WAMBO COAL PTY LTD
2017 ANNUAL REVIEW

1 January – 31 December 2017

<table>
<tr><td>Name of operation</td><td>Wambo Coal Mine</td></tr>
<tr><td>Name of operator</td><td>Wambo Coal Pty Ltd</td></tr>
<tr><td>Development consent /Project Approval #</td><td>DA305-7-2003, DA177-8-2004, EPBC 2003/1138, EPBC 2016/7636, EPBC 2016/7816</td></tr>
<tr><td>Name of holder of development consent</td><td>Wambo Coal Pty Ltd</td></tr>
<tr><td>Title/Mining lease #</td><td>CL365, CL374, CL397, CCL743, ML1402, ML1572, ML1594, A444, EL7211</td></tr>
<tr><td>Name of holder of mining lease</td><td>Wambo Coal Pty Ltd</td></tr>
<tr><td>Water licence #</td><td>As per Table 3</td></tr>
<tr><td>Name of holder of water licence</td><td>Wambo Coal Pty Ltd</td></tr>
<tr><td>MOP start date</td><td>31 March 2015</td></tr>
<tr><td>MOP end date</td><td>30 March 2020</td></tr>
<tr><td>Annual Review start date</td><td>1 January 2017</td></tr>
<tr><td>Annual Review end date</td><td>31 December 2017</td></tr>
<tr><td colspan="2">I, Peter Jaeger, certify that this audit report is a true and accurate record of the compliance status of Wambo Coal Mine for the period 1 January 2017 to 31 December 2017 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).</td></tr>
<tr><td>Name of authorised reporting officer</td><td>Peter Jaeger</td></tr>
<tr><td>Title of authorised reporting officer</td><td>Senior Environmental Advisor</td></tr>
<tr><td>Signature of authorised reporting officer</td><td></td></tr>
<tr><td>Date</td><td>29/3/18</td></tr>
</table>

Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
EPL529	No
DA305-7-2003	No
DA177-8-2004	Yes
EPBC 2003/1138	Yes
EPBC 2016/7636	Yes
EPBC 2016/7816	N/A[1]
CL365	Yes
CL374	Yes
CL397	Yes
CCL743	Yes
ML1402	Yes
ML1574	Yes
ML1592	Yes
A444	Yes
EL7211	Yes
Water licences (As per **Table 3**)	Yes

[1] EPBC 2016/7816 has not yet been determined and is not in effect.

Non-Compliances

Relevant Approval	Condition #	Condition Description (summary)	Compliance Status	Comment	Where addressed in Annual Review
DA305-7-2003	6 (Sch. 4)	Night-time Noise Impact Assessment Criteria	Non-compliant	Unsustained, negligible exceedance of Night-time Noise Impact Assessment Criteria.	Section 10.1
EPL529	L4.1	Noise Limits	Non-compliant		
DA305-7-2003	65 (Sch. 4)	Reporting of Blasting Results	Non-compliant	Reports have not yet been prepared for the blasts on 18 October, 24 November and 15 December 2017, or for the period July to December 2017.	Section 10.2
EPL529	M2.2	Air Monitoring Requirements	Non-compliant	Failure to record PM_{10} levels continuously at PM03 (EPA ID. 15) due to technical issues.	Section 10.3
EPL529	M4.1	Weather Monitoring	Non-compliant	Software issues prevented continuous weather monitoring.	Section 10.4

Relevant Approval	Condition #	Condition Description (summary)	Compliance Status	Comment	Where addressed in Annual Review
EPL 529	M2.3	Water Monitoring Point	Non-compliant	Hardware failure at EPL Monitoring Point 7 led to inaccurate Electrical Conductivity (EC) readings.	Section 10.5

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).

TABLE OF CONTENTS

TABLES

FIGURES

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 2017 – 31 December 2017. This Annual Review has been prepared in accordance with the NSW Department of Planning and Environment (DPE) *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.

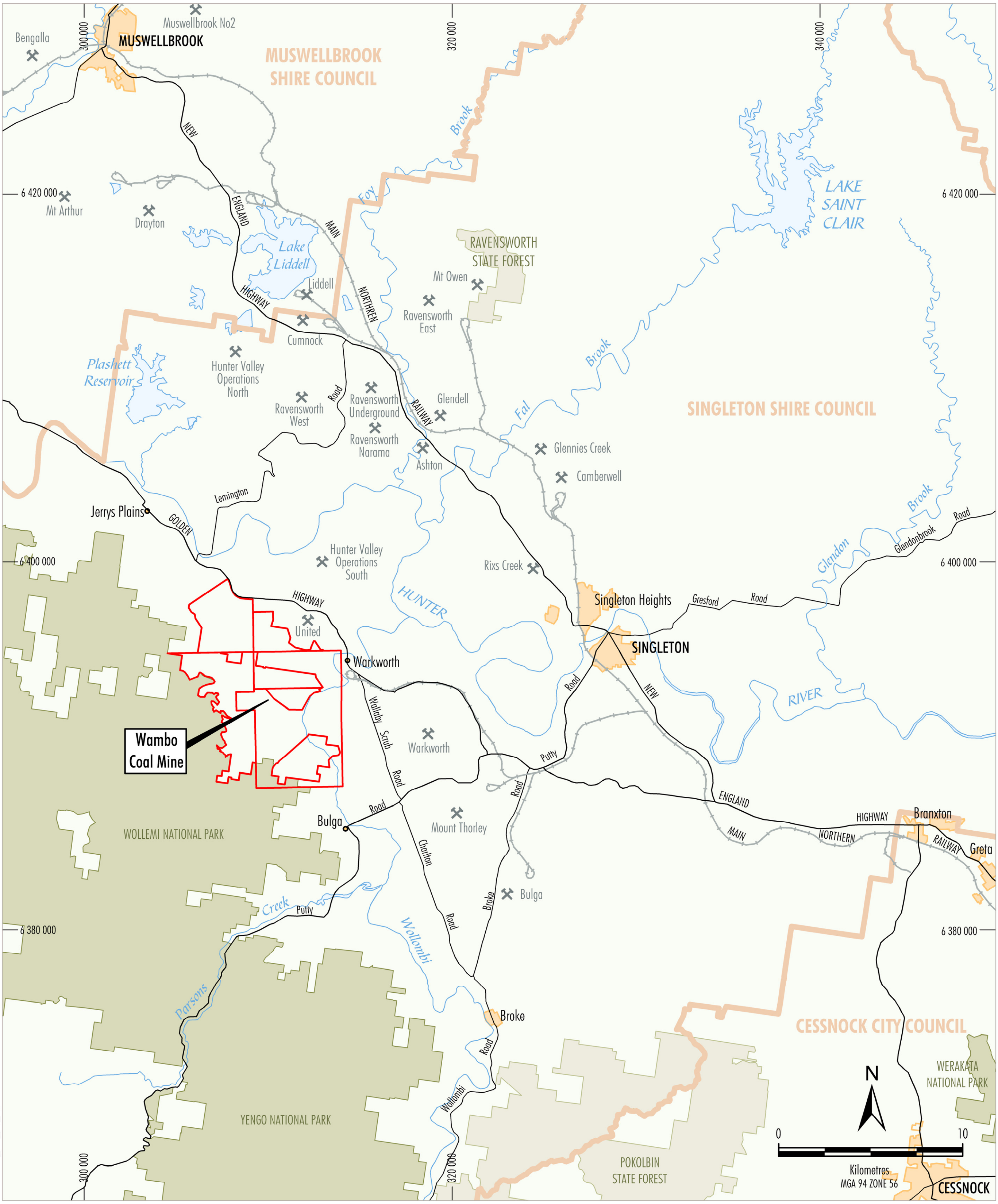
This Annual Review is distributed to a range of stakeholders including government authorities, Singleton Shire Council and members of the WCPL Community Consultative Committee (CCC). A copy of the Annual Review will be made available on the Peabody Energy website (www.peabodyenergy.com).

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	Senior Environmental Advisor	(02) 6570 2206
Albert Scheepers	General Manager	(02) 6570 2208



LEGEND
- Mining and Coal Lease Boundary
- Local Government Boundary
- Mining Operation

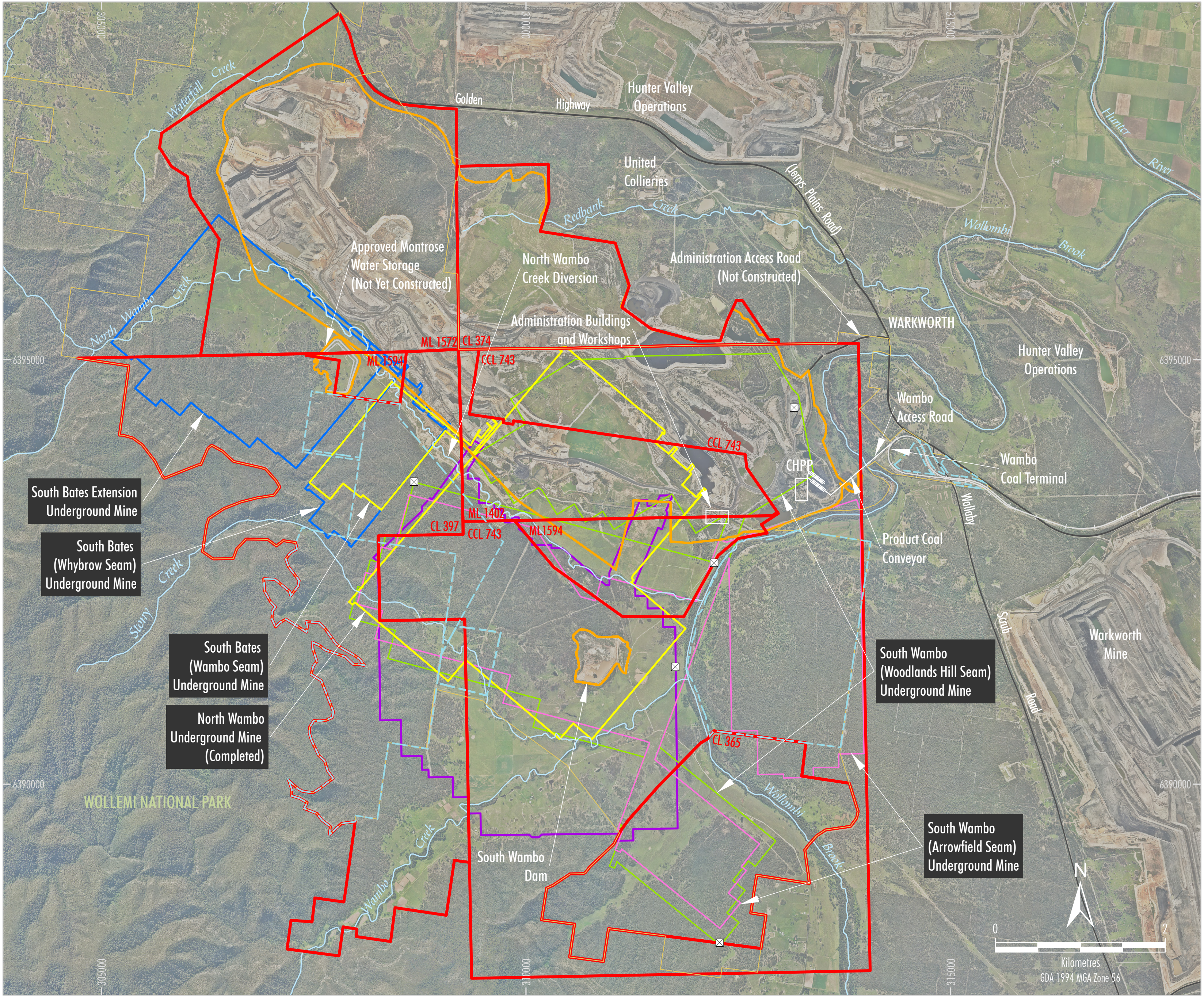
Source: Geoscience Australia (2009)

Peabody

WAMBO COAL MINE

Regional Location

Figure 1



LEGEND

- Mining and Coal Lease Boundary
- WCPL Owned Land
- Existing/Approved Surface Development Area
- Approved 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: Department of Lands (July 2009); WCPL (2018); WCPL Orthophoto (May 2017)

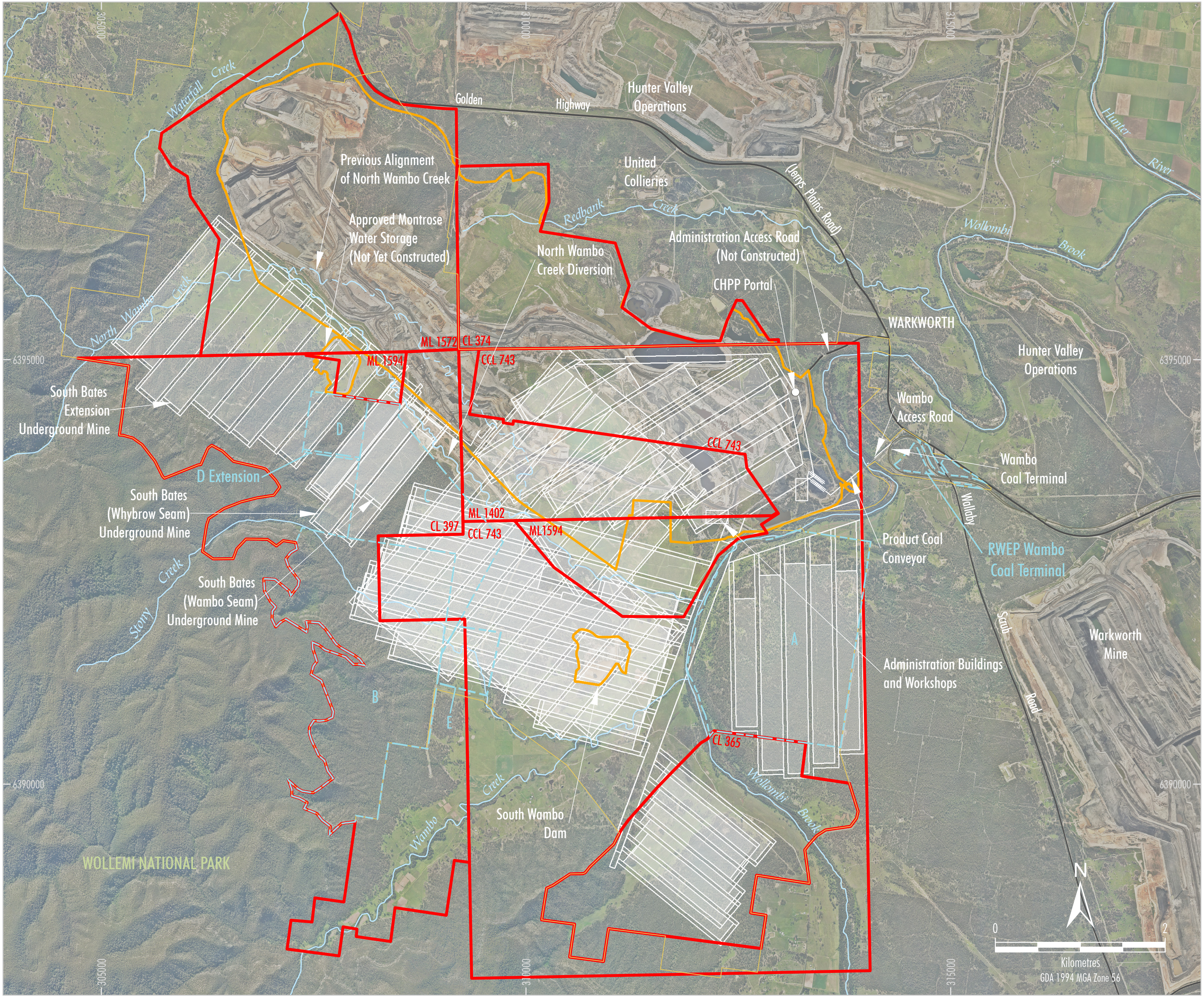
Peabody

WAMBO COAL MINE

Approved Wambo Coal Mine General Arrangement

Figure 2

WAM-09-15_AR 2017_203A



WAM-09-15_AR 2017_204A

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

Source: Department of Lands (July 2017); WCPL (2018); Orthophoto: WCPL (May 2017)

Peabody

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 (**Tables 2 and 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]	DPE	04/02/2004	31/12/2039
Development Approval	DA177-8-2004[3]	DPE	16/12/2004	16/12/2025
EPBC Approval[4]	EPBC 2003/1138	DoEE	23/11/2004	31/12/2029
EPBC Approval[4]	EPBC 2016/7636	DoEE	30/4/2017	01/03/2037
EPBC Approval[4]	EPBC 2016/7816	DoEE	Approval not yet issued	
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
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[5]	DRG	04/10/2007	16/05/2016
Exploration Licence	EL7211	DRG	22/01/2013	29/09/2019
Environment Protection Licence	EPL529	EPA	17/08/2017	-
S101 Approval[6]	Approval to discontinue use of the North East Tailings Dam (NETD)	DRG	03/09/2009	-

1. DoEE = Federal 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 15 times since the original approval was granted in 2004. The last modification, for approval to mine additional longwall panels in the Whybrow Seam at the South Bates Extension Underground Mine and to extend the life of the mine to 2039, was granted in December 2017.
3. DA177-8-2004 has been modified twice since the original approval was granted in 2004. The last modification, for approval to establish a locomotive provisioning facility adjacent to the WCPL Rail Loadout Facility, was granted in February 2012.
4. EPBC = *Environment Protection and Biodiversity Conservation Act 1999.*
5. 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*. An application to renew A444 was submitted to the Division of Resources and Energy (now DRG) on 16 May 2016 remains under review, as advised by DRG 8 February 2018.
6. Section 101 of the *Coal Mine Health and Safety Act (CMHSA) 2002.*

Table 3: WCPL's Water Licences

Licence Number	Description	Expiry Date	Entitlement	Category	Nominated Work	Expiry Date	Comment
Hunter Regulated River Water Source							
WAL 718 (20SL060212)	Hunter River Pump	Perpetuity	1000 unit shares (high security)	Regulated River (high security)	20WA200632	30/6/2027	-
WAL 8599 (20SL061206)	Hunter River Pump	Perpetuity	6 unit shares (high security)	Regulated River (high security)	20CA201459	25/09/2018	-
WAL 8600 (20SL061206)	Hunter River Pump	Perpetuity	868 unit shares (general security)	Regulated River (general security)	20CA201459	25/09/2018	-
WAL 8604 (20BL061206)	Hunter River Pump	Perpetuity	240 unit shares (supplementary water)	Supplementary Water	20CA201459	25/09/2018	-
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	20WA208642	31/07/2022	
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	20WA211372	31/7/2022	-
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)							
WAL 39735 (20BL168643)[1]	Dewatering Bore	Perpetuity	40 unit shares	Aquifer	20MW065010	-	-
WAL 39738 (20BL132753)[1]	Old Well No. 1	Perpetuity	243 unit shares	Aquifer	20MW065010	-	-
WAL 39803 (20BL166910)[1] (20BL173032)[1] (20BL173033)[1] (20BL173034)[1] (20BL173035)[1]	Dewatering (Bore No. 1)	Perpetuity	450 unit shares	Aquifer	20MW065010	-	WaterNSW to confirm conversion status and release WAL. Department of Industry – Water (DI-Water) to confirm nominated work number.

Licence Number	Description	Expiry Date	Entitlement	Category	Nominated Work	Expiry Date	Comment
WAL41494 (20BL168017)[1] (20BL172061)[#1] (20BL173040)[1]	Dewatering (Bore No. 2 and 2a)	Perpetuity	750 unit shares	Aquifer	20MW065010	-	WaterNSW to confirm conversion status and release WAL. DI-Water to confirm nominated work number.
WAL41532 (20BL172156)[1]	Dewatering	Perpetuity	98 unit shares	Aquifer	20MW065010	-	WaterNSW to confirm conversion status and release WAL. DI-Water to confirm nominated work number.
WAL41528 (20BL167738[#1])	Dewatering Bore	11/09/15	57 ML/year	NA	20MW065010	-	WaterNSW to confirm conversion status and release WAL. DI-Water to confirm nominated work number.
WAL41520 (20BL173844[1])	Dewatering Bore	Perpetuity	9 unit shares	Aquifer	20MW065010	-	DI-Water to confirm nominated work number.
20BL168997	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL168998	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL168999	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL169000	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL170638	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL172237	Monitoring Bore (GW14, GW18, GW21)	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL172238	Monitoring Bore (GW12)	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL172240	Monitoring Bore (GW15)	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL172242	Monitoring Bore (GW16, GW17)	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL172244	Monitoring Bore (GW20)	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL172255	Monitoring Bore (GW22)	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL172256	Monitoring Bore (GW13)	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.

Licence Number	Description	Expiry Date	Entitlement	Category	Nominated Work	Expiry Date	Comment
20BL172257	Monitoring Bore (GW19)	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL172332	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL173032	Monitoring		Groundwater monitoring	NA		30 Nov 2021	
20BL173290	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL173291	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL173292	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL173293	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	DI-Water to confirm conversion status.
20BL173946	Monitoring	Perpetuity		NA			
20BL009818	Bore	Perpetuity	Stock	NA	-	-	DI-Water to confirm conversion status.
20BL009819	Bore	Perpetuity	Stock	NA	-	-	DI-Water to confirm conversion status.
20BL009820	Bore	Perpetuity	Stock	NA	-	-	DI-Water to confirm conversion status.
20BL009821	Bore	Perpetuity	Stock	NA	-	-	DI-Water to confirm conversion status.
20BL143779	Bore	Perpetuity	Stock/Domestic	NA	-	-	DI-Water to confirm conversion status.

WAL = water access licence, ML/year = megalitres per year.

Renewal lodged prior to expiry.

1. In mid-2015, WCPL applied to the Department of Primary Industries – Water (now Department of Industry – Water [DI-Water]) to combine all of its groundwater licences that contained an extraction entitlement into a single licence. The purpose of this licence was to streamline mining activities and simplify the reporting of extraction against licensed entitlements. As such, WCPL was licensed to extract a total of 1,647 ML from all groundwater sources under the *Water Act 1912*. This combined licence was confirmed to be active by DI-Water in correspondence received on the 18 February 2016, the status of its' conversion to licences under the *Water Management Act 2000* is yet to be advised by DI-Water.

2.2 Changes to Approvals

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

- DA305-7-2003 was modified once:
  - In December 2017, to facilitate the mining of additional longwall panels in the Whybrow Seam at the South Bates Underground Mine and to extend the life of the mine.
- WCPL's Extraction Plan for South Bates Underground Longwalls 11 to 16 was submitted in January 2017, revised in July 2017 and approved in October 2017[1].
- The Mining Operations Plan (MOP)/Rehabilitation Management Plan was amended on two occasions during the reporting period; once in March and once in May. A new MOP (for the period 2018-2020) was lodged with DRG in December 2017.
- EPBC 2017/7636 for the extension of the South Wambo Underground Mine was issued on 30 April 2017.

In 2018, WCPL will apply for a Mining Lease (ML) to cover the area of the South Bates Underground Extension not covered by an existing ML (**Figure 2**).

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 6, Condition 12 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 6, Condition 6 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.

[1] On 11 October 2017, DPE approved the South Bates Underground 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 DPI-Water (now DI-Water). In the interim, WCPL continues to operate under the approved Site Water Management Plan (and associated component plans) dated October 2015.

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]
Environmental Management Strategy	Approved – 2009[3]	Version 3 (Jan 09)
Blast Management Plan[4]	Approved – 2017	Version 7 (Jul 17)
Noise Management Plan	Approved – 2014	Version 6 (Feb 14)
Air Quality & Greenhouse Gas Management Plan	Approved – 2017	Version 5 (Aug 17)
Biodiversity Management Plan (previously the Flora and Fauna Management Plan)	Approved – 2017	Version 13 (Jul 17)
Bushfire Management Plan	Approved – 2014[4]	Version 4 (Aug 13)[5]
Site Water Management Plan[6]	Approved – 2015	Various[6] (Nov 15)
MOP/Rehabilitation Management Plan	Approved – 2017	Amendment F (May 17)[7]
Conservation Management Plan (European)	Under review	Version 2 (July 2012)

1. Approved version as at the end of the reporting period.
2. On 11 October 2017, DPE 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 DI-Water. In the interim, WCPL continues to operate under the approved Site Water Management Plan (and associated component plans) dated October 2015.
3. The Environmental Management Strategy was revised during the reporting period and submitted to DPE for approval on 26 July 2017.
4. Includes WCPL's Blast Fume Management Strategy (Version 3) which was approved in November 2015.
5. The Bushfire Management Plan was revised during the reporting period. A copy of the revised Bushfire Management Plan was provided to the Singleton Shire Council and the NSW Rural Fire Service (RFS) in December 2017. WCPL will address comments from the Singleton Shire Council and RFS, and provide the updated plan to DPE for approval in 2018.
6. Includes WCPL's Surface Water Monitoring Program (Version 9), Groundwater Monitoring Program (Version 10), Erosion and Sediment Control Plan (ESCP) (Version 7), Surface and Groundwater Response Plan (Version 9) and Site Water Balance (Version 1). A revised version of the ESCP (Version 8) was prepared by WCPL and submitted for approval in April 2016. Until the Site Water Management Plan submitted with the South Bates Underground Mine Extraction Plan for Longwalls 11 to 16 is approved, WCPL continues to operate under the approved Site Water Management Plan (and associated component plans) dated October 2015.
7. The MOP was modified on two occasions during the reporting period; once in March and once in May. A new MOP (for the period 2018 – 2020) was lodged with DRG in December 2017.

3.0 Operations Summary

3.1 2017 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 Underground (current longwall mining area):
  - Longwall 12 (completed 17 December 2016 [note not extracted within the reporting period]);
  - Longwall 13 (commenced 9 January and completed 18 June 2017); and
  - Longwall 14 (commenced 30 July 2017 and completed 15 January 2018 [note, completed outside of the reporting period]).
- South Bates Extension (next longwall mining area):
  - First workings development.
- Open Cut:
  - Continued mining operations in Montrose East Pit;
  - Continued mining operations in Montrose West Pit (progressing in a northerly direction to Montrose East Pit);
  - Continued mining operations in the upper coal seam (Whybrow Seam) in the Roses Pit (South Bates Extended); and
  - Completion of mining in Glen Munro Pit (South Wambo Boxcut) in July 2017.

Table 5 shows the production summary for 2017, compared to the production for 2016 and the forecast production for 2017 and 2018.

Table 5: Production Summary

Material	Unit[1]	Approved limit (specify source)	2016 reporting period (actual)	2017 reporting period (forecast)	2017 reporting period (actual)	2018 reporting period (forecast)
Waste Rock/ Overburden	bcm	-	26,704,560	31,500,000	32,300,000	31,590,000
ROM Coal/ Ore	Mt	14.7[2]	9.4	9.4	8.3	8.24
Coarse Reject	Mt	-	2.3	2.3	2.16	2.41
Fine Reject (Tailings)	Mt	-	0.8	0.8	0.94	0.43
Saleable Product	Mt	15[3]	6.3	6.1	5.7	5.41

1. bcm = bank cubic metres, Mt = million tonnes.
2. DA305-7-2003, Condition 7 Schedule 3.
3. DA177-8-2004, Condition 6 Schedule 3. Refers to product coal transported off-site.

During the reporting period, a total of 5.2 Mt of product coal was transported off-site via rail (no coal was hauled off-site by trucks). The excess saleable product produced during the reporting period (i.e. approximately 0.5 Mt) was stockpiled on-site. The actual ROM coal production (8.3 Mt) was less than the forecast ROM coal production (9.4 Mt) due to difficult underground conditions and longwall continuity. **Figure 4** shows the coal transported off-site on a weekly basis.

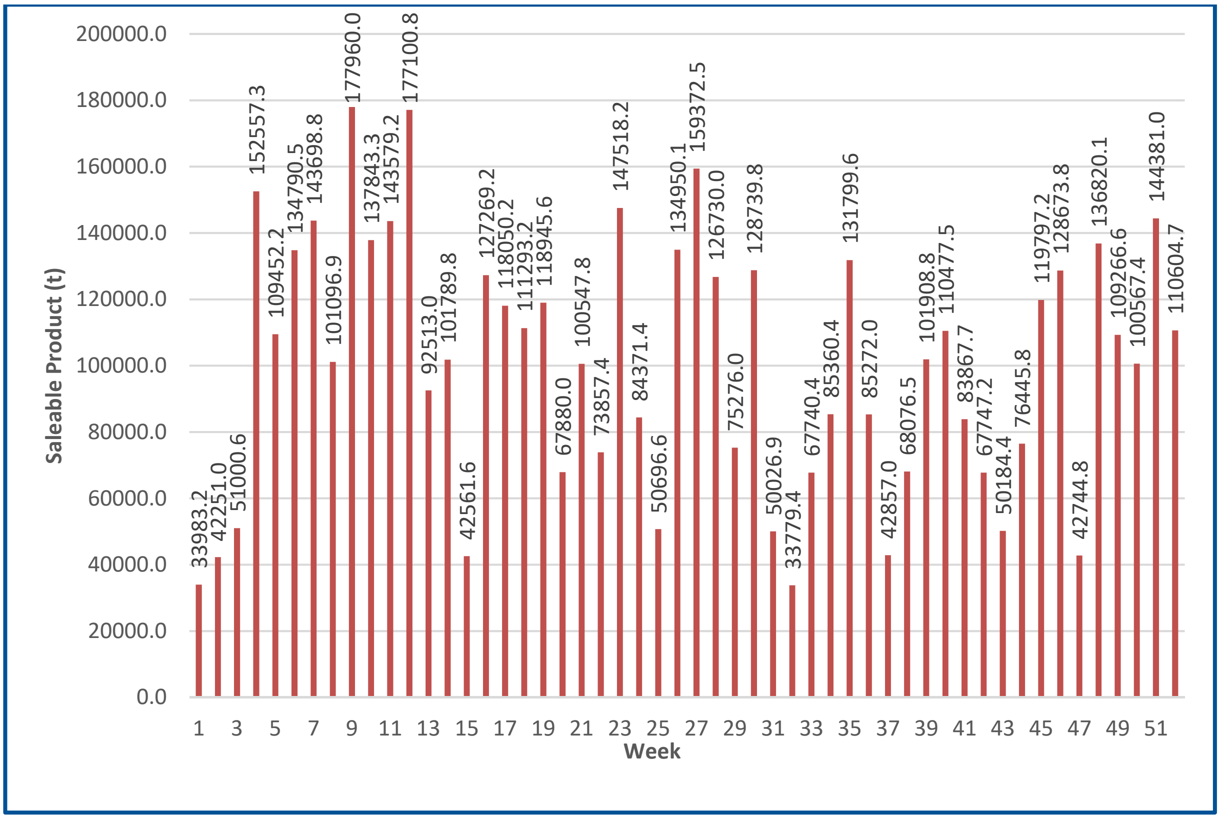


Figure 4: Coal Transported Off-site during the Reporting Period

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 in Montrose East Pit, to allow mining of lower ratio reserves.
- Continued mining in Montrose West Pit, in an overall northerly direction towards Montrose East Pit.
- Continued mining in Roses Pit (forecast for completion in 2018).
- Continued mining at the South Bates Underground Mine, including Longwall 15 (commenced 15 January 2018) and Longwall 16 (expected to commence in April 2018).
- Mining at the South Bates Extension Underground Mine (forecast to commence at Longwall 17 in September 2018).

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 and 2016 Annual Review and their current status are summarised in **Table 6** and **Table 7**, respectively. In addition, further information/actions requested by DPE and DRG 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. During the reporting period, WCPL revised the Bushfire Management Plan. A copy of the revised Bushfire Management Plan was provided to the Singleton Shire Council and the NSW Rural Fire Service (RFS) in December 2017. WCPL will address any comments from the Singleton Shire Council and RFS and provide the updated plan to DPE for approval in 2018.	Section 5.16
• Air Quality and Greenhouse Gas Management Plan;		Completed. A revised Air Quality and Greenhouse Gas Management Plan (AQGGMP) was submitted and approved in 2017.	Section 5.3
• Flora and Fauna Management Plan (to be renamed the Biodiversity Management Plan);		Completed. The Flora and Fauna Management Plan (FFMP) (renamed the Biodiversity Management Plan [BioMP]) was reviewed and revised during the reporting period. The BioMP was approved by DPE 11 October 2017.	Section 5.6
• Environmental Management Strategy; and		Completed. The Environmental Management Strategy was revised and submitted to DPE for approval on 26 July 2017.	Section 2.3
• MOP (to include revised mining and rehabilitation plans and rehabilitation performance criteria and monitoring requirements).		Completed. The MOP was revised during the reporting period to include revised mining and rehabilitation plans and rehabilitation performance criteria and monitoring requirements.	Section 7.0

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
WCPL will update the Surface Water Monitoring Program to reflect changes made to the stream flow monitoring program in 2015.		Ongoing. The Surface Water Monitoring Program was revised in December 2016 (Version 10) and submitted with the draft Extraction Plan for South Bates Underground Mine Longwalls 11 to 16. On 11 October 2017, DPE approved the Extraction Plan for South Bates Underground Mine Longwalls 11 to 16, with the exception of the Site Water Management Plan (including the Surface Water Monitoring Program). WCPL is revising the Site Water Management Plan to address comments received from DPI-Water (now DI-Water) and anticipates that the revised plan (incorporating the updated Surface Water Monitoring Program) will be approved in 2018.	Section 6.1
Installation of GPS units on site water carts pending review of budgets.		Ongoing. GPS units have not been installed. WCPL continues to monitor the frequency and movement of water carts across the site.	Section 5.3.4
Finalisation of the Voluntary Conservation Agreements for the Biodiversity Offset Areas;		Completed. The Voluntary Conservation Agreements (VCAs) were finalised during the reporting period.	Section 5.6.2
Development of an Aboriginal Cultural Heritage Management Plan;		Completed. In 2016, WCPL developed a Heritage Management Plan 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 submitted as part of the Longwalls 11 – 16 Extraction Plan for the South Bates Underground Mine and was approved by DPE in October 2017.	Section 5.7

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
Commissioning of an audit of the HRSTS discharge system to ensure its effectiveness;		Ongoing. The Hunter River Salinity Trading Scheme (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. Upon completion of this review, the guidelines for a HRSTS audit will be developed and an audit commenced in 2018.	Section 6.3.4
A new blast monitoring system and service provider will be sourced to minimise non recorded events associated with poor 3/4G phone reception. A tender for this system was issued in 2015 with review of proposals to be completed in February 2016. A provider will be engaged and the new system installed by March 2016 (approximately); and		Completed. Four blast monitoring stations were installed in 2016 to monitor impacts of blasting. The new systems had a 100% data capture rate during the reporting period.	Section 5.2.3
A new dust monitoring system will be installed pending the outcome of discussions between EPA and DPE. This new system will monitor PM10 and PM2.5 particulates with monitors relocated to more closely monitor emitted particulates up and down wind of the Mine. As part of this change in monitoring the EPA is proposing that all existing dust monitoring is replaced with Beta Attenuation Monitor units (BAMS). The timing of this and subsequent variations to the EPL are determinant on when the EPA finalises their consultation with the DPE and its outcome.		Completed. During the reporting period, the AQGGMP was revised and submitted for approval. As part of this plan, the dust monitoring system has been revised.	Section 5.3.4
The 2015 Annual Review stated that a Topsoil Management Procedure was developed and implemented in 2014 and the procedure would be subject to review in 2016.		Completed. The Topsoil Management Procedure was revised in 2016.	Section 5.14
Aerial seeding will be considered as an option for reseeding of rehabilitation scheduled for 2016.		Completed. Aerial seeding was not considered to be a viable option during the reporting period.	Section 7.1.7
An audit of known subsidence impacts will be undertaken during the next reporting period to determine if these have self-repaired, are stable but pose a risk to long-term sustainable land use, or are deteriorating in condition.		Completed. An audit of known subsidence impacts was commissioned and commenced during 2017. The audit was completed during the 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
A scope of works to progress subsidence repairs will be developed in alignment with the subsidence audit in 2016.		Ongoing. The audit of known subsidence impacts was completed during the reporting period. During the next reporting period, the results of the audit will be used to develop a program of works for the repair of subsidence impacts identified by the audit.	Section 5.9.3 and 7.1.7
As a result of actions requested by DPE in 2015, an independent Rehabilitation Audit was commenced in December 2015 by GHD.	DPE	Completed. The rehabilitation audit was completed and the report finalised in June 2016. An update on the status of the audit recommendations has been included.	Section 9.3
Include in the Annual Environment Management Report, for the 2016 reporting period, an update on the status of the audit recommendations, including: 1. Matters that have been addressed in MOP amendments. 2. A strategy and timeframe for addressing matters that are still outstanding (ie no reporting or monitoring mechanisms, or completion criteria). 3. Matters that are subject to further refinement (pending the results of monitoring).	DRE[1,2] (now DRG)	Completed. An update on the status of the audit recommendations has been included.	Section 9.3
A program to the satisfaction of the Director Environmental Sustainability that includes timing is developed for the existing rehabilitation areas that do not meet the requirement of the consent conditions as reflected in the Mining Operations Plan. The plan is to be submitted to DRE by 1 December 2016 and progress towards implementation of actions is to be reported in the AEMR for 2016.		Completed. As advised by DRG, this requirement is satisfied by the approved MOP which is also compliant with DA305-7-2003.	-
A program is developed to manage contamination of laydown areas for equipment. The plan is to be submitted to DRE by 1 December 2016 and progress towards implementation of actions is to be reported in the AEMR for 2016 reporting period.		Completed. A report was issued to DRE on 1 December 2016. The report detailed that WCPL had removed all equipment from site contributing to the identified contamination and remediated the hydrocarbon spill.	-
The continued monitoring of subsidence and repair is reported in the AEMR for 2016 reporting period.		Completed. Monitoring of subsidence and repairs has been reported.	Section 5.9.3

1. Letter from DRE (now DRG) to WCPL re 2016 Rehabilitation Audit, dated 4 August 2016.
2. Letter from DRE (now DRG) to WCPL re 2015 AEMR, dated 25 August 2016.

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
In accordance with Condition 7, Schedule 6 of DA305-7-2003, WCPL will commission and pay the full cost of an IEA.	WCPL	Completed. An IEA was undertaken by Hansen Bailey during the reporting period.	Section 9.5
An audit of known subsidence impacts was commissioned and commenced during the reporting period to determine if the known subsidence impacts have self-repaired, are stable but pose a risk to long-term sustainable land use, or are deteriorating in condition. The results of the audit will be reported in the next reporting period.		Completed. The audit of known subsidence impacts was undertaken during the reporting period by SLR Consulting Pty Ltd.	Section 7.1.7
Subsidence repair trials will be undertaken in accordance with any recommendations made in the audit of known subsidence impacts.		Ongoing. The audit of known subsidence impacts was undertaken during the reporting period by SLR Consulting Pty Ltd. WCPL is developing a program for remediation of suitable areas identified in the Subsidence Register (including subsidence repair trials).	Section 5.9.3 and 7.1.7
WCPL will seek approval for the Extraction Plan submitted for South Bates Underground Longwalls 11-16.		Completed. The Extraction Plan for South Bates Underground Longwalls 11 to 16 was approved by DPE during the reporting period.	Section 2.3
WCPL will submit a CMCP to DPE in the first half of 2017.		Ongoing. The CMCP will be developed and submitted to DPE for approval following the determination of the United Wambo Open Cut Coal Project.	Section 7.1.2
WCPL will undertake a lighting review, including the rail loop and refuelling facility.		Completed. An independent audit of lighting at the Mine was completed in June 2017.	Section 9.4
WCPL will use the Initial Post-Establishment Monitoring Checklist (or an adapted version of the checklist) to confirm and record any deviations from the proposed rehabilitation method/activities for each rehabilitation area.		Ongoing. The Initial Post-Establishment Monitoring Checklist has been developed and will be implemented during the next reporting period to confirm and record any deviations from the proposed rehabilitation method/activities for each rehabilitation area.	Section 9.3

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
WCPL will undertake an internal audit of topsoil stockpile management to assess if topsoil stockpiles are being managed in accordance with the Topsoil Management Procedure.		Completed. A desktop Topsoil Stockpile Management Audit was completed in December 2017. Early in 2018 a drone flyover was undertaken to document stockpile condition. The Audit found that stockpiles are generally managed in accordance with the Topsoil Management Procedure.	Section 5.14
Works associated with the North East Tailings Dam Rehabilitation Strategy, including the construction of a trial abutment and any additional works undertaken (if the trial is successful).		Ongoing. CPT will commence after the main deposition finishes in the HPTD, scheduled for quarter two 2018. This delay was due to operational concerns with electrical modifications to the CPT and access gear which introduced additional hazards when working on an active emplacement area. It is anticipated that CPT will be complete by quarter three 2018. Following CPT, details regarding capping design and capping works will be finalised.	Section 7.1.1
WCPL will undertake a review and update of the following management plans and strategies:		-	-
• Environmental Management Strategy.		Ongoing. The Environmental Management Strategy was revised and submitted to DPE for approval on 26 July 2017.	Section 2.2
• Conservation Management Plan for the WHC.		Ongoing. The Conservation Management Plan (European) is currently under review.	Section 2.2
• Bushfire Management Plan.		Ongoing. During the reporting period, WCPL revised the Bushfire Management Plan. A copy of the revised Bushfire Management Plan was provided to the Singleton Shire Council and the NSW Rural Fire Service (RFS) in December 2017. WCPL will address any comments from the Singleton Shire Council and RFS and provide the updated plan to DPE for approval in 2018.	Section 5.16

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
DRG stated that the 2016 Annual Review was considered to be accepted, subject to the following terms:	DRG[1]	Completed. The requested information was provided to DRG 1 September 2017.	-
1. A review of rehabilitation undertaken to date (actions and present condition of rehabilitated areas) and a proposed program for the Fenwick Property, including timing for undertaking the actions, is to be provided to the Division of Resources and Geoscience by 1 September 2017.			
2. A program is developed to manage weeds at the Homestead Backfill Project and Wombat Pit rehabilitation area, including timing for undertaking the actions, is to be provided to the Division of Resources and Geoscience by 1 September 2017.			
3. A program is developed that prioritises historic subsidence impacts, including timing for undertaking the actions, is to be provided to the Division of Resources and Geoscience by 1 September 2017.			
4. Confirm if all topsoil stockpiles on the RL 160 Dump have been used. If not, the topsoil inventory is to be revised and is to be provided to the Division of Resources and Geoscience by 1 September 2017.			
The DPE reviewed the 2016 Annual Review and requested that the following additional information be provided:	DPE[2]	Completed. WCPL provided the requested information to DPE as Appendix H of the 2016 Annual Review. DPE confirmed[3] that, in consideration of the additional information provided, the 2016 Annual review generally satisfied the requirements of Condition 5, Schedule 6 of DA305-7-2003.	-
a) **Erosion and Sediment Control** … Please provide a detailed explanation of why the failure occurred and what measures have been put in place to prevent future failures.			
b) **Surface Water Monitoring** … Please provide an explanation of why it took such a long period of time to replace the flow monitors and what safeguards have been put in place to minimise the risk of future failures. Please update figure 9 to show the location of FM9. Further, please provide to the Department further information relating to the flow and stream bed profile of South Wambo Creek at FM15 and FM16.			
c) **Noise** – Table 36, action number 27 requires a revised progress comment.			

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
d) **Biodiversity** … Please provide: • Details of the investigation that will be undertaken to assess the dieback of *Angophora floribunda* in the Warkworth Sands area of the Remnant Woodland Enhancement Area and any mitigation measures undertaken or proposed to be undertaken; • An assessment of the suitability of *Acacia saligna* and *Eucalyptus cladocalyx* as Woodland rehabilitation species including the potential to become weeds and impact biodiversity values on site. Describe any management actions undertaken during the reporting period to minimise this risk and future management actions to reduce risk; and • An explanation of why there are still areas of exposed soil, active erosion and poor native vegetation establishment on the North Wambo Creek diversion. Describe works undertaken during the reporting period to improve the biodiversity outcomes for the North Wambo Creek diversion and any proposed works for the next reporting period.			

1. Letter from DRG to WCPL RE: 2016 Annual Environmental Management Report, dated 18 July 2017.
2. Letter from DPE to WCPL RE: Annual Review 2016, dated 19 May 2017.
3. Letter from DPE to WCPL RE: Annual Review 2016 Additional Information, dated 13 July 2017.

5.0 Environmental Performance

5.1 Noise

Noise Impact Assessment Criteria for the Mine are defined in Table 9 of DA305-7-2003 (Condition 6, Schedule 4), Table 2 of DA177-8-2004 (Condition 3, Schedule 4) and EPL529 (Condition L4). Additional noise conditions relating to land acquisition, operating hours, rail noise, noise monitoring and WCPL's Noise Management Plan (NMP) are also detailed in these approval documents.

5.1.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the approval criteria for noise is included in **Table 8.**

Table 8: Approval Criteria for Noise

Criteria[1]	dBA	Land Number[2]
Day - $L_{Aeq\ (15\ min)}$	35	All land
Evening/Night - $L_{Aeq\ (15\ min)}$	41	94
	40	3, 4B, 15B, 16, 25, 28A & B, 33, 39, 40 & 254A
	39	5, 6, 7, 37, 48
	38	1, 17, 18, 38, 49, 63, 75, 91
	37	27, 43, 137, 163, 246
	36	13B, 178, 188, 262A, B & C
	35	All other residential or sensitive receptors[3]
Night - $L_{A1\ (1\ min)}$	50	All land

Note: dBA = A-weighted decibels.

1. Criteria as per Condition 6, Schedule 4 of DA305-7-2003.
2. Properties identified in Table 9 of DA305-7-2003 (Condition 6, Schedule 4).
3. Excluding the receptors listed in Condition 1, Schedule 4 of DA305-7-2003.

A summary of the Environmental Impact Statement (EIS) predictions for noise is included in **Appendix B**, 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 8**, 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, with the exception of an administrative non-compliance with the night-time noise impact assessment criteria (**Section 10.1**).

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

Forty-nine (49) 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).

5.1.2.1 Comparison with EIS Predictions

An annual report summarising WCPL's 2017 attended noise monitoring data and comparisons against the EIS noise predictions is included in **Appendix B** (Global Acoustics 2018)**.**

Global Acoustics (2018) compared predicted noise levels from the Year 9 scenario in the EIS against the actual noise levels measured during 2017. The comparison indicated that meteorological conditions included in the EIS modelled predictions did not regularly occur during attended monitoring. When meteorological conditions were relevant, the results show that measured noise levels from the Mine were generally well under the predicted levels.

5.1.3 Trends and Key Management Implications

Global Acoustics (2018) considered that there are no significant differences in measured site noise levels at N01, N03 and N23 over the 2015 to 2017 period (**Appendix B**). Trends at these sites are either downwards, or unreliable due to a larger number of non-recordable measurements.

At N16, Global Acoustics (2018) has identified a potential upward trend over the past three years which may have been exaggerated by a reduction in the number of inaudible or non-mine recordings. This trend could be attributed to mining progressing towards N16.

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.

WCPL previously identified an opportunity to further improve the Mine's environmental performance through the sound attenuation of three CAT789 trucks. This sound attenuation is no longer proposed.

5.2 Blasting

Air Blast Overpressure Limits and Ground Vibration Impact Assessment Criteria for the Mine are defined in Tables 12 and 13 of DA305-7-2003 (Conditions 11 and 12, Schedule 4), Tables 3 and 4 of DA177-8-2004 (Conditions 8 and 9, Schedule 4) and EPL529 (Condition L5). Additional conditions relating to blasting hours and frequency, property inspections, assessments and investigations, cumulative impacts, operating conditions, blasting near the Wambo Homestead Complex (WHC), blast monitoring, blast fume and WCPL's Blast Management Plan (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 9.**

Table 9: Approval Criteria for Blasting

Parameter	Criteria[1]	Allowable Exceedance
Airblast Overpressure Level dB (Lin Peak)	115	5% of the total number of blasts over a 12 month period
	120	0%
Ground Vibration Peak Particle Velocity (mm/s)[2]	5	5% of the total number of blasts over a 12 month period
	10	0%

1. Criterion as per Conditions 11 & 12, Schedule 4 of DA305-7-2003.Criteria must not be exceeded at any residence on privately-owned land.
2. 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).

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 9,** 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 10**).

Table 10: 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

Air blast overpressure and ground vibration levels recorded during the monitoring period complied with the approval criteria at all monitoring locations. A total of 96 blasts were undertaken at the Mine during the reporting period. **Table 11** 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.

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

Table 11: Blast Monitoring Results 2017

Parameter	Criteria	Exceedances									
		BM01		BM02		BM03		BM05		BM07	
		No.	%	No.	%	No.	%	No.	%	No.	%
Airblast Overpressure Level (dB Lin Peak [dBL])	115	2	2.11	2	2.11	1	1.05	3	3.16	0	0
	120	0	0	0	0	0	0	0	0	0	0
Ground Vibration Peak Particle Velocity (mm/s)	5	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0

Less than 5% of all blasts had a recorded overpressure greater than 115 dBL, and no blasts had a recorded overpressure greater than 120 dBL. Similarly, no blasts had a 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.

WCPL complied with all approval criteria and performance indicators during the reporting period; however, WCPL identified a non-compliance in relation to blasting as reports on monitoring results have not yet been prepared in accordance with Condition 65, Schedule 4 of DA305-7-2003 (**Section 10.2**).

Blasting was undertaken on a Sunday on one occasion during the reporting period, however prior approval from the EPA was obtained.

Seven (7) complaints were received regarding blasting (i.e. relating to general blasting, vibration, 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 12.**

Table 12: Comparison of EIS Predictions and 2017 Monitoring Data – Blasting

Land Holder	Midpoint Distance to Dwellings[1]	Predicted levels		Closest WCPL Blast Monitor to Land Holder	Maximum recorded level during 2017	
		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]	115.9 dBL	0.21 mm/s
25 Fenwick	3,300 m	114 dBL	1.9 mm/s	BM03[2]	115.9 dBL	0.21 mm/s
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: dB = decibels, µPa = micropascals, PVS = peak vector sum, m = metres, dBL = low frequency noise level.

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 115.9 dBL was recorded at BM03 (26 April 2017), which is located closer to blasting activity than the Fenwick and Lambkin dwellings. This was 1.9 dB above the predicted airblast overpressure level for Fenwick (114 dBL) and 3.9 dB above 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:

- 118.8 dBL at BM01 (approximately 3 km north of BM03 [also located on WCPL land]);
- 102.4 dBL at BM02 (approximately 5 km north east of BM03); and
- 110.9 dBL at BM05 (approximately 10 km north east of BM03).

The maximum ground vibration level recorded at BM03 was 0.33 mm/s (on 10 February 2017). This is well below the predicted levels for both Lambkin and Fenwick.

5.2.3 Trends and Key Management Implications

There were 96 blasts recorded during 2017, compared with 106 in 2016, 79 in 2015, 75 in 2014 and 62 in 2013. Air blast overpressure and ground vibration levels recorded during the 2017 blasts were similar to those recorded in the previous reporting periods. No exceedances of the blasting limits have been recorded at WCPL during the last five reporting periods.

During the reporting period, blasting was undertaken within 2 km of the WHC on four occasions (12 October, 18 October, 24 November and 15 December 2017). In accordance with Condition 62, Schedule 4 of DA305-7-2003, ground vibration and air blast levels were recorded for each event.

It should be noted that Condition 64, Schedule 4 of DA305-7-2003 requires that:

> *64. Ground vibration and air blast levels experienced at the Wambo Homestead Complex blast monitoring station are not to exceed the structural damage assessment criteria prescribed by Australian Standard AS 2187.2-1993 (or its latest version) "Explosives – Storage Transport and Use" for Sensitive and Heritage Structures to prevent damage to the heritage items.*

As described in the approved WCPL BMP, the latest version of *AS 2187.2-2006* no longer has reference to Sensitive and Heritage Structures which previously provided the criteria of a peak particle vibration (PPV) of 5 mm/s for the WHC. WCPL has continued to apply this conservative PPV limit and will undertake further monitoring and assessments if there is a need to modify this criteria in the future.

The ground vibration and air blast levels for three of the four events did not exceed the blasting limits for the WHC. However, on 12 October 2017, the WHC monitor recorded overpressure of 115.7 dB and ground vibration of 0.57 mm/s. In accordance with Condition 66, Schedule 4, the approved structural engineer (Bill Jordan & Associates) advised that the blast recording showed no characteristics of the ground motion which could have an effect on WHC (Bill Jordan & Associates 2017a).

Bill Jordan & Associates (2017b) also considered the highest ground vibrations recorded at BM03 between January and June 2017 and concluded that the recorded ground vibrations would have no effect on the WHC.

Reports have not yet been prepared for the blasts on 18 October, 24 November and 15 December 2017 (**Section 10.2**). A report covering the July – December 2017 period (which will include consideration of the blasts that were within 2 km of the WHC) is currently in preparation.

WCPL achieved a data capture rate of 100% for overpressure and 100% for vibration during the reporting period[2]. The data capture rate for blasting has previously been an issue at the Mine, however, the blast monitoring system was replaced in June 2016 and, following installation, the data capture rate has been 100% for both overpressure and vibration.

5.2.4 Implemented or Proposed Management Actions

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

Copies of the six monthly and monthly reports on blasting within 2 km of the WHC will be forwarded to the NSW Heritage Office during the next reporting period.

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

5.3 Air Quality

Air Quality Criteria for the Mine are defined in Tables 2, 3 and 4 of DA305-7-2003 (Condition 4, Schedule 4), Tables 5, 6 and 7 of DA177-8-2004 (Condition 14, Schedule 4) 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

A summary of the approval criteria for air quality is included in **Table 13.**

A summary of the 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 EIS predictions refer to the EIS (Resource Strategies 2003).

In addition to the statutory requirements detailed in **Table 13**, WCPL is also required to meet additional requirements, in accordance with the approved WCPL AQGGMP. These requirements include reporting of greenhouse gas monitoring data in the Annual Review (**Section 5.4**).

Table 13: Approval Criteria for Air Quality

	Pollutant	Averaging Period	Criterion [a, b]
Long-term Impact Assessment Criteria	TSP	Annual	[c]90 µg/m^3
	PM_{10}	Annual	[c]30 µg/m^3
	Deposited Dust[d]	Annual	[e]2 g/m^2/month (maximum increase)
			[c]4 g/m^2/month (maximum total)
Short-term Impact Assessment Criteria	PM_{10}	24 hour	[c]50 µg/m^3

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

a. Criterion as per Condition 4, Schedule 4 of DA305-7-2003 and Condition 14, Schedule 4 of DA177-8-2004. This criterion must not be exceeded at any residence on privately-owned land or on more than 25% of any privately-owned land.

b. Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.

c. Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).

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.

e. Incremental impact (i.e. incremental increase in concentrations due to the development on its own)

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 summary of the air quality monitoring data is included in **Appendix C.**

During the reporting period, WCPL complied with all statutory conditions relating to air quality, with the exception of monitoring 24 hour PM_{10} levels at PM03 on three occasions (**Section 10.3**).

During these missed events, WCPL's three other PM_{10} monitors captured all data. This equates to a 99% capture rate for the PM_{10} monitoring system. At no point during the monitoring period was more than one monitoring point down. Failure to capture data can be attributed to an intermittent fault with the uninterruptible power supply of the PM03 monitor.

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

The annual average TSP concentration at all four monitoring locations did not exceed the long-term impact annual average criteria of 90 µg/m^3 at any residence on any privately owned land.

The annual average dust deposition criterion was exceeded at two gauges on WCPL-owned land (D1 and D7). This is not considered to be a non-compliance as the annual average dust deposition at all other dust deposition gauges (on WCPL-owned and privately-owned land) was below the long-term impact assessment criteria.

None of WCPL's PM_{10} monitors recorded annual averages above the compliance criteria of 30 µg/m^3 for the year.

There were 7 days where PM_{10} concentrations above 50 µg/m^3 were recorded at a monitor. **Section 5.3.3.2** describes the operational controls applied on each of these days.

Five (5) 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 1 of DA305-7-2003 (Condition 1, Schedule 4) nor did it exceed the Land Acquisition Criteria listed in Tables 5 to 7 of DA305-7-2003 (Condition 5, Schedule 4).

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

5.3.2.1 Comparison with EIS Predictions

The EIS (Resource Strategies 2003) included predicted cumulative TSP, PM_{10} and dust deposition levels for three operational scenarios (Years 2, 7 and 9). The Year 7 and 9 scenarios best represent current operations at the Mine.

A summary of the predicted cumulative annual average TSP, PM_{10} and dust deposition levels for the Year 7 and 9 scenarios at the residences assessed in the EIS (Resource Strategies 2003) air quality assessment, that are most representative of the WCPL air quality monitoring sites, is provided in **Table 14**. The monitored annual average TSP, PM_{10} and dust deposition levels during the reporting period are also provided in **Table 14**.

Table 14: Comparison of EIS Predictions and 2017 Monitoring Data – Air Quality

Parameter	Receiver		EIS Prediction		2017 Monitoring
	Monitoring Site	EIS Residence	Year 7 (2011)	Year 9 (2013)	
Annual Average TSP (µg/m³)	HV01	19B (L Kelly)	46.7	40.5	68.8
	HV02	WCPL	12.6	13.4	61.6
	HV03	33 (DJ Thelander & JA O'Neill)	17.6	20.0	50.0
	HV04	40 (KM Muller)	32.8	30.5	64.1
Annual Average PM_{10} (µg/m³)	AQ01 (PM01)	19B (L Kelly)	39.2	34.5	20.6
	AQ02 (PM02)	WCPL	11.0	11.8	19.1
	AQ03 (PM03)	33 (DJ Thelander & JA O'Neill)	16.2	18.1	14.6
	AQ04 (PM04)	40 (KM Muller)	29.1	26.6	17.1
Average Annual Deposited Dust (g/m²/month)	D01	No Representative Dwelling Modelled	N/A	N/A	4.1
	D03	20 (Jerrys Plains Coal Terminal)	1.0	0.78	2.8
	D07	No Representative Dwelling Modelled	N/A	N/A	4.3
	D09	No Representative Dwelling Modelled	N/A	N/A	2.0
	D11	2 (W & D Lambkin)	0.35	0.35	1.4
	D12	51 (CM Hawkes Pty Ltd)	1.81	2.09	3.0
	D17	41B (Jelopo Pty Ltd)	0.31	0.33	1.2
	D19	19B (L Kelly)	1.48	1.10	2.3
	D20	WCPL	0.36	0.36	1.1
	D21	33 (DJ Thelander & JA O'Neill)	0.36	0.42	1.2
	D22	40 (KM Muller)	0.73	0.73	2.4
	D23	WCPL	0.28	0.28	3.9
	D24[1]	75 (BA Barnes)	0.23	0.24	0.7
	D25	37 (IA & JE Lawry)	0.38	0.48	1.9
	D26	24 (AJ Long)	0.68	0.34	1.4

1. Depositional Dust Gauge D24 failed to record a result in December 2017 due to the vial being broken. The vial was identified as being broken upon collection with no evidence available as to the cause. Monitoring at D24 is no longer required under the approved AQGGMP.

The annual average TSP concentrations were above the predicted cumulative TSP concentrations at the relevant residences assessed in the EIS (Resource Strategies 2003) (**Table 14**). This is consistent with the 2014, 2015 and 2016 results.

The annual average PM_{10} concentrations were below the predicted cumulative annual average PM_{10} concentrations at the relevant residences assessed in the EIS (Resource Strategies 2003) with the exception of AQ02 (WCPL owned residence). This is also consistent with the 2014, 2015 and 2016 results.

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 14**). This is consistent with the 2014, 2015 and 2016 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);
- current WCPL mine layout/progression is similar but not the same as the modelled scenarios; and
- the EIS (Resource Strategies 2003) cumulative predictions included emissions from surrounding mining operations (i.e. United Colliery, Hunter Valley Operations and Warkworth Mine) but did not include emissions from general background sources as indicated by background monitoring to avoid double counting of existing mining-related emissions (this is particularly the case for TSP and dust deposition).

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

TSP levels recorded by WCPL's four High Volume Air Samplers (HVAS) during the reporting period were higher than those recorded in 2016, similar to those recorded during 2013 and 2014, and generally consistent with levels recorded in the previous five reporting periods, as shown in **Table 15** 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 returning to similar levels in 2017.

Table 15: TSP Annual Averages (µg/m³) (2011-2017)

HVAS	2011	2012	2013	2014	2015	2016	2017
HV01	56.7	64.8	61	66	54.8	47.8	68.8
HV02	48.8	61.4	62	58	51.5	47.7	61.6
HV03	49.0	38.9	41	48	40.6	39.5	50.0
HV04	41.0	58.6	49	63	60.6	56.6	64.1

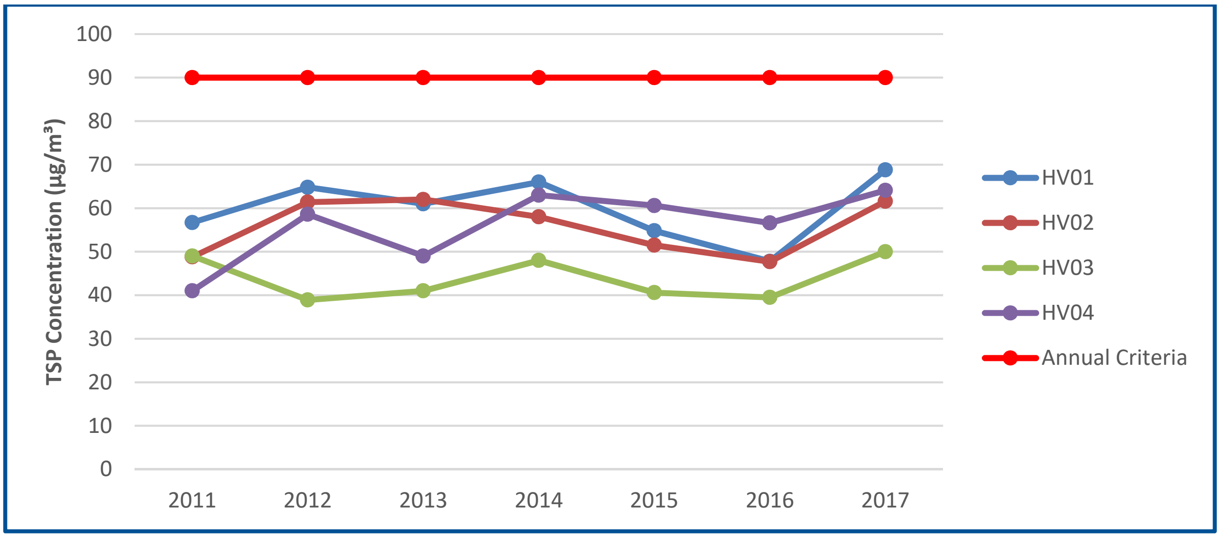


Figure 5: TSP Annual Averages (2011-2017)

Compared to the EIS predictions for Year 9 (**Table 14**) (Resource Strategies 2003), WCPL's recorded TSP levels (**Table 15**) are higher than the levels predicted.

5.3.3.2 PM$_{10}$

PM$_{10}$ concentrations recorded by WCPL's four Tapered Element Oscillating Microbalance Analyser (TEOM's) during the reporting period were similar to those recorded during 2012, 2013 and 2014 and higher than those reported in 2011, 2015 and 2016 as shown in **Table 16** and **Figure 6.** The data shows that PM$_{10}$ concentrations have remained relatively consistent over the last seven years, with the highest results being recorded in 2012 or 2013 and the lowest results recorded in 2011, 2015 and 2016.

Table 16: PM$_{10}$ Annual Averages (µg/m^3) (2011-2017)

TEOM	2011	2012	2013	2014	2015	2016	2017
Annual Average in µg/m^3							
AQ01 (PM01)	16.8	21.0	19.3	18.0	15.7	15.6	20.6
AQ02 (PM02)	17.2	21.1	22.3	19.0	16.0	17.5	19.1
AQ03 (PM03)	16.7	16.6	16.5	15.3	12.9	14.1	14.6
AQ04 (PM04)	16.2	18.3	16.8	17.7	16.5	16.3	17.2
Maximum 24-hour Average in µg/m^3							
AQ01 (PM01)	49	47	65	55	52	49	66
AQ02 (PM02)	83	76	97	70	55	49	52
AQ03 (PM03)	43	47	71	51	43	39	39
AQ04 (PM04)	43	45	65	56	71	44	49
Number of Days Above 24-hour Average Criteria							
AQ01 (PM01)	0	0	4	2	1	0	5
AQ02 (PM02)	2	7	20	2	3	0	2
AQ03 (PM03)	0	0	1	1	0	0	0
AQ04 (PM04)	0	0	3	1	2	0	0

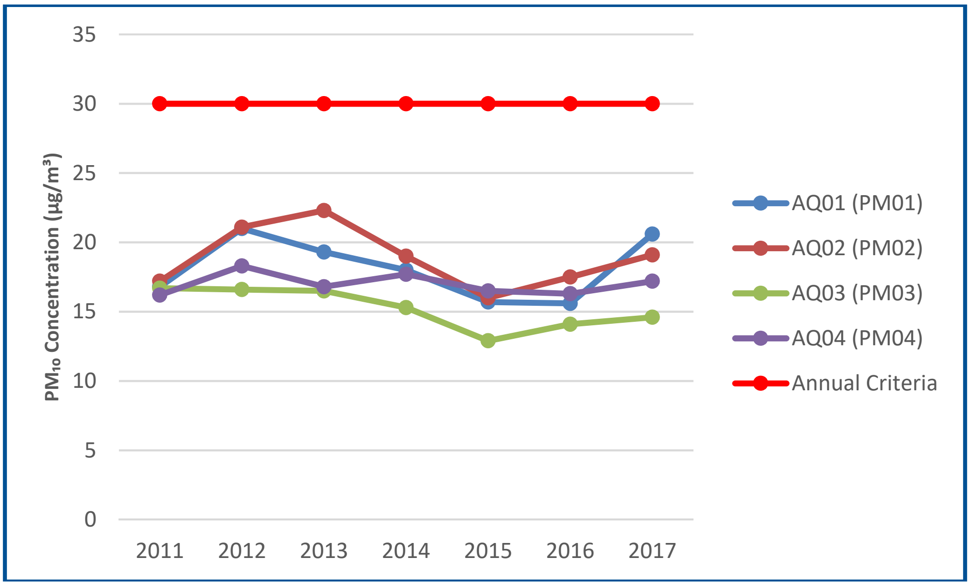


Figure 6: PM$_{10}$ Annual Averages (2011-2017)

A review of the PM$_{10}$ data for 2017 was completed 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 17 outlines the operational responses on each of the days with elevated PM$_{10}$ concentrations.

Table 17: Operational Actions Implemented on Days of Elevated PM_{10}

Date	Measured 24-hour Average PM_{10} Concentration in µg/m³ (estimated site contribution by Jacobs in parentheses) AQ01 (Coralie)[1]	AQ02 (Caban)	AQ03 (Thelander)	AQ04 (Muller)	Time of Peak Dust	Operational Response	Comment on Compliance
14/01/2017	66 (4.5)	27 (0.0)	20 (0.5)	23 (1.1)	1.00 am – 4.00 am	Site analysis tool run to determine WCPL's contribution. Five excavators were running over night shift. This was reduced to four as one of the excavators last bucket was at 12.30 pm with the remaining four excavators last buckets between 2.27 am and 2.35 am. Three water carts operated during day shift; four water carts operated during night shift. One water cart was down for seven hours during night shift due to a flat tyre. Seven hours of downtime were recorded for the five excavators running during night shift.	Concentration above 50 µg/m³ would have occurred in the absence of WCPL and contribution was small (<10%). Reasonable and feasible measures implemented on site.
29/01/2017	53 (0.4)	22 (0.9)	22 (0.0)	32 (2.1)	2.00 am – 3.00 am	Site analysis tool run to determine WCPL's contribution. No material contribution identified which indicated no further action required. Five excavators were running over night shift with the last buckets between 2.32 am and 2.35 am. Four water carts were running during night shift. No downtime for any of the excavators was recorded during the night shift.	Concentration above 50 µg/m³ would have occurred in the absence of WCPL and contribution was immaterial (<1%). Reasonable and feasible measures implemented on site.
06/05/2017	15 (0.1)	52 (2.6)	8 (0.0)	8 (0.0)	7.00 pm – 9.00 pm	Site analysis tool run to determine WCPL's contribution. Three water carts operated during night shift. Five excavators were running over night shift with no downtime recorded.	WCPL contribution was small (5%). Reasonable and feasible measures implemented on site.

Date	Measured 24-hour Average PM_{10} Concentration in µg/m^3 (estimated site contribution by Jacobs in parentheses)				Time of Peak Dust	Operational Response	Comment on Compliance
	AQ01 (Coralie)[1]	AQ02 (Caban)	AQ03 (Thelander)	AQ04 (Muller)			
24/09/2017	53 (5.2)	45 (2.3)	32 (0.0)	28 (0.3)	Across the day	Site analysis tool run to determine WCPL's contribution. Four water carts operated during day shift; three water carts operated during night shift. Excavators and loader downtime during day shift; excavator downtime during night shift. Exceedance notified to DPE on 27/09/2017.	WCPL contribution was small (<10%). Reasonable and feasible measures implemented on site. Regional PM_{10} dust levels during this period were generally greater than or consistent with PM_{10} levels recorded at WCPL's AQ01.
27/09/2017	40 (0.0)	51 (0.0)	39 (0.3)	49 (8.7)	6.00 pm – 7.00 pm	Site analysis tool run to determine WCPL's contribution. No material contribution was identified which indicated that no further action was required.	Concentration above 50 µg/m^3 would have occurred in the absence of WCPL and contribution was immaterial (<1%). Reasonable and feasible measures implemented on site.
15/12/2017	53 (0.0)	36 (0.0)	32 (0.0)	44 (6.4)	1.00 am – 2.00 am	Site analysis tool run to determine WCPL's contribution – No material contribution indicated no further action required. Six excavators were running over night shift. One excavator had last bucket at 10.22 pm with the remainder of the excavators last buckets between 2.20 am and 2.30 am. Four water carts were running during the night shift. One of the water carts was down for three hours. 10.25 hours of downtime was recorded for the excavators during night shift.	Concentration above 50 µg/m^3 would have occurred in the absence of WCPL and contribution was immaterial (<1%). Reasonable and feasible measures implemented on site.
29/12/2017	53 (4.0)	19 (1.1)	9 (0.0)	19 (1.1)	8.00 pm – 11.00 pm	Site analysis tool run to determine WCPL's contribution. Three water carts operated during night shift. Excavator downtime during night shift.	WCPL contribution was small (<10%). Reasonable and feasible measures implemented on site.

1. It is noted that the short-term impact assessment criteria in Condition 4, Schedule 4 of DA 305-7-2003 do not apply to the one privately-owned residence in Warkworth (as it is listed in Table 1 of the Consent). On this basis, Site AQ01 is not a compliance point.

5.3.3.3 *Dust Deposition*

Dust deposition levels recorded by WCPL's 15 dust deposition gauges (DDGs) during the reporting period remained consistent with levels recorded in the previous six reporting periods as shown in **Table 18**.

Table 18: Dust Deposition Annual Averages (g/m²/month) (2011-2017)

DDG	2011	2012	2013	2014[1]	2015[1]	2016[1]	2017[1]
Privately Owned Land							
D11	2.0	2.2	2.2	2.5	2.2	2.3	1.4
D17	1.4	1.7	2.8	1.8	1.7	1.4	1.2
D21	1.2	1.4	1.9	1.9	2.0	1.7	1.2
D22	1.2	1.4	2.0	2.2	2.0	2.2	2.4
D24[2]	1.1	1	1.1	1.4	1.4	1.0	0.7
D25	1.6	2.2	2.7	2.7	2.6	2.8	1.9
WCPL Owned Land							
D01	8.1	15.8	8.8	2.9	2.8	3.7	4.1
D03	3.0	2.2	2.8	3.0	3.0	2.8	2.8
D07	5.2	5.0	5.0	6.0	5.4	3.9	4.3
D09	3.7	4.5	3.9	2.0	3.3	2.6	2.0
D12	2.8	3.2	2.9	3.3	3.3	3.3	3.0
D19	2.5	2.9	3.1	2.9	3.1	2.5	2.3
D20	1.4	1.7	1.7	1.8	1.6	1.6	1.1
D23	2.0	1.8	1.8	2.1	1.8	1.4	3.9
D26	1.2	1.6	1.3	2.0	2.1	1.9	1.4

1. Throughout the period of sampling it was noted some of the dust gauges contained various sources of foreign material including bird droppings, insects, sticks and other organic matter when analysed. Contamination was 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.
2. Depositional Dust Gauge D24 failed to record a result in December 2017 due to the vial being broken. The vial was identified as being broken upon collection with no evidence available as to the cause. Monitoring at D24 is no longer required under the approved AQGGMP.

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.

WCPL is currently reviewing alternatives to fitting 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. During the reporting period, an updated AQGGMP was approved.

5.4 Greenhouse Gas

5.4.1 Approval Criteria/EIS Predictions and Management Plan Requirements

There is no approval criterion for greenhouse gas emissions in WCPL's statutory approvals.

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 2013 to 2017. 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 19** below is for the period 1 July 2016 – 30 June 2017. Data for the second half of the 2017 reporting period will be included in the 2018 Annual Review.

A total of 170,705 tonnes of CO_2 was emitted by the Mine's ventilation systems in 2017 compared to the predicted 2,380,053 tonnes.

The emissions predictions in the 2003 EIS were based on the assumption that the simultaneous mining of two longwalls (Wambo and Arrowfield/Bowfield) in conjunction with Arrowfield/Bowfield gas drainage would occur during 2017. 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 793,445 tonnes of $CO_{2\text{-}e}$ was emitted from the operation from all other sources. This is higher than the predicted 252,606 tonnes of $CO_{2\text{-}e}$ due to the inclusion of 518,263 tonnes of $CO_{2\text{-}e}$ 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 carbon dioxide seam 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 2016-17 financial year was the first 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 (964,150 tonnes of $CO_{2\text{-}e}$) is similar to previous reporting periods (**Table 19**).

Table 19: Comparison of EIS Predictions and Monitoring Data – Greenhouse Gas

Parameter	Monitoring Point	Monitoring Frequency	Emissions Calculated	Calculated CO_2-e tonnes for 2013 – 2014	Calculated CO_2-e tonnes for 2014 – 2015	Calculated CO_2-e tonnes for 2015 – 2016	Calculated CO_2-e tonnes for 2016 – 2017	EIS predicted CO_2-e tonnes for 2017[1]
Ventilation Systems								
Methane	Main Ventilation Shaft	Real-time continuous	Emission factor to convert from tonnes of CH4 to tonnes of CO_2-e	591,362	703,596	618,127	137,521	
Carbon Dioxide	Main Ventilation Shaft	Real-time continuous	Tonnes of CO_2-e	23,205	26,750	30,552	33,184	
Total				**614,567**	**730,346**	**648,679**	**170,705**	**2,380,053**
Other (Diesel and Electrical Power)								
Diesel Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	98,084	92,935	97,983	97,274	
Oil Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	39 (plus 3,652 kL not combusted)[2]	280 (plus 321 kL not combusted)	339 (plus 104 kL not combusted)	44 (plus 206 kL not combusted)	
Grease Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	0 (plus 4,880 kL not combusted)[2]	0 (plus 63 kL not combusted)	0 (plus 42 kL not combusted)	0 (plus 26 kL not combusted)	
Electricity Use	Calculated from invoices	Annually	Emission factor to convert from kWh use to tonnes of CO_2-e	79,869	78,576	76,506	63,435	
ROM Coal Production	Calculated from weight meter and survey	Monthly	Fugitive emissions factor based on ROM production[3]	70,183 (UG Stockpile residual emissions) 12,155 (OC Fugitives)	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)	
Sub-Total				**260,330**	**262,814**	**280,005**	**793,445**	**252,606**
Total				**874,897**	**993,160**	**928,684**	**964,150**	**2,632,659**

Note: CO_2-e = carbon dioxide equivalent, CH4 = methane, 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.

5.4.3 Trends and Key Management Implications

Levels of total CO_2 emissions monitored from the main ventilation shafts in 2016 were approximately 10% lower than the equivalent period in 2015 and were similar to levels in 2014.

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 2017, however energy efficiency is considered during the design and construction of haul roads and mine planning.

5.5 Meteorology

WCPL are required to maintain a meteorological monitoring station at the Mine and monitor the parameters specified in Table 11 of DA305-7-2003 (Condition 10, Schedule 4) and EPL529 (Condition M4), using the specified units of measure, averaging period, frequency and sampling method described in the tables.

WCPL's meteorological monitoring station was located approximately 250 m east of the administration building, within the project boundary. In July 2017, WCPL replaced the meteorological monitoring station.

WCPL maintains the meteorological monitoring station in accordance with Australian Standard (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[3];
- Wind speed (at 10 m);
- Wind direction (at 10 m);
- Solar radiation (at 10 m);
- Humidity; and
- Sigma theta.

Table 20 summarises the annual rainfall, temperature and wind direction data for 2017, compared to the previous three reporting periods. Data for this reporting period is a compilation of data from the new and old meteorological monitoring stations.

Due to software issues, weather monitoring measurements were not able to be collected for a period between 1 February and 3 February 2017. Supplementary weather data was obtained from an adjacent mine to supplement WCPL's data records (**Section 10.4**).

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

Table 20: Environmental Performance – Meteorology (2014-2017)

	2014	2015	2016	2017
Rainfall (mm)	556.44	789.49	721.18	442.50
Maximum Temperature (°C)[1]	45.3 (Nov)	40.8 (Nov)	41.6 (Dec)	46.8 (Feb)
Minimum Temperature (°C)[1]	-1.7 (June)	-0.85 (June)	-3.4 (July)	-3.5 (July)
Mean Temperature (°C)[1]	18.11	19.17	18.4	18.5
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)

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

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.

5.6 Biodiversity

WCPL has developed a BioMP (previously called the FFMP) for the Mine which has been extensively reviewed and subsequently approved in October 2017 (Version 13).

The BioMP (Version 13) replaces WCPL's FFMP (Version 8) and incorporates the Biodiversity Offset Management Strategy required under Condition 40, Schedule 4 of DA305-7-2003. It also addresses the requirements within the Voluntary Conservation Agreements prepared under Condition 41(a), Schedule 4 of DA305-7-2003, and the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* EPBC approvals (EPBC 2003/1138 and EPBC 2016/7636).

The BioMP also meets the requirement for a Biodiversity Management Plan under Condition 22C, Schedule 4 of DA305-7-2003 in support of the Extraction Plan for the South Bates Underground Mine Longwalls 11 to 16. During the next reporting period, the BioMP will be updated in support of 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 (TARP) 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 22, Schedule 4 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, EPBC2003/1138 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 21** and **Table 22**, respectively**.**

Table 21: 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
North Wambo Creek Diversion (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 22: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	15-20	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, NGCS = 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, FL= length of fallen logs >10 cm diameter within the vegetation plot.
2. PCT42: River Red Gum/River Oak riparian woodland wetland in the Hunter Valley, PCT1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter, PCT1658: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak – Coast Banksia woodland on sands of the Warkworth area, 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 and 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) during 2015 and were registered in 2017, in accordance with Condition 41, Schedule 4 of DA305-7-2003. WCPL has applied to revise the VCAs to include RWEA E.

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 and October 2017 across both remnant woodland and post-mining rehabilitation areas. A copy of the 2017 Annual Flora and Fauna Monitoring Report (Eco Logical 2018a) is included in **Appendix E.**

Despite unusually dry conditions, remnant woodland sites appear to be generally performing well, with a low cover of exotic species and are either meeting or just falling short of completion criteria (**Table 21** and **Table 22**), with no additional management required (Eco Logical 2018a). Exotic species cover remains high in the River Red Gum / River Oak riparian woodland where historic disturbance has been greatest. These areas generally exceed completion criteria and VCA targets for exotic plant cover. 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.

The dieback of *Angophora floribunda* (Rough-barked Apple) observed within the Warkworth Sands area of RWEA A in 2016 appears to be recovering, with abundant epicormic growth observed in 2017. 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 2018a).

As reported in previously, the NWCD has not yet met completion criteria for landscape function and this area will require additional management actions to ensure that all completion criteria and other commitments are met in the near future. Woodland rehabilitation areas 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 Wambo Creek and Stony Creek showed little change between the current year and the previous year over the three separate reaches of each creek surveyed. Condition scores for North Wambo Creek were slightly larger than the previous year but review of transect photos and examination of the data suggest this may be due to the effect of different observers completing the surveys in the previous year. No evidence of additional subsidence impacts was noticed on any of the creeks. While North Wambo Creek is currently fenced to prevent grazing impacts and to improve environmental condition, large reaches of Stony Creek remain grazed by cattle. Wambo Creek has been heavily impacted by historic clearing and grazing and had the lowest condition score of the three creeks (Eco Logical 2018a).

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, and 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 management of exotic flora and weeds 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). Eco Logical (2018a) recommended to give priority to species such as this in the mine's weed control program. 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.

Eco Logical (2018a) made recommendations to improve woodland rehabilitation areas, which include focusing 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 was likely reduced by the very dry conditions at the time of survey.

Eco Logical (2018a) concluded that there were no significant changes in total site scores at South Wambo Creek and Stony Creek, while the average total score for North Wambo Creek increased from 2016. Recommendations include continuing to restrict cattle access to the currently grazed areas of South Wambo and Stony Creek to encourage tree regeneration and prevent erosion and planting of trees in over-cleared riparian areas (that are unlikely to regenerate naturally with cattle exclusion).

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 six bird species have been recorded during timed bird surveys over the last three years, with 74 (69%) of these recorded during 2017. The total number of bird species detected each year has varied over time but the number of species recorded during 2017 are consistent with previous years.

Bird assemblages in 2017 were not compared statistically to previous surveys. However assemblages appear broadly similar to the previous 4 years and also data from 2009 monitoring. *Pachycephala rufiventris* (Rufous Whistler), *Lichenostomus chrysops* (Yellow-faced Honeyeater), and *Malurus cyaneus* (Superb Fairy-wren), were the three most widely recorded species in the last three monitoring events (2015-2017) and 14 of the 20 most widely recorded species in terms of monitoring sites in 2009 (RPS 2009) were in the top 20 most widely recorded species during 2017.

Eight threatened species listed under the NSW Biodiversity Conservation Act 2016, were recorded during 2017 surveys. *Calyptorhynchus lathami* (Glossy Black-Cockatoo) and *Neophema pulchella* (Turquoise Parrot) were two threatened species not recorded in 2016.

Eco Logical (2018a) identified minor mine subsidence cracks at vegetation monitoring sites V6-B1c, V6-B2, V6-B2c, V10-A2, V11-B1 and bird monitoring site BP15 within the Narrow-leaved Ironbark and Slaty Gum communities. More extensive subsidence impacts were observed on a ridgeline road in RWEA B between bird monitoring site BP12 and flora monitoring site v14-B1 in RWEA B, where a succession of large and deep cracks were observed.

An addendum to the annual flora and fauna monitoring report (**Appendix E**) was prepared by Eco Logical (2018b) and further considered subsidence impacts against the performance measures in DA305-7-2003. The addendum (Eco Logical 2018b) concluded that as this area was undermined by the North Wambo Underground Mine prior to February 2011, the current performance measures were not applicable to this subsidence impact. Eco Logical (2018b) recommended that WCPL remedy the subsidence impact to prevent further damage from erosion and reduce risks to native fauna and flora, while considering the surrounding *Central Hunter Grey Box-Ironbark Woodland EEC*.

The aquatic monitoring report (Niche 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

During the next reporting period, the BioMP will be updated as part of the Longwalls 17 – 20 Extraction Plan for the South Bates Extension Underground Mine.

WCPL will 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]).

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 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 finalised and approved during the reporting period.

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 during the reporting period:

- Due diligence surveys for four exploratory drill holes in January 2017. Two of the drill holes were located within the existing mining leases and covered by AHIP #2222 and two were outside the mine lease area and area covered by AHIP #2222. A total of six sites were investigated;
- Due diligence surveys for drilling in EL7211 in February and March 2017;
- Due diligence surveys for a proposed electricity transmission line realignment on the eastern margin of the Mine (involving six new power lines) in May 2017. Three of the power poles would be located outside of AHIP #2222; and
- Due diligence surveys for drilling in A444 in May 2017.

The due diligence surveys completed during the reporting period identified minimal or no impact to Aboriginal heritage from the proposed works. WCPL plans to continue due diligence surveys as required during the next reporting period. No change in the current procedure is planned.

During the reporting period, WCPL was notified by Glencore that two isolated artefacts previously identified during Aboriginal heritage surveys undertaken for the United Project (i.e. AHIMS 37-5-0694 [United IF-1] and AHIMS 37-5-0695 [United IF-2]), had been disturbed during progression of the approved Wambo Coal Mine open pit. Both of these sites are isolated artefacts of low scientific significance and are located in a disturbed context. Both of these sites are located within the boundary of AHIP #2222.

Accordingly, WCPL is preparing Aboriginal Site Impact Recording Forms for these sites to be provided to AHIMS so that the status of these sites can be updated. Further, WCPL will undertake a review of the site database and confirm that all relevant records associated with the United Project have been included in the WCPL database.

Condition 51, Schedule 4 of DA305-7-2003 requires WCPL to develop a management plan for the management of Aboriginal cultural heritage in RWEA A within 12 months of entering into the VCA in consultation with the Aboriginal communities and OEH. The VCAs were finalised during the reporting period.

5.8 Non-Aboriginal Heritage

WCPL is required to prepare a Conservation Management Plan (CMP) for the WHC in accordance with Conditions 58 and 59, Schedule 4 of DA305-7-2003. A CMP was prepared by WCPL in 2006 and reviewed in 2012 by heritage consultants Godden Mackay Logan. The CMP is currently under review.

An annual photographic record of the elevations of all structures at the WHC was completed during the reporting period and will be lodged with the NSW Heritage Office, Singleton Shire Council and a copy of the report provided to DPE, in accordance with Condition 61, Schedule 4 of DA305-7-2003.

An archival recording of the Whynot homestead and outbuildings was completed during the reporting period and a copy will be submitted to Singleton Shire Council and relevant local historical societies in 2018 in accordance with Condition 62A, Schedule 4 of DA305-7-2003.

During the reporting period, WCPL undertook blasting that was within 2 km of the WHC. 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**).

5.9 Subsidence

5.9.1 Extraction Plans

During the reporting period, WCPL received approval for the South Bates Underground Longwalls 11-16 Extraction Plan. The Extraction Plan was submitted to DPE in January 2017, revised in July 2017 and approved in October 2017, 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 DPI-Water (now DI-Water). In the interim, WCPL continues to operate under the approved Site Water Management Plan (and associated component plans) dated October 2015.

5.9.1.1 Extraction Plan for South Bates Underground Longwalls 11-16

A Modification Application for South Bates Underground (Wambo Seam) Longwalls 14-16 was submitted to DPE in July 2015 (DA305-7-2003 MOD 15) and approved on 10 November 2015.

In 2016, WCPL prepared an Extraction Plan for the South Bates Underground Longwalls 11-16 (by way of updating the approved South Bates Underground Longwalls 11-13 Extraction Plan to include Longwalls 14-16).

The South Bates Underground Longwalls 11-16 Extraction Plan was submitted to DPE in January 2017, revised in July 2017 and approved on 11 October 2017. This South Bates Underground Longwalls 11-16 Extraction Plan superseded the previously approved South Bates Underground Longwalls 11-13 Extraction Plan.

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

- Incident Report – to be prepared as required and submitted (by email) to DPE (Manager, Mining Projects), DRG (Subsidence Executive Officer), SANSW (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 DPE (Manager, Mining Projects), DRG (Subsidence Executive Officer) and OEH (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 DPE (Manager, Mining Projects), DRG (Subsidence Executive Officer), SANSW (District Manager), OEH/EPA (General Contact/National Parks and Wildlife Service) and DPI-Water (Manager Strategic Stakeholder Liaison) (now DI-Water).
- Annual Review – to be updated annually for the period 1 January to 31 December and submitted (by email and post) to DPE (Manager, Mining Projects), DRG (Subsidence Executive Officer), DRG (Director – Environmental Sustainability), SANSW (District Manager), OEH/EPA (General Contact/National Parks and Wildlife Service), DPI-Water (Manager Strategic Stakeholder Liaison) (now DI-Water), Singleton Shire Council (General Manager) and CCC Members.

The component management plans of the South Bates Underground Longwalls 11-16 Extraction Plan reference components of a number of existing 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 Underground Longwalls 11-16 will be updated accordingly.

5.9.2 Approval Criteria/EIS Predictions and Management Plan Requirements

In accordance with DA305-7-2003 (Tables 14A and 14B), WCPL must ensure that there are no exceedances of the Subsidence Impact Performance Measures detailed in **Table 23.**

Underground mining was undertaken at South Bates Underground Longwalls 13 and 14 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 Underground Longwall 13 undermined the NWCD during the reporting period. Longwall 14 did not directly undermine the NWCD. These longwalls were offset from the base of the Wollemi National Park escarpment by a 26.5 degree angle of draw. No impacts to the escarpment were observed during the reporting period (**Section 5.9.3**).

Table 23: Subsidence Impact Performance Measures

Aspect	Performance Measures[1]
Water – Wollombi Brook	Negligible subsidence impacts. Negligible environmental consequences. Controlled release of excess site water only in accordance with EPL requirements.
Cliffs – Low level cliffs[2]	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 within the South Bates Extension Area).
Biodiversity – Wollemi National Park	Negligible subsidence impacts. Negligible environmental consequences.
Biodiversity – Warkworth Sands Woodland Community	Minor cracking and ponding of the land surface or other impact. 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 impact. Negligible environmental consequences.
Biodiversity – Central Hunter Valley Eucalypt Forest and Woodland Ecological Community[2]	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.
Biodiversity – Other species, populations or communities listed under the *Biodiversity Conservation Act 2016* or the *Environment Protection and Biodiversity Conservation Act 2016*	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.
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	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	No 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.
2. These conditions are only applicable from the approval of MOD 17 onwards (i.e. December 2017).

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

During the reporting period, WCPL undertook longwall mining in the South Bates Underground Longwalls 13 and 14 (**Section 3.1**). Subsidence monitoring was undertaken in accordance with the approved South Bates Underground Longwalls 11-16 Extraction Plan. Mining in North Wambo Underground Longwalls 8 – 10A is complete and the entries have been sealed.

Table 24 summarises the actual versus predicted subsidence results for Longwalls 8a to 10a at the North Wambo Underground Mine and for Longwalls 11 to 13 at the South Bates (Whybrow Seam) Underground Mine. The subsidence monitoring results for Longwall 14 at the South Bates (Wambo Seam) Underground Mine will be reported in the next Annual Review. The monitoring shows that the actual maximum subsidence recorded for both sets of longwalls was similar to the predicted range.

Table 24: Subsidence Monitoring – Actual versus Predicted for North Wambo Underground Mine Longwalls 8a to 10a and South Bates Underground Mine Longwalls 11 to 13

Monitoring Line ID	Predicted S_{max} (mm)[1]	Actual S_{max} (mm)	Difference (mm)	Consistent With Predicted Range
North Wambo Underground Mine Longwalls 8a to 10a[1]				
CL9A-Line	2,300	2,121	179	Y
CL9B-Line	2,325	1,917	408	Y
CL9C-Line	2,275	1,920	355	Y
DL10A-Line	1,600	1,538	62	Y
SD-Line	2,375	1,788	587	Y
T-Line	2,300	1,434	866	Y
XL1-Line	2,300	1,680	620	Y
XL2-Line	2,300	2,088	212	Y
XL6-Line	2,400	2,100	300	Y
South Bates (Whybrow Seam) Underground Mine Longwalls 11 to 13[2]				
7XL-Line	1,950	1,694	256	Y
CL13B-Line	1,850	1,767	83	Y

1. *North Wambo Underground Mine: Subsidence Review Report for WMLW8A to WMLW10A* (Mine Subsidence Engineering Consultants [MSEC], 2017a).
2. *South Bates Underground Mine: Subsidence Review Report for South Bates WYLW13* (MSEC, 2017b).

An audit of subsidence impacts was undertaken by SLR Consulting (SLR) during the reporting period to identify new subsidence impacts over recent mining areas (Longwalls 11 and 12 at the South Bates [Whybrow Seam] 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 audit identified a total of 102 sites with subsidence impacts across the Wambo site (SLR 2017). Of these, SLR recommended that 49 be remediated and the remainder be monitored in case future remediation is required. A majority of the sites recommended for remediation (e.g. 31 out of 49) overlie Longwalls 11 and 12 of the South Bates Underground Mine, and as such, remediation would not be undertaken until the completion of Longwalls 14 to 16 (and the completion of active subsidence).

WCPL is preparing a program of works for the remediation of the 18 sites that are not overlying Longwalls 11 and 12. Remediation would be undertaken using natural fill. This option generally involves the use of civil earthworks machinery (excavators, backhoes, bobcats, trucks etc.) and fill material (e.g. soils, sands, gravels, clays, wood mulch, chicken litter), to remediate subsidence impacts (e.g. surface cracking, sinkholes) caused by mining operations. These works would be undertaken in consideration of potential impacts including; additional surface disturbance (e.g. access tracks, stockpiles etc.), erosion, potential for increased spread of weeds, and potential impacts to sensitive area (e.g. archaeological sites or sensitive ecological areas).

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 and September 2017. There were no cliff instabilities identified along the escarpment from these surveys.

Visual inspections of surface impacts above South Bates Underground Mine and along the NWCD were carried out by WCPL and MSEC during the extraction of South Bates Underground Longwall 11, Longwall 12 and Longwall 13. The observed surface deformations are typically within those predicted to occur by MSEC. Whilst surface cracking up to approximately 300 mm in width occurred near the finishing end of Longwall 13, these cracks represented less than 0.1% of the total length of mapped surface cracking above this longwall.

Ground movements resulting from the extraction of Longwalls 11 to 13 at the South Bates Underground Mine have also been measured using LiDAR surveys (i.e. by comparing a survey undertaken in September 2015 [before extraction of Longwalls 11 to 13 began] and in September 2017 [after the completion of Longwall 13]. 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.

MSEC (2017a) concluded that the profiles of the observed changes in surface levels reasonably match the predicted profiles of vertical subsidence. The maximum observed changes in surface level along each of the three crosslines (i.e. across Longwalls 11, 12 and 13) were less than the maxima predicted. The observed changes in surface level along the longitudinal line (i.e. along Longwall 13) are greater than the predicted vertical subsidence in some locations. MSEC (2017a) concluded that these locally higher areas of subsidence were likely to be due to the effects of the steep slopes associated with the spur, ephemeral drainage lines and the banks of the creek diversion. There was also an area above Longwall 13 that experienced additional subsidence due to the start of Longwall 14.

Eco Logical (2018a) identified minor mine subsidence cracks at vegetation monitoring sites V6-B1c, V6-B2, V6-B2c, V10-A2, V11-B1 and bird monitoring site BP15 within the Narrow-leaved Ironbark and Slaty Gum communities. More extensive subsidence impacts were observed on a ridgeline road in RWEA B between bird monitoring site BP12 and flora monitoring site v14-B1 in RWEA B, where a succession of large and deep cracks were observed.

An addendum to the annual flora and fauna monitoring report (Eco Logical 2018a) was prepared by Eco Logical (2018b) and further considered subsidence impacts against the performance measures in DA305-7-2003. The addendum (Eco Logical 2018b) concluded that as this area was undermined by the North Wambo Underground Mine prior to February 2011, as such the current performance measures were not applicable to this subsidence impact. Eco Logical (2018b) recommended that WCPL remedy the subsidence impact to prevent further damage from erosion and reduce risks to native fauna and flora, while considering the surrounding *Central Hunter Grey Box-Ironbark Woodland EEC*.

5.9.4 Trends and Key Management Implications

It is considered by MSEC (2017a) that the observed ground movements for South Bates Underground Mine Longwalls 11, 12 and 13 were consistent with predictions. Identified subsidence impacts will continue to be monitored and proactively repaired.

5.9.5 Implemented or Proposed Management Actions

During the next reporting period, WCPL will continue to implement the approved extraction plans for South Bates Underground Longwalls 11-16.

WCPL will also develop a program of works for the remediation of the subsidence impacts identified by the subsidence audit in areas away from active subsidence (**Section 5.9.3**).

5.10 Exploration

During the reporting period, 91 exploration holes were drilled in WCPL's licensed exploration and mine lease areas. Of these holes, 67 were non-core, 20 were core holes and 4 were partially cored holes. Twenty four (24) holes were drilled within EL7211 and A444 and as such these holes were subject to the Exploration Activity Application and Assessment Process as part of the Part 5 approval process. The remainder were drilled within WCPL's mining leases and were managed under WCPL's site surface disturbance permit system.

Rehabilitation of exploration sites is undertaken continuously throughout the exploration program and immediately upon backfilling of logged holes. Preliminary rehabilitation has been completed and inspected for 80 sites within mine and exploration leases. The remaining 11 sites will be inspected to determine rehabilitation status during the next reporting period. All exploration sites within EL7211 and A444 have been rehabilitated and inspected.

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 3,298,988 kg of waste was generated by the Mine. Of this, 75.71% was recycled and 24.29% was taken to landfill or disposed of off-site as hazardous waste.

The total waste removed from the Mine in 2017 was more than in 2016, 2015 and 2013 (2,709,881 kg, 2,252,922 kg and 1,615,289 kg, respectively) but less than 2014 (4,860,142 kg) (**Figure 7**). The main reasons for the differences in waste generated by the Mine are:

- The waste report for January 2016 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 2016 waste report the total waste generated in 2016 would be less.
- 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 significantly 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 2017 (75.71%) was more than reported in 2016 (71.77%) and 2015 (67.87%) but less than that reported for 2014 (82.82%) 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 for 2014.

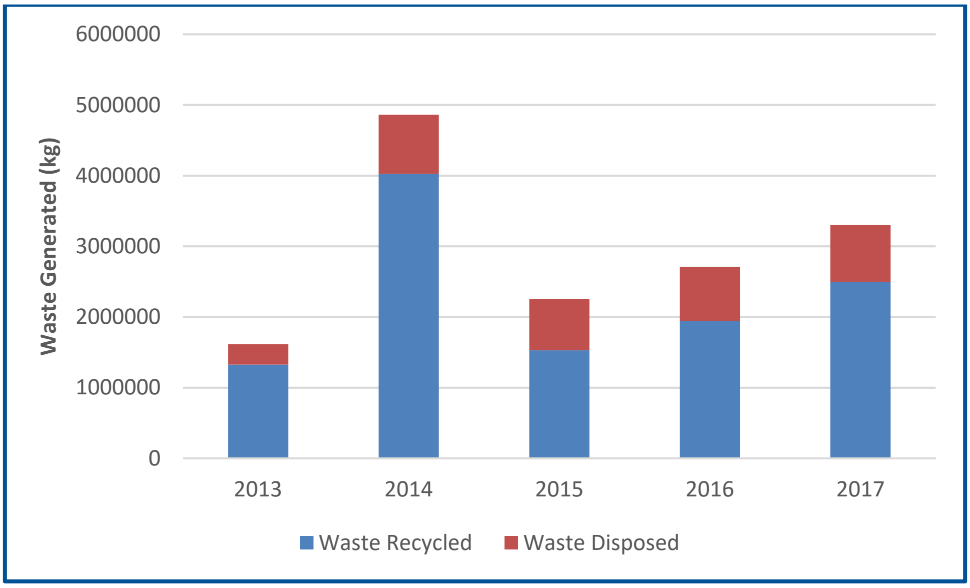


Figure 7: Waste Volumes (2013-2017)

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.

During 2016, WCPL monitored lighting impacts along the Montrose Ridge as mining continued to the north. As a result of this monitoring, WCPL installed low light lighting plant and continues to ensure frequent communication of potential lighting impacts at pre-start meetings.

In July 2017, an external lighting audit was undertaken which considered spill light, glare and sky glow from fixed and mobile light sources. The audit confirmed that the Mine is operating in compliance with *AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting* (**Section 9.4**).

There were nine (9) complaints received during the reporting period relating to lighting impacts from WCPL's mining operations (**Section 8.3**).

5.13 Contaminated Land

No contaminated land event, that posed a 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

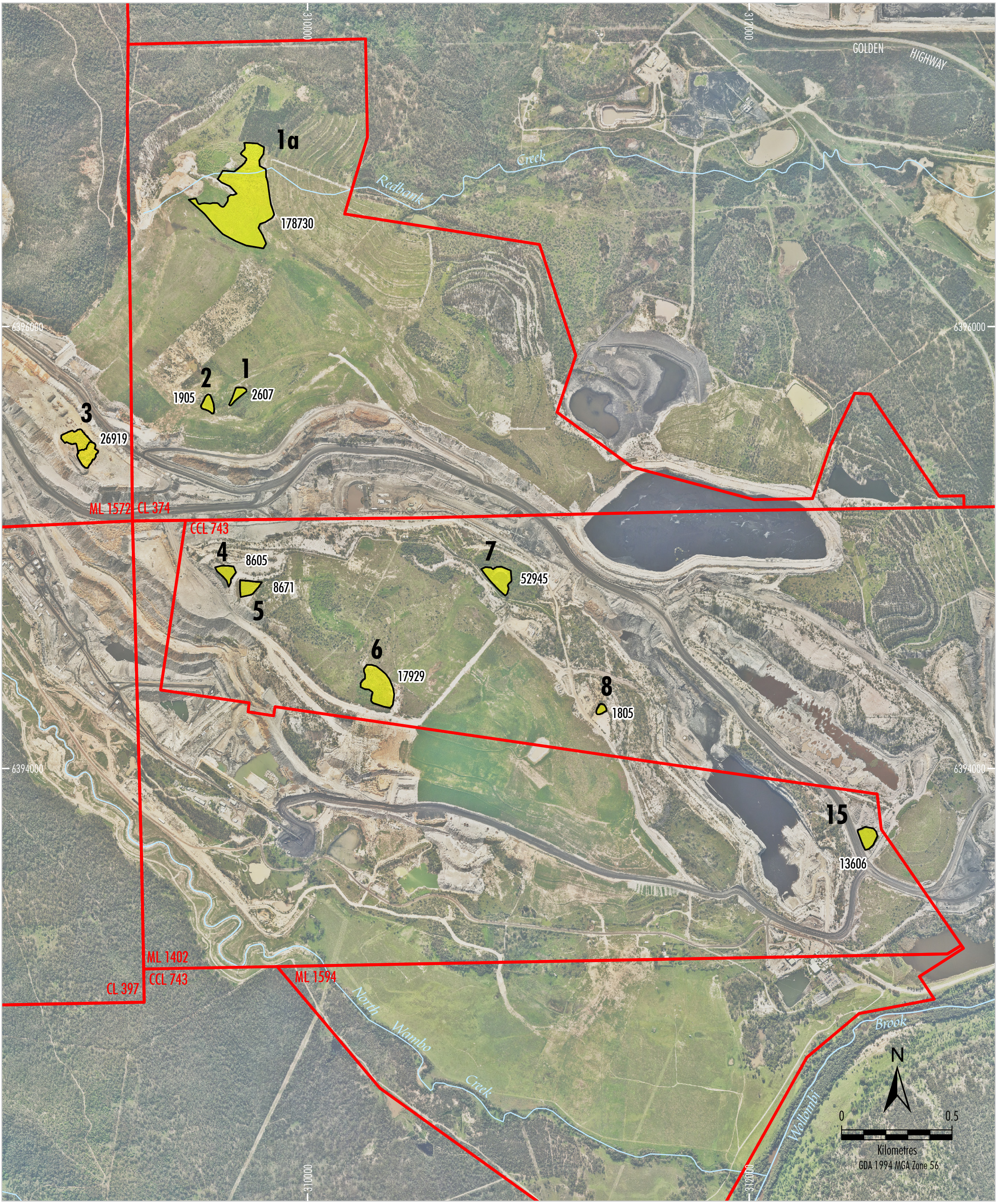
During the reporting period, WCPL undertook an inventory of topsoil stockpiles on-site, including location, volume and condition. This inventory (as at the end of the reporting period) is summarised in **Table 25** below. Topsoil stockpile locations, as at the end of the reporting period, are shown on **Figure 8.**

Table 25: Topsoil Inventory

Stockpile Reference Number	Location	Volume (m^3)
1a	RL160	178730
1	RL160	2607
2	RL160	1905
3	RL160 Dump	26919
4	Sarah Marie Dump	8605
5	Sarah Marie Dump	8671
6	Sarah Marie Dump	17929
7	Ridge Reload	52945
8	Ridge Dump	1805
15	Charlies Hole Dump	13606

Note: m^3 = cubic metres.

Topsoil is managed at the Mine in accordance with the Wambo Coal Topsoil Management Procedure. WCPL will continue to manage topsoil at the Mine in accordance with the Topsoil Management Procedure.



LEGEND

Mining and Coal Lease Boundary

Topsoil Stockpile

5 Stockpile Reference Number

1805 Stockpile Volume (m^3)

Source: WCPL (2018); © NSW Department of Planning and Environment (2017)
Orthophoto: WCPL (May 2017)

Peabody

WAMBO COAL MINE

Topsoil Locations

Figure 8

5.15 Weed and Pest Management

During the reporting period, WCPL undertook two vertebrate pest management programs, two targeting wild dogs and foxes (one in summer and one in spring).

The wild dog and fox programs were considered to be successful due to the high rate of baits being taken by the target species (86% of the baits taken in summer and 79% of baits in spring), Rural & Environmental Management Pty Ltd (REM) (2017a; 2017b) concluded that there continues to be wild dog, fox, pig and hare activity in the area and recommended that the pest management programs be undertaken again in the future to manage the pest populations. Pigs and hares were not a focus of the management programs, but were observed on a number of occasions.

During the reporting period, WCPL also undertook a program to manage kangaroo populations (to assist in rehabilitation establishment).

WCPL commissioned Rural & Environmental Management Pty Ltd (REM) to undertake management and control of weed species within the operations areas of the Mine during 2017. Weed management techniques included spraying, cut and paint and manual removal. During the reporting period, a total of 31 days of weed control work at the Mine and an additional eight days of weed control work at adjoining WCPL-owned properties was undertaken by a two person crew.

A summary of the total areas of specific weeds treated by REM (2018) is provided in **Table 26** and shown in **Figure 9** and **Figure 10**.

Table 26: Approximate Area of Weeds Treated at the Mine during 2017

Weeds Treated	Treatment Measure and Zone	Area (ha)
Pear species, blue heliotrope, galenia	Sprayed - Treatment area – re-treatment and expanding RWEA A	6.21
African boxthorn, lantana, green cestrum	Cut & paint boxthorn, manual removal lantana – RWEA A	3.87
African boxthorn & olive, lantana, green cestrum	Cut & paint, manual removal of lantana - RWEA A	6.17
Pear species	Sprayed - Beltline Brook Paddock. Area covered now significantly larger	5.67
African boxthorn & olive, wild peach, green cestrum	Cut & paint - Wollombi Brook (north)	2.71
Pear species, galenia & blue heliotrope	Area previously sprayed RWEA A	0.52
Balloon vine, moth vine, African boxthorn & olives	Sprayed - RWEA A	0.05
Pear species, blue heliotrope, galenia	Sprayed - RWEA A	19.56
African Olive	Cut & paint - RWEA A	10.73
Mother of Millions	Sprayed - RWEA A	10.23
Pear species, blue heliotrope, galenia	Sprayed - RWEA A	0.60
Silverleaf nightshade, variegated thistle, common thornapple	Sprayed - Lower South Wambo	0.40
Total		66.72

LFA undertaken by Eco Logical (2018a) in 2017 found that landscape organisation scores for the NWCD appear to have either increased slightly or remained constant since the previous monitoring conducted in 2016.

Pest and weed management will continue as required on-site and on agistment managed properties throughout the next reporting period.

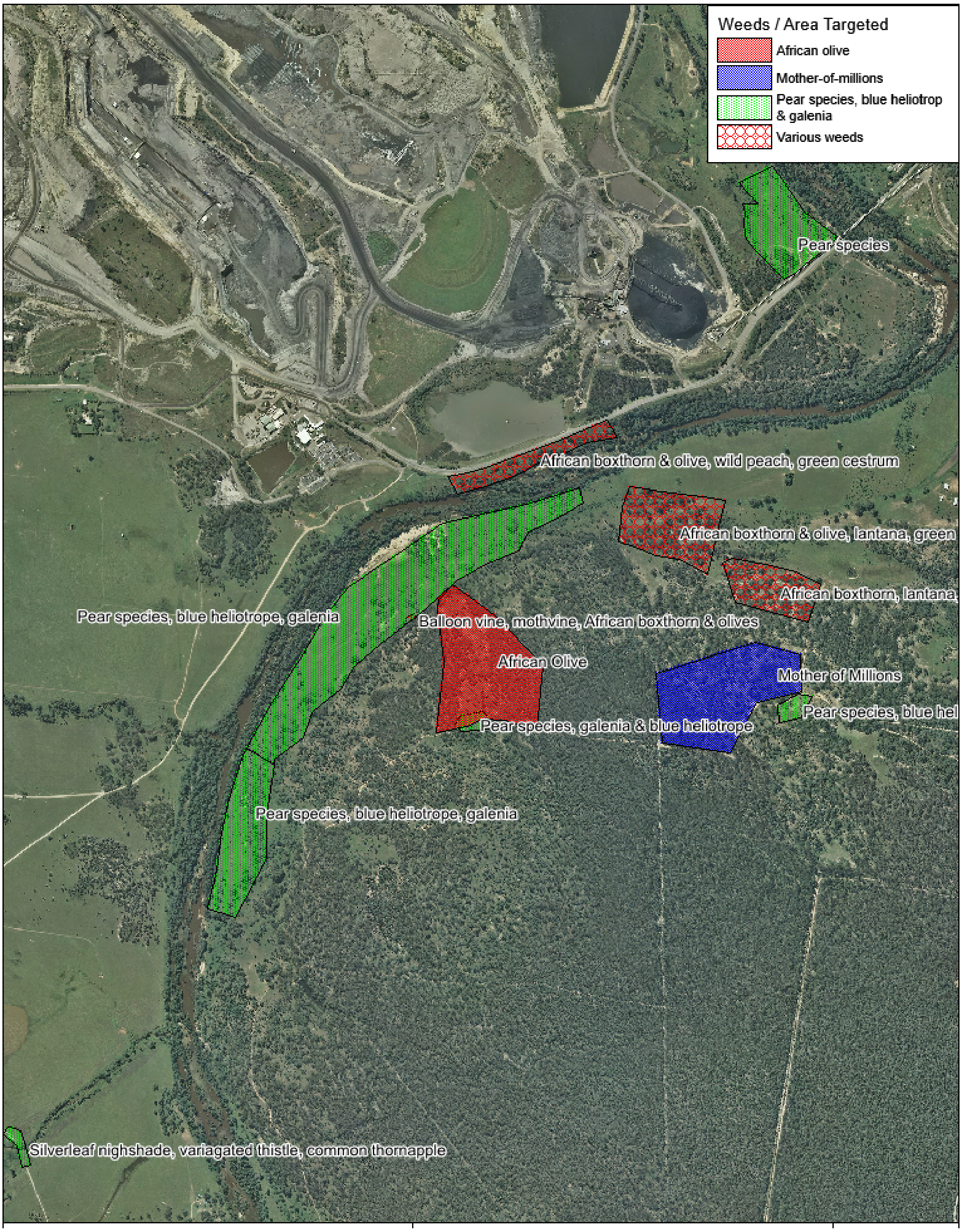


Figure 9: Weed Control Overview for the Mine (REM, 2018)

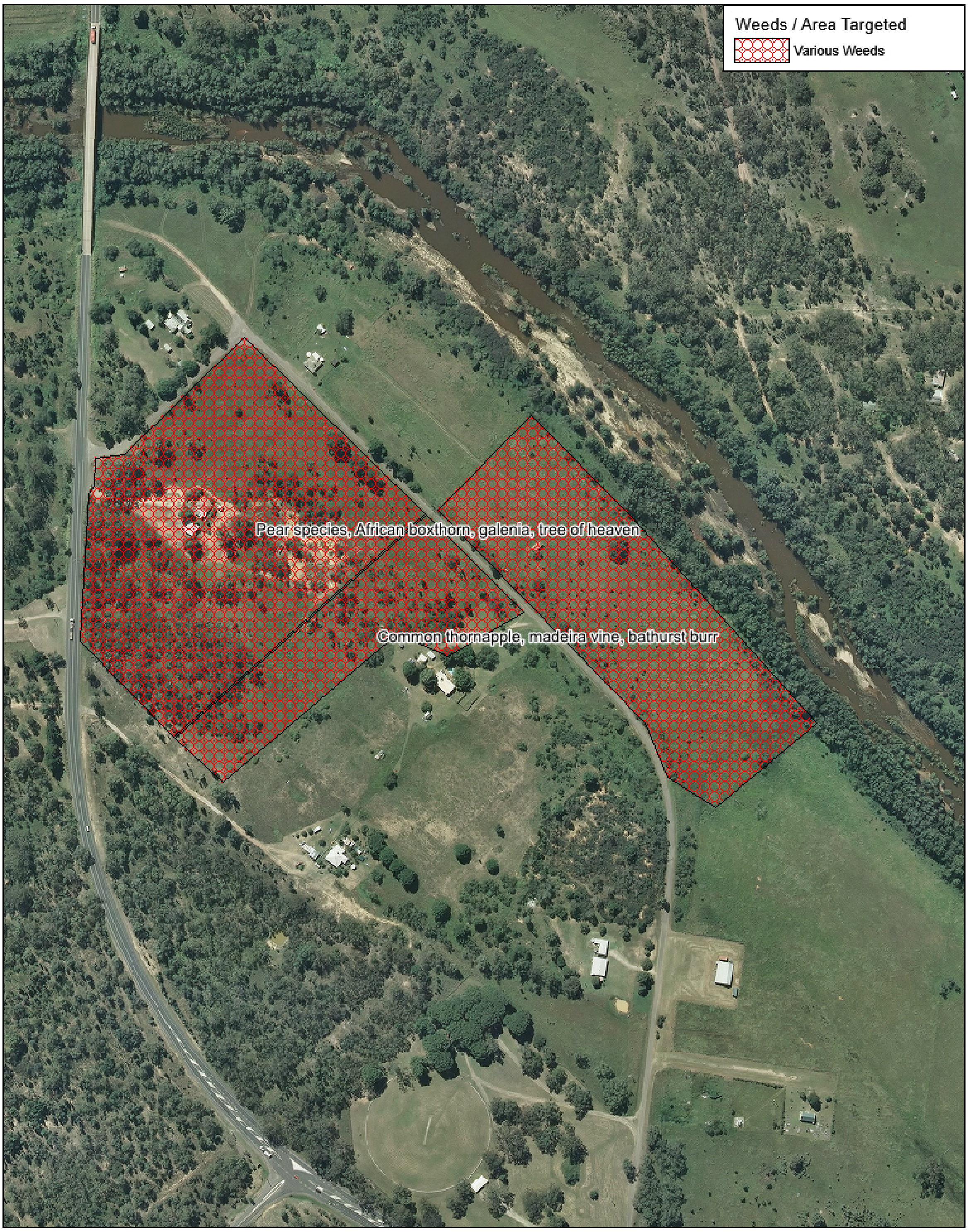


Figure 10: Weed Control for WCPL-owned Properties (REM, 2018)

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.

During the reporting period, WCPL revised the Bushfire Management Plan. A copy of the revised Bushfire Management Plan was provided to the Singleton Shire Council and the NSW Rural Fire Service (RFS) in December 2017. WCPL will address any comments from the Singleton Shire Council and RFS and provide the updated plan to DPE for approval in 2018.

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.

The Bushfire Risk Assessment undertaken in 2017 concluded that the Mine has inherent and maintained bushfire mitigation features that provide a high level of bushfire preparedness. Notwithstanding, a number of actions were recommended and implemented during the reporting period, WCPL:

- Mechanically removed vegetation within the 1 m clearance either side of the fire trail (fire trail should be 4 m wide with 1 m clearance either side) and ensured vertical clearance along the fire trail is greater than 4 m; and
- Submitted the revised BFMP for review and consultation with the RFS and Singleton Shire Council.

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 (Hansen Bailey 2017) noted a minor (<1 m^3) spontaneous combustion event, which WCPL has been managed and monitored. WCPL will continue to monitor for signs of spontaneous combustion in the next reporting period.

6.0 Water Management

Water quality discharge criteria for the Mine is defined in Table 15 of DA305-7-2003 (Condition 24, Schedule 4) 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 Surface Water Monitoring Program (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 December 2016 (Version 11) and submitted with the Extraction Plan for South Bates Underground Mine Longwalls 11-16. On 11 October 2017, DPE approved the Extraction Plan for South Bates Underground Mine Longwalls 11 to 16, 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 DPI-Water (now DI-Water). In the interim, WCPL continues to operate under the approved Site Water Management Plan (and associated component plans) dated October 2015.

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 9). 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 27** and **Table 28.**

Triggers for the local mine site 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 27: Surface Water Quality Impact Criteria[1]

Sampling Site	Parameter[2]	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)[3]	
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)[3]	
SW07 – Wambo Creek	pH	7.4	7.9
	EC (µS/cm)	360	724
	TSS (mg/L)	29 (low flow) to 331 (high flow)[3]	
SW08 – Stony Creek	pH	6.8	7.4
	EC (µS/cm)	288	416
	TSS (mg/L)	5 (low flow) to 15 (high flow)[3]	
SW39 – Waterfall Creek	pH	7.3	7.8
	EC (µS/cm)	159	429
	TSS (mg/L)	582 (low flow) to 1,922 (high flow)[3]	

1. From Table 11, Version 9 of the WCPL SWMP.
2. EC = electrical conductivity, TSS = total suspended solids, µS/cm = microSiemens per centimetre, mg/L = milligrams per litre.
3. Low flow condition based on 80th percentile of recorded concentrations and high flow criteria based on maximum recorded concentrations.

Table 28: 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 10, Version 9 of the WCPL SWMP.

In addition to the surface water monitoring requirements detailed in **Table 27** and **Table 28,** 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 29**).

Table 29: 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 27**) 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 80^{th} Percentile Trigger Value (**Table 27**) after three consecutive sampling events.

WCPL recorded no exceedances of the surface water quality impact assessment criteria during the reporting period.

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 C.**

The WCPL stream flow monitoring system consists of (**Figure 11**):

- Five monitoring stations on North Wambo Creek (US-FM1, FM1, FM2, FM3 and FM4);
- Two monitoring stations on South Wambo Creek (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, FM4 and FM12. There were no recordable flow events at FM1, FM13, FM14, FM15 and FM16, and no flow events were recorded at US-FM1 since installation in December 2017.

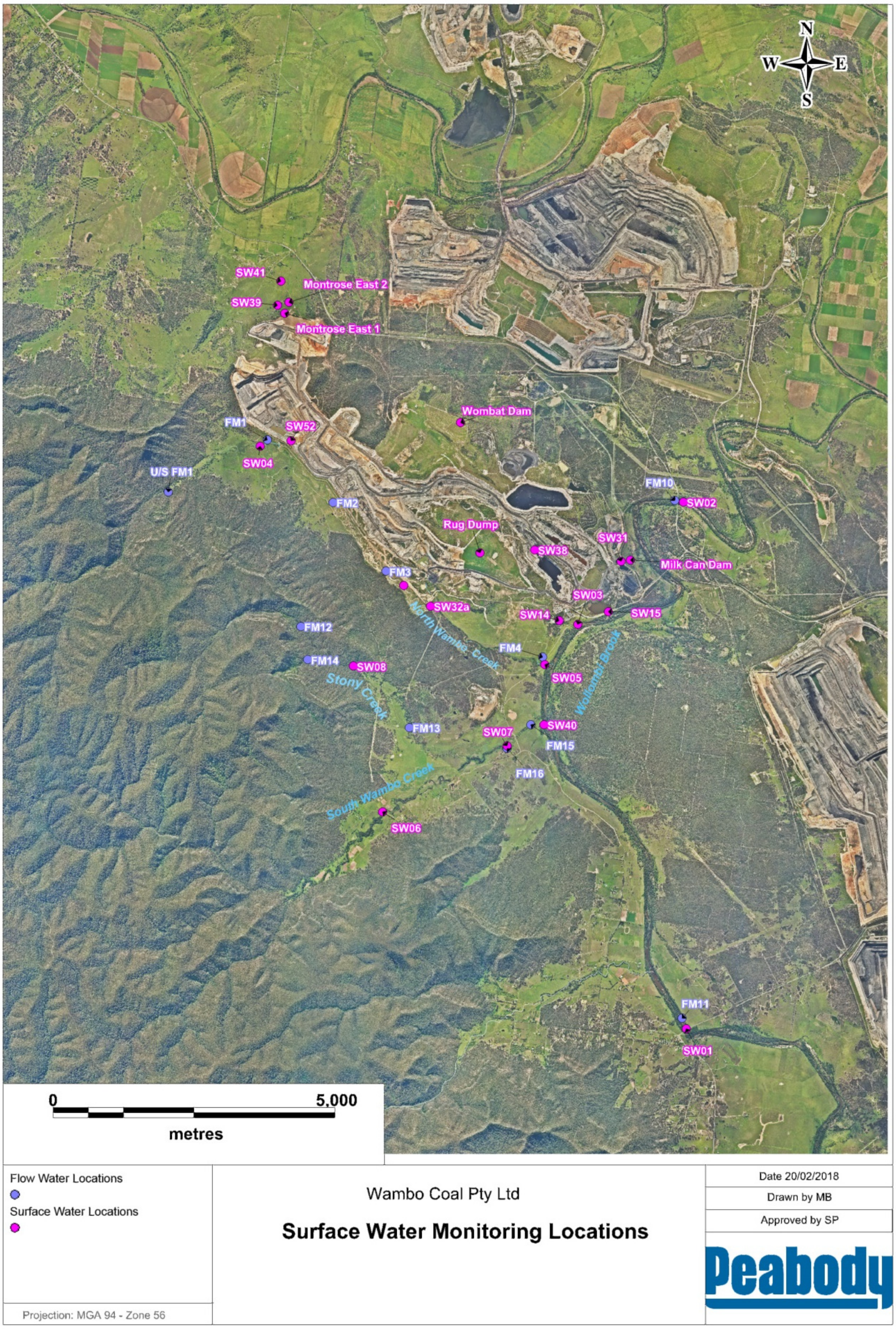


Figure 11: WCPL Flow Monitoring Locations

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.

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

WCPL commissioned an independent review of the flow monitoring network in August 2017. The review was undertaken by Environmental Instrument Solutions, and the following recommendations were implemented by WCPL:

- An additional flow monitoring station was installed on North Wambo Creek upstream of FM1 (US-FM1);
- FM1 was relocated approximately 300 to 400 metres further downstream on North Wambo Creek;
- Cross sections and long sections were re-surveyed at each flow monitoring station so that changes in stream characteristics since the previous surveys in 2013 could be incorporated into the development of new flow rating curves; and
- The re-establishment of each of the flow monitoring station’s sensor height was compared to the cease to flow point at that site.

A new flow monitoring station (US-FM1) was installed on North Wambo Creek during December 2017 approximately 1 km upstream of the original site of FM1.

During the next reporting period, WCPL will continue to implement the approved SWMP (Version 9) or the revised version (Version 11) if approved.

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.

Version 10 of the GWMP was approved by DPE on 27 November 2015.

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 10), is included in **Table 30.**

Table 30: 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
P206	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).
3. Specific trigger levels for GW08 and GW09 have not been established, however, if GW08 and GW09 do not recover within 12 months of the cessation of dewatering pumping (ceased in early 2016), WCPL may consider installing replacement bores that allow monitoring of the alluvium and underlying Interburden material. The levels in GW08 and GW09 will be monitored in 2017, and trigger levels established if appropriate.
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 30,** WCPL is also required to meet additional requirements, in accordance with the approved GWMP, Extraction Plan for the North Wambo Underground Longwalls 8-10A and Extraction Plan for the South Bates Underground Longwalls 11-16. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL GWMP (**Table 31**).

Table 31: 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 pumping of water from the North Wambo Underground Mine roadways requires regular pumping at rates higher than normal.
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 10).

A number of trigger level exceedances were recorded for groundwater levels and EC during the reporting period (**Table 32**). These exceedances are summarised in **Section 6.2.3** and discussed further in the report *Wambo Annual Review Groundwater Analysis* (HydroSimulations 2018a) (**Appendix F**).

Hydrographs for relevant groundwater monitoring bores were assessed to determine whether observed trends were due to weather or mining and shallow bores were assessed for compliance with the groundwater level and water quality performance indicators (HydroSimulations 2018a).

No bores were decommissioned during the reporting period.

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

Table 32: Groundwater Trigger Level Exceedances[1]

Bore	Number of Trigger Level Exceedances[2]		
	Depth to Groundwater - Min (10th percentile)	Depth to Groundwater - Max (90th percentile)	EC
P106		6 (dry)	
P109			N/A
P114		6 (dry)	
P116			
P202	1		
P206			
P301	N/A		
P315			
GW02			
GW08	N/A		
GW09	N/A – Bore Dry		
GW11		1	
GW12		4	
GW13		6	N/A
GW15			
GW16	N/A		
GW17	N/A		
P16		6	
P20		2	
Total	**1**	**31**	**0**

1. From Table 3 of the report *Wambo Annual Review Groundwater Analysis* (HydroSimulations 2018a) (**Appendix F**).
2. 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 30**) by HydroSimulations (2018a).

The 10th percentile trigger allows identification of anomalously shallow depths to groundwater. It is important to note that the baseline monitoring data used to create the trigger levels (from July 2003 until August 2007) were recorded during a period of lower than average rainfall.

From October 2007 to mid-2016, a period of generally greater than average rainfall has been observed. Consequently, instances where trigger levels were observed to exceed the minimum (10th percentile) levels during this period should not be attributed to the Mine's activity (HydroSimulations 2018a).

During the reporting period, a single trigger level exceedance of the 10th percentile level was recorded at P202 in April 2017. HydroSimulations (2018a) concluded that this exceedance was not significant and should not be attributed to the Mine's activity, being likely due to a spike in the rainfall trend and Wollombi Brook stage height at the time of the trigger.

The 90th percentile trigger allows identification of anomalously deep depths to groundwater. During the reporting period, 31 exceedances of the 90th percentile level were recorded at P114, P106, GW11, GW12, GW13, P16 and P20. HydroSimulations (2018a) concluded that:

- As reported previously, the low groundwater levels at P114 are a clear effect from the mining of North Wambo Underground Longwall 10A (HydroSimulations 2018a). Every observation in the reporting period recorded the bore as dry.
- All observations at P106 during the reporting period were below the maximum depth-to-water trigger level. It is unlikely that this large apparent decline in groundwater level is related to mining. Dipping the bore for depth and investigating integrity was recommended in HydroSimulations (2018a).
- The groundwater level at GW11 was below the maximum depth-to-water trigger in December 2016. HydroSimulations (2017) concluded that further readings were required to clarify the response at GW11. Readings from February and April 2017 show a recovery to levels approximately 1 m above the maximum depth to water trigger. This is associated with a minor increase in the rainfall trend and indicates that ongoing mining effect is unlikely. A single exceedance of the 90th percentile level was recorded during the reporting period in June 2017 before recovering in August 2017. No mining effect is likely to impact GW11 at this time and no significant dry conditions were recorded between January and June 2017 to induce the observed decline. It is possible an error was made with the groundwater level in June 2017. No mining effect related to the South Bates Underground Mine has been observed at GW11 during 2017 (HydroSimulations 2018b).
- GW12 exhibits an ongoing mining effect from North Wambo Underground longwall extraction, with trigger exceedances observed from April to October 2017 with the bore reported dry. A slight recovery of approximately 0.2 m was observed in December 2017 which indicates a rainfall response despite the long-term trend showing below average conditions. The mining effect observed at GW12 is unlikely to be related to the South Bates Underground Mine (HydroSimulations 2018c).
- GW13 is located on the eastern side of Wollombi Brook about 3 km from WCPL's North Wambo Underground Mine workings. During the reporting period, all observations exceeded the maximum trigger level. These observations confirm the likely impact stated previously in which the progression of the Warkworth open cut induces the decline in groundwater level at GW13.

- P16 is located downstream of the mining operations along the Wollombi Brook and less than a kilometre upstream of the FM10 Wambo flow monitoring site. In 2017, P16 reported six groundwater levels below the maximum depth-to-water trigger. While the declining groundwater levels correlate with a declining rainfall and stage height trend, the observations are the lowest recorded for the entire period of measurement and do not show the same previously observed response to peaks in rainfall and river stage height. P20 is located near P16 and had two groundwater level observations below the maximum depth-to-water trigger in October and December 2017. Groundwater levels at P20 correlate with the long-term rainfall trend and the interpolated Wollombi Brook stage height throughout the period of measurement. A large hydraulic gradient between the river stage and the groundwater level at P16 and P20 is present. It is believed that the alluvial aquifer at P16 and P20 could be disconnected from the Wollombi Brook. Vertical recharge from the river to the alluvial aquifer can occur, however the decrease in the Wollombi Brook stage height induces a reduction in recharge through the unsaturated zone and consequently in the groundwater level at P16 and P20. No mining effects can be identified at P16 and P20, as North Wambo Underground operations have been completed since December 2015, the open cut north of the bores has yet to commence and the nearest longwall at the South Bates Underground Mine (Longwall 13) is 5.2 km away.

No exceedances of triggers for EC or pH occurred during the reporting period (HydroSimulations 2018a).

Hydrographs of observed groundwater levels were reviewed by HydroSimulations in combination with a review of subsidence parameters and WCPL's groundwater model. Additional detail is available in **Appendix F**.

HydroSimulations also conducted an assessment against the performance indicators and relevant subsidence impact performance measures for North Wambo Underground Longwalls 8-10A (HydroSimulations 2018c) and South Bates Underground Longwalls 11-16 (HydroSimulations 2018b).

It was concluded by HydroSimulations (2018c) that the subsidence impact performance measure of *Negligible impact to Wollombi Brook* was upheld for the extraction of North Wambo Underground Longwalls 8-10A.

It was concluded by HydroSimulations (2018b) that the performance indicators for groundwater levels in alluvial bores and flow in Wollombi Brook were exceeded during the reporting period. None of the exceedances of water level of EC can be attributed to mining at the South Bates Underground Mine, and the absence of flow at the FM10 gauging station is unlikely to be attributable to mining at the South Bates Underground Mine unless flows in North Wambo Creek have been captured.

HydroSimulations (2018b) recommends further assessment of flow at Wollombi Brook to identify the cause of zero flow downstream at FM10 when there is measurable flow at FM 11 upstream. This should include analysis of the flows in North Wambo Creek at gauging stations FM2 and FM4 to test whether flow has been reduced below normal levels as a result of mining beneath the North Wambo Creek Diversion.

The observed exceedances of the groundwater level and EC performance indicators did not result in an exceedance of the subsidence impact performance measure of *Negligible impact to Wollombi Brook*.

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

6.2.4 Implemented or Proposed Management Actions

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

HydroSimulations (2018a; 2018b; 2018c) recommended:

- Monthly monitoring of P114 if EC and groundwater level triggers are exceeded during the next measurement.
- Investigation in to the integrity of P106 and whether the ‘dry’ readings are correct for the original drilled depth of the hole.
- Monthly monitoring of the new bore drilled between Longwall 14 and VWP N2 to confirm the groundwater recovery of the Wambo Seam associated with the completion of the North Wambo Underground operations.
- Resurvey of the GW11 collar elevation and dipping at the next bi-monthly observation.
- Replacement bores should be installed for GW08 and GW09 as the groundwater levels have not recovered.
- Further assessment of flows along Wollombi Brook (i.e. to identify the cause of zero flow downstream at FM10 and measurable flow upstream at FM11 during periods of low flow).

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 DI-Water of discharge opportunity must be received;
- Flow of water in Wollombi Brook at the DI-Water Bulga Gauging Station (FM11) needs to be more than 500 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 35 credits under the HRSTS.

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 33.**

Table 33: 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 2017, compared to eleven in 2016, six in 2015, one in 2014 and 27 in 2013. The total volume of water discharged in 2017 (0 ML) was less than 2016 (416 ML), 2015 (140.1 ML), 2014 (9.6 ML) and 2013 (1221.44 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 2015 to 30 June 2016) was submitted to the EPA on 21 August 2017, 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 Water NSW, continued regular calibration of instrumentation and development of operating procedures. During the next reporting period, the procedure will be updated to reflect modifications made to the system and guidelines for a HRSTS audit will be developed and an audit commenced.

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 DPE) in April 2008. A requirement of the approval was to comply with the requirements of the then Department of Water and Energy (now Department of Industry – 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 FM locations:

- FM1, upstream of the NWCD;
- US-FM1, approximately 1 km upstream of FM1 (installed in December 2017);
- 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 (2018) and a summary is provided in **Table 34**. There were no recordable flow events at FM1 (including the backup sensor) or US-FM1 (since its installation in December 2017) during the period 1 February 2017 to 31 January 2018. Flow monitoring data is included in the AECOM report (**Appendix G**).

Table 34: NWCD Discharge Flow Monitoring – 2017

Flow Monitoring Station	No. of Flow Events Recorded	Maximum Stream Height Recorded (m)	Maximum Theoretical Flow Rate Recorded (ML/day)
FM2	6	0.237	20.6
FM3	6	0.281	52.3
FM4	1	0.157	47.5
FM4 (backup sensor)	1	0.175	56

6.5 Water Take

WCPL maintains a variety of Water Access Licences (WALs) under the *Water Management Act 2000* which consist of High, General and Supplementary securities, as detailed in **Table 35**.

During the reporting period, WCPL extracted a total of 139.5 ML of water from the Wollombi Brook under WAL 18437, 210.8 ML of water from the Hunter River under WAL 718 and 672.2 ML from porous rock groundwater sources. As show in **Table 35**, all water take was less than the allowable limits under the relevant WALs.

No water was used for irrigation purposes during the reporting period (from licence 20WA200632).

Table 35: Environmental Performance – Water Take

Licence Number	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	1000 unit shares (high security)	Regulated River (high security)	0	210.8	210.8
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	0	0
WAL 8604 (20BL061206)	Hunter River Pump	Perpetuity	240 unit shares (supplementary water)	Supplementary Water	0	0	0
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	0	139.5	139.5
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	0	0	0
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)							
WAL 39735 (20BL168643)[1]	Dewatering Bore	Perpetuity	40 unit shares	Aquifer	336[2]	584[2]	920[2]
WAL 39738 (20BL132753)[1]	Old Well No. 1	Perpetuity	243 unit shares	Aquifer			
WAL 39803 (20BL166910)[1] (20BL173032)[1] (20BL173033)[1] (20BL173034)[1] (20BL173035)[1]	Dewatering (Bore No. 1)	Perpetuity	450 unit shares	Aquifer			

Licence Number	Description	Expiry Date	Entitlement	Category	Passive take/ inflows (ML)	Active pumping (ML)	Total (ML)
WAL41494 (20BL168017)[1] (20BL172061)[#1] (20BL173040)[1]	Dewatering (Bore No. 2 and 2a)	Perpetuity	750 unit shares	Aquifer			
WAL41532 (20BL172156)[1]	Dewatering	Perpetuity	98 unit shares	Aquifer			
WAL41528 (20BL167738[#1])	Dewatering Bore	11/09/15	57 ML/year	NA			
WAL41520 (20BL173844[1])	Dewatering Bore	Perpetuity	9 unit shares	Aquifer			

\# Renewal lodged prior to expiry.

