cross Section Profile, May 2013



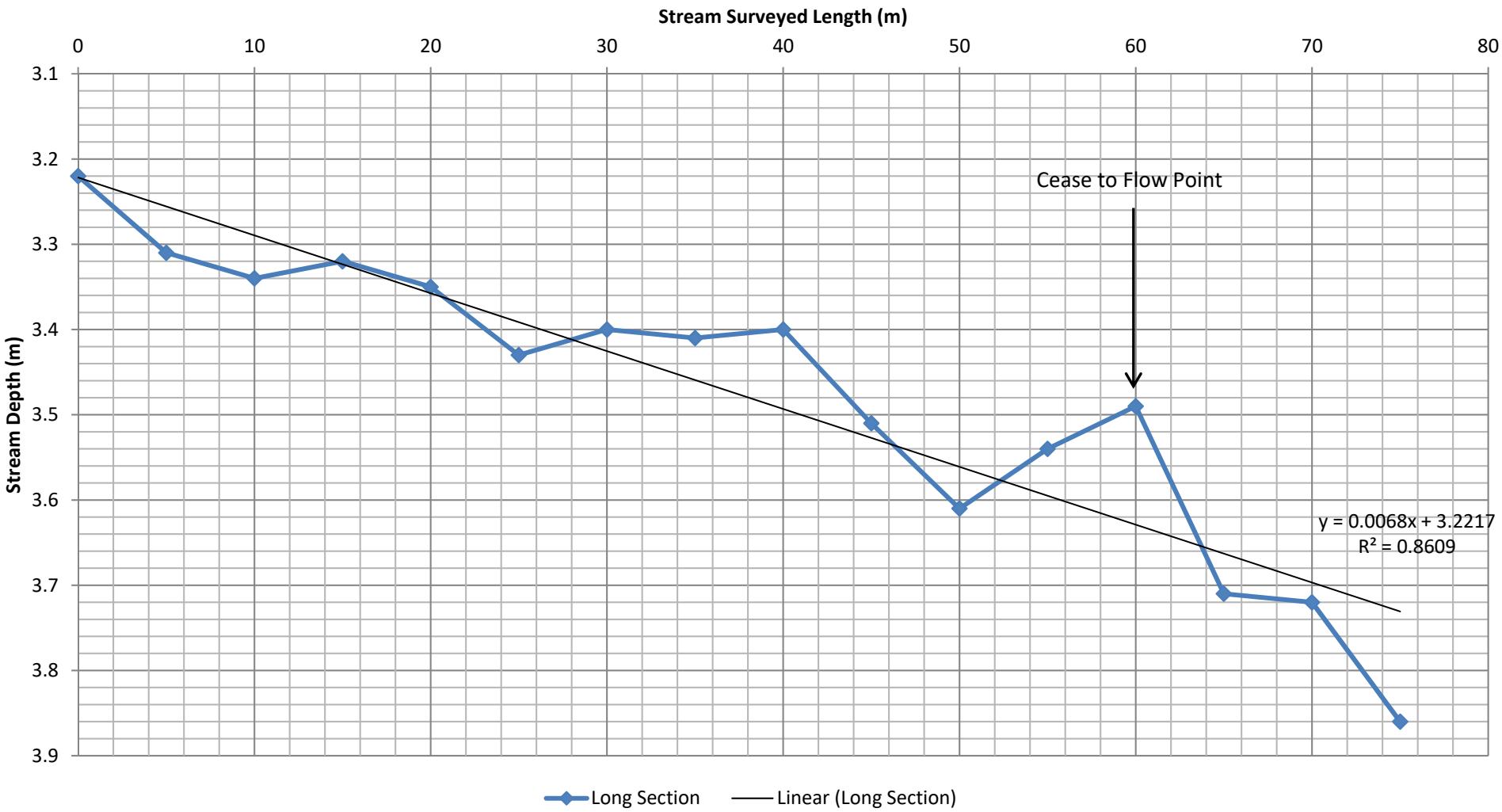
Flow Monitoring Station 3 North Wambo Creek Theoretical Flow Rating Curve, January 2018



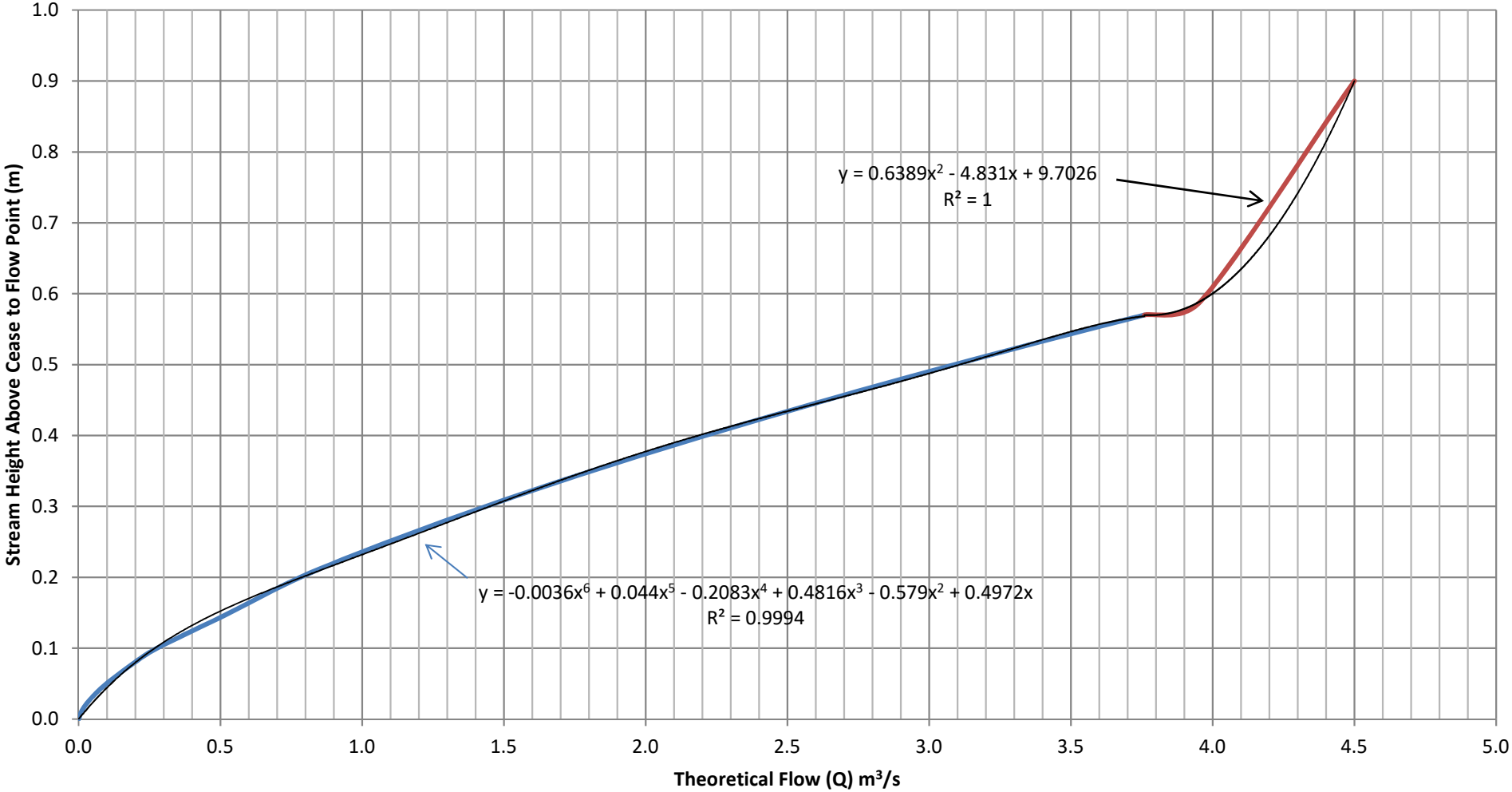
Flow Monitoring Station 3 North Wambo Creek Stream Bed Cross Section Profile, May 2013



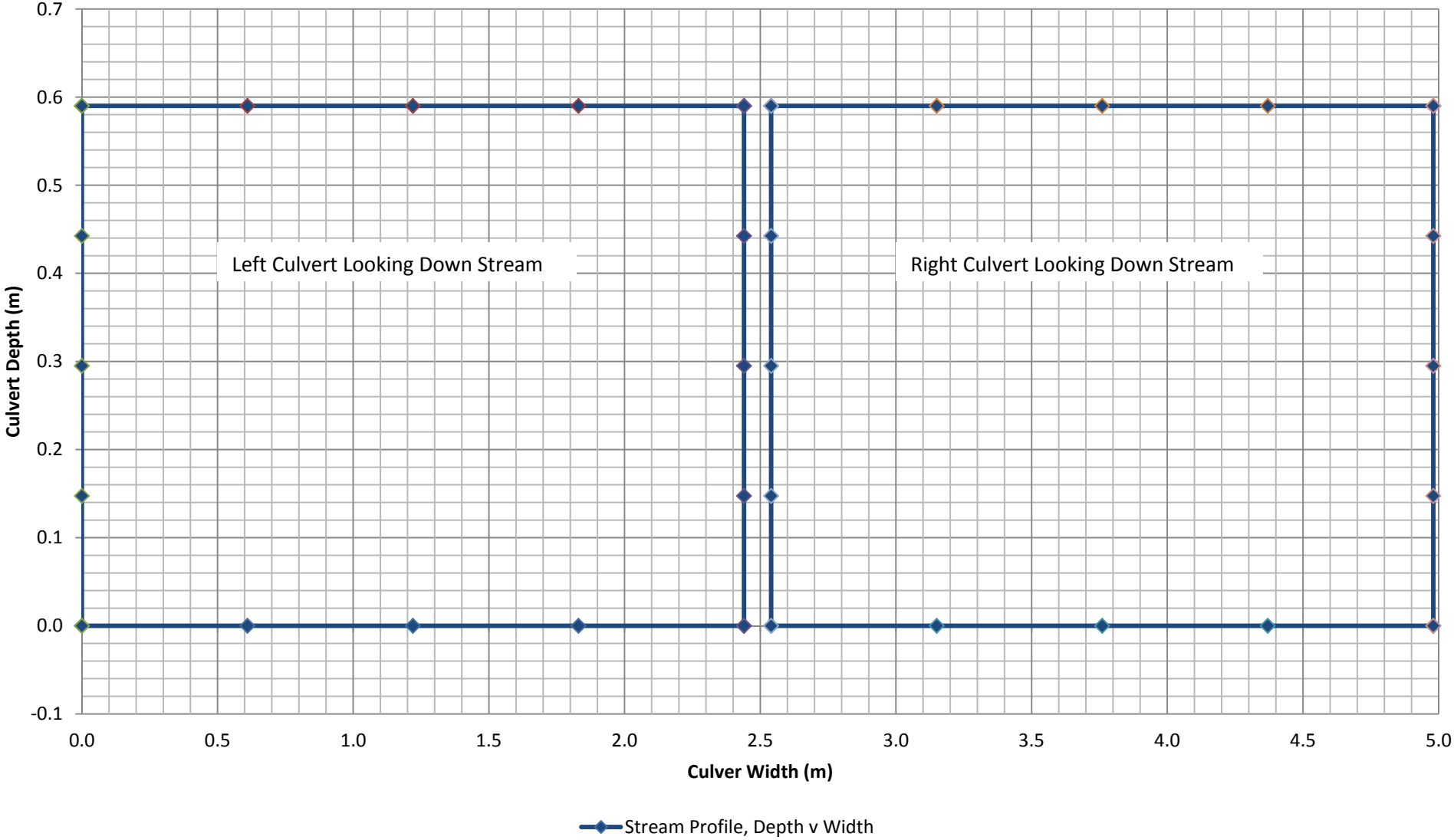
Flow Monitoring Station 3 North Wambo Creek Long Section Profile Through Cease to Flow Point January 2018



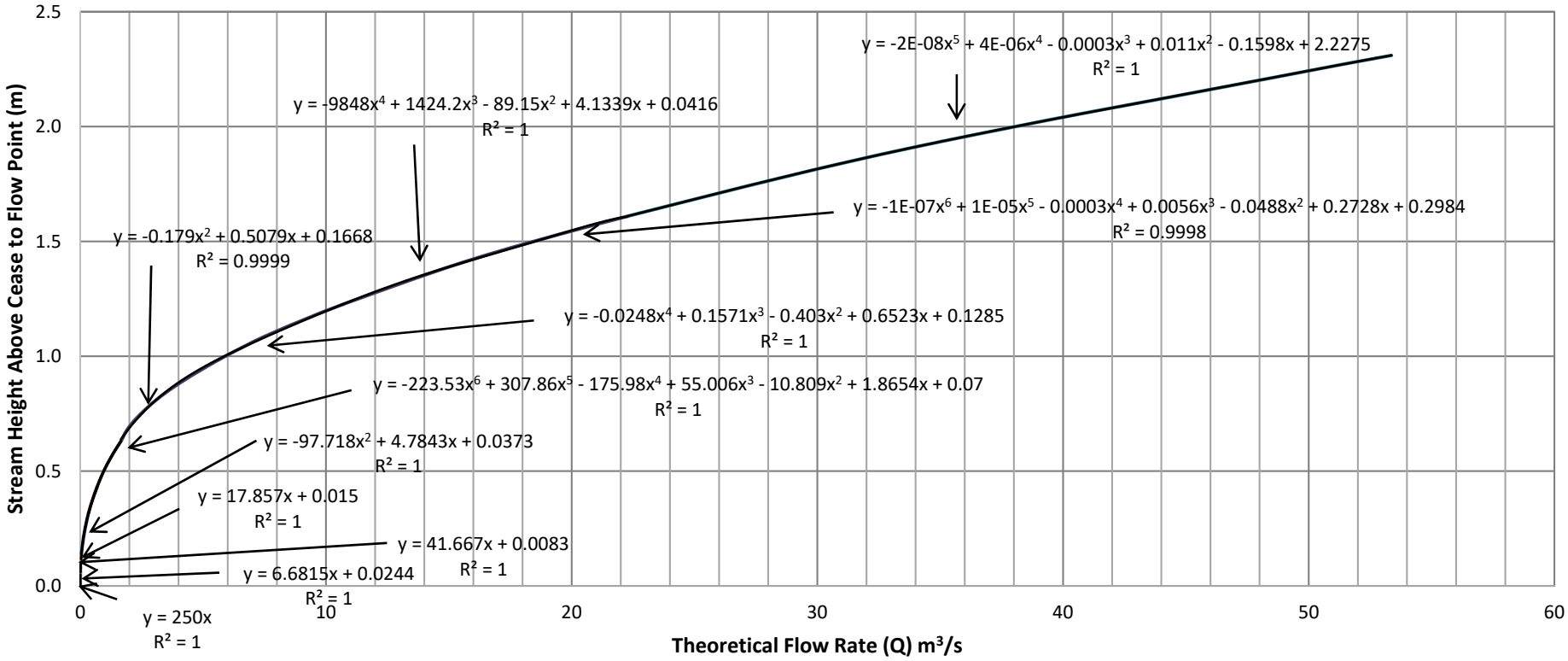
Flow Monitoring Station 4 North Wambo Creek Theoretical Flow Rating Curve, January 2018