1. In mid-2015, WCPL applied to the Department of Primary Industries – Water (now DI-Water) to combine all of its groundwater licences that contained an extraction entitlement into a single licence. The purpose of this licence was to streamline mining activities and simplify the reporting of extraction against licensed entitlements. As such, WCPL was licensed to extract a total of 1,647 ML from all groundwater sources under the *Water Act 1912*. This combined licence was confirmed to be active by DI-Water in correspondence received on the 18 February 2016, the status of its' conversion to licences under the *Water Management Act 2000* is yet to be advised by DI-Water.
2. During the next reporting period, an investigation will be made into directly monitoring the groundwater seepage reporting to the underground and open-cut workings.

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 2017 is provided in **Table 36**.

Table 36: 2017 Site Water Balance

Water Sources	Volume (ML)
Hunter River	211
Wollombi Brook	139
United Collieries	31
Rainfall/Runoff	1335
Underground Seepage	584
Open Cut Seepage	336
Total Water Inputs	**2637**
Water Usage	**Volume (ML)**
Dust Suppression	969
CHPP Consumption	1385
Underground	60
United	0
Workshop Water	40
Domestic Usage	2
Total Water Usage	**2457**
Water Loss	**Volume (ML)**
Evaporation – Mine Water & Tailings Dam	625
HRSTS Discharge	0
Seepage	0
Water Balance	**-445**

A total of 211 ML was extracted from the Hunter River and 139 ML was extracted from Wollombi Brook during the reporting period. This is above the EIS forecast annual average extraction volume of 106 ML (Resource Strategies 2003). When combined with water sourced from the United Collieries (31 ML), this brings the total volume of water imported to approximately 14.4% of the total water input. This is higher than the EIS forecast of an average of 2.6% (Resource Strategies 2003) however, this increase is consistent with the identified trend of increases in water imports as coal production increases.

A total of 1,335 ML of runoff from rainfall was intercepted during the reporting period. Underground and open cut seepage represented 22.1% and 12.7% of total supply compared to a forecast of 13.8% and 28.5%, respectively (Resource Strategies 2003).

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

6.8 Erosion and Sediment Control

6.8.1 Management Plan Requirements

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

Version 7 of the ESCP was approved by DPE on 27 November 2015.

6.8.2 Performance during the Reporting Period

During the reporting period, WCPL complied with all requirements detailed in the ESCP (Version 7).

No complaints were received relating to erosion and sediment control in 2017.

6.8.3 Trends and Key Management Implications

Following an incident in January 2016, the ESCP was revised and resubmitted to DPE in March 2016 for approval. The ESCP contains a number of operational changes which will be implemented following approval of the ESCP.

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

6.8.4 Implemented or Proposed Management Actions

During the reporting period, additional contour drains were developed at the Montrose East, Rug Dump and Le Baron rehabilitation areas. The Rug Dump rehabilitated final landform design includes approximately 2.7 km of contour drains, a 250 m long rock lined channel and two sediment basins. Collected water is pumped back into the mine water system.

During 2018, a site wide catchment plan will be developed for the site.

7.0 Rehabilitation

7.1 Rehabilitation Performance during the Reporting Period

7.1.1 Status of Disturbance and Rehabilitation

Proposed rehabilitation and disturbance activities for the reporting period are detailed in WCPL's approved MOP Amendment F (2015-2020) and summarised in **Table 37**.

Table 37: Actual versus Proposed Rehabilitation Activities (2017)

	2017 Proposed	2017 Actual
Total Disturbance (ha)	63.6	69
Total Rehabilitation (ha)	52.9	53[1]
Cumulative Rehabilitation (ha)		620.8

Note: ha = hectares.

1. Consisting of 32.8 ha at Montrose East, 12.7 ha at Rug Dump and 7.5 ha at Le Baron.

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 was 5.4 ha more than the forecast disturbance area and the total rehabilitation undertaken was 0.1 ha more than the forecast rehabilitation area. These discrepancies were due to updates to mine planning and scheduling (as per MOP Amendment F).

On 27 June 2016, WCPL was issued with a condition requiring the development of a rehabilitation strategy for the North East Tailings Dam to the satisfaction of the Minister for Industry, Resources & Energy (for inclusion in a MOP). WCPL finalised and submitted the North East Tailings Dam Rehabilitation Strategy (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 Hunter Pit Tailings Dam (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 kPa up to about 350 kPa (Fitton, 2017).

With the success of the HPTD trial, WCPL are developing a capping design viability 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 ~3m thick as part of the capping final design.

As recommended by WCPL's tailings consultant (Fitton, 2017), Cone Penetration Testing (CPT) will be undertaken to understand 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.

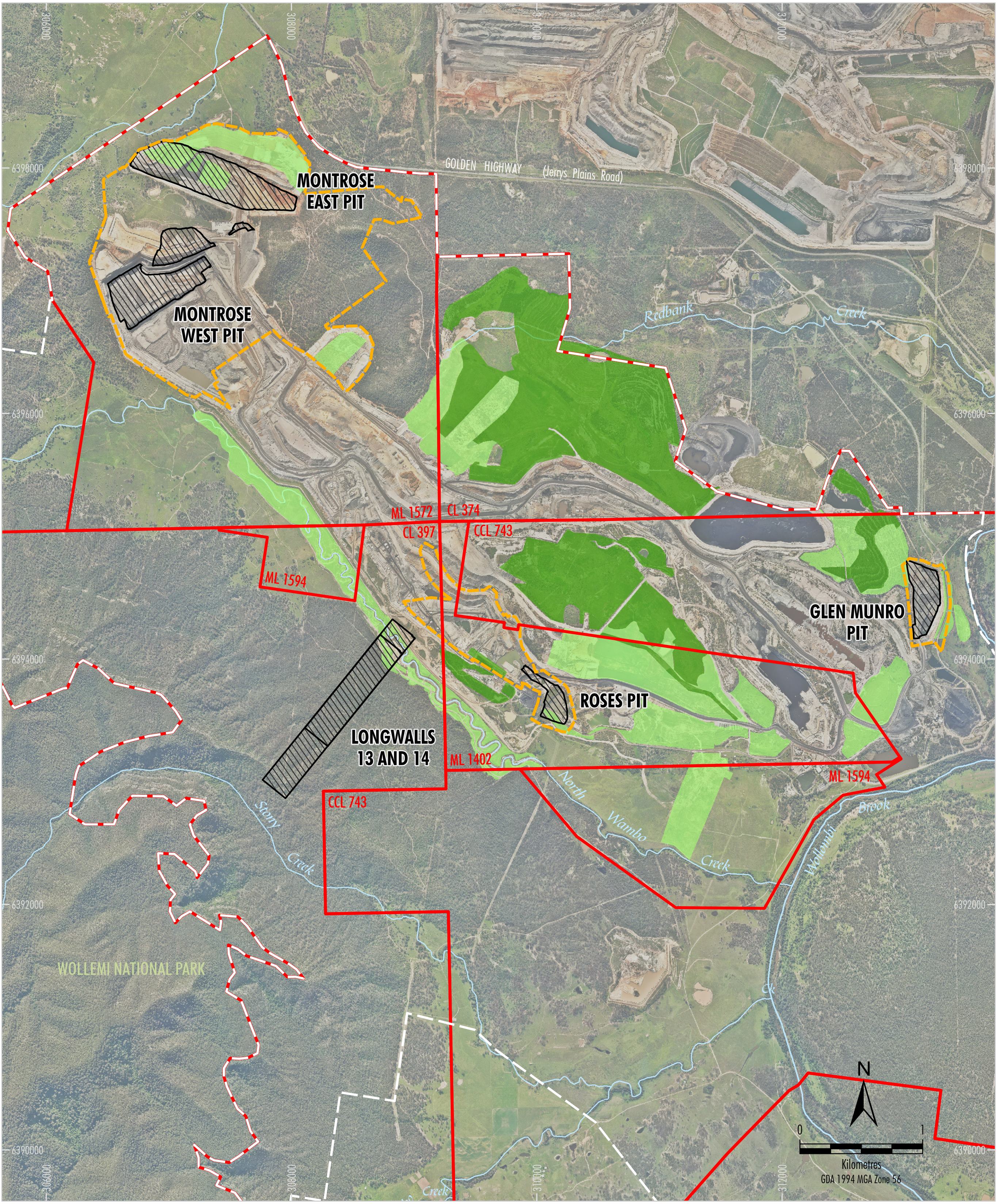
The following is a summary of key project milestones proposed (in the MOP) by WCPL regarding the capping method for both the NETD and HPTD:

- CPT for the NETD and HPTD in July 2017;
- Finalise capping design for NETD and HPTD in August 2017;
- Capping Works – commence intermittent disposal of double flocculated tailings in NETD and HPTD in November 2017; and
- Capping Works – complete intermittent disposal of double flocculated tailings in NETD and HPTD in February 2020.

CPT will commence after the main deposition finishes in the HPTD, scheduled for quarter two 2018. This delay was due to operational concerns with electrical modifications to the CPT and access gear which introduced additional hazards when working on an active emplacement area. It is anticipated that CPT will be complete by quarter three 2018. Following CPT, details regarding capping design and capping works will be finalised.

At the end of the reporting period, WCPL was actively mining in the following areas (as shown on **Figure 12**):

- South Bates Underground Longwall 14 (completed 15 January 2018);
- Montrose West Pit (up to Strip MP28);
- Montrose East Pit (up to Strip MPE03); and
- Roses Pit (up to PR01).



LEGEND
- Mining and Coal Lease Boundary
- DA 305-7-2003 Boundary
- MOP 2015-2020 Amendment F - Extent of Open Cut Mining
- 2017 Indicative Mined Area
- Woodland Corridor
- Mixed Pasture/Woodland

Source: WCPL (2018); © NSW Department of Planning and Environment (2017)
Orthophoto: WCPL (May 2017)

Peabody

WAMBO COAL MINE

Status of Mining and Rehabilitation

Figure 12

7.1.1.1 Montrose East Rehabilitation

Rehabilitation activities at Montrose East (**Figure 13**) were undertaken in two (2) stages during the reporting period. Stage one (1) began with dozer push to final landform in January 2017. Topsoil was delivered from the RL 160 topsoil stockpile location via the Open Cut (OC) Cat truck fleet. Topsoil was then spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer, ripped using a chisel plough and gypsum applied at a rate of 6 tonnes per hectare (t/ha). Organic Growth Medium (OGM) was also applied at a rate of 100 t/ha. Contour drains were installed to manage water drainage to Montrose East Dam 1. The Stage 1 area was seeded in May 2017 with a winter/autumn pasture seed mix. The total area rehabilitated was approximately 18 ha.

The Stage two (2) dozer push began in August 2017. Topsoil was delivered directly from the Montrose East Extension Pit by the OC Cat truck fleet. Topsoil (including mulched vegetation incorporated into the soil as part of the vegetation clearing) was spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer, ripped using a chisel plough, gypsum applied at 6 t/ha and OGM applied at 100 t/ha. Contour drains were installed to manage water to the Montrose East Drop Structure. The Stage 2 area was seeded in December 2017 with a Spring/Summer pasture seed mix that was broadcast by a New Holland tractor. The total area rehabilitated was approximately 14 ha.

During the next reporting period, WCPL will complete the 'Montrose East Drop Structure', which is required to control water from the catchment area, and the light vehicle access boundary road will be narrowed. This area will be seeded with a tree corridor seed mix.

7.1.1.2 Rug Dump Rehabilitation

Rehabilitation of Rug Dump (**Figure 14**) continued during the reporting period with bulk push of overburden material commencing and finishing in September 2017. Final seeding of the area was also completed in September 2017. Topsoil was delivered through a 939 loader and OC Cat truck fleet from topsoil stockpiles located on the Rug Dump. Topsoil was spread by D10 dozers to a depth between 100 mm to 200 mm, trimmed with a D6 dozer and gypsum applied at 6 t/ha. OGM was also applied at 100 t/ha. Contour drains were also constructed on the Rug Dump area. The area was chisel ploughed and the Spring/Summer pasture seed mix was broadcast by New Holland tractor.

During the next reporting period, WCPL will monitor rehabilitation progress as hot and dry conditions were experienced after sowing and the area may need to be re-seeded following substantial rain.

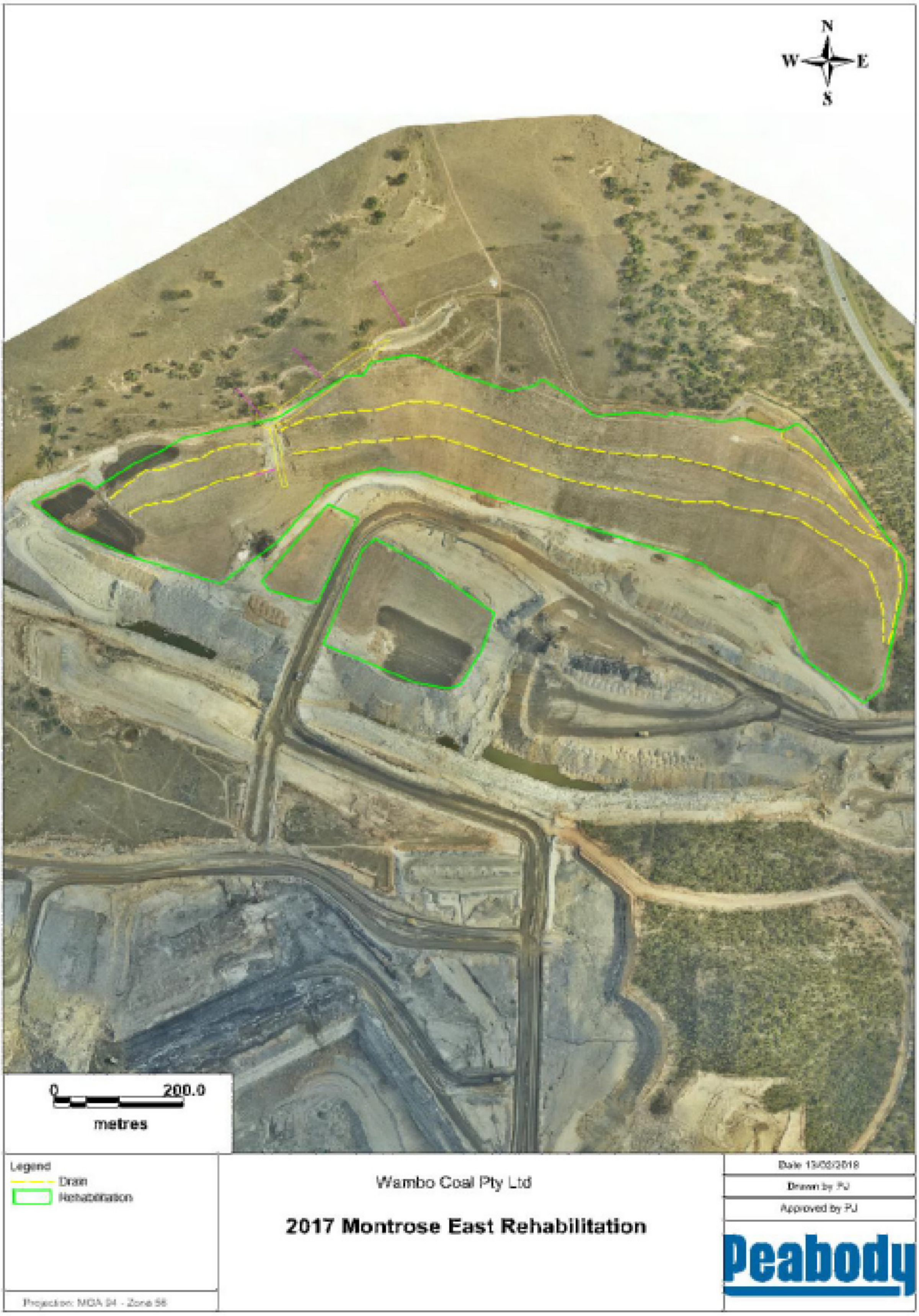


Figure 13: 2017 Montrose East Rehabilitation

Figure 14: 2017 Rug Dump Rehabilitation

7.1.1.3 Le Baron Rehabilitation

Rehabilitation of the Le Baron area (**Figure 15**) during the reporting period included bulk push of overburden material (in August 2017) and final seeding of the area with a Spring/Summer pasture seed mix (in December 2017). Topsoil was delivered directly from the Montrose East Extension Pit by the OC Cat truck fleet. Topsoil (including mulched vegetation incorporated into the soil as part of the vegetation clearing) was spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer, ripped using a chisel plough and gypsum applied at 6t/ha. OGM was also applied at 100t/ha. The area was chisel ploughed and the Spring/Summer pasture seed mix was broadcast by New Holland tractor.

During the next reporting period, WCPL will monitor rehabilitation progress as hot and dry conditions were experienced after sowing and the area may need to be re-seeded following substantial rain.

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 Amendment F (2015-2020). 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 is described in MOP Amendment F (2015-2020).

WCPL's Conceptual Mine Closure Plan (CMCP) will be developed and submitted to DPE for approval following the determination of the United Wambo Open Cut Coal Project (SSD-7142).

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

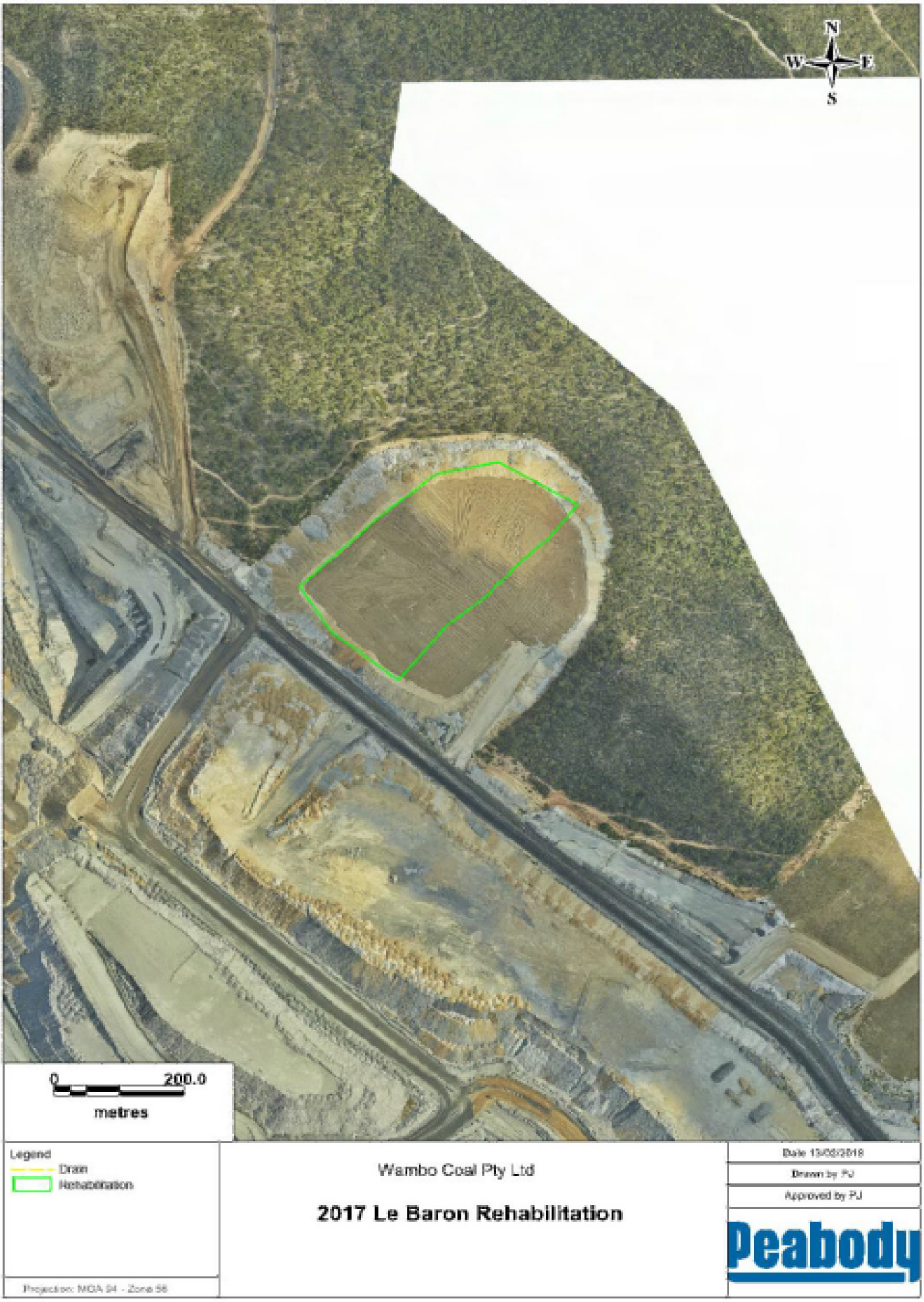


Figure 15: 2017 Le Baron Rehabilitation

7.1.3 Key Rehabilitation Performance Indicators

Table 38 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 2018 is consistent with the scheduled rehabilitation detailed in the MOP (2018-2020).

Table 38: 2017 Rehabilitation Status and Forecast for 2018

Mine Area Type	Previous Reporting Period (Actual) (ha)	This Reporting Period (Actual) (ha)	Next Reporting Period (Forecast) (ha)
A. Total mine footprint[1]	1,755.3	1,881.8	2,000.2
B. Total active disturbance[2]	1,192	1261	1343.1
C. Land being prepared for rehabilitation[3]	0	0	0
D. Land under active rehabilitation[4]	567.8*	620.8	657.1
E. Completed rehabilitation[5]	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 the MOP/Rehabilitation Management Plan [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 the 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 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 DRG that the area has successfully met the rehabilitation land use objectives and completion criteria.

* Land under active rehabilitation for the previous reporting period has been updated from the value previously reported in WCPL's 2016 Annual Review, as more detailed rehabilitation mapping has been undertaken.

7.1.4 Renovation or Removal of Buildings

During the reporting period WCPL undertook repair/maintenance work on an unused building which was then provided to the Country Women's Association (**Section 8.2**). The building was transported from the Mine to Belford.

No other 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 the reporting period. 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 RCE) be completed to accompany the Audit Reports. The ESF2 form was submitted to DRG on 14 December 2017.

7.1.6 Variations in Activities Proposed in the MOP

During the reporting period, rehabilitation was undertaken in accordance with the activities proposed in the approved MOP Amendment F (2015-2020).

7.1.7 Trials, Research Projects and Other Initiatives

During the reporting period, the MOP (2015-2020) was updated (via Amendment E and Amendment F) to:

- Include first workings using underground mining methods of the Whybrow Seam, via the existing South Bates Open Cut (up to 200 m beyond the open cut limits) and the recovery of coal through these non-subsiding first workings.
- Amend the open cut mine plan rehabilitation and disturbance sequences within Montrose East Pit, Montrose Pit and Roses Pit.
- Amend the longwall panel lengths of Longwalls 14, 15 and 16 at the South Bates (Wambo Seam) Underground Mine.
- Describe the revised capping methodology proposed by WCPL for the North East Tailings Dam.
- Revise the completion criteria to align with the revised completion criteria and monitoring program within the approved BioMP.

The following rehabilitation trials were undertaken during the reporting period:

- capping studies of North East Tailings Dam;
- incorporation of organic matter with topsoil material; and
- application of gypsum to improve soil sodicity and structure along NWCD and rehabilitation outcomes.

As described in **Section 7.1.1**, WCPL finalised and submitted the North East Tailings Dam Rehabilitation Strategy to DRE (now DRG) on 21 November 2016. WCPL have since developed a revised design based on feedback received from DRG.

An audit of subsidence impacts was undertaken by SLR Consulting during the reporting period to identify new subsidence impacts over recent mining areas (Longwalls 11 and 12 at the South Bates [Whybrow Seam] 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). During the next reporting period, WCPL will develop a program of works for the remediation of the subsidence impacts identified by the subsidence audit in areas away from active subsidence (**Section 5.9.3**).

7.1.8 Key Issues That May Impact Successful Rehabilitation

Where possible, seeding of revegetation areas has been undertaken following substantial rainfall events, however, poorer than average rainfall for 2017 has impacted on germination and pioneer growth. Revegetation will be assessed in 2018 for areas that require additional seeding.

7.2 Actions for the next reporting period

7.2.1 Final Rehabilitation Outcomes

Completion criteria for rehabilitation on-site have been developed as part of the new BioMP (which replaced the FFMP) and have been incorporated into the latest MOP. These completion criteria were developed using a combined LFA/Biometric monitoring methodology, utilising a combination of site specific analogue sites and DRG developed community benchmarks where analogue sites within the local region are not present.

WCPL's CMCP will be developed and submitted to DPE for approval following the determination of the United Wambo Open Cut Coal Project (SSD-7142).

7.2.2 Rehabilitation Trials, Research Projects and Other Initiatives

The following rehabilitation trials will continue in 2018:

- capping trials of North East Tailings Dam (as described in **Section 7.1.1**);
- incorporation of organic matter with topsoil material;
- subsidence repair trials (based on the program of works being developed by WCPL following the subsidence impact audit); and
- application of gypsum to improve soil sodicity and structure along NWCD and rehabilitation outcomes.

7.2.3 Proposed Rehabilitation in the Next Reporting Period

The following areas, detailed in the MOP (2018-2020), are scheduled for rehabilitation during the next reporting period:

- Montrose East (8.6 ha);
- Baron Zone Dump (16.8 ha);
- RL110 Embankment (3.9 ha);
- Rug Dump (12.9 ha);
- Waterfall Ramp (2.6 ha);
- RL160 Embankment (7.7 ha); and
- Bates South Slip Area (5.56 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 11 April;
- Tuesday 8 August; and
- Monday 11 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 Community Information Sessions

These sessions are an opportunity for local residents to meet senior mine personnel to discuss current and future operations where possible. Advertisements are published in the Singleton Argus and flyers are delivered to the surrounding district to notify interested community stakeholders to attend.

During the reporting period, WCPL conducted a number of open community information sessions.

8.1.3 Newsletters

No newsletters were published by WCPL during the reporting period, however, Glencore published a community newsletter in August 2017 relating to the United Wambo Open Cut Coal Project. This newsletter is available on the Glencore United Wambo Project website (http://www.unitedproject.com.au).

8.1.4 Other Community Engagement Activities

During the reporting period, WCPL also conducted several site visits, including a professional development tour for representatives of the Port Stephens Shire Council and Singleton Shire Council.

8.2 Community Contributions

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

- Donation to subsidise rehabilitation of rescued native fauna;
- Singleton Youth Boxing Sponsorship for 2017;
- Sponsorship of 'Wambo Wolves' charity rugby league team for the Westpac Rescue Charity Knockout Competition;
- Sponsorship of Newcastle Cystic Fibrosis Race Day;
- Sponsorship of the Singleton District Junior Cricket Association;
- Sponsorship of the JPC Cricket Club;
- Sponsorship of the Parents & Citizens (P&C) Christmas party;
- Maintenance Team fundraising through 2017 Mystery Box Rally;
- Outstanding Business Awards – Gold Sponsor (Employer of Choice category);
- Shave for a Cure (Peabody-wide fundraiser); and
- Donation, repair/maintenance and transport of an unused building to the Country Women's Association.

8.3 Community Complaints

WCPL received a total of 70 community complaints for the reporting period, including seven (7) for blasting, forty-nine (49) for noise, five (5) for dust and nine (9) for lighting impacts. In 2017, the number of complaints relating to lighting, dust and blasting remained relatively consistent with 2016, 2015, 2014 and 2013; however, the number of complaints received relating to noise increased (**Figure 16**).

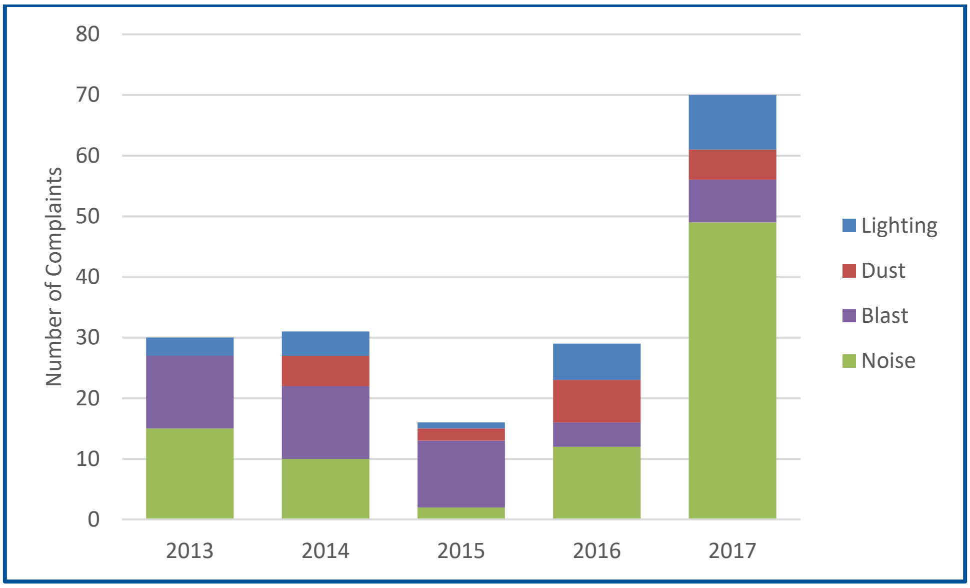


Figure 16: Community Complaints (2013-2017)

Complaints relating to blasting have remained relatively consistent, with seven (7) complaints recorded during 2017 (one [1] for blast fume, four [4] for vibration, one [1] for dust and one [1] general) compared with twelve [12] in 2013 (nine [9] for blast fume and three [3] for noise and vibration), twelve [12] in 2014 (three [3] for blast fume, seven [7] for noise and vibration, one [1] for dust and [1] general), eleven (11) in 2015 (all for vibration) and four (4) in 2016 (three [3] for vibration and one [1] for fume).

The number of noise complaints increased in 2017 when compared to previous years. This is considered to be in response to operations moving closer to sensitive receivers. 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 remained relatively consistent, with five (5) complaints received in 2017, compared with seven (7) in 2016, two (2) in 2015, five (5) in 2014 and zero (0) in 2013.

Throughout 2017, a total of nine (9) complaints were received relating to lighting. This is a slight increase in the number of complaints relating to lighting when compared to previous years, where WCPL received six (6) in 2016, one (1) in 2015, four (4) in 2014 and three (3) in 2013. Similar to the complaints relating to noise, this is considered to be in response to operations moving closer to sensitive receivers. 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 DPE and EPA. A summary of the detailed reports provided to the DPE and EPA in response to the complaints is provided in **Section 10.6**.

Condition 82, Schedule 4 of DA305-7-2003 requires that:

> *82. If a landowner of any dwelling assessed in the EIS as having a high potential visual impact requests the Applicant in writing to investigate ways to minimise the visual impact of the development on his/her dwelling, the Applicant must:*
>
> *(a) within 28 days of receiving this request, commission a suitably qualified person whose appointment has been approved by the Secretary, to investigate ways to minimise the visual impacts of the development on the landowner's dwelling; and*
>
> *(b) give the landowner a copy of the visual impact mitigation report within 14 days of receiving this report.*
>
> *If both parties agree on the measures that should be implemented to minimise the visual impact of the development, then the Applicant shall implement these measures to the satisfaction of the Secretary.*
>
> *If the Applicant and the landowner disagree on the measures that should be implemented to minimise the visual impact of the development, then either party may refer the matter to the Secretary for resolution.*
>
> *If the matter cannot be resolved within 21 days, the Secretary shall refer the matter to an Independent Dispute Resolution Process (see Appendix 2).*

On 7 December 2016, a landholder on Jerrys Plains Road emailed the Senior Compliance Officer of the DPE expressing their concerns arising from the visual impact caused by mining activity related to WCPL's Montrose East Pit arising since 5 November 2016 and requesting that action be taken in accordance with Condition 83, Schedule 4 of DA305-7-2003.

On 20 December 2016, Wambo Coal formally engaged Terras Landscape Architects (Terras) having received confirmation from the DPE that Terras's nominated director was a suitably qualified person to undertake the assessment and reporting.

The visual assessment undertaken by Terras (2017) concluded that, while it was possible to see the mining workings associated with the Montrose East Pit from the landowner's residence, the extent of the impact was not significant. Terras (2017) considered that landscaping efforts (e.g. erection of visual screens) would not result in any measurable benefit given the expected temporary nature of the impact (i.e. less than 12 months) and the time required for the visual screen to grow (e.g. up to five years for any benefit and longer to effect full screening).

Terras (2017) provided the following recommendations:

- A liaison be nominated from WCPL as a single point of contact for the landowner.
- A program of works be prepared that seeks to have the rehabilitation works undertaken in a manner that focuses on "greening" the upper batters of Montrose East Pit (i.e. the portion that the landowner can see from their property) in the shortest possible time so that the most visible portions of the stockpiles are treated first.
- The program of works be explained to the landowner, including an explanation of timeframes particularly in the next twelve months.

WCPL completed all recommendations made by Terras (2017) during the reporting period, with the exception of the rehabilitation works on Montrose East Pit, which are ongoing due to drier weather in 2017.

9.0 Independent Audits

9.1 2015 Independent Environmental Audit for EPBC 2003/1138

An IEA was undertaken by Umwelt in February 2015 to assess compliance against EPBC 2003/1138, the Biodiversity Offset Strategy (BOS) required by DA305-7-2003, and the commitments made in WCPL's FFMP. The audit report was finalised in May 2015 and submitted to DoEE and DPE in accordance with Condition 4 of EPBC 2003/1138 and Condition 50, Schedule 4 of DA305-7-2003. A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

Two (2) non-compliances and 14 recommendations for improvement were identified during the audit. **Table 39** summarises the recommendations from this audit and WCPL's progress against the action plan developed to address these recommendations.

The next IEA for EPBC 2003/1138 and the BOS is due in 2020.

9.2 2015 Independent Environmental Audit for South Bates Underground 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 11-13, in accordance with Condition 37, Schedule 4 of DA305-7-2003.

The report was finalised in June 2015 and submitted to DPE. **Table 40** summarises the recommendations from this audit and WCPL's progress against these recommendations.

9.3 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 41** 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).

9.4 2017 Lighting Audit

In July 2017, an external lighting audit of the Mine was commissioned by WCPL and undertaken by Electrical Projects Australia (2017) to consider the lighting associated with the Mine's surface mining operations, CHPP, train load out facility and general workshop/building lighting throughout the site.

The purpose of the audit was to ensure the Mine complies with *AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting*.

Electrical Projects Australia conducted site inspections on 4 July and 13 July 2017 and undertook a night lighting observation on 13 July 2017.

The audit confirmed that the Mine is compliant with *AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting*, however, Electrical Projects Australia recommended that the following would assist to reduce glare from the main workshop area:

- Use Type C cut-off fittings where possible.
- Aim any other type of fittings downwards below 30 degrees.
- Adjust any lighting that may be operated on a combination of PE cell and time clock or with an after-hours pushbutton facility to reduce use at night (if not required in some areas).

9.5 2017 Independent Environmental Audit

An Independent Environmental Audit (IEA) was undertaken by Hansen Bailey in November and December 2017 to assess compliance against DA305-7-2003 and DA177-8-2004 (as modified). The audit also assessed compliance against EPL529 and ML1572. The audit report was finalised in December 2017 and submitted to DPE in accordance with Condition 7, Schedule 6 of DA305-7-2003. A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

Twenty-one (21) non-compliances, comprised of 17 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. Eight issues were identified as low risk and one issue as medium risk. The report also included 36 recommendations for improvement. **Table 42** summarises the recommendations from this audit and WCPL's progress against these recommendations.

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

9.6 Independent Environmental Audit for South Bates Extension Extraction Plan

Condition 37, Schedule 4 of DA305-7-2003 requires that:

> *37. Prior to seeking approval from the Department for an extraction plan in any coal seam not previously subject to second workings within the relevant longwall domain, unless the Secretary directs otherwise, the Applicant must commission a suitably qualified person, whose appointment has been approved by the Secretary, to conduct an independent audit of the subsidence, surface water, and ground water impacts of the development.*
>
> *…*

"Longwall domain" is defined in DA305-7-2003 as "Areas 1, 2, 3 and 4 as identified in Figure 9 of the document titled South Wambo Underground Mine Modification Environmental Assessment (see condition 2(q) of Schedule 3)".

Based on the above, Wambo Coal considered that an independent audit under Condition 37, Schedule 4 was not required prior to lodgement of an Extraction Plan for the South Bates Extension.

In addition to the above, Wambo Coal considered that an independent audit would not provide additional benefit for the Extraction Plan given the Environmental Assessment for MOD 17 included a comprehensive assessment of subsidence, surface water and groundwater impacts associated with longwalls the subject of the upcoming Extraction Plan.

On 29 January 2018, DPE confirmed that an independent audit under Condition 37, Schedule 4 of DA305-7-2003 would not be required prior to lodgement of an Extraction Plan for the South Bates Extension.

Table 39: Actions from the 2015 IEA for EPBC 2003/1138, the BOS and FFMP

No.	Recommendation	Action Plan Progress
EPBC 2003/1138		
1	Wambo should ensure that approval is sought and granted for all future activities in the RWEP area A. Alternatively, Wambo could seek a general agreement with the Minister for the activities that are permitted within RWEP Area A, without Wambo needing to specifically get approval prior to each activity.	Noted.
2	Wambo should ensure that approval is sought and granted for all future activities in the RWEP areas. Alternatively, Wambo could seek a general agreement with the Minister for the activities that are permitted within RWEP Area A, without Wambo needing to specifically get approval prior to each activity. This agreement may be obtained by revising the FFMP to clearly identify which activities are permitted within the RWEP areas and the environmental controls to manage these activities, and where necessary, the further approvals that need to be obtained. The revised FFMP should be provided to the Minister for approval.	Noted.
3	Prior to undertaking any further activities within the RWEP areas, Wambo should revise the FFMP to clearly identify which activities are permitted within the RWEP areas and the environmental controls to manage these activities, and where necessary, the further approvals that need to be obtained. The revised FFMP should be provided to the Minister for approval.	Complete. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.
Biodiversity Offset Strategy (Conditions 44-50, Schedule 4 of DA305-7-2003)		
4	Update the FFMP to include more specific management measures relating to subsidence impacts in the RWEP areas.	Complete. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.
5	Update the Vegetation Clearance Protocol (VCP) to address the control of weeds during clearing activities.	
6	The FFMP should be revised to include more targeted management strategies for each RWEP area in consideration of the habitat features present.	
7	Complete the annual reviews of the performance of the FFMP.	Complete - Refer **Section 5.6**.
8	Complete future audits within the required timeframe or obtain approval from the Minister for an extension to the timeframe.	Noted.
FFMP		
9	It is recommended that Wambo update site processes/procedures to ensure nesting/breeding times for species known to occur and likely to occur on site are known and considered in the timing of clearing activities.	Completed. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.
10	It is recommended that Wambo install nest boxes and structures in accordance with the FFMP and/or commission an ecological assessment to determine the extent of hollow resources currently occurring in the Wambo land holding, particularly in offset areas and make recommendations regarding the identification of any areas that are low in hollow resources that could therefore benefit from the introduction of nest boxes.	Nest boxes planned for installation in 2018.

No.	Recommendation	Action Plan Progress
11	Wambo should include reporting on the specific flora and fauna management strategies/management measures implemented during the year in each AEMR.	Complete - Refer **Section 5.6**.
12	Wambo should ensure that approval is sought and granted for all future activities in the RWEP area A. Alternatively, Wambo could seek a general agreement with the Minister for the activities that are permitted within RWEP Area A, without Wambo needing to specifically get approval prior to each activity.	Noted.
13	Improve documentation of rehabilitation monitoring processes. Wambo could consider developing an inspection checklist to address the relevant requirements and document corrective actions.	Completed. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.
14	Wambo should complete incident notifications as required of the FFMP. Alternatively, if this was not the intention of the FFMP, the FFMP should be revised to reflect the intended reporting requirements and relevant legislative requirements and the revised FFMP provided to the Ministers for approval.	Completed. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.

Table 40: Actions from the 2015 IEA for South Bates Underground Longwalls 11-13 Extraction Plan

No.	Recommendation	Action Plan Progress
Coal Mine Subsidence		
1	Some minor apparent errors or discrepancies in the LW7 End of Panel Report regarding tilt data should be investigated and rectified for LW7, as well as ensuring that such apparent errors are not present in the later End of Panel reports.	Complete and re-sent to DRE (now DRG).
2	Given the limited amount of multi-seam longwall mining in Australia, it is imperative that the maximum amount of subsidence data is gathered from such operations, and in particular, from Wambo. This data should be used to continue to review existing techniques, and conduct ongoing research to further develop the understanding of such behaviour, in order to improve the prediction algorithms and methodologies available. This should be a priority for future subsidence research, and in particular, the understanding of three seam operations requires significant further research and development, due to the lack of reliable validation data at present. Until such work is conducted, predictions of this type of subsidence behaviour should be regarded with due caution and should include a significant level of conservative assessment.	The Subsidence Monitoring Program for the South Bates Underground Mine has been prepared in consultation with DRE (now DRG).
Surface Water		
3	To meaningfully interpret trends in the monitoring data in terms of the possible impacts of the project on loss of baseflow, water quality measurements need to be coupled with reliable streamflow measurements.	Following the audit, WCPL reviewed its flow gauging stations. As a result, new gauging stations were installed on Stony Creek (and one of its tributaries).
4	The Surface Water Management Plan sets trigger levels, however, there are no actions proposed for when levels are exceeded. If future monitoring indicates that the potential trends identified in this report are statistically significant, an investigation should be undertaken to identify the cause and the potential consequences.	Trigger Action Response Plans (TARPs) are included in WCPL's Surface and Groundwater Response Plan (SGWRP), which forms part of WCPL's Water Management Plan. The SGWRP was updated following this audit. The revised SGWRP was approved by DPE on 27 November 2015.
5	The accuracy of streamflow data is not adequate for assessing changes in low flows through the impacted reaches. The geometry and character of streams is such that the flow rating curves are unlikely to be sufficiently accurate to measure small changes in baseflow. Consideration should be given to installing low flow measuring flumes and undertaking flow gauging to calibrate the rating curves.	Following the audit, WCPL reviewed its flow gauging stations. As a result, new gauging stations were installed on Stony Creek (and one of its tributaries).

No.	Recommendation	Action Plan Progress
6	Areas of subsidence which are not free-draining were observed during the site visit. Water collected in these areas is likely to be lost to evaporation. While the quantity of water involved is probably small, it is not clear that these catchment losses were properly accounted for as part of the previous impact assessment. Areas of standing water should be identified and appropriate actions taken if they are found to be significant.	The EIS (Resource Strategies 2003) predicted that ponding would occur in low-lying areas above the underground mining areas. As part of WCPL's recent modification (MOD 12), existing and predicted topographical depressions have been identified and assessed. In many instances, it is preferable to minimise works to re-grade areas in order to allow drainage of topographic depressions, as such works have the potential to lead to other problems, such as erosion.
7	The available stream cross-sections and long-sections are not adequate for identifying areas potentially impacted by subsidence and designing appropriate mitigation measures. The collection of survey data in the impacted reach should be targeted at collating high quality data in the areas likely to be impacted by subsidence. Consideration should be given to preparing surface level impact maps rather than 1-dimensional cross-sectional strings. This should be complemented by a comprehensive photographic geomorphic field monitoring program to proactively monitor for future damage and the success of mitigation works.	The approved Extraction Plan for the South Bates (Whybrow Seam) Underground Mine included obtaining a detailed photographic geomorphic record and review of 3-dimensional surface level maps for the NWCD in advance of, and following, mining beneath the NWCD (to incorporate the recommendations of this audit). WCPL has commissioned Alluvium Consulting to monitor subsidence impacts on the NWCD.
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.	An investigation into the declining water levels in bores GW08 and GW09 was undertaken during 2015 and reported in the 2015 Annual Review.
9	It is recommended that the groundwater impact assessment criteria be reviewed, and re-defined in terms of the minimum impact considerations described in the Aquifer Interference Policy for highly productive and less productive groundwater.	The SGWRP was updated following this audit. The revised SGWRP was approved by DPE on 27 November 2015.
10	It is further recommended that annual reporting in the AEMR be expanded to include a consideration of longer-term trends or changes, rather than limiting the analysis to the current year's data only	A consideration of longer-term trends and changes in groundwater levels and quality is discussed in **Section 6.2** and **Appendix F**.

Table 41: Actions from the 2016 Rehabilitation Audit

No.	Recommendation	Action Plan Progress
1	Defining rehabilitation activities and who is responsible for doing each activity is a key component of both rehabilitation and maintenance. Roles and responsibilities should be assigned for each rehabilitation activity including maintenance activities. These should be developed in the MOP and communicated to relevant site personnel.	Roles and responsibilities for rehabilitation activities are detailed in the approved MOP. These roles and responsibilities have been communicated to the relevant site personnel.
2	The Initial Post-Establishment Monitoring Checklist or an adapted version of the checklist should be used to confirm and record any deviations from the proposed rehabilitation method/ activities for each rehabilitation area. There is currently no review process to confirm that overburden has been characterised, topsoil tested etc. Characterisation is important to determine amelioration rates.	The Initial Post-Establishment Monitoring Checklist has been developed and will be implemented during the next reporting period to confirm and record any deviations from the proposed rehabilitation method/ activities for each rehabilitation area.
3	The Rehabilitation Register should be reviewed, with information added to bring it up to date and continued to be maintained at least annually.	The Rehabilitation Register will be reviewed annually and updated accordingly.
4	The Topsoil Management Procedure would benefit from the development of a checklist/ ITP with key activities to ensure that requirements are undertaken in accordance with the procedure.	This will be incorporated in the next revision of the Topsoil Management Procedure.
5	Ensure that site personnel with responsibilities for topsoil removal and management are identified and are aware of their role and the need for communication with the Environment and Community Manager (or representative).	Responsibilities have been detailed in the latest version of the Topsoil Management Procedure, and relevant personnel made aware of their responsibilities.
6	Review the topsoil suitability key parameters and testing requirements and update the Topsoils Management Procedure accordingly.	This will be incorporated in the next revision of the Topsoil Management Procedure.
7	Undertake a topsoil audit of existing topsoil stockpiles to establish the volume and condition of stored topsoil. Use this information to prioritise future utilisation of topsoil resource.	An audit of existing topsoil stockpile volumes was undertaken in 2015 and in 2016. The Topsoil Management Procedure requires the condition of topsoil stockpiles to be assessed prior to reuse if the stockpile is greater than five years old.
8	Undertake an internal an audit of topsoil stockpiles and associated documentation to assess if topsoil stockpiles are being managed in accordance with the Topsoil Management Procedure.	An internal audit of topsoil stockpile management will be undertaken during the next reporting period.
9	Review the landform and drainage of existing rehabilitated areas (area at the top RL160) to identify flow paths and ensure that surface water does not enter the mine water system and ensure that water is directed to designed water storage areas.	Revision of landform drainage is ongoing across WCPL with a goal to ensure clean water drainage reports off-site where possible.
10	Construction of landform to the specifications for slope gradient and lengths should be undertaken during landform shaping.	The approved MOP specifies performance indicators and completion criteria for slope gradient and lengths.
11	Review of the current final landform design against water management and erosion performance and update documentation accordingly, as required.	Revision of landform drainage is ongoing across WCPL with a goal to ensure clean water drainage reports off-site where possible.

No.	Recommendation	Action Plan Progress
12	Consider testing soil key parameters prior to reuse of stockpiled soil as the soil parameters will change within the soil over time.	The Topsoil Management Procedure requires an assessment of topsoil quality prior to reuse if a stockpile is greater than five years old.
13	Consider various topsoil depths based on the soil complex to be utilised. Various reuse topsoil depths would be based on pre-stripping topsoil survey.	Topsoil stripping depths are defined in the Topsoil Management Procedure and MOP for various soil types. The MOP requires that topsoil replacement average depths of at least 100 mm.
14	Ensure that the sampling techniques in the Topsoil Management Procedure and the Completion Criteria are consistent and that ranges provided in the Topsoil Management Procedure can be ameliorated or develop/ progress during rehabilitation to meet the Completion Criteria.	The Topsoil Management Procedure and the Completion Criteria are consistent.
15	Floristic and fauna habitat monitoring contained in the Flora and Fauna Management Plan should be referenced in both the MOP.	The MOP includes reference to the monitoring contained within the FFMP (now BioMP).
16	EFA indices should be presented in the annual monitoring report and assessed for each individual transect.	Detailed reporting and analysis of the LFA is provided in the Annual Flora and Fauna Monitoring Report (**Appendix E**). This includes individual analysis for each transect, comparisons against previous monitoring at individual sites and the presentation of historical data to allow the functional status of each transect to be compared between years to establish if the rehabilitation is trending towards a functional system.
17	EFA provides an indicator and should not be averaged across sites. There is more benefit in identifying the ecosystem function of individual sites than vegetation communities. The next annual monitoring report should reflect this.	
18	An EFA indicator should only be compared against indicators from previous monitoring at each individual transect site. The next annual monitoring report should reflect this.	
19	EFA indices should be presented and assessed for each individual transect in the annual monitoring report. The format of the Annual Monitoring Reports for 2006, 2007 and 2008 allows the functional status of each transect to be compared between years to establish if the rehabilitation is trending towards a functional system. Reporting EFA indices in this fashion should be recommenced in future annual monitoring reports.	
20	Weed density trigger added to the TARP and appropriate management response including maintenance spot weed spraying.	The TARP in the MOP includes a trigger for exotic cover and appropriate management measures, including maintaining seasonal weed spraying measures as required by the FFMP (now BioMP).
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.

No.	Recommendation	Action Plan Progress
22	Looking at the indices for each (transect) landscape across various indicators (stability, infiltration and nutrient cycling), it is also possible to detect where problems or weaknesses are occurring and management and maintenance actions are required. The TARP should therefore be used in conjunction with the EFA and floristic and fauna habitat monitoring results to identify management and maintenance actions.	Triggers and actions in MOP Amendment F have been developed based on the LFA and floristic and fauna habitat monitoring detailed in the FFMP (now BioMP).
23	Trigger values should be developed for the seven consequence/ hazards that do not currently have triggers (topsoil chemistry, waste rock chemistry, unable to cap tailings dam, poor establishment, species diversity and composition for woodland corridors and pasture/woodland areas, weeds).	Trigger values have been developed for all consequence/hazards described in the TARP in the MOP.
24	Reference in the MOP should be made to the floristic and fauna habitat monitoring of rehabilitated areas in the Flora and Fauna Management Plan.	The MOP includes reference to the monitoring of rehabilitated areas contained within the FFMP (now BioMP).
25	The rehabilitation monitoring program and TARP should be closely integrated to ensure that monitoring identifies the potential for unsuccessful rehabilitation and triggers appropriate management and maintenance responses.	The TARP in the MOP includes specific reference to the rehabilitation monitoring including triggers for appropriate management and maintenance in the event unsuccessful rehabilitation is identified.
26	Slashing or controlled grazing is recommended for dense monoculture pastures such as those dominated by Rhodes grass. Depending on the length of time the grassland rehabilitation areas have been established and the seed mix used, reseeding with desirable species and/ or tube stock planting could be undertaken.	The status of the monoculture grassland rehabilitation areas will be reviewed and, if suitable, consideration will be given to reseeding with desirable species and/or undertaking tube stock planting.

Table 42: Actions from the 2017 IEA for DA305-7-2003 and DA177-8-2004

No.	Recommendation	Action Plan Progress
Previous Audit Non-compliances		
1	Review actions recommended by previous audit (2014) which have not been completed. Update management plans as required to address recommendations that are relevant to contemporary operations.	Noted.
DA305-7-2003 Non-compliance Recommendations		
2	Recommend that formal written requests to the Secretary are made in the future if consultation with regulators is not intended to be conducted in relation to management plans.	Noted.
3	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 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.
4	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.	Consideration will be given to flood levels in the vicinity of the Hales Crossing sump and pump arrangement. The existing pump may be able to be placed onto a raised platform or relocated.
5	A comparison of the overall site water balance to the EIS predictions should be presented in future Annual Reviews. If the differences between the EIS water management system and operations are such that a meaningful comparison of the predictions is not possible, or the EIS does not provide sufficient detail on the water balance predictions to allow a comparison of the water balance (which looks likely based upon Appendix E of the EIS), this should be acknowledged.	The EIS does not provide sufficient detail on the water balance predictions to allow a comparison of the water balance, therefore no comparison has been included in the Annual Review. A revised Site Water Balance was completed in support of MOD17 to DA305-7-2003.
6	The Annual Reviews do not explicitly forecast compliance with the HRSTS rules. It is recommended that the forecast presented in future Annual Reviews is expanded to explicitly address forecast compliance.	The Annual Review has been updated to include forecast compliance with HRSTS rules (**Section 6.3.4**).
7	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 added to the next revision of the Site Water Management Plan.
8	Letter (c) and (d) in Schedule 3 Condition 2 are located and made publicly available on website.	WCPL is unable to locate these documents.
DA305-7-2003 Continual Improvement Recommendations		
9	It is recommended that details of any exceedances are explained in the Annual Reviews. This includes referencing any local bushfires/RFS activity/extreme weather events that may have been the cause.	Agreed.

No.	Recommendation	Action Plan Progress
10	As soon as possible, investigate and remedy the likely calibration error for the overpressure microphone on the Thelander blast monitor, which developed in August 2017 after the last calibration check in July 2017. WCPL completed this after the site visit and prior to the finalisation of this report.	Complete.
11	Monitoring results for the period 23/2/2017 to 29/3/2017 were reported incorrectly (overpressure and vibration levels were swapped in the results table). Recommend that monitoring data is checked monthly to ensure results are reported correctly.	WCPL has improved its data management with the implementation of the Equis database and repository of results.
12	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.
13	Seek written approval for blasting within 500 m of Crown and HVO land before blasting within 500 m of this land in the next audit period.	Noted. Blasting is scheduled within 500m of privately owned land early 2018. WCPL has commenced consultation and the development of this procedure. Once completed, the Procedure will form part of the BMP and will be submitted to DPE for approval.
14	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.	HydroSimulations will consider this recommendation in 2018.
15	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 was completed in support of MOD17 to DA305-7-2003 and the results added to the next revision of the Site Water Management Plan. Monitoring will be proposed in the next revision to the SWMP.
16	The GWMP should be updated with the suggestions provided by NSW Government subsequent to approval of the GWMP in November 2015 and resubmitted. Updates should include: • A more contemporary reference to groundwater sampling techniques; • Amendment of the text relating to purging of groundwater bores to be consistent with the latest guidelines; • Outline the methods of water quality data upload from the laboratory; • The bore labels in Figure 7 need to be clear for all bores; and • General update of text relating to historical or proposed activities.	These changes will be made during the next revision of the GWMP.

No.	Recommendation	Action Plan Progress
17	It is recommended that section 2.2.16 of the Site Water Management Plan is improved by providing a high level strategy for the decommissioning of water management structures (including the management of water during the decommissioning process) as part of any future update of the Site Water Management Plan.	A high level discussion will be added to the SWMP during its next revision, consistent with the MOP.
18	Update GWMP to include Montrose Dam prior to its construction.	The timing for the construction of Montrose Dam is to be confirmed. Montrose Dam will be added to the GWMP prior to construction.
19	Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open-cut workings	HydroSimulations will consider this recommendation in 2018.
20	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 will contact OEH and seek to finalise the conservation agreement for Offset Area E. An extension to the timing to 31 July 2018 was granted by DPE.
21	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 TSC Act 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 re carried out.
22	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 on 7 November 2005. WCPL will seek to recover this contribution.
23	Aerial on page 8 of the induction should be updated to be current.	A copy of the 2017 aerial has been provided for the induction.
24	Site 3 and site 9 non-indigenous heritage items should be identified in the field. Then correspondence as required in the condition should occur to close out this item.	Site 3 is identified as abandoned Homestead A and Site 9 is abandoned Tractor. An assessment will be made as to the significance of these items and as to whether they are moveable. This information will be documented in the next review of the Cultural Heritage Management Plan, scheduled for 2018. Correspondence will be drafted to the Power House Museum to advise the outcome and close out this item.

No.	Recommendation	Action Plan Progress
25	Provide a more recent notification to owners of private residences of right to visual mitigation under consent condition.	Condition 83, Schedule 4 of DA305-7-2003 requires '*if a landowner of any dwelling assessed as having a high potential visual impact requests in writing.. to investigate ways to minimise the visual impact of the development on his/her dwelling*…' Table 4.4 in the EIS identifies Holt, Moses, Muller and Fenwick and subsequent text includes Skinner and Long as residences with high visual impacts. Fenwick and Muller are the only properties that remain privately owned. Correspondence will be sent to these landowners to advise of their rights under Condition 83, Schedule 4 by 30 June 2018.
26	The Annual Review for 2016 reports 6 lighting complaints for the period however only 5 are reported in the register. Recommend that all complaints are reported correctly in future.	Noted.
27	Woodland corridors in the RL 160 dump areas are developed further to join the existing areas and the MOP is amended at next review to show proposed and defined corridors.	The establishment of woodland corridors is an important component of the biodiversity and offset strategy. MOP Plan 2 (*Mine Domains at Commencement of MOP*) shows the rehabilitation corridors.
28	Notification to landowners of the publication of management documents and monitoring results on the website is updated at regular intervals (suggested 4-5 yearly).	Agreed.
29	Once the revised EMS is approved it must be sent to the relevant agencies, Council and CCC within 14 days.	Agreed.
DA177-8-2004 Non-compliance Recommendations		
30	Correspondence should be sought from RMS confirming that upgrades to the Golden Highway/Wallaby Scrub Road intersection are not required.	Mt Thorley Warkworth (MTW) has received DPE approval to mine through Wallaby Scrub Road. There has been ongoing correspondence between WCPL and RMS on this issue which will be finalised once MTW plans are known.
DA177-8-2004 Continual Improvement Recommendations		
31	No evidence of reporting on measures to minimise loading outside specified hours to DPE's approval. Recommended that a summary of train movement times is added to future Annual Reviews.	A summary of train movement times will be added to the next Annual Review.
32	Reviewed 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.

No.	Recommendation	Action Plan Progress
33	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 (not in the Modification currently being assessed).
34	Confirmation from DPE should be sought in future to confirm this condition is not required to be triggered.	The Air AQGGMP (Version 7, currently with DPE for approval) 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 DPE if deemed necessary.
Other		
35	It is recommended that the road drain outside the coal stockpile perimeter collection drainage network be de-silted and monitored to confirm whether the flow direction of the drain is adequate.	WCPL has engaged consultants to review catchment drainage and boundaries and assess the efficiency of drains and sediment dams in each catchment. Any sediment dams or road drains identified to be undersized or in need of de-silting (including the Gordon Below Franklin Dam) will be actioned appropriately.
36	It is recommended that accumulated sediment is removed from the Gordon Below Franklin where necessary in order to reinstate the design/operating storage capacity.	

10.0 Incidents and Non-compliances during the Reporting Period

No incidents were identified by WCPL during the reporting period.

Five (5) non-compliances were recorded by WCPL during the reporting period. These non-compliances were recorded against EPL529 and DA305-7-2003 (refer **Statement of Compliance** at the front of this document) and related to the following events:

- Administrative non-compliance with the night-time noise impact assessment criteria (**Section 10.1**);
- Delayed preparation of reports on the results of blasting within 2 km of the WHC (**Section 10.2**);
- Failure to continuously monitor PM_{10} levels at one site (**Section 10.3**);
- Failure to continuously monitor weather conditions (**Section 10.4**); and
- Hardware failure leading to inaccurate Electrical Conductivity readings (**Section 10.5**).

In addition to the above, DPE 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 DPE and/or EPA (**Section 10.6**).

10.1 Night-time Noise Impact Assessment Criteria

During the reporting period, WCPL complied with all statutory noise conditions and requirements detailed in the WCPL NMP, with the exception of an administrative non-compliance with the night-time noise impact assessment criteria.

Monitoring during the reporting period was undertaken in accordance with the WCPL NMP. Noise levels from the Mine complied with the relevant criteria at all sites during attended monitoring in Quarter 1 and Quarter 4, 2017. The following exceedances were measured by Global Acoustics (2018) during attended monitoring in Quarter 2 and Quarter 3, 2017:

- On 13 June 2017 at 22:40, the Mine exceeded the $L_{Aeq,15minute}$ criterion at N16 by 1 dB. An exhaust, engine and fan continuum from the Mine was audible during the measurement, generating a site only L_{Aeq} of 41 dB (which exceeded the criteria of 40 dB). A surge in engine noise generated a $L_{A1,1minute}$ of 49 dB (which did not exceed the criteria of 50 dB). The Open Cut Examiner (OCE) was contacted at the completion of this measurement and advised of elevated levels. The OCE advised that an excavator working in an exposed area had ceased operation. A remeasure was then undertaken with resulting levels below the relevant limits.

- On 28 August 2017 at 22:41, the Mine exceeded the $L_{Aeq,15minute}$ and $L_{A1,1minute}$ criteria at N16 by 1 dB respectively. An engine continuum from the Mine was audible throughout the measurement. Track noise, equipment scrape, squeal and whine, rear dump truck transmission noise and quackers were also noted. These sources generated a site only L_{Aeq} of 41 dB (which exceeded the criteria of 40 dB). Equipment whine generated a site only $L_{A1,1minute}$ of 51 dB (which exceeded the criteria of 50 dB). As the Mine only levels were greater than the L_{Aeq} and $L_{A1,1minute}$ criteria, the CHPP Control Room was contacted in accordance with the exceedance procedure. A remeasure was then undertaken with resulting levels below the relevant limits.

While the measured noise levels exceeded the noise impact assessment criteria, WCPL considers that these results are not non-compliances with the conditions of DA305-7-2003. The exceedances were not sustained, and, in accordance with the Industrial Noise Policy, as they were only 1 dB over the criteria, they would be considered negligible (i.e. unlikely to be noticed by residents). It is also noted that no complaints were received by WCPL relating to noise levels around these times and the IEA conducted by Hansen Bailey (2017) considered these exceedances to be administrative non-compliances.

On both occasions the DPE and EPA were notified of the exceedances.

10.2 Preparation of Reports on Monitoring Results for Blasting

Condition 65, Schedule 4 of DA305-7-2003 requires that:

> *65. The approved structural engineer is to report to the Applicant on the monitoring results each month for blasting within 2 km of the Wambo Homestead Complex and 6 monthly for the remainder of the open cut mining operation and make recommendations to ensure the conservation and prevention of damage to the significant heritage structures. Copies of these reports are to be forwarded to the NSW Heritage Office.*

Blasting within 2 km of the WHC occurred on 12 October, 18 October, 24 November and 15 December 2017.

The approved structural engineer has reported on the monitoring results to WCPL for the blast on 12 October 2017 (Bill Jordan & Associates 2017a) and for the period January to June 2017 (Bill Jordan & Associates 2017b). Copies of these reports will be forwarded to the NSW Heritage Office.

Reports have not yet been prepared for the blasts on 18 October, 24 November and 15 December 2017. A report covering the July – December 2017 period (which will include consideration of the blasts that were within 2 km of the WHC) is currently in preparation.

Copies of the six monthly and monthly reports on blasting within 2 km of the WHC will be forwarded to the NSW Heritage Office during the next reporting period.

10.3 PM_{10} Monitoring

During the reporting period a PM_{10} reading was missed three times.

During these missed events, WCPL's three other PM_{10} monitors captured all data. This equates to a 99% capture rate for the PM_{10} monitoring system. At no point during the monitoring period was more than one monitoring point down. Failure to capture data can be attributed to an intermittent fault with the uninterruptible power supply of the PM03 monitor.

10.4 Monitoring of Weather Conditions

Due to software issues, weather monitoring measurements were not able to be collected for a period between 1 February and 3 February 2017. This is considered to be a non-compliance with Condition M4.1 of EPL529.

Weather data for this period was obtained from an adjacent mine to supplement WCPL's data records.

10.5 Inaccurate Electrical Conductivity Readings

Due to hardware failures, inaccurate electrical conductivity readings were taken from EPL Monitoring Point 7 (GW12, GW13, GW17 and P301) in February 2017. This is considered to be a non-compliance with Condition M2.3 of EPL529.

The non-compliance was rectified by changing the environmental monitoring service provider and reviewing monitoring equipment.

10.6 Requests for Information

During the reporting period, requests for information were made by DPE and EPA following a number of complaints received by WCPL (**Section 8.3**). A summary of the complaints made and information requests is provided in **Table 43**.

Table 43: DPE and EPA Requests for Information

Date of Complaint	Relevant Agency	Category	Comment
Noise			
6 April	EPA	Noise	The EPA received eighteen (18) complaints relating to noise from the Mine during the reporting period. On each occasion, the EPA advised WCPL of the complaint and requested WCPL investigate and provide a response. WCPL undertook a detailed review of monitoring data and operations at the time of each complaint including: • Results from the real time noise monitoring network (recorded every 15 minutes). • Review of audio recordings to interpret contributing noise sources at the time of the complaint. • Results from the meteorological station (recorded every 15 minutes). • Operational activities (e.g. locations of active excavators/dozers, blasting times). • Management activities (e.g. shutdown or relocation of equipment, recent communications at pre-start meetings, planning). The results of the review were reported to the EPA.
18 April	EPA	Noise	
18 April	EPA	Noise	
20 April	EPA	Noise	
22 April	EPA	Noise	
7 May	DPE	Noise	
19 May	DPE & EPA	Noise	
28 May	DPE & EPA	Noise	
5 June	EPA	Noise	
5 June	EPA	Noise	
11 June	DPE	Noise	
11 June	EPA	Noise	
14 June	EPA	Noise	
15 June	EPA	Noise	
16 June	EPA	Noise	
9 September	EPA	Noise	
17 September	EPA	Noise	
26 September	EPA	Noise	
Dust			
26 September	EPA	Dust	The EPA received two (2) complaints relating to dust from the Mine during the reporting period. On each occasion, the EPA advised WCPL of the complaint and requested WCPL investigate and provide a response. WCPL undertook a detailed review of monitoring data and operations at the time of each complaint including: • Results from the real time PM_{10} monitoring network (recorded every 15 minutes). • Recent rainfall. • Results from the meteorological station (recorded every 15 minutes). • Operational activities (e.g. locations of active excavators/dozers, water cart activities, blasting times). • Management activities (e.g. shutdown or relocation of equipment, recent communications at pre-start meetings, planning). The results of the review were reported to the EPA.
16 October	EPA	Dust	
Blasting			
20 October	EPA	Blasting	The EPA received one (1) complaint relating to blasting from the Mine during the reporting period. On this occasion, the EPA advised WCPL of the complaint and requested WCPL investigate and provide a response. WCPL undertook a review of blast times on the date of the complaint and concluded that no corresponding blast was undertaken (i.e. two blasts were initiated by WCPL on 20 October 2017, both after the time of the complaint). The results of the review were reported to the EPA.

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:

- A program of works for the repair of subsidence impacts identified by the audit will be developed based on the outcomes of the subsidence repair trials.
- Copies of the six monthly and monthly reports on blasting within 2 km of the WHC will be sent to the NSW Heritage Office.
- An Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 will be prepared and submitted.
- The remaining 11 exploration holes will be inspected to determine rehabilitation status.
- The 'Montrose East Drop Structure', which is required to control water from the catchment area, will be completed and the light vehicle access boundary road will be narrowed (this area will be seeded with a tree corridor seed mix).
- Rehabilitation progress will be monitored as hot and dry conditions were experienced after sowing and the area may need to be re-seeded following substantial rain.
- The Initial Post-Establishment Monitoring Checklist will be implemented to confirm and record any deviations from the proposed rehabilitation method/ activities for each rehabilitation area.
- An internal audit of topsoil stockpile management will be undertaken.
- Works associated with the NETDRS will continue. CPT will commence after the main deposition finishes in the 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.
- The following management plans and strategies will be finalised:
  - Bushfire Management Plan;
  - Environmental Management Strategy;
  - Conservation Management Plan (European) for the WHC; and
  - Site Water Management Plan.

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

- AECOM, 2018. *Report on stream flow events along North Wambo, South Wambo and Stony Creeks for the period 1 February 2017 to 31 January 2018.*
- Australian and New Zealand Environment and Conservation Council, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Canberra.
- Bill Jordan & Associates, 2017a. *Wambo Homestead Blasting – Event of 12 October 2017*.
- Bill Jordan & Associates, 2017b. *Wambo Homestead: Review of ground vibration records, January 2017 to June 2017*.
- Eco Logical Australia Pty Ltd, 2018a. *Wambo Coal Mine Annual Flora and Fauna Monitoring Report 2016 – Volume 1.* Prepared for Wambo Coal Pty Ltd.
- Eco Logical Australia Pty Ltd, 2018b. *Addendum to Wambo Coal Mine Annual Flora and Fauna Monitoring, 2017 – Subsidence Impacts*. Report prepared for Wambo Coal Pty Ltd, 7 March 2018.
- Electrical Projects Australia, 2017. *External Lighting Audit for Wambo Coal – Surface Operations*. July 2017.
- Fitton Tailings Consultants Pty Ltd, 2017. *Secondary Flocculation Capping Assessment for Wambo Tailings Storages (May 2017)*.
- GHD, 2016. *Wambo Coal Rehabilitation Audit – Audit Report.* June 2016.
- Global Acoustics, 2018. *Wambo Coal Mine Annual report – Environmental Noise Monitoring 1 January 2017 to 31 December 2017*. Prepared for Wambo Coal Pty Ltd. Report No. 18005_R01. 8 February 2018.
- Hansen Bailey, 2017. *Wambo Coal Mine and Rail Loop Independent Environmental Audit Report.* 7 December 2017.
- HydroSimulations, 2014. *North Wambo Underground Longwall 10A Modification Groundwater Assessment*. Report prepared for Wambo Coal Pty Ltd.
- HydroSimulations, 2017. *Wambo Annual Review Groundwater Analysis*. Report No. HS2017/07. March 2017.
- HydroSimulations, 2018a. *Wambo Annual Review Groundwater Analysis*. Report No. WAM018 – Report HS2018/10. 7 March 2018.
- HydroSimulations, 2018b. *Compliance with Subsidence Performance Measure in the South Bates Underground Mine Extraction Plan – Longwalls 11 to 63).* Report HS2018/11. March 2018.
- HydroSimulations, 2018c. *Compliance with Subsidence Performance Measure in the NWU Extraction Plan (LW8-10A).* Report HS2018/12. March 2017.
- Jacobs, 2018. *Wambo Mine 2017 Air Quality Review.* 12 February 2018.
- Jansen, A, *et. al.*, 2005. *Rapid Appraisal of Riparian Condition, Version 2*. River Management Technical Guideline No. 4A, Land & Water Australia, Canberra.
- Mine Subsidence Engineering Consultants, 2017a. *North Wambo Underground Mine: Subsidence Review Report for WMLW8A to WMLW10A*.
- Mine Subsidence Engineering Consultants, 2017b. *South Bates Underground Mine: Subsidence Review Report for South Bates WYLW13*.

- New South Wales Department of Planning and Environment, 2015. *Post-approval requirements for State significant mining developments – Annual Review Guideline – October 2015.*
- Niche Environment and Heritage, 2016. *Annual Environmental Reporting 2016 – Aquatic Ecosystem Monitoring.* Prepared for Peabody Energy – Wambo Coal Pty Ltd. October 2016.
- Resource Strategies, 2003. *Wambo Development Project Environmental Impact Statement.* Prepared for Wambo Coal Pty Ltd. July 2003.
- Rural & Environmental Management Pty Ltd, 2017a. *Wambo Coal Summer Vertebrate Pest Management Report: For Vertebrate Pest Management undertaken between 17 February and 3 March 2017*. Report prepared for Wambo Coal Pty Ltd. March 2017.
- Rural & Environmental Management Pty Ltd, 2017b. *Wambo Coal Spring Vertebrate Pest Management Report: For Vertebrate Pest Management undertaken between 5 September to 19 September 2017*. Report prepared for Wambo Coal Pty Ltd. March 2017.
- Rural & Environmental Management Pty Ltd, 2018. *Weed Management Services 2017 Summary.* Report prepared for Wambo Coal Pty Ltd. February 2018.
- SLR Consulting Pty Ltd, 2017. *Wambo Baseline Subsidence Survey*.
- Terras Landscape Architects, 2017. *Visual Mitigation Report Wambo Coal – Montrose East Pit*. Report prepared February 2017.

APPENDIX A

APPROVAL CONDITIONS SPECIFICALLY RELATING TO THE ANNUAL REVIEW

Approval	Condition	Description	Where addressed in Annual Review
DA305-7-2003	Condition 25, Schedule 4	Each year, the Applicant must: (a) review the site water balance for the development against the predictions in the EIS; (b) re-calculate the site water balance for the development; (c) assess current and forecast compliance with the rules of the Hunter River Salinity Trading Scheme; and (d) report the results in the Annual Review.	Sections 6.3.4 and 6.7
DA305-7-2003	Condition 49, Schedule 4	The Applicant must: (a) review the performance of the Flora and Fauna Management Plan annually, in consultation with the Hunter Coalfield Flora & Fauna Advisory Committee (when established); and (b) revise the document as necessary to take into account any recommendations from the annual review.	Section 5.6
DA305-7-2003	Condition 78, Schedule 4	The Applicant must: (a) keep records of the: - amount of coal transported from the site each year; and - number of coal haulage truck movements generated each day by the development; and (b) include these records in the Annual Review.	Section 3.1
DA305-7-2003	Condition 86, Schedule 4	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; (c) report on greenhouse gas monitoring and abatement measures in the Annual Review, to the satisfaction of the Secretary.	Section 5.4
DA305-7-2003	Condition 88, Schedule 4	For the life of the development, the Applicant must: (a) monitor the amount of waste generated by the development; (b) investigate ways to minimise waste generated by the development; (c) implement reasonable and feasible measures to minimise waste generated by the development; and (d) report on waste management and minimisation in the Annual Review, to the satisfaction of the Secretary.	Section 5.11

Approval	Condition	Description	Where addressed in Annual Review
DA305-7-2003	Condition 5, Schedule 6	By the end of March each year, the Applicant must submit a report to the Department reviewing the environmental performance of the development to the satisfaction of the 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, which includes a comparison of these results against: - the relevant statutory requirements, limits or performance measures/criteria; - the monitoring results of previous years; and - the relevant predictions in the EIS; (c) identify any non-compliance over the previous calendar year, and describe what actions were (or are being) taken to ensure compliance; (d) identify any trends in the monitoring data over the life of the development; (e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and (f) describe what measures will be implemented over the current calendar year to improve the environmental performance of the development.	This Annual Review
DA305-7-2003	Condition 6, Schedule 6	Within 3 months of: (a) the submission of an annual review under Condition 5 above; … the Applicant must review, and if necessary revise, the strategies, plans, and programs required under this consent to the satisfaction of the Secretary.	Section 2.3
DA305-7-2003	Condition 12, Schedule 6	From the end of June 2011, the Applicant shall: (a) make copies of the following publicly available on its website: - … - the annual reviews of the development; - ...; and (b) keep this information up-to-date, to the satisfaction of the Secretary.	Section 1.0

Approval	Condition	Description	Where addressed in Annual Review
DA177-8-2004	Condition 4, Schedule 5	If the independent review determines that any relevant criteria in schedule 4 are being exceeded, but that more than one mine is responsible for this non-compliance, then together with the relevant mine/s, the Applicant shall: (a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent person, and conduct further monitoring until there is compliance with the relevant criteria; or (b) secure a written agreement with the landowner and other relevant mines to allow exceedances of the relevant criteria, to the satisfaction of the Director-General. If the independent review determines that any relevant acquisition criteria in schedule 4 are being exceeded, but that more than one mine is responsible for this non-compliance, then upon receiving a written request from the landowner, the Applicant shall acquire all or part of the landowner's land on as equitable a basis as possible with the relevant mine/s, in accordance with the procedures in conditions 6-7 below.	Section 9.6
DA177-8-2004	Condition 4, Schedule 6	Within 1 year of the date of this consent, and annually thereafter, the Applicant shall submit an Annual Review on the development to the Director-General and relevant agencies. This report must: (a) identify the standards and performance measures that apply to the development; (b) include a summary of the complaints received during the last year, and compare this to the complaints received in previous years; (c) include a summary of the monitoring results on the development during the last year; (d) include an accurate record of the amount of product coal transported on the development over the last year on a weekly basis; (e) include an analysis of these monitoring results against the relevant: - impact assessment criteria; - monitoring results from previous years; and - predictions in the SEE; (f) identify any trends in the monitoring over the life of the development; (g) identify any non-compliance during the last year; and, if necessary, (h) describe what actions were, or are being taken, to ensure compliance.	This Annual Review

Approval	Condition	Description	Where addressed in Annual Review
DA177-8-2004	Condition 8, Schedule 6	From 31 May 2012, the Applicant shall: (a) make copies of the following publicly available on its website: … - the annual reviews (over the last 5 years); …; and (b) keep this information up-to-date, to the satisfaction of the Director-General.	Section 1.0
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 H
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 7.1.7 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 in Annual Review
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

Approval	Condition	Description	Where addressed in Annual Review
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

ANNUAL NOISE MONITORING REPORT

Wambo Coal Mine
Annual Report

Environmental Noise Monitoring
1 January to 31 December 2017

Prepared for
Wambo Coal Pty Limited

Global Acoustics

Noise and Vibration Analysis and Solutions

Global Acoustics Pty Ltd
PO Box 3115 | Thornton NSW 2322
Telephone +61 2 4966 4333
Email global@globalacoustics.com.au
ABN 94 094 985 734

Wambo Coal Mine – Annual Report

Environmental Noise Monitoring
1 January to 31 December 2017

Reference: 18005_R01
Report date: 8 February 2018

Prepared for

Wambo Coal Pty Limited
PMB 1
Singleton NSW 2330

Prepared by

Global Acoustics Pty Ltd
PO Box 3115
Thornton NSW 2322

Prepared:	Robert Kirwan Acoustics Consultant	QA Review:	Amanda Borserio Acoustics 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 a summary of the monthly environmental noise surveys conducted around Wambo Coal Mine (WCM), and the Wambo Coal Rail Spur (WCRS) from 1 January to 31 December 2017. The mine and spur operate under separate development consents and have been monitored separately. Reporting, however, has been combined in this document.

WCM was granted consent (DA 305-7-2003) in February 2004, which enables the extension of current open cut and underground mining operations. The latest modification to this consent was approved in December 2017.

The WCRS consists of two Development Applications (DA's):

- The Wambo Rail Loop (DA 177-8-2004); and
- The Wambo Rail Line (DA 235/97).

The relevant sections of these consents are reproduced in Appendix A.

The *Wambo Coal Environmental Management System, Noise Monitoring Plan* (EMP011, February 2014) was prepared in accordance with Schedule 4 of both consents. The Noise Monitoring Plan (NMP) indicates that monitoring will be conducted for WCM and WCRS activities, and the noise levels to be used for assessment.

Attended environmental noise monitoring described in this report was undertaken at four sites on a one night per month basis during 2017. The survey purpose was to quantify and describe the existing acoustic environment around WCM and WCRS and compare results with relevant development consent conditions.

Noise levels from WCM complied with the relevant criteria at all sites during Quarter 1 and 4, 2017 attended monitoring. The following exceedances were measured during Quarter 2 and 3, 2017:

- On 13 June 2017 at 22:40, WCM exceeded the $L_{Aeq,15minute}$ criterion at N16 by 1 dB. An exhaust, engine and fan continuum from WCM was audible during the measurement, generating a site only L_{Aeq} of 41 dB. A surge in engine noise generated the $L_{A1,1minute}$ of 49 dB. The OCE was contacted at the completion of this measurement and advised of elevated levels. The OCE advised that an excavator working in an exposed area had ceased operation. A remeasure was then undertaken with resulting levels below the relevant limits.
- On 28 August 2017 at 22:41, WCM exceeded the $L_{Aeq,15minute}$ and $L_{A1,1minute}$ criteria at N16 by 1 dB respectively. An engine continuum from WCM was audible throughout the measurement. Track noise, equipment scrape, squeal and whine, rear dump truck transmission noise and quackers were also noted. These sources generated a site only L_{Aeq} of 41 dB. Equipment whine generated the site only $L_{A1,1minute}$ of 51 dB. As WCM only levels were greater than the L_{Aeq} and $L_{A1,1minute}$ criteria, WCM's CHPP Control Room was contacted in accordance with the exceedance procedure. A remeasure was then undertaken with resulting levels below the relevant

limits.

It is noted that wind speeds and/or temperature inversion conditions were at levels greater than which development consent conditions would apply for WCM and WCRS activities in some instances.

There have been no significant changes in noise level trends over the past three years.

Predicted noise levels from Year 9 were compared against actual noise levels measured during 2017. Results of the comparison indicate that meteorological conditions included in the EIS modelled predictions did not regularly occur during attended monitoring. When meteorological conditions were relevant, results show that measured noise levels from WCM were generally well under the predicted levels.

Global Acoustics Pty Ltd

Table of Contents

Appendices

1 INTRODUCTION

1.1 Background

Global Acoustics was engaged by Wambo Coal Pty Ltd to provide a summary of the monthly environmental noise surveys conducted around Wambo Coal Mine (WCM), and the Wambo Coal Rail Spur (WCRS) from 1 January to 31 December 2017. The mine and spur operate under separate development consents and have been monitored separately. Reporting, however, has been combined in this document.

Wambo Coal operates both open cut and underground mining operations from their mine at Warkworth, NSW. The open cut operations include use of heavy mobile equipment in open cut pits, on haul roads and on waste rock emplacements. The underground operations have surface facilities. Both operations utilise a coal handling and preparation plant (CHPP) including conveyors, bins and other material-handling infrastructure.

The WCRS is located between Mt Thorley and Warkworth Village, New South Wales (as shown in Figure 1) and includes the following components:

- a product coal stockpile and reclaim area, product coal conveyor, train load-out bin, rail loop and a rail spur from the Wambo Coal Mine to Mount Thorley;
- rail transport of product coal to the market, an intermittent activity that can take place at any time; and
- a locomotive refuelling facility.

A noise survey around both the WCM and the WCRS is required monthly as detailed in the Noise Management Plan (NMP).

Attended environmental noise monitoring described in this report was undertaken at four sites on a one night per month basis during 2017. Figure 1 shows the monitoring locations.

The survey purpose was to quantify and describe the existing acoustic environment around WCM and WCRS and compare results with relevant limits.

1.2 Monitoring Locations & Frequency

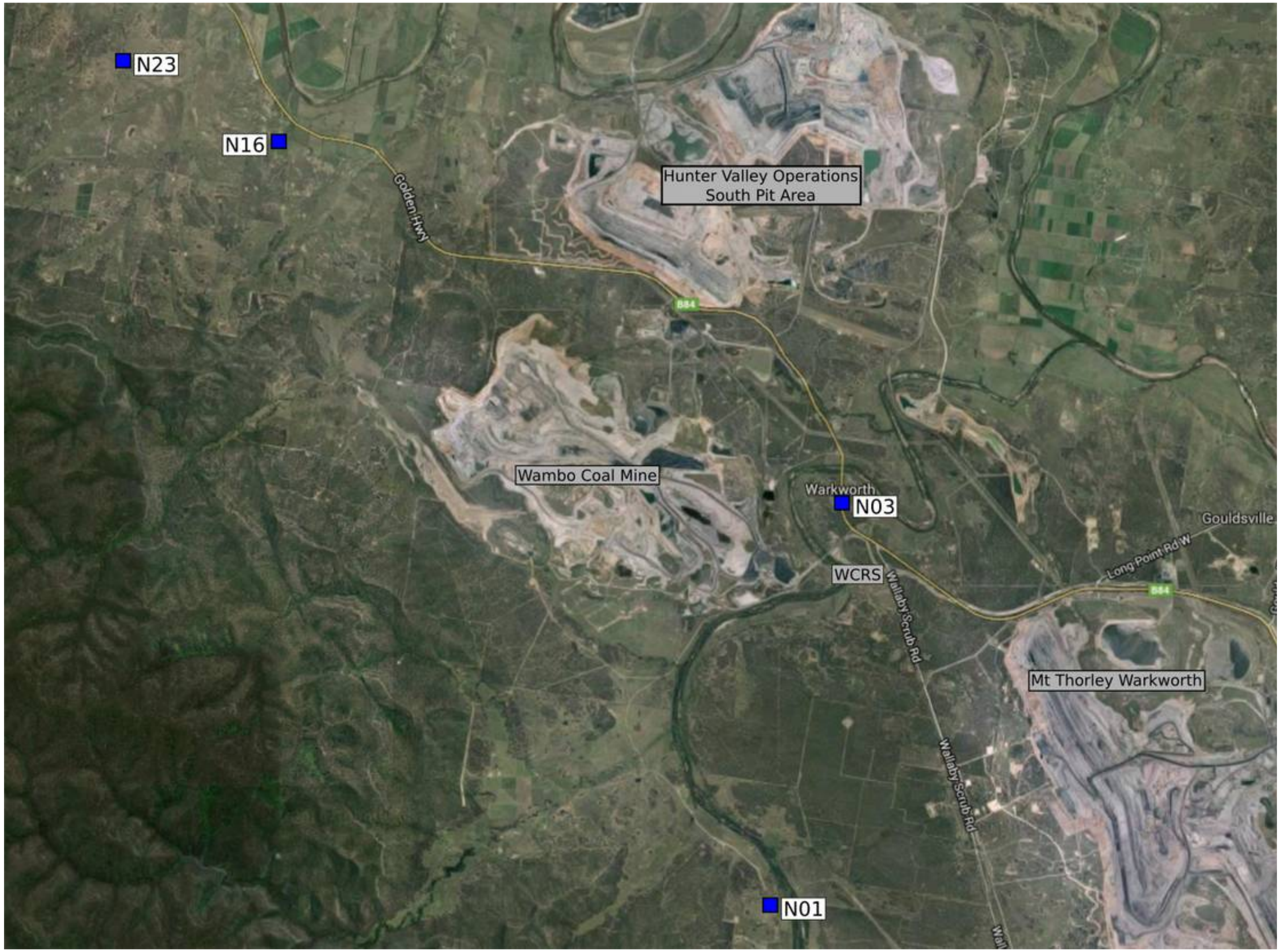
Attended noise monitoring was conducted at a total of four locations for WCM and the WCRS. There are also two real-time monitors (from a total of four) at other locations. Table 1.1 outlines the monitor type and frequency for the noise monitoring locations; attended monitoring locations are shown in Figure 1.

Table 1.1: WAMBO COAL MONITORING LOCATIONS & FREQUENCY[1,2]

Site Reference	Site Location	Monitor Type	Consent Requirements	Frequency [1]
N01	*Lambkin Residence*	Attended	Mine Development Consents	Monthly
N03	*Kelly Residence*	Real-time & Attended	Mine and Rail Spur Development Consent	Continuous & Monthly
N16	*Muller Residence*	Real-time & Attended	Mine Development Consent	Continuous & Monthly
N20	Thelander Residence	Real-time	Mine Development Consent	Continuous
N21	Wambo South Residence	Real-time	Mine Development Consent	Continuous
N23	*Redmanvale Road*	Attended	Mine Development Consent	Monthly

Notes:

1. *Sourced from the Wambo Coal Noise Monitoring Plan -EMP011, February 2014; and*
2. *Attended locations are shown in italics.*



Source: Google Maps

Figure 1: WCM Attended Noise Monitoring Sites

1.3 Terminology & Abbreviations

Some 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
L_A	The A-weighted root mean squared (RMS) noise level at any instant
L_{A10}	The noise level which is exceeded for 10 percent of the time, which is approximately the average of the maximum noise levels
L_{A90}	The level exceeded for 90 percent of the time, which is approximately the average of the minimum noise levels. 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_{Aeq}	The average noise energy during a measurement period
dB(A)	Noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise
SPL	Sound pressure level (SPL), fluctuations in pressure measured as 10 times a logarithmic scale, the reference pressure being 20 micropascals
ABL	Assessment background level (ABL), the 10th percentile background noise level for a single period (day, evening or night) of a 24 hour monitoring period
RBL	Rating background level (RBL), the background noise level for a period (day, evening or night) determined from ABL data
Hertz (Hz)	Cycles per second, the frequency of fluctuations in pressure, sound is usually a combination of many frequencies together
VTG	Vertical temperature gradient in degrees Celsius per 100 metres altitude. Estimated from wind speed and sigma theta data
SC	Stability Class. Estimated from wind speed and sigma theta data
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 DEVELOPMENT CONSENT

2.1 Wambo Coal Mine Development Consent

WCM was granted consent (DA 305-7-2003) in February 2004, which enables the extension of current open cut and underground mining operations. The latest modification to this consent was approved in December 2017. The relevant sections of this modification are reproduced in Appendix A.

The *Wambo Coal Environmental Management System, Noise Monitoring Plan* (EMP011, February 2014) was prepared in accordance with Schedule 4. The NMP indicates that monitoring will be conducted for WCM activities, and the noise levels to be used for assessment. Monitoring for noise from mining activities is undertaken at the properties numbered N01, N03, N16 and N23.

It should be noted that properties N01 and N03 are subject to acquisition upon request, as detailed in Schedule 4, Condition 1 of DA 305-7-2003. As such, there are no operational noise goals that apply to these properties.

Table 2.1 summarises relevant noise assessment criteria for WCM.

Table 2.1: WAMBO COAL MINE NOISE CRITERIA

Location	Day $L_{Aeq,15minute}$ dB	Evening / Night $L_{Aeq,15minute}$ dB	Night $L_{A1,1minute}$ dB
N01 [2]	NA	NA	NA
N03 [2]	NA	NA	NA
N16 [1]	35	40	50
N23 [1]	35	38	50

Notes:

1. *Criteria from Development Consent DA 305-7-2003; and*
2. *N01 and N03 are acquisition upon request and criteria are NA 'not applicable'.*

While the consent does not specify noise limits under which the above criteria apply, the NSW EPA environment protection licence (EPL No. 529) specifies that the limits apply under the following meteorological conditions:

- wind speeds of up to 3 m/s at 10 metres above ground level; or
- temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.

2.2 Wambo Coal Rail Spur Development Consent

The WCRS consists of two Development Applications (DA's):

- The Wambo Rail Loop (DA 177-8-2004), modified in February 2012 to include a rail refuelling facility; and
- The Wambo Rail Line (DA 235/97).

The *Wambo Coal Environmental Management System, Noise Management Plan* (EMP011, February 2014) was prepared in accordance with Schedule 4. The NMP indicates that monitoring will be conducted for WCRS activities, and the noise levels to be used for assessment. The relevant sections of the consents are reproduced in Appendix A.

Monitoring for noise from rail activities has previously been undertaken at properties numbered N01, N24 and N25 for rail pass-by noise. Locations N24 and N25 have been removed from the monitoring program following long-term demonstrated compliance. Monitoring is still undertaken at N01 as part of the mine consent, however, monitoring of the rail activities is no longer required. As detailed in the NMP, monitoring at these locations will recommence following any complaints or if there is a change in rolling stock.

It should be noted that properties at N01 are subject to acquisition upon request, as detailed in Schedule 4, Condition 1 of DA 305-7-2003. As such, there are no operational noise goals that apply directly to this property.

Quarterly monitoring of the rail loading facility is no longer undertaken at N03, due to a demonstrated history of compliance. Should anything change with the procedure for refuelling or a resident complaint be received, further monitoring will be undertaken to determine changes to received noise levels.

2.3 Modifying Factors – January to October 2017

Noise monitoring and reporting is carried out generally in accordance with the Environment Protection Authority (EPA) 'Industrial Noise Policy' (INP). Chapter 4 of the INP deals specifically with modifying factors that may apply to industrial noise. The most common modifying factors are addressed in detail below.

As detailed in L4.3 of the EPL:

> *The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.*

2.3.1 Tonality, Intermittent and Impulsive Noise

As defined in the Industrial Noise Policy:

> *Tonal noise contains a prominent frequency and is characterised by a definite pitch.*
>
> *Impulsive noise has high peaks of short duration and a sequence of such peaks.*
>
> *Intermittent noise is characterised by the level suddenly dropping to the background noise levels several times during a measurement, with a noticeable change in noise level of at least 5 dB. Intermittent noise applies to night-time only.*

Years of monitoring have shown that noise levels from mining operations, particularly those levels measured at significant distances from the source are relatively continuous. Given this, noise levels from WCM at the monitoring locations are unlikely to be intermittent. In addition, there is no equipment on site that is likely to generate tonal or impulsive noise as defined in the INP.

2.3.2 Low Frequency Noise

INP Method

As defined in the Industrial Noise Policy:

> *Low frequency noise contains major components within the low frequency range (20 Hz to 250 Hz) of the frequency spectrum.*

As detailed in Chapter 4 of the INP, low frequency noise should be assessed by measuring the site only C-weighted and site only A-weighted level over the same time period. The correction/penalty of 5 dB is applied *if the difference between the two levels is 15 dB or more*.

Broner Method

Low frequency noise can also be assessed using the method specified in the paper *"A Simple Method for Low Frequency Noise Emission Assessment"* (Broner JLFNV Vol29-1 pp1-14 2010). If the site only C-weighted noise level at a receptor exceeds the relevant modifying factor trigger, a 5 dB penalty (modifying factor) is added to predicted levels. This method is included to provide a comparison with the INP method.

Low Frequency Assessment Methods

Low frequency assessment methods are detailed in Table 2.2.

Table 2.2: LOW FREQUENCY ASSESSMENT METHODS AND MODIFYING FACTOR TRIGGERS

Method	Calculation Method	Night Period Modifying Factor Trigger	Day Period Modifying Factor Trigger
Broner, 2010	Site only L_{Ceq} to 250 Hz	>60	>65
INP, total	Site only Total L_{Ceq} minus Site only L_{Aeq}	>=15	>=15

A Draft Industrial Noise Guideline (dING) was released in September 2015, and while low frequency noise results from WCM during January to May 2017 have been compared to the assessment methods and modifying factor triggers presented above, June to October 2017 monitoring results have additionally been compared to the dING assessment method. The applicability of these triggers has been considered when applying low frequency modifying factor corrections.

2.4 Modifying Factors – November and December 2017

The EPA 'Noise Policy for Industry' (NPfI, 2017) 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.

2.4.1 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 characterised by the level suddenly dropping/increasing several times during a measurement, with a noticeable change in noise level of at least 5 dB. Intermittent noise applies to night-time only and is not intended to be applied to changes in noise level due to meteorology.*

Years of monitoring have indicated that noise levels from mining operations, particularly those levels measured at significant distances from the source are relatively continuous. Given this, noise levels at the monitoring locations are unlikely to be intermittent. In addition, there is no equipment on site that is likely to generate tonal noise as defined in the NPfI.

2.4.2 Low Frequency Noise

NPfI Method

The NPfI contains the current method of assessing low frequency noise, which isa 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 Assessment Method

3.1.1 Overview

Noise monitoring was conducted at the nearest residences in accordance with the Environment Protection Authority (EPA) 'Industrial Noise Policy' (INP) guidelines and Australian Standard AS 1055 'Acoustics, Description and Measurement of Environmental Noise'. The mine was operating during all monitoring periods.

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 emitted from the Wambo Coal noise source during the entire measurement period (i.e. the highest level of the worst minute during the 15-minute measurement).

As indicated in the consent conditions, the $L_{A1,1minute}$ measurement should be undertaken at 1 metre from the dwelling façade and the $L_{Aeq,15minute}$ measurement within 30 metres of the dwelling. However, the direct measurement of noise at 1 metre from the façade is not practical during monitoring for this project. In most cases, monitoring near the residence is impractical due to barking dogs or issues with obtaining access. In all cases, measurements for this survey were undertaken at a suitable and representative location.

Meteorological data was obtained from the Wambo Coal Mine meteorological station. This allowed correlation of atmospheric parameters and measured noise levels. Ground level atmospheric condition measurement was also undertaken during attended monitoring.

3.1.2 Attended Noise Monitoring

Attended noise monitoring was conducted at all sites generally during night hours. While night period monitoring is the required time to measure the source of interest, we consider atmospheric conditions during the later stages of the evening period to be the same as those during the night period and so it is valid to compare results from this measurement to night period criteria. The duration of all measurements was 15 minutes.

Attended monitoring is preferred to the use of loggers when determining compliance with prescribed limits; 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).

The terms 'Inaudible' (IA) or 'Not Measurable' (NM) may be used in this report. When site noise is noted as IA, no site noise was audible at the monitoring location. NM indicates that some site noise was audible, but indeterminate due to one of the following reasons:

- site noise levels were insignificant and unlikely, in many cases, to be even noticed; or
- site noise levels were masked by another relatively loud noise source, but were estimated to be less than L_{Aeq} 30 dB, which is insignificant in terms of any applicable criterion.

If site noise were NM due to masking but estimated to be significant in relation to a relevant criterion, we would employ methods as per the Industrial Noise Policy (e.g. measure closer and back calculate) to determine a value for reporting. All sites noted NM in this report are due to insignificant absolute values.

3.2 Meteorological Data

Meteorological data was obtained from the Wambo meteorological station. Atmospheric parameters included wind speed, wind direction, rainfall and sigma theta. This data allowed correlation of atmospheric parameters and measured noise levels. Meteorological data was available in 5 minute intervals.

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 the measurement period and whether those conditions relate to noise criteria being applicable. In order to accurately compare 5-minute meteorological data to 15-minute noise level measurement periods, a rolling 15-minute meteorological interval was produced by converting each 5-minute meteorological interval into an average of the preceding three 5-minute intervals. The rolling 15-minute meteorological interval which most closely matched the 15-minute noise level measurement period was then adopted as the predominant meteorological conditions for that measurement period.

Where rolling averages could not be used (such as for VTG and stability class), the predominant condition, corresponding with the majority of 5-minute meteorological intervals, was adopted.

3.3 Weather Conditions

Weather conditions were recorded at each location during each noise level measurement. Although the consent is not specific as to where the meteorological data should be sourced, information from WCM has been used as it is measured with an elevated anemometer as is required by the consent. The anemometer at WCM is not overly distant from the monitoring locations and is considered to be representative of the general area. Wind speeds measured at 10 metres above ground are usually higher than those measured closer to ground level. In accordance with consent conditions, noise criteria only apply in wind speeds up to 3 metres per second.

4 RESULTS

There were a total of four monitoring locations during 2017, as listed in Table 1.1 and shown on Figure 1.

4.1 Quarter 1, 2017

4.1.1 Total Noise Levels

Noise levels measured at each location during attended 15 minute surveys are provided in Table 4.1.

Table 4.1: MEASURED NOISE LEVELS – QUARTER 1, 2017[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	09/01/2017 22:29	48	46	42	40	41	38	34	54
N03	09/01/2017 23:29	51	48	46	42	43	40	38	66
N16	09/01/2017 21:34	49	46	43	41	42	40	38	63
N23	09/01/2017 22:52	48	47	40	35	37	32	31	50
N01	10/02/2017 00:08	47	37	36	35	35	34	32	55
N03	09/02/2017 23:35	86	78	53	44	63	40	38	71
N16	09/02/2017 22:36	56	41	39	36	37	35	33	56
N23	09/02/2017 22:06	52	42	40	37	38	36	32	57
N01	07/03/2017 22:11	55	48	39	36	38	35	32	53
N03	07/03/2017 23:40	74	52	45	37	43	35	34	66
N16	07/03/2017 22:41	44	40	37	36	36	34	32	53
N23	07/03/2017 22:02	56	40	38	36	36	34	32	55

Notes:

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

4.1.2 Wambo Coal Mine Noise

Noise levels generated by activity at Wambo mine are shown in Table 4.2 and Table 4.3, where comparison of measured $L_{Aeq,15}$ minute and $L_{A1,1}$ minute levels for WCM is made with relevant noise criteria.

Table 4.2: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 1, 2017

Location	Start Date and Time	Wind Speed m/s	VTG[7] ^{0}C/100m	Criterion $L_{Aeq,15min}$ dB[1]	Criterion Applies? [3]	WCM $L_{Aeq,15min}$ dB [4,5]	Exceedance [6,8]
N01[2]	09/01/2017 22:29	2.4	-1.0	NA	NA	IA	NA
N03[2]	09/01/2017 23:29	2.4	0.5	NA	NA	41	NA
N16	09/01/2017 21:34	2.1	-1.0	40	Yes	37	Nil
N23	09/01/2017 22:52	2.6	-1.0	38	Yes	25	Nil
N01[2]	10/02/2017 00:08	0.5	4.1	NA	NA	27	NA
N03[2]	09/02/2017 23:35	0.8	4.1	NA	NA	NM	NA
N16	09/02/2017 22:36	0.9	4.1	40	No	30	NA
N23	09/02/2017 22:06	0.8	4.1	38	No	IA	NA
N01[2]	07/03/2017 22:11	1.6	0.5	NA	NA	IA	NA
N03[2]	07/03/2017 23:40	2.7	0.3	NA	NA	36	NA
N16	07/03/2017 22:41	1.6	1.3	40	Yes	33	Nil
N23	07/03/2017 22:02	1.7	0.5	38	Yes	33	Nil

Notes:

1. *Development consent criterion;*
2. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
3. *Noise emission limits identified in the above table apply under meteorological conditions of:*
   - *Wind speeds of up to 3 m/s at 10 metres above ground level; or*
   - *Temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.*
4. *Estimated or measured $L_{Aeq,15minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
8. *Bold and red text indicate an exceedance of relevant criterion; and*
9. *Criterion may or may not apply due to rounding of meteorological data values.*

Table 4.3: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 1, 2017

Location	Start Date and Time	Wind Speed m/s	VTG[7] $^0C/100m$	Criterion $L_{A1,1min}$ dB[1]	Criterion Applies? [3]	WCM $L_{A1,1min}$ dB [4,5]	Exceedance [6,8]
N01[2]	09/01/2017 22:29	2.4	-1.0	NA	NA	IA	NA
N03[2]	09/01/2017 23:29	2.4	0.5	NA	NA	45	NA
N16	09/01/2017 21:34	2.1	-1.0	50	Yes	43	Nil
N23	09/01/2017 22:52	2.6	-1.0	50	Yes	32	Nil
N01[2]	10/02/2017 00:08	0.5	4.1	NA	NA	35	NA
N03[2]	09/02/2017 23:35	0.8	4.1	NA	NA	NM	NA
N16	09/02/2017 22:36	0.9	4.1	50	No	40	NA
N23	09/02/2017 22:06	0.8	4.1	50	No	IA	NA
N01[2]	07/03/2017 22:11	1.6	0.5	NA	NA	IA	NA
N03[2]	07/03/2017 23:40	2.7	0.3	NA	NA	42	NA
N16	07/03/2017 22:41	1.6	1.3	50	Yes	35	Nil
N23	07/03/2017 22:02	1.7	0.5	50	Yes	38	Nil

Notes:

1. *Development consent criterion;*
2. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
3. *Noise emission limits identified in the above table apply under meteorological conditions of:*
   - *Wind speeds of up to 3 m/s at 10 metres above ground level; or*
   - *Temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.*
4. *Estimated or measured $L_{Aeq,15minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
8. *Bold and red text indicate an exceedance of relevant criterion; and*
9. *Criterion may or may not apply due to rounding of meteorological data values.*

4.1.3 Low Frequency Assessment

Table 4.4 provides statistics for attended noise monitoring undertaken around WCM during Quarter 1, 2017.

Table 4.4: ATTENDED MEASUREMENT STATISTICS FOR WCM – QUARTER 1, 2017

Conditions	Total for Quarter 1, 2017
Number of measurements	12
Number of measurements where WCM was measurable, was within 5 dB of the relevant criterion and the relevant criterion applied	1

One of the 12 measurements occurred during which WCM was measurable (not "inaudible" or "not measurable"), was within 5 dB of the relevant criterion and where meteorological conditions resulted in criteria applying (in accordance with the consent). Further analysis of low frequency noise applicable to this measurement was conducted however no penalty was required to be applied.

4.2 Quarter 2, 2017

4.2.1 Total Noise Levels

Noise levels measured at each location during attended 15 minute surveys are provided in Table 4.5.

Table 4.5: MEASURED NOISE LEVELS – QUARTER 2, 2017[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	18/04/2017 22:34	42	37	36	35	35	34	31	55
N03	18/04/2017 23:06	45	38	36	33	34	32	30	53
N16	18/04/2017 23:00	43	41	39	35	36	32	30	52
N23	18/04/2017 22:33	43	41	39	37	37	35	32	58
N01	15/05/2017 23:42	38	35	33	30	30	27	24	52
N03	15/05/2017 22:50	50	48	44	39	41	38	36	64
N16	15/05/2017 22:48	45	42	39	35	36	32	30	52
N23	15/05/2017 22:21	39	34	30	27	28	24	21	49
N01	15/06/2017 22:20	51	42	40	37	38	36	34	55
N03	13/06/2017 23:32	52	47	44	41	42	38	36	63
N16	13/06/2017 22:40	50	46	43	40	41	38	35	56
N16[2]	13/06/2017 23:12	42	39	37	34	35	32	30	54
N23	13/06/2017 22:08	46	40	36	34	35	33	30	55

Notes:

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

4.2.2 Wambo Coal Mine Noise

Noise levels generated by activity at Wambo mine are shown in Table 4.6 and Table 4.7, where comparison of measured $L_{Aeq,15minute}$ and $L_{A1,1minute}$ levels for WCM is made with relevant noise criteria.

Table 4.6: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 2, 2017

Location	Start Date and Time	Wind Speed m/s	VTG[7] °C/100m	Criterion $L_{Aeq,15min}$ dB[1]	Criterion Applies? [3]	WCM $L_{Aeq,15min}$ dB [4,5]	Exceedance [6,8]
N01[2]	18/04/2017 22:34	0.3	4.1	NA	NA	IA	NA
N03[2]	18/04/2017 23:06	0.0	4.1	NA	NA	<25	NA
N16	18/04/2017 23:00	0.0	4.1	40	No	36	NA
N23	18/04/2017 22:33	0.4	4.1	38	No	NM	NA
N01[2]	15/05/2017 23:42	1.1	3.0	NA	NA	<30	NA
N03[2]	15/05/2017 22:50	0.8	4.1	NA	NA	40	NA
N16	15/05/2017 22:48	0.7	4.1	40	No	34	NA
N23	15/05/2017 22:21	0.2	4.1	38	No	NM	NA
N01[2]	15/06/2017 22:20	0.1	0.5	NA	NA	<30	NA
N03[2]	13/06/2017 23:32	1.0	0.5	NA	NA	38	NA
N16	13/06/2017 22:40	1.8	0.5	40	Yes	41	**1**
N16[10]	13/06/2017 23:12	1.3	-1.0	40	Yes	33	Nil
N23	13/06/2017 22:08	2.1	-1.0	38	Yes	33	Nil

Notes:

1. *Development consent criterion;*
2. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
3. *Noise emission limits identified in the above table apply under meteorological conditions of:*
    - *Wind speeds of up to 3 m/s at 10 metres above ground level; or*
    - *Temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.*
4. *Estimated or measured $L_{Aeq,15minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
8. *Bold and red text indicate an exceedance of relevant criterion;*
9. *Criterion may or may not apply due to rounding of meteorological data values; and*
10. *Remeasure.*

Table 4.7: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 2, 2017

Location	Start Date and Time	Wind Speed m/s	VTG[7] $^0C/100m$	Criterion $L_{A1,1min}$ dB[1]	Criterion Applies? [3]	WCM $L_{A1,1min}$ dB [4,5]	Exceedance [6,8]
N01[2]	18/04/2017 22:34	0.3	4.1	NA	NA	IA	NA
N03[2]	18/04/2017 23:06	0.0	4.1	NA	NA	29	NA
N16	18/04/2017 23:00	0.0	4.1	50	No	43	NA
N23	18/04/2017 22:33	0.4	4.1	50	No	24	NA
N01[2]	15/05/2017 23:42	1.1	3.0	NA	NA	32	NA
N03[2]	15/05/2017 22:50	0.8	4.1	NA	NA	49	NA
N16	15/05/2017 22:48	0.7	4.1	50	No	45	NA
N23	15/05/2017 22:21	0.2	4.1	50	No	NM	NA
N01[2]	15/06/2017 22:20	0.1	0.5	NA	NA	<30	NA
N03[2]	13/06/2017 23:32	1.0	0.5	NA	NA	42	NA
N16	13/06/2017 22:40	1.8	0.5	50	Yes	49	Nil
N16[10]	13/06/2017 23:12	1.3	-1.0	50	Yes	38	Nil
N23	13/06/2017 22:08	2.1	-1.0	50	Yes	41	Nil

Notes:

1. *Development consent criterion;*
2. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
3. *Noise emission limits identified in the above table apply under meteorological conditions of:*
   - *Wind speeds of up to 3 m/s at 10 metres above ground level; or*
   - *Temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.*
4. *Estimated or measured $L_{Aeq,15minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
8. *Bold and red text indicate an exceedance of relevant criterion; and*
9. *Criterion may or may not apply due to rounding of meteorological data values; and*
10. *Remeasure.*

4.2.3 Low Frequency Assessment

Table 4.8 provides statistics for attended noise monitoring undertaken around WCM during Quarter 2, 2017.

Table 4.8: ATTENDED MEASUREMENT STATISTICS FOR WCM – QUARTER 2, 2017

Conditions	Total for Quarter 2, 2017
Number of measurements	12
Number of measurements where WCM was measurable, was within 5 dB of the relevant criterion and the relevant criterion applied	2

Two of the 12 measurements occurred during which WCM was measurable (not "inaudible" or "not measurable"), was within 5 dB of the relevant criterion and where meteorological conditions resulted in criteria applying (in accordance with the consent). Further analysis of low frequency noise applicable to this measurement are provided in Table 4.9.

Table 4.9: LOW FREQUENCY NOISE MODIFYING FACTOR ASSESSMENT – QUARTER 2, 2017

Location	Start Date and Time	INP		Broner		dING	
		Result[1] $L_{Ceq} - L_{Aeq}$ dB	Penalty dB	Result[2] L_{Ceq} dB	Penalty dB	Result[3] Max exceedance of ref spectrum dB	Penalty dB
N16[6]	13/06/2017 23:12	**17**	5	51	0	Nil	0
N23	13/06/2017 22:08	**19**	5	53	0	**0.2**	2

Notes:

1. *Low frequency modifying factor trigger is $L_{Ceq} - L_{Aeq}$ >= 15 dB as per the INP;*
2. *Night L_{Ceq} modifying factor trigger is L_{Ceq} 60 dB as per Broner (2010);*
3. *Low frequency modifying factor trigger is comparison of measured spectrum against a reference spectrum as per the dING;*
4. *Bold results and penalties in red are where the relevant modifying factor trigger was exceeded;*
5. *Where it is not possible to determine the site only result due to the presence of other low frequency noise sources occurring during the measurement, this is noted as NA (not available) and no further assessment has been undertaken; and*
6. *Remeasure.*

WCM complied with the relevant limits using the Broner method of assessing low frequency noise at both monitoring locations. Results were above the relevant INP low frequency modifying factor trigger during the remeasure at N16 and measurement at N23. The measurement at N23 also triggered the threshold value using the dING method of assessing low frequency. Neither measurement exceeded relevant criteria with the penalties applied.

4.3 Quarter 3, 2017

4.3.1 Total Noise Levels

Noise levels measured at each location during attended 15 minute surveys are provided in Table 4.10.

Table 4.10: MEASURED NOISE LEVELS – QUARTER 3, 2017[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	07/07/2017 00:09	38	36	34	33	33	31	29	55
N03	07/07/2017 00:32	53	48	46	44	44	42	40	66
N16	06/07/2017 23:08	58	45	39	31	36	21	19	49
N23	06/07/2017 22:36	48	37	28	25	27	23	21	43
N01	29/08/2017 00:04	40	31	29	27	27	26	24	51
N03	28/08/2017 23:17	54	49	47	45	45	43	41	63
N16	28/08/2017 22:41	51	47	43	40	41	38	35	54
N16[2]	28/08/2017 23:58	48	45	41	38	39	36	34	54
N16[3]	07/09/2017 22:00	59	56	50	28	44	23	21	48
N23	28/08/2017 22:04	50	37	33	30	31	27	24	48
N01	14/09/2017 22:15	40	38	34	30	31	26	22	52
N03	14/09/2017 23:30	71	48	45	42	44	41	39	66
N16	14/09/2017 22:56	63	57	46	30	44	24	22	52
N23	14/09/2017 22:03	48	41	37	29	33	25	22	47

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM;*
2. *Re-measure; and*
3. *Follow-up monitoring.*

4.3.2 Wambo Coal Mine Noise

Noise levels generated by activity at Wambo mine are shown in Table 4.11 and Table 4.12, where comparison of measured $L_{Aeq,15minute}$ and $L_{A1,1minute}$ levels for WCM is made with relevant noise criteria.

Table 4.11: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 3, 2017

Location	Start Date and Time	Wind Speed m/s	VTG[7] ^{0}C/100m	Stability Class	Criterion $L_{Aeq,15min}$ dB[1]	Criterion Applies? Consent / EPL [3]	WCM $L_{Aeq,15min}$ dB [4,5]	Exceedance [6,8]
N01[2]	07/07/2017 00:09	0.0	4.1	G	NA	NA	32	NA
N03[2]	07/07/2017 00:32	0.0	4.1	G	NA	NA	42	NA
N16	06/07/2017 23:08	0.0	4.1	G	40	No	33	NA
N23	06/07/2017 22:36	0.0	4.1	G	38	No	IA	NA
N01[2]	29/08/2017 00:04	0.1	-1.0	D	NA	NA	IA	NA
N03[2]	28/08/2017 23:17	0.2	4.1	G	NA	NA	43	NA
N16	28/08/2017 22:41	0.8	-1.0	D	40	Yes	**41**	**1**
N16[10]	28/08/2017 23:58	0.4	4.1	G	40	No	38	NA
N16[11]	07/09/2017 22:00	0.6	3.0	F	40	Yes / No	25	Nil
N23	28/08/2017 22:04	0.0	4.1	G	38	No	30	NA
N01[2]	14/09/2017 22:15	3.3	-1.0	D	NA	NA	NM	NA
N03[2]	14/09/2017 23:30	4.0	-1.0	D	NA	NA	NM	NA
N16	14/09/2017 22:56	3.3	-1.0	D	40	No	<25	NA
N23	14/09/2017 22:03	2.8	0.5	E	38	Yes	<20	Nil

Notes:

1. *Development consent and EPL criterion;*
2. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{Aeq,15minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
8. *Bold and red text indicate an exceedance of relevant criterion;*
9. *Criterion may or may not apply due to rounding of meteorological data values;*
10. *Re-measure; and*
11. *Follow-up monitoring.*

Table 4.12: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 3, 2017

Location	Start Date and Time	Wind Speed m/s	VTG[7] °C/100m	Stability Class	Criterion $L_{A1,1min}$ dB[1]	Criterion Applies? Consent / EPL[3]	WCM $L_{A1,1min}$ dB [4,5]	Exceedance [6,8]
N01[2]	07/07/2017 00:09	0.0	4.1	G	NA	NA	33	NA
N03[2]	07/07/2017 00:32	0.0	4.1	G	NA	NA	50	NA
N16	06/07/2017 23:08	0.0	4.1	G	50	No	40	NA
N23	06/07/2017 22:36	0.0	4.1	G	50	No	IA	NA
N01[9]	29/08/2017 00:04	0.1	-1.0	D	NA	NA	IA	NA
N03[9]	28/08/2017 23:17	0.2	4.1	G	NA	NA	53	NA
N16	28/08/2017 22:41	0.8	-1.0	D	50	Yes	**51**	**1**
N16[10]	28/08/2017 23:58	0.4	4.1	G	50	No	48	NA
N16[11]	07/09/2017 22:00	0.6	3.0	F	50	Yes / No	34	NA
N23	28/08/2017 22:04	0.0	4.1	G	50	No	37	NA
N01[2]	14/09/2017 22:15	3.3	-1.0	D	NA	NA	NM	NA
N03[2]	14/09/2017 23:30	4.0	-1.0	D	NA	NA	NM	NA
N16	14/09/2017 22:56	3.3	-1.0	D	50	No	<25	NA
N23	14/09/2017 22:03	2.8	0.5	E	50	Yes	<20	Nil

Notes:

1. *Development consent and EPL criterion;*
2. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{Aeq,15minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
8. *Bold and red text indicate an exceedance of relevant criterion;*
9. *Criterion may or may not apply due to rounding of meteorological data values;*
10. *Re-measure; and*
11. *Follow-up monitoring.*

4.3.3 Low Frequency Assessment

Applicability of the low frequency penalty is determined by a number of factors including whether or not WCM was the only low frequency source, was measurable (not "inaudible", "not measurable" or less than a maximum cut-off value of 30 dB), was within 5 dB of the relevant criterion and where meteorological conditions resulted in criteria applying (in accordance with the project approval).

Low frequency modification factors were not required to be applied to measured WCM levels during Quarter 3, 2017.

4.4 Quarter 4, 2017

4.4.1 Total Noise Levels

Noise levels measured at each location during attended 15 minute surveys are provided in Table 4.13.

Table 4.13: MEASURED NOISE LEVELS – QUARTER 4, 2017[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	12/10/2017 23:44	61	37	33	32	33	30	28	52
N03	12/10/2017 23:12	85	78	55	38	64	34	30	67
N16	12/10/2017 22:09	46	43	40	38	39	37	35	58
N23	13/10/2017 00:39	52	38	36	34	34	32	30	54
N01	14/11/2017 22:38	51	45	41	39	39	37	34	56
N03	14/11/2017 23:12	65	58	45	37	45	35	33	64
N16	14/11/2017 22:31	47	45	44	42	42	40	38	62
N23	14/11/2017 22:01	51	46	44	41	42	39	37	62
N01	4/12/2017 22:45	50	46	42	38	40	35	31	52
N03	4/12/2017 23:32	48	42	38	36	37	34	32	65
N16	4/12/2017 22:32	47	42	39	37	37	35	32	56
N23	4/12/2017 22:00	41	40	37	34	35	32	30	53

Notes:

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

4.4.2 Wambo Coal Mine Noise

Noise levels generated by activity at Wambo mine are shown in Table 4.14 and Table 4.15, where comparison of measured $L_{Aeq,15minute}$ and $L_{A1,1minute}$ levels for WCM is made with relevant noise criteria.

Table 4.14: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 4, 2017

Location	Start Date and Time	Wind Speed m/s	VTG[7] °C/100m	Stability Class	Criterion $L_{Aeq,15min}$ dB[1]	Criterion Applies? Consent / EPL [3]	WCM $L_{Aeq,15min}$ dB [4,5]	Exceedance [6,8]
N01[2]	12/10/2017 23:44	0.8	4.1	G	NA	NA	IA	NA
N03[2]	12/10/2017 23:12	0.8	0.5	E	NA	NA	35	NA
N16	12/10/2017 22:09	1.0	3.0	F	40	Yes / No	NM	Nil
N23	13/10/2017 00:39	0.4	3.0	F	38	Yes / No	<30	Nil
N01[2]	14/11/2017 22:38	1.1	-1.0	D	NA	NA	IA	NA
N03[2]	14/11/2017 23:12	1.0	-1.0	D	NA	NA	<35	NA
N16	14/11/2017 22:31	1.1	-1.0	D	40	Yes	38	Nil
N23	14/11/2017 22:01	1.4	-1.0	D	38	Yes	<30	Nil
N01[2]	4/12/2017 22:45	2.1	0.5	E	NA	NA	IA	NA
N03[2]	4/12/2017 23:32	2.5	-1.0	D	NA	NA	35	NA
N16	4/12/2017 22:32	2.1	-1.0	D	40	Yes	32	Nil
N23	4/12/2017 22:00	1.2	0.5	E	38	Yes	<30	Nil

Notes:

1. *Development consent and EPL criterion;*
2. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3°C/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{Aeq,15minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
8. *Bold and red text indicate an exceedance of relevant criterion; and*
9. *Criterion may or may not apply due to rounding of meteorological data values.*

Table 4.15: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 4, 2017

Location	Start Date and Time	Wind Speed m/s	VTG[7] °C/100m	Stability Class	Criterion $L_{A1,1min}$ dB[1]	Criterion Applies? Consent / EPL[3]	WCM $L_{A1,1min}$ dB [4,5]	Exceedance [6,8]
N01[2]	12/10/2017 23:44	0.8	4.1	G	NA	NA	IA	NA
N03[2]	12/10/2017 23:12	0.8	0.5	E	NA	NA	38	NA
N16	12/10/2017 22:09	1.0	3.0	F	50	Yes / No	42	Nil
N23	13/10/2017 00:39	0.4	3.0	F	50	Yes / No	30	Nil
N01[9]	14/11/2017 22:38	1.1	-1.0	D	NA	NA	IA	NA
N03[9]	14/11/2017 23:12	1.0	-1.0	D	NA	NA	39	NA
N16	14/11/2017 22:31	1.1	-1.0	D	50	Yes	44	Nil
N23	14/11/2017 22:01	1.4	-1.0	D	50	Yes	<30	Nil
N01[2]	4/12/2017 22:45	2.1	0.5	E	NA	NA	IA	NA
N03[2]	4/12/2017 23:32	2.5	-1.0	D	NA	NA	43	NA
N16	4/12/2017 22:32	2.1	-1.0	D	50	Yes	42	Nil
N23	4/12/2017 22:00	1.2	0.5	E	50	Yes	32	Nil

Notes:

1. *Development consent and EPL criterion;*
2. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{Aeq,15minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
8. *Bold and red text indicate an exceedance of relevant criterion; and*
9. *Criterion may or may not apply due to rounding of meteorological data values.*

4.4.3 Low Frequency Assessment

Applicability of the low frequency penalty is determined by a number of factors including whether or not WCM was the only low frequency source, was measurable (not "inaudible", "not measurable" or less than a maximum cut-off value of 30 dB), was within 5 dB of the relevant criterion and where meteorological conditions resulted in criteria applying (in accordance with the project approval).

Low frequency modification factors were not required to be applied to measured WCM levels during Quarter 4, 2017.

4.5 Review of Site Noise Level Trends

Trends in measured site noise levels incorporating data from start of Quarter 1 2015 to the end of Quarter 4 2017 were reviewed to assess changes in measured $L_{Aeq,15minute}$ and $L_{A1,1minute}$ levels for WCM over the past three years of regular attended monitoring.

Figures 2 to 5 display measured $L_{Aeq,15minute}$ and $L_{A1,1minute}$ levels for the four monitoring locations with linear trend lines included to show any changes in data measurements over the past 3 years.

It should be noted that for the purpose of graphing data, all measurements that were either inaudible (IA), not measurable (NM), <30 dB or <20 dB have been assigned a value of 0.

4.5.1 N01 - Lambkin

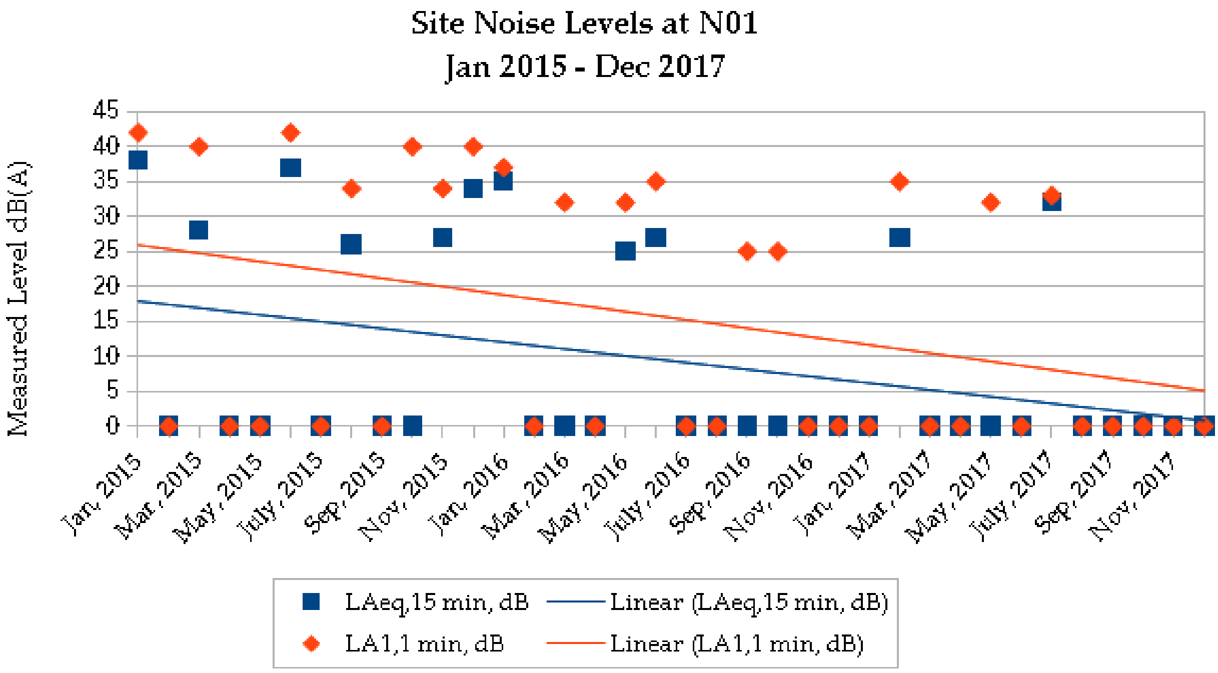


Figure 2: Summary of Measured Site Noise levels, N01 – Lambkin

There are no significant differences in measured site noise levels at monitoring location N01 over the 2015 to 2017 period.

Both $L_{Aeq,15minute}$ and $L_{A1,1minute}$ levels showed a decreasing trend, most likely due to a larger number of non-recordable and inaudible measurements in 2017.

4.5.2 N03 - Kelly

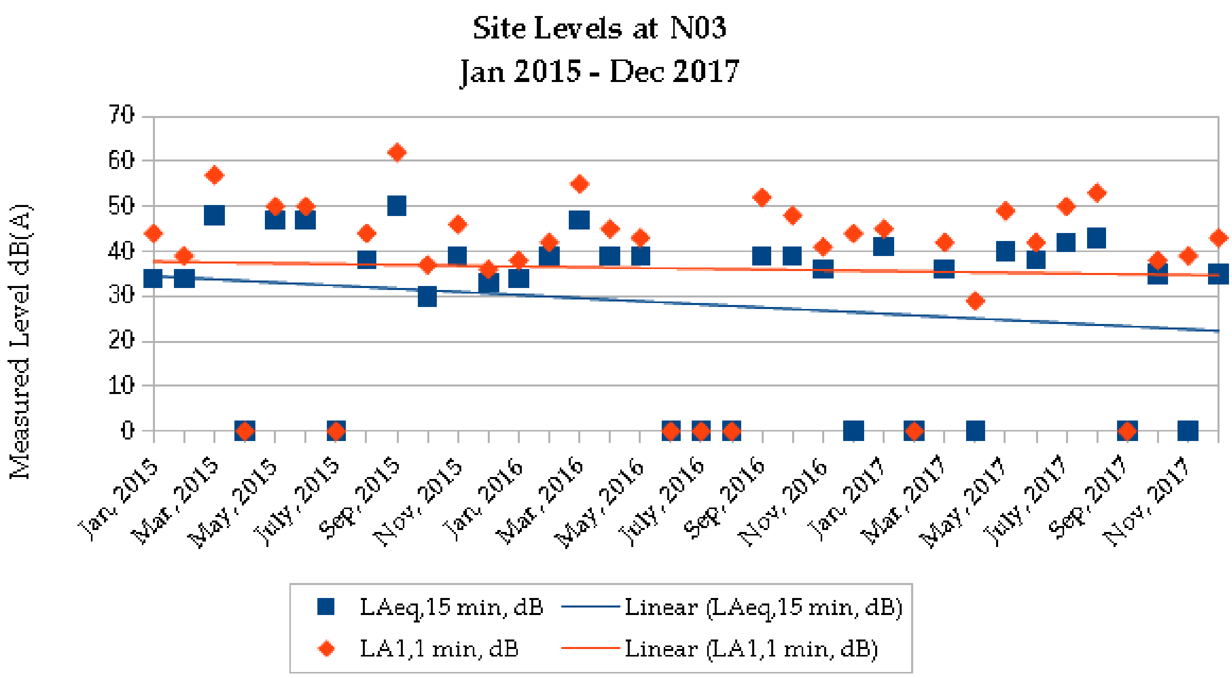


Figure 3: Summary of Measured Site Noise levels, N03 – Kelly

There are no significant differences in measured site noise levels at monitoring location N03 over the 2015 to 2017 period.

All measurement values were fairly consistent over the period, with a very slight downward trend for $L_{Aeq,15minute}$ levels.

4.5.3 N16 - Muller

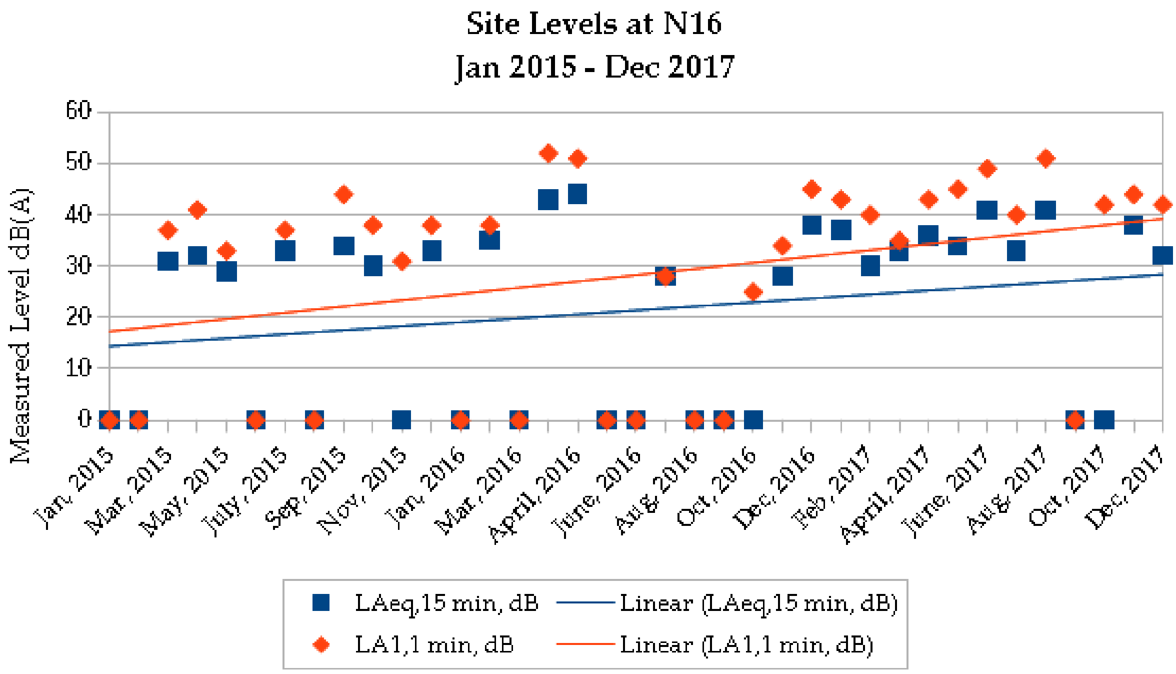


Figure 4: Summary of Measured Site Noise levels, N16 – Muller

Measured site noise levels at location N16 have shown a definite upward trend over the past three years. Few measurements in 2017 were either IA or NM which further helped the trend. This can possibly be attributed to N16 being in the direction of pit progression.

4.5.4 N23 - Carter

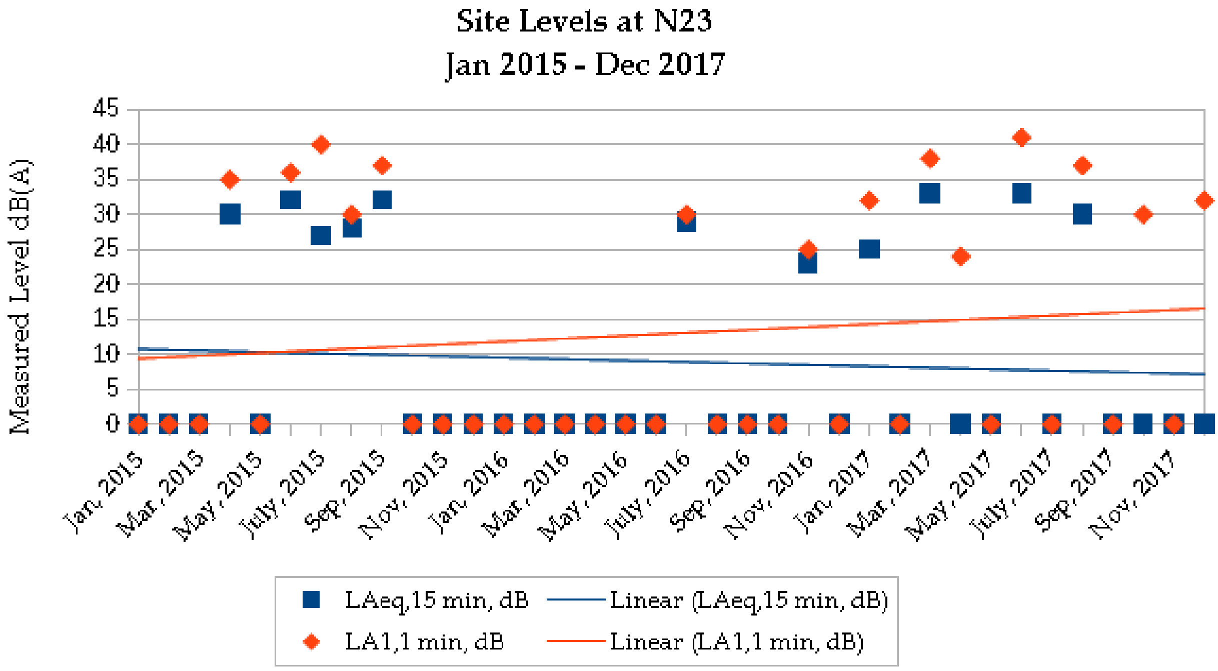


Figure 5: Summary of Measured Site Noise levels, N23 – Carter

There are no significant differences in measured site noise levels at monitoring location N23 over the 2015 to 2017 period.

Due to a larger number of non-recordable measurements, the trends are not reliable.

4.6 Comparison with EIS

Predicted Year 9 operational noise levels from Table 5.4.1 of the EIS (June 2003) are reproduced for the monitoring locations during the night period only as shown in Table 4.16.

Year 9 predictions have been used for comparison of measured levels. As detailed in the EIS, Year 9 operations are representative of the nearest open-cut operations to Bulga Village including Wambo and Arrowfield Seam underground, CHPP and train loading system operations (with train movement).

Table 4.16: WAMBO OPERATIONAL $L_{Aeq,15minute}$ dB EIS PREDICTIONS, YEAR 9

Location	Adverse SE Wind Summer, Autumn, Spring - Night	Adverse Inversion W Wind Winter - Night
N01, Lambkin	21	35
N03, Kelly	57 [3]	56 [3]
N16, Muller	37 [1]	25
N23, Redmanvale Road, Thelander	40 [2]	18

Source: Wambo EIS (June 2003)

Notes from Table 5.4.1 of EIS:

1. *Marginal Noise Management Zone 1 to 2 dBA above project specific criteria;*
2. *Moderate Noise Management Zone 3 to 5 dBA above project specific criteria; and*
3. *Noise Affectation Zone >5 dBA above project specific criteria.*

Table 3.2.3 of the EIS details applicable periods for predicted noise levels. This table has been reproduced below. It should be noted that data in Table 4.17 and Table 4.18 in this report detail the differences against predicted levels for the relevant seasons and periods. This comparison addresses wind speed, wind direction and temperature gradient. Air temperature and relative humidity have not been included in the comparison.