Flow Monitoring Station 4 North Wambo Creek Two Culverts Cross Section Profiles, May 2013

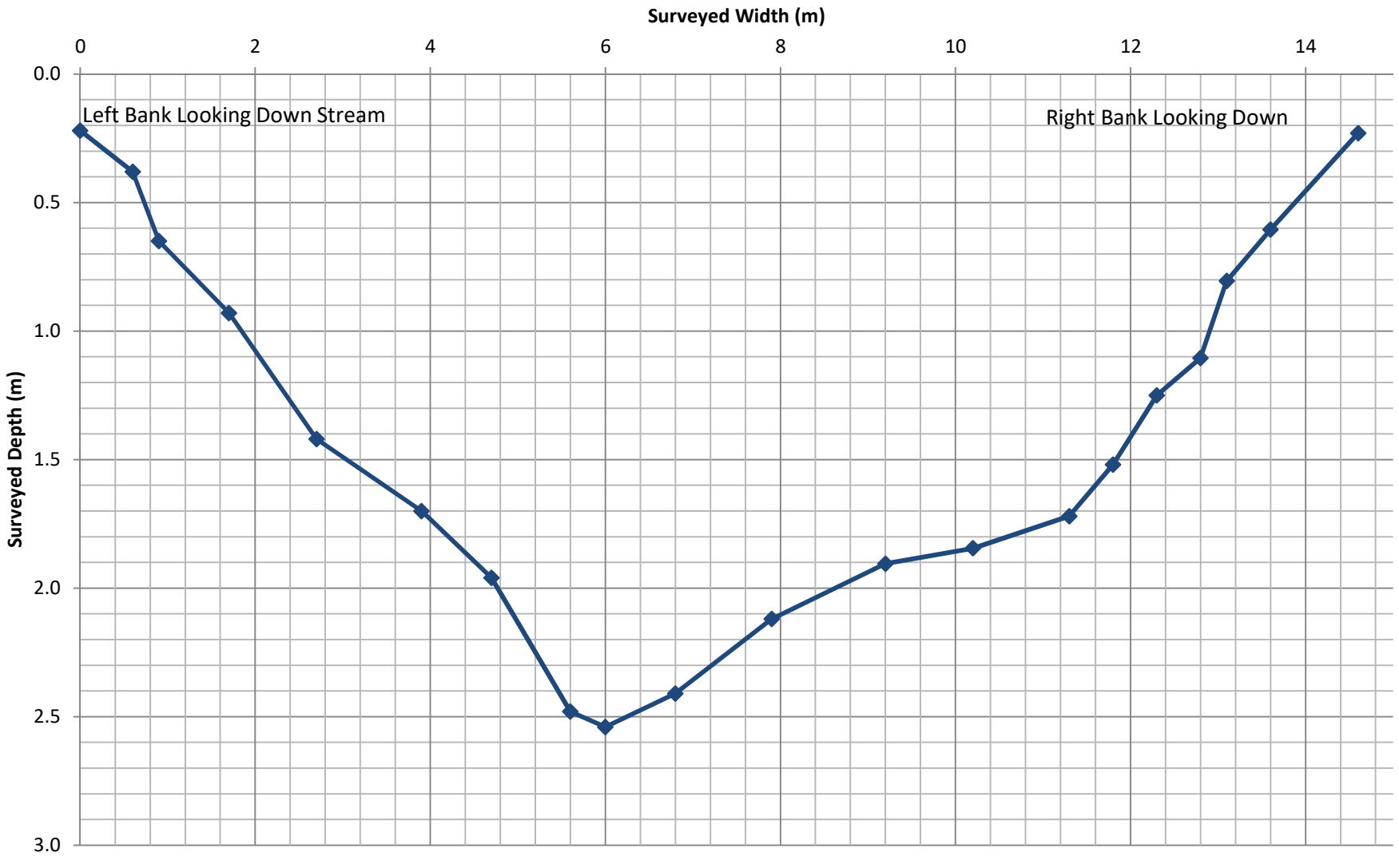


Flow Monitoring Station 9 (Brossi) South Wambo Creek Theoretical Flow Rating Curve, May 2019

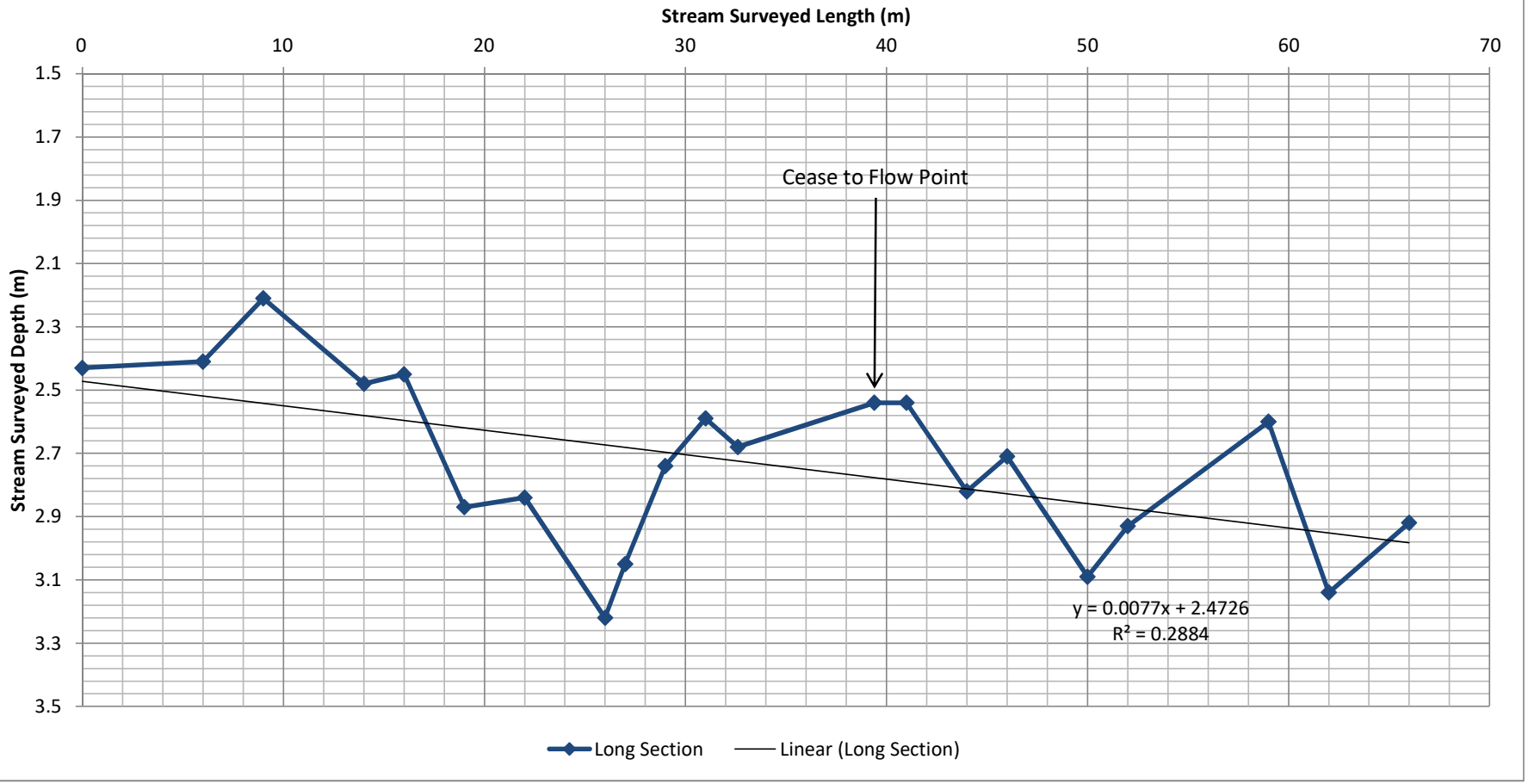


Flow Q v Height (m) Section 1 (0.0 to 0.01m)
Flow Q v Height (m) Section 2 (0.01 to 0.02m)
Flow Q v Height (m) Section 3 (0.02 to 0.03m)
Flow Q v Height (m) Section 4 (0.03 to 0.06m)
Flow Q v Height (m) Section 4 (0.06 to 0.08m)
Flow Q v Height (m) Section 4 (0.08 to 0.14m)
Flow Q v Height (m) Section 4 (0.14 to 0.32m)
Flow Q v Height (m) Section 4 (0.32 to 0.43m)
Flow Q v Height (m) Section 4 (0.43 to 0.63m)
Flow Q v Height (m) Section 4 (0.63 to 1.61m)
Flow Q v Height (m) Section 4 (1.61 to 1.1m)
Linear (Flow Q v Height (m) Section 1 (0.0 to 0.01m))
Linear (Flow Q v Height (m) Section 2 (0.01 to 0.02m))
Linear (Flow Q v Height (m) Section 3 (0.02 to 0.03m))
Linear (Flow Q v Height (m) Section 4 (0.03 to 0.06m))
Poly. (Flow Q v Height (m) Section 4 (0.06 to 0.08m))
Poly. (Flow Q v Height (m) Section 4 (0.08 to 0.14m))
Poly. (Flow Q v Height (m) Section 4 (0.14 to 0.32m))
Poly. (Flow Q v Height (m) Section 4 (0.32 to 0.43m))
Poly. (Flow Q v Height (m) Section 4 (0.43 to 0.63m))
Poly. (Flow Q v Height (m) Section 4 (0.63 to 1.61m))
Poly. (Flow Q v Height (m) Section 4 (1.61 to 1.1m))

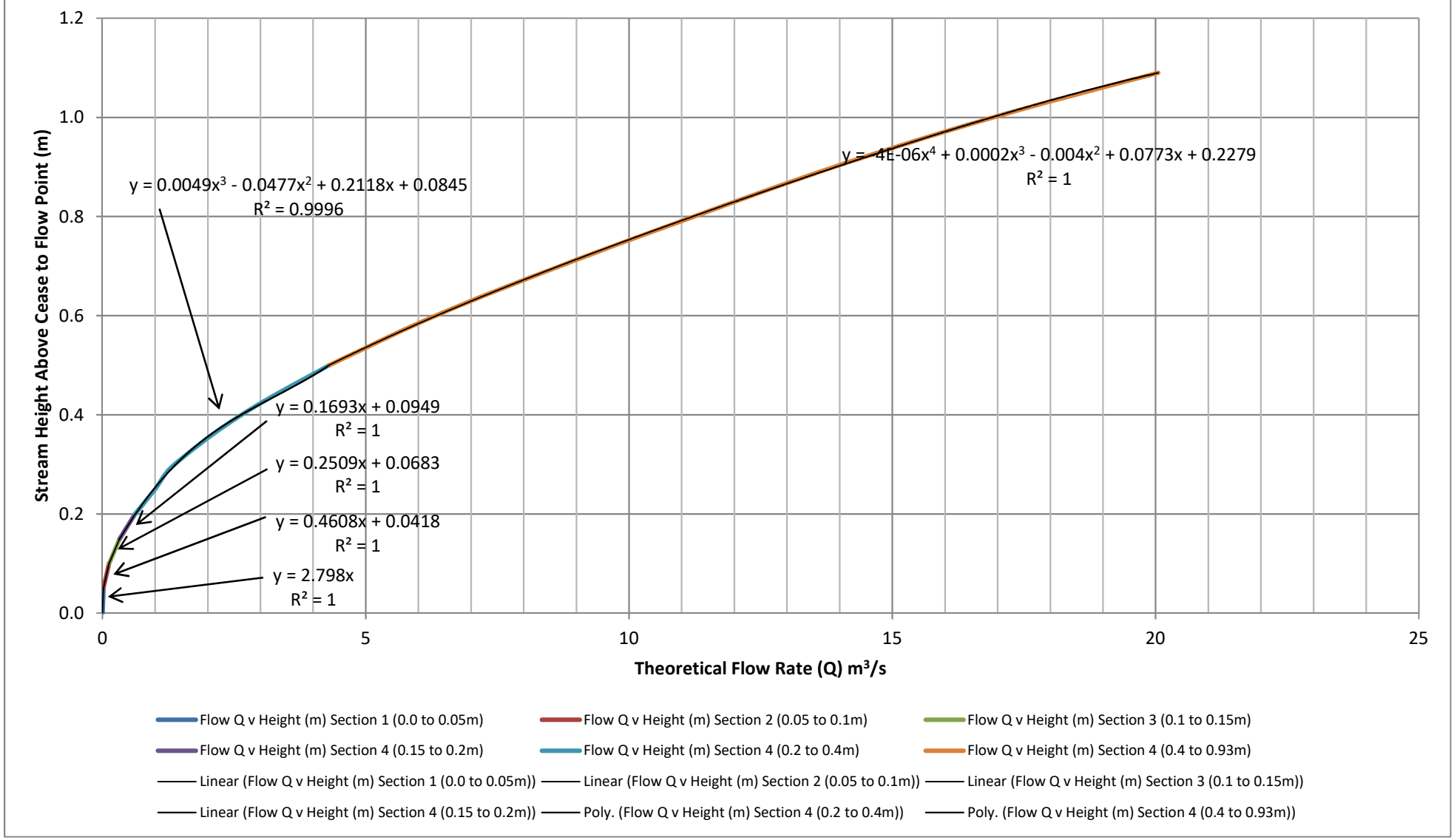
Flow Monitoring Station 9 (Brossi) South Wambo Creek
Cease to Flow Point Cross Section Survey
December 2018