Table 3.2.3 Non-Adverse (Calm) and Adverse Noise Modelling Meteorological Parameters

Season	Period	Air Temp	Relative Humidity	Wind Velocity[1]	Temperature Gradient[1]
Non-Adverse Annual	Daytime	18°C	60%	0 m/s	0°C/100 m
Adverse Summer Autumn Spring	Evening and Night-time	12°C	75%	SE 3 m/s	0°C/100 m
Adverse Winter	Evening and Night-time	6°C	90%	W 2 m/s	3°C/100 m

Note 1: NSW INP (2000) default adverse wind speed 3 m/s and default inversion 3°C/100m plus 2 m/s wind.

Source: Wambo EIS (June 2003)

4.6.1 Year 9 Comparison

Measured operational levels have been compared to the predicted levels for Year 9 in the EIS for the relevant meteorological conditions. In the tables below, a positive difference is where the measured level is greater than the predicted level and a negative difference is where the measured levels are less than the predicted level. Notation used in the tables to denote differences is irrespective of the integer value sign. For example, the notation >-17 means the values are more than 17 dB less than the predicted level.

Table 4.17 provides the difference between measured and predicted levels with 3 m/s winds from the south east (SE) during the night period in summer, autumn and spring.

Table 4.17: 2017 WAMBO OPERATIONAL $L_{Aeq,15minute}$ dB DIFFERENCE AGAINST PREDICTED SE WIND CONDITIONS DURING SUMMER, AUTUMN AND SPRING – NIGHT, YEAR 9[1,2,4]

Location	Jan 17	Feb 17	Mar 17	Apr 17	May 17	Sep 17	Oct 17	Nov 17	Dec 17
N01, Lambkin[5]	IA	NR	IA[3]	IA[3]	NR	NR	NR	NR	NR
N03, Kelly[6]	-16[3]	NR	NR	NR	NR	NR	NR	NM	NR
N16, Muller	0	NR	-4[3]	NR	NR	NR	NR	1	-5
N23, Redmanvale Road, Thelander	-15	NR	-7[3]	NM[3]	NR	NR	NR	NM	NM[3]

Notes:

1. *NR denotes met conditions not relevant, NA denotes not applicable, IA denotes conditions relevant but Wambo inaudible during monitoring, NM denotes conditions relevant but Wambo not measurable during monitoring;*
2. *SE wind conditions assumes winds at speeds between 0.1 and 3.0 m/s from a wind direction of 112.5 to 157.5 degrees during monitoring. Assumes no inversion conditions, i.e. the VTG is less than -0.5 °C/100m (equivalent to stability categories A to D) during monitoring. All met data is taken from a height of 10 metres (meteorological station);*
3. *Wind conditions relevant, however, VTG is positive (greater than 0 degrees per 100 metres) during monitoring;*
4. *Measurements during Summer, Autumn and Spring only;*
5. *This property has been acquired by another mine, and, was previously acquisition (by Wambo) on request; no criteria applied there during 2017; and*
6. *Acquisition upon request.*

Table 4.18 provides the difference between measured and predicted levels with up to 2 m/s winds from the west (W) and a 3 degree per 100 metre vertical temperature gradient (VTG) during the night period in winter only.

Table 4.18: 2017 WAMBO OPERATIONAL $L_{Aeq,15minute}$ dB DIFFERENCE AGAINST PREDICTED W WIND CONDITIONS DURING WINTER - NIGHT, YEAR 9[1,2,4]

Location	June 17	July 17	August 17
N01, Lambkin[5]	NR	NR	NR
N03, Kelly[6]	NR	NR	NR
N16, Muller	NR	NR	NR
N23, Redmanvale Road, Thelander	NR	NR	NR

Notes:

1. *NR denotes met conditions not relevant, NA denotes not applicable, IA denotes conditions relevant but Wambo inaudible during monitoring, NM denotes conditions relevant but Wambo not measurable during monitoring;*
2. *W wind conditions assumes winds at speeds between 0.1 and 2.0 m/s from a wind direction of 247.5 to 292.5 degrees during monitoring. Inversion conditions assumes a 3°C/100m VTG during monitoring. All met data is taken from a height of 10 metres (meteorological station);*
3. *Wind from W direction, however all other meteorological conditions not relevant;*
4. *Measurements during Winter only;*
5. *This property has been acquired by another mine, and, was previously acquisition (by Wambo) on request; no criteria applied there during 2017; and*
6. *Acquisition upon request.*

As shown in the tables above, a comparison of predicted and measured levels from Wambo Year 9 operation shows very limited measurements that fall within meteorological conditions predicted. This comparison does not take into account operational activities at the time of monitoring compared to predicted scenarios.

5 CONCLUSION

5.1 Attended Noise Monitoring

Noise levels from WCM complied with the relevant criteria at all sites during Quarter 1 and 4, 2017 attended monitoring. The following exceedances were measured during Quarter 2 and 3, 2017:

- On 13 June 2017 at 22:40, WCM exceeded the $L_{Aeq,15minute}$ criterion at N16 by 1 dB. An exhaust, engine and fan continuum from WCM was audible during the measurement, generating a site only L_{Aeq} of 41 dB. A surge in engine noise generated the $L_{A1,1minute}$ of 49 dB. The OCE was contacted at the completion of this measurement and advised of elevated levels. The OCE advised that an excavator working in an exposed area had ceased operation. A remeasure was then undertaken with resulting levels below the relevant limits.
- On 28 August 2017, at 22:41, WCM exceeded the $L_{Aeq,15minute}$ and $L_{A1,1minute}$ criteria at N16 by 1 dB respectively. An engine continuum from WCM was audible throughout the measurement. Track noise, equipment scrape, squeal and whine, rear dump truck transmission noise and quackers were also noted. These sources generated a site only L_{Aeq} of 41 dB. Equipment whine generated the site only $L_{A1,1minute}$ of 51 dB. As WCM only levels were greater than the L_{Aeq} and $L_{A1,1minute}$ criteria, WCM's CHPP Control Room was contacted in accordance with the exceedance procedure. A remeasure was then undertaken with resulting levels below the relevant limits.

There were no changes to train refuelling procedures so no monitoring for the WCRS was undertaken during 2017.

It is noted that wind speeds and/or temperature inversion conditions were at levels greater than which development consent conditions would apply for WCM activities in some instances.

5.2 Site Noise Level Trends

There have been no significant changes in noise level trends over the past three years.

5.3 Comparison with EIS

Predicted noise levels from Year 9 were compared against actual noise levels during 2017. Results of the comparison indicate that meteorological conditions included in the EIS modelled predictions did not regularly occur during attended monitoring. When meteorological conditions were relevant, results show that measured noise levels from WCM were generally well under the predicted levels.

Global Acoustics Pty Ltd

APPENDIX

A DEVELOPMENT CONSENT

A.1 WAMBO COAL MINE DEVELOPMENT CONSENT

A.1.1 Relevant Wambo Coal Mine Development Consent Conditions

The relevant sections of the December 2017 modified conditions are reproduced below:

SCHEDULE 4
SPECIFIC ENVIRONMENTAL CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from the landowner of the land listed in Table 1, the Applicant must acquire the land in accordance with the procedures in conditions 9-11 of schedule 5:

Table 1: Land subject to acquisition upon request

2 – Lambkin	23A & B - Kannar
13C - Skinner	31A,B,C & D - Fisher
19A & B – Kelly	51 – Hawkes
22 – Henderson	56 - Haynes

Note: For more information on the numbering and identification of properties used in this consent, see Attachment 1 of the EIS for the Wambo Development Project. Lands titled 23A & B – Kannar, 31A,B,C & D – Fisher, 51 – Hawkes and 56 – Haynes have been acquired and are now mine-owned.

[1]NOISE

Noise Impact Assessment Criteria

6. The Applicant must ensure that the noise generated by the Wambo Mining Complex does not exceed the noise impact assessment criteria presented in Table 9.

Table 9: Noise impact assessment criteria dB(A))

Day $L_{Aeq(15\ minute)}$	Evening/Night $L_{Aeq(15\ minute)}$	Night $L_{A1(1\ minute)}$	Land Number
35	41	50	94 – Curlewis
			3 – Birrell

[1] Incorporates EPA GTAs

Day $L_{Aeq(15\ minute)}$	Evening/Night $L_{Aeq(15\ minute)}$	Night $L_{A1(1\ minute)}$	Land Number
35	40	50	4B – Circosta 15B - McGowen/Caslick 16 – Cooper 23C – Kannar 25 – Fenwick 28A & B – Garland 33 -Thelander/O'Neill 39 – Northcote 40 – Muller 254A – Algie
35	39	50	5 – Strachan 6 - Merrick 7 - Maizey 37 - Lawry 48 - Ponder
35	38	50	1 - Brosi 17 - Carter 18 - Denney 38 - Williams 49 - Oliver 63 - Abrocuff 75 - Barnes 91 - Bailey
35	37	50	27 - Birralee 43 - Carmody 137 - Woodruff 163 - Rodger/Williams 246 - Bailey
35	36	50	13B - Skinner 178 - Smith 188 - Fuller 262A, B & C - Moses
35	35	50	All other residential or sensitive receptors, excluding the receptors listed in condition 1 above

Notes:

- Noise generated by the Wambo Mining Complex is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy

Land Acquisition Criteria

7. If the noise generated by the Wambo Mining Complex exceeds the criteria in Table 10, the Applicant must, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in conditions 9-11 of schedule 5.

Table 10: Land acquisition criteria dB(A)

Day/Evening/Night $L_{Aeq(15\ minute)}$	Property
43	94 - Curlewis
	23C – Kannar
	254A - Algie
40	All other residential or sensitive receptor, excluding the receptors listed in condition 1 above

Note: Noise generated by the Wambo Mining Complex is to be measured in accordance with the notes presented below Table 9 above. Property 23C – Kannar has been acquired and is now mine-owned.

Operating Conditions

8. The Applicant must:
   (a) implement best management practice to minimise the operational, low frequency and traffic noise of the Wambo Mining Complex;

(b) operate a comprehensive noise management system for the Wambo Mining Complex that uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day to day planning of mining operations and the implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this consent;
(c) maintain the effectiveness of noise suppression equipment (if fitted) on plant at all times and ensure defective plant is not used operationally until fully repaired;
(d) ensure that noise attenuated plant (if used) is deployed preferentially in locations relevant to sensitive receivers;
(e) minimise the noise impacts of the Wambo Mining Complex during meteorological conditions when the noise limits in this consent do not apply;
(f) co-ordinate the noise management for the Wambo Mining Complex with the noise management at nearby mines (including HVO South, HVO North and Mt Thorley Warkworth mines) to minimise the cumulative noise impacts of these mines and the Wambo Mining Complex,

to the satisfaction of the Secretary.

Noise Management Plan

9. The Applicant must prepare a Noise Management Plan for the Wambo Mining Complex to the satisfaction of the Secretary. This plan must:
   (a) be prepared in consultation with the EPA, and submitted to the Secretary for approval by the end of June 2013;
   (b) describe the measures that would be implemented to ensure:
   - best management practice is being employed;
   - the noise impacts of the Wambo Mining Complex are minimised during meteorological conditions when the noise limits in this consent do not apply; and
   - compliance with the relevant conditions of this consent;

   (c) describe the proposed noise management system in detail;
   (d) include a monitoring program that:
   - uses a combination of real-time and supplementary attended monitoring measures to evaluate the performance of the Wambo Mining Complex;
   - adequately supports the proactive and reactive noise management system for the Wambo Mining Complex;
   - includes a protocol for determining exceedances of the relevant conditions in this consent;
   - evaluates and reports on the effectiveness of the noise management system for the Wambo Mining Complex;
   - provides for the annual validation of the noise model for the Wambo Mining Complex; and

   (e) include a protocol that has been prepared in consultation with the owners of nearby mines (including HVO South, HVO North and Mount Thorley Warkworth mines) to minimise the cumulative noise impacts of these mines and the Wambo Mining Complex.

   The Applicant must implement the approved management plan as approved from time to time by the Secretary.

A.2 WAMBO RAIL SPUR DEVELOPMENT CONSENT

The relevant sections of the February 2012 modified conditions for the rail spur are reproduced below:

SCHEDULE 4
GENERAL ENVIRONMENTAL CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from the landowner of the land listed in Table 1, the Applicant shall acquire the land in accordance with the procedures in conditions 1-3 of schedule 5.

Table 1: Land subject to acquisition upon request

19 - L Kelly	55 - E & C Burley

Note: For more information on the numbering and identification of properties used in this consent, see Attachment 1A and Attachment 1B of the SEE for the Alterations to the Wambo Development Project – Rail and Train Loading Infrastructure.

2. While the land listed in Table 1 is privately owned, the Applicant shall implement all practicable measures to ensure that the impacts of the development comply with the predictions in the SEE, and the relevant conditions in this consent, at any residence on this land, to the satisfaction of the Director-General.

[1]NOISE

Noise Impact Assessment Criteria

3. The Applicant shall ensure that noise generated by the development, combined with noise generated by any development in the Wambo Mining Complex, does not exceed the noise criteria provided in Table 2, unless higher noise criteria are specified in the consent for the Wambo Coal Mine (DA 305-7-2003).

Table 2: Noise impact assessment criteria dB(A)

Day $L_{Aeq(15\ minute)}$	***Evening/Night*** $L_{Aeq(15\ minute)}$	***Night*** $L_{A1(1\ minute)}$	***Land Number***
35	*35*	*50*	*All private residential or sensitive receptors, excluding the receptors listed in Table 1*

Notes:

- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*
- *For this condition to apply, the exceedance of the criteria must be systemic.*

Construction Hours

4. The Applicant shall ensure that all construction work is carried out from 7 am to 6 pm Monday to Saturday (inclusive) and 8 am to 6 pm Sundays and Public Holidays.

Operating Hours

5. The Applicant shall:
   (a) take all practicable measures to minimise train movements at the development on Friday evening (6 pm-9 pm) and Sunday morning (9 am-12 am);
   (b) report on the implementation and effectiveness of these measures,
   to the satisfaction of the Director-General.

Rail Noise

6. The Applicant shall seek to ensure that its rail spur is only accessed by locomotives that are approved to operate on the NSW rail network in accordance with noise limits L6.1 to L6.4 in RailCorp's EPL (No. 12208) and ARTC's EPL (No. 3142) or a Pollution Control Approval issued under the former *Pollution Control Act 1970*.

Noise Monitoring

7. The Applicant shall monitor the noise generated by the development, and noise generated by the Wambo Mine, in general accordance with the Noise Management Plan for the Wambo Mining Complex and the *NSW Industrial Noise Policy*.

7A. By 31 May 2012, the Applicant shall review and update the Noise Management Plan for the Wambo Mining Complex, including a noise monitoring protocol for evaluating compliance with the criteria in condition 3 above.

7B. During the first 12 months of operation of the Rail Refuelling Facility, the Applicant must conduct attended noise monitoring at the nearest private receptor during refuelling events, no less often than every three months.

A.3 WAMBO RAIL LINE DEVELOPMENT CONSENT

The relevant sections of the 1998 conditions for the rail line are reproduced below:

Operational Noise

8. The Applicant shall ensure noise emissions from the operations of the railway line when measured at any residence along the railway line corridor shall not exceed the following EPA criteria:

(a) planning level of $L_{Aeq\,24hr}$ 55dBA; and

(b) maximum passby level of L_{Amax} 85dBA

The noise criteria levels shall be measured under prevailing weather conditions in accordance with EPA requirements and to be consistent with EPA's requirements as applied to the New South Wales coal industry, or otherwise agreed to by the EPA.

9. Prior to the commencement of operations, the Applicant shall prepare in consultation with the EPA and Singleton Shire Council an Operational Noise Management Plan. The Operation Noise Management Plan shall demonstrate that all practical design and noise mitigation methods have been undertaken to achieve the noise levels specified in Condition 8.

APPENDIX C

ENVIRONMENTAL MONITORING DATA SUMMARIES

Date & Time	Blast ID	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/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec
13/01/2017	WMB093	99.30	0.05	98.30	0.06	97.30	0.03	105.40	0.63	96.10	0.73
16/01/2017	WMB095	95.30	0.29	107.60	2.06	91.20	0.06	87.70	0.02	80.40	0.02
19/01/2017	WMB098	101.30	0.46	108.10	2.09	98.10	0.09	108.30	0.04	94.50	0.03
20/01/2017	WMB09A	111.00	0.09	107.40	0.12	107.60	0.06	109.40	0.58	92.90	0.22
23/01/2017	WMB09F	91.00	0.05	94.70	0.04	91.20	0.03	108.40	0.54	95.90	0.33
25/01/2017	WMB09K	100.80	0.52	111.30	1.62	90.70	0.08	97.40	0.02	86.60	0.02
30/01/2017	WMB0A7	110.80	0.03	101.20	0.03	90.90	0.03	110.60	0.37	101.80	0.21
2/02/2017	WMB09P	101.30	0.19	109.30	1.60	106.50	0.06	108.00	0.02	93.10	0.01
4/02/2017	WMB09R	107.50	0.19	104.80	0.13	102.80	0.10	112.00	1.45	106.10	0.67
9/02/2017	WMB0CT	99.40	0.10	113.20	0.66	94.30	0.03	86.90	0.01	71.50	0.01
10/02/2017	WMB0A5	95.40	0.03	100.40	0.04	93.10	0.02	104.80	0.21	100.00	0.26
10/02/2017	WMB0A6	96.40	0.15	105.30	0.18	95.90	0.21	107.10	1.14	101.70	0.49
17/02/2017	WMB0AG	100.50	0.04	100.40	0.03	98.80	0.05	106.00	0.23	101.00	0.27
17/02/2017	WMB0AH	97.60	0.03	104.80	0.05	100.90	0.03	106.50	0.25	100.50	0.48
17/02/2017	WMB0CU	104.80	0.03	100.30	0.06	96.70	0.02	104.10	0.35	96.20	0.09
21/02/2017	WMB0AK	94.30	0.15	108.90	0.71	98.50	0.04	89.60	0.01	82.60	0.01
23/02/2017	WMB0AL	85.90	0.15	91.70	0.12	87.10	0.08	106.90	0.86	98.60	0.71
12/03/2017	WMB0B5	93.40	0.08	97.30	0.07	95.60	0.08	110.80	0.54	107.00	0.55
12/03/2017	WMB0B6	103.20	0.15	106.70	0.14	101.50	0.12	115.10	1.29	106.30	0.61
13/03/2017	WMB0B7	104.50	0.19	107.60	0.12	103.70	0.13	107.70	1.66	102.50	1.25
13/03/2017	WMB0B8	93.40	0.15	94.1	0.19	89.70	0.15	109.20	0.80	103.20	0.43
21/03/2017	WMB0BI	91.10	0.05	94.50	0.05	89.30	0.04	109.60	0.67	101.80	0.31
22/03/2017	WMB0BL	105.60	0.12	101.40	0.09	105.70	0.05	105.30	0.79	99.80	0.82

Date & Time	Blast ID	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/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec
29/03/2017	WMB0BQ	98.40	0.12	103.00	0.07	101.20	0.08	108.70	0.62	101.10	0.60
10/04/2017	WMB0C8	112.90	0.15	99.60	0.12	94.60	0.12	96.40	1.04	105.20	1.44
10/04/2017	WMB0C9	106.10	0.16	109.20	0.12	88.70	0.09	107.80	2.06	91.00	0.82
19/04/2017	WMB0CP	84.10	0.10	89.20	0.20	84.20	0.07	102.70	0.29	91.70	0.17
26/04/2017	WMB0CW	108.60	0.08	103.40	0.08	103.80	0.06	111.50	0.67	105.60	0.67
26/04/2017	WMB0CX	102.60	0.04	104.90	0.04	101.90	0.03	112.40	0.24	98.70	0.23
26/04/2017	WMB0CY	118.80	0.19	102.40	0.16	115.90	0.08	110.90	0.78	108.00	0.54
1/05/2017	WMB0D5	102.00	0.19	100.20	0.14	103.30	0.10	100.60	1.08	96.20	1.27
2/05/2017	WMB0D8	104.20	0.06	98.00	0.05	95.60	0.04	108.50	0.46	101.30	0.23
2/05/2017	WMB0D9	94.90	0.14	94.60	0.19	94.40	0.08	102.30	0.72	96.20	0.51
6/05/2017	WMB0DD	110.50	0.17	119.30	0.13	107.40	0.07	118.40	0.70	107.40	0.29
11/05/2017	WMB0DG	95.50	0.12	96.90	0.11	96.10	0.06	108.10	0.60	106.80	0.66
11/05/2017	WMB0DH	101.30	0.04	101.70	0.06	102.60	0.04	118.50	0.42	106.50	0.42
23/05/2017	WMB0DY	101.00	0.17	101.00	0.10	99.60	0.07	110.70	0.44	103.90	0.26
23/05/2017	WMB0DZ	100.20	0.05	100.20	0.04	99.20	0.02	107.80	0.18	100.00	0.20
23/05/2017	WMB0E0	104.00	0.07	105.50	0.21	105.70	0.04	98.80	0.40	96.00	0.48
29/05/2017	WMB0E6	95.40	0.08	93.40	0.07	93.10	0.06	96.00	0.54	91.90	0.47
29/05/2017	WMB0E7	99.70	0.18	107.90	0.22	99.20	0.14	107.20	0.67	96.30	0.44
5/06/2017	WMB0ED	95.10	0.21	96.90	0.14	91.80	0.16	104.70	1.44	100.50	1.66
5/06/2017	WMB0EE	95.30	0.19	100.00	0.13	89.50	0.13	105.10	0.85	95.90	0.62
13/06/2017	WMB0EK	110.60	0.46	115.90	1.86	92.70	0.12	103.60	0.03	91.00	0.04
15/06/2017	WMB0EL	94.40	0.13	96.50	0.16	92.50	0.08	106.50	0.53	98.10	0.27
15/06/2017	WMB0EM	89.20	0.05	89.20	0.04	90.60	0.03	109.30	0.42	105.40	0.43

Date & Time	Blast ID	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec
23/06/2017	WMB0ET	98.00	0.07	102.90	0.07	99.00	0.04	106.90	0.26	96.50	0.17
23/06/2017	WMB0EU	103.40	0.09	105.60	0.07	107.60	0.04	102.20	0.50	98.30	0.55
30/06/2017	WMB0F2	93.50	0.16	95.10	0.10	92.30	0.08	103.50	0.88	97.80	0.83
30/06/2017	WMB0FD	90.20	0.11	97.50	0.22	85.90	0.06	90.30	0.08	83.30	0.09
3/07/2017	WMB0F5	100.40	0.03	102.70	0.03	100.10	0.01	109.80	0.10	96.30	0.07
5/07/2017	WMB0FA	113.40	0.22	101.90	0.23	97.20	0.17	98.00	0.99	81.00	1.31
6/07/2017	WMB0FC	97.30	0.04	94.50	0.05	92.10	0.03	99.60	0.41	69.60	0.49
14/07/2017	WMB0FO	101.60	0.16	103.90	0.08	103.70	0.07	104.30	0.77	96.40	0.78
14/07/2017	WMB0FP	103.00	0.05	100.00	0.10	100.60	0.04	104.20	0.40	93.20	0.34
24/07/2017	WMB0FZ	100.30	0.13	98.70	0.09	100.80	0.07	104.00	0.82	72.30	1.07
24/07/2017	WMB0G0	101.80	0.19	106.00	0.13	101.50	0.13	106.40	0.65	71.50	0.47
31/07/2017	WMB0G9	109.00	0.07	97.40	0.04	95.30	0.05	99.20	0.30	83.10	0.31
31/07/2017	WMB0GA	105.60	0.19	100.90	0.10	100.00	0.16	102.40	1.18	87.10	1.38
9/08/2017	WMB0GI	96.90	0.06	95.30	0.06	97.90	0.07	100.20	0.44	71.50	0.45
9/08/2017	WMB0GJ	94.90	0.07	93.10	0.05	86.70	0.04	99.20	0.79	74.40	1.13
9/08/2017	WMB0GK	95.70	0.05	91.20	0.05	91.10	0.03	102.30	0.39	69.60	0.43
14/08/2017	WMB0GO	100.80	0.07	100.90	0.05	98.70	0.03	111.50	0.21	81.30	0.12
14/08/2017	WMB0GP	95.20	0.05	98.30	0.07	94.90	0.02	106.70	0.21	72.30	0.12
23/08/2017	WMB0H1	94.80	0.08	96.00	0.06	95.10	0.05	94.90	0.37	67.10	0.40
23/08/2017	WMB0H2	90.50	0.06	91.10	0.06	92.30	0.05	97.70	0.63	69.60	0.75
23/08/2017	WMB0H3	93.60	0.06	88.90	0.04	91.40	0.05	109.20	0.49	71.50	0.54
4/09/2017	WMB0GI	102.90	0.04	96.30	0.04	113.00	0.04	108.30	0.15	77.10	0.09
4/09/2017	WMB0GJ	99.10	0.08	95.90	0.07	93.40	0.06	98.10	0.88	72.30	0.62

Date & Time	Blast ID	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec
12/09/2017	WMB0GK	98.10	0.11	100.50	0.08	98.30	0.06	99.30	0.54	68.40	0.44
12/09/2017	WMB0GO	99.70	0.06	101.00	0.08	99.40	0.04	109.30	0.49	74.40	0.35
19/09/2017	WMB0GP	107.50	0.05	110.30	0.04	93.50	0.03	98.50	0.19	76.10	0.10
25/09/2017	WMB0H1	104.40	0.31	98.70	0.20	104.40	0.19	100.00	0.85	68.40	0.65
29/09/2017	WMB0H2	108.90	0.05	98.60	0.04	103.30	0.04	104.80	0.59	72.30	0.59
9/10/2017	WMB0I2	108.50	0.22	109.00	0.12	104.40	0.12	104.80	1.02	88.10	1.09
12/10/2017	WMB0I7	115.70	0.57	103.90	0.09	107.60	0.17	95.90	0.04	104.20	0.04
18/10/2017	WMB0IE	103.30	0.42	93.80	0.06	97.00	0.11	108.50	0.03	73.10	0.03
20/10/2017	WMB0IM	97.70	0.04	96.90	0.05	98.90	0.04	102.70	0.46	97.70	0.41
20/10/2017	WMB0IN	110.40	0.13	110.60	0.08	110.70	0.06	108.70	0.90	96.90	0.83
30/10/2017	WMB0IW	99.20	0.02	94.80	0.05	99.60	0.02	107.20	0.20	99.30	0.23
30/10/2017	WMB0IX	101.00	0.13	99.70	0.11	110.00	0.08	104.30	1.65	100.90	1.05
3/11/2017	WMB0J4	100.30	0.06	96.80	0.04	98.20	0.04	104.00	0.80	98.60	0.54
3/11/2017	WMB0J5	105.50	0.05	104.90	0.06	106.00	0.05	104.20	0.74	98.50	0.73
16/11/2017	WMB0JE	78.40	0.01	78.20	0.01	78.90	0.01	86.70	0.04	86.20	0.04
24/11/2017	WMB0JP	97.80	0.02	92.00	0.15	101.70	0.01	107.30	0.07	104.70	0.06
24/11/2017	WMB0JM	102.90	0.15	102.80	0.14	104.20	0.13	111.20	2.75	110.50	1.87
24/11/2017	WMB0JN	102.00	0.27	93.80	0.07	100.30	0.07	93.90	0.02	91.20	0.02
29/11/2017	WMB0JW	92.90	0.03	94.50	0.02	87.10	0.02	105.20	0.13	107.00	0.12
1/12/2017	WMB0K1	98.80	0.07	95.90	0.20	95.80	0.04	101.80	0.58	99.10	0.61
1/12/2017	WMB0K2	93.30	0.05	94.40	0.03	100.00	0.01	101.30	0.11	93.00	0.05
7/12/2017	WMB0K6	94.90	0.09	94.60	0.07	93.60	0.07	105.00	0.68	100.40	0.77
15/12/2017	WMB0KN	103.30	0.32	89.60	0.10	94.40	0.14	99.90	0.04	99.50	0.03

Date & Time	Blast ID	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/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec
19/12/2017	WMB0KR	98.60	0.12	105.60	0.11	95.90	0.05	100.90	0.35	95.40	0.19
20/12/2017	WMB0KY	102.80	0.02	88.50	0.10	98.60	0.01	96.10	0.11	93.20	0.12
29/12/2017	WMB0L0	95.50	0.08	96.20	0.08	99.00	0.07	104.70	0.50	100.60	0.23
29/12/2017	WMB0L1	97.00	0.02	90.90	0.02	91.70	0.01	105.30	0.16	100.00	0.08

Date	D01 Ash Residue (g/m^2 /month)	D01 Insoluble Solids (g/m^2 /month)	D01 AR/IS Ratio	D03 Ash Residue (g/m^2 /month)	D03 Insoluble Solids (g/m^2 /month)	D03 AR/IS Ratio	D07 Ash Residue (g/m^2 /month)	D07 Insoluble Solids (g/m^2 /month)	D07 AR/IS Ratio
Jan-17	2.5	7.4	33.78	1.5	4.5	33.33	2.9	5.1	56.86
Feb-17	3	13.7	21.9	3.5	4.6	76.09	3	4.5	66.67
Mar-17	2	8	25	3.5	6.8	51.47	21	23.3	90.13
Apr-17	8.7	25.1	34.66	5.1	8.1	62.96	3.3	5.5	60
May-17	4.9	19.7	24.87	2	2.4	83.33	1.5	2	75
Jun-17	2.6	6.9	37.68	1.5	2.3	65.22	4.3	5.3	81.13
Jul-17	9.1	25.4	35.82	3.9	6.2	62.9	1.1	1.8	61.11
Aug-17	4.2	12.7	33	1.6	3.2	50	2.3	3.5	65
Sep-17	2.6	11	23.64	1.1	3.1	35.48	2	2.6	76.92
Oct-17	2	4.4	45.4	2.8	4.7	59.5	3.9	5.5	70.9
Nov-17	2.1	3.3	63	2.2	3.6	61	2.5	3.6	69
Dec-17	5.7	9.6	59.3	4.4	6.5	67.6	3.9	5.3	73.5

Average	4.12	12.27	36.50	2.76	4.67	59.07	4.31	5.67	70.52

Date	D09 Ash Residue (g/m^2 /month)	D09 Insoluble Solids (g/m^2 /month)	D09 AR/IS Ratio	D11 Ash Residue (g/m^2 /month)	D11 Insoluble Solids (g/m^2 /month)	D11 AR/IS Ratio	D12 Ash Residue (g/m^2 /month)	D12 Insoluble Solids (g/m^2 /month)	D12 AR/IS Ratio
Jan-17	2.9	6.4	45.31	1.2	1.8	66.67	1.9	3	63.33
Feb-17	1.8	2.4	75	1.5	2.4	62.5	2.7	3.8	71.05
Mar-17	3.3	4.2	78.57	1.8	2.4	75	3.1	4.2	73.81
Apr-17	1.8	4.3	41.86	1.8	2.5	72	2.1	3.1	67.74
May-17	1.2	1.5	80	1.2	2.3	52.17	1.4	1.8	77.77
Jun-17	1.3	2.2	59.09	1	1.6	62.5	2.1	3.2	65.63
Jul-17	1.3	2	65	0.5	1.6	31.25	1.4	1.9	73.68
Aug-17	3.2	6	53	1.3	2.2	59	1.6	2.5	64
Sep-17	2.5	3.7	67.57	1.6	2.1	76.19	1.6	3.7	43.24
Oct-17	2.1	3	70	1.5	2.3	65.2	9.1	13.3	68.4
Nov-17	1.2	1.6	75	1.3	1.9	68	3	6.7	44
Dec-17	1.6	2.2	72.7	1.5	2.3	65.2	5.6	9.8	57.1
Average	2.02	3.29	65.26	1.35	2.12	62.97	2.97	4.75	64.15

Date	D17			D19			D20		
	Ash Residue (g/m^2 /month)	Insoluble Solids (g/m^2 /month)	AR/IS Ratio	Ash Residue (g/m^2 /month)	Insoluble Solids (g/m^2 /month)	AR/IS Ratio	Ash Residue (g/m^2 /month)	Insoluble Solids (g/m^2 /month)	AR/IS Ratio
Jan-17	0.9	2	45	1.3	1.9	68.42	1	1.6	62.5
Feb-17	0.9	1.2	75	2.8	4.4	63.64	1	1.4	71.43
Mar-17	1.6	2	80	2.8	3.9	71.79	1.6	2.2	72.73
Apr-17	2.8	4.2	66.67	1.4	2.5	56	0.9	1.9	47.37
May-17	1.2	1.8	66.66	1.6	2.2	72.72	0.8	1.1	72.72
Jun-17	1.1	1.9	57.89	1.9	2.9	65.52	0.9	1.4	64.29
Jul-17	0.3	0.5	60	0.8	1.5	53.33	0.7	1	70
Aug-17	0.4	0.6	66	1.5	2.4	62	1.2	1.9	63
Sep-17	0.8	0.8	100	1.8	2.4	75	1.3	1.8	72.22
Oct-17	1.4	2.4	58.3	3.6	5.8	62	1.5	2.4	62.5
Nov-17	0.9	1.5	60	3.2	4.5	71	1	1.6	62
Dec-17	1.5	1.9	78.9	5.1	7.3	69.8	1.4	1.8	77.7
Average	1.15	1.73	67.87	2.32	3.48	65.94	1.11	1.68	66.54

Date	D21 Ash Residue (g/m^2 /month)	D21 Insoluble Solids (g/m^2 /month)	D21 AR/IS Ratio	D22 Ash Residue (g/m^2 /month)	D22 Insoluble Solids (g/m^2 /month)	D22 AR/IS Ratio	D23 Ash Residue (g/m^2 /month)	D23 Insoluble Solids (g/m^2 /month)	D23 AR/IS Ratio
Jan-17	0.8	1.2	66.67	1.1	1.5	73.33	2.3	5.7	40.35
Feb-17	1.8	2.3	78.26	2.1	2.9	72.41	1.6	2.8	57.14
Mar-17	1.4	1.8	77.78	2.4	3.3	72.73	28.6	38.9	73.52
Apr-17	0.7	1.5	46.67	1.6	7.6	21.05	3.3	5.6	58.93
May-17	1	1.3	76.92	2.4	2.9	82.75	1.1	1.4	78.57
Jun-17	1.2	1.8	66.67	5.8	7.1	81.69	0.6	0.9	66.67
Jul-17	0.5	0.6	83.33	3.7	6.2	59.67	0.7	1.6	43.75
Aug-17	0.5	0.8	62	1	1.8	55	1.3	2.1	61
Sep-17	1.2	1.7	70.59	1.4	1.8	77.78	1	1.3	76.92
Oct-17	1.6	2.3	69.5	2.3	3	76.6	2	3.2	62.5
Nov-17	2	2.8	71	1.8	2.2	81	2.1	2.8	75
Dec-17	1.7	2.3	73.9	2.7	3.6	75	2	2.6	76.9
Average	1.20	1.70	70.27	2.36	3.66	69.08	3.88	5.74	64.27

Date	D24 Ash Residue (g/m^2 /month)	D24 Insoluble Solids (g/m^2 /month)	D24 AR/IS Ratio	D25 Ash Residue (g/m^2 /month)	D25 Insoluble Solids (g/m^2 /month)	D25 AR/IS Ratio	D26 Ash Residue (g/m^2 /month)	D26 Insoluble Solids (g/m^2 /month)	D26 AR/IS Ratio
Jan-17	0.8	1.9	42.11	2.5	3.3	75.76	1.4	2.5	56
Feb-17	0.7	1.2	58.33	2.1	2.8	75	1.6	2.3	69.57
Mar-17	1.2	1.7	70.59	3.2	4.1	78.05	1.8	2.4	75
Apr-17	1	3	33.33	1.5	2.1	71.43	0.9	1.5	60
May-17	0.5	0.8	62.5	1.6	1.9	84.21	1.4	1.7	82.35
Jun-17	0.6	0.7	85.71	2.1	2.7	77.78	0.8	1.1	72.73
Jul-17	0.2	0.2	100	0.7	1	70	1.1	1.6	68.75
Aug-17	0.3	0.5	60	0.8	1.2	66	1.5	2.8	53
Sep-17	0.5	0.7	71.43	1.3	1.6	81.25	1.2	1.5	80
Oct-17	0.8	2.2	36.3	2.3	3.3	69.6	1.4	1.9	73.6
Nov-17	1	1.6	62	2	2.4	83	1.4	1.9	73
Dec-17	-*	-*	-*	2.6	3.5	74.2	2.2	4.5	48.8
Average	0.69	1.32	62.03	1.89	2.49	75.52	1.39	2.14	67.73

* Upon collection the sample bottle was found to be broken. No sample was able to be obtained for this sample period.

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
1/01/2017	23.00	19.56	19.60	14.76	20.70	16.55	22.00	16.53
2/01/2017	17.16	18.42	11.45	13.15	15.60	15.17	14.00	14.70
3/01/2017	18.40	19.05	14.20	14.00	15.70	14.95	15.70	15.05
4/01/2017	19.70	19.70	13.80	13.80	14.20	14.20	14.40	14.40
5/01/2017	18.60	19.15	11.20	12.50	12.80	13.50	14.50	14.45
6/01/2017	20.90	19.73	14.30	13.10	15.30	14.10	16.20	15.03
7/01/2017	20.70	19.98	12.70	13.00	11.40	13.43	12.40	14.38
8/01/2017	24.80	20.94	18.80	14.16	16.30	14.00	24.70	16.44
9/01/2017	28.30	22.17	27.20	16.33	20.70	15.12	31.20	18.90
10/01/2017	33.80	23.83	28.50	18.07	26.00	16.67	31.20	20.66
11/01/2017	29.90	24.59	32.40	19.86	25.10	17.73	41.90	23.31
12/01/2017	34.60	25.70	28.00	20.77	29.00	18.98	28.00	23.83
13/01/2017	37.80	26.91	38.80	22.57	22.40	19.32	26.50	24.10
14/01/2017	65.30	30.40	27.30	23.00	20.70	19.45	23.20	24.02
15/01/2017	36.30	30.89	29.70	23.56	30.80	20.39	24.20	24.03
16/01/2017	31.10	30.91	30.40	24.08	28.30	21.00	30.90	24.56
17/01/2017	28.90	30.76	25.50	24.19	19.40	20.89	22.70	24.43
18/01/2017	28.60	30.62	30.90	24.63	22.60	21.00	19.10	24.07
19/01/2017	27.50	30.43	22.30	24.49	23.30	21.14	25.00	24.13
20/01/2017	24.66	30.09	18.20	24.12	17.50	20.93	18.40	23.79
21/01/2017	28.50	30.00	23.30	24.07	24.10	21.11	20.40	23.61
22/01/2017	29.60	29.98	20.60	23.89	24.90	21.31	21.20	23.48
23/01/2017	25.70	29.76	21.60	23.78	16.80	21.08	22.90	23.45
24/01/2017	35.30	30.03	22.80	23.73	18.60	20.96	21.00	23.33
25/01/2017	18.00	29.48	13.20	23.25	12.70	20.59	13.90	22.90
26/01/2017	19.90	29.06	16.80	22.97	16.70	20.42	16.40	22.62
27/01/2017	25.20	28.90	14.30	22.61	16.70	20.26	16.10	22.35
28/01/2017	31.90	29.02	21.00	22.54	18.50	20.19	24.10	22.42
29/01/2017	54.90	30.02	23.80	22.59	24.20	20.35	33.80	22.86
30/01/2017	27.20	29.91	23.00	22.61	14.90	20.14	19.80	22.74
31/01/2017	30.00	29.92	27.30	22.78	18.20	20.08	21.60	22.70
1/02/2017	25.50	29.76	17.20	22.58	21.30	20.12	19.20	22.58
2/02/2017	25.03	29.61	16.80	22.39	19.10	20.08	20.80	22.52
3/02/2017	32.80	29.71	19.80	22.31	18.40	20.03	22.60	22.53
4/02/2017	16.60	29.30	26.20	22.43	15.40	19.88	17.50	22.37
5/02/2017	35.40	29.48	25.40	22.52	12.70	19.67	14.40	22.13
6/02/2017	36.90	29.70	30.30	22.75	22.10	19.74	27.10	22.27
7/02/2017	20.80	29.45	16.60	22.57	16.20	19.64	20.30	22.22
8/02/2017	21.00	29.21	14.90	22.36	14.60	19.50	13.80	21.98

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
9/02/2017	21.11	28.99	25.70	22.45	16.20	19.41	21.60	21.97
10/02/2017	40.20	29.29	31.70	22.69	19.90	19.42	25.30	22.06
11/02/2017	47.80	29.76	28.50	22.84	32.00	19.74	35.70	22.41
12/02/2017	48.60	30.23	42.80	23.34	36.50	20.16	39.60	22.84
13/02/2017	28.04	30.18	25.90	23.40	22.40	20.22	23.20	22.85
14/02/2017	35.70	30.31	24.50	23.43	20.60	20.23	21.50	22.82
15/02/2017	24.90	30.19	22.10	23.40	17.70	20.17	19.60	22.74
16/02/2017	45.20	30.53	30.40	23.56	23.90	20.25	27.80	22.86
17/02/2017	38.31	30.70	32.90	23.76	22.88	20.31	32.17	23.06
18/02/2017	21.70	30.51	17.30	23.62	15.70	20.21	16.70	22.93
19/02/2017	17.80	30.23	14.80	23.44	15.20	20.10	16.20	22.78
20/02/2017	31.70	30.27	14.10	23.24	10.40	19.90	12.00	22.56
21/02/2017	39.40	30.45	26.90	23.32	27.00	20.05	31.40	22.74
22/02/2017	32.20	30.49	24.90	23.35	25.10	20.15	26.90	22.82
23/02/2017	33.90	30.55	32.10	23.52	27.20	20.29	35.40	23.07
24/02/2017	37.40	30.69	29.30	23.63	29.80	20.47	34.40	23.29
25/02/2017	14.10	30.37	13.40	23.44	9.90	20.27	17.40	23.17
26/02/2017	16.50	30.12	13.40	23.25	12.20	20.12	17.90	23.08
27/02/2017	17.70	29.89	13.00	23.07	13.80	20.01	19.40	23.01
28/02/2017	11.72	29.57	16.18	22.94	8.02	19.79	12.93	22.83
1/03/2017	11.90	29.26	9.70	22.71	8.10	19.59	11.20	22.63
2/03/2017	19.80	29.09	12.40	22.53	10.90	19.44	13.80	22.47
3/03/2017	8.90	28.75	9.80	22.32	6.60	19.22	10.70	22.27
4/03/2017	6.20	28.37	5.00	22.03	4.50	18.97	5.30	21.99
5/03/2017	9.50	28.06	7.00	21.78	6.40	18.77	6.50	21.74
6/03/2017	13.60	27.83	11.50	21.62	10.30	18.63	15.40	21.64
7/03/2017	13.50	27.60	13.00	21.48	10.90	18.51	17.30	21.57
8/03/2017	13.70	27.39	13.40	21.35	11.70	18.40	15.50	21.47
9/03/2017	13.80	27.18	11.10	21.20	11.20	18.29	14.40	21.36
10/03/2017	15.80	27.01	16.70	21.13	15.10	18.24	18.20	21.32
11/03/2017	19.30	26.89	14.70	21.03	16.20	18.21	20.10	21.30
12/03/2017	24.60	26.86	21.10	21.03	16.30	18.18	28.90	21.41
13/03/2017	27.00	26.86	27.80	21.13	22.10	18.24	31.90	21.56
14/03/2017	23.40	26.81	16.70	21.07	16.80	18.22	20.70	21.55
15/03/2017	16.50	26.66	12.40	20.94	10.30	18.11	13.00	21.43
16/03/2017	7.60	26.40	6.84	20.75	7.50	17.96	10.00	21.27
17/03/2017	12.25	26.21	11.60	20.62	8.50	17.83	13.40	21.16
18/03/2017	17.90	26.09	12.90	20.52	12.90	17.76	13.70	21.06
19/03/2017	13.90	25.93	17.10	20.47	5.30	17.60	11.90	20.94

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
20/03/2017	29.90	25.98	29.20	20.59	16.80	17.59	22.90	20.96
21/03/2017	21.40	25.92	18.40	20.56	13.30	17.53	16.10	20.90
22/03/2017	17.20	25.81	17.20	20.52	8.60	17.42	9.00	20.75
23/03/2017	14.90	25.67	7.00	20.35	10.50	17.33	13.90	20.66
24/03/2017	15.20	25.54	9.00	20.20	10.10	17.24	11.10	20.54
25/03/2017	23.60	25.52	17.20	20.17	16.50	17.23	19.90	20.53
26/03/2017	22.20	25.48	21.60	20.18	20.40	17.27	21.40	20.55
27/03/2017	24.40	25.47	17.20	20.15	15.70	17.25	20.10	20.54
28/03/2017	35.40	25.58	32.80	20.30	31.30	17.42	31.30	20.67
29/03/2017	1.20	25.30	22.20	20.32	17.00	17.41	19.30	20.65
30/03/2017	11.00	25.13	10.30	20.20	8.20	17.31	8.70	20.51
31/03/2017	14.50	25.01	14.40	20.14	16.70	17.30	16.70	20.47
1/04/2017	15.50	24.72	12.40	19.89	13.30	17.26	14.90	20.30
2/04/2017	13.94	24.61	11.54	19.80	12.74	17.21	17.63	20.27
3/04/2017	10.80	24.46	7.60	19.66	7.90	17.11	13.80	20.20
4/04/2017	11.10	24.31	8.40	19.54	8.70	17.02	14.10	20.14
5/04/2017	9.30	24.16	7.00	19.41	8.70	16.93	11.60	20.05
6/04/2017	9.40	24.00	6.70	19.28	8.30	16.84	12.00	19.96
7/04/2017	12.10	23.88	8.80	19.17	12.70	16.80	18.40	19.95
8/04/2017	13.00	23.77	10.40	19.08	12.30	16.75	18.30	19.93
9/04/2017	13.90	23.67	14.00	19.03	8.80	16.67	10.50	19.84
10/04/2017	37.80	23.81	38.30	19.22	37.70	16.88	34.90	19.99
11/04/2017	18.10	23.75	13.90	19.17	16.30	16.88	19.00	19.98
12/04/2017	10.40	23.62	10.70	19.09	9.10	16.80	14.20	19.92
13/04/2017	11.60	23.51	10.80	19.01	11.80	16.75	15.30	19.88
14/04/2017	14.90	23.42	12.00	18.94	12.10	16.71	18.80	19.86
15/04/2017	20.90	23.40	18.80	18.94	16.10	16.70	21.60	19.88
16/04/2017	24.50	23.41	22.80	18.98	19.30	16.72	25.90	19.94
17/04/2017	27.00	23.44	21.40	19.00	23.20	16.79	27.10	20.00
18/04/2017	28.20	23.49	19.80	19.01	21.10	16.83	24.30	20.04
19/04/2017	18.30	23.44	19.30	19.01	15.70	16.82	23.00	20.07
20/04/2017	15.00	23.36	21.00	19.03	10.50	16.76	17.10	20.04
21/04/2017	16.90	23.31	17.60	19.01	12.60	16.72	18.90	20.03
22/04/2017	17.80	23.26	21.50	19.04	10.90	16.67	16.40	20.00
23/04/2017	13.30	23.17	19.60	19.04	10.40	16.61	13.00	19.94
24/04/2017	22.40	23.16	37.80	19.21	23.40	16.67	21.60	19.95
25/04/2017	18.40	23.12	20.10	19.21	13.30	16.64	16.20	19.92
26/04/2017	6.70	22.98	5.50	19.09	4.30	16.54	4.10	19.79
27/04/2017	9.20	22.86	7.30	18.99	6.20	16.45	6.70	19.67

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average
28/04/2017	8.46	22.74	9.60	18.91	9.20	16.39	13.60	19.62
29/04/2017	8.50	22.62	16.70	18.90	9.30	16.33	13.70	19.57
30/04/2017	16.00	22.56	16.60	18.88	14.70	16.31	17.60	19.56
1/05/2017	9.70	22.46	13.60	18.83	7.10	16.24	11.30	19.49
2/05/2017	16.80	22.41	25.30	18.89	12.50	16.21	16.30	19.46
3/05/2017	14.70	22.35	17.90	18.88	14.00	16.19	20.00	19.47
4/05/2017	11.60	22.26	14.30	18.84	11.90	16.15	20.20	19.47
5/05/2017	15.40	22.21	19.30	18.84	14.00	16.14	21.20	19.49
6/05/2017	14.60	22.15	53.20	19.12	8.60	16.08	10.20	19.41
7/05/2017	15.70	22.10	28.40	19.19	13.60	16.06	13.90	19.37
8/05/2017	26.50	22.13	23.30	19.22	22.10	16.10	30.90	19.46
9/05/2017	16.20	22.08	32.50	19.33	17.60	16.12	24.60	19.50
10/05/2017	16.70	22.04	16.20	19.30	11.70	16.08	17.00	19.48
11/05/2017	19.60	22.02	25.80	19.35	14.10	16.07	18.10	19.47
12/05/2017	30.10	22.09	31.60	19.44	22.40	16.12	26.50	19.52
13/05/2017	26.50	22.12	26.80	19.50	20.40	16.15	25.90	19.57
14/05/2017	16.20	22.07	12.10	19.44	11.20	16.11	12.90	19.52
15/05/2017	10.60	21.99	17.20	19.43	7.70	16.05	7.10	19.43
16/05/2017	15.20	21.94	23.40	19.46	11.70	16.02	14.50	19.39
17/05/2017	24.20	21.96	25.00	19.50	18.70	16.04	22.70	19.42
18/05/2017	24.80	21.98	27.60	19.56	20.50	16.07	23.40	19.45
19/05/2017	9.50	21.89	9.60	19.48	9.50	16.02	11.20	19.39
20/05/2017	7.50	21.78	5.70	19.39	5.20	15.94	5.50	19.29
21/05/2017	12.40	21.72	10.30	19.32	8.00	15.89	9.50	19.22
22/05/2017	14.30	21.67	13.10	19.28	16.90	15.89	21.40	19.23
23/05/2017	13.47	21.61	13.20	19.24	10.80	15.86	13.70	19.19
24/05/2017	10.30	21.53	11.20	19.18	6.20	15.79	6.50	19.11
25/05/2017	12.30	21.47	14.20	19.14	6.20	15.73	7.40	19.03
26/05/2017	11.50	21.40	18.60	19.14	9.00	15.68	14.30	18.99
27/05/2017	17.50	21.37	13.10	19.10	9.40	15.64	11.60	18.94
28/05/2017	17.30	21.34	14.10	19.07	8.60	15.59	9.30	18.88
29/05/2017	9.80	21.27	25.20	19.11	6.30	15.53	5.00	18.78
30/05/2017	11.00	21.20	15.80	19.09	6.90	15.47	7.30	18.71
31/05/2017	6.05	21.10	13.70	19.05	NaN*	15.47	7.30	18.63
1/06/2017	8.80	21.02	19.60	19.05	3.80	15.39	3.35	18.53
2/06/2017	11.00	20.95	25.44	19.10	9.80	15.36	12.40	18.49
3/06/2017	17.30	20.93	15.70	19.07	6.80	15.30	11.50	18.45
4/06/2017	9.80	20.86	7.40	19.00	8.40	15.25	16.80	18.44
5/06/2017	15.40	20.82	4.10	18.90	9.70	15.22	7.90	18.37

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
6/06/2017	11.70	20.76	11.50	18.86	9.00	15.18	7.50	18.30
7/06/2017	5.70	20.67	3.80	18.76	4.30	15.11	5.20	18.22
8/06/2017	7.60	20.58	5.90	18.68	5.90	15.05	6.70	18.14
9/06/2017	8.20	20.51	7.40	18.61	8.30	15.01	9.00	18.09
10/06/2017	7.50	20.43	4.70	18.52	7.10	14.96	8.10	18.02
11/06/2017	7.70	20.35	5.50	18.44	9.40	14.93	14.50	18.00
12/06/2017	13.80	20.31	9.40	18.39	11.90	14.91	16.40	17.99
13/06/2017	11.30	20.25	10.30	18.34	10.20	14.88	15.60	17.98
14/06/2017	9.80	20.19	7.00	18.27	8.90	14.84	14.10	17.95
15/06/2017	16.50	20.17	9.30	18.21	11.10	14.82	17.70	17.95
16/06/2017	17.20	20.15	15.10	18.20	12.40	14.80	15.80	17.94
17/06/2017	16.10	20.13	14.20	18.17	14.70	14.80	17.50	17.94
18/06/2017	13.10	20.08	14.00	18.15	12.80	14.79	18.60	17.94
19/06/2017	14.60	20.05	14.90	18.13	13.50	14.78	19.90	17.95
20/06/2017	7.20	19.98	6.10	18.06	7.50	14.74	8.20	17.90
21/06/2017	9.70	19.92	18.80	18.06	7.70	14.70	9.50	17.85
22/06/2017	14.20	19.88	19.50	18.07	11.30	14.68	12.30	17.81
23/06/2017	14.00	19.85	26.10	18.12	9.70	14.65	9.00	17.76
24/06/2017	13.30	19.81	14.00	18.09	9.90	14.62	11.90	17.73
25/06/2017	12.30	19.77	18.20	18.09	8.70	14.59	8.70	17.68
26/06/2017	15.20	19.74	27.70	18.15	8.40	14.55	10.40	17.64
27/06/2017	26.10	19.78	29.30	18.21	16.80	14.57	24.30	17.68
28/06/2017	19.40	19.78	16.10	18.20	12.60	14.56	13.30	17.65
29/06/2017	9.40	19.72	6.20	18.13	6.40	14.51	6.80	17.59
30/06/2017	8.50	19.66	5.40	18.06	5.10	14.46	10.30	17.55
1/07/2017	13.20	19.62	8.50	18.01	7.50	14.42	11.80	17.52
2/07/2017	10.70	19.57	8.50	17.96	6.60	14.38	8.10	17.47
3/07/2017	16.40	19.56	14.20	17.94	10.40	14.36	10.80	17.43
4/07/2017	15.30	19.53	12.80	17.91	7.40	14.32	7.20	17.38
5/07/2017	11.40	19.49	12.80	17.88	6.90	14.28	6.80	17.32
6/07/2017	13.20	19.46	12.80	17.85	7.30	14.24	7.00	17.26
7/07/2017	16.00	19.44	17.10	17.85	6.10	14.20	6.70	17.21
8/07/2017	14.20	19.41	18.10	17.85	8.70	14.17	8.80	17.16
9/07/2017	15.40	19.39	28.00	17.90	8.80	14.14	8.00	17.12
10/07/2017	11.50	19.35	17.30	17.90	7.30	14.10	7.40	17.06
11/07/2017	14.20	19.32	20.00	17.91	8.40	14.07	10.40	17.03
12/07/2017	23.30	19.34	14.71	17.90	12.20	14.06	18.00	17.03
13/07/2017	16.90	19.33	10.00	17.86	8.10	14.03	12.60	17.01
14/07/2017	18.30	19.32	12.50	17.83	10.00	14.01	9.30	16.97

Date of Run	PM01 - Coralie (Sentinex 19) PM10 24 Hour Result (ug/m³)	PM01 YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM10 24 Hour Result (ug/m³)	PM02 YTD Average	PM03 - Thelander (Sentinex 21) PM10 24 Hour Result (ug/m³)	PM03 YTD Average	PM04 - Muller (Sentinex 22) PM10 24 Hour Result (ug/m³)	PM04 YTD Average
15/07/2017	9.20	19.27	9.30	17.78	5.90	13.97	7.20	16.92
16/07/2017	17.00	19.26	18.20	17.79	9.90	13.95	13.70	16.91
17/07/2017	14.20	19.23	12.60	17.76	7.60	13.92	10.30	16.87
18/07/2017	14.53	19.21	15.50	17.75	7.40	13.88	7.60	16.83
19/07/2017	10.90	19.17	13.10	17.73	7.00	13.85	7.20	16.78
20/07/2017	12.50	19.14	19.00	17.73	7.00	13.82	6.80	16.73
21/07/2017	14.30	19.11	20.90	17.75	9.40	13.79	16.50	16.73
22/07/2017	18.20	19.11	21.00	17.76	7.90	13.76	8.30	16.69
23/07/2017	17.90	19.10	21.90	17.78	9.00	13.74	8.40	16.64
24/07/2017	13.90	19.08	24.30	17.82	8.50	13.71	8.40	16.60
25/07/2017	16.00	19.06	21.70	17.83	8.90	13.69	9.80	16.57
26/07/2017	28.60	19.11	33.40	17.91	10.60	13.68	10.80	16.54
27/07/2017	17.00	19.10	20.90	17.92	12.20	13.67	16.30	16.54
28/07/2017	17.50	19.09	31.80	17.99	8.40	13.64	8.80	16.51
29/07/2017	20.70	19.10	29.30	18.04	6.90	13.61	7.20	16.46
30/07/2017	21.70	19.11	28.40	18.09	10.70	13.60	10.00	16.43
31/07/2017	24.10	19.13	24.90	18.13	20.80	13.63	27.40	16.48
1/08/2017	10.50	19.09	10.80	18.09	10.41	13.62	15.60	16.48
2/08/2017	27.90	19.13	21.40	18.11	20.70	13.65	27.10	16.53
3/08/2017	29.30	19.18	18.60	18.11	22.40	13.69	25.50	16.57
4/08/2017	5.60	19.12	7.10	18.06	4.40	13.65	3.80	16.51
5/08/2017	12.30	19.09	8.20	18.01	5.70	13.61	5.90	16.46
6/08/2017	13.70	19.06	11.50	17.98	3.91	13.57	7.00	16.42
7/08/2017	15.00	19.04	10.60	17.95	5.70	13.53	7.70	16.38
8/08/2017	9.10	19.00	11.60	17.92	6.40	13.50	6.50	16.33
9/08/2017	10.50	18.96	12.00	17.89	7.80	13.47	6.00	16.29
10/08/2017	15.40	18.94	21.40	17.91	7.10	13.44	6.60	16.24
11/08/2017	16.90	18.94	28.90	17.96	5.80	13.41	10.60	16.22
12/08/2017	13.10	18.91	25.20	17.99	4.70	13.37	8.70	16.18
13/08/2017	17.00	18.90	16.70	17.99	10.10	13.35	21.70	16.21
14/08/2017	18.10	18.90	35.80	18.06	9.20	13.34	9.80	16.18
15/08/2017	23.30	18.92	24.50	18.09	10.80	13.32	13.40	16.17
16/08/2017	22.70	18.93	29.90	18.14	9.10	13.31	13.30	16.16
17/08/2017	16.50	18.92	16.10	18.14	12.00	13.30	10.90	16.13
18/08/2017	23.30	18.94	17.60	18.13	12.90	13.30	8.70	16.10
19/08/2017	10.60	18.91	15.70	18.12	10.90	13.29	5.50	16.05
20/08/2017	18.00	18.90	17.00	18.12	9.20	13.27	15.40	16.05
21/08/2017	21.80	18.91	38.90	18.21	5.70	13.24	16.60	16.05
22/08/2017	26.80	18.95	25.90	18.24	9.57	13.22	42.90	16.17

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
23/08/2017	24.60	18.97	36.50	18.32	13.80	13.22	22.90	16.20
24/08/2017	23.20	18.99	24.00	18.34	30.40	13.30	17.40	16.20
25/08/2017	14.80	18.97	21.00	18.35	17.30	13.31	18.20	16.21
26/08/2017	16.60	18.96	31.70	18.41	17.70	13.33	9.60	16.18
27/08/2017	15.20	18.95	21.30	18.42	14.80	13.34	8.80	16.15
28/08/2017	12.90	18.92	15.00	18.41	9.30	13.32	11.90	16.13
29/08/2017	19.50	18.92	20.10	18.41	9.30	13.31	21.70	16.16
30/08/2017	17.73	18.92	32.79	18.47	11.80	13.30	16.12	16.16
31/08/2017	17.10	18.91	21.30	18.48	15.00	13.31	18.30	16.17
1/09/2017	23.50	18.93	31.90	18.54	19.20	13.33	24.50	16.20
2/09/2017	20.60	18.94	40.20	18.63	11.10	13.32	16.00	16.20
3/09/2017	29.40	18.98	41.10	18.72	15.70	13.33	14.30	16.19
4/09/2017	17.30	18.97	17.60	18.71	20.26	13.36	11.80	16.17
5/09/2017	14.80	18.96	17.60	18.71	12.40	13.36	10.70	16.15
6/09/2017	11.60	18.93	17.80	18.71	10.20	13.34	8.50	16.12
7/09/2017	15.60	18.91	20.50	18.71	8.80	13.32	7.30	16.09
8/09/2017	13.00	18.89	17.40	18.71	8.60	13.31	7.10	16.05
9/09/2017	16.70	18.88	18.90	18.71	13.90	13.31	21.00	16.07
10/09/2017	27.20	18.91	29.80	18.75	17.60	13.33	26.10	16.11
11/09/2017	20.70	18.92	41.00	18.84	14.10	13.33	13.90	16.10
12/09/2017	22.50	18.93	37.50	18.91	15.90	13.34	14.50	16.09
13/09/2017	32.30	18.99	41.60	19.00	19.40	13.36	17.50	16.10
14/09/2017	9.70	18.95	8.40	18.96	7.60	13.34	6.40	16.06
15/09/2017	10.30	18.92	17.40	18.96	9.20	13.32	8.70	16.03
16/09/2017	14.30	18.90	18.90	18.96	13.00	13.32	11.10	16.01
17/09/2017	18.60	18.90	14.20	18.94	16.50	13.33	27.00	16.06
18/09/2017	21.90	18.91	20.90	18.94	15.50	13.34	19.80	16.07
19/09/2017	19.70	18.91	22.50	18.96	17.10	13.36	16.70	16.07
20/09/2017	27.90	18.95	23.10	18.97	20.80	13.39	30.80	16.13
21/09/2017	24.30	18.97	25.10	19.00	15.90	13.40	16.90	16.13
22/09/2017	33.60	19.02	36.10	19.06	20.40	13.42	18.90	16.14
23/09/2017	38.50	19.10	49.90	19.18	25.10	13.47	26.50	16.18
24/09/2017	53*	19.22	44.70	19.27	31.50	13.53	28.60	16.23
25/09/2017	39.90	19.30	27.70	19.30	19.90	13.56	16.80	16.23
26/09/2017	35.90	19.36	25.40	19.33	22.50	13.59	22.50	16.25
27/09/2017	42.70	19.45	51*	19.44	37.90	13.68	49.60	16.38
28/09/2017	35.00	19.50	35.20	19.50	22.80	13.72	23.90	16.41
29/09/2017	17.90	19.50	18.00	19.50	10.50	13.70	9.00	16.38
30/09/2017	18.60	19.50	17.00	19.49	14.50	13.71	12.00	16.36

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
1/10/2017	29.10	19.50	30.60	19.50	20.10	13.70	27.60	16.40
2/10/2017	40.20	19.60	36.70	19.50	37.70	13.80	38.20	16.40
3/10/2017	22.10	19.60	18.40	19.50	16.10	13.80	24.20	16.50
4/10/2017	31.90	19.60	26.30	19.60	22.40	13.80	24.30	16.50
5/10/2017	22.60	19.60	18.80	19.60	18.60	13.80	19.50	16.50
6/10/2017	31.30	19.70	34.10	19.60	23.00	13.90	17.10	16.50
7/10/2017	26.50	19.70	20.40	19.60	26.30	13.90	23.60	16.50
8/10/2017	23.00	19.70	18.30	19.60	17.80	13.90	20.80	16.50
9/10/2017	12.90	19.70	12.50	19.60	8.70	13.90	9.20	16.50
10/10/2017	32.60	19.70	25.20	19.60	28.30	14.00	24.80	16.50
11/10/2017	36.00	19.80	25.80	19.60	24.70	14.00	34.80	16.60
12/10/2017	17.10	19.80	13.80	19.60	11.60	14.00	14.00	16.60
13/10/2017	33.20	19.80	28.20	19.60	29.40	14.00	32.00	16.70
14/10/2017	21.90	19.87	16.20	19.60	16.60	14.00	21.90	16.70
15/10/2017	24.30	19.80	10.70	19.60	11.90	14.00	13.90	16.70
16/10/2017	25.60	19.90	14.00	19.60	18.60	14.10	16.00	16.70
17/10/2017	37.20	19.90	22.50	19.60	25.20	14.10	20.80	16.70
18/10/2017	24.90	19.90	20.10	19.60	18.30	14.10	18.40	16.70
19/10/2017	26.10	20.00	23.30	19.60	16.80	14.10	26.70	16.70
20/10/2017	14.60	19.90	9.80	19.60	9.00	14.10	10.00	16.70
21/10/2017	18.10	19.90	18.20	19.60	17.30	14.10	17.60	16.70
22/10/2017	22.00	19.90	16.80	19.60	14.00	14.10	17.10	16.70
23/10/2017	14.50	19.90	10.70	19.50	11.30	14.10	12.30	16.70
24/10/2017	13.30	19.90	12.50	19.50	9.50	14.10	11.30	16.70
25/10/2017	20.70	19.90	19.50	19.50	13.20	14.10	11.70	16.60
26/10/2017	24.90	19.90	24.80	19.50	24.40	14.10	27.20	16.70
27/10/2017	14.50	19.90	41.30	19.60	12.10	14.10	11.30	16.70
28/10/2017	17.20	19.90	15.10	19.60	15.80	14.10	19.00	16.70
29/10/2017	18.70	19.90	15.40	19.60	12.20	14.10	13.60	16.70
30/10/2017	22.80	19.90	16.20	19.50	18.60	14.10	14.60	16.70
31/10/2017	14.30	19.90	12.20	19.50	12.70	14.10	11.30	16.60
1/11/2017	20.30	19.92	17.30	19.56	22.20	14.19	19.80	16.69
2/11/2017	28.70	19.95	23.60	19.57	23.20	14.22	26.40	16.72
3/11/2017	20.40	19.95	21.00	19.58	17.70	14.23	17.20	16.73
4/11/2017	12.30	19.93	9.50	19.55	11.50	14.22	11.50	16.71
5/11/2017	9.50	19.90	6.10	19.50	6.40	14.19	6.40	16.68
6/11/2017	11.40	19.87	8.30	19.47	8.10	14.17	7.80	16.65
7/11/2017	17.50	19.86	10.30	19.44	11.30	14.16	12.20	16.63
8/11/2017	11.70	19.83	10.70	19.41	13.50	14.16	12.10	16.62

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average
9/11/2017	14.90	19.82	9.90	19.38	12.20	14.16	14.90	16.61
10/11/2017	14.80	19.80	12.10	19.35	13.50	14.15	14.30	16.61
11/11/2017	18.10	19.80	15.50	19.34	13.80	14.15	14.50	16.60
12/11/2017	20.60	19.80	13.90	19.33	18.00	14.16	17.70	16.60
13/11/2017	22.80	19.81	18.10	19.32	18.50	14.18	20.00	16.61
14/11/2017	21.90	19.82	15.50	19.31	15.40	14.18	20.60	16.63
15/11/2017	19.60	19.82	15.30	19.30	19.40	14.20	25.00	16.65
16/11/2017	22.80	19.82	16.20	19.29	16.70	14.21	20.40	16.66
17/11/2017	23.10	19.83	13.50	19.27	16.50	14.21	19.30	16.67
18/11/2017	19.00	19.83	12.70	19.25	12.70	14.21	12.60	16.66
19/11/2017	23.80	19.84	14.00	19.23	17.40	14.22	16.70	16.66
20/11/2017	18.30	19.84	14.30	19.22	17.10	14.23	15.90	16.66
21/11/2017	23.60	19.85	17.10	19.21	21.60	14.25	21.20	16.67
22/11/2017	19.70	19.85	19.30	19.21	18.90	14.26	19.20	16.68
23/11/2017	21.80	19.86	17.70	19.21	19.60	14.28	17.40	16.68
24/11/2017	28.80	19.88	25.10	19.22	20.10	14.30	23.70	16.70
25/11/2017	36.70	19.93	17.10	19.22	25.60	14.33	32.50	16.75
26/11/2017	28.80	19.96	16.90	19.21	19.10	14.35	22.90	16.77
27/11/2017	23.00	19.97	19.40	19.21	21.10	14.37	20.90	16.78
28/11/2017	26.80	19.99	17.60	19.21	21.00	14.39	23.50	16.80
29/11/2017	26.30	20.01	14.30	19.19	17.00	14.40	20.50	16.81
30/11/2017	31.50	20.04	17.70	19.19	21.90	14.42	20.40	16.82
1/12/2017	32.60	20.08	17.80	19.18	23.10	14.44	26.20	16.85
2/12/2017	23.90	20.09	20.90	19.19	20.10	14.46	18.90	16.86
3/12/2017	16.30	20.08	6.60	19.15	4.50	14.43	2.50	16.82
4/12/2017	18.10	20.08	12.40	19.13	13.10	14.43	18.50	16.82
5/12/2017	10.80	20.05	11.30	19.11	8.40	14.41	10.20	16.80
6/12/2017	9.40	20.02	6.70	19.07	6.30	14.39	4.40	16.76
7/12/2017	14.50	20.00	11.60	19.05	7.80	14.37	8.70	16.74
8/12/2017	34.50	20.04	25.00	19.07	26.50	14.40	27.70	16.77
9/12/2017	23.70	20.05	18.70	19.07	18.00	14.41	19.30	16.78
10/12/2017	21.50	20.06	15.60	19.06	16.40	14.42	18.50	16.78
11/12/2017	23.49	20.07	15.24	19.04	12.57	14.41	21.17	16.80
12/12/2017	18.60	20.06	22.40	19.05	18.57	14.43	24.40	16.82
13/12/2017	25.20	20.08	25.90	19.07	21.00	14.44	27.20	16.85
14/12/2017	40.90	20.14	27.60	19.10	21.90	14.47	23.50	16.87
15/12/2017	52.70	20.23	35.70	19.15	31.30	14.51	43.90	16.95
16/12/2017	33.20	20.27	29.10	19.17	25.90	14.55	36.10	17.00
17/12/2017	34.20	20.31	24.50	19.19	26.56	14.58	31.60	17.04

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
18/12/2017	43.60	20.38	22.80	19.20	20.40	14.60	25.60	17.07
19/12/2017	28.10	20.40	19.30	19.20	16.04	14.60	18.30	17.07
20/12/2017	37.80	20.45	24.90	19.22	24.60	14.63	26.30	17.10
21/12/2017	43.00	20.51	23.50	19.23	20.20	14.65	25.80	17.12
22/12/2017	23.90	20.52	15.80	19.22	14.09	14.64	18.90	17.13
23/12/2017	29.70	20.55	27.00	19.24	16.39	14.65	29.50	17.16
24/12/2017	22.90	20.55	20.10	19.24	13.78	14.65	20.00	17.17
25/12/2017	14.20	20.53	14.10	19.23	12.40	14.64	12.90	17.16
26/12/2017	15.70	20.52	11.30	19.21	11.40	14.63	11.30	17.14
27/12/2017	35.10	20.56	18.90	19.21	9.67	14.62	21.40	17.15
28/12/2017	23.90	20.57	19.30	19.21	12.21	14.61	30.10	17.19
29/12/2017	53.60	20.66	20.20	19.21	6.18	14.59	20.30	17.20
30/12/2017	20.70	20.66	12.10	19.19	NaN*	14.59	12.10	17.18
31/12/2017	28.60	20.68	24.90	19.21	NaN*	14.59	23.00	17.20

* **Thelander monitor had an intermittent fault with the UPS and as a result the TEOM was in operable and therefore no data was available on these days.**

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW01	Jan-17	7.49	776	3	
SW01	Feb-17	7.9	854	5	
SW01	Mar-17	7.4	814	8	
SW01	Mar-17	7.19	505	5	
SW01	Apr-17	7.06	552	5	
SW01	May-17	7.11	703	8	
SW01	Jun-17	7.38	496	7	
SW01	Jul-17	7.28	620	5	Slow
SW01	Aug-18	7.23	719	5	
SW01	Sep-18	7.48	822	8	
SW01	Oct-18	7.34	707	5	
SW01	Oct-18	7.36	706	7	
SW01	Nov-17	7.69	775	8	
SW01	Dec-17	7.52	774	5	
SW02	Jan-17	7.64	901	5	
SW02	Feb-17				No flow
SW02	Mar-17	7.44	943	7	
SW02	Mar-17	7.39	767	5	
SW02	Apr-17	7.16	543	5	
SW02	May-17	7.32	634	8	
SW02	Jun-17	7.59	519	5	
SW02	Jul-17	7.4	578	5	Slow
SW02	Aug-18	7.4	675	5	
SW02	Sep-18	7.46	906	5	
SW02	Oct-18	7.48	890	<5	
SW02	Oct-18	7.33	800	9	
SW02	Nov-17				No flow
SW02	Dec-17	7.59	1050	5	
SW03	Jan-17	7.75	1100	2	
SW03	Feb-17	8.07	2030	11	
SW03	Mar-17	7.72	1890	9	
SW03	Mar-17	7.12	468	30	
SW03	Apr-17	6.99	532	6	
SW03	May-17	7.11	624	19	
SW03	Jun-17	7.46	484	26	
SW03	Jul-17	7.25	527	5	Trickle
SW03	Aug-18	7.15	814	6	
SW03	Sep-18	7.62	1270	6	
SW03	Oct-18	7.64	1380	10	
SW03	Oct-18	7.59	1340	6	
SW03	Nov-17	7.78	1920	16	
SW03	Dec-17	7.78	1960	10	

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW04	Jan-17				No flow
SW04	Feb-17				No flow
SW04	Mar-17				No flow
SW04	Mar-17				No flow
SW04	Apr-17				No flow
SW04	May-17				No flow
SW04	Jun-17				Dry
SW04	Jul-17				Dry
SW04	Aug-18				Dry
SW04	Sep-18				Dry
SW04	Oct-18				Dry
SW04	Oct-18				Pool
SW04	Nov-17				Dry
SW04	Dec-17				Dry
SW05	Jan-17				No flow
SW05	Feb-17				No flow
SW05	Mar-17				No flow
SW05	Mar-17	7.23	410	272	
SW05	Apr-17				No flow
SW05	May-17				No flow
SW05	Jun-17				Pool
SW05	Jul-17				No flow
SW05	Aug-18				Dry
SW05	Sep-18				Dry
SW05	Oct-18				Pool
SW05	Oct-18				Pool
SW05	Nov-17				Dry
SW05	Dec-17				Dry
SW06	Jan-17				No flow
SW06	Feb-17				No flow
SW06	Mar-17				No flow
SW06	Mar-17				No flow
SW06	Apr-17				No flow
SW06	May-17				No flow
SW06	Jun-17				Dry
SW06	Jul-17				Dry
SW06	Aug-18				Dry
SW06	Sep-18				Dry
SW06	Oct-18				Dry
SW06	Oct-18				Dry
SW06	Nov-17				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW06	Dec-17				Pool
SW07	Jan-17				No flow
SW07	Feb-17				No flow
SW07	Mar-17				No flow
SW07	Mar-17				No flow
SW07	Apr-17				No flow
SW07	May-17				No flow
SW07	Jun-17				Pool
SW07	Jul-17				Dry
SW07	Aug-18				Dry
SW07	Sep-18				Dry
SW07	Oct-18				Dry
SW07	Oct-18				Pool
SW07	Nov-17				Dry
SW07	Dec-17				Dry
SW08	Jan-17				No flow
SW08	Feb-17				No flow
SW08	Mar-17				No flow
SW08	Mar-17				No access
SW08	Apr-17				No flow
SW08	May-17				No flow
SW08	Jun-17				No access
SW08	Jul-17				Dry
SW08	Aug-18				Dry
SW08	Sep-18				Dry
SW08	Oct-18				Dry
SW08	Oct-18				No access
SW08	Nov-17				Dry
SW08	Dec-17				Dry
SW12	Jan-17				No flow
SW12	Feb-17				No flow
SW12	Mar-17				No flow
SW12	Mar-17				No flow
SW12	Apr-17				No flow
SW12	May-17	8.75	6890		
SW14	Jan-17				No flow
SW14	Feb-17				No flow
SW14	Mar-17				No flow
SW14	Mar-17				No flow
SW14	Apr-17				No flow

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW14	May-17	7.39	684		
SW14	Jun-17	7.59	712	38	
SW14	Jul-17	8.33	718	-	
SW14	Aug-18	8.48	676	-	
SW14	Sep-18	8.44	742	-	
SW14	Oct-18	8.33	809	16	
SW14	Nov-17	8.32	492	-	
SW14	Dec-17	8.49	591	5	
SW15	Jan-17				No flow
SW15	Feb-17				No flow
SW15	Mar-17				No flow
SW15	Mar-17				No flow
SW15	Apr-17				No flow
SW15	May-17	9.02	6680	96	
SW15	Jun-17	8.82	7040	36	
SW15	Jul-17	8.69	7440	24	
SW15	Aug-18	8.76	7620	16	
SW15	Sep-18	9.06	8420	26	
SW15	Oct-18	9.17	7710	75	
SW15	Oct-18	9.24	8020	94	
SW15	Nov-17	9.08	8820	298	
SW15	Dec-17	8.92	8990	183	
SW20	Jan-17				No flow
SW20	Feb-17				No flow
SW20	Mar-17				No flow
SW20	Mar-17				No flow
SW20	Apr-17				No flow
SW20	May-17				Insufficient water
SW20	Jul-17				No access
SW20					No access
SW20					No access
SW27	Jan-17				No flow
SW27	Feb-17				No flow
SW27	Mar-17				No flow
SW27	Mar-17	8.12	671	115	
SW27	Apr-17				No flow
SW27	May-17				No flow
SW27	Jun-17				Dry
SW27	Jul-17				Dry
SW27	Aug-18				Dry
SW27	Sep-18				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW27	Oct-18				Pool
SW27	Oct-18				Pool
SW27	Nov-17				Dry
SW27	Dec-17				Pool
SW30	Jan-17				No flow
SW30	Feb-17				No flow
SW30	Mar-17				No flow
SW30	Mar-17				No flow
SW30	Apr-17				No flow
SW31	Jan-17				No flow
SW31	Feb-17				No flow
SW31	Mar-17				No flow
SW31	Mar-17				No flow
SW31	Apr-17				No flow
SW31	May-17	9.03	6890		
SW31	Jun-17	8.68	6860	230	
SW31	Jul-17	8.9	7650	-	
SW31	Aug-18	9	7650	-	
SW31	Sep-18	9.12	8100	-	
SW31	Oct-18	9.29	6890	87	
SW31	Nov-17	9.05	6560	-	
SW31	Dec-17	9.12	7980	541	
SW32a	Jan-17				No flow
SW32a	Feb-17				No flow
SW32a	Mar-17				No flow
SW32a	Mar-17				No flow
SW32a	Apr-17				No flow
SW32a	May-17				No flow
SW32a	Jun-17				Dry
SW32a	Jul-17				Dry
SW32a	Aug-18				Dry
SW32a	Sep-18				Dry
SW32a	Oct-18	7.66	588	376	
SW32a	Oct-18	7.79	598	852	
SW32a	Nov-17				Dry
SW32a	Dec-17				Pool
SW38	Jan-17				No flow
SW38	Feb-17				No flow
SW38	Mar-17				No flow
SW38	Mar-17				No flow

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW38	Apr-17				No flow
SW38	May-17	9.01	6660		
SW38	Jun-17	8.76	6770	52	
SW38	Jul-17	8.94	7350	-	
SW38	Aug-18	8.97	7290	-	
SW38	Sep-18	9.07	7730	-	
SW38	Oct-18	9.17	8070	71	
SW38	Nov-17	9.06	7930	-	
SW38	Dec-17	9.06	8960	647	
SW39	Jan-17				No flow
SW39	Feb-17				No flow
SW39	Mar-17				No flow
SW39	Mar-17				No flow
SW39	Apr-17				No flow
SW39	May-17				No flow
SW39	Jun-17				Dry
SW39	Jul-17				Dry
SW39	Aug-18				Dry
SW39	Sep-18				Dry
SW39	Oct-18				Pool
SW39	Oct-18				Pool
SW39	Nov-17				Dry
SW39	Dec-17				Dry
SW40	Jan-17	7.62	780	4	
SW40	Feb-17				No flow
SW40	Mar-17				No flow
SW40	Mar-17	7.15	567	5	
SW40	Apr-17	6.99	516	5	
SW40	May-17	7.11	613	5	5
SW40	Jun-17	7.45	476	7	
SW40	Jul-17	7.57	586	5	Slow
SW40	Aug-18	7.4	604	5	
SW40	Sep-18				No flow
SW40	Oct-18				Pool
SW40	Oct-18				Pool
SW40	Nov-17	7.64	660	<5	
SW40	Dec-17	7.55	667	5	

Date	HV01 - Coralie			HV02 - Wambo Road			HV03 - Thelander			HV04 - Muller		
	TSP (µg/m³)	Monthly Mean	YTD Average	TSP (µg/m³)	Monthly Mean	YTD Average	TSP (µg/m³)	Monthly Mean	YTD Average	TSP (µg/m³)	Monthly Mean	YTD Average
6/01/2017	90.00		90.00	30.30		90.00	67.30		90.00	64.20		90.00
12/01/2017	99.50		94.75	80.80		80.89	85.60		80.91	84.70		80.64
18/01/2017	96.20		95.23	99.70		86.28	94.90		85.43	44.20		82.42
24/01/2017	108.00		98.43	58.40		86.78	60.10		84.66	55.80		81.54
30/01/2017	106.00	99.94	99.94	77.40	69.32	89.04	56.00	72.78	84.84	50.40	59.86	81.28
5/02/2017	131.00		105.12	113.00		93.35	56.60		87.18	48.90		82.75
11/02/2017	140.00		110.10	86.70		95.93	114.00		90.18	95.40		85.70
23/02/2017	111.00		110.21	76.40		96.32	85.90		90.87	134.00		87.47
24/02/2017	95.70	119.43	108.60	95.40	92.88	97.49	91.30	86.95	92.19	140.00	104.58	89.58
1/03/2017	48.90		102.63	34.10		94.15	31.90		89.42	64.90		87.46
7/03/2017	30.20		96.05	26.50		90.45	23.40		86.36	74.80		85.24
13/03/2017	77.20		94.48	77.60		89.87	60.40		85.86	123.00		85.37
19/03/2017	75.50		93.02	49.70		88.61	34.40		84.58	70.40		84.32
25/03/2017	76.60	61.68	91.84	63.40	50.26	87.26	51.70	40.36	83.14	86.20	83.86	82.91
3/04/2017	19.50		87.02	30.60		84.66	33.10		81.16	58.80		81.28
6/04/2017	13.20		82.41	8.60		81.72	14.50		78.77	61.10		79.39
12/04/2017	17.80		78.61	19.10		79.32	23.40		76.84	63.80		77.86
18/04/2017	50.50		77.04	51.60		78.29	62.30		76.17	89.60		77.42
24/04/2017	58.30		76.06	89.20		78.10	78.00		76.16	86.00		77.42
30/04/2017	43.00	33.72	74.41	38.70	39.63	76.19	45.10	42.73	74.47	47.60	67.82	75.71
6/05/2017	51.40		73.31	110.00		76.28	22.40		74.12	37.40		75.18
12/05/2017	51.00		72.30	58.20		75.60	49.60		73.58	85.60		74.82
18/05/2017	70.10		72.20	55.60		75.21	68.00		73.36	79.20		74.64
24/05/2017	27.20		70.33	35.50		73.99	14.60		72.23	17.10		73.47
30/05/2017	27.10	45.36	68.60	47.60	61.38	72.65	14.40	33.80	70.98	15.30	46.92	72.01
5/06/2017	36.80		67.37	39.65.80		72.15	26.00		70.39	19.60		71.29

Date	HV01 - Coralie			HV02 - Wambo Road			HV03 - Thelander			HV04 - Muller		
	TSP (µg/m³)	Monthly Mean	YTD Average	TSP (µg/m³)	Monthly Mean	YTD Average	TSP (µg/m³)	Monthly Mean	YTD Average	TSP (µg/m³)	Monthly Mean	YTD Average
11/06/2017	16.50		65.49	11.10		70.69	23.30		69.25	47.50		70.33
18/06/2017	22.80		63.96	21.80		69.52	26.30		68.30	50.10		69.52
23/06/2017	32.00		62.86	68.40		69.02	17.20		67.70	17.50		68.82
29/06/2017	15.10	24.64	61.27	8.10	27.35	67.26	5.80	19.72	66.06	11.80	29.30	67.14
5/07/2017	29.40		60.24	46.50		66.59	7.80		65.34	8.70		66.35
11/07/2017	35.00		59.45	51.00		66.06	24.30		64.81	29.60		65.79
17/07/2017	31.80		58.62	32.40		65.33	9.90		64.09	5.40		65.02
23/07/2017	54.10		58.48	84.90		65.34	14.70		63.85	15.20		64.63
29/07/2017	76.90	45.44	59.01	102.00	63.36	65.54	12.40	13.82	63.73	12.00	14.18	64.13
4/08/2017	17.20		57.85	22.90		64.68	6.10		62.96	8.10		63.36
10/08/2017	48.00		57.58	58.20		64.42	9.60		62.57	8.00		62.88
16/08/2017	69.30		57.89	73.30		64.48	25.90		62.46	29.40		62.68
22/08/2017	121.00		59.51	94.50		65.14	92.20		63.04	138.00		63.34
28/08/2017	39.90	59.08	59.02	40.30	57.84	64.65	45.40	35.84	62.69	46.80	46.06	62.94
3/09/2017	99.30		60.00	115.00		65.27	42.70		63.00	39.90		63.08
9/09/2017	60.50		60.01	65.00		65.19	46.00		62.92	92.00		63.12
15/09/2017	25.90		59.22	67.30		64.87	18.30		62.58	21.30		62.74
21/09/2017	85.30		59.81	83.80		65.12	41.80		62.67	41.00		62.74
27/09/2017	154.00	85.00	61.90	150.00	96.22	66.45	138.00	57.36	63.97	197.00	78.24	64.04
3/10/2017	113.00		63.02	77.80		66.83	64.30		64.23	131.00		64.42
9/10/2017	51.40		62.77	57.90		66.64	39.90		64.06	48.60		64.25
15/10/2017	127.00		64.11	31.30		66.78	47.10		64.12	64.80		64.29
21/10/2017	61.40		64.05	75.70		66.79	60.40		64.15	69.40		64.32
27/10/2017	34.00	77.36	63.45	37.60	56.06	66.44	27.80	47.90	63.83	22.40	67.24	63.94
2/11/2017	74.70		63.67	65.40		66.47	70.20		63.91	109.00		64.11
8/11/2017	46.80		63.35	34.30		66.14	52.50		63.71	48.50		63.92

Date	HV01 - Coralie			HV02 - Wambo Road			HV03 - Thelander			HV04 - Muller		
	TSP (μg/m^3)	Monthly Mean	YTD Average	TSP (μg/m^3)	Monthly Mean	YTD Average	TSP (μg/m^3)	Monthly Mean	YTD Average	TSP (μg/m^3)	Monthly Mean	YTD Average
14/11/2017	110.00		64.23	67.50		66.40	69.90		63.92	144.00		64.27
20/11/2017	71.10		64.35	55.50		66.35	73.80		63.96	79.90		64.33
26/11/2017	148.00	90.12	65.87	81.70	60.88	67.04	97.70	72.82	64.51	149.00	106.08	64.94
2/12/2017	112.00		66.70	96.30		67.45	93.40		64.89	98.50		65.28
8/12/2017	99.70		67.28	65.80		67.62	90.30		65.10	87.60		65.48
14/12/2017	113.00		68.07	78.40		67.93	100.00		65.43	46.40		65.66
20/12/2017	124.00		69.01	68.40		68.23	63.40		65.64	94.70		65.87
26/12/2017	58.60	101.46	68.84	29.20	67.62	68.16	77.50	84.92	65.68	36.40	72.72	65.87

APPENDIX D

WAMBO MINE 2017 AIR QUALITY MONITORING REVIEW

710 Hunter Street
Newcastle West NSW 2302 Australia
PO Box 2147 Dangar NSW 2309
Australia
T +61 2 4979 2600
F +61 2 4979 2666
www.jacobs.com

25 March 2018

Attention: Merri Bartlett
Wambo Coal Pty Ltd
PMB 1, Singleton NSW 2330

Project Name: Wambo Coal
Project Number: IA176700

Dear Merri

Wambo Mine 2017 Air Quality Monitoring Review

I have completed a review of Wambo Coal's air quality monitoring data for 2017. Please see attached for the outcomes of the analyses.

In summary there were seven (7) days in 2017 when the PM_{10} concentration at one or more of the four monitoring locations exceeded 50 µg/m^3. The data on each of these days were examined in order to identify the likely contribution of Wambo Coal activities to the measured results. The analysis indicated that activities at Wambo mine were likely to have contributed to some of the measured results. None of the calculated site contributions exceeded Wambo Coal's Development Consent acquisition criteria for 24-hour average PM_{10} of 50 µg/m^3. There were three days identified when calculated site contribution influenced compliance with the impact assessment criterion of 50 µg/m^3 (specifically 6/5/2017, 24/9/2017 and 29/12/2017).

The site contribution to monitored levels was calculated by an upwind-downwind approach. There are some limitations to this approach, which have been identified, and it was noted that the calculated site contributions will have some embedded uncertainty.

Yours sincerely

Shane Lakmaker
Principal (Air Quality)
(02) 4979 2663
shane.lakmaker@jacobs.com

25 March 2018

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). **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 – Wambo/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).

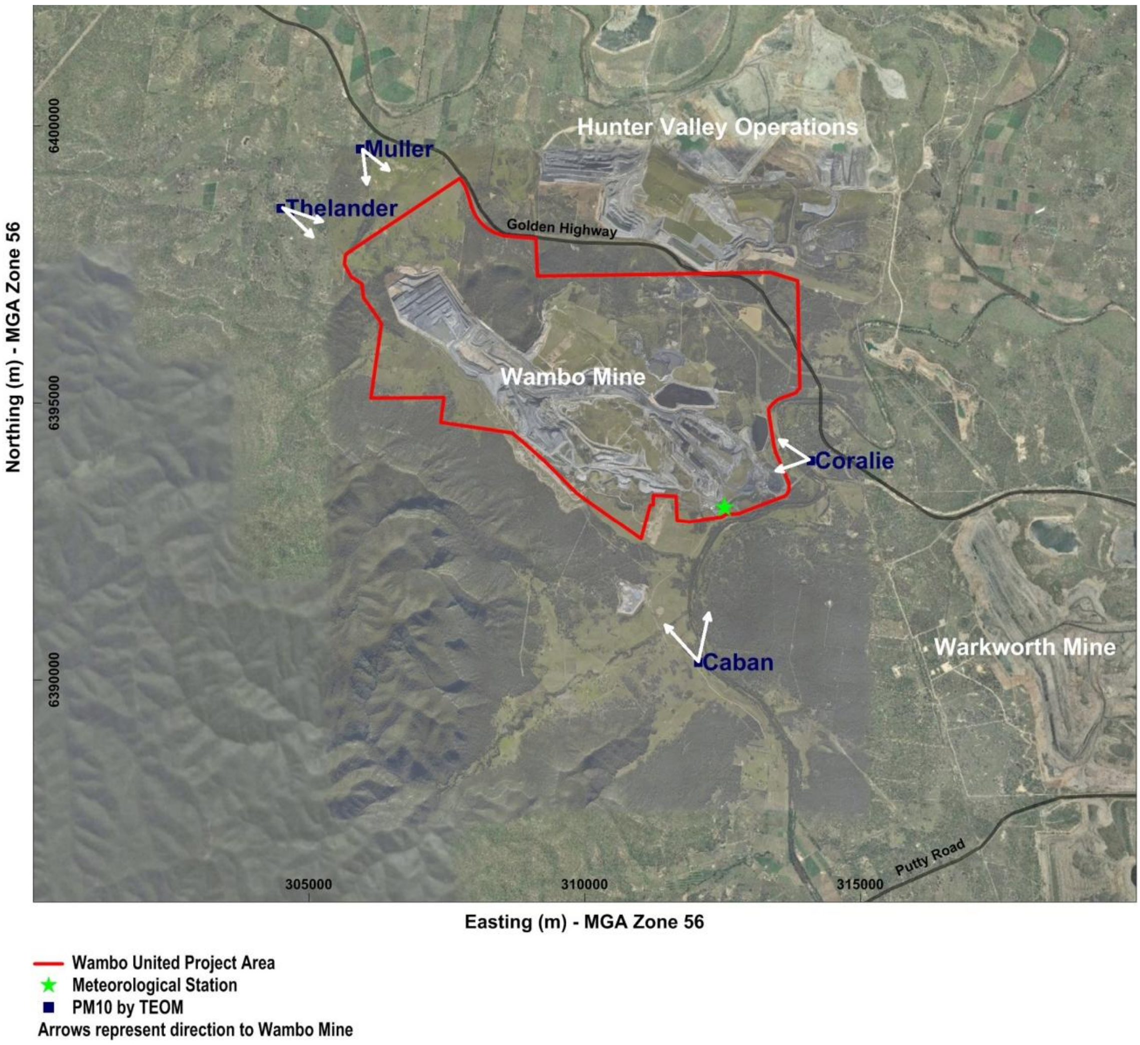


Figure 1 Location of monitoring stations around Wambo Mine

A review of the Wambo Coal's monitoring data has been carried out. The purpose of the review was to identify all days in 2017 when the PM_{10} concentration at one or more locations exceeded 50 µg/m^3, and to identify the likely contribution of Wambo Coal activities to the measured results on these days.

2. Approach to Review

The monitoring data review involved:

- Obtaining and collating the monitoring data into 10-minute average records of PM_{10} concentrations and 10-minute average records of wind speed and wind direction. Data from the 2017 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 the 24-hour average criteria, and the annual average.
- Analysing all days in 2017 when the PM_{10} concentration at one or more location exceeded 50 µg/m^3. The data for each "exceedance" day was analysed by preparing graphs showing the 10-minute 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.

The contribution of Wambo Coal activities to the measured results was calculated by first determining the wind direction ranges which coincided with a wind direction from Wambo Mine towards each monitor (see **Table 1**). The site contribution to each monitor was then calculated for every 10-minute average record in each exceedance day based on the concurrent wind direction, and using downwind concentration minus upwind concentration calculations. Finally, the site contribution to each monitor was calculated as a 24-hour average. 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.

Table 1 Wind directions to Wambo mining activities

Monitoring site	Directions to Wambo mining activities
Muller	Between 130 and 180 degrees from true north
Wambo / 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

Outcomes of the review are provided below.

3. Monitored Results

The data capture rates are shown in **Table 2**. Generally, a data capture rate of 90 to 95% 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 2 Data capture rates

Year	D1 – Muller	D2 – Wambo	D3 – Coralie	D4 - Thelander
2017	99.5%	99.5%	99.3%	96.0%

Table 3 summarises the measured PM_{10} concentration data for each site. There were seven (7) unique days when the PM_{10} concentration exceeded 50 µg/m^3 at one or more locations. These instances occurred at the Wambo and Coralie monitors.

Table 3 Summary of measured PM_{10} concentrations in 2017

Statistic	D1 – Muller	D2 – Wambo	D3 – Coralie	D4 - Thelander
Maximum 24-hour average (µg/m^3)	49	52	66	39
Number of days above 50 µg/m^3	0	2	5	0
Annual average (µg/m^3)	16	18	20	14

Table 4 lists the seven days when the 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at one or more locations.

Table 4 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			
	D1 – Muller	D2 – Wambo	D3 – Coralie	D4 - Thelander
14/01/2017	23	27	66	20
29/01/2017	32	22	53	22
6/05/2017	8	52	15	8
24/09/2017	28	45	53	32
27/09/2017	49	51	40	39
15/12/2017	44	36	53	32
29/12/2017	19	19	53	9

Figure 2 shows all measured 24-hour average concentrations from each monitoring site in 2017. The Development Consent includes 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)

The exceedances of 50 µg/m^3 were primarily measured in summer and spring, although one day in May recorded and elevated concentration. **Section 4** provides an analysis of the data on each exceedance day, in order to determine the likely contribution of Wambo Coal's activities to the measured results.

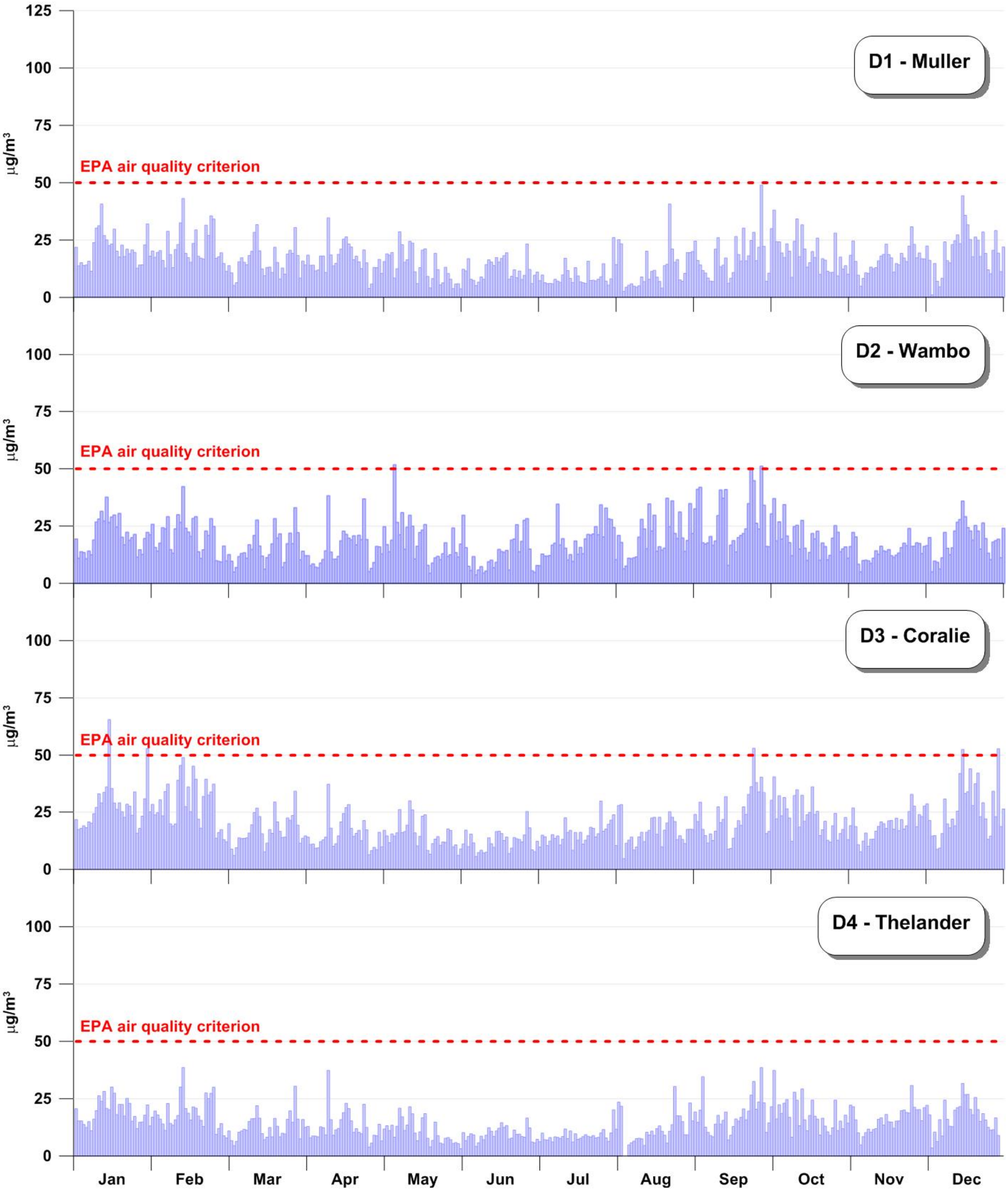


Figure 2 Measured 24-hour average PM_{10} concentrations

4. Exceedance Day Analyses

Figure 3 shows the measured 10-minute PM_{10} concentrations on 14 January 2017. It can be seen from the legend in this figure that the 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at Coralie (specifically, 66 µg/m^3). The PM_{10} concentrations at Coralie differed from measurements at the other sites between 1 and 4 am, when a peak of around 500 µg/m^3 occurred. This peak coincided with light variable winds, mainly from the south.

For each 10-minute average period, the contribution from Wambo mine was determined based on the wind conditions at the time and the position of upwind and downwind monitors. On this particular day the 24-hour average site contribution to the monitored level at Coralie (66 µg/m^3) was calculated to be 4.5 µg/m^3. This result indicates that the Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

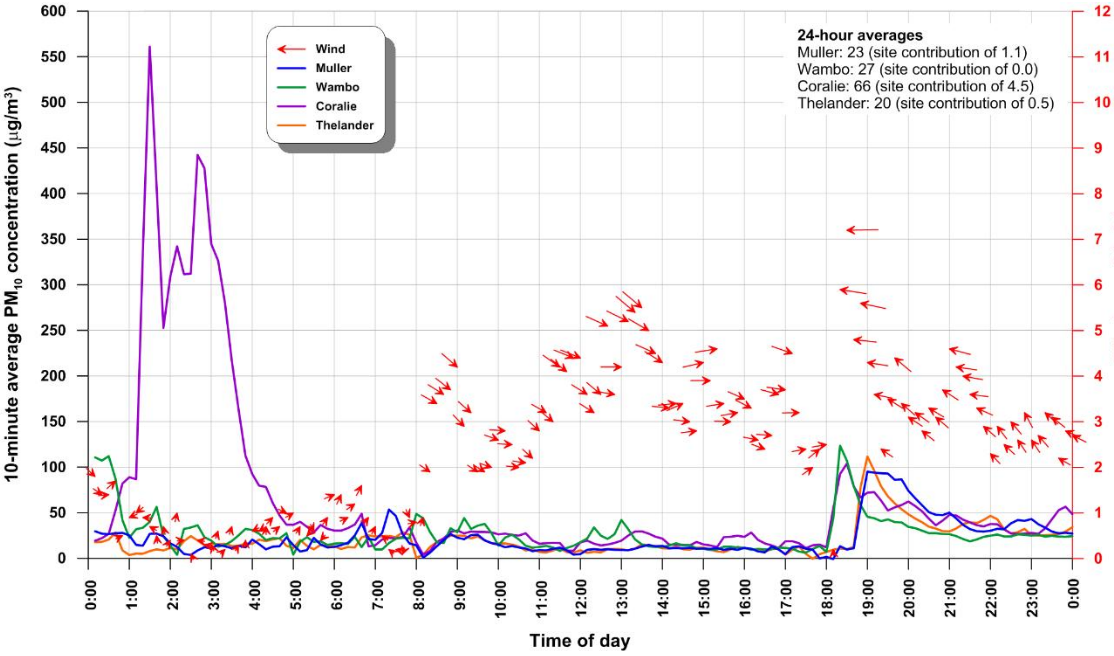


Figure 3 PM_{10} concentrations and wind conditions on 14 Jan 2017

Figure 4 shows the measured 10-minute PM_{10} concentrations on 29 January 2017. The 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at Coralie (53 µg/m^3). This result was influenced by elevated PM_{10} concentrations between 2 and 3 am, when concentrations up to around 300 µg/m^3 were measured. The peak coincided with light variable winds, mainly from the south. On this particular day the 24-hour average site contribution to the monitored level at Coralie was calculated to be 0.4 µg/m^3. This result indicates that the Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

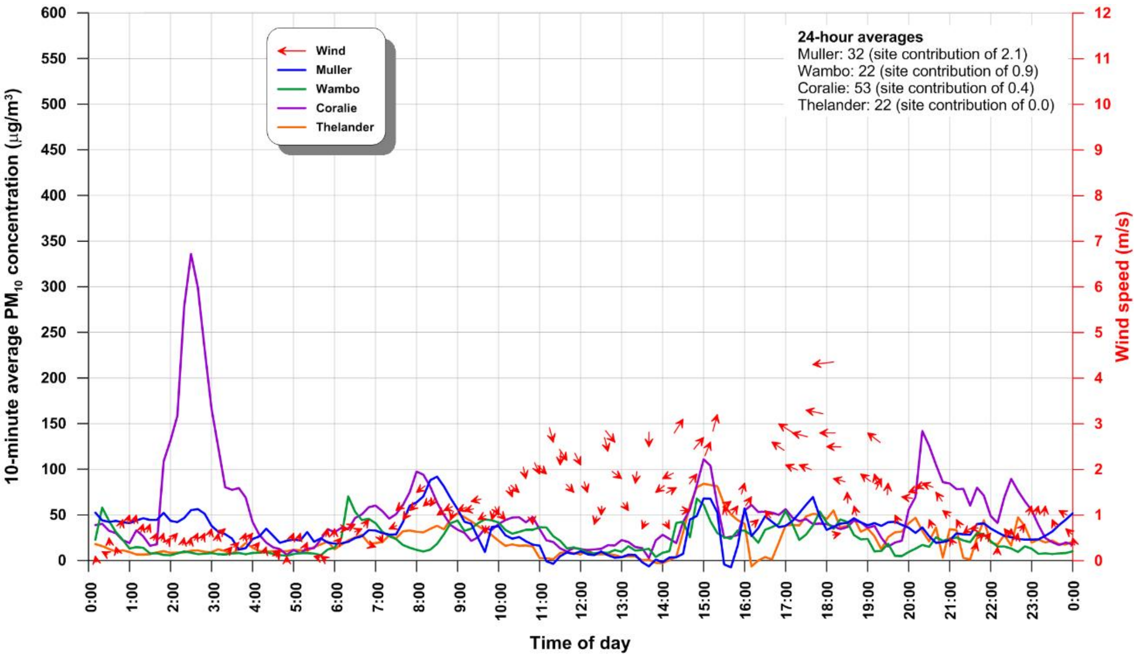


Figure 4 PM_{10} concentrations and wind conditions on 29 Jan 2017

Figure 5 shows the measured 10-minute PM_{10} concentrations on 6 May 2017. The 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at Wambo (52 µg/m^3). This result was influenced by elevated PM_{10} concentrations between 7 and 9 pm, when concentrations up to around 1,000 µg/m^3 were measured. The peak coincided with light variable winds. On this particular day the 24-hour average site contribution to the monitored level at Wambo was calculated to be 2.6 µg/m^3. If this contribution were to be removed from the measured result, the 24-hour average at the Wambo monitoring site would have been less than 50 µg/m^3. However the result indicates that the Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

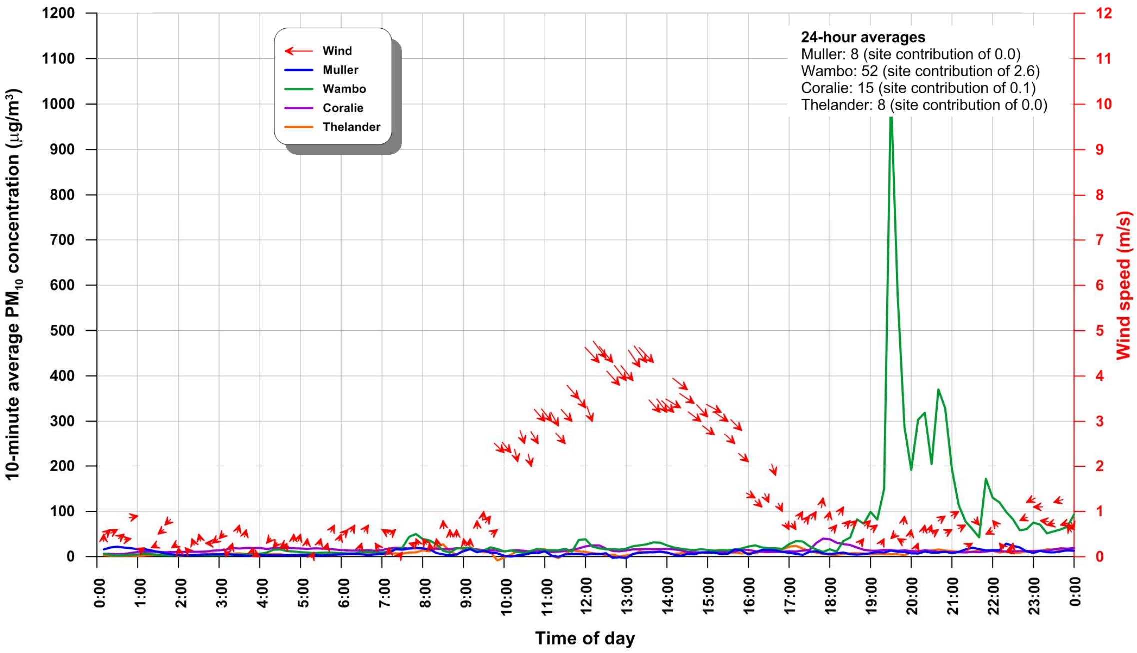


Figure 5 PM_{10} concentrations and wind conditions on 6 May 2017

Figure 6 shows the measured 10-minute PM_{10} concentrations on 24 September 2017. The 24-hour average PM_{10} concentration exceeded 50 µg/m³ at Coralie (53 µg/m³). This result was influenced by generally elevated PM_{10} concentrations across most of the day, with peaks at various times. The 24-hour average site contribution to the monitored level at Coralie was calculated to be 5.2 µg/m³. If this contribution were to be removed from the measured result, the 24-hour average at the Coralie monitoring site would have been less than 50 µg/m³. However the result indicates that the Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m³.

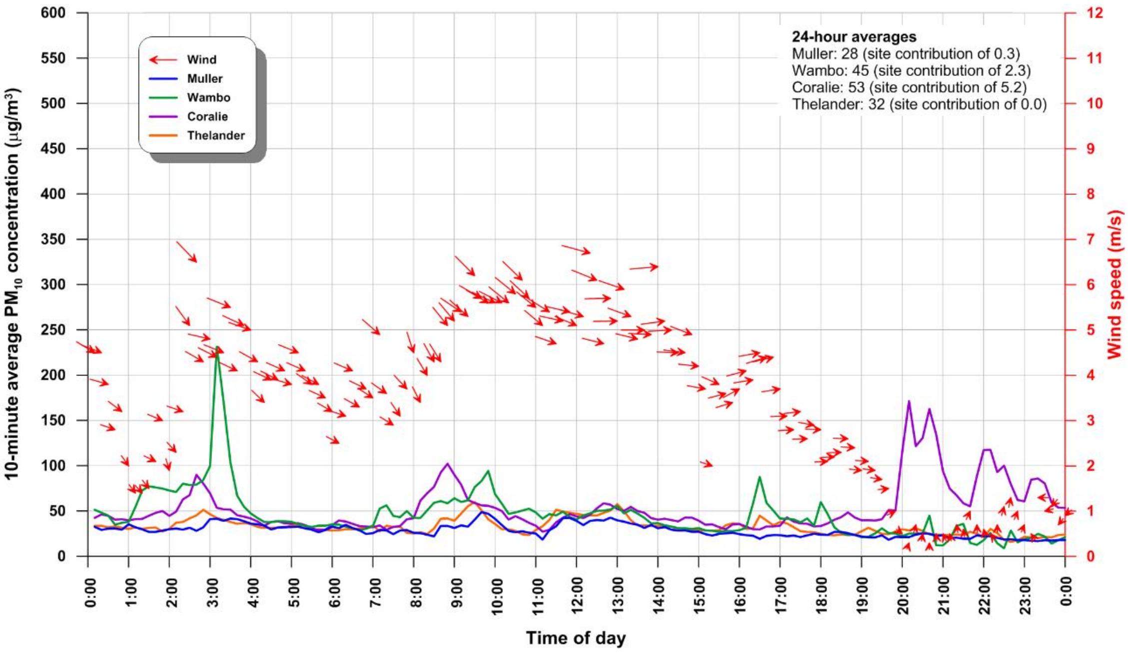


Figure 6 PM_{10} concentrations and wind conditions on 24 Sep 2017

Figure 7 shows the measured 10-minute PM_{10} concentrations on 27 September 2017. The 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at Wambo (51 µg/m^3). This result was influenced by elevated PM_{10} concentrations between 6 and 7 pm, when concentrations up to around 600 µg/m^3 were measured. The peak coincided with light variable winds. On this particular day the 24-hour average site contribution to the monitored level at Wambo was calculated to be 0.0 µg/m^3. This result indicates that the Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

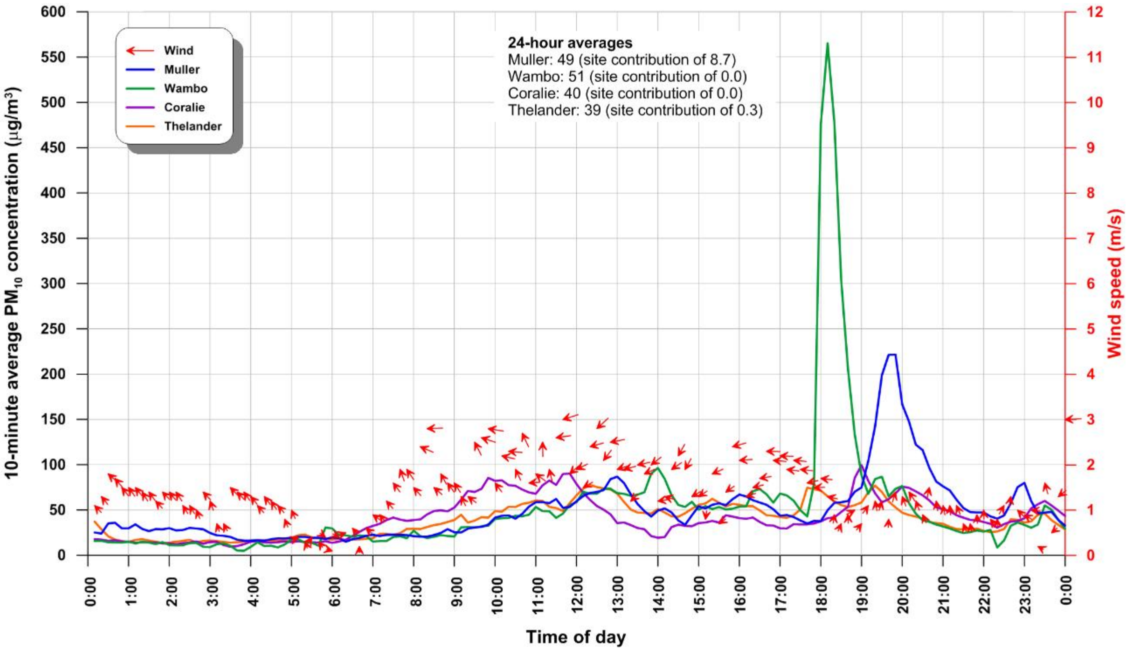


Figure 7 PM_{10} concentrations and wind conditions on 27 Sep 2017

Figure 8 shows the measured 10-minute PM_{10} concentrations on 15 December 2017. The 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at Coralie (53 µg/m^3). This result was influenced by elevated PM_{10} concentrations between 1 and 2 am, when concentrations up to around 300 µg/m^3 were measured. The peak coincided with moderate winds from the south. On this particular day the 24-hour average site contribution to the monitored level at Coralie was calculated to be 0.0 µg/m^3. This result indicates that the Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

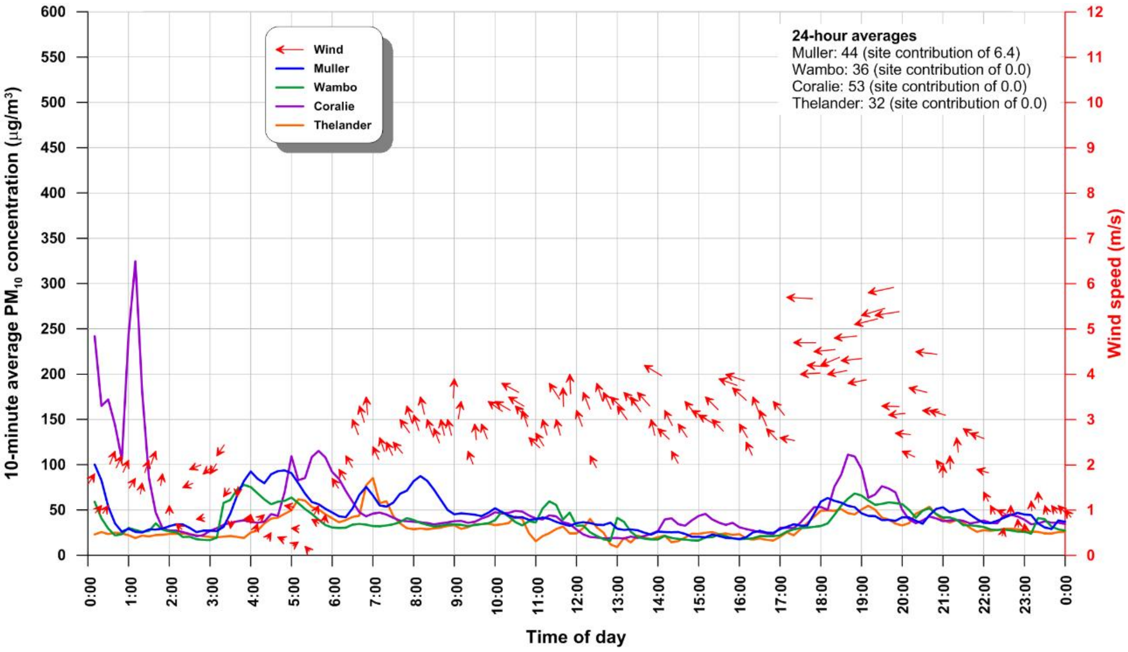


Figure 8 PM_{10} concentrations and wind conditions on 15 Dec 2017

Figure 9 shows the measured 10-minute PM_{10} concentrations on 29 December 2017. The 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at Coralie (53 µg/m^3). This result was influenced by elevated PM_{10} concentrations between 8 and 11 pm, when concentrations up to around 400 µg/m^3 were measured. The peak coincided with light variable winds. On this particular day the 24-hour average site contribution to the monitored level at Coralie was calculated to be 4.0 µg/m^3. If this contribution were to be removed from the measured result, the 24-hour average at the Coralie monitoring site would have been less than 50 µg/m^3. However the result indicates that the Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

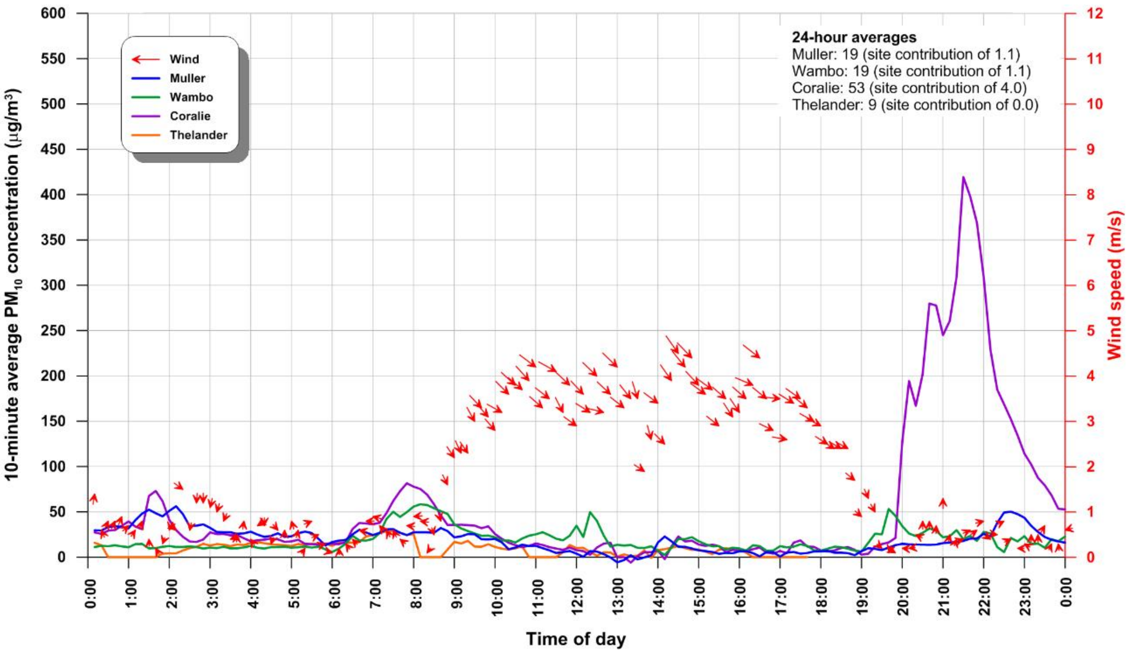


Figure 9 PM_{10} concentrations and wind conditions on 29 Dec 2017

Table 5 lists the seven 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 wind observations. None of the calculated site contributions were above Wambo Coal's Development Consent acquisition criterion.

Table 5 Site contribution for days above 50 µg/m^3 PM_{10} at one or more locations

Date	Measured 24-hour average PM_{10} concentration in µg/m^3 (calculated site contribution in parentheses)			
	Muller	Wambo	Coralie	Thelander
14/01/2017	23 (1.1)	27 (0.0)	66 (4.5)	20 (0.5)
29/01/2017	32 (2.1)	22 (0.9)	53 (0.4)	22 (0.0)
6/05/2017	8 (0.0)	52 (2.6)	15 (0.1)	8 (0.0)
24/09/2017	28 (0.3)	45 (2.3)	53 (5.2)	32 (0.0)
27/09/2017	49 (8.7)	51 (0.0)	40 (0.0)	39 (0.3)
15/12/2017	44 (6.4)	36 (0.0)	53 (0.0)	32 (0.0)
29/12/2017	19 (1.1)	19 (1.1)	53 (4.0)	9 (0.0)

5. Conclusion

The main conclusions of this monitoring data review were as follows:

- There were seven (7) unique days when the PM_{10} concentration exceeded 50 µg/m^3 at one or more monitoring locations in 2017.
- Activities at Wambo mine were likely to have contributed to some of the measured results however none of the calculated site contributions exceeded Wambo Coal's Development Consent acquisition criteria. There were three days identified (6/5/2017, 24/9/2017 and 29/12/2017) when the calculated site contribution influenced compliance with the impact assessment criterion.

APPENDIX E

ANNUAL FLORA AND FAUNA MONITORING REPORT 2017

Wambo Coal Mine

Annual Flora and Fauna Monitoring Report 2017 – Volume 1

Prepared for
Wambo Coal Pty. Ltd.

1 March 2018

DOCUMENT TRACKING

Item	Detail
Project Name	Wambo Coal Mine Annual Flora and Fauna Monitoring, 2017
Project Number	6725
Project Manager	Daniel McKenzie (02) 4910 3403 Level 7, 19 Bolton Street, Newcastle, NSW
Prepared by	Daniel McKenzie
Reviewed by	Daniel Magdi
Approved by	Martin Sullivan
Status	Final
Version Number	1
Last saved on	1 March 2018
Cover photo	Clockwise from left: A *Eucalyptus cladocalyx* (Sugar Gum) planting at Wambo Coal Mine, the vulnerable woodland bird *Climacteris picumnus victoriae* (Brown Treecreeper –eastern subspecies) and Spotted-gum Forest in remnant woodland and recently seeded *Acacia* species establishing on the post-mining landform. Photos by Daniel McKenzie.

This report should be cited as 'Eco Logical Australia 2017. *Wambo Coal Mine Flora and Fauna Monitoring Report - Volume 1*. Prepared for Wambo Coal Pty Ltd.

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Merri Bartlett and Harry Egan from Wambo Coal Pty Ltd.

Contents

List of figures

List of plates

List of tables

Abbreviations

Abbreviation	Description
AEMR	Annual Environmental Management Report
BC Act	NSW Biodiversity Conservation Act 2016
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
HBT	Hollow-bearing Tree
INFI	Infiltration Index
LFA	Landscape Function Analysis
LOI	Landscape Organisation Index
NGCG	Native Ground Cover - Grasses
NGCO	Native Ground Cover - Other
NGCS	Native Ground Cover - Shrubs
NI	Nutrient Index
NMS	Native Midstorey Cover – the projected native foliage cover of midstorey (%)
NOS	Native Overstorey – the projected native foliage cover of canopy (%)
NPS	The number of Native Plant Species
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type
RWEA	Remnant Woodland Enhancement Area
RWEP	Remnant Woodland Enhancement Program
SI	Stability Index
SSA	Soil Surface Assessment

Abbreviation	Description
TEC	Threatened Ecological Community
VCA	Voluntary Conservation Area
WCPL	Wambo Coal Pty Ltd

Key findings

The following section details the key findings of the 2017 spring flora and fauna monitoring. Several different components make up this monitoring program. Floristic surveys, bird surveys, Landscape Function Analysis and riparian condition surveys and were all conducted during September and October 2017 across both remnant woodland and post-mining rehabilitation areas.

Despite unusually dry conditions during the survey period, remnant woodland sites appear to be generally performing well, with a low cover of exotic species and are either meeting or falling just short of completion criteria, with no additional management required. However, exotic species cover remains high in the River Red Gum / River Oak riparian woodland where historic disturbance has been greatest. These areas generally exceed completion criteria and voluntary conservation area (VCA) targets for exotic plant cover. Plantings of canopy species could be considered in the open grassland areas of on the Wollombi Brook floodplain in Remnant Woodland Enhancement Area (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.

The dieback of *Angophora floribunda* (Rough-barked Apple) observed within the Warkworth Sands area of RWEA ‘A’ in 2016 appears to be recovering, with abundant epicormic growth observed in 2017. Bird surveys in remnant woodland sites reflected the good condition of these woodland areas with RWEA areas 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.

The North Wambo Creek Diversion has not yet met completion criteria for landscape function and this area will require additional management actions to ensure that all completion criteria and other commitments are met in the near future. Woodland rehabilitation areas 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. 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 area are generally meeting landscape function performance targets for all attributes with the exception of landscape organisation, which was likely reduced by the very dry conditions at the time of survey.

Riparian condition scores for Wambo Creek and Stony Creek showed little change between the current year and the previous year over the three separate reaches of each creek surveyed. Condition scores for North Wambo Creek were slightly larger than the previous year but review of transect photos and examination of the data suggest this may be due to the effect of different observers completing the surveys in the previous year. No evidence of additional subsidence impacts were noticed on any of the creeks. While North Wambo Creek is currently fenced to prevent grazing impacts and to improve environmental condition, large reaches of Stony Creek remain grazed by cattle. Wambo Creek has been heavily impacted by historic clearing and grazing and had the lowest condition score of the three creeks. 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.

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 2017. 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, compare to performance criteria or past results (where relevant) and identify what and where management actions may be required.

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.
- **Mine subsidence observations and other management issues -** provides observations of mine subsidence and other management issues on land owned by WCPL

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, Alex Gorey and Gordon Patrick from September 11 to 18, 2017. 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).

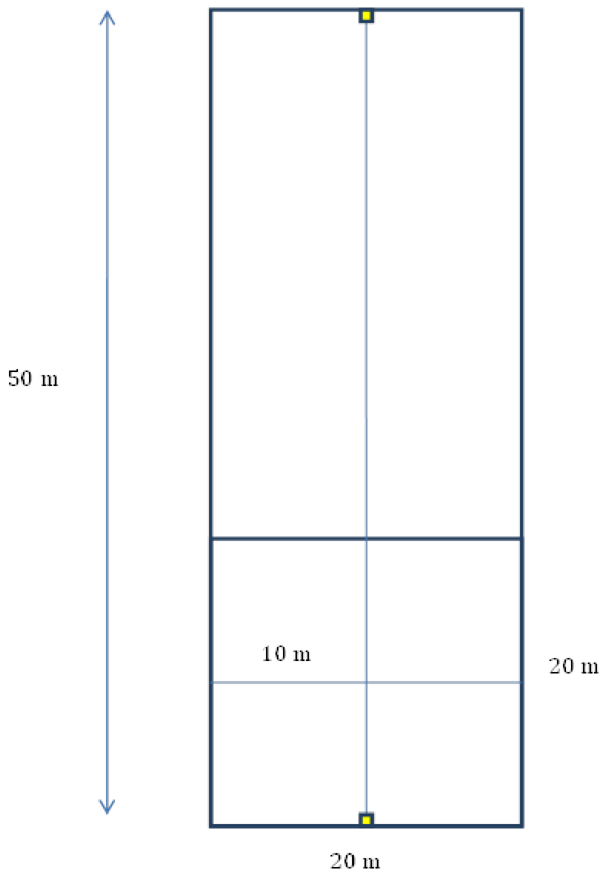


Figure 1: Biometric vegetation plot dimensions

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.

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 Environment Protection and Biodiversity Conservation Act 1999 (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	PCT 1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass	Listed BC Act, E: Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the New South	V9-A1

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	TEC	Plot name
Ironbark/Bulloak/Paperbark Forest	woodland of the central and lower Hunter	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	V9-B1
			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

*** 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 8 monitoring periods from 2010 to 2017 and cover of exotic species over the last three monitoring periods (2015, 2016 and 2017). 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.

Community condition benchmarks (developed by OEH for each PCT) have been modified to provide realistic, ambitious but achievable performance criteria for each plant community. Monitoring results can then be compared to these criteria to determine if management actions are likely to be required. 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.

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 has 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

Attribute	Red (needs greater improvement)	Orange (in need of improvement)	Yellow (not meeting target but values still acceptable)	Green (excellent – 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 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

In addition to those performance criteria listed above, Annexure C of the Voluntary Conservation Agreements (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 fol iage 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

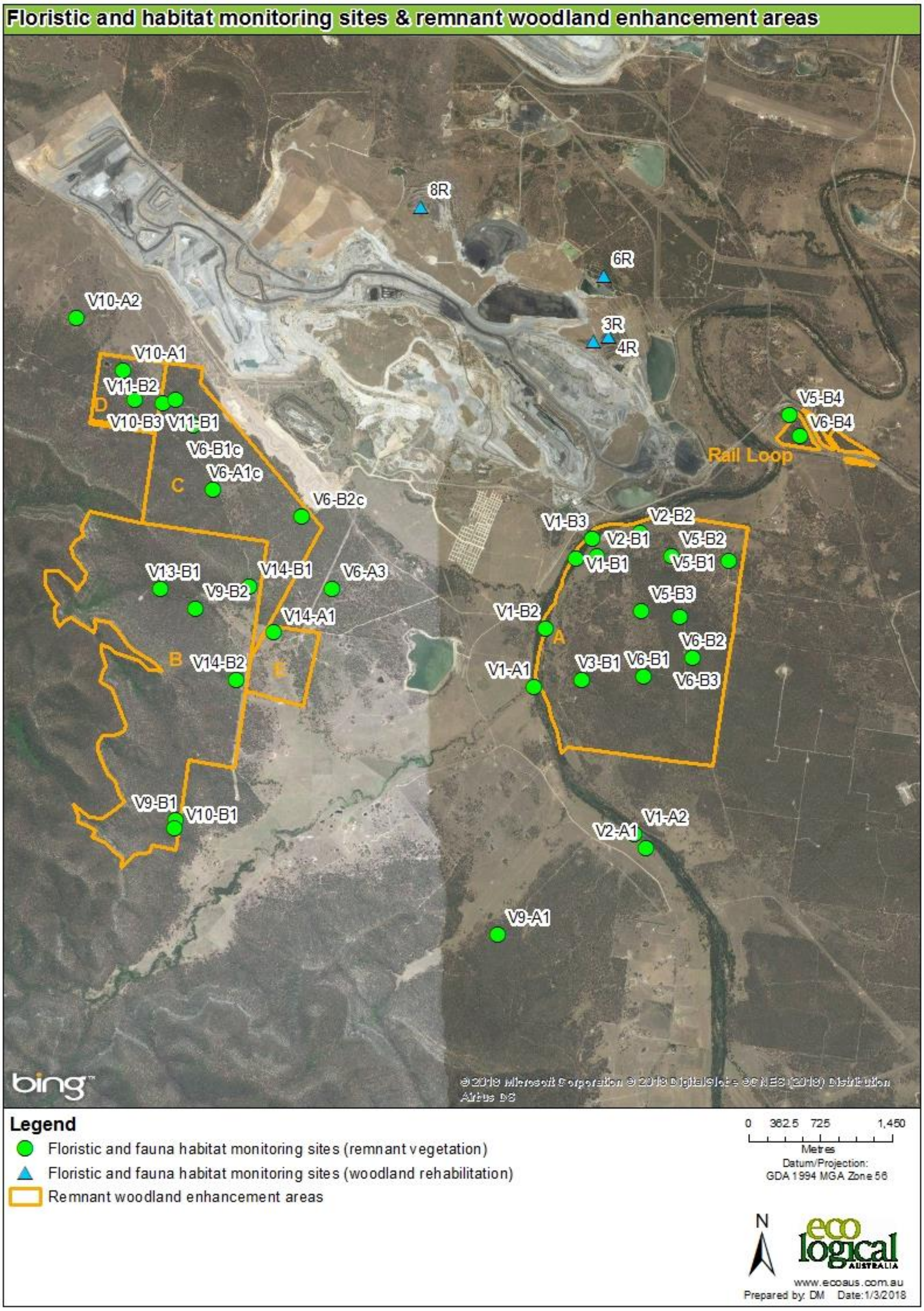


Figure 2: Floristic and habitat monitoring sites and RWEAs

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 provided in **Volume 2**.

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

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**. As reported in previous years, the main management issue in this zone is the high cover of exotic plant species. Sites V2-B1 (referred to as A1 in VCA) and V1-B2 (referred to as A3 in VCA) either exceed (A3) or fall just below (A1) the maximum permitted exotic plant cover for years 2 - 5 as stated within the VCA's.

The remaining performance measures are generally being met, with the exception of native grass cover which fell slightly below performance criteria.

Trends over time

The average number of native species recorded per monitoring plot in River Red Gum / River Oak riparian woodland has increased over time. The number of native species has increased at almost all monitoring sites (including reference sites) between the 2010 and 2017 monitoring periods.

Site V1-A1, located outside of the RWEA's was the only exception to this trend in which the number of native species appears to have halved over the same time period from 10 species in 2010 to five species in the last three years.

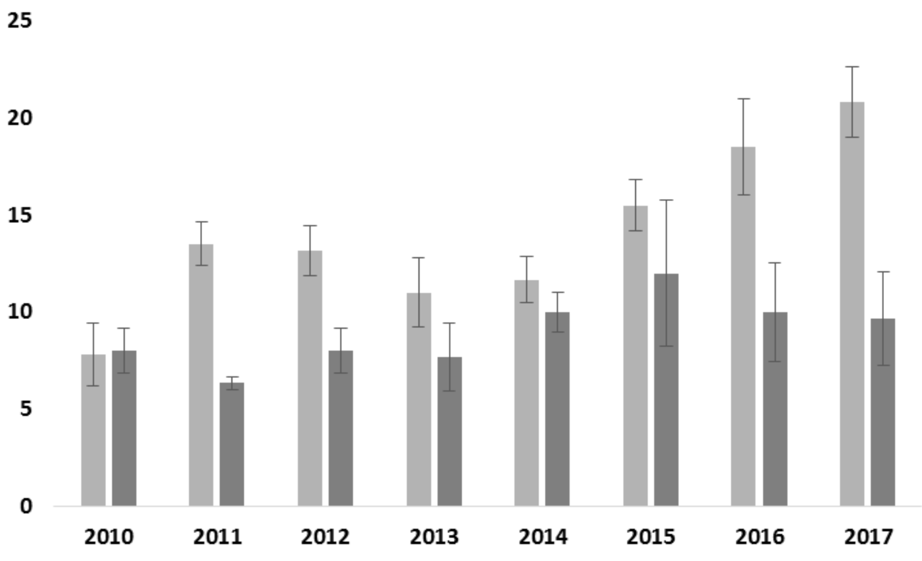


Figure 3: Average number of native species per plot in monitoring sites within riparian woodland in RWEA A (light grey) and from three reference sites outside the boundary of RWEA's (dark grey). Error bars represent standard error

Total cover of exotic species has been recorded since 2014 and results are quite variable over time, even within each site. However, in general, exotic cover has remained high across all riparian woodland monitoring sites over the monitoring periods, with the exception of site V3-B1 which has consistently had very low exotic plant species cover.