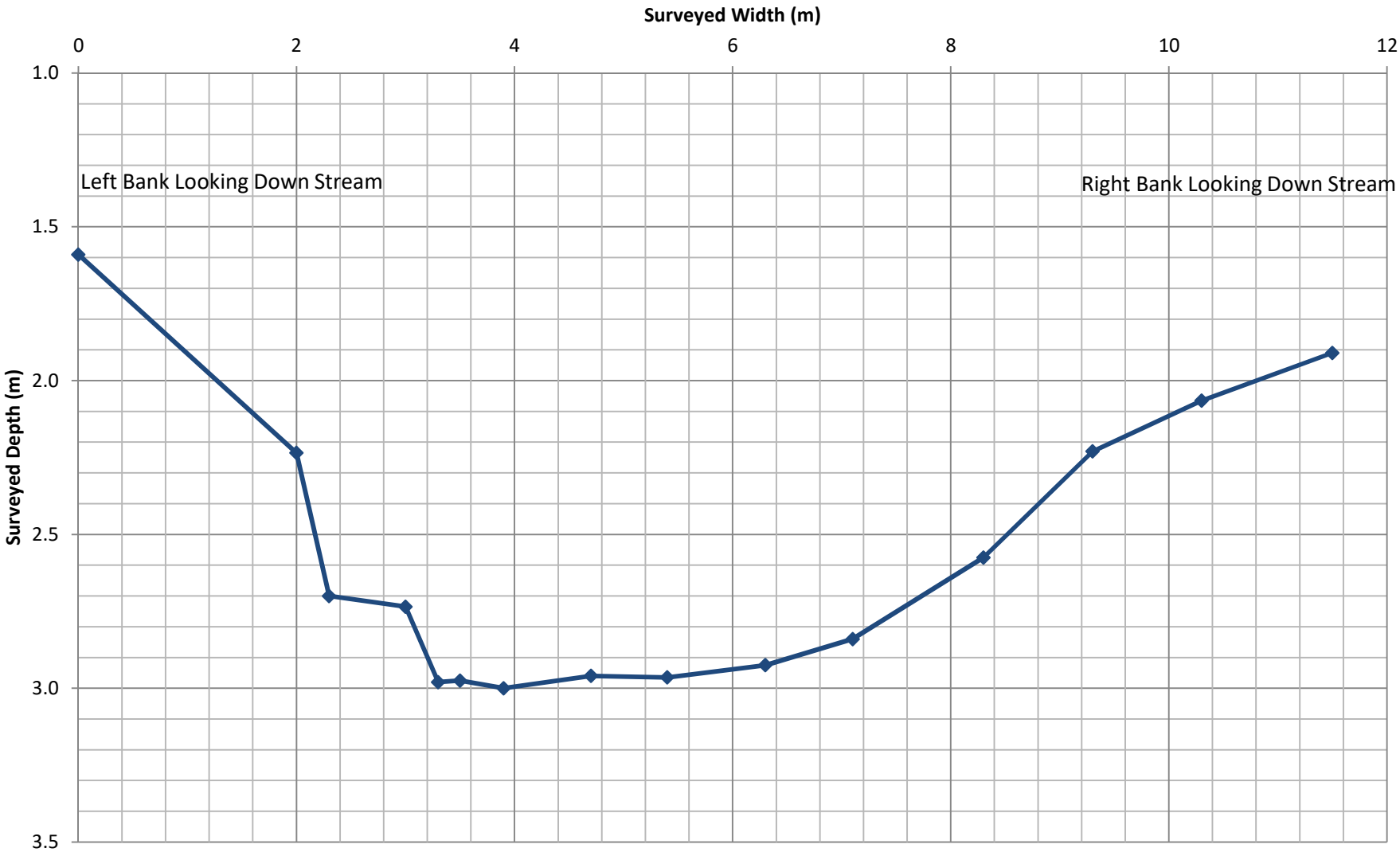
Flow Monitoring Station 9 (Brossi) South Wambo Creek Long Section
Profile Through Cease to Flow Point
December 2018



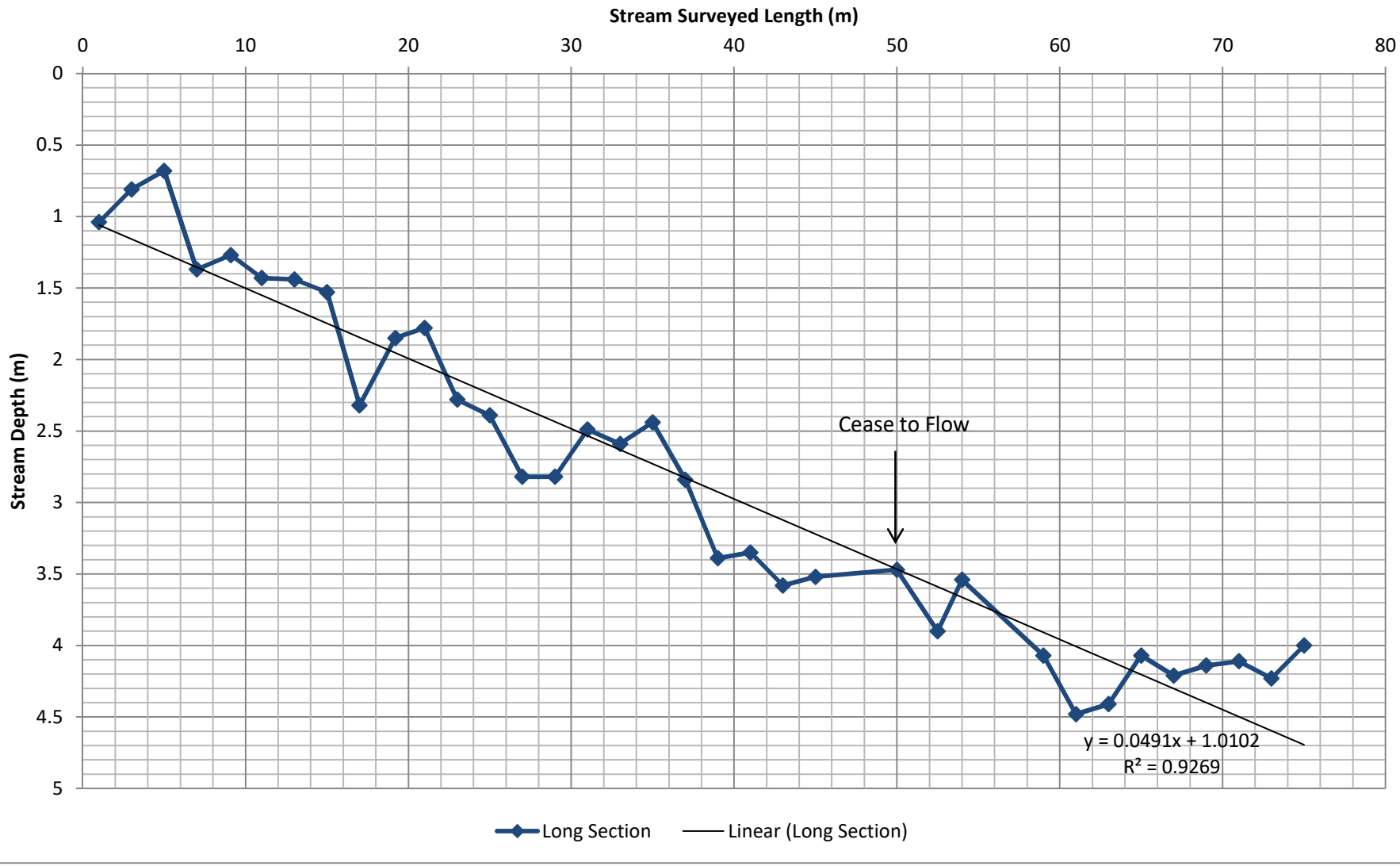
Flow Monitoring Station 12 Stoney Creek Up Theoretial Flow Rating Curve May 2019



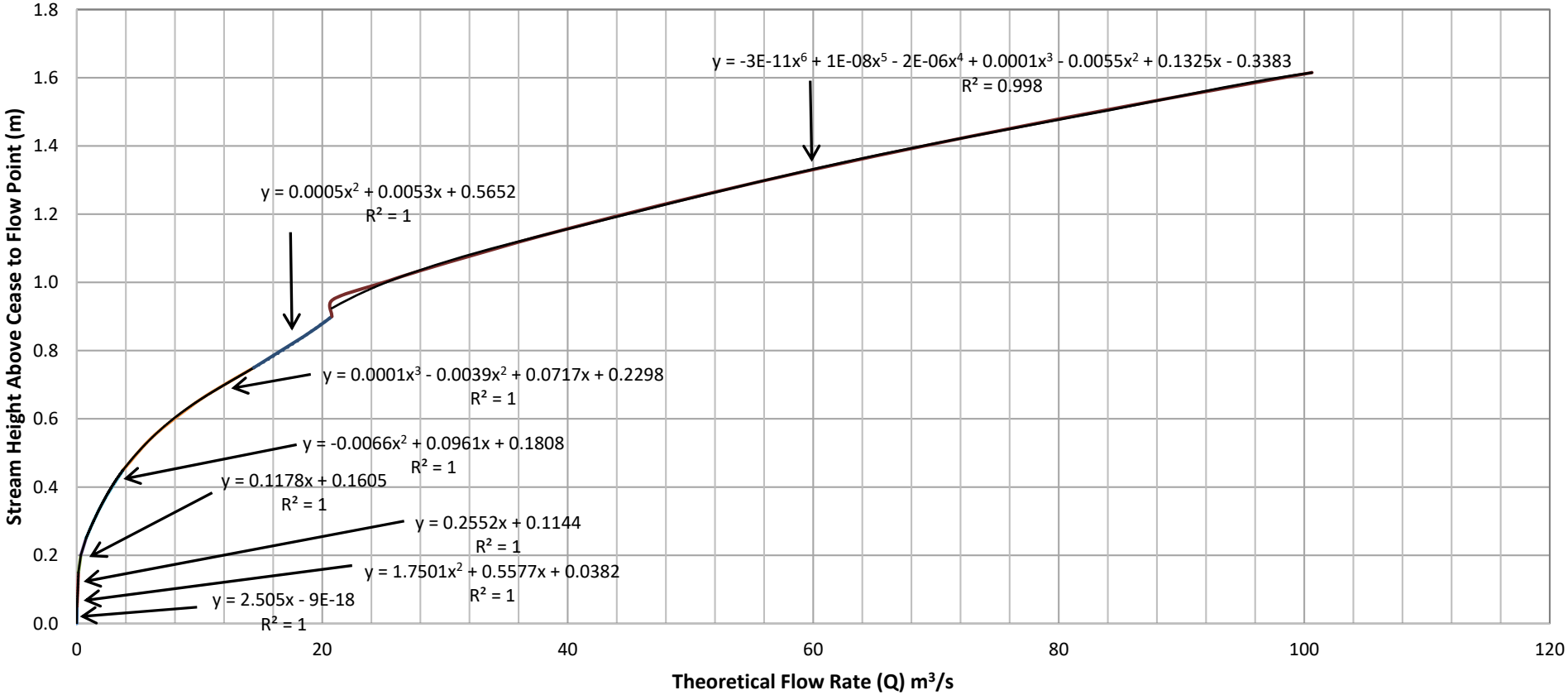
Flow Monitoring Station 12 Stoney Creek Up Flow Cease to Flow Point Cross Section Survey December 2018



Flow Monitoring Station 12 Stoney Creek Up Long Section Profile Through Cease to Flow Point December 2018

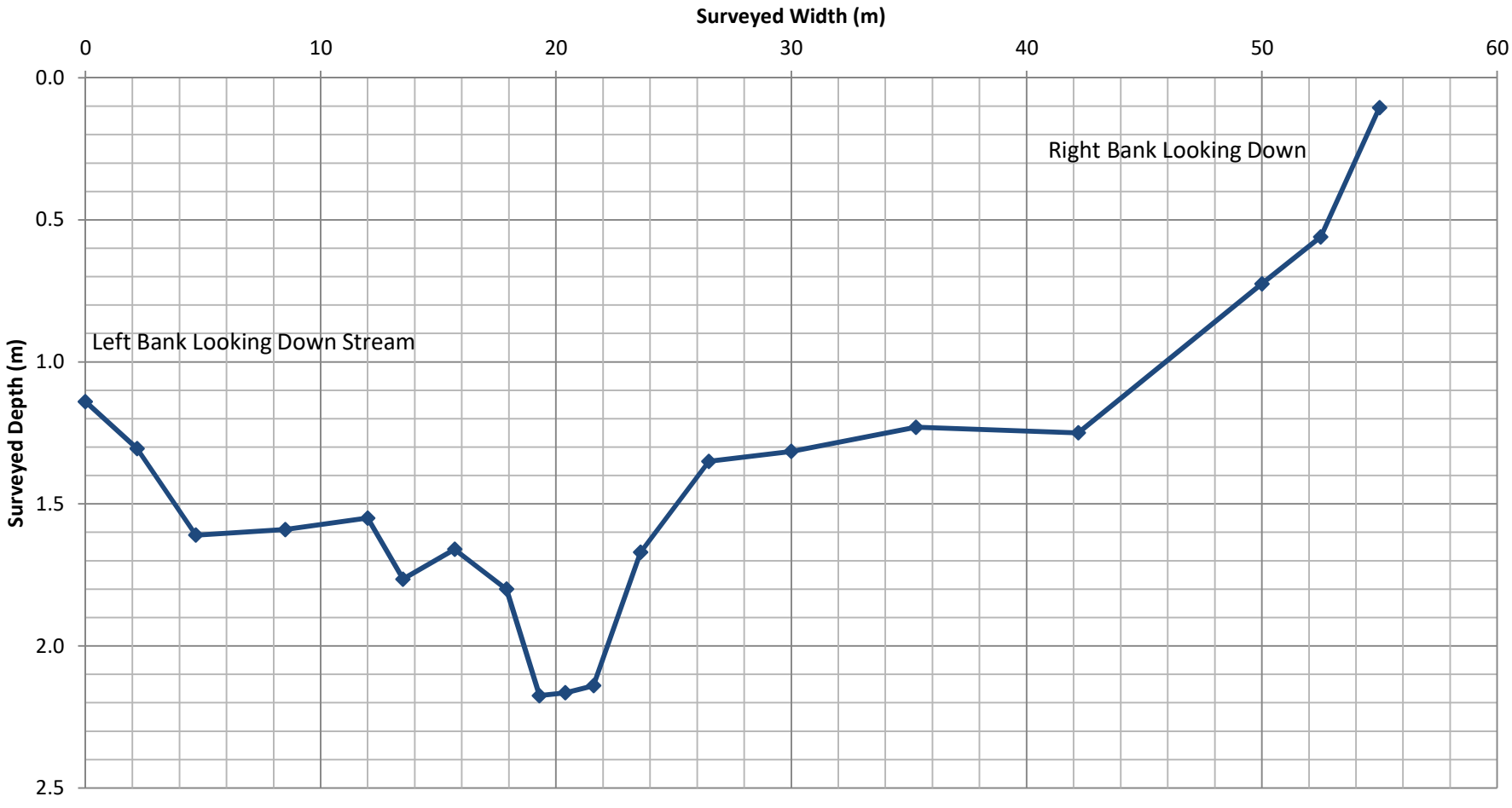


Flow Monitoring Station 13 Stoney Creek Down Theoretical Flow Curve
May 2019

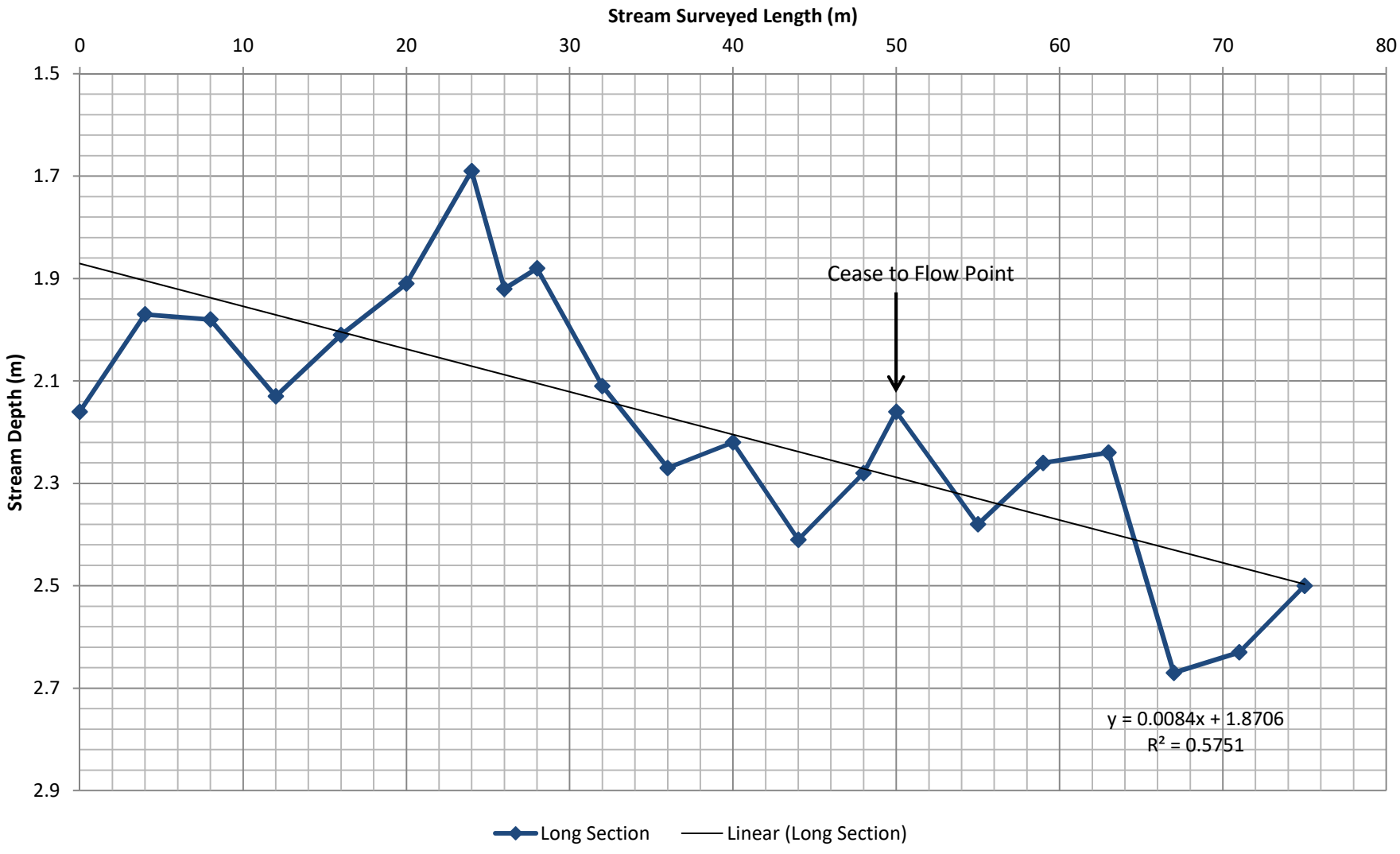


Flow Q v Height (m) Section 1 (0.0 to 0.05m)
Flow Q v Height (m) Section 2 (0.05 to 0.15m)
Flow Q v Height (m) Section 3 (0.15 to 0.20m)
Flow Q v Height (m) Section 4 (0.20 to 0.25m)
Flow Q v Height (m) Section 4 (0.25 to 0.45m)
Flow Q v Height (m) Section 4 (0.45 to 0.75m)
Flow Q v Height (m) Section 4 (0.75 to 0.90m)
Flow Q v Height (m) Section 4 (0.90 to 1.6m)
Linear (Flow Q v Height (m) Section 1 (0.0 to 0.05m))
Poly. (Flow Q v Height (m) Section 2 (0.05 to 0.15m))
Linear (Flow Q v Height (m) Section 3 (0.15 to 0.20m))
Linear (Flow Q v Height (m) Section 4 (0.20 to 0.25m))
Poly. (Flow Q v Height (m) Section 4 (0.25 to 0.45m))
Poly. (Flow Q v Height (m) Section 4 (0.45 to 0.75m))
Poly. (Flow Q v Height (m) Section 4 (0.75 to 0.90m))
Poly. (Flow Q v Height (m) Section 4 (0.90 to 1.6m))

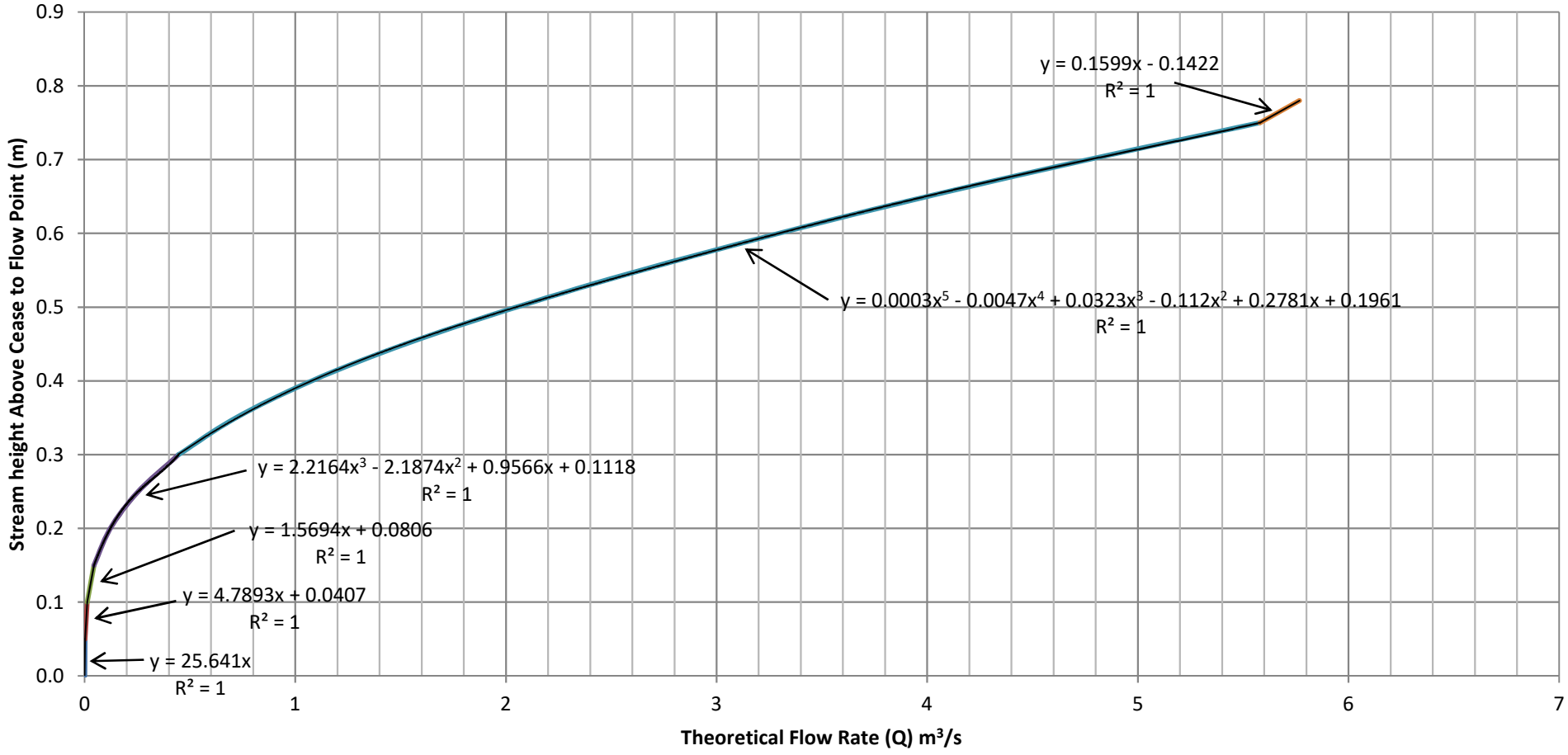
Flow Monitoring Station 13 Stoney Creek Down Cease to Flow Point Cross Section Survey December 2018



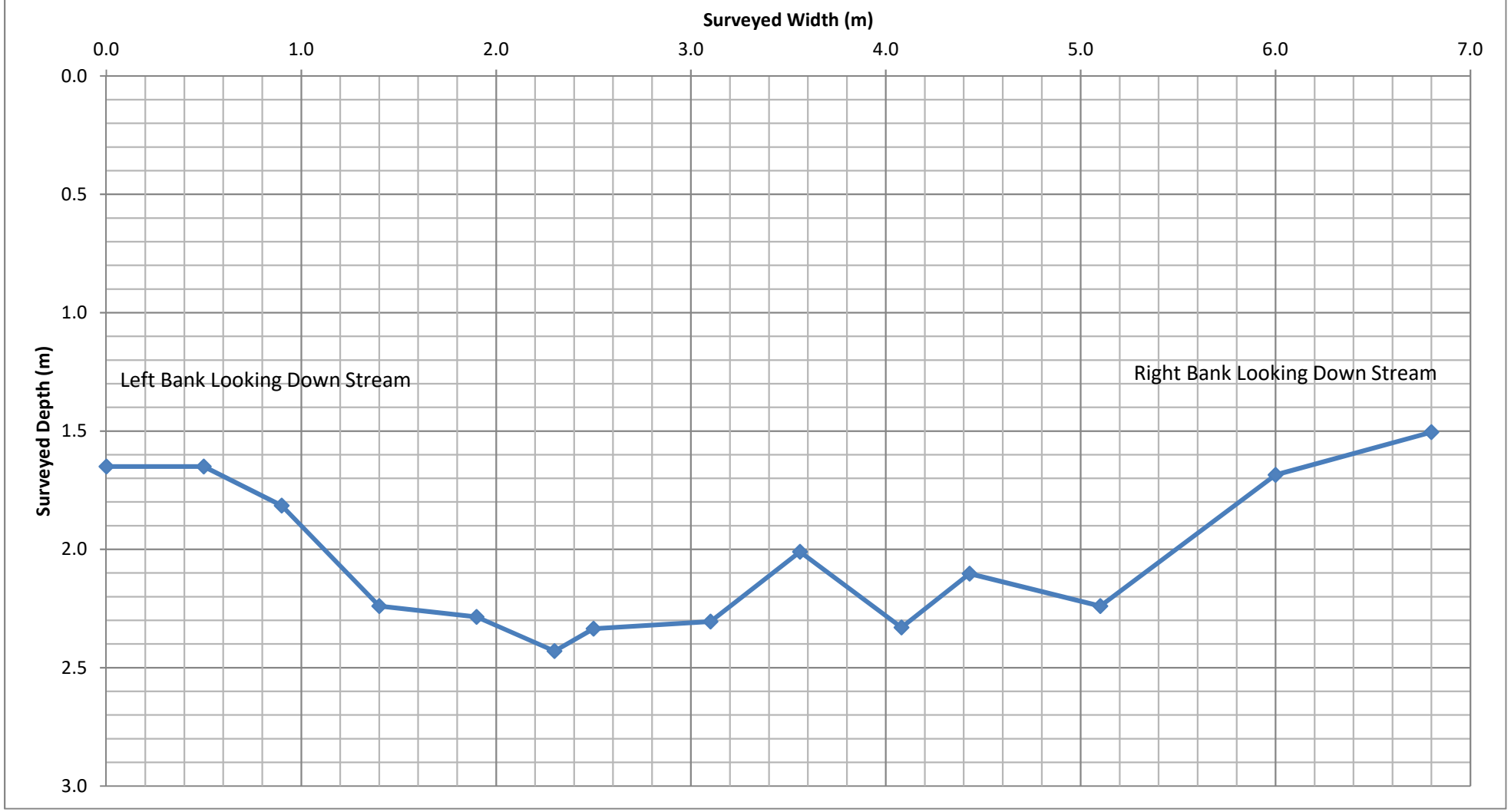
Flow Monitoring Station 13 Stoney Creek Down Long Section
Profile Through Cease to Flow Point December 2018



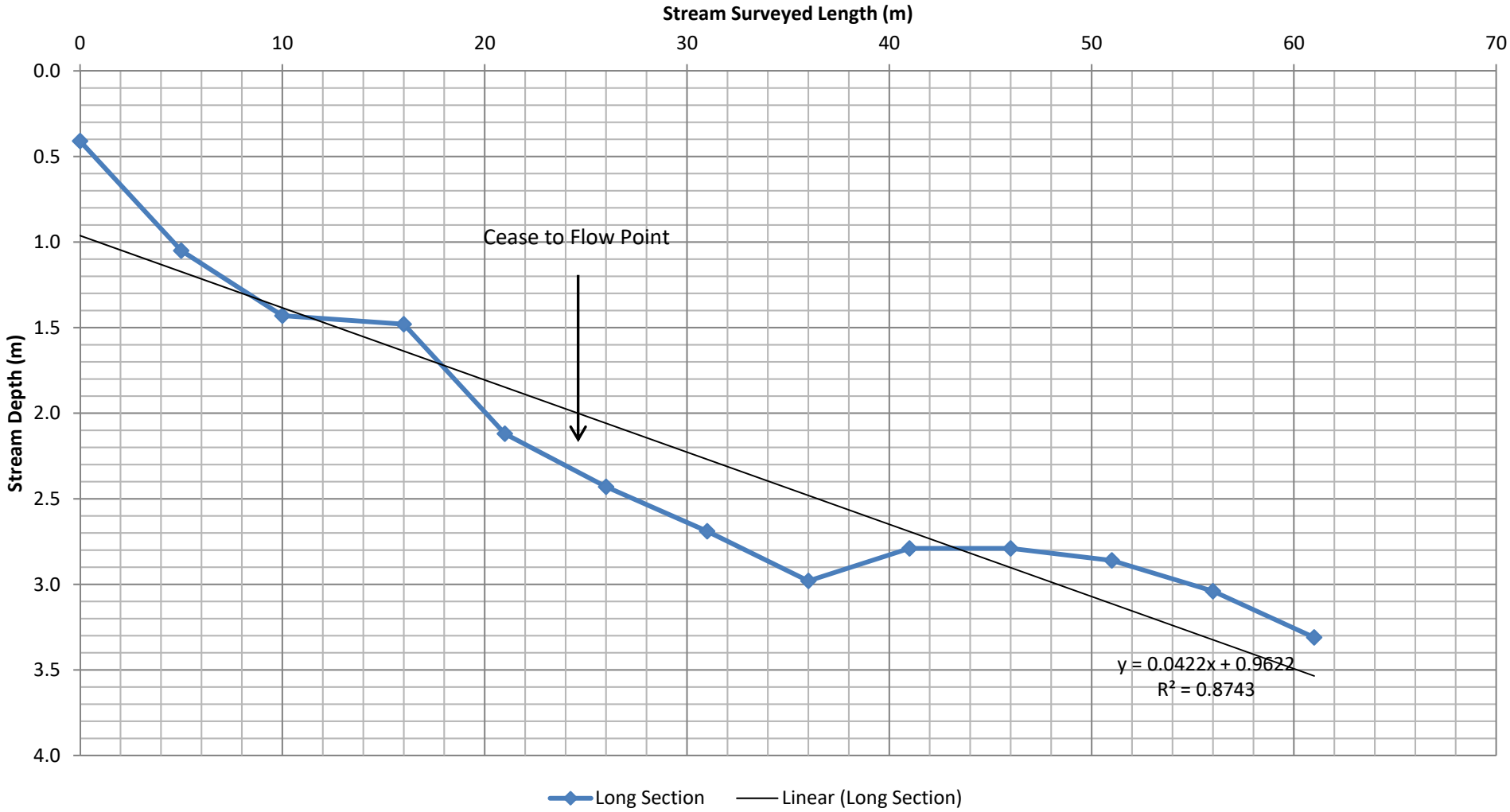
Flow Monitoring Station 14 Stoney Creek Tributary Theoretical Flow Rating Curve January 2018