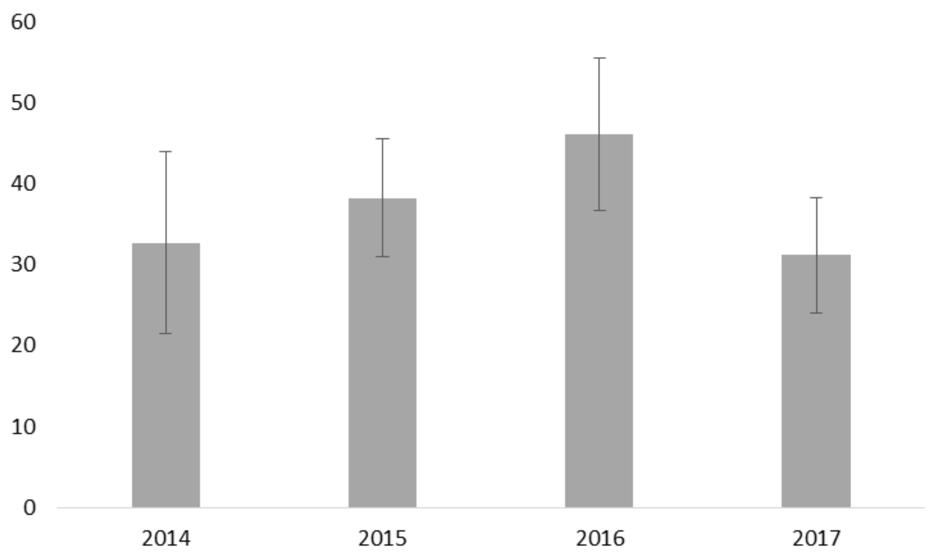


Figure 4: Average exotic plant species cover (%) within all riparian woodland monitoring sites per year

Several priority weeds are present in the River Red Gum / River Oak riparian woodland 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.

The same weed species have generally been recorded with a similar cover/abundance score to the previous monitoring period (2016). However *Echium plantagineum* (Pattersons Curse) was recorded at two additional sites during 2017. General weed observations while traversing RWEA A indicate that the spraying of larger infestations of *Opuntia* spp. in previously cleared areas on the Wollombi Brook floodplain during 2016 has substantially reduced their abundance in 2017 within the targeted areas.

Photo monitoring points in this zone, show only minor changes in structure within this vegetation zone between years 2017 and 2015 (**Plate 2** & **Plate 3**), and 2017 and 2013 monitoring (**Plate 3** & **Plate 4**). This is also observable in canopy cover and mid-storey cover scores, which have remained relatively similar over recent years despite some obvious observer bias inherent when different observers estimate cover and in some cases issues with distinguishing mid-storey cover from canopy cover.

Table 4: Declared weeds observed within the River Red Gum / River Oak riparian woodland PCT

Scientific Name	Common Name	Site	Biosecurity duty (NSW Biosecurity Act 2015)
Asparagus asparagoides	Bridal Creeper	V1-B1, V2-B1, V2-B2	**Prohibition on dealings -** Must not be imported into the State or sold
Echium plantagineum	Patterson's Curse	V1-A2, V1-B2, 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-B1, 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 aurantica	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-A2, V1-B3, V2-B1	**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-A1, V1-A2, V1-B2, V1-B3, V2-A1, V2-B1, V2-B2, V3-B1	**Prohibition on dealings -** Must not be imported into the State or sold

Plate 2: Flora monitoring site V3-B1 during 2017 – dry weather conditions are evident

Plate 3: Flora monitoring site V3-B1 during 2015

Plate 4: Monitoring site A3 during 2017

Plate 5: Monitoring site A3 during 2013

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	5	63.5	0	6	0	0	48	1	0	72
		Outside of RWEP	V1-A2	13	13.5	13	50	0	0	49.5		0	42
		A	V1-B1	21	38	0	4	0	0	0		1	10
		A	V1-B2	25	20	18.5	24	0	0	42		1	5
		A	V1-B3	14	9.5	37.5	14	0	0	17.1		1	12
River Red Gum Woodland		Outside of RWEP	V2-A1	11	5.5	0	24	2	2	36		0	5
		A	V2-B1	18	22.5	12.5	0	0	4	58		0	13
		A	V2-B2	21	21	12	12	0	30	30		0	3
Yellow Box / Blakely's Red Gum / Rough-barked Apple Forest		A	V3-B1	26	20.5	1	24	0	38	0		0	39
Average values for RWEA monitoring sites				20.8	21.9	13.6	13	0	12	24.5	1	0.5	13.6
Performance criteria				>20	10-50	10-50	20-60	1-5	5-30	<10	1	-	-

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 forms 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 fell below performance criteria in 2017 despite meeting the criteria in previous years. A decline in the number of native plant species detected in this community has occurred in 2017, with an average of 31.5 native species recorded in 2016 and only 18.25 species recorded in 2017 (**Figure 5**). This may be a result of the extremely dry conditions at the time of survey exacerbated by the canopy dieback over the previous year.

As with previous years of monitoring, exotic species cover was relatively low across most of the monitoring plots. An apparent large reduction in exotic species cover at site V5-B4 (within the rail loop), may be related to the drier climatic conditions and absence of *Melinis repens* (Red Natal grass) or that the lack of seed heads made it difficult to identify this exotic species which was previously recorded as abundant. The environmental weed *Bryophyllum* sp. (Mother of Millions) was observed to be abundant in certain locations in 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, with weed spraying observed in RWEA A during monitoring surveys.

Photo-monitoring point A2 within this PCT shows little change in vegetation structure between the 2013 and 2017 monitoring periods (**Plate 7** & **Plate 8**). However the impact of dry climatic conditions and epicormic growth following the *Angophora floribunda* dieback previously mentioned, can be observed in the 2017 photo. Canopy and mid-storey cover scores collected by ELA from the 2015 to 2017 monitoring periods are also similar between years.

Canopy dieback of *A. floribunda* in some areas of this community was observed during the 2016 monitoring program. These trees are now displaying abundant epicormic growth, and it appears most trees have survived this dieback event to date (**Plates 9** & **10**)

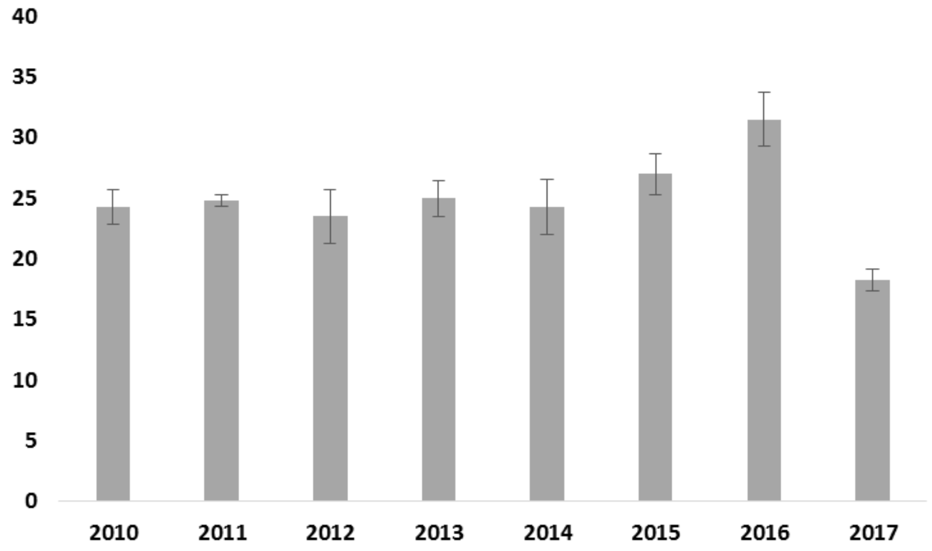


Figure 5: The average number of native species recorded within Warkworth Sands Woodland monitoring plots over time showing a decline during the current year.

Plate 7: Photo monitoring point A2 during 2017

Plate 8: Photo monitoring point A2 during 2013

Plate 9: Severe *Angophora floribunda* canopy dieback in parts of Warkworth Sands Woodland in RWEA A during 2016

Plate 10: Partial recovery of *Angophora floribunda* canopy dieback during 2017

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	18	14	1.5	42	2	32	16	1	0	6
		A	V5-B2	19	20	2	36	0	66	2		0	8
		A	V5-B3	20	5.5	17.5	12	4	42	0		0	37
		Rail Loop	V5-B4	16	18	5.5	44	6	6	0		0	21
Average values for RWEP and Rail Loop monitoring sites				18.3	14.4	6.6	33.5	3	36.5	4.5	1	0	18
Performance criteria				>20	10-40	10-50	4-20	5-30	5-35	<10	1	-	-

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 BC Act listed EEC C*entral 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 under the Commonwealth EPBC Act.

This community appears to be performing well with a very low cover of exotic species and a large number of native species present at each monitoring plot (**Table 6**). The number of native species recorded was lower than the previous year at most of the monitoring sites in this community and fell slightly below the performance criteria for this attribute. However, the average number of native species recorded in 2017 is similar to years 2011 – 2014 monitoring. Examination of biometric data reveals that little to no change in exotic cover, canopy or mid-storey has 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 points A4 and C1 (**Plates 12 -15**) with no major changes visible between the 2013 and 2017 monitoring periods.

Minor mine subsidence cracks were noticed at 4 of the 8 monitoring plots within this PCT. However vegetation damage at these sites was insignificant.

Plate 11: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest at WCPL

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	24	34	12	46	4	26	0	1	24	6
		Outside of RWEP	V6-A3	24	19.5	12	32	2	18	0		0	16
		A	V6-B1	19	17	13.5	18	0	6	0		0	102
		C	V6-B1c	31	14.5	11	36	4	14	0		0	48
		A	V6-B2	19	11.5	9	34	4	2	0		0	57
		C	V6-B2c	28	11.5	24	26	4	20	0		0	28
		A	V6-B3	23	15	9	22	2	10	2		0	92
		Rail Loop	V6-B4	13	33	0	22	0	4	0		0	3
Grey Gum / Narrow-leaf / Ironbark / Bulloak / Honeymyrtle Forest		C	V11-B1	26	19.5	11	32	6	6	2		0	110
		C	V11-B2	31	24.5	23	54	2	8	0		0	54
Average values for RWEP and Rail loop monitoring sites				23.7	20.0	12.5	32.2	2.8	10.7	0.4	1	2.4	51.6
Performance criteria				>25	10-40	5-10	15-50	5-10	5-40	<5	1	-	-

The average number of native species recorded in each plot within this PCT had dropped from 2015 and 2016 monitoring periods, but remains similar to years prior to the 2015 monitoring (**Figure 6**). This pattern is closely followed by the reference site data, suggesting that these increases in native species richness are unlikely to be directly derived from management interventions and are possibly more related to weather patterns, with 2012 being a year of well below average rainfall, larger than median rainfall in 2016 and below average rainfall in 2017.

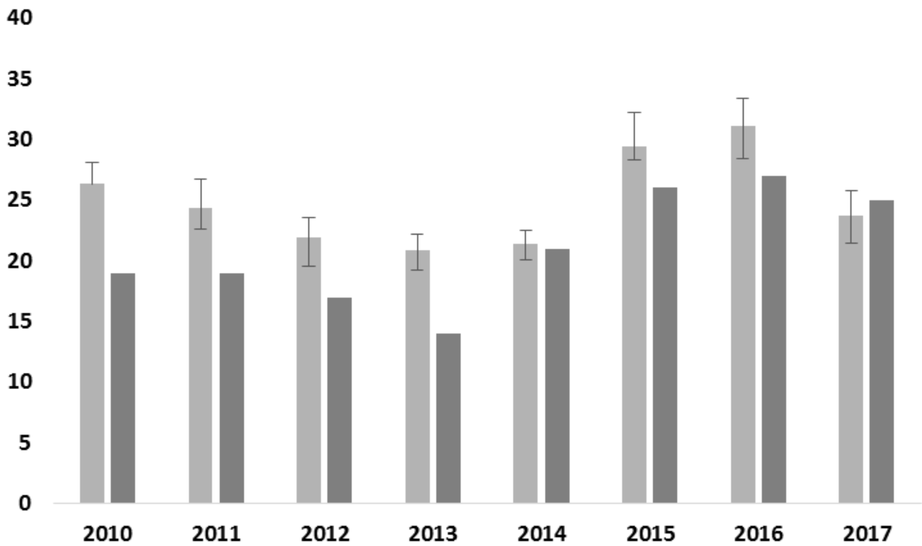


Figure 6: Average number of native species recorded in Narrow-leaved Ironbark - Bull Oak - Grey Box open forest within RWEAs (light grey) compared to reference site V6-A3 (dark grey). Error bars represent the standard error of the mean

Plate 12: Photo-monitoring point A4 during 2017

Plate 13: Photo-monitoring point A4 during 2013


Plate 14: Photo-monitoring point C1 during 2013


Plate 15: Photo-monitoring point C1 during 2017

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 midstorey 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 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 regards to performance criteria with large numbers of native species present at each monitoring plot, despite falling just short of performance criteria for this attribute (32 species on average rather than >35). The number of native species in this PCT was in line with previous years (**Figure 7**). Most other attributes meet performance criteria with the cover of native shrubs and other natives falling just short of the criteria (**Table 8**). Monitoring plot V10-B1 continues to be the most diverse in regards to native plant species. Generally, few weed species are present within this PCT, with the exception of small infrequent occurrences of *Opuntia* species (Prickly Pear, Creeping Pear or Tiger Pear).

Photo-monitoring points in this community show little change in vegetation structure between the 2013 and 2017 monitoring periods (**Plate 16 & Plate 17**)

Plate 16: Photo-monitoring point B2 during 2013

Plate 17: Photo-monitoring point B2 during 2017

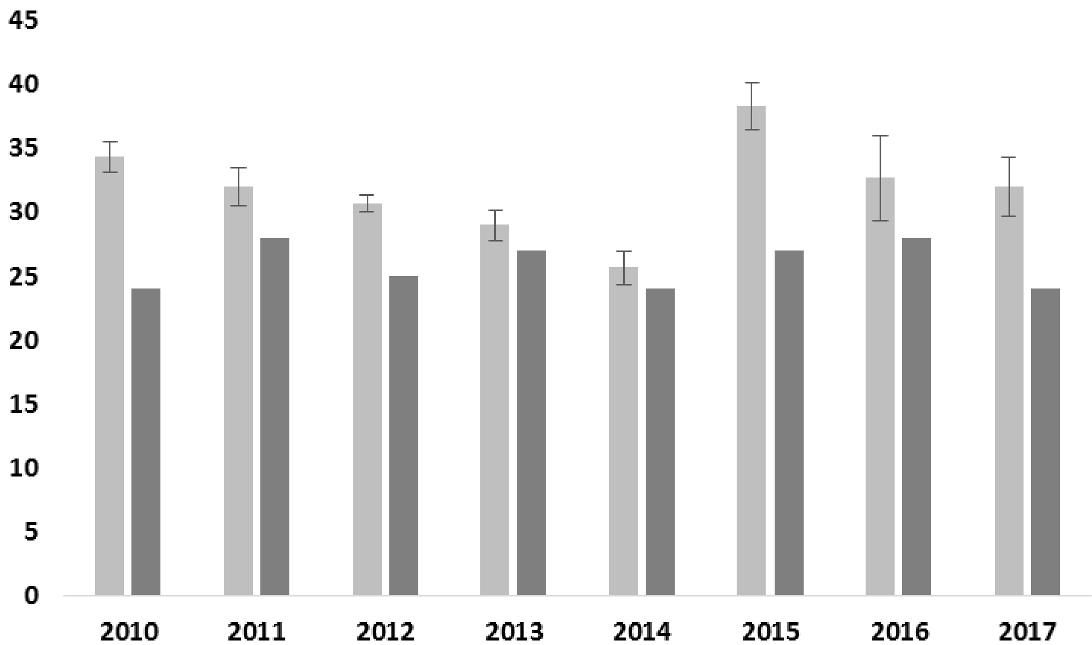


Figure 7: The average number of native species in Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland within RWEAs (light grey) compared to the recorded number at reference site V9-A1 (dark grey). Error bars represent the standard error of the mean

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	NNS	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	24	17.5	22.5	10	8	16	2	1	0	25
		B	V9-B1	32	25.5	13.5	34	6	4	4		0	67
		B	V9-B2	29	36.5	13.5	54	8	6	0		0	22
		B	V10-B1	36	30	20.5	14	0	0	4		0	25
Average values for RWEP monitoring sites				32.3	30.6	15.8	34	4.7	3.3	2.6	1	0	38
Performance criteria				>35	15-40	5-20	30-50	5-15	5-40	< 5	1	-	-

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 18**). This community is listed under the 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, the Slaty Box - Grey Gum shrubby woodland community 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 2017. The recorded number of native species has fluctuated over time but in 2017 results were similar to the previous year (**Figure 8**).

Plate 18: A typical example of Slaty Box woodland at WCPL during 2017

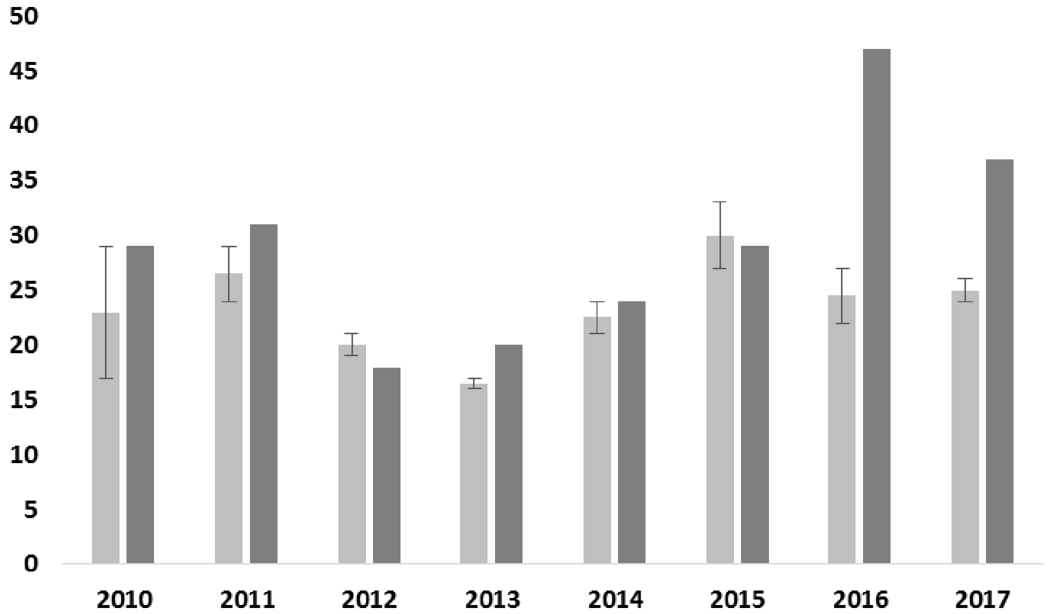


Figure 8: The mean number of native species recorded in Slaty Box shrubby woodland within RWEAs (light grey) compared to reference site V10-A2 (dark grey) Error bars represent the standard error of the mean

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	26	25	10.5	26	0	4	0	1	0	53
		Outside of RWEP area	V10-A2	37	21	10.5	24	6	8	0		0	16
		D	V10-B3	24	40	10.5	12	8	6	0		0	87
Average values for RWEP monitoring sites				25	32.5	10.5	19	4	6.0	0	1	0.0	70
Performance criteria				21	15-40	5-30	5-30	0-25	2-10	< 5	1	-	-

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 required number of native species. However, the recorded value is still very high with 37 native species recorded in the 20 x 20 plot and is considered acceptable. Over-storey and mid-storey cover was slightly higher than the upper limit given in the performance criteria. Again this was only slightly greater than the performance criteria and no additional management is required. A proliferation of non-grass species such as herbs and twiners contributed to a "Native Ground Cover -Other" (NGCO) score that exceeds the performance criteria for this vegetation type. This is also considered acceptable, particularly as only one monitoring site samples this community and the variability of different patches is not entirely captured. No decline in number of native species or increase in exotic cover was observed from the previous monitoring event in 2016.

Plate 19: White Mahogany - Spotted Gum - Grey Myrtle forest

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	37	46.5	44	18	2	32	0	1	0	70
Performance criteria				>45	15-45	5-40	5-40	10-20	5-20	0	1	-	-

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 20**). 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 and the number of native species recorded has dropped slightly at all monitoring sites within this community from the previous year (**Figure 9**)**.** Similar numbers of native plant species were observed at these sites during 2014 monitoring. The numbers of native plant species in this community have fluctuated over time in a similar fashion to other communities, with a slight dip in the number of species recorded during 2012, and 2013, 2014 monitoring, before peaking during the 2015/16 monitoring, before returning with similar numbers recorded in 2017 to earlier monitoring years. 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.

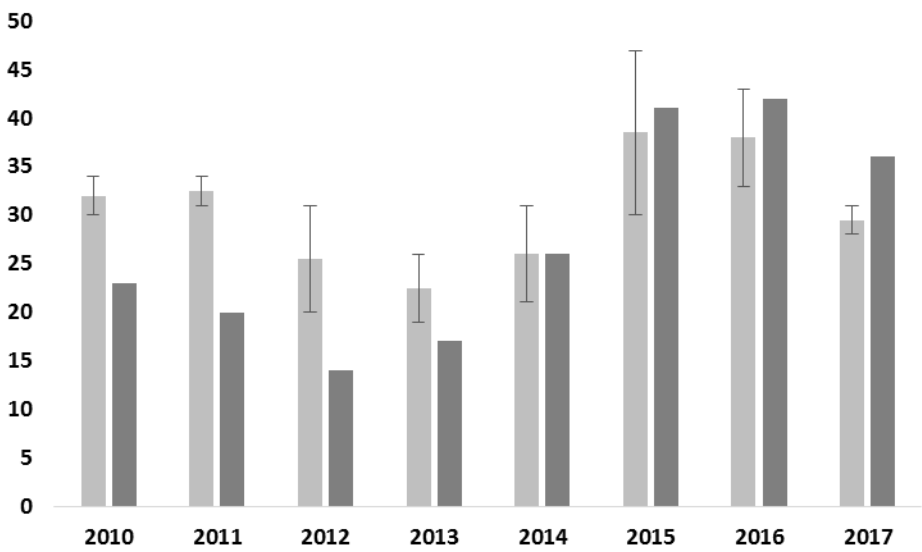


Figure 9: The mean number of native species recorded in Brush Wilga/Native Olive shrubland within RWEAs (light grey) compared to reference site V10-A2 (dark grey)

Plate 20: Brush Wilga/Native Olive Shrubland at V14-A1

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	36	8	56	8	2	16	0	1	0	0
		B	V14-B1	28	10	38.5	36	2	12	0		0	45
		B	V14-B2	31	16	55.5	38	8	30	2		0	5
Average values for RWEP monitoring sites				29.5	13	47	37	5	21	1	1	0	25
Performance criteria				>30	5-40	5-40	30-50	5-10	10-40	<5	1	-	-

*considered a variant of this PCT

2.1.4 Conservation agreement requirements and photo monitoring points

Annexure C of the Voluntary Conservation Agreements (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 9**. Two of the 10 monitoring plots (A2 and A3) exceed the exotic cover limits for the 2-5 year targets. Site A2 had numerous *Anagallis arvensis* (Scarlet Pimpernel) and several other common pasture weeds with scattered *Opuntia* spp. (Tiger Pear and Prickly Pear). Site A3, within the riparian zone of Wollombi Brook had a moderate cover (5-25%) of *Ehrharta erecta* (Panic Veldtgrass) along with 20 other common exotic flora species.

Site A1 falls below the exotic cover limit, however a high exotic cover score was recorded consisting of species such as *Galenia pubescens* (Galenia) and several other common weeds of pasture/native grasslands such as *Bidens subalternans* (Greater Beggar's Ticks) and *Heliotropium amplexicaule* (Blue Heliotrope).

No exotic cover was recorded at Site CT2 despite this site having 52% exotic cover recorded in the previous year. It is suspected that the dry conditions at the time of survey in 2017 prevented detection of *Melinis repens* (Red Natal Grass) which was abundant during the previous year monitoring. Exotic cover is very low at the remaining sites and all these fell below the exotic cover limits.

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 2017
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	58
A	A2	V5-B1	20	15	16
A	A3	V1-B2	30	20	42
A	A4	V6-B1	10	5	0
B	B1	V13-B1	5	5	0
B	B2	V9-B1	5	5	4
C	C1	V11-B1	5	5	2
D	D1	V10 -B3	5	5	0

* Site CT2 has previously had a high cover of the exotic *M.repens.* It is suspected that the current result is due to dry conditions at the time of survey, rather than absence of the species.

Comparison of photo-monitoring sites between 2013 and 2017 monitoring show little change in vegetation over this time period. Dry conditions during the 2017 monitoring are apparent in some photographs, with less green vegetative growth apparent, but in general, no major changes in species composition or structure are apparent.

The canopy dieback in RWEA A observed during 2016 monitoring is visible at site A2, with new growth covering tree branches. The condition of the PCTs in these RWEAs is assessed in detail in the previous sections, with photos of each monitoring site included in **Volume 2.**

2.1.5 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, 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 management of exotic flora and weeds 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). It is recommended to give priority to species such as this in the mine's weed control program. 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 Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland, Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest and Brush Wilga/Native Olive shrubland during 2017 appear to have dropped from the previous monitoring period. As the months leading up to the flora surveys were particularly dry (9 mm total in July August and early September recorded at Singleton Army Base (BOM 2017)) this result is not surprising. Dry conditions prevent the detection of species as identification becomes difficult through lack of seed heads or flowers and some species rely on soil banks to survive dry periods, with their vegetative components drying up and breaking down. Two of these vegetation communities are woodland and open forest on sandy substrate or low hills and are more exposed to sunlight and drying winds. Canopy dieback within Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland in 2016 is likely exacerbated the impact of these dry weather conditions.

Angophora floribunda dieback observed within RWEA A in the previous year is concerning as this community is listed as a CEEC under the Commonwealth EPBC Act. However this issue was likely a natural phenomenon, as the area in question is not currently being undermined and dieback in *A. floribunda* was also noticed elsewhere in the locality away from WCPL at the time. Abundant epicormic growth was observed during 2017 on most of the *A. floribunda* trees having been affected by the dieback event in 2016 and it appears likely that the majority of trees may recover in time.

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.

2.2.1 Methods

Bird monitoring during spring 2017 was consistent with the two previous monitoring events in timing of surveys and methods. 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). A total sample period of 20 minutes was conducted at each survey site.

Twenty-six (26) sites were surveyed on two separate occasions between September 18 and 26, 2017 (**Figure 12**), with one morning and one afternoon survey conducted per site. However, due to a technical issue with electronic data collection, data for morning and afternoon surveys at one riparian site (BP17), and evening surveys at three sites (BP15,18 and 19) was lost post-survey. While regrettable, afternoon bird survey data is generally less diverse and of lower abundance than morning surveys (which were recorded at the three sites) and BP17 is one of four monitoring sites that sample the riparian bird community of Wollombi Brook.

The total number of bird species recorded each year 2007-17, 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 2017 monitoring observed a total of 74 bird species from 25 monitoring sites during formal bird surveys. This number is slightly lower than the median from all 26 sites in previous monitoring periods (81 species), but is similar to the number of species recorded during the 2016 monitoring (78 species) and is within range of previous surveys, which have varied between a low of 64 species in 2012 to 94 in 2014 (**Figure 10)**.

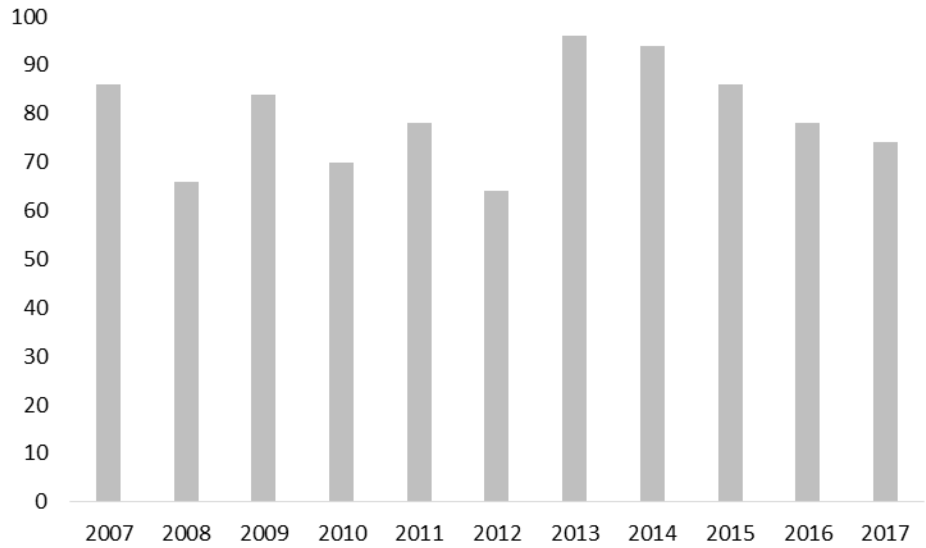


Figure 10: Number of bird species recorded at monitoring plots 2007 - 2017

The average number of bird species per 20 minute bird survey 2017 (9.94) was slightly less than the previous two monitoring periods (12.4 and 12.1) in 2015 and 2016.

In 2017, the number of species detected at each site varied between 6 (at site BP15) and 25 (at BP11), with an average of 16.7 species recorded per monitoring site. This is a slight drop from 2015 (19.2) but similar to 2016 (18.3) and RPS (2009) with an average of 17.9 species recorded at each of their 24 survey plots (slightly less than in current survey) (**Figure 11)**.

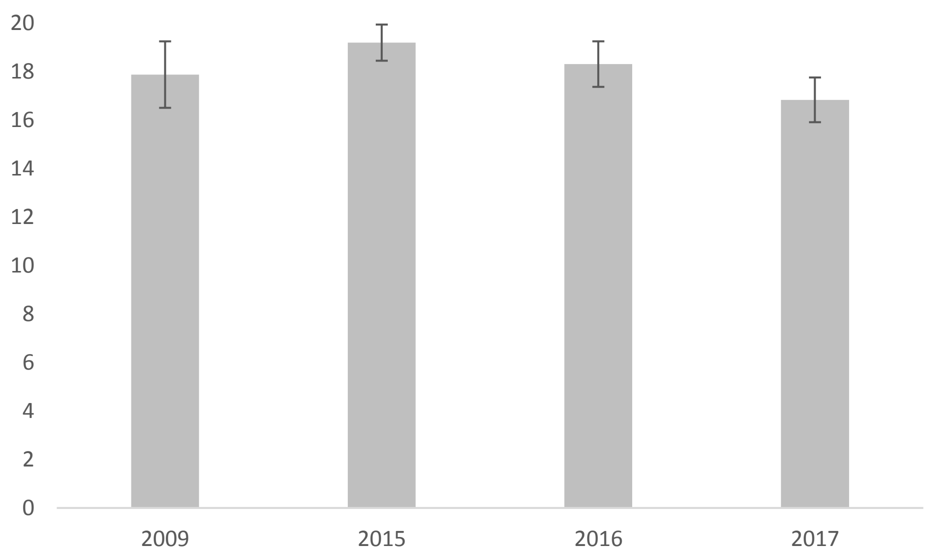


Figure 11: Average number of bird species recorded per monitoring site during 2009, 2015, 2016 and 2017

The average number of birds recorded per survey was similar to that recorded in recent years with 26.1 birds recorded per survey during 2017 and a bird density of 13.05 birds/ha/20 mins. Similar numbers were recorded during the 2016, 2015 and 2014 monitoring periods, with 27.9, 28 and 30.8 birds per survey respectively. Numbers of birds were not presented in RPS (2009) and it is assumed only bird species were recorded.

The most species-diverse site during 2017 was BP11 (25 species), followed by BP3 (22 species). BP11 was notably the most species-diverse site in 2016, and a high score in 2015. BP11 is located on Stony Creek at the periphery of different 3 habitat types, while BP3 is on Wollombi Brook in riparian *Casuarina cunninghamiana* (River Oak) dominated forest. BP15 although only surveyed on a single morning in 2017 was the most species poor site in 2017, with only 6 species recorded. This site is located in relatively young Narrow-leaved Ironbark - Bull Oak - Grey Box open forest and windy weather conditions at the time of survey may have affected results.

Bird assemblages in during 2017 were not compared statistically to previous surveys. However assemblages appear broadly similar to the previous 4 years and also data from 2009 monitoring. *Pachycephala rufiventris* (Rufous Whistler), *Lichenostomus chrysops* (Yellow-faced Honeyeater), and *Malurus cyaneus* (Superb Fairy-wren), were the three most widely recorded species in the last three monitoring events (2015-2017) and 14 of the 20 most widely recorded species in terms of monitoring sites in 2009 (RPS 2009) were in the top 20 most widely recorded species during 2017.

Eight threatened species listed under the NSW Biodiversity Conservation Act 2016, were recorded during 2017 surveys. *Calyptorhynchus lathami* (Glossy Black-Cockatoo) and *Neophema pulchella* (Turquoise Parrot) were two threatened species not recorded in 2016.

The same group of threatened species were recorded in the 2014, 2015, and 2016 monitoring periods, with the following exceptions. Two additional threatened species, *Petroica boodang* (Scarlet Robin) and *Grantiella picta* (Painted Honeyeater), were recorded in 2014 (outside of formal bird survey) and 2015 respectively. *Melanodryas cucullata* (Hooded Robin), Scarlet Robin, and *Circus assimilis* (Spotted Harrier) were all observed on a single occasion outside of designated bird surveys in 2015 but were not observed in 2016 or 2017. Turquoise Parrot (recorded this year) had not been recorded at WCPL during bird monitoring surveys since 2013 (Niche 2014b).

Comparison of numbers of threatened species between the 2015-2017 monitoring periods and the number of sites they were recorded at during the 2009 and 2014 to 2017 monitoring periods show that both *Chthonicola sagittata* (Speckled Warbler) and *Daphoenositta chrysoptera* (Varied Sittella) were recorded more widely during surveys in 2014, while larger numbers of Varied Sittella and *Glossopsitta pusilla* (Little Lorikeet) were observed in 2017 compared to the previous two monitoring years.

Hooded Robin and Turquoise Parrot appear to have only rarely been observed during monitoring surveys at Wambo and are uncommon in the area. Favourable Glossy Black-cockatoo habitat in the area is likely to be restricted to Warkworth sands area in RWEA A, where this species food trees are present making observations of this species uncommon. The nomadic Painted Honeyeater have also been infrequently observed in small numbers during previous survey reflecting their threatened species status and nomadic lifestyle.

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 RWEP areas.

One hundred and six bird species have been recorded during timed bird surveys over the last three years, with 74 (69%) of these recorded during 2017. The total number of bird species detected each year has varied over time but the number of species recorded during 2017 are consistent with previous years.

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 changes across the Hunter Valley. The average number of bird species detected per monitoring site has dropped slightly since the 2015 monitoring while the average number of birds recorded per survey have remained relatively constant over this time period.

Dry climatic conditions at the time of survey may explain the slight drop in the total number of bird species and average number of bird species detected per monitoring site when compared to previous years.

Anecdotal reports of an influx of birds into the Hunter Valley with a generally more western distribution occurred at this time, presumably as a result of dry conditions. Red-capped Robin was one such species that was recorded at WCPL much more frequently in 2017, with 14 individuals occurring at eight monitoring sites, some with fledgling young. This species was not recorded in the previous year and only one individual was recorded during the 2015 monitoring.

Comparison of numbers of threatened species 2015-2017 and the number of sites they were recorded at 2009 & 2014 to 2017 show that both *Chthonicola sagittata* (Speckled Warbler) and *Daphoenositta chrysoptera* (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.

As mentioned in previous reports, the analysis of bird data in order to measure the effectiveness of woodland enhancement measures is limited by both the design of the current monitoring program, previous changes in methodology, the type of data previously collected, and limited data from previous bird monitoring. Interpretation of the data was further limited as RPS (2009) did not record relative abundance data and provided a species list only, while different survey methodology between Niche (2014b) and the past three years prevented a direct comparison with bird community data collected in 2014. A previous flora and fauna monitoring review by ELA (2016b) has discussed these issues in detail and recommendations included in the review remain relevant.

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 from 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 a completion criteria based for biometric monitoring has also been developed for these areas.

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 the 27 September and 12 October 2017 by ELA ecologists Daniel McKenzie and Sarah Stevens.

Sites on the North Wambo Creek Diversion were adjusted slightly during the 2016 and 2017 monitoring to better sample the slope and riparian zone and avoid crossing the regularly disturbed creek channel as per LFA methodology. Monitoring site 14R is located away from the creek diversion on Wambo Creek and provides an example of a cleared agricultural riparian zone that has been relatively undisturbed by open-cut mining activities. Site 5R, located within an area designated for pasture rehabilitation was moved down slope slightly during 2017 monitoring, to avoid a road which had recently been constructed through the previous monitoring plot.

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 11 monitoring periods from 2006 – 2016, 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 was used to highlight the performance of each LFA site and is shown below in **Table 13.**

Table 13: Colour system devised to highlight the performance of each LFA site

Green	Yellow	Orange	Red
Area is generally meeting or exceeding 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

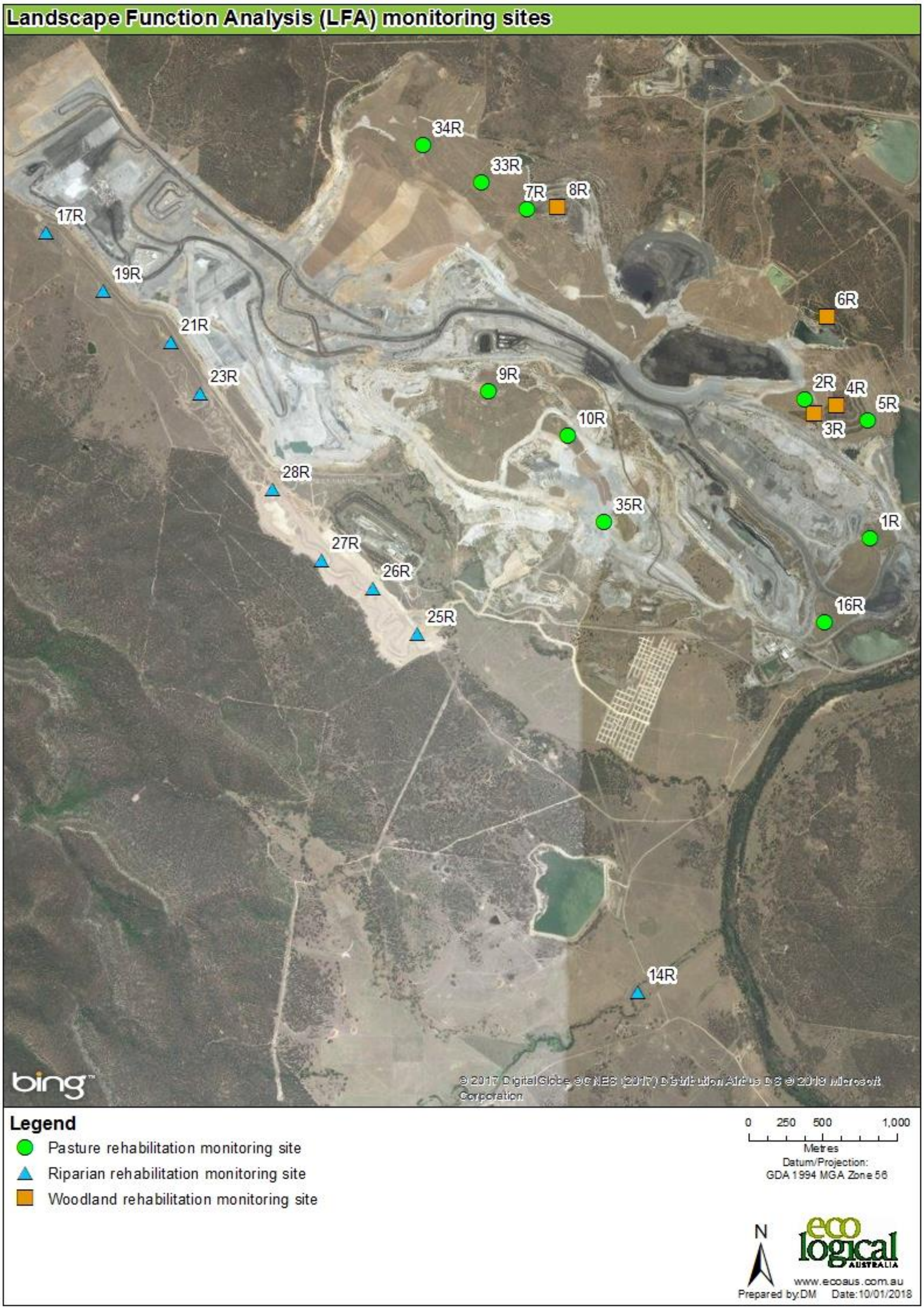


Figure 13: LFA monitoring sites

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* species (**Plate 22**). However, some promising signs for the future of the diversion area were observed with *Acacia* and occasional *Eucalyptus* sp. seedlings observed nearby several transects in the south of the diversion area as a result of direct seeding works. The creek bed also has sections of young *Casuarina cunninghamiana* (River Oak) and *Eucalyptus* sp. establishing, naturally particularly in the north of the creek diversion (**Plate 23**).

Plate 21: North Wambo Creek Diversion during 2017

Plate 22: Redgum and River Oak establishing within the diverted creek channel on North Wambo Creek

Table 14: North Wambo Creek Diversion LFA results in 2017 (Plots are organised by location - upstream to downstream)

Monitoring Plot	LOI	ST	INFI	NI
17R	0.92	62.2	38.6	33.3
19R	0.71	64.6	30	26.7
21R	0.87	60.5	35	31.1
23R	0.34	44.1	28.6	19.5
28R	0.41	52.2	38.2	26.4
27R	0.29	46.7	33.5	19.6
26R	0.72	61.1	27.9	25.6
25R	0.74	58.6	31.9	26.2
Average score	**0.63**	**56.25**	**32.96**	**26.05**
Target score	**>0.84**	**>62**	**>41**	**>37**
14R	**0.99**	**53.9**	**40.3**	**29.5**

Average landscape organisation index (LOI) scores do not meet performance targets and have remained similar during the previous three years of monitoring, despite some minor changes in the location of transects and reshaping/ripping of areas in the south of the diversion during 2015 and 2017 to prevent further erosion and to control weeds. Three monitoring sites (23R, 27R and 28R) had transects comprised of more than 50% bare soil (average 64%). Monitoring sites 27R and 28R had recently been ripped and reshaped prior to survey in an effort to control weeds, establish cover and prevent erosion. Site 23R had issues with erosion (also noted in previous reports), with rills, scalds and eroding creek banks recorded. Several rills are likely to exceed the depth specified in the completion criteria in regards to erosion control (WCPL 2015).

Landscape organisation scores are generally highest in the north (where transects are positioned on lower gradients and disturbance for the diversion appears to have been less extensive and less recent) and generally lower in the southern sites where slopes are steeper, more prone to erosion and more recent disturbance has occurred. 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. Low scores during the 2008 monitoring may reflect the bare soil of the newly created diversion followed by the establishment of a cover crop in the following year.

The average stability index at creek diversion sites during 2017 remain similar to the previous year and fall below performance targets. 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 infiltration and nutrient indices also fell below performance criteria but have increased since 2015 (**Figure 16** & **Figure 17**).

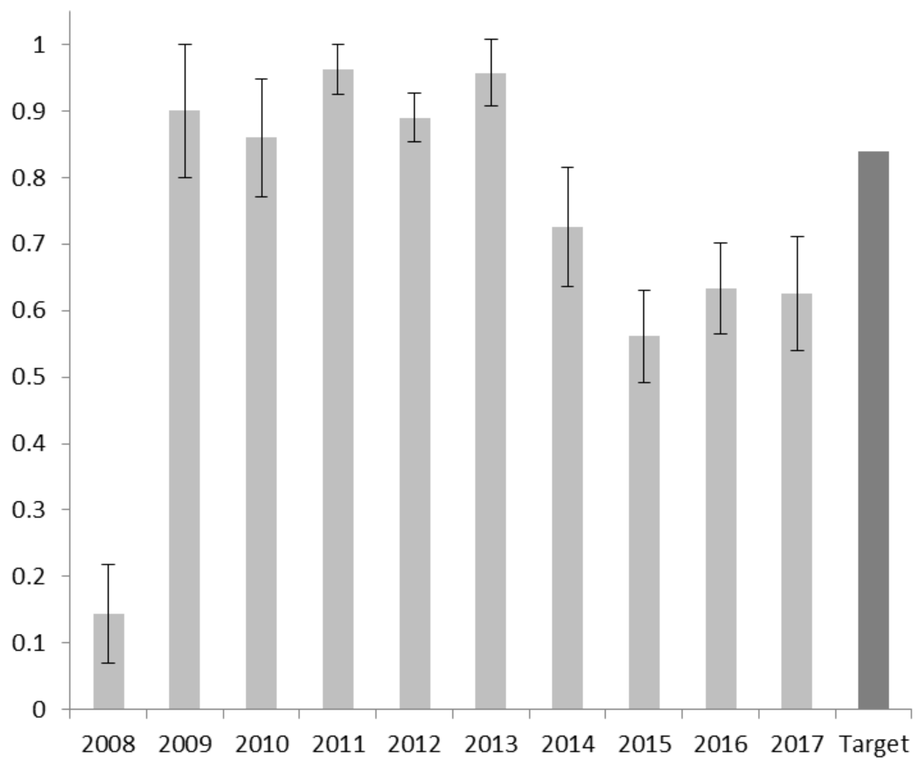


Figure 14: **Average landscape organisation scores from the creek diversion sites**. Average scores onwards from 2015 incorporate four additional sites (25r, 26R, 27R and 28R). Error bars represent standard error of the mean. Only 3 sites 19R, 21R and 23R were sampled in 2008.

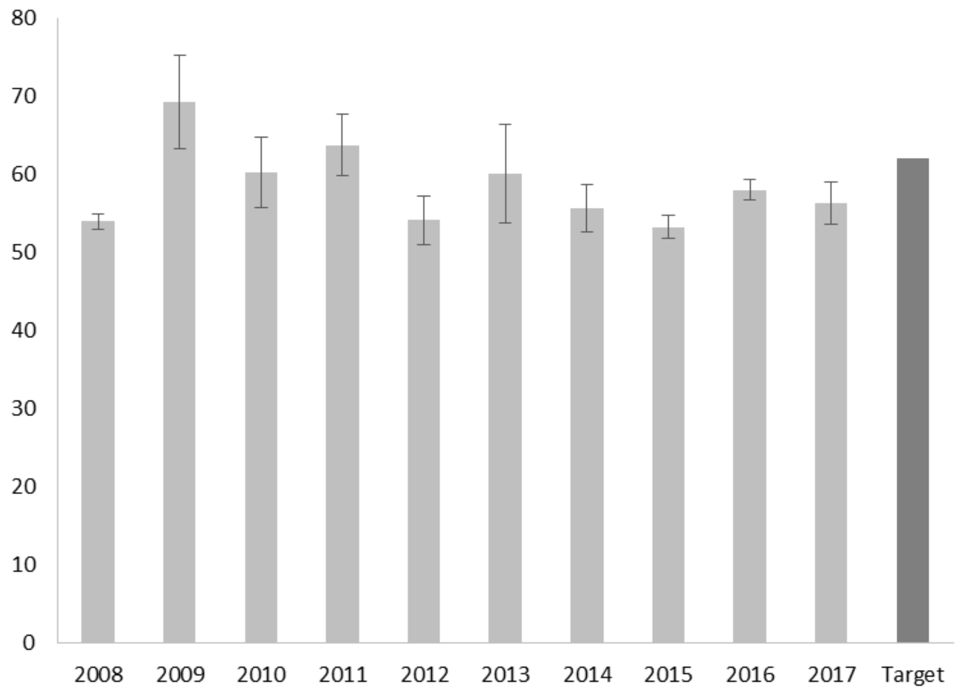


Figure 15: Average stability index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year since 2009-2014. Average scores in 2015 and 2016 incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008.

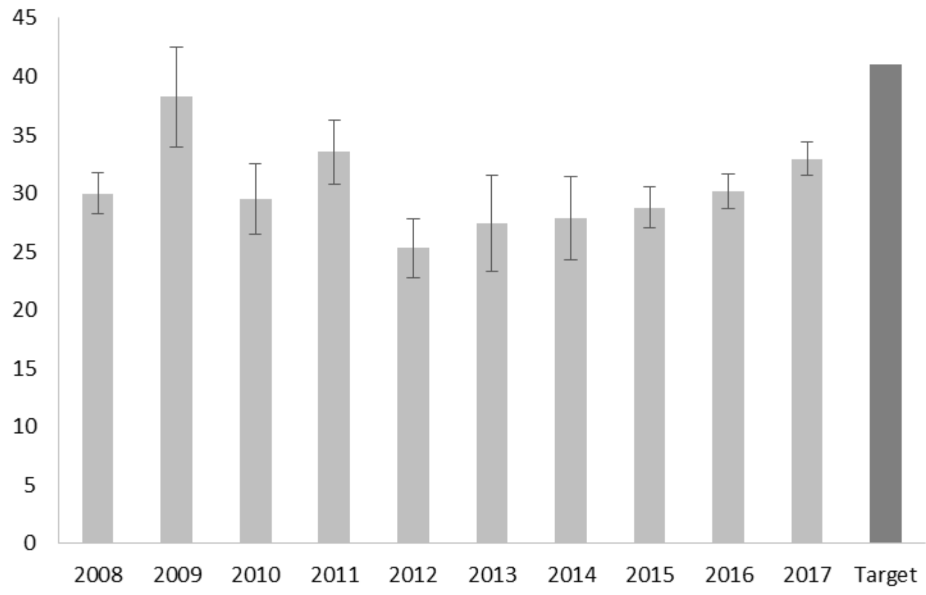


Figure 16 : Mean infiltration index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year between 2009 -2014. Average scores in 2015 and 2016 incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The green bar represents completion criteria for the Infiltration Index

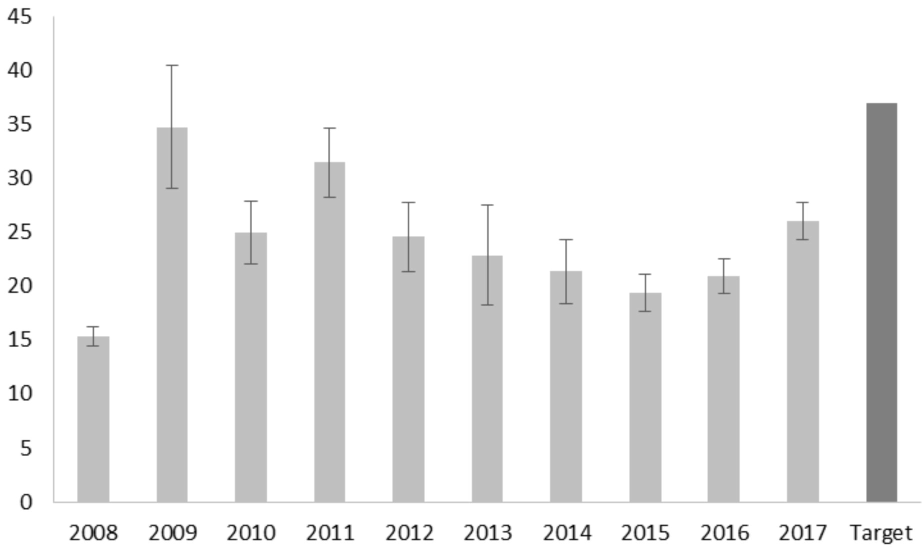


Figure 17: Mean nutrient index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year between 2009 -2014. Average scores in 2015 and 2016 incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The green bar represents completion criteria for the Nutrient Index

Table 15: Site description of each creek diversion transect

Transect	Notes	Photograph
17R	Transect consists of relatively flat ground covered in pasture. Low grass, primarily *Cynodon dactylon* and grass tussocks, primarily exotic *Chloris gayana* make up 92% of the transect.	
19R	Transect relatively flat and comprised primarily of low grass (67.4%) dispersed with patches of bare soil (29.5%). Young *Eucalyptus* and *Acacia* species are growing on creek banks downstream.	

Transect	Notes	Photograph
21R	Transect relatively flat grassland, with low sparse grass and patches of *Galenia pubescens*. Bare soil makes up 13% of transect length.	
23R	Low grass occurs over 36% of the transect. Large bare patches of stony soil occur towards the middle and end of transect and bare soil patches cover 66% 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 slumping on western bank. A stand of ~ 5m tall *Casuarina cunninghamiana* and seedlings and some young Eucalypts are growing on creek banks.	

Transect	Notes	Photograph
28R	Transect primarily samples the relatively steep eastern creek bank. The majority of this transect has been recently ripped to control *Galenia pubescens* and erosion. Logs and dense tussock grasses are present at the bottom of the slope.	
27R	Transect samples the relatively steep western bank of the cutting. The majority of this transect has been recently ripped to control *Galenia pubescens* and erosion. Low sparse grasses and logs dominate the flat area adjacent to the creek channel.	

Transect	Notes	Photograph
26R	Transect samples the relatively steep eastern bank to the edge of the creek channel. Low grass dominated this transect in 2017 covering 51% of the transect. Bare soil areas make up 28 % of the transect.	
25R	This slope is relatively steep with low grass dominating 57% 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 26% of the transect. Large tussock grasses (*Chloris gayana*) and logs are present at the bottom of the transect near the creek channel.	

3.3.2 Woodland rehabilitation

Vegetation in woodland rehabilitation areas consisted primarily of *Eucalyptus cladocalyx* and occasionally *Corymbia maculata* (Spotted Gum) (**Plate 23**). *Acacia saligna* (Golden Wreath Wattle) forms the dominant midstorey species in some areas. However this appears to be dying off at most monitoring sites. *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 the substrate in these areas consists of fine grey sediment intermixed with rocks and forms a sandy clay. 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 particular issues with exotic weeds were identified in these areas, however patches of *Galenia pubescens* were common in monitoring plot 6R. Results from these woodland rehabilitation areas remain very similar to 2015 (when they were first sampled floristically). With the exception of site 6R, the number of native species remains very low when compared to natural woodland sites nearby. Three of the four sites have less than 10 native species with the 20 x 20 m monitoring plot. Mid-storey and groundcover remain very sparse, with no groundcover score recorded along biometric transects for 3 of the 4 monitoring sites.

Plate 23: Woodland rehabilitation area dominated by *E. cladocalyx* at site 8R

Monitoring site 6R is different to the other three woodland rehabilitation sites with more than three times the number of native species (28 species), greater canopy cover and more groundcover than the other patches of woodland rehabilitation.

As these areas have been established using outdated rehabilitation techniques a performance criteria has been developed for these older rehabilitation areas. However a generally small number of native species and lack of groundcover mean that these measures 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	4	23.5	2	0	0	0	0	Planted	0	0
	4R	4	28.5	2	0	0	0	0		0	0
	6R	28	45	2	10	2	2	8		0	25.5
	8R	8	17.5	2.5	2	4	0	0		0	0
Average values		5.3	28.6	2.1	3	1.5	0.5	2	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 previous monitoring design with four LFA monitoring locations at sites 3R, 4R, 6R and 8R. Scores fell within the range of the recorded scores from 3 reference sites sampled over 5 years starting in 2010 and ending in 2014. Site 6R was the best performing site and met all of the established performance targets. The remaining sites generally fell just short of performance targets. Landscape organisation at sites 3R and 8R was substantially short of the performance target, with these sites having large areas of exposed bare soil. 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. LFA results are presented in **Table 17** below.

Table 17: LFA scores and performance criteria for woodland rehabilitation areas

Monitoring Plot	LOI	ST	INFI	NI
3R	0.68	60	39.6	33
4R	0.86	61.9	43.8	40.5
6R	0.92	62.5	60.7	47.4
8R	0.68	62.6	37.5	35.5
Average score	0.79	61.75	45.4	39.1
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

Both photos taken at the sites and collected data, show that these sites have remained quite stable over the last four years despite some dieback of *Acacia saligna* and growth of trees (**Plate 24** & **Plate 25**). 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. Average stability, nutrient and infiltration indices were larger than the previous two years but values were similar to those recorded in several years prior to the 2015 monitoring. Increased infiltration was largely due to a large increase in values from site 6R, where leaf litter contributed 86% of the total score for infiltration. Scores for leaf litter at each query zone in site 6R during 2017 were generally in a higher class (class 7 – 100% cover and 21-70 mm thick) and recorded moderate decomposition while those in the previous year were recorded as being a slightly lower class (class 6 -100% cover and up to 20mm thick) and as having slight decomposition.

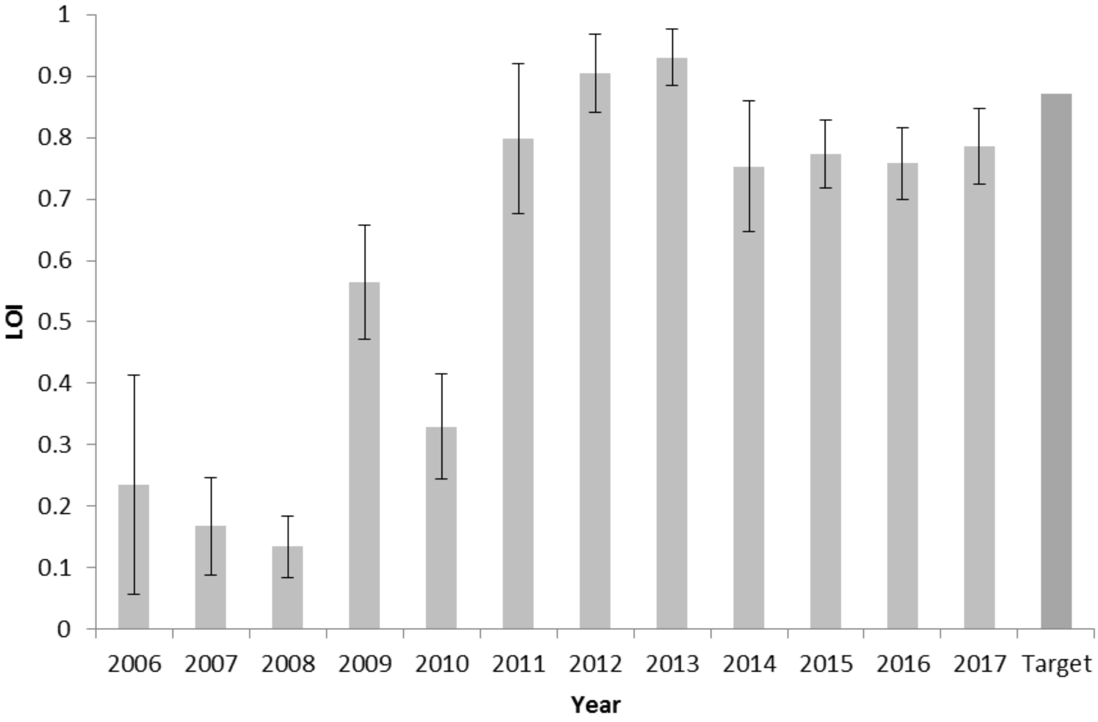


Figure 18: Average landscape organisation scores across the four woodland rehabilitation sites since 2006

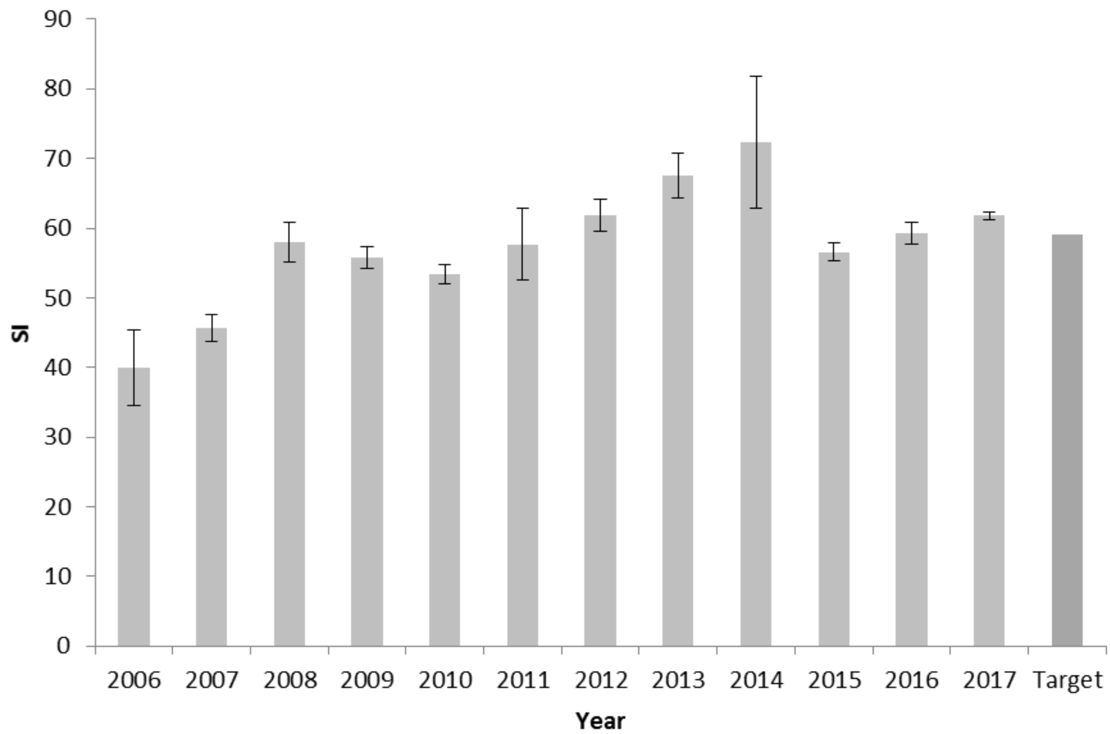


Figure 19: Average stability scores across the four woodland rehabilitation sites since 2006

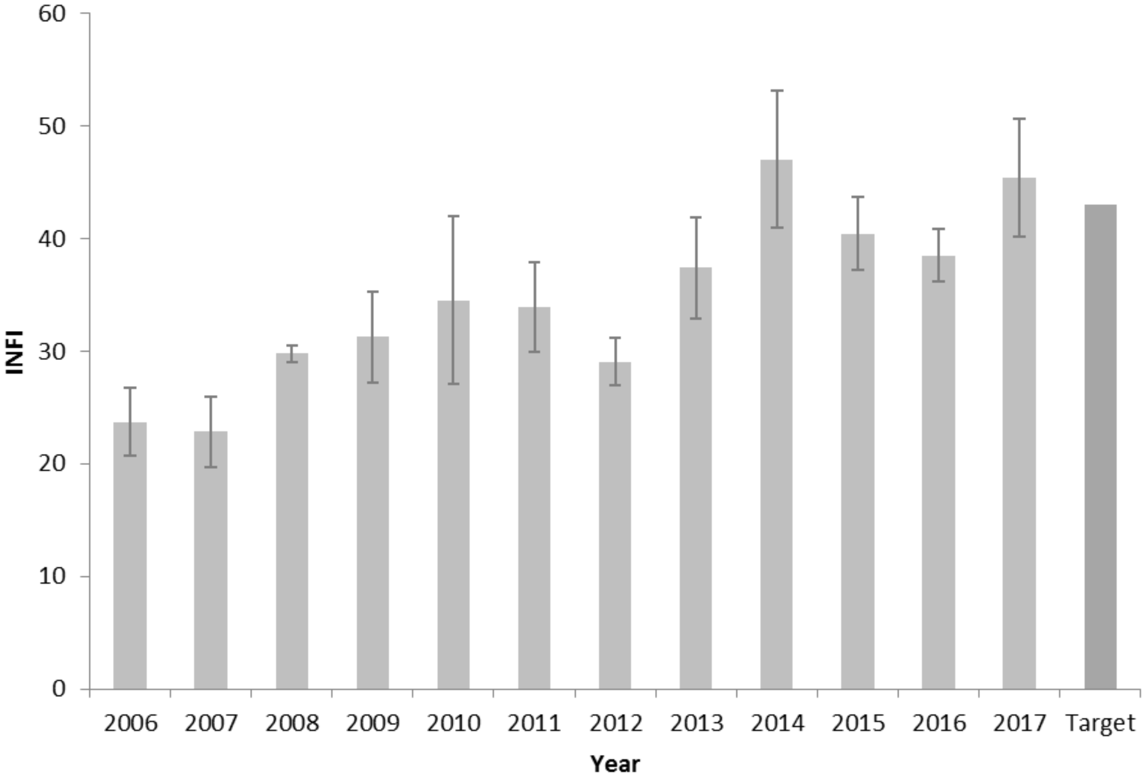


Figure 20: Average infiltration scores across the four woodland rehabilitation sites since 2006

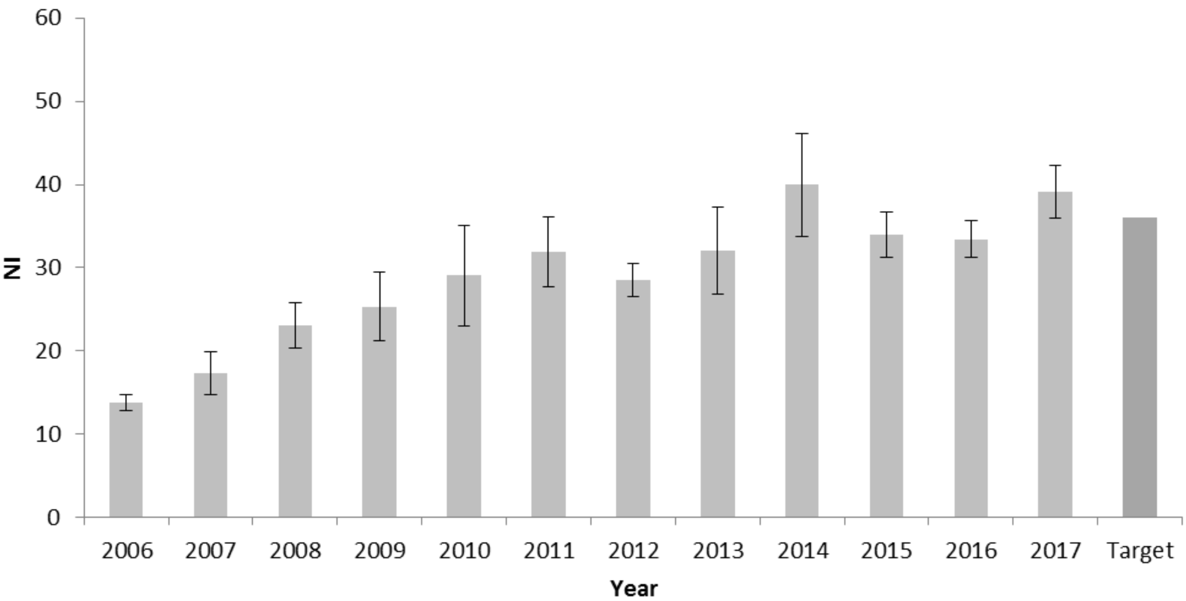


Figure 21 Average nutrient index scores across the four woodland rehabilitation sites since 2006

Plate 24: Site 3R during 2014

Plate 25: Site 3R during 2017

Table 18: Site description of each woodland rehabilitation transect

Transect	Notes	Photograph
3R	A relatively flat transect through a planting of *Eucalyptus cladocalyx*. Scattered and sparse *Corymbia maculata* are also present. Only two groundcover species *Enchylaena tomentosa* and *Cymbopogon refractus* were recorded in the 20 x 20 m plot and were very sparse. Leaf litter is the major patch type making up 58% of the LFA transect. Bare rocky soil areas make up 32 % of the transect.	
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 and almost non-existent. Leaf litter is the major patch type on the LFA transect, covering 85% of the transect. Patches of bare soil make up 14.2 %, with rocks and fallen branches making up the remainder	

Transect	Notes	Photograph
.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 (77.6% 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*. Bare soil makes up 32% of the transect length with leaf litter making up the remaining 68%.	

3.3.3 Pasture rehabilitation

Pasture rehabilitation is currently meeting performance targets for all attributes with the exception of landscape organisation (LOI), which had a relatively high average score (73% of transects covered by resource accumulating patches) despite not meeting the performance target (**Table 19**). As in the previous year, the average LOI was reduced by the influence of sites 2R and 5R, which performed the worst in terms of LOI with 50 and 60 % respectively of the transect being comprised of bare soil.

LOI scores during 2017 dropped slightly at all sites from the previous year, with a 10% increase (range 8-23%) in the number of bare soil patches. This was most pronounced at site 5R with a 23% increase in bare soil patches. 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 was no bare soil patches present in the transects at all. While no raw data sheets prior to the 2015 monitoring are available to investigate this claim, examination of site photos suggest some of these previous LOI scores may be erroneous.

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.

Average stability indices remained consistent with previous monitoring events (**Figure 23**). Average infiltration and nutrient cycling scores dropped slightly from the previous year but generally remain consistent with previous monitoring years (**Figure 24** & **Figure 25**).

A new site was added in 2017 (named 35R) in an area of recently established pasture rehabilitation. As expected this site fell short of performance targets for landscape organisation and nutrient cycling status. As rehabilitation at this site was so recently established, this site was not included in average scores for pasture sites.

Plate 26: Pasture rehabilitation area dominated by *Chloris gayana* (Rhodes Grass), near site 33R

Table 19: LFA scores and performance criteria for pasture rehabilitation areas 2016

Monitoring Plot	LOI	ST	INFI	NI
1R	0.77	62.4	40.5	36.7
2R	0.5	51	28.1	23.3
5R	0.4	61.9	28.8	23.6
7R	0.88	64.6	38.4	29.7
9R	0.65	60.2	29.6	25.6
10R	0.91	67	40.2	33.2
16R	0.96	63.3	44.5	36.6
33R	0.91	65.5	41.5	32.4
34R	0.67	64.3	36.6	31
Average score	0.73	62.24	36.47	30.23
35R (area of recent rehabilitation added in 2017 – not included in average scores for 2017)	0.61	62.2	29.2	23.7
Target score	0.93	61	29	25

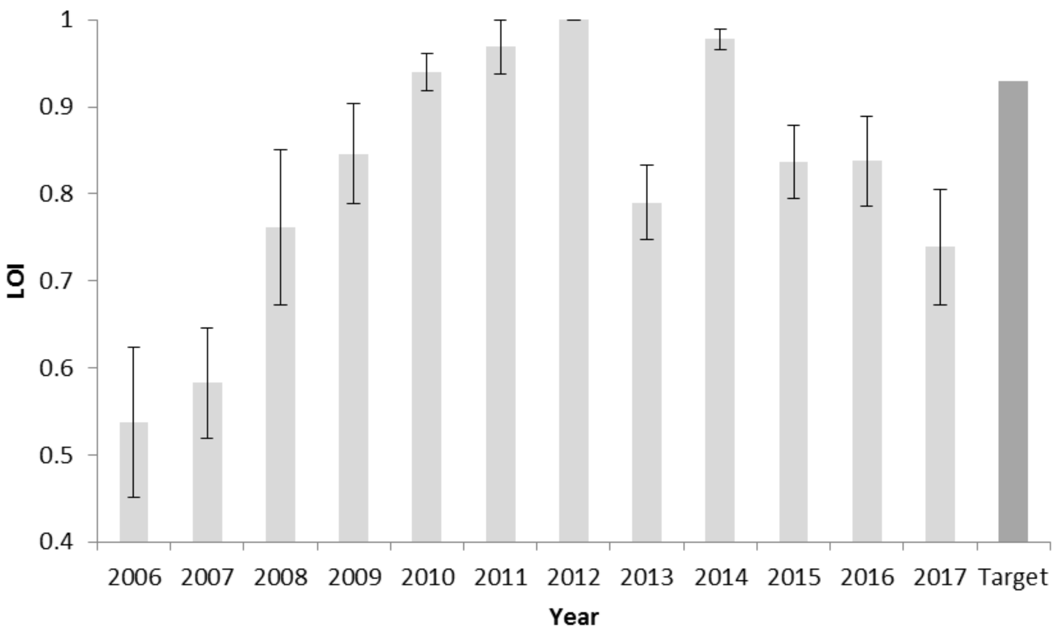


Figure 22: Average Landscape Organisation Index scores from pasture rehabilitation sites 2006-2016. Error bars represent standard error and green bar represents performance criteria. Only four sites were sampled in 2006 and 2007, increasing to nine sites in 2010.

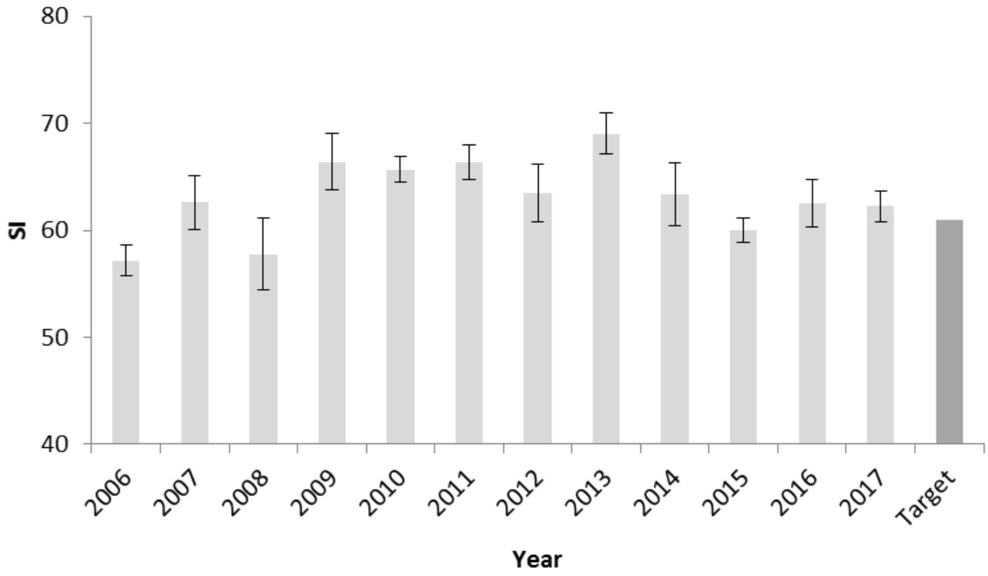


Figure 23: Average Stability Index scores from pasture rehabilitation sites 2006-2016. Error bars represent standard error and green bar represents performance criteria.

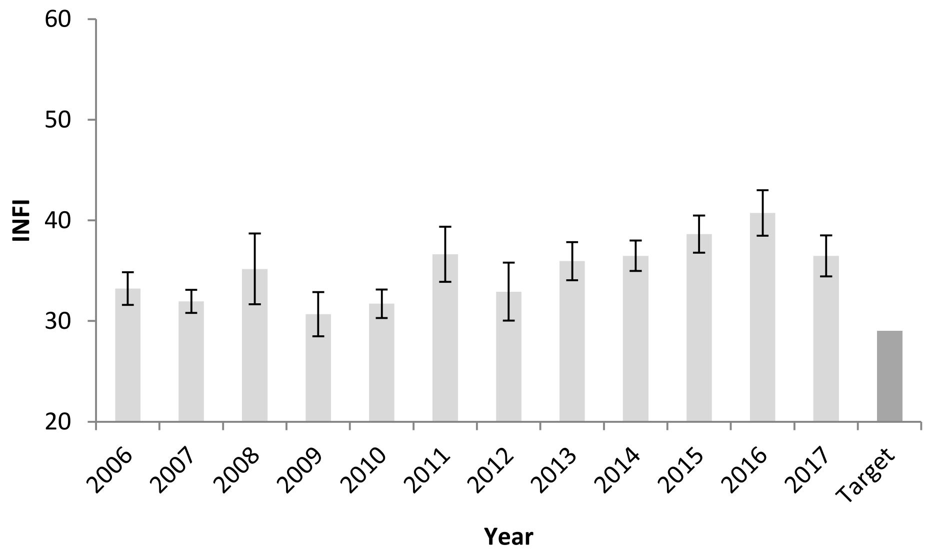


Figure 24: Average Infiltration Index scores from pasture rehabilitation sites 2006-2016. Error bars represent standard error and green bar represents performance criteria.

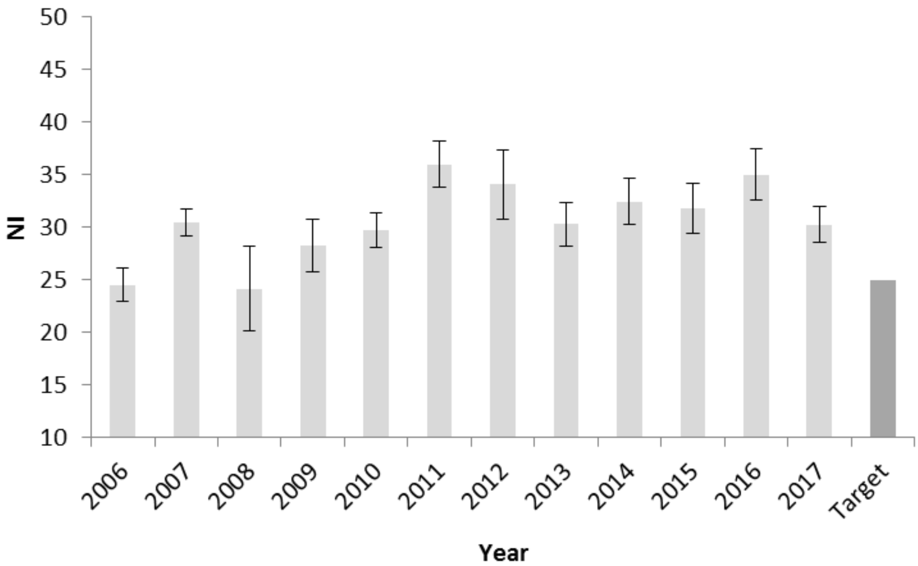


Figure 25: Average Nutrient Index scores from pasture rehabilitation sites 2006-2016. Error bars represent standard error and green bar represents performance criteria.

Table 20: Site description of each pasture rehabilitation transect

Transect	Notes	Photograph
1R	Large clumps of the exotic *Chloris gayana*, associated grassy leaf litter and low grass patches make up 77% of the transect and are the main stabilising features of this rehabilitation area near the coal preparation plant. Comparison of photos from Niche (2014c) of this site, show that tussock grasses appear to have become sparser over time at this site.	
2R	This transect runs down a very slight slope and was dominated by bare soil (50%) and leaf litter (33%). Leaf litter was mostly dead exotic vegetation and grass that had died off with the dry climatic conditions at the time of survey. The large area of exposed bare soil contributed to this site having a poor stability score. The soil in this area is local red/brown clay soil which has facilitated the colonisation of native species such as *Cymbopogon refractus* and Acacia spp. Comparison of photos from Niche (2014c) of this site, show *Acacia salicina* has become more abundant in the area over time.	

Transect	Notes	Photograph
5R	This transect was moved slightly downhill from its previous location during 2017 as an access road had been constructed through the previous transect. This site is dominated by bare soil areas (60%). As a result of the abundance of bare soil areas, this site had the lowest landscape organisation score in 2017 and fell short of infiltration and nutrient cycling performance targets. Exotic tussock grasses (*Setaria* sp.) (14%), low grass (11%), rocks (7.5%) and litter (7%) make up the majority of the patches present. Some large *A. salicina* are present surrounding the transect area,	
7R	Transect was dominated by *C. gayana* tussocks (58%), short grass (26%) and areas of bare soil (12%). The locally native *Acacia salicina* is colonising rehabilitation in this area.	

Transect	Notes	Photograph
9R	A large rocky soil scald dominates the start of this transect and as a result was one of only two pasture rehab sites to fall below performance criteria for soil stability. This scald is surrounded by patches of the environmental weed *Galenia pubescens.* Large clumps of *C. gayana* are the dominant feature for the remainder of the plot. Bare soil makes up 35% of the transect length with short grass (30%) and larger tussock grass clumps (21%) also prevalent.	
10R	The high cover of exotic *Melilotus* sp. and *Anagallis arvensis* (Scarlet Pimpernel) observed at this site in 2016 had died back in 2017 leaving large dense tussocks *C. gayana* (38.4%) and leaf litter fallen from the dense tussocks and dry dead exotic perennial vegetation (37.5 %). Low grazed patched of primarily *Cenchrus clandestinus* (Kikuyu) made up the remainder of vegetation patches. Bare soil patches were minimal making up 9.4% of the transect length. No star pickets are present at this transect.	

Transect	Notes	Photograph
16R	Transect primarily composed of fallen dry grass (68%) primarily originating from the dense tussocks of *C. gayana* and dead exotic perennial vegetation. *C. gayana* tussocks made up 14% of the transect length, low grass and surviving patches of exotic perennial vegetation made up the remainder of patches within the transect. Only a small area of bare soil was present (4%) providing a high LOI score for the site and meeting performance criteria for this attribute.	
33R	Transect primarily composed dense tussocks of *C. gayana* (83%), low grass and small patches of the environmental weed *G. pubescens* made up the remaining patches. Bare soil patches made up only 9% of the transect. *C. gayana* grass tussocks were the main contributor to stability, infiltration and nutrient cycling scores for the site.	

Transect	Notes	Photograph
34R	Transect primarily composed of dense tussocks of *C. gayana* (44%) with fallen dead grass (leaf litter - 20%) and low spreading grassy patches (3.5%). Bare soil patches comprised 32.5 % of the transect length. Grass tussocks were the primary contributor to the sites stability score.	
35R (new site)	A new site was added during 2017 in a recently seeded area of pasture rehabilitation. Bare soil (39.5%) and low grass (38%) dominated this new area of rehabilitation, followed by patches of dry dead vegetation (litter) which comprised 16% of the transect. This transect followed a clear pattern as a result of recent ripping, with small ridges of bare soil followed by troughs filled with vegetation or litter.	

3.4 Conclusion and recommendations

3.4.1 North Wambo Creek diversion

The North Wambo Creek Diversion did not meet the completion targets for LFA with only two monitoring sites in the north of the diversion meeting targets for landscape organisation and three sites composed of more than 50% bare soil. Recent soil ripping and reshaping (to control weeds and erosion) at two monitoring sites has contributed to these LFA scores that are lower than the completion criteria.

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.

As a whole the creek diversion appears relatively stable without excessive erosion. However some areas of erosion that exceed completion criteria targets are present, with some deeper rills and large areas of bare soil observed at 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.

3.4.2 Woodland rehabilitation

Woodland rehabilitation monitoring sites met most performance targets in regard to LFA, largely due to the presence of leaf litter layers which provide protection from soil erosion. All sites appear visually similar to the previous two years of monitoring and this similarity was also observed in the recorded data, with similar landscape organisation and biometric scores recorded as previous years. The areas surrounding monitoring sites 3R, 4R and 8R are remain structurally similar as each other, while site 6R has a much larger number of species present, larger trees and more groundcover than the other three sites.

Average stability, nutrient and infiltration indices were larger than the previous two years but values were similar to those recorded in several years prior to 2015 monitoring. Increased average infiltration scores in 2017 was largely due to a large increase in infiltration values from site 6R. This was primarily due to slightly different in leaf litter thickness and decomposition being recorded and are likely a result of observer interpretation rather than any actual changes at the site.

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 2017 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 landscape organisation 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 correctly.

3.4.3 Pasture rehabilitation

Average LFA scores for pasture rehabilitation generally met completion criteria, with the exception of landscape organisation, which was still quite high 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.

LOI scores in 2017 dropped slightly at all sites from the previous year and is likely attributable to the extremely dry conditions experienced in the months prior to survey in 2017. Actions to improve poorly performing pasture sites could involve the slashing of large grass tussocks and subsequent mulching of bare areas to improve the soil profile in bare areas.

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.

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 on Wambo Creek has been disturbed by historic agricultural activities.

4.2 Methods

Field sampling for the riparian monitoring was undertaken between 19 October 2017 and 25 October 2017. The Rapid Appraisal of Riparian Condition method, developed by Jansen et. al. 2005 and used during the 2016 monitoring, was utilised during this assessment. 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 used to sample approximately 500 m length of riparian zone. The location of sample 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.* Although not directly comparable, site photos and scores from available past monitoring reports (ELA (2016) Niche (2014d) and RPS (2009)) were also reviewed.

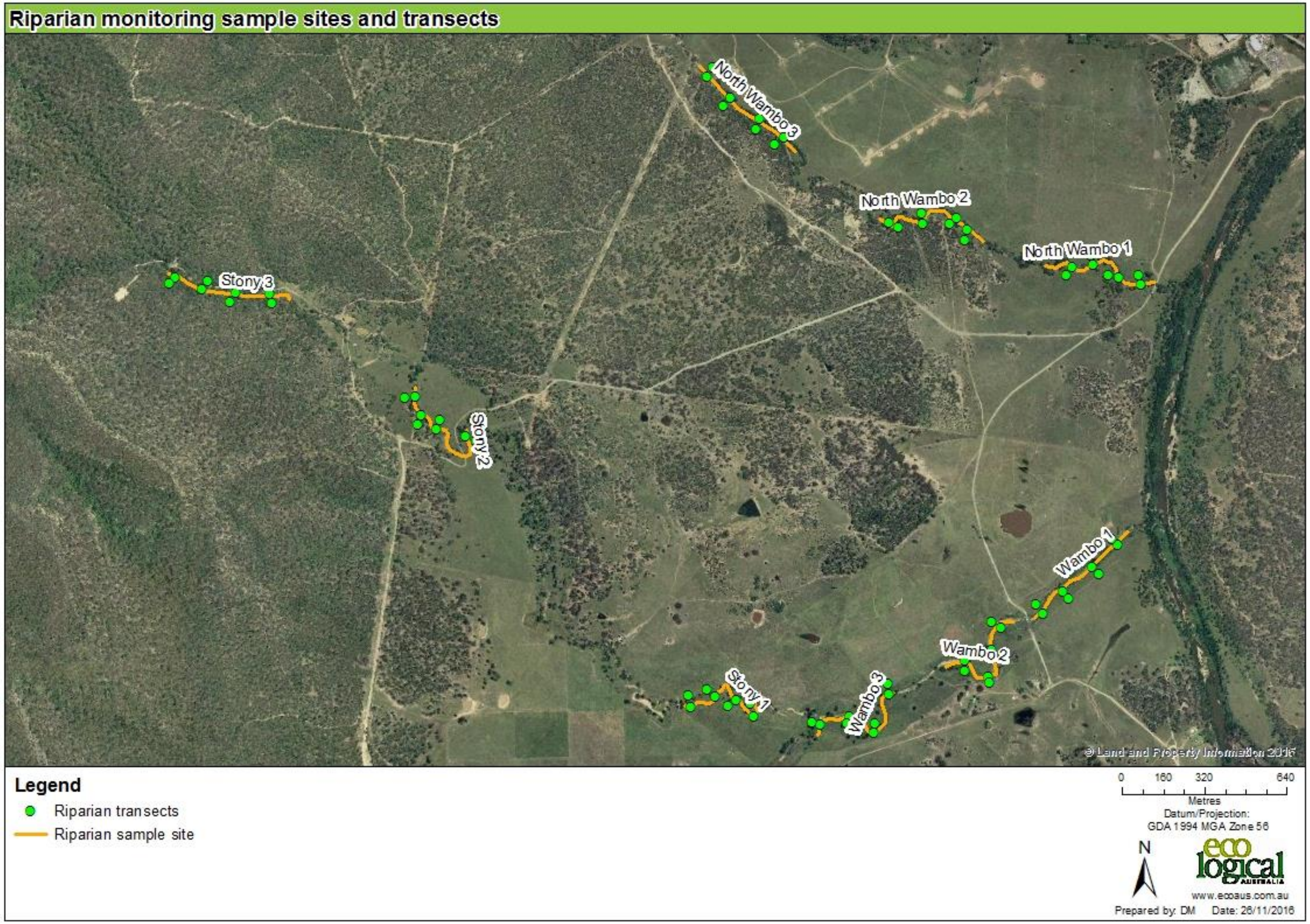


Figure 26: Location of riparian monitoring cross-sections and transects

4.3 Results

The results of the riparian condition monitoring are presented below, with raw data included in Volume 2 of this report.

The average total score for Wambo Creek and Stony Creek showed little change between the current year and the previous year over the three separate reaches surveyed (**Figure 27**). South Wambo Creek remains the lowest scoring creek system in regards to the sub-indices measured. The average total score for North Wambo Creek increased from the previous year with an overall increase in the sub-indices *Cover, Natives, Debris,* and *Features*.

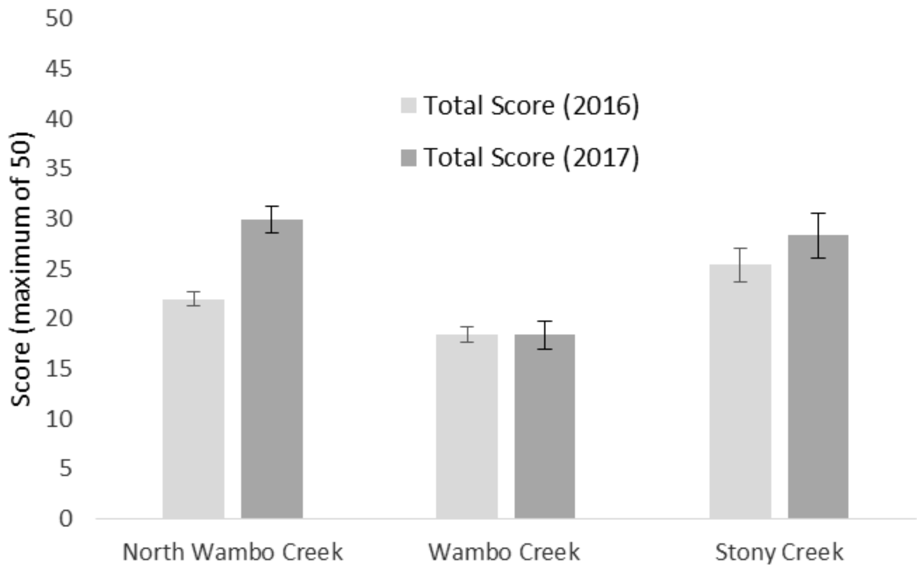


Figure 27: Average "Total Score" score for North Wambo Creek, Wambo Creek, and Stony Creek, from surveys in 2016 and 2017

The *Features* score (presence of native canopy and understorey regeneration, presence of large native tussock grasses) for South Wambo Creek dropped from the previous year, but other sub-indices did not change. Stony Creek also did not display much change, however a slight increase in *Cover* was recorded.

Large variability in the *habitat*, *debris* and *features* sub-index 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 this 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. Site photos from Niche (2014) are similar to 2017, however it is clear vegetation has increased in height and canopy density in some places over this time period.

4.4 Conclusions and recommendations

No significant changes were observed in total site scores at South Wambo Creek and Stony Creek.

The average total score for North Wambo Creek increased from the previous year with an overall increase in the sub-indices *Cover, Natives, Debris,* and *Features*. Cover score values for vegetation affect scores of both *Cover* and *Natives* sub-indices. Increases to *Cover* and *Natives* sub-indices between the 2016 and 2017 monitoring periods were primarily due to interpretation of the methodology in regards to tree canopy cover. Increased native cover scores may also have been a result of the dry conditions at the time of survey through the reduction in the cover of exotic forbs.

Higher scores for leaf litter, fallen logs and the presence of dead trees and hollow-bearing trees contributed to higher debris scores in 2017 while a larger score for both native canopy and mid-storey regeneration contributed to a larger *Features* score. It is not expected that the presence of dead trees and hollow-bearing trees would change much within a year and it is possible some of these habitat features were not recorded in 2016, or a wider area around the transect was considered in 2017.

The recommendations in previous monitoring reports still applicable to these areas. These include restricting cattle access to the currently grazed areas of South Wambo and Stony Creek to encourage tree regeneration and prevent erosion. Plantings of trees in over-cleared riparian areas (that are unlikely to regenerate naturally with cattle exclusion) will also be beneficial to this area and the surrounding environment.

5 Mine subsidence observations and other management issues

Several management issues were observed during the 2017 monitoring surveys across the RWEAs and rehabilitated landforms.

5.1 Remnant woodland enhancement areas

Minor mine subsidence cracks were noted during flora field work at sites V6-B1c, V6B2, V6-B2c, V10-A2, V11-B1 within the Narrow-leaved Ironbark and Slaty Gum communities.

Severe mine subsidence cracks were noted during bird surveys on a ridge line road in RWEA B near bird monitoring site BP12, with a series of deep cracks (up to 8m deep and 40cm wide) observed (**Plate 27**). These had caused the access trail to become unsuitable for vehicles and several small trees to become unstable.

Plate 27: Deep mine subsidence cracks on ridgeline near bird monitoring site BP12

Plate 28: A tree stump from a recently cut-down tree observed in the south of RWEA B

5.2 Rehabilitated land

The condition of rehabilitated land has been discussed in **Section 3**. However some relevant opportunistic observations were made while traversing the mine site. Some deep holes were observed within areas of rehabilitation during floristic and LFA monitoring works. Two deep holes were observed near site 4R within an area designated for woodland rehabilitation. One of these holes was approximately 2 m deep and 2 m wide and presents a danger to both humans and wildlife (**Plate 29**). An additional 1.5 m deep hole undermining a contour bank was also observed in pasture rehabilitation between monitoring sites 33R and 7R. Erosion issues were also present in a large area nearby where vegetation had failed to establish (**Plate 30**).

Plate 29: A ~2 m deep hole near rehabilitation monitoring site 4R

Plate 30: A hillside suffering from soil erosion issues between monitoring sites 33R and 7R

5.3 Weed issues

While environmental weeds have largely been discussed in previous sections, some issues require mentioning. *Olea europaea* subsp. *cuspidata*, otherwise known as African Olive, is present in gardens and other areas surrounding the main carpark and administration building at WCPL (**Plate 31**). As previously mentioned, this environmental weed is listed as a priority weed in the Hunter and invasion of native plant communities by this species is listed as a 'Key Threatening Process' under Schedule 4 of the BC Act. *Lantana camara* (Lantana) is another priority weed and also a Weed of National Significance (WONS) that was observed in a single patch in a rehabilitation area 150 m north-east of monitoring site 2R. These weeds should be managed as a priority to prevent their spread.

Plate 31: *Olea europaea* subsp. *cuspidata* (African Olive) growing beneath trees in gardens adjacent to the main carpark at WCPL

References

Department of Environment and Climate Change (DECC) 2008a *Biobanking Assessment Methodology*. Department of Environment and Climate Change NSW 59–61 Goulburn Street, Sydney.

Department of Environment and Climate Change (DECC) 2008b *Biometric 2.0 – A Terrestrial Biodiversity Assessment Tool for the NSW Native Vegetation Assessment Tool* - Operational Manual. Department of Environment and Climate Change NSW 59–61 Goulburn Street, Sydney

Department of Primary Industries (DPI) 2017. *NSW WeedWise – Priority weeds for the Hunter.* Available online at: http://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=115

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) 2016b. Wambo Coal Mine – *Flora and Fauna Monitoring Program Review* Prepared for Wambo Coal Pty Ltd

Eco Logical Australia (ELA) 2017a. *Wambo Coal Mine Flora and Fauna Monitoring Report (2016)* Prepared for Wambo Coal Pty Ltd

Harden G. (ed.) 1992. *Flora of NSW Volume 3*. UNSW Press, Sydney.

Harden G. (ed.) 1993. Flora of NSW Volume 4. UNSW Press, Sydney.

Harden G. (ed.) 2000. *Flora of NSW Volume 1. Revised Edition.* UNSW Press: Sydney.

Harden G. (ed.) 2002. *Flora of NSW Volume 2. Revised Edition*. UNSW Press, Sydney.

Jansen, A., Robertson, A., Thompson, L. & Wilson, A., 2005, *Rapid appraisal of riparian condition, version 2,* River Management Technical Guideline No. 4A, Land & Water Australia, Canberra.

Niche Environment and Heritage 2014a. *EMP010 Monitoring 2014 – Flora and habitat complexity*. Prepared for Wambo Coal Pty Ltd

Niche Environment and Heritage 2014b. *EMP010 Monitoring 2014 – Indicator Species (birds)*. Prepared for Wambo Coal Pty Ltd

Niche Environment and Heritage 2014c. *EMP010 Monitoring 2014 – Open Cut and Riparian LFA* Prepared for Wambo Coal Pty Ltd

Niche Environment and Heritage 2014d. *EMP010 Monitoring 2014 – Riparian EFA*. Prepared for Wambo Coal Pty Ltd

Resource Strategies 2014. *Wambo Coal Mine Rehabilitation Management Plan (draft.)* Prepared for Wambo Coal Pty Ltd.

Royal Botanic Gardens and Domain Trust (RBGDT) 2015. *PlantNET – The Plant Information Network System of the Royal Botanic Gardens and Domain Trust*, Sydney, Australia. Available online at http://plantnet.rbgsyd.nsw.gov.au

RPS 2010. *2009 Annual Ecological Monitoring Report*. Prepared for Wambo Coal Pty Ltd.

Tongway, D.J. and Hindley, N.L. 2004. *Landscape Function Analysis: Procedures for monitoring and assessing landscapes, with special reference to mine sites and rangelands*. Published by CSIRO Sustainable Ecosystems, Canberra, ACT.

Wambo Coal Pty Ltd (2014) *Flora & Fauna Management Plan – Amendment A*. Unpublished report by Wambo Coal Pty Ltd

Wambo Coal Pty Ltd (2015) *Mining Operations Plan 2015 -2020.* Unpublished report by Wambo Coal Pty Ltd

Wambo Coal Pty Ltd (2017) *Biodiversity Management Plan*. Unpublished report by Wambo Coal Pty Ltd

HEAD OFFICE
Suite 4, Level 1
2-4 Merton Street
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 0145
F 02 6103 0148

COFFS HARBOUR
35 Orlando Street
Coffs Harbour Jetty NSW 2450
T 02 6651 5484
F 02 6651 6890

PERTH
Suite 1 & 2
49 Ord Street
West Perth WA 6005
T 08 9227 1070
F 08 9322 1358

DARWIN
16/56 Marina Boulevard
Cullen Bay NT 0820
T 08 8989 5601
F 08 8941 1220

SYDNEY
Level 6
299 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9264 0717

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 0125
F 02 4910 0126

ARMIDALE
92 Taylor Street
Armidale NSW 2350
T 02 8081 2681
F 02 6772 1279

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 4268 4361

BRISBANE
Suite 1 Level 3
471 Adelaide Street
Brisbane QLD 4000
T 07 3503 7191
F 07 3854 0310

ST GEORGES BASIN
8/128 Island Point Road
St Georges Basin NSW 2540
T 02 4443 5555
F 02 4443 6655

NAROOMA
5/20 Canty Street
Narooma NSW 2546
T 02 4476 1151
F 02 4476 1161

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1230
F 02 6372 9230

GOSFORD
Suite 5, Baker One
1-5 Baker Street
Gosford NSW 2250
T 02 4302 1220
F 02 4322 2897

1300 646 131
www.ecoaus.com.au

Wambo Coal Mine

Annual Flora and Fauna Monitoring Report 2017 – Volume 2

Prepared for
Wambo Coal Pty. Ltd.

7 February 2018




DOCUMENT TRACKING

Item	Detail
Project Name	Wambo Coal Mine Annual Flora and Fauna Monitoring, 2017
Project Number	17NEW - 6725
Project Manager	Daniel McKenzie (02) 4910 3403 Level 7, 19 Bolton Street, Newcastle, NSW
Prepared by	Daniel McKenzie
Reviewed by	Daniel McKenzie
Approved by	Martin Sullivan
Status	Final
Version Number	1
Last saved on	7 February 2018
Cover photo	Clockwise from left: *Eucalyptus cladocalyx* (Sugar Gum) planting at Wambo, the vulnerable woodland bird *Climacteris picumnus victoriae* (Brown Treecreeper –eastern subspecies), Spotted-gum Forest in remnant woodland enhancement area and recently seeded *Acacia* species establishing on the post-mining landform. Photos by Daniel McKenzie.

This report should be cited as 'Eco Logical Australia 2017. *Wambo Coal Mine Flora and Fauna Monitoring Report - Volume 2*. Prepared for Wambo Coal Pty Ltd.

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Merri Bartlett from Wambo Coal Pty Ltd.

Contents

List of plates

List of tables

1 Introduction

This document provides raw data and photographs taken during spring 2017 monitoring at Wambo Coal Pty Ltd.

2 Flora monitoring

2.1 Monitoring data

Data collected during the 2017 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

Table 1: Biometric plot data for remnant woodland areas

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	L-litter	Bare ground/Rock
V1-A1	5	63.5	0	6	0	0	48	0	N	72	36	12
V1-A2	13	13.5	13	50	0	0	49.5	0	N	42	6	0
V1-B1	21	38	0	4	0	0	0	1	Y	10	82	14
V1-B2	25	20	18.5	24	0	0	42	0	Y	5	38	2
V1-B3	14	9.5	37.5	14	0	0	17.1	1	Y	12	58	12
V2-A1	11	5.5	0	24	2	2	36	0	Y	5	20	22
V2-B1	18	22.5	12.5	0	0	4	58	0	N	13	34	4
V2-B2	21	21	12	12	0	30	30	0	Y	3	24	4
V3-B1	26	20.5	1	24	0	38	0	0	Y	39	44	0
V5-B1	18	14	1.5	42	2	32	16	0	N	6	20	2
V5-B2	19	20	2	36	0	66	2	0	Y	8	8	0
V5-B3	20	5.5	17.5	12	4	42	0	0	N	37	44	0
V5-B4	16	18	5.5	44	6	6	0	0	Y	21	44	2
V6-A1c	24	34	12	46	4	26	0	0	N	59	24	6
V6-A3	24	19.5	12	32	2	18	0	0	Y	16	42	8
V6-B1	19	17	13.5	18	0	6	0	0	Y	102	70	6
V6-B1c	31	14.5	11	36	4	14	0	0	Y	48	42	6
V6-B2	19	11.5	9	34	4	2	0	0	N	57	56	4
V6-B2c	28	11.5	24	26	4	20	0	0	Y	28	44	14
V6-B3	23	15	9	22	2	10	2	0	Y	92	58	6

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	L-litter	Bare ground/Rock
V6-B4	13	33	0	22	0	4	0	0	N	3	60	14
V9-A1	24	17.5	22.5	10	8	16	2	0	Y	25	56	10
V9-B1	32	25.5	13.5	34	6	4	4	0	Y	67	36	14
V9-B2	28	36.5	13.5	54	8	6	0	0	Y	22	32	6
V10-A1	26	25	10.5	26	0	4	0	0	Y	53	50	20
V10-A2	37	21	10.5	24	6	8	0	0	Y	16	46	16
V10-B1	36	30	20.5	14	0	0	4	0	Y	25	66	16
V10-B3	24	40	10.5	12	8	6	0	0	Y	87	68	6
V11-B1	26	19.5	11	32	6	6	2	0	N	110	42	14
V11-B2	31	24.5	23	54	2	8	0	0	Y	54	38	2
V13-B1	37	46.5	44	18	2	32	0	0	Y	70	52	2
V14-A1	36	8	56	8	2	16	0	0	N	0	46	28
V14-B1	28	10	38.5	36	2	12	0	0	N	45	32	22
V14-B2	31	16	55.5	38	8	30	2	0	N	5	22	8

Table 2: Biometric plot data for woodland rehabilitation monitoring plots

Plot Name	NPS	OS	MS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	L-litter	Bare ground/Rock
3R	4	23.5	2	0	0	0	0	0	Planted	0	58	32
4R	4	28.5	2	0	0	0	0	0		0	85	15
6R	22	45	2	10	2	2	8	0		25.5	78	9
8R	8	17.5	2.5	2	4	0	0	0		0	68	32

Table 3: Flora species list 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 B1 c	V6 B2	V6 B2 c	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 sp.	Lantern Bush	N																														1	1	1	1	1
Acacia amblygona	Fan Wattle	N															1	1			3			3		2		1			2					
Acacia binervia	Coast Myall	N																	1						1			1	3	2		3				
Acacia decora	Western Silver Wattle	N																												3						
Acacia decurrens	Black Wattle, Green Wattle	N		4			3							3	2																					
Acacia falciformis	Broad-leaved Hickory	N																										1								
Acacia filicifolia	Fern-leaved Wattle	N				3		1		3																										
Acacia implexa	Hickory Wattle	N							1															1												
Acacia parramattensis	Parramatta Wattle	N				1			3																											
Acacia salicina	Cooba	N				1																								2					3	
Acacia sp. (bipinnate)		N								2																										
Acetosa sagittata	Turkey Rhubarb	E		2		2																														
Acetosella vulgaris	Sorrel, Sheep Sorrel	E						2	1		1																									
Adiantum aethiopicum	Common Maidenhair	N																															1			
Aira cupaniana	Silvery Hairgrass	E						2																												
Ajuga australis	Austral Bugle	N																																1		1
Allocasuarina luehmannii	Bulloak	N										1		2	1	1	4	3	3	1	4	3	4	3		3	2	2			2	3				
Alternanthera sp.		N																						1												
Amyema cambagei	She-oak Mistletoe	N		1																																
Amyema congener subsp. *congener*		N							1																											1
Amyema gaudichaudii	Paperbark Mistletoe	N																							1		2		1							
Anagallis arvensis	Scarlet/Blue Pimpernel	E	3	2	3	2	2	1	2		1	2	1																							
Angophora floribunda	Rough-barked Apple	N									1	3	4	2	4																					
Argemone ochroleuca	Mexican Poppy	E	1																																	
Aristida ramosa	Purple Wiregrass	N									2			1	2	1	2	2	1	2	1	1	3	2	1		1	3		2				2	1	3
Aristida sp.	Wiregrass	N														1																1			1	
Aristida vagans	Threeawn Speargrass	N									3		2	2	3	2	3	2	2	2	2	2			2	2	2	2	1		2	3			2	1
Arthropodium milleflorum	Vanilla Lily	N																1	2		1			1				1			1	1				
Asparagus asparagoides	Bridal Creeper	E			2				1	1																										
Asparagus sp.		E								1																										
Aster spp.		E			1		2				1		1																							
Austrodanthonia spp.		N														1										1				1						
Austrostipa ramosissima	Stout Bamboo Grass	N		1		3			2							2													1				3			3
Austrostipa scabra subsp. *scabra*		N																								2			1					1	1	2
Austrostipa sp.		N														1			2	1							2	1		2	1					
Austrostipa verticillata	Slender Bamboo Grass	N																																1		
Backhousia myrtifolia	Grey Myrtle	N				1																														

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 B1 c	V6 B2	V6 B2 c	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
Banksia integrifolia	Coast Banksia	N										2	2	3																						
Bertya oleifolia		N																															1		1	
Bidens pilosa	Cobbler's Pegs	E										1	1							1																
Bidens subalternans	Greater Beggar's Ticks	E				2			3																											
Bothriochloa macra	Red Grass	N																																1		
Brachychiton populneus subsp. populneus	Kurrajong	N							3	1		1	1							2	1													4	1	
Breynia oblongifolia	Coffee Bush	N					1					2	2	1	1	1						1		1	1	1			1	1		1				1
Breynia sp.		N			3																															
Briza minor	Shivery Grass	E						2	1																											
Bromus catharticus	Prairie Grass	E	1	1																																
Brunoniella australis	Blue Trumpet	N															1																			
Bryophyllum delagoense	Mother of Millions	E											2																							
Bursaria spinosa	Native Blackthorn	N				1										1			2	1					4	3	2	3	4	1	2	3	2			2
Callitris glaucophylla	White Cypress Pine	N																										1								
Calotis cuneifolia	Purple Burr-Daisy	N																									1							1	1	
Calotis lappulacea	Yellow Burr-daisy	N										2					1																	1	1	
Cardiospermum grandiflorum	Balloon Vine	E		2	2	2	3																													
Carex inversa	Knob Sedge	N			1						1																						?			
Cassinia arcuata	Sifton Bush	N																1													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			1
Centella asiatica	Pennywort	N		1							1																									
Centipeda minima	Spreading Sneezeweed	N									2																									
Cerastium glomeratum	Mouse-ear Chickweed	E							2																											
Cheilanthes distans	Bristly Cloak Fern	N														2			2								1	1		1		1		1	2	1
Cheilanthes sieberi subsp. sieberi		N				2	2	2	2	2	1			2	1			3	1	2	2	4	1	2	1	1	1	1	1	1	2		1	1		1
Chloris gayana	Rhodes Grass	E	1																																	
Chloris ventricosa	Tall Chloris	N														2			1			1								1					2	
Choretrum candollei	White Sour Bush	N						1											1									1			1	1				
Chrysocephalum apiculatum	Common Everlasting, Yellow Buttons	N			1			2				1																								
Cirsium vulgare	Spear Thistle	E	1		1		2																													
Clematis aristata	Old Man's Beard	N			2	1	1																						1							
Commelina cyanea	Scurvy Weed	N	1				2																						1				1			
Conyza bonariensis	Flaxleaf Fleabane	E	1	1		2																														
Conyza sumatrensis	Tall fleabane	E			1	2	1				1																									
Corymbia maculata	Spotted Gum	N																						4	2	4			3				3			
Cymbonotus lawsonianus	Bear's Ear	N																										1						1		

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 B1 c	V6 B2	V6 B2 c	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
Cymbopogon refractus	Barbed Wire Grass	N						1		2	2				2	2	3	2	3	2	4	2	1	3	2	2	1	2	3	2	1	2	2		3	2
Cynodon dactylon	Common Couch	N	3	4	2	1	2	3	2	2	3		2		1					1			1					1					2			
Cyperus gracilis	Slender Flat-sedge	N									1		1										1													
Cyperus polystachyos		N																						1												
Cyperus spp.		N									1														1				1							
Daucus spp.		N					1																													
Daviesia genistifolia	Broom Bitter Pea	N															1									1										
Desmodium brachypodum	Large Tick-trefoil	N														1			1		2	1			1	1							1	1		2
Desmodium rhytidophyllum		N																								1										
Desmodium varians	Slender Tick-trefoil	N														1										1		1	1	1			1	1		2
Dianella longifolia		N								1																			1							1
Dianella prunina		N												1					1						1			1			1	2				
Dianella revoluta var. revoluta		N														1	1				2			1	1			1	1				1			
Dichelachne sp.		N								1																										
Dichondra repens	Kidney Weed	N								1	1		2					2	1	3	2	2		1			1	1							1	2
Dichondra sp.		N																							1				2				1	2		
Digitaria spp.		N									2																					2			2	
Dodonaea viscosa subsp. cuneata		N															1		1						1	2			1		3					
Echinopogon caespitosus	Bushy Hedgehog-grass	N																															1			
Echium plantagineum	Patterson's Curse	E		3		2	1		1																											
Ehrharta erecta	Panic Veldtgrass	E	2	3	3	3	2		2	3								1																		
Einadia hastata	Berry Saltbush	N		1		1			3	1				2																				1		
Einadia nutans	Climbing Saltbush	N							1												1															
Einadia sp.		N										1	2	2		1					1		1				1	1			1					
Einadia trigonos	Fishweed	N																			1															
Entolasia marginata	Bordered Panic	N																															1			
Entolasia stricta	Wiry Panic	N																						1	1						2	3			1	
Epacris sp.		N															1																			
Eragrostis brownii	Brown's Lovegrass	N											1						1	1					2		2				2					1
Eragrostis curvula	African Lovegrass	E					1	1																												
Eragrostis leptostachya	Paddock Lovegrass	N																1				1												1		
Eragrostis sp.							1									1							1													
Eremophila debilis	Amulla	N															1			1	2													1		
Eucalyptus blakelyi	Blakely's Red Gum	N									4																									
Eucalyptus camaldulensis	River Red Gum	N						3	4	4																										
Eucalyptus crebra	Narrow-leaved Ironbark	N									1						4	1	4		4	1	1	4	3	3	3	4	3		3	3	3			4
Eucalyptus dawsonii	Slaty Gum	N										2															3			3						
Eucalyptus moluccana	Grey Box	N																3		3	3	3											3		3	
Eucalyptus punctata	Grey Gum	N																							1				3		3	3				
Euchiton involucratus	Star Cudweed	N			1						1			1																						
Eustrephus latifolius	Wombat Berry	N																												1						

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 B1 c	V6 B2	V6 B2 c	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
Exocarpos cupressiformis	Native Cherry	N								3															2											
Exocarpus strictus	Cherry Ballart	N							2																											
Fabaceae sp.		N															1																			
Facelis retusa	Annual Trampweed	E		1	1		1	1	1																											
Gahnia aspera	Rough Saw-sedge	N														1										1	1	1	1	1				1	1	
Gahnia sp.		N																															2			
Galenia pubescens	Galenia	E		3		2		1	4	1			1																							
Galium propinquum	Maori Bedstraw	N															1																1	1		
Geijera salicifolia var. salicifolia		N																																1	2	2
Geitonoplesium cymosum	Scrambling Lily	N																											1				1	1		1
Geranium sp.		N																																		1
Glycine clandestina		N								1	1	1				1		1	1		1			2	1	1	1	1	1			1	1	1	1	1
Glycine microphylla		N											1			1	2				1				1											
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	E																				1					1					1				
Goodenia hederacea	Ivy Goodenia	N										2																1								
Goodenia rotundifolia	Star Goodenia	N																	1		1			1	1	1			1		1	2				
Grevillea montana	Moutain Grevillea	N																								2		1	1		1	1				
Grevillea robusta	Silky Oak	N			2																															
Heliotropium amplexicaule	Heliotrope	E		3		2	3	2	3	2																										
Hibbertia obtusifolia	Hoary guinea flower	N																										1				1				
Hibiscus heterophyllus subsp. heterophyllus	Native Rosella	N																															2			
Hydrocotyle verticillata	Sheild Pennywort	N			2	1																														
Hypericum gramineum	Native St Johns Wort	N									1																									
Hypochoeris radicata	Catsear	E		1	2	1		3	1		1	1	1																							
Imperata cylindrica	Bladey Grass	N										2	4																							
Isolepis inundata	Swamp Club-sedge	N			4	2																														
Isopogon dawsonii	Nepean Conebush	N												3																						
Jacksonia scoparia	Dogwood	N																							1							1				
Juncus polyanthemus		N									4				1																					
Juncus sp.		N			1							1																1								
Juncus usitatus	Common Rush	N				2																														
Laxmannia gracilis	Slender Wire Lily	N																					2	1			1									
Lepidosperma laterale	Variable Swordsedge	N																														3				
Leptospermum petersonii	Lemon-scented Teatree	N				3																														
Leptospermum sp.		N													1																					
Leptospermum polyanthum		N		3	2		5																													
Leucopogon muticus	Blunt Beard-heath	N																														2				
Lomandra confertifolia subsp. pallida		N									2	3	3	5								1				2				1		2				
Lomandra filiformis	Wattle Matt-rush	N																										2								

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 B1 c	V6 B2	V6 B2 c	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
Lomandra filiformis subsp. coriacea		N								1								2							1				1			1				
Lomandra filiformis subsp. filiformis		N						2									1					2					1			2						
Lomandra longifolia	Spiny-headed Mat-rush	N		1	2																												2			
Lomandra multiflora	Many-flowered Mat-rush	N																	1			2				1	1	1			1	1	1			
Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush	N									2		3	1	2	1?		1					1													
Lomandra sp.		N													1				2	1			1	1									1		1	
Lycium ferocissimum	African Boxthorn	E		3		2																						1		1						
Macrozamia flexuosa		N																	1						1											
Macrozamia reducta		N																								1			1							
Maireana microphylla	Small-leaf Bluebush	N																																1		
Maytenus silvestrus	Narrow-leaved Orange Bush	N														1											1		1							2
Melaleuca decora	White Feather Honeymyrtle	N																2	3	3	3	3	1	3	4		4	3	3		3	3				
Melaleuca thymifolia	Thyme Honeymyrtle	N									2																									
Melia azedarach	White Cedar	N							1																											
Melichrus urceolatus	Urn Heath	N																								1										
Microlaena stipoides var. stipoides	Weeping Grass	N		4	3	2	4	1	1	3			1															1	1					1		
Minuria leptophylla	Minnie Daisy	N															1																			
Modiola caroliniana	Red-flowered Mallow	E	1																																	
Notelaea longifolia	Large Mock-olive	N																			1												1			
Notelaea microcarpa var. microcarpa		N				3			2	1	1	1	1	2	1		1	1		2	1	1				2	2		1	3		3	3	4	4	5
Oenothera stricta subsp. stricta	Common Evening Primrose	E						2																												
Olea europaea subsp. cuspidata		E			1		1			1																										
Olearia elliptica	Sticky Daisy Bush	N															1		4	3	1				3	3			2	2	2	3			2	4
Oplismenus aemulus	Basket Grass	N			3	3	2			1																							1			1
oplismenus imbicilus		N				2																														
Opuntia aurantiaca	Tiger Pear	E							2			1						1		1		1		1												
Opuntia humifusa	Creeping pear	E								1																										
Opuntia stricta	Prickly Pear	E		1			2		1	1		1	2	2	1	1		1	2	1	1	2	1	1	1		2	1	1	1	1	1				1
Oxalis corniculata	Creeping Oxalis	E		1																																
Oxalis perennans	Native Oxalis	N						2		1	1	2	2									1			1			1						1		1
Oxalis radicosa		N				1			1																											
Oxalis spp.		N					2																										1			
Pandorea pandorana	Wonga Wonga Vine	N																															1			
Panicum simile	Two-colour Panic	N																													1					
Pavonia hastata	Pink Pavonia	E		2			2	2	2	5	3																									
Pennisetum clandestinum	Kikuyu Grass	E	1																																	
Persicaria sp.		N			1						1																									
Persoonia linearis	Narrow-leaved Geebung	N												2											1				1			1				

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 B1 c	V6 B2	V6 B2 c	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
Petrorhagia nanteuilii	Childing Pink	E						2		1																										
Phragmites australis	Common Reed	N	2	3	2	1																														
Pimelea linifolia	Slender rice flower	N										4	2		2																					
Pimelea latifolia subsp. hirsuta		N																															2			
Plantago debilis	Shade Plantain	N																				1						1						1	1	
Plantago lanceolata	Lamb's Tongues	E	1				1	2	1	1	1																									
Poa annua	Summer grass	E				2																														
Polyscias sambucifolia	Elderberry Panax	N			1																															
Pratia purpurascens	Whiteroot	N								1	1			2								1			1				1				1			
Pseudognaphalium luteoalbum	Jersey Cudweed	E	1	1	1																															
Psydrax oderatum	Shiny-leaved Canthium	N																									1									
Pteridium esculentum	Bracken	N										4	4	3																						
Pultenaea spinosa	Spiny Bush-pea	N																								2		1								
Rhagodia parabolica	Mealy Saltbush	N																																1		
Richardia humistrata	Richardia	E						2		1		1																								
Romulea sp.		E									1																									
Rubus parvifolius	Native Raspberry	N				2																														
Rumex brownii	Swamp Dock	N	1	1		1				1																										
Rytidosperma (Austrodanthonia) spp.		N														1			1		1								1	1	1			1	1	
Salix spp.	Willow	E	3																																	
Schoenus brevifolius	Zig-zag Bog-rush	N															1		1		1			1		1										
Senecio madagascariensis	Fireweed	E	2	1		1	3	2	2	1	1				1		1		1	1	1	1	1	1		1		1			1	1		1		
Senecio quadridentatus	Cotton Fireweed	N							1																											
Setaria sp.		E		1								1																								
Sida corrugata	Corrugated Sida	N				2	1									1	1		1		1									1			1	1	1	
Sida rhombifolia	Paddy's Lucerne	E	1			1			1																											
Sida sp.		N			1				2																											
Silene gallica var. gallica	French Catchfly	E						1		1																										
Solanum nigrum	Black-berry Nightshade	E	1	1		1			2																											
Solanum prinophyllum	Forest Nightshade	N												1					1	1		1		1								1				
Solanum spp.		N																																1		1
Solivia sessilis	Bindii	E						1																												
Sonchus asper	Prickly Sowthistle	E					1																													
Sonchus oleraceus	Common Sowthistle	E	3	1	1	2	2			1																										
Spartothamnella juncea	Bead-bush	N														1																		2	2	2
Sporobolus creber	Western Rat's Tail Grass	N																1	1		1			1			2	1	1	1	1					
Sporobolus elongatus	Slender Rat-tail Grass	N															1								1									1		
Stellaria media	Chickweed	E		1		2	2		2																											
Stephania japonica	Snake Vine	N		1	2	2																														
Swainsona galegifolia	Smooth Darling Pea	N																															1	1		
Tagetes minuta	Stinky Roger	E				2			3																											

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 B1 c	V6 B2	V6 B2 c	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
Thistle sp.		E	1	1																																
Tradescantia fluminensis	Wandering Jew	E			1	2																														
Trifolium arvense	Hare's Foot Clover	E						1																												
Trifolium campestre	Hop Clover	E						1																												
Unidentified exotic herb		E					2																													
Unidentified grass		E									1																									
Unidentified herb		N															1																			
Unidentfied native creeper		N																				3														
Unidentified shrub		N																													3					
Unidentified succulent		N																	1																	
Unidentified twiner	Unidentified native twiner	N																						1												
Verbascum virgatum	Twiggy Mullein, Green Mullein	E				2																														
Verbena bonariensis	Purpletop	E					1	1			1																									
Verbena rigida	Veined Verbena	E						1		2																										
Veronica plebeia	Trailing Speedwell	N						1																												
Veronica sp.		N								1																										
Viola sp.		N			2																															
Vittadinia sulcata	Furrowed New Holland Daisy	N																1		1		1					1			2				1	1	1
Vulpia bromoides	Squirrel Tail Fescue	E						1																												
Vulpia myuros	Rat's Tail Fescue	E			1					2																										
Wahlenbergia communis	Tufted Bluebell	N													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	Golden Wreath Wattle	NLN	3	1	1	
Acacia sp.		N		1		1
Acacia sp.		N		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		
Bursaria spinosa	Native Blackthorn	N				1
Calotis cuneifolia	Purple Burr-Daisy	N	2			2
Calotis lappulacea	Yellow Burr-daisy	N				2
Chloris gayana	Rhodes Grass	E	1	1		
Chloris ventricosa	Tall Chloris	N				1

Scientific Name	Common Name	Native/Exotic	4R	8R	3R	6R
Corymbia maculata	Spotted Gum	N	2	2	1	2
Cymbopogon refractus	Barbed Wire Grass	N	1	1	1	2
Dichondra repens	Kidney Weed	N				1
Einadia hastata	Berry Saltbush	N				1
Enchylaena tomentosa	Ruby Saltbush	N	2	1	1	2
Eucalyptus cladocalyx	Sugar Gum	NLN	4	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				2
Sida rhombifolia	Paddy's Lucerne	E				2
Small unidentified sedge						1
Unidentified twiner		N				1
Unidentified grass		N				2
Unidentified sp.		N				1

NLN = non-local Australian native species

2.2 Photographs of floristic monitoring plots

A photograph has been taken at the start and end of the 50 m central transect within each floristic 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

No end photograph of V2-B1

Plate 14: V2-B2 – start

Plate 15: V2-B2 – end

Plate 16: V3-B1 – start

Plate 17: V3-B1 – end

2.2.1 Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area

Plate 18: V5-B1 – start

Plate 19: V5-B1 – end

Plate 20: V5-B2 – start

Plate 21: V5-B2 – end

Plate 22: V5-B3 – start

Plate 23: V5-B3 – end

Plate 24: V5-B4 – start

Plate 25: V5-B4 – end

2.2.2 Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter

Plate 26: V6-A1c – start

Plate 27: V6-A1c - end

Plate 28: V6-A3 – start

Plate 29: V6-A3 – end

Plate 30: V6-B1 – start

Plate 31: V6-B1 – end

Plate 32: V6-B1c – start

No end photograph of V6-B1c

Plate 33: V6-B2 start

Plate 34: V6-B2 – end

Plate 35: V6-B2c – start

Plate 36: V6-B2c - end

Plate 37: V6-B3 – start

Plate 38: V6-B3 – end

Plate 39: V6-B4 – start

Plate 40: V6-B4 – end

Plate 41: V11–B1 – start

Plate 42: V11-B1 – end

Plate 43: V11-B2 – start

Plate 44: V11-B2 – end

2.2.3 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Plate 45: V9-A1 – start

Plate 46: V9-A1 – end

Plate 47: V9-B1 – start

Plate 48: V9-B1 – end

Plate 49: V9-B2 – start

No end photograph of V9-B2

Plate 50: V10-B1 – start

Plate 51: V10-B1 – end

2.2.4 Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion

Plate 52: V10-A1 – start

Plate 53: V10-A1 – end

Plate 54: V10-A2 – start

V

Plate 55: V10-A2 – end

Plate 56: V10-B3 – start

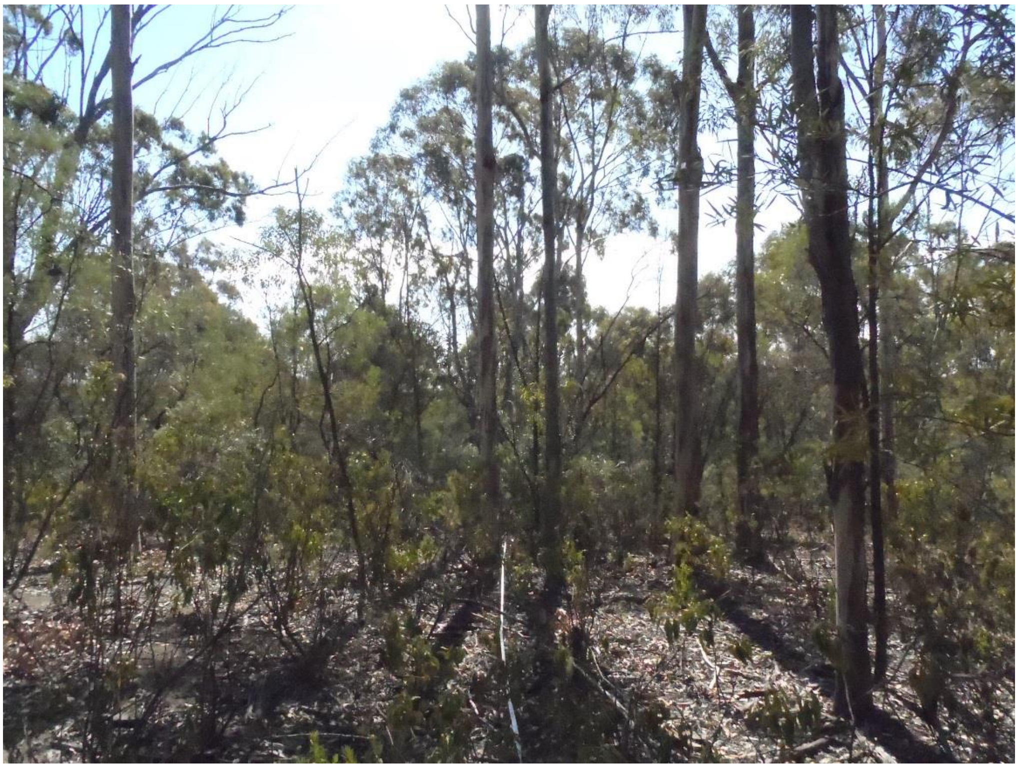


Plate 57: V10-B3 – end

2.2.5 White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley

Plate 58: V13-B1 – start

Plate 59: V13-B1 – end

2.2.6 Brush Wilga/Native Olive Shrubland

Plate 60: V14-A1 – start

Plate 61: V14-A1 – end

Plate 62: V14-B1 – start

Plate 63: V14-B1 – end

2.3 Photo-monitoring points

Plate 64: A2 – 2013

Plate 65: A2 - 2017

Plate 66: A3 - 2013

Plate 67: A3 - 2017

Plate 68: A4 - 2013

Plate 69: A4 - 2017

Plate 70: B1 - 2013

Plate 71: B1 - 2017

Plate 72: B2 - 2013

Plate 73: B2 – 2017

Plate 74:C1 – 2013

Plate 75: C1 - 2017

Plate 76: CT1 - 2013

Plate 77: CT1 - 2017

Plate 78: CT2 - 2013

Plate 79: CT2 - 2017

Plate 80: D1 2013

Plate 81: D1 2017

3 Landscape function analysis –site photos

3.1 North Wambo Creek diversion and riparian areas

Plate 82: 17R

Plate 83: 19R

Plate 84: 21R

Plate 85: 23R

Plate 86: 25R

Plate 87: 26R

Plate 88: 27R

Plate 89: 28R

3.2 Woodland rehabilitation areas

Plate 90: 3R

Plate 91: 4R

Plate 92: 6R

Plate 93: 8R

3.3 Pasture rehabilitation areas

Plate 94: 1R

Plate 95: 2R

Plate 96: 5R

Plate 97: 7R

Plate 98: 9R

Plate 99: 10R

Plate 100: 16R

Plate 101: 33R

Plate 102: 34R

Plate 103: 35R

4 Riparian condition assessment

4.1 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	5.10	7.75	3.50	3.25	2.50	22.10
North Wambo 2	8.75	9.00	5.50	4.25	3.75	31.25
North Wambo 3	9.25	9.00	6.00	8.50	3.75	36.50
Wambo 1	1.46	6.50	3.00	0.50	1.00	12.46
Wambo 2	3.25	7.50	3.75	2.50	1.25	18.25
Wambo 3	7.00	8.00	3.50	4.25	1.75	24.50
Stony Creek 1	2.00	6.75	3.25	5.50	2.00	19.50
Stony Creek 2	5.00	8.50	4.50	2.75	2.50	23.25
Stony Creek 3	11.00	10.50	7.50	8.00	5.25	42.25

5 Bird monitoring

5.1 Bird monitoring data

Table 6: Species and maximum count of birds, heard and observed over two site visits; morning and afternoon during October 2017

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**	**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	0	0	0	0	0	0	4	0	0	4	1
Acanthiza lineata	Striated Thornbill	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	11	2
Acanthiza nana	Yellow Thornbill	0	10	7	8	0	5	0	0	0	0	1	0	2	1	0	4	10	2	6	1	10	7	7	0	0	71	14
Acanthiza pusilla	Brown Thornbill	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	1	3	2	3	0	0	0	0	0	0	10	7
Acanthiza reguloides	Buff-rumped Thornbill	0	4	0	5	0	3	0	0	0	0	0	0	1	2	0	0	0	3	0	0	10	0	5	0	0	33	8
Aegotheles cristatus	Australian Owlet-nightjar	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	2	1
Alisterus scapularis	Australian King-Parrot	3	0	2	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	10	5
Aquila audax	Wedge-tailed Eagle	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	2	2
Artamus cyanopterus	Dusky Woodswallow	0	0	0	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	17	4
Artamus superciliosus	White-browed Woodswallow	15	0	15	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	3
Cacatua galerita	Sulphur-crested Cockatoo	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	7	6

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**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**	**No. sites**
Cacomantis flabelliformis	Fan-tailed Cuckoo	1	0	4	0	0	0	0	0	2	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	10	6
Calyptorhynchus lathami	Glossy Black-Cockatoo	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Chalcites basalis	Horsfield's Bronze-Cuckoo	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	2
Chalcites lucidus	Shining Bronze-Cuckoo	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	3	3
Chthonicola sagittata	Speckled Warbler	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	4	0	1	1	0	12	7
Climacteris picumnus	Brown Treecreeper	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5	2
Colluricincla harmonica	Grey Shrike-thrush	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	1	7	6
Coracina novaehollandiae	Black-faced Cuckoo-shrike	0	0	0	0	0	1	2	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	1	9	8
Coracina papuensis	White-bellied Cuckoo-shrike	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Corcorax melanorhamphos	White-winged Chough	5	0	0	0	0	4	0	0	0	0	0	0	0	5	0	0	0	0	4	0	0	11	0	0	0	29	5
Cormobates leucophaea	White-throated Treecreeper	0	0	0	0	0	0	0	0	1	1	1	1	0	2	0	2	0	0	0	1	0	0	0	1	0	10	8
Corvus coronoides	Australian Raven	1	2	3	1	1	2	0	2	0	0	0	0	0	2	2	0	1	0	0	1	2	1	1	0	1	22	14
Corvus orru	Torresian Crow	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	2	0	0	4	3
Cracticus nigrogularis	Pied Butcherbird	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2
Cracticus tibicen	Australian Magpie	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	1	1
Cracticus torquatus	Grey Butcherbird	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	4	4

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**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**	**No. sites**
Dacelo novaeguineae	Laughing Kookaburra	1	2	1	3	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	13	7
Daphoenositta chrysoptera	Varied Sittella	1	0	0	0	2	0	0	0	0	9	0	0	0	5		7	0	0	0	0	0	0	0	0	0	24	5
Dicaeum hirundinaceum	Mistletoebird	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	3	3
Eolophus roseicapillus	Galah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1
Eopsaltria australis	Eastern Yellow Robin	0	1	0	0	1	1	0	1	2	1	6	2	2	2	0	3	0	0	0	1	2	0	0	0	1	26	14
Geopelia humeralis	Bar-shouldered Dove	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	2
Gerygone albogularis	White-throated Gerygone	0	0	0	2	0	0	1	2	0	0	0	0	0	1	2	1	0	0	0	1	0	0	1	0	0	11	8
Glossopsitta pusilla	Little Lorikeet	0	0	0	7	0	0	5	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	3
Leucosarcia picata	Wonga Pigeon	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Lichenostomus chrysops	Yellow-faced Honeyeater	2	0	4	2	17	6	0	1	5	4	6	10	0	2	0	0	4	7	0	1	8	2	2	5	4	88	18
Lichenostomus leucotis	White-eared Honeyeater	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Lichenostomus melanops	Yellow-tufted Honeyeater	0	0	0	0	0	0	15	5	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	3
Lichenostomus penicillatus	White-plumed Honeyeater	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	3	18	3
Malurus cyaneus	Superb Fairy-wren	6	0	15	0	0	0	0	2	0	7	8	0	1	1	0	2	6	2	3	3	3	0	0	2	0	55	13

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	18	19	20	21	22	23	24	25	26	Total	No. sites
Malurus lamberti	Variegated Fairy-wren	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	1	0	4	3
Manorina melanocephala	Noisy Miner	2	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	4
Manorina melanophrys	Bell Miner	0	0	0	0	0	0	0	15	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	2
Melithreptus brevirostris	Brown-headed Honeyeater	0	0	0	0	0	0	0	0	0	1	1	4	0	4	0	0	0	0	1	2	2	2	0	10	0	27	9
Melithreptus lunatus	White-naped honeyeater	0	0	0	0	0	0	0	5	4	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	3
Merops ornatus	Rainbow Bee-eater	4	0	2	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	11	6
Microcarbo melanoleucos	Little Pied Cormorant	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
Microeca fascinans	Jacky Winter	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	2	7	4
Myiagra inquieta	Restless Flycatcher	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Neochmia temporalis	Red-browed Finch	0	0	8	0	0	0	0	3	0	0	7	0	0	0	0	0	3	0	2	0	0	0	0	0	0	20	4
Neophema pulchella	Turquoise Parrot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Oriolus sagittatus	Olive-backed Oriole	5	1	6	1	0	0	0	1	0	0	0	0	0	2	0	0	4	0	0	0	0	0	0	0	0	16	6
Pachycephala pectoralis	Golden Whistler	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	2	2
Pachycephala rufiventris	Rufous Whistler	0	1	0	1	4	0	5	5	3	5	2	3	7	0	2	2	4	1	0	0	5	0	1	3	5	55	17
Pardalotus punctatus	Spotted Pardalote	0	4	0	0	4	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	15	8

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	18	19	20	21	22	23	24	25	26	Total	No. sites
Pardalotus striatus	Striated Pardalote	1	0	0	1	0	0	0	1	0	2	0	2	2	3	1	2	0	0	2	1	1	1	1	0	0	21	14
Petrochelidon nigricans	Tree Martin	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	1	1
Petroica goodenovii	Red-capped Robin	0	0	0	1	1	1	0	0	0	3	0	0	0	0	0	0	0	2	0	0	3	2	1	0	0	14	8
Phalacrocorax carbo	Great Cormorant	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
Phaps chalcoptera	Common Bronzewing	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
Philemon corniculatus	Noisy Friarbird	1	1	1	0	0	7	0	1	0	0	1	0	2	1	0	4	0	0	3	1	1	1	0	0	0	25	13
Platycercus eximius	Eastern Rosella	4	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	3
Plectorhyncha lanceolata	Striped Honeyeater	0	2	2	0	1	0	0	0	0	0	0	1	0	3	0	0	4	0	3	0	0	0	0	1	0	13	7
Pomatostomus temporalis	Grey-crowned Babbler	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	12	3
Psephotus haematonotus	Red-rumped Parrot	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1
Psophodes olivaceus	Eastern Whipbird	0	0	0	0	0	0	0	3	1	0	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	8	5
Rhipidura albiscapa	Grey Fantail	0	0	1	1	0	0	1	1	1	1	1	1	0	1	1	2	0	2	0	1	1	0	0	0	0	16	14
Rhipidura leucophrys	Willie Wagtail	0	0	2	0	1	1	0	3	0	0	5	1	0	0	0	0	0		0	0	0	0	0	1	2	16	8
Scythrops novaehollandiae	Channel-billed Cuckoo	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Sericornis frontalis	White-browed Scrubwren	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
Smicrornis brevirostris	Weebill	0	0	0	0	0	0	0	0	0	1	0	0	3	4	2	2	0	0	1	1	4	0	1	1	0	20	10

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**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**	**No. sites**
Strepera graculina	Pied Currawong	3	1	3	0	1	0	0	1	2	1	3	1	2	3	0	1	1	0	2	1	1	0	0	1	1	28	17
Taeniopygia bichenovii	Double-barred Finch	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2
Todiramphus sanctus	Sacred Kingfisher	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	3
Zosterops lateralis	Silvereye	10	5	0	5	5	0	0	0	5	15	0	0	0	0	0	0	0	10	20	15	1	0	0	1	0	92	11
	TOTAL	17	14	22	17	15	16	14	22	20	18	25	13	9	21	6	18	15	12	14	18	21	12	21	19	19		

ecological AUSTRALIA

ISO 14001 Environmental Management

AS/NZS 4801:2001 Occupational Health and Safety Management

ISO 9001 Quality Management

HEAD OFFICE
Suite 2, Level 3
668-672 Old Princes Highway
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 0145
F 02 9542 5622

COFFS HARBOUR
35 Orlando Street
Coffs Harbour Jetty NSW 2450
T 02 6651 5484
F 02 6651 6890

PERTH
Suite 1 & 2
49 Ord Street
West Perth WA 6005
T 08 9227 1070
F 02 9542 5622

MELBOURNE
Level 1, 436 Johnstone St
Abbotsford, VIC 3076
T 1300 646 131

SYDNEY
Suite 1, Level 1
101 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9542 5622

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 0125
F 02 9542 5622

ARMIDALE
92 Taylor Street
Armidale NSW 2350
T 02 8081 2685
F 02 9542 5622

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 9542 5622

BRISBANE
Suite 1, Level 3
471 Adelaide Street
Brisbane QLD 4000
T 07 3503 7192
F 07 3854 0310

1300 646 131
www.ecoaus.com.au

HUSKISSON
Unit 1, 51 Owen Street
Huskisson NSW 2540
T 02 4201 2264
F 02 9542 5622

NAROOMA
5/20 Canty Street
Narooma NSW 2546
T 02 4302 1266
F 02 9542 5622

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1234
F 02 6372 9230

GOSFORD
Suite 5, Baker One
1-5 Baker Street
Gosford NSW 2250
T 02 4302 1221
F 02 9542 5622

ADELAIDE
2, 70 Pirie Street
Adelaide SA 5000
T 08 8470 6650
F 02 9542 5622

ECO LOGICAL AUSTRALIA PTY LTD
ABN 87 096 512 088
www.ecoaus.com.au

Nicole Dobbins
Environmental Advisor
Peabody Australia

Addendum to Wambo Coal Mine Annual Flora and Fauna Monitoring, 2017 – Subsidence Impacts

7 March 2018

Dear Nicole,

Subsidence Impacts

Observations of mine subsidence were noted during the 2017 flora and flora monitoring program for Wambo Coal Proprietary Limited (WCPL). However, as flora and fauna monitoring fieldwork is focussed on the remnant woodland enhancement areas (RWEAs) and immediate surrounds, no inspections occurred within the boundaries of Wollombi National Park or areas overlying the recently approved (December 2017) South Bates Underground Extension. These flora and fauna monitoring sites are also primarily located in low relief areas, so cliff lines and ridgetops were not visited extensively during the monitoring program.