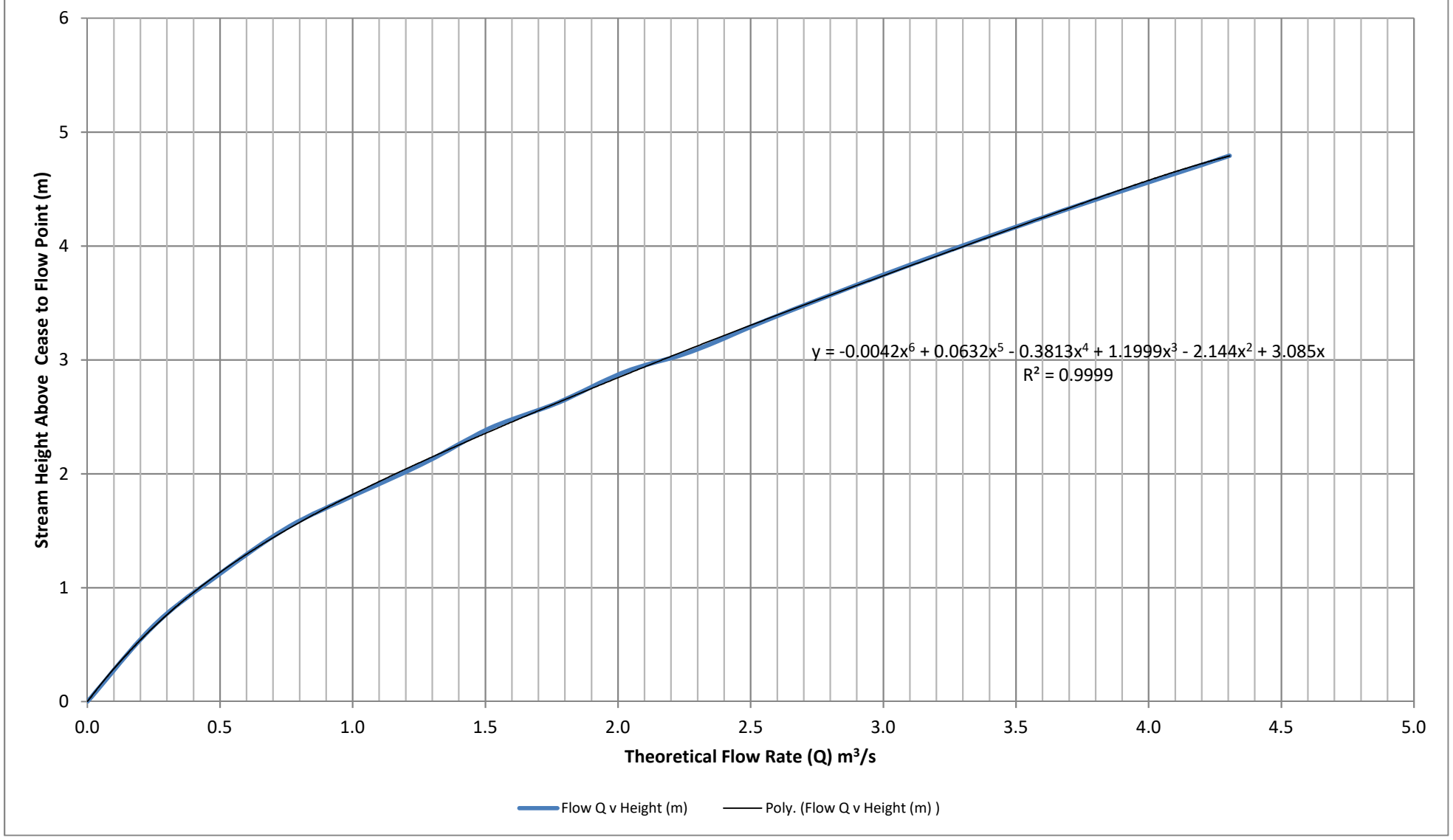
Flow Monitoring Station 14 Stoney Creek Tributary Cease To Flow Point Cross Section Survey December 2018



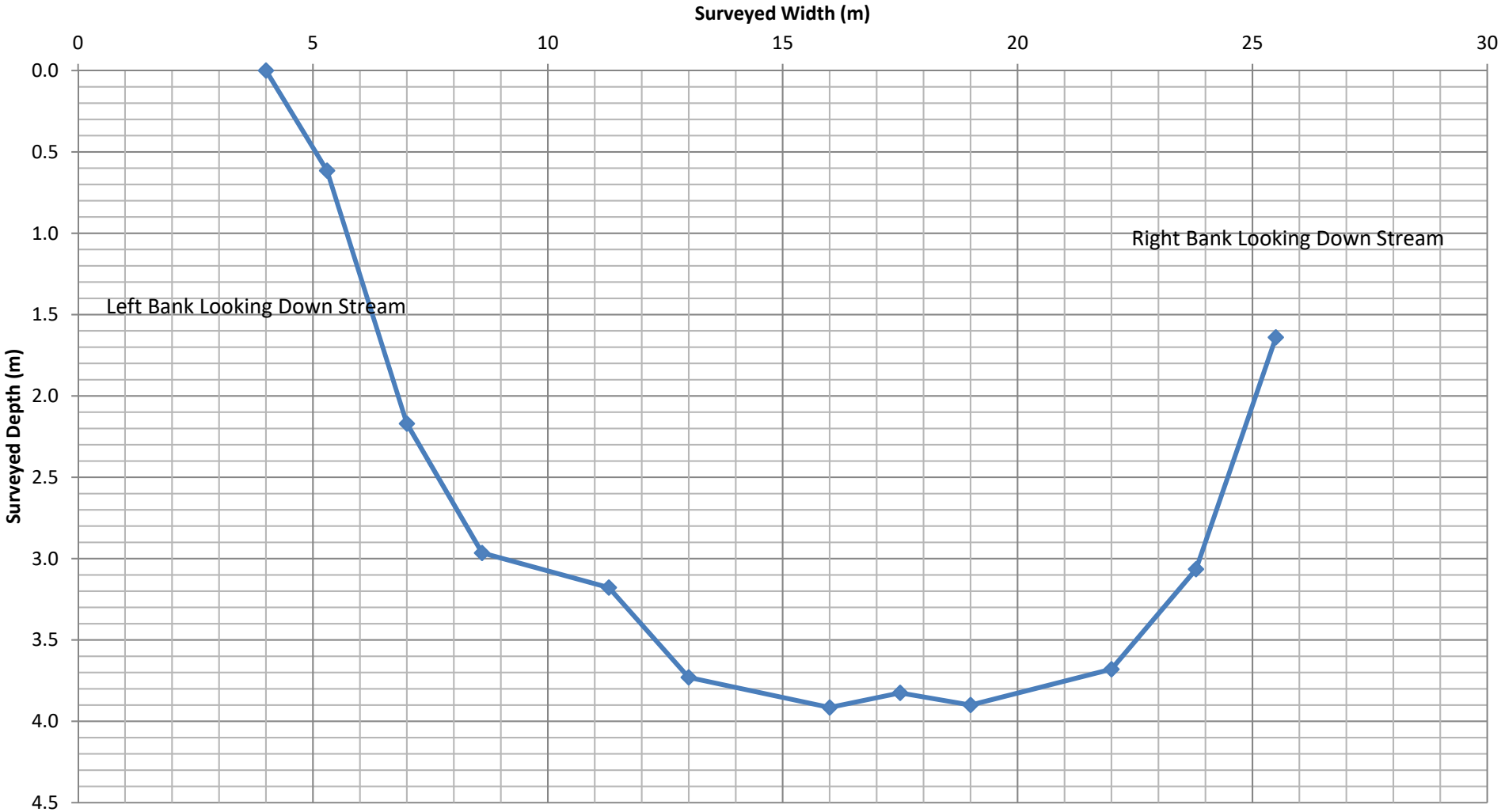
Flow Monitoring Station 14 Stoney Creek Tributary Long Section Profile Through Cease to Flow Point December 2018



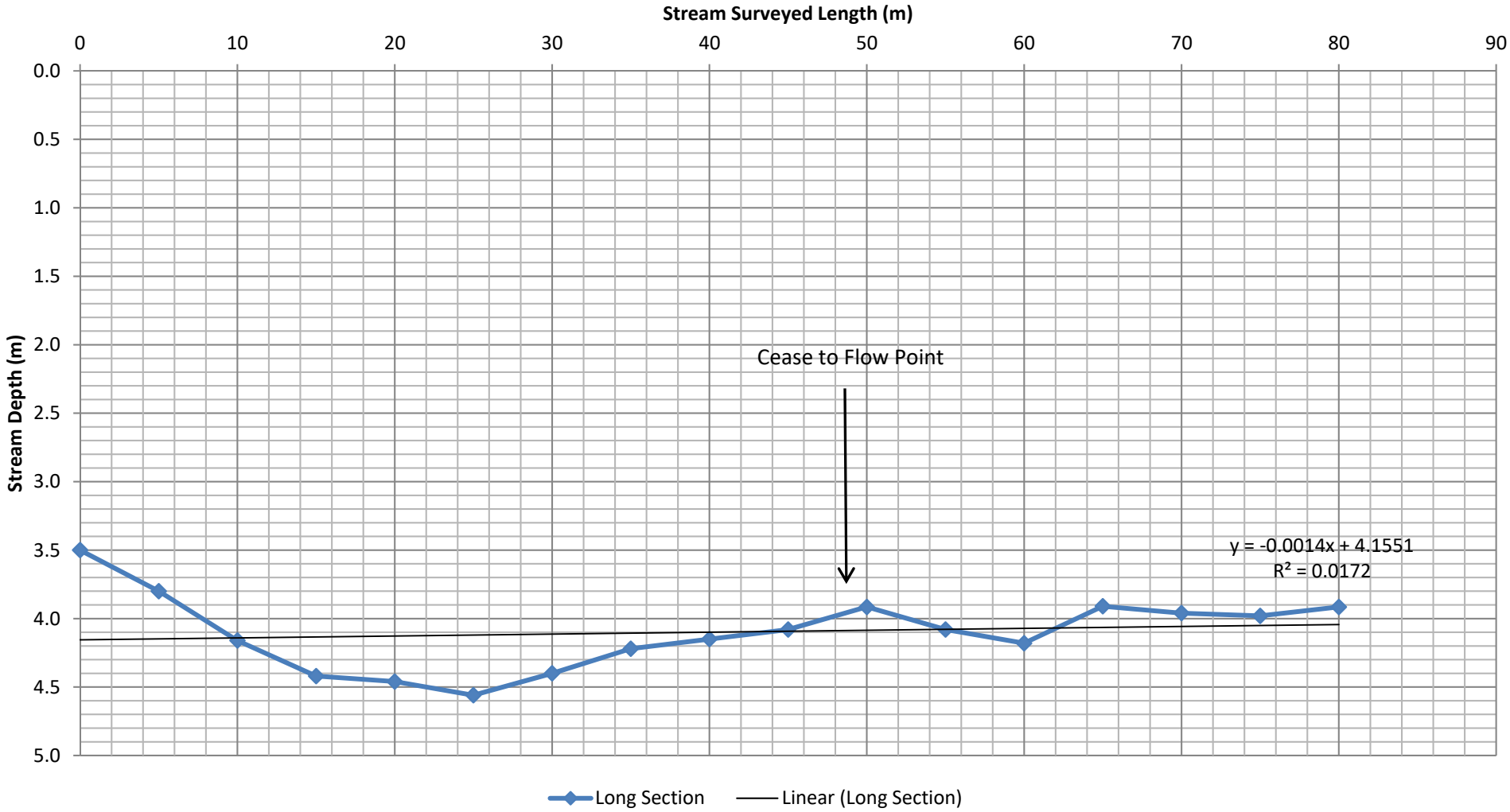
Flow Monitoring Station 15 South Wambo Creek
Theoretical Flow Rating Curve, December 2016



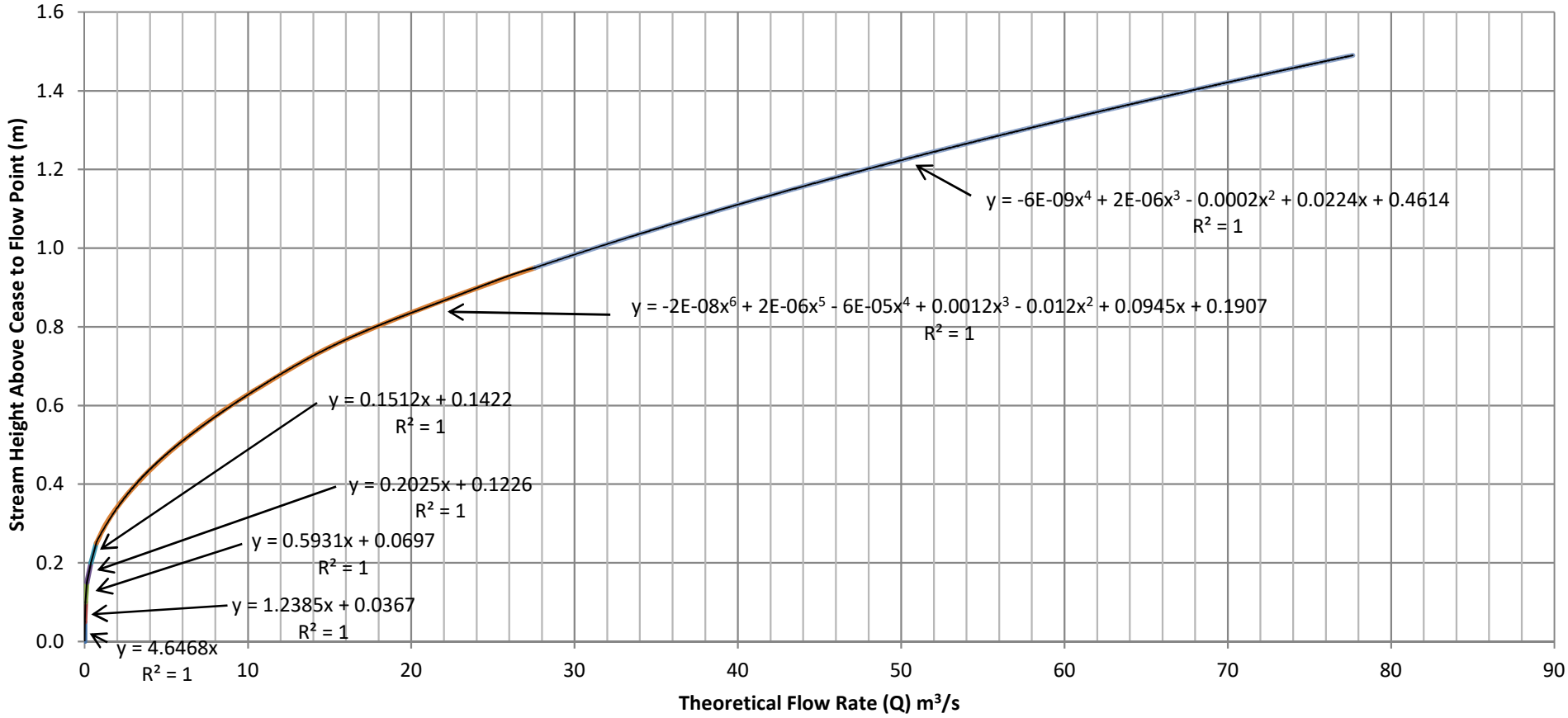
Flow Monitoring Station 15 South Wambo Creek Cease to Flow Point
Cross Section Survey
January 2018



Flow Monitoring Station 15 South Wambo Creek Long Section Profile Through Cease to Flow Point January 2018

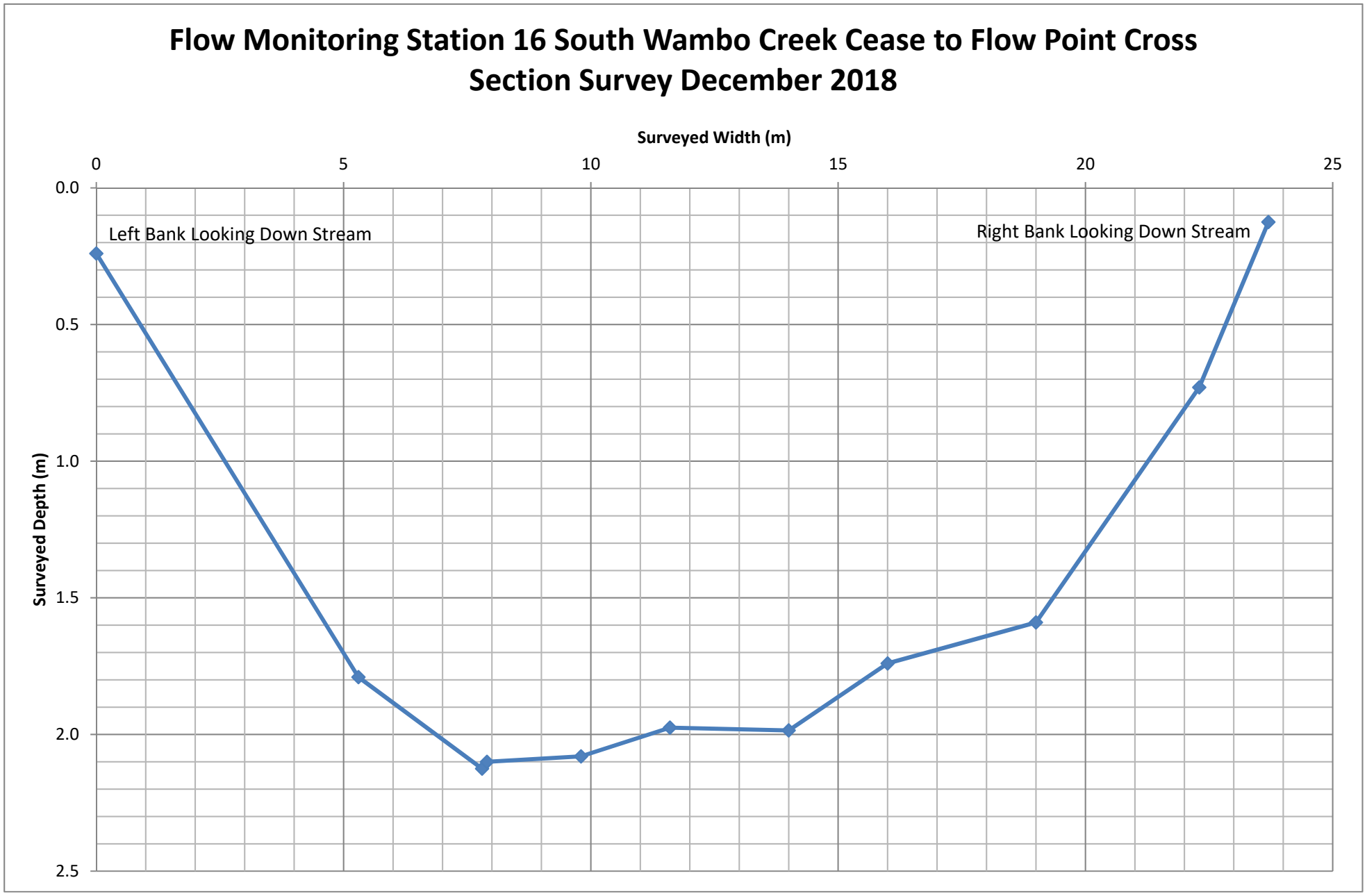


Flow Monitoring Station 16 South Wambo Creek Theoretical Flow Rating Curve, January 2018

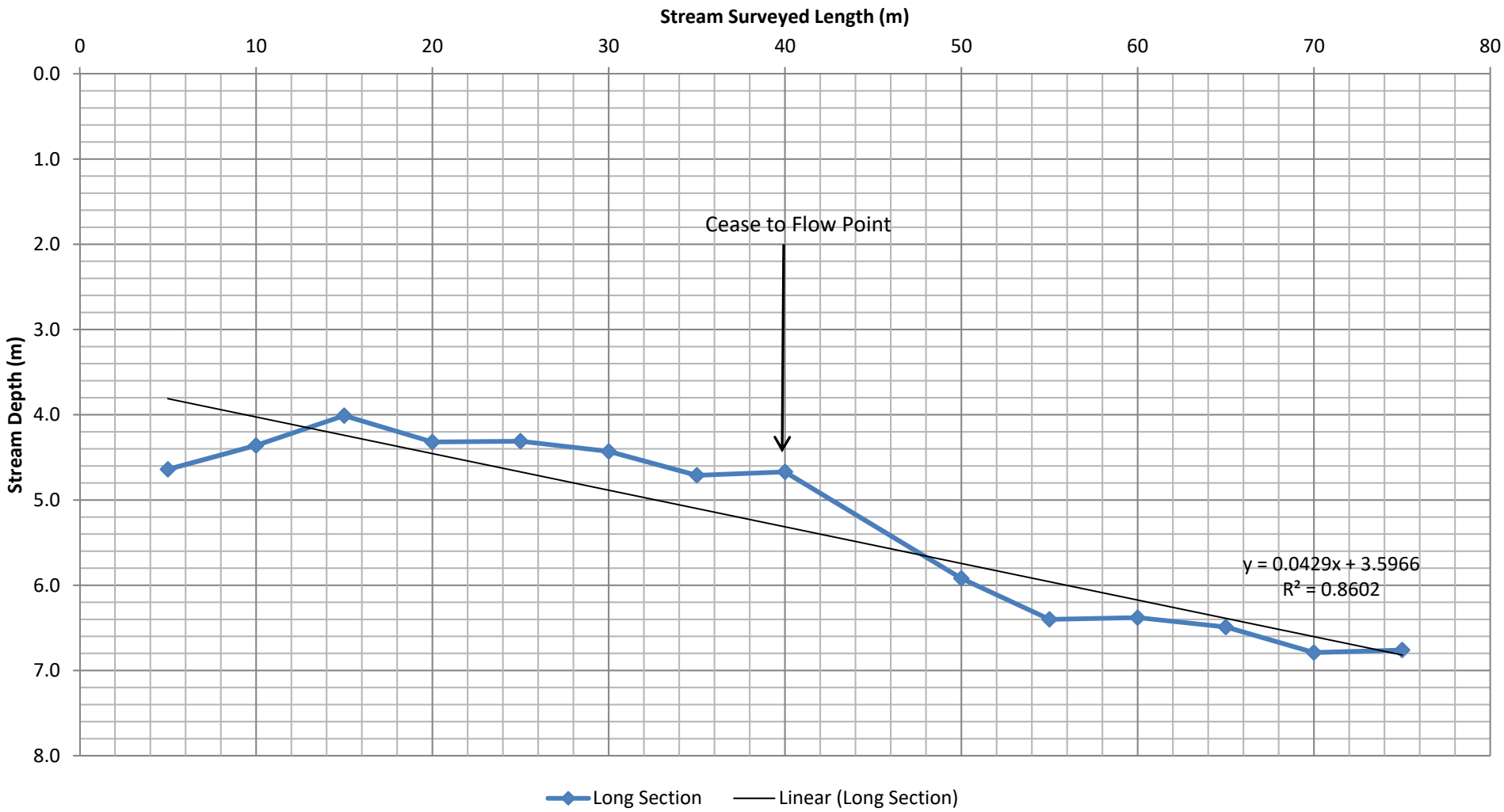


Flow Q v Height (m) Section 1 (0.0 to 0.05m)
Flow Q v Height (m) Section 2 (0.05 to 0.1m)
Flow Q v Height (m) Section 3 (0.1 to 0.15m)
Flow Q v Height (m) Section 4 (0.15 to 0.2m)
Flow Q v Height (m) Section 4 (0.2 to 0.25m)
Flow Q v Height (m) Section 4 (0.25 to 0.95m)
Flow Q v Height (m) Section 4 (0.95 to 1.49m)
Linear (Flow Q v Height (m) Section 1 (0.0 to 0.05m))
Linear (Flow Q v Height (m) Section 2 (0.05 to 0.1m))
Linear (Flow Q v Height (m) Section 3 (0.1 to 0.15m))
Linear (Flow Q v Height (m) Section 4 (0.15 to 0.2m))
Linear (Flow Q v Height (m) Section 4 (0.2 to 0.25m))
Poly. (Flow Q v Height (m) Section 4 (0.25 to 0.95m))
Poly. (Flow Q v Height (m) Section 4 (0.95 to 1.49m))

Flow Monitoring Station 16 South Wambo Creek Cease to Flow Point Cross Section Survey December 2018



Flow Monitoring Station 16 South Wambo Creek Long Section Profile Through Cease to Flow Point December 2018