The level of disturbance to native vegetation and the condition of the surrounding vegetation was noted where subsidence was observed. Biodiversity performance measures and indicators from the development consent (DA 305-7-2003) and Wambo Coal Biodiversity Management Plan (WCPL 2017) are used to assess the impact of subsidence relating to longwall mining upon ecological communities located within the RWEAs at Wambo Coal. Additional observations and findings relevant to these performance measures and indicators are detailed below.

The 2017 Annual Flora and Fauna Monitoring report (ELA 2017) recorded minor mine subsidence cracks at vegetation monitoring sites V6-B1c, V6-B2, V6-B2c, V10-A2, V11-B1 and bird monitoring site BP15 within the Narrow-leaved Ironbark and Slaty Gum communities. The Narrow-leaved Ironbark community is likely to correspond with the Endangered Ecological Community (EEC) *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions* while Slaty gum woodland forms the Vulnerable Ecological Community (VEC) *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* as listed under the NSW *Biodiversity Conservation Act 2016*. Sections of this community at lower elevation and in good condition with a Eucalypt canopy are also likely to be the Critically Endangered Ecological Community (CEEC) *Central Hunter Valley eucalypt forest and woodland* listed under the Commonwealth *EPBC Act 1999*. However vegetation damage at these sites was considered negligible with only relatively minor surface cracks observed and as such, subsidence performance measures were not exceeded at these locations.

More extensive subsidence impacts were observed on a ridgeline road in RWEA B between bird monitoring site BP12 and flora monitoring site v14-B1 in RWEA B, where a succession of large and deep cracks were observed. However, it is understood this area was undermined by the North Wambo Underground Mine prior to February 2011 and as such, the current performance measures are not applicable to this subsidence impact. It is recommended WCPL remedy this subsidence impact to prevent further damage from erosion and reduce risks to native fauna and flora, while considering the surrounding *Central Hunter Grey Box-Ironbark Woodland* EEC.

Yours sincerely,

Daniel McKenzie

Daniel McKenzie, Ecologist, Eco Logical Australia

The following table is based on Table 21 in the Wambo Coal Biodiversity Management Plan and excludes 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 1: Performance measures, indicators and findings

Biodiversity	Performance measure	Performance indicator (WCPL 2017)	2017 findings
Wollemi National Park	Negligible subsidence impacts and environmental consequences	The performance indicators will be considered to have been exceeded if conventional vertical subsidence exceeds 20 millimetres (mm) or the limit of 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.	N/A - Vertical subsidence as the base of escarpment or cliff or rock face instability not inspected as part of the flora and fauna monitoring program in 2017. However no major rock falls were observed during the 2017 monitoring program.
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 above Longwalls 11 to 16 indicate a statistically significant downward trend or change between monitoring periods not observed at analogue/reference sites.	No vegetation damage observed at sites V6-B1c and V11-B1 beyond narrow surface cracks. Vegetation at these sites and in the wider area remained in good condition at the time of survey Other subsidence observations are related to mining which occurred prior to Feb 2011 and as such performance measures are not applicable.
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 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.	Area not currently undermined – no subsidence observations
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.

APPENDIX F

WAMBO ANNUAL REVIEW GROUNDWATER ANALYSIS

NPM Technical Pty Ltd ● ABN 52 613 099 540 ● T/A **HydroSimulations**
PO Box 241, Gerringong NSW 2534. Phone: (+61 2) 4234 3802

adam.skorulis@hydrosimulations.com

DATE:	28 March 2018
TO:	Nicole Dobbins Environmental Advisor
	Wambo Coal Pty Ltd Peabody Energy Australia PMB 1, Singleton NSW 2330
FROM:	Adam Skorulis, Dr Derek Yates, Maxime Philibert
RE:	Wambo Annual Review Groundwater Analysis
OUR REF:	WAM018 – Report HS2018/09

INTRODUCTION

This letter report contains the analysis and information required to address the following components of the Annual Environmental Management Review (AEMR) for the Wambo Coal Mine for the 2017 calendar year:

1 Review hydrographs for relevant groundwater monitoring bores and conduct a cause-and-effect analysis to determine whether trends are due to weather or mining.

2 Assess shallow bores for compliance with the groundwater level and water quality performance indicators (Tables 9 and 10 of the GWMP).

3 Compare groundwater monitored levels to model predictions from the South Bates Extension Modification Groundwater Assessment (HydroSimulations, 2017a).

4 Address recommendations from the 2017 WCPL Independent Environmental Audit.

Each scope item is addressed separately in the following sections.

1 ANNUAL REVIEW OF MONITORING DATA

Key data assessment results of time series groundwater level and Electrical Conductivity (EC) data, in relation to trigger levels prescribed in the Groundwater Monitoring Program (Peabody, 2015a) for the 2017 monitoring period, are outlined below. Trends from the entire period of observation have also been assessed to provide context for the 2017 monitoring period.

1.1 Key Groundwater Monitoring Sites

Bores at key sites have been selected (HydroSimulations 2017b) to identify potential impacts from recent areas of longwall (NWU LW8b and SBU LW11 and LW12) and open cut mining at, and nearby, Wambo Coal Mine (WCM).

1.1.1 North Wambo Underground (NWU) impacts

Available EC and groundwater level monitoring data have been assessed at key locations P114, P116, P202, P206, P106 and P109 (**Figure 1**).

1.1.1.1 Observations and Assessment

Groundwater level at location P114 shows a strong relationship with the long-term rainfall trend (rainfall residual mass) from 2003 to late 2014 (**Figure 2**). Following this, the groundwater level departs from the rainfall trend and declines gradually to August 2015 before dropping rapidly to the last date of measurement in August 2016 (since then, to December 2017 the bore has been reported as 'Dry'). A minor response was recorded in February 2016 corresponding to an increase in the rainfall trend. Groundwater level has decreased by ~5.5 m from August 2015 to August 2016, including a drop of 1.7 m due to the reported subsidence over Longwall 10a (MSEC, 2017). P114 is located over NWU Longwall 10a (**Figure 1**), which began extraction in June 2015. The rapid decline in groundwater level following the beginning of extraction is therefore interpreted as an NWU mining impact. Groundwater EC at P114 was fresh (<1000 µS/cm) from August 2003 to October 2011 before a sharp increase in December 2011 to brackish conditions with EC of 3000-7000 µS/cm occurring until August 2015. Following this, EC has further increased with approximately 10000 µS/cm recorded from December 2015 to the last measurement in August 2016, aside from a slight freshening to 8000 µS/cm following above average rainfall in February 2016. Groundwater level and groundwater EC were not recorded from August 2016 to January 2017. P114 was reported as dry from February 2017 to December 2017.

At location P116 (**Figure 3**) groundwater level shows a moderate response to the long-term rainfall trend and good correlation with the HydroSimulations' interpolated Wollombi Brook stage height. The average groundwater level from late 2003 to April 2007 increases by about 1.5m to a new average from June 2007, to December 2016. This may indicate recovery from drawdown caused by the Homestead Longwall 9 mining of the Whybrow Seam that removed coal to within 10m of P116. However, it is more likely to represent a return to above average rainfall following the 'Millennium Drought' that affected much of Eastern Australia in the 2000's. This is indicated by a large increase in the rainfall trend, a 3m increase in groundwater level at P116, and increases in Wollombi Brook stage height. Groundwater levels during 2016 have declined by ~1 m, with only a minor increase occurring August 2016 to October 2016. This is despite an increase in the rainfall trend and an increase in the Wollombi Brook stage height of a magnitude that has previously correlated with increases in groundwater level. This may indicate a mining effect from the extraction of North Wambo Underground Longwall 10a. Groundwater levels decrease by ~1m between December 2016 and June 2017, followed by a small increase in August 2017 that stabilises to the end of 2017. Climatic conditions likely explain the decline in groundwater levels in 2017, indicated by a decreasing rainfall trend. EC levels at P116 (approximately 5000 µS/cm) indicate saline water at the start of measurement in 2003 but show a large drop between April 2007 and July 2007, correlating with the 3m increase in groundwater level associated with the end of the Millennium Drought. Since July 2007, water has remained relatively fresh (about 1000 µS/cm) while groundwater levels have remained consistently above 53 mAHD. However, notable spikes in EC level are seen to occur in conjunction with declines in groundwater level below approximately 53 mAHD (April 2010 – August 2011 and August 2014 – March 2015 and June 2017 - October 2017); the EC and groundwater level curves show a strong inverse relationship since 2007.

HydroSimulations (2016, 2017), has made assessments relating to the leakage of saline mine water from South Wambo Dam to the Wambo Creek alluvium. These assessments found no evidence for leakage from South Wambo Dam and instead show that increases in EC are associated with periods of lower groundwater level most likely related to the interception of saline Permian groundwater at the base of the Wambo Creek Alluvium.

P202 (**Figure 4**) groundwater level shows good correlation with HydroSimulations' interpolated Wollombi Brook stage height, and a moderate correlation with the long-term rainfall trend. An increase in average groundwater level of ~1 m is seen following a high river stage in June 2007, which continues until the most recent observation in December 2017. This may indicate recovery from drawdown caused by the extraction of Homestead Longwall 9a mining of the Whybrow seam 160 m west of P202. However, it is more likely to represent a return to an above average rainfall trend (as explained in the P116 paragraph above). Groundwater EC at P202 is brackish (4000-5000 µS/cm) during early observations followed by a period of freshening (~2800 µS/cm) associated with the high groundwater level in June 2007. Following this period, groundwater EC fluctuates independently from groundwater level, stream stage and long-term rainfall trends at levels 3000-10500 µS/cm. High salinity periods occur from June 2008 to April 2010 and April 2014 to February 2015. A sharp decrease in groundwater EC occurs in October 2017 from 3800 µS/cm to 380 µS/cm (the lowest recorded EC by >2000 µS/cm), EC then rapidly recovers in December 2017 to earlier conditions, at levels around 3700 µS/cm. It is possible that the October 2017 sample was taken incorrectly, the cause of the other fluctuations in EC is not apparent.

P206 (**Figure 5**) groundwater levels show similar trends to those seen in P202, with an increase in average water level of 1.5 m following a high river stage in June 2007. This may indicate recovery from drawdown caused by the extraction of Homestead Longwall 9a in the Whybrow seam 70 m to the west of P206. Again however, it is more likely to represent a return to an above average rainfall trend (as explained in the P116 paragraph above). From June 2007 good correlation is seen between the HydroSimulations' interpolated stream stage and the long-term rainfall trend, with increases in groundwater level linked to high stream stage and rainfall events. Groundwater level is observed to decline by 2 m during 2016, despite an increase in the rainfall trend. While this may indicate a mining effect from NWU LW10a, Wollombi Brook stage height is also observed to decline at both the downstream Warkworth and upstream Bulga gauging stations during 2016 (Seen in the interpolated stage height in **Figure 5**). As the Bulga station could not be affected by mining at Wambo, Wollombi Brook level is more likely to be influencing the groundwater level at P206 rather than mining. Groundwater level demonstrates a decline of 2.77m during 2017, correlating with a general decline in the long-term rainfall trend. No response is observed in groundwater level to a spike in the rainfall trend in March 2017 that is also observed in the Wollombi Brook stage height. It is possible that an ongoing mining effect from NWU LW10a is indicated by this lack of groundwater level response. It is also possible the March rainfall event was not of sufficient magnitude to cause a significant increase in groundwater level. Groundwater EC at P206 is mostly stable between 2000 – 3000 µS/cm but can be seen to decline rapidly in correlation with spikes in groundwater level associated with high river stage and rainfall events. This may indicate the infiltration of rain water into the borehole or gravel pack surrounding the bore during large storm events as seen in June 2007 and April 2015. Minor freshening's also occur at smaller spikes in groundwater level associated with rainfall and stage height.

Groundwater level in P106 shows good correlation with the long-term rainfall trend (**Figure 6**) and the interpolated stage height for Wollombi Brook. Larger fluctuations in groundwater level are observed in P106 in comparison with P114, P116, P202 and P206 (**Figures 2-5**). This is likely to be indicative of ephemeral flow in Wambo Creek, or lower specific yield in its associated alluvium. Groundwater EC at P106 is relatively fresh (less than 1000 µS/cm) and responds to the climatic influence on groundwater levels. Low groundwater levels correlate with increased EC, where a gradual decline is seen in correlation with an increasing trend in rainfall from June 2007 to December 2016, as observed in the other bores located between North Wambo Underground mine area and the confluence of Wambo Creek and Wollombi Brook. Groundwater level responses to climatic factors such as rainfall trend and stage height during 2016 appear to be muted when compared with events of similar magnitude in earlier observations. This indicates a possible mild mining effect caused by Longwall 10a extraction. All observations in 2017, report P106 as dry. Data available to HydroSimulations indicates the depth of P106 to be 14 m. For P106 to reporting a true 'dry' reading, the groundwater level at P106 would need to have dropped by ~5.5m between December 2016 and February 2017, the largest decline observed between 2 bi-monthly measurements since the beginning of observation by a factor of 5. While a low river stage and decreasing rainfall trend, or an ongoing mining effect caused by Longwall 10a extraction may be responsible for the 'dry' observations. HydroSimulations recommends further investigation of the bore to check that it has not silted up or suffered collapse.

Time series groundwater level in P109 (**Figure 7**) is very similar to P106. 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. Groundwater EC is stable at around 600 µS/cm aside from a 6-month period April-August 2013 where EC was 1000 uS/cm. This correlates with a period of low rainfall and groundwater level. Groundwater levels during the 2017 monitoring period show a consistent climatic response to previous observations. This indicates a continued influence of ephemeral flow in Wambo Creek.

1.1.2 North Wambo Underground or Dewatering Impact at GW08 and GW09

Since April 2012, the groundwater levels in bores GW08 and GW09 have decreased by ~3 m (**Figure 8**). Available groundwater level monitoring data have been assessed for GW08 and GW09 to determine the cause of the decreased water level.

1.1.2.1 Assessment

GW08 and GW09 are located to the east of NWU. The closest NWU longwalls to GW09 are Longwall 9 (extracted mid 2014 - early 2015) and Longwall 8b (extracted late 2015 – early 2016) (**Figure 1**). The closest NWU Longwalls to GW08 are Longwalls 10 and 10a (extracted consecutively early 2015 – late 2015) (**Figure 1**). Significant drawdown in both GW08 and GW09 (**Figure 8**) begins in mid-2012, at the time when NWU Longwall 5 was being extracted (1.1 km from GW09 and 1.4 km from GW08) and Longwall 6 development headings were driven. Prior to 2012 there was a slow decline in groundwater levels, probably due to the combined effects of approaching NWU mining of the Wambo Seam, the approaching Wambo open cut, and perhaps the approaching United mining in the Arrowfield Seam below, which finished in 2012. An increase in the rate of decline occurs from 2012, coincident with the commencement of dewatering of the Wambo Seam in the old workings adjacent to North Wambo Longwall 8b by means of two production bores. 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. While no observation data was available for the 2015 monitoring period, observations have been made for the 2016 monitoring period from April 2016. The single observation at GW09 shows the bore has gone dry, and a continued decline in groundwater level occurs at GW08, indicating an ongoing mining effect associated with Longwall 8b. This suggests that the earlier decline from 2013 to 2014 was not solely due to the effect of the dewatering bores. In 2017, observations at GW09 demonstrate the bore is still dry. Groundwater levels at GW08 increase in April 2017 followed by a gradual decline in groundwater level of less than 1 m to December 2017, corresponding to the long-term rainfall trend. The ongoing decline in groundwater levels and dry condition at GW08 and GW09 respectively, may now be related to the decreasing rainfall trend taking place in 2017. While a North Wambo underground mining effect may be ongoing. any possible recovery could be masked by the below average rainfall. Also to be noted, the latest groundwater level observation recorded in December 2017 at GW08 is 53.04 mAHD. The bottom elevation of the bore is 53mAHD. Consequently, GW08 is nearly dry.

1.1.3 Montrose open cut impact

Groundwater level data has been assessed at GW16 and GW17 and VWP N5 (**Figure 1**) to determine whether the Montrose open cut (about 300 m distant) has had an impact on alluvial groundwater levels. Observations have been made at these locations since August 2010.

1.1.3.1 Long term observations

Both GW16 (**Figure 9**) and GW17 (**Figure 10**) show good correlation to the long-term rainfall trend, with a period of increasing water level from the beginning of observation until mid-2012 coinciding with above average rainfall. A decrease in groundwater level of ~5 m is seen in both locations from August 2013 to February 2015 during average rainfall conditions, before increasing again by about 3 m to June 2015. The second half of 2015 shows another decrease in groundwater level of 3 m in GW16 and 2 m in GW17. Increases in groundwater level of 4 m and 5 m in GW16 and GW17 respectively, are observed in correlation with a rainfall trend increase in February 2016. At GW16 this is followed by a 5 m decrease in groundwater level to August 2016, which recovers by 2 m for October and December 2016 observations. GW17 groundwater levels following February 2016 decline by 4 m to December 2016. During the 2017 monitoring period, groundwater level at GW16 declines by 2.3m. At GW17 groundwater level declines slightly (~1m) to October 2017 before increasing by the same amount to the December 2017 observation. The groundwater level decline at GW16correlates with the decreasing rainfall trend, while the increase in groundwater level of 1m at GW17 observed at the end of 2017 is not related to any apparent climatic trend. The EC at GW16 shows a spike in salinity of 1138 µS/cm in February 2017 before freshening to 777 µS/cm in April 2017 and gradually increasing to ~1000 µS/cm. This matches with the observed decline in groundwater level. EC observations at GW17 in 2017 are slightly more saline than in 2016, with levels from 5300-5400 µS/cm. EC at GW17 records seem to respond significantly less to the decrease in the rainfall trend and groundwater level than for GW16 and remain relatively consistent throughout the reporting period. The EC records remain disparate – fresh at GW16 (in alluvium) and saline at GW17 (beneath alluvium).

N5 (**Figure 11**), is a multi-piezometer grouted bore located 2km North of current SBU mining (**Figure 1**) at an elevation of 110.1 mAHD. It has four VWPs 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. Since stabilising in October 2015, the shallowest Permian sensor (N5-4) has been recording a consistent groundwater level that shows a good correlation with the rainfall trend during the 2016 and 2017 reporting period. A decline in groundwater level of ~10 m has been observed in the three lower sensors during the 2016 monitoring period. A decline of ~4 m at the Wambo Seam sensor N5-1 was observed during 2017 monitoring period, while the Whybrow – Wambo Seam Interburden(N5-2) and Whybrow Seam(N5-3) sensors have reported a stable groundwater level.

1.1.3.2 Assessment

Previous reporting (HydroSimulations 2016, 2017) attributed earlier fluctuations of groundwater level at GW16 and GW17 to climate and ephemeral flows in North Wambo Creek as the main influences on groundwater level. The increasing amplitude in groundwater level response, particularly at GW16, indicates a likely mining effect following removal of material from the adjacent open cut, given that the most recent declines are contrary to the rainfall trend. The rapid recovery that is observed following increases in the rainfall trend is likely due to ephemeral flow in North Wambo Creek and a low specific yield in its associated alluvium. Some of the drawdown may also be attributed to the extraction of South Bates Underground LW11 and LW12. However, the longwalls are over 2 km away, indicating that most of the observed mining effect can be attributed to the open cut. In 2017, climatic conditions are contributing to the decline in groundwater level at both GW16 and GW17, however the most recent increase in groundwater level at GW17 does not correspond with the decreasing rainfall trend. As assessed in 2016, the removal of material from Montrose open cut is likely developing regional depressurisation and consequently likely to also be responsible for the low groundwater level at GW16 and GW17 during 2017.

As GW16 and GW17 are upgradient of the Montrose pit, there can be no effect on EC from the open cut operation.

The decline in groundwater level in the lower three sensors of N5 is likely due to regional depressurisation by open cut mining and NWU mining in the Wambo Seam, and the onset of SBU mining in the Whybrow Seam. However, in 2017, the decline in groundwater level has slowed, with a reduced drawdown at the deepest sensor N5-1 and a stabilised groundwater level for the two upper sensors, N5-2 and N5-3. The southerly movement of mining at South Bates in the Whybrow Seam, and the end of Wambo Seam extraction at NWU is likely to have help groundwater level to stabilise. The gradual ongoing depressurisation of the Wambo Seam may be related to dewatering associated with the Montrose open-cut and current South Bates Wambo Seam workings.

1.1.4 South Bates Impact

Groundwater level data have been assessed at VWPs N2 and N3 as well as GW21 to identify the impact of the extraction of South Bates LW11, LW12, LW13 and LW14. Data at the VWPs has been recorded since July 2015 and GW21 has recorded bi-monthly data since October 2010.

1.1.4.1 Observations

N2 (**Figure 12**), located between North Wambo Underground and South Bates Underground (**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) that have been recording since July 2015. The uppermost sensor (N2-6) at 40 m depth shows a decline in groundwater level of 2 m to a near zero pressure head from the start of observation to the most recent readings. This likely represents the sensor stabilising but may also represent a response to a below average period in the rainfall trend. During the 2016 monitoring period, a 1 m increase in groundwater level is observed from January to March following a period of above average rainfall. From April 2016 to the last recorded date in December 2017, groundwater level declines to read zero pressure. Similar observations are made in the other two Permian overburden sensors at N2. The sensor at 70 m depth (N2-5) shows a stable, gently increasing groundwater level that does not appear to respond to the rainfall trend from the beginning of observation in July 2015 until March 2016. Groundwater level at this sensor then declines by 14 m until July 2017, where the recorded head level falls below the sensor elevation. A gradually declining groundwater level is reported to the end of 2017 but may now be unreliable with less than 0 m pressure head. The 100 m deep sensor (N2-4) shows a 9 m decline in groundwater level from March 2016 to March 2017 where the groundwater level falls below the reported sensor elevation. The groundwater level continues to decline to the end of the monitoring period, however these readings may be unreliable when reporting less than 0 m pressure head. The lower sensors in the Whybrow Seam and interburden have both recorded declines in groundwater level since the beginning of observation. The Whybrow-Wambo Seam interburden sensor at 173 m depth (N2-2) has recorded a decline in groundwater level of approximately ~3m to a slightly lower pressure head ~57m above sensor than observed in 2016 (~60m)., while the Whybrow Seam sensor at 140 m depth (N2-3) has only recorded a pressure head of ~10 m. The Wambo Seam sensor at 204 m depth (N2-1) recorded an approximately 25 m decline in groundwater level from the beginning of observation in August 2015 to the beginning of 2017. During the first half of 2017, the groundwater level continued to decline at a rate similar to previously observed, before dropping suddenly by 2 m in June. This drop is followed by a recovery of approximately 8 m that continued for the remainder of the monitoring period.

N3 (**Figure 13**), located above the northern edge of South Bates underground Longwall 11 with a ground elevation of 104.9 mAHD It is a multi-piezometer grouted bore with six VWPs 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) that have been recording since July 2015. All sensors besides N3-5, within Permian Overburden at 55 m depth, have not recorded accurate groundwater levels since May 2016. The behaviour of these sensors before failure have been described in previous Annual Reviews (HydroSimulations 2016, 2017). The Permian overburden sensor at 55 m depth (N3-5) shows a gradual increase from near zero pressure head at the beginning of recording to peak at a level ~10 m above the sensor in May 2016. Groundwater level then declines and remains stable at approximately 1.5 m above the sensor until July 2017, Groundwater level then declines to reach a near-zero pressure head at the end of the 2017 monitoring period.

GW 21 (**Figure 14**) is located within 10 m of N2 (Figure 1), between North Wambo Underground Longwall 1 and South Bates Underground Longwall 13. Early observations were infrequent (only three between October 2010 and October 2013 before more regular bi-monthly monitoring was conducted), or reported the bore as dry, so it is difficult to identify any climate driven trends in groundwater level. A gradual decline in groundwater level with no response to the rainfall trend from July 2011 is seen through to December 2015 where the bore was again reported as dry. The 2016 monitoring period showed some groundwater level response to increases in the rainfall trend in both February (very minor ~10 cm) and October (~30 cm). At the end of the monitoring period groundwater level was ~20 cm above the base of the bore. All observations within the 2017 monitoring period reported GW21 as dry. Below average rainfall, as indicated by the decreasing rainfall trend is also observed for most of the reporting period. The climatic condition in 2017 exposing a decrease in the rainfall trend could explain the dry condition at GW21. However previous observations of the decline in groundwater level showed minor or no responses to rainfall at GW21. Dry condition makes it difficult to assess a mining impact from South Bates Underground at GW21. Water quality has not been sampled at GW21.

1.1.4.2 Asssessment

The decrease in groundwater level observed in the Permian overburden sensors at N2 indicates a mining impact caused by the extraction of South Bates Underground Longwall 11 that has continued through South Bates Longwall 12, 13 and 14 extractions to the end of the 2017 observation period. The declining groundwater levels in the lower coal seam and interburden sensors show evidence of a mining effect most likely caused by the extraction of North Wambo Underground longwalls. This decline has continued, at a consistent rate during the extraction of South Bates longwalls in all but the Wambo Seam sensor (N2-1), indicating no worsening of the mining effect dues to South Bates Mining. The recovery in the Wambo Seam sensor (N2-1) may indicate an increase in pressure as the mining of LW14 in the Wambo Seam approaches. However, a fault exists between VWP N2 and LW14, which may protect the lower N2 sensors from a South Bates mining effect. The rising groundwater level observed at N2-1 could be due to recovery within the North Wambo Underground longwalls which are no longer dewatered.

During the 2017 monitoring period, groundwater levels in the Permian Overburden have a relatively stable trend although a gradual minor decline is observed as mining at LW13 and LW14 progresses. The Whybrow Seam and interburden sensors shows a minor mining effect caused by the beginning of extraction at SBU LW13 and LW14. The increase in groundwater level in the Wambo Seam correlates with the progress and beginning of mining at SBU LW13 and LW14 respectively

The decline in groundwater level in Permian sensors prior to failure also shows evidence of a South Bates mining effect at N3. The sensor failure is most likely related to subsidence following the extraction of Longwall 11. The single remaining sensor (N3-5) recording in the Permian Overburden declines gradually during 2017 showing evidence of an ongoing mining effect most likely caused by SBU mining.

A mining effect is likely observed at GW21 resulting from North Wambo Underground longwall extraction prior to the first observation made. With the near-dry level of the bore, a mining effect caused by South Bates Underground is not able to be observed. A lack of an expected mining effect from South Bates longwall extraction has previously been suggested (HydroSimulations, 2017a), due to the mitigating effect of a fault between GW21 and South Bates Underground. However, analysis of the Permian Overburden sensors in N2 shows a clear South Bates mining effect and desaturation of the same strata in which GW21 is located. During 2017, no further mining effect can be observed at GW21 due to the groundwater level being so close to the base of the bore, while drawdown of approximately 10 m has been observed in Permian groundwater levels very close by. 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.

1.2 Peabody (2015) Wambo Coal Groundwater Monitoring Program - Trigger Levels

Trigger values are used to initiate investigations into the groundwater levels or groundwater quality at Wambo Coal Mine. The trigger levels in **Table 1** are presented in the Wambo Groundwater Monitoring Program (Peabody (2015; Table 9[1] and Table 10) as the result of statistical analysis on pre-mining baseline monitoring data. Triggers for groundwater level occur when a single bi-monthly observation exceeds or falls below the specified depth to groundwater. 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 1 Peabody (2015) Groundwater Level and Quality Trigger Levels

Bore	Groundwater Level (mAHD) *(metres above Australian Height Datum)*		Groundwater Quality		
	Maximum (10th percentile depth)	Minimum (90th percentile depth)	EC (µS/cm)	pH min	pH max
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	#N/A				
P315	90.34	85.64	552	6.0	7.4
GW02	76.70	74.00	715	6.7	7.4
GW08	#N/A				
GW09	#N/A				
GW11	76.00	73.50	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	#N/A				
GW17	#N/A				
P16	50.38	49.68	10832	7	7.7
P20	50.30	49.20	10625	7	7.6

Not applicable

[1] Table 9 expresses the triggers as depth to water in metres below top of casing. For convenience of analysis, they are converted here to equivalent groundwater elevations (mAHD)

1.2.1 2017 Groundwater Level Statistics

Table 2 presents 10th and 90th percentile statistics for groundwater levels at nominated water level trigger sites for the 2017 monitoring period.

Table 2 2017 10th and 90th Percentile Groundwater Levels

Bore	Groundwater Level (mAHD) *(metres above Australian Height Datum)*		Depth to Groundwater (mBTOC) *(metres below top of casing)*	
	2017 Minimum (90th percentile depth)	2017 Maximum (10th percentile depth)	2017 Minimum (10th percentile)	2017 Maximum (90th percentile)
P106*	dry		dry	
P109	56.4	56.8	5.6	6.1
P114*	dry		dry	
P116	52.2	52.8	6.2	6.9
P202	51.9	52.4	7.9	8.4
P206	40	41.8	18.5	20.2
P301	72.2	73	15.2	16
P315	86.2	87.1	7.7	8.2
GW02	74.2	75.2	5.5 7.3	6.4 8.3
GW08	53.1	53.6	5.9 6.4	6.4 6.9
GW09	55.1		6.9	
GW11	71.9	74.4	5.6	8.1
GW12	74.7	75.1	12.2	12.6
GW13	56.6	56.8	5.7	6
GW15	51.3	51.6	10.7	11.1
P16	48.9	49.4	8.1	8.6
P20	49.1	49.6	7.8	8.3

* 'Bore Dry'

1.2.2 Trigger Level Exceedances

Table 3 presents counts of trigger level exceedances for the 2017 monitoring period.

Table 3 Trigger Level exceedances in the 2017 monitoring year

Bore	Number of Trigger Level Exceedances in 2017 Observations				
	Minimum depth-to-water (10th percentile)*	Maximum depth-to-water (90th percentile)**	EC	pH min	pH max
P106		6 (Dry)			
P109			#N/A		
P114		6 (Dry)			
P116					
P202	1				
P206					
P301	#N/A				
P315					
GW02					
GW08	#N/A				
GW09	#N/A – Bore Dry				
GW11		1			
GW12		4	#N/A		
GW13		6			
GW15					
GW16	#N/A				
GW17	#N/A				
P16		6			
P20		2			

Blank cells represent no trigger exceedance, #Not applicable
*Minimum depth-to-water is equivalent to maximum groundwater level (mAHD)
**Maximum depth-to-water is equivalent to minimum groundwater level (mAHD)

1.2.2.1 Minimum (10th Percentile) Triggers

The 10th percentile triggers allow identification of anomalously shallow depths to groundwater.

It is important to note that the baseline monitoring data used to create the trigger levels (from July 2003 until August 2007) were taken during a period of lower than average rainfall (see the Bulga rainfall residual mass plotted on the hydrographs e.g. **Figure 2**). From October 2007 to mid-2016, a period of generally greater than average rainfall was been observed. Consequently, instances where groundwater levels were observed to exceed the minimum (10th percentile) trigger levels during this period should not be attributed to Wambo Coal Mine activity. A high rainfall event in January 2016 influenced the aquifers for some months, and was probably the cause of trigger exceedance. Under most circumstances, a high water level is not necessarily problematic unless the groundwater EC increases from evaporative processes. A decrease in the rainfall trend has been observed during the 2017 monitoring period, indicating below average rainfall.. A single trigger level exceeded the minimum (10th percentile) level at P202 in April 2017 monitoring period by 5cm, the only minimum trigger recorded for 2017. This exceedance is not significant and should not be attributed to Wambo Coal Mine activity, being likely due to a spike in the rainfall trend and Wollombi Brook stage height at the time of the trigger.

1.2.2.2 Maximum (90th Percentile) Triggers

The 90th percentile triggers allow identification of anomalously deep depths to groundwater.

P114, P106, GW11, GW12, GW13, P16 and P20 (**Figure 18**) have exceeded the trigger level for the 90th percentile (maximum) depth to water in the 2017 monitoring year.

As stated earlier, the low groundwater levels at P114 are a clear effect from the mining of Longwall 10A. Every observation in the 2017 monitoring period falls below the maximum depth-to-water trigger level with the bore reporting dry.

At P106, all observations for the 2017 monitoring period are below the maximum depth-to-water trigger level. As was stated earlier, it is unlikely this large apparent decline in groundwater level is mining related. Dipping the bore for depth, and investigating integrity is recommended by HydroSimulations.

GW11 (**Figure 15**) reported a groundwater level below the maximum depth-to-water trigger in December 2016. The trigger in December 2016 follows a groundwater level decline of ~2.5 m since August 2016 to a level 0.2 m below the trigger. It was proposed in the previous AEMR (HydroSimulations, 2017b) that possible water loss from the alluvium further downstream on Wambo Creek, associated with North Wambo Underground mine has caused the observed drawdown and the trigger exceedance at GW11 Further readings were required to clarify the unexpected response at GW11. Readings from February and April 2017 show a recovery to levels approximately 1 m above the maximum depth to water trigger. This is associated with a minor increase in the rainfall trend and indicates that any ongoing mining effect is unlikely.

GW11 also reports a groundwater level below the maximum depth-to-water trigger in June 2017. This observation exceeds the trigger level by ~3.4 m, indicating a groundwater level that is lower than the base of the bore according to data available HydroSimulations. This value is then followed by a groundwater recovery in August 2017, returning to compliance with the trigger level conditions. It is difficult to explain the sharp decline in groundwater level at GW11. GW11 is located within the alluvium associated with Wambo Creek, upstream to the NWU and SBU mining at a distance of 1.5km and 3.5km respectively. No mining effect is likely to impact GW11 at this time and no significant dry condition has been recorded between January and June 2017 to induce the observed decline. Furthermore, no major rainfall event was recorded before the rapid groundwater recovery in August 2017. It is possible an error has been made with the groundwater level measurement in June 2017. HydroSimulations recommends that GW11 collar elevation be resurveyed as well as dipped for bore depth at the next bi-monthly observation.

GW12 (**Figure 7**) exhibits an ongoing mining effect from North Wambo Underground longwall extraction, with a trigger exceedance occurring in February 2016 as the bore reported dry. A recovery of ~2.5 m is observed, associated with the above average rainfall in early 2016. The elevated groundwater level is only maintained for a single observation, before declining over the remainder of 2016 and reporting dry for 4 observations from April to October 2017. The observed decline and trigger exceedance during 2017 correlates with a period of below average rainfall and cannot be solely attributed to an ongoing mining effect. It is likely that Longwall 8a extraction has reduced the ability for the alluvial material to retain water outside periods of above average rainfall at GW12. This effect is unrelated to SBU mining.

GW13 is located on the eastern side of Wollombi Brook about 3 km from NWU workings (**Figure 1**). During the 2017 monitoring period, all six observations exceeded the maximum trigger level (**Figure 16**). This observation confirms the likely impact stated previously in which the progression of the Warkworth open cut induces the decline in groundwater level at GW13. At the end of 2017 the trigger level was exceeded by more than 0.5m.

The monitoring bores P16 (Figure 17) and P20 (Figure 18) are located downstream of the mining operations along the Wollombi Brook and less than a kilometre upstream to the FM10 Wambo flow monitoring site. P16 shows a good correlation to the long-term rainfall trend and the interpolated Wollombi Brook stage height from the beginning of recording in 2005, to March 2016. A declining groundwater level of approximately1.5m is observed from March 2016 to December 2017. In 2017, P16 reports six groundwater levels below the maximum depth-to-water trigger with the last record exceeding the trigger level by 0.84m. While the declining groundwater levels during 2017 correlate with a declining rainfall and stage height trend, the observations are the lowest recorded for the entire period of measurement and do not show the same previously observed response to peaks in rainfall and river stage. P20 is located near P16 and has two groundwater level observations below the maximum depth-to-water trigger in October and December 2017. Groundwater level at P20 correlates with the long-term rainfall trend and the interpolated Wollombi Brook stage height throughout the period of measurement. A large hydraulic gradient between the river stage and the groundwater level at P16 and P20 is present. It is believed that the alluvial aquifer at P16 and P20 could be disconnected from the Wollombi Brook. Vertical recharge from the river to the alluvial aquifer can occur, however the decrease in the Wollombi Brook stage height induces a reduction in recharge through the unsaturated zone and consequently in the groundwater level at P16 and P20. No mining effects can be identified at P16 and P20, as NWU operations have been completed since December 2015. The open cut North of the bores has yet to commence and the nearest SBU LW13 is 5.2 km away.

1.2.2.3 EC Triggers

No triggers for EC occurred in 2017 observations

1.2.2.4 pH Triggers

No triggers for pH occurred in 2017 observations.

2 OBSERVED AND MODELLED GROUNDWATER LEVELS

Hydrographs of observed groundwater levels and HydroSimulations (2017a) modelled groundwater levels at key sites are presented in **Figure 19** to **Figure 30**. The following sections contain an assessment of the modelled groundwater levels where mining impacts might be observed.

2.1 Montrose Open Cut

The elevation of modelled heads at GW16 (**Figure 19**) and GW17 (**Figure 20**) is reasonably good. The variation in heads in the observed data has not been replicated as no data was available for stage height at North Wambo Creek, influential to water levels in the alluvium and shallow groundwater system. As GW17 is closer to the open cut (**Figure 1**), it is predicted to be impacted at an earlier time and to a greater extent than GW16. The model conservatively indicates the mining effect at GW17 to be larger than the impact in the observed data. The apparent underestimation of the model at GW16 is likely related to the period of below average rainfall observed in 2017 that is not included in the model. The observed rate of decline at GW16 is higher predicted in 2017 which may be product of both climate and a mining effect. The predicted decline in groundwater level at GW17 is greater than observed at the end of 2017. While the model overestimates the drawdown at GW17, the predicted rate of decline reduces at the end of 2017 and compares well with the trend in the observed data.

The performance of the modelled heads at N5 (**Figure 21**) is poor, with modelled heads much higher than what is seen in 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. The model requires lower vertical hydraulic conductivities in this area. This would have the effect of providing greater protection for the alluvium from underground mining effects.

2.2 North Wambo Underground

The performances of modelled heads at four standpipes in **Figures 22-25** (P114, P116, GW08, GW09) have been assessed against observed data where North Wambo Underground mining activity may impact groundwater levels.

Previous reporting for P114 (HydroSimulations, 2016) had underestimated the drawdown associated with North Wambo Underground Longwall 10a 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 extends into model layer 2. The modelled heads presented for P114 (**Figure 22**) 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. Subsidence in the vicinity of P114 following the extraction of LW10a, ranges from 1.5m to 1.8m (MSEC, 2017).

P116 (**Figure 23)** shows quite good correlation between maximum modelled and observed heads and the declining trend with time. The climate driven variations in water level are not present due to the use of long term averages for river stage in modelling, and probable overestimation of the specific yield, 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. P116 does not lie directly over NWU workings and therefore shows only minor predicted drawdown resulting from mining activity, which occurs at the same time the observed groundwater level shows drawdown attributable to mining.

Loss of groundwater from the alluvium in which GW08 and GW09 are screened is currently of concern to DPI Water. HydroSimulations' modelled heads at GW08 (**Figure 24**) and GW09 (**Figure 25**) show a good match with the trends seen in the observed data. Although simulated initial heads are lower than observed, the drawn-down heads in 2017 are near the correct level, while overestimated. During the 2017 monitoring period, observed groundwater level at GW08 has continued to decline while modelled heads show a milder response. it should be noted that GW08 is near-dry at the end of 2017.At GW09, the bore has gone dry due to mining related drawdown, so it is not possible to compare the performance of observed groundwater level with that modelled for 2017.

The simulated groundwater levels at P106 (**Figure 26**) follow the observed declining trend and match the upper envelope of measurements. The water level amplitudes are not reproduced due to the absence of streamflow dynamics in the model. In 2017, P106 is reported dry making the comparison between simulated and observed data difficult. It may be that this dry observation is a result of a bore malfunction and does not necessarily indicate a failing of the model to predict a mining impact

At P109 (**Figure 27**), agreement was very good from 2003 to 2007 but the model has continued 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 would overestimate drawdown impacts in this area. During the 2017 monitoring period, simulated groundwater decline matches relatively well with the observed declining trend in groundwater level. The streamflow dynamics and missing recharge component still influence the model output by overestimating groundwater impact in this area.

2.3 South Bates

The performances of modelled heads at the GW21 standpipe bore (**Figure 28**) and N2 and N3 VWPs (**Figures 29-30**) have been assessed against observed data where South Bates mining activity may impact groundwater levels.

GW21 modelled heads show little correlation with observed groundwater levels (**Figure 28**). However, the first observation made at GW21 is after a mining effect from North Wambo Underground Longwall 1 would likely have occurred, resulting in the bore nearly going dry. This means the observed data at GW21 are not useful in assessing model performance. The model results indicate a strong mining effect caused by both North Wambo and South Bates longwall extraction. In 2017, it remains difficult to assess the model performance at GW21 as the bore was recorded dry. The model results indicate an on-going mining effect with a groundwater level below the bottom of the bore likely due to the extraction occurring at South Bates longwalls.

Both N2 (**Figure 29**) and N3 (**Figure 30**) modelled heads face difficulty in accurately representing groundwater level in the Permian overburden sensors as three sensors are located within one model layer at each location. However, the 30 m sensor at N3 (N3-6), and the 70 m sensor at N2 (N2-5) both show an excellent match with observed data until the end of December 2017. The lower sensors in N2 overestimate groundwater level but are accurate in indicating an ongoing mining effect from North Wambo that continues through the beginning of South Bates Underground mining. The modelled head in the Wambo Seam does not match the increase in groundwater level observed at the end of December 2017. 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.

It is difficult to assess the performance of the lower sensors at N3 due to sensor failure before trends in groundwater level could be properly established. The single recording sensor at 55m (N3-5) shows an overestimate of groundwater heads, but an accurate rate of decline in the groundwater level during 2017.

2.4 Assessment

The groundwater levels as predicted by HydroSimulations (2017a) generally show a good match with the magnitude and timing of impacts associated with Wambo Coal Mine. Areas where the model is not performing well can usually 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, or
- the long-tern average rainfall and evapotranspiration rates used in the model not capturing the variation in alluvial groundwater levels caused by periods of above or below average rainfall.

Overall, the groundwater model performs well and remains fit for purpose to predict the timing and magnitude of impacts to groundwater caused by Wambo Coal Mine.

O

3 2017 WCPL 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;

1. 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.

2. 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 will be considered in 2018 and any required changes will be adopted in future revisions of the WCPL Groundwater Monitoring Program.

4 RECOMMENDATIONS

- Monthly monitoring of P114 if EC and water level triggers are exceeded at the next measurement round.

- Investigation in to the integrity of P106 and whether the 'dry' readings are correct for the original drilled depth of the hole.

- Monthly monitoring of new bore drilled between LW14 and VWP N2 to confirm the groundwater recovery of the Wambo Seam associated with the completion of NWU operations

5 REFERENCES

HydroSimulations (2016) *Wambo Annual Review Groundwater Analysis*. Report HS2016/07 for Wambo Coal Pty Ltd. March 2016

HydroSimulations (2017a) *South Bates Extension Modification Groundwater Assessment.* Report HS2016/51 for Wambo Coal Pty Ltd. February 2017

HydroSimulations (2017b) *Wambo 2016 AEMR Groundwater Analysis.* Report HS2017/07 for Wambo Coal Pty Ltd. March 2017

MSEC (2017) *Wambo Coal: North Wambo Underground Mine – Subsidence Review Report for WMLW8A to WMLW10A.* Report Number: MSEC879 for Wambo Coal Pty Ltd, April 2017

Peabody (2015) *Wambo Coal Groundwater Monitoring Program.* Document No. WA-ENV-MNP-509.1 October 2015.

Filepath: X:\HYDROSIM\WAM022\WP\HS2017_07a_wambo_AEMR_2017_ASedits_v4.docx

Figures

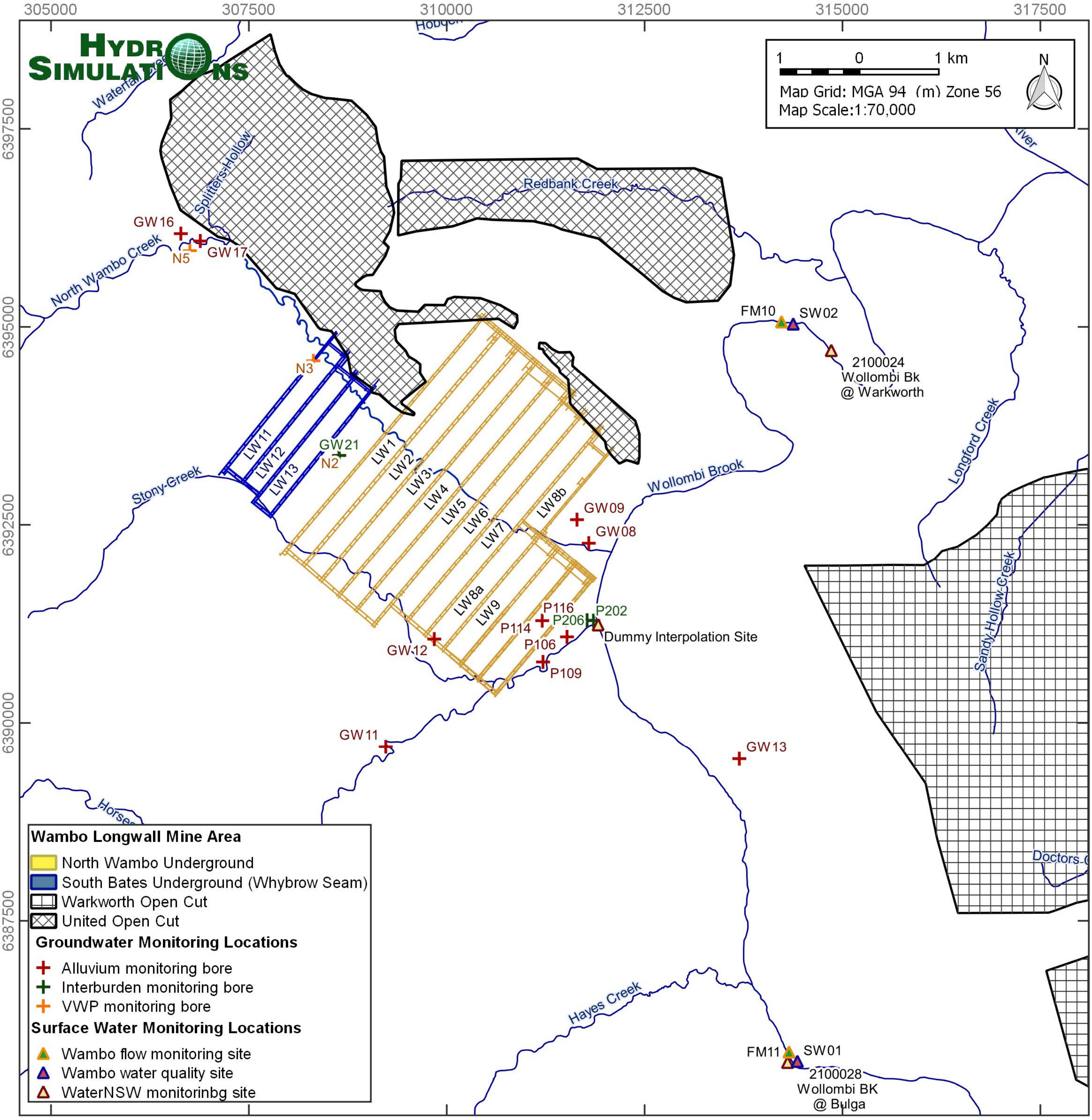


Figure 1 **Locations of bores discussed in this report**

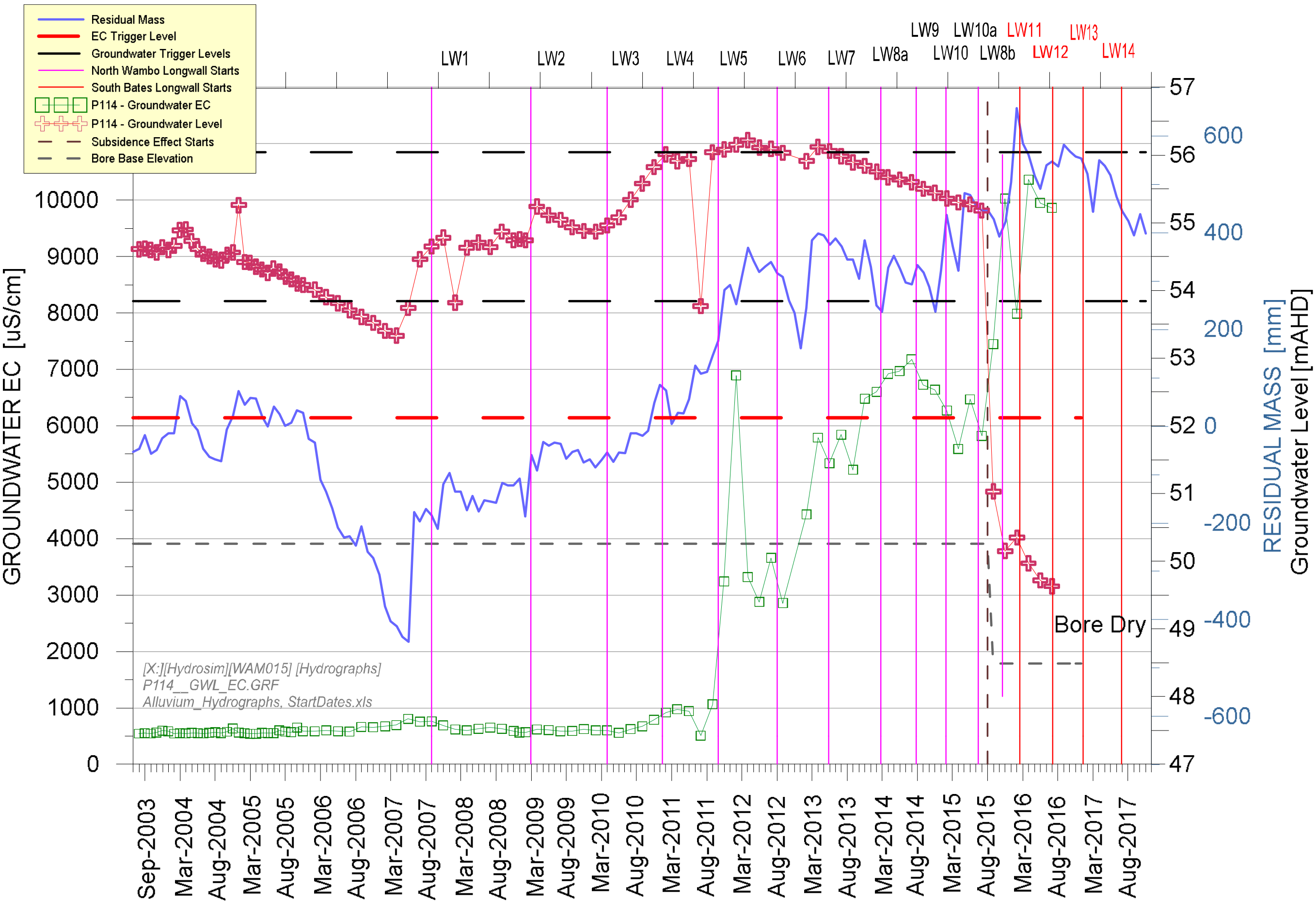


Figure 2 **P114 Groundwater Level and EC**

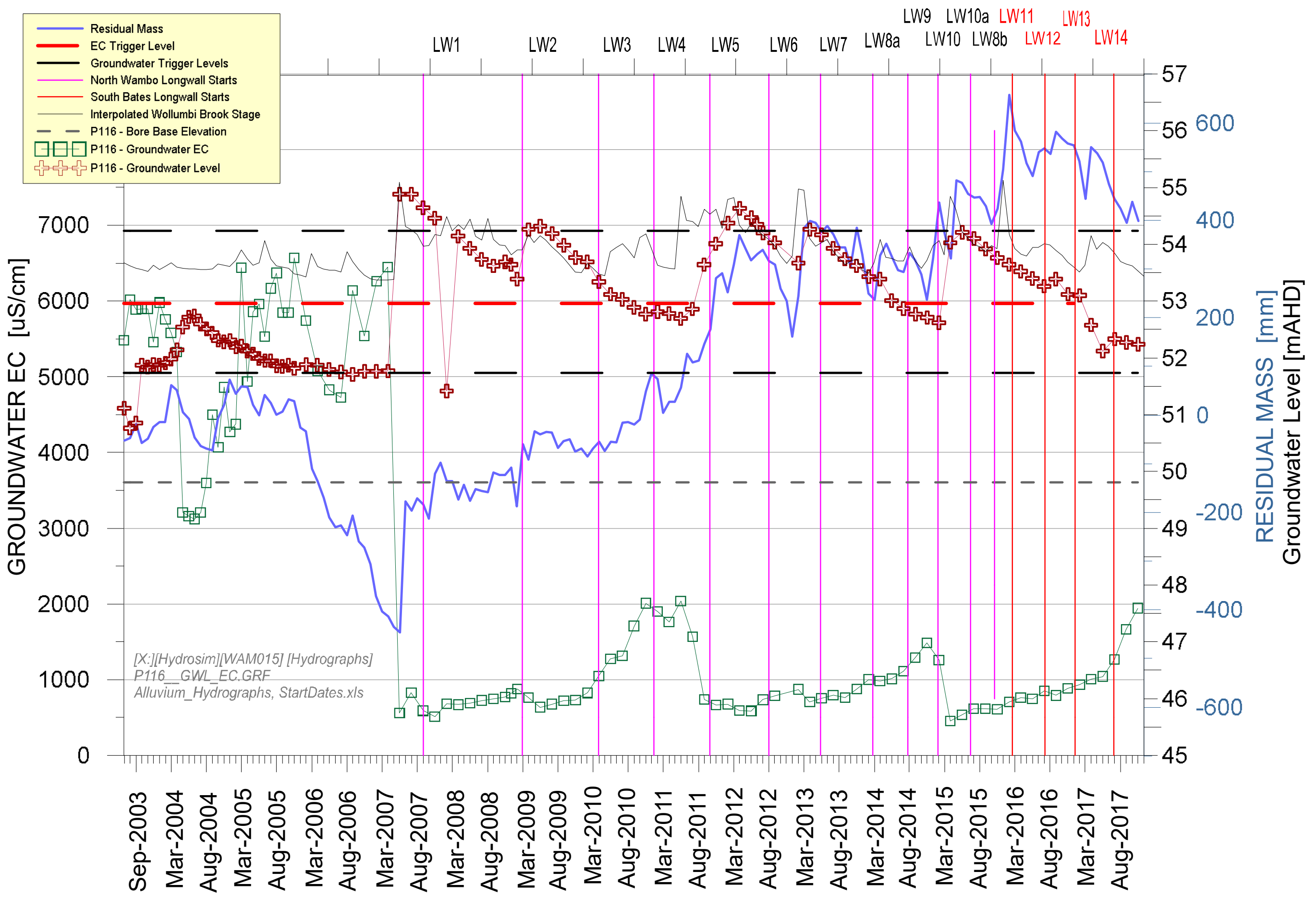


Figure 3 P116 Groundwater Level and EC

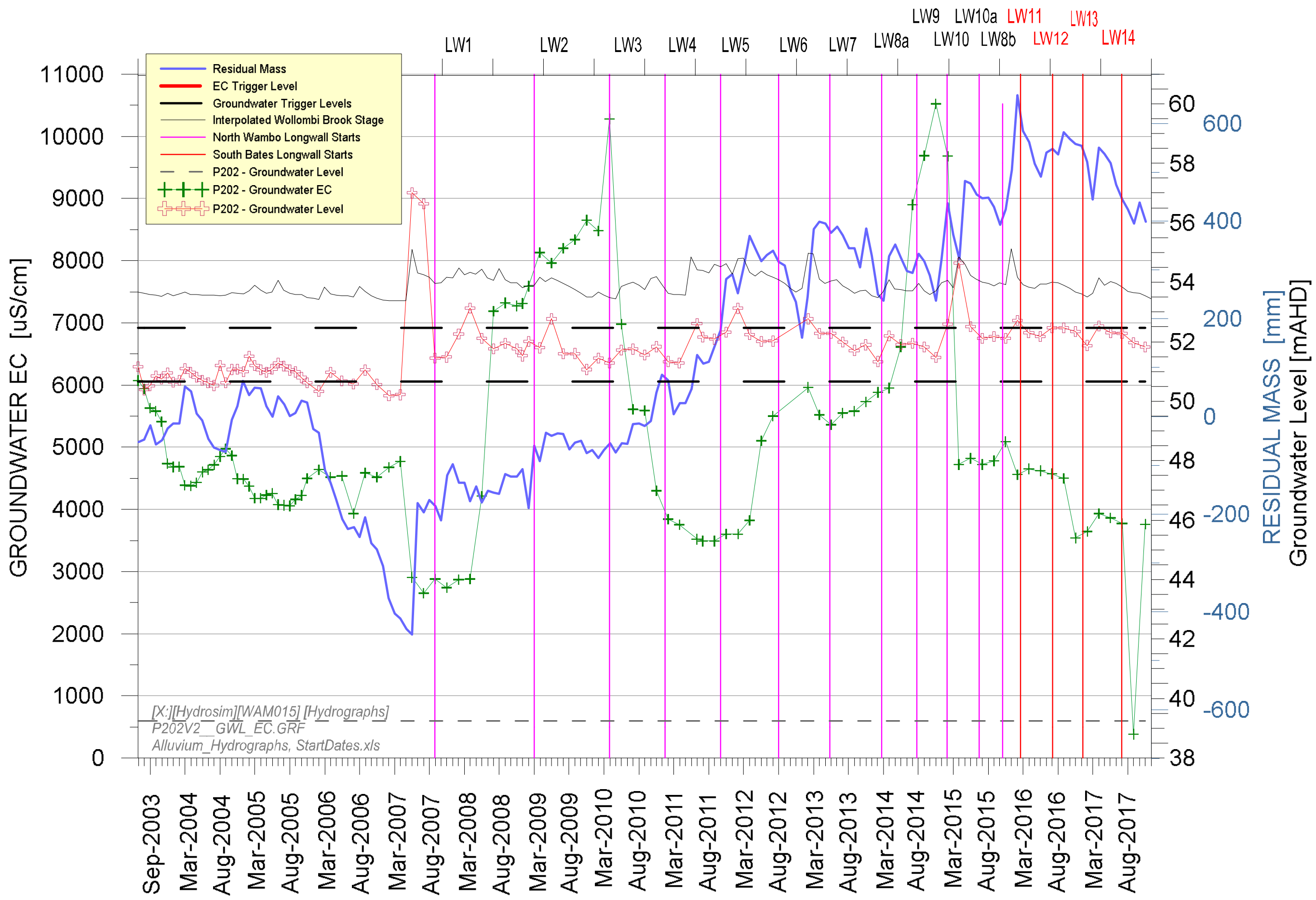


Figure 4 **P202 Groundwater Level and EC**

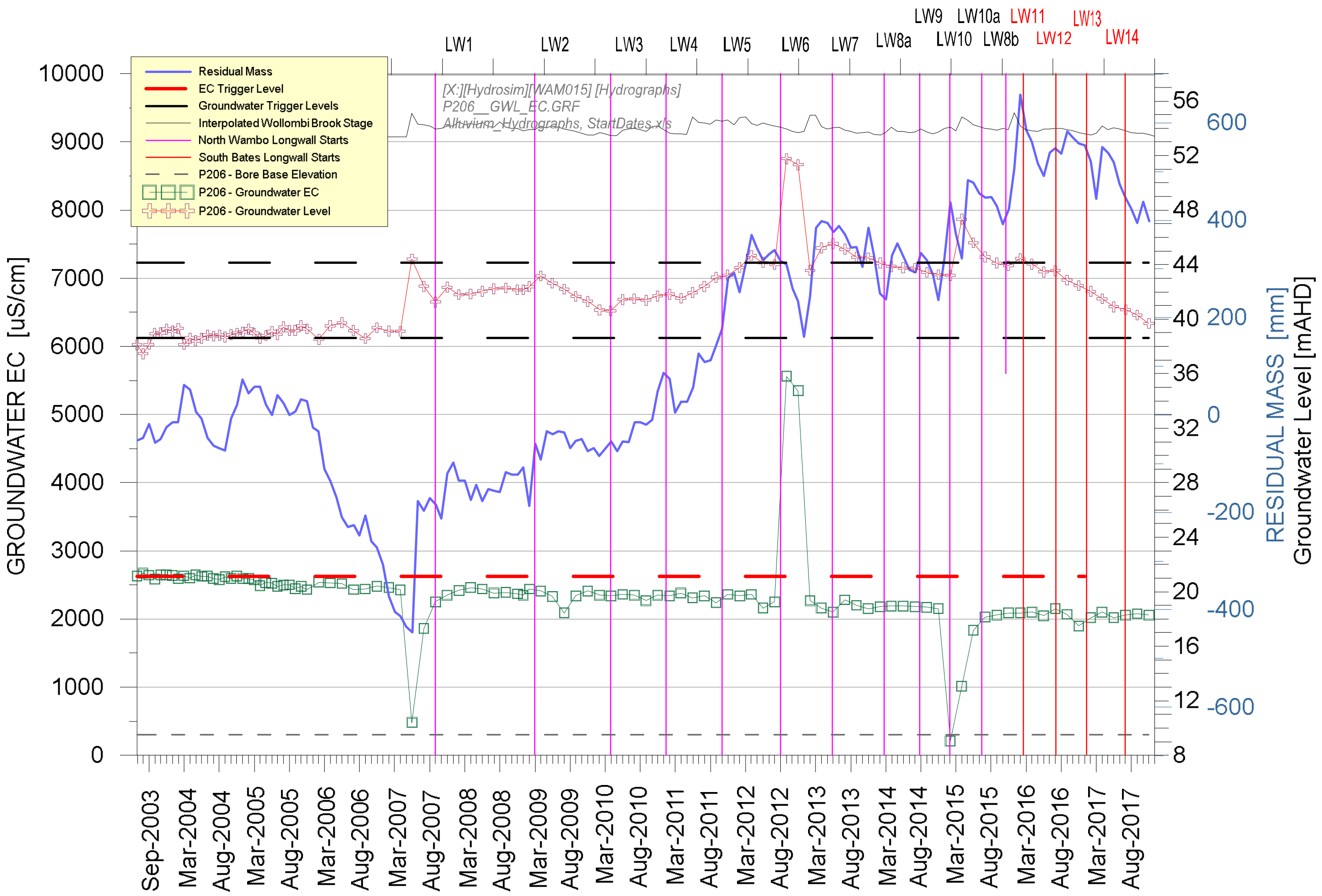


Figure 5 **P206 Groundwater Level and EC**

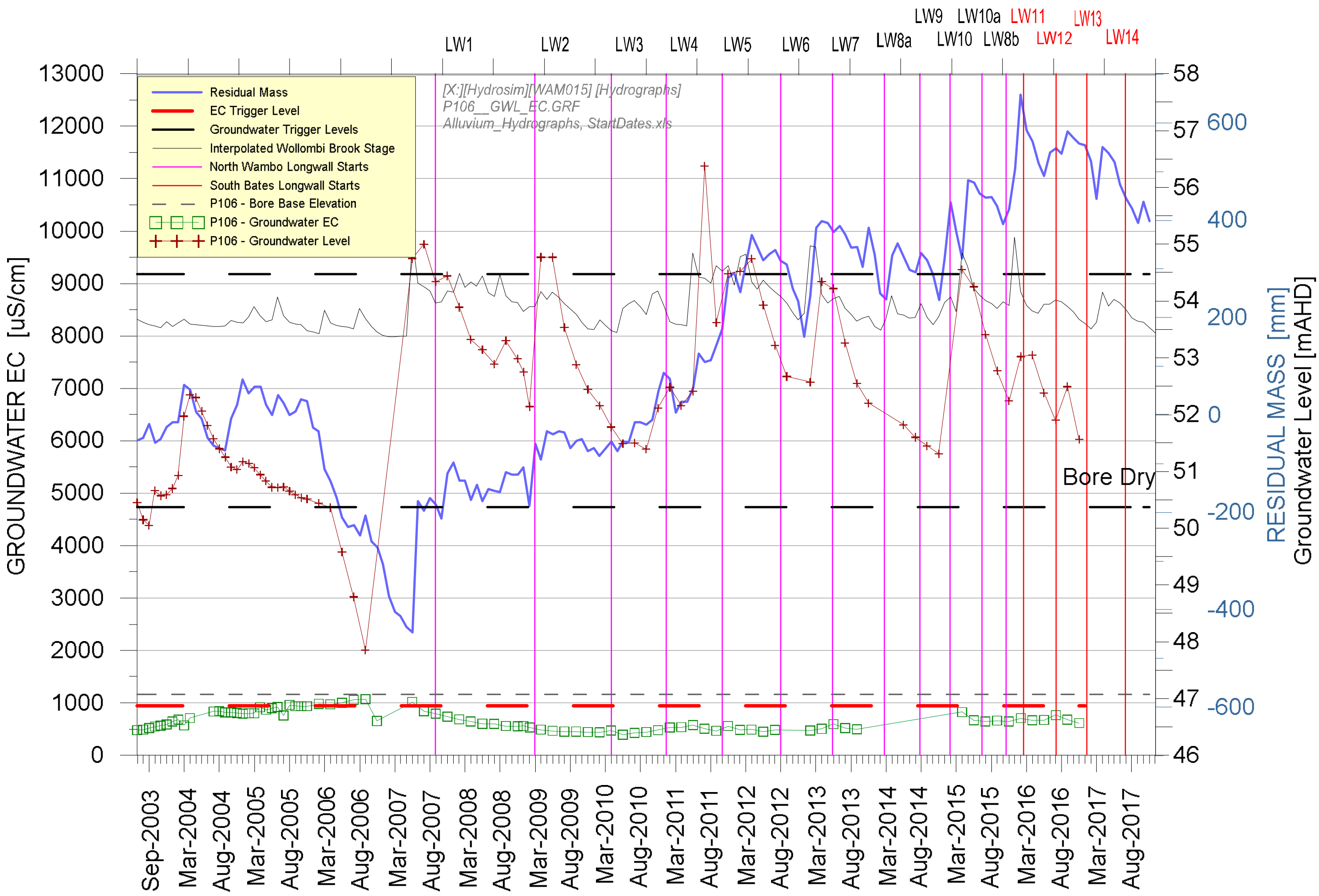


Figure 6 **P106 Groundwater Level, EC and Interpolated Wollombi Brook stage height**

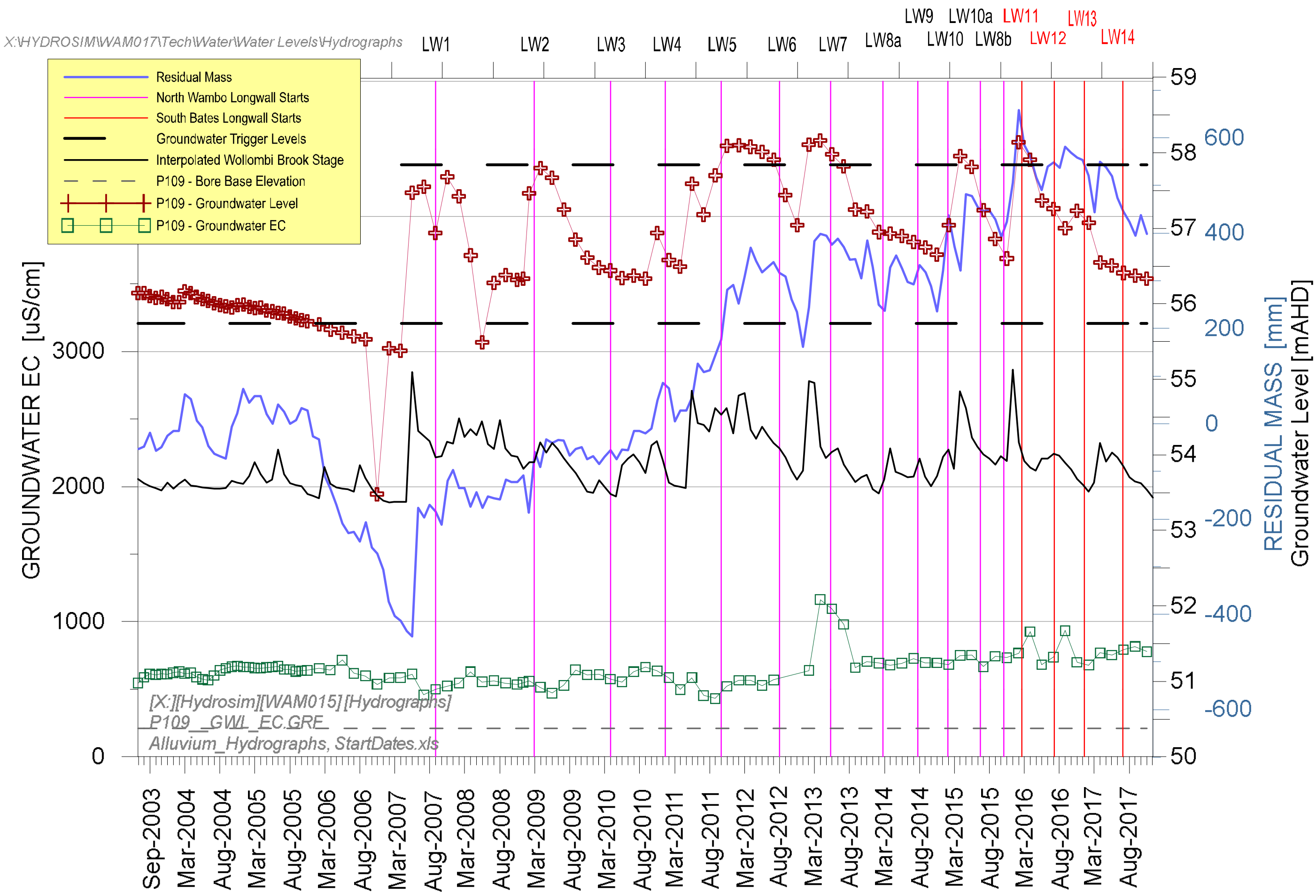


Figure 7 P109 Groundwater Level, EC and Interpolated Wollombi Brook stage height

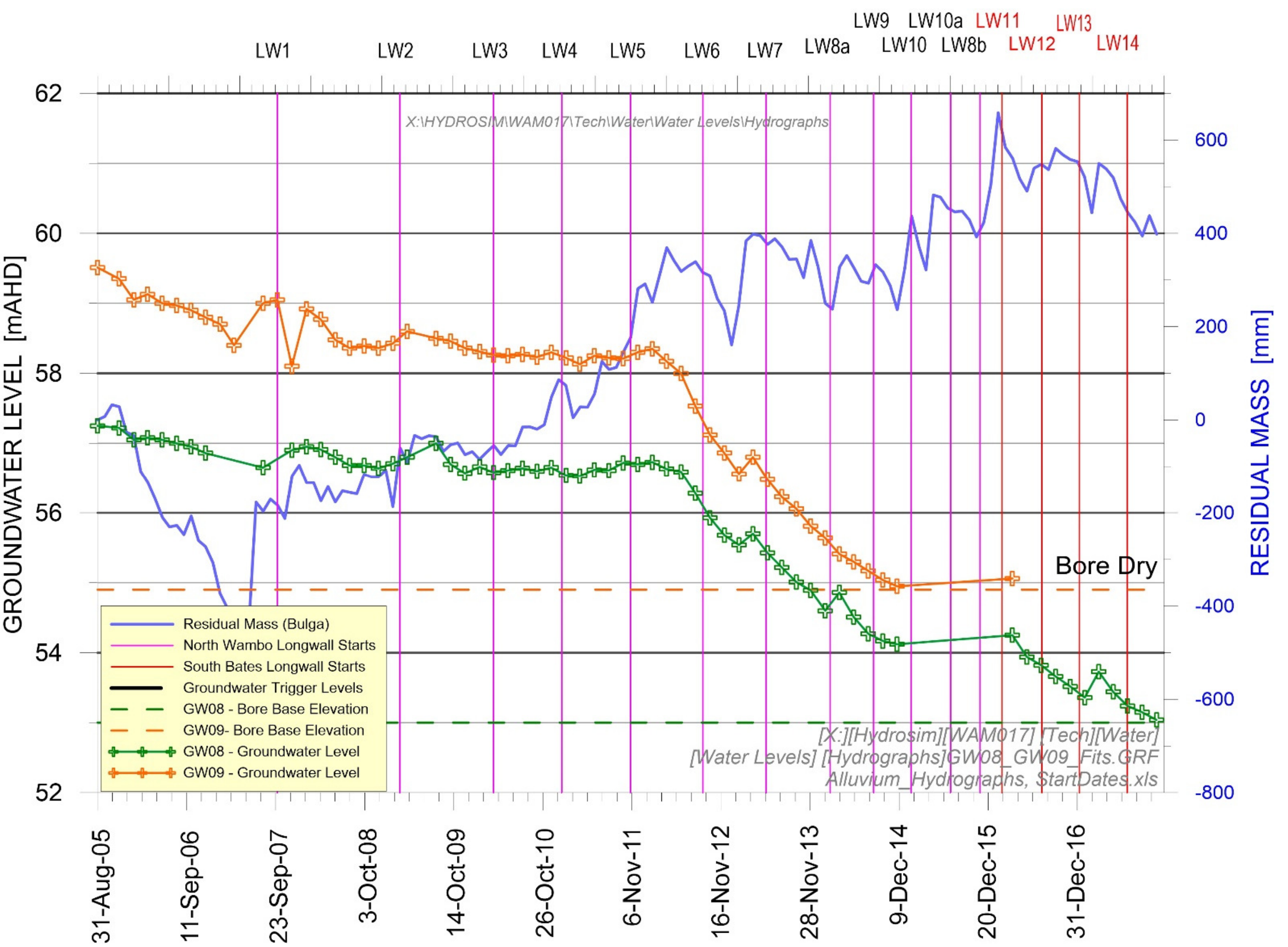


Figure 8 **GW08 and GW09 Hydrographs**

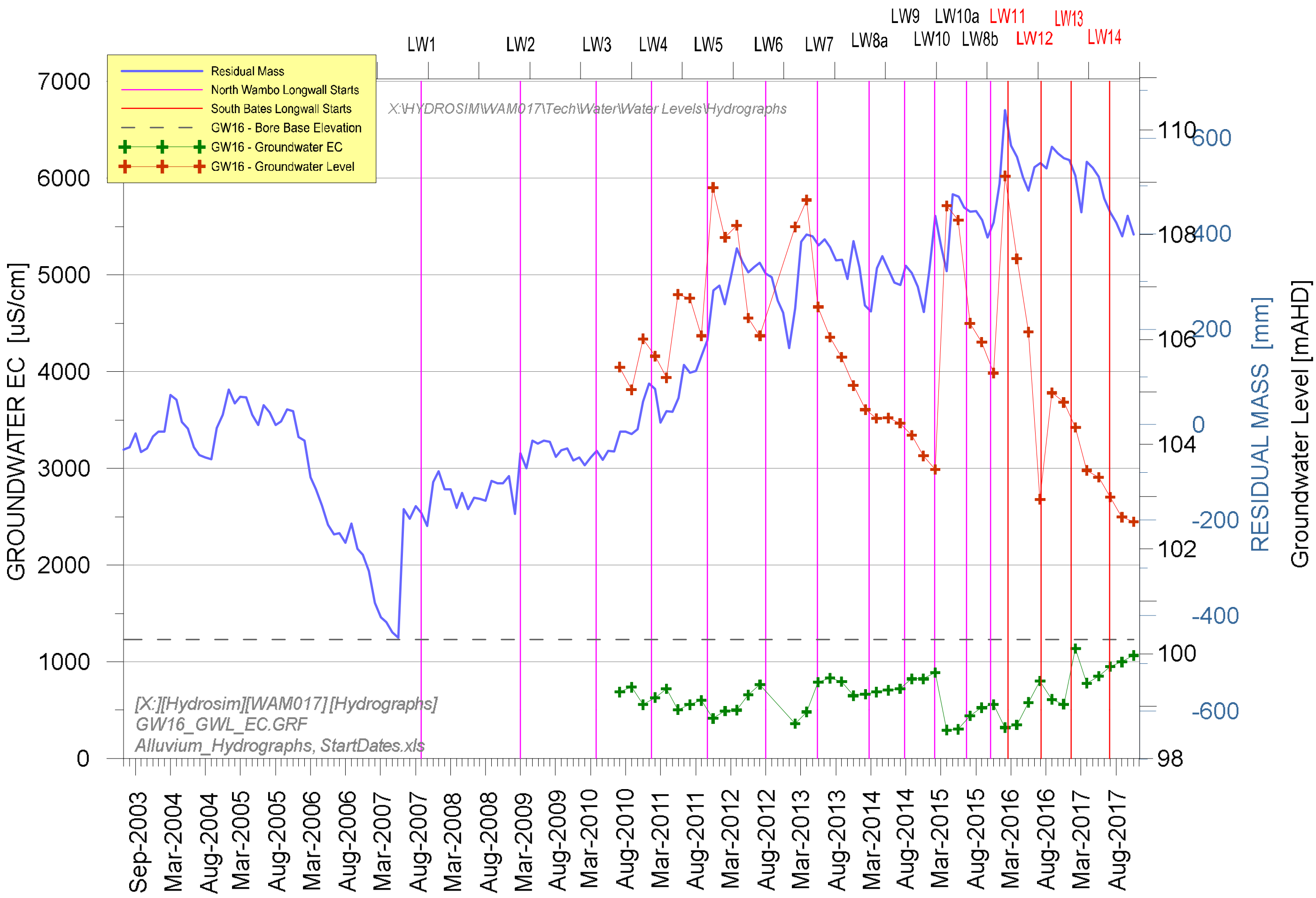


Figure 9 **GW16 groundwater level and EC**

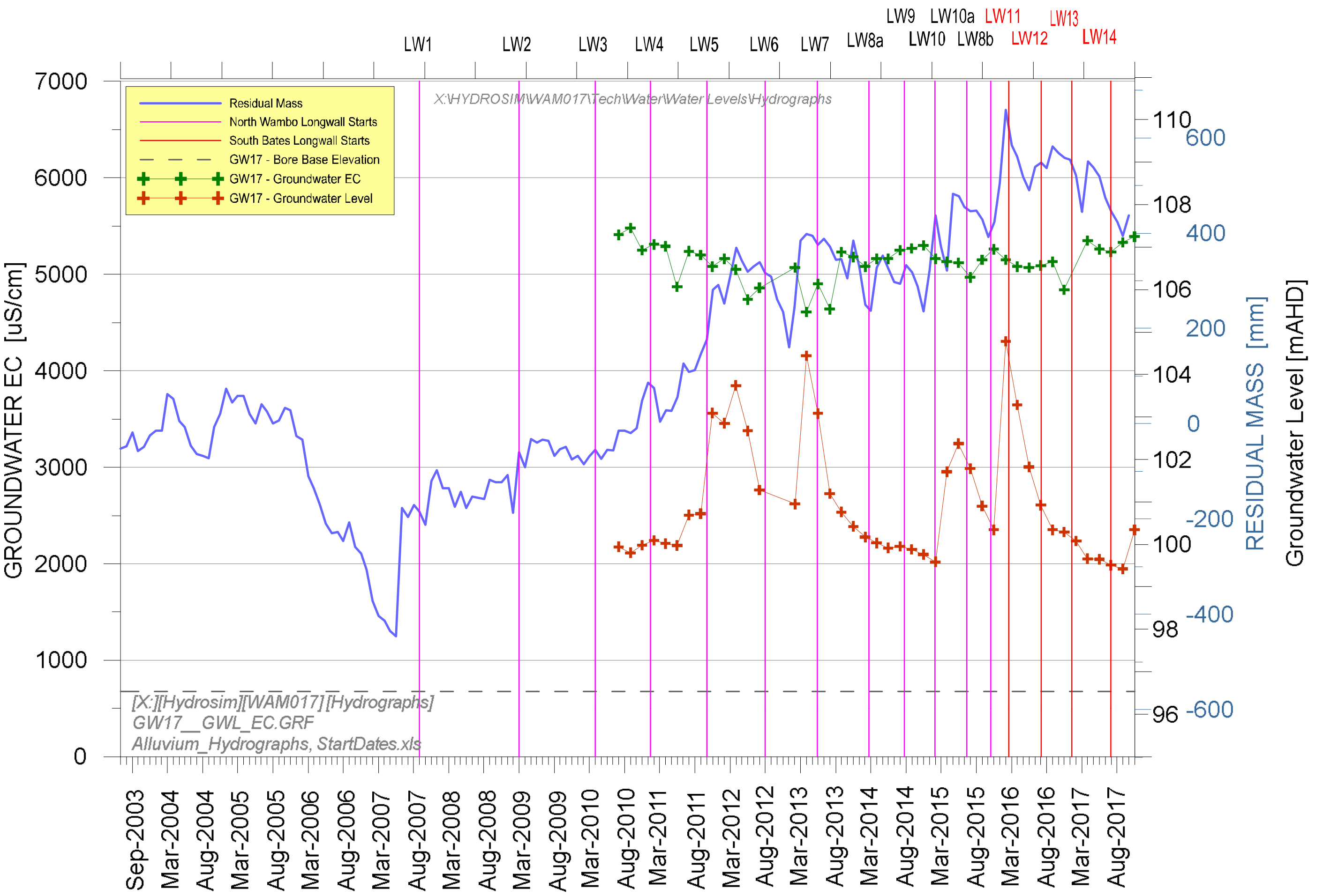


Figure 10 GW17 Groundwater Level and EC

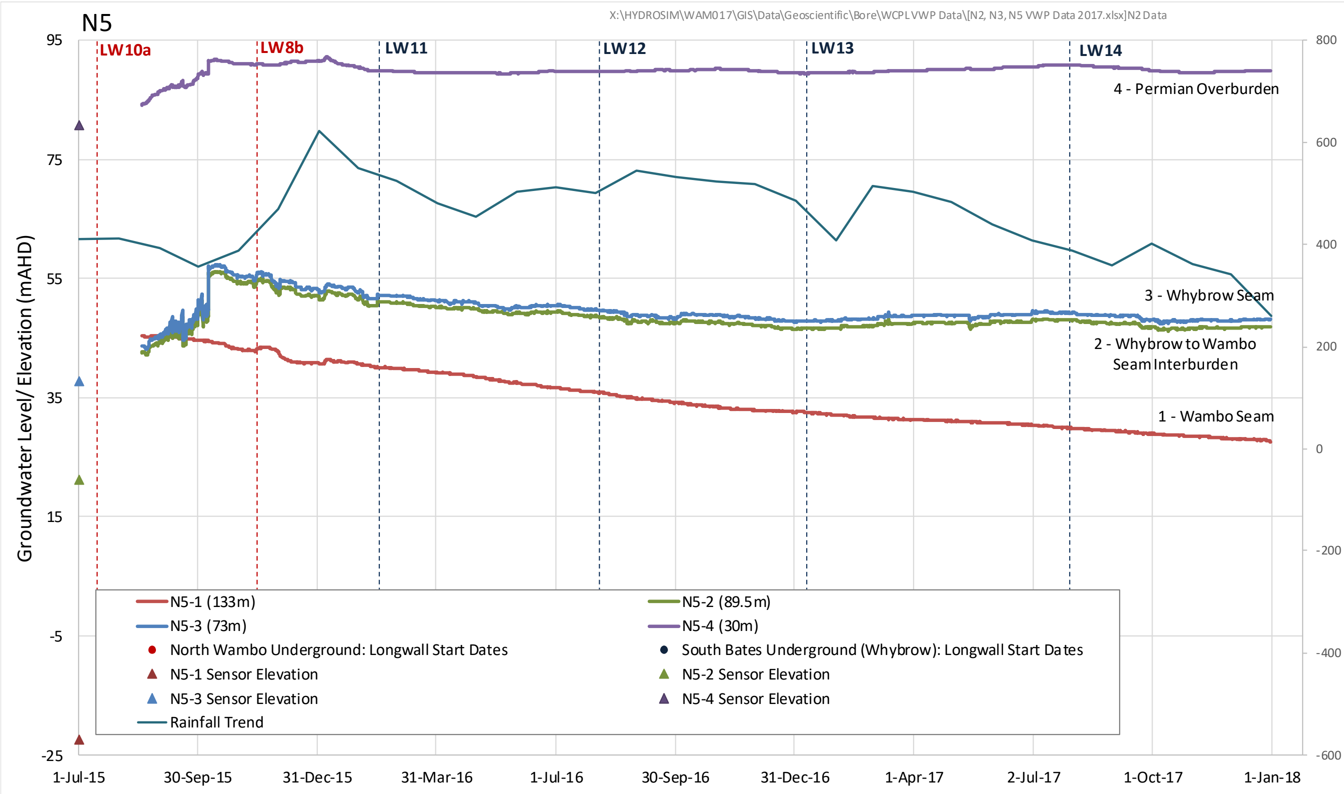


Figure 11 N5 Hydrograph

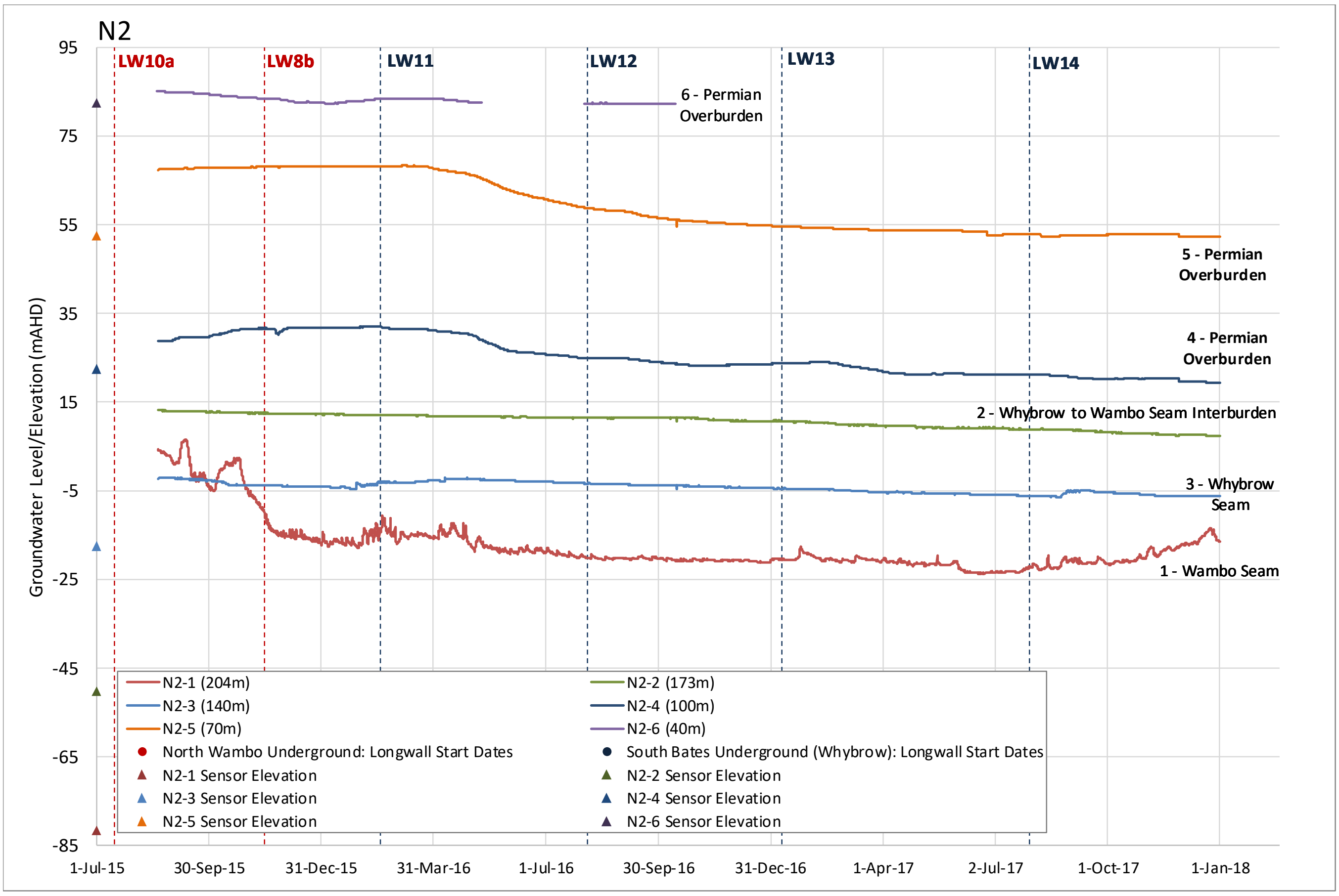


Figure 12 N2 Hydrograph

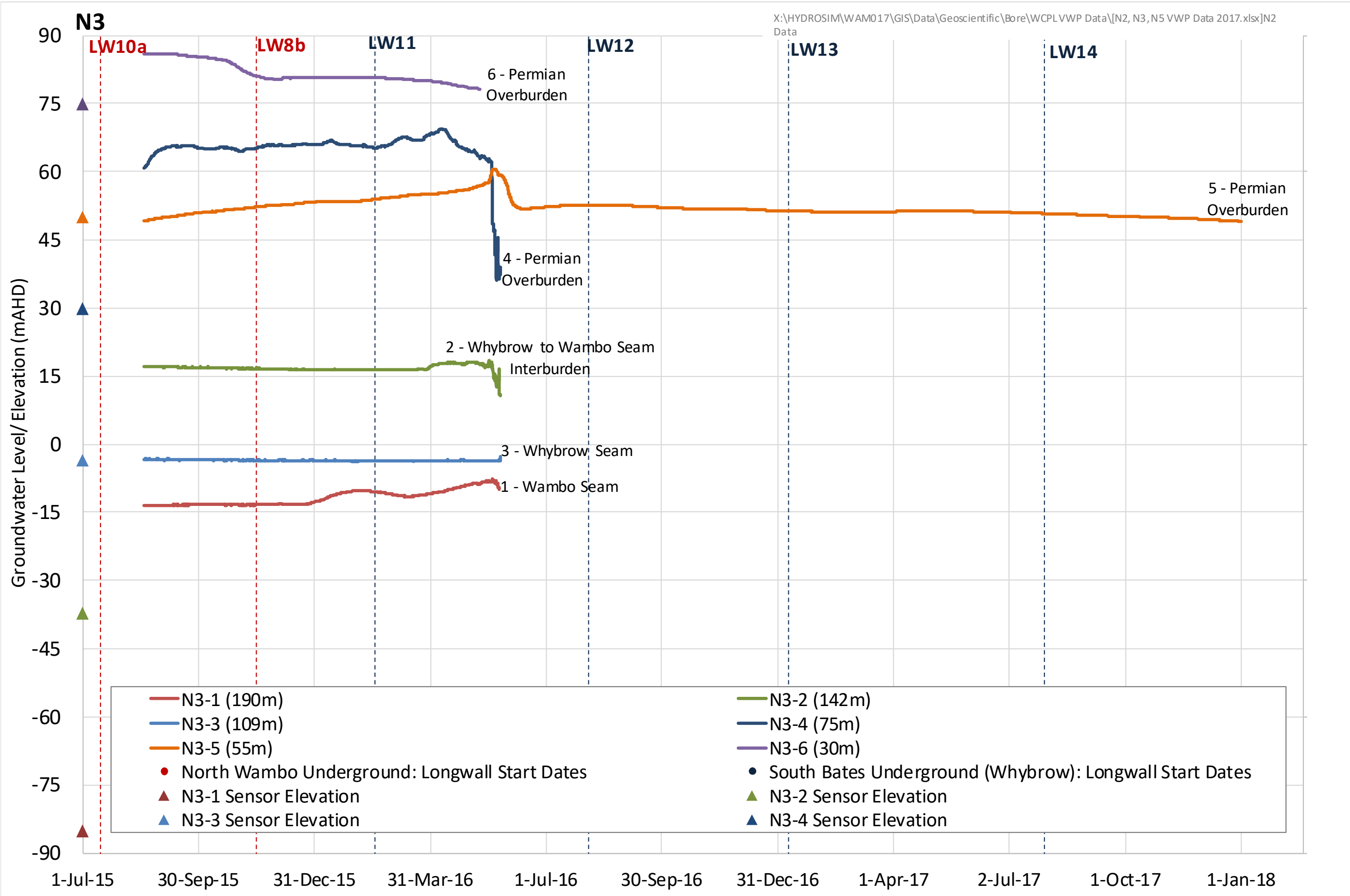


Figure 13 N3 Hydrograph

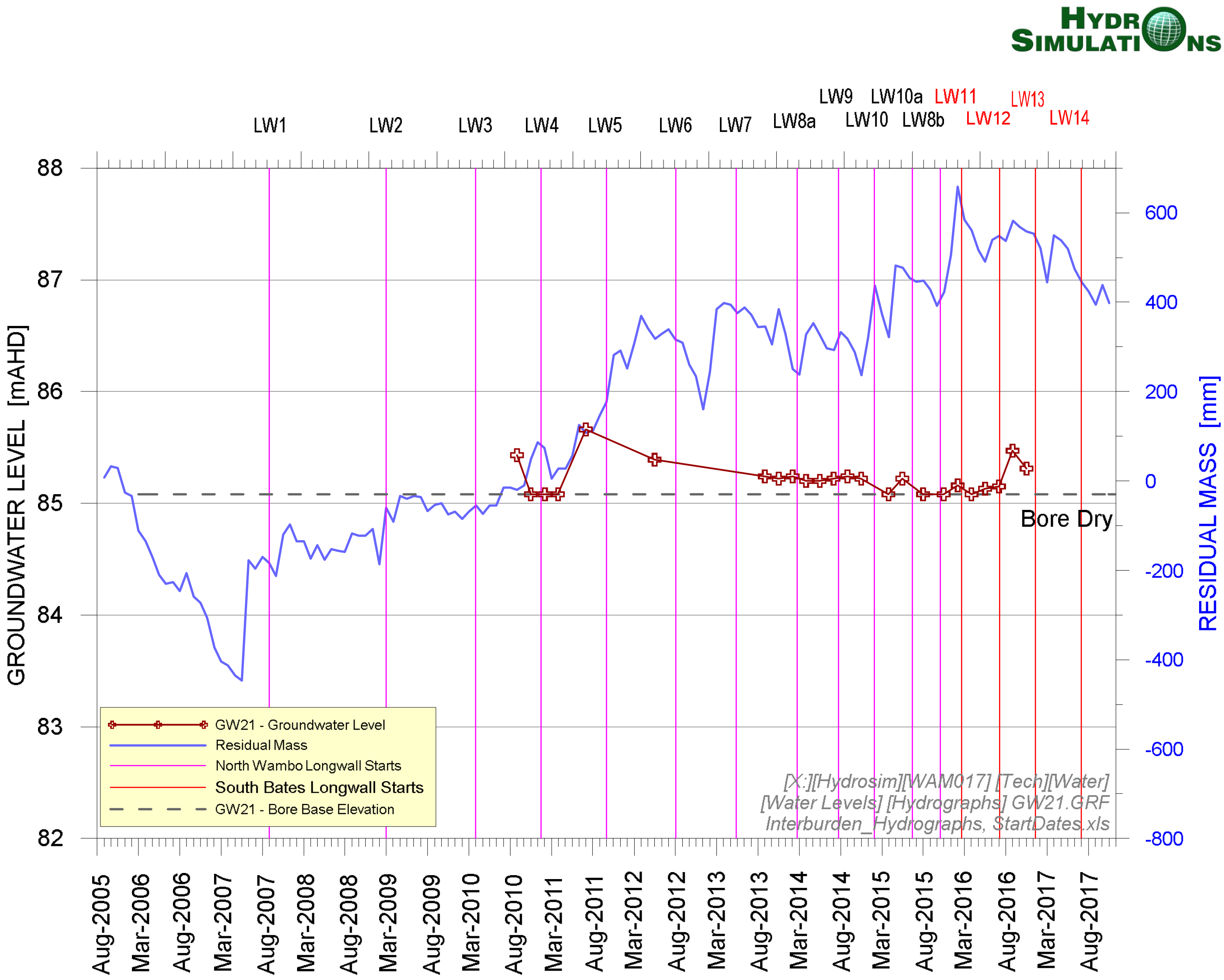


Figure 14 GW21 Groundwater Level

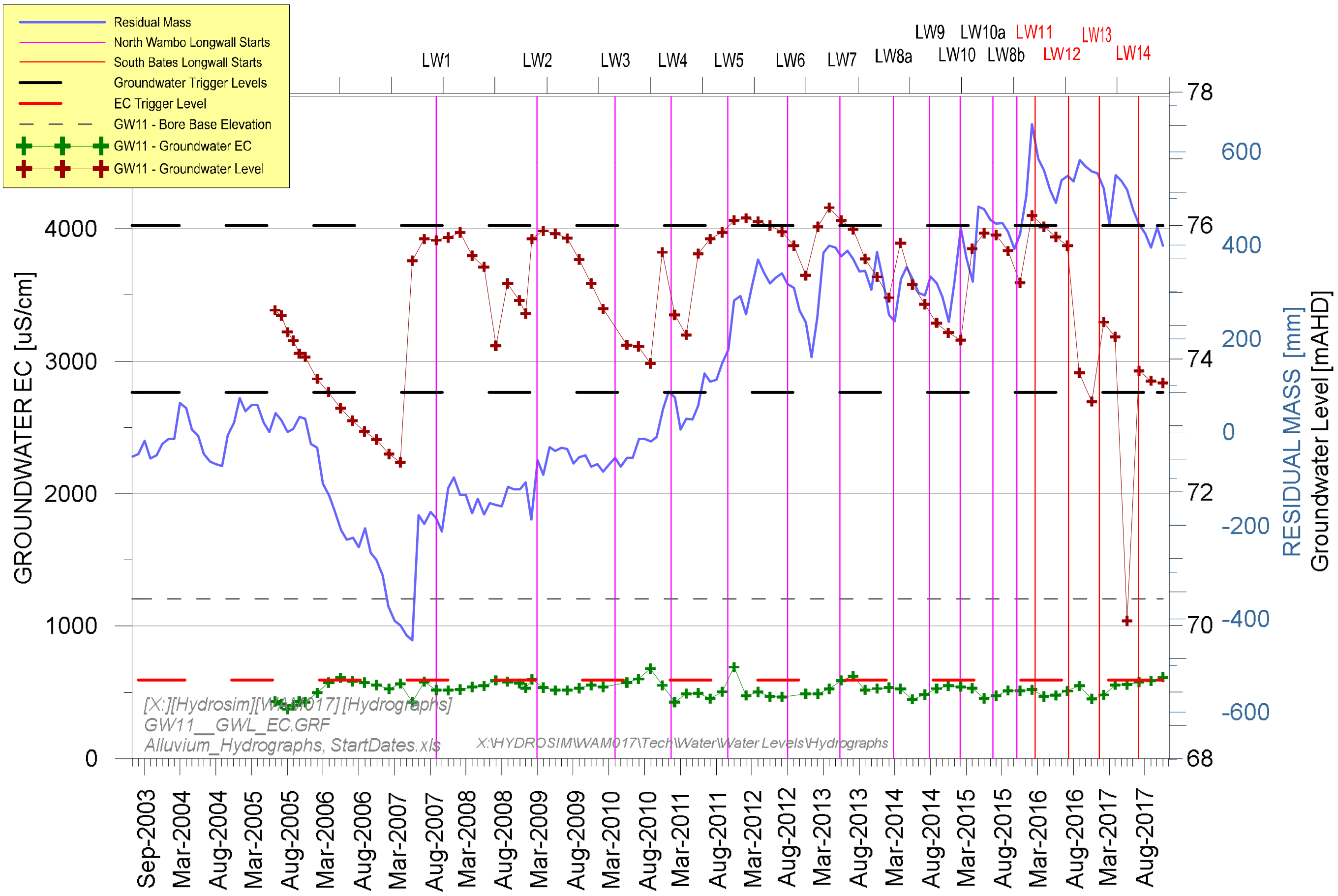


Figure 15 GW11 groundwater level and EC

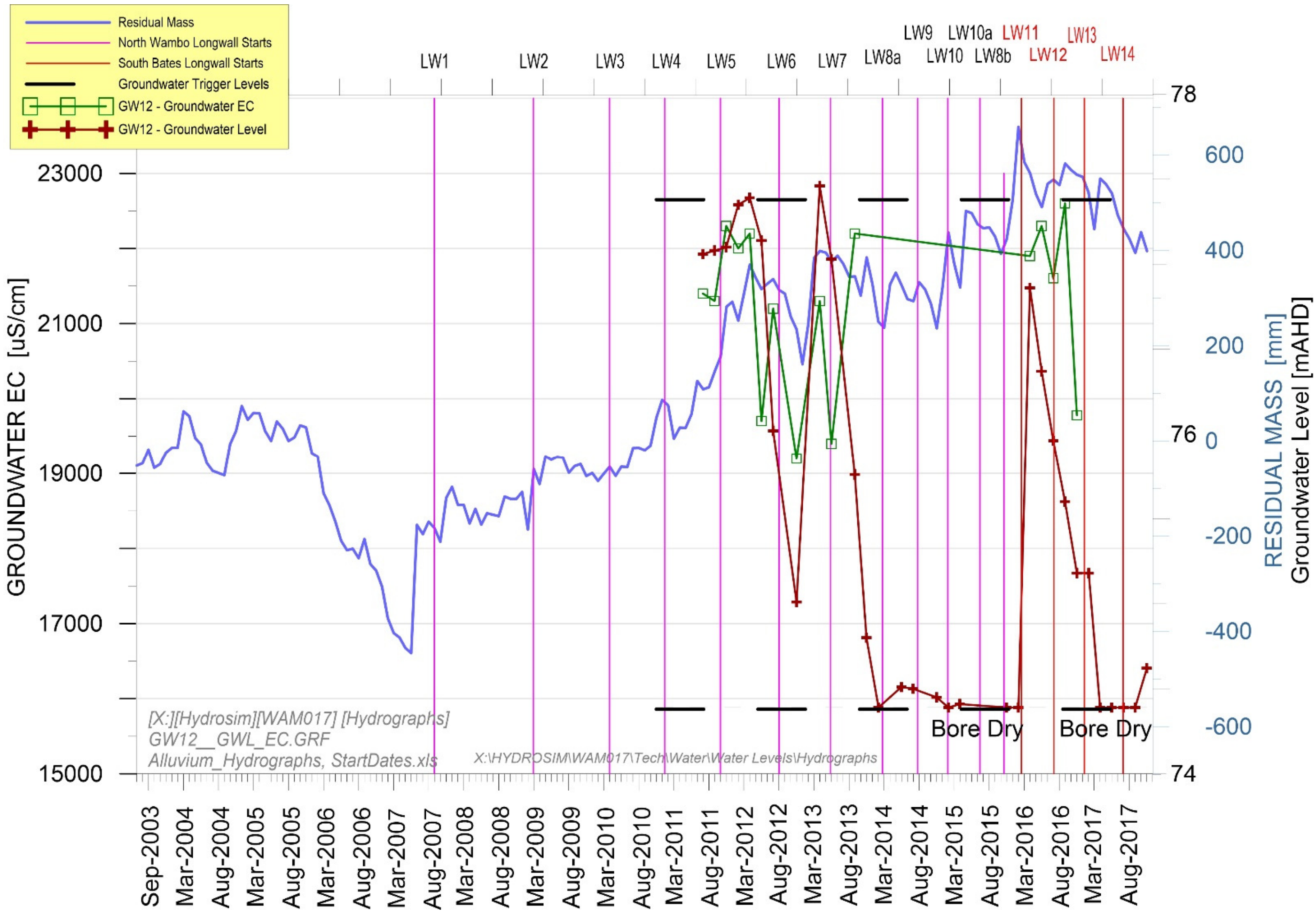
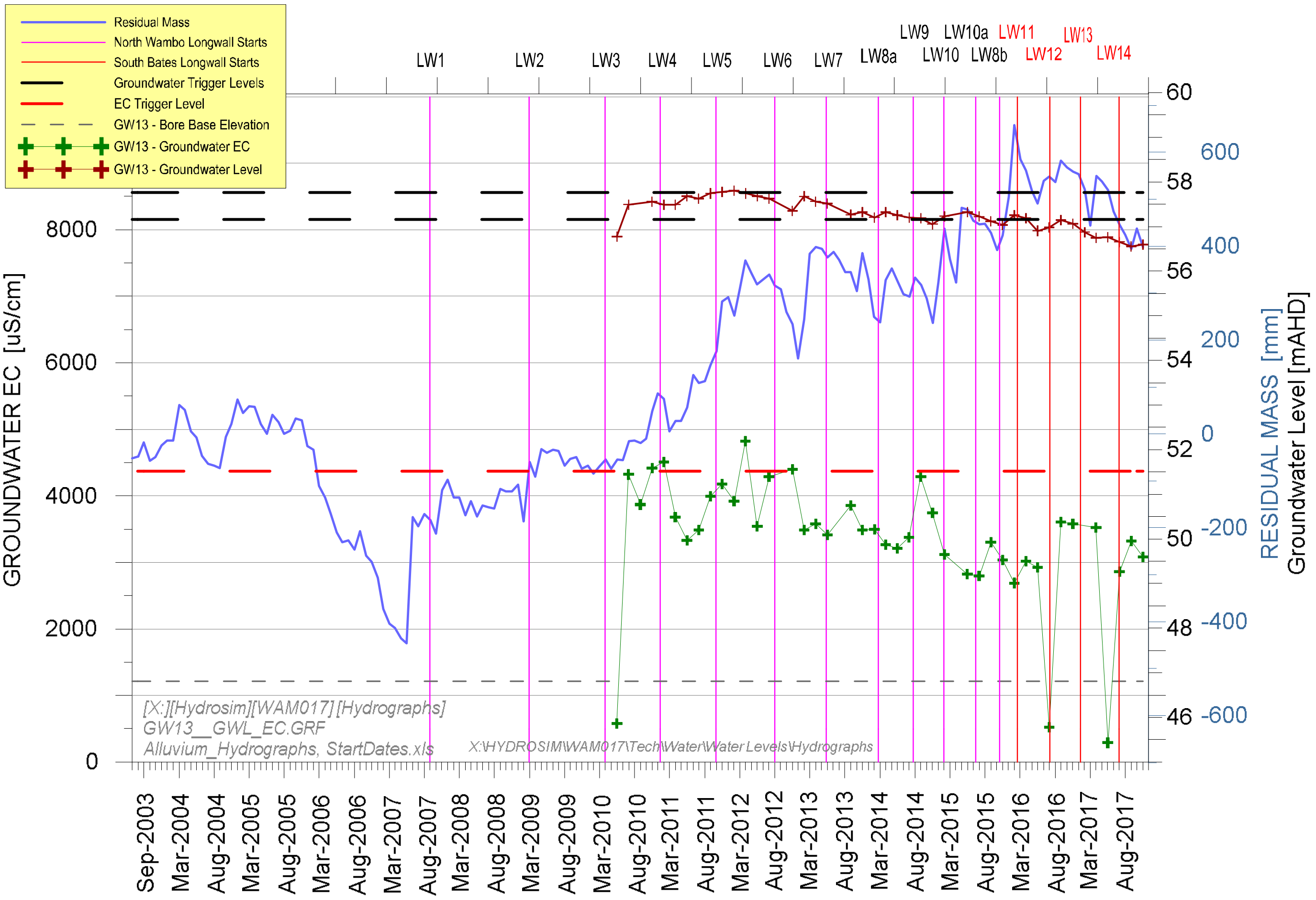


Figure 16 **GW12 Groundwater Level and EC**



Residual Mass
North Wambo Longwall Starts
South Bates Longwall Starts
Groundwater Trigger Levels
EC Trigger Level
GW13 - Bore Base Elevation
GW13 - Groundwater EC
GW13 - Groundwater Level
LW1
LW2
LW3
LW4
LW5
LW6
LW7
LW8a
LW9
LW10
LW10a
LW8b
LW11
LW12
LW13
LW14
GROUNDWATER EC [uS/cm]
RESIDUAL MASS [mm]
Groundwater Level [mAHD]
[X:][Hydrosim][WAM017] [Hydrographs]
GW13__GWL_EC.GRF
Alluvium_Hydrographs, StartDates.xls
X:\HYDROSIM\WAM017\Tech\Water\Water Levels\Hydrographs