Appendix C

Stream Height, Theoretical Flow, Daily and Cumulative Rainfall Charts

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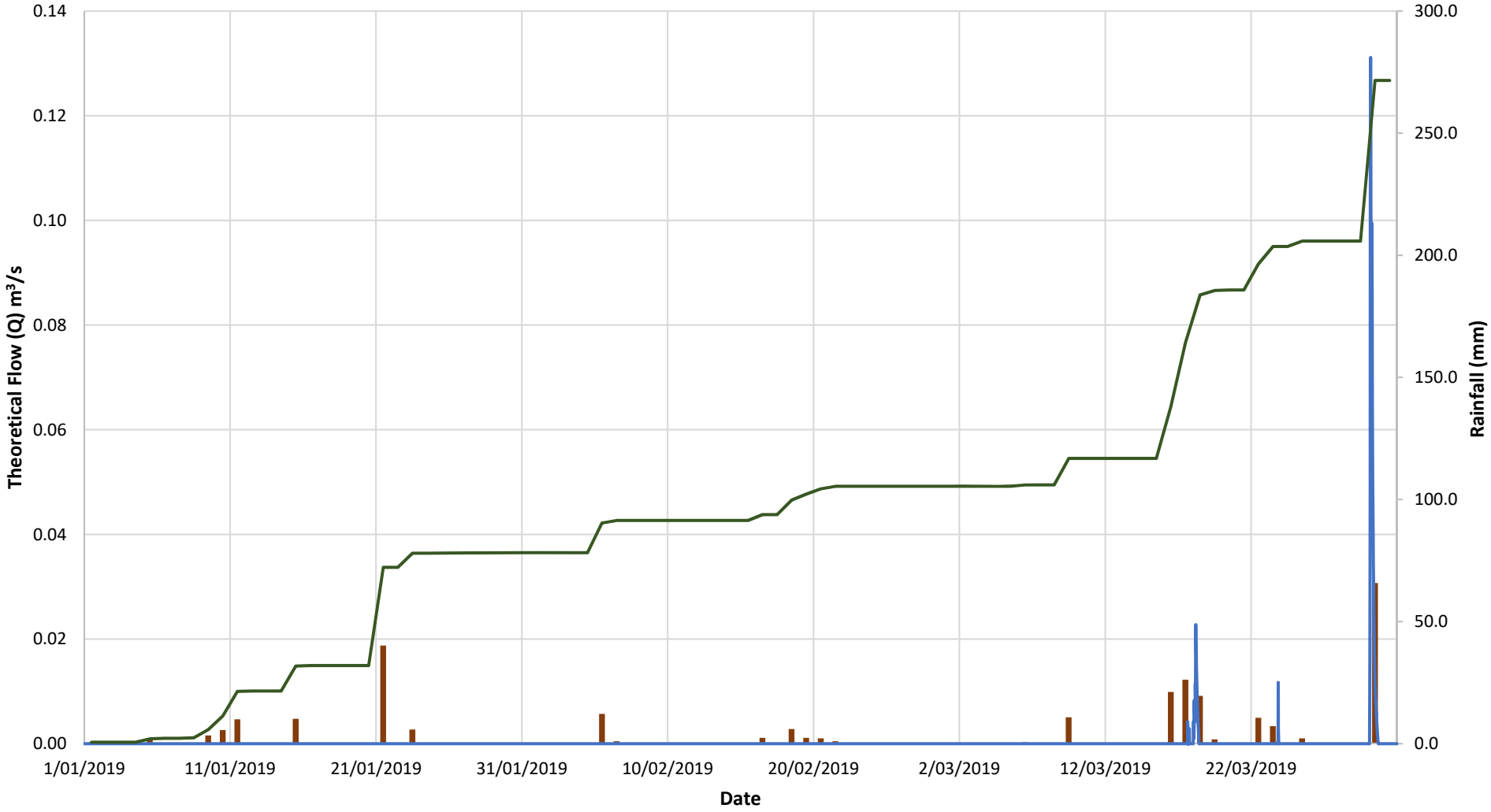
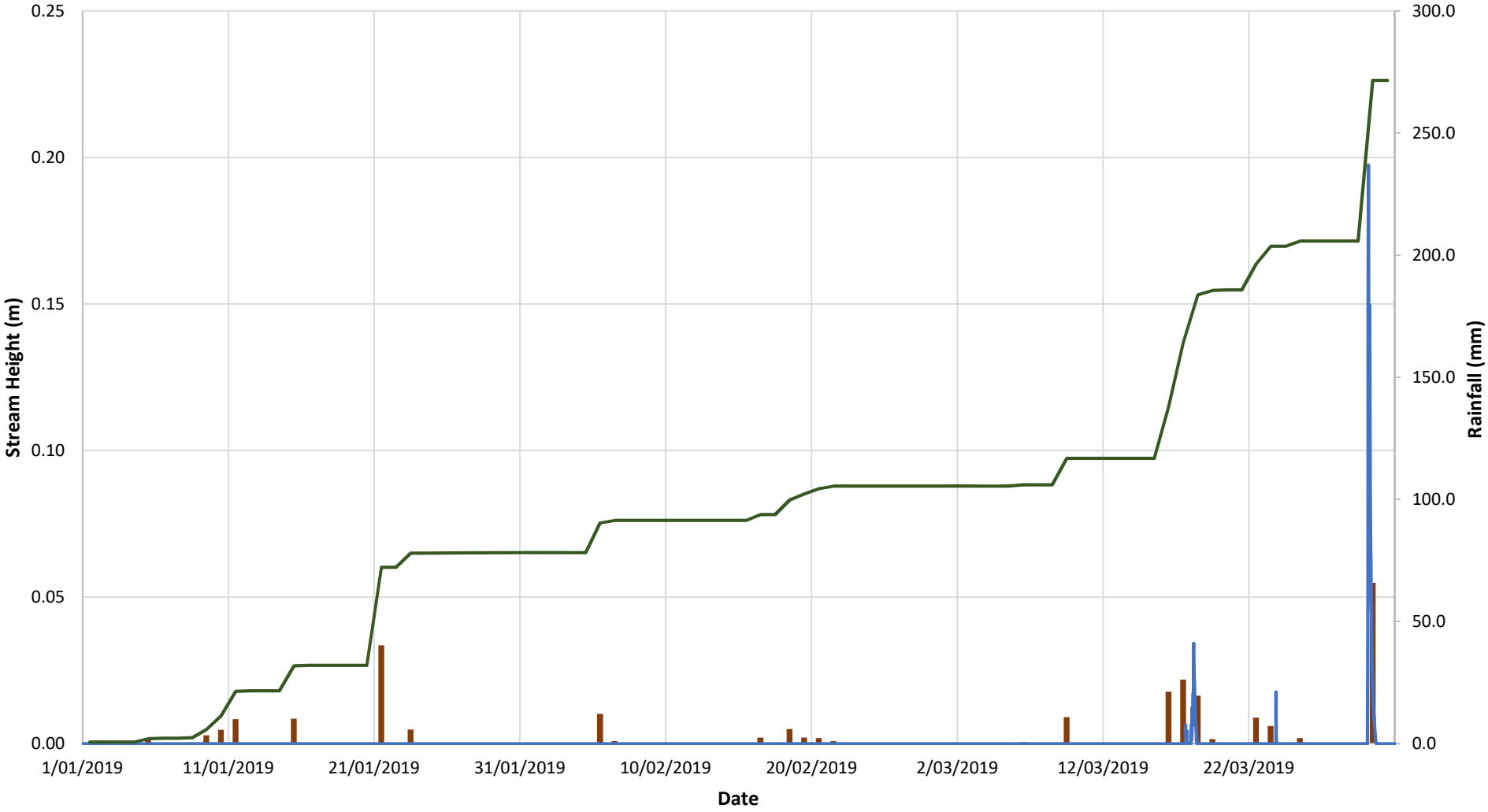
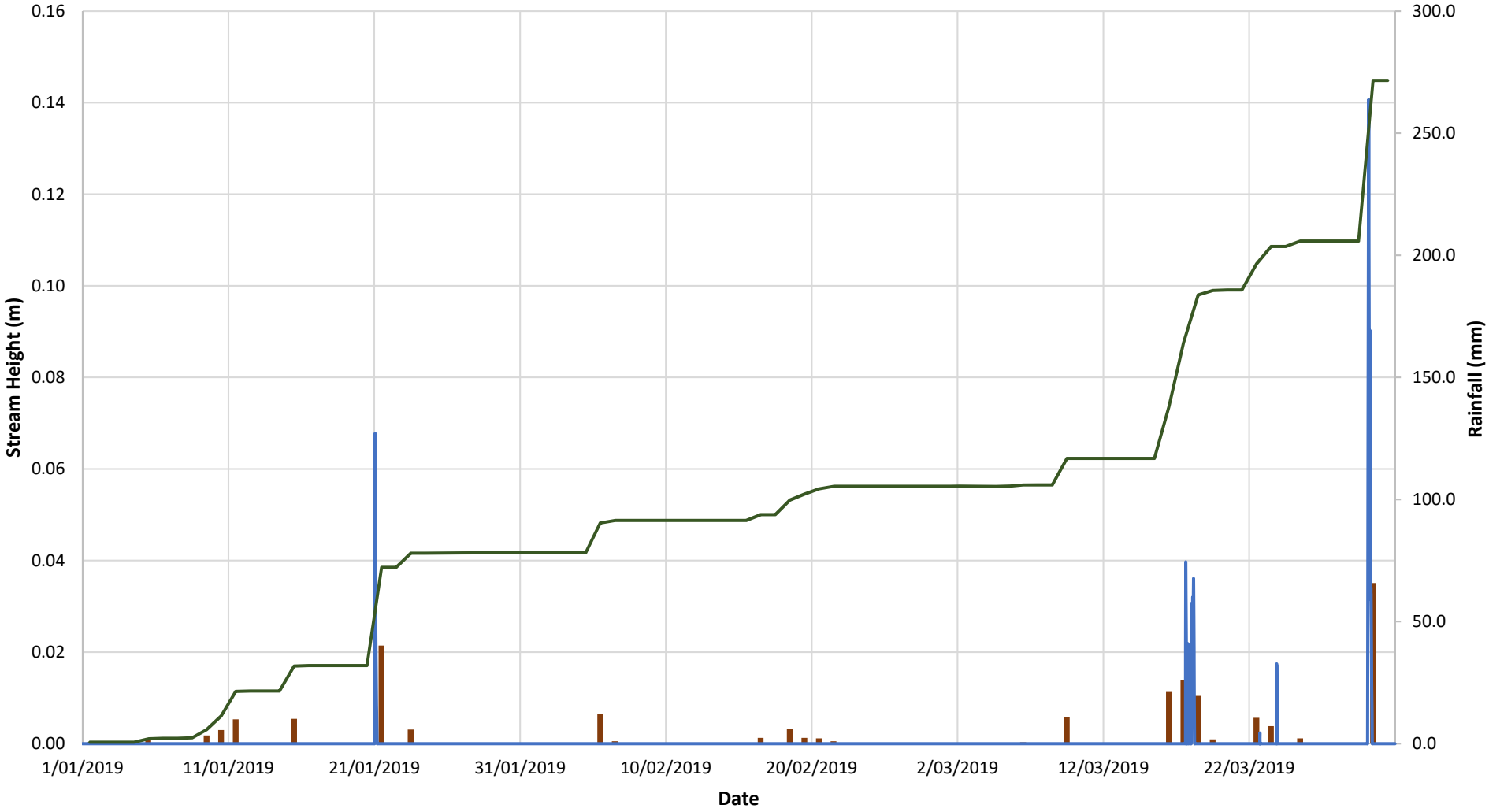
Flow Monitoring Station 2 North Wambo Creek
Theoretical Flow (Q) and Rainfall
1 January to 31 March 2019



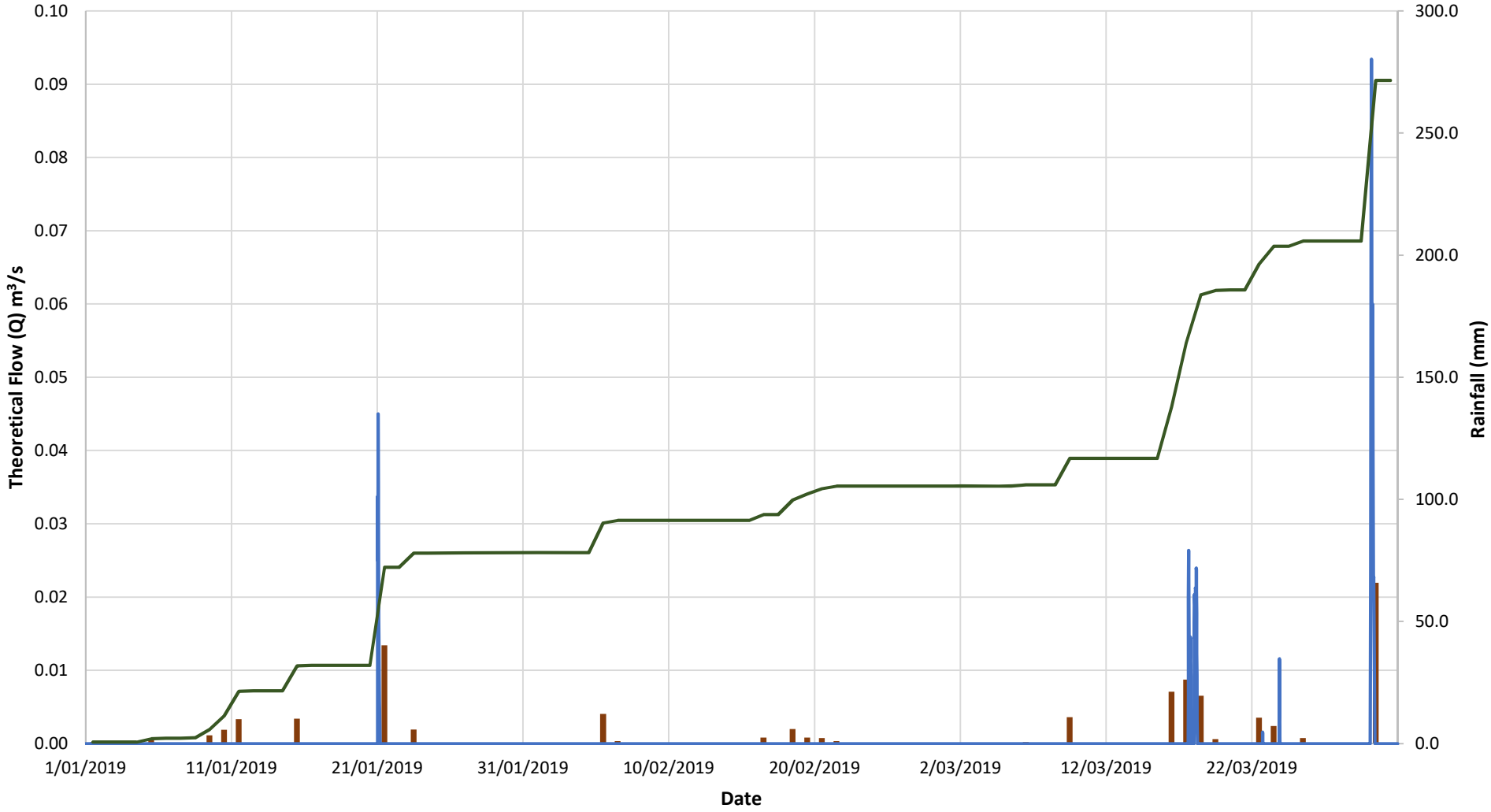
Flow Monitoring Station 2 North Wambo Creek
Stream Height and Rainfall
1 January to 31 March 2019



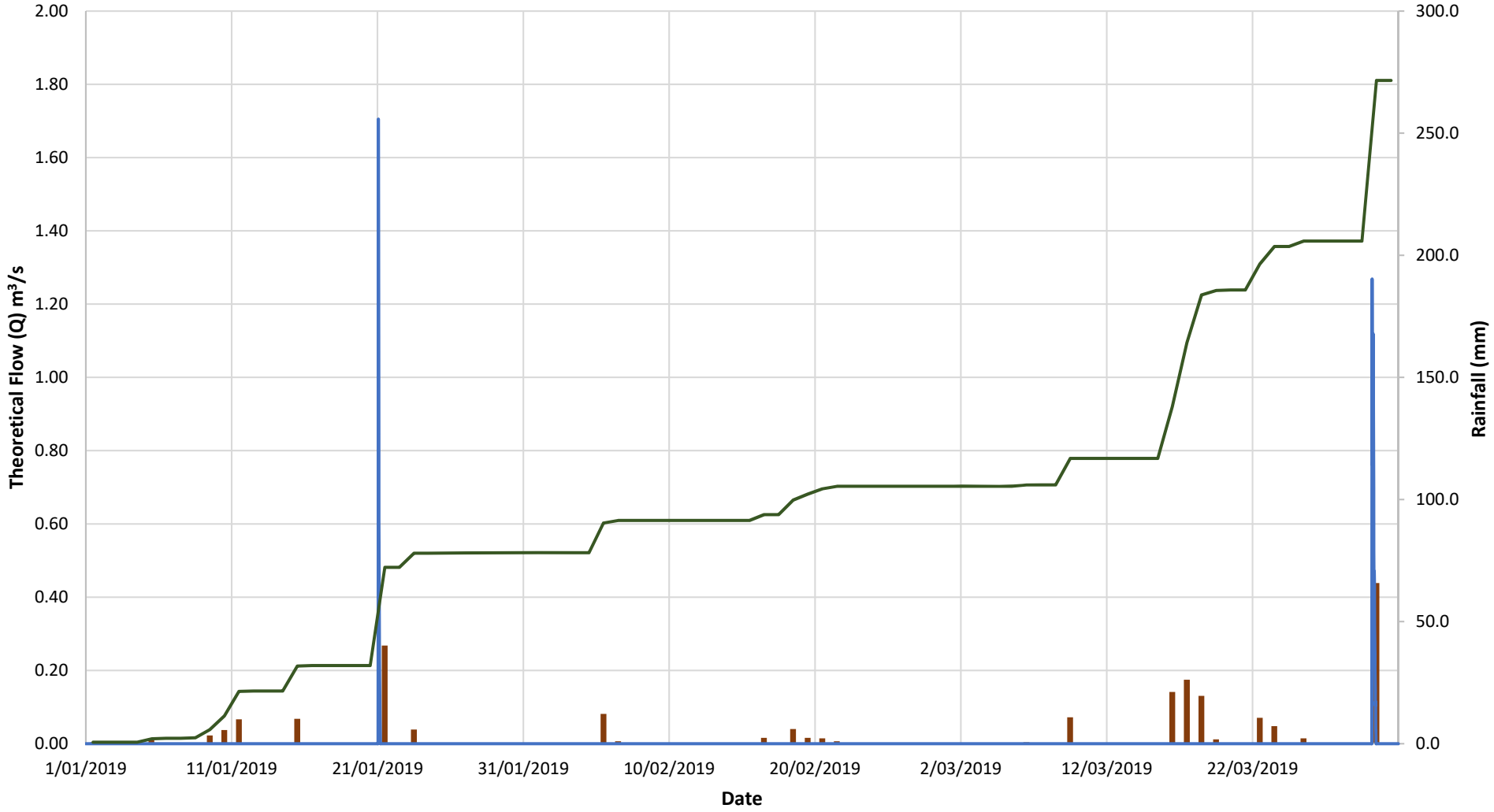
Flow Monitoring Station 3 North Wambo Creek
Stream Height and Rainfall
1 January to 31 March 2019



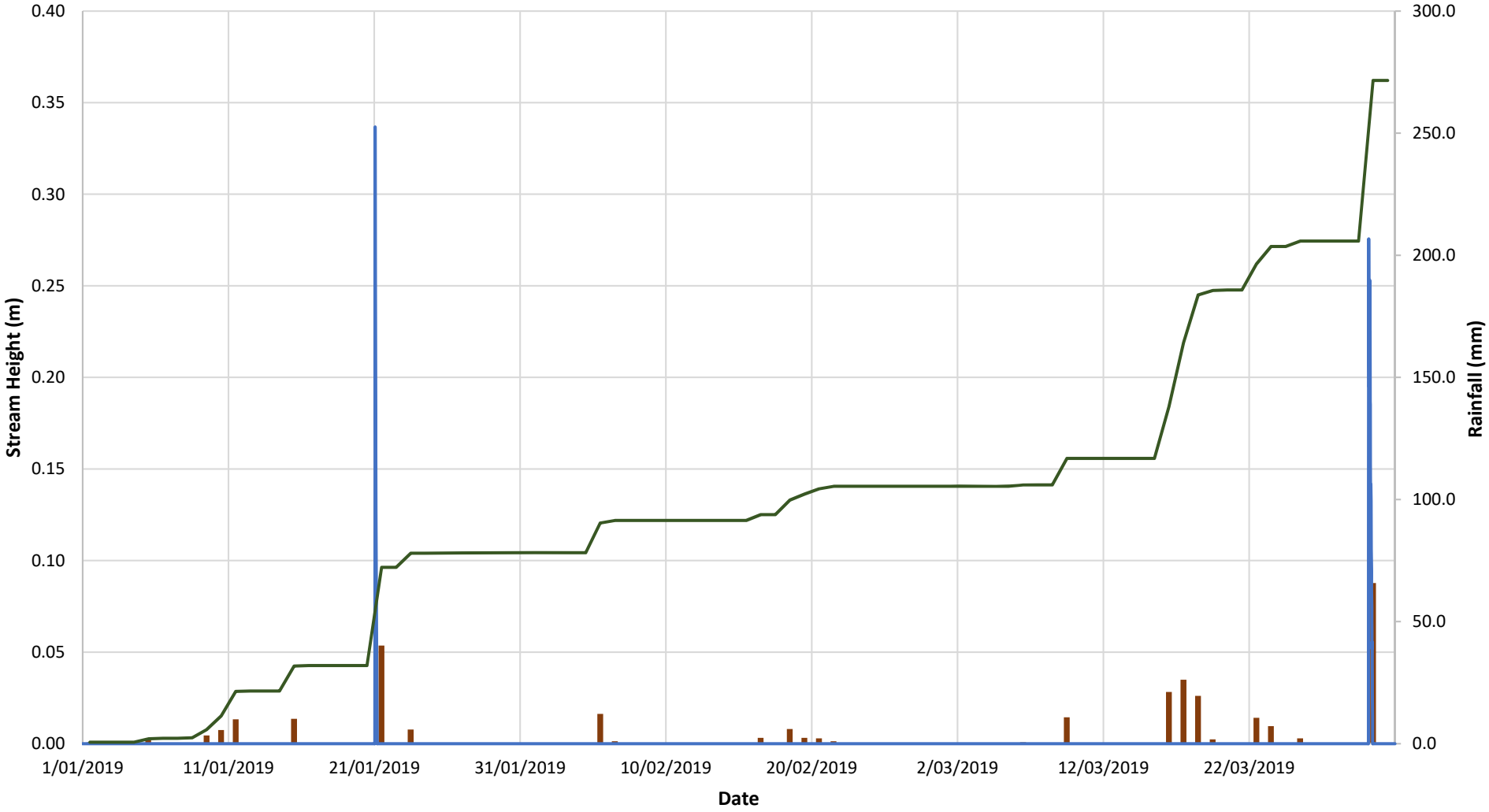
Flow Monitoring Station 3 North Wambo Creek
Theoretical Flow (Q) and Rainfall
1 January to 31 March 2019



Flow Monitoring Station 4 North Wambo Creek
Theoretical Flow (Q) and Rainfall
1 January to 31 March 2019



Flow Monitoring Station 4 North Wambo Creek
Stream Height and Rainfall
1 January to 31 March 2019



APPENDIX I

WAMBO COAL PTY LTD
2019 ANNUAL COMPLIANCE REPORT
(EPBC 2016/7636 AND EPBC 2016/7816)

WAMBO COAL PTY LTD
2019 ANNUAL COMPLIANCE REPORT

(EPBC 2016/7636 and EPBC 2016/7816)

1 January – 31 December 2019

Document Control

Title	Wambo Coal 2019 Annual Compliance Report (EPBC 2016/7636 and EPBC 2016/7816)
General Description	Review of compliance with the conditions of EPBC 2016/7636 and EPBC 2016/7816
Document Owner	Manager: Environment & Community

Revisions

Rev No	Date	Description	By	Checked	Signature
1	March 2020	Original	WCPL	ND/PJ	

This report addresses Condition 5 of the Wambo Coal Pty Limited (WCPL) Environment Protection and Biodiversity Conservation (EPBC) Approval 2016/7636 for the South Wambo Underground Mine Extension, which states:

> *The person taking the action must publish a report on the website addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions D10 and D15 of Schedule 2 of the **state development consent**. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** (by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**) at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.*

Table 1 provides a reconciliation of the conditions of EPBC 2016/7636 and their compliance status.

This report also addressed Condition 5 of the WCPL EPBC Approval 2016/7816 for the South Bates Extension Underground Mine, which states:

> *The person taking the action must publish a report on the website addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions D10 and D15 of Schedule 2 of the **state development consent**. Documentary evidence providing proof of the date of publication must be provided to the **Department** (by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**) at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.*

Table 2 provides a reconciliation of the conditions of EPBC 2016/7816 and their compliance status.

Table 1: EPBC Approval 2016/7636 Compliance Summary

Condition	Status	Comment
1. The person taking the action must: a. Not clear more than 0.9 ha of Central Hunter Valley Eucalypt Forest and 3.4 ha of foraging habitat for the Regent Honeyeater *(Anthochaera phrygia)*.	Compliant	The action has not yet been commenced. WCPL has not cleared more than 0.9 hectares (ha) of Central Hunter Valley Eucalypt Forest or more than 3.4 ha of foraging habitat for the Regent Honeyeater (*Anthochaera Phrygia*) as part of the action.
b. Implement conditions A1 and A2 of Schedule 2 of the **state development consent** to minimise the impacts of the action on **protected matters**.	Compliant	WCPL implements Conditions A1 and A2, Schedule 2 of the Development Consent (DA305-7-2003).
c. Implement environmental performance conditions B1-B11, B51-B55, B62-B73 and B75-B77 of Schedule 2 of the **state development consent**, where the conditions relate to avoiding, mitigating, managing, offsetting, monitoring or recording, or reporting on impacts to **protected matters**. In implementing these conditions, the approval holder must protect at least 18.3 ha of Central Hunter Valley Eucalypt Forest and at least 27.7 ha of foraging habitat for the Regent Honeyeater *(Anthochaera phrygia)* in perpetuity.	Compliant	WCPL implements Conditions B1-B11, B51-B55, B62-B73 and B75-B77 of Schedule 2 of the Development Consent (DA305-7-2003). WCPL has applied to amend an existing Voluntary Conservation Agreement (VCA) under the NSW *National Parks and Wildlife Act, 1974* to conserve Remnant Woodland Enhancement Program Area E in perpetuity, which includes 18.3 ha of Central Hunter Valley Eucalypt Forest and Woodland and 27.7 ha of foraging habitat for the Regent Honeyeater.
2. Within 30 days after the **commencement of the action**, the person taking the action must advise the **Department** in writing of the actual date of **commencement of the action**.	Not applicable	The action has not yet been commenced. Mining at the approved South Wambo Underground Mine is planned to commence after completion of mining at the South Bates Underground Mine. WCPL will advise the Department in writing of the commencement of the action within 30 days of commencement.
3. Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all management plans, programs, strategies and reviews required by condition 1. Each management plan, program, strategy and review must be published on the **website**, and notification must be provided to the **Department**, within 1 month of being approved by the Secretary of the NSW Department of Planning & Environment (or nominee of the Secretary).	Compliant	Copies of all management plans, programs, strategies and reviews required by condition 1 of EPBC 2016/7636 are available to the public on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports. Relevant management plans include the Site Water Management Plan, Biodiversity Management Plan and Life of Mine Rejects Emplacement Strategy. An Extraction Plan for areas related to the action has not yet been prepared. Notification is provided to the Department within one month of the approval of any management plans, programs, strategies and reviews by the Secretary of the NSW Department of Planning & Environment (or nominee of the Secretary).

Condition	Status	Comment
4. The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by condition 1, 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.	Compliant	WCPL maintains accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by condition 1. WCPL will make these records available upon request to the Department.
5. The person taking the action must publish a report on their **website** addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions D10 and D15 of Schedule 2 of the **state development consent**. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** (by email to EPBCmonitoring@environment.gov.au or an address as stipulated by the **Department**) at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.	Compliant	The WCPL 2019 Annual Review (including this report) will be published on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.
6. Any potential or actual contravention of the conditions of this approval, including contravention of a commitment made in a management plan, program, strategy and review required by condition 1 must be reported to the **Department** within 7 days of the person taking the action becoming aware of the actual or potential contravention.	Not applicable	No events contravening (or potentially contravening) the conditions of this approval have occurred.
7. Upon the direction of the **Minister**, the person taking the action 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 and audit criteria must be approved by the **Minister** prior to the commencement of the audit. The audit report must address the criteria to the satisfaction of the **Minister**.	Not applicable	Upon the direction of the Minister, WCPL will ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister.
8. If, at any time after 5 years from the date of this approval, the person taking the action has not substantially commenced the action, then the person taking the action must not substantially commence the action without the written agreement of the **Minister**.	Not applicable	WCPL has not yet commenced the action. Mining at the approved South Wambo Underground Mine is planned to commence after completion of mining at the South Bates Underground Mine. If WCPL has not substantially commenced the South Wambo Underground Mine prior to 30 April 2022 (i.e. five years after the date EPBC 2016/7636 was granted), WCPL will seek the written agreement of the Minister prior to substantially commencing the action.

Table 2: EPBC Approval 2016/7816 Compliance Summary

Condition	Status	Comment
1. The person taking the action must: a. Implement administrative conditions A1 and A2 of Schedule 2 of the **state development consent** to minimise the impacts of the action on **protected matters**.	Compliant	WCPL implements Conditions A1 and A2, Schedule 2 of the Development Consent (DA305-7-2003).
b. Implement environmental performance conditions B1-B3, B7-B10, B51-B55 and B62- B68 of Schedule 2 of the **state development consent**, where the conditions relate to avoiding, mitigating, managing, offsetting, monitoring or recording, or reporting on impacts to **protected matters**.	Compliant	WCPL implements Conditions B1-B3, B7-B10, B51-B55 and B62-B68, Schedule 2 of the Development Consent (DA305-7-2003).
c. Notify the **Department** in writing of any proposed change to the **conditions** of the **state development consent**, referred to in conditions 1a and 1b, within 5 **business days** of formally proposing a change or becoming aware of any other proposed change.	Compliant	No changes to DA 305-7-2003 (the state development consent) have been proposed following the issue of EPBC Approval 2016/7816 on 4 May 2018. DA 305-7-2003 Modification 16 associated with the proposed United Wambo Open Cut Coal Mine Project was lodged on 8 August 2016. The Referral for EPBC 2016/7816 was lodged on 22 November 2016 and described the changes proposed by the United Wambo Open Cut Coal Mine Project.
d. Notify the **Department** in writing of any change to conditions of the **state development consent**, referred to in conditions 1a to 1b, within 5 **business days** of a change to **conditions** being finalised.	Compliant	The Department was notified in writing of changes to the conditions in Development Consent (DA305-7-2003) (Modification 16) within the allocated time period following the conditions being finalised.
2. Within 25 **business days** after the **commencement of the action**, the person taking the action must advise the **Department** in writing of the actual date of **commencement of the action**.	Compliant	WCPL provided a notification to the Department of the actual date of commencement of the action (3 December 2018), however this was not completed within 30 days of the commencement of the action.

Condition	Status	Comment
3. Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all management plans and strategies required by conditions B1-B3, B7-B10, B51-B55 and B62-B68 of Schedule 2 of the **state development consent** on their website. Each management plan and strategy must be published on the **website** within 1 month of being approved by the **Secretary** and remain there for a period of no less than 5 years.	Compliant	Copies of all management plans, programs, strategies and reviews required by condition 1 of EPBC 2016/7636 are available to the public on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports. Relevant management plans include the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20, Site Water Management Plan, Biodiversity Management Plan and Life of Mine Rejects Emplacement Strategy. Notification is provided to the Department within one month of the approval of any management plans, programs, strategies and reviews by the Secretary of the NSW Department of Planning & Environment (or nominee of the Secretary).
4. The person taking the action 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 strategies required by conditions B1-B3, B7-B10, B51-B55 and B62-B68 of Schedule 2 of the **state development consent**, 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 this **approval**.	Compliant	WCPL maintains accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by Conditions B1-B3, B7-B10, B51-B55 and B62-B68, Schedule 2. WCPL will make these records available upon request to the Department.
5. The person taking the action must publish a report on their website addressing compliance with each of the **conditions** of this **approval**, including implementation of any management plans and strategies required by condition 1. The reporting period and report publication must comply with conditions D10 and D15 of Schedule 2 of the **state development consent**. Documentary evidence providing proof of the date of publication must be provided to the **Department** (by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**) at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.	Compliant	The WCPL 2019 Annual Review (including this report) will be published on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.

Condition	Status	Comment
6. Any potential or actual contravention of the conditions of this **approval**, including contravention of a commitment made in a management plan or strategy required by condition 1 must be reported to the **Department** no later than 7 **business days** of the person taking the action becoming aware of the actual or potential contravention, by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**.	Not applicable	No events contravening (or potentially contravening) the conditions of this approval have occurred.
7. Upon the direction of the **Minister**, the person taking the action 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 and audit criteria must be approved by the **Minister** prior to the commencement of the audit. The audit report must address the criteria to the satisfaction of the **Minister**.	Not applicable	Upon the direction of the Minister, WCPL will ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister.
8. If, at any time after 5 years from the date of this **approval**, the person taking the action has not substantially **commenced the action**, then the person taking the action must not **commence the action** without the written agreement of the **Minister**.	Compliant	WCPL commenced the action within five years of the date of the approval of EPBC 2016/7816.