Figure 17 GW13 groundwater level and EC

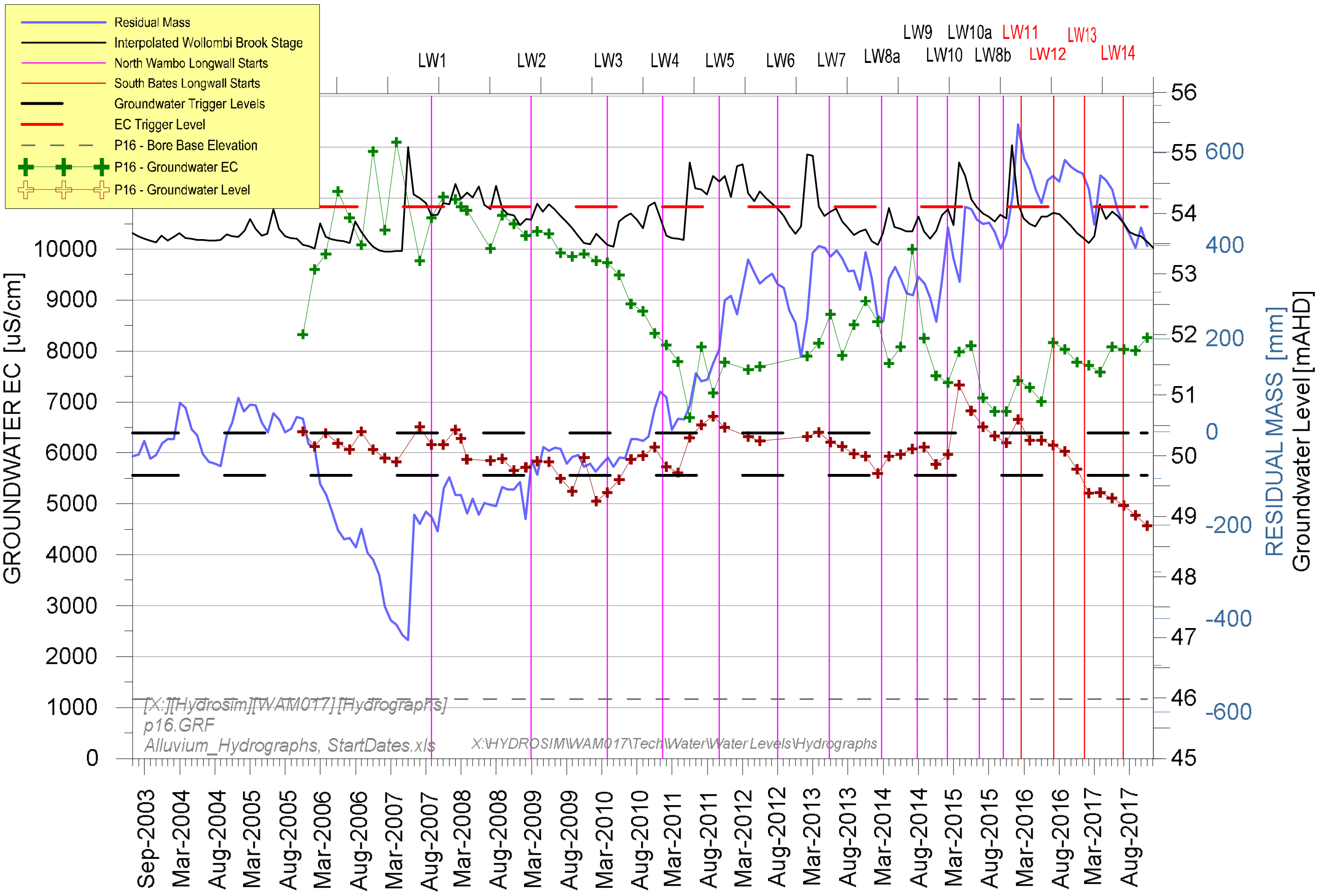


Figure 17 P16 Groundwater Level

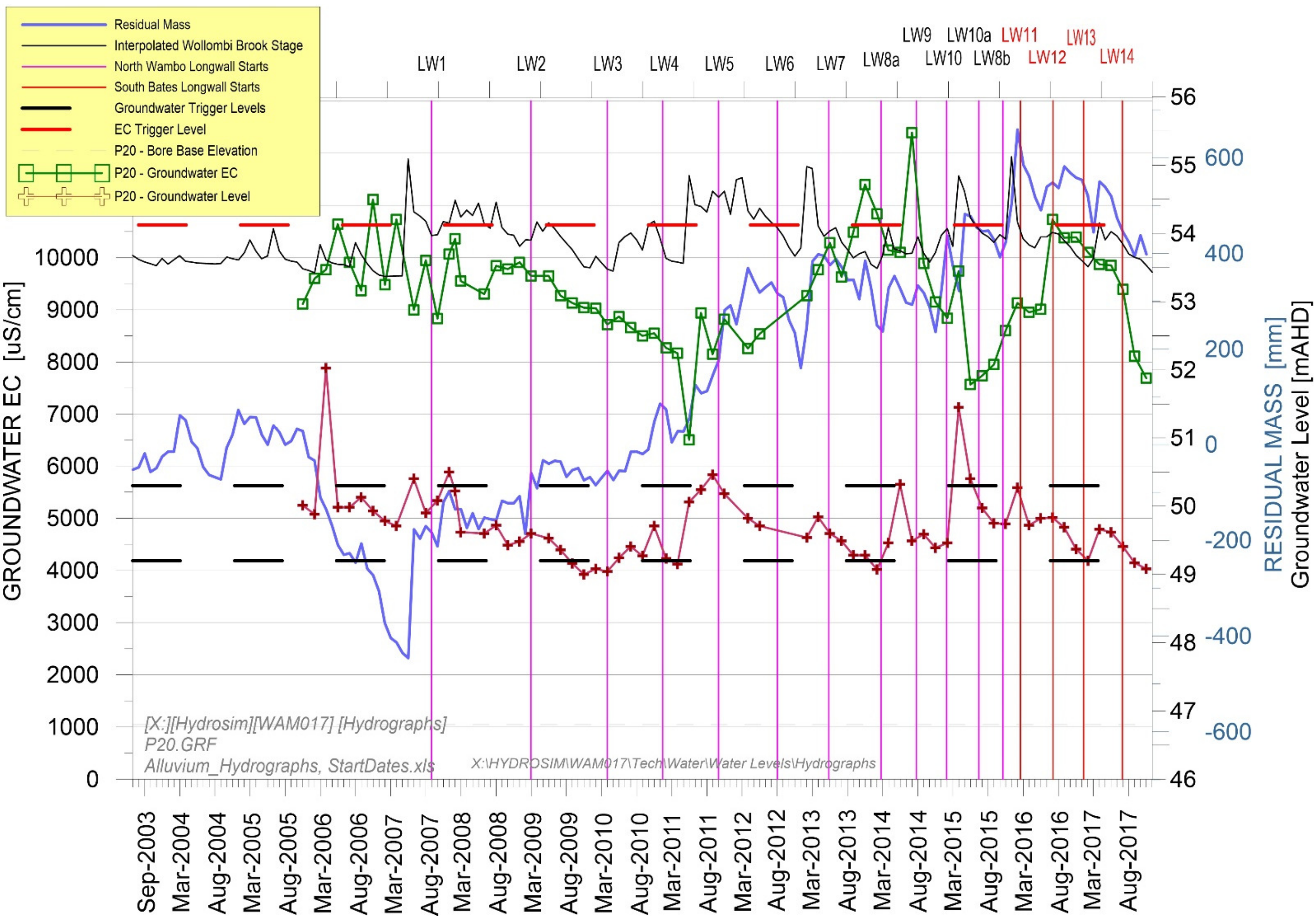


Figure 18 **P20 Groundwater Level**

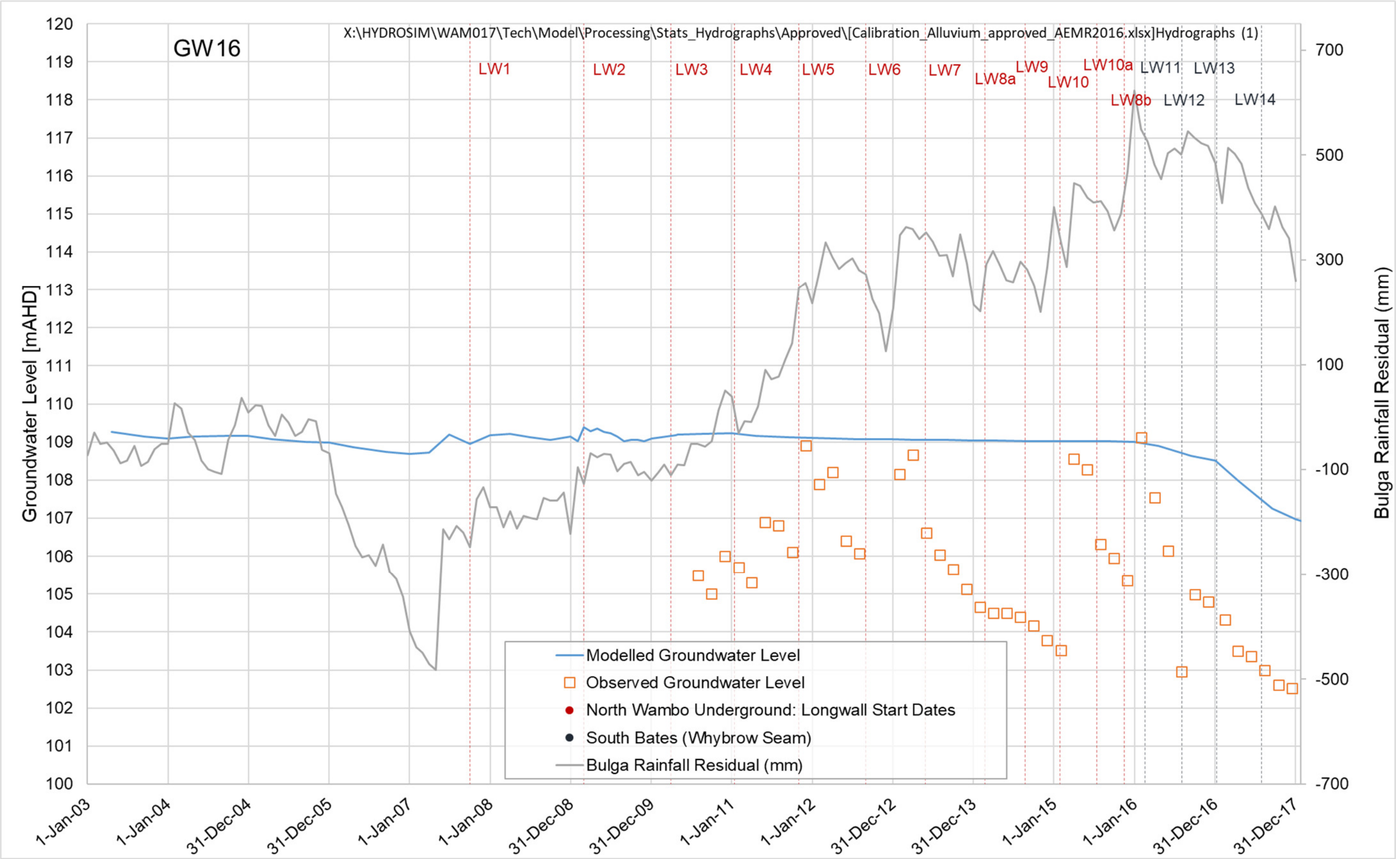


Figure 19 GW16 Calibration Hydrographs

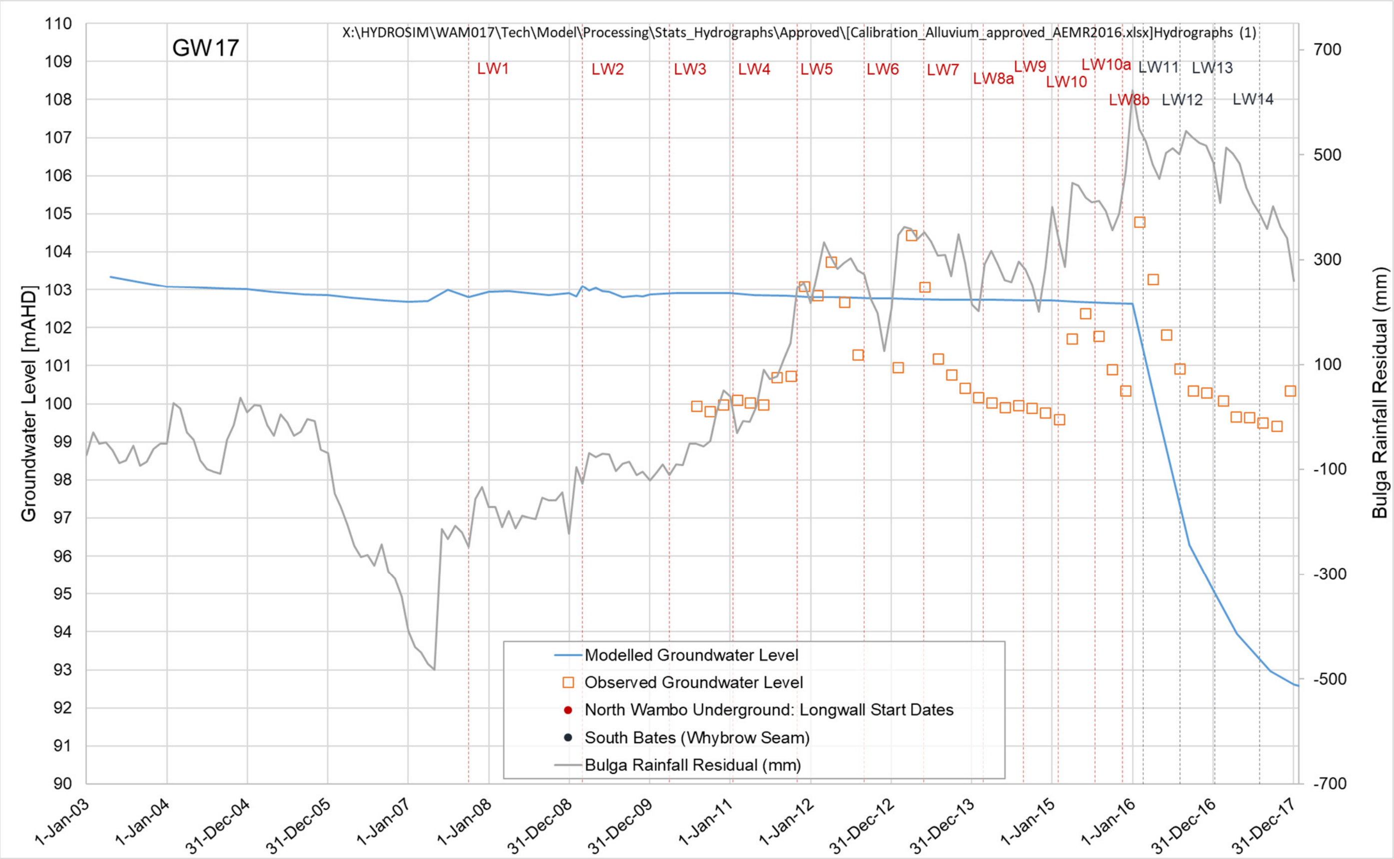


Figure 20 GW17 Calibration Hydrographs

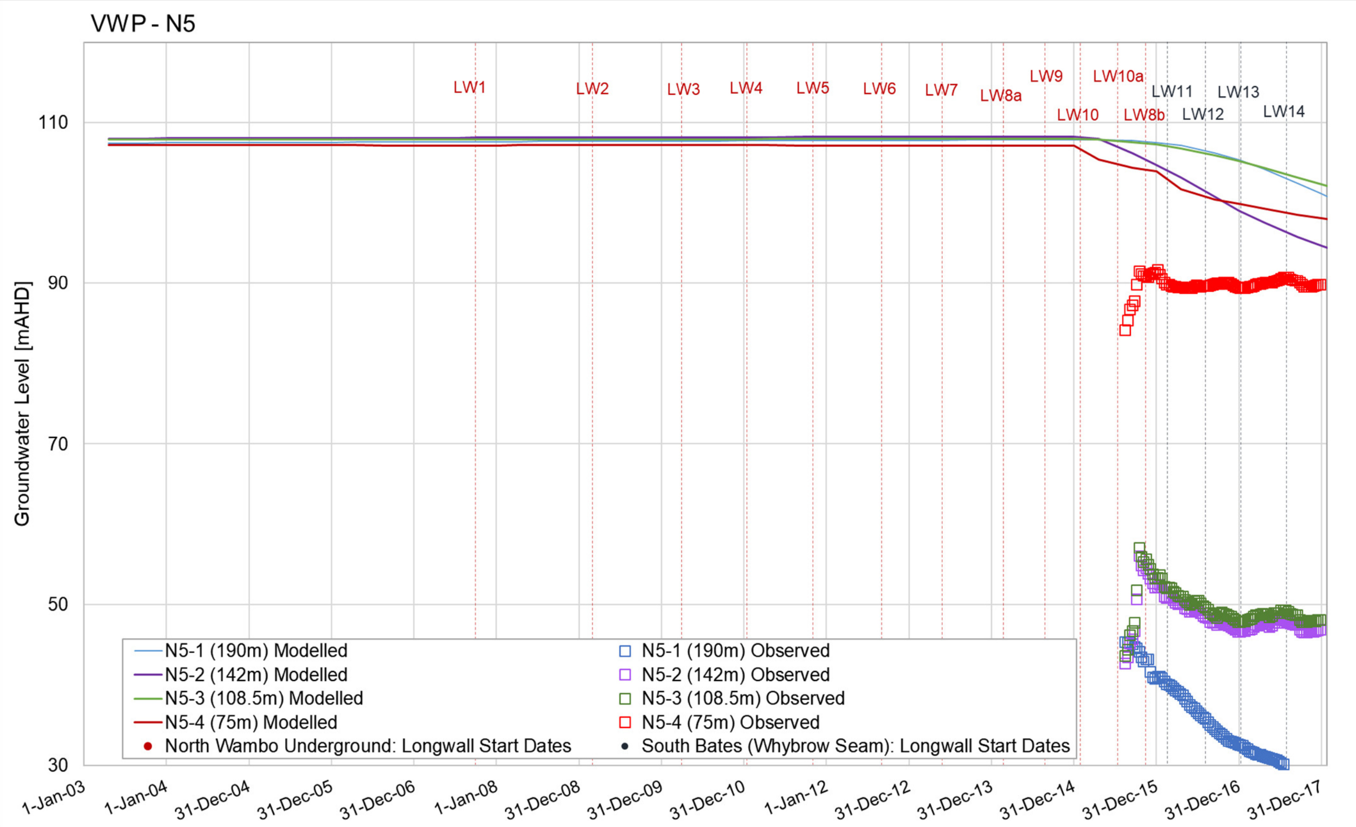


Figure 21 N5 Calibration Hydrographs

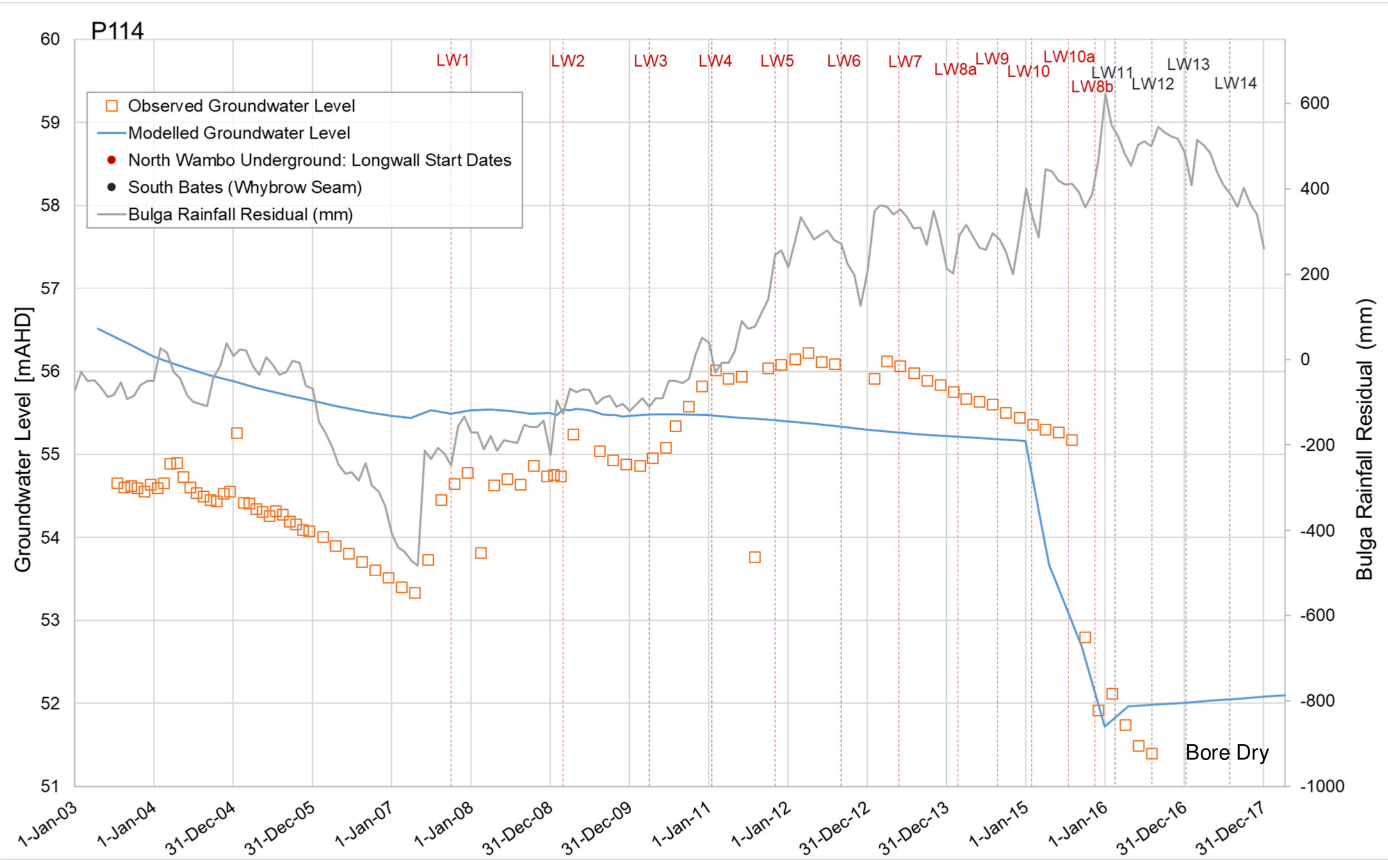


Figure 22 P114 Calibration Hydrographs

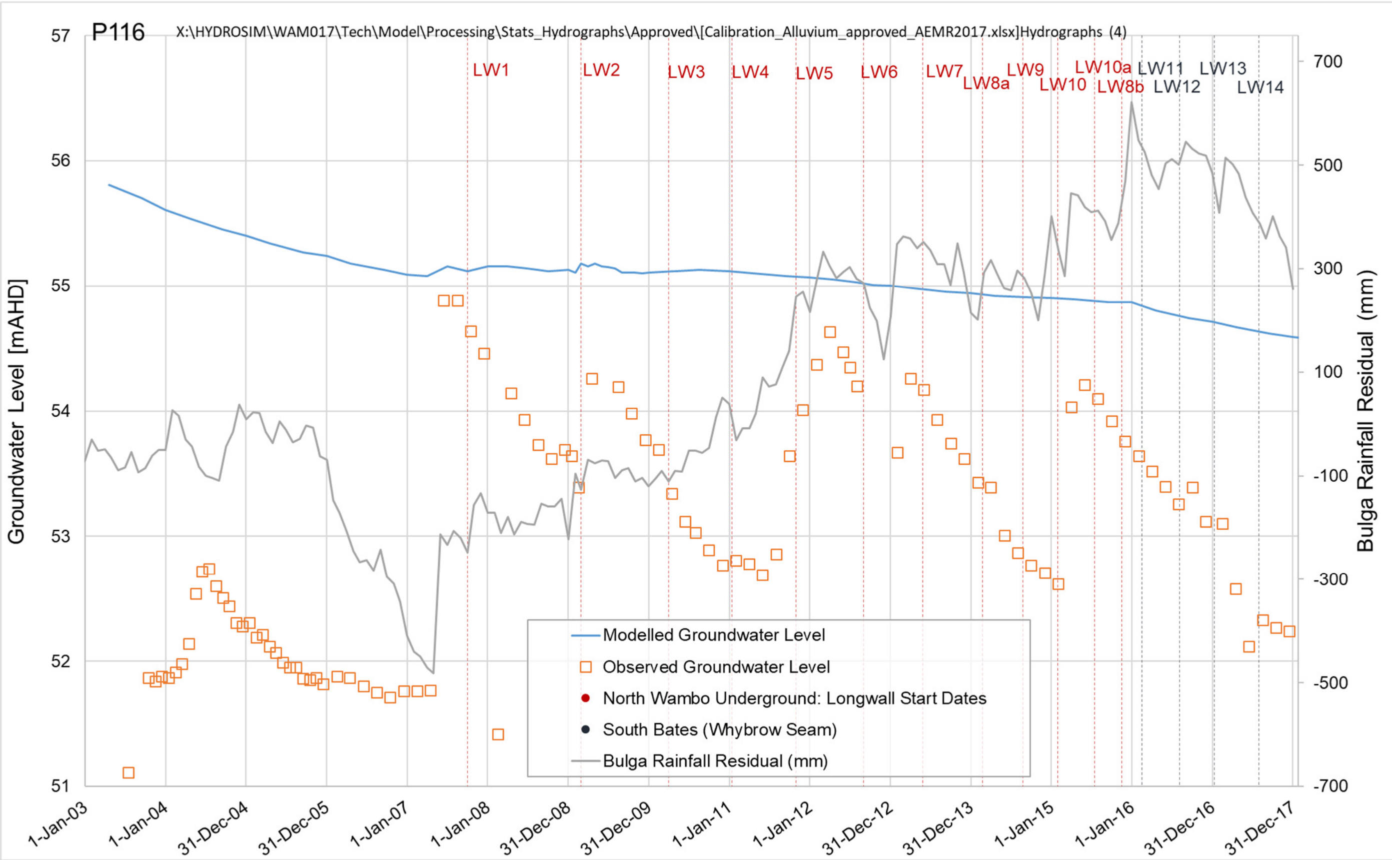


Figure 23 P116 Calibration Hydrographs

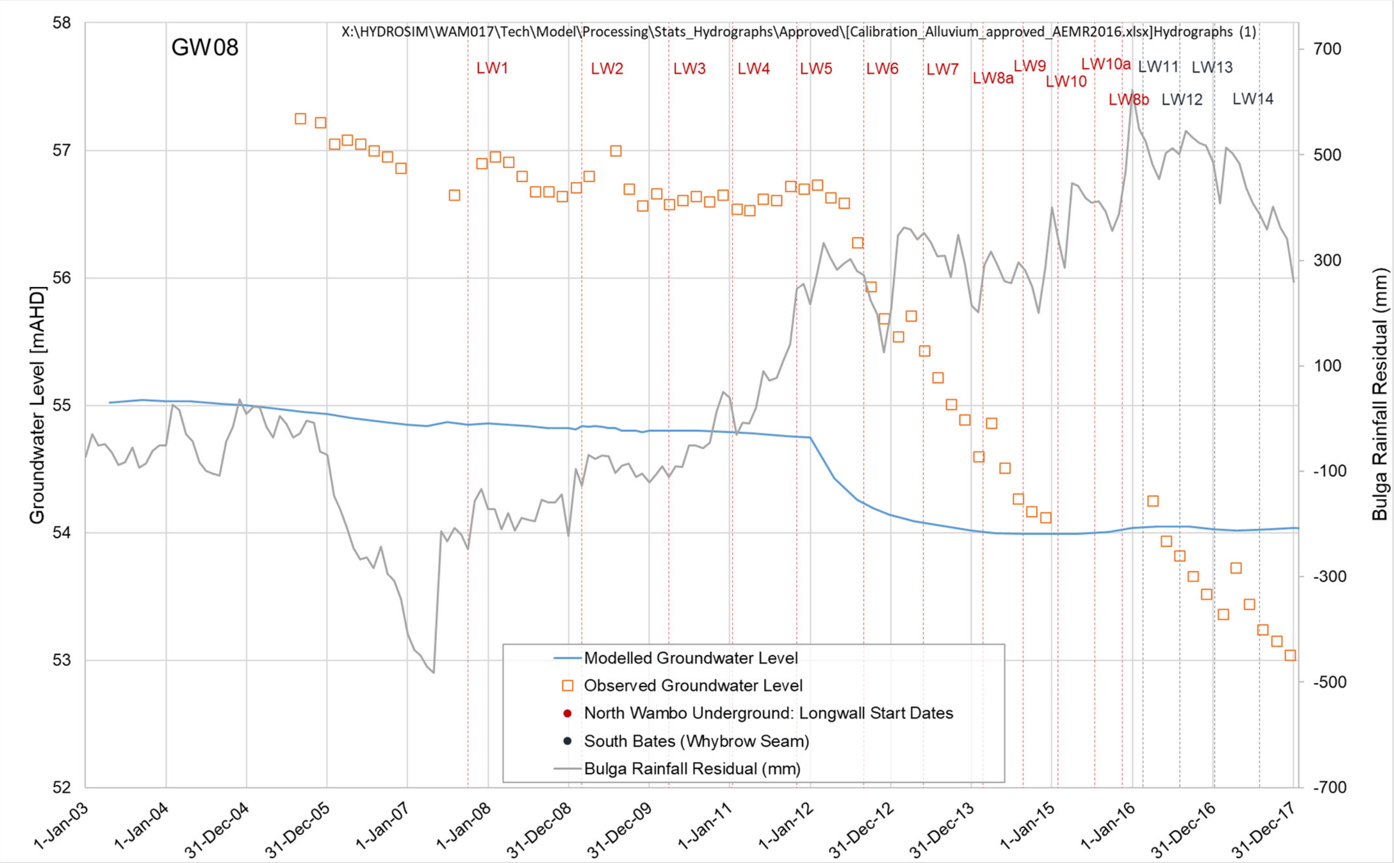


Figure 24 GW08 Calibration Hydrographs

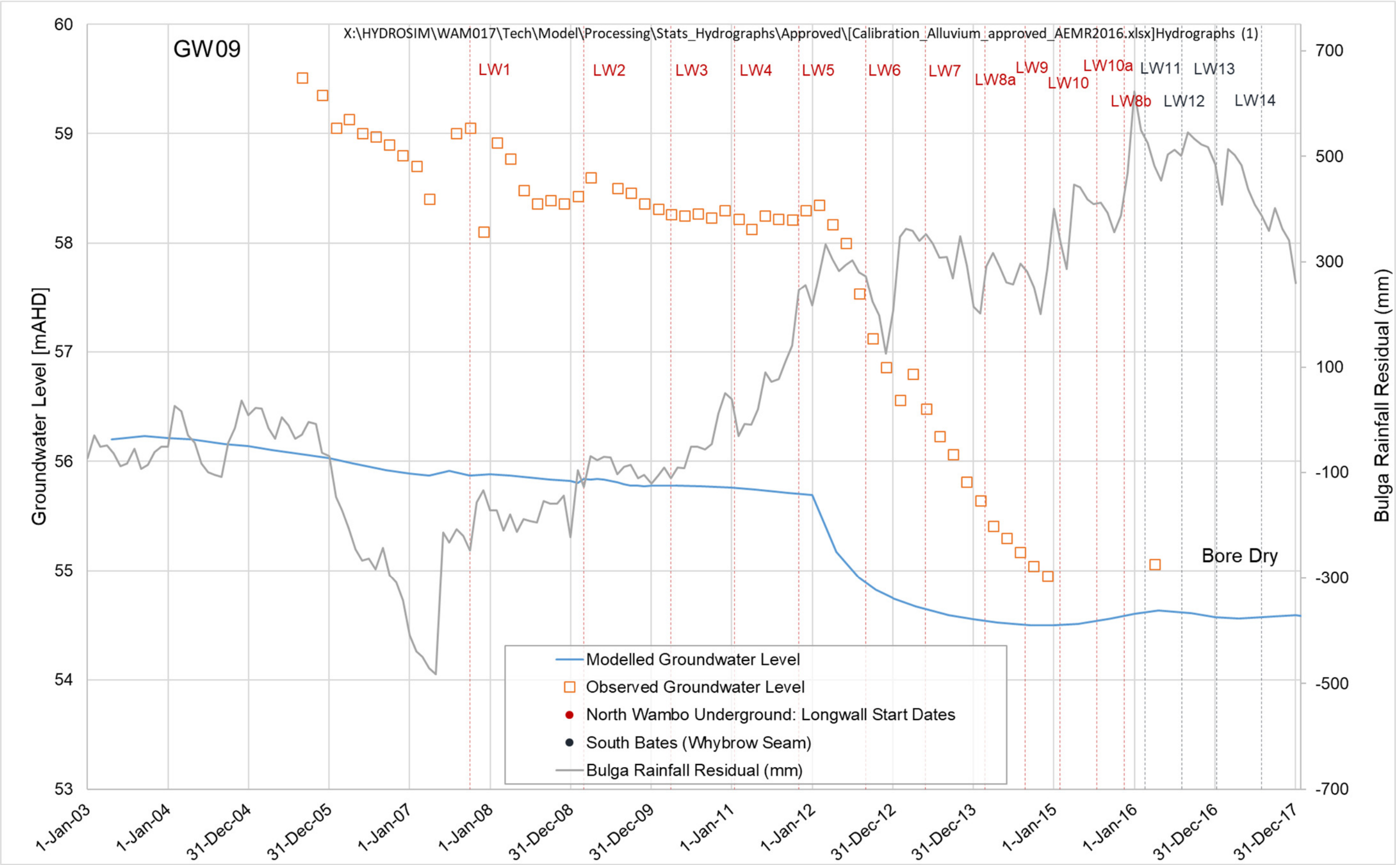


Figure 25 GW09 Calibration Hydrographs

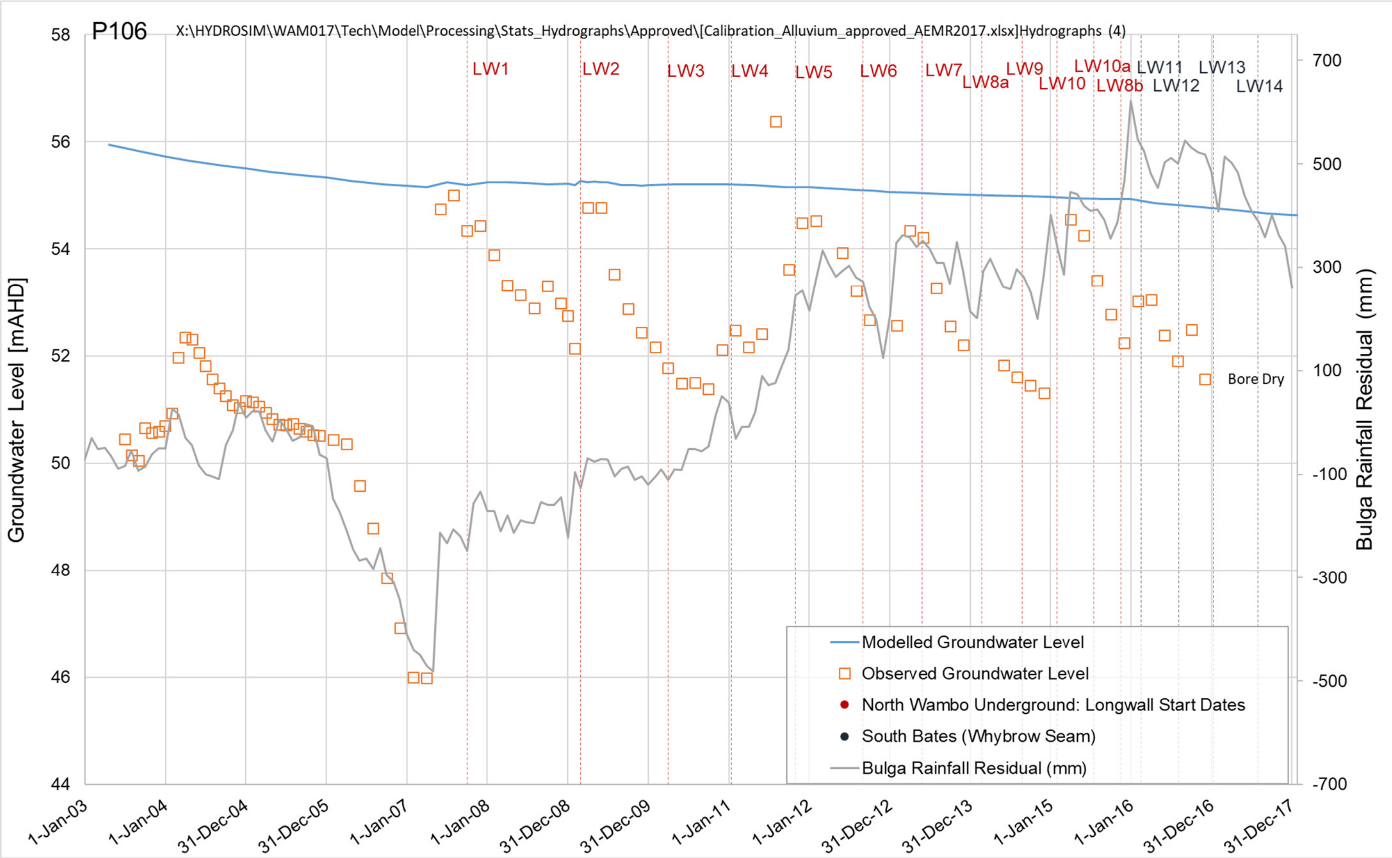


Figure 26 P106 Calibration Hydrographs

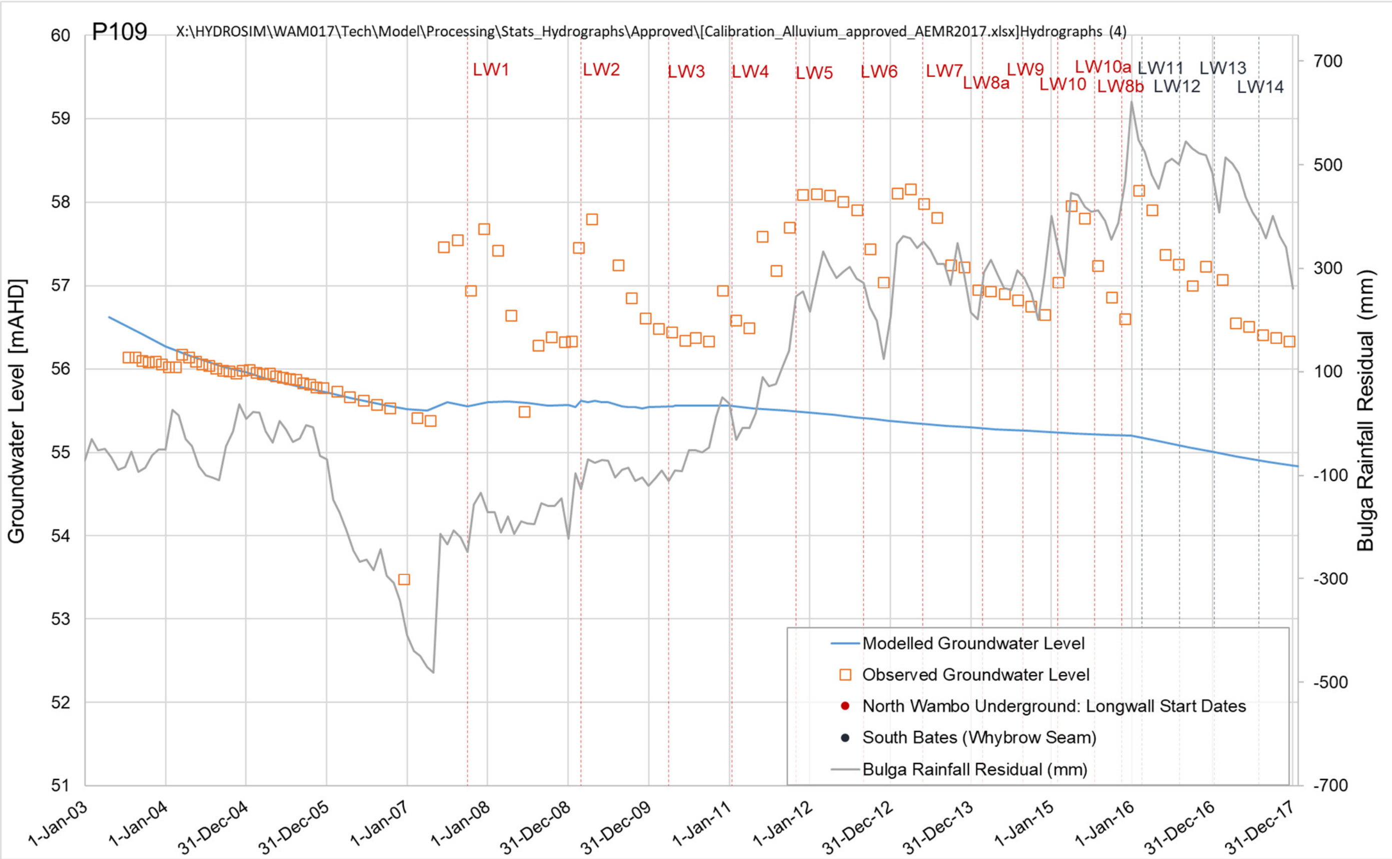


Figure 27 P109 Calibration Hydrographs

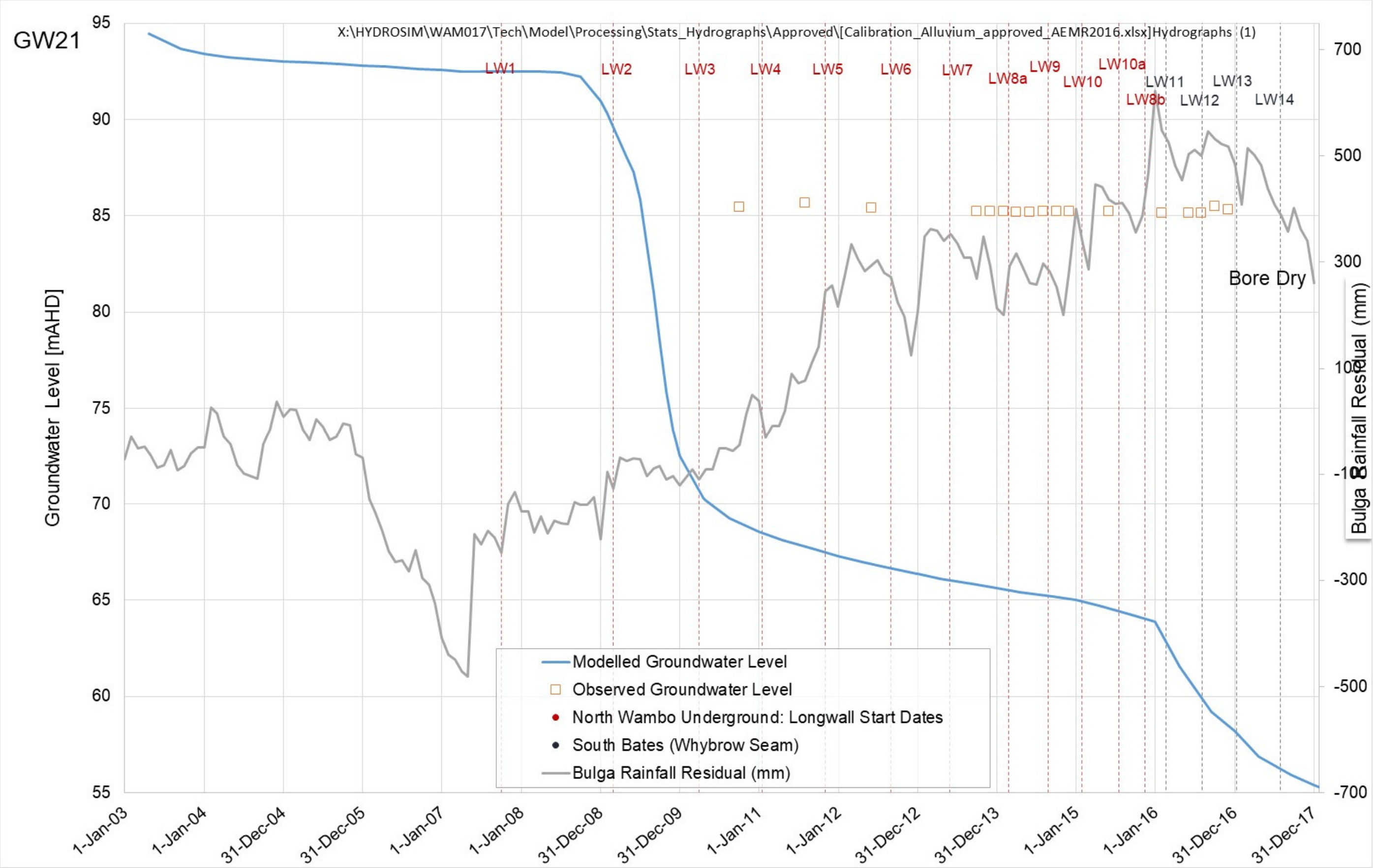


Figure 28 GW21 Calibration Hydrographs

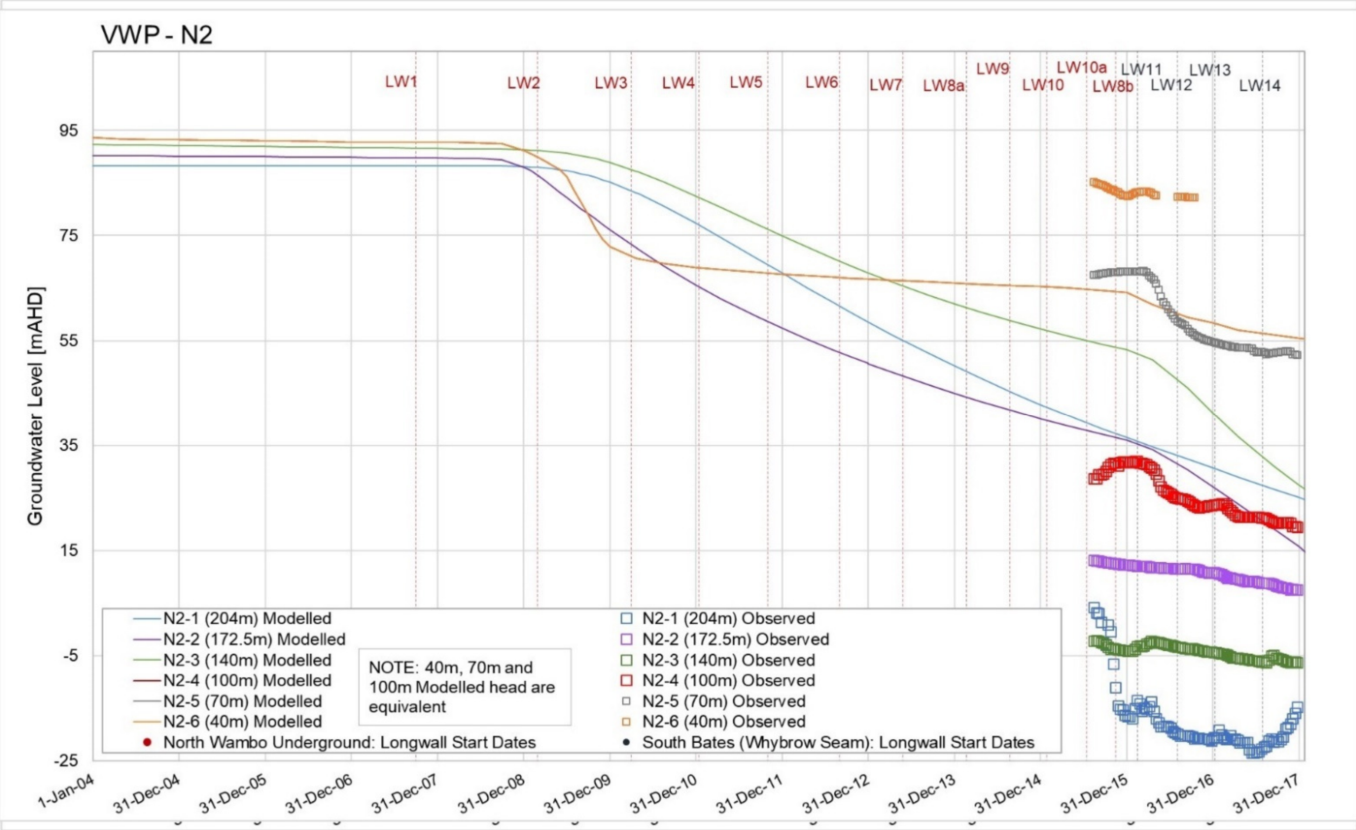


Figure 29 N2 Calibration Hydrographs

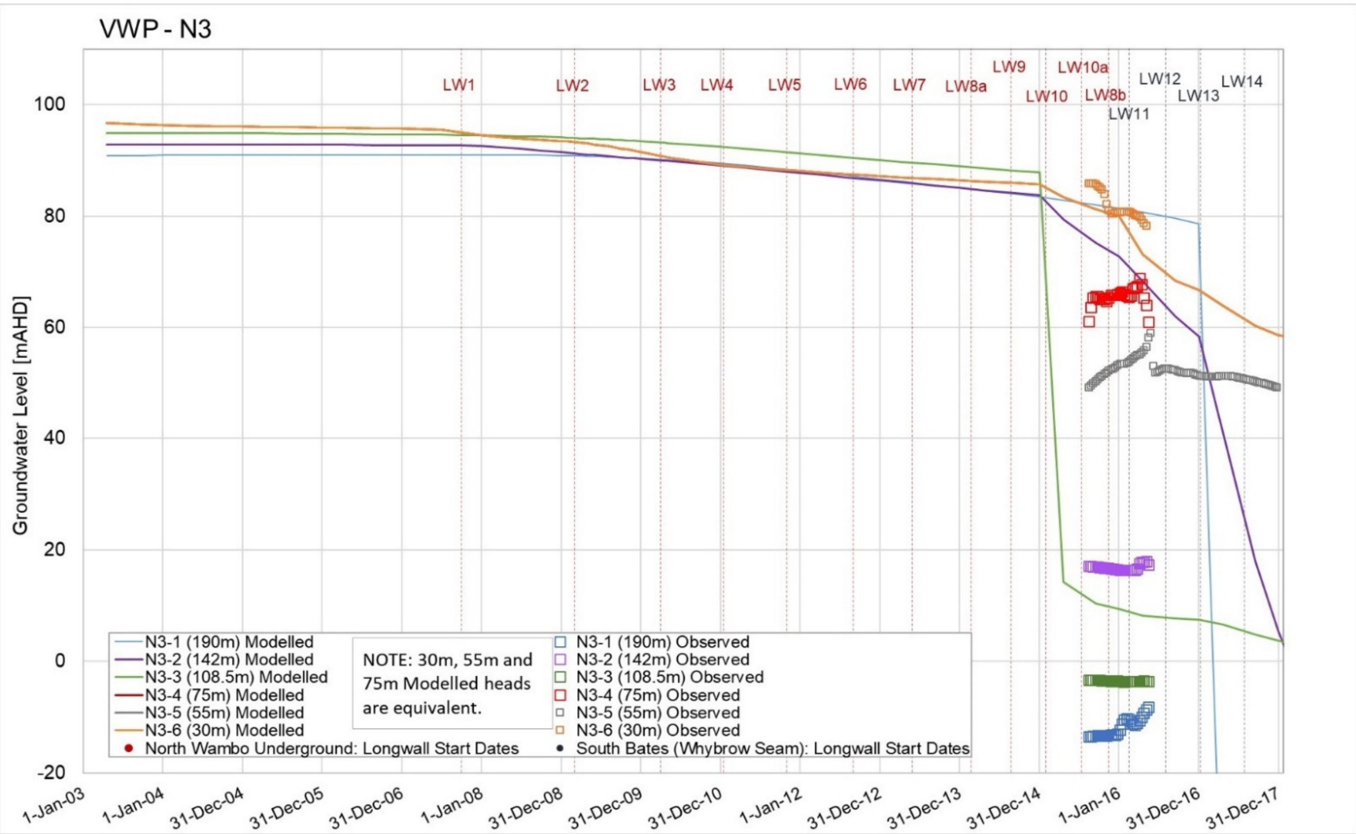


Figure 30 N3 Calibration Hydrographs

HYDRO SIMULATIONS

NPM Technical Pty Ltd ● ABN 52 613 099 540 ● T/A **HydroSimulations**
PO Box 241, Gerringong NSW 2534. Phone: (+61 2) 4234 3802

adam.skorulis@hydrosimulations.com

DATE:	26 March 2018
TO:	Nicole Dobbins Environmental Advisor Wambo Coal Pty Ltd Peabody Energy Australia PMB 1, Singleton NSW 2330
FROM:	Dr Derek Yates and Adam Skorulis
RE:	Compliance with subsidence performance measure in the NWU Extraction Plan (LW8-10a)
OUR REF:	HS2018/12 [Wam022]

1 INTRODUCTION

This letter report contains the analysis and information required to address compliance with the subsidence performance measure as outlined in the North Wambo Underground (NWU) Extraction Plan for Longwalls 8 to 10a (Peabody 2015a). The subsidence impact performance measure is: *Negligible impact to Wollombi Brook*. Compliance has been assessed using the performance indicators in **Table 1**. The reporting period referred runs from 31 December 2016 to 31 Dec 2017, the end of the 2017 monitoring period.

Table 1 Subsidence performance measure – LW8 to LW10a NWU

Feature	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Measure
Wollombi Brook	*Surface water quality in Wollombi Brook exceeds the surface water quality criteria in the SWMP[1].*	*Negligible impact to Wollombi Brook*
	Pumping of water from the North Wambo Underground Mine roadways requires regular pumping at rates higher than normal.	
	Groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP[2].	
	Groundwater quality in alluvial bores exceeds the groundwater quality criteria in the GWMP.	

[1] Wambo Coal Surface Water Monitoring Program (Peabody 2015c)

[2] Wambo Coal Groundwater Monitoring Program (Peabody 2015b)

2 WOLLOMBI BROOK SURFACE WATER QUALITY

The impact assessment criteria for Wollombi Brook (**Table 2**) are sourced from the most recent Surface Water Monitoring Program (SWMP) (Peabody, 2015c), and are based on the 20th and 80th percentile values of the specified parameters from the available dataset. The site assessed, SW02 (**Figure 1**), is located downstream of Wambo Coal Mine, where impacts to water quality caused by North Wambo Underground are most appropriately assessed.

Table 2 Surface water impact criteria

Sampling Site	Parameter	Lower Limit	Upper Limit
SW02 – Wollombi Brook	pH	7.4	8.1
	EC (µS/cm)	599	1947
	TSS (mg/L)	17 (low flow) – 308 (high flow)[1]	

[1] Low flow conditions are based on 80th percentile of recorded concentrations and high flow criteria on maximum recorded concentrations

The data assessed for the reporting period are sourced from monthly environmental reporting conducted by Wambo Coal Mine, as well as the WaterNSW online resource (NSW Office of Water, 2017) that provides daily flow and electrical conductivity (EC) data.

An exceedance occurs when water quality results exceed the 80th percentile trigger values after two consecutive sampling events for Level 1 response management measures and three consecutive sampling events for Level 2 response contingency phase (Peabody, 2015d).

Throughout the reporting period there have been no exceedances of the EC upper limits at SW02 (**Figure 2**). EC was recorded by Wambo Coal Mine at below the lower limit on four occasions during the reporting period, which correlates with freshening periods observed in the daily monitoring at the WaterNSW 'Wollombi Bk @ Warkworth' site. However, this raises no concern as the freshening is likely associated with periods of rainfall (**Figure 2**).

No exceedances of Total Suspended Solid levels (TSS) occurred for 'Low Flow' or 'High Flow' conditions during reporting period (**Figure 3**).

The pH level fell below the lower limit on two occasions in 2017 (Mar-Apr and Jun-Jul), but these events are of no concern, being coincident with the periods of rainfall mentioned above.

3 ALLUVIAL GROUNDWATER LEVEL

Alluvial groundwater level criteria assessed for exceedances in this report are sourced from the most recent GWMP (Groundwater Monitoring Program) (Peabody, 2015b). These are based on minimum and maximum depth-to-water trigger levels derived from 10th and 90th percentiles of historical recordings.

The GWMP lists 19 bores with trigger levels, though five bores have N/A entries. The trigger values are not assessment criteria but are used to initiate investigations according to the Surface and Ground Water Response Plan (SGWRP) (Peabody, 2015d). The SGWRP provides a protocol for the investigation, notification, and mitigation of identified exceedances of these assessment criteria. To investigate potential groundwater leakage from Wollombi Brook, the Trigger Action Response Plan (TARP) in the SGWRP considers the water level responses at 10 named bores (Peabody, 2015d):

- Level 1 – Response Management Measures: Groundwater monitoring of standing water levels in bores P106, P109, P114, P116 within the Wambo Creek alluvium and GW13 and GW15 within the Wollombi Brook alluvium, identifies a decreasing trend, beyond natural fluctuations and predicted modelled impacts; for more than two consecutive monitoring events, and/or

- Level 2 – Response Contingency Phase: Groundwater monitoring of standing water levels in bores GW08 and GW09 and GW016 and GW017 within the North Wambo Creek alluvium, exceed the standing water trigger values as provided in the GWMP, beyond natural fluctuations, for more than three consecutive monitoring events.

3.1 Level 1 Response Management Measures

Groundwater level at 8 alluvial bores have shown exceedances of the trigger levels during the 2017 reporting period, (P202, P106, P114, GW13 GW11, GW12, P16, P20 shown in **Figures 4 to 11**).

P202 (**Figure 4**) shows only a single exceedance of the minimum depth-to-water, correlating with a spike in the average rainfall trend in early 2017. This does not require further investigation.

The remaining 7 bores (P114, P106, P16, P20, GW11, GW12, GW13) show exceedances of the maximum depth-to-water trigger level during the 2017 monitoring period. P106, P114 and GW13 are included in the TARP (see below).

3.1.1 TARP Bores

Data available to HydroSimulations indicates the depth of P106 to be 14 m (**Figure 5**). For P106 to reporting a true 'dry' reading, the groundwater level at P106 would have to have dropped by ~5.5m between December 2016 and February 2017. This drop would represent the largest decline observed between 2 bi-monthly measurements since the beginning of observation by a factor of 5. While a low river stage and decreasing rainfall trend, or an ongoing mining effect caused by Longwall 10a extraction may be responsible for the 'dry' observations. HydroSimulations recommends further investigation of the bore to check that it has not silted up or suffered collapse. As NWU mining was completed in December 2015, it is very unlikely that a mining effect of this magnitude would occur during 2017.

P114 (**Figure 6**) is reporting as dry for the entire monitoring period, indicating a maximum depth-to-water trigger exceedance for all 2017 observations. This is a clear ongoing effect from the mining of Longwall 10a.

GW13 (**Figure 7**) triggers occurred for the entire 2017 monitoring period, to the lowest recorded groundwater levels. The approaching Warkworth open cut (2.4 km away) in conjunction with lower than average rainfall is more likely to be the cause than an ongoing effect from NWU (3 km away).

3.1.2 Non-TARP Bores with Trigger Exceedances

GW11 (**Figure 8**) reports a groundwater level below the maximum depth-to-water trigger in June 2017. This observation exceeds the trigger level by ~3.4 m, indicating a groundwater level that is lower than the base of the bore according to data available to HydroSimulations. This value is then followed by a groundwater recovery in August 2017, returning to compliance with the trigger level conditions. It is difficult to explain the sharp decline in groundwater level at GW11. GW11 is located within the alluvium associated with Wambo Creek, upstream of mining at NWU by 1.5km. No mining effect is likely to impact GW11 at this time and no significant dry condition has been recorded between January and June 2017 to induce the observed decline. Furthermore, no major rainfall event was recorded before the rapid groundwater recovery in August 2017. It is possible an error has been made with the groundwater level measurement in June 2017. HydroSimulations recommends that GW11 collar elevation be resurveyed as well as dipped for bore depth at the next bi-monthly observation. There is no apparent NWU mining effect observed at GW11 during the 2017 period of measurement.

GW12 (**Figure 9**) exhibits an ongoing mining effect from North Wambo Underground longwall extraction, trigger exceedances are observed from April to October 2017 with the bore reported as dry. A recovery of ~0.2 m is observed to December 2017 which likely indicates a minor rainfall response despite the long-term trend showing below average conditions.

The monitoring bores P16 (**Figure 10**) and P20 (**Figure 11**) are located downstream of the mining operations along the Wollombi Brook and less than a kilometre upstream to the FM10 Wambo flow monitoring site. At P16 a declining groundwater level of approximately1.5m is observed from March 2016 to December 2017. In 2017, P16 reports six groundwater levels below the maximum depth-to-water trigger with the last record exceeding the trigger level by 0.84m. While the declining groundwater levels during 2017 correlate with a declining rainfall and stage height trend, the observations are the lowest recorded for the entire period of measurement and do not show the same previously observed response to peaks in rainfall and river stage. P20, located near P16 has two groundwater level observations below the maximum depth-to-water trigger in October and December 2017. Groundwater level at P20 correlates with the long-term rainfall trend and an interpolated Wollombi Brook stage height throughout the period of measurement. A large hydraulic gradient between the river stage and the groundwater level at P16 and P20 is present. It is believed that the alluvial aquifer at P16 and P20 could be disconnected from the Wollombi Brook. Vertical recharge from the river to the alluvial aquifer can occur, but the decrease in the Wollombi Brook stage height induces a reduction in recharge through the unsaturated zone and consequently in the groundwater level at P16 and P20. No mining effects can be identified at P16 and P20, as NWU operations have been completed since December 2015, the open cut found North of the bores has yet to commence and the nearest SBU LW13 is 5.2 km away.

3.2 Level 2 - Response Contingency Phase

An assessment of groundwater level for bores GW08, GW09, GW16 and GW17 (**Figures 12 to 15**) is required as part of the TARP for Wollombi Brook and Wambo Creek Alluvium. The current GWMP (WCPL, 2015) does not provide trigger values for these bores. An assessment has been conducted on all bores within the Level 2 TARP to examine groundwater data during the 2017 monitoring period, and identify any trends occurring beyond natural fluctuations.

GW08 (**Figure 12**) and GW09 (**Figure 13**) have both displayed an ongoing NWU mining effect since mid-2012, that is observed through until the end of 2017. In 2017, observations at GW09 demonstrate the bore is still dry. Groundwater levels at GW08 increase in April 2017 followed by a gradual decline in groundwater level of less than 1 m to December 2017, corresponding to the long-term rainfall trend. The ongoing decline in groundwater levels and dry condition at GW08 and GW09 respectively, may now also be related to the decrease in the long-term rainfall trend taking place in 2017. While a North Wambo underground mining effect may be ongoing. any possible recovery associated with the cessation of dewatering, could be muted by the conditions of below average rainfall.

In absence of specific trigger values, the GWMP (WCPL, 2015) suggests the installation of replacement bores near GW08 and GW09 if no recovery is observed within 12 months of the cessation of dewatering NWU workings. Despite the possibility of recovery being muted by below average rainfall, HydroSimulations would see value in the installation of new standpipe bores, monitoring both alluvium and underlying interburden material above NWU workings. This would allow for a better understanding of recovery or ongoing impacts associated with NWU mining.

Previous reporting (HydroSimulations 2016, 2017) attributed earlier fluctuations of groundwater level at GW16 (**Figure 14**) and GW17 (**Figure 15**) to climate and ephemeral flows in North Wambo Creek. The increasing amplitude in groundwater level response, particularly at GW16, indicates a likely mining effect from the removal of material from the adjacent open cut, given that declines in groundwater level during 2016 and early 2017 are contrary to the rainfall trend. The rapid recovery that is observed following increases in the rainfall trend is likely due to ephemeral flow in North Wambo Creek and a low specific yield in its associated alluvium. As previously assessed, the removal of material from Montrose open cut is probably developing regional depressurisation and consequently is also likely to be responsible for the low groundwater level at GW16 and GW17 during 2017. This would be enhanced by the below average rainfall during 2017, indicated by a declining long-term rainfall trend. NWU mining has been complete since December 2015 and is therefore unlikely to be responsible for any trends in groundwater level observed at GW16 and GW17.

4 ALLUVIAL GROUNDWATER QUALITY

Alluvial groundwater quality criteria assessed for exceedances in this report are sourced from the most recent GWMP (Peabody, 2015b). The GWMP lists 15 bores with EC and pH trigger values, but three have N/A entries.

Water quality triggers for EC are based on 90th percentile values from recorded historical data at each bore. An exceedance of the 90th percentile EC value in three consecutive bi-monthly observations triggers an investigation.

At Wambo, pH is consistently between 6 and 8 at a majority of alluvial monitoring locations. 10th and 90th percentile values are used as minimum and maximum trigger values. An investigation is triggered following exceedances on two consecutive bi-monthly monitoring events.

No EC exceedances are observed during the 2017 monitoring period. It should be noted, that dry bores such as GW12, P106 and P114 are not able to provide EC readings.

No exceedances of pH requiring an investigation occurred during the reporting period. It should be noted, that dry bores such as GW12, P106 and P114 are not able to provide pH readings.

5 PUMPING

Mining of NWU longwalls was completed in December 2015. Since then, the workings have been sealed and there is no ongoing pumping.

6 CONCLUSION

While some exceedances of trigger levels resulting from North Wambo Underground mining have been observed in the alluvial bores for both groundwater level and EC, there is no longer any pumping occurring from North Wambo Underground workings, or any exceedances of surface water quality triggers observed at Wollombi Brook. A summary assessment is given in **Table 3**.

Table 3 Assessment of subsidence impact performance measure – LW8 to LW10a NWU

Feature	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Measure	Subsidence Impact Performance Indicator Exceeded?	Overall Subsidence Impact Compliance Upheld
Wollombi Brook	*Surface water quality in Wollombi Brook exceeds the surface water quality criteria in the SWMP.*	*Negligible impact to Wollombi Brook*	**No**	**Yes**
	Pumping of water from the North Wambo Underground Mine roadways requires regular pumping at rates higher than normal.		**No**	
	Groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP.		**Yes (at P106, P114, GW13, P16, P20, GW11, GW12, GW08, GW09, GW16, GW17)**	
	Groundwater quality in alluvial bores exceeds the groundwater quality criteria in the GWMP.		**No**	

Exceedances have been observed at:

- P106 – observed dry bore not consistent with previous observations, further investigation requested.
- P114 – which can no longer be considered representative of alluvium;
- GW13 – most likely affected by Warkworth Mine.
- GW11 – not in the TARP;
- GW12 – not in the TARP; and
- P16 – not in the TARP;
- P20 – not in the TARP;
- GW08, GW09 – No recovery following the cessation of NWU dewatering, recommended installation of replacement bores
- GW16, GW17 – most likely affected by Montrose open cut and below average rainfall;

As such, compliance with the subsidence performance measure for the extraction of Longwalls 8 to 10a of North Wambo Underground is upheld. There is *negligible impact to Wollombi Brook*.

7 REFERENCES:

HydroSimulations (2016) *Wambo Annual Review Groundwater Analysis*. Report HC2016/07 for Wambo Coal Pty Ltd. March 2016

HydroSimulations (2017) *Wambo Annual Review Groundwater Analysis*. Report HC2017/09 for Wambo Coal Pty Ltd. March 2017

NSW Office of Water (2017) http://realtimedata.water.nsw.gov.au/water.stm?ppbm=DAILY_REPORTS&dr&3&drkd_url Accessed 20/3/2017

Peabody (2015a) *Subsidence Monitoring Program for North Wambo Underground Mine Longwalls 8 to 10A.* Document Number SWMP LW8-10a. April 2015

Peabody (2015b) *Wambo Coal Groundwater Monitoring Program.* Document No. WA-ENV-MNP-509.1. October 2015

Peabody (2015c).*Wambo Coal Surface Water Monitoring Program.* Document No. WA-ENV-MNP-509.2. October 2015

Peabody (2015d). *Wambo Coal Surface and Ground Water Response Plan.* Document No. WA-ENV-MNP-509.4. October 2015

Filepath: X:\HYDROSIM\WAM022\WP\HS2018_12_NWU_SubsidenceCompliance_2017.docx

Figures

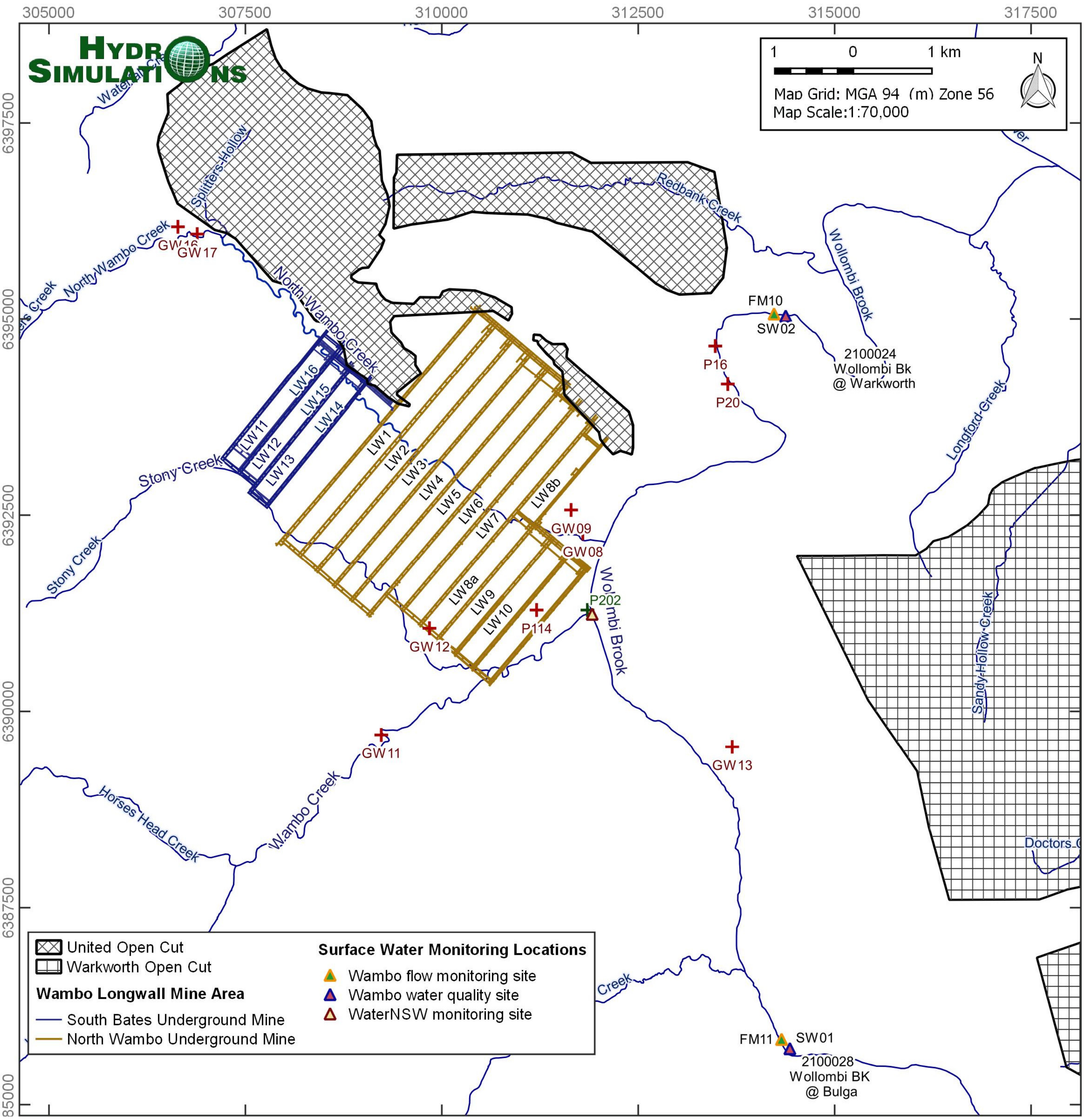


Figure 1 Locations of bores discussed in this report.

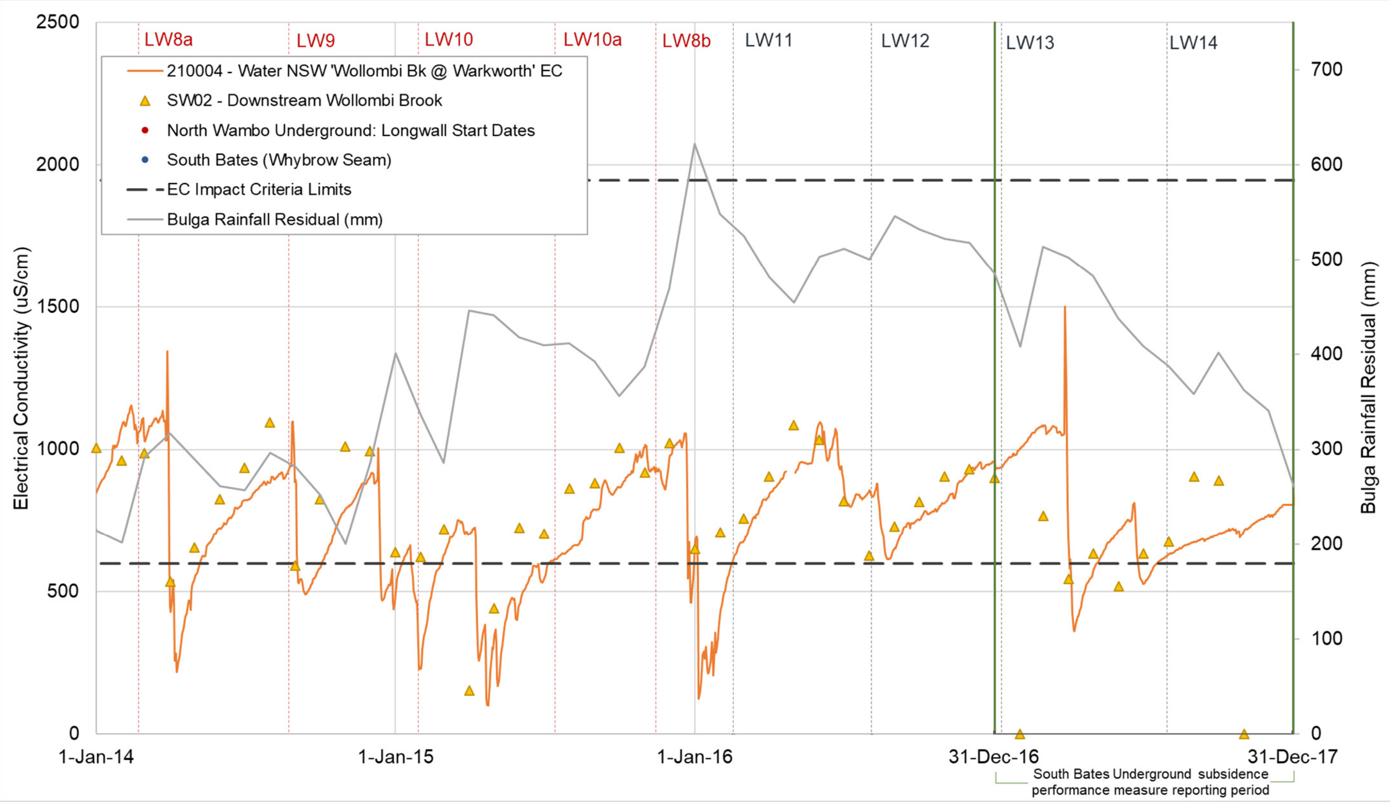


Figure 2 SW02 - EC Surface water quality data and trigger levels

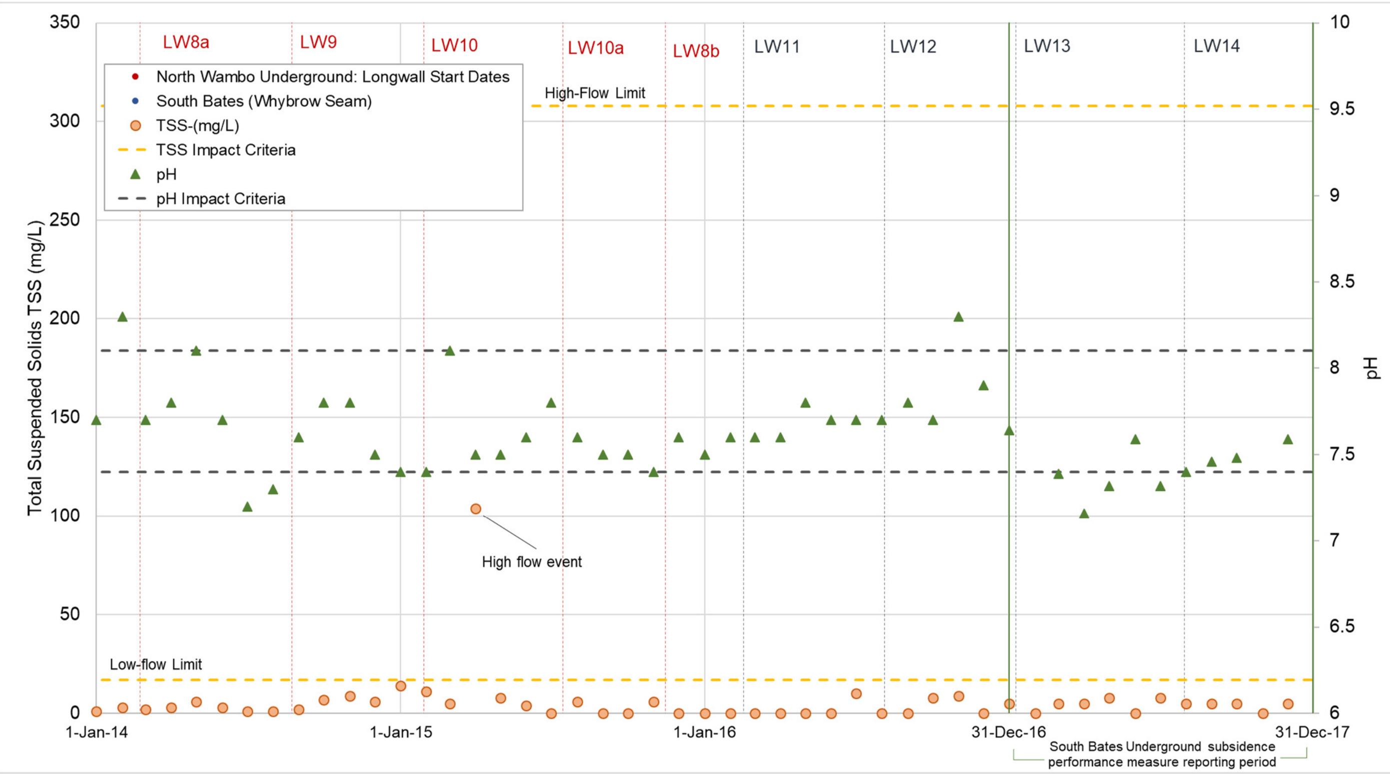


Figure 3 SW02 – pH and TSS Surface water quality data and trigger levels

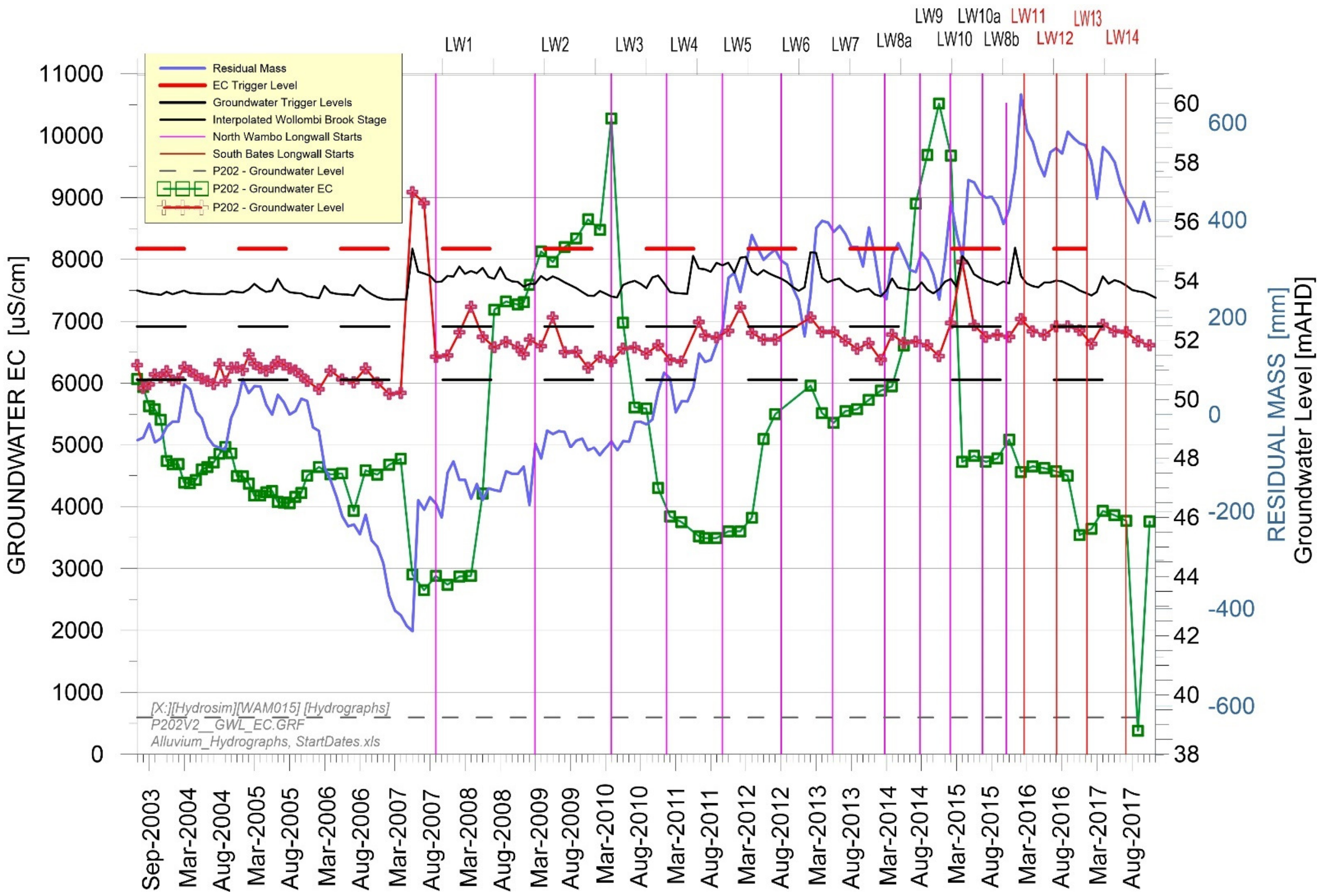


Figure 4 P202 Groundwater Level and EC data and trigger levels

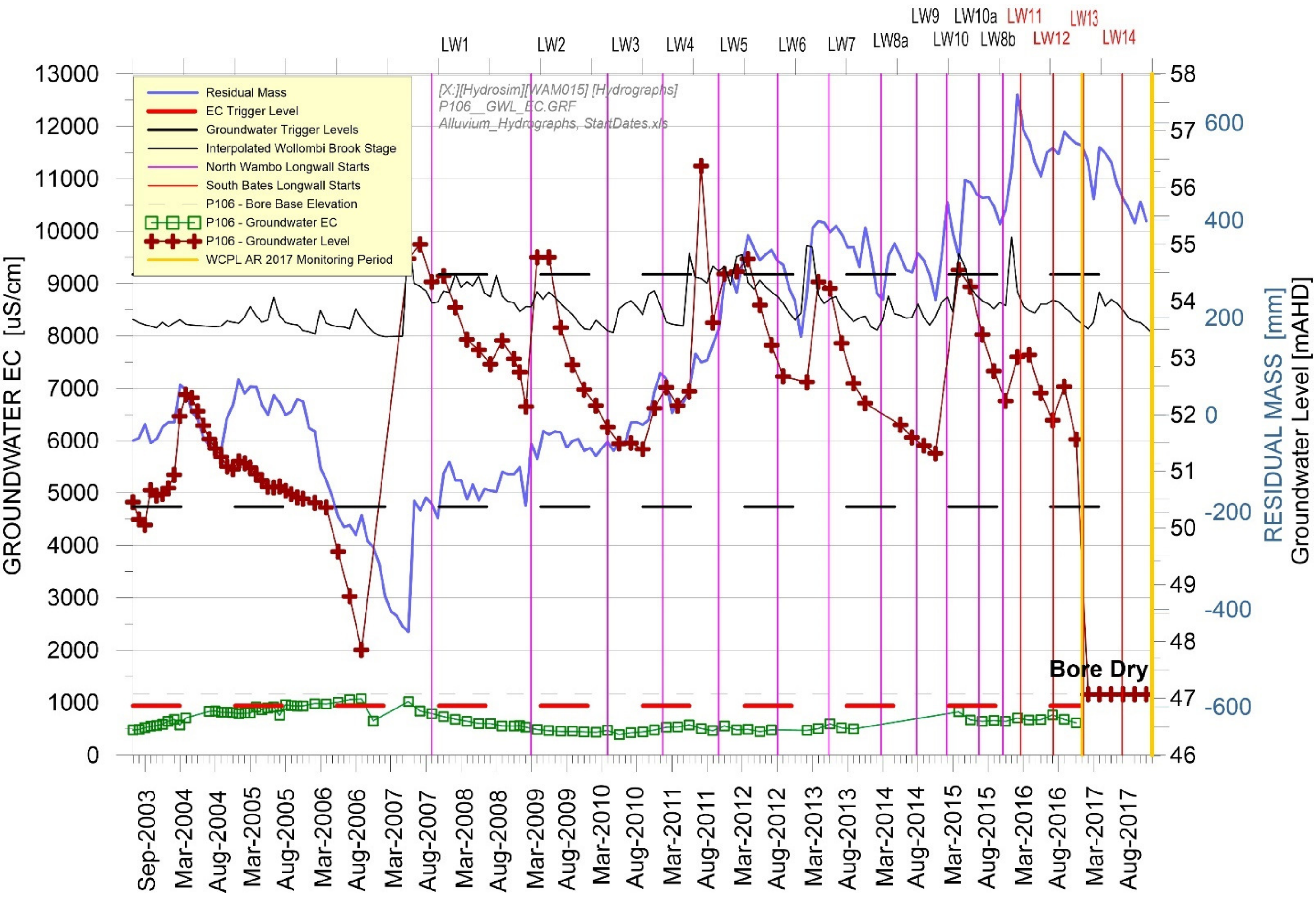


Figure 5 P106 Groundwater Level and EC data and trigger levels

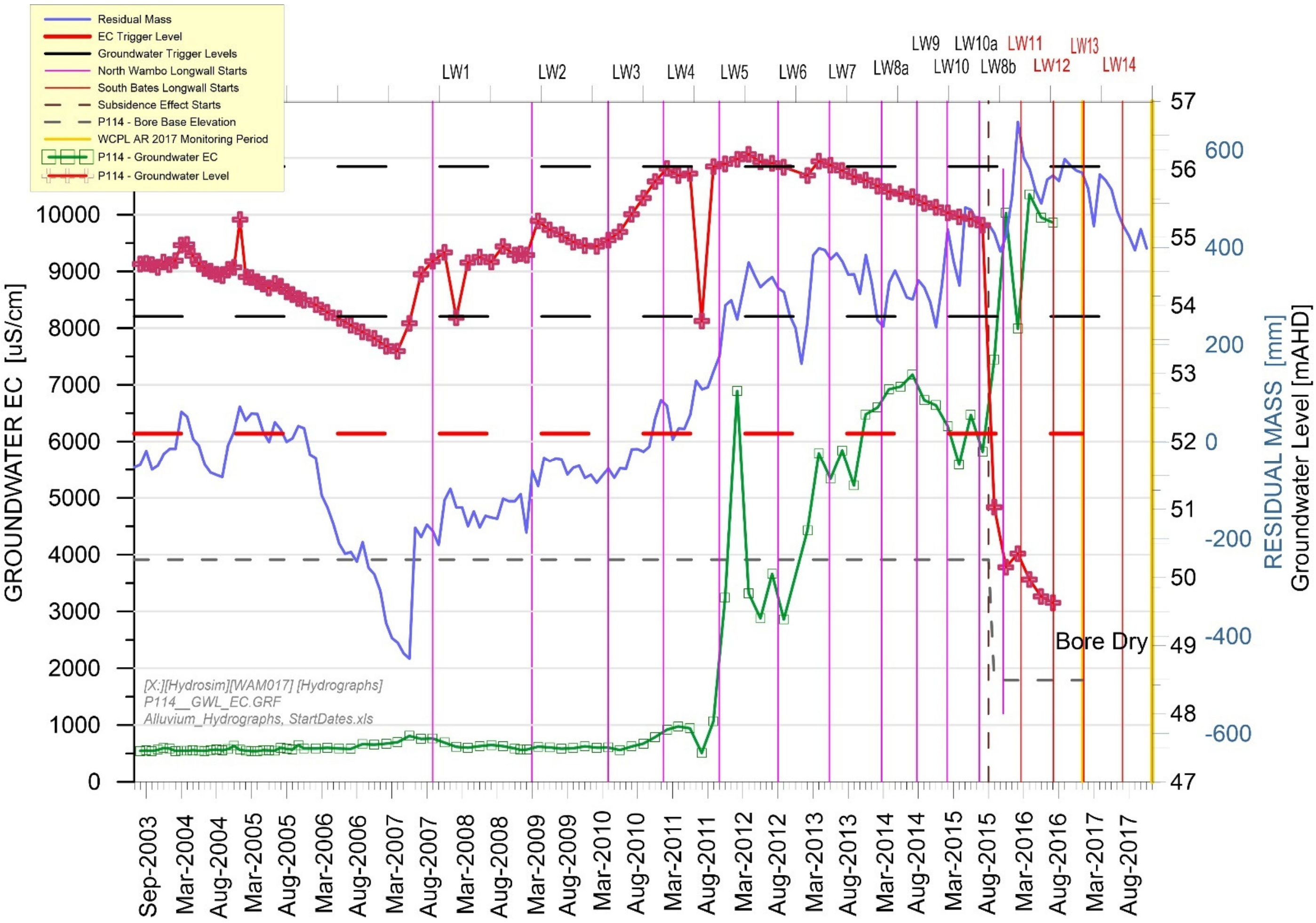


Figure 6 P114 Groundwater Level and EC data and trigger levels

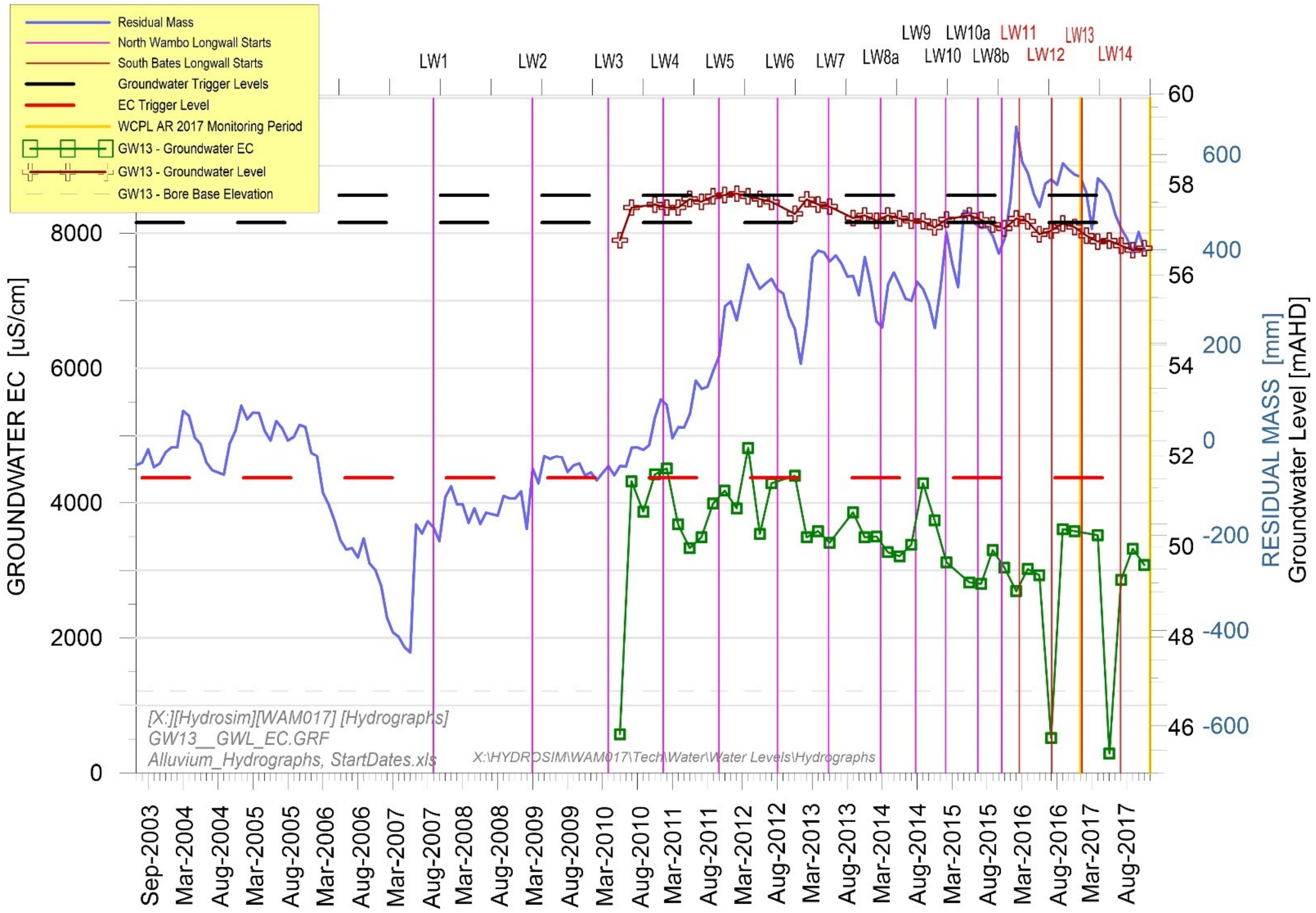


Figure 7 **GW13 Groundwater Level and EC data and trigger levels**

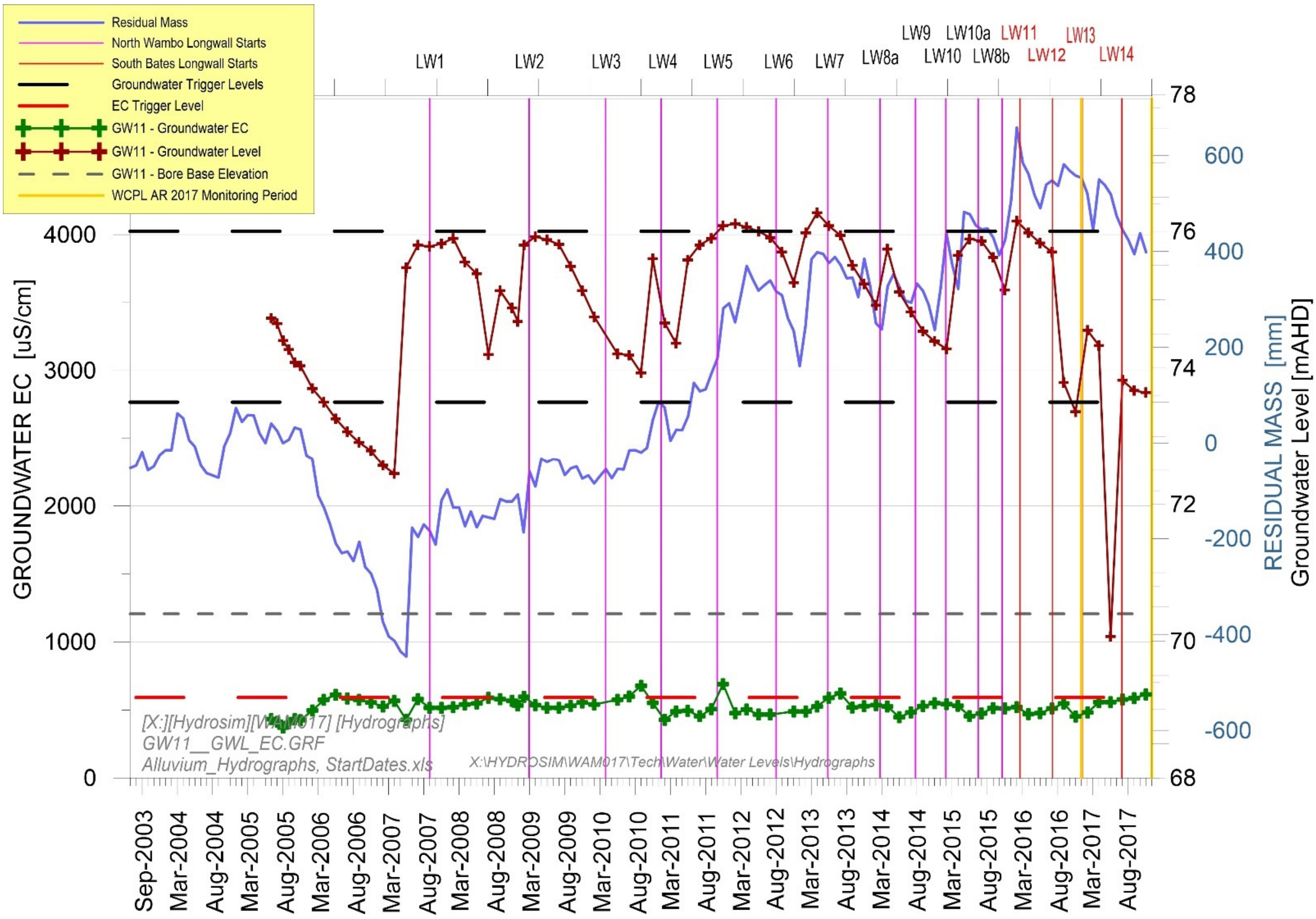


Figure 8 GW11 Groundwater Level and EC data and trigger levels

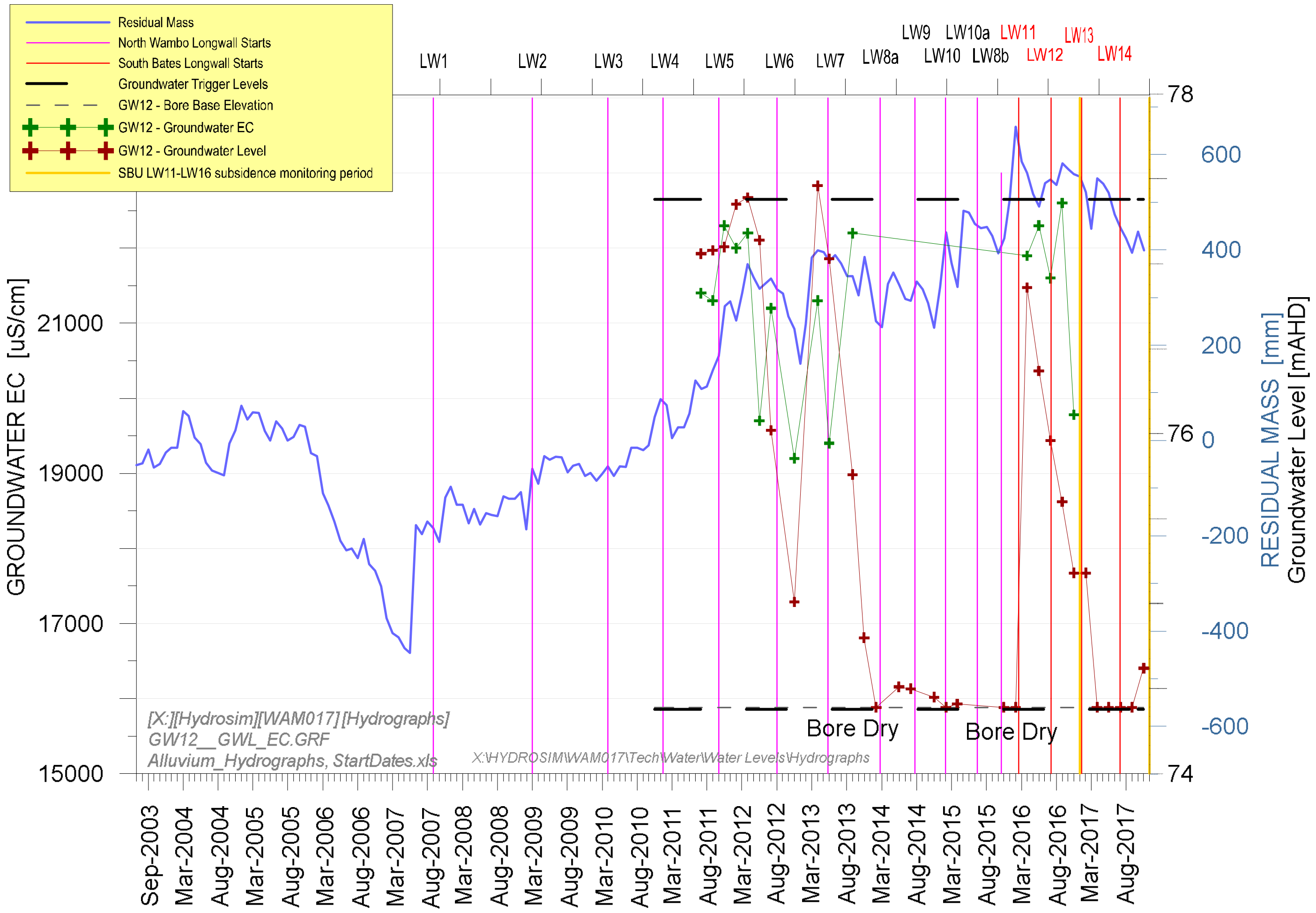


Figure 9 GW12 Groundwater Level and EC data and trigger levels

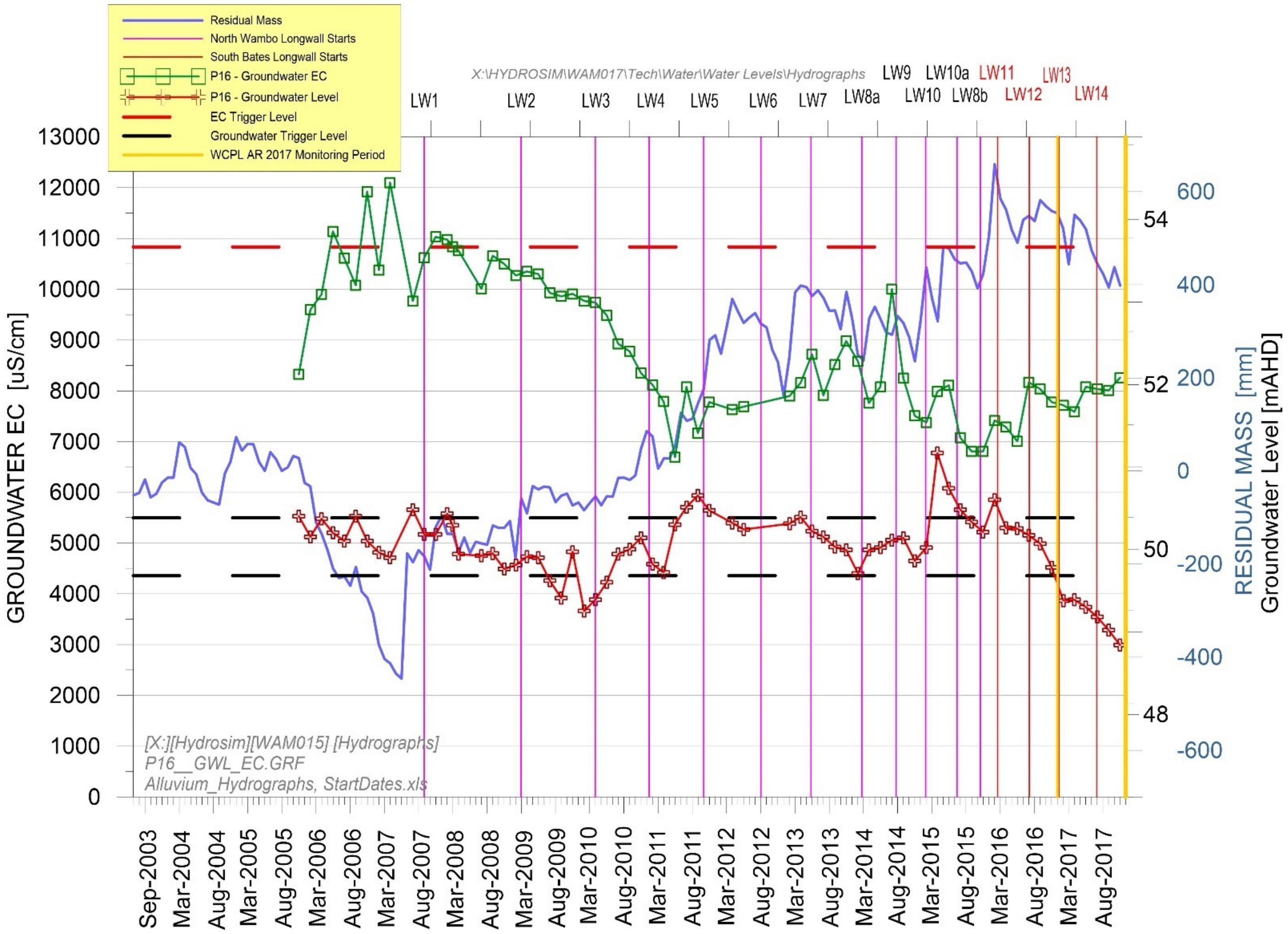


Figure 10 P16 groundwater level and EC Level and EC data and trigger levels

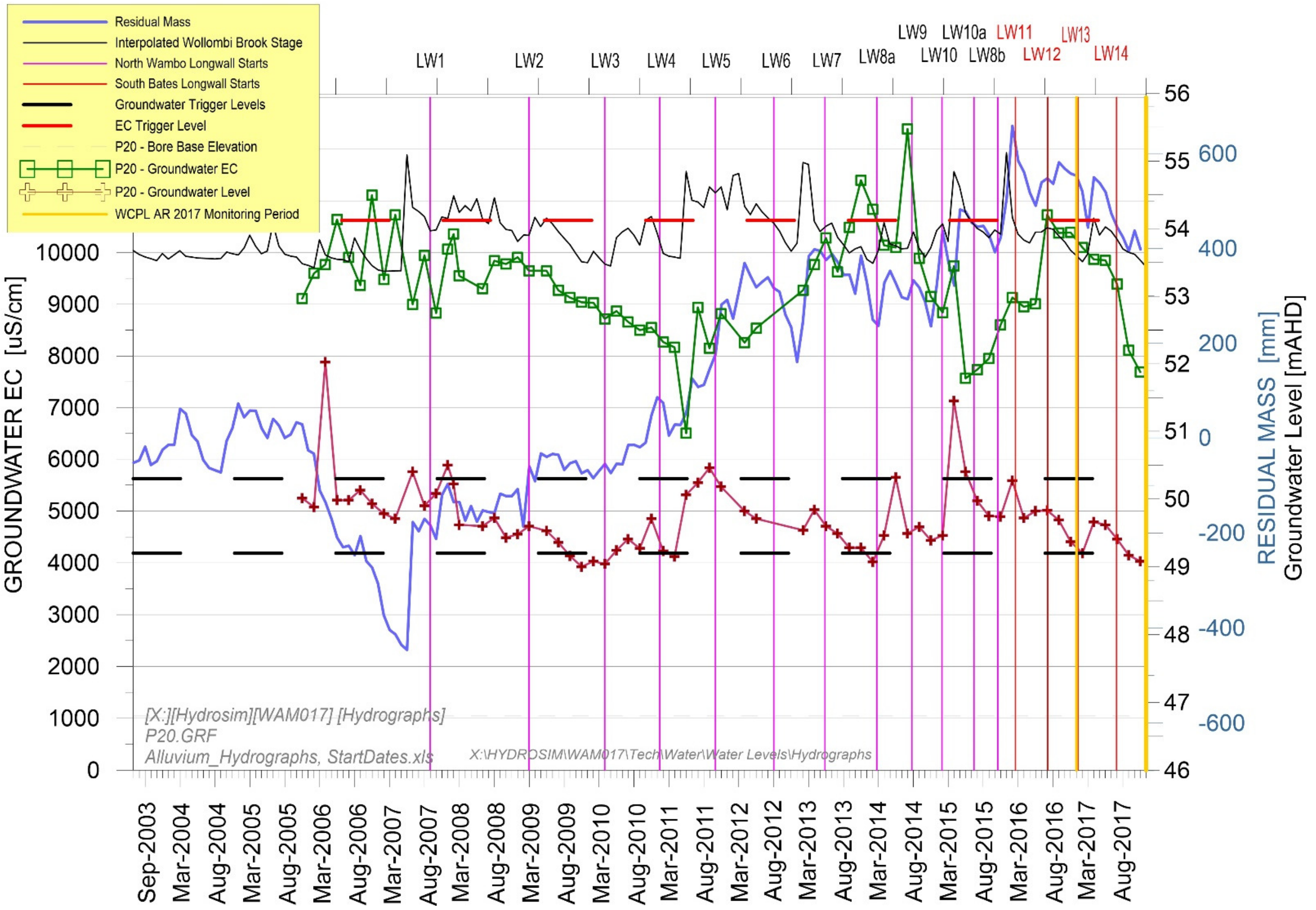


Figure 11 P20 groundwater level and EC Level and EC data and trigger levels

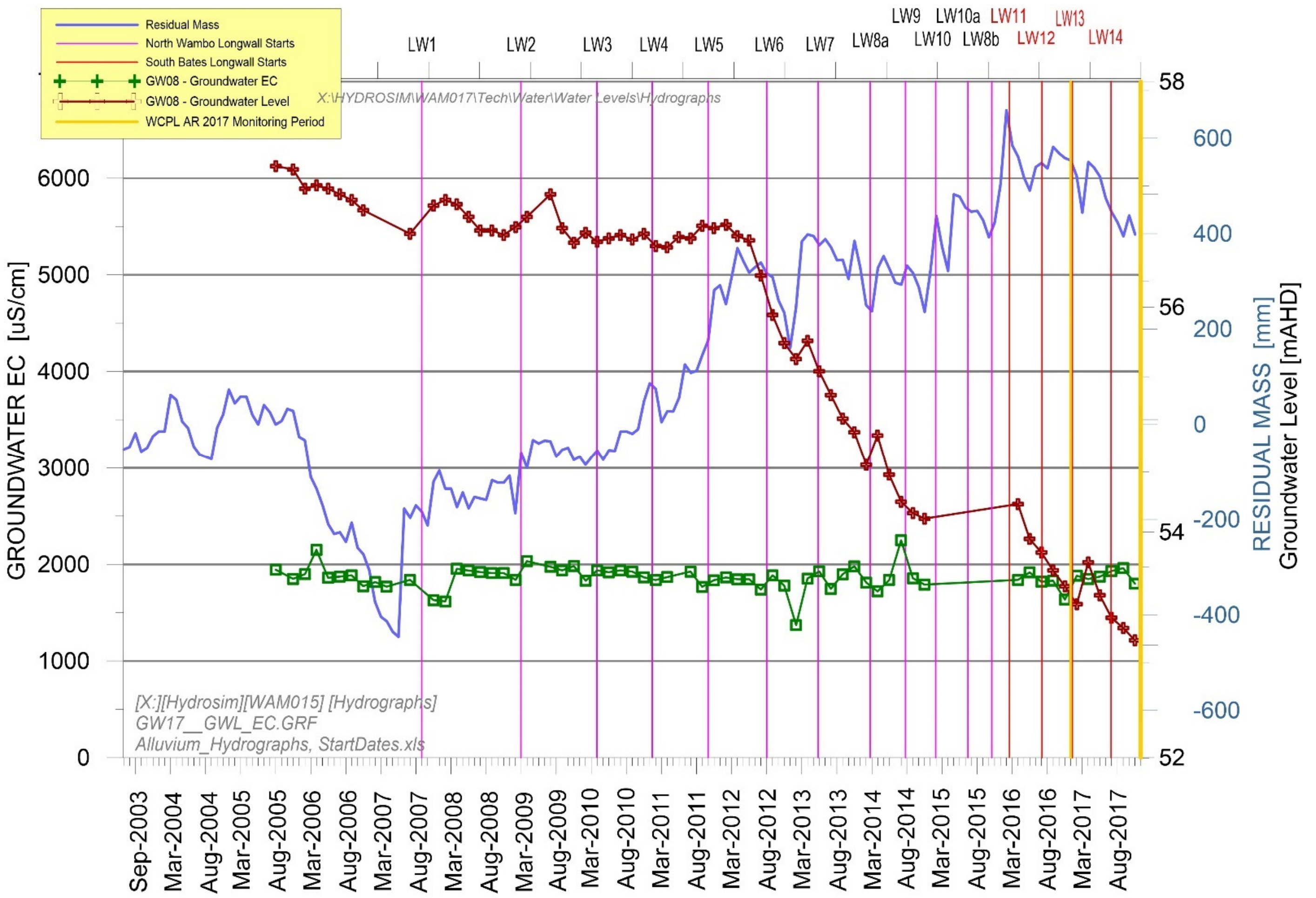


Figure 12 GW08 groundwater level and EC

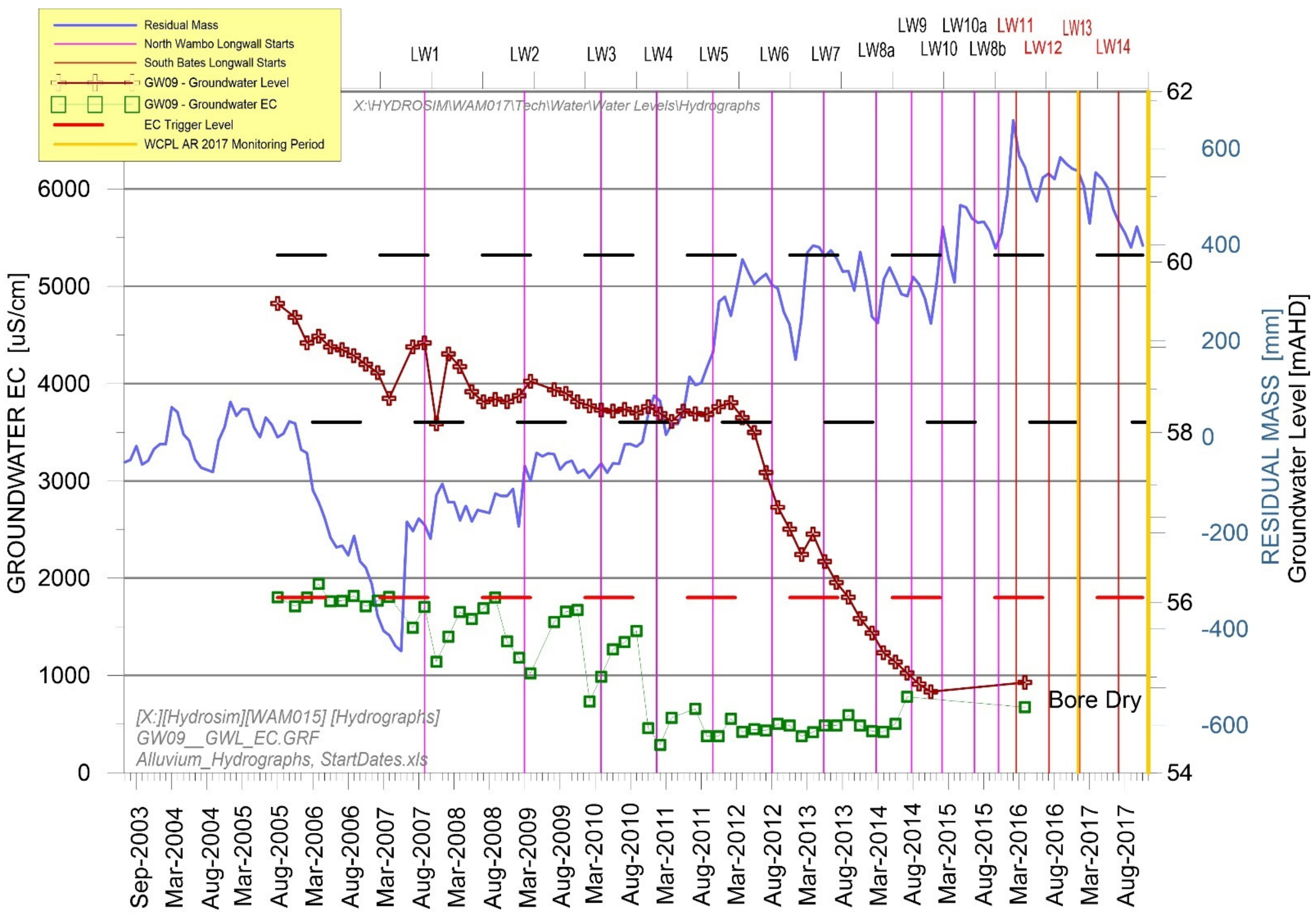


Figure 13 GW09 groundwater level and EC

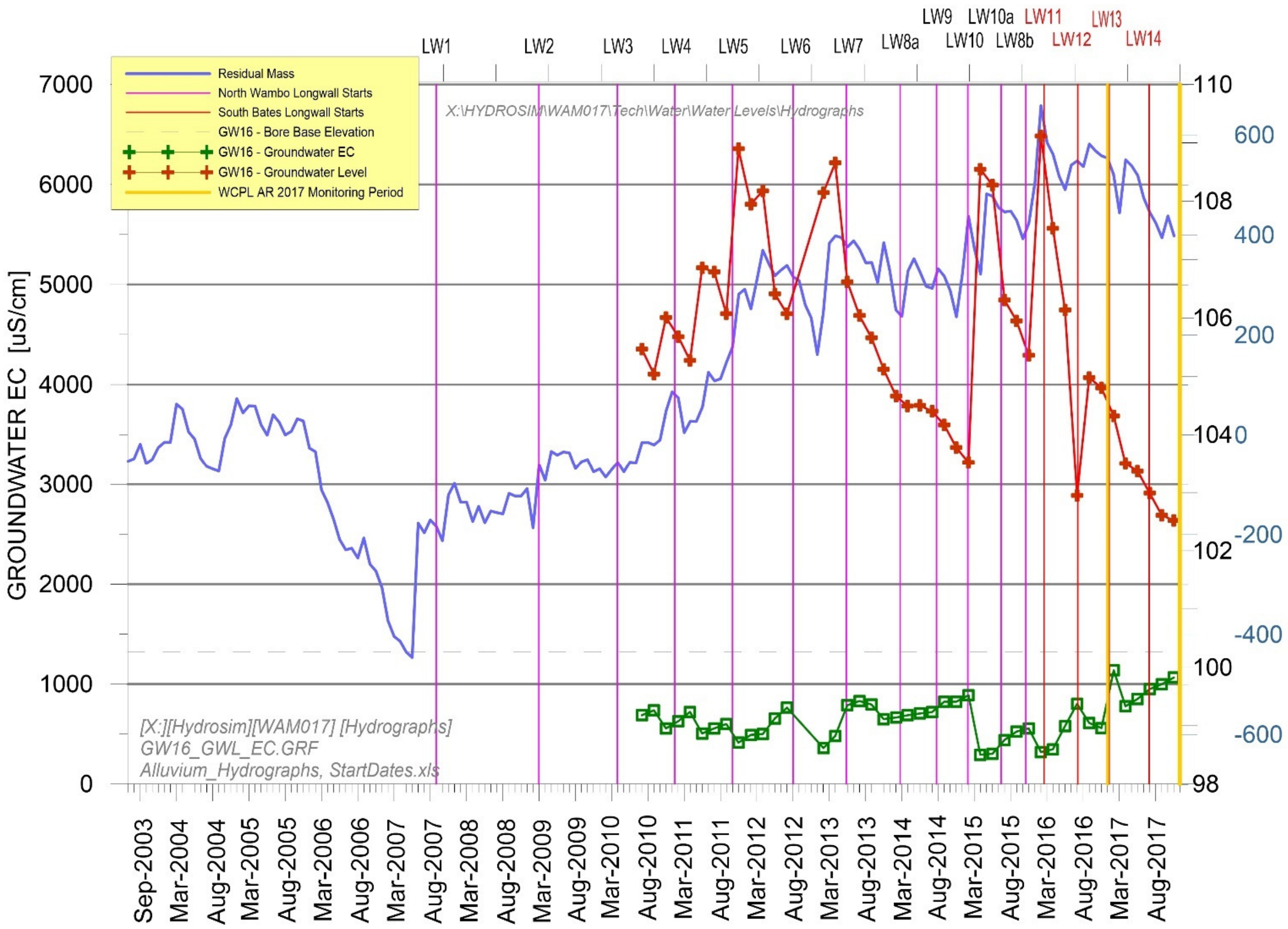


Figure 14 GW16 groundwater level and EC

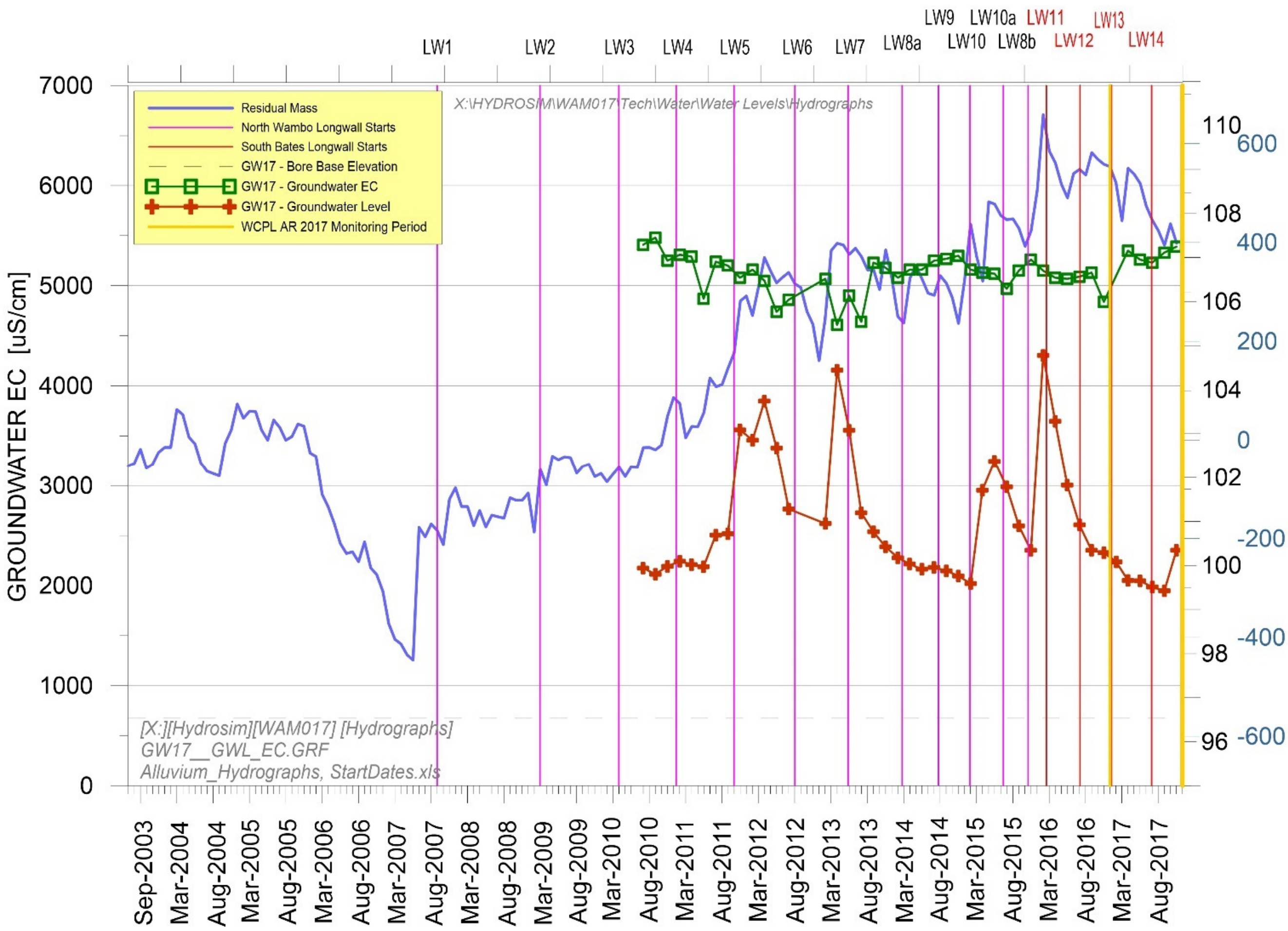


Figure 15 GW17 groundwater level and EC

NPM Technical Pty Ltd ● ABN 52 613 099 540 ● T/A **HydroSimulations**
PO Box 241, Gerringong NSW 2534. Phone: (+61 2) 4234 3802

adam.skorulis@hydrosimulations.com

DATE:	26 March 2018
TO:	Nicole Dobbins Environmental Advisor Wambo Coal Pty Ltd Peabody Energy Australia PMB 1, Singleton NSW 2330
FROM:	Dr Derek Yates and Adam Skorulis
RE:	Compliance with subsidence performance measure in the South Bates Underground Mine Extraction Plan - Longwalls 11 to16
OUR REF:	HS2018/11 [Wam022]

1 INTRODUCTION

This letter report contains the analysis and information required to address the compliance of the subsidence performance measure as outlined in the South Bates Underground (SBU) Extraction Plan for Longwalls 11 to 16. The subsidence impact performance measure assessed is: *Negligible impact to Wollombi* Brook. Compliance has been assessed using the performance indicators in **Table 1** for the reporting period: 1 Jan 2017 to 31 Dec 2017. Longwall 13 commenced on 9 January 2017, Longwall 14 extraction commenced on 30 July 2017.

Table 1 Subsidence performance measure – LW11 to LW16 SBU

Feature	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Measure
Wollombi Brook	*Surface water quality in Wollombi Brook exceeds the surface water quality criteria in the SWMP[1].*	*Negligible impact to Wollombi Brook*
	Groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP[2].	
	Groundwater quality in alluvial bores exceeds the groundwater quality criteria in the GWMP.	
	Zero flow is recorded at the Warkworth gauging station (FM10) and measurable flow is recorded at the Bulga gauging station (FM11).	

[1] Wambo Coal Surface Water Monitoring Program (Peabody 2015c)

[2] Wambo Coal Groundwater Monitoring Program (Peabody 2015b)

2 WOLLOMBI BROOK SURFACE WATER QUALITY

The impact assessment criteria for Wollombi Brook (**Table 2**) are sourced from the most recent Surface Water Monitoring Program (SWMP) (Peabody, 2015c), and are based on the 20th and 80th percentile values for the specified parameters from the available dataset. The site assessed, SW02 (**Figure 1**), is located downstream of Wambo Coal Mine, where impacts to water quality caused by mining are most appropriately assessed. However, SBU mining is about 4 km from Wollombi Brook and must have considerably less effect than North Wambo Underground (NWU) mining.

Table 2 Surface water impact criteria

Sampling Site	Parameter	Lower Limit	Upper Limit
SW02 – Wollombi Brook	pH	7.4	8.1
	EC (µS/cm)	599	1947
	TSS (mg/L)	17 (low flow) – 308 (high flow)^	

^ Low flow conditions are based on 80th percentile of recorded concentrations and high flow criteria on maximum recorded concentrations

The data assessed for the reporting period is sourced from monthly environmental reporting conducted by Wambo Coal Mine, as well as the WaterNSW online resource (NSW Office of Water, 2017) that provides daily flow and electrical conductivity (EC) data.

An exceedance occurs when water quality results exceed the 80th percentile trigger values after two consecutive sampling events for Level 1 response management measures and three consecutive sampling events for Level 2 response contingency phase (Peabody, 2015d).

Throughout the reporting period there have been no exceedances of the EC limits at SW02 (**Figure 2**). A freshening period is observed to fall below the lower limit in the daily monitoring at the WaterNSW 'Wollombi Bk @ Warkworth' site early in the reporting period. However, this raises no concern as the freshening is likely associated with periods of rainfall (**Figure 2**).

No exceedances of Total Suspended Solid levels (TSS) occurred for 'Low Flow' conditions during the 2016 monitoring period (**Figure 3**).

The pH level fell below the lower limit on two occasions in 2017 (Mar-Apr and Jun-Jul), but these events are of no concern, being coincident with the periods of rainfall mentioned above.

3 ALLUVIAL GROUNDWATER LEVEL

Alluvial groundwater level criteria assessed for exceedances in this letter are sourced from the most recent GWMP (Groundwater Monitoring Program) (Peabody, 2015b). These are based on minimum and maximum depth-to-water trigger levels derived from 10th and 90th percentiles of historical recordings.

The GWMP lists 19 bores with trigger levels, though five bores have N/A entries. The trigger values are not assessment criteria but are used to initiate investigations according to the Surface and Ground Water Response Plan (SGWRP) (Peabody, 2015d). The SGWRP provides a protocol for the investigation, notification, and mitigation of identified exceedances of these assessment criteria. To investigate potential groundwater leakage from Wollombi Brook, the Trigger Action Response Plan (TARP) in the SGWRP considers the water level responses at 10 named bores (Peabody, 2015d):

- Level 1 – Response Management Measures: Groundwater monitoring of standing water levels in bores P106, P109, P114, P116 within the Wambo Creek alluvium and GW13 and GW15 within the Wollombi Brook alluvium, identifies a decreasing trend, beyond natural fluctuations and predicted modelled impacts; for more than two consecutive monitoring events, and/or

- Level 2 – Response Contingency Phase: Groundwater monitoring of standing water levels in bores GW08 and GW09 and GW016 and GW017 within the North Wambo Creek alluvium, exceed the standing water trigger values as provided in the GWMP, beyond natural fluctuations, for more than three consecutive monitoring events.

3.1 Level 1 Response Management Measures

Groundwater level at 8 alluvial bores have shown exceedances of the trigger levels during the 2017 monitoring period (P202, P106, P114, GW13 GW11, GW12, P16, P20 shown in **Figures 4** to **11**).

P202 (**Figure 4**) shows only a single exceedance of the minimum depth-to-water, correlating with a spike in the average rainfall trend in early 2017. This does not require further investigation.

The remaining 7 bores (P114, P106, P16, P20, GW11, GW12, GW13) show exceedances of the maximum depth-to-water trigger level during the 2017 monitoring period. P106, P114 and GW13 are included in the TARP (see below).

3.1.1 TARP Bores

Data available to HydroSimulations indicates the depth of P106 to be 14 m (**Figure 5**). For P106 to reporting a true 'dry' reading, the groundwater level at P106 would have to have dropped by ~5.5m between December 2016 and February 2017, the largest decline observed between 2 bi-monthly measurements since the beginning of observation by a factor of 5. While a low river stage and decreasing rainfall trend, or an ongoing mining effect caused by Longwall 10a extraction may be responsible for the 'dry' observations. HydroSimulations recommends further investigation of the bore to check that it has not silted up or suffered collapse. The apparent decline in groundwater level is unrelated to SBU mining.

P114 (**Figure 6**) is reporting as dry for the entire monitoring period, indicating a maximum depth-to-water trigger exceedance for all 2017 observations. This is a clear ongoing effect from the mining of Longwall 10a. The mining effect is unrelated to SBU mining.

GW13 (**Figure 7**) shows triggers occurred for the entire 2017 monitoring period, to the lowest recorded groundwater levels. The approaching Warkworth open cut is the likely cause, given its proximity to GW13 (approximately 1 km east). NWU completed operations in December 2015, and is between GW13 and SBU. It is therefore unlikely that NWU or SBU are the cause of declining groundwater levels at GW13.

3.1.2 Non-TARP Bores with Trigger Exceedances

GW11 (**Figure 8**) reports a groundwater level below the maximum depth-to-water trigger in June 2017. This observation exceeds the trigger level by ~3.4 m, indicating a groundwater level that is lower than the base of the bore according to data available HydroSimulations. This value is then followed by a groundwater recovery in August 2017, returning to compliance with the trigger level conditions. It is difficult to explain the sharp decline in groundwater level at GW11. GW11 is located within the alluvium associated with Wambo Creek, upstream to the NWU and SBU mining at a distance of 1.5km and 3.5km respectively. No mining effect is likely to impact GW11 at this time and no significant dry condition has been recorded between January and June 2017 to induce the observed decline. Furthermore, no major rainfall event was recorded before the rapid groundwater recovery in August 2017. It is possible an error has been made with the groundwater level measurement in June 2017. HydroSimulations recommends that GW11 collar elevation be resurveyed as well as dipped for bore depth at the next bi-monthly observation. There is no SBU mining effect observed at GW11 during the 2017 period of measurement.

GW12 (**Figure 9**) exhibits an ongoing mining effect from North Wambo Underground longwall extraction, trigger exceedances are observed from April to October 2017 with the bore reported dry. A recovery of ~0.2 m is observed to December 2017 which likely indicates a rainfall response despite the long-term trend showing below average conditions. The mining effect observed at GW 12 is unlikely to be related to SBU mining.

The monitoring bores P16 (**Figure 10**) and P20 (**Figure 11**) are located downstream of the mining operations along the Wollombi Brook and less than a kilometre upstream to the FM10 Wambo flow monitoring site. At P16 a declining groundwater level of approximately1.5m is observed from March 2016 to December 2017. In 2017, P16 reports six groundwater levels below the maximum depth-to-water trigger with the last record exceeding the trigger level by 0.84m. While the declining groundwater levels during 2017 correlate with a declining rainfall and stage height trend, the observations are the lowest recorded for the entire period of measurement and do not show the same previously observed response to peaks in rainfall and river stage. P20 is located near P16 and has two groundwater level observations below the maximum depth-to-water trigger in October and December 2017. Groundwater level at P20 correlates with the long-term rainfall trend and an interpolated Wollombi Brook stage height throughout the period of measurement. A large hydraulic gradient between the river stage and the groundwater level at P16 and P20 is present. It is believed that the alluvial aquifer at P16 and P20 could be disconnected from the Wollombi Brook. Vertical recharge from the river to the alluvial aquifer can occur, however the decrease in the Wollombi Brook stage height induces a reduction in recharge through the unsaturated zone and consequently in the groundwater level at P16 and P20. No mining effects can be identified at P16 and P20, NWU operations have been completed since December 2015, the open cut found North of the bores has yet to commence and the nearest SBU LW13 is 5.2 km away.

3.2 Level 2 - Response Contingency Phase

An assessment of groundwater level for bores GW08, GW09, GW16 and GW17 is required as part of the TARP for Wollombi Brook and Wambo Creek Alluvium. The current GWMP (WCPL, 2015) does not provide trigger values for these bores. An assessment has been conducted on all bores within the Level 2 TARP to examine groundwater data during the 2017 monitoring period, and identify any trends occurring beyond natural fluctuations.

GW08 (**Figure 12**) and GW09 (**Figure 13**) have both displayed an ongoing NWU mining effect since mid-2012, that is observed through until the end of 2017. In 2017, observations at GW09 demonstrate the bore is still dry. Groundwater levels at GW08 increase in April 2017 followed by a gradual decline in groundwater level of less than 1 m to December 2017, corresponding to the long-term rainfall trend. The ongoing decline in groundwater levels and dry condition at GW08 and GW09 respectively, may now also be related to the decrease in the long-term rainfall trend taking place in 2017. While a North Wambo underground mining effect may be ongoing. any possible recovery associated with the cessation of dewatering, could be muted by the conditions of below average rainfall.

In absence of specific trigger values, the GWMP (WCPL, 2015) suggests the installation of replacement bores near GW08 and GW09 if no recovery is observed within 12 months of the cessation of dewatering NWU workings. Despite the possibility of recovery being muted by below average rainfall, HydroSimulations would see value in the installation of new standpipe bores, monitoring both alluvium and underlying interburden material above NWU workings. This would allow for a better understanding of recovery or ongoing impacts associated with NWU mining. No South Bates Underground mining effect is observed at GW08 or GW09.

Previous reporting (HydroSimulations 2016, 2017) attributed earlier fluctuations of groundwater level at GW16 (**Figure 14**) and GW17 (**Figure 15**) to climate and ephemeral flows in North Wambo Creek as the main influences on groundwater level. The increasing amplitude in groundwater level response, particularly at GW16, indicates a likely mining effect from the removal of material from the adjacent open cut, given that declines in groundwater level during 2016 and early 2017 are contrary to the rainfall trend. The rapid recovery that is observed following increases in the rainfall trend is likely due to ephemeral flow in North Wambo Creek and a low specific yield in its associated alluvium. As previously assessed, the removal of material from Montrose open cut is likely developing regional depressurisation and consequently likely to also responsible for the low groundwater level at GW16 and GW17 during 2017. This would be enhanced by the below average rainfall during 2017, indicated by a declining long-term rainfall trend. The approved SBU Longwalls (11-26) are over 2km from GW16 and GW17 and are unlikely to be causing an observable mining effect.

4 ALLUVIAL GROUNDWATER QUALITY

Alluvial groundwater quality criteria assessed for exceedances in this report are sourced from the most recent GWMP (Groundwater Monitoring Program) (Peabody, 2015b). The GWMP lists 15 bores with EC and pH trigger values, but three have N/A entries.

Water quality triggers for EC are based on 90th percentile values from recorded historical data at each bore. An exceedance of the 90th percentile EC value in three consecutive bi-monthly observations triggers an investigation.

At Wambo pH is consistently between 6 and 8 at most alluvial monitoring locations. 10th and 90th percentile values are used as minimum and maximum exceedance values. An investigation is triggered following exceedances on two consecutive bi-monthly monitoring events.

No EC exceedances are observed during the 2017 monitoring period. It should be noted, that dry bores such as GW12, P106 and P114 are not able to provide EC readings.

No exceedances of pH requiring an investigation occurred during the reporting period. It should be noted, that dry bores such as GW12, P106 and P114 are not able to provide pH readings.

5 WOLLOMBI BROOK FLOW DIFFERENTIAL

The performance indicator for flow at Wollombi Brook is considered exceeded if the Warkworth gauging station (FM10) records zero flow, and the Bulga gauging (FM11) station records measurable flow at the same time (**Figure 1**).

HydroSimulations was not provided with site recordings of flow by Wambo Coal Mine for FM10, or FM11. Discharge rate data in ML/ day was therefore downloaded from the WaterNSW website (NSW Office of Water, 2017) for the 'Wollombi Bk at Bulga' (station number: 210008) and 'Wollombi Bk at Warkworth' (station number: 210004), which correlate with FM11 and FM10 respectively. Wollombi Brook discharge is initially presented using a logarithmic y-axis scale (**Figure 16**) to clearly capture the relationship between gauging stations in periods of both low and high flow. It is again presented for the reporting period only, using a regular y-axis (**Figure 17**) to display the apparent differential between flow at the gauging stations between periods of low and near zero flow.

Previous reporting (HydroSimulations, 2017) identified trends in discharge volumes between the two Wollombi Brook gauging stations. Early data shows an excellent match between discharge rates at both stations, with low and declining flow conditions showing generally higher discharge volumes at the Warkworth gauging station than at the Bulga gauging station. This is expected due to the larger catchment area downstream at the Warkworth gauging station, as well as tributaries such as Wambo, Sandy, and North Wambo Creeks feeding flow.

At the beginning of the reporting period (January to March 2017), the upstream Bulga (FM11) gauging station reports a measurable flow (although very low, <1 ML/day), while the downstream Warkworth (FM10) gauging station reports no-flow (**Figure 9)** This effect was first observed in late November 2016 (HydroSimulations ,2017), preceded by a flow recession beginning mid-November, in which the downstream, Warkworth site recorded a decline in flow earlier, and at a greater rate than the Bulga site. This is a change from historical observations and may indicate a change in the relationship between flows at the two locations. However, a return to previously observed trends, in which the flow rate at the Warkworth station retains a higher discharge rate than the Bulga station during declining flow conditions, is observed following rainfall events and subsequent periods of high flow in April and June 2017

A period of zero flow in the downstream Warkworth gauging station and measurable flow in the upstream Bulga gauging station also occurs from September 2017 to December 2017, again with only very low flows <1 ML/day recorded at the Bulga Station. This period of low flow correlates with a large decline in the long-term rainfall trend.

An exceedance of the subsidence performance indicator for flow in Wollombi Brook occurs at both the beginning and end of the 2017 reporting period and may indicate an exceedance of the performance measure for the South Bates Underground mine to have a '*negligible impact on Wollombi Brook*'. It is difficult to directly correlate this lack of flow at the Warkworth gauging station with longwall extraction at South Bates Underground. The South Bates longwalls are over 3.5 km away from Wollombi Brook which is likely to be too distant to cause any direct effect. Impacts to Wollombi Brook from South Bates longwall extraction would most likely be caused by impacts to the now diverted North Wambo Creek. An impact on the flow in Stony Creek is unlikely given the substantial depth of cover (for the coal seam) at the south-western ends of the SBU longwall panels.

A reduction in discharge due to South Bates mining from North Wambo Creek could result in the current observed flow pattern, in which the low upstream flow at Bulga is lost to groundwater before reaching the downstream Warkworth gauging station, coupled with reduced replenishment of Wollombi Brook with North Wambo Creek tributary flow.

While this explanation would be reasonable in the absence of other nearby stresses, the nearby Warkworth open cut (minimum 1.5 km from Wollombi Brook), ongoing effects from North Wambo Underground longwall extraction and the Montrose Open Cut are likely to be still affecting Wollombi

Brook and North Wambo Creek discharge. This indicates that the if impacts observed are mining related, they are likely to be cumulative from all mining occurring in the area rather than specifically attributable to South Bates Underground.

6 ASSESSMENT OF PERFORMANCE MEASURE AND RECOMMENDATIONS

In the event that the subsidence impact performance measure relating to water is exceeded or likely to be exceeded, the Extraction Plan for South Bates Underground Mine Longwalls 11 to 16 details a contingency plan that should be employed to more accurately assess the cause of the exceedance.

A summary assessment is given in **Table 3**.

Table 3 Subsidence impact performance measure – SBU LW11-LW16

Feature	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Measure	Subsidence Impact Performance Indicator Exceeded?	Overall Subsidence Impact Compliance Upheld
Wollombi Brook	*Surface water quality in Wollombi Brook exceeds the surface water quality criteria in the SWMP.*	*Negligible impact to Wollombi Brook*	**No**	**Yes**[1]
	Groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP.		**Yes (at P106, P114, GW13, P16, P20, GW11, GW12, GW08, GW09, GW16, GW17)**	
	Groundwater quality in alluvial bores exceeds the groundwater quality criteria in the GWMP.		**No**	
	Zero flow is recorded at the Warkworth gauging station (FM10) and measurable flow is recorded at the Bulga gauging station (FM11).		**Yes**	

1 Subject to change – Non-compliance may be indicated following further investigation of surface water flows as recommended by HydroSimulations.

Exceedances have been observed at:

- P106 – observed dry bore not consistent with previous observations, further investigation requested;
- P114 – which can no longer be considered representative of alluvium;
- GW13 – most likely affected by Warkworth Mine; and
- P16 - not in the TARP;
- P20 - not in the TARP;
- GW11 – not in the TARP;
- GW12 – not in the TARP;

- GW08, GW09 – Not affected by SBU mining. However, no recovery observed following the cessation of NWU dewatering, recommended installation of replacement bores;

- GW16, GW17 – most likely affected by Montrose open cut and below average rainfall;

- FM10 – zero flow at downstream gauging station.

None of the exceedances of water level or EC can be confidently attributed to SBU mining. The absence of flow at the FM10 gauging station is unlikely to be attributable to SBU mining, given a separation of 4 km between the mine and Wollombi Brook, unless flows in North Wambo Creek have been captured.

HydroSimulations recommends further assessment flow at Wollombi Brook to identify the cause of zero flow downstream at FM10 (Warkworth gauging site) and measurable flow FM11 upstream. This should include analysis of the flows in North Wambo Creek at gauging stations FM2 and FM4 to test whether flow has been reduced below normal levels as a result of SBU mining beneath the North Wambo Creek Diversion.

7 REFERENCES

HydroSimulations (2016a) *Wambo Annual Review Groundwater Analysis*. Report HC2016/07 for Wambo Coal Pty Ltd. March 2016

HydroSimulations (2016b) *South Wambo Underground Mine Modification - Groundwater Assessment*. Report HC2016/01 for Wambo Coal Pty Ltd. March 2016

NSW Office of Water (2017) http://realtimedata.water.nsw.gov.au/water.stm?ppbm=DAILY_REPORTS&dr&3&drkd_url Accessed 20/3/2017

Peabody (2015a) *Subsidence Monitoring Program for North Wambo Underground Mine Longwalls 8 to 10A.* Document Number SWMP LW8-10a. April 2015

Peabody (2015b) *Wambo Coal Groundwater Monitoring Program.* Document No. WA-ENV-MNP-509.1. October 2015

Peabody (2015c).*Wambo Coal Surface Water Monitoring Program.* Document No. WA-ENV-MNP-509.2. October 2015

Peabody (2015d).*Wambo Coal Surface and Ground Water Response Plan.* Document No. WA-ENV-MNP-509.4. October 2015

Filepath: X:\HYDROSIM\WAM022\WP\HS2018_11a_SBU_SubsidenceCompliance_2017.docx

Figures

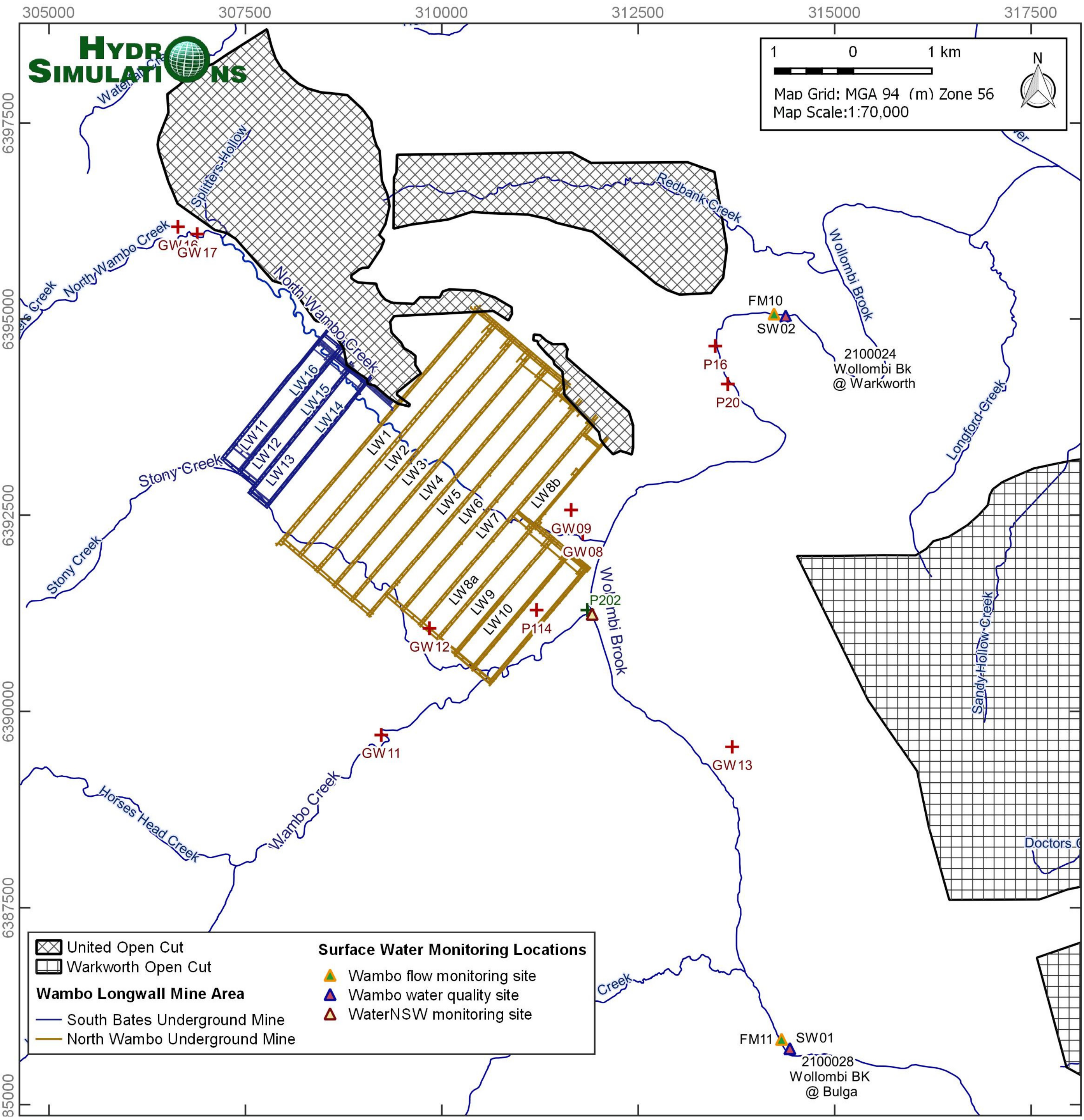


Figure 1 Locations of groundwater and surface water sites discussed in this report.

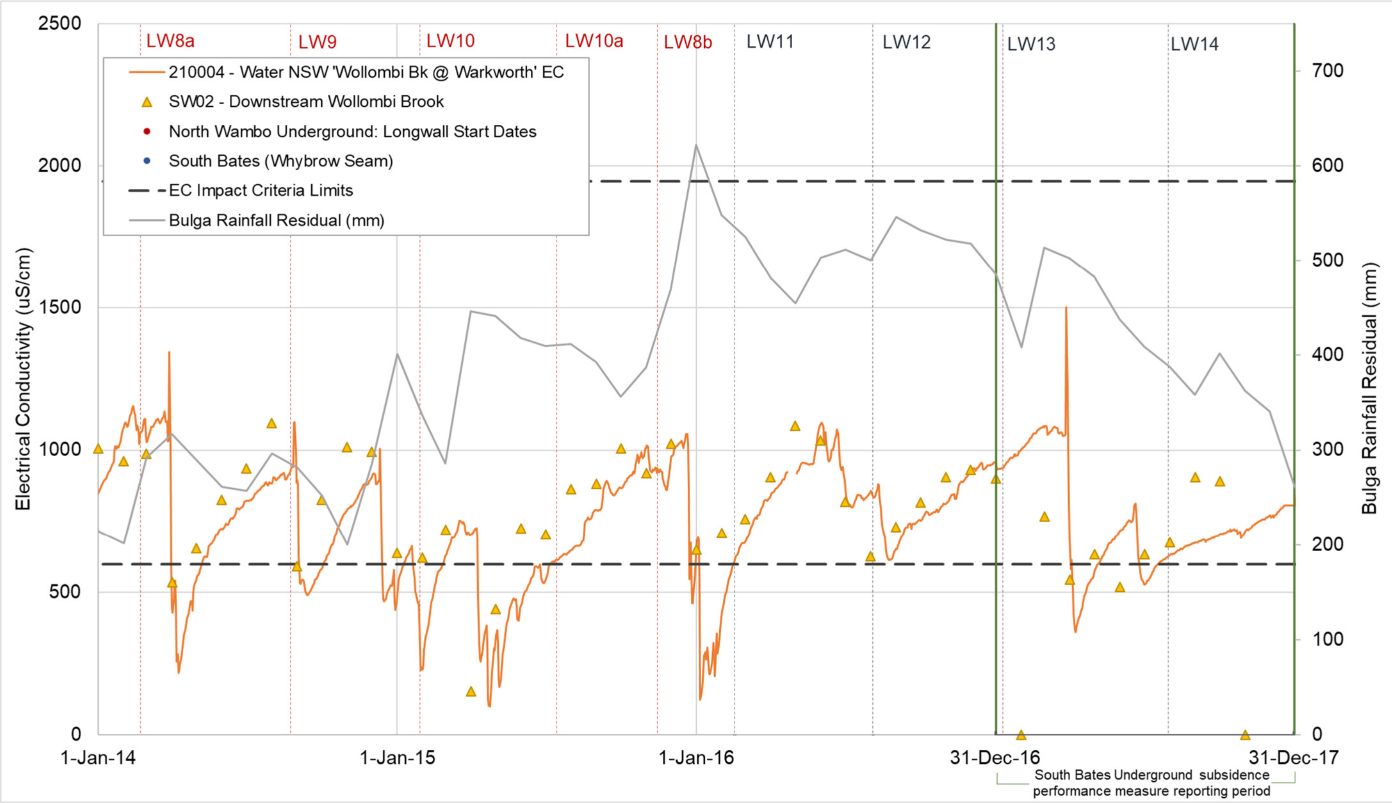


Figure 2 SW02 - EC Surface water quality data and trigger levels

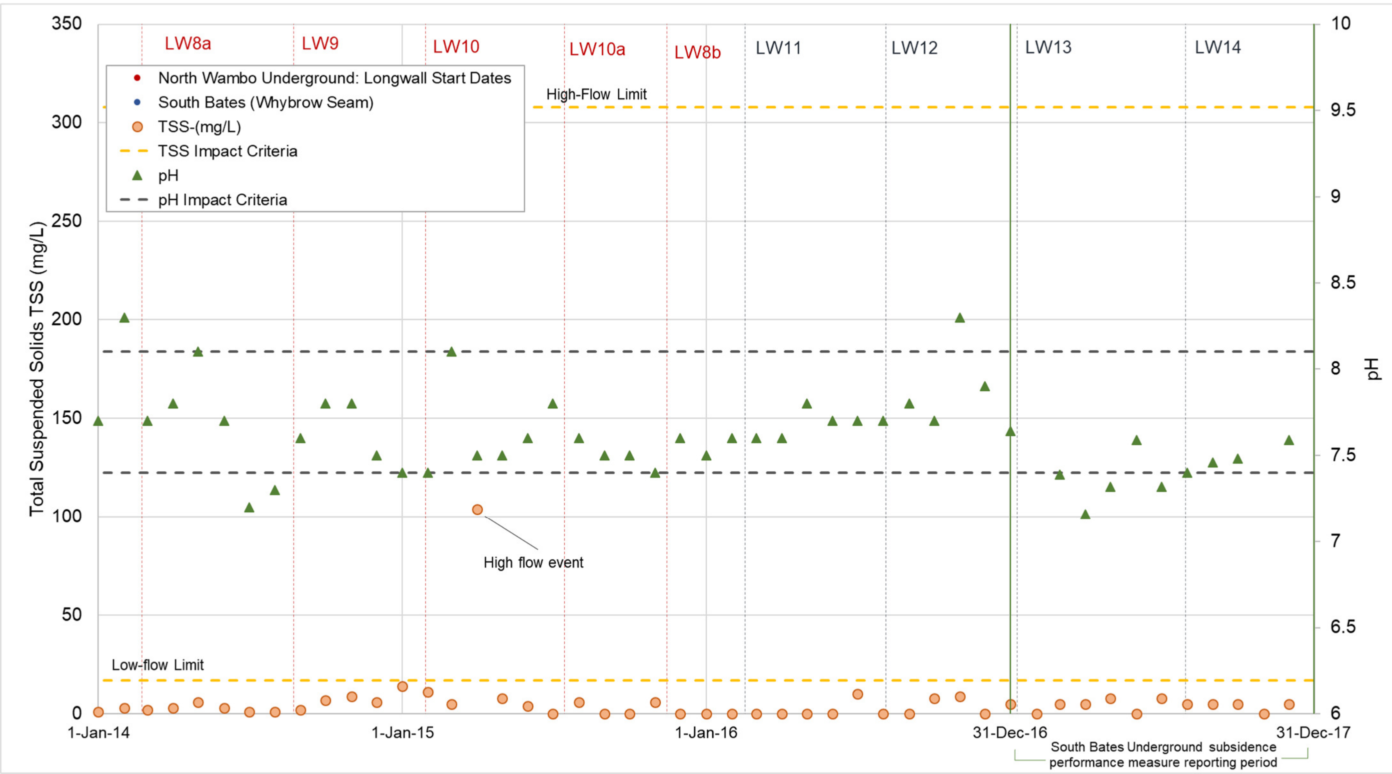


Figure 3 SW02 – pH and TSS Surface water quality trigger level

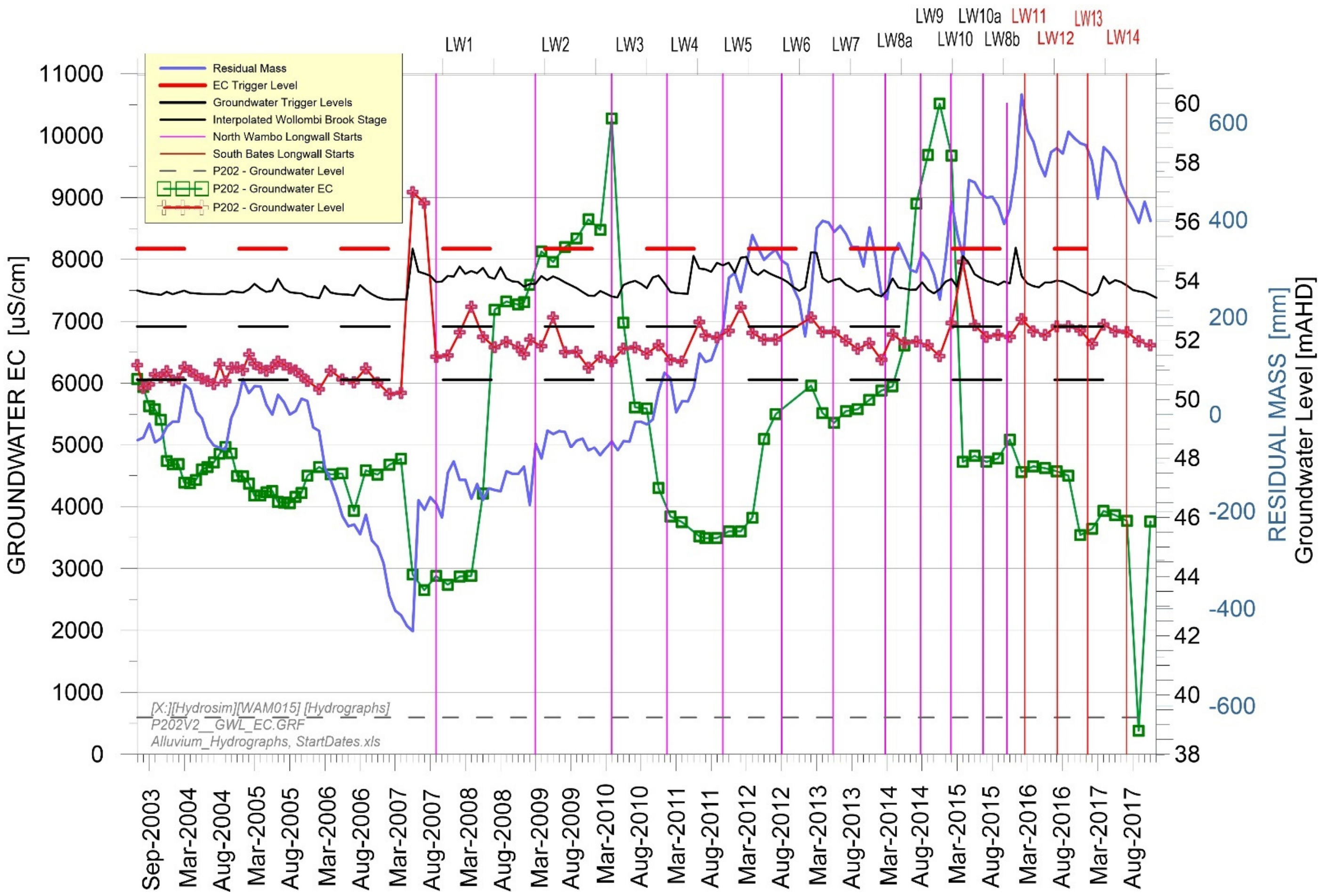


Figure 4 **P202 Groundwater Level and EC data and trigger levels**

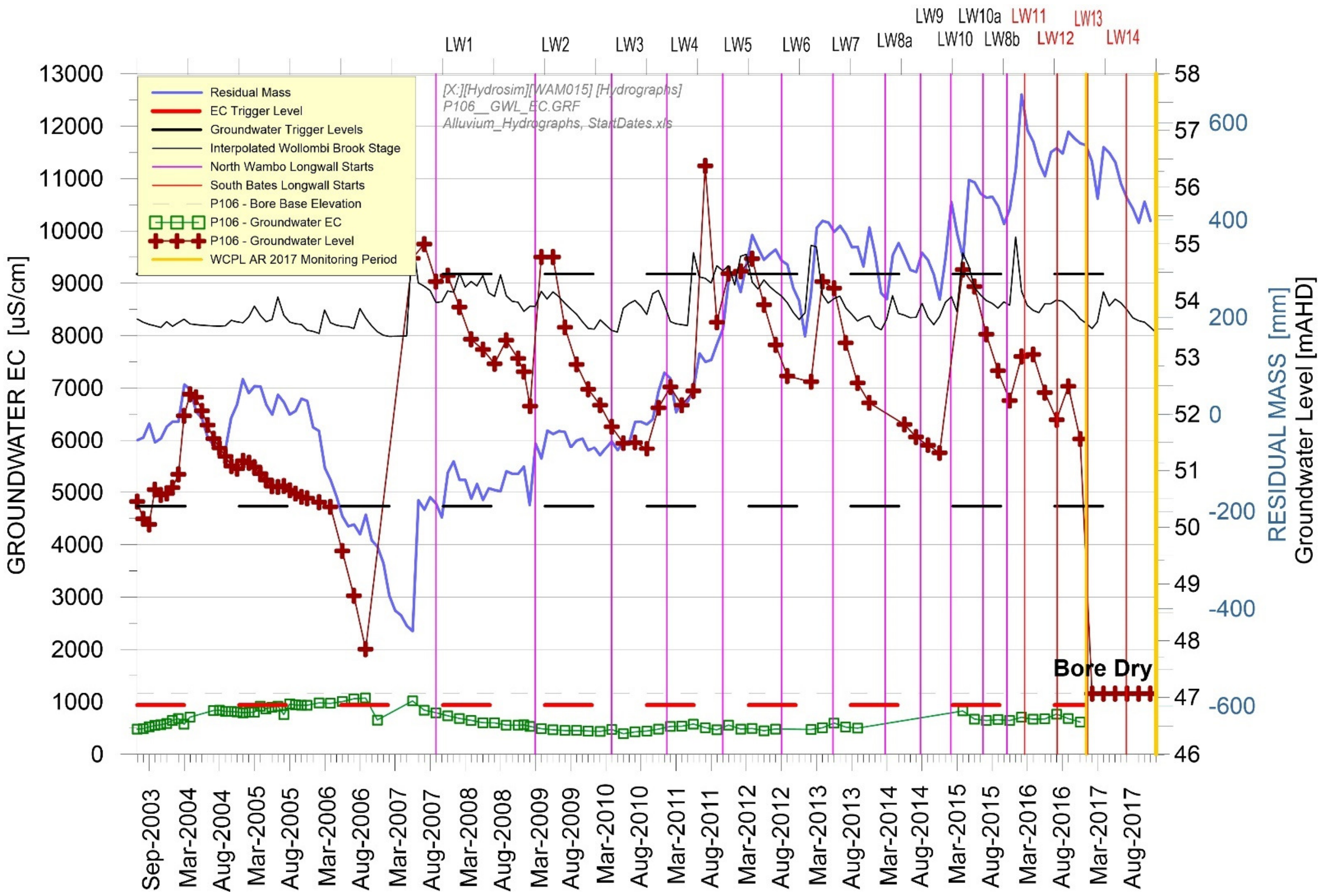


Figure 5 P106 Groundwater Level and EC data and trigger levels

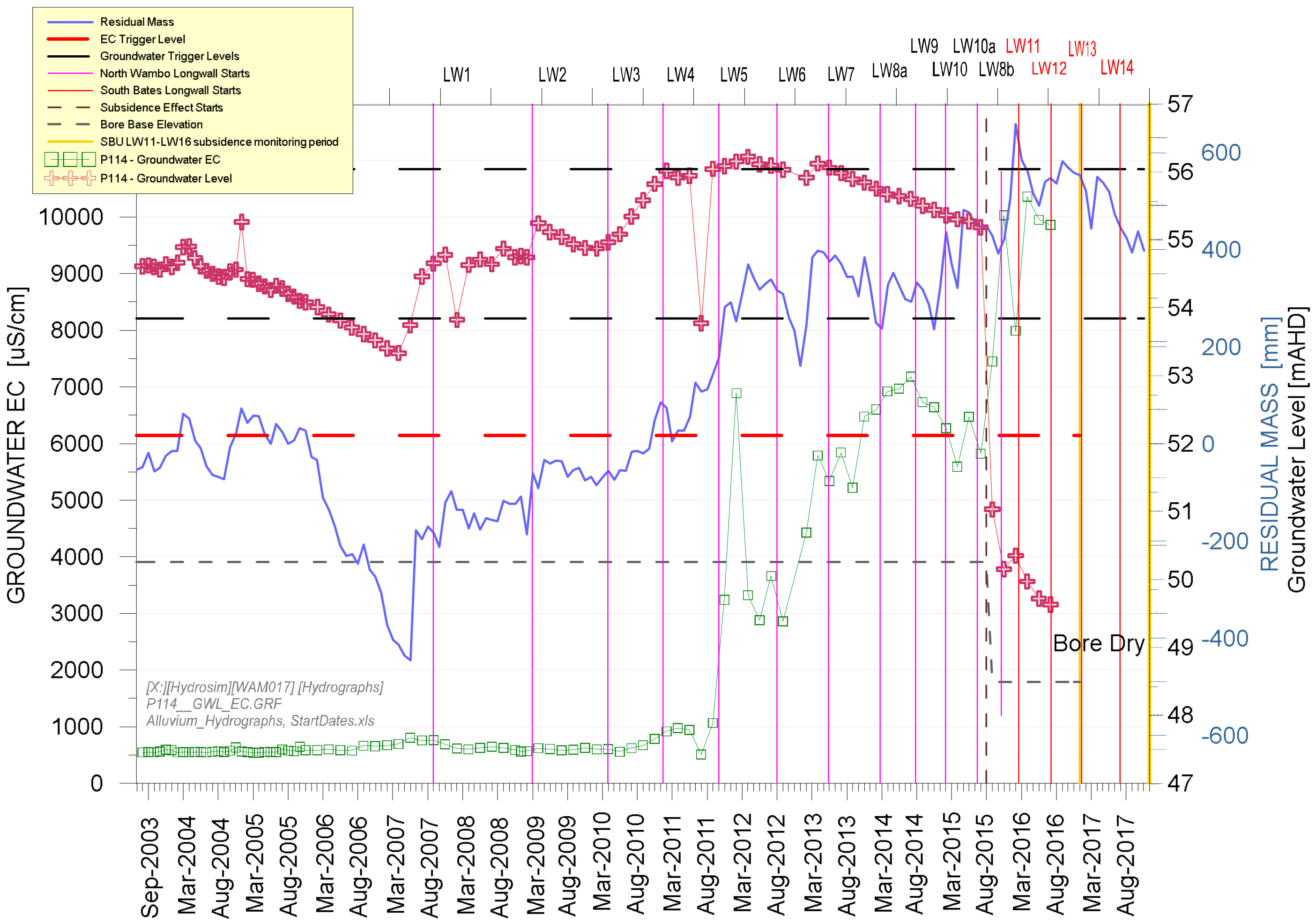


Figure 6 **P114 Groundwater Level and EC data and trigger levels**

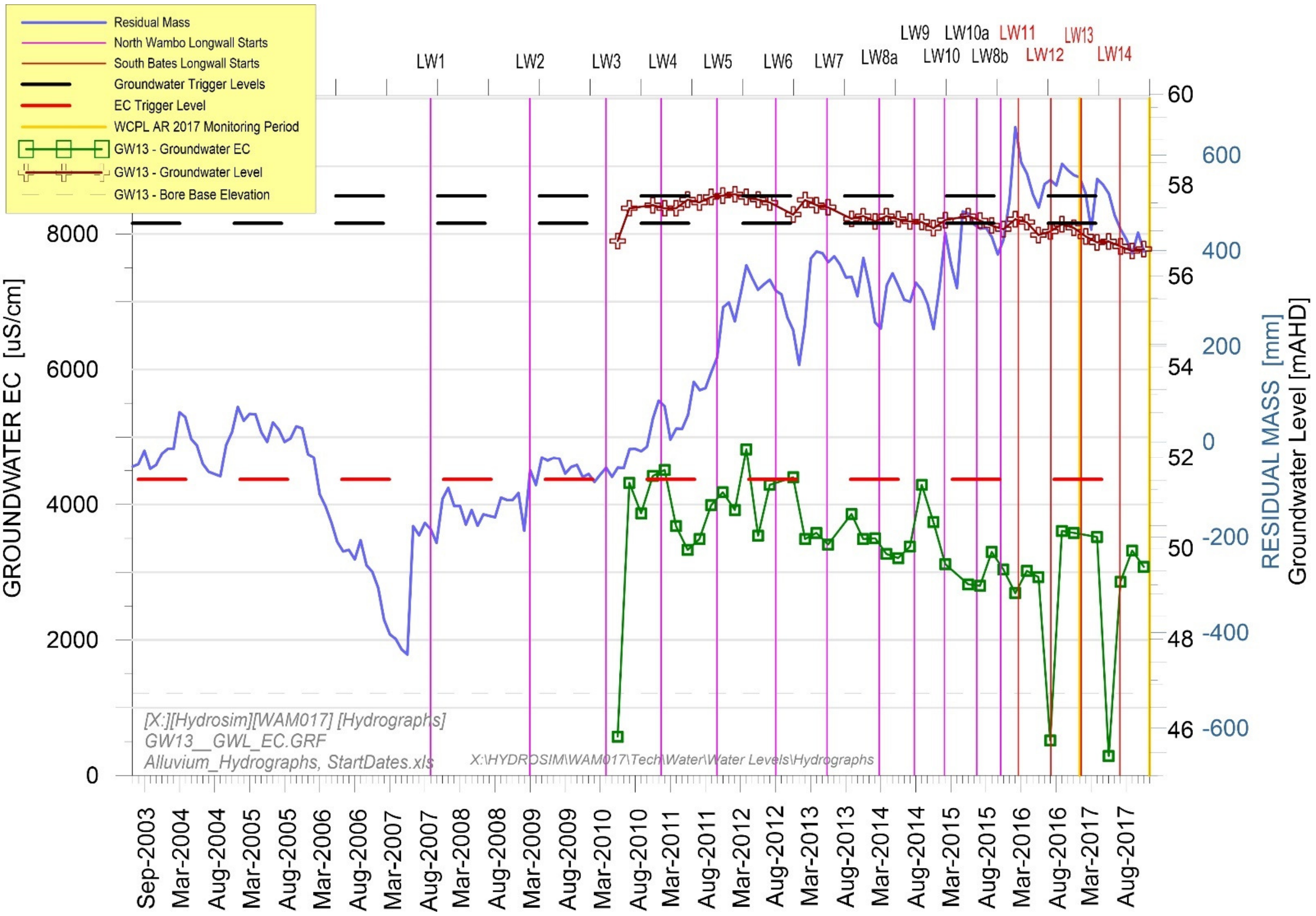


Figure 7 GW13 Groundwater Level and EC data and trigger levels

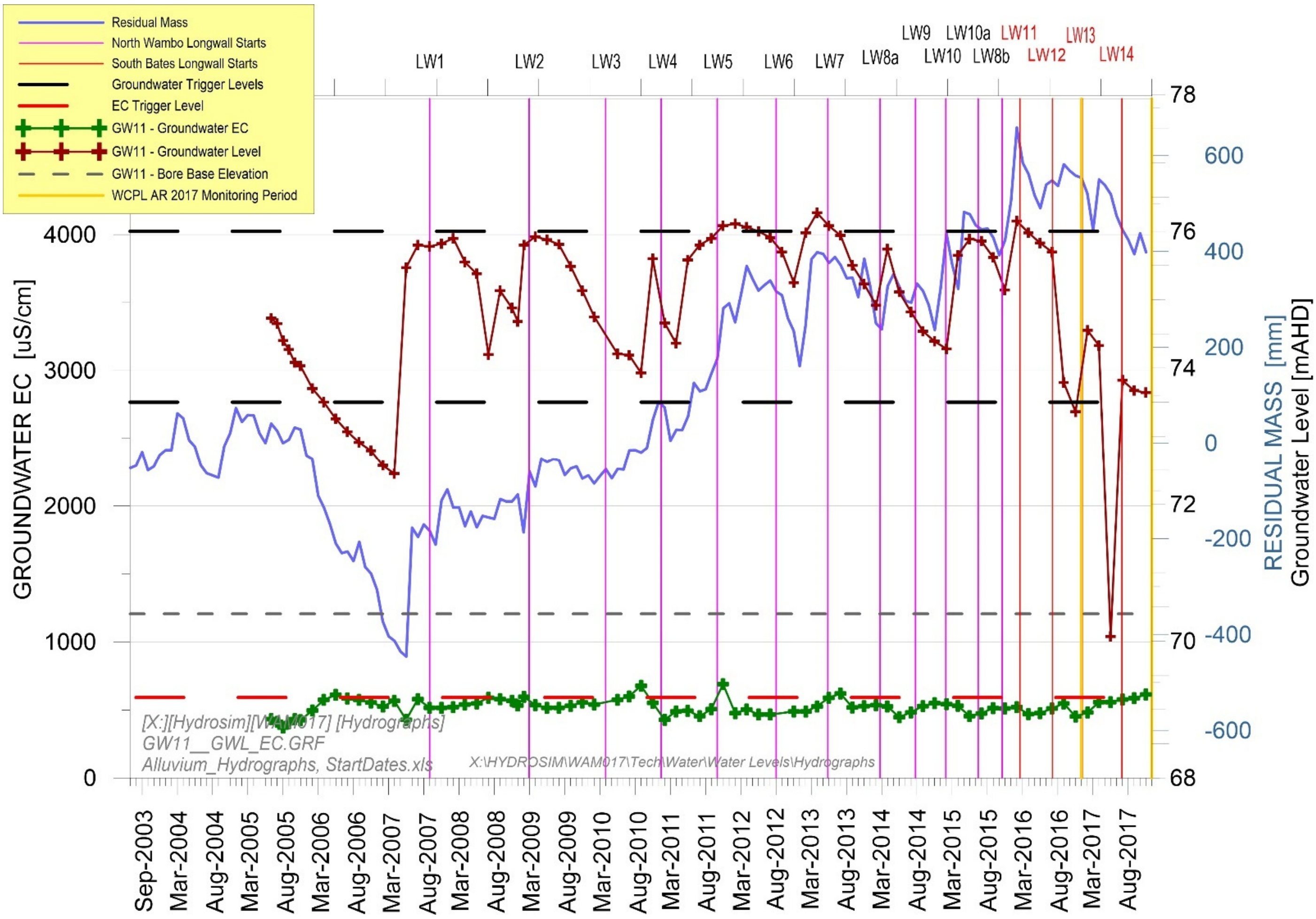


Figure 8 GW11 Groundwater Level and EC data and trigger levels

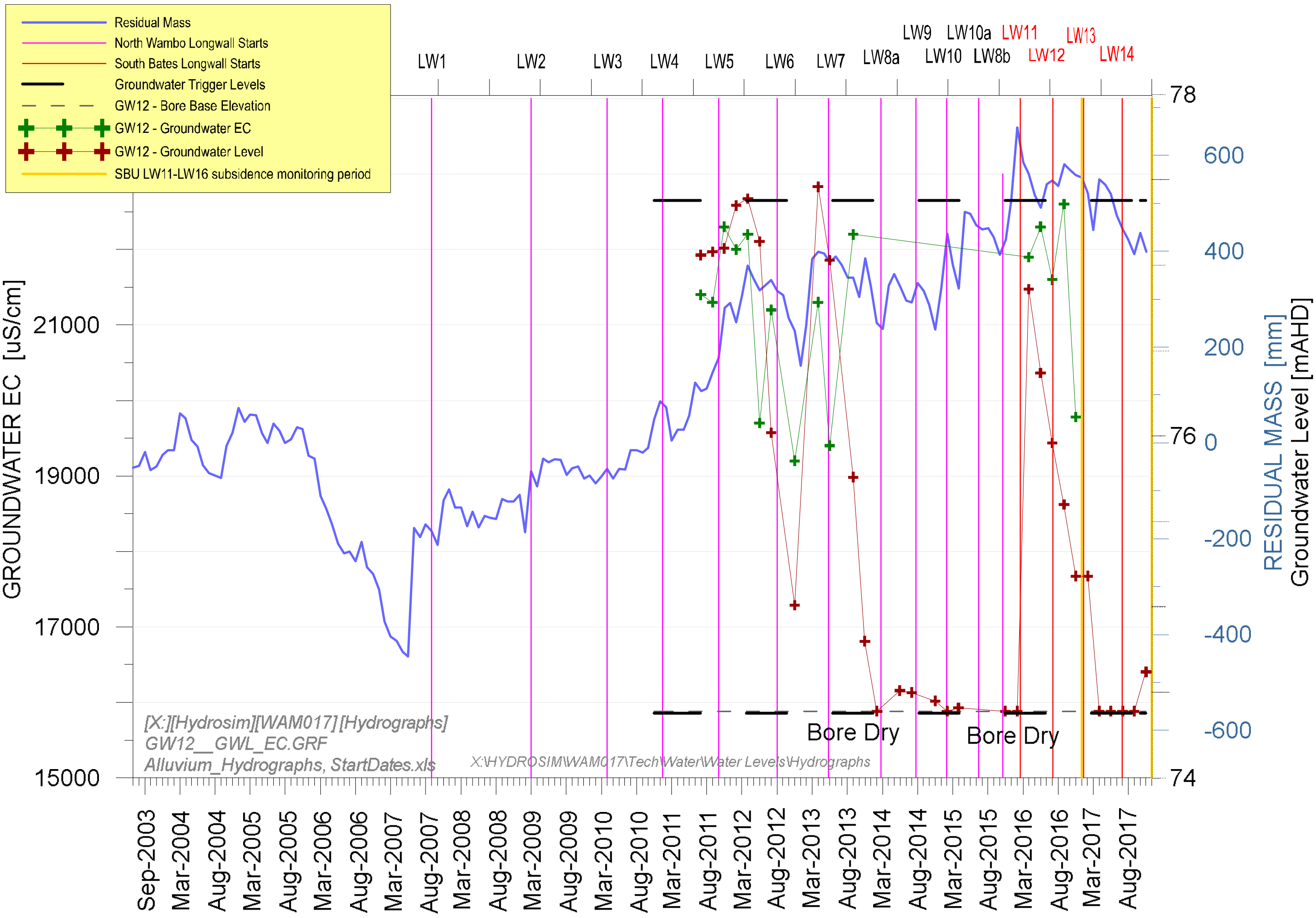


Figure 9 **GW12 Groundwater Level and EC data and trigger levels**

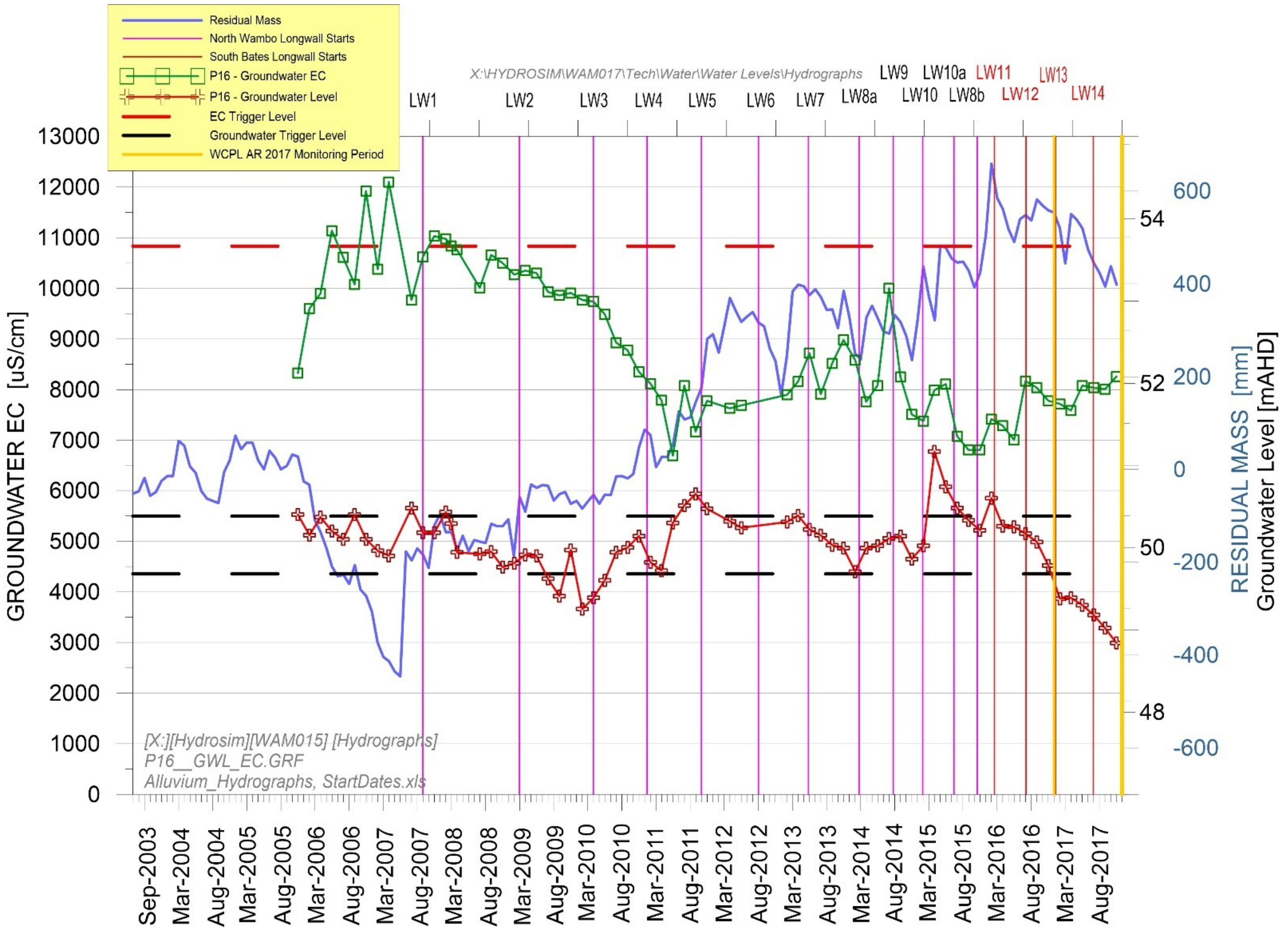


Figure 10 P16 Groundwater Level and EC data and trigger levels

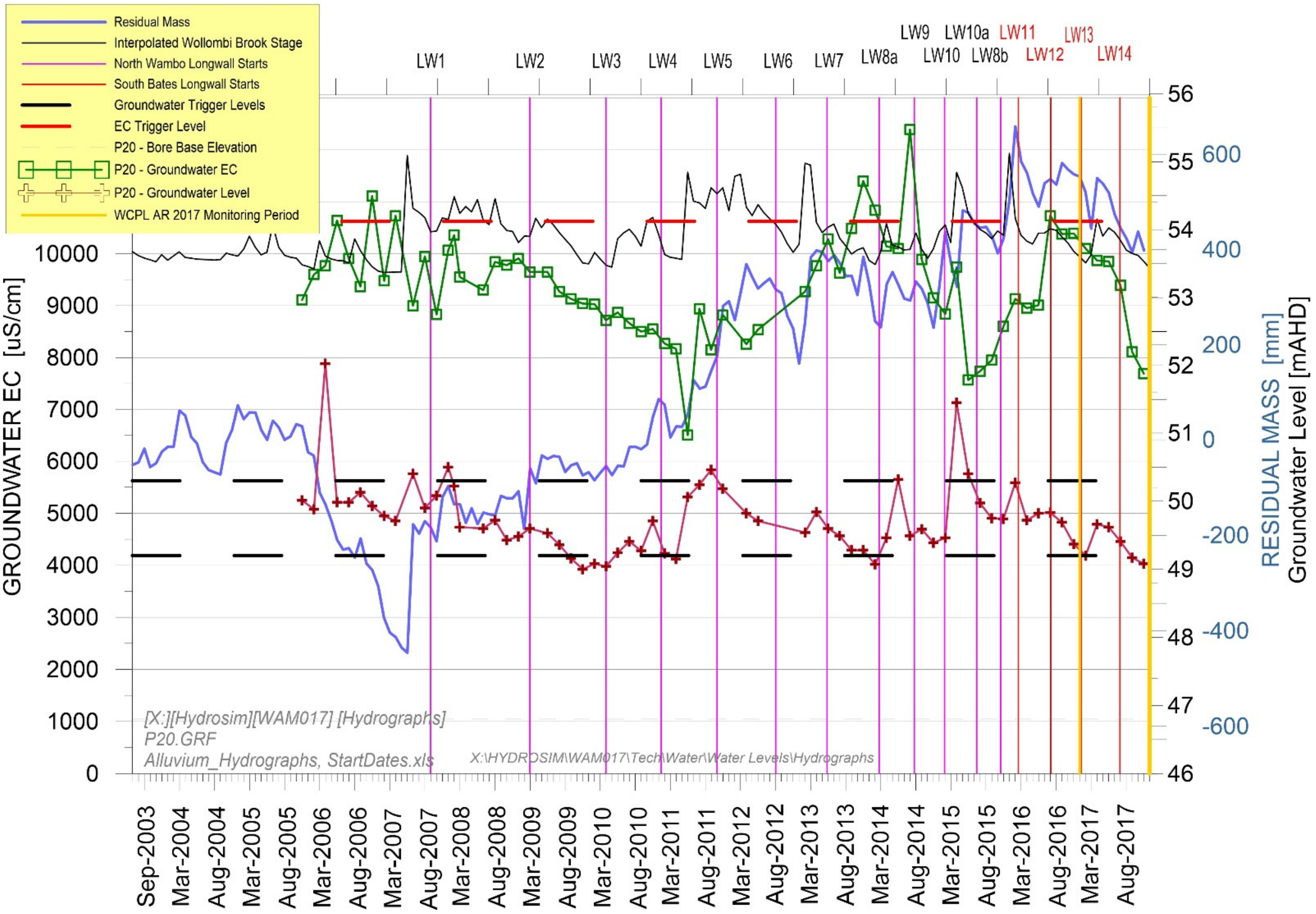


Figure 11 P20 Groundwater Level and EC

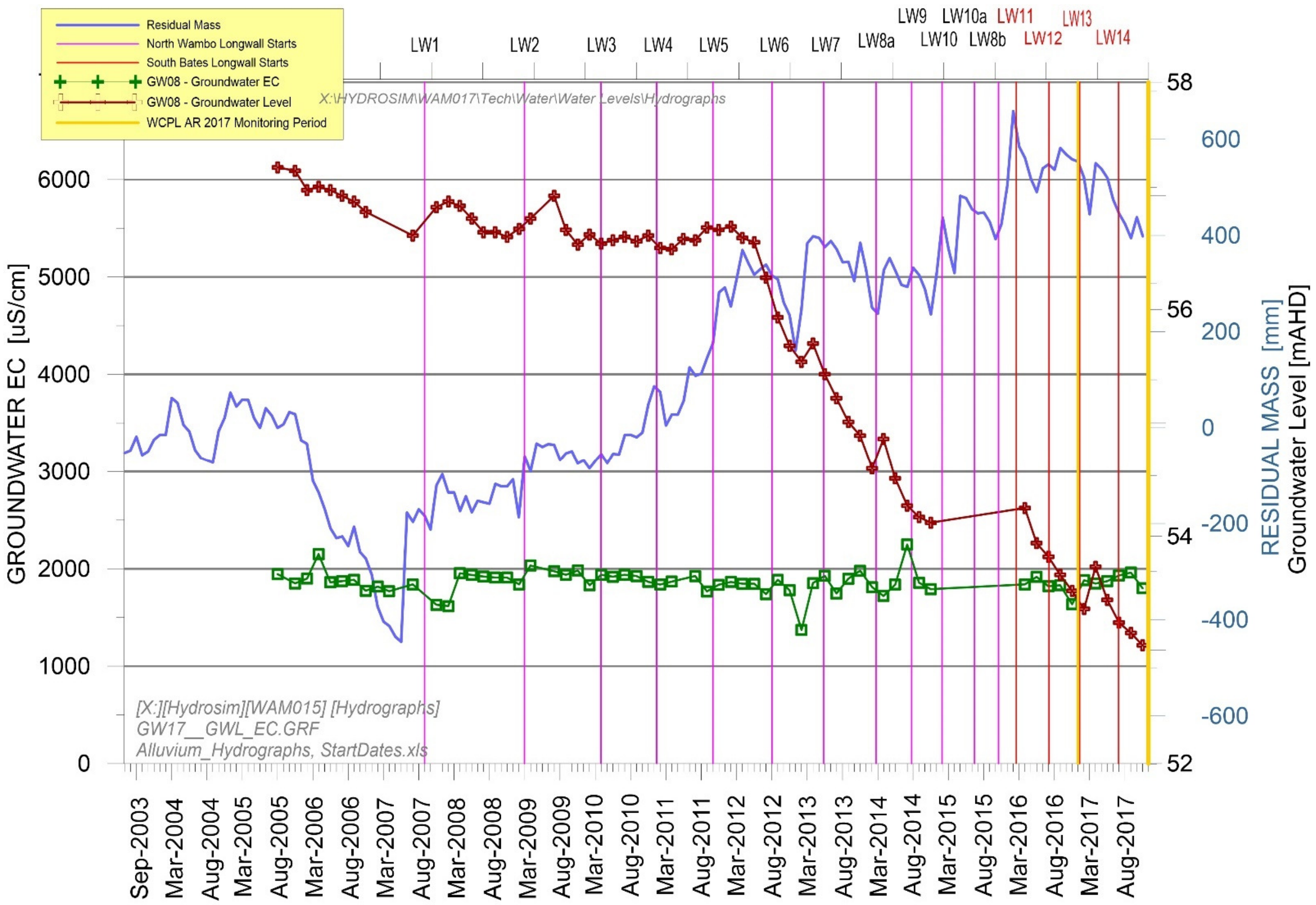


Figure 12 **GW08 groundwater level and EC**

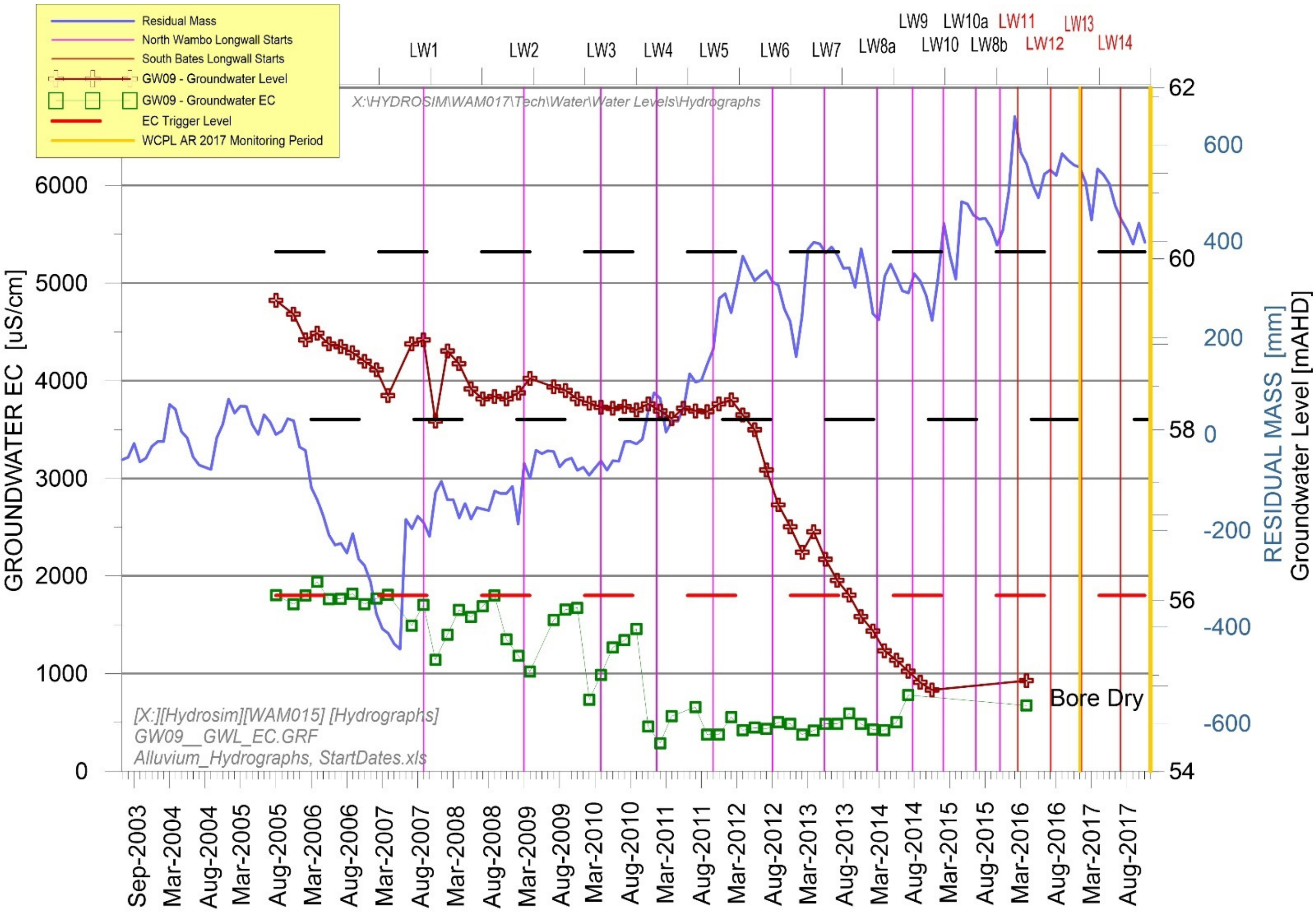


Figure 13 **GW09 groundwater level and EC**

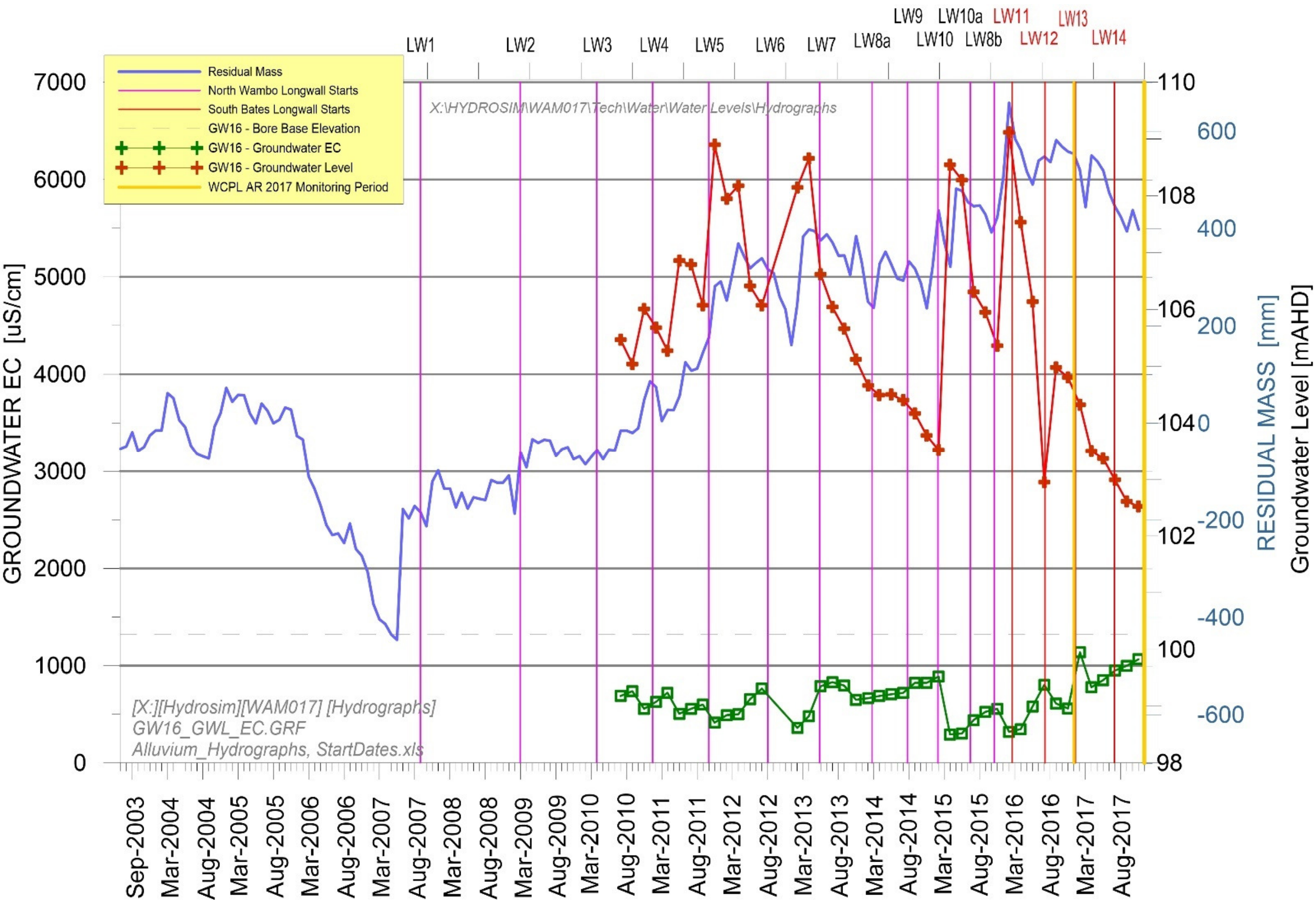


Figure 14 GW16 groundwater level and EC

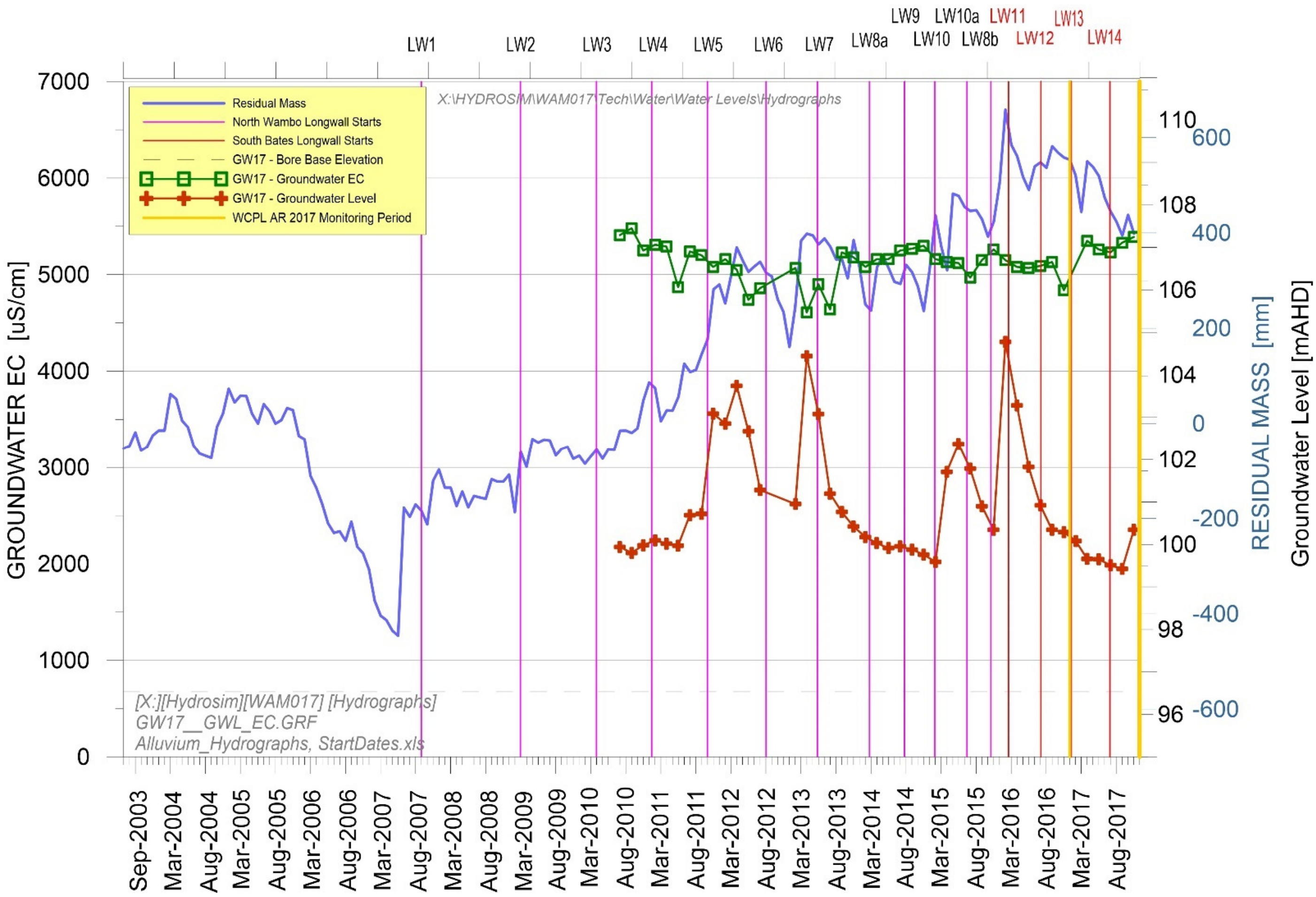


Figure 15 GW17 groundwater level and EC

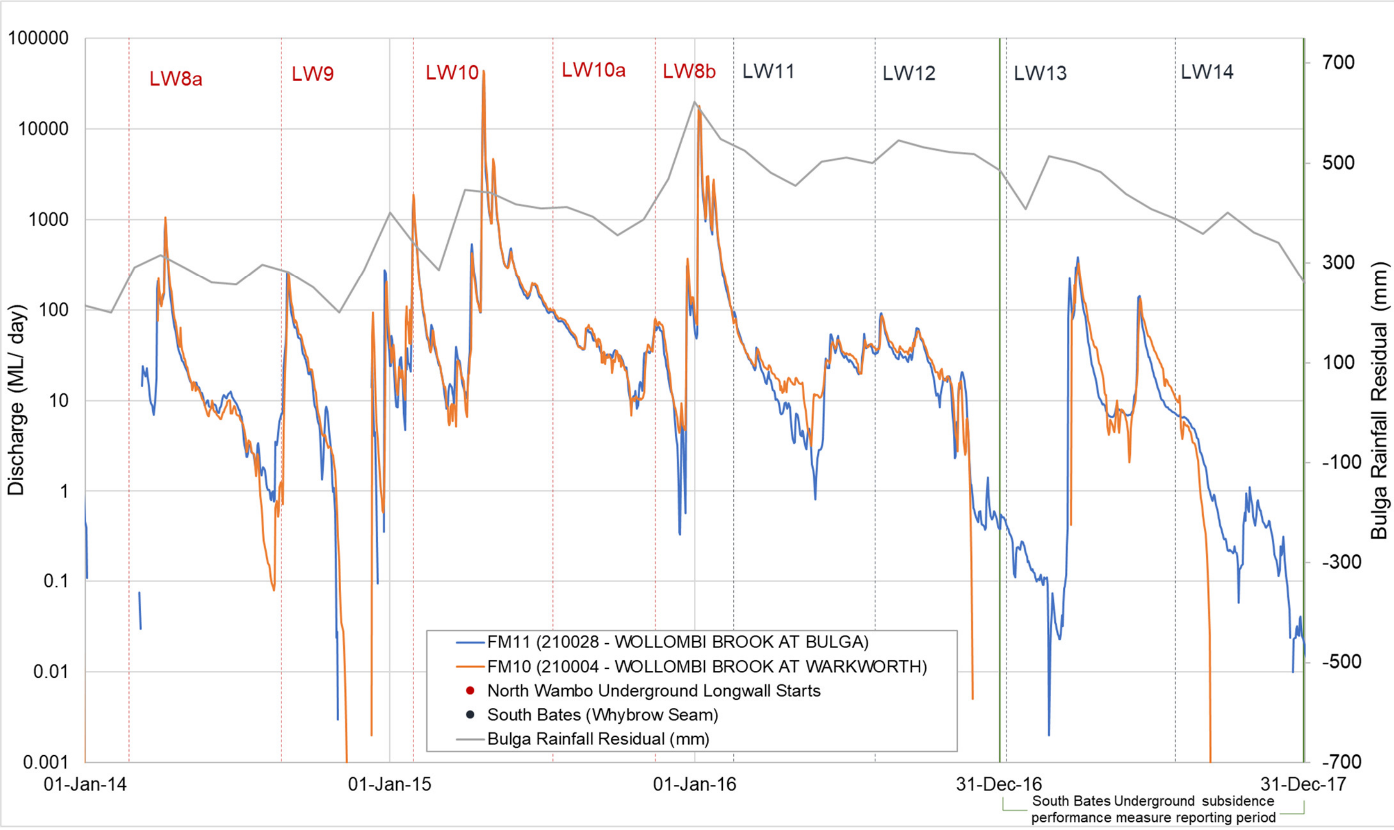


Figure 16 Wollombi Brook flow recording (logarithmic y-axis) and rainfall residual mass

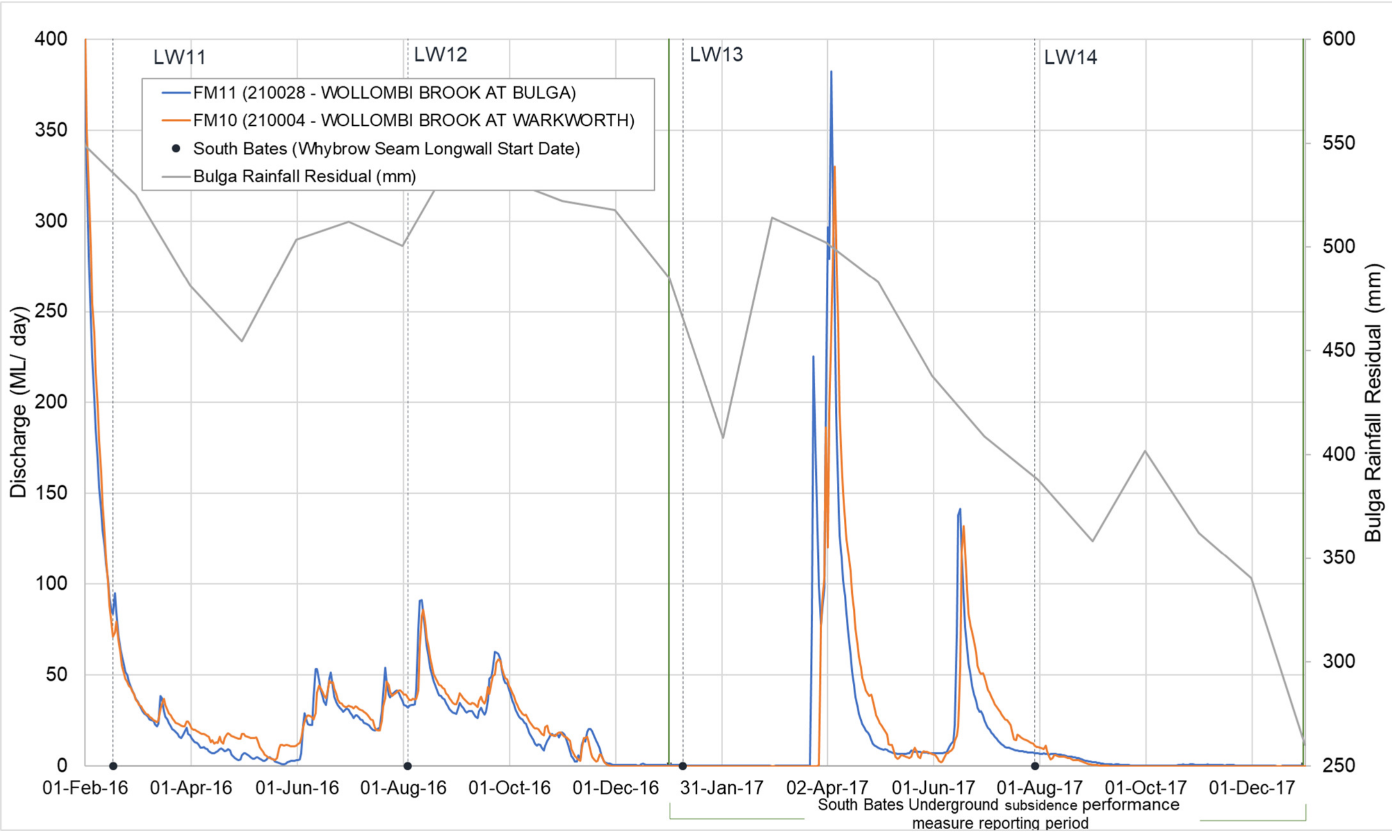


Figure 17 Wollombi Brook flow recording

APPENDIX G

STREAM FLOW MONITORING REPORT

AECOM Imagine it. Delivered.

AECOM Australia Pty Ltd
St Patrick's Commercial Centre
Queens Street
Singleton NSW 2330
Australia
www.aecom.com

+61 2 6575 9000 tel
+61 2 6575 9099 fax
ABN 20 093 846 925

6 March 2018

Commercial-in-Confidence

Merri Bartlett
Environmental Advisor
Wambo Coal Pty Ltd.
ABN: 13 000 668 057
PMB 1
Singleton NSW 2330

Dear Merri

Report on stream flow events along North Wambo, South Wambo and Stoney Creeks for the period 1 February 2017 to 31 January 2018.

Please find contained within this report a summary of probable flow events which occurred along North Wambo, South Wambo and Stoney Creeks from and inclusive of 1 February 2017 to 31 January 2018.

The flow monitoring network now comprises of ten 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 two flow monitoring station, and;
- Stoney Creek has two monitoring station with an additional flow monitoring station located on a major tributary to Stoney Creek.

Further details of the configuration and location of each flow monitoring station can be viewed in **Section 1.0** below.

Theoretical flow rates were calculated from the pressure data downloaded from each station's data logger. The pressure data was converted to a stream height in metres using the following formula:-

Measured Water Level (m) = Measured Pressure (kPa) X Conversion Factor (0.101972 m/kPa)

This conversion factor was obtained from the manufacturers of the pressure transducers.

In August 2017 Wambo Coal commissioned an independent review of their flow monitoring network. This review was carried out by Chris Frink from Environmental Instrument Solutions. The following recommendations from this review were implemented:-

- An Additional flow station be installed on North Wambo Creek upstream of flow monitoring station1;
- The relocation of Flow Monitoring Station 1 further downstream from its original location on North Wambo Creek;
- Cross sections and long sections were re-surveyed at each flow monitoring station so changes in stream characteristics since the previous surveys in 2013 can be incorporated into the development of new flow rating curves, and;
- The re-establishment of each of the flow monitoring station's sensor height compared to the cease to flow point at that site.

AECOM performed the cross section and long section surveys, including the re-establishment of the sensor height to the cease to flow point at the flow monitoring stations along South Wambo and Stoney Creeks plus the new and re-located flow monitoring stations on North Wambo Creek. The survey data was supplied to Wambo Coal and Environmental Instrument Solutions.

Environmental Instrument Solutions provided AECOM via Wambo Coal the data required to construct the revised/new Theoretical Flow Curves. From these curves polynomial equations were derived and applied to the height data collected to produce theoretical flow rate for probable flow event when they occurred at a flow monitoring station.

1.0 Flow Station Locations, Configurations and General Observations

1.1 Flow Monitoring Station 1 (FM1)

Flow Monitoring Station 1 was originally located at the top of North Wambo Creek and was re-located approximately 300 to 400m further downstream in December 2017 (GPS E307013 N6396135). The station contains a Campbell Scientific (CSA) CS451 SDI-12 pressure transducer connected to a CSA CR800 series data logger, the logger and sensor are powered by a 12 volt lead acid battery with solar charging. Average stream height is logged on an hourly basis along with maximum and minimum stream height occurring in the hour. In addition an Insitu Rugged TROLL 100 absolute pressure sensor was also installed and is logging data at ten minute intervals.

Figures 1, 2 and **3** below illustrate the new location of Flow Monitoring Station 1 with its backup sensor. Photos were taken post installation during the cross and long section surveys.

The original backup sensor, also an Insitu Rugged TROLL 100 absolute pressure sensor remains installed at the original site as requested. Data is being logged at 15 minute intervals.

Figure 1 Re-Located Flow Monitoring Station 1 North Wambo Creek Downstream View – January 2018.

Figure 2 Re-Located Flow Monitoring Station 1 North Wambo Creek Uptream – January 2018.

Figure 3 Re-Located Flow Monitoring Station 1 North Wambo Creek Sensor and Backup Sensor in relation to the Stream Bed – January 2018.

1.2 New Flow Monitoring Station (Upper North Wambo Creek).

This flow monitoring station was installed on North Wambo Creek during December 2017 and is located approximately 1 kilometre upstream of the original site of Flow Monitor Station 1 (GPS E305250 N6395200). This station contains an Insitu Rugged TROLL 100 absolute pressure sensor. Data is logged at 10 minute intervals.

Figures 4, **5**, and **6** illustrate the location of this flow monitoring station. Photos were taken post installation during the cross and long section surveys.

Figure 4 New Flow Monitoring Station (Upper North Wambo Creek) North Wambo Creek Downstream View – January 2018.

Figure 5 New Flow Monitoring Station (Upper North Wambo Creek) North Wambo Creek Upstream View – January 2018.

Figure 6 New Flow Monitoring Station (Upper North Wambo Creek) Sensor in relation to the Stream Bed – January 2018.

1.3 Flow Monitoring Station 2 (FM2)

Flow Monitoring Station 2 is located downstream from Flow Station 1 approximately midway along the old North Wambo Creek diversion. This station contains a CSA CS450 SDI 12 pressure transducer connected to a CSA CR200X series data logger, the logger and sensor are powered by a 12 volt lead acid battery with solar charging. Average stream height data is collected at ten minute intervals.

An Insitu Rugged BaroTROLL was installed in the data logger enclosure at this site. This BaroTROLL is utilised to compensate the pressure data collected from the Rugged TROLL100s located at Flow Stations 1 (old and new location), the New Flow Station on North Wambo Creek and Flow Station 4 for changes in atmospheric pressure. This sensor logs the atmospheric pressure internally at 15 minute intervals.

1.4 Flow Monitoring Station 3 (FM3)

Flow Monitoring Station 3 was originally located on North Wambo Creek between the old Wambo Underground Surface Infrastructure and the Open Cut Overburden. Due to the expansion of mining activity in the area the station was removed on 8 November 2012 and repositioned approximately midway along the new diversion of North Wambo Creek downstream of Flow Station 2. Flow Station 3 was reinstalled on 21 and 22 May 2013.

This station comprises a CSA CS451 SDI-12 pressure transducer connected to a CSA CR200X series data logger, the logger and sensor are powered by a 12 volt lead acid battery with solar charging. Average stream height data is logged every 10 minutes.

1.5 Flow Monitoring Station 4 (FM4)

Flow Monitoring Station 4 is located at the Wambo Mine Road culvert which crosses North Wambo Creek upstream of the confluence of North Wambo Creek and Wollombi Brook.

This flow station has a CSA CS451 SDI-12 pressure transducer connected to a CSA CR200X series data logger, the logger and sensor are powered by a 12 volt lead acid battery with solar charging. Average stream height data is logged at 10 minute intervals.

During May 2013 (27 May 2013), at the request of Wambo Coal, an Insitu Rugged TROLL100 absolute pressure sensor was installed at this site as a backup sensor. This sensor logs pressure internally at 15 minute intervals.

1.6 Flow Monitoring Station 5 (FM15)

Flow Monitoring Station 5, renamed FM15, is located on South Wambo Creek just upstream of the confluence of South Wambo Creek and Wollombi Brook and approximately 100 to 200m downstream of its original location. This flow monitoring station was relocated to its current location in December 2016 following its destruction during a flood event in February 2013.

This station comprises of an Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10 minute intervals.

1.7 Flow Monitoring Station 6 (FM16)

Flow Station 6, renamed FM16, is located on South Wambo Creek approximately 200 to 300 metres up stream of the washout on Wambo Mine Road.

The station comprises of an Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10 minute intervals.

The barometric correcting sensor (BaroLogger) used for correcting the absolute pressure readings from flow Stations 5 and 6 is located in the logger box of old Flow Station 6.

1.8 Flow Monitoring Station 9

Flow Monitoring Station 9 is located on South Wambo Creek approximately 200 to 300m upstream of the confluence of South Wambo and Stoney Creeks.

This flow station has a HSA WL2100W SDI-12 connected to a CSA CR200X Series data logger. Average stream height data is logged at 10 minute intervals.

It was observed during the April 2013 inspection and data download that a significant amount of sediment had been deposited on top of the pressure sensor during the high flow events which occurred in January and February 2013. It is estimated from looking at the gauging board where the sensor is located that approximately 500mm of sediment was deposited in the stream bed. This situation is still unchanged.

The data retrieved from this flow station is unusable. This was communicated to Wambo Coal's Environmental team after the May 2015 data collection and they decided not to continue with the data collection at this site.

1.9 Stoney Creek Up Flow Monitoring Station (FM12)

This flow monitoring station was installed in December 2015 and is located on Stoney Creek above the proposed area to be mined. GPS co-ordinates are Easting 307607 Northing 6392828. Due to the remote location of this flow station the flow sensor is an Insitu RuggedTROLL 100 absolute pressure sensor.

This sensor logs stream height at 10 minute intervals internally. This station replaces flow station 8.

1.10 Stoney Creek Tributary Flow Station (FM14)

This flow station was installed in December 2015 and is located on a major tributary of Stoney Creek above the proposed area to be mined. GPS co-ordinates are Easting 307716 Northing 6392242. Due to the remote location of this flow station the flow sensor is an Insitu RuggedTROLL 100 absolute pressure sensor.

1.11 Stoney Creek Down Flow Station (FM13)

This flow station was installed in December 2015 and is located approximately 100m further downstream of Flow Station 7 below the proposed area to be mined. GPS co-ordinates are Easting 309530 Northing 6391043. For continuity with the other two new flow stations the flow sensor at this flow station is an Insitu RuggedTROLL 100 absolute pressure sensor.

This flow station replaces Flow Station 7.

1.12 Stoney Creek Barro Correction Sensors.

The absolute pressure readings recorded by the Insitu Rugged TROLL100 sensors utilised in the Stoney Creek up and Down plus the Tributary Flow Monitoring Stations require correction for fluctuations in barometric pressure. To achieve this two Insitu RuggedBARRO sensors set to log barometric pressure every 10 minutes, are required due to the vertical height difference between the Stoney Creek Up and Tributary flow stations and the Stoney Creek Down Flow Station.

The barometric correction sensor for the Stoney Creek Up and Tributary Flow Stations is located on the infrastructure associated with Flow Station 8.The barometric correction sensor associated with the Stoney Creek Down Flow Station is located on the infrastructure related to Flow Station 7.

2.0 Summary of Results

Tables 1 to **4** below present a summary of probable flow events for each flow station (including the backup sensors located at flow stations 1 and 4) for the period from 1 February 2017 to 31 January 2018.

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.

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:-

$V = (Rh^{2/3} \text{ X } Sw^{1/2})/n$

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. The theoretical flow rating curve for Flow Monitoring Station 5 is based on the 2013 survey data as this site is under review for possible re-location.

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 heights were 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**.

There were no recordable flow events at the following flow stations during the period 1 February 2017 to 31 January 2018:-

- Flow Monitoring Station 1 including the backup Sensor – North Wambo Creek;
- Flow Monitoring Station 5 (FM15) South Wambo Creek;
- Flow Monitoring Station 6 (FM16) South Wambo Creek;
- Flow Monitoring Station FM13 (Stoney Creek Down) Stoney Creek, and;
- Flow Monitoring Station FM14 Stoney Creek Tributary.

No flow events were recorded at the new flow station on North Wambo Creek since installation in December 2017.

All results displayed in the following tables in respect to stream flow are theoretical and should be treated as such.

Table 1 Flow Monitoring Station 2 North Wambo Creek Mid Old Diversion – Summary of Results – 1 February 2017 to 31 January 2018.

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	21/03 19:30	22/03 0:10	0.2	0.054	0.167	0.028	2.38	0.123	10.6
2	24/03 2:00	24/03 11:10	0.4	0.024	0.074	0.006	0.48	0.027	2.37
3	30/03 12:30	31/03 7:50	0.8	0.064	0.211	0.036	3.10	0.190	16.5
4	23/10 0:40	23/10 1:00	0.0	0.006	0.009	0.001	0.06	0.001	0.09
5	26/10 22:20	27/10 4:30	0.3	0.056	0.237	0.035	3.00	0.238	20.6
6	5/12 19:40	5/12 20:30	0.0	0.013	0.024	0.002	0.18	0.004	0.37

Table 2 Flow Monitoring Station 3 North Wambo Creek Mid New Diversion – Summary of Results – 1 February 2017 to 31 January 2018.

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	5/03 5:50	5/03 18:50	0.5	0.014	0.086	0.007	0.61	0.064	5.52
2	18/03 3:20	18/03 7:00	0.2	0.006	0.020	0.002	0.21	0.008	0.70
3	21/03 19:30	22/03 0:00	0.2	0.062	0.281	0.076	6.60	0.605	52.3
4	22/03 20:00	22/03 21:50	0.1	0.008	0.014	0.003	0.26	0.006	0.48
5	24/03 2:00	24/03 9:20	0.3	0.030	0.095	0.016	1.42	0.075	6.51
6	30/03 11:20	31/03 3:00	0.7	0.076	0.228	0.077	6.65	0.393	34.0

Table 3 Flow Monitoring Station 4 North Wambo Creek – 1 February 2017 to 31 January 2018.

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	30/03 19:50	31/03 4:50	0.4	0.069	0.157	0.192	16.6	0.550	47.5
1[1]	30/03 19:28	31/03 4:28	0.4	0.083	0.175	0.240	20.7	0.648	56

[1] Note:- Flow event 1 as depicted by the backup sensor.

Table 4 Flow Monitoring Station FM12 (Stoney Creek Up) Stoney Creek – 1 February 2017 to 1 January 2018.

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	31/03 2:43	15/04 19:53	15.7	0.082	0.193	0.007	0.59	0.032	2.75

A summary of total monthly rain fall data presented in **Table 5** below was derived from the Wambo Coal's Meteorological Station located next to the helicopter pad near the Mine Infrastructure Area.

Table 5 Monthly Total Rain Fall Data – 1 February 2017 to 31 January 2017.

Month	Wambo Coal's Meteorological Station Total Rain Fall (mm)	Number of Days Rain Fell in the Month
February – 2017	5.3	5
March – 2017	159.8	17
April – 2017	30.8	9
May – 2017	18.8	4
June – 2017	22.0	10
July – 2017	1.4	6
August – 2017	10.2	4
September – 2017	8.8	3
October – 2017	103.6	13
November – 2017	22.6	6
December – 2017	48.0	12
January – 2018	7.2	4

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 graphical depictions on stream height and theoretical flow in conjunction with daily and cumulative rain in three month increments.

- Increment one – 1 February to 30 April 2017;
- Increment two – 1 May to 31 July 2017;
- Increment three – 1 August to 31 October 2017, and;
- Increment four – 1 November 2017 to 31 January 2018.

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 2016 for flow station 5 (FM15) while the theoretical rating curves for the remaining flow monitoring station were derived from data points received by AECOM in January 2018 as mentioned above;
- North Wambo, South Wambo and Stoney 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 Stoney 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.

3.0 Recommendations

The following actions are recommended by AECOM to help improve the quality of the data received from the flow monitoring stations at Wambo Coal:-

- Relocate Flow Monitoring Station 9 to a location on South Wambo Creek where there is a reach/channel with suitably stable control; and
- Re-program the data logger at Flow Monitoring Station 1 so as to bring the logging interval into line with all the other stations in the flow monitoring network.

If you have any questions or require any clarification of aspects in this report please contact us in the Singleton office.

Yours faithfully

Scott McDonald
Principal Environmental Chemist
scott.mcdonald@aecom.com

Mobile: +61 414 493 642
Direct Dial: +61 2 4911 4848

Chad Whitburn
Compliance Services - Team Leader
Chad.Whitburn@aecom.com

Mobile: +61 457 806 872
Direct Dial: +61 2 4911 4983
Direct Fax: +61 2 4911 4999

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.

Appendix A

Flow Station Field Sheets & Data Logger Status Sheets

This page has been left blank intentionally.

AECOM

GPS :

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 2.06.17

Station ID: Stony creek trib Time: 8:55

Solar Panel Condition: NIL

~~Solar Panel Output: (V)~~ ~~Solar Panel Cleand: Y / N~~

Battery Voltage: Used 14% Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: NA Current Offset: NA Datum Changed: Y / N

New Datum: NA New Offset: NA

Stream Obsevations: Dry No Flow Flow

General Site Observation: same conditions as previous visit.

GPS : E 307711 N 6392234

memory used 100% - bag Data wrap on

Station ID: stony Creek up Time: 9:40

Solar Panel Condition: NIL

~~Solar Panel Output: (V)~~ ~~Solar Panel Cleand: Y / N~~

Battery Voltage: Used 13% Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: NA Current Offset: NA Datum Changed: Y / N

New Datum: NA New Offset: NA

Stream Obsevations: Dry No Flow Flow

General Site Observation: flow observed downstream of flow station

memory 100% Data wrap on

Page / of 37 Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 2/6/17

Station ID: Stony Ck UP Buro Time: 1025

Solar Panel Condition: Nil

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: Used 13% Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: ~~Y / N~~

Current Datum: NA Current Offset: NA Datum Changed: ~~Y / N~~

New Datum: NA New Offset: NA

Stream Obsevations: ~~Dry No Flow Flow~~ NA

General Site Observation: Memory used 100%

Data wrap on.

Station ID: Stony Ck Down Time: 1055

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: 14% Used Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: NA Current Offset: NA Datum Changed: Y / N

New Datum: NA New Offset: NA

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory used 100% Data wrap on

Page 2 of 33 Initials:

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 2/6/17

Station ID: Stony Ck Down Boro Time: 11 10

Solar Panel Condition: Na

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: 13% used Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: NA Current Offset: NA Datum Changed: Y / N

New Datum: – New Offset: –

Stream Obsevations: Dry No Flow Flow NA

General Site Observation: Memory Used 100% Data Wrap Off.

Station ID: ________ Time: ________

Solar Panel Condition: ________

Solar Panel Output: ________ (V) Solar Panel Cleand: Y / N

Battery Voltage: ________ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ________ Current Offset: ________ Datum Changed: Y / N

New Datum: ________ New Offset: ________

Stream Obsevations: Dry No Flow Flow

General Site Observation: ________

Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/6/17

Station ID: 4 Backup Station Time: 825

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: Used 85% Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Signs of recent (maybe) flow through the station. 100% memory used Data wrap on

Station ID: 4 Time: 835

Solar Panel Condition: Dusty with Bird Droppings

Solar Panel Output: 18.71 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.81 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: See aboves no signs of flow

Station clock reset ≈ 30 min fast.

Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/6/17

Station ID: 3 Time: 910

Solar Panel Condition: Dusty + Bird Droppings

Solar Panel Output: 21.3 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.65 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: 1 Backup Time: 955

Solar Panel Condition:

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: 37% used Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: 100% Memory used Data Wrap on

Initials:

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/6/17

Station ID: 1 Time: 1000

Solar Panel Condition: Bird Droppings

Solar Panel Output: 1.78 (V) Solar Panel Cleand: Y / N

Battery Voltage: 12.12 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: Northwards Backup Bore Time: 1045

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: Used 39% Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: ~~Y / N~~

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow N/A

General Site Observation: 100% memory used

Data wrap on.

Page 6 of 33 Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/6/17

Station ID: 2 Time: 1015

Solar Panel Condition: Bird Dropping & Dusty

Solar Panel Output: 22.2 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.60 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: ______

Station ID: 5 Time: 1130

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: Used 3% Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: NA Current Offset: NA Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 25%

Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/6/17

Station ID: 6 Time: 1155

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: 3% used Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: NA Current Offset: NA Datum Changed: Y / N

New Datum: NA New Offset: NA

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 25%

Station ID: 8th Wambo Bus Time: 1200

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: 3% used Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: NA Current Offset: NA Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow NA

General Site Observation: 25% Memory used.

Page 8 of 33 Initials: [illegible]

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary
5/06/2017 10:08:19

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: 11.91 °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: 6/02/2015 08:48:14
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
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: 14.78
Lithium Battery: 3.32
Number of times voltage has dropped below 12V: 0
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary
5/06/2017 10:55:02

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: 13.69

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
5/06/2017 09:12:03

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: 13.68

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 5/06/2017 08:48:19

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: 13.80

RF Information
Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 25.08.17

Station ID: STONEY CRK TRIB Time: 8:40

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: – Current Offset: – Datum Changed: ~~Y / N~~

New Datum: – New Offset: –

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used: 100% Data wrap on
battery used: 16%

Station ID: STONEY CRK UP Time: 9:15

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: – Current Offset: – Datum Changed: ~~Y / N~~

New Datum: – New Offset: –

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used: 100% Data wrap on
battery used: 15%

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 25.08.17

Station ID: STONEY CRK UP BARO Time: 10:00

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: NA Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used: 100% - Data wrap on

battery used: 15%.

Station ID: STONEY CRK DOWN Time: 10:15

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: NA Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: battery used: 16%.

memory used: 100%.

Page 10 of 33

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 25.08.17

Station ID: STONEY CRK DOWN BARO Time: 10:35

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: – Current Offset: – Datum Changed: ~~Y / N~~

New Datum: – New Offset: –

Stream Obsevations: Dry No Flow Flow

General Site Observation: battery used: 15%.

memory used: 100% Data wrap on

Station ID: ________ Time: ______

Solar Panel Condition: ________

Solar Panel Output: ______ (V) Solar Panel Cleand: Y / N

Battery Voltage: ______ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ______ Current Offset: ______ Datum Changed: Y / N

New Datum: ______ New Offset: ______

Stream Obsevations: Dry No Flow Flow

General Site Observation: ________

Page 11 of 34 Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 24/8/17

Station ID: 4 Time: 845

Solar Panel Condition: Very Dusty

Solar Panel Output: 19.79 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.74 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: ~~Y / N~~

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: 4 BV Time: 955

Solar Panel Condition: Na

Solar Panel Output: Na (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: Nu Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory used 100% Data Wiped
Battery used 37%

Page 12 of 33 Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo   Project Number: 60248386   Date: 24/8/17

Station ID: 3   Time: 910

Solar Panel Condition: Bird Dropping & Dust

Solar Panel Output: 21.12 (V)   Solar Panel Cleand: Y / N

Battery Voltage: 13.49   Battery Replaced: Y / N

Data Collected: Y / N   Sensor Operating: Y / N   Logger Operating: Y / N

Current Datum: —   Current Offset: —   Datum Changed: Y / N

New Datum: —   New Offset: —

Stream Obsevations: Dry   No Flow   Flow

General Site Observation: No Flow Since last Data Collection event. Sensor un fouled by sand.

Station ID: 1   Time: 945

Solar Panel Condition: Bird Droppings & Dust

Solar Panel Output: NA (V)   Solar Panel Cleand: Y / N

Battery Voltage: 14.18   Battery Replaced: Y / N

Data Collected: Y / N   Sensor Operating: Y / N   Logger Operating: Y / N

Current Datum: —   Current Offset: —   Datum Changed: Y / N

New Datum: —   New Offset: —

Stream Obsevations: Dry   No Flow   Flow

General Site Observation:

Page 13 of 33   Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 24/8/17

Station ID: LBU Time: 1000

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: NA Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory used 100% data wrap on

Battery used 39%

Station ID: 2 Time: 1030

Solar Panel Condition: Dusty

Solar Panel Output: 27.90 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.50 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Page 14 of 33

Initials:

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 24/8/17

Station ID: Buro Sensor Time: 1040

Solar Panel Condition: NA

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: ~~Bat~~ Memory Used 100% Data wrapor.
Battery Used. 41 %

Station ID: 5 Time: 1100

Solar Panel Condition: N/A

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 34%
Battery Used. 5 %

Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 24/8/12

Station ID: 6 Time: 1125

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 34%

Battery Used 5%

Station ID: SWC Bore Time: 1140

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 34%

Battery Used 5%

Initials: [illegible]

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary
24/08/2017 09:57:13

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: 18.95 °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: 6/02/2015 08:48:14
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: 14.09
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 24/08/2017 10:35:31

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: 13.55

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 24/08/2017 09:19:05

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: 13.56

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 24/08/2017 08:48:11

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

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 20/11/17

Station ID: CC BU Time: 825

Solar Panel Condition: —

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: ~~Y / N~~

Data Collected: ~~Y / N~~ Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100 %

Battery Used = 39 %

(Data Wrap ON)

Station ID: 4 Time: 830

Solar Panel Condition: Dusty With Bird Droppings.

Solar Panel Output: ~~13.4~~ 19.25 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.49 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo　　Project Number: 60248386　　Date: 20/11/17

Station ID: 53　　Time: 855

Solar Panel Condition: Bird Dropping

Solar Panel Output: 19.75 (V)　　Solar Panel Cleand: Y / N

Battery Voltage: ~~11.50~~ 13.40　　Battery Replaced: Y / N

Data Collected: Y / N　　Sensor Operating: Y / N　　Logger Operating: Y / N

Current Datum: —　　Current Offset: —　　Datum Changed: Y / N

New Datum: —　　New Offset: —

Stream Obsevations: Dry　No Flow　Flow

General Site Observation:

Station ID: 51BU　　Time: 935

Solar Panel Condition: —

Solar Panel Output: — (V)　　Solar Panel Cleand: ~~Y / N~~

Battery Voltage: —　　Battery Replaced: ~~Y / N~~

Data Collected: ~~Y / N~~　　Sensor Operating: ~~Y / N~~　　Logger Operating: ~~Y / N~~

Current Datum: —　　Current Offset: —　　Datum Changed: ~~Y / N~~

New Datum: —　　New Offset: —

Stream Obsevations: Dry　No Flow　Flow

General Site Observation: Memory Used 100% Data wrap old
So　Battery used 40%

Page 18 of 33　　Initials:

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo   Project Number: 60248386   Date: 20/11/2017

Station ID: S Y   Time: 940

Solar Panel Condition: Bird Droppings

Solar Panel Output: 14.43 (V)   Solar Panel Cleand: Y / N

Battery Voltage: 14.07   Battery Replaced: Y / N

Data Collected: Y / N   Sensor Operating: Y / N   Logger Operating: Y / N

Current Datum: —   Current Offset: —   Datum Changed: Y / N

New Datum: —   New Offset: —

Stream Obsevations: Dry   No Flow   Flow

General Site Observation: Sensor Cable length 40ft.

Station ID: Nth Wambo CK Baro   Time: 10 20

Solar Panel Condition: —

Solar Panel Output: — (V)   Solar Panel Cleand: ~~Y / N~~

Battery Voltage: —   Battery Replaced: ~~Y / N~~

Data Collected: Y / N   Sensor Operating: Y / N   Logger Operating: Y / N

Current Datum: —   Current Offset: —   Datum Changed: Y / N

New Datum: —   New Offset: —

Stream Obsevations: Dry   No Flow   Flow

General Site Observation: Memory Used = 100% Data wrap on
Battery Used = 43%

Page 19 of 33   Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 20/4/17

Station ID: S2 Time: 1030

Solar Panel Condition: Dust 7

Solar Panel Output: 20.61 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.57 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: 55 Time: 1100

Solar Panel Condition: —

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 43% Data Wrap ON
Battery Used 7%

Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 20/11/17

Station ID: S6 Time: 1115

Solar Panel Condition: NA

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry ~~No Flow~~ Flow

General Site Observation: Memory Used 43% Data Wrap ON
Battery Used 7%

Station ID: Sth Wamb Baro Time: 1130

Solar Panel Condition: —

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 43% Data Wrap ON
Battery Used 7%

Initials: [initials]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 21/11/17

Station ID: SCTRIB Time: 920

Solar Panel Condition: —

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: ~~Y / N~~

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used % 100 Data Wrap ok

Battery Used. 18%

Station ID: SCUP Time: 1010

Solar Panel Condition: —

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 100 % Data Wrap OK

Battery Used 17 %

Page 22 of 33 Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 21/11/17

Station ID: SC UP Bao Time: 1105

Solar Panel Condition: —

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: ~~Y / N~~

Data Collected: ~~Y / N~~ Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: New Offset:

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 100% Data Wrap on

Battery Used 17%

Station ID: SC Down Time: 1135

Solar Panel Condition: —

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 100% Data wrap ON

Battery Used 18%

Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 21/11/17

Station ID: SC Dow Boro Time: 1150

Solar Panel Condition: —

Solar Panel Output: — (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: — Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: ~~Y~~ / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: ~~Dry No Flow Flow~~

General Site Observation: Memory Used 100% Data Wrap on
Battery Used 17%

Station ID: ______ Time: ______

Solar Panel Condition: ______

Solar Panel Output: ______ (V) Solar Panel Cleand: Y / N

Battery Voltage: ______ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ______ Current Offset: ______ Datum Changed: Y / N

New Datum: ______ New Offset: ______

Stream Obsevations: Dry No Flow Flow

General Site Observation: ______

Initials: [illegible]

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary 20/11/2017 09:47:48

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: 23.27 °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: 6/02/2015 08:48:14
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: 13.98
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 2 CR200 Series Data Logger Status Summary 20/11/2017 10:37:10

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: 13.56

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
20/11/2017 09:00:31

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: 13.40

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 20/11/2017 08:39:38

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: 13.49

RF Information
Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/2/18

Station ID: SCTRIB Time: 900

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~ NA

Battery Voltage: NA Battery Replaced: ~~Y / N~~ NA

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data Wrap On
Battery Used = 20%

Station ID: SCUP Time: 935

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100 Data Wrap ON
Battery Used 18%

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/2/18

Station ID: Stony Ck Barro Time: 1020

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: ~~Dry No Flow Flow~~

General Site Observation: Memory used = 100% Data Wrap On

Battery Used = 18%

Station ID: Stony Ck Down Time: 1050

Solar Panel Condition: NA

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data Wrap Out

Battery Used = 20%

Page 26 of 33 Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/2/18

Station ID: Stony Down Burro Time: 1100

Solar Panel Condition:

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data Wipe on
Battery Used = 18%

Station ID: F5 Time: 1130

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 50% Data Wipe on
Battery Used - 9%

Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/2/18

Station ID: 6 Time: 1145

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED - 50%

BATTERY USED - 9%

Station ID: ST WAMBO BARRO Time: 1150

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Page 28 of 33 Initials: [illegible]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: S4 Time: 945

Solar Panel Condition: Very Dusty

Solar Panel Output: 19.46 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.34 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: SaBU Time: 1000

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used ≈ 100% DataWrap on
Battery Used = 41%

Page 27 of 33 Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: 3 Time: 1015

Solar Panel Condition: Bird Droppings

Solar Panel Output: 20.12 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.28 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: 5th Wambo Ck U/S Time: 1045

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 12 % Data Wrap on

Battery Used 1 %

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: FM1 old Location Time: 1110

Solar Panel Condition: Backup sensor N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: ~~Y~~ / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data wrap on

Battery Used = 42%

Station ID: FM1 New location Time: 1125

Solar Panel Condition: Good

Solar Panel Output: Cycling (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.91 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: FM1 New location Backup Sensor Time: 1130

Solar Panel Condition: —

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: NA Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 12 % Data Wrap Off

Battery Used 1 %

Station ID: FM2 Time: 1155

Solar Panel Condition: Good

Solar Panel Output: ~~13.7~~ 21.28 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.28 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: Nth Wambo Ck Bore Time: 1200

Solar Panel Condition: — NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data Wrap on

Battery Used = 4.6%

Station ID: ________ Time: ________

Solar Panel Condition: ________

Solar Panel Output: ________ (V) Solar Panel Cleand: Y / N

Battery Voltage: ________ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ________ Current Offset: ________ Datum Changed: Y / N

New Datum: ________ New Offset: ________

Stream Obsevations: Dry No Flow Flow

General Site Observation: ________

Initials: [illegible]

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary
6/02/2018 10:23:58

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: 33.81 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 1 - Reset this value. If errors continue, contact Campbell Scientific.

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: 13.91
Lithium Battery: 3.43
Number of times the datalogger's 12V supply has dropped below operating threshold: 4 - Check your battery
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary
6/02/2018 10:54:30

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: 13.34

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 6/02/2018 09:16:25

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: 13.27

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 6/02/2018 09:48:31

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

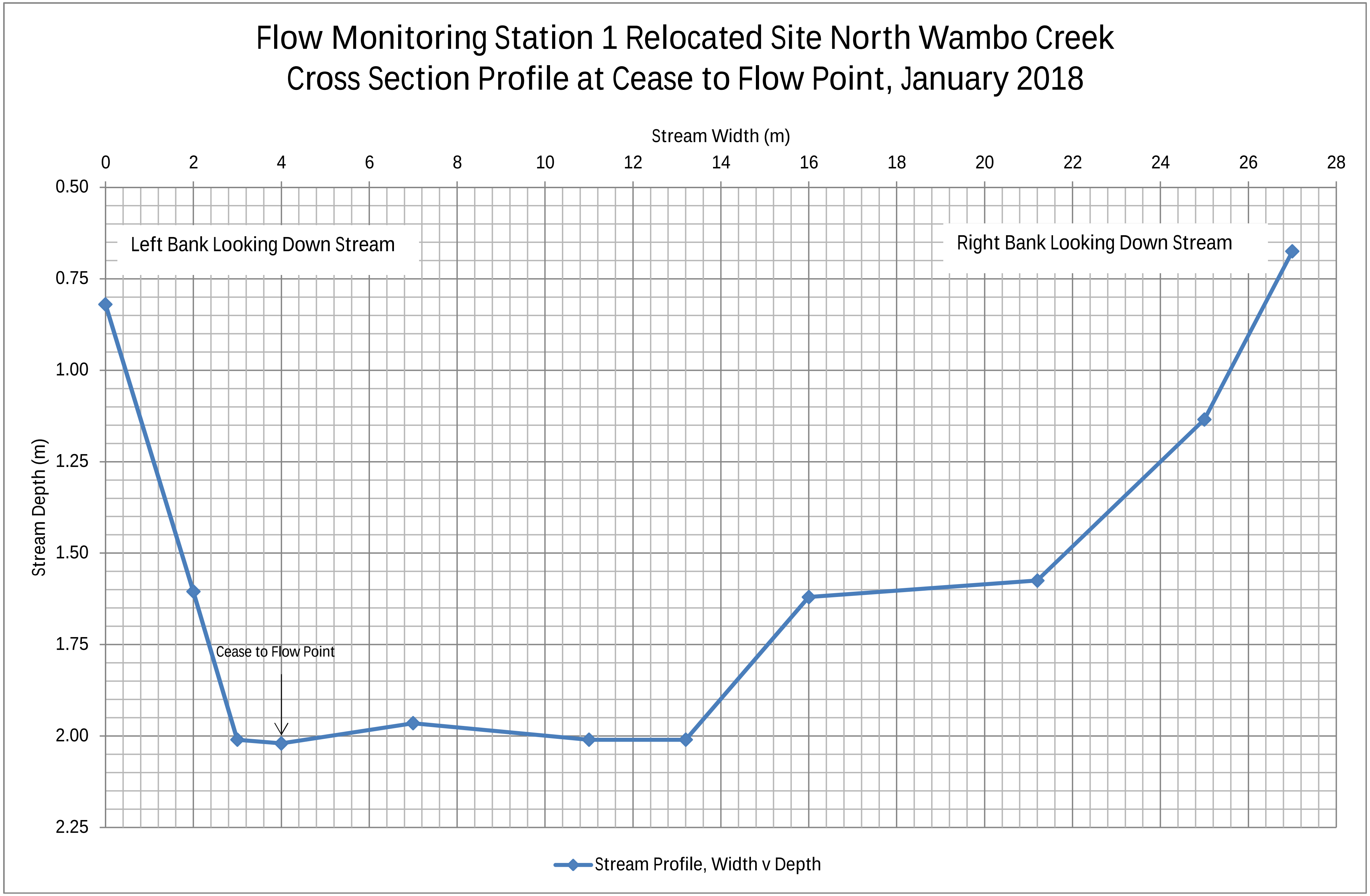
Battery Information
Battery Voltage: 13.36

RF Information
Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

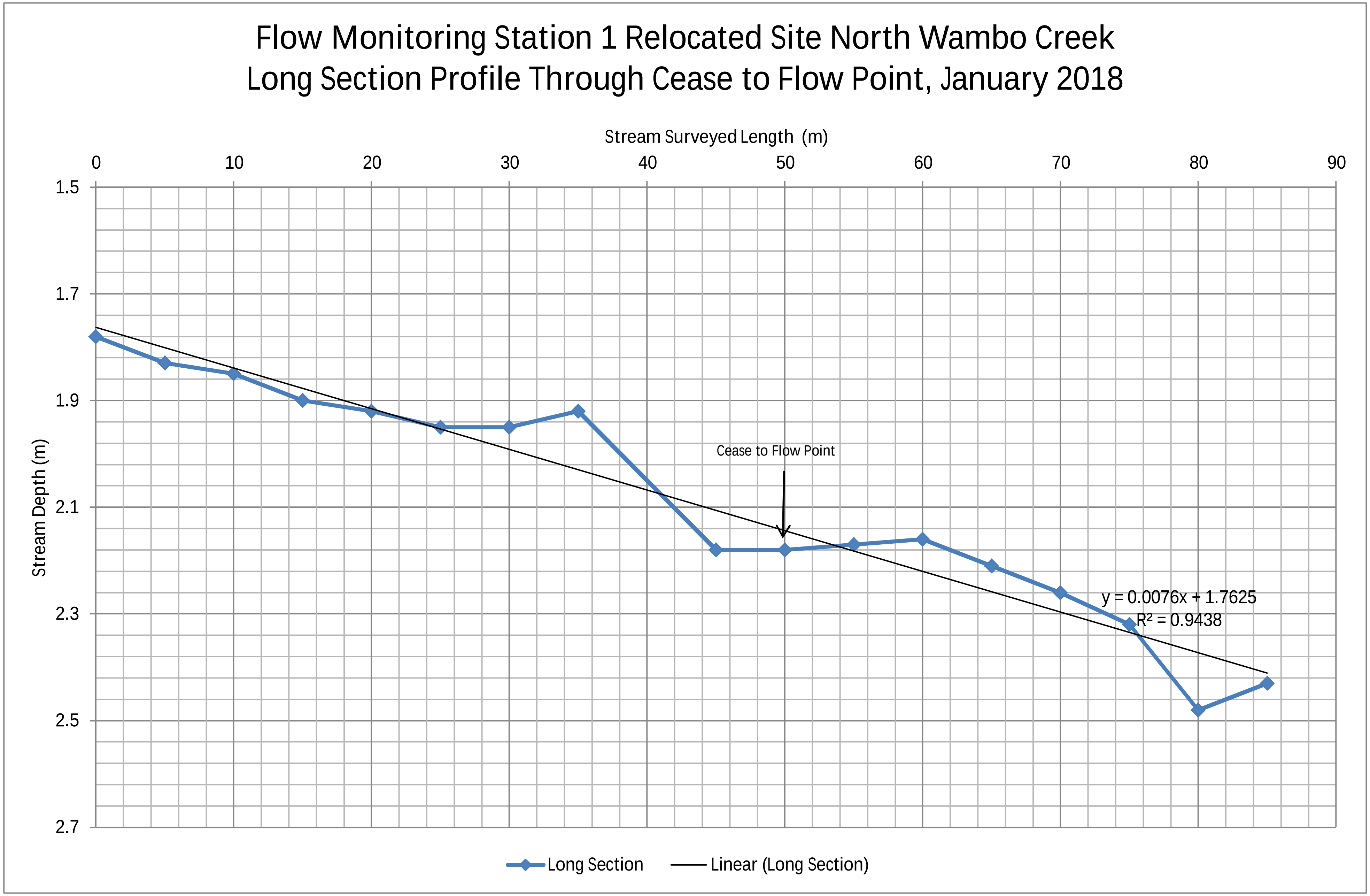
Appendix B

Stream Theoretical Flow Rating and Profile Curves

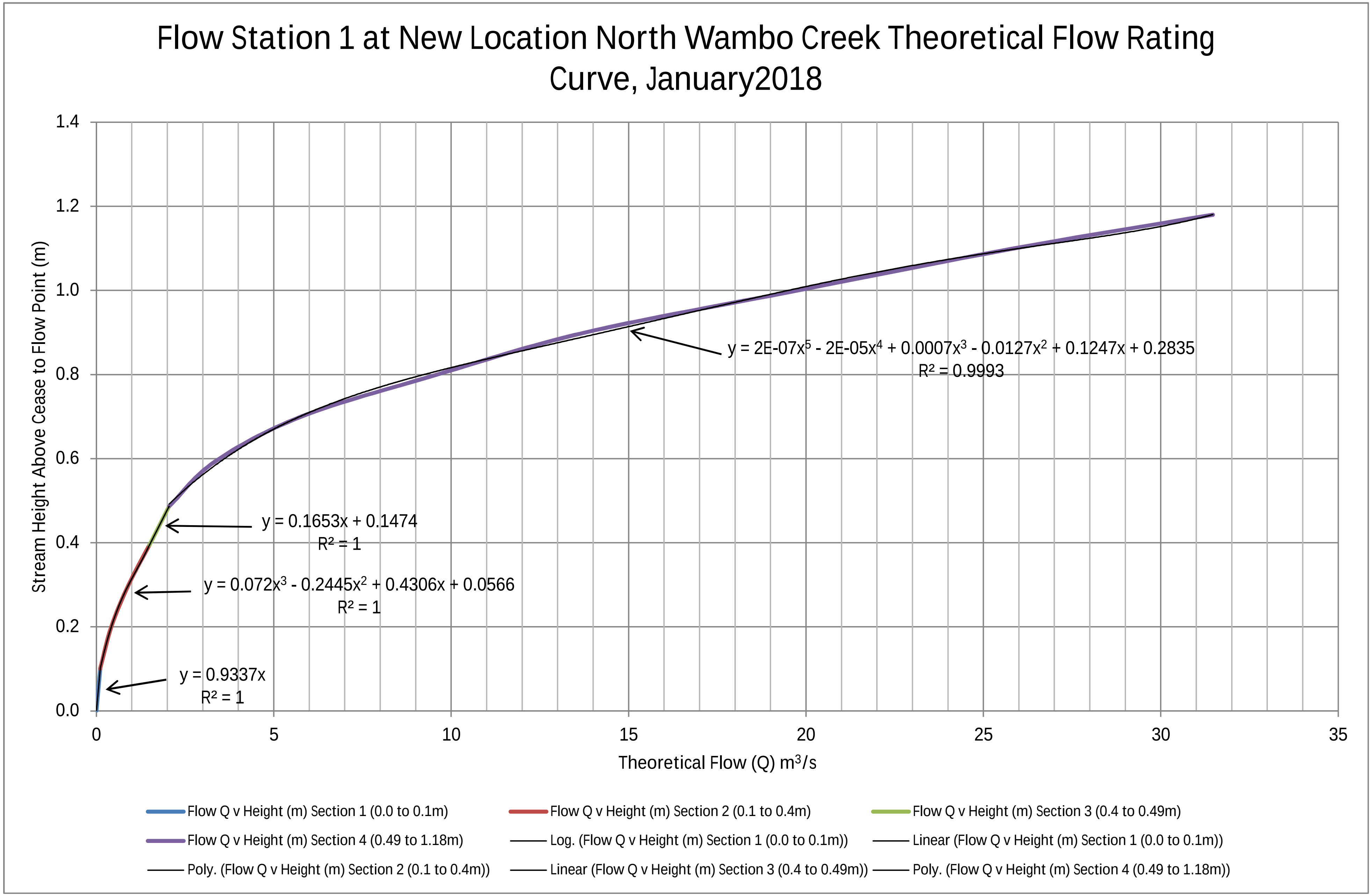
This page has been left blank intentionally.

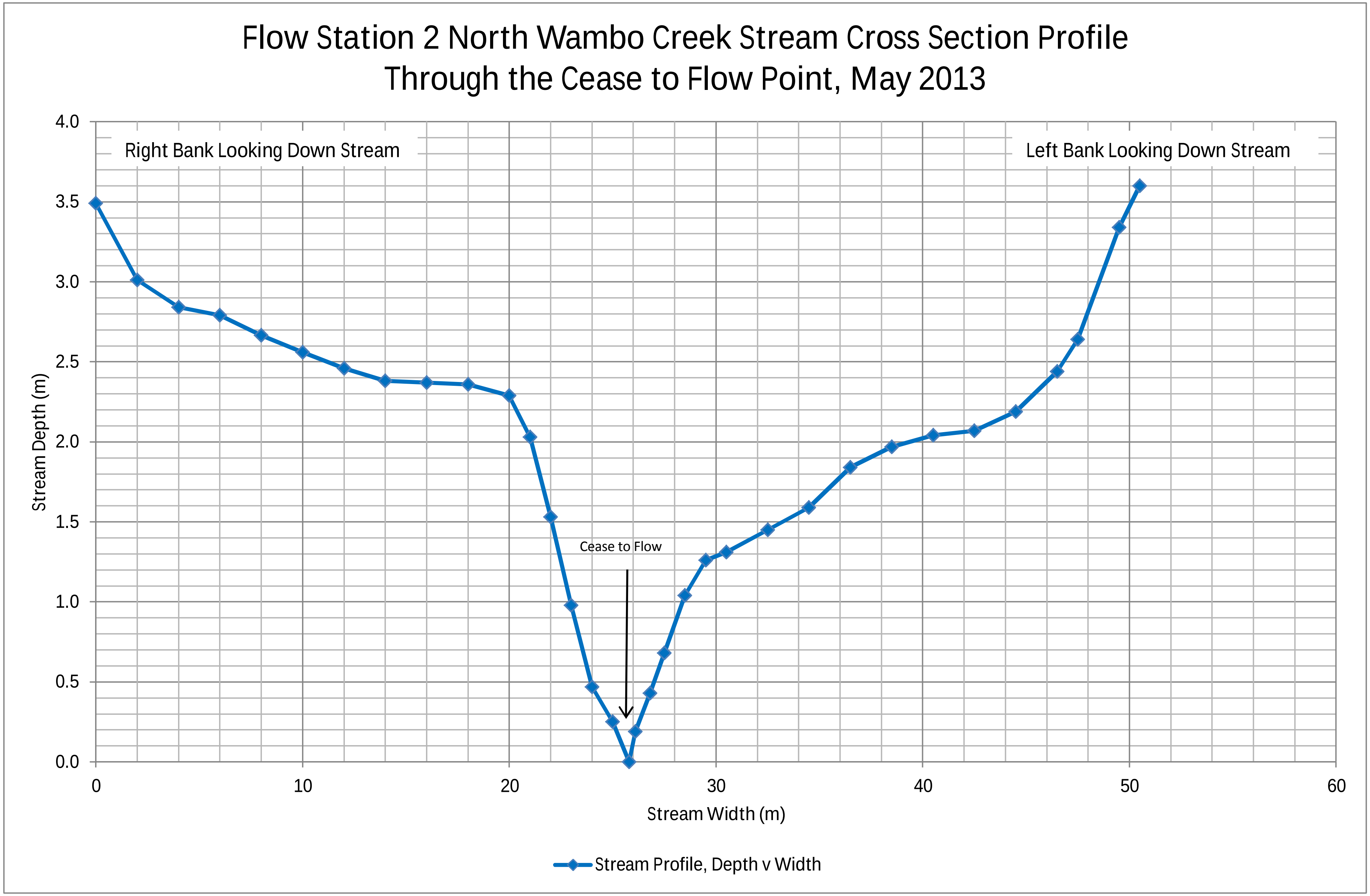


Flow Monitoring Station 1 Relocated Site North Wambo Creek
Cross Section Profile at Cease to Flow Point, January 2018
Stream Width (m)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
Stream Depth (m)
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Stream Profile, Width v Depth

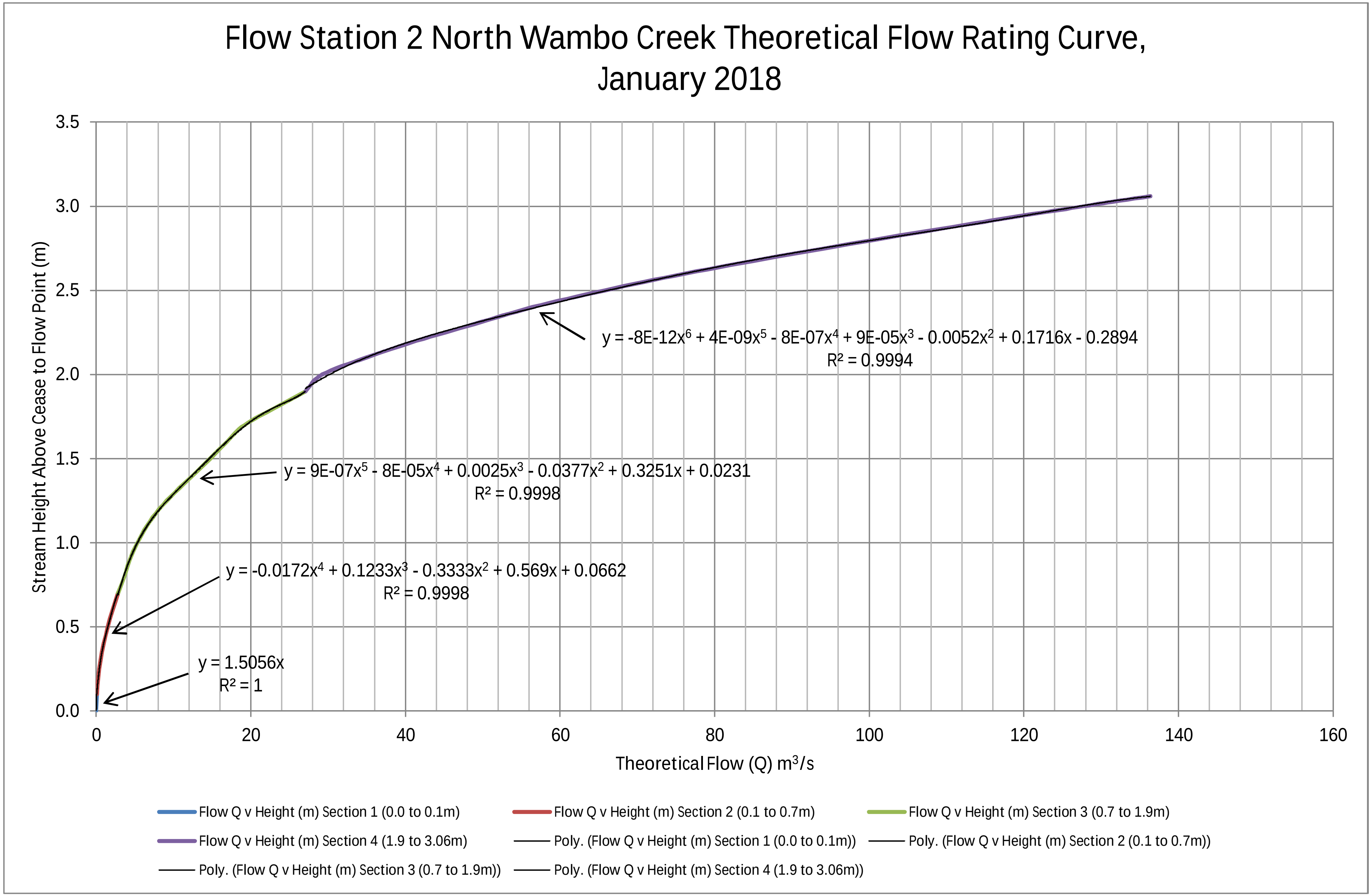


Flow Monitoring Station 1 Relocated Site North Wambo Creek
Long Section Profile Through Cease to Flow Point, January 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
90
1.5
1.7
1.9
2.1
2.3
2.5
2.7
Stream Depth (m)
Cease to Flow Point
y = 0.0076x + 1.7625
R² = 0.9438
Long Section
Linear (Long Section)

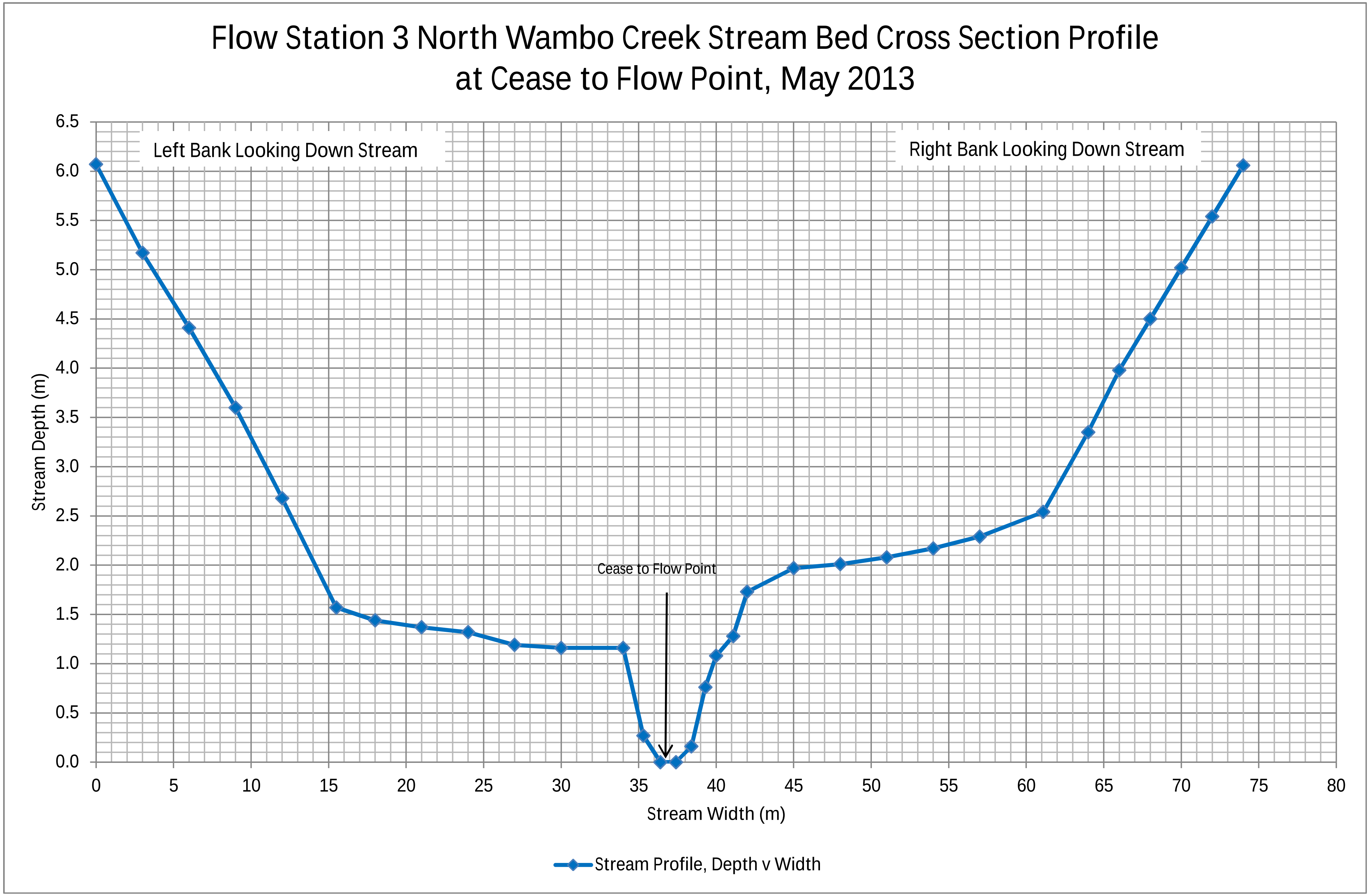

Flow Station 1 at New Location North Wambo Creek Theoretical Flow Rating Curve, January2018
Stream Height Above Cease to Flow Point (m)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
35
Theoretical Flow (Q) m³/s
y = 2E-07x⁵ - 2E-05x⁴ + 0.0007x³ - 0.0127x² + 0.1247x + 0.2835
R² = 0.9993
y = 0.1653x + 0.1474
R² = 1
y = 0.072x³ - 0.2445x² + 0.4306x + 0.0566
R² = 1
y = 0.9337x
R² = 1
Flow Q v Height (m) Section 1 (0.0 to 0.1m)
Flow Q v Height (m) Section 2 (0.1 to 0.4m)
Flow Q v Height (m) Section 3 (0.4 to 0.49m)
Flow Q v Height (m) Section 4 (0.49 to 1.18m)
Log. (Flow Q v Height (m) Section 1 (0.0 to 0.1m))
Linear (Flow Q v Height (m) Section 1 (0.0 to 0.1m))
Poly. (Flow Q v Height (m) Section 2 (0.1 to 0.4m))
Linear (Flow Q v Height (m) Section 3 (0.4 to 0.49m))
Poly. (Flow Q v Height (m) Section 4 (0.49 to 1.18m))

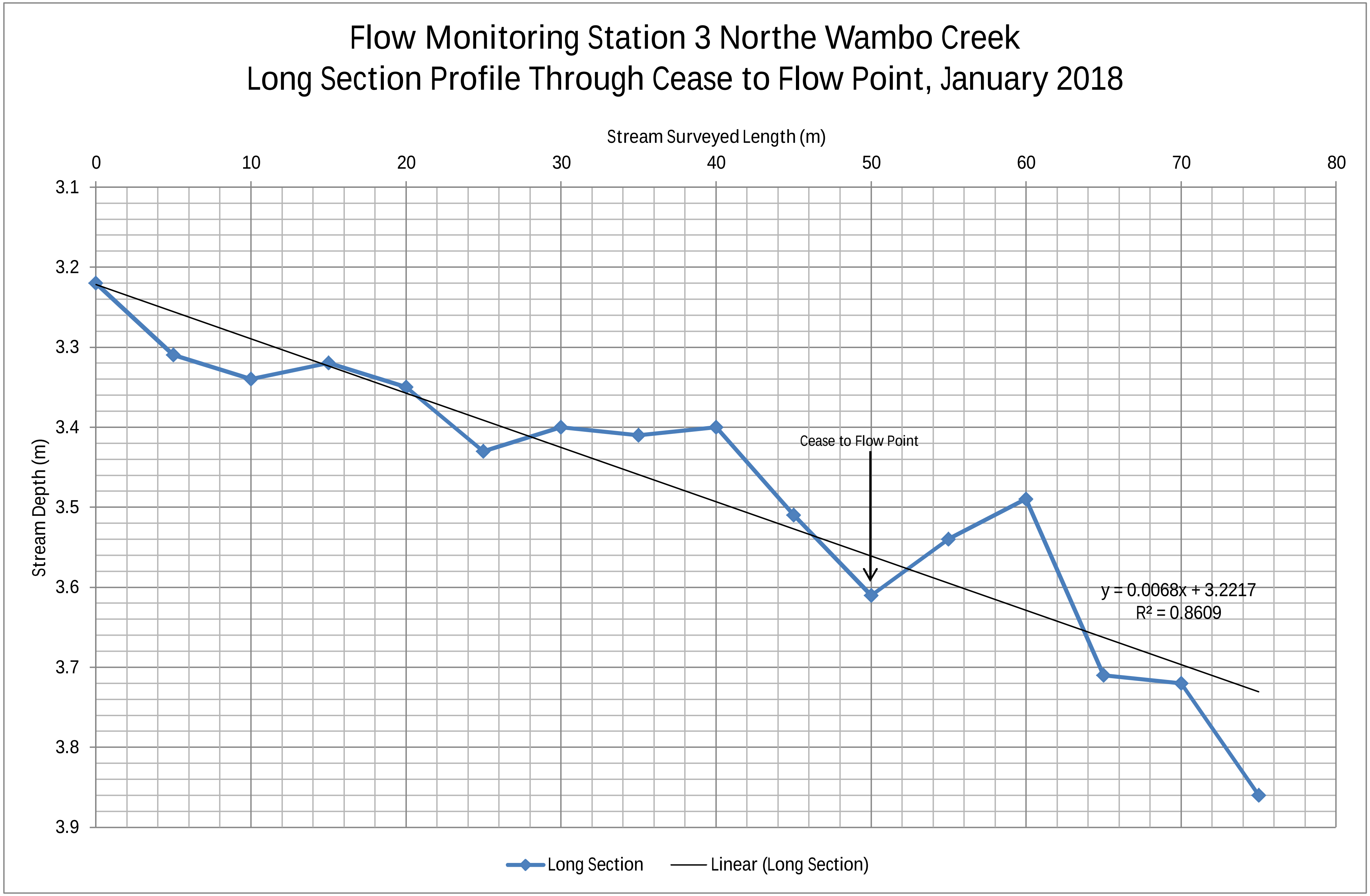


Flow Station 2 North Wambo Creek Stream Cross Section Profile
Through the Cease to Flow Point, May 2013
Right Bank Looking Down Stream
Left Bank Looking Down Stream
Cease to Flow
Stream Depth (m)
Stream Width (m)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
Stream Profile, Depth v Width

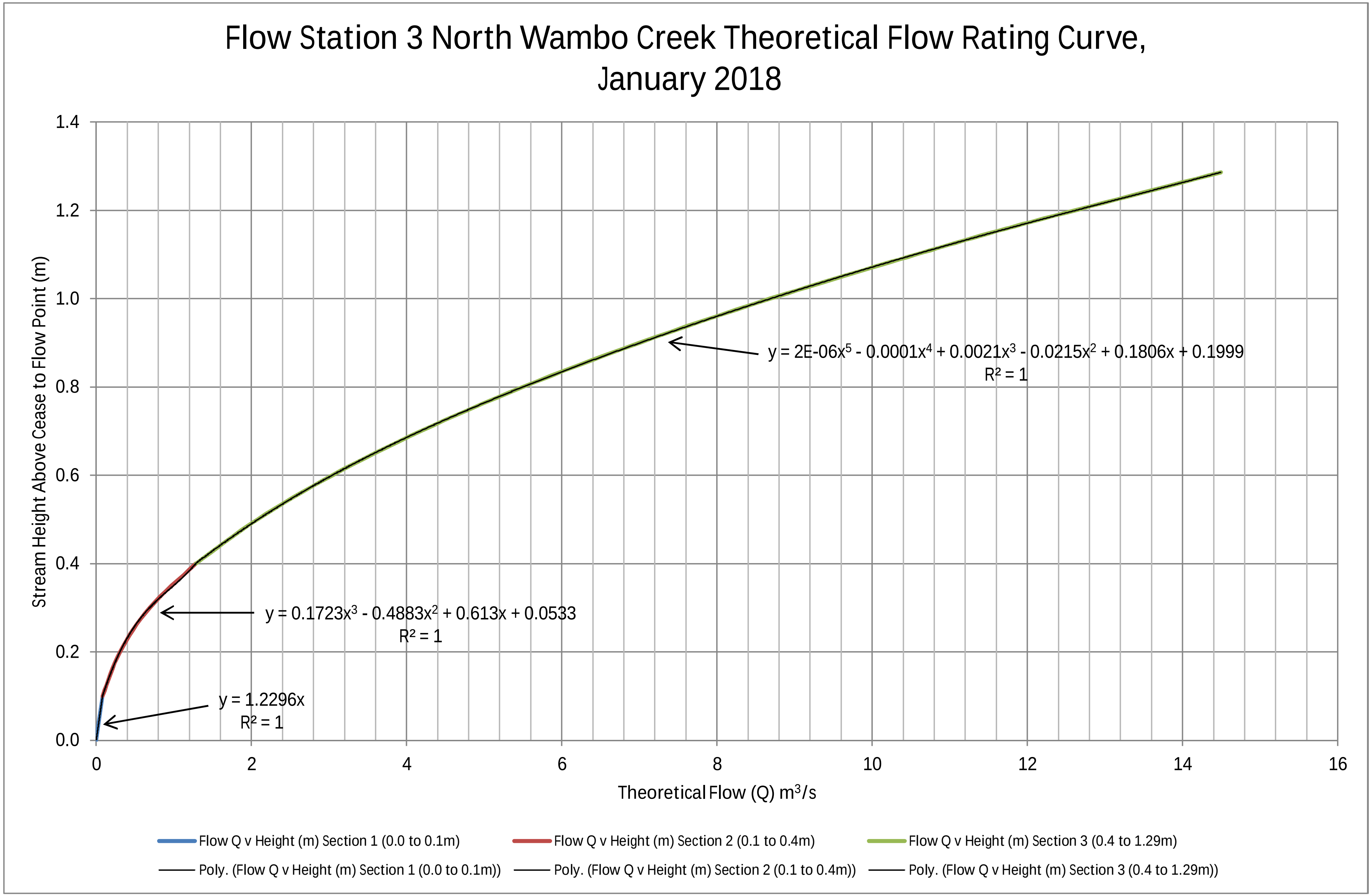


Flow Station 2 North Wambo Creek Theoretical Flow Rating Curve, January 2018
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m3/s
y = -8E-12x6 + 4E-09x5 - 8E-07x4 + 9E-05x3 - 0.0052x2 + 0.1716x - 0.2894
R² = 0.9994
y = 9E-07x5 - 8E-05x4 + 0.0025x3 - 0.0377x2 + 0.3251x + 0.0231
R² = 0.9998
y = -0.0172x4 + 0.1233x3 - 0.3333x2 + 0.569x + 0.0662
R² = 0.9998
y = 1.5056x
R² = 1
Flow Q v Height (m) Section 1 (0.0 to 0.1m)
Flow Q v Height (m) Section 2 (0.1 to 0.7m)
Flow Q v Height (m) Section 3 (0.7 to 1.9m)
Flow Q v Height (m) Section 4 (1.9 to 3.06m)
Poly. (Flow Q v Height (m) Section 1 (0.0 to 0.1m))
Poly. (Flow Q v Height (m) Section 2 (0.1 to 0.7m))
Poly. (Flow Q v Height (m) Section 3 (0.7 to 1.9m))
Poly. (Flow Q v Height (m) Section 4 (1.9 to 3.06m))

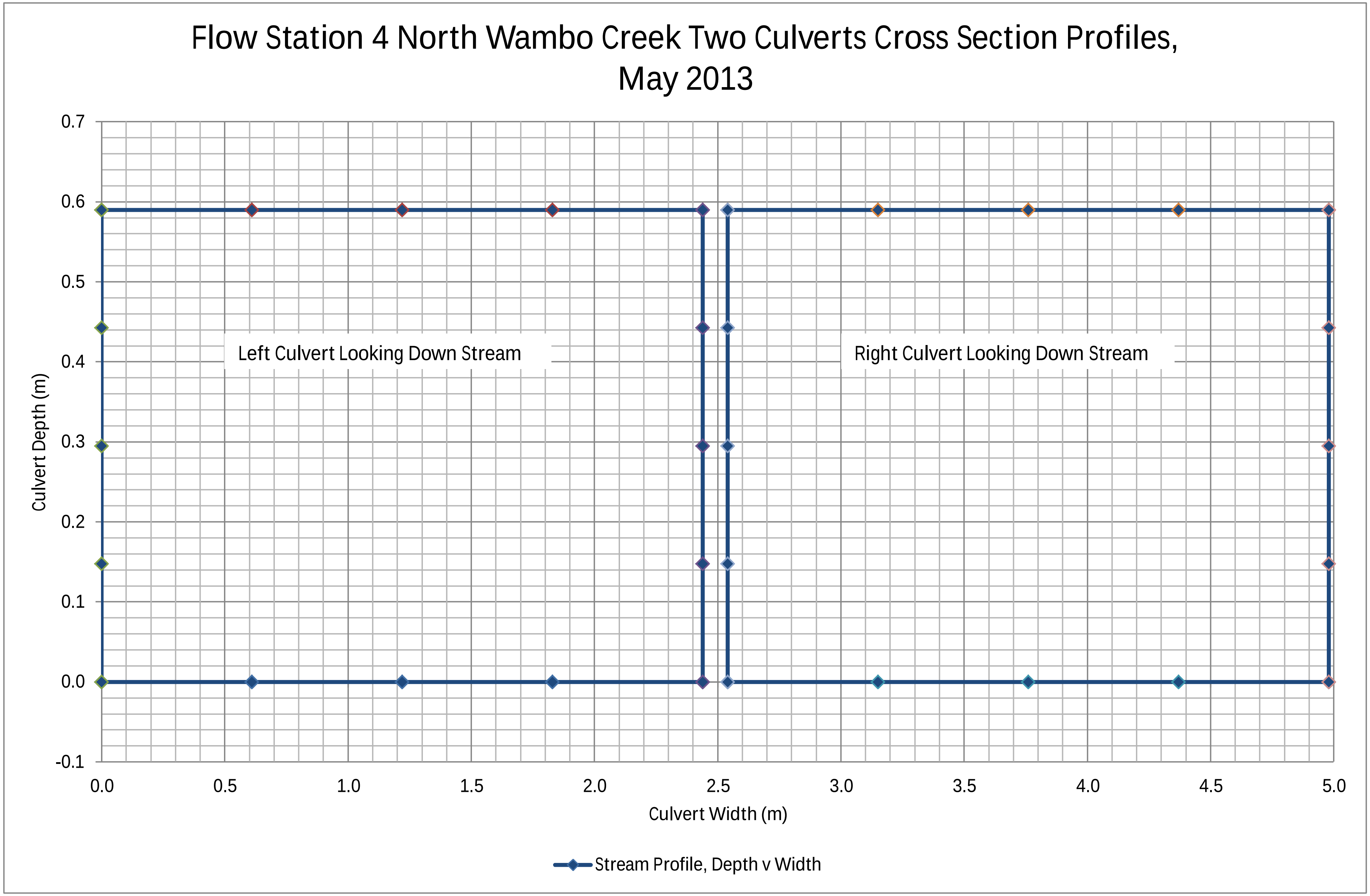

Flow Station 3 North Wambo Creek Stream Bed Cross Section Profile
at Cease to Flow Point, May 2013
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Stream Depth (m)
Stream Width (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Stream Profile, Depth v Width

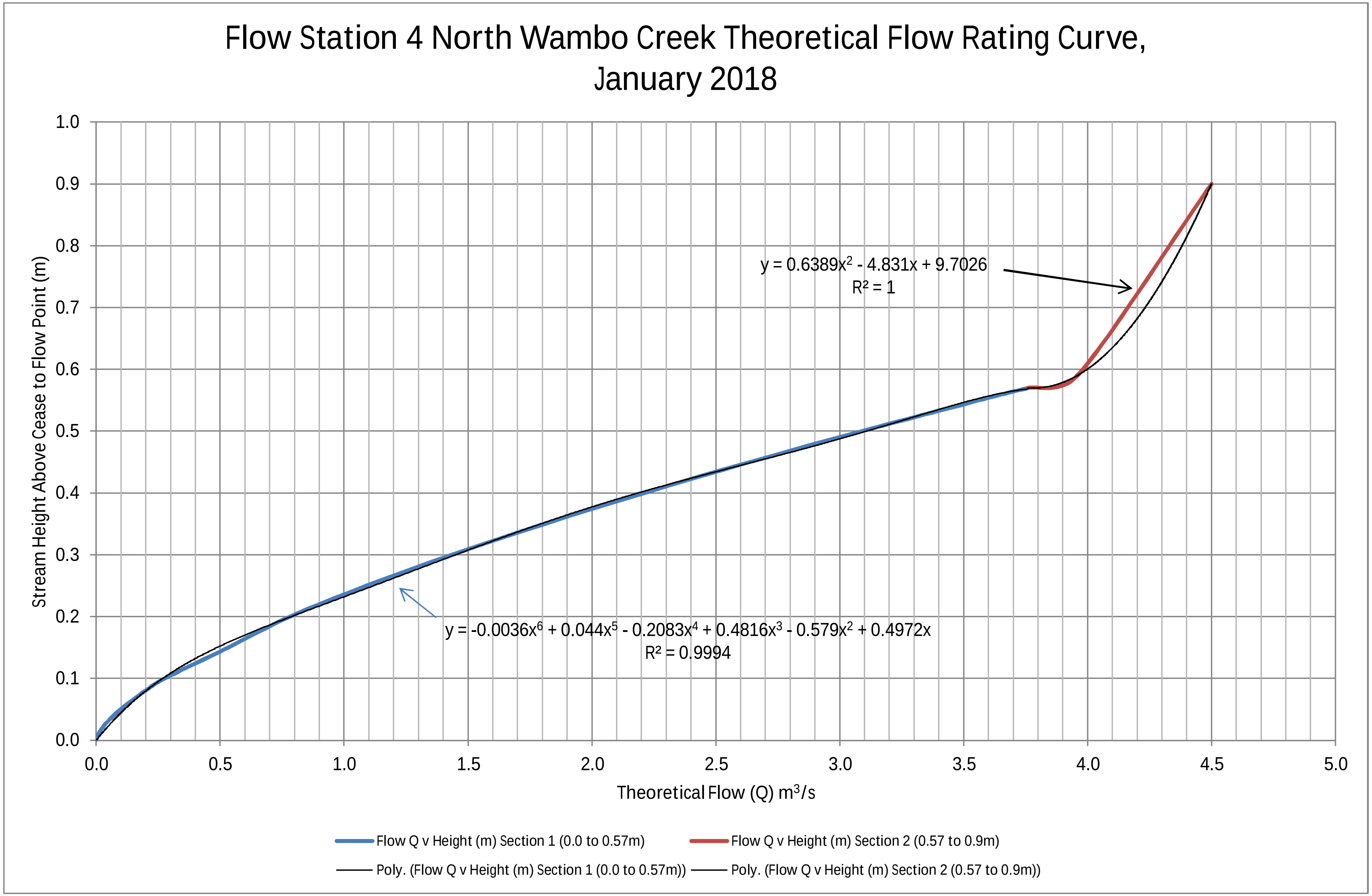


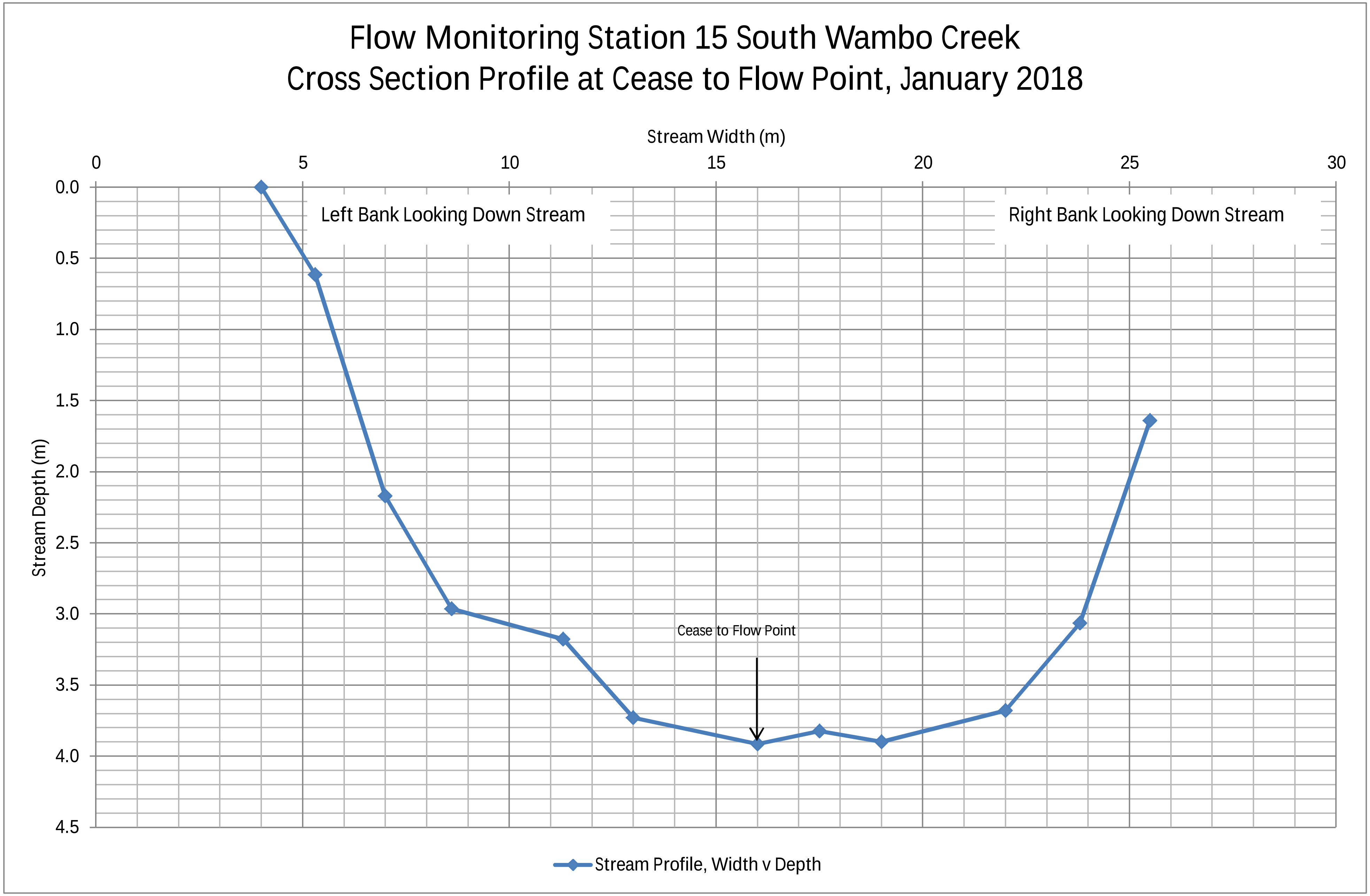
Flow Monitoring Station 3 Northe Wambo Creek
Long Section Profile Through Cease to Flow Point, January 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
Stream Depth (m)
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
Cease to Flow Point
y = 0.0068x + 3.2217
R² = 0.8609
Long Section
Linear (Long Section)

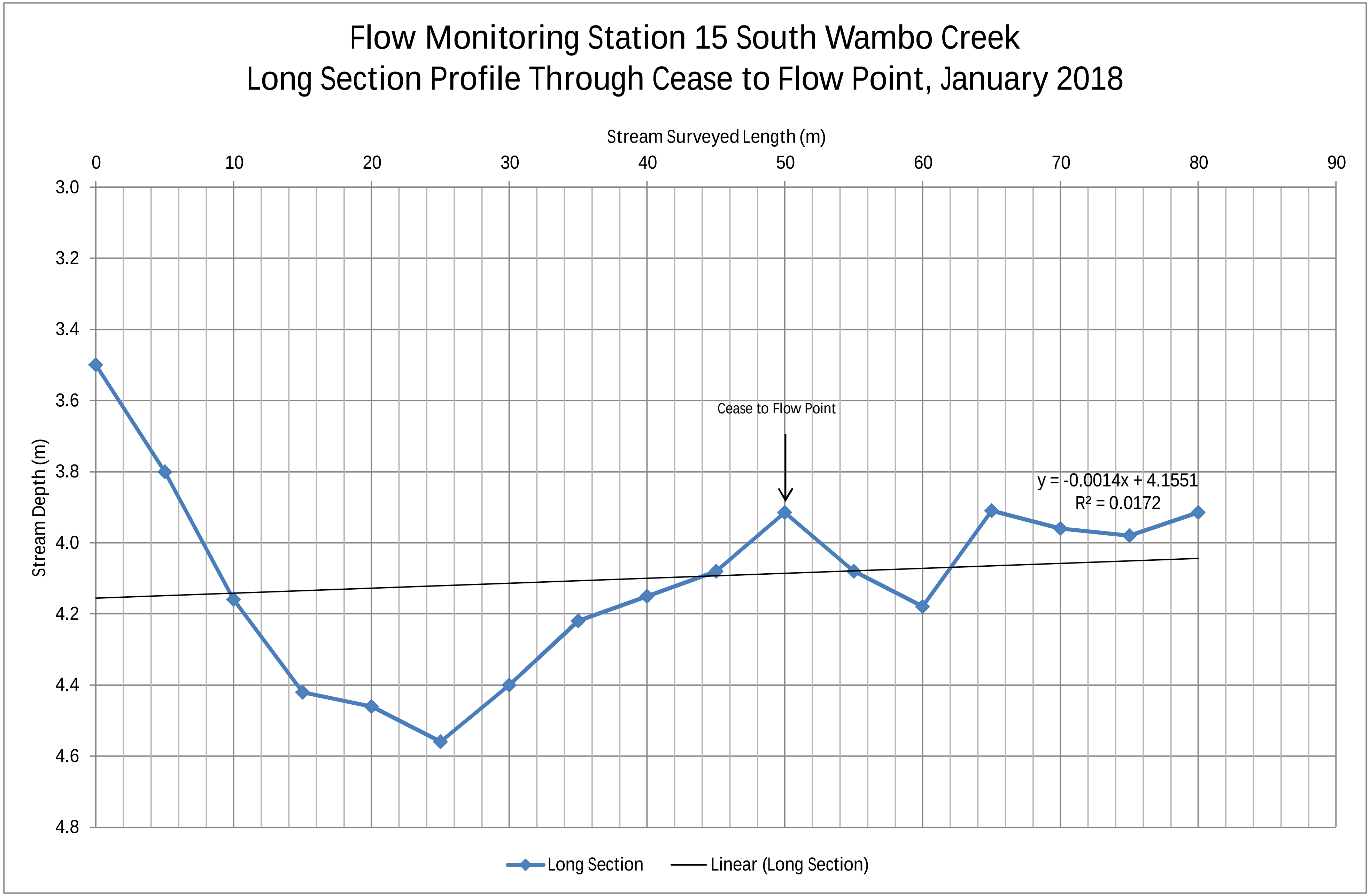


Flow Station 3 North Wambo Creek Theoretical Flow Rating Curve, January 2018
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
y = 2E-06x⁵ - 0.0001x⁴ + 0.0021x³ - 0.0215x² + 0.1806x + 0.1999
R² = 1
y = 0.1723x³ - 0.4883x² + 0.613x + 0.0533
R² = 1
y = 1.2296x
R² = 1
Flow Q v Height (m) Section 1 (0.0 to 0.1m)
Flow Q v Height (m) Section 2 (0.1 to 0.4m)
Flow Q v Height (m) Section 3 (0.4 to 1.29m)
Poly. (Flow Q v Height (m) Section 1 (0.0 to 0.1m))
Poly. (Flow Q v Height (m) Section 2 (0.1 to 0.4m))
Poly. (Flow Q v Height (m) Section 3 (0.4 to 1.29m))

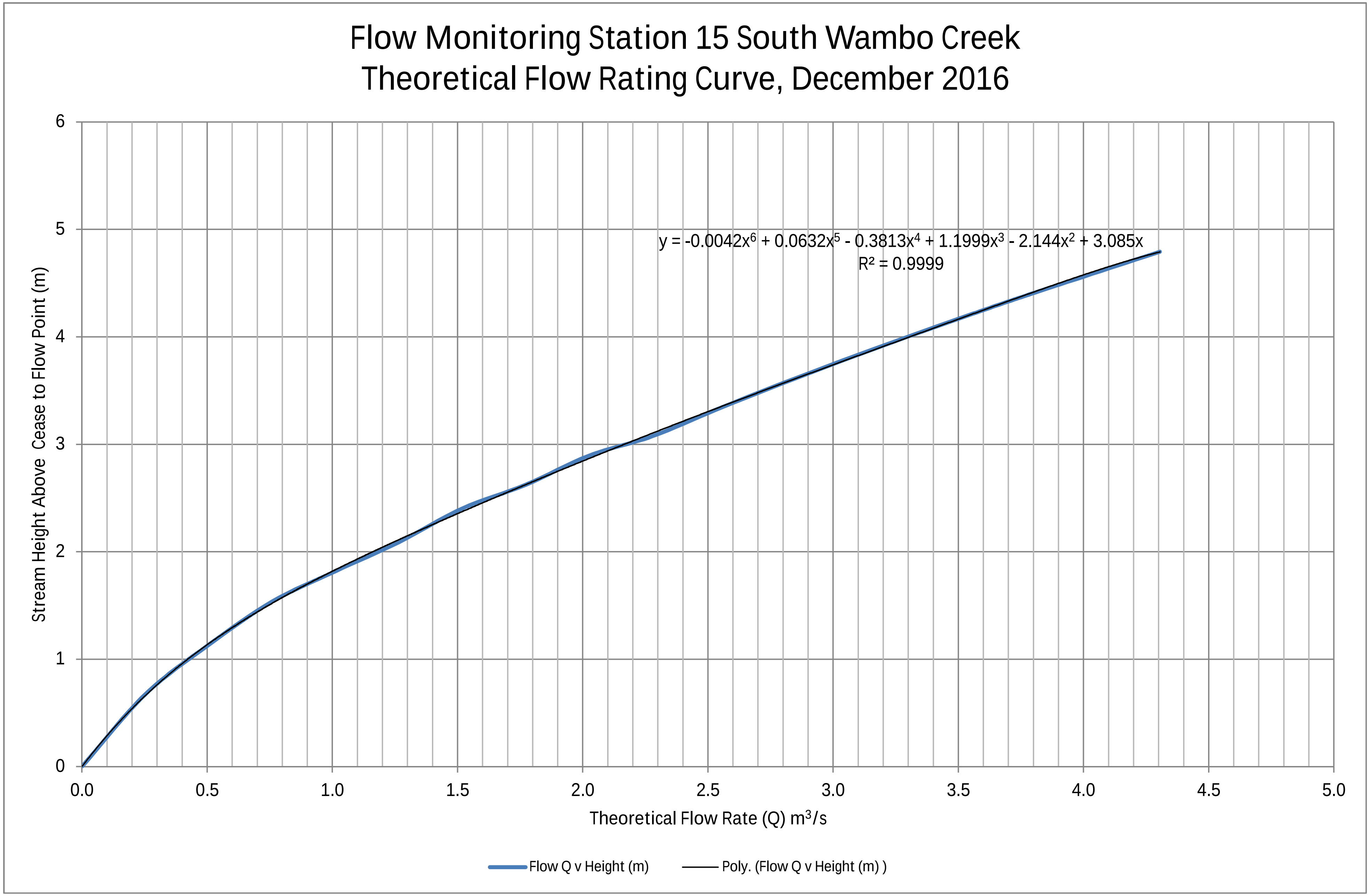

Flow Station 4 North Wambo Creek Two Culverts Cross Section Profiles, May 2013
Left Culvert Looking Down Stream
Right Culvert Looking Down Stream
Culvert Depth (m)
Culvert Width (m)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Stream Profile, Depth v Width


Flow Station 4 North Wambo Creek Theoretical Flow Rating Curve, January 2018
y = 0.6389x² - 4.831x + 9.7026
R² = 1
y = -0.0036x⁶ + 0.044x⁵ - 0.2083x⁴ + 0.4816x³ - 0.579x² + 0.4972x
R² = 0.9994
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Flow Q v Height (m) Section 1 (0.0 to 0.57m)
Flow Q v Height (m) Section 2 (0.57 to 0.9m)
Poly. (Flow Q v Height (m) Section 1 (0.0 to 0.57m))
Poly. (Flow Q v Height (m) Section 2 (0.57 to 0.9m))

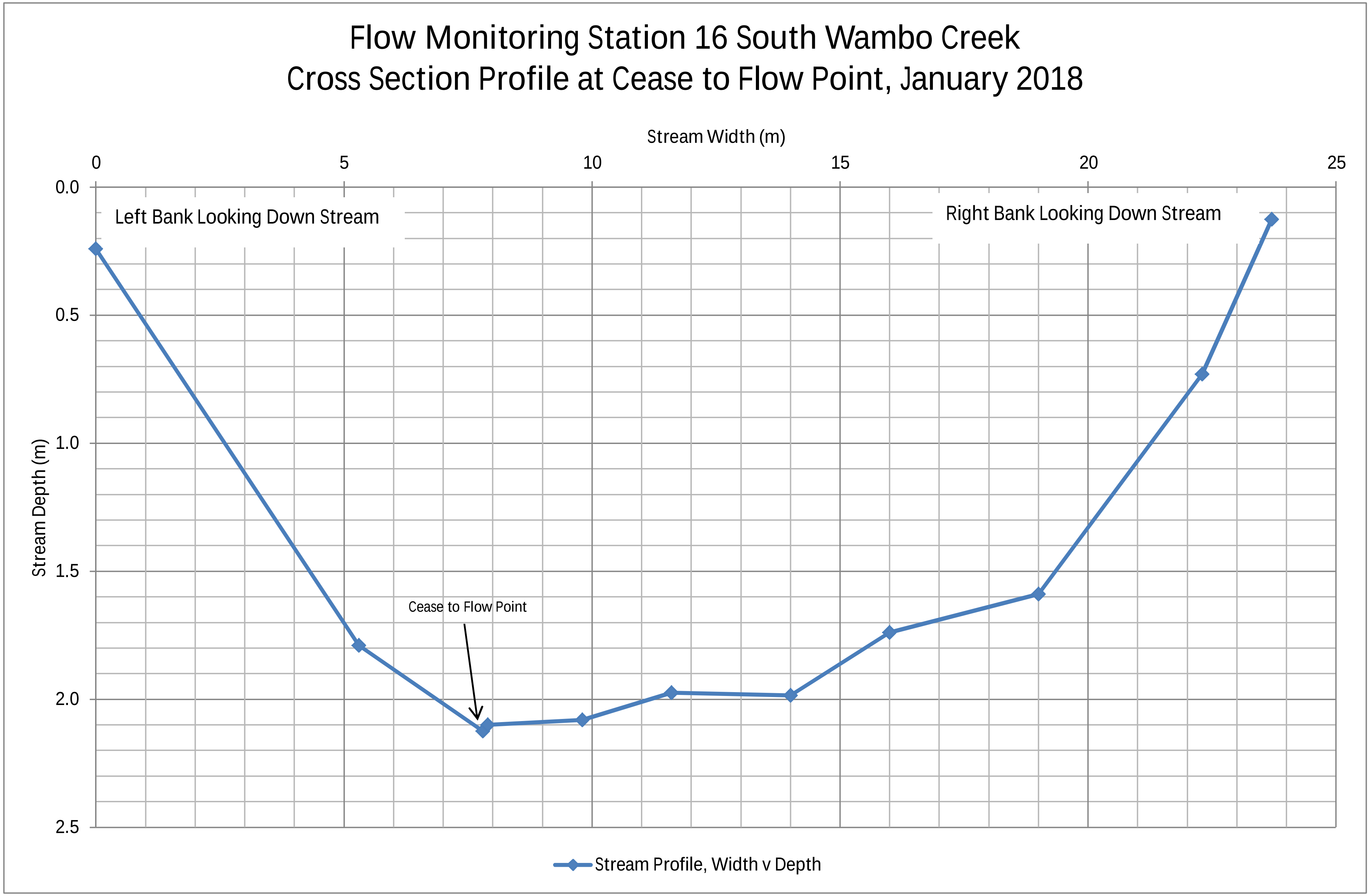

Flow Monitoring Station 15 South Wambo Creek
Cross Section Profile at Cease to Flow Point, January 2018
Stream Width (m)
0
5
10
15
20
25
30
Stream Depth (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Stream Profile, Width v Depth



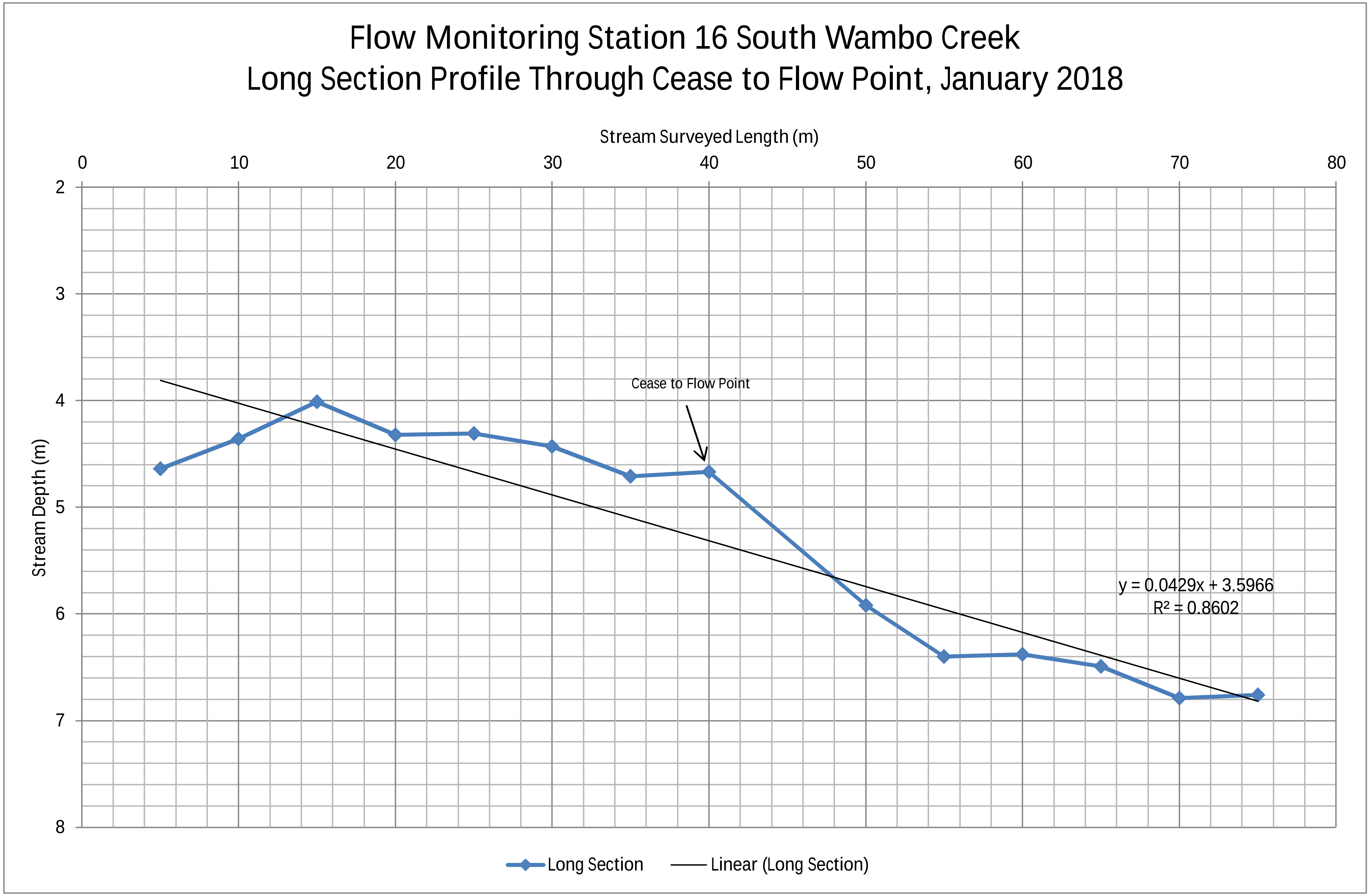
Flow Monitoring Station 15 South Wambo Creek
Long Section Profile Through Cease to Flow Point, January 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
90
Stream Depth (m)
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
Cease to Flow Point
y = -0.0014x + 4.1551
R² = 0.0172
Long Section
Linear (Long Section)

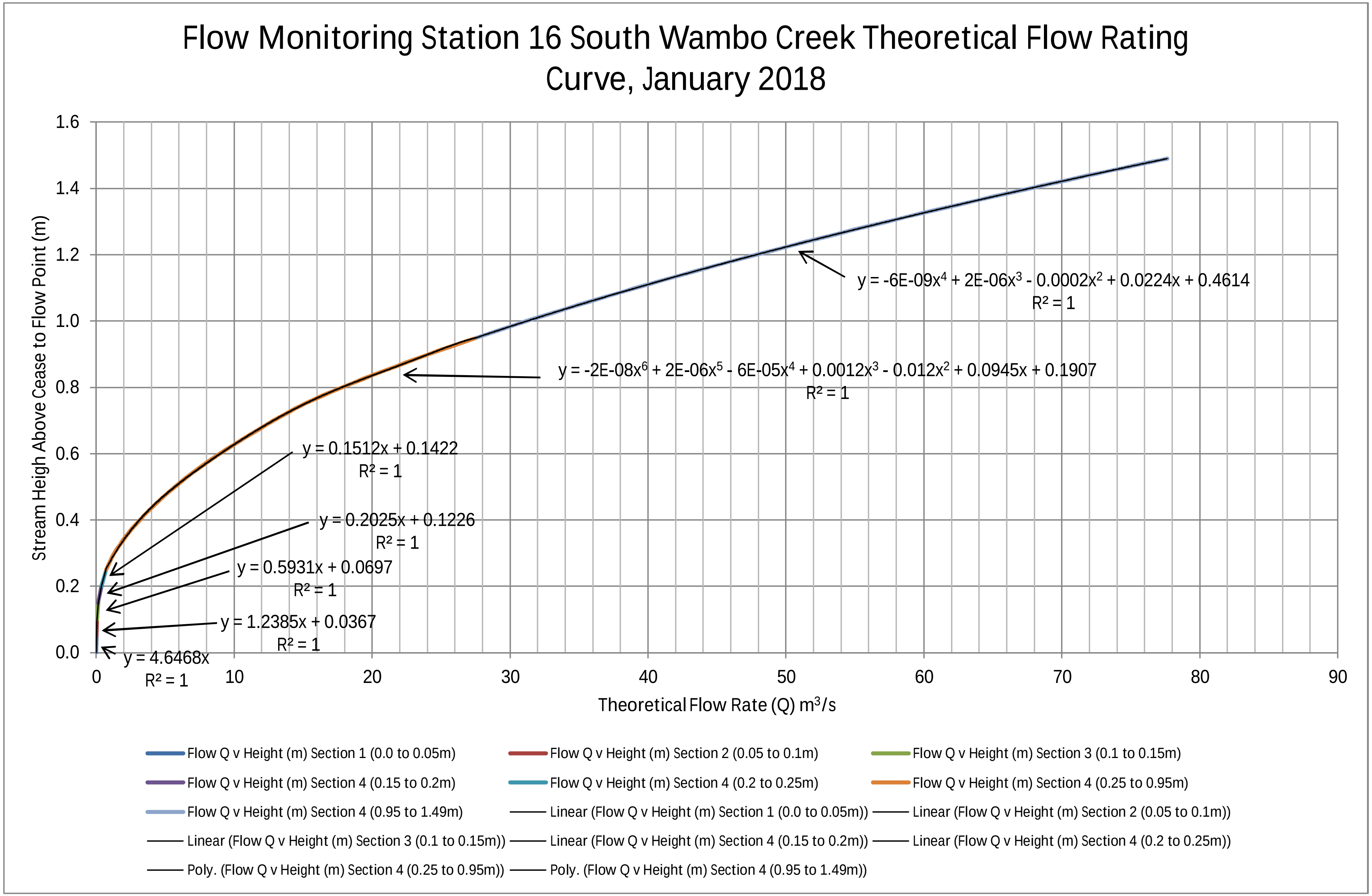


Flow Monitoring Station 15 South Wambo Creek
Theoretical Flow Rating Curve, December 2016
y = -0.0042x⁶ + 0.0632x⁵ - 0.3813x⁴ + 1.1999x³ - 2.144x² + 3.085x
R² = 0.9999
Stream Height Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m³/s
0
1
2
3
4
5
6
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Flow Q v Height (m)
Poly. (Flow Q v Height (m))

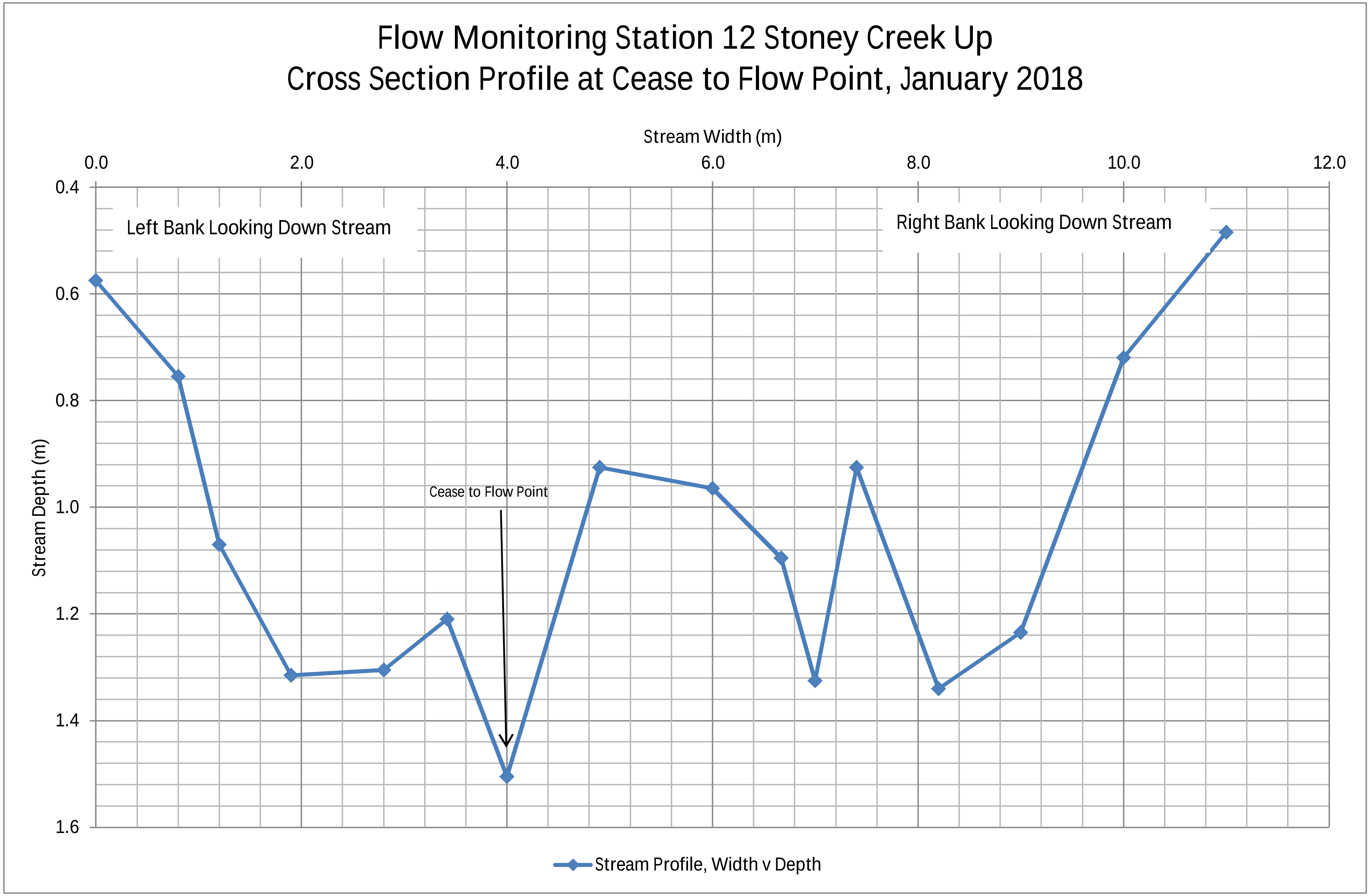


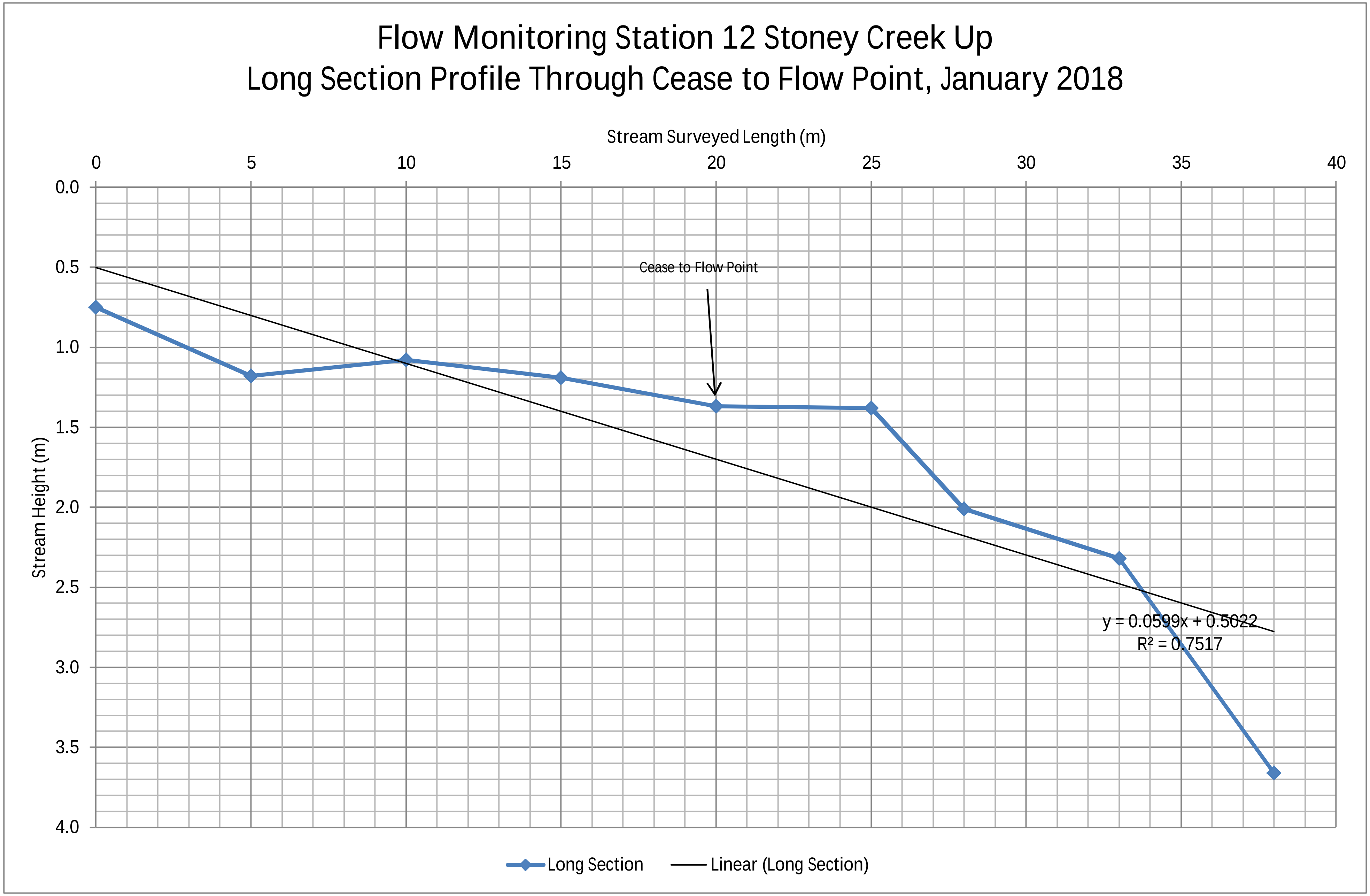
Flow Monitoring Station 16 South Wambo Creek
Cross Section Profile at Cease to Flow Point, January 2018
Stream Width (m)
0
5
10
15
20
25
0.0
0.5
1.0
1.5
2.0
2.5
Stream Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Stream Profile, Width v Depth


Flow Monitoring Station 16 South Wambo Creek
Long Section Profile Through Cease to Flow Point, January 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
2
3
4
5
6
7
8
Stream Depth (m)
Cease to Flow Point
y = 0.0429x + 3.5966
R² = 0.8602
Long Section
Linear (Long Section)

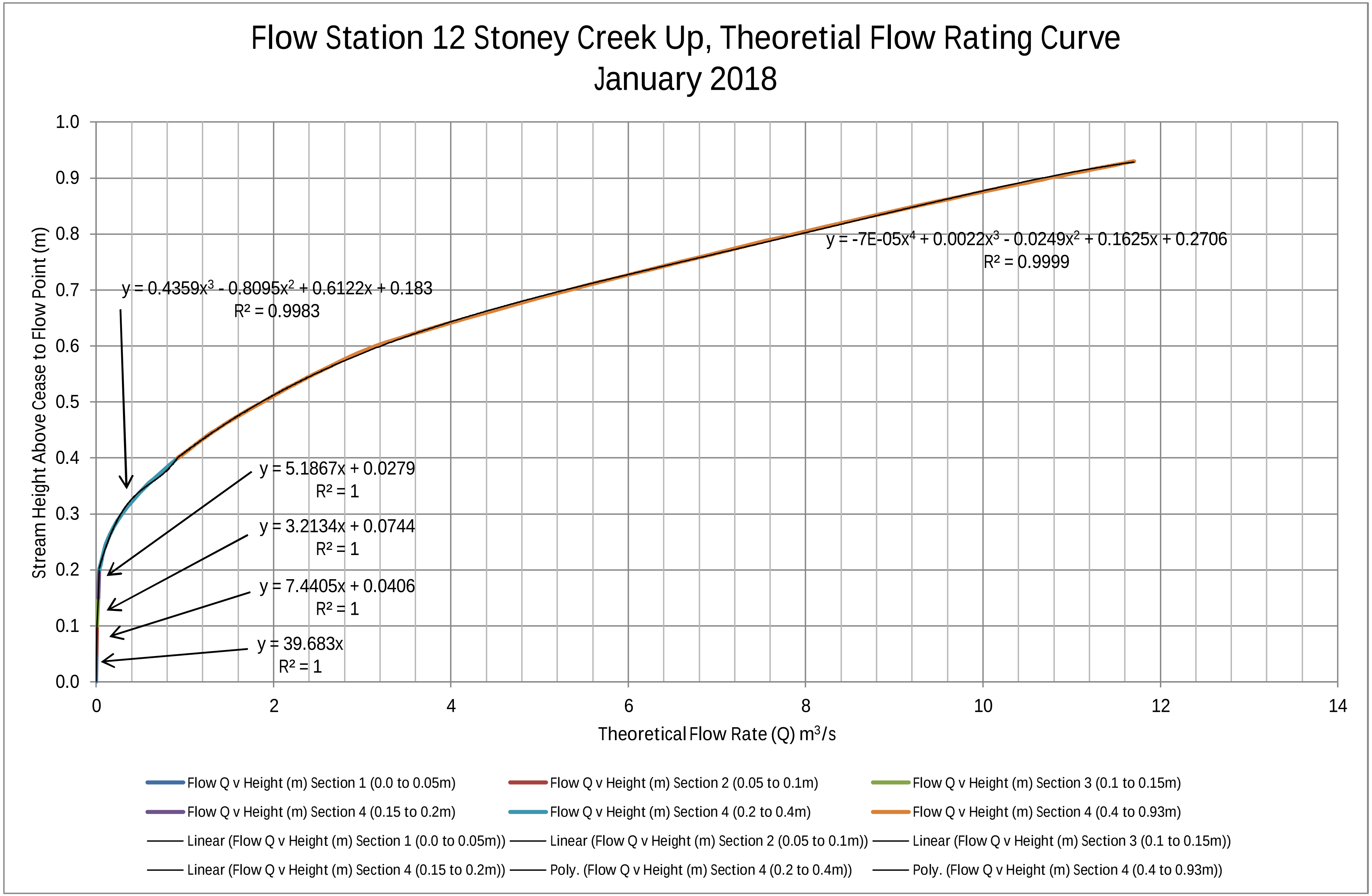


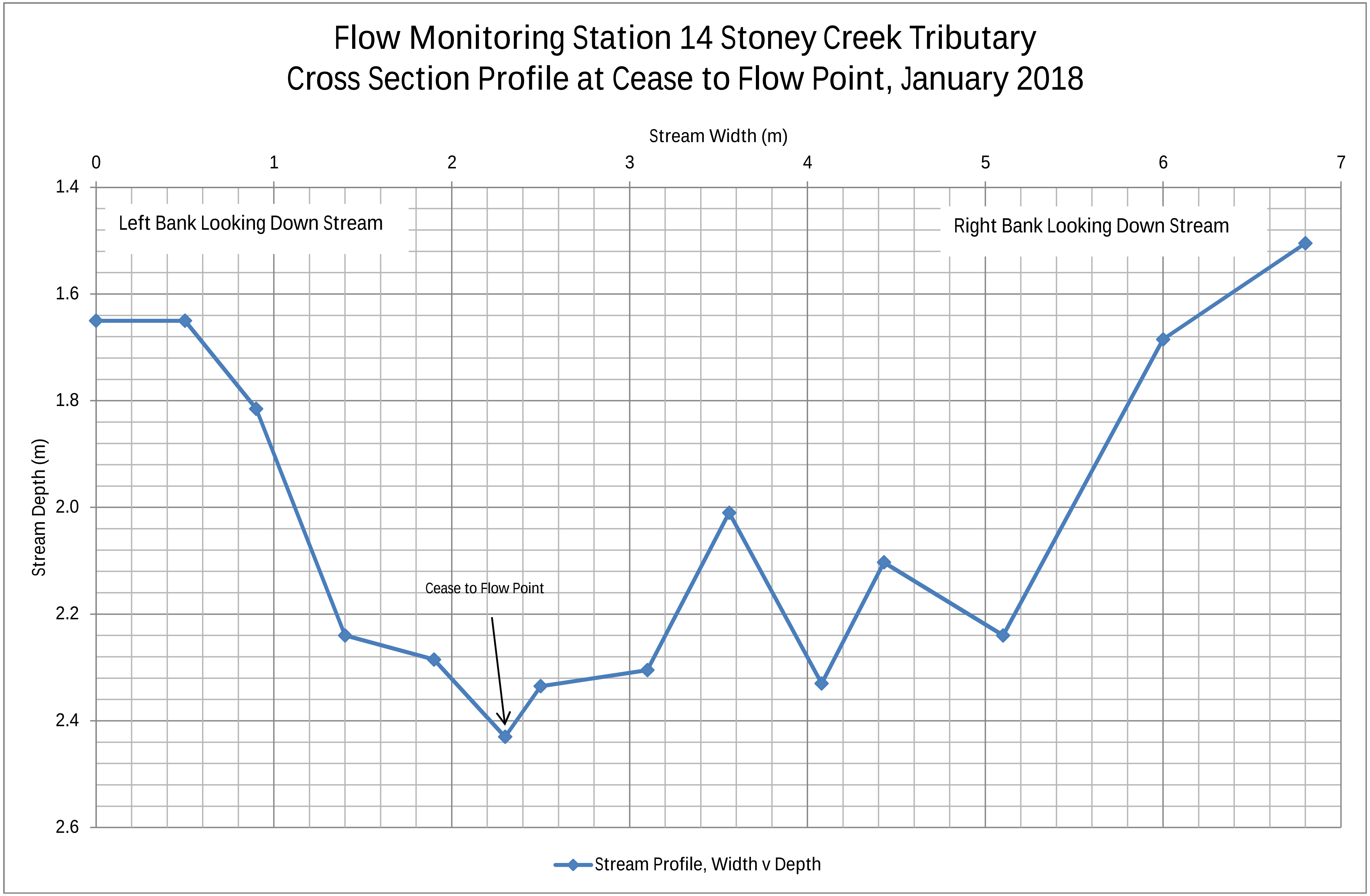
Flow Monitoring Station 16 South Wambo Creek Theoretical Flow Rating Curve, January 2018
Stream Heigh Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m3/s
y = -6E-09x4 + 2E-06x3 - 0.0002x2 + 0.0224x + 0.4614
R² = 1
y = -2E-08x6 + 2E-06x5 - 6E-05x4 + 0.0012x3 - 0.012x2 + 0.0945x + 0.1907
R² = 1
y = 0.1512x + 0.1422
R² = 1
y = 0.2025x + 0.1226
R² = 1
y = 0.5931x + 0.0697
R² = 1
y = 1.2385x + 0.0367
R² = 1
y = 4.6468x
R² = 1
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 12 Stoney Creek Up
Cross Section Profile at Cease to Flow Point, January 2018
Stream Width (m)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Stream Depth (m)
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Stream Profile, Width v Depth

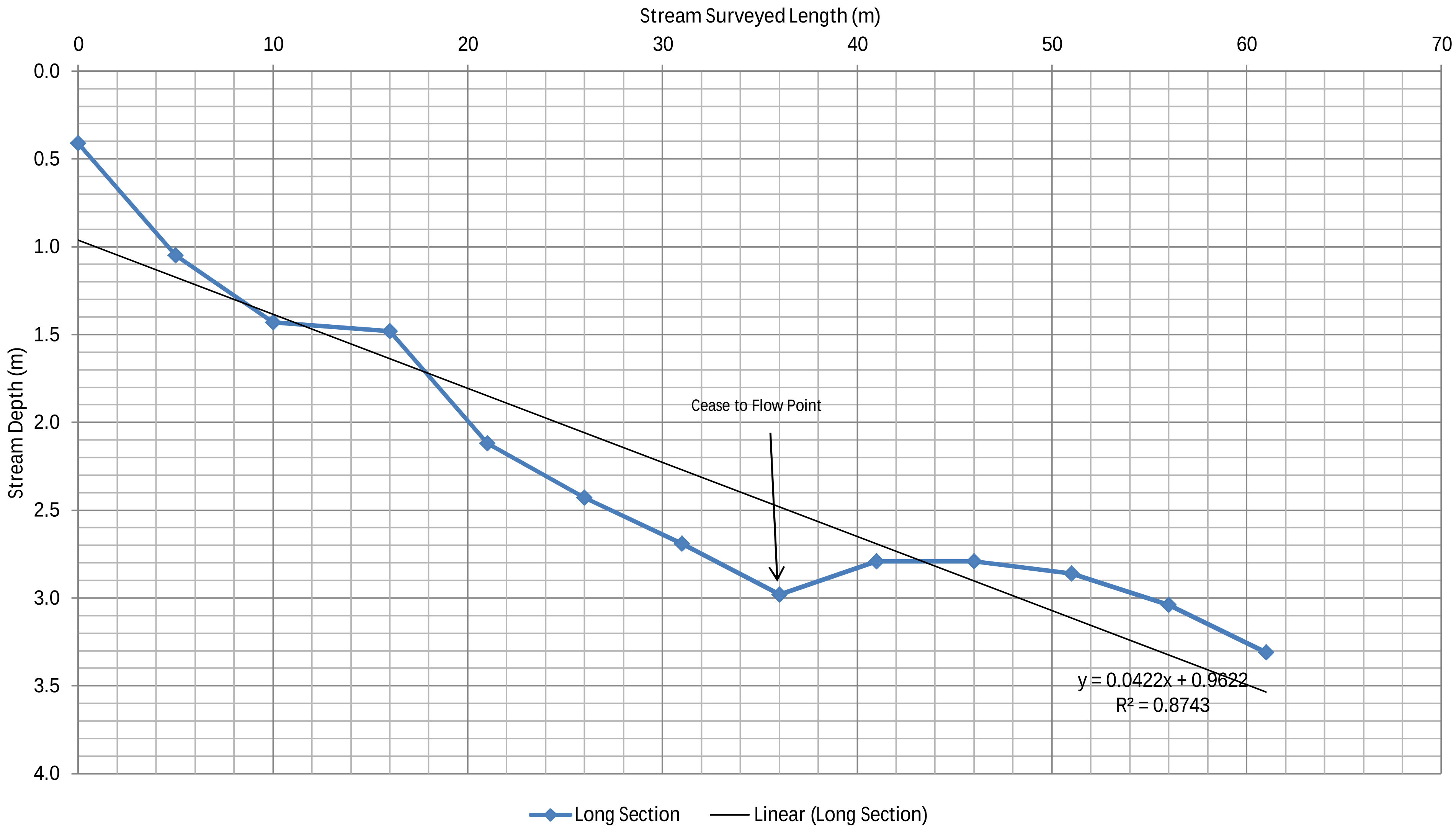


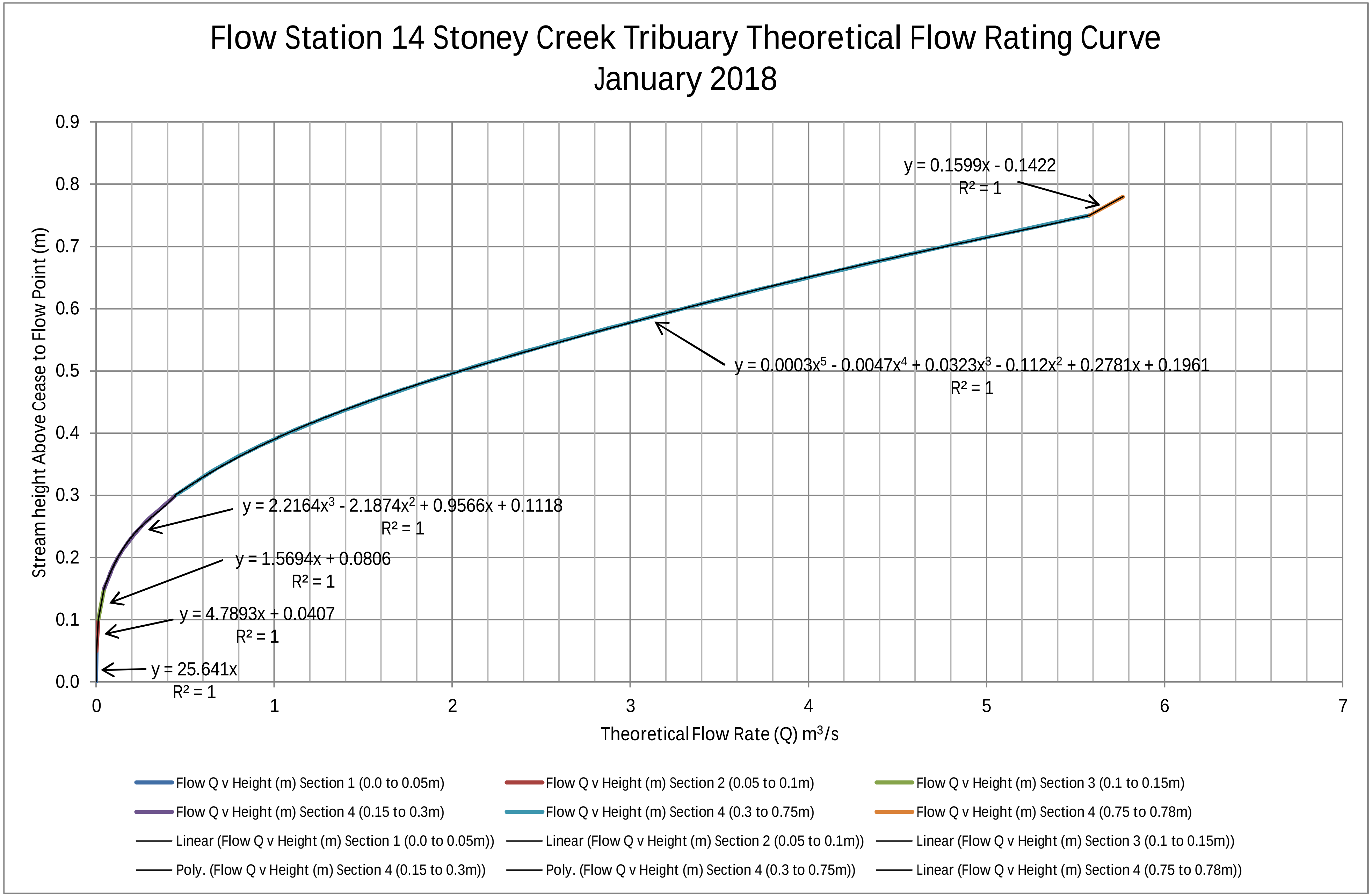
Flow Monitoring Station 12 Stoney Creek Up
Long Section Profile Through Cease to Flow Point, January 2018
Stream Surveyed Length (m)
0
5
10
15
20
25
30
35
40
Stream Height (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Cease to Flow Point
y = 0.0599x + 0.5022
R² = 0.7517
Long Section
Linear (Long Section)


Flow Station 12 Stoney Creek Up, Theoretial Flow Rating Curve
January 2018
Stream Height Above Cease to Flow Point (m)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
8
10
12
14
Theoretical Flow Rate (Q) m3/s
y = -7E-05x4 + 0.0022x3 - 0.0249x2 + 0.1625x + 0.2706
R² = 0.9999
y = 0.4359x3 - 0.8095x2 + 0.6122x + 0.183
R² = 0.9983
y = 5.1867x + 0.0279
R² = 1
y = 3.2134x + 0.0744
R² = 1
y = 7.4405x + 0.0406
R² = 1
y = 39.683x
R² = 1
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 0.4m)
Flow Q v Height (m) Section 4 (0.4 to 0.93m)
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))
Poly. (Flow Q v Height (m) Section 4 (0.2 to 0.4m))
Poly. (Flow Q v Height (m) Section 4 (0.4 to 0.93m))

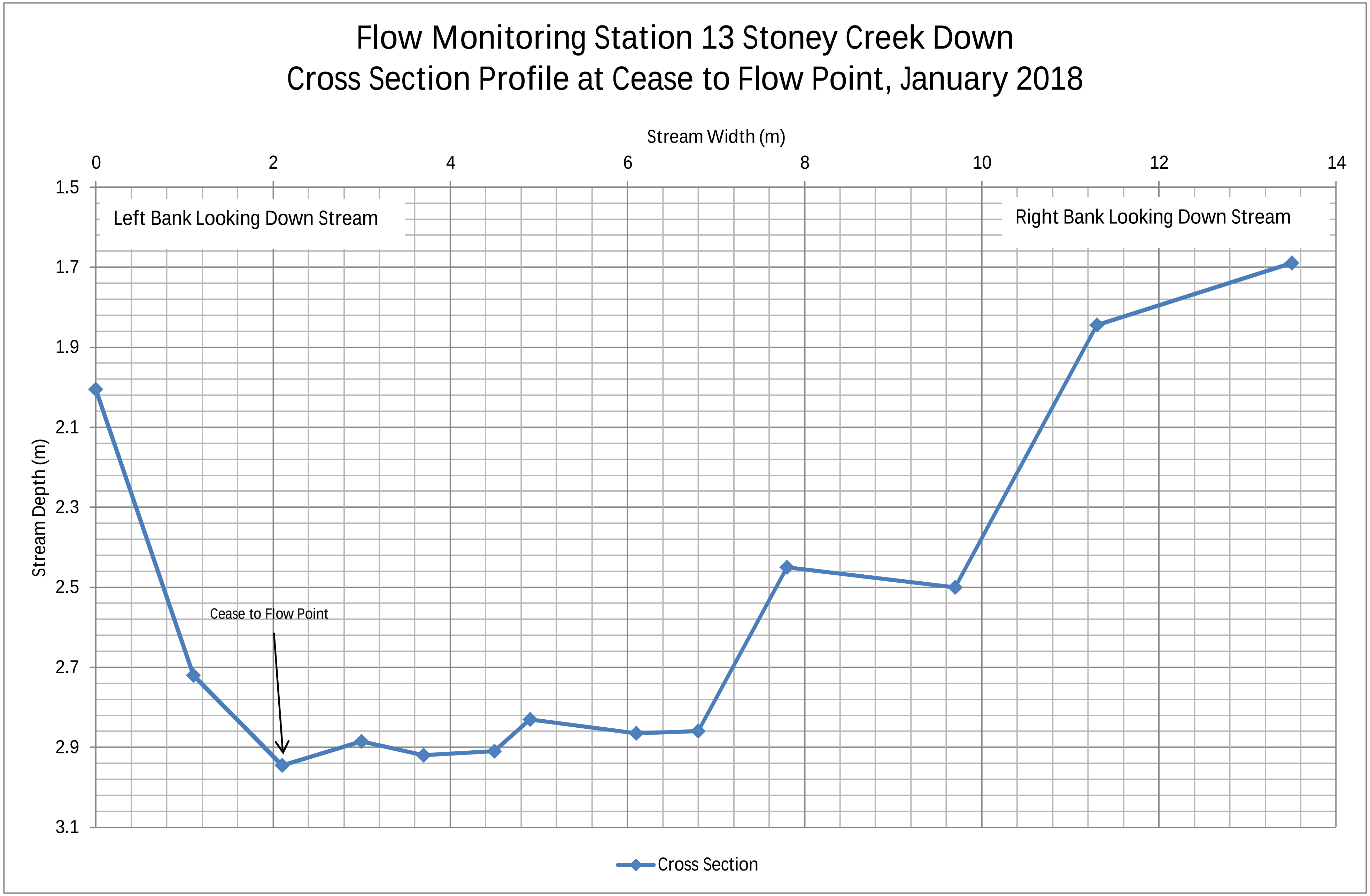

Flow Monitoring Station 14 Stoney Creek Tributary
Cross Section Profile at Cease to Flow Point, January 2018
Stream Width (m)
0
1
2
3
4
5
6
7
1.4
1.6
1.8
2.0
2.2
2.4
2.6
Stream Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Stream Profile, Width v Depth

Flow Monitoring Station 14 Stoney Creek Tributary
Long Section Profile Through Cease to Flow Point, January 2018

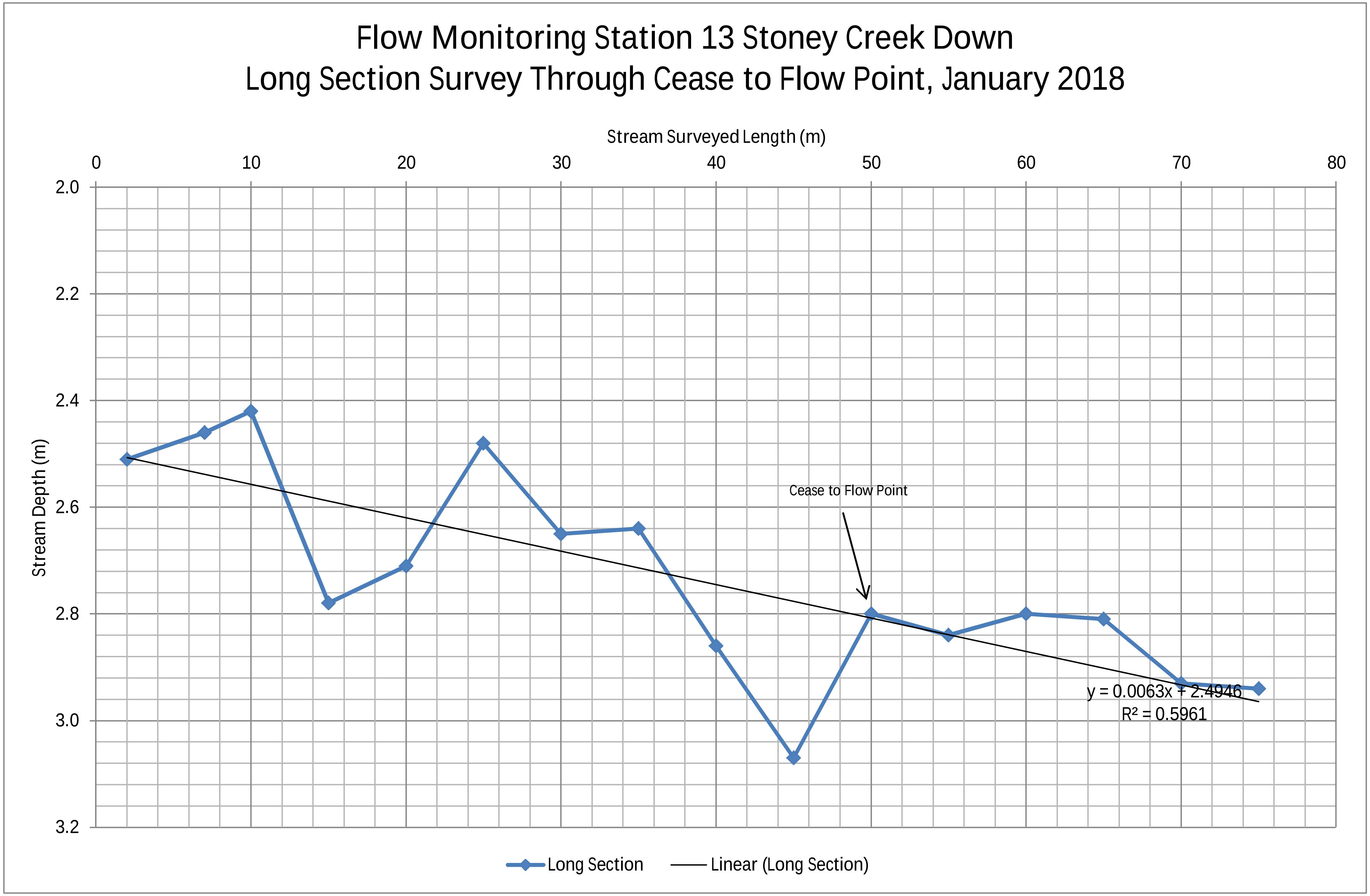


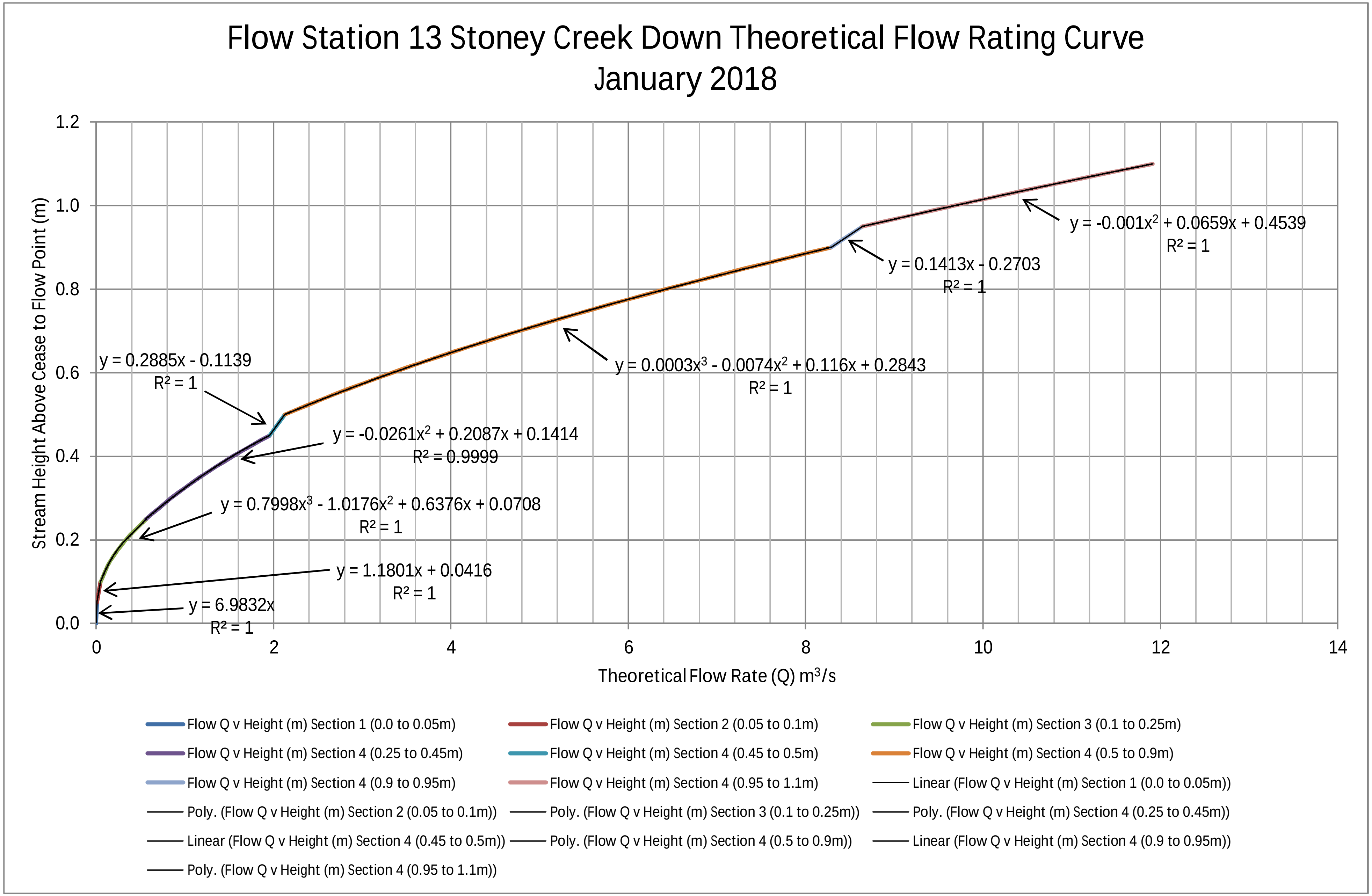


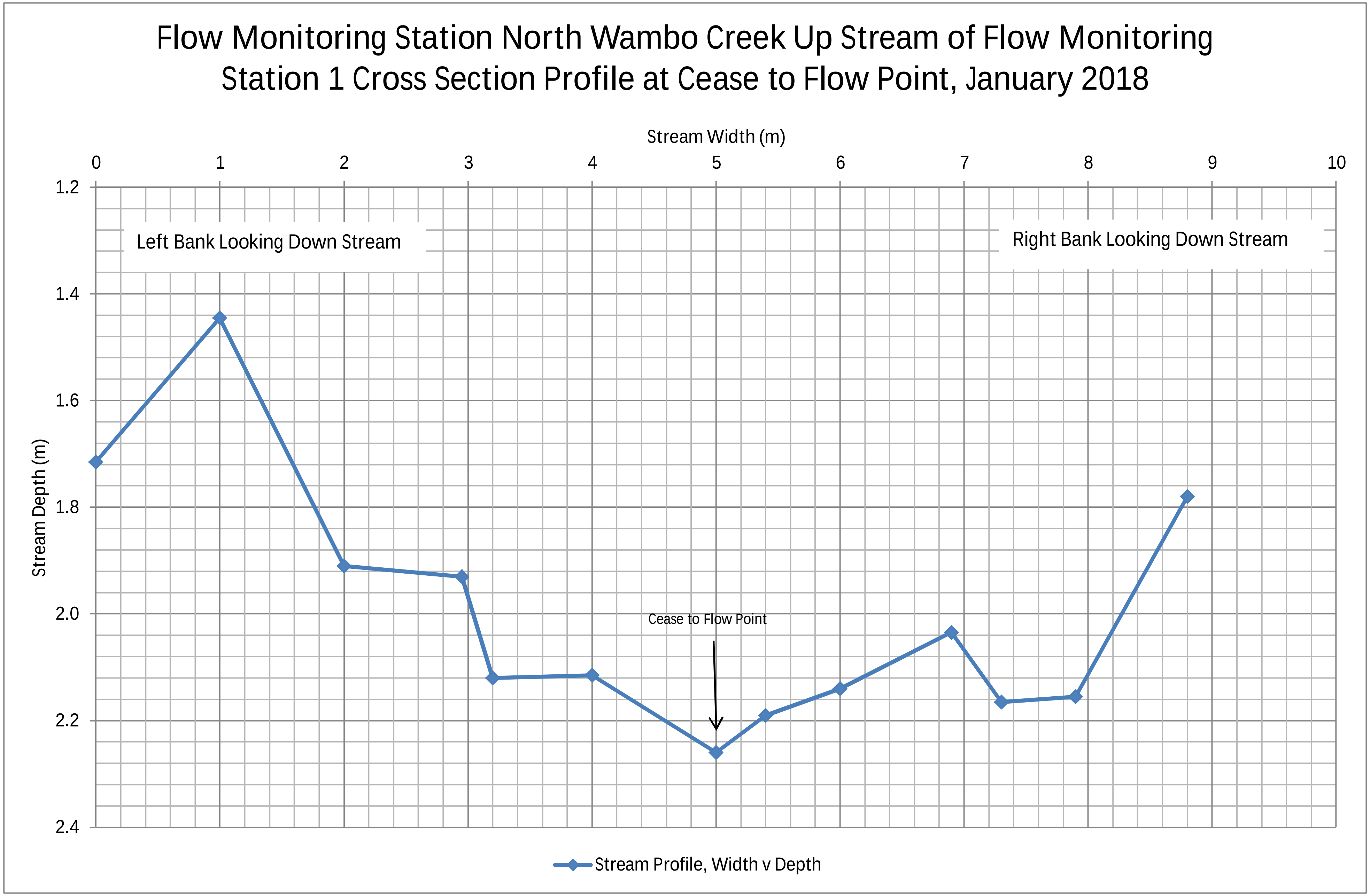
Flow Station 14 Stoney Creek Tribuary Theoretical Flow Rating Curve
January 2018
Stream height Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m3/s
y = 0.1599x - 0.1422
R² = 1
y = 0.0003x5 - 0.0047x4 + 0.0323x3 - 0.112x2 + 0.2781x + 0.1961
R² = 1
y = 2.2164x3 - 2.1874x2 + 0.9566x + 0.1118
R² = 1
y = 1.5694x + 0.0806
R² = 1
y = 4.7893x + 0.0407
R² = 1
y = 25.641x
R² = 1
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 0.3m)
Flow Q v Height (m) Section 4 (0.3 to 0.75m)
Flow Q v Height (m) Section 4 (0.75 to 0.78m)
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))
Poly. (Flow Q v Height (m) Section 4 (0.15 to 0.3m))
Poly. (Flow Q v Height (m) Section 4 (0.3 to 0.75m))
Linear (Flow Q v Height (m) Section 4 (0.75 to 0.78m))



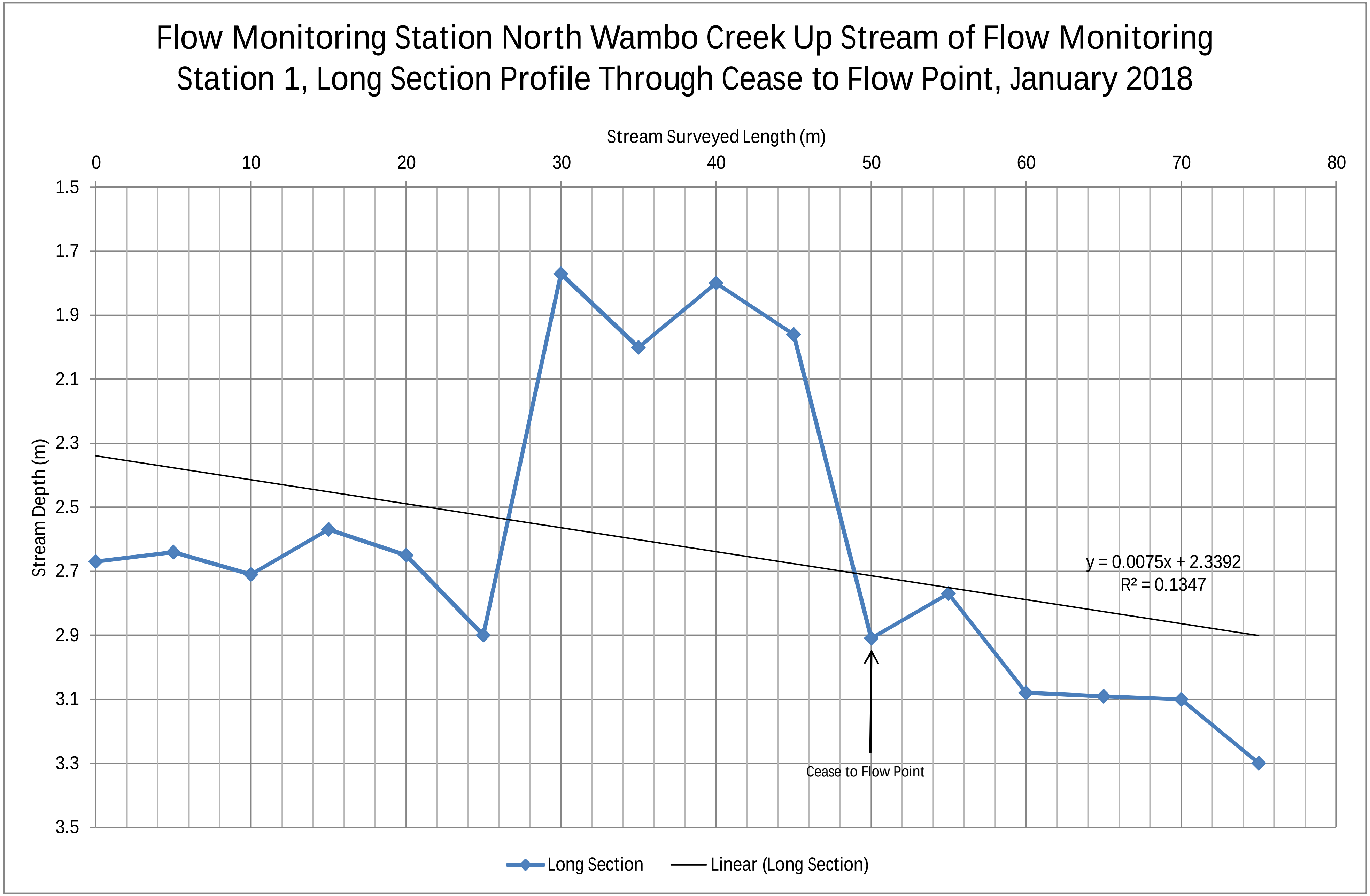
Flow Monitoring Station 13 Stoney Creek Down
Cross Section Profile at Cease to Flow Point, January 2018
Stream Width (m)
0
2
4
6
8
10
12
14
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1
Stream Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Cross Section


Flow Monitoring Station 13 Stoney Creek Down
Long Section Survey Through Cease to Flow Point, January 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
2.0
2.2
2.4
2.6
2.8
3.0
3.2
Stream Depth (m)
Cease to Flow Point
y = 0.0063x + 2.4946
R² = 0.5961
Long Section
Linear (Long Section)


Flow Station 13 Stoney Creek Down Theoretical Flow Rating Curve
January 2018
Stream Height Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m³/s
y = 6.9832x
R² = 1
y = 1.1801x + 0.0416
R² = 1
y = 0.7998x³ - 1.0176x² + 0.6376x + 0.0708
R² = 1
y = -0.0261x² + 0.2087x + 0.1414
R² = 0.9999
y = 0.2885x - 0.1139
R² = 1
y = 0.0003x³ - 0.0074x² + 0.116x + 0.2843
R² = 1
y = 0.1413x - 0.2703
R² = 1
y = -0.001x² + 0.0659x + 0.4539
R² = 1
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 0.25m)
Flow Q v Height (m) Section 4 (0.25 to 0.45m)
Flow Q v Height (m) Section 4 (0.45 to 0.5m)
Flow Q v Height (m) Section 4 (0.5 to 0.9m)
Flow Q v Height (m) Section 4 (0.9 to 0.95m)
Flow Q v Height (m) Section 4 (0.95 to 1.1m)
Linear (Flow Q v Height (m) Section 1 (0.0 to 0.05m))
Poly. (Flow Q v Height (m) Section 2 (0.05 to 0.1m))
Poly. (Flow Q v Height (m) Section 3 (0.1 to 0.25m))
Poly. (Flow Q v Height (m) Section 4 (0.25 to 0.45m))
Linear (Flow Q v Height (m) Section 4 (0.45 to 0.5m))
Poly. (Flow Q v Height (m) Section 4 (0.5 to 0.9m))
Linear (Flow Q v Height (m) Section 4 (0.9 to 0.95m))
Poly. (Flow Q v Height (m) Section 4 (0.95 to 1.1m))

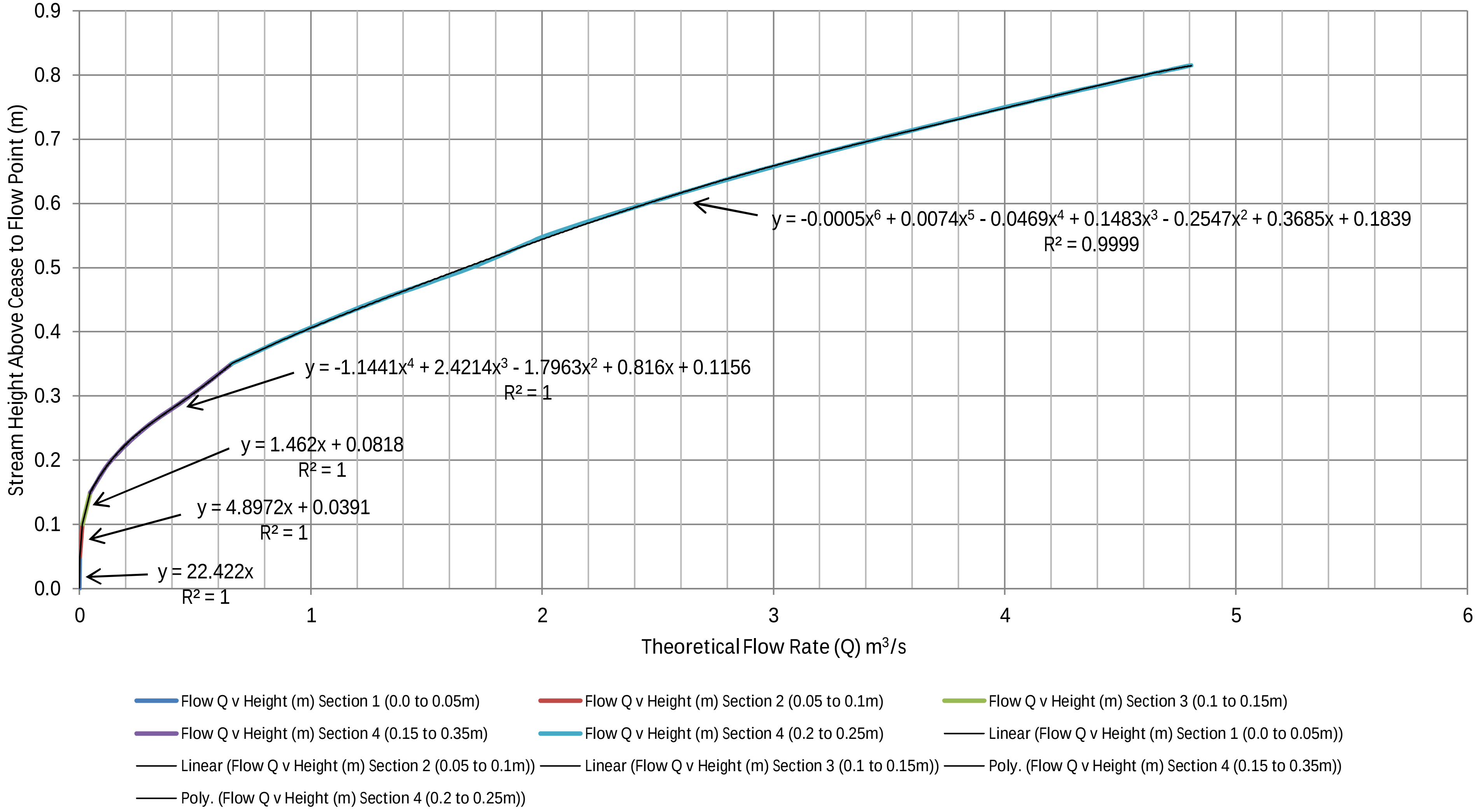


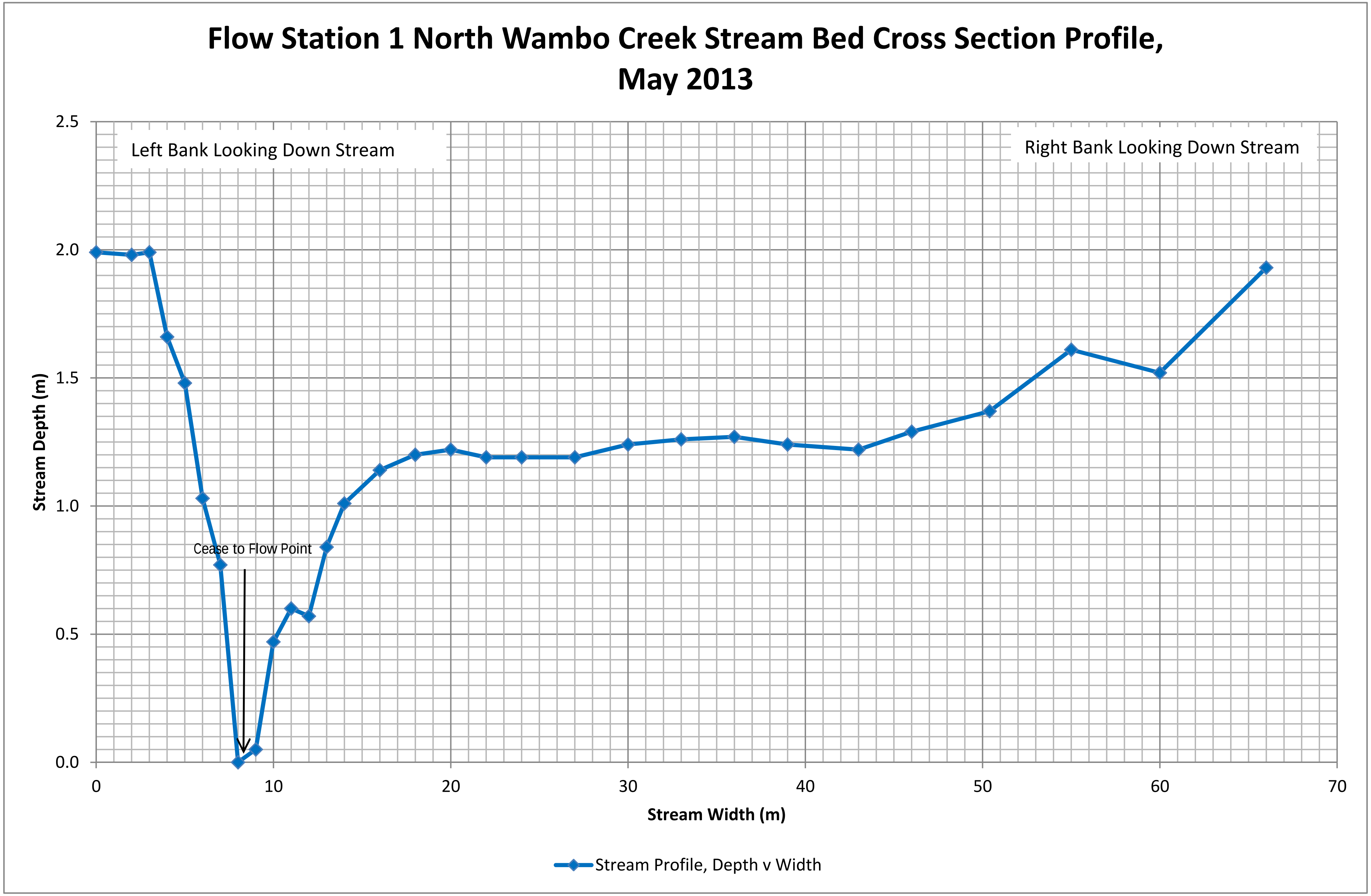
Flow Monitoring Station North Wambo Creek Up Stream of Flow Monitoring Station 1 Cross Section Profile at Cease to Flow Point, January 2018
Stream Width (m)
0
1
2
3
4
5
6
7
8
9
10
1.2
1.4
1.6
1.8
2.0
2.2
2.4
Stream Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Stream Profile, Width v Depth



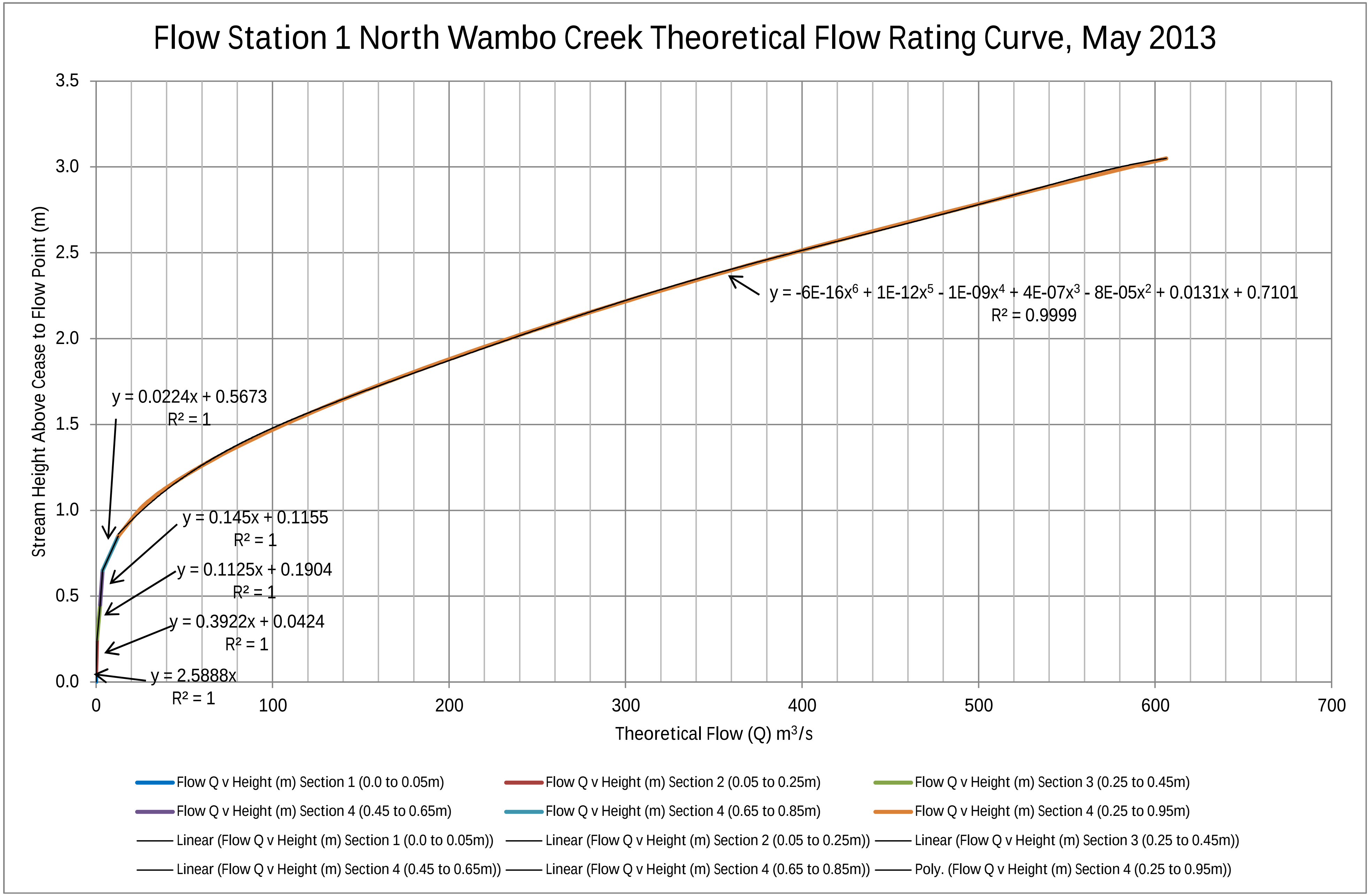
Flow Monitoring Station North Wambo Creek Up Stream of Flow Monitoring Station 1, Long Section Profile Through Cease to Flow Point, January 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
Stream Depth (m)
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1
3.3
3.5
y = 0.0075x + 2.3392
R² = 0.1347
Cease to Flow Point
Long Section
Linear (Long Section)

Flow Monitoring Station North Wambo Creek Upstream of Flow Monitoring Station 1 Theorectical Flow Rating Curve, January 2018





Flow Station 1 North Wambo Creek Stream Bed Cross Section Profile,
May 2013
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Cease to Flow Point
Stream Depth (m)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
Stream Width (m)
Stream Profile, Depth v Width

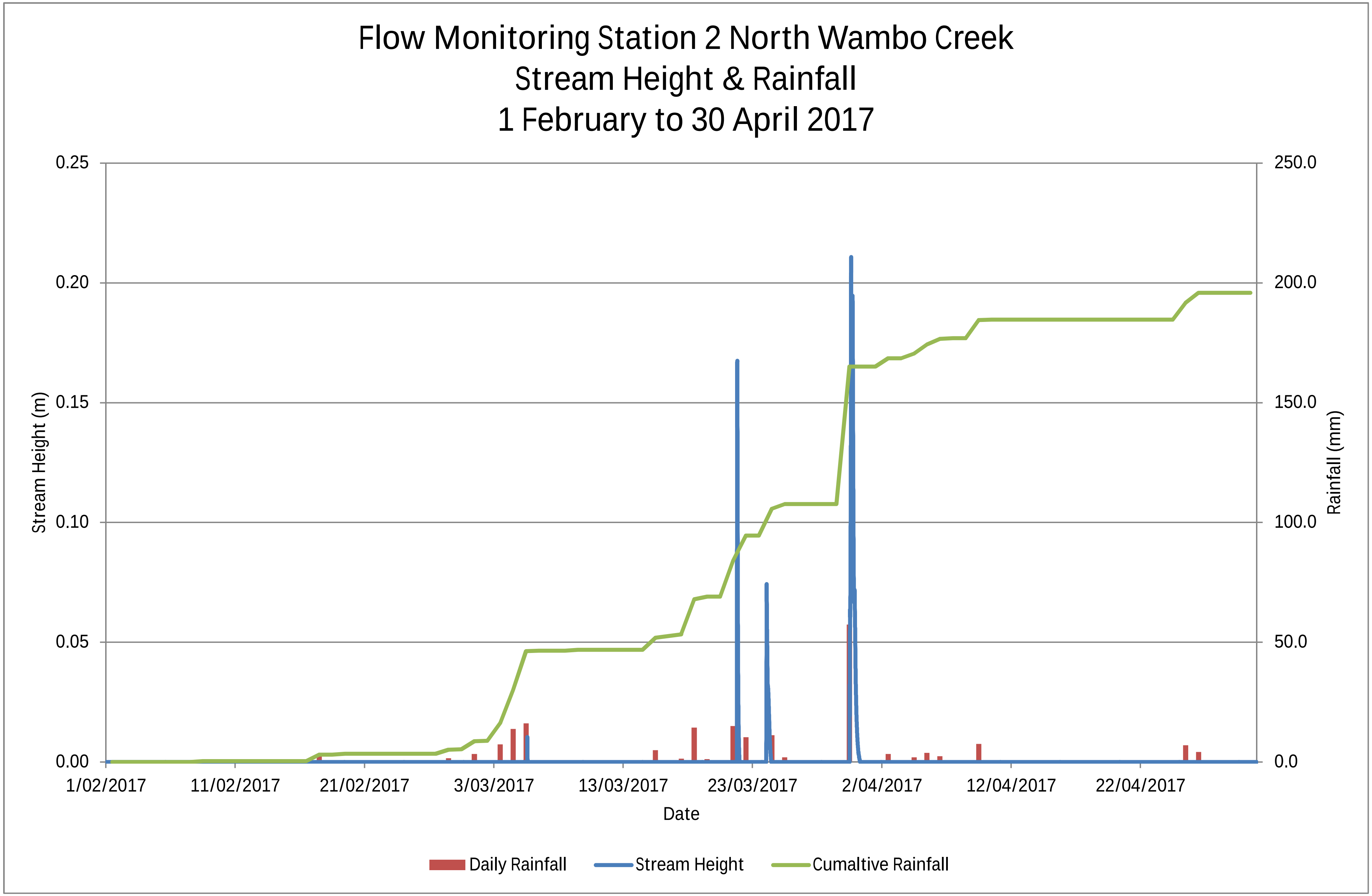


Flow Station 1 North Wambo Creek Theoretical Flow Rating Curve, May 2013
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0
100
200
300
400
500
600
700
y = -6E-16x⁶ + 1E-12x⁵ - 1E-09x⁴ + 4E-07x³ - 8E-05x² + 0.0131x + 0.7101
R² = 0.9999
y = 0.0224x + 0.5673
R² = 1
y = 0.145x + 0.1155
R² = 1
y = 0.1125x + 0.1904
R² = 1
y = 0.3922x + 0.0424
R² = 1
y = 2.5888x
R² = 1
Flow Q v Height (m) Section 1 (0.0 to 0.05m)
Flow Q v Height (m) Section 2 (0.05 to 0.25m)
Flow Q v Height (m) Section 3 (0.25 to 0.45m)
Flow Q v Height (m) Section 4 (0.45 to 0.65m)
Flow Q v Height (m) Section 4 (0.65 to 0.85m)
Flow Q v Height (m) Section 4 (0.25 to 0.95m)
Linear (Flow Q v Height (m) Section 1 (0.0 to 0.05m))
Linear (Flow Q v Height (m) Section 2 (0.05 to 0.25m))
Linear (Flow Q v Height (m) Section 3 (0.25 to 0.45m))
Linear (Flow Q v Height (m) Section 4 (0.45 to 0.65m))
Linear (Flow Q v Height (m) Section 4 (0.65 to 0.85m))
Poly. (Flow Q v Height (m) Section 4 (0.25 to 0.95m))

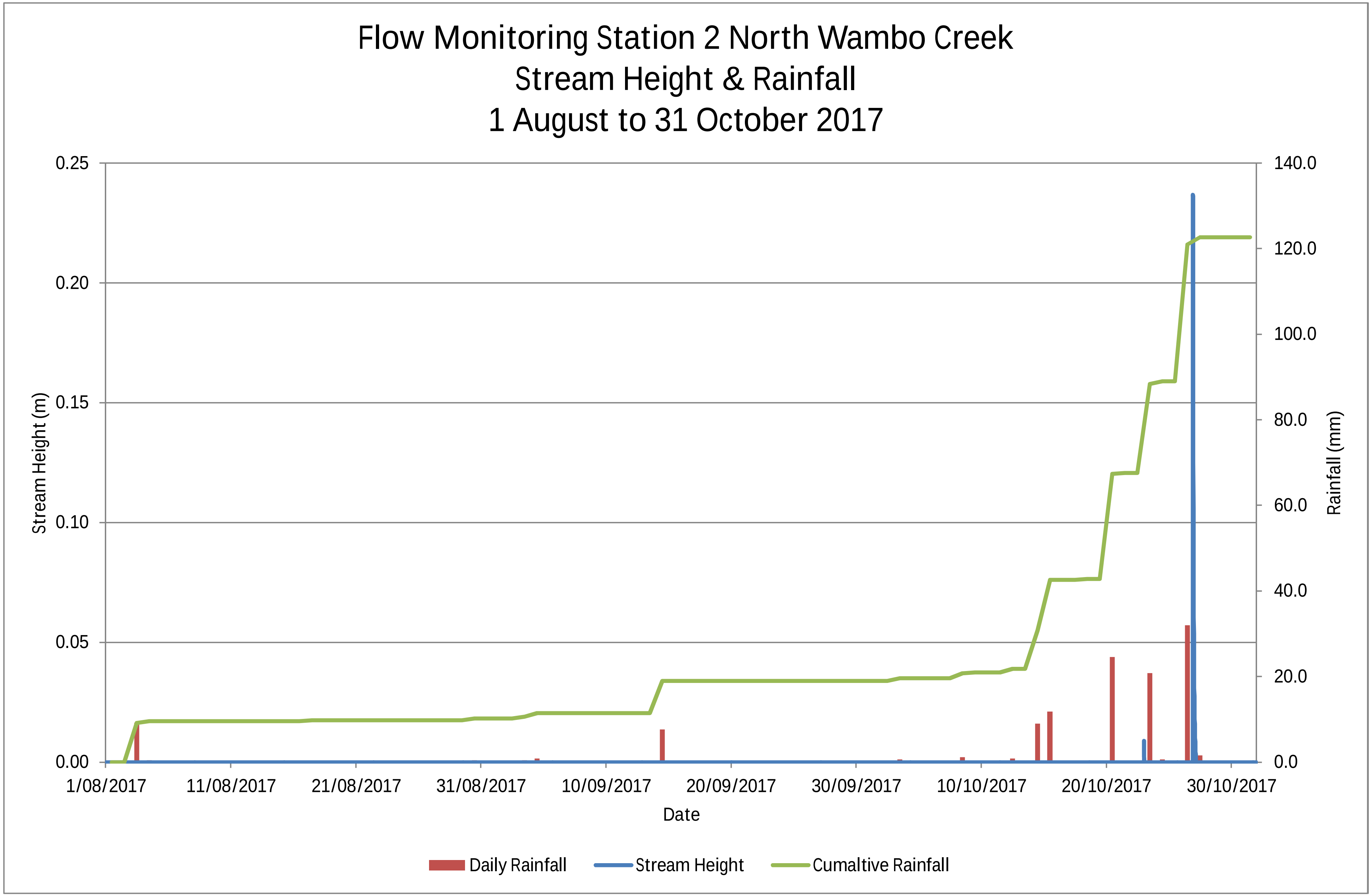
Appendix C

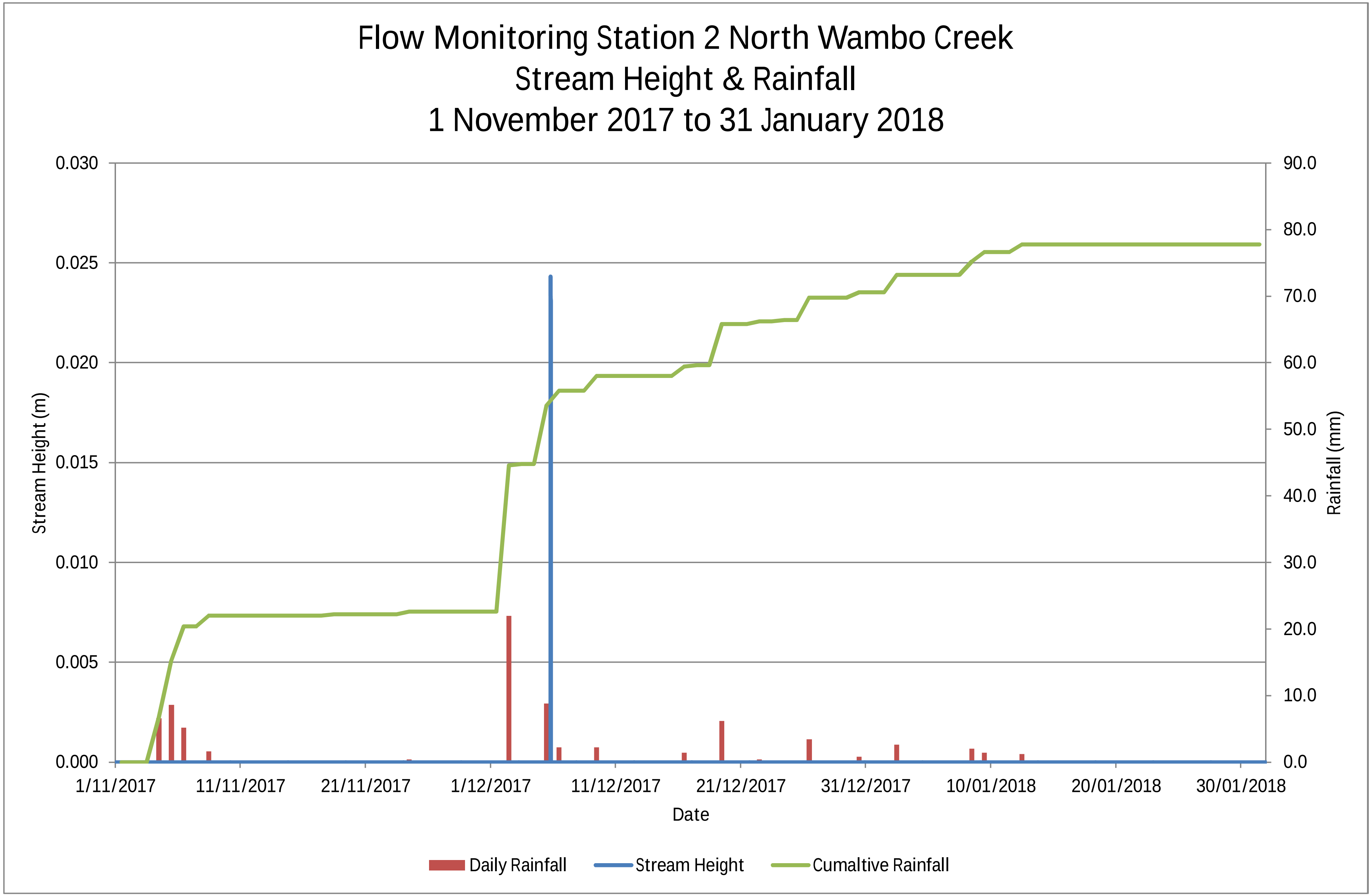
Stream Height, Theoretical Flow, Daily and Cumulative Rainfall Charts

This page has been left blank intentionally.

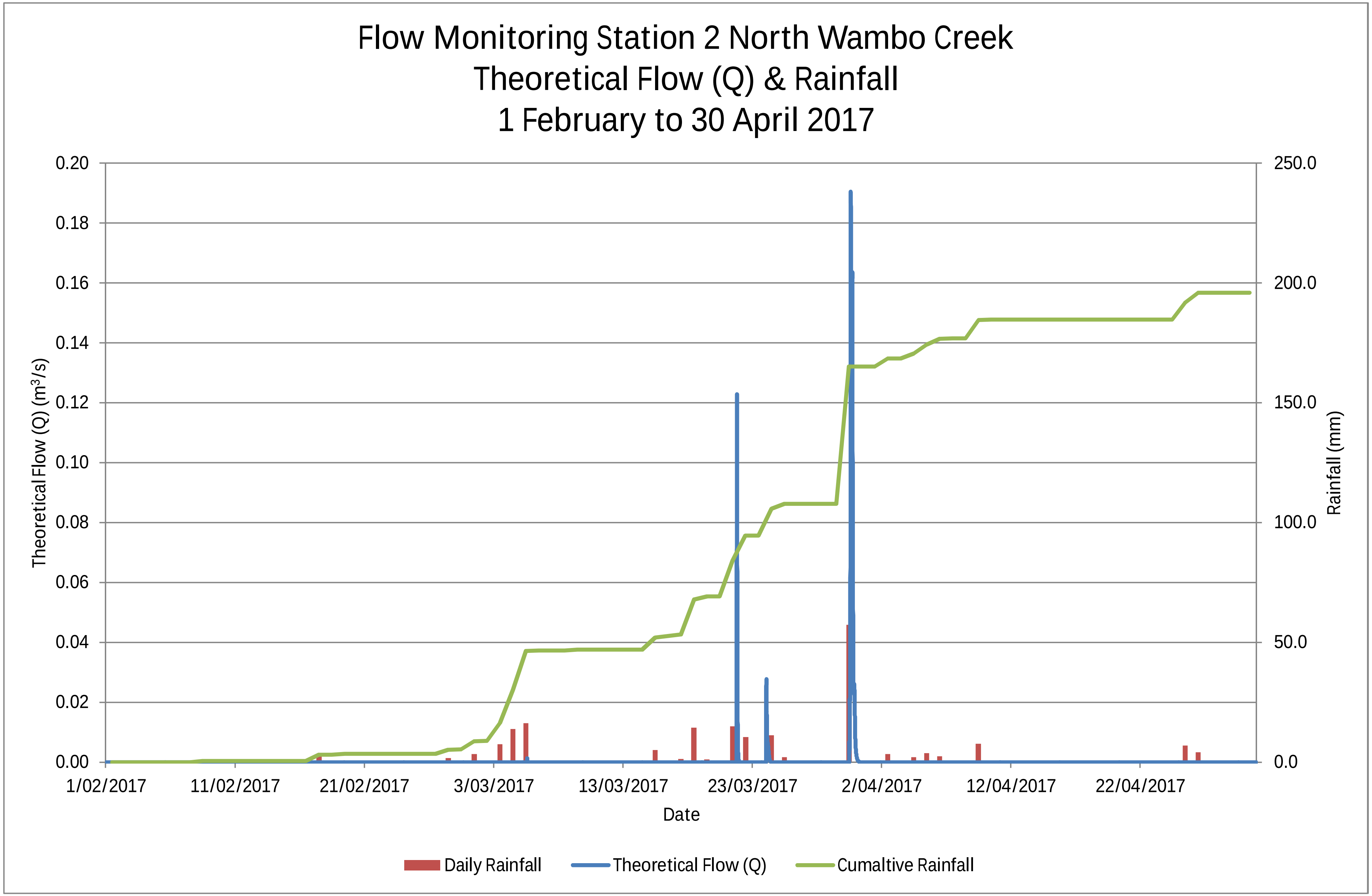


Flow Monitoring Station 2 North Wambo Creek
Stream Height & Rainfall
1 February to 30 April 2017
0.25
0.20
0.15
0.10
0.05
0.00
Stream Height (m)
250.0
200.0
150.0
100.0
50.0
0.0
Rainfall (mm)
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

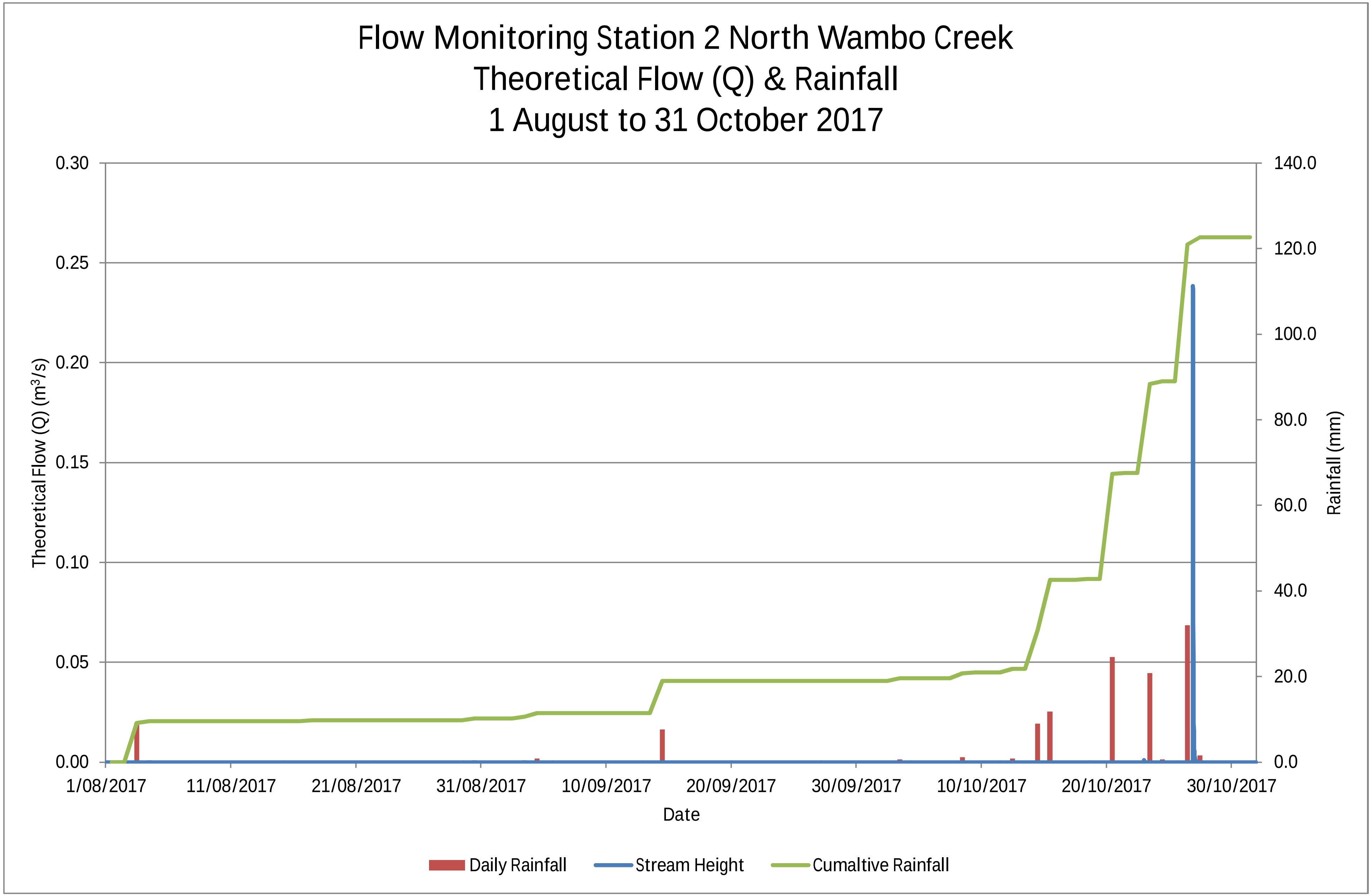

Flow Monitoring Station 2 North Wambo Creek
Stream Height & Rainfall
1 August to 31 October 2017
Stream Height (m)
0.25
0.20
0.15
0.10
0.05
0.00
Rainfall (mm)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/08/2017
11/08/2017
21/08/2017
31/08/2017
10/09/2017
20/09/2017
30/09/2017
10/10/2017
20/10/2017
30/10/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

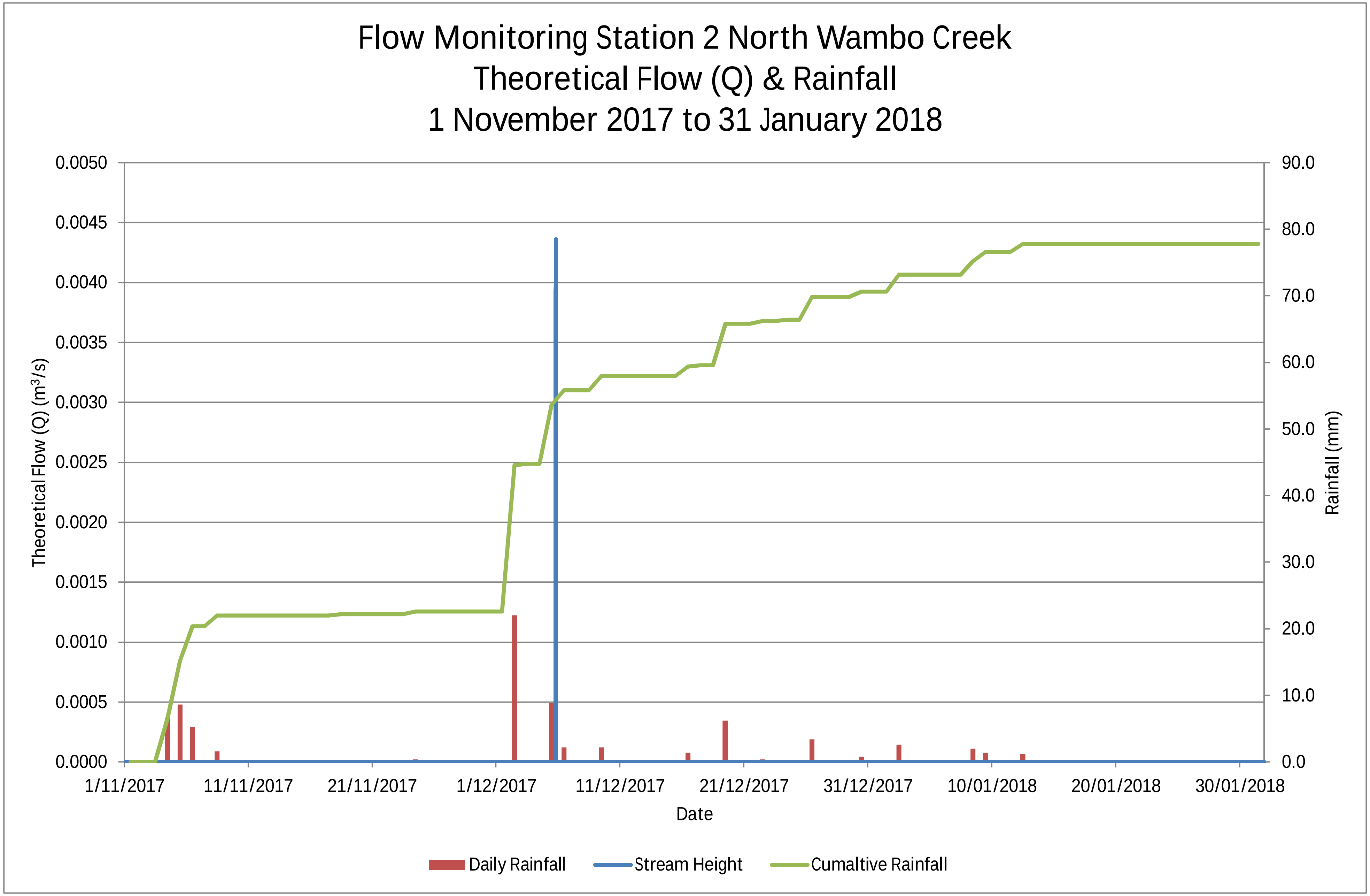


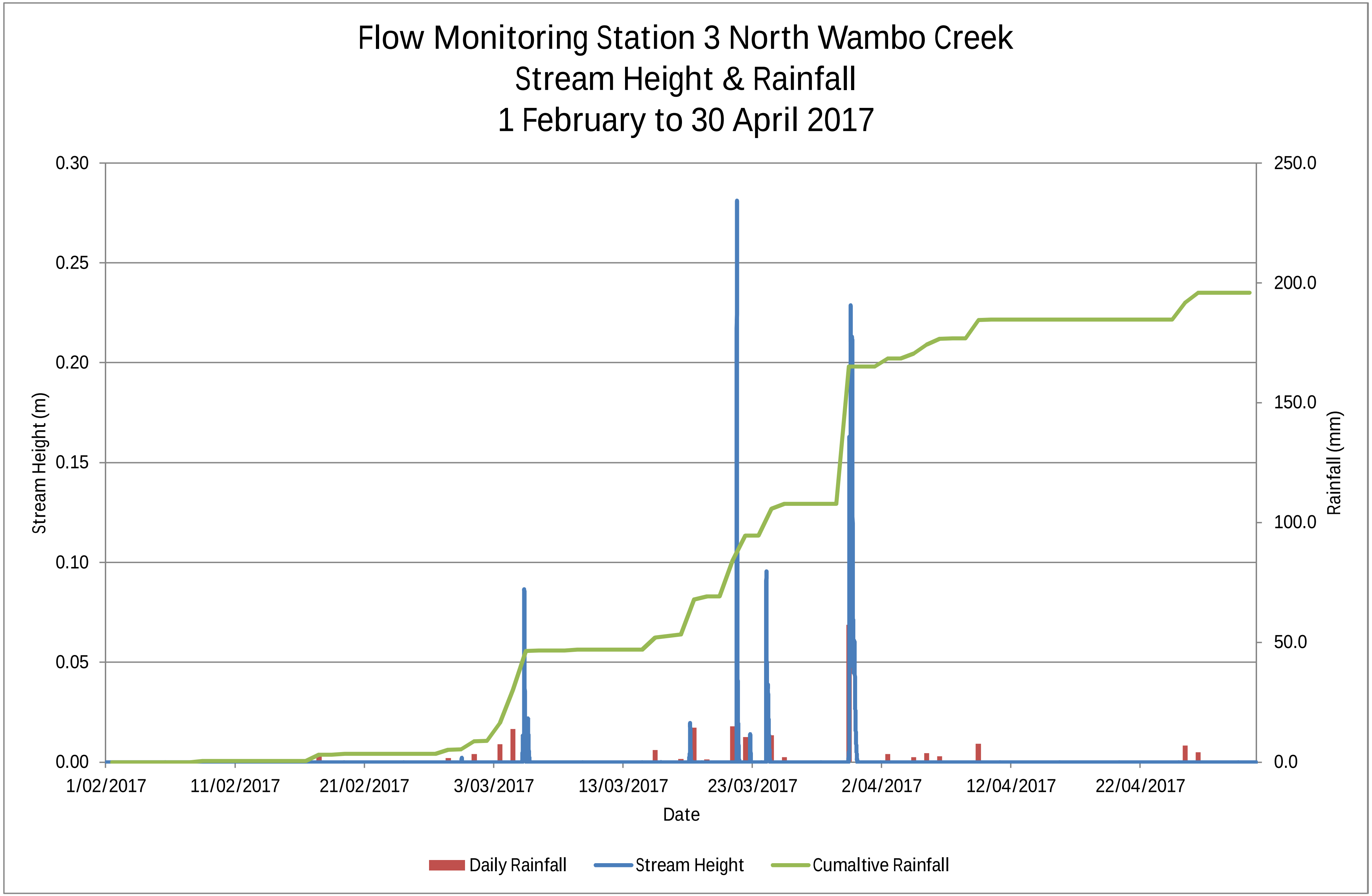
Flow Monitoring Station 2 North Wambo Creek
Stream Height & Rainfall
1 November 2017 to 31 January 2018
Stream Height (m)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Rainfall (mm)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1/11/2017
11/11/2017
21/11/2017
1/12/2017
11/12/2017
21/12/2017
31/12/2017
10/01/2018
20/01/2018
30/01/2018
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall



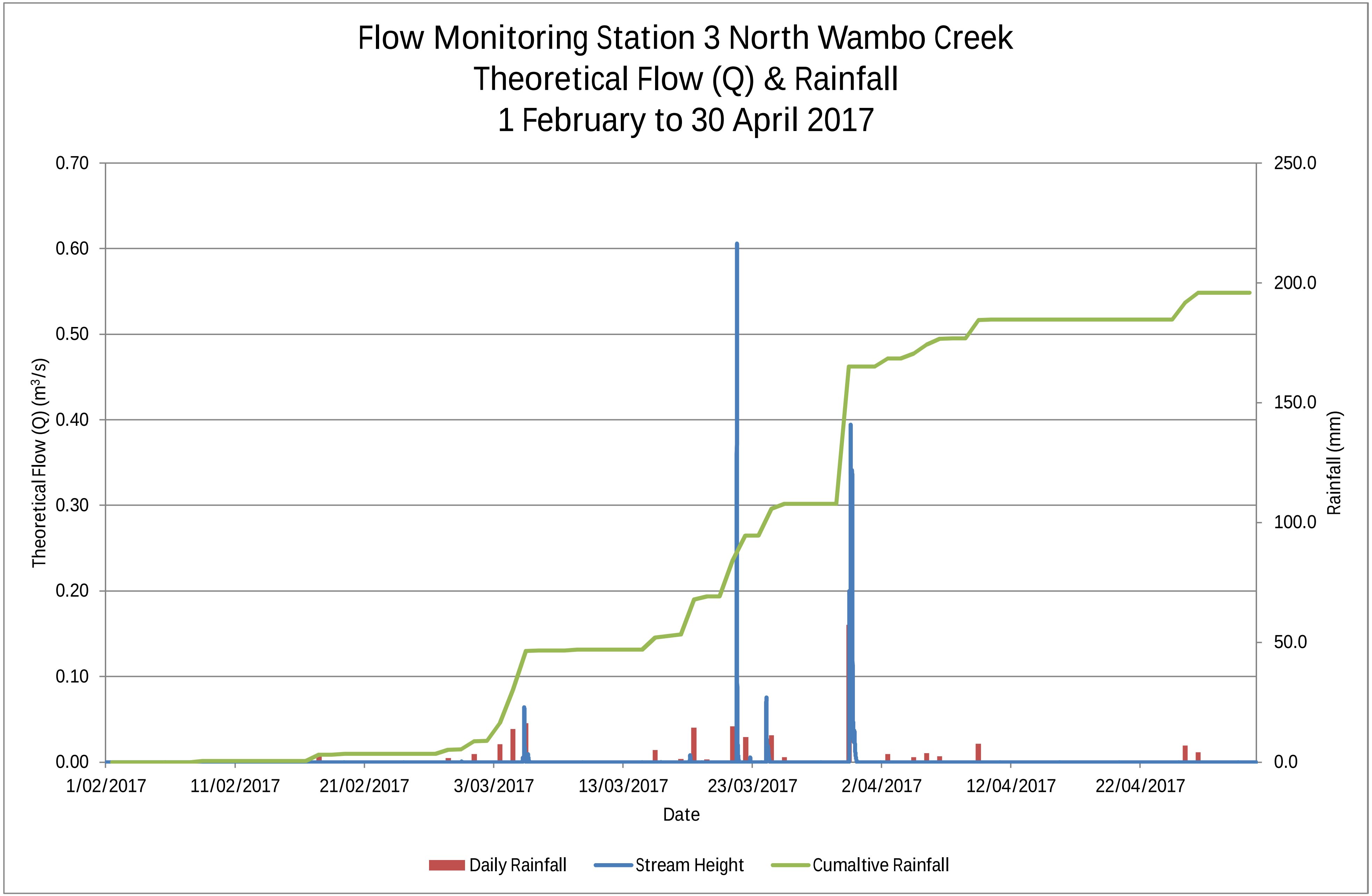
Flow Monitoring Station 2 North Wambo Creek
Theoretical Flow (Q) & Rainfall
1 February to 30 April 2017
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Theoretical Flow (Q) (m³/s)
250.0
200.0
150.0
100.0
50.0
0.0
Rainfall (mm)
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Date
Daily Rainfall
Theoretical Flow (Q)
Cumaltive Rainfall


Flow Monitoring Station 2 North Wambo Creek
Theoretical Flow (Q) & Rainfall
1 August to 31 October 2017
Theoretical Flow (Q) (m³/s)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Rainfall (mm)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/08/2017
11/08/2017
21/08/2017
31/08/2017
10/09/2017
20/09/2017
30/09/2017
10/10/2017
20/10/2017
30/10/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

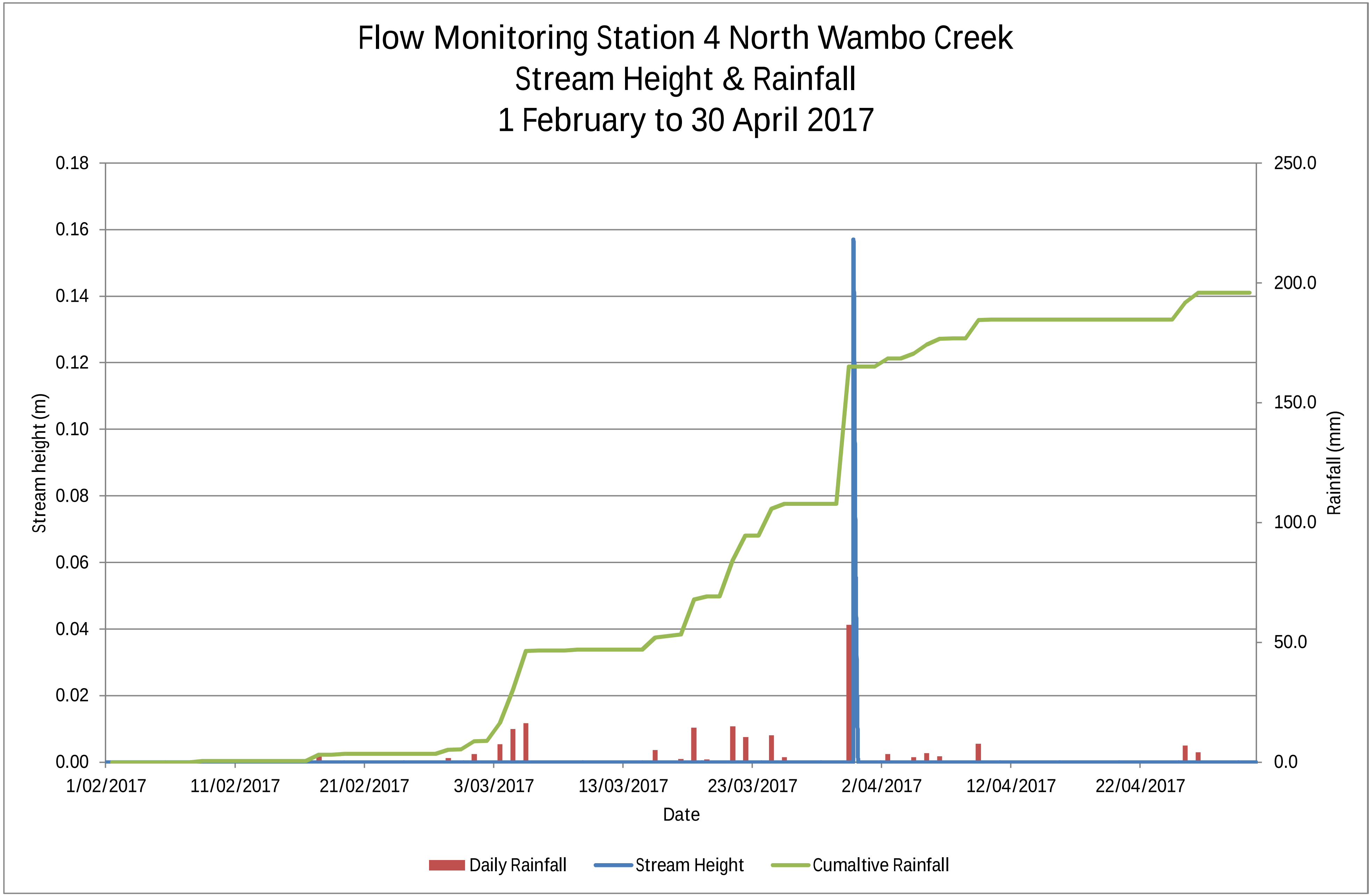

Flow Monitoring Station 2 North Wambo Creek
Theoretical Flow (Q) & Rainfall
1 November 2017 to 31 January 2018
Theoretical Flow (Q) (m³/s)
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Rainfall (mm)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1/11/2017
11/11/2017
21/11/2017
1/12/2017
11/12/2017
21/12/2017
31/12/2017
10/01/2018
20/01/2018
30/01/2018
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

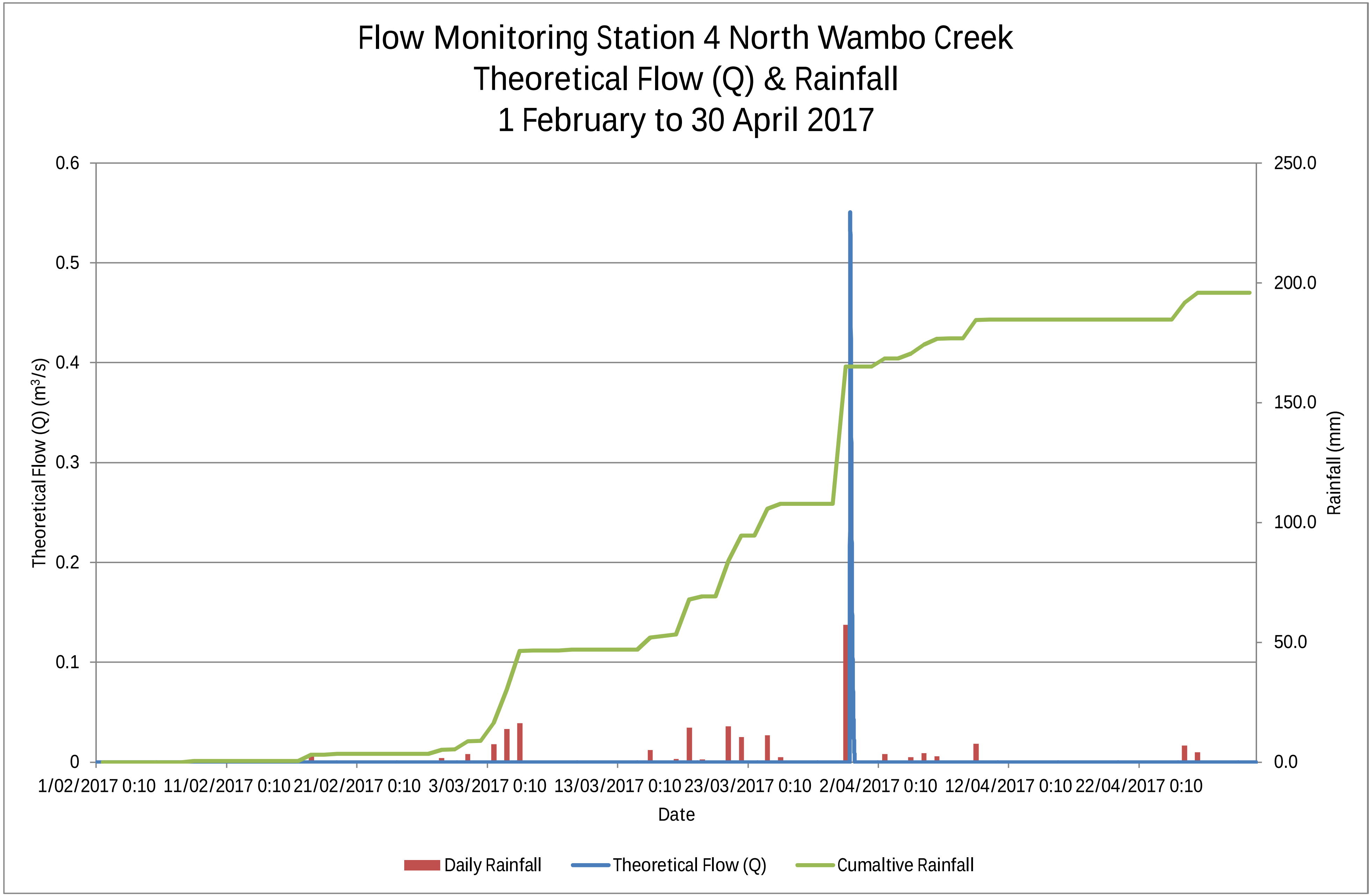


Flow Monitoring Station 3 North Wambo Creek
Stream Height & Rainfall
1 February to 30 April 2017
Stream Height (m)
Rainfall (mm)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
250.0
200.0
150.0
100.0
50.0
0.0
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

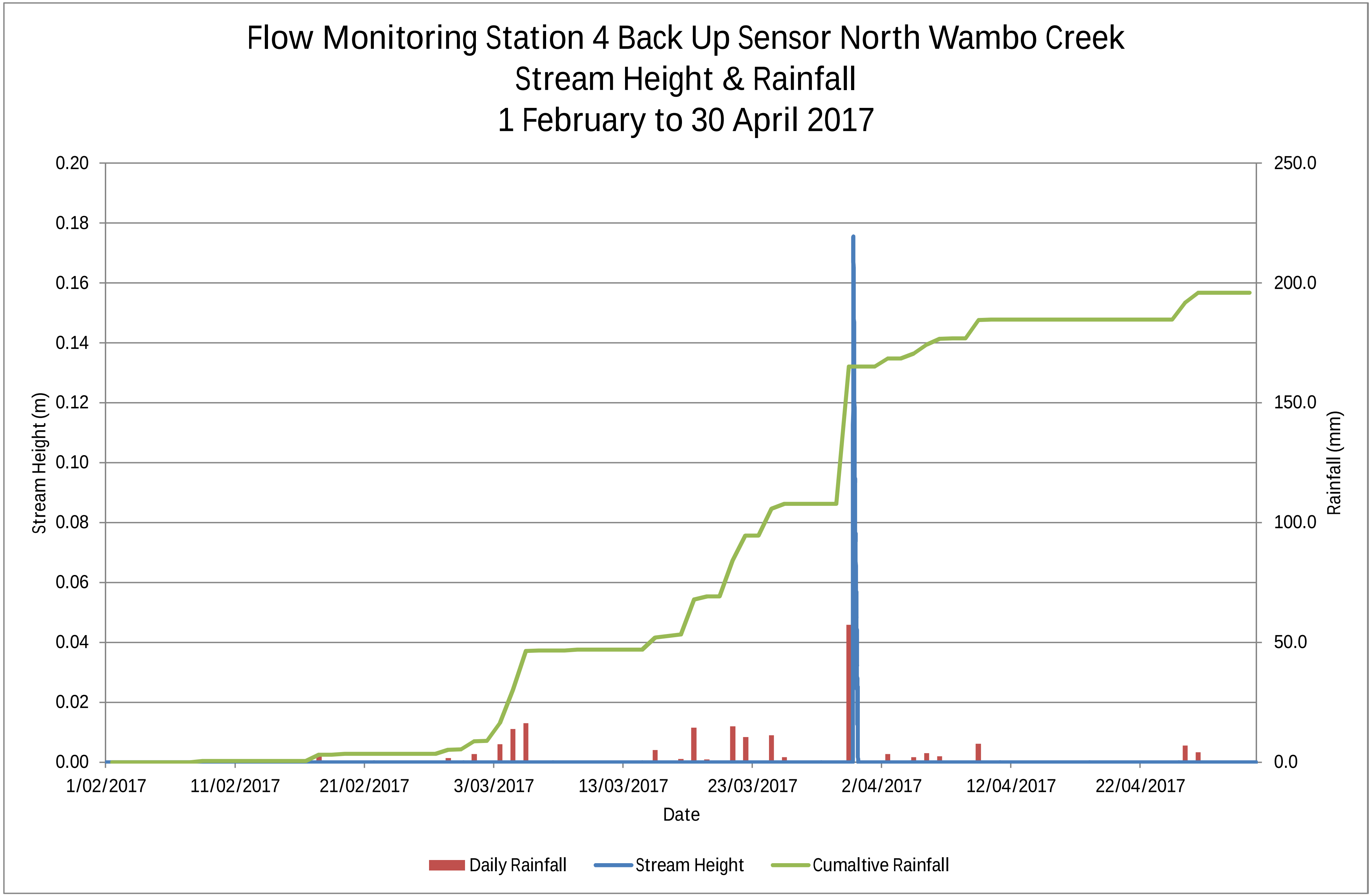


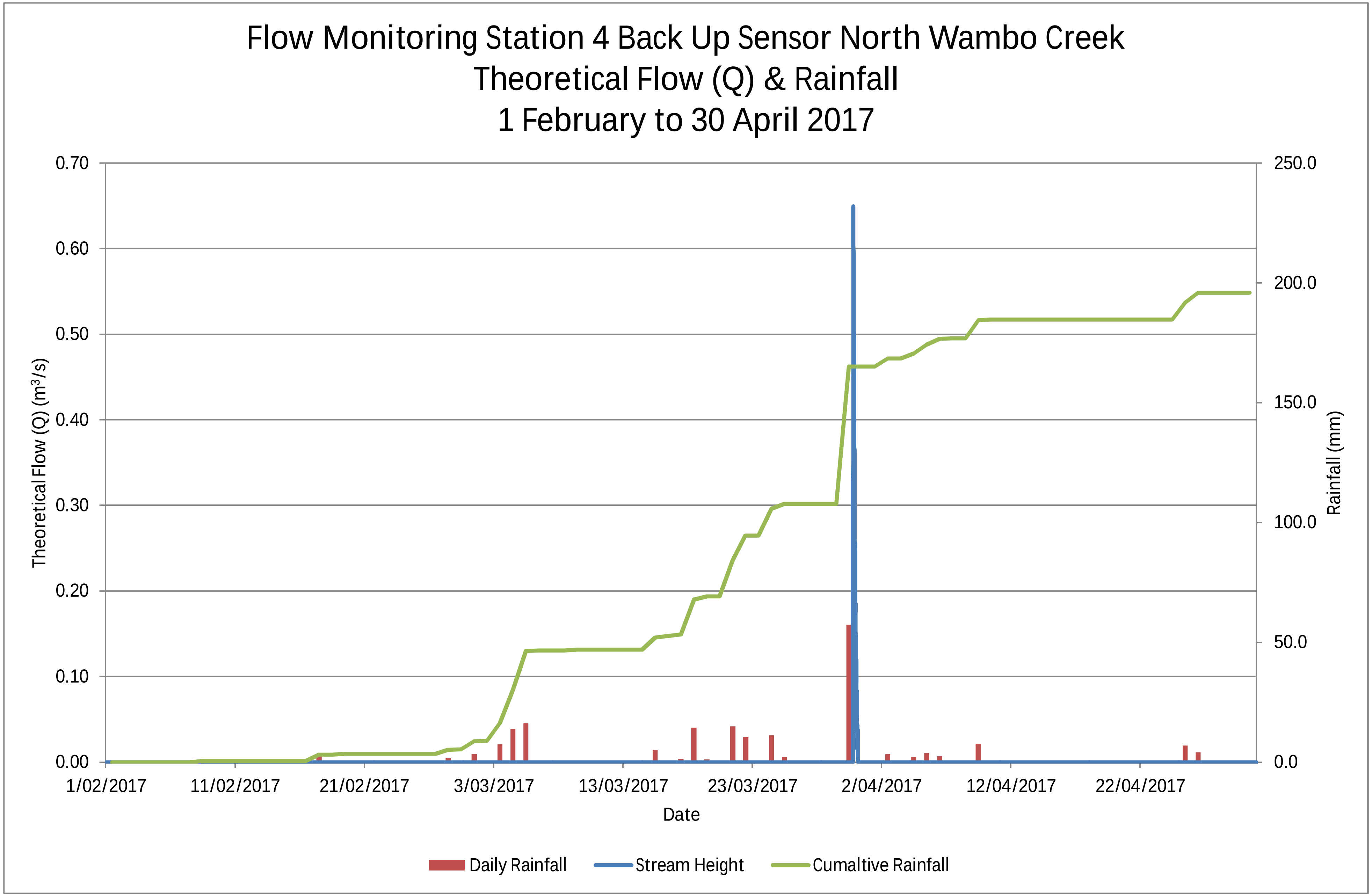
Flow Monitoring Station 3 North Wambo Creek
Theoretical Flow (Q) & Rainfall
1 February to 30 April 2017
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
250.0
200.0
150.0
100.0
50.0
0.0
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

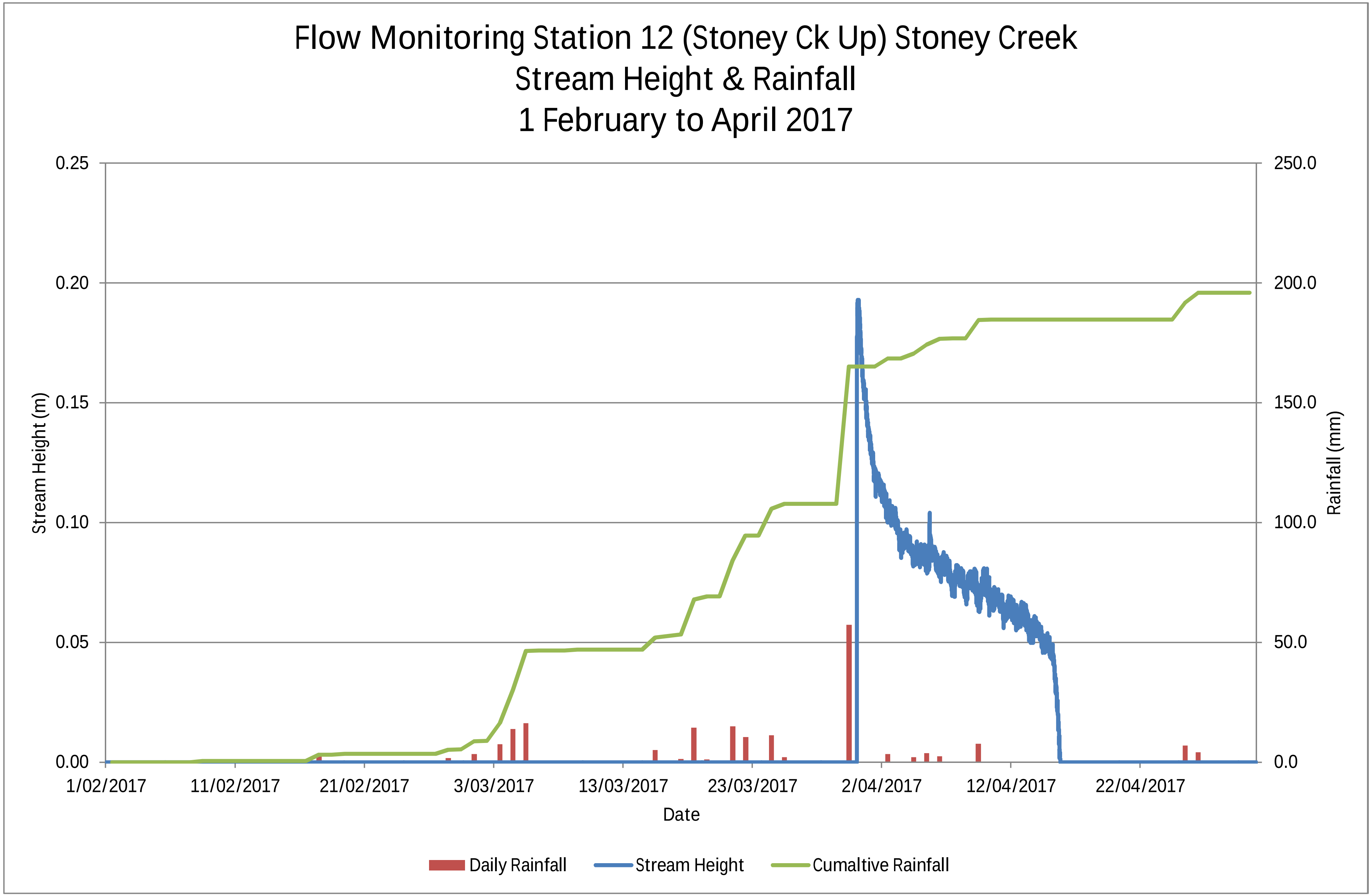

Flow Monitoring Station 4 North Wambo Creek
Stream Height & Rainfall
1 February to 30 April 2017
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Stream height (m)
250.0
200.0
150.0
100.0
50.0
0.0
Rainfall (mm)
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

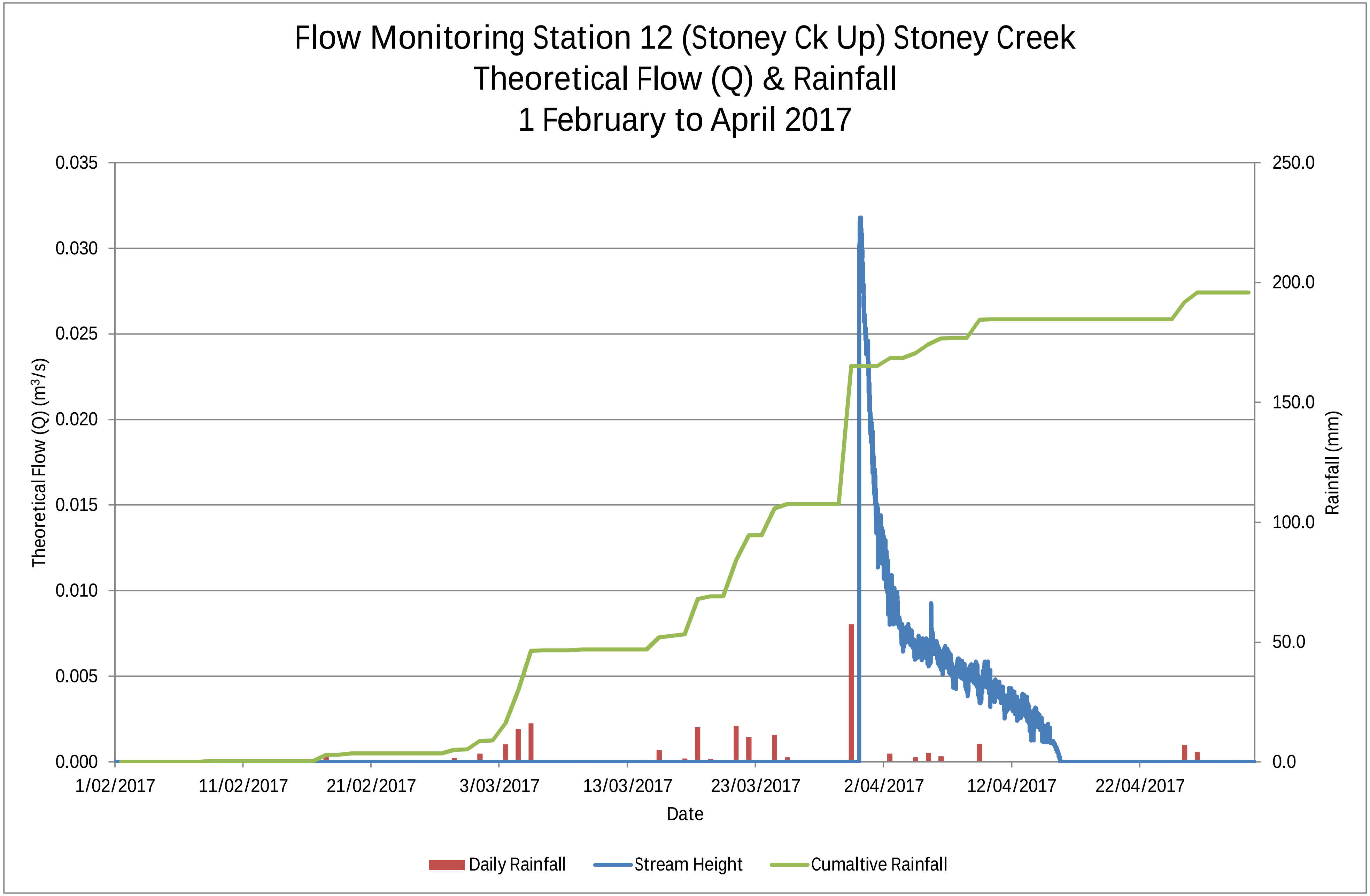


Flow Monitoring Station 4 North Wambo Creek
Theoretical Flow (Q) & Rainfall
1 February to 30 April 2017
Theoretical Flow (Q) (m³/s)
0.6
0.5
0.4
0.3
0.2
0.1
0
Rainfall (mm)
250.0
200.0
150.0
100.0
50.0
0.0
1/02/2017 0:10
11/02/2017 0:10
21/02/2017 0:10
3/03/2017 0:10
13/03/2017 0:10
23/03/2017 0:10
2/04/2017 0:10
12/04/2017 0:10
22/04/2017 0:10
Date
Daily Rainfall
Theoretical Flow (Q)
Cumaltive Rainfall


Flow Monitoring Station 4 Back Up Sensor North Wambo Creek
Stream Height & Rainfall
1 February to 30 April 2017
Stream Height (m)
Rainfall (mm)
Date
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.0
50.0
100.0
150.0
200.0
250.0
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Daily Rainfall
Stream Height
Cumaltive Rainfall


Flow Monitoring Station 4 Back Up Sensor North Wambo Creek
Theoretical Flow (Q) & Rainfall
1 February to 30 April 2017
Theoretical Flow (Q) (m³/s)
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Rainfall (mm)
250.0
200.0
150.0
100.0
50.0
0.0
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall


Flow Monitoring Station 12 (Stoney Ck Up) Stoney Creek
Stream Height & Rainfall
1 February to April 2017
Stream Height (m)
Rainfall (mm)
0.25
0.20
0.15
0.10
0.05
0.00
250.0
200.0
150.0
100.0
50.0
0.0
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall



Flow Monitoring Station 12 (Stoney Ck Up) Stoney Creek
Theoretical Flow (Q) & Rainfall
1 February to April 2017
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
250.0
200.0
150.0
100.0
50.0
0.0
1/02/2017
11/02/2017
21/02/2017
3/03/2017
13/03/2017
23/03/2017
2/04/2017
12/04/2017
22/04/2017
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

APPENDIX H

WAMBO COAL PTY LTD
2017 ANNUAL COMPLIANCE REPORT
(EPBC 2016/7636)

WAMBO COAL PTY LTD
2017 ANNUAL COMPLIANCE REPORT

(EPBC 2016/7636)

1 January – 31 December 2017

Document Control

Title	Wambo Coal 2017 Annual Compliance Report (EPBC 2016/7636)
General Description	Review of compliance with the conditions of EPBC 2016/7636
Document Owner	Environment & Community Manager

Revisions

Rev No	Date	Description	By	Checked	Signature
1	March 2018	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 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 noncompliance 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.*

Table 1 provides a reconciliation of the conditions of EPBC 2016/7636 and their compliance status.

Table 1: EPBC (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 1, 2 and 2A of schedule 3 of the **state development consent** to minimise the impacts of the action on **protected matters**.	Compliant	WCPL implements Conditions 1, 2 and 2A, Schedule 3 of the Development Consent (DA305-7-2003).
c. Implement environmental performance conditions 22 - 41A and 44-·-50 in Schedule 4 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 22 to 41A, Schedule 4 and Conditions 44 to 50, Schedule 4 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 act on 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 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**.	Compliant	The WCPL 2017 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 must be approved by the **Minister** prior to the commencement of the audit. Audit criteria must be agreed to by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister**.	Not applicable	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